ACES 2014

A Community on Ecosystem Services
Linking Science, Practice and Decision Making

December 8-12, 2014 | Washington, DC

www.conference.ifas.ufl.edu/aces

USGS science for a changing world

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The Freshwater Trust

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EPRI ELECTRIC POWER RESEARCH INSTITUTE

ESP Ecosystem Services Partnership

esri

center for leadership in global sustainability VirginiaTech

FARE The Council on Food, Agricultural & Resource Economics

Duke NICHOLAS INSTITUTE FOR ENVIRONMENTAL POLICY SOLUTIONS

COMPASS

Welcome to ACES 2014!

On behalf of A Community on Ecosystem Services (ACES) and our partners in Ecosystem Markets and the Ecosystem Services Partnership (ESP), we welcome you to the ACES 2014 Conference! Ecosystem services science and practice continues to advance, and the ecosystem services community continues to expand. The ACES conference has grown along with the ecosystem services community and includes sessions addressing a broad range of topics, methods, and practices. ACES 2014 includes sessions on biophysical science and the production of ecosystem services, the interrelationship between human well-being and ecosystem services, the impacts of climate change on terrestrial and marine ecosystems and services, monetary and non-monetary valuation techniques, the development of market-like structures, and the role of Traditional Ecological Knowledge.

ACES 2014 extends over five days and will include 15 pre-conference workshops, six plenary sessions, 14 town halls, as well as hundreds of oral presentations and posters. ACES continues to include the research, resource management, conservation, entrepreneur, policy, and Native American communities in government, non-profits, academia, and the private sector. There will be over 500 participants at ACES 2014 from over 30 nations, including leaders from all levels of government, NGO's, academia, and the private sector.

ACES 2014 has a track of sessions focused on ecosystem services and federal policy, organized by COMPASS, with guidance from the Executive Office of the President. Also of note will be presentations and posters from around the world including developing countries, and on topics related to urban ecosystem services and their valuation. This conference will once again provide a venue for synthesizing the research, methods, tools, policies, and cultural values needed to more routinely and effectively incorporate ecosystem services into resource management, conservation, restoration, and development decisions.

We wish to thank the partners and the Planning and Program Committee members for their exceptional efforts to make ACES 2014 a success. Their insights and support are greatly appreciated, and this conference could not have happened without them. In particular, we are grateful for the continued outstanding efforts of the staff of the University of Florida, IFAS Office of Conferences and Institutes in organizing the logistics and making this conference possible, and the strong leadership of Jasmine Garcia and Jhanna Gilbert in this endeavor.

We anticipate that ACES 2014 will provide many opportunities to share science advances and state-of-the-art practices and to continue the dialogue and information sharing within the ecosystem services community. As always, we encourage you to attend sessions that are outside of your field, network, meet old friends, and establish new interdisciplinary relationships.

Thank you for attending ACES 2014!

Frank Casey, Ph.D.
Planning Committee Chair
Ecosystem Services Theme Lead
Science and Decisions Center
Energy Minerals and Environmental Health
U.S. Geological Survey

Dianna M. Hogan, Ph.D.
Program Committee Chair
Research Physical Scientist
Eastern Geographic Science Center and
Science and Decisions Center Affiliate
U.S. Geological Survey

Table of Contents

Welcome Letter i

Planning Committee v

Conference Partner Recognition vii

Detailed Program Agenda viii

Topical Poster Locator xxx

Poster & Exhibit Room Floor Plan xxxi

Poster Directory xxxii

Conference Abstracts 1

Author Index 367

Late Abstract Submissions 377

Notes 380

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A Special Thank You to Our Conference Partners

Cascadia Ecosystem Services Partnership

COMPASS

Council on Food, Agricultural and Resource Economics

Defenders of Wildlife

Duke University, Nicholas Institute for Environmental Policy Solutions

Ecosystem Services Partnership

Electric Power Research Institute

ENVIRON International Corporation

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Esri

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RTI International

The Freshwater Trust

U.S. Department of Agriculture, Office of Environmental Markets

U.S. Department of the Interior, Bureau of Land Management

U.S. Environmental Protection Agency

U.S. Forest Service

U.S. Geological Survey

University of Florida, Institute of Food and Agricultural Sciences

Virginia Tech Center for Leadership in Global Sustainability

World Resources Institute

Detailed Program Agenda

Sunday	***Sunday, December 7, 2014***			
5:00pm-7:00pm	Pre-Conference Registration Open - *Skyview Lounge* Early Exhibitor Move-In and Poster Set-Up - *Arlington Ballroom Salons 1-3*			
Monday	***Monday, December 8, 2014***			
7:00am-5:00pm	Conference Registration Open - *Skyview Lounge*			
7:00am-8:00am	**Morning Refreshments and Exhibit/Poster Set-Up** - *Arlington Ballroom Salons 1-3*			
8:00am-8:00pm	Ad Hoc Space Available - *Jefferson, Madison, Jackson Rooms (Lobby Level)*			
	Morning Pre-Conference Workshops			
8:00am-11:30am	**Workshop 1-AM**	**Workshop 2-AM**	**Workshop 3-AM**	**Workshop 4-AM**
Location	**Grand Ballroom Salon A**	**Grand Ballroom Salon B**	**Grand Ballroom Salon C**	**Grand Ballroom Salon D-E**
Organizer	**Lydia Olander**, Duke University, National Ecosystem Services Partnership	**Joseph Nicolette & Lionel Camus**, ENVIRON International Corp. & Fram Centre	**Leah Harris Palm-Forster**, Michigan State University	**Katie Riley & Jeremy Sokulsky**, Environmental Incentives, LLC
8:00am-9:30am	**Methods for Incorporating Ecosystem Services into Planning and Decision-Making** *All-Day Workshop*	**Ecosystem Services, Climate Change, and the Arctic Environment**	**Coordinated Approaches to Enhance Ecosystem Services in Watersheds Dominated by Agriculture**	**Designing Performance-Driven Ecosystem Service Programs**
9:30am-10:00am	**AM Break -** *Arlington Ballroom Salons 1-3*			
10:00am-11:30am	AM Workshop Continued	AM Workshop Continued	AM Workshop Continued	AM Workshop Continued
11:30am-1:00pm	**Lunch Break - On Own**			
11:45am-12:45pm	**Public Listening Session** - *Grand Ballroom Salon A*			
	Coastal Green Infrastructure for Climate Resilience: Developing a Federal Research Agenda **Moderators** **Anne Kinsinger**, Associate Director for Ecosystems, U.S. Geological Survey **Hannah Safford**, SINSI Fellow, White House Office of Science and Technology Policy **David Yoskowitz**, Chief Economist, NOAA Stakeholders are invited to provide individual input to help inform the development of a Federal research agenda on the role of coastal green infrastructure in enhancing climate resilience.			
	Afternoon Pre-Conference Workshops			
1:00pm-4:30pm	**Workshop 1-PM**	**Workshop 2-PM**	**Workshop 3-PM**	**Workshop 4-PM**
Location	**Grand Ballroom Salon A**	**Grand Ballroom Salon B**	**Grand Ballroom Salon C**	**Grand Ballroom Salon D-E**
Organizer	**Lydia Olander**, Duke University, National Ecosystem Services Partnership	**Carrie Sanneman**, Willamette Partnership	**Alex Echols**, Sand County Foundation	**Stacy Small-Lorenz**, Environmental Defense Fund
1:00pm-2:30pm	***Continued*: Methods for Incorporating Ecosystem Services into Planning and Decision-Making** *All-Day Workshop*	**Best Practice in Program Design: Key Decisions in Building Ecosystem Service Payment, Incentive, or Trading Programs that Work**	**Improving Ecosystem Services from Agricultural Lands: Modern Technology and Markets**	**Getting Better Biodiversity Outcomes From Coordinated Environmental Markets**
2:30pm-3:00pm	**PM Break -** *Arlington Ballroom Salons 1-3*			
3:00pm-4:30pm	PM Workshop Continued	PM Workshop Continued	PM Workshop Continued	PM Workshop Continued
	Workshops Conclude			
	Monday Evening Town Hall Meetings			
4:45pm-5:50pm	**Habitat Exchange Mock Transaction**		**Integrating the Value of Nature into Business Decisions**	
Location	**Grand Ballroom Salons D-E**		**Grand Ballroom Salons F-G**	
Organizer	**Katie Riley & Jeremy Sokulsky, Environmental Incentives, LLC**		**Sheila Walsh Reddy, The Nature Conservancy**	
12:15pm-12:20pm	**Introduction & Overview**		**Introduction & Overview**	
12:20pm- 1:20pm	**Town Hall Discussion**		**Town Hall Discussion**	
6:00pm-7:00pm	**Welcome Happy Hour Social - Hotel Lounge/ Atrium**			

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	Morning Pre-Conference Workshops			
8:00am-11:30am	**Workshop 5-AM**	**Workshop 6-AM**	**Workshop 7-AM**	**Workshop 8-AM**
Location	**Grand Ballroom Salon F-G**	**Grand Ballroom Salon H**	**Grand Ballroom Salon J**	**Grand Ballroom Salon K**
Organizer	**Amy Rosenthal**, Natural Capital Project - World Wildlife Fund	**Marilyn Buchholtz ten Brink**, Interagency Working Group on Ocean Social Sciences, US EPA	**Constance Best**, Pacific Forest Trust	**Douglas Bruggeman**, Ecological Services & Markets
8:00am-9:30am	**Back to the Future: Scenario Development for Ecosystem Services** *(participants encouraged to bring own laptop)*	**Incorporating Ecosystem Services Concepts and Measures into Coastal, Marine and Great Lakes Management**	**The Forest Carbon Offset Market Comes of Age: Lessons from the Launch of California's Landmark Climate Action Program**	**Modeling Species Banking at a Landscape-Scale** *(participants must provide own PC laptop)*
9:30am-10:00am	**AM Break** - *Arlington Ballroom Salons 1-3*			
10:00am-11:30am	AM Workshop Continued	AM Workshop Continued	AM Workshop Continued	AM Workshop Continued
11:30am-1:00pm	**Lunch Break - On Own**			
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	Afternoon Pre-Conference Workshops			
1:00pm-4:30pm	**Workshop 5-PM**	**Workshop 6-PM**	**Workshop 7-PM**	**Workshop 8-PM**
Location	**Grand Ballroom Salon F-G**	**Grand Ballroom Salon H**	**Grand Ballroom Salon J**	**Grand Ballroom Salon K**
Organizer	**Christine Feurt**, University of New England	**Timothy Boucher**, The Nature Conservancy	**Jeffrey Thomas**, Puyallup Tribe of Indians	**Jonathan Kochmer & Nora Wahlund**, Earth Economics
1:00pm-2:30pm	**Communicating Ecosystem Services Using Collaborative Learning and Mental Models**	**Natural Infrastructure: Reducing Risks and Generating Co-Benefits Along Coastlines and in Floodplains**	**Ecosystems and Community/ Tribal Social-Ecological Systems**	**Ecosystem Valuation Toolkit: Online Tools for Valuing Natural Capital** *(participants must provide own laptop)*
2:30pm-3:00pm	**PM Break** - *Arlington Ballroom Salons 1-3*			
3:00pm-4:30pm	PM Workshop Continued	PM Workshop Continued	PM Workshop Continued	PM Workshop Continued
	Workshops Conclude			
	Monday Evening Town Hall Meetings			
4:45pm-5:50pm	**Habitat Exchange Mock Transaction**		**Integrating the Value of Nature into Business Decisions**	
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12:15pm-12:20pm	**Introduction & Overview**		**Introduction & Overview**	
12:20pm- 1:20pm	**Town Hall Discussion**		**Town Hall Discussion**	
6:00pm-7:00pm	**Welcome Happy Hour Social - Hotel Lounge/ Atrium**			

Program Agenda continues on the following page.

Tuesday	*Tuesday, December 9, 2014*	
7:00am-5:00pm	Conference Registration Open - *Skyview Lounge*	
7:00am-8:00am	**Morning Refreshments and Poster Set-Up** - *Arlington Ballroom Salons 1-3*	
8:00am-8:00pm	Ad Hoc Space Available - *Jefferson, Madison, Jackson Rooms (Lobby Level)*	
8:00am-10:00am	**Opening Plenary Session** - *Arlington Ballroom Salons 4-6*	
8:00am-8:10am	**Introductions and Announcements** **Frank Casey**, Science and Decisions Center, U.S. Geological Survey, ACES 2014 Conference Chair	
8:10am-8:40am	**ACES 2014 Welcome Addresses** **Suzette Kimball**, Acting Director, U.S. Geological Survey **Thomas Tidwell**, Chief, USDA Forest Service	
8:45am-10:00am	**Plenary Session 1** ***Ecosystem Services: Key Advances and Challenges in Linking Science, Practice, and Decision Making*** **Moderator: Mark Schaefer**, Global Fellow, Woodrow Wilson International Center for Scholars **Panel Members** **Ann M. Bartuska**, Deputy Under Secretary for Research, Education, and Economics, U.S. Department of Agriculture **William Ginn**, Executive Vice President, Global Conservation Initiative, The Nature Conservancy **Stephen Polasky**, Regents Professor and Fesler-Lampert Professor of Ecological & Environmental Economics, University of Minnesota **J.B. Ruhl**, David Daniels Allen Distinguished Chair of Law, Vanderbilt University **Steven L. Stockton**, Director of Civil Works, U.S. Army Corps of Engineers	
10:00am-10:30am	**AM Break -** *Arlington Ballroom Salons 1-3*	
10:30am-12:00pm	**Plenary Session** - *Arlington Ballroom Salons 4-6*	
	Plenary Session 2 ***Ecosystem Services and Public Policy: Status, Opportunities, and Challenges*** **Moderator: Lynn Scarlett**, Managing Director of Public Policy, The Nature Conservancy **Keynote Address - Sally Jewell**, Secretary, U.S. Department of the Interior **Remarks and Discussion** **Jay Jensen**, Associate Director for Land & Water Ecosystems, White House Council on Environmental Quality **Robert Bonnie**, Under Secretary for Natural Resources and Environment, U.S. Department of Agriculture	
12:00pm-1:30pm	**Boxed Lunch -** *Arlington Ballroom Salons 1-3*	
Tuesday Lunch Town Hall Meetings		
12:15pm-1:20pm	**Managing Agricultural Hydrology to Deploy Ecosystem Service Markets** *featuring presentation by Chief Jason Weller, USDA NRCS*	**Ecosystem Services and Municipal Planning: Engaging Local Decision-Makers**
Location	**Grand Ballroom Salons D-E**	**Grand Ballroom Salons F-G**
Organizer	**Alex Echols, Sand County Foundation**	**Coeli Hoover, US Forest Service**
12:15pm-12:20pm	**Introduction & Overview**	**Introduction & Overview**
12:20pm- 1:20pm	**Town Hall Discussion**	**Town Hall Discussion**

Tuesday	*Tuesday, December 9, 2014*			
	Concurrent Sessions - 1			
1:30pm-3:15pm	**Session 1A**	**Session 1B**	**Session 1C**	**Session 1D**
Location	**Grand Ballroom Salon A**	**Grand Ballroom Salon B**	**Grand Ballroom Salon C**	**Grand Ballroom Salon D-E**
	Ecosystem Services in Agriculture and Forestry	**Integrating Ecosystem Services Into Program Planning, Budget, Management, and Performance**	**Improving Ecosystem Services from Agricultural Lands**	**The Use of Citizen Science to Advance Ecosystem Services Implementation**
Moderator	**Robert Deal**	**Melanie Stansbury**	**Alex Echols**	**Dianna Hogan**
1:30pm-1:35pm	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
1:35pm-1:55pm	**Vitalie Gulca** The Role of Ecosystem Services in Forests of Developing and Developed Countries	**Panel Session** **Ann Bartuska,** U.S. Department of Agriculture **Sally Collins,** Independent Consultant **Olivia Ferriter,** U.S. Department of the Interior **Mark Schaefer,** Woodrow Wilson International Center for Scholars	**Dave White** Bringing DWM for Ecosystem Services to Market: Why DWM is Well Positioned to Enter Ecosystem Service Markets	**Pierre Glynn** Ecosystem Services and Citizen Science: A New Framework for Engagement
1:55pm-2:15pm	**Jeffrey Kline** Timber, Carbon Storage, and Habitat Production Possibilities		**Mark Kieser** Cost Comparison of DWM Ecosystem Service Delivery with Conventional Strategies	**Alexey Voinov** Values in Modeling: Making Ecosystem Services Operational
2:15pm-2:35pm	**Gary Bentrup** Designer Landscapes: Enhancing Ecosystem Services on Ag Lands		**Brian Hicks** Bringing Drainage Water Management for Ecosystem Services to Market: What Farmers Need To Participate	**Barbara Martinez** Citizen Science and Crowd-Sourced Data To Assess Cultural Goods and Services
2:35pm-2:55pm	**Jan Lewandrowski** Farm-Level Assessment of the Potential for Managing Crop Production Systems, Livestock Productions Systems, & Agricultural Land		**Andrew McElwaine** Bringing Agriculture and Municipalities Together to Improve the Environment and Save Money for Taxpayers	**Mattijs Van Maasakkers** Monitoring and Verification of Ecosystem Services Markets
2:55pm-3:15pm	**Dana Bauer** Pollination Services and Grower Decision Making		**Discussion and Q & A**	**Discussion and Q & A**
3:15pm-3:45pm	**PM Break -** *Arlington Ballroom Salons 1-3*			

Tuesday	*Tuesday, December 9, 2014*			
	Concurrent Sessions - 1			
1:30pm-3:15pm	**Session 1E**	**Session 1F**	**Session 1G**	**Session 1H**
Location	**Grand Ballroom Salon F-G**	**Grand Ballroom Salon H**	**Grand Ballroom Salon J**	**Grand Ballroom Salon K**
	Arctic Ecosystem Services and Climate Change	**Advancing the SEEA Experimental Ecosystem Accounting**	**How to Use Economic Valuation of Ecosystems to Inform Decision-Making**	**Cultural Implications for Ecosystem Services 1**
Moderator	**Lionel Camus & Nina Mari Jørgensen**	**Mark Eigenraam**	**Erin Gray**	**Paula Harrison**
1:30pm-1:35pm	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
1:35pm-1:55pm	**Claire Armstrong** Arctic Marine Ecosystem Services and Values	**Julian Chow** Overview of the SEEA Experimental Ecosystem Accounting	**Richard Waite** Making Ecosystem Valuation Count for Decision Making in the Caribbean	**Paul Ringold** Research Questions to Identify Ecological Indicators Most Useful for Linking Ecosystems and Human Well-Being
1:55pm-2:15pm	**Rolf Anker Ims** Ecosystem Services Provided by Terrestrial Habitats in the Arctic	**François Soulard** Ecosystem Accounting in Canada	**Peter Schuhmann** The Valuation of Marine Ecosystem Goods and Services in the Caribbean: A Literature Review and Framework for Future Valuation Efforts	**Joanna Piwowarczyk** Marine and Coastal Ecosystem Services in Daily Experiences of Citizens of Gulf of Gdansk, Southern Baltic
2:15pm-2:35pm	**Raychelle Daniel** Ecosystem Services in the Arctic from the Local Perspective and Future Challenges in Light of a Changing Environment	**Miroslav Honzák** Ecosystem Accounting in Peru	**David Gill** Assessment of the Economic Value of Reef Fishing and Dive Tourism in Caribbean Coastal Communities	**Cheryl Willis** Revealing Cultural Ecosystem Services at the Coast and in the Sea: Lessons from Cornwall, UK
2:35pm-2:55pm	**Kim Holmén** Climate Change in Svalbard – Physical Changes	**Mark Eigenraam** Advancing the SEEA Experimental Ecosystem Accounting: Challenges and Next Steps	**Tundi Agardy** Valuations in the Broadest Sense Promote Uptake	**Kenneth Bagstad** Mapping Ecosystem Services for National Park Service Management
2:55pm-3:15pm	**Brad Raffle and Joseph Nicolette** Climate Change and the Growth of Oil and Gas Exploration in the Arctic	**Discussion and Q & A**	**Steve Polasky** Making Ecosystem Valuation Count for National Accounting	**Discussion and Q & A**
3:15pm-3:45pm	**PM Break -** *Arlington Ballroom Salons 1-3*			

Tuesday	*Tuesday, December 9, 2014*			
	Concurrent Sessions - 2			
3:45pm-5:30pm	**Session 2A**	**Session 2B**	**Session 2C**	**Session 2D**
Location	**Grand Ballroom Salon A**	**Grand Ballroom Salon B**	**Grand Ballroom Salon C**	**Grand Ballroom Salon D-E**
	Fostering Resilience in the Rogue Basin	**Developing Standards for the Application of Ecosystem Services Valuation in Cost-Benefit and Tradeoff Analysis Policy and Decision Tools**	**Agriculture Perspectives on Water Quality Trading**	**Links Between Ecosystem Services and Human Well-Being**
Moderator	**Jodi Schoenen**	**Stuart Levenbach**	**Brian Brandt**	**Frank Casey**
3:45pm-3:50pm	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
3:50pm-4:10pm	**Sara Vickerman** Assessing Ecological Values in the Rogue Basin of Oregon	**Panel Session** **Jim Boyd,** Resources for the Future (RFF) **Dixon Landers,** U.S. Environmental Protection Agency **Doug Lipton,** National Oceanic and Atmospheric Administration (NOAA) **Steve Polasky,** University of Minnesota	**Brian Brandt** Overview of Ohio River Basin Water Quality Trading and Stimulating Environmental Markets projects from Ag Perspective	**Cass Hunter** A Participatory Tool for Estimating Future Impacts on Ecosystem Services and Livelihoods in Torres Strait
4:10pm-4:30pm	**Jodi Schoenen** Conflict and Fragmentation in Land Management		**Jeremy Peters** Perspective and Engagement of Conservation Districts on WQT Markets	**Jeffrey Thomas** Developing Tribal Well-being Indicators for the Puyallup Indian Reservation
4:30pm-4:50pm	**Gwyn Myer** Addressing the Impacts of Climate Change on Ecosystem Benefits in a Management Context		**Ryan Bennett** Perspective and Engagement of Dairy Industry on WQT Markets	**Susan Flensburg** Climate Change Health Assessments for Three Coastal, Riverine and Lake System Communities in Southwest Alaska
4:50pm-5:10pm	**Nikola Smith** Application of Ecological, Social and Economic Values to Land Management Planning and Implementation		**Pete Conkle** Perspective of Producers and Local SWCD Staff Participating in WQT Markets	**Jamie Donatuto** Evaluating Human Well-Being in Relation to Shellfish as a Place-Based Cultural Ecosystem Service of the Puget Sound Region of the Salish Sea
5:10pm-5:30pm	**Discussion and Q & A**		**Discussion and Q & A**	**Richard Pollnac** Livelihood Activities, Activity Satisfaction and Well-being: Examples from Coastal Fisheries
	Tuesday Evening Town Hall Meetings			
5:45pm-6:50pm	**The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES): Opportunities for Science to Inform International Policy on Biodiversity Change**		**Federal Coordination in the Chesapeake Bay-Reducing Complexity in Water Quality Trading**	
Location	**Grand Ballroom Salons D-E**		**Grand Ballroom Salons F-G**	
Organizer	**Clifford Duke, Ecological Society of America Charles Perrings, Arizona State University**		**Kathryn Zook, USDA - Office of Environmental Markets**	
5:45pm-5:50pm	**Introduction & Overview**		**Introduction & Overview**	
5:50pm-6:50pm	**Town Hall Discussion**		**Town Hall Discussion**	

Tuesday	*Tuesday, December 9, 2014*			
	Concurrent Sessions - 2			
3:45pm-5:30pm	**Session 2E**	**Session 2F**	**Session 2G**	**Session 2H**
Location	**Grand Ballroom Salon F-G**	**Grand Ballroom Salon H**	**Grand Ballroom Salon J**	**Grand Ballroom Salon K**
	Arctic Ecosystem Services: Policy and Adaptive Decision-Making	**Going Mainstream: Applications of Environmental Accounting to Public and Private Investing**	**The National Climate Assessment and Decision-Making About Ecosystem Services**	**Cultural Implications for Ecosystem Services 2**
Moderator	**Nina Mari Jørgensen & Joseph Nicolette**	**Jeremy Sokulsky**	**Ilya Fischhoff & Emily Cloyd**	**Mary Snieckus**
3:45pm-3:50pm	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
3:50pm-4:10pm	**Per Fauchald** Changes in Ecosystem Service Flows Given Climate Change	**Jeremy Sokulsky** Principles of Environmental Accounting	**Peter Groffman** Ecosystems, Biodiversity, and Ecosystem Services	**Benson Sherrouse** Improving Social-Value Transfer Through Social-Context Matching
4:10pm-4:30pm	**Vera Hausner** How Does Governance and Socioeconomic Conditions Influence Spatial Use and Priorities of Local People in the Arctic?	**David Zippin** Applying Environmental Accounting Principles to Improve the Effectiveness of Large-Scale Habitat Conservation Plans	**Juli Trtanj** Linking Ecosystem Services, Climate, and Public Health	**Elizabeth Gomez** A Dynamic Ecological and Economic Model Linking Oyster Reef Bioenergetics to Final Ecosystem Services
4:30pm-4:50pm	**Suzanne Ban** Adaptive Management of Arctic Marine Mammal Populations in Response to Changing Arctic Conditions	**Timothy Male** Focusing on Outcomes: New Policies and Opportunities to Turn Around Declining Candidate Species	**Jim Murley** Coastal Community Planning - Challenges and Opportunities	**David Blockstein** Consequences for Ecosystem Services Today from the Extinction of the Passenger Pigeon (Ectopistes Migratorius) a Century Ago
4:50pm-5:10pm	**Lionel Camus and Jack Word** Oil Spill Response and Planning in the Arctic: Adaptive Management With a Focus on Ecosystem Services	**Elizabeth Lauck** Environmental Accounting and Foreign Assistance: Increasing Accountability and Improving Results	**Lindene Patton** Insurance & Climate Change: Risks, Opportunities and the US NCA3	**Zachary Ancona** Mapping Social Values and Ecosystem Services Hotspots for National Forests in the Rocky Mountain Region
5:10pm-5:30pm	**David Moore** Using Ecosystem Services to Demonstrate the Environmental Sustainability of Arctic Oil and Gas Exploration	**Jerome Ryan** How Environmental Accounting Provides for Increased Private Sector Capital Investment in Ecosystems	**Discussion and Q & A**	**Discussion and Q & A**
	Tuesday Evening Town Hall Meetings			
5:45pm-6:50pm	**The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES): Opportunities for Science to Inform International Policy on Biodiversity Change**		**Federal Coordination in the Chesapeake Bay-Reducing Complexity in Water Quality Trading**	
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5:45pm-5:50pm	**Introduction & Overview**		**Introduction & Overview**	
5:50pm-6:50pm	**Town Hall Discussion**		**Town Hall Discussion**	

Wednesday	*Wednesday, December 10, 2014*			
7:00am-5:00pm	Conference Registration Open - *Skyview Lounge*			
7:20am-7:50am	**NESP Guidebook Launch** - *Grand Ballroom Salon F-G*			
8:00am-8:00pm	Ad Hoc Space Available - *Jefferson, Madison, Jackson Rooms (Lobby Level)*			
8:00am-9:45am	**Plenary Session** - *Arlington Ballroom Salons 4-6*			
	Plenary Session 3 ***The Role of Traditional Ecological Knowledge in Ecosystem Service Assessment and Valuation*** **Moderator: Monique Fordham**, National Tribal Liaison, U.S. Geological Survey **Panel Members** **Preston Hardison**, Natural Resource Department, Tulalip Tribes **Doug Harris**, Deputy Tribal Historic Preservation Officer, Narragansett Indian Tribal Historic Preservation Office **Jim Ransom**, Director of Tehotiienawakon, Mohawk Council of Akwesasne **Margaret Hiza Redsteer**, Research Scientist, Flagstaff Science Center, U.S. Geological Survey			
9:45am-10:15am	**AM Break** - *Arlington Salons 1-3*			
	Concurrent Sessions - 3			
10:15am-12:00pm	***Special Concurrent Session*** **Tribe/Academia Partnership Forges New Frontier in Tribal Historic Preservation & Marine Geoarchaeological Research**			
	Location: Arlington Ballroom Salons 4-6			
	Moderator: Doug Harris			
	Speakers: Doug Harris, John King, and David Robinson			
10:15am-12:00pm	**Session 3A**	**Session 3B**	**Session 3C**	**Session 3D**
Location	**Grand Ballroom Salon A**	**Grand Ballroom Salon B**	**Grand Ballroom Salon C**	**Grand Ballroom Salon D-E**
	Sustainability and Ecosystem Services	**Assessing a Role for an Ecosystem Services Approach in Urban Coastal Management, Green Infrastructure, and Climate Resilience**	**Environmental Markets 1**	**Partnerships in Ecosystem Services**
Moderator	**Carl Shapiro**	**Laura Petes**	**Carrie Sanneman**	**Sara O'Brien**
10:15am-10:20am	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
10:20am-10:40am	**Steve Polasky** Make it Fit	**Panel Session** **Holly Bamford,** National Oceanic and Atmospheric Administration (NOAA) **David Batker,** Earth Economics **Michael Curley,** Environmental Law Institute (ELI) **Mary Ruckelshaus,** Natural Capital Project, Stanford University **Jody Springer,** Federal Emergency Management Agency (FEMA)	**Lydia Olander** Managing Risks and Liabilities in Environmental Markets in the US	**Rachel Muir** Supporting the Science Needs for Revitalizing Urban Rivers and Communities Through the Urban Waters Federal Partnership
10:40am-11:00am	**Maria Cristina Infante** Ecosystem Services Value at Risk: A New Approach for Sustainability		**Eric Sprague** Connecting Landowners to Forest Mitigation Banking in Maryland	**Heidi Huber-Stearns** Investments in Watershed Services and Sustainable Institutions
11:00am-11:20am	**Shaina Sehgal** Integrating Multiple Stakeholders in the Ecological Restoration of an Iron Ore Mine in India		**Ederson Zanetti** Green Farm: Harmonizing Social Responsibility, Environmental Sustainability and Profitable Business	**Deborah McGrath** Academic Institutions as Partners in Developing World PES Programs
11:20am-11:40am	**Aurélien Bruel** Economic Valuation of Changes in Ecosystem Services Provision Within a Life Cycle Approach		**Eric Hallstein & Mark Reynolds** Using a Reverse Auction to Dynamically Source Bird Habitat	**Ione Taylor** Ecosystem Services Applied to Graduate Level Education in Energy and Mineral Resources
11:40am-12:00pm	**Brain Voigt** Visual Resource Management Under Alternative Oil and Gas Development Scenarios in the Moab, UT Region		**Doug Bruggeman** The Value of Learning about Natural History in Biodiversity Markets	**Ann Hayden Peridas** Central Valley Habitat Exchange: Creating Voluntary Environmental Markets and Science-based Solutions for People and the Environment

Wednesday	*Wednesday, December 10, 2014*			
7:00am-5:00pm	Conference Registration Open - *Skyview Lounge*			
7:20am-7:50am	**NESP Guidebook Launch** - *Grand Ballroom Salon F-G*			
8:00am-8:00pm	Ad Hoc Space Available - *Jefferson, Madison, Jackson Rooms (Lobby Level)*			
8:00am-9:45am	**Plenary Session** - *Arlington Ballroom Salons 4-6*			
	Plenary Session 3 ***The Role of Traditional Ecological Knowledge in Ecosystem Service Assessment and Valuation*** **Moderator: Monique Fordham**, National Tribal Liaison, U.S. Geological Survey **Panel Members** **Preston Hardison**, Natural Resource Department, Tulalip Tribes **Doug Harris**, Deputy Tribal Historic Preservation Officer, Narragansett Indian Tribal Historic Preservation Office **Jim Ransom**, Director of Tehotiienawakon, Mohawk Council of Akwesasne **Margaret Hiza Redsteer**, Research Scientist, Flagstaff Science Center, U.S. Geological Survey			
9:45am-10:15am	**AM Break -** *Arlington Salons 1-3*			
	Concurrent Sessions - 3			
10:15am-12:00pm	***Special Concurrent Session*** **Tribe/Academia Partnership Forges New Frontier in Tribal Historic Preservation & Marine Geoarchaeological Research**			
	Location: Arlington Ballroom Salons 4-6			
	Moderator: Doug Harris			
	Speakers: Doug Harris, John King, and David Robinson			
10:15am-12:00pm	**Session 3E**	**Session 3F**	**Session 3G**	**Session 3H**
Location	**Grand Ballroom Salon F-G**	**Grand Ballroom Salon H**	**Grand Ballroom Salon J**	**Grand Ballroom Salon K**
	Applying an Ecosystem Services Framework for Urban Decision Making	**Ecosystem Services Valuation Perspectives**	**Linking Decisions to Stakeholder Values in the Guánica Bay Watershed**	**Coastal and Marine Implications in Ecosystem Services**
Moderator	**Susan Wachter**	**Malka Pattison**	**Patricia Bradley**	**Greg Reub**
10:15am-10:20am	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
10:20am-10:40am	**Marc Imhoff** Energy, Policy, and Ecosystems Services on a Nine Billion Person Planet: What's Ahead?	**Gregory Valatin** Insights from Behavioural Economics for Global Sustainability	**Patricia Bradley** Linking Decisions to Stakeholder Values in the Guánica Bay Watershed, Puerto Rico	**David Yoskowitz** Ecosystem Services and NOAA's Restore Act Science Program
10:40am-11:00am	**Dianna Hogan** Integrating Ecosystem Services with Local Land Use Decision Making	**Lauretta Burke** The Future of Revaluing Ecosystems	**William Fisher** Decision Scenario Analysis for Addressing Sediment Accumulation in Lago Lucchetti, Puerto Rico	**Ariana Sutton-Grier** Connecting Stressors, Ocean Ecosystem Services, and Human Health
11:00am-11:20am	**David Hsu** The Market for Green Infrastructure in Philadelphia	**Elliott Campbell** Incorporating Ecosystem Services into the Genuine Progress Indicator (GPI)	**Debbie Santavy** Developing a Biological Condition Gradient for the Protection of Coral Reefs in Guánica Bay	**Tracy Rouleau** ESV and NOAA's Restore Program: Developing Actionable Information for Local Decision-Making
11:20am-11:40am	**Julie Ulrich** Expanding Ecosystem Services Using A Network Based Approach To Green Infrastructure	**Darius Semmens** A Research Synthesis on the Spatial Ecological and Economic Subsidies of Migratory Species	**Bob Leeworthy** Ecosystem Service Valuation	**Anthony Dvarskas** Incorporating Natural Capital and Ecosystem Services Impacts into Economic Vulnerability Assessments
11:40am-12:00pm	**Discussion and Q & A**	**Kelley Myers** Can We Measure Public Values for Protecting Ecosystem Services?	**Susan Yee** Assessing Sustainability of Coral Reef Ecosystem Services Using a Spatially-Explicit Decision Support Tool	**Evan Branosky** Stormwater Retention Credit Trading and Other Green Infrastructure Incentives in the District Of Columbia

Wednesday	Wednesday, December 10, 2014			
12:00pm-1:30pm	**Boxed Lunch -** *Arlington Ballroom Salons 1-3*			
12:15pm-1:20pm	***Wednesday Lunch Town Hall Meetings***			
Linking Health and Nature: Making Sure People Are Really Part of Ecosystem Services		**An Interdisciplinary Approach to Assessing Ecosystem Service Values – Moving Beyond Economics**	**Launch of the President's Ecosystem Vulnerability Climate Data Initiative and EcoINFORMA: Using Data and Tools to Build Resilience**	
Grand Ballroom Salons D-E		**Grand Ballroom Salons F-G**	**Grand Ballroom Salon H**	
Organized By: Bobby Cochran, Willamette Partnership		**Organized By: David Ervin, Portland State University**	**Organized By: Olivia Ferriter, US Geological Survey**	
Introduction & Overview (5 min)		**Introduction & Overview (5 min)**	**Introduction & Overview (5 min)**	
Town Hall Discussion (1 hour)		**Town Hall Discussion (1 hour)**	**Town Hall Discussion (1 hour)**	
	Concurrent Sessions - 4			
1:30pm-3:15pm	**Session 4A**	**Session 4B**	**Session 4C**	**Session 4D**
Location	**Grand Ballroom Salon A**	**Grand Ballroom Salon B**	**Grand Ballroom Salon C**	**Grand Ballroom Salon D-E**
	Assessing and Managing for Sustainable Rangelands' Ecosystem Goods and Services	**Integrating Ecosystem Services Into the Implementation of Water Resource Projects**	**Environmental Markets 2**	**Mitigation for One & All: An Integrated Framework for Biodiversity and Ecosystem Services**
Moderator	**Kristie Maczko**	**David Wegner**	**Bobby Cochran**	**Joshua Goldstein**
1:30pm-1:35pm	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
1:35pm-1:55pm	**Brianne Lind** A National Social and Economic Survey of Public Lands Ranchers	**Panel Session** **Robyn Colosimo,** U.S. Army **Joel Corona,** U.S. Environmental Protection Agency **Martin Doyle,** Duke University **Mami Hara,** City of Philadelphia **Benjamin Simon,** U.S. Department of the Interior	**Barbara Wyse** Watershed Restoration: Valuation of Water Supply Benefits	**Joshua Goldstein** Bringing Ecosystem Services into Regional Mitigation Avoidance Guidance
1:55pm-2:15pm	**Nancy Labbe** Cows for Conservation		**Bobbi Hudson** Nutrient Bioextraction with Shellfish, A Viable Component of Water Quality Trading for the Puget Sound Region, Washington State	**Lisa Mandle** Integrating Ecosystem Services into Impact Assessment and Offset Siting in Colombia and Beyond
2:15pm-2:35pm	**Chad Ellis** The Value of Technical Assistance		**Chris Rea** Market Reconstruction and Environmental Protection in an Era of Exchange	**Nicholas Miller** The Watershed Approach: Leveraging Watershed Outcomes from Site Mitigation
2:35pm-2:55pm	**Kim Stackhouse-Lawson** Sustainability Assessment of Beef Production		**Gwendolen Rees** Public Transactions Costs of Nutrient Trading Programs	**Christina Kennedy** Benefits to Business and Conservation from Landscape-level Mitigation Planning
2:55pm-3:15pm	**William Fox** An Integrated Social, Economic & Ecological Conceptual (ISEEC) Framework		**Jimmy Kagan** Ecosystem Services Crediting Strategies for Transportation Agencies	**Graham Watkins** Integrating Ecosystem Services in Project and Mitigation Decisions at the Inter-American Development Bank
3:15pm-3:45pm	**PM Break -** *Arlington Ballroom Salons 1-3*			

Wednesday	Wednesday, December 10, 2014			
12:00pm-1:30pm	**Boxed Lunch -** *Arlington Ballroom Salons 1-3*			
12:15pm-1:20pm	***Wednesday Lunch Town Hall Meetings***			
	Linking Health and Nature: Making Sure People Are Really Part of Ecosystem Services	**An Interdisciplinary Approach to Assessing Ecosystem Service Values – Moving Beyond Economics**	**Launch of the President's Ecosystem Vulnerability Climate Data Initiative and EcoINFORMA: Using Data and Tools to Build Resilience**	
	Grand Ballroom Salons D-E	**Grand Ballroom Salons F-G**	**Grand Ballroom Salon H**	
	Organized By: Bobby Cochran, Willamette Partnership	**Organized By: David Ervin, Portland State University**	**Organized By: Olivia Ferriter, US Geological Survey**	
	Introduction & Overview (5 min)	**Introduction & Overview (5 min)**	**Introduction & Overview (5 min)**	
	Town Hall Discussion (1 hour)	**Town Hall Discussion (1 hour)**	**Town Hall Discussion (1 hour)**	
	Concurrent Sessions - 4			
1:30pm-3:15pm	**Session 4E**	**Session 4F**	**Session 4G**	**Session 4H**
Location	**Grand Ballroom Salon F-G**	**Grand Ballroom Salon H**	**Grand Ballroom Salon J**	**Grand Ballroom Salon K**
	Urban Forestry Research and Tools for Ecosystem Services Decision-Making	**Generating Revenues for the Private Provision of Public Goods**	**Private Sector Uptake of Ecosystem Services Indicators and Analytical Approaches**	**How's that Working? Ecosystem Services from the Perspective of State Regulators**
Moderator	**Susannah Lerman & Elizabeth Larry**	**Stephen Swallow**	**Sissel Waage**	**Gretchen Greene**
1:30pm-1:35pm	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
1:35pm-1:55pm	**J. Morgan Grove** Urban Tree Canopy (UTC) Prioritization: How Decision Tools Can Bring People Together To Improve Ecosystem Services	**Stephen Swallow** Generating Revenue From "Consumers" For Ecosystem Services: Lessons From Bobolink Farming	**Elizabeth Uhlhorn** Strategy for Implementation of Ecosystem Services Valuation at the Dow Chemical Company	**Nicole Maness** Using an Ecosystem Services Framework to Restore Aquatic Habitat in Oregon
1:55pm-2:15pm	**David Nowak** Valuing Urban Forest Ecosystems: A Sneak Peak at i-Tree Landscape	**Pengfei Liu** Understanding a Field Auction for Ecosystem Services using the Experimental Economics Laboratory	**Jessica Fox** Reflections from a Decade of Investigating the Business Case for Ecosystem Services in the Electric Power Industry	**Mike Mills** Utilizing Ecosystem Services to Generate Support for Endangered Species Recovery
2:15pm-2:35pm	**Erika Svendsen** Understanding the Social Benefits of Urban Green Space: Community Stewardship and Resilience in NYC	**Zhi Li** The Potential To Use Subsidies As "Assurance Payments" To Attract Donations In Support Of Ecosystem Services	**Gregory Biddinger** Framework for Inclusion of Natural Capital into Corporate Land Management	**Speaker TBD** Bringing Ecosystem Services Analysis into Wetland Restoration in California
2:35pm-2:55pm	**Tischa Muñoz-Erickson** The Importance of Knowledge-Action Systems for Achieving Sustainable Solutions	**Achyut Kafle** Using an Experimental Auction Process to Identify Publicly Valued Ecosystem Restoration Projects	**Sissel Waage** Taking the 'Pulse' of the Leading Edge of Assessing Business Risk & Opportunity	**Greg Reub** Ecosystem Services, Habitat Banks and the Endangered Species Act
2:55pm-3:15pm	**Susannah Lerman** Beyond Benefits for Humans: How Cities can Support Ecosystem Services for Wildlife	**Achyut Kafle** Integrating Hydrology and Economics in Environmental Decision Making for Improved Water Quality	**Discussion and Q & A**	**Discussion and Q & A**
3:15pm-3:45pm	**PM Break -** *Arlington Ballroom Salons 1-3*			

Wednesday	*Wednesday, December 10, 2014*			
	Concurrent Sessions - 5			
3:45pm-5:30pm	**Session 5A**	**Session 5B**	**Session 5C**	**Session 5D**
Location	**Grand Ballroom Salon A**	**Grand Ballroom Salon B**	**Grand Ballroom Salon C**	**Grand Ballroom Salon D-E**
	The Promise of Blue Carbon	**Incorporating an Ecosystem Services Approach Into Natural Resource Restoration and Coastal Management**	**Payment for Ecosystem Services**	**Market-based Approaches for Recovery of Imperiled Species**
Moderator	**Ariana Sutton-Grier**	**Emma Roach**	**Emily Pindilli**	**Timothy Male**
3:45pm-3:50pm	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
3:50pm-4:10pm	**Diane Hoskins & Brian Needelman** Applying the New Tidal Wetland and Seagrass Restoration Methodology	**Panel Session** **Katie Arkema,** Natural Capital Project, Stanford University **Adam Davis,** Ecosystem Investment Partners (EIP) **Margaret Palmer,** National Socio-Environmental Synthesis Center/ University of Maryland **Pervaze Sheikh,** Congressional Research Service **David Yoskowitz,** National Oceanic and Atmospheric Administration (NOAA)	**Max Nielsen-Pincus** The Influence of Sense of Place on the Willingness to Pay for Ecosystem Services	**Larry Bright** Emerging Policy Directions to Support Market-Based Approaches for Endangered Species and Habitat Conservation
4:10pm-4:30pm	**Thomas Walker** Blue Carbon Economics of Salt Marsh Restoration		**Aaron Lien** A Classification System for Payment for Ecosystem Services Programs	**Garth Fuller** Sage-grouse Case Study: Scaling Up to Address Landscape-Scale Threats to Species
4:30pm-4:50pm	**Amber Moore & Ariana Sutton-Grier** Incorporating Coastal Blue Carbon into the Implementation of U.S. Federal Policies		**Kelli McCune** Lessons Learned from an Ecosystem Services Pilot in CA Watershed	**Sara O'Brien** Linking Species-, Site-, and Landscape-Level Information in Sage-grouse Mitigation
4:50pm-5:10pm	**Emily Pidgeon** Blue Carbon: A Transformational Tool for Marine Management and Conservation Globally		**Karen Bennett** Payment for Forest Environmental Services: Lessons Learned from Vietnam	**Sam Baraso** Linking State and Federal Policies to Protect Prairies, Pollinators, and Other Critters in the Pacific NW
5:10pm-5:30pm	**Discussion and Q & A**		**Paula Swedeen** Overcoming Barriers to Implementing PES Programs for Private Forestlands in the Pacific Northwest, USA	**Nicole Maness** Butterfly-Safe Wine? Layering Incentives to Maximize Species Benefit on Private Lands
5:45pm-7:45pm	**Poster Reception -** *Arlington Ballroom Salons 1-3*			
	Wednesday Evening Town Hall Meeting			
7:30pm-8:35pm	**Ecosystem Services in Federal Decision Making: Synthesis and Reflection**			
Location	**Grand Ballroom Salons F-G**			
Organizer	**Erica Goldman, COMPASS**			
7:30pm-7:35pm	**Introduction & Overview**			
7:35pm-8:35pm	**Town Hall Discussion**			

Wednesday	*Wednesday, December 10, 2014*			
	Concurrent Sessions - 5			
3:45pm-5:30pm	**Session 5E**	**Session 5F**	**Session 5G**	**Session 5H**
Location	**Grand Ballroom Salon F-G**	**Grand Ballroom Salon H**	**Grand Ballroom Salon J**	**Grand Ballroom Salon K**
	Greening Cities for Ecosystem Services	**Ecosystem Service Valuation Applications 1**	**Decision Making in Ecosystem Services 1**	**Improving Regulatory Water Quality Programs in the U.S. using Ecosystem Services**
Moderator	**Stephanie Pincetl**	**Luanne Lohr**	**Rebecca Moore**	**Heather Fisher & Jerry Diamond**
3:45pm-3:50pm	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
3:50pm-4:10pm	**Theodore Eisenman** Rooting Ecosystem Services Theory in Urban Greening Practice	**Hughes Simpson** Texas Statewide Assessment of Forest Ecosystem Services	**Simone Maynard** How Appropriate is your Framework for Conducting Ecosystem Services Assessments?!	**Doug Norton** Recovery Potential Screening: A Comparative Watershed Assessment Tool
4:10pm-4:30pm	**Tom Whitlow** Does Green Infrastructure Affect Air Quality and Human Health	**Cristina Carollo** Valuation of Non-Market Services Provided by Gulf of Mexico Habitats	**Marian Weber** Interactions Between Public Preferences, Land Development, and Municipal Land Use Policies	**Jerry Diamond** Recasting Aquatic Designated Uses as Ecosystem Services in Clean Water Act Programs
4:30pm-4:50pm	**Gina Lovasi** A Public Health Perspective on Urban Trees and Green Spaces	**Keri Bryan** Economic Valuation of Flood Mitigation Services	**Stephen Posner** Conditions that Facilitate the Use of Ecosystem Service Knowledge in Decision-Making	**Heather Fisher** Approaching TMDLs as Long-Term Investments
4:50pm-5:10pm	**William Sullivan** Ecosystems and Human Health? A Skeptic's Assessment	**Jérôme Dupras** Using Valuation to Measure the Economic Impacts of Land-Use Changes on the Spanish Mediterranean Coast	**Roger Keller** Hopes and Fears Regarding the Implementation of the Ecosystem Services Concept in Switzerland	**George Van Houtven** Economic and Ecosystem Service Targeting of Nutrient Control Efforts to Meet the Goals of the Chesapeake Bay TMDL
5:10pm-5:30pm	**Kelly Burks-Copes** Performance Metrics for Ecosystem Goods and Services Generated in the Post-Sandy Environment	**Karen Gaffney and Andrea Mackenzie** Healthy Lands & Healthy Economies: Advancing the Application of Ecosystem Services in California	**Discussion and Q & A**	**Discussion and Q & A**
5:45pm-7:45pm	**Poster Reception** - *Arlington Ballroom Salons 1-3*			
	Wednesday Evening Town Hall Meeting			
7:30pm-8:35pm	**Ecosystem Services in Federal Decision Making: Synthesis and Reflection**			
Location	**Grand Ballroom Salons F-G**			
Organizer	**Erica Goldman, COMPASS**			
7:30pm-7:35pm	**Introduction & Overview**			
7:35pm-8:35pm	**Town Hall Discussion**			

Thursday	*Thursday, December 11, 2014*			
7:00am-5:00pm	Conference Registration Open - *Skyview Lounge*			
7:00am-8:00am	**Morning Refreshments** - *Arlington Ballroom Salons 1-3*			
8:00am-8:00pm	Ad Hoc Space Available - *Jefferson, Madison, Jackson Rooms (Lobby Level)*			
8:00am-9:45am	**Plenary Session** - *Arlington Ballroom Salons 4-6*			
	Plenary Session 4 ***International Perspectives on Incorporating Ecosystem Services into Decision Making: Science and Practice*** **Moderator: Joseph Nicolette**, ENVIRON International Corporation **Panel Members** **Roy Haines-Young**, Professor and Director of the Centre for Environmental Management (CEM), The University of Nottingham **Simone Maynard**, Director, Simone Maynard Consulting and Scholar, Australian National University **Jon Waterhouse**, Founder, Network of Indigenous Knowledge			
9:45am-10:15am	**AM Break -** *Arlington Ballroom Salons -3*			
	Concurrent Sessions - 6			
10:15am-12:00pm	**Session 6A**	**Session 6B**	**Session 6C**	**Session 6D**
Location	**Grand Ballroom Salon A**	**Grand Ballroom Salon B**	**Grand Ballroom Salon C**	**Grand Ballroom Salon D-E**
	Using Earth Observation for Ecosystem Service Assessments	**Integrating Ecosystem Services into Federal Resource Management and Planning**	**Water Resources and Ecosystem Services**	**Natural Infrastructure for Improved Water Supplies**
Moderator	**Eva Maria Haas**	**Sally Collins**	**Al Cofrancesco**	**Carla Friedrich**
10:15am-10:20am	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
10:20am-10:40am	**Eva Maria Haas** Nature Valued From Space	**Janet Cushing** Case Studies on Considering Ecosystem Services in US Army Corps Civil Works Projects	**Julianna Corrales** A Phosphorus Credit Trading Program in an Agricultural Watershed	**Aaron Reuben** The Linkage Between The Energy-Food-Water Nexus and Ecosystems
10:40am-11:00am	**Eva Maria Haas** Linking Ecosystem Services to Earth Observation Products	**Edward Maillett** Considering Ecosystem Services in Fish and Wildlife Refuge Operations	**Spencer Phillips** Economic Value of Implementing the Chesapeake Bay Clean Up Plan	**Rob McDonald** Quantifying The Relationship Between Natural Landscapes and Treatment Technology and Costs
11:00am-11:20am	**John Finisdore** Using Earth Observation for Ecosystem Service Assessments: Trial Studies	**Tracy Rouleau** Integrating Ecosystem Services Into Ocean and Coastal Management Objectives	**Madeline Hall** New Zealand Water Quality Trading Markets; Lessons from Lake Taupo	**Todd Gartner** Demonstrating The Business Case And Creating A Pipeline For Natural Infrastructure Investments
11:20am-11:40am	**Stefanie Sieber & Daniel Juhn** **Panel discussion** How Earth Observation Changed the Way We Assess Ecosystems - User Perspectives	**Nikola Smith** Ecosystem Services and U.S. Forest Service Land Management	**Rebecca Logsdon** Ecosystem Service Assessments for Water Resources Management: A Comparison of Two Models	**Kevin Smith** Deploying Private Sector Capital To Scale Natural Infrastructure Opportunities
11:40am-12:00pm		**Robert Winthrop** Considering Ecosystem Services at the Bureau of Land Management	**Jingmei Yao** On Quantifying the Value of Streams Purification Service	**George Hawkins** Providing Sustainable Water Services To Urban Centers
12:00pm-1:30pm	**Boxed Lunch - Arlington Ballroom Salons 1-3**			
	Thursday Lunch Town Hall Meetings			
12:15pm-1:20pm	**Applying an Ecosystem Services Framework to Climate Change Adaptation**		**Strategy-Building for Ecosystem Services and Markets at USDA**	
Location	**Grand Ballroom Salons D-E**		**Grand Ballroom Salons F-G**	
Organizer	**Frank Casey, US Geological Survey**		**Kathryn Zook, USDA - Office of Environmental Markets**	
12:15pm-12:20pm	**Introduction & Overview**		**Introduction & Overview**	
12:20pm- 1:20pm	**Town Hall Discussion**		**Town Hall Discussion**	

Thursday	*Thursday, December 11, 2014*			
7:00am-5:00pm	Conference Registration Open - *Skyview Lounge*			
7:00am-8:00am	**Morning Refreshments** - *Arlington Ballroom Salons 1-3*			
8:00am-8:00pm	Ad Hoc Space Available - *Jefferson, Madison, Jackson Rooms (Lobby Level)*			
8:00am-9:45am	**Plenary Session** - *Arlington Ballroom Salons 4-6*			
	Plenary Session 4 ***International Perspectives on Incorporating Ecosystem Services into Decision Making: Science and Practice*** **Moderator: Joseph Nicolette**, ENVIRON International Corporation **Panel Members** **Roy Haines-Young**, Professor and Director of the Centre for Environmental Management (CEM), The University of Nottingham **Simone Maynard**, Director, Simone Maynard Consulting and Scholar, Australian National University **Jon Waterhouse**, Founder, Network of Indigenous Knowledge			
9:45am-10:15am	**AM Break -** *Arlington Ballroom Salons -3*			
	Concurrent Sessions - 6			
10:15am-12:00pm	**Session 6E**	**Session 6F**	**Session 6G**	**Session 6H**
Location	**Grand Ballroom Salon F-G**	**Grand Ballroom Salon H**	**Grand Ballroom Salon J**	**Grand Ballroom Salon K**
	Mechanisms behind Health Linkages to Green Space	**Ecosystem Service Valuation Applications 2**	**Decision Making in Ecosystem Services 2**	**Ecosystem Services Within System Frameworks**
Moderator	**Laura Jackson**	**Dixon Landers**	**David Blockstein**	**Marilyn ten Brink**
10:15am-10:20am	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
10:20am-10:40am	**William Sullivan** Two Mechanisms Underlying the Health Benefits of Exposure to Green Spaces	**Patrick Walsh** Water Quality and Property Prices in the Chesapeake Bay	**Elizabeth Murray** An Assessment of Existing Tools for Addressing Ecosystem Goods and Services in the Context of Corps Planning	**Marilyn ten Brink** A Systems Approach to Exploring Sustainable Solutions
10:40am-11:00am	**Beth Myers** School Gardens + Children's Physical Activity	**Rebecca Moore** Preferences for Stream Health Improvements in Macon County, NC	**Leslie Richardson** Facilitating the Inclusion of Nonmarket Values in BLM Planning	**Roelof Boumans** Climate Change Effects on Ecosystem Services and Human Health
11:00am-11:20am	**Laura Jackson** Evidence for Near-Road Air Pollution Abatement by Tree Cover	**Matt Weber** Valuing Ecosystem Services of an Impacted Waterway in the Southwestern US	**André Mascarenhas** Participatory Selection of Ecosystem Services - Insights from Lisbon Metropolitan Area	**Andrea Bassi** Model Complementarity for Integrated Spatial Planning (ISP)
11:20am-11:40am	**Kathleen Bush** Connecting Green Space, Tree Cover, and Birth Outcomes in Durham-Chapel Hill, NC	**Paola Bernazzani** Valuing Ecosystem Services to Promote Low Emission Development Strategies in the Lower Mekong Region	**Pieter Booth** The ECOAIM™ Framework for Ecosystem Services Identification, Production Functions, and Modeling Flows	**Ingrid Heilke** Integration and Display of Ecosystem Services & Indicators using the Driver-Pressure-State Impact-Response Framework and Dynamic Web Application
11:40am-12:00pm	**Jessica Daniel** Linking Ecosystem Services and Human Health: The Eco-Health Relationship Browser	**Christos Makriyannis** Accounting for Outcome Uncertainty in Ecosystem Service Valuation	**Rachel Neugarten** Rapid Assessment of Ecosystem Services for Site Prioritization	**Heera Lee** A Quantitative Review of Relationships Between Ecosystem Services
12:00pm-1:30pm	**Boxed Lunch - Arlington Ballroom Salons 1-3**			
	Thursday Lunch Town Hall Meetings			
12:15pm-1:20pm	**Applying an Ecosystem Services Framework to Climate Change Adaptation**		**Strategy-Building for Ecosystem Services and Markets at USDA**	
Location	**Grand Ballroom Salons D-E**		**Grand Ballroom Salons F-G**	
Organizer	**Frank Casey, US Geological Survey**		**Kathryn Zook, USDA - Office of Environmental Markets**	
12:15pm-12:20pm	**Introduction & Overview**		**Introduction & Overview**	
12:20pm- 1:20pm	**Town Hall Discussion**		**Town Hall Discussion**	

Thursday	*Thursday, December 11, 2014*			
	Concurrent Sessions - 7			
1:30pm-3:15pm	**Session 7A**	**Session 7B**	**Session 7C**	**Session 7D**
Location	**Grand Ballroom Salon A**	**Grand Ballroom Salon B**	**Grand Ballroom Salon C**	**Grand Ballroom Salon D-E**
	Recent Developments in Ecosystem Services Classification	**US Forest Service: Integrating Ecosystem Services into Operations & Management**	**Taking Water Quality Trading to the Next Level: Unifying the Message and Scaling Up**	**Quantification of Ecosystem Services—Standard Metrics and Tools**
Moderator	**Charles Rhodes**	**Greg Arthaud**	**Todd Gartner**	**Christopher Hartley**
1:30pm-1:35pm	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
1:35pm-1:55pm	**Dixon Landers** USEPA's Final Ecosystem Goods and Services (FEGS) Classification System	**Kawa Ng** Considering Ecosystem Services and Economic Sustainability in Forest Planning: Feasible Options	**Bob Rose** Clean Water Act Perspective: Water Quality Trading	**Christopher Hartley** Government's Role in Tool Development for Environmental Markets
1:55pm-2:15pm	**Paramita Sinha** National Ecosystem Services Classification System (NESCS)	**Tim Foley** The Marsh Project: An Ecosystem Services Approach to NEPA Project Planning	**David Primozich** Taking WQT to the Next Level: Unifying the Message and Scaling Up	**Lydia Olander** Identifying Modeling Gaps and Building Better Tools Through Partnerships
2:15pm-2:35pm	**Roy Haines-Young** The Common International Classification of Ecosystem Services (CICES)	**Krista Gebert & Delilah Jaworski** Early Adopter Forests and Ecosystem Services Under the 2012 Planning Rule	**Carrie Sanneman** Scaling Up Water Quality Trading Through a National Network Approach	**Marlen Eve** Methods and Tools for Quantifying Farm-Scale Greenhouse Gas Fluxes
2:35pm-2:55pm	**Miroslav Honzák** Ecosystem Services Classification and Ecosystem Accounting	**Robert Deal** The National Ecosystem Services Strategy Team	**Chris Hornback** A Utility Perspective on Water Quality Trading	**Shaun McKinney** Tools to Measure Water Quality: The Nutrient Tracking Tool
2:55pm-3:15pm	**Discussion and Q & A**	**Karen Bennett** Cool Soda-Using Ecosystem Services to Design and Value Land Management	**Brooks Smith & Mark Kieser** National Water Quality Trading Alliance Mission and Goals, Forward-Looking Opportunities and Obstacles to WQT	**Emily Pindilli** The Role of Quantification Tools in Biodiversity and Habitat Markets
3:15pm-3:45pm	**PM Break -** *Arlington Ballroom Salons 1-3*			

Thursday	*Thursday, December 11, 2014*			
	Concurrent Sessions - 7			
1:30pm-3:15pm	**Session 7E**	**Session 7F**	**Session 7G**	**Session 7H**
Location	**Grand Ballroom Salon F-G**	**Grand Ballroom Salon H**	**Grand Ballroom Salon J**	**Grand Ballroom Salon K**
	Valuing the Multiple Benefits of Healthy Urban Ecosystems	**Balancing Perfect with Practical – Creating Meaningful Values and Quantities of Ecosystem Service Benefits**	**Business and Ecosystem Services**	**Biodiversity and Ecosystem Services: Partners or Competitors?**
Moderator	**Tracy Stanton**	**Lisa Wainger & Marisa Mazzotta**	**Carl Lucero**	**Sara Vickerman**
1:30pm-1:35pm	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
1:35pm-1:55pm	**Dale Blahna** Cultivating Urban Ecosystem Services: An Overview of the Green Cities Research Alliance	**Marisa Mazzotta** Non-Monetary Benefits without Apology: The Economic Theory and Practice of Ecosystem Service Benefit Indicators	**Jim South** Integrating the Value of Nature into Business Decisions	**Daniel Doak** What Are the Different Purposes of Conservation, and Can We Reconcile Them?
1:55pm-2:15pm	**Zachary Christin** Quantifying Cultural and Social Ecosystem Services in the Urban Context	**Lisa Wainger** Designing Non-Monetary Benefit Indicators that Reflect Use and Preferences	**France Guertin** Establishing the Value of Nature: How "Voice of the Customer" informed the ESII Tool	**Steve Zack** Old World Vultures and Carcass Poisoning: An Ecosystem Service Unraveled
2:15pm-2:35pm	**Kathleen Wolf** Metro Nature Design for Public Health - Urban Ecosystem Services	**Elena Besedin** Improving Meta-Analysis as a Practical Tool for Valuing Ecosystem Services	**Mary Klein** New Nature of Business: How Companies Integrate Biodiversity	**Jimmy Kagan** Measuring Ecological Integrity Across Jurisdictions and Scales
2:35pm-2:55pm	**Taylor Ricketts** Show Me More than the Money: Ecosystem Services and Health	**Robert Johnston** Ensuring the Joint Ecological and Economic Salience of Ecosystem Service Values: An Application to Riparian Restoration	**Sandra Werner** Linking Ecosystem Services to Business Risk: An Oil and Gas Perspective	**Panel Discussion** Healy Hamilton, Gordon Toevs, and Ariana Sutton-Grier
2:55pm-3:15pm	**Paul Sandifer** Human Health Connections to Ecosystem Services, Nature, and Biodiversity	**Austin Troy** The Challenge of Applying the Ecosystem Services Framework across the Settlement Spectrum	**Doug MacNair** The USEPA Final Ecosystem Goods and Services Classification System (FEGS-CS): Implications for Corporations	**Panel Discussion** Melissa Kenney, John Schmerfeld, and Frank Casey
3:15pm-3:45pm	**PM Break -** *Arlington Ballroom Salons 1-3*			

Thursday	*Thursday, December 11, 2014*			
	Concurrent Sessions - 8			
3:45pm-5:30pm	**Session 8A**	**Session 8B**	**Session 8C**	**Session 8D**
Location	**Grand Ballroom Salon A**	**Grand Ballroom Salon B**	**Grand Ballroom Salon C**	**Grand Ballroom Salon D-E**
	Climate Change Impacts and Ecosystem Services	**Modeling the Production of Ecosystem Services**	**Needs Challenges and Opportunities in Establishing Principles and Guidelines for Payment for Environmental Services**	**Building the Data Infrastructure to Support Nation-Wide Ecosystem Services Assessments**
Moderator	**Janet Cushing**	**Randy Bruins & Marc Russell**	**Alexandra Varga**	**Dean Urban**
3:45pm-3:50pm	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
3:50pm-4:10pm	**Paula Harrison** Ecosystem Service Provision in a Changing Europe	**Marc Russell** The Importance of Context in Development and Application of Ecosystem Services Production Functions	**Shahid Naeem** Conflicts, Compatibilities, and Coherencies Between Natural Science and Payment for Ecosystem Services	**Dean Urban** Data and Infrastructure Needs for Ecosystem Services Assessment
4:10pm-4:30pm	**David Mushet** Land-Use and Climate Change Impacts on Ecosystem Services in the Northern Great Plains, USA	**Lisa Wainger** A Framework for Integrating Ecosystem Services in Corps Planning	**Charles Perrings** IPBES and Payments for Ecosystem Services Impacted by Biodiversity Change	**Anne Neale** EPA's EnviroAtlas as a Resource for Nationwide Ecosystem Services Assessments
4:30pm-4:50pm	**Mohammed Alamgir** Ecosystem Services based Adaptation to Climate Change: Why and How?	**Randy Bruins** Introducing the Ecosystem Services Production Function Library	**Jane Carter Ingram** Ecological Knowledge and Tools for Enhancing Ecosystem Service Incentives and Markets	**Jimmy Kagan** Building Midscale Datasets to Support Ecosystem Services Assessments
4:50pm-5:10pm	**William Kepner** Evaluating Biodiversity Response to Forecasted Land-Use Change in the San Pedro River Basin	**Theodore DeWitt** Assessing the Transferability of Ecosystem Service Production Estimates and Functions	**Tundi Agardy** The Scientific Foundation for Marine PES	**Robert Johnston** Enhancing the Geospatial Validity of Meta-Analysis to Support Ecosystem Service Benefit Transfer
5:10pm-5:30pm	**Bruce Byers** Assessing the Relationship of Climate Change, Forests, and Ecohydrology in Honduras	**Jonathan Kochmer** Linking Ecosystem Services Benefit Transfer Databases and Ecosystem Services Production Function Libraries	**Gabriel Thoumi** Needs, Challenges and Opportunities for Payment for Environmental Services (PES) to Meet Corporate Demand	**Lynn Maguire** Scale and Context Dependence in Multicriteria Analyses of Ecosystem Services
	Thursday Evening Town Hall Meetings			
5:45pm-6:50pm	**Leveraging Partnerships to Enhance Preparedness and Resilience for Climate Change and Ecosystem Services**		**What is Ecosystem Accounting Anyway? Could it Be a Game Changer for Sustainable Development?**	
Location	**Grand Ballroom Salons D-E**		**Grand Ballroom Salons F-G**	
Organizer	**Ilya Fischhoff, US Global Change Research Program**		**Rosimeiry Portela, Conservation International and Glenn-Marie Lange, World Bank**	
5:45pm-5:50pm	**Introduction & Overview**		**Introduction & Overview**	
5:50pm-6:50pm	**Town Hall Discussion**		**Town Hall Discussion**	

Thursday	*Thursday, December 11, 2014*			
	Concurrent Sessions - 8			
3:45pm-5:30pm	**Session 8E**	**Session 8F**	**Session 8G**	**Session 8H**
Location	**Grand Ballroom Salon F-G**	**Grand Ballroom Salon H**	**Grand Ballroom Salon J**	**Grand Ballroom Salon K**
	Urban Environments and Ecosystem Services	**Is the Ecosystem Services Quantification Framework Appropriate for Natural Resources Damages Assessment?**	**Understanding Uncertainty: Lessons from the Real World**	**Quantifying Natural Infrastructure Benefits for Decision-Making**
Moderator	**Paul Young**	**Pieter Booth & Joseph Nicolette**	**Paul Manson**	**Tracy Stanton**
3:45pm-3:50pm	Introduction & Overview	Introduction & Overview	Introduction & Overview	Introduction & Overview
3:50pm-4:10pm	**Jennifer Richkus** Key lessons Learned from Practitioners on Ecosystem Services at the Urban Scale	**Mark Rockel** Comparing Classifications of Ecosystem Services under NRDA, The Millennium Assessment, and the USEPA	**Duncan Gromko** Promoting Biodiversity-Positive Loans Given Data Uncertainty	**David Batker** How Ecosystem Service Valuation and Quantification Tools Can Support Municipal Drinking Water Source Protection
4:10pm-4:30pm	**Valerie Dupont** The Integration of Biodiversity Values in Urban Development Projects in New South Wales	**Pieter Booth** Challenges in Applying Ecosystem Services Evaluation to Natural Resource Damage Cases: Ecological Considerations	**France Guertin** Aligning Acceptable Amounts of Uncertainty With Specific Types of Decisions	**Genevieve Bennett** Quantifying the Benefits of Watershed Investments: Findings from the 'State of Watershed Investments 2014'
4:30pm-4:50pm	**Wei Tongyang** Using Choice-Based Conjoint Analysis to Estimate Different Groups' Preferences for Water Environmental Changes	**Theodore Tomasi** Ecosystem Services and Human Use and Nonuse Losses in Natural Resource Damage Assessment	**Kevin Halsey** Designing and Developing Tools that Track and Reduce Uncertainty	**Todd Gartner** Demonstrating the Business Case and Creating a Pipeline for Natural Infrastructure Investments
4:50pm-5:10pm	**Kiichiro Hayashi** Assessment of Urban Forest Ecosystem Services by People's Subjective Value in Japan	**Amanda Halter** Legal Implications of Ecosystem Service Valuation Approaches in Natural Resource Damages Assessment And Other Regulatory Regimes	**Mark Rounsevell** Quantifying the Uncertainties Within a Cross-Sectoral, Integrated Assessment of the Impact of Climate Change on Ecosystem Services in Europe	**Mark Kieser** Evaluating Green Infrastructure for Public and Private Investment: Lessons from Lima, Peru
5:10pm-5:30pm	**Nora Wahlund** Advancing Ecosystem Service Inclusion in Benefit-Cost Analysis at the Local Level: FEMA Policy Impacts in Southern Wisconsin	**Discussion and Q & A**	**Discussion and Q & A**	**Timm Kroeger** Estimating the 'Return on Investment' in Natural Infrastructure: Rio Camboriú Watershed, Santa Catarina State, Brazil
	Thursday Evening Town Hall Meetings			
5:45pm-6:50pm	**Leveraging Partnerships to Enhance Preparedness and Resilience for Climate Change and Ecosystem Services**		**What is Ecosystem Accounting Anyway? Could it Be a Game Changer for Sustainable Development?**	
Location	**Grand Ballroom Salons D-E**		**Grand Ballroom Salons F-G**	
Organizer	**Ilya Fischhoff, US Global Change Research Program**		**Rosimeiry Portela, Conservation International and Glenn-Marie Lange, World Bank**	
5:45pm-5:50pm	**Introduction & Overview**		**Introduction & Overview**	
5:50pm-6:50pm	**Town Hall Discussion**		**Town Hall Discussion**	

Program Agenda continues on the following page.

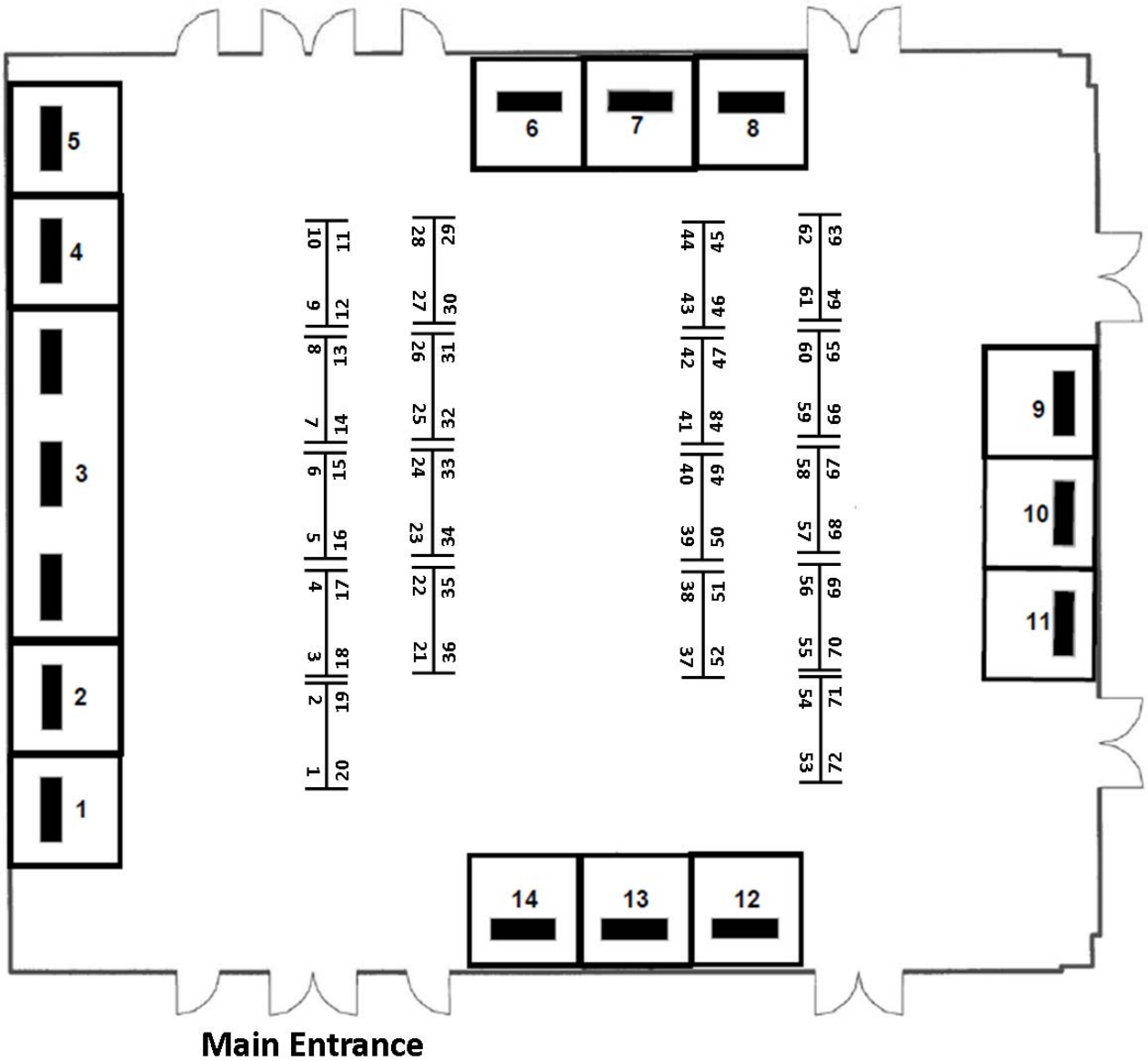
Friday	*Friday, December 12, 2014*
7:00am-12:00pm	Conference Registration Open - *Skyview Lounge*
7:00am-8:00am	**Morning Refreshments & Poster Removal** - *Arlington Ballroom Salons 1-3*
8:00am-12:00pm	Ad Hoc Space Available - *Jefferson, Madison, Jackson Rooms (Lobby Level)*
8:00am-9:45am	**Plenary Session** - *Arlington Ballroom Salons 4-6*
	Plenary Session 5 ***Climate Change and Ecosystem Services*** **Moderator: David Yoskowitz**, Chief Economist, NOAA **Panel Members** **Virginia Burkett**, Chief Scientist for Climate and Land Use Change, U.S. Geological Survey **Paula Harrison**, Senior Research Fellow, Environmental Change Institute, University of Oxford **Bill Hohenstein**, Director, U.S. Department of Agriculture Climate Change Program Office **Daniel R. Wildcat**, Professor, Haskell Indian Nations University and Convener, Indigenous Peoples' Climate Change Working Group
9:45am-10:15am	**AM Break & Exhibitor Strike -** *Arlington Ballroom Salons 1-3*
10:15am-12:00pm	**Closing Plenary Session** - *Arlington Ballroom Salons 4-6*
	Plenary Session 6 ***ACES 2014 Synthesis: Future Directions for Ecosystem Services Research and Practice*** **Moderator: Anne Kinsinger**, Associate Director for Ecosystems, U.S. Geological Survey **Panel Members** **Bobby Cochran**, Executive Director, Willamette Partnership **Michael Jenkins**, President and CEO, Forest Trends **Janet Ranganathan**, Vice President for Science and Research, World Resources Institute **Paul Sandifer**, Chief Science Advisor, NOAA's National Ocean Service
	Conference Concludes
12:00pm-2:00pm	**Last Call - Poster, Display, and Exhibit Removal**

Topical Poster Locator

Presentation Theme	Poster No.
Adaptation and Climate Change	37 & 38
Adaptive Decision Making in the Face of Uncertainty	10
Economic and Non-Economic Valuation	12 - 23
Ecosystem Service Identification Production and Flows	48 - 72
Ecosystem Services and Human Health	46 & 47
Institutions, Markets, Incentives, and Legal Frameworks	40 - 44
Public Policy, Science, and Practice	1 - 9
Public-Private Partnerships and Inter-Agency Coordination	45
Quantifying the Effects of Ecosystem Restoration	24
Sustainability and Resilience	25 - 28
Urban Ecosystems and Services	32 - 36
Using Ecosystem Services for Energy and Water Resource Planning	29 - 31
Voluntary Conservation Program Initiatives	39
What's Next? A Decade After Millennium Report	11

Poster & Exhibit Room Floor Plan

Arlington Ballroom Salons 1-3



Poster Directoy

Poster #

1 **THE BENEFITS OF RESTORATION IN URBANIZING WATERSHEDS: DEVELOPING VALUE INDICATORS AND UNDERSTANDING SOCIAL BARRIERS AND OPPORTUNITIES -- *Marisa Mazzotta,*** US EPA

2 **MAINSTREAMING ECOSYSTEM SERVICES AND NATURAL CAPITAL -- *Marion Potschin,*** Centre for Environmental Management

3 **EMPOWERING EUROPEAN COMMUNITIES TO IMPROVE NATURAL RESOURCE MANAGEMENT FOR HUMAN WELL-BEING: THE OPPLA WEB PORTAL & COMMUNITIES OF PRACTICE -- *Mark Rounsevell,*** University of Edinburgh

4 **WATER QUALITY TRADING PROGRAM REQUIREMENTS AND MONITORING -- *Julia Bond,*** The Freshwater Trust

5 **INCORPORATING ECOSYSTEM SERVICES INTO NEPA SOCIOECONOMIC ANALYSES -- *Barbara Wyse,*** Highland Economics

6 **BALANCING BUSINESS NEEDS WITH MEASURES OF ECOLOGICAL SERVICES -- *Damian Preziosi,*** Integral Consulting Inc.

7 **LINKING PUBLIC WELFARE AND PAYMENTS FOR ECOSYSTEM SERVICES: FLAGSTAFF WATERSHED PROTECTION PROJECT -- *Roy Miller,*** Northern Arizona University

8 **ESTIMATING THE SIZE AND IMPACT OF THE ECOSYSTEM RESTORATION ECONOMY -- *Todd BenDor,*** University of North Carolina - Chapel Hill

9 **ECOSYSTEM SERVICES, ENVIRONMENTAL STRESSORS AND DECISION MAKING – RESULTS OF A GLOBAL SETAC AND ESA PELLSTON WORKSHOP -- *Clifford Duke,*** Ecological Society of America

10 **DECISION SUPPORT TOOL FOR EVALUATING WATERSHED MANAGEMENT PRACTICES -- *Elias G Bekele,*** Illinois State Water Survey

11 **BEHAVIORAL SCIENCE OF NATURAL INFRASTRUCTURE INVESTMENTS -- *Sheila Walsh Reddy,*** The Nature Conservancy

12 **EVALUATING THE ECOSYSTEM SERVICE OF NUTRIENT REMOVAL IN A COASTAL WATERSHED: A CASE STUDY OF NEW HAMPSHIRE'S GREAT BAY -- *Chelsea Berg,*** Plymouth State University

13 **FLOODING THE INSURANCE MARKETS: HOW ARE FLOOD MITIGATION SERVICES PERCEIVED? -- *Jonathon Loos,*** Plymouth State University

14 **SMALL STORMWATER, NATIONAL VALUE -- *Heather Fisher,*** Tetra Tech, Inc.

15 **ECOSYSTEM SERVICE VALUE OF CARBON SEQUESTRATION IN THE NATIONAL PARK SYSTEM -- *Chris Huber,*** U.S. Geological Survey

16 **QUANTIFYING THE GREENHOUSE GAS BENEFITS OF AGRICULTURE AND FORESTRY MANAGEMENT PRACTICES -- *Marlen Eve,*** U.S. Department of Agriculture

17 **ECOSYSTEM SERVICES ON FOREST AND AGRICULTURAL LANDS OF MARYLAND: A SURVEY OF MARYLAND TREE FARMERS AND AGRICULTURAL LANDOWNERS -- *Bob Tjaden,*** University of Maryland College Park

Poster #

18 **OPTIMIZATION OF ECOSYSTEM SERVICES FOR LAND MANAGEMENT AND RESOURCE ALLOCATION IN AGROECOSYSTEMS. -- *Trung Nguyen,*** Colorado State University

19 **MACROECONOMIC CONSEQUENCES OF LOST POLLINATION SERVICES -- *Dana Bauer,*** Boston University

20 **GULF OF MEXICO OFFSHORE ECOSYSTEM SERVICES: STAKEHOLDER VALUATION WORKSHOPS -- *Carlota Santos,*** Harte Research Institute at Texas A&M University-Corpus Christi

21 **VALUATION OF ECOSYSTEM SERVICES FOR ENVIRONMENTAL DECISION MAKING IN SOUTH FLORIDA -- *Nadia Seeteram,*** Florida International University

22 **THE ECOSYSTEM SERVICES IDENTIFICATION AND INVENTORY (ESII) TOOL: SUPPORTING BUSINESSES TO VALUE NATURE AT AND AROUND A SITE -- *Sheila Walsh Reddy,*** The Nature Conservancy

23 **MEASURING THE SOCIAL VALUE OF ECOSYSTEM SERVICES BY COUPLING THE SolVES TOOL WITH ECOLOGICAL DATA -- *Landon Knapp,*** College of Charleston

24 **A NEW TOOL FOR QUANTIFYING FORESTED WETLAND RESTORATION EFFECTS AND ENHANCING IMPLEMENTATION -- *Megan Lang,*** University of Maryland College Park

25 **PAYMENT FOR ECOSYSTEM SERVICES AS A MEANS TO PROMOTE SOCIO-ECOLOGICAL CONNECTIVITY -- *Mary Schorse,*** University of Delaware

26 **IMPACTS OF UNCONVENTIONAL ENERGY DEVELOPMENT ON WESTERN US RANGELANDS: AN EVALUATION FRAMEWORK -- *Kristie Maczko,*** Sustainable Rangelands Roundtable

27 **CONSIDERING ECOSYSTEM SERVICES WHEN SEEKING GLOBAL FOOD SECURITY THROUGH SUSTAINABLE LIVESTOCK INTENSIFICATION -- *Marion Deerhake,*** RTI International

28 **EVALUATION OF ECOSYSTEM SERVICES UNDER VARYING CLIMATE AND GRAZING SCENARIOS: THREE RIVERS SOURCE REGION, CHINA -- *Rebecca Logsdon,*** Purdue University

29 **USING THE FOREST ECOSYSTEM SERVICES TOOLKIT (FEST) TO ASSESS THE IMPLICATIONS OF BIOMASS HARVESTING ON ECOSYSTEM SERVICES -- *Jesse Caputo,*** SUNY ESF

30 **AN ECOLOGICAL AND ECONOMIC APPROACH TO ECOSYSTEM SERVICES IN RIVERS. -- *Daniel Spooner,*** USGS Leetown Science Center

31 **THE BIOENERGY POTENTIAL OF INVASIVE ALIEN PLANT SPECIES CONTROL -- *Koenraad Van Meerbeek,*** KU Leuven

32 **NEAR ROAD TREE COVER IN THE TAMPA, FL, ENVIROATLAS COMMUNITY AREA -- *Alexandra Sears,*** US EPA Office of Research and Development

33 **PROXIMITY TO PARKS IN THE PHOENIX, AZ, ENVIROATLAS COMMUNITY AREA -- *Alexandra Sears,*** US EPA Office of Research and Development

34 **AIR POLLUTION TOLERANCE INDEX OF PLANTS - A TOOL FOR URBAN GREENING -- *NATIVIDAD LACDAN,*** University of the Philippines Manila

Poster #

35 **MODLEING LAND USE/LAND COVER AND CORRESPONDING CHANGES IN ECOSYSTEM SERVICES -- *John Lagrosa,*** University of Florida - School of Forest Resources & Conservation

36 **METER-SCALE URBAN LAND COVER MAPPING FOR EPA ENVIROATLAS -- *Charles Rudder,*** U.S. Environmental Protection Agency

37 **ANALYSIS OF BIRD HABITAT-BASED BIODIVERSITY METRICS AT A NATIONAL SCALE -- *Kenneth Boykin,*** New Mexico State University

38 **ECOSYSTEM SERVICES AND CLIMATE CHANGE ADAPTATION: TOWARDS AN INTEGRATED MODEL OF OPTIMAL ROTATION LENGTH -- *Gregory Valatin,*** Forest Research

39 **CHARACTERISTICS OF SELECT NATURAL RESOURCES CONSERVATION SERVICE LANDSCAPE INITIATIVES AND ASSOCIATED ENVIRONMENTAL BENEFITS -- *Eric Barnes,*** Natural Resources Conservation Service

40 **CHESAPEAKE BAY NUTRIENT TRADING TOOL: ESTIMATING ON-FARM CREDITABLE NUTRIENT AND SEDIMENT REDUCTIONS -- *Sara Walker,*** World Resources Institute

41 **BUILDING THE TOOLS TO LINK URBAN DEMAND FOR WATER QUALITY CREDITS WITH AGRICULTURAL SUPPLIERS -- *Susan Payne,*** Maryland Department of Agriculture

42 **ENABLING CONDITIONS FOR THE EMERGENCE OF WATER UTILITY PAYMENTS FOR ECOSYSTEM SERVICES PROGRAMS IN THE UNITED STATES -- *Drew Bennett,*** Oregon State University

43 **EVALUATING ADDITIONALITY AND LEAKAGE ISSUES FROM VOLUNTARY PARTICIPATION IN FOREST CARBON OFFSET PROGRAMS -- *Gregory Latta,*** Oregon State University

44 **UNDERSTANDING RANCHERS' PREFERENCES FOR CONSERVATION INCENTIVES -- *Colleen Svancara,*** University of Arizona

45 **USING WATERSHED-SCALE RESTORATION FOR HYDROPOWER COMPLIANCE -- *Alex Johnson,*** The Freshwater Trust

46 **INTEGRATING ECOSYSTEM SERVICES INTO HEALTH IMPACT ASSESSMENT -- *Laura Jackson,*** U.S. Environmental Protection Agency

47 **HUMAN HEALTH AND METRO NATURE VALUATION LIMITATIONS -- *Kathleen Wolf,*** University of Washington

48 **A NET ECOSYSTEM SERVICES ANALYSIS OF REMEDIAL ALTERNATIVES FOR A SURFACE IMPOUNDMENT IN THE SOUTHWEST -- *Emily Cooper,*** ERM

48 **A NET ECOSYSTEM SERVICES ANALYSIS OF REMEDIAL ALTERNATIVES FOR A SURFACE IMPOUNDMENT IN THE SOUTHWEST -- *Richard Dunford,*** Environmental Economics Services

49 **THE ANATOMY OF THE ESII TOOL – A SYSTEM DESIGNED TO MEASURE ECOSYSTEM SERVICE PRODUCTION AND BENEFIT FLOWS IN A CORPORATE ENGINEERING CONTEXT -- *Kevin Halsey,*** EcoMetrix Solutions Group

50 **ECOSYSTEM SERVICES ASSESSMENT AND PRIORITIZATION: A TOOL FOR DECISION-MAKING IN THE REAL WORLD -- *Spencer Phillips,*** Key-Log Economics

51 **OVERVIEW: ECOSYSTEM SERVICES IDENTIFICATION & INVENTORY (ESII) TOOL -- *Jeffrey North,*** The Nature Conservancy

Poster #

52 **THE USE OF A NEW ECOSYSTEM SERVICES ASSESSMENT TOOL, EPA H2O, FOR IDENTIFYING, QUANTIFYING, AND VALUING ECOSYSTEM SERVICES PRODUCTION -- *Marc Russell,*** US EPA - Gulf Ecology Div.

53 **MODELING VISTA AND LANDSCAPE AESTHETICS FOR NATURAL RESOURCES DECISION MAKING -- *Sheryl Law,*** Exponent

54 **USING MODELING APPROACHES TO UNDERSTAND AND RESPOND TO LAND-BASED SOURCE POLLUTION IMPACTS ON CORAL REEF ECOSYSTEM SERVICES -- *Kirsten Oleson,*** UH Manoa

55 **USING BIG DATA ANALYTICS TO TARGET CONSERVATION INVESTMENTS -- *Mark Reynolds,*** The Nature Conservancy in CA

56 **EVALUATING ECOSYSTEM SERVICES PROVIDED THROUGH CONSERVATION EASEMENTS -- *Stephanie Larson,*** UC Cooperative Extension

57 **LINKING LAND USE CHANGE TO RECREATIONAL FISHERY VALUATION WITH A SPATIALLY EXPLICIT BEHAVIOR MODEL: A CASE STUDY FROM TAMPA BAY, FL USA -- *Richard Fulford,*** US EPA - Gulf Ecology Div.

58 **LINKING ECOSYSTEM SERVICES SUPPLY TO STAKEHOLDER VALUES IN GUÁNICA BAY WATERSHED, PUERTO RICO -- *Susan Yee,*** U.S. Environmental Protection Agency

59 **LINKING STRUCTURAL AND PROCESS-BASED ATTRIBUTES OF SALT MARSHES AND MANGROVES TO ECOSYSTEM SERVICE PROVISION -- *Lauren Hutchison,*** Harte Research Institute

60 **ASSESSING REGIONAL SOIL ORGANIC CARBON STOCKS FROM TOPSOIL MEASUREMENTS USING HISTORICAL PROFILE DATA AND A DEPTH EXTRAPOLATION MODEL -- *Sam Ottoy,*** KU Leuven

61 **STATE OF THE SCIENCE: WETLAND NITROGEN, CARBON AND PHOSPHORUS CYCLING MODELS -- *Amirreza Sharifi,*** University of Maryland

62 **A FRAMEWORK FOR DETERMINING CAUSES OF ECOSYSTEM SERVICE IMPAIRMENT AT CONTAMINATED SITES -- *Derek Pelletier,*** ENVIRON International Corp

63 **FLOODPLAINS BY DESIGN: VALUING NATURAL INFRASTRUCTURE IN THE CONNECTICUT RIVER BASIN. -- *Kris Johnson,*** The Nature Conservancy, North America Freshwater Program

64 **HISTORICAL ECOSYSTEM SERVICE FEATURE EXTRACTION AND LANDUSE CHANGE IN POCATELLO, IDAHO -- *Brock Lipple,*** Idaho State University

65 **PUBLIC INPUT ON STREAM MONITORING FROM RESIDENTS OF THE WILLAMETTE VALLEY, OREGON, US -- *Matt Weber,*** U.S. EPA, Office of Research and Development

66 **CONTENT ANALYSIS TO DOCUMENT PUBLICLY VALUED ECOSYSTEM SERVICES OF RIVERS AND STREAMS -- *Matt Weber,*** U.S. EPA, Office of Research and Development

67 **ASSESSING THE BENEFITS OF OYSTER REEF RESTORATION IN THE CHESAPEAKE BAY -- *Howard Townsend,*** NOAA/NCBO

68 **SPATIAL VALUATION OF GOODS AND SERVICES IN A REEF SYSTEM: DYNAMICS OF VALUE ALLOCATION DUE TO MANAGEMENT ACTIONS -- *Patricia Arceo,*** Institute of Marine Sciences and Fisheries. University of Veracruz

Poster #

69 **METHOD EVALUATION FOR ITINERANT ECOSYSTEM SERVICE PROVIDERS -- *Claudia Reynoso,*** School of Natural Resources & Environment

70 **OZONE EFFECTS ON ECOSYSTEM SERVICES AT GREAT SMOKY MOUNTAINS NATIONAL PARK -- *Andrew Bingham,*** National Park Service

71 **PEWI: FOSTERING A BROADER AUDIENCE FOR AGROECOSYSTEM SIMULATION -- *Carrie Chennault,*** Iowa State University

72 **THREE BUSINESS CASES FOR NATURE FROM THE DOW CHEMICAL COMPANY'S FREEPORT, TX FACILITY -- *Jennifer Molnar,*** The Nature Conservancy

Poster Session and Reception – Wednesday, December 10, 2014
5:45pm-7:45pm (Arlington Ballroom Salons 1-3)

Abstracts

Listed alphabetically by presenting author last name.
Presenting author names appear in **bold**.

THE SCIENTIFIC FOUNDATION FOR MARINE PES

Tundi Agardy
Forest Trends, Washington DC USA

Payments for Ecosystem Services (PES) and other market-based mechanisms for protecting natural capital have only recently been employed in the marine realm. In part this is due to the lack of conventional property rights, which requires that contract developers utilize access rights instead of property rights to 'sell' ecosystem service delivery. However another major factor in the slow utilization of PES for marine and coastal habitat protection has been the limited capacity that exists to assess marine ecosystem services, determine their value, and ascertain what factors affect ecosystem services delivery. Without this scientific foundation for understanding and communicating marine ecosystem service values, the global interest in PES and biodiversity offsets has largely bypassed marine ecosystems – ironically, since the need for innovative financing may be greater in coastal and marine areas than in any other biome.

New rapid assessment techniques for quantifying and valuing marine ecosystem services, from blue carbon to shoreline stabilization, have now come on line. Practical experience with ecosystem services assessment and with techniques that allow for problem-scoping to identify clear priorities for management intervention can now be summarized, highlighting scientific principles that can support PES development in the marine arena. Much of this scientific foundation is common to PES in general, but some features are unique to the ocean environment and the special challenges presented by marine conservation.

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VALUATIONS IN THE BROADEST SENSE PROMOTE UPTAKE

Tundi Agardy
MARES Program, Forest Trends, Washington DC USA

WRI's insightful and honest assessment of how economic valuation information has been used in marine and coastal policy decisions throughout the Caribbean hints that much ecosystem services information remains stuck in the scientific and conservation realms. This is not new, of course – the Millennium Ecosystem Assessment and the preceding Pilot Assessment of Global Ecosystems devoted significant effort to describing ecosystem services in a way that would resonate with decision makers and the public, and neither succeeded to the degree we in the conservation community would have liked. Language remains an issue, as does scientific uncertainty about ecosystem services delivery in changing environmental conditions. However, there are demonstrable ways to promote better uptake of information on ecosystem services, their worth to society, and the necessity of protecting our valued natural capital.

Valuations can raise awareness, inform planning, and generate the political will to take concrete steps to protect ecosystems and maintain ecosystem services delivery. Yet certain suspicions remain about economic studies. When focused on a single ecosystem service (provisioning of a particular commodity, such as carbon, or on a single regulating services, such as protection of valuable coastal properties from storms), local communities can begin to fear that 'their' ecosystems will be taken over by those profiting from the service. In the extreme, there exist very real fears of land grabs and privatization that benefits the wealthy and powerful, while restricting access to local users. For this reason, economic valuations should be performed in the broadest possible way: across all ecosystem services and at the largest possible geographical scale. Economic assessments should be complemented by valuations that take non-monetary values into account.

Rather than striving for absolute total values for ecosystem services being generated from a site, it may be more effective to use the economic valuations to complement qualitative information on what matters to users. Valuations should be done in tandem, across all ecosystem services. This allows planners to be able to highlight relatively more valuable areas – information which can then be used in marine spatial planning, coastal planning, marine protected area siting and design, and trade-off analysis. Performing the broadest possible valuations, and presenting the data in a way that they can logically and easily be incorporated into planning and decision-making, will promote better uptake of ecosystem services information.

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ECOSYSTEM SERVICES BASED ADAPTATION TO CLIMATE CHANGE: WHY AND HOW?

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Ecosystem services (ES) are the benefits community receive from ecosystems. The necessity of ES for community well-being and sustainable development is universally accepted. ES have already been negatively impacted by climate change and will only deteriorate further during this century, if adequate adaptation measures are not taken. Noting ES are a relatively new dimension in the context of climate change, globally scientists and policy makers are busy searching for suitable adaptation options and ensuring an uninterrupted flow of ES. In this study, we have used climate change models, and synthesized the scholarly findings to answer two research questions (i) Why are ES based adaptations required? and (ii) What types of suitable adaptation options are available to ensure an uninterrupted supply (and flow) of ES? The study has been conducted in the Wet Tropics, Australia considering its outstanding national and global ecological significance. Our study has revealed that apart from the temporal and spatial variation, the magnitude of climate change impacts will be different for each ES. Therefore ES-based adaptations will ensure a sustainable supply and flow of ES, generating multiple ecological and community co-benefits. We have found a number of available adaptation options for different ES with substantial scientific evidence in the scholarly findings which can be implemented quite readily in the face of climate change. Some of these are: climate regulation- natural forests protection, agroforestry, planting higher wood density trees; water provision and regulation- upland forests protection, riparian restoration; coastal protection and erosion control- mangrove protection and landward facilitation, restoration of littoral forests, coastal plantation, green engineering; habitat provision-ecological connectivity, agroforestry; timber provision-planting tropical cyclone resistant trees. This study shall be useful for decision makers to incorporate suitable ES based adaptation options into their climate change related decisions, and for practitioners to select suitable adaptation options for interested ES.

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CAN CULTURAL AND BIOPHYSICAL ECOSYSTEM SERVICE MAPPING INFORM NATIONAL FOREST MANAGEMENT? A SIX-FOREST CASE STUDY FOR THE ROCKY MOUNTAIN REGION

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Research quantifying and mapping ecosystem services and public perceptions of value in national forests is becoming more important to resource managers as the intensity of resource use increases. Combining spatial data for biophysically modeled ecosystem services with spatial models of cultural ecosystem services derived from survey data can assist managers in identifying potential regions of management synergies and tradeoffs. This can be accomplished by generating maps that identify statistically significant hotspots and coldspots for ecosystem services. We conducted this analysis for six national forests in Colorado and Wyoming: Arapaho-Roosevelt, White River, Medicine Bow-Routt, Pike-San Isabel, Shoshone, and Bridger-Teton. Using the Artificial Intelligence for Ecosystem Services (ARIES) tool, we modeled and mapped four ecosystem services – carbon sequestration and storage, sediment regulation, water yield and scenic viewsheds for recreationists and nearby homeowners. Using spatial and aspatial information collected from resident surveys and the Social Values for Ecosystem Services (SolVES) tool we mapped 12 "social values" that generally correspond to cultural ecosystem services. We identified social values and ecosystem services hotspots and coldspots using spatial statistical methods, including the Getis-Ord Gi* statistic. We then overlaid social values and ecosystem services hotspots and coldspots to generate maps of potential management synergies and conflicts. Our results highlight areas where biophysical values and those identified by survey respondents align or diverge from one another, which can help inform potential ecosystem services-based resource management strategies. Hotspot analysis enables spatial, visual comparisons between cultural and other ecosystem services, putting difficult-to-monetize cultural services on a level playing field for decision making with biophysically modeled services that are more amenable to monetary valuation. Further research will generalize this method of hotspot analysis for use in spatial planning on public lands by other agencies, including the National Park Service.

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SPATIAL VALUATION OF GOODS AND SERVICES IN A REEF SYSTEM: DYNAMICS OF VALUE ALLOCATION DUE TO MANAGEMENT ACTIONS

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The Veracruz reef system became a national park in 2000 (PNSAV for its Spanish acronym) but to date a management program has not been established, much less implemented. While some restrictions for fisheries have been enforced, new plans have been developed to actually close areas deemed endangered. Also, plans for port expansion have caused modification of the port boundaries. In this paper, we use information of catch, plus species prices. By using workshops and interviews with fishermen we analyze the fisheries dynamics in the park boundaries from 1998 to 2012. We take a spatial approach to determine how the present fish regimes and port expansion affect the reef zones. We estimate the economic consequences of establishing non-take zones around reefs, under the present proposal for the park management program. We found fishermen are already switching to pelagic/high-price species from higher trophic levels. We estimate the costs for the new management strategies as well as the recovery in potential biomass and value for future fishing permits. Implications of the results fishermen are discussed.

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ARCTIC MARINE ECOSYSTEM SERVICES AND VALUES

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The arctic is expected to be affected by climate change early and substantially. And though arctic areas are sparsely populated, the natural environment plays a central role in peoples' lives, be it for subsistence, labour income, recreation or general well-being. On current sub-arctic shelf areas, where boreal species will become more prominent, ecosystem services such as those related to fisheries, may well increase. This may be advantageous for coastal human communities, indigenous and otherwise, increasing or securing values connected to benefits of cultural and provisioning services from fisheries. Though still highly uncertain, ice-freed off-shelf areas may not give the increased fisheries expected in coastal areas. Provisioning and cultural services for commercial and indigenous users from species that spend part of their life cycle on land and part on ice (e.g. polar bears, seals and walrus), are threatened by climate change. Clearly this would also involve a loss for people worldwide due to existence values. It is becoming increasingly clear that such values may be substantial, as can be shown in studies of cold water coral valuation. Option values related to for example bioprospecting, further underline the need to secure ecosystem services for the future.

The loss or reduction of services from Arctic ecosystems points to the need to protect the remaining Arctic and Arctic ice areas from activities that might produce additional stress. This clearly raises questions about trade-offs regarding the increase in activities that provide benefits to humans, such as seabed mining, oil and gas exploitation, as well as transport, all activities that are expected to increase in the Arctic in the face of ice cover reduction. The final service losses likewise point to the need for adaptive management efforts to limit negative effects of existing and potential human use.

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MAPPING ECOSYSTEM SERVICES FOR NATIONAL PARK SERVICE MANAGEMENT

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Information about ecosystem services is increasingly requested as an input to decision making for public lands and waters. In the case of parks and protected areas, flows of ecosystem services are particularly important (i.e., how protected areas provide benefits to surrounding communities and how decisions beyond their borders impact park resources), as are public perceptions of value. The National Park Service and U.S. Geological Survey are collaborating on a project to link social values and ecosystem services mapping for NPS planning and management. Spatially explicit data for ecosystem services and social values, while rarely available to support park management, could provide valuable information to balance natural resource protection and visitor use. In this study, conducted at Cape Lookout National Seashore, a barrier island system along the North Carolina coast, we use a mixed-methods modeling approach to ecosystem services quantification in support of park planning. We: 1) used biophysical models to map and quantify, and where possible attach monetary values to, coastal storm protection, fisheries, and water quality, and 2) used survey data and the Social Values for Ecosystem Services (SolVES) tool to map public preferences for cultural ecosystem services. We surveyed residents of Carteret County, NC and visitors engaged in two temporally distinct recreational activities: fall surf fishing and summer beachgoing. Our results highlight areas where biophysical values and those held by different user groups correspond and diverge. They can thus be used to identify potential management synergies and conflict as resource managers consider different alternatives. Results can thus inform planning at Cape Lookout while demonstrating an approach that could be applied to other units within the National Park Service, particularly in coastal settings.

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CLIMATE CHANGE IMPACTS ON ECOSYSTEM SERVICES AND LIVELIHOODS OF FOREST COMMUNITIES IN SOUTH-WEST NIGERIA.

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Ecosystem services and livelihoods coupled with changing climate have strong connection especially in developing countries, where tropical rainforests are of great value to millions of people. However, the recent increasing changes in climate impacts on forests ecological systems and livelihoods. Forest dependent communities are consequently vulnerable to ecosystem changes needed for their financial, spiritual, social and emotional wellbeing. This paper examines climate change impacts on ecosystem services and livelihoods of the forest communities in southwest Nigeria. This research identifies the various ecosystem services available in the study area, the sources of livelihoods of the people as well as coping and mitigating strategies practiced by the forest communities. The study was carried out in three of the six states making up South-western Nigeria across the rainforest vegetation zones, two forest reserves were selected in each state and primary data was obtained from two communities around the selected forest reserves through the use of semi-structured questionnaires, in-depth interviews with key stakeholders and focus group discussions. Quantitative information analysed using Statistical Package for Social Sciences (SPSS). The qualitative data collected was subjected to descriptive statistics. From the results, forest ecosystem provides provisioning, regulating, cultural and supporting services to the forest communities, with provisioning services having highest importance. The main source of income of the respondents is rain–fed agriculture while others are into trading. The major livelihoods affected by climate change are agriculture and fishing. The result of the study indicates that climate change is reducing the natural ability of the forests to provide ecosystem services especially provisioning and cultural services. In order to minimize the impacts the forest communities have adopted various on-farm and off-farm adaptation and coping strategies to improve agriculture, biodiversity conservation and management of water resources. This paper also suggests adaptation and mitigation strategies that will make it possible for policy makers to effectively improve ecosystem services and climate change in South-west Nigeria.

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ADAPTIVE MANAGEMENT OF ARCTIC MARINE MAMMAL POPULATIONS IN RESPONSE TO CHANGING ARCTIC CONDITIONS

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Adaptive Management is a discretionary, learning-based approach to structured decision making that can be used in conjunction with the NEPA and Federal permitting processes. Adaptive Management includes the following steps: predict, mitigate, implement, monitor, and adapt. The Adaptive Management process considers appropriate adjustments to federal Actions (i.e., decisions related to the issuance of permits and authorizations under multiple statutes). It also can be used to suggest innovative mitigation and monitoring tools as the results of current mitigation and monitoring procedures, as well as new science, become better understood.

What role does climate change play in developing an agile Adaptive Management strategy for Arctic marine mammal populations? This presentation examines tools for managing the uncertainty that is inherent in any decision-making process, and presents a decision framework for integrating uncertainty due to changing Arctic conditions into Adaptive Management strategies for Arctic marine mammal populations. Climate change impacts must be addressed over broad spatial and temporal scales, and consideration will need to shift from historic species assemblages to a broader range of ecosystem services. Potential climate change scenarios such as the reduced extent of sea ice and altered air and water temperature regimes must be used to guide active adaptive strategies that will become a part of everyday mangement decisions.

Adaptive Management allows resource managers to test assumptions, adjust policy, and incorporate learning into future decision making and management goals. By implementing a process to integrate potential climate change scenarios into the management of marine mammal populations, policies can be enacted to enhance conservation of these populations that may be facing serious declines. These declines may be due not only to climate change, but also to multiple stressors such as prey limitation and habitat reduction. Potential climate change scenarios, as they apply to polar bear and walrus, are presented to show how active Adaptive Management can close some of the uncertainty gaps by using feedback loops during monitoring and implementation.

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LINKING STATE AND FEDERAL POLICIES TO PROTECT PRAIRIES, POLLINATORS, AND OTHER CRITTERS IN THE PACIFIC NW

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The Endangered Species Act has been instrumental in the protection of the United States's biodiversity since its passing in 1973. Its species-based scope, however, is narrow and presents challenges towards bringing about the holistic landscape conservation that is necessary for both biodiversity and ecosystem services delivery.

While ecological niches and species-specific habitat are relevant towards the life cycle of an endangered species, the associated scale often conflicts with landscape conservation and ecosystem service provisioning. In Washington's South Puget Sound, Thurston County, is protecting imperiled prairie ecosystems by leveraging not only the Endangered Species Act, but also Washington's Growth Management Act. The implementation of these two policies is helping target key prairies across the landscape to deliver real ecosystem services while meeting regulatory obligations under the ESA. Using restoration and conservation incentives, the County's mitigation framework reinforces the survival and recovery of these ecosystems in perpetuity. An *in-lieu* fee banking approach supports the development of conservation banks within a reserve network, while key partners such as the Department of Defense and NRCS contribute to this Sentinel Landscape. This presentation will highlight challenges and potential solutions in leveraging policies, economics, and science to protect rare ecosystems.

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CHARACTERISTICS OF SELECT NATURAL RESOURCES CONSERVATION SERVICE LANDSCAPE INITIATIVES AND ASSOCIATED ENVIRONMENTAL BENEFITS

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Purpose

The Natural Resources Conservation Service provides financial assistance for implementing conservation practices to help private landowners protect natural resources. Efforts have been made to target those funds to specific natural resource issues through landscape initiatives. This poster presentation will provide a brief overview of select Natural Resources Conservation Service (NRCS) landscape conservation initiatives and the expected environmental benefits associated with them. By addressing nationally and regionally important conservation goals that transcend localities, NRCS uses landscape conservation initiatives to accelerate the results that can be achieved through voluntary conservation programs.

Scope

Five initiatives are selected for this poster session. Initiative specific overviews will include the following: Great Lake Restoration Initiative (GLRI), Lesser Prairie Chicken Initiative (LPCI), Long Leaf Pine Initiative (LLPI), Mississippi River Basin Initiative (MRBI), and Sage Grouse Initiative (SGI). The selected initiatives target water quality, forest restoration, wetland restoration, and wildlife habitat management. For each initiative, the poster will highlight initiative conservation goals, geographic focus, funding process, regulatory benefit to program participants and examples of environmental benefits. Historical enrollment data (contracts, acres, financial assistance amounts) will be included for tabular review as an indicator of the level of Agency investment. Maps are included to provide insight into the geographically targeted areas of each initiative.

Methods and Results

Environmental benefits will be estimated using existing accepted analyses of environmental costs and benefits associated with conservation practices, as well as case studies. A success story for each initiative will be provided to provide an actual experience of the positive impact realized by the various initiatives. Benefits for targeted funds will be compared to benefits for general program activity to estimate level of cost and conservation effectiveness.

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MODEL COMPLEMENTARITY FOR INTEGRATED SPATIAL PLANNING (ISP

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Integrated Spatial Planning (ISP) is a collection of methods and tools for harmonizing the diverse goals of society (e.g. economic development, biodiversity conservation, climate change adaptation, etc.) by modelling how these goals relate to land use and spatial configuration. ISP was implemented in two projects in Indonesia and Thailand, providing a framework for optimizing multiple goals and identifying where there will likely be trade-offs between goals.

Three models were used to develop and analyse various impacts of selected spatial development scenarios in the Heart of Borneo (HoB), and more specifically in Kalimantan, Indonesia. The models forming the HoB modelling framework are: (a) IDRISI Land Change Modeler (LCM); (b) Integrated Valuation of Ecosystem Services and Trade Offs (InVEST), and (c) a System Dynamics macro-economic model (SD). The most important contribution of the SD model is its systemic structure that includes endogenous links within and across the economic, social, and environmental sectors through a variety of feedback loops. Through the use of endogenous formulations, and by using the results of LCM and InVEST (including ecosystem services) the model provided information on the socio-economic and environmental repercussions of various policy interventions, highlighting key systemic drivers (both reinforcing and balancing) that would influence future scenarios. Used in combination, the above methods enabled the generation of broad, cross-sectoral spatial scenarios addressing environmental, economic, and social issues in a single coherent framework for analysis.

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HOW ECOSYSTEM SERVICE VALUATION AND QUANTIFICATION TOOLS CAN SUPPORT MUNICIPAL DRINKING WATER SOURCE PROTECTION

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All water utilities and private wells rely on natural assets to provide water. These assets include watersheds, open space, rivers, lakes, groundwater, and aquifers. Natural and built (man-made) capital assets provide and filter clean water for every sector of the economy including agriculture, industry, businesses and households. Healthy watersheds reliably provision and filter water, saving ratepayers billions of dollars nationwide compared to filtration plants. These same watersheds provide a suite of other benefits including biodiversity, habitat, recreation, flood protection, aesthetic and cultural value.

Many drinking water utilities invested in acquisition and protection of their watersheds when they were created in the 19th and 20th centuries, and utilities across the nation continue to recognize the economic, environmental and public benefits of watershed protection for meeting future challenges. However, today's economic tools, accounting systems and asset management practices are focused on traditional "built" solutions to water management, and methods and standards to properly account for the value of investments in watershed protection are still emerging. This may be a barrier towards more widespread investment in natural infrastructure.

This presentation will review some of the tools currently available for valuing and accounting for ecosystem services in a water utility context. Case studies from the work of Earth Economics will be used to provide examples of how ecosystem services valuation has been incorporated into traditional and non-traditional utility decision making tools, and used to inform water utility investments, including:

Ecosystem Services Valuation How valuation of watersheds can provide information about the size of the asset and scale of investment needed in a utility's capital and O&M budgets.
Benefit-Cost Analysis How ecosystem services can be incorporated into benefit cost analysis and used to demonstrate the economic value of restoration projects, such as a levee setback project in Washington State.
Damage Assessments How ecosystem service valuation was used to support an appeal for federal assistance following the 2013 Yosemite Rim Fire in California.
Accounting for Natural Capital How accounting frameworks have been developed for including natural capital in a utility's financial statements, with partner utilities in Oregon and North Carolina.

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MACROECONOMIC CONSEQUENCES OF LOST POLLINATION SERVICES

Dana Marie Bauer *and Ian Sue Wing*
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Pollination is a valuable ecosystem service which provides a variety of benefits including food and fiber, plant-derived medicines, ornamentals, and other aesthetics. Mounting evidence of long-run declines of both managed and wild insect pollinators at local and regional levels has raised concerns over potential risks to global food security and economic development. A particular worry is the convergence of these trends along with global agriculture's increasing dependence on pollination services. These concerns have spurred efforts to quantify the economic benefits of pollination as an ecosystem service and assess the economic and broader societal impacts of adverse supply shocks.

In this paper, we develop an approach to assess the macroeconomic impacts of catastrophic losses of pollination ecosystem services at global and regional scales. We incorporate the pollinator dependence of different agricultural crops into the production functions of a multi-region, multi-sector computable general equilibrium (CGE) model. We simulate catastrophic pollinator declines as exogenous reductions in the productivity of crop sectors by the fraction of pollinator-dependent production. The resulting price and quantity adjustments across domestic and international markets for agricultural and non-agricultural commodities elucidate the welfare impacts of pollinator declines and the economic channels through which they operate. In most regions, producers of pollinator intensive crops end up benefiting because direct output losses are outweighed by increased prices, while non-agricultural sectors experience large adverse indirect impacts, resulting in overall losses whose magnitudes vary substantially. By comparison, partial equilibrium analyses tend to overstate the costs to agricultural producers, understate aggregate economy-wide losses, and overstate the impacts on consumers' welfare losses. Our results suggest a willingness to pay for global agricultural pollination services of $127-$152 billion.

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POLLINATION SERVICES AND GROWER DECISION MAKING

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Recent declines in pollinator populations and species diversity have raised concerns regarding potential risks to global and regional food security, as well as concerns regarding economic development in countries where agriculture is a large portion of the economy. Globally, 75% of primary crop species and 35% of primary crop production relies on animal-mediated pollination, most of which is provided by bees. Crop pollination is provided by both managed bee colonies and wild (native and feral) pollinators. Growers of pollinator-dependent crops have the option to lease managed bee colonies during peak bloom periods, engage in habitat maintenance and restoration activities to improve the on-farm supply of wild pollination services, rely on wild pollinators sustained through off-farm habitat, or apply a mix of pollination service management strategies. However, there remains a great deal of uncertainty regarding the various pollination strategies and resulting crop yields. Another consideration for growers is the general (but not necessarily specific) knowledge that they can't prevent on-farm managed or wild pollinators from leaving their farm. Thus, individual growers are not able to fully capture the benefits of on-farm investments in pollination service, creating an incentive to under-supply both types of on-farm pollinators. Because of the complexities involved in understanding pollination service spillovers, consideration of these spillover effects may be ignored by growers in their decision-making process. Conceptually, it is easier to understand the process of renting a colony of 30,000 honey bees than it is to understand the relationships between quantity, quality, and spatial arrangement of wild pollinator habitat and the on-farm delivery of wild pollination services. Thus, there may be a bias among growers to choose the more easily understood pollination alternative, colony rental.

In this paper, we develop a grower decision making model that determines the profit-maximizing choice among leased honey bee colonies and on-farm native pollinator habitat restoration. We conduct substantial sensitivity analyses to examine the tradeoffs among the two decision variables for a variety of scenarios and identify potential thresholds when one pollination service strategy is chosen over the other versus engaging in both strategies simultaneously. Results indicate a combination of pollination strategies is optimal in most scenarios for our case study of pumpkin. While costs of pollination alternatives have some impact, the key factor driving the distribution of pollination effort (leasing bees versus planting/restoring wild habitat) is the level of off-farm wild pollinator habitat in the surrounding landscape.

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DECISION SUPPORT TOOL FOR EVALUATING WATERSHED MANAGEMENT PRACTICES

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A web-based decision support tool is developed to evaluate the water quality benefits of selected watershed best management practices in Lake Decatur tributary watersheds. Lake Decatur is the major source of public water supply for the City of Decatur in Illinois. The lake has a total drainage area of 925 square miles of which nearly 90 percent is cropland. Agricultural runoff from its watershed has been the main cause of the lake's water quality impairment, degrading the provision of a crucial life-supporting ecosystem service by the lake. In an effort to improve the watershed water quality, models have been developed for Big Ditch and Big/Long Creek subwatersheds using the Soil and Water Assessment Tool (SWAT) to accurately estimate their contribution of flow, sediment, and nutrient loadings that eventually end up in the lake. These watershed models were further modified to simulate selected conventional and new emerging best management practices (BMPs) that help reduce the watershed sediment and nutrient loads such as nitrate and total phosphorus. The BMPs include nutrient management, cover crops, perennial crops, constructed wetlands, drainage water management, bioreactors, saturated buffers, and filter strips. When optimally placed, these BMPs could be effective in reducing agricultural runoff, watershed sediment and nutrient yields, thereby improving the provision of ecosystem services. To identify the optimal placement of these BMPs with respect to pollutant reduction and associated implementation costs, the watershed models are coupled with a multi-objective optimization algorithm known as Archived-micro Genetic Algorithm 2 (AMGA2). The coupled models provide optimal tradeoff solutions with varying level of BMP implementations and pollutant reductions. For both subwatersheds, nutrient management is found to be the best alternative with an average annual cost savings of $6.42/kg N/ha, resulting in an average nitrate reduction of 14.9 percent. Filter strips and bioreactors are more cost-effective as compared to all BMPs except nutrient management. Cover crops in general are found to be less cost-effective than most of the BMPs evaluated. In contrast, perennial alfalfa is the least cost-effective with an average annual cost per reduction of $69.8/kg N/ha, providing an average nitrate load reduction of 42.1 percent. Cover crops and perennial alfalfa resulted in a maximum water yield reduction (i.e., up to 16 percent), in the months of October and November, which could be detrimental to lake reservoir storage during drought years. Therefore, before implementing perennial and cover crops for their water quality benefits, due consideration should be given to their impact on watershed water yields, particularly in periods of low flows. Successful adoption of BMPs such as bioreactors and constructed wetlands would require the provision of incentives to the producers in the form of cost-sharing as they provide no added value to them. The web-based decision support tool allows simulating the water quality benefits of different BMP types and implementation scenarios by varying their placements in the watershed and analyzing associated costs. It is also capable of providing optimal tradeoff solutions and placement scenarios for selected BMPs and subwatersheds, allowing informed decision-making through a comparison of different implementation scenarios.

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ESTIMATING THE SIZE AND IMPACT OF THE ECOSYSTEM RESTORATION ECONOMY

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For decades, industry groups and the American media have propagated the notion that environmental protection is bad for business. Proponents of development projects that require environmental permits to impact species habitat, water resources and other natural features often appeal to the public using the assumption that more jobs will be created by allowing for environmentally-destructive development practices. What has been almost entirely missing from this public debate is a detailed accounting of the economic output and jobs in the U.S. that are actually created through environmental conservation, restoration, and mitigation actions – the activities that are part of what we will call the "Restoration Economy." This sector is comprised by a variety of industries, including earth movers, plant nurseries, legal and planning practices, landscape architects, construction companies, environmental consultants, finance companies and other firms that contribute to the ecological restoration process.

The goal of this paper is to provide a high-level accounting of the size and scope of the Restoration economy in terms of employment, value added and overall economic output on a national scale. We begin with a definition of the Restoration Economy based on a detailed review of the literature on ecological restoration, including 14 local and state-level case studies of environmental restoration projects. This literature depicts a restoration and mitigation industry that not only protects public environmental goods, but also contributes to national economic growth and employment. We present a deep description of the drivers of demand in the restoration economy and discuss potential for its expansion.

Next, we conduct a national survey of businesses that participate in restoration work in order to a) estimate of the total sales and number of jobs directly associated with the Restoration Economy, and, b) provide a profile of this nascent sector in terms of type of restoration work, industrial classification, workforce needs, and growth potential. We then use the survey results as inputs into a national input-output model (IMPLAN 3.1) in order to estimate the indirect and induced economic impacts of restoration activities. Based on this analysis we conclude that the Restoration Economy directly employs 126,000 workers and generates $9.5 billion in economic output (sales) annually. This activity in turn supports and additional 95,000 jobs and $ 15 billion in output through indirect (business-to-business) linkages and increased household spending.

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ENABLING CONDITIONS FOR THE EMERGENCE OF WATER UTILITY PAYMENTS FOR ECOSYSTEM SERVICES PROGRAMS IN THE UNITED STATES

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The concept of payments for ecosystem services (PES) has largely been framed as market-based or market-like approach to environmental conservation. Underlying this conceptual framing is the Coase Theorem, which emphasizes efficiency through the reduction of transaction costs, secure property rights, and the lack of government intervention. An alternative perspective is emerging that sees PES not as a market-based solution, but as incentives for collective action. This conceptual framing allows research on PES to be informed by the extensive scholarship on collective action, including research on factors influencing successful self-organization. Building off insights from collective action theory, this research asks "Under what conditions are actors able to successfully self organize to take collective action in the form of PES?" Using a qualitative comparative analysis (QCA) that integrates data from semi-structured interviews, program reports, and existing case studies, I compare the conditions influencing the success of actors to self organize in 10 cases where PES programs were pursued by water utilities in the United States. Many of the same factors identified in the collective action literature, such as a local champion, collaborative planning processes, and engagement of trusted intermediaries, are directly relevant to self-organization through PES in these examples and supports the view of collective action as an alternative conceptual framing for PES. The implications of these findings suggest that promoting social capital and the collaborative capacity of stakeholders can facilitate the implementation of PES in addition to focusing on factors emphasized by the Coasean perspective.

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QUANTIFYING THE BENEFITS OF WATERSHED INVESTMENTS: FINDINGS FROM THE *STATE OF WATERSHED INVESTMENTS 2014*

Genevieve Bennett *and Nathaniel Carroll*
Forest Trends' Ecosystem Marketplace, Washington DC, USA

Watershed investments – which seek to restore or preserve natural landscapes in order to safeguard "watershed services" like pollution filtration or aquifer recharge – are an increasingly popular model to manage water risk. Uptake of watershed investment strategies around the world has grown steadily in the last five years, from an estimated 127 active programs in 2008 to at least 400 in 2013, delivering more than US $9.5 billion toward watershed protection activities annually. So-called "natural infrastructure" strategies offer water managers and users the ability to address pollution or supply challenges at their source on the landscape. They are often more cost-effective than traditional infrastructure systems, and have the potential to deliver additional co-benefits like local livelihoods support, biodiversity protection, or enhanced carbon storage.

In spite of this growth, actual benefits deriving from these programs are often unclear. Impacts – whether in hydrological, biophysical, economic or social terms – may be difficult or costly to measure, monitor, or clearly link to program interventions. Information at a broad scale about what kinds of monitoring & evaluation (M&E) practices are in place across programs has been mostly unavailable to date, let alone widely-available data on actual benefits being observed. In 2012, Forest Trends' Ecosystem Marketplace's "State of Watershed Payments" report, which inventoried watershed investment programs worldwide, found that hydrological monitoring appeared to be in place for only around 60 percent of active programs, while monitoring of socio-economic impacts was extremely rare. This lack of data on monitoring and evaluation makes it difficult to assess the aggregate benefits of watershed investments, whether in terms of hydrological outcomes, cost-effectiveness, or co-benefits delivery. It may also turn away potential program investors who need to understand their ecological and/or financial return on investment.

This presentation will review high-level findings from the 2014 'State of Watershed Investments' report dataset, focusing on utility-led programs and looking specifically at the current state of practice of M&E and what conclusions can be drawn about program performance. The goal is to begin to build an understanding of how programs are measuring and tracking their outcomes: we will discuss key drivers behind efforts to quantify results, and highlight trends in methodology, metrics, and common practice across geography and program type. On the whole, M&E practices are found to be more robust than they were even just a few years ago, though variation in metrics and methods used by programs to quantify benefits (especially in economic terms) means that the 'big picture' of performance is still rather fuzzy.

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COOL SODA – USING ECOSYSTEM SERVICES TO DESIGN AND VALUE LAND MANAGEMENT

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A U.S. Forest Service interdisciplinary team used a "Design Charette" process combined with an ecosystem services assessment to develop an integrated restoration plan for the Cool Soda project area on the Sweet Home Ranger District of the Willamette National Forest. Three purposes drove this pilot process: demonstrating a new, integrated method of developing a project proposal for NEPA analysis; using an understanding of the inherent capacity of the land to identify where key ecosystem services are produced on the landscape; and evaluating all lands in the watershed without regard to ownership. The Cool Soda project area is a sub-watershed of the Willamette River Basin in Oregon. The 4500 hectare sub-watershed is 60% private industrial timber lands and 40% public ownership with various land management objectives defined throughout. The private lands were predominantly in the hands of one owner who agreed to be a partner in this planning process.

A six person interdisciplinary team (IDT), including the president of the private timber lands company, with co-team leaders, a process and ecosystem services coach and 19 stakeholders formed the core of this planning approach. Following project area and IDT selection the process kicked off with a solid week of ***Knowledge Transfer*** when forty seven additional consultants from all levels of government, non-profit, industry, environmental and research institutions freely shared their knowledge of the planning area with all involved. This phase brought the entire team up to a level of mutual understanding of the environmental and socio-political contexts within the project area. Next a series of data gathering and public sharing meetings resulted in ***Collective Learning***. This phase brought an understanding of the ecosystem services valued by the stakeholders, where those services are inherently produced within this planning area, and established a baseline of existing environmental and socio-political conditions and a projection of desired conditions. Project ideas were put forward for group consideration resulting in the final "all lands" ***Restoration Design*** presented to the stakeholders.

Three key ecosystem service or "benefits from nature" themes emerged from the process: Streams and Wild Fish; Forests and Wildlife; and Community and Culture. Each theme focused on important objectives to achieve, identified potential projects that could be implemented both in the near-term and in the long-term, and itemized how each project resulted in outcomes that enhance or detract from "benefits from nature" or ecosystem services.

The enhanced interdisciplinary interactions internally and among stakeholders made this project a success. Utilizing interdisciplinary skills in developing a holistic landscape proposal was refreshing and allowed all participants to be valued throughout the process. This is in direct contrast to the typical planning processes where a single or a few disciplines put treatment units forward for timber harvest and all other disciplines and stakeholders simply design mitigation measures. Many of the proposed actions from the Cool Soda project have already been implemented and a NEPA analysis is on-going for some of the vegetation and fuels treatment proposals. Integrating this process into typical project planning schedules would enhance the quality of land management decisions and improve interdisciplinary team functions throughout the agency.

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PAYMENT FOR FOREST ENVIRONMENTAL SERVICES: LESSONS LEARNED FROM VIETNAM

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Although forest environmental services play important roles in both environmental and social sustainability, their actual values are often underestimated and there is often a limited empirical case to illustrate how these values could be acknowledged and protected in forestry policies. Payment for environmental services (PES) offers a new approach in mainstreaming these values in broader forestry sector. Using Vietnam as a case study, we discuss how PES could improve both environmental and social outcomes as well as the challenges for PES policies to deliver effective, efficient and equitable outcomes.

In 2004, the government of Vietnam, drawing on the concept of PES, laid the foundations for a nationwide program of Payments for Forest Environmental Services (PFES). Vietnam is the first country in Asia to initiate a nationwide PFES scheme. The goals of the PFES program in Vietnam are to improve forest quality and quantity, increase the forestry sector's contribution to the national economy, reduce the state's financial burden for forest protection and management, and improve environmental conditions and social well-being. The PFES program is a major breakthrough for Vietnam's forestry sector and it has undergone numerous refinements and improvements during the pilot phase. In particular, major achievements have been made in establishing legal frameworks and institutional arrangements, generating substantial revenue, and gaining political commitment and interest in supporting PFES at both central and provincial government levels and among local people, all of which suggest a bright future for PFES. This research is the first comprehensive review or analysis of the program and of its progress toward achieving its goals.

For PFES to have outcomes that are effective, efficient and equitable, however, policy makers need to work toward developing a functional monitoring and evaluation system, with an accessible grievance mechanism, to ensure transparency and accountability in the distribution of PFES revenues from central to local levels. PFES could also benefit by being part of a more holistic program, working with complementary conservation and socio-economic development programs. The PFES program delivery would be further supported by long-term capacity building for government staff and households, communities and their representatives.

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DESIGNER LANDSCAPES: ENHANCING ECOSYSTEM SERVICES ON AG LANDS

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Ecosystem services provide a foundation for the well-being of individuals and society and land managers typically strive to enhance desirable services. For example, farmers plant crops and manage the soil and hydrologic conditions to favor crop production. However, maximizing for a single or small set of ecosystem services on agricultural lands has often been at the expense of other ecosystem services including pollination and clean water. Maximization of crop production services has also contributed to landscapes that are increasingly vulnerable to pressures from a highly variable climate, dynamic markets, and changing environmental conditions.

We must be more deliberate in managing our food-producing landscapes for multiple ecosystem services while recognizing landscape modification for bolstering other ecosystem services must be accomplished efficiently, at low cost, and with minimum effect on crop production. This means intentionally designing and managing our agricultural conservation practices to provide the desired types and levels of ecosystem services. A purposeful design and planning approach will be essential to optimizing returns from markets for ecosystem services.

By using a landscape ecological planning and design process, we can enhance the area-efficiency and cost effectiveness of practices by: (1) designing each installation for optimum combinations of services; (2) targeting locations and emphasizing design features that produce disproportionately greater benefits and synergies; (3) avoiding locations and minimizing design features that produce conflict, cancelling effects, or negative consequences; and (4) tailoring the design from location to location depending on site capabilities and landowner preferences. We illustrate how this process works by focusing on conservation practices commonly called vegetative buffers.

Advances in research are creating the basis for tools that can help land managers better design and locate these conservation practices, to visualize multiple design options, and compare benefits and trade-offs. We will present several tools available including: Conservation Buffers: Design Guidelines for Buffers, Corridors, and Greenways (www.bufferguidelines.net) which synthesizes and distills over 1,400 research publications into illustrated rules-of-thumb for designing multifunctional buffers; AgBufferBuilder (www2.ca.uky.edu/BufferBuilder/), a GIS-based tool for designing water quality buffers, and CanVis (nac.unl.edu/simulation/products.htm), a visual simulation tool for depicting design alternatives. By including planning and design within the ecosystem services framework, we can create more resilient farms and ranches that produce numerous benefits for landowners and society.

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EVALUATING THE ECOSYSTEM SERVICE OF NUTRIENT REMOVAL IN A COASTAL WATERSHED: A CASE STUDY OF NEW HAMPSHIRE'S GREAT BAY

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New Hampshire's Great Bay, valued as one of 28 "estuaries of national significance," provides a host of economic, ecological, and social environmental services that are threatened by the deterioration of water quality and increased levels of nitrogen (PREP, 2013).The US Environmental Protection Agency has issued several NPDES permits that mandate the reduction of point source pollution to the limits of technology. In order to meet the new NPDES permits' nitrogen effluent limits of 3 mg N/L standard, the aging built infrastructure must be updated, and the combined capital costs are about $354 million (DES, 2010; Kessler, 2010). Alternatives, such as land conservation and natural infrastructure, provide ways of reducing nitrogen sources from stormwater runoff or nonpoint source pollution. Relying on expert stakeholder input, we will develop several land use scenarios to model the various levels of nitrogen reduction. Two modeling programs, the University of New Hampshire's water balance model FrAMES and the Natural Capital Project's InVEST nutrient retention model, will be utilized to execute the stakeholder-based scenarios. Based upon the comparative results from InVEST and FrAMES, we can determine whether alternative management programs can avoid some of the projected costs of wastewater treatment plant upgrades.

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VALUING ECOSYSTEM SERVICES TO PROMOTE LOW EMISSION DEVELOPMENT STRATEGIES IN THE LOWER MEKONG REGION: A CASE STUDY OF KHAO YAI NATIONAL PARK, THAILAND

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Deforestation is occurring at a rapid pace in developing Asian nations, and protected areas play an important role in slowing deforestation rates. The protection of forest areas avoids emissions of carbon and protects other vital ecosystem services provided by these areas. Understanding the economic value of the ecosystem services provided by forest areas helps to ensure that the value of forests are considered in land use decisions, where protection is weighed against extractive land uses such timber harvesting and agriculture. This study uses ecosystem valuation methods to estimate the value of forest areas within Thailand's Khao Yai National Park. We use a variety of ecosystem valuation methods to estimate the value of eight distinct ecosystem services provided by forests in Khao Yai National Park. Estimating the value of these ecosystem services over a 30-year period and summing the values resulted in estimates of the total economic value of forests in Khao Yai National Park ranging from $4.3 billion to $6.0 billion in 2012 US dollars. The highest value ecosystem services were those that involved direct or indirect use by local residents and visitors, such as water supply, tourism, and erosion control.

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IMPROVING META-ANALYSIS AS A PRACTICAL TOOL FOR VALUING ECOSYSTEM SERVICES

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Benefit-cost analysis of environmental regulations rarely affords sufficient time to develop original primary studies to value specific policy effects. In the rulemaking context, benefit transfer is often the only remaining option for valuing changes in ecosystem services affected by environmental policies or resource management options. Because of the growing consensus in the economic literature that function-based transfers typically outperform unit-value transfers, meta-analysis techniques have been increasingly used by economists as a potential basis for policy analysis conducted by government agencies charged with the stewardship of natural resources. For example, more than a half-dozen meta-analyses of water quality valuation studies have been published in peer-reviewed journals in recent years. Many authors have noted the potential of meta-analysis such as these to generate robust, accurate and broadly applicable benefit functions. Yet although these meta-analyses characterize the systematic influences of many study, economic, resource and population attributes on willingness to pay (WTP) for water quality improvements, the characterization of affected resources and ecosystem services is often insufficient to tailor the estimated meta-regression to specific policy contexts. For example, a typical limitation of these analyses is an inability to account for geospatial factors affecting resource values such as the geographic scale of affected resources, the availability of regional substitutes, and the relevant market area. To address this deficiency in the resulting meta-analytic benefit functions, policy analysts must use a variety of ad hoc assumptions and adjustments when applying the results to policy analysis; these are likely to bias estimated values.

To become a truly practical and accurate tool for valuing changes in ecosystem services, meta-analytic benefit functions must incorporate welfare-relevant geospatial factors. These factors, however, have been mostly absent from existing meta-analyses because the geospatial characteristics of studied sites seldom vary within original ecosystem service valuation studies, and so few primary studies report these characteristics. Reconstructing relevant geospatial measures for primary study sites (e.g., using information from outside geospatial data sources) can be challenging and resource-intensive. However, use of augmented meta-data that combines study-reported information with geospatial data from other sources enables the estimated meta-regressions to capture a wider range of relevant geospatial factors and to better tailor benefit transfers to specific policy applications.

This presentation reports on the estimation and results of the first meta-regression for US water quality valuation specifically designed to better incorporate geospatial patterns and data, including more accurate measures of geospatial scale and regional substitutes. We illustrate the application of this meta-regression to the valuation of hypothetical water quality improvements in surface water resulting from regulations of industrial discharges, and compare the estimated benefits with alternative estimates based on meta-analyses that do not incorporate geospatial variables in the valuation function and thus require ad hoc adjustments to account for geospatial factors. Discussion focuses on the implications of omitting geospatial characteristics from meta-regression for nationwide ecosystem service valuation, and the need for developing meta-data and meta-analyses that can be better tailored to the policy context and thus provide more practical tools for ecosystem service analysis.

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NATURAL LAND MANAGEMENT: FRAMEWORK FOR INCLUSION OF NATURAL CAPITAL INTO CORPORATE LAND MANAGEMENT

Gregory R. Biddinger
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Over the last 10 years there has been a growing interest by corporations to integrate or upgrade ecosystem services as part of their management strategies for operating and surplus properties. Those strategies can range from including natural landscapes as green infrastructure or operating buffers to redevelopment of idled and surplus properties into sources marketable ecosystem services. Corporations have progressed from implementation of such practices from simple random opportunistic applications to systematic inclusion in their business practices and planning process. This presentation will provide a framework for how corporations can build internal processes and practices to integrate nature capital into their land management strategies. The outcome of such standard review and assessment processes will be highlighted with case studies. The challenges to advancing such practices for the private sector will be discussed.

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OZONE EFFECTS ON ECOSYSTEM SERVICES AT GREAT SMOKY MOUNTAINS NATIONAL PARK

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Protected areas such as National Parks are recognized as important providers of ecosystem services – benefits nature conveys to humans. However, some threats to these services, such as air pollution, can derive from outside the park's boundaries. Ground-level ozone (O3) is a man-made pollutant which at elevated levels can damage vegetation, resulting in decreased growth and increased water loss through evapotranspiration, resulting in decreased overall streamflow. Using studies conducted on similar ecosystems nearby, we estimate the potential loss due to O3 damage of two ecosystem services: climate regulation (through the intermediate service of carbon sequestration) and water provisioning (through streamflow) at Great Smoky Mountain NP. These ecosystem functions directly benefit humans by providing a livable climate and by providing downstream beneficiaries with water for drinking, agriculture, recreation and hydropower. We found the loss from impairment of these services could be significant when O3 levels are elevated. A 50% increase in O3 exposure is projected to result in a loss of C sequestration of 500,000 – 960,000 mT C yr-1 while a 25% reduction in O3 concentrations could result in an increase in streamflow of 109.6M m3 from the park during the critical dry Aug.-Oct. period. This highlights the important services provided by protected landscapes such as National Parks and the need for more in-depth research on the effects air pollution can have on the benefits we receive from nature.

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CULTIVATING URBAN ECOSYSTEM SERVICES: AN OVERVIEW OF THE GREEN CITIES RESEARCH ALLIANCE

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In 2009, the U.S. Forest Service Pacific Northwest Research Station initiated a program of "urban forestry research." There were no formal objectives for the program, just the general expectation the PNW Station would implement an interdisciplinary research program related to urban natural resource sustainability and advance Forest Service strategic planning goals to "engage urban America" and "encourage partnerships." While there are Forest Service urban forestry research programs in other regions of the country, this is the first in the Pacific Northwest.

Initial research projects reflected four themes from Forest Service Research and Development: forest inventory and health assessment tools, urban natural resources stewardship, community sustainability, and ecosystem services. An ancillary result of this research was the development of an informal research partnership called the Green Cities Research Alliance (GCRA), with public and private sector partners from Seattle and Portland metro areas. The GCRA also played a key role in the application process and subsequent designation of the Green River-Duwamish Waterway as an Urban Waters Federal Partnership (UWFP) in King County, WA.

This presentation will provide an overview of the GCRA, the general operating procedure of the group, and a summary of key research themes, results, and applications. We will also discuss future directions of the alliance. In general, the GCRA reflects a bottom up approach to urban forestry research. We are loosely following a Collective Impact Group model where a few key leaders act as facilitators for subgroups of participants that form around common research topics of interest. The Collective Impact Group approach is also guiding the activities of the leaders and participants in the Green-Duwamish UWFP. Subgroups are emerging to pursue topics such as salmon habitat restoration, social acceptability and public health implications of trees and green infrastructure, and environmental justice. The advantages, disadvantages, and future applications of the Collective Impact Group approach to urban sustainability research will be discussed.

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CONSEQUENCES FOR ECOSYSTEM SERVICES TODAY FROM THE EXTINCTION OF THE PASSENGER PIGEON (ECTOPISTES MIGRATORIUS) A CENTURY AGO

David Blockstein

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In 1800, billions of Passenger Pigeons *Ectopistes migratorius* crisscrossed the skies of the eastern United States and Canada. Passing flocks darkened the skies for many hours. Yet, by 1900 the species was virtually extinct, and on September 1, 1914, Martha, the last of her species, died in the Cincinnati Zoo. The Passenger Pigeon was a vitally important component of the eastern deciduous forest and other ecosystems in eastern North America as a seed predator and a dispersal agent, a food source (including for humans), a disturbance factor, and redistributor of soil nutrients. Ecological consequences of the extinction of the Passenger Pigeon included reduction of disturbances in the forest, which may have been important for the establishment of canebrakes in the southeastern US, an end to the selective favoring of red oaks over white oaks due to dietary preferences by the pigeons, and a possible increase in the incidence of Lyme disease due to a release from competition for local deer mice populations that fed on mast. These impacts are still being felt a century after the last Passenger Pigeon died.

Project Passenger Pigeon (www.passengerpigeon.org) uses this teachable moment of the centenary of the extinction of this iconic species for conservationists, scientists, educators, and public to consider how the most abundant bird in the world went extinct over a matter of decades and to ponder its implications for today.

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WATER QUALITY TRADING PROGRAM REQUIREMENTS AND MONITORING

*Carrie Leonard and **Julia Bond***
The Freshwater Trust, Portland, OR, USA

The integrity of water quality trading programs is critical to their long-term viability. Regulated entities interested in water quality trades to comply with permit requirements need assurances that a trading program is a viable option. At the same time, regulators require programs to adhere to standards governing the creation and use of credits while the public expects programs that protect and enhance water quality over the long term. The Freshwater Trust's experience with putting policy and science into the practice of credit-generating water quality trading programs includes a focus on practical market mechanisms enhanced by rigorous quality standards and monitoring.

We will show that critical components for valid and functional projects in a water quality trading context include: quality standards, independent verification, credit registration, scaled-up operations, risk management, and a long view.

Quality standards ensure that credits used to offset discharger impacts meet strict, proscribed standards.

Third-party verification is needed to ensure that the quality standards and site management are being met.

A credit registry helps regulated entities and regulators guarantee and report publicly the credits used to offset regulated impacts.

Scalable, multi-year restoration programs demand long-term preparation and recruitment schedules, efficiencies in contracting, site preparation and maintenance, and subcontractor consistency.

The liability inherent in delivering compliance credits requires professional contracting, financing, and accountability mechanisms to manage risk.

Finally, as each project for thermal or nutrient compliance must be maintained for five to 20 years, cost modeling and pricing must become more comprehensive to drive down the total costs of implementation and maintenance.

In this poster, we will present our experience with restoration projects that embed the standards and quantification necessary for compliance-grade credit generation used in current Pacific Northwest water quality trading programs. We will step through a successful water quality trading process, from estimating the potential ecosystem services in a watershed or service area, implementing the program, and monitoring and ensuring compliance over the life of the program. This process can be applied to many projects that seek to evaluate and use water quality trading as an alternative to built solutions for compliance.

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CHALLENGES IN APPLYING ECOSYSTEM SERVICES EVALUATION TO NATURAL RESOURCE DAMAGE CASES: ECOLOGICAL CONSIDERATIONS

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Natural Resource Damage Assessment (NRDA) is inherently a regulatory process that provides natural resource Trustees with a means to seek compensation for losses of [ecosystem] services resulting from the release of oil and hazardous substances. Although the conceptual currency of NRDA services appears indistinguishable from those defined in an assessment based on ecosystem services (ES), there are important differences. Many of these differences stem from requirements of the NRDA process that greatly complicate and perhaps cripple the ability to use ES assessment. These requirements include: 1) the need to establish causation, and 2) the need to distinguish service levels under temporally and spatially explicit "baseline" conditions. The need to establish causation is problematic in an ES assessment context, because it requires parsing service losses among a wide variety of stressors, including natural stressors, habitat alteration over time, and multiple chemicals in multiple media. The need to quantify injury and service losses may be hampered further in an ES assessment approach, due to the need to define and quantify services to humans—thus requiring establishment of reliable biophysical production functions. In addition, NRDA requires quantification of service losses relative to a "baseline" level of services that would have been provided absent the release in question. Because an ES assessment approach is holistic, in that it is intended to measure service flows and consumption of services, tools would need to be developed to parse service flows between baseline service levels and service levels "with injury."

NRDA practice has evolved over the past 20 years to incorporate innovative "equivalency analysis" approaches that obviate the need to quantify and monetize service losses. Equivalency analysis approaches are inconsistent with some of the basic premises associated with ES assessment and quantification. This presentation will define and describe these issues and present examples of these disconnects rendering an ES assessment approach unworkable in the NRDA context. The presentation will also identify and discuss one potential benefit of an ES assessment approach in NRDA—identification and evaluation of restoration options. An ES approach may allow for more flexibility in the design of restoration alternatives by focusing on improvements in human well-being at the lowest cost, rather than replacing injured habitat or wildlife using equivalency approaches that often include little consideration of cost.

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THE ECOAIM™ FRAMEWORK FOR ECOSYSTEM SERVICES IDENTIFICATION, PRODUCTION FUNCTIONS, AND MODELING FLOWS: A CASE STUDY AT A U.S. MILITARY INSTALLATION

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The Ecological Assets, Inventory, and Management (EcoAIM™) framework and tool was developed to allow explicit consideration of ecosystem services tradeoffs in natural resource decision making. Initially, EcoAIM™ was implemented with a three-part, phased, structured stakeholder engagement process that: 1) defined the decision-making process, which includes the goals and objectives of the installation and identifying the key stakeholders and the beneficiaries of ecosystem services; 2) identified the key ecosystem services that were essential to the missions and operations at the military installation; and 3) determined the biophysical production functions that generate the ecosystem services for modeling and mapping ecosystem service flows. The structured stakeholder engagement process consisted of teleconference meetings, in-person interviews, and group workshops. Initial meetings focused on discerning the personnel involved with natural resource management decision making and mapping the flow of environmental information through interactions among departments and committees. Subsequent stakeholder engagement concentrated on understanding the notional mission and vision for the installation. The results from the structured stakeholder engagement process were used to customize the geospatial analysis tool for modeling aesthetics, habitat provisioning for biodiversity, recreational opportunities, and nutrient sequestration. The results from the geospatial tool were presented as gains and losses, providing a basis on which decision makers can base judgments about ecosystem services tradeoffs.

Data on the existing (baseline) ecosystem services conditions were used to compare a scenario in which a large natural area was converted to an office park. The habitat provisioning for biodiversity model determined that the scenario would produce a 10% decrease in ecosystem service value due to increased fragmentation of forests and contiguous wetlands. The landscape aesthetics model determined a 10% increase in value due to the greater number and diversity of land-use types under the development scenario. The vista model indicated a decrease in viewshed but no other significant changes in land-patch diversity or richness. Although the recreational opportunities increased in the scenario from the baseline, the results showed no change in overall value, because the high scores were outside the initial model parameters. Similarly, model results for the nutrient sequestration remained unchanged, because baseline conditions already had low scores, and the scenario scores were outside the limits of the model.

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CLIMATE CHANGE EFFECTS ON ECOSYSTEM SERVICES AND HUMAN HEALTH

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Human health and well-being are and will be affected by climate change, both directly through changes in extreme weather events and indirectly through weather induced changes in societal systems and their supporting ecosystems. The goal of this study was to develop and apply a broadly applicable modeling and decision support platform (HYGEIA) that considers direct and indirect climate change effects on human health and the effectiveness of mitigation options from increased ecosystem services. The model's first application examined how climate change induced heat stress could affect morbidity and mortality in Travis County, Texas (Austin and vicinity) and how increased vegetation coverage, applied in several different ways, could quantitatively mitigate heat stress effects. The model was developed in a manner which will allow ready adaptation to other locations and health endpoints, and will allow users to examine tradeoffs and indirect effects of mitigation options. The HYGEIA platform was constructed using the Multiscale Integrated Model of Ecosystem Services (MIMES) and includes a temporally and spatially explicit dynamic eco-hydrology and land use model, as well as a human demographics population model that interacts with the landscape.

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ANALYSIS OF BIRD HABITAT-BASED BIODIVERSITY METRICS AT A NATIONAL SCALE

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Ecosystem services have become a key issue of this century in resource management, conservation planning, and environmental decision analysis. Mapping and quantifying ecosystem services have become strategic national interests for integrating ecology with economics to help understand the effects of human policies and actions and their subsequent impacts on both ecosystem function and human well-being. Some characteristics of biodiversity are valued by humans in varied ways, and thus are important to include in any assessment that seeks to identify and quantify the benefits of ecosystems to humans. Some biodiversity metrics clearly reflect ecosystem services (e.g., abundance and diversity of game species), whereas others reflect indirect and difficult to quantify relationships to services (e.g., relevance of species diversity to ecosystem resilience, cultural value of native species). Wildlife habitat has been modeled at broad spatial scales and can be used to map a number of biodiversity metrics. In the present study, we map metrics reflecting ecosystem services or biodiversity features derived from US Geological Survey Gap Analysis Program data for land cover and habitat models for bird species. Metrics include species richness for all birds, harvestable species (i.e., small game), NatureServe conservation status (G1-G3) species, birds of conservation concern, and threatened and endangered species. We also present results of metrics focusing on species identified by federal and state agencies or non-governmental organizations as species of interest based on conservation or climate vulnerability. The project is being conducted at multiple scales in a phased approach, starting with place-based studies, then multi-state regional areas, culminating in the national-level EnviroAtlas. As an example of this incremental approach, we provide results for the contiguous United States. Geographic patterns differed among metrics across the study area.

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LINKING DECISIONS TO STAKEHOLDER VALUES IN THE GUÁNICA BAY WATERSHED, PUERTO RICO

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This presentation lays the foundation for the session by introducing the structured decision-making approach (SDM) that is being used by the Environmental Protection Agency (EPA) in the Guánica Bay watershed of southwestern Puerto Rico. EPA is working with other agencies to protect coral reefs from effects of sediment, nutrient and contaminants in watershed runoff.
SDM is an organized approach for identifying and evaluating alternatives and making defensible choices in complex decision situations. SDM has six steps: 1) clarify the decision context; 2) define objectives and evaluation criteria; 3) develop alternative(s); 4) estimate consequences; 5) evaluate trade-offs and select alternatives; 6) and implement and monitor. A key aspect of SDM is the engagement of stakeholders, experts and decision-makers to create a deliberative environment that deals rigorously with both facts and values in decision-making.

The presentation will provide an overview of SDM and application of SDM in Guánica Bay, including archival research on social and economic history of the region. Three workshops with stakeholders, experts and decision-makers were held to explore past decisions, characterize the decision landscape for the Watershed Management Plan, and better understand what stakeholders value in the watershed. The workshops included detailed discussions of the effects of human activity in the watershed on downstream environmental condition and ecosystem services.

Outcomes of this research include: 1) an improved understanding of the values and perceptions of citizens in different communities of the watershed, 2) a broader decision landscape (beyond coral reef protection), 3) a clearer understanding of the decision alternatives and how they might support or conflict with different objectives, and 4) important insights to the value of engaging stakeholders early and often in the decision process.

The application of SDM in the Guánica Bay project demonstrates that SDM can be successfully used in the watershed setting for identifying and evaluating alternatives and making defensible choices in complex decision situations.

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BRINGING ECOSYSTEM SERVICES ANALYSIS INTO WETLAND RESTORATION IN CALIFORNIA: THE LONG AND WINDING ROAD

Peter Brand *Presented by:* ***Speaker TBD***
California Coastal Conservancy

Purpose
The purpose of this talk is to identify the challenges faced by a regulator new to the ecosystem services (ES) framework when attempting to use the approach to wetland restoration.

Scope
This talk will cover the process of learning about the ES framework and outline points of consideration that I have encountered when attempting to develop an ES analysis that will support wetland restoration in the Ormond Beach area of Ventura County.

Methods
The presentation will identify the points a regulator needs to consider in order to understand how best the ES framework can be moved from planning into an actionable strategy. Points to consider include: What kind of ecosystem services analysis is needed? What kind of technological expertise is needed to complete the analysis? How will the analysis be used? How much will the analysis cost? Are there different approaches that could be used? Are there any liabilities associated with the quantification? Do we need to use monetary estimates? In each case, the points of consideration will be evaluated as they would apply to the Ormond Beach wetland restoration project. Where answers have become clear, those will be related and where there is still uncertainty, this uncertainty will be explained.

Results
The results of the review will describe how the ES framework may be used within the California Coastal Conservancy, and identify the challenges and obstacles.

Conclusions
Conclusions will point toward additional areas of resolution, and address how obstacles may be overcome in the future.

Recommendations
Recommendations will also be developed for California and for other states in similar circumstances.

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AGRICULTURE PERSPECTIVES ON WATER QUALITY TRADING

Brian Brandt, Jeremy Peters, Ryan Bennett** and **Pete Conkle

Starting in 2009, the Electric Power Research Institute (EPRI), American Farmland Trust (AFT) and other collaborators worked with state agencies in Ohio, Indiana and Kentucky to develop and agree upon a water quality trading (WQT) plan for interstate trading in the Ohio River Basin. Water quality trading is an innovative market-based approach to achieving water quality goals for nutrients such as phosphorus and nitrogen through programs that allow permitted emitters to purchase nutrient reductions from another source. In the ORB WQT project, these nutrient credits come from farmers who implement best management practices that reduce nutrient run-off. The ORB WQT project is innovative and unique in its regional and interstate focus, in the leadership that has been shown by the participating states, in the involvement of major stakeholder groups in the Basin, in its strong emphasis on a scientific framework and defensible trading roles and in its determination to secure ancillary ecosystem service benefits with the water quality trades. The agencies signed the trading plan in August 2012.

During 2013 and 2014, EPRI and AFT worked with 12 SWCDs in interstate watersheds to complete nearly 30 projects on farms to reduce nutrient runoff. The projects were implemented on both row-crop and livestock farms and included a range of seasonal and structural practices. Presenters in this symposium will provide insights into the perspective of producers that have participated in the trading program, producer groups that have the potential to participate in Water Quality Trading markets and Soil and Water Conservation Districts that can provide technical and administrative services in Water Quality Trading programs.

Presentation 1: “Overview of Ohio River Basin Water Quality Trading and Stimulating Environmental Markets Projects from Ag Perspective” Presenter: Brian Brandt, Director of Ag Conservation Innovations, American Farmland Trust

Presentation 2: “Perspective and Engagement of Conservation Districts on Water Quality Trading Markets,” Presenter: Jeremy Peters, Chief Operations Officer, National Association of Conservation Districts

Presentation 3: “Perspective and Engagement of Dairy Industry in Water Quality Trading Markets” Presenter: Ryan Bennett, Director of Government Relations, National Milk Producers Federation

Presentation 4: “Perspective of Producers and Local SWCD Staff Participating in Water Quality Trading Markets” Presenter: Pete Conkle, District Program Coordinator, Columbiana County SWCD

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STORMWATER RETENTION CREDIT TRADING AND OTHER GREEN INFRASTRUCTURE INCENTIVES IN THE DISTRICT OF COLUMBIA

Evan Branosky[1] *and Matthew Espie*[2]

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The Stormwater Retention Credit (SRC) trading program provides revenue for voluntary installations of green infrastructure that enhances regulating (e.g., water timing and flows, erosion control, natural hazard mitigation) and supporting (e.g., habitat, nutrient cycling, water cycling) ecosystem services. Other programs, such as RiverSmart Rewards, which offers discounts on impervious area fees in the District, and direct-spending programs, provide additional revenue to finance projects that benefit the District's waterbodies. This session will explain the objectives and structure of these programs. In addition, it will review the tools available for potential participants to calculate benefits from their projects for marine ecosystems and determine SRCs from planned projects. The session will also address the financing issues that potential participants should consider before becoming involved in these programs.

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EMERGING POLICY DIRECTIONS TO SUPPORT MARKET-BASED APPROACHES FOR ENDANGERED SPECIES AND HABITAT CONSERVATION

Paul Souza
US Fish and Wildlife Service

Presented by: **Larry Bright**

In 2014, the Department of Interior is releasing several guidance and policy documents related to market-based approaches for endangered species and habitat conservation. Paul Souza will discuss the emerging national policy environment around mitigation, including implications for an evolving, landscape-scale approach to better achieve development and conservation goals.

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ECONOMIC VALUATION OF CHANGES IN ECOSYSTEM SERVICES PROVISION WITHIN A LIFE CYCLE APPROACH

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Daily our activities depend on, and impact, the natural capital. In order to improve the integration of the natural capital in their decisions, private and public decision makers have little information. One instance of this lack of information is foremost related to the dependence level of production activities towards natural assets, which constitute a risk for both corporate and society sustainability. To decrease these pressures to the natural capital, we need methods that allow producing better suitable information for decision making. Yet the transition from scientific knowledge to actual decision remains an important challenge for researchers, companies and public administrations. In this research, we propose to focus on impacts of economic activities regarding the consumption-production processes, for which the prices of goods and services do not fully reflect actual ecological (and social) costs. This disjunction produces unbalances within the economy, advantaging those organizations that do not take into account different externalities in the management of their activities. We assume here that the provision of quantitative and economic information on environmental externalities would allow consider them in decisions. In order to get the relevant information, we propose to combine life cycle approach and the ecosystem services (ES) concept. With our method, we assess how changes in ES provision influence changes in livelihoods, health, cultural values and others metrics of well-being. Changes in ES provision are assessed by drawing upon ES models at the landscape scale as developed in the InVEST models. First we propose to focus on changes generated by eutrophication impact as an application case, and assess changes in ES provision at the production step from a product generated by three different agricultural production systems, that is an intensive one (baseline) vs. an extensive one vs. an organic one. Our focus is water purification, water provision and recreative ES in an agricultural area. Our results show that an expression in terms of costs as derived from standard economic methods would be significant for integrating the natural capital in accountings, and suggest suitable tools to foster genuine incentives and make economic activities more sustainable.

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THE VALUE OF LEARNING ABOUT NATURAL HISTORY IN BIODIVERSITY MARKETS

Doug Bruggeman
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Use of biodiversity markets to mitigate impacts of development on biodiversity has become increasingly common despite the lack of evidence that such programs achieve conservation goals. A common problem is information asymmetry between land owners pursuing development, who have to buy scientific information to support their goals, and government regulators. Some have argued that this process leads to a bias favoring development over biodiversity protection. This is particularly problematic when attempting to organize trades at a landscape scale to minimize the effects of habitat fragmentation, a commonly cited goal of these markets. A general theory useful for predicting changes in species persistence as habitat area and connectivity change over time is still missing from ecology. Therefore, our ability to predict the conservation value associated with trades, and thus the effectiveness of these markets, remains limited.

In order to develop incentives for learning how landscape change affects species persistence, this study applied Decision Analysis (DA) to hypothetical trades in dynamic landscapes for the red-cockaded woodpecker (*Picoides borealis;* RCW*)*. DA provides a structured approach for including uncertainty into habitat trading decisions. Due to the absence of general theories, spatially-structured, process-based models are often needed such as individual-based, spatially-explicit population models (IB-SEPMs). This study demonstrates how IB-SEPMs can be used to value tradable credits for habitat protection given uncertainty in species' dispersal behaviors. Pattern Oriented Modeling was used to test the ability of alternative dispersal models to reproduce patterns of abundance and genetic diversity observed in nature. The suite of models that most faithfully reproduced observed patterns were then used to evaluate habitat trading scenarios. To incorporate the effects of habitat loss versus fragmentation into the conservation value of trades, Landscape Equivalency Analysis was used to estimate the credits and debits generated by each scenario and putative dispersal model. Landscape Equivalency Analysis is an extension of the resource-based compensation approach applied to a landscape-scale. The equivalency of two habitat patches is estimated by their contribution to abundance and genetic diversity measured at the landscape scale. This approach reduces the probability that a patch serving as a sink is traded for a patch that served as a source, and the probability that other patches in the landscape switch from being a source to a sink as a result of landuse change.

DA determined whether all dispersal models agree regarding which is the most cost-effective trade. If dispersal models disagree regarding which is the best trade, the Expected Value of Perfect Information (EVPI) will be greater than zero. When EVPI is greater than zero, then compared to the case of ignoring uncertainty, collecting more data and reducing uncertainty may lead to a different trade that provides greater conservation benefits at a lower cost. Therefore, EVPI provides an upper-bound estimate of a cost-effective level of investment in research. This study demonstrates that EVPI for RCWs will vary depending on the locations of habitat patches traded. These results suggest that inclusion of DA within biodiversity markets may provide incentives for improving model accuracy in a cost-effective manner.

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INTRODUCING THE ECOSYSTEM SERVICES PRODUCTION FUNCTION LIBRARY

Randall J.F. Bruins[1]*, Theodore H. DeWitt*[2]*, Ming Sheng*[3]*, Melissa Errend*[4]*, Jessica Moon*[5]*, Gregg Lomnicky*[6]*, John Wilson*[6] *and Miranda Gray*[4]

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Ecosystem service production functions (ESPFs) are ecological models capable of estimating the production of ecosystem services. EPA is building a literature-based, online library of ESPFs to assist the development of decision support tools that can help communities preserve and improve their health and well-being. The ESPF-Library (ESPF-L) is needed because ecological valuation approaches based on land cover alone (e.g., benefit transfer, dollars-per-hectare) may not adequately account for variations in ecosystem service production due to stressors, gradients of environmental quality or environmental change. Some modeling and mapping systems geared specifically to ecosystem-service production estimation are available, but many other models described in the literature would also be implementable for this purpose if their key characteristics could be readily accessed and compared. The ESPF-L is structured to clarify the types of questions and environmental contexts each model has been used to address, the ecosystem services it may help to estimate, and the feasibility of its application. ESPF-L fields describe a model's predictor and response variables and the spatiotemporal frame and ecological characteristics of its documented applications. Linkages are made to two ecosystem-service classification systems under development, the Common International Classification of Ecosystem Services and EPA's National Ecosystem Services Classification System. A model-variable typology, based on an ecological management cascade (i.e., from human action, to ecological status, to human well-being), helps users explore potential for inter-model linkage. Ranges of variable values and validation metric values for model applications are recorded; these and other ESPF-L fields lay groundwork for future formal treatment of model (or response estimate) transferability.

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ECONOMIC VALUATION OF FLOOD MITIGATION SERVICES

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The ecosystem services provided by wetlands are widely recognized but difficult to quantify. In particular, estimating the effect of landcover and land use on downstream flood outcomes remains challenging, although economic valuation can be a key step in incorporating ecosystem services into decisions. We estimate the economic value of flood mitigation by the Otter Creek wetlands for Middlebury, VT using scenarios with and without wetlands to buffer the flood that followed Tropical Storm Irene, as well as for ten historic floods. In each case the observed hydrographs reflect the influence of upstream wetlands, whereas without wetlands the river is assumed to deliver the same water volume over a shorter time interval which reflects the timing of water delivery recorded in hydrographs upstream of the wetland complex. We mapped flood extents for each scenario using LiDAR DEM data and calculated monetary losses as a function of flood depth and housing value. We measure the economic value of wetlands for flood mitigation as the difference in damages between the with and without wetlands scenario for each flood, and determine the mean annual value of flood mitigation services as a function of the mitigation value for each flood and the return interval of that flood. Our analysis indicates an 88% reduction in damages following Irene and equivalently significant mitigation values over time. Economic impacts of this magnitude stress the importance of wetland conservation and warrant the consideration of ecosystem services in land use decisions.

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THE FUTURE OF REVALUING ECOSYSTEMS

Lauretta Burke
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How do people, governments, and corporations "value" ecosystems? And how can you put a price on the vast array of social, economic, and environmental benefits that ecosystems provide?
These are just two of the questions experts sought to address at "The Future of Revaluing Ecosystems," an event convened in Bellagio, Italy, by the World Resources Institute (WRI) in collaboration with the Rockefeller Foundation, Forum for the Future, and the Economist Intelligence Unit. The meeting brought together 32 participants from public, private, non-profit, and research sectors to consider how society could include in public and private decision-making a more complete valuing of the benefits ecosystems provide to people. The discussions shed light on how we can evaluate ecosystems' worth to communities and businesses —and how to use these valuations to foster better environmental stewardship.
The loss and degradation of ecosystems is caused, in part, by the limited ways in which they are valued. While ecosystems are almost always valued for extractive resources, they are rarely valued for the full suite of goods and services they provide. In addition, markets rarely capture the environmental costs of production, such as air and water pollution, or the emission of carbon dioxide.

The premise behind the meeting is that if decision-makers understood ecosystems' true worth—taking into account all the goods and services they provide—it would help promote longer-term thinking and provide incentives for restoration and sustainable use of ecosystems. To that end, experts at the event in Bellagio explored the many current as well as anticipated barriers to mainstreaming ecosystem valuations, and began exploring concrete solutions that could be viable by 2025. WRI has developed a summary of key ideas emerging from the meeting, including:

Scaling up the restoration of degraded landscapes through the development of "restoration bonds," which would provide funding needed in the short-term to transition from conventional practices that degrade ecosystems to more sustainable production systems that restore ecosystems;

Mainstreaming ecosystem service risk assessments in private sector supply chains – thereby encouraging more sustainable use and restoration of ecosystems;

Communicating the resiliency and benefits of healthy ecosystems thought more targeted modeling, monitoring, and compilation of validated and compelling information, and by having "rapid response teams" ready to share information shortly after disasters like storms, floods, and droughts, and establishing a "data peace corps" to assist local stakeholder groups in conducting economic valuations of the services and benefits provided by ecosystems.

The presentation will highlight opportunities for integrating ecosystem services in decision-making across different scales.

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PERFORMANCE METRICS FOR ECOSYSTEM GOODS AND SERVICES GENERATED BY NATURAL, NATURE-BASED (NNBF) AND STRUCTURAL FEATURES IN THE POST-SANDY ENVIRONMENT

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Ecosystem goods and services (EGS) characterization is a relatively new tool in flood risk assessment and management , but has promise in providing planners and managers with a method to assess competing natural and nature-based features (NNBF) and structural design options with the intent of enabling better, more holistic flood risk management solutions. There is strong interest across many organizations to use NNBF in combination with structural features to reduce coastal flooding risks and improve the social, economic, and ecosystem resilience of coastal systems nationwide. In the aftermath of Hurricane Sandy, there is now evidence that NNBF can reduce flood risk and provide a wide range of economic, environmental, and social benefits above and beyond the direct impacts of flood inundation, waves, and erosion. Here we describe an initiative to support the North Atlantic Coast Comprehensive Study (NACCS) in developing relevant performance metrics (couched in terms of EGS) that can be used to characterize the benefits generated by solutions for the post-Sandy recovery efforts. Twenty one ecosystem services were used with 72 quantitative performance metrics to capture the full suite of social, environmental, and economic benefits generated by 30 NNBF and structural features, used to promote flood risk reduction and improve the resilience of coastal communities. Each feature (e.g., dunes, wetlands, seawalls, etc.) was decomposed into its critical components (i.e., physical characteristics such as soils and vegetative properties) and the ecosystem functions and processes associated with these components were linked through causal pathways to the goods or services the feature would provide (e.g., aesthetics, habitat provisioning, wave attack reduction). From there, benefits were derived (e.g., scenic beauty, Threatened and Endangered species protection, flood risk reduction) and a metric for each line of evidence was developed (e.g., vegetative cover visible to local community, habitat suitability indices, and flood prone area reduction). We developed three methods to analyze EGS-based benefits for the NACCS. The first approach focuses on a qualitative ranking system where stakeholder preferences are elicited with regards to NNBF applications. A second, semi-quantitative method has been developed to expose lines of evidence linking features to benefits through causal pathways. The third approach focuses on the development of quantifiable metrics using readily available GIS-based data to characterize landscape-level performance of NNBF using a variety geoprocessing techniques documented in the relevant scientific literature. In addition, a Benefit Transfer table was developed using published to provide an alternative means for quantitatively characterizing the goods and services. We conclude by describing the knowledge gaps still remaining, discuss the path forward with respect to new research initiatives that could be undertaken to support both the NACCS and the field of EGS as a whole.

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CONNECTING GREEN SPACE, TREE COVER, AND BIRTH OUTCOMES IN DURHAM-CHAPEL HILL, NC

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Green space provides many ecosystem services relevant to human health. We investigated associations between green space, tree cover, and near-road tree cover with birth weight (BWT), pre-term birth (PTB), and low birth weight (LBW).

Births occurring around Durham-Chapel Hill, NC, between 1 January 2004 and 31 December 2009 (n = 27,293) were included. Land cover was classified based on 2010 USDA National Agriculture Imagery Program data at 1-meter resolution. Percent total green space, percent tree cover, and percent near-road tree cover were calculated around each address using 50m, 100m, 250m, and 500m buffers. Proximity to a major road was dichotomized as near (<250m) or far (≥250m) using NCDOT data. Linear regression was used to model BWT (g) and logistic regression was used to model LBW (<2500g) and PTB (< 37 weeks), both controlling for maternal race, age, education, tobacco use, parity, marital status, and infant sex. A stratified analysis compared effects across proximity to a major road, race, and education.

Both percent green space and percent tree cover around the home were significantly associated with a moderate increase in BWT. A 10% increase in green space within 50m of the home was associated with a 6.37g (95% confidence interval (CI): 2.91, 9.82) increase in BWT; the association was consistent across buffer size. A 10% increase in near-road tree cover within 250m of the home was associated with a reduction in the odds of LBW, 0.997 (95% CI: 0.994, 0.999) and PTB, 0.997 (95% CI: 0.995, 1.000). While not significant across all buffers for the overall population, near-road tree cover is consistently protective for the population within 250m of a major road.

Few studies have reported on the role of green space in reducing the risk of poor birth outcomes; none have designed a high-resolution near-road tree cover metric to explore near-road air pollution abatement as a potential mechanism. This work further highlights the potential buffering capacity and health promotional aspects of green space and tree cover.

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ASSESSING THE RELATIONSHIP OF CLIMATE CHANGE, FORESTS, AND ECOHYDROLOGY IN HONDURAS

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An assessment of climate change vulnerability and its links to biodiversity conservation in southern Honduras was conducted last year for the U.S. Agency for International Development (USAID) by a multi-disciplinary team of consultants from the African and Latin American Resilience to Climate Change (ARCC) Project. The latest Intergovernmental Panel on Climate Change (IPCC) projections for temperature and precipitation were used to model the ecological climate envelope in southern Honduras in 2050. Climate predictions suggest a very significant eco-climatic shift, which would decrease the area suitable for cooler and wetter types of upland forest ecosystems by almost 50 percent. Such upland forests play a critical role in the ecohydrology of the Gulf of Fonseca Basin, enhancing infiltration and reducing surface runoff, and thereby stabilizing stream flows and recharging aquifers. Therefore, this predicted eco-climatic shift has the potential to degrade a critical ecosystem service upon which the livelihoods and economy of the region depend. Because the eleven protected areas of the region conserve important areas of natural forests and mangroves, they contribute significantly to the maintenance of ecohydrological services and anchor the natural climate resilience of the region. Climate change adaptation in southern Honduras will require watershed- and landscape-scale forest protection and restoration. Compensation mechanisms to finance those activities need to involve all potentially-affected stakeholders, from commercial agro-industries and municipalities to small-scale subsistence farming and fishing communities.

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INCORPORATING ECOSYSTEM SERVICES INTO THE GENUINE PROGRESS INDICATOR (GPI)

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The genuine progress indicator (GPI) is an alternative measure to Gross Domestic Product (GDP), that discounts non-productive spending (e.g. costs of crime, family breakdown), inequality, and decreases in long term sustainability (e.g. loss of natural lands, depletion of non-renewable resources), in an effort to better reflect the current condition and trajectory of the studied state, country, or region. When the GPI was first conceived it did not include ecosystem services in the equation except to calculate what was lost when land was developed. Recent calculations of the GPI in Utah and Baltimore, Maryland have included ecosystem services on the positive side of the GPI ledger, but a consistent methodology for doing so has yet to be developed. This presentation will review how previous work has incorporated ecosystem services into the GPI and the ramifications of doing so. Suggestions will be made for incorporating ecosystem services into the Maryland GPI in a way consistent with the goal of GPI calculations, i.e. reflecting the effect of services from the environment on the welfare of people residing in the studied area. Results for the State of Maryland with and without the inclusion of ecosystem services in the GPI equation will be presented, and implications for current and future policy discussed.

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OIL SPILL RESPONSE AND PLANNING IN THE ARCTIC: ADAPTIVE MANAGEMENT WITH A FOCUS ON ECOSYSTEM SERVICES

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Given the growth in oil and gas exploration and production in Arctic regions, it will be important to understand the ecosystem services provided by various Arctic regions and adaptively develop response actions to minimize potential risks to these ecosystem services. The prevention of oil spills remains a top priority for the oil and gas industry with a continued industry commitment to responsible Arctic exploration and development. In addition, the oil and gas industry recognizes the benefits from continuous improvement of oil spill response and preparedness actions and is committed to further improve the technologies and methodologies for Arctic oil spill response. In order to build on existing research and improve the technologies and methodologies for Arctic spill response, the oil and gas industry has established an Arctic Oil Spill Response Technology - Joint Industry Programme (Arctic Oil Spill Response JIP). The JIP is developing and enhancing technologies to minimize a spill's impact on the environment to improve the ability to respond to oil spills in the unlikely event they occur. One focus of the JIP is the development of a Net Environmental Benefit Analysis (NEBA) framework for response decision-making and environmental impact assessments related to Arctic spills. The JIP will be evaluating a variety of response technologies such as dispersants, remote sensing, mechanical recovery, and in-situ burning in field settings so as to support the development of actions that help to minimize risks to the environment. These technologies will be evaluated within several Arctic regions so as to assist in adaptively managing oil spill response actions to protect ecosystem services in these areas. This presentation will include an overview of the JIP ongoing work in this area including a discussion of the NEBA framework with a focus on the development of Arctic Response Consequence Analysis Tables (ARCAT) for use in response decision-making. In addition, an overview of the field studies being designed will be discussed.

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USING THE FOREST ECOSYSTEM SERVICES TOOLKIT (FEST) TO ASSESS THE IMPLICATIONS OF BIOMASS HARVESTING ON ECOSYSTEM SERVICES

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The Forest Ecosystem Services Toolkit (FEST) is a collaborative USDA-funded effort to couple long-term ecological data with contextual social information to generate dynamic measures of ecosystem services (ES). Currently in development, FEST will allow users to explore how forest management, climate change and pollution shape the capacity of forest watersheds to deliver essential and desirable services to human populations at multiple scales. Our initial focus is on regulating and supporting services, such as the capacity of forest watersheds to provide high quality water to meet multiple human needs and to sustain growth of biomass for use as timber, energy feedstocks, carbon storage, or wildlife habitat. Ultimately, it will be possible to use FEST to understand trade-offs as well as bundling among ecosystem services. This will be valuable to regulators and policy-makers hoping to understand how the flow of ecosystem services from forests may change under multiple scenarios of management, land use, climate change, and acid deposition.

In this case study, we used FEST methodologies to assess the impacts of biomass harvesting on a suite of ecosystem services, including flow regulation (flood regulation, drought mitigation, flow stability), water quality regulation (regulation of chemical pollutants, remediation of nutrient pollution), greenhouse gas regulation, and supporting services associated with forest growth (standing biomass, forest composition). Services were assessed using both social data and long-term ecological data from three research sites: Hubbard Brook Experimental Forest, Turkey Lakes Watershed, and the Neversink River Research Watershed. In the short-term, trade-offs were apparent between provisioning services (biomass fiber) and both greenhouse gas regulation and forest growth services. In contrast, biomass removals did not strongly impact regulation of water flow or water quality. In the long-term, greenhouse gas regulation and forest growth services recovered in harvested stands as stand vegetation regrew. In fact, there is reason to believe that, over multiple rotations, the cumulative value of the greenhouse gas regulation service in the harvested stands would eventually exceed that in the reference stands.

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VALUATION OF NON-MARKET SERVICES PROVIDED BY GULF OF MEXICO HABITATS

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There exists the need for primary research in the area of passive use values, particularly as they relate to Gulf of Mexico coastal ecosystem services. Passive use values are not associated with any direct use of the ecosystem so they cannot be assessed by means of information on actual behavior. Estimating these values requires using stated preference valuation techniques. Because the passive use valuation literature on coastal ecosystem services in the Gulf of Mexico is very limited and transferring results from other studies to the current context entails yet additional limitations and concerns, a sample of residents of the five U.S. Gulf States was surveyed to elicit their preferences for habitat conservation options.

Here we present the results of a survey that was administered to about 1200 households in the Gulf of Mexico region to value the non-market ecosystem services provided by coastal habitats, specifically marshes, mangroves, and oyster reefs. Respondents were asked to choose amongst different programs where each alternative was described by several attributes, one of which was cost to the household. Econometric methods, specifically logit models, were employed to analyze the probability of choosing a specific program as a function of the levels of program attributes and respondent characteristics. The estimated coefficients for different program attributes revealed information on preferences and the tradeoffs respondents were willing to accept between different attributes. Given that one of the attributes was cost, the tradeoffs between different attributes were expressed in monetary terms as willingness to pay for conservation of habitat and associated passive use ecosystem services.

While the immediate aim of this project was to value ecosystem services provided by specific Gulf habitats, the long-term impact of this project will be its influence on how our coastal natural assets are effectively managed.

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PEWI: FOSTERING A BROADER AUDIENCE FOR AGROECOSYSTEM SIMULATION

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PEWI, an acronym for People in Ecosystems Watershed Integration, is an interactive, web-based educational tool for exploring relationships between land use and ecosystem service tradeoffs in an agricultural watershed. We have designed PEWI as a simple tool to help users understand complex relationships between human design of the landscape and agricultural and environmental outcomes. With PEWI, our objective is to allow users to better visualize market and non-market environmental outcomes of land-use decisions.

PEWI is an open-source online tool with a simple approach: users design and evaluate patterns of land use on a virtual US Corn Belt watershed across multiple years and variable climate conditions. PEWI illustrates agronomic, watershed, and biodiversity management principles important for sustainable land use and land management. The tool also teaches complex principles key to human livelihoods, including resilience and adaptation during periods of climate and political-economic uncertainty. Our goal is to foster multidimensional and integrative thinking regarding land-management decisions. PEWI differs from other models that simulate the complex tradeoffs associated with land use in that it does not require guidance from expert modelers. The tool provides instant feedback to any user, reveals both relative and absolute tradeoffs among ecosystem services, and does not require user-supplied data. This innovative approach allows stakeholders to simultaneously consider agricultural land use, climate conditions, production outcomes (e.g., crops and livestock), and environmental outcomes such as nutrient and sediment levels in water, habitat provision for biodiversity, soil erosion, and carbon management.

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ADVANCING SEEA EXPERIMENTAL ECOSYSTEM ACCOUNTING

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Ecosystem accounting is an emerging field dealing with integrated biophysical data, monitoring changes in ecosystem assets and linking those changes to economic and human activity. The development of ecosystem accounting is in response to a wide range of demands for integrated information that can link analytical and policy frameworks on environmental sustainability, human well-being, and economic growth and development.

Increasingly, polices are being considered in a more integrated, multi-disciplinary fashion with economic, social and environmental factors being assessed when determining appropriate policy responses. Ecosystem accounting can provide a new perspective that can be used to support decisions on the most effect use of ecosystems in support of individual and societal well-being.

The System of Environmental-Economic Accounting (SEEA) Experimental Ecosystem Accounting (EEA), considered by the United Nations Statistical Commission at its 44th session in 2013 as an important step in the development of a statistical framework for ecosystem accounting. It provides a synthesis of the current knowledge in this area and represents a strong and clear convergence across disciplines of ecology, economics and statistics on many core aspects related to the measurement of ecosystems.

Increasing the application of SEEA EEA can provide an integrated measurement framework to inform the post-2015 development agenda and the Sustainable Development Goals monitoring process. The structural links between SEEA EEA and the standard economic accounts of the System of National Accounts (SNA) make it possible to evaluate the extent to which ecosystems are impacted by economic activity and assess the potential for alternative patterns of consumption and production, alternative uses of energy and the extent of decoupling of growth, the effectiveness of resources spent to restore the environment, and the trade-offs between alternative uses of the environment.

The SNA provides an integrated and coherent set of information on the economic system. SEEA EEA provides a picture of trends in ecosystems through integration of information on stocks and changes in stocks of ecosystem assets, and information on flows of ecosystem services. Linking the changes in stocks and services with beneficiaries (individuals and society) can provide a coherent picture of trends. Through the application of consistent principles and conventions, ecosystem accounting provides a tool for compiling information on environmental changes and linking these changes to economic and human activity.

The development and testing of the SEEA EEA requires multiple disciplines across many agencies. The establishment of appropriate institutional mechanisms is essential if the work is to be routinely implemented. The advancement of the SEEA EEA program will improve the integration of information on ecosystems into decision making and policy processes.

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QUANTIFYING CULTURAL AND SOCIAL ECOSYSTEM SERVICES IN THE URBAN CONTEXT

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Contributions of urban ecosystems to human well-being have been emphasized in recent policy, but with less attention to important cultural and social services and nonmaterial values. And despite the fact that ecosystem services (ES) are beginning to surface in land steward policies and decision making, consideration and application of cultural ES in the urban context have received little attention in the social sciences. In order to appropriately prioritize land use decisions and adequately plan for the steps needed to ensure cultural sustainability and ecological biodiversity, the links between urban greenspaces, economic prosperity, and cultural value must become evident.

Earth Economics (EE) will present current research on the development of a framework for identifying and quantifying social and cultural ES. In 2013-14, Earth Economics conducted an economic and social analysis of natural infrastructure within the Green-Duwamish Watershed, which flows directly into to the Puget Sound. The project was designed to facilitate watershed-wide investment in ES and sustainable planning and management of natural resource and to test a new framework for identifying and valuing cultural and social benefits as part of an overall ecosystem service valuation of the watershed.

This framework is informed by work EE undertook in 2011, where it partnered with Metro Parks Tacoma to provide an analysis of the ES, health and social values of the 70 parks in Tacoma, WA. With an emphasis on the importance of restoration in the parks, the study focused on the increased value of removing invasive species and the rehabilitation of the park's natural vegetation. This research included estimations of health benefits from physical activity and air purification, two ancillary services provided by Tacoma's urban parks. Earth Economics' report contributed to the passing of a $198 million bond in 2014, passed unanimously by voters in Tacoma, WA.

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A NET ECOSYSTEM SERVICES ANALYSIS OF REMEDIAL ALTERNATIVES FOR A SURFACE IMPOUNDMENT IN THE SOUTHWEST

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A surface impoundment at a manufacturing facility in the Southwest is currently dry. Part of the impoundment has 1-foot of soil and vegetation covering hazardous substances released by the manufacturing facility, while the remainder of the impoundment has no soil cover or vegetation. The state regulatory agency wants the partial soil cover and vegetation removed and then the entire impoundment covered with 3-feet of soil and seeded vegetation. The company prefers to leave the partial soil cover and vegetation in place, and then put 1-foot of soil cover with seeded vegetation over the remainder of the surface impoundment. An intermediate remedial alternative would be to remove the partial soil cover and vegetation and put a 2-foot soil cover with seeded vegetation over the entire surface impoundment.

A Net Ecosystem Services Analysis (NESA) is being considered to rank the remedial alternatives from best to worst from an ecosystem services perspective. Specifically, a NESA uses Habitat Equivalency Analysis (HEA) to estimate the aggregate, net ecosystem services over time provided by each remedial alternative, and the remedial alternative with the greatest aggregate, net ecosystem services is the preferred alternative. Alternatives with negative net ecosystem services should not be implemented, because they do more harm than good. The costs of the remedial alternatives play no role in a NESA.

There will be five main steps in the NESA. The first step will be to identify the ecosystem services provided by the vegetation on the partial soil cover on the surface impoundment and the vegetation on the borrow areas where the soil for the cover of the remainder of the surface impoundment will be obtained. Then, in the second step a representative ecosystem service for the vegetation will be selected or an index of several ecosystem services will be developed. The third step will be to estimate the proportion of the selected ecosystem service/index relative to the maximum possible ecosystem service/index for the next 50 years for each remedial alternative for both the surface impoundment and borrow areas. In the fourth step, the timepaths of the relative ecosystem services for each remedial alternative will be converted into their present-value equivalent using a 3% discount rate and then will be summed. The final step will be to rank the remedial alternatives from best to worst using the magnitude of the present-value-equivalent, aggregate, net ecosystem services.

If the NESA is implemented in the Fall, as planned, then the results will be available by December for the ACES conference. If the NESA is not implemented, then the authors will use illustrative inputs and calculations to demonstrate the use of the methodology for ranking remedial alternatives from an ecosystem services perspective.

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A PHOSPHORUS CREDIT TRADING PROGRAM IN AN AGRICULTURAL WATERSHED

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Lake Okeechobee is the largest lake in the southeastern United States and is a central hydraulic component of the Everglades ecosystem in South Florida. Throughout the years, the Lake Okeechobee watershed has been degraded as wetlands and natural habitats have been replaced with farms, urban areas, and dairy operations. Excessive phosphorus loadings from these diverse sources have been identified as the leading causes of the lake's impairment. Reducing phosphorus loadings in the watershed is necessary to restore and enhance the lake's ecosystem services. However, this generally involves the implementation of phosphorus loading control programs requiring economic resources and investments. Water quality trading programs have emerged over the past decades as a mechanism to cost-effectively achieve water quality objectives in impaired watersheds. The main objective of this research was to assess the environmental and economic benefits of implementing a phosphorus credit trading program in a sub-basin of Lake Okeechobee watershed (S191 sub-basin), as compared to a command-and-control approach, while achieving a specific phosphorus reduction goal.

A comprehensive methodology coupling hydrology and water quality models to an economic model was developed, to estimate the Total Phosphorus (TP) loadings generated at the farm level, reaching the streams, and attenuated to the sub-basin outlet from all sources within the basin. Once the TP loadings were assessed, the optimal combination of Best Management Practices (BMPs) was determined while minimizing the cost of attaining a TP reduction target. Moreover, a complete trading scenario was developed in order to 1) determine the optimal credit price, 2) identify potential buyers and sellers of credits, 3) estimate the amount and cost of credits to be traded while considering features, such as trading ratios and transactions fees, and 4) estimate the potential cost savings of a phosphorus credit trading program. The cost savings of the trading program was quantified considering two phosphorus abatement scenarios: a command-and-control approach and a least-cost abatement approach.

The hydrology and water quality modeling yield TP loadings of 106.4, 91, and 85 mtons yr^{-1} at the farm level, reaching the streams, and attenuated to the sub-basin outlet, respectively. Almost 95% of the TP loadings reaching the nearby streams were attributed to agriculture sources, and only 1.2% originated from urban areas. A 30% load reduction was estimated as the most cost-effective TP target for the two abatement scenarios, and the individual allocation was set at a TP load target of 1.6 kg ha^{-1} yr^{-1} (at the nearby stream level). The least-cost abatement scenario generated a potential cost savings of 27% ($1.3 million per year), based on an optimal credit price of $179. Dairies (major buyer), ornamentals, row crops, and sod farms were identified as potential credit buyers, whereas improved pastures (major seller), citrus, and urban areas were identified as potential credit sellers. Almost 81% of the TP credits available for trading were exchanged. The methodology developed in this study can be adapted to deal with different forms of trading sources, contaminants, or other technologies and management practices in different watersheds.

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CASE STUDIES ON CONSIDERING ECOSYSTEM SERVICES IN US ARMY CORPS CIVIL WORKS PROJECTS

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There has been interest for several decades in assessing the benefits that humans derive from naturally functioning ecosystems. The concept of ecosystem goods and services is not entirely new to the U.S. Army Corps of Engineers (Corps). As reflected in the 1950 publication, "A Water Policy for the American People" (The Report for the President's Water Resources Policy Commission), services that might be "enhanced" to allow for economic development have long been recognized as opportunities for intervention and alteration by humans. The Corps is exploring the potential for using Ecosystem Goods and Services assessment as a means of illustrating the value of Corps projects, particularly restoration projects, in ways that are more meaningful to the public than solely by the habitat metrics currently employed.

This talk will describe a few past attempts to consider, either implicitly or explicitly, ecosystem goods and services in the context of Corps project planning, and identifies obstacles those efforts met that could be avoided in the future. The lessons learned from previous attempts are informing the development of a framework and guidelines that could be used by Corps Districts to analyze ecosystem goods and services in the planning process.

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LINKING ECOSYSTEM SERVICES AND HUMAN HEALTH: THE ECO-HEALTH RELATIONSHIP BROWSER

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Ecosystems and the services they provide have been linked in the literature to multiple human health outcomes. Demonstrated and proposed mechanisms focus on the hazard buffering and health-promotional aspects of ecosystems. The Eco-Health Relationship Browser is an interactive, educational tool created by the US EPA to illustrate the many published linkages between human health and ecosystem services, and explores mechanisms where possible. The Browser provides results from studies designed to isolate health effects mediated by nature experiences, versus physical activity or social interaction that lacks a green component.

Services such as air and water filtration, heat mitigation, and water regulation act as buffers against environmental pollutants and natural hazards. Filtration and many other regulating services have been quantified under a range of field conditions. Epidemiological evidence supports hazard buffering by natural features, typically through plausible associations rather than causal experiments. Opportunities for physical activity and engagement with nature can promote healthy behaviors; these services have been linked to a broad range of improved health outcomes, including reductions in stress and blood pressure and improvements in cognitive function. For health promotional services, physiological evidence of stress reduction has been documented in direct response to both visual and physical access to green space. This health benefit promotes cognitive function and is protective for many diseases. Stress reduction has been shown to result from physical activity, social interaction, and engagement with nature.

The Browser represents the state of the science on eco-health relationships. It was designed to demonstrate the multiple benefits of green infrastructure and increase awareness of nature's role in individual and community health and well-being. The current version features four ecosystems, including urban systems, six ecosystem services, and more than 30 related health outcomes. Information presented in the Browser is the result of a systematic literature review evaluating the evidence from peer-reviewed journal articles published from 1 January 1990 to 31 December 2013. Diagnostics show that these publications have increased dramatically over time, and span the ecology, public health, and urban design literature. The Browser can help users identify the extent to which ecosystem services have been associated with health outcomes, and has the potential to help practitioners and decision makers better understand the synergistic benefits of healthy and functioning ecosystems.

Although this material was reviewed and approved by EPA, it does not necessarily reflect official Agency policy.

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ECOSYSTEM SERVICES IN THE ARCTIC FROM THE LOCAL PERSPECTIVE AND FUTURE CHALLENGES IN LIGHT OF A CHANGING ENVIRONMENT

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Healthy Arctic ecosystems are of fundamental economic, cultural and spiritual importance to indigenous Arctic peoples. Ecosystem Services (ES) should be recognized as outcomes of natural environmental processes that affect people and through a positive feed-back system, people affect those processes. In this presentation we highlight ES from an Inuit perspective. ES benefiting humans include: provisional (food), regulating (water filtration), support (biomass) and cultural (knowledge systems) services. ES interact with one another; for example migration timing or changes in supporting services could impact when harvest preparations and practices occur. Climate change adds complexity, as the relationships people have with the environment transform. For example, within Inuit Traditional Knowledge it is understood that ice is a common abiotic feature interacting and affecting all other subsystems. While the culture evolved to survive within an environment dominated by ice, people developed knowledge and traditions of how to use ice for transportation, storage, water, protection, among others. As the ice thins and changes, the knowledge and relationship held between the culture and the ice will change. As a result, hunting strategies change. Hunting strategies include multiple social and cultural characteristics, such as education, language, and many others. This example stresses the complexity of interlinking systems. Because ES categories are inter-connected through the Arctic food-web, creating a model through a food-web-lens will allow the incorporation of both social & natural science systems in addition to traditional knowledge.

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THE NATIONAL ECOSYSTEM SERVICES STRATEGY TEAM

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Ecosystem services have emerged as an integrating concept to describe the broad suite of goods and services that people receive from nature. In response to the growing interest in ecosystem services, the USFS is identifying needs and opportunities for supporting and further developing an integrated ecosystem services program across the agency. A cross-deputy USFS community of ecosystem services practitioners has formed, and in June 2012 this community held its first ever Ecosystem Services Champions Forum to begin a dialogue on strategic direction for the agency around ecosystem services. Building from this effort the Associate Deputy Chiefs (ADC) signed a charter in January 2013 to establish the National Ecosystem Services Strategy Team (NESST). The NESST core team included scientists from the Forest Service R&D, program specialists from S&P, and planners and economists from NFS in order to address different objectives of each Deputy Area. This original grassroots effort was empowered by the ADC directive and NESST charter that states their purpose is "to collaboratively develop national strategy and policy around ecosystem services and integrate it into Forest Service programs and operations." This is the first effort of its kind for the agency to look broadly across all deputy areas and comprehensively assess opportunities to incorporate ecosystem services approaches into USFS programs and activities.

Across all activities and programs inventoried, NESST identified key next steps needed to take advantage of potential opportunities including policy development, guidance, tools and research methodologies, capacity, and communication and collaboration. NESST provides broad national-scale direction for the agency but will depend on examples of ecosystem services approaches that are implemented at the project and forest scale. For our presentation, we will discuss NESST's national policy development and strategy-building, and how this vision will incorporate an ecosystem services approach into agency decision-making, measuring and reporting, and how it supports and catalyses effective investment in ecosystem services.

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CONSIDERING ECOSYSTEM SERVICES WHEN SEEKING GLOBAL FOOD SECURITY THROUGH SUSTAINABLE LIVESTOCK INTENSIFICATION

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International development agencies are investing significant resources to promote Sustainable Intensification of agriculture in developing countries to address food insecurity. Intensive livestock production in these countries runs the risk of depleting ecosystem services by repeating less than optimum nutrient management practices experienced in the US in the past three decades.

The purpose of this paper is to provide an overview of potential global ecosystem service impacts of livestock intensification and discuss insights gained from two United States case studies into mitigating those impacts. Case studies such as these can inform conservation of and/or generation of bonus ecosystem services to assure intensification remains environmentally sustainable. One case study demonstrates how to leverage a spatially explicit watershed tool to analyze ecosystem service-generating Best Management Practices (BMPs) for nutrient management planning, conservation planning, pasture, and stream access control, while the second study demonstrates application of Intergovernmental Panel on Climate Change algorithms to optimize manure management from a greenhouse gas emissions perspective.

In the former case study, assumed BMP nutrient removal efficiencies for 104 livestock and poultry operations ranging from less than 10% to 80% were estimated to reduce delivery of 57,865 and 3,910 lbs of nitrogen and phosphorus, respectively, to surface waters. These BMPs and their reductions can inform ecosystem service generation, including carbon sequestration. In the latter case study, a comparative analysis was performed for applying four IPCC manure storage practice categories at 190 dairy operations: lagoon, liquid/slurry with natural crust, liquid slurry without natural crust, and dry waste /litter storage. The methodology demonstrates that operation of liquid/slurry manure storage practice without the natural crust cover at dairy farms would emit 75% less greenhouse gas (7,395,000 CO2-eq) than the actual emissions.

It is recommended that international development agencies consider lessons learned from these case studies and their methods developed for predicting 1) avoided ecosystem service impacts and 2) bonus ecosystem services that can be generated. Early adoption of such predictive methods can inform agencies as they plan and implement livestock and poultry production programs in targeted regions.

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PUBLIC DRAIN FEE REDUCTION PROGRAM TO SUPPORT BIOLOGICAL WATERSHED OUTCOMES

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Public drainage fee assessments may present a novel funding mechanism to support agricultural Best Management Practices that can not only reduce public drain maintenance expenditures but also improve the health of aquatic ecosystems. Public ditches, or drains, are common features of Midwest agricultural areas, providing drainage and flood prevention to private property. Sediment impairs the function of these drains, typically requiring the use of heavy machinery to remove excess sediment. In Michigan, drain maintenance expenses are financed through drain fee assessments which are levied on landowners within the drainage district. Assessments are based on the proportional benefit the property receives from the public drain system, typically determined by property size and broad land-use categories. This project aims to test whether Drain Fee Assessments can be revised to incorporate rebates for sediment reductions to reward landowners for adopting agricultural Best Management Practices (BMPs) that reduce drainage management costs. This concept is currently being piloted in two drainage districts in Van Buren County, Michigan and is being further explored through a statewide assessment of public drainage management expenditures. Ecologically significant sediment reduction goals were estimated for the Van Buren County pilot drainage districts with the Soil and Water Assessment Tool (SWAT), modelling watershed Index of Biotic Integrity responses to varying levels of agricultural BMPs. Landowner outreach and contract enrollment is underway. The statewide assessment has identified that the number and extent of public drains is not well documented in the state and that drain management expenditures for sediment removal are either not explicitly tracked or not readily estimated. Many of the Drain Managers contacted through the assessment have also expressed a reluctance to implement performance-based drain fee assessment due to perceived political and legal challenges. Results from the Van Buren County pilot will demonstrate whether landowners are interested and potentially supportive of efficient drain assessment programs, but it is likely that identification of additional cost or management benefits to Drain Managers will be needed for larger scale support of these programs.

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ASSESSING THE TRANSFERABILITY OF ECOSYSTEM SERVICE PRODUCTION ESTIMATES AND FUNCTIONS

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Estimates of ecosystem service (ES) production, and their responses to stressors or policy actions, may be obtained by direct measurement, other empirical studies, or modeling. Direct measurement is costly and often impractical, and thus many studies transfer ES production estimates or models that were obtained or developed in other contexts. This is analogous to socioeconomic benefits transfer, but in the ecological realm. However, few studies rigorously assess the assumptions, accuracy, and errors associated with ecological information transfers, nor the implications for using these estimates at new sites. We have developed methodology to help assess the risk of transferring ES estimates and models. For ES estimates, the transferability assessment (TA) focuses on identifying the expected level of variance in a transferred estimate by describing the contextual differences between the estimate's origin and the transfer site. For ES models, the TA focuses on evaluating the transferred model's potential performance level given both contextual differences between sites and possible changes made to the model. A key part of this work is identifying contextual information that might predict the success of a transfer and creating metrics of contextual difference. The TA was designed in collaboration with the development of EPA's Ecosystem Service Production Function Library (ESPF-L). We demonstrate an example of a TA, including how transfer reliability can be visualized across dimensions of context.

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RECASTING AQUATIC DESIGNATED USES AS ECOSYSTEM SERVICES IN CLEAN WATER ACT PROGRAMS

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The USEPA water quality standards program is based on the 50 year old concept of designated uses (DUs), which specify maximum pollutant levels and, in some States, aquatic biological community characteristics that are thresholds for waterbody compliance with the Clean Water Act (CWA). Most of the DUs adopted by states and tribes are similar to certain provisioning ecosystem services (ES) such as drinking water supply and recreation (e.g., boating, fishing). Strikingly absent in the DU concept is supporting or regulating services, which results in disjointed and often ineffective aquatic ecosystem protection and restoration strategies. The CWA focus on waterbodies, to the exclusion of surrounding land uses and land-water interactions, impedes the achievement of DUs and CWA goals in general.

Two case studies, a Central Valley, CA, USA stream and the lower San Diego River, CA USA exemplify the challenges of complying with competing DUs, based only on water quality parameters, in an agricultural and urban dominated system, respectively. The focus on water quality parameters, often to the exclusion of other relevant factors such as geomorphic habitat features, presence of biological stressors such as invasive species, and hydrologic regime (e.g., urban stormwater and agricultural irrigation effects on stream flow) results in the *appearance* of DU attainment in these two different systems when in fact the actual ES those uses represent are not being provided. An examination of ES actually provided versus the demand for those services (either via public involvement and/or through CWA regulations) in these two case studies is used to demonstrate a potential way in which ES can help improve the DU process. Key to this type of change in use designations and assessment is a clear process by which the regulatory body (e.g., State, Tribe, USEPA) interacts with stakeholders to identify and protect the ES that should be maintained for a given waterbody or watershed. The two case studies highlight how an ES framework, coupled with a watershed stakeholder process, could help identify and achieve multiple beneficial uses in an aquatic system.

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WHAT ARE THE DIFFERENT PURPOSES OF CONSERVATION, AND CAN WE RECONCILE THEM?

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Multiple efforts have recently been made to refocus the field of conservation biology and the practical work of conservation agencies and organizations, de-emphasizing the goal of protecting natural ecosystems or biodiversity for their intrinsic values in favor of protecting the environment for its benefits to humans. While encompassing an emphasis on ecosystem services, these new efforts go farther than most work on ecosystem services, by arguing that efforts to save natural systems or species that are not of direct benefit to humans (often argued as narrowly meaning economic benefits) are misdirected, have failed in the past, and will defeat future progress in conservation. These arguments over the direction of conservation science have inspired debate among academics and conservationists and motivated fundamental changes in the world's largest conservation groups. Despite claims these new, and narrower emphasizes for conservation are supported by the biological and social sciences, we argue here that this painting of the past and the future of conservation has little empirical or logical support. Rather, these new shifts in motivations and goals appear to arise largely from a belief system in which needs and wants of humans hold superiority over any intrinsic rights and values of nature. We counter that conservation has already been successful by embracing multiple goals and approaches, and that the efforts to narrow what are considered valid approaches to conservation are both unreasoned and counter-productive.

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EVALUATING HUMAN WELL-BEING IN RELATION TO SHELLFISH AS A PLACE-BASED CULTURAL ECOSYSTEM SERVICE OF THE PUGET SOUND REGION OF THE SALISH SEA

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We will discuss methods and results from our project employing cultural ecosystem services metrics to better understand the functional, generative and/or provisional relationship of: shellfish harvesting, quality of life activities in proximity to shorelines, sense of place, and other aspects of community well-being. This project builds on more than a decade of socio-eco-cultural indicator development work at the Swinomish Indian Tribal Community, well as with Indigenous and non-Indigenous communities in both the US and Canada by project investigators. We use a mixed-method approach, drawing from Structured Decision Making (SDM) and qualitative approaches to identify, define and assess human well-being associated with the provision of cultural ecosystem services to Puget Sound residents using rigorous, defensible, and locally-vetted indicators.

Via facilitated group workshops, we test indicators based on methods from anthropology and other participatory approaches and from judgment and decision making for designing scales and metrics for subjective variables. The indicators are developed through a two-step process: identified by key community representatives though semi-structured interviews, then refined and tested in group workshops as a series of narrative descriptions of values and ranking tasks. Project researchers facilitated workshops with 3 population subgroups: (a) tribal shellfish interest group, (b) nontribal harvester group, and (c) nontribal non-harvester group in two geographic areas: (1) Central Puget Sound and Swinomish Reservation and (2) South Puget Sound and the Squaxin Island Reservation. This project fills a critical gap in the Puget Sound Partnership's vital signs Quality of Life indicators by addressing sense of place, recreation, and proximity to shorelines as provisioning of cultural ecosystem services and well-being.

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THE INTEGRATION OF BIODIVERSITY VALUES IN URBAN DEVELOPMENT PROJECTS IN NEW SOUTH WALES

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According to the New South Wales State of the Environment Report 2012, biodiversity values keep declining in NSW and the long-term prospects of many species are poor. One of the main causes for the decline of native species is the clearing of native vegetation for urban development. In an attempt to improve the protection of biodiversity values in NSW, the Parliament adopted in 2008 a market-based scheme (BioBanking) that aims to better integrates biodiversity values into development projects. According to this mechanism, any landowner may enter into an agreement with the Minister of the Environment (BioBanking Agreement) in which they commit to manage all or part of their property with the objective of improving or maintaining the ecological values of the site. This commitment generates credits that can be sold to developers that have to compensate for their negative impacts on the environment (offsets). If a developer chooses to enter into the program, their project is deemed to have no significant impacts on endangered species and they are exempted from the obligation to conduct a species impact statement (SIS) under the Environmental Planning and Assessment Act. The whole project, including the offset, must at least be environmentally neutral. However, five years later, the scheme hasn't been as effective as the Government hoped. A current review of the scheme identifies several potential reasons for this under-use. Among these are the high standards of offset required under the BioBanking Methodology, high upfront costs and the voluntary nature of the scheme.

This presentation will start with an overview of the BioBanking scheme, and will then compare it to the traditional assessment of biodiversity impacts under the Environmental Planning and Assessment Act (the "SIS route") and the requirement of offsets in this later context. By this comparison, we will show that the BioBanking route has higher standards, more stringent requirements and complex procedures than the traditional SIS route. As such, this latter route represents an easy and more flexible alternative, and can deter developers from entering the BioBanking route.

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ECOSYSTEM SERVICES, ENVIRONMENTAL STRESSORS AND DECISION MAKING – RESULTS OF A GLOBAL SETAC AND ESA PELLSTON WORKSHOP

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There is increasing awareness that improved environmental management can be achieved by considering more explicitly the benefits that humans receive from ecosystems. In a broad sense, the contributions of ecological systems to the health and well being of people can be considered ecosystem goods and services (hereafter ecosystem services). The ecosystem service concept provides a framework for considering whole ecosystems in decision making, for valuing the services they provide, and for ensuring that society can maintain a healthy and resilient natural environment now and for future generations. A Pellston Workshop was convened by SETAC and the Ecological Society of America (ESA) in Shepherdstown, WV, USA, at the end of September 2014 to develop: 1) broad consensus about, and practical guidance for, the application of the ecosystem services concept to environmental decision making as part of a movement towards environmental sustainability; and 2) work products in the form of scientific manuscripts, booklets, and presentation materials needed to promote environmental stewardship through application of the ecosystem services concept by the memberships of SETAC and ESA globally, and society more generally. Thirty participants from academia, government, industry, and NGOs around the world worked toward consensus on a path forward for putting the ecosystem services concept to practical use in decision making. Individual workgroups considered five main topics: 1) ecosystem services, protection goals and environmental decision making; 2) understanding and applying ecological production functions; 3) applying the ecosystem services concept to risk assessment; 4) applying the ecosystem services concept in natural resource management and restoration; and 5) practical guidance for applying the ecosystem services concept in environmental decision making. This presentation highlights the key findings and recommendations of each workgroup, together with overall recommendations for improving the use of ecosystem services in decision making.

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USING ECOSYSTEM SERVICES VALUATION TO MEASURE THE ECONOMIC IMPACTS OF LAND-USE CHANGES ON THE SPANISH MEDITERRANEAN COAST (EL MARESME, 1850-2010)

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Over the last few decades, Mediterranean coastal areas have experienced profound land-use changes due mainly to urban sprawl and reforestation at the expense of former traditional agrarian mosaics and natural resources, such as beach areas or open freshwaters. These changes have had severe negative consequences on the biodiversity and ecological state of the territory. The overall objective of this study was to evaluate the economic impacts of these consequences. By reconstructing the landscape of El Maresme County (Barcelona, Spain) for three historical points in time (1850, 1954 and 2010), we were able to assess how these land-use changes have affected the ecosystem services (ES) by calculating the non-market and market values of the ES provided by each land-use through market prices and benefit-transfer methods. Results show an important decrease in the value of ES since the 1950's (almost 21 million Euros per year) due to urban sprawl. Despite the major changes occurring between the 1850's and 1950's, non-market values did not alter very much due to the type of agriculture that was practiced. Our results show the necessity to take into account the non-market valued ES when designing land planning policies, and especially those concerning beaches and coastal systems.

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INCORPORATING NATURAL CAPITAL AND ECOSYSTEM SERVICES IMPACTS INTO ECONOMIC VULNERABILITY ASSESSMENTS

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Projections of climate change impacts, including more frequent and severe coastal storms, have motivated research into understanding the vulnerability of coastal communities to these events. These vulnerability assessments frequently consider demographic variables such as income, age, and education as well as economic variables including business disruptions, loss of commercial and residential infrastructure, and expected costs of damage cleanup. The purpose of this research is to begin to extend the current approaches for assessing economic vulnerability to incorporate the risks associated with impacts to environmental assets, including beaches, county, state, and national parks and wildlife refuges, and their associated ecosystem services. The current scope of this work includes Nassau and Suffolk counties on Long Island, New York, areas of particular interest given the impact of Superstorm Sandy upon these coastal counties. At present, the study only considers a subset of impacts upon ecosystem-related benefits—recreational use and provisioning of biomass.

Using a GIS-based approach in combination with existing data on visitation levels and other uses associated with these natural assets, we have developed an approach for integrating environmental asset impacts into evaluations of community vulnerability. Results indicate the variable distribution of potential impacts across the Long Island region and provide a screening tool for ascertaining the areas of highest value (in terms of ecosystem-related benefits) and highest risk. The potentially allows decision makers to prioritize funding to protect, where feasible, the most vulnerable natural assets through directed activities. The annual timing and severity of storms and spatial distribution of beneficiaries affects the degree of loss of ecosystem service benefits associated with these assets. Conclusions from this work include the need to evaluate the location and use of these assets when considering overall risks to economic and human well-being. Future analyses should continue to build upon this initial framework. Recommendations for future efforts include incorporation of non-use losses from changes in the condition of the environmental asset. In addition, implementing appropriate techniques for generating dollar values that can be used in benefit-cost analyses of measures designed to enhance the resiliency of environmental assets would be useful to decision makers.

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BRINGING DRAINAGE WATER MANAGEMENT FOR ECOSYSTEM SERVICES TO MARKET: WHAT IS DRAINAGE WATER MANAGEMENT, WHAT IT IS NOT AND WHAT IS THE POTENTIAL FOR LARGE SCALE ADOPTION TO DELIVER ECOSYSTEM SERVICES

Alex Echols
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Nutrient inputs are critical to the production of abundant reliable food supplies, but if nutrients are lost from agricultural lands can become a significant contributor to environmental degradation. One of the key opportunities to address this degradation is to manage the hydrology that moves nutrients off of agricultural lands. These practices are particularly attractive because they are highly effective, low in cost compared to other conservation practices, and reliable in their performance of ecosystem services in a highly variable environment.

This session will provide an overview of:

The scale that Drainage Water Management (DWM) can be implemented on in the US

What DWM is including the following practices

Tile line management

Surface drainage management

Bio Reactors

Saturated buffers

Nutrient treatment wetlands

Innovative technology on the horizon

What DWM is not including

Degradation of wetlands

Expansion of drainage

Monitoring outcomes from DWM

Third party verification of ecosystem services delivered

Funding including

Federal financial assistance available from USDA

Market investment in ecosystem services

The potential of DWM to make a significant contribution to reduction in environmental challenges such as hypoxia in the Gulf of Mexico and harmful algal blooms in the Great Lakes.

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ROOTING ECOSYSTEM SERVICES THEORY IN URBAN GREENING PRACTICE

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Municipalities around the world are showing significant interest in urban greening, defined here as the introduction or conservation of vegetation within the jurisdictional limit of cities. Singapore has established a goal of "pervasive greenery . . . wherever the eye could see." Berlin and Seattle have adopted innovative planning policies that require the minimum surface of a site to contain flora. Toronto, Portland, and Tokyo are pursuing efforts to promote vegetated roofs, and roughly 100 living walls have been installed in Paris. Cities across the United States, in turn, have launched large-scale tree planting initiatives – some of which are aiming for a million trees within the decade.

To implement greening initiatives and maintain plant material across the urban landscape, municipal officials and non-governmental actors must rationalize the allocation of limited capital and resources in the contested space of the city they serve. Ecosystem services have emerged as a prominent basis and decision-making tool in this process. Yet, many commonly cited advantages of urban flora are poorly supported by empirical evidence, and numerous studies frame urban vegetation as an ecosystem disservice.

These discrepancies problematize urban greening theory and practice, and suggest flaws in the conceptualization and application of ecosystem services in urban settings. Drawing upon an assessment of existing literature, this presentation will explore the potential source, contours, and implications of this gap, focusing on three points of tension: 1/ conflicting definitions of urban ecosystem services; 2/ varying conception of ecosystem functions vis-à-vis ecosystem services; and 3/ lack of public health scholarship in ecosystem services discourse. The latter point is especially noteworthy, as human health is "the central aspect" of ecosystem services according to the Millennium Ecosystem Assessment.

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THE VALUE OF TECHNICAL ASSISTANCE

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Science-based technical assistance is the foundation for resource conservation and environmental management on the nation's grazing lands. Grazing lands provide critical habitat for numerous plants and animals. They provide environmental benefits such as habitat for wildlife, open space and healthy watersheds, as well as food and other commodities. These lands provide many economic and environmental benefits not only to those who own them, but to all citizens. The extent of these benefits and impact is dependent upon how well these lands are managed. If not managed properly, these benefits will not be realized. If managed properly, then many will benefit. As land managers and professionals providing assistance, our goal should be to promote the wise use of our grazing lands resources and manage them so that the benefits are widespread and enjoyed by all.

The value of conservation to society is long-established. The value of technical assistance is not. This paper describes the financial impact and value of conservation technical assistance provided by the Samuel Roberts Noble Foundation (SRNF). The SRNF agricultural division assists agricultural producers and land stewards in attaining their financial, quality-of-life and stewardship goals in an ever-evolving environment by educating and counseling them on the adoption of sustainable, research-proven practices.

This program is staffed by consultants with expertise in the following disciplines: pasture and range, livestock, soils and crops, agricultural economics, horticulture, and wildlife and fisheries. Consultants work closely together across these disciplines to develop recommendations that address each client's unique circumstances. Factors influencing these recommendations commonly include land type, producer skill set and goals. Consulting services are provided at no cost to agricultural producers actively participating in the SRNF consultation program.

Consultants require feedback and information from agricultural producers to ensure that recommendations are appropriate to the agricultural producer's circumstances and the production environment. This feedback can be used to measure the impact of consultation services.

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METHODS AND TOOLS FOR QUANTIFYING FARM-SCALE GREENHOUSE GAS FLUXES

Marlen D. Eve
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Emerging environmental markets have the potential to incentivize additional conservation on the land. Land managers require tools that will enable them to quickly and easily assess these opportunities under various management scenarios. To be useful in the market space, tools need to display scientific rigor, be transparent and undergo extensive stakeholder vetting. In order to be useful to a broad set of stakeholders, the tools need to be cost effective and easy to use. USDA enlisted the help of 40 scientists to author, and 30 experts to provide scientific review of, an entity-scale greenhouse gas quantification methods report. In all, four rounds of review by federal and academic experts were conducted to ensure validity and transparency of the contents, followed by a public comment period. The report is a first step toward providing land managers with standardized and vetted GHG assessment tools.

The objective was to create a standard set of GHG estimation methods for USDA, and to provide a framework for development of a tool that would help landowners estimate the GHG impacts of their management decisions. The methods presented in the report address GHG emissions and carbon sequestration for the entire farm, ranch or forest operation, and also provide the opportunity to assess individual practices or management decisions. The report provides the scientific basis and a blueprint for web-based tools that will facilitate estimation of annual emissions and sequestration at the local scale. It is critical that the tools demonstrate accuracy, completeness and ease of use.

The process for ensuring the scientific rigor and transparency of the methods will be presented. Efforts have also been undertaken to ensure that these GHG estimation tools are coordinated with USDA tools for quantifying other environmental services such as water quality. Following these methods and utilizing USDA tools, a land manager can assess management options and successfully engage in environmental markets for reduction of GHG emissions. An example scenario will be presented to demonstrate the usefulness and user friendliness of the USDA GHG estimation methods and tools.

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QUANTIFYING THE GREENHOUSE GAS BENEFITS OF AGRICULTURE AND FORESTRY MANAGEMENT PRACTICES

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Purpose: Provisions of Section 2709 of the Food, Conservation, and Energy Act of 2008, direct the U.S. Department of Agriculture (USDA) to prepare technical guidelines and science-based methods to measure environmental service benefits from conservation and land management activities, initially focused on carbon. This presentation will summarize the resulting methods to estimate greenhouse gas (GHG) emissions and removals from agricultural and forestry activities.
Scope: Methods are provided for five sectors: 1) Cropland and Grazing Land Systems; 2) Managed Wetland Systems; 3) Animal Production Systems; 4) Managed Forest Systems; and 5) Land-Use Change. The methods presented address GHG emissions and carbon sequestration for the entire entity or operation, and provide the opportunity to assess individual practices or management decisions.
Methods used: The methods are designed to: 1) provide a scientific basis for methods that can be used by landowners and managers, USDA, and other stakeholders to estimate changes in GHG emissions and removals at the local entity scale; 2) create a standard set of GHG quantification guidelines and methods for use by stakeholders; 3) quantify all significant emissions and removals associated with specific source categories; 4) quantify emissions from land-use change and carbon sequestration from land management practices and technologies; and 5) support the development of entity-, farm-, or forest-scale GHG inventories that will facilitate the participation of landowners in public and private environmental market registries and reporting systems. To develop the methods, USDA formed three Working Groups to provide recommendations on the methods, and sought feedback via an interagency review process, expert review, and public review. The methods address GHG emissions and removals from agricultural and forestry activities.
Results: In addition to the estimation methods, the research gaps and uncertainties and limitations are provided.

Conclusions: The scientific vetting that underpins these methods will provide standardization for USDA carbon tools, which will enhance their usefulness for land managers, GHG registries, State and Federal agencies, and other USDA stakeholders.

Recommendations: USDA is using the methods to develop GHG inventory tools that can help prepare farmers, ranchers and forest landowners to enter into carbon markets. Current USDA carbon tools, such as NRCS's COMET-Farm, are being updated to incorporate the new methods. USDA will also use the methods to assess the GHG performance of current and future conservation programs and initiatives, and to prioritize research and data collection in order to improve agriculture and forestry GHG inventories from local to national scales.

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CHANGES IN ECOSYSTEM SERVICE FLOWS GIVEN CLIMATE CHANGE

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The Arctic is undergoing major changes as a result of global warming, globalization, increased resource extraction and population changes. This has increased the pressure on ecosystems and introduced new challenges for people living in the small resource-dependent communities in the high north. These communities are highly dependent on local harvesting of wildlife and fish for subsistence. We review how environmental and societal changes in the Arctic affect the utilization and status of these important provisional ecosystem services. First, we investigate the utilization of different fish and wildlife resources in Arctic North America and Greenland. Second, we briefly review how the availability and abundance of these resources has changed due to previous over-harvest and climate change. Finally, we review the major societal changes in the Arctic and investigate how these changes have affected the harvest of fish and wildlife. The recovery from previous industrialized overharvest combined with climate change has induced large fluctuations in the arctic ecosystems and consequently the availability of fish and wildlife resources. On the other hand, the introduction of new technologies and increasing human populations has not raised the harvest pressure from local users. On the contrary, harvest rates have decreased most possibly due to increased wage labor and importation of food combined with restricted market access and harvests regulations. We conclude that the communities in the high north have been transforming from traditional isolated subsistence communities to “modern” communities with a closer connection to the national and international economy. These changes have altered the demand for ecosystem services, suggesting that societal changes at present are more important for the change in the flow of provisional ecosystem services to local communities than climate driven changes in the natural resources. We suggest that the transformation of the Arctic communities will be fundamental for how Arctic people adapt and respond to an accelerating impact from climate change.

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COMMUNICATING ECOSYSTEM SERVICES USING COLLABORATIVE LEARNING AND MENTAL MODELS

Christine Feurt
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Engaging stakeholders in ecosystem service management is one of the greatest challenges facing researchers conducting assessments and policy makers implementing science based programs. High impact communications about the value of ecosystem services can motivate people to act in ways that protect and sustain the services they care about. Decision-making about ecosystem services requires engaging people with diverse and conflicting perspectives in dialogues about what is at stake, who benefits and who stands to lose. This workshop provides participants with practical and effective techniques immediately applicable in a variety of contexts to improve ecosystem service communication and stakeholder engagement strategies. Collaborative Learning is a powerful stakeholder engagement process that can move groups forward in spite of conflicts, uncertainty and complexity. Collaborative Learning, designed with knowledge of the mental models used by stakeholders, can reduce conflict, contribute to development of shared meaning among the group and facilitate actions that sustain ecosystem services recognized as important. These methods are well suited to ecosystem services professionals working in research, policy and management whose work depends upon effective science communication, collaborative partnerships and on-going adaptive management approaches to value, manage and sustain ecosystem services.

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USING EARTH OBSERVATION FOR ECOSYSTEM SERVICE ASSESSMENTS: TRIAL STUDIES

John Finisdore
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The Geographic Ecosystem Monitoring & Assessment project (G-ECO-MON) sponsored 10 trials around the globe that highlight the effectiveness of Earth Observation (EO) in improving management and delivery of ecosystem services. These trials provide insight into the practical application and benefits of EO in a variety of contexts. In totality they show how EO can be cost effective and even outperform alternatives.

A rigorous trial evaluation process was integrated into the design of G-ECO-MON. From April to November 2014, the contribution of EO in supporting ecosystem service assessment and monitoring was evaluated in terms of:

- Cost
- Efficiency and effectiveness
- Multiplier effect--spurring continued use of EO

The evaluation method consisted of initial interviews prior to the provision of services by G-ECO-MON for each trial. This was followed by a detailed evaluation: seven projects were interviewed at the completion of services; three projects participated in a workshop at the completion of services. In addition, a short survey was sent to all project partners.

The presentation will present the findings, conclusions and recommendations from the trials, highlighting the strengths and weaknesses of EO for ecosystem assessment and monitoring.

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APPROACHING TMDLS AS LONG-TERM INVESTMENTS

Heather Fisher
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The total maximum daily load (TMDL) process under the Clean Water Act (CWA) can impose expensive requirements, and lawsuits against TMDLs are not uncommon. The concept of ecosystem services provides an opportunity to shine a positive light on TMDL development and encourage more collaborative solutions to water quality problems. Instead of a singular, expensive requirement, communities might consider a TMDL as a tool towards achieving broader improvements in ecosystem services.

The Clarks Creek Dissolved Oxygen and Sediment TMDL, in Washington State, is an example of a TMDL that began as a collaborative process, and through careful attention to ecological connections as well as multiple stakeholder needs, the TMDL is supporting investment in long-term community benefits. A key challenge in the TMDL development was to satisfy CWA requirements for documentation while providing targets that could directly translate into solutions. The resulting targets were quantified in terms of reduction in untreated stormwater flow, aquatic plant density, and riparian shading – measures that can be directly tied to ecosystem stressors as well as on-the-ground management strategies. The collaborative groundwork and specialized ecological studies paid off, and the TMDL is now bolstering local water quality improvement efforts, some with broader ecological, social, and economic benefits.

The case of Clarks Creek, while unique in some aspects, illustrates how an ecosystem services approach can be applied to TMDLs. To demonstrate an application to other TMDLs, Watson Lake in Prescott, Arizona provides a recent example of a nutrient TMDL dealing with complex ecological mechanisms and a diverse stakeholder group. Watson Lake receives runoff from urban areas and experiences extreme hydrologic changes due, in part, to downstream water supply needs. In the context of this second example, a checklist and rating system are proposed as tools that can help guide management toward a positive net benefit for the watershed and community.

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SMALL STORMWATER, NATIONAL VALUE

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A nationwide value was estimated for the groundwater recharge volumes that would be achieved if small stormwater retention policies, in addition to current policies, were implemented from 2020 to 2040. The valuation was designed to produce a conservative benefit estimate by focusing solely on the consumptive use benefit of groundwater and employing conservative assumptions throughout the analysis. Economic decision makers were expected to choose a less expensive method to address their water consumption (e.g., conservation, reuse programs, etc.), and the selection of data accounted for this possibility.

The valuation was limited to counties in the contiguous U.S. who are likely to benefit from additional groundwater recharge. The criteria for identifying counties were 1) reliance on groundwater use to meet current water supply demands and 2) projected water shortages in the future. The states of Connecticut, Maine, Rhode Island, and Vermont were eliminated from the analysis because none of their counties met the projected scarcity screening criteria.

Available data on the costs for water conservation, water reuse programs, aquifer storage and recovery, and desalinization were reviewed. None of these datasets provided sufficient data on a nationwide basis to establish a dollar value for groundwater. However, relatively large datasets of permanent western water rights transfer prices, bulk sales rates, and water utility retail rates were available, and these data provided the best means for a representative benefit estimate. Available data were reviewed for each state, and one representative value ($/acre-foot of recharge) was selected per state. The values were reported as ranges representing differing discount and escalation rate assumptions.

Across all 44 states considered, the maximum value range was $280-$650/acre-foot for Colorado and the minimum value range was $10-$20 per acre-foot for Idaho. Values selected for Montana ($220-$520 per acre-foot) and New Mexico ($140-$330 per acre-foot) were also relatively high compared to other states. The unit values were applied to estimates of groundwater recharge volume that could be achieved for new development and redevelopment when additional stormwater is retained beyond the current retention standards. Multiple scenarios with varying assumptions were developed, and the nationwide annualized value for the resulting ground water recharge was estimated to range from about $20 million to $200 million depending on the scenario.

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DECISION SCENARIO ANALYSIS FOR ADDRESSING SEDIMENT ACCUMULATION IN LAGO LUCCHETTI, PUERTO RICO

William S. Fisher[1] *and Justin Bousquin*[2]

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A Bayesian belief network (BBN) was used to characterize the effects of sediment accumulation on water storage capacity of a reservoir (Lago Lucchetti) in southwest Puerto Rico and the potential of different management options to increase reservoir life expectancy. Water and sediment enter the Lago Lucchetti from the watershed and from a tunnel linked to three upstream reservoirs. The BBN was initialized using the original construction volume of the reservoir (1952) and two bathymetric surveys completed in 1986 and 2000, which show that water storage capacity has declined dramatically because of sediment trapping. As the reservoir fills in, the ability to trap sediment declines so greater amounts of incoming sediment are moving downstream to sensitive ecosystems. Sensitivity analysis demonstrated most of the sediment delivery to Lago Lucchetti was from sediment erosion in the Lucchetti watershed with only a minor contribution from upstream reservoirs (8%). A management option to dredge the reservoir would add significantly to reservoir life expectancy; conversion of sun-grown to shade-grown cultivation in the Lucchetti watershed would decrease sediment delivery by about 11%. A BBN approach is very flexible, allowing consideration of multiple decision alternatives, alone and in combination, and accommodating both qualitative and quantitative information.

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CLIMATE CHANGE HEALTH ASSESSMENTS FOR THREE COASTAL, RIVERINE AND LAKE SYSTEM COMMUNITIES IN SOUTHWEST ALASKA

*Michael Brubaker[1], **Susan Flensburg**[2] and Jennifer Skarada[3]*
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Bristol Bay communities in southwest Alaska seek local scale information to mitigate negative climate effects and develop healthy methods for adaptation. Residents dependent on subsistence plant and wildlife species are concerned about threats to food and water resources, public safety, and infrastructure. Funded by the Western Alaska Landscape Conservation Cooperative, the Climate Change Health Assessments performed for three rural villages are the first to focus on the Bristol Bay Region and document climate change impacts and potential impacts as described by community residents and interpreted through the lens of public health. The presentation will cover the process for undertaking and involving communities in the climate change health assessments, highlights of the findings for each community, and outcomes.

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CONSERVING HABITAT AND TRADITIONAL USE IN THE NUSHAGAK RIVER WATERSHED IN SOUTHWEST ALASKA

Tim Troll[1] and ***Susan Flensburg***[2]
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The Nushagak Mulchatna Watershed Council is a consortium of Tribes that reside in the Nushagak drainage in Southwest Alaska and partner organizations. The watershed council in a project supported by Bristol Bay Native Association, The Nature Conservancy and Bristol Bay Heritage Land Trust wrote and adopted the Nushagak River Watershed Traditional Use Area Conservation Plan. The foundation for the plan was developed from the traditional ecological knowledge obtained through interviews. The plan has become a blueprint for conservation in the region and has been used to raise over two million dollars to fund the water resources conservation strategies and the land resources conservation strategies outlined in the plan. The presentation will highlight these strategies and corresponding projects to date that are of relevance to ecosystem services. Many of these accomplishments also led to international recognition for the Nushagak Mulchatna Watershed Council and the Bristol Bay Heritage Land Trust by the International River Foundation.

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THE MARSH PROJECT: AN ECOSYSTEM SERVICES APPROACH TO NEPA PROJECT PLANNING

Holly Jewkes[1], Joe Bowles[1], and Nikola Smith[2] *Presented by: **Tim Foley**[1]*
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The Deschutes National Forest (DNF) in Central Oregon has been exploring the use of ecosystem services as a driving concept in NEPA project planning since 2009. As a pilot for these efforts, the Marsh Project on the Crescent Ranger District tests how using an ecosystem services framework can enhance public participation in the NEPA process and lead to a purpose and need, proposed actions, and outcomes on the ground which better recognize the full suite of benefits provided by National Forest System lands.

The 30,000 acre Marsh planning area is a unique ecosystem with both marsh and upland forest components. It provides a diverse array of ecosystem services to an equally diverse public. The project's purpose and need is based on maintaining and enhancing a core set of ecosystem services expressed by the public: clean and free-flowing water, forest products, high quality dispersed recreation, mushroom harvesting opportunities, plant and animal habitat, and scenic views. The project addresses threats to these ecosystem services such as fire, insects and disease, and unmanaged recreation, while also avoiding impacts to key aspects of the landscape that are recognized as sources of those ecosystem services.

This presentation will discuss the differences in the Marsh project NEPA process compared to a more conventional process, with special emphasis on public involvement and development of purpose and need and proposed action. It will highlight how these differences in thinking and in process can lead to more interdisciplinary NEPA decisions that incorporate recognition of the full suite of ecosystem services into projected outcomes.

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REFLECTIONS FROM A DECADE OF INVESTIGATING THE BUSINESS CASE FOR ECOSYSTEM SERVICES IN THE ELECTRIC POWER INDUSTRY

Jessica Fox[1] *and B.Madsen*[2]

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There is growing interest in integrating the concept of ecosystem services into the corporate world and a number of grey literature publications have promoted the business case for doing so. While these publications highlight success stories, they generally do not present a realistic view of both the success and failure of application of ecosystem services in the corporate context. Since 2000, the Electric Power Research Institute has been researching and investigating application of ecosystem services in the corporate context but to date, much of this research has been confidential. We use our experience within the electric power sector to provide a "reality check" on the business case for ecosystem services in the United States. In this presentation, we present a case study of the electric power sector, explore the most compelling motivations for investigation and action, discuss failed application of the concept, and explore potential tools to advance corporate application of ecosystem services.

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AN INTEGRATED SOCIAL, ECONOMIC & ECOLOGICAL CONCEPTUAL (ISEEC) FRAMEWORK – ASSESSING SUSTAINABILITY IN RANGELAND ECOSYSTEMS

***W.E. Fox**, K. Mazcko, J. Tanaka, U. Kreuter*
Texas A&M AgriLife Research, Temple, TX, USA

Use of criteria and indicators for assessing rangeland sustainability is an evolving practice that can inform land managers and decision makers in their development of policy regarding the stewardship of our natural resources. However, individual criteria and/or indicators, in and of themselves, do not provide a viable platform for assessing the complex nature of rangelands. In an effort to expand their usefulness, members of the Sustainable Rangelands Roundtable initiated an effort that resulted in the development of the Integrated Social, Economic & Ecological Conceptual (ISEEC) framework. The framework provides a basis upon which relationships between biophysical and socio-economic components of an ecosystem can be visualized and related as data is generated from the population of the indicator sets. It has been suggested that unless science can be brought to society through meaningful translations, we will continue to see degradation of landscapes and decision-making with less than optimal information. The use of scientific and technological resources alone does not necessarily lead to successful management of natural resources. These aspects provide evidence to guide decision-making, but land managers may also consider socioeconomic and institutional components that may condition, and ultimately drive, the decision-making process. The ISEEC framework provides a guide to integrating the biophysical and socio-economic components of an ecosystem and brings together these two “equally” important components through the concept of ecosystem goods and services.

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GROWTH AND DEVELOPMENT OF NATURAL INFRASTRUCTURE FOR WATER SUPPLY

Carla Friedrich
United Nations Environment Programme, Washington, D.C., USA

Carla Friedrich will serve as moderator of this session. To provide context for the panel discussion, she will present background information about the increasing recognition of the role of natural infrastructure for water security around the world. She will highlight current efforts by the United Nations Environment Programme to foster better understanding and appropriate valuation of ecosystem services to secure long-term water supplies.

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LINKING LAND USE CHANGE TO RECREATIONAL FISHERY VALUATION WITH A SPATIALLY EXPLICIT BEHAVIOR MODEL: A CASE STUDY FROM TAMPA BAY, FL USA

R.S. Fulford[1]*, M. Russell*[1]*, D. Yoskowitz* [2]*, and J. Rogers*[1]

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Drawing a link between habitat change and production and delivery of ecosystem services is a priority in coastal estuarine ecosystems. This link is needed to fully understand how human communities can influence ecosystem sustainability. Mechanistic modeling tools are highly functional for exploring this link as they allow for the synthesis of multiple ecological and behavioral dynamics into a projection of cumulative effects. We developed a spatially-explicit individual-based model intended to explore the link between coastal habitat change and both the production and delivery of recreational fishing to anglers. This model tracks growth, mortality, and movement of individual fish based on temporally and spatially dynamic habitat characteristics and translates the outcome into a projection of annual net fish production. The model also can track angler behavior and distribution as a function of habitat features and allows for a projection of fish-angler interactions and the impact on recreational fishing. This model has been applied in an index estuary (Tampa Bay) to address two unique stressors of estuarine habitat (Climate variability and impacts of land use change) to examine the influence of mechanistic assumptions on production and delivery outcomes. Findings demonstrate the transferability of the model between ecosystems and stressors. Simulation results also suggest that the link between climatic and anthropogenic stressors related to local decision making, such as land use change, and fishery health are dependent on behavioral responses, as well as specific habitat alterations. Mechanistic models such as the one use in this study are data intensive, but valuable tools for projecting the impacts of estuarine habitat change because they are easily transferred between systems and are not as dependent on empirically derived relationships, which may also be altered by habitat change.

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SAGE-GROUSE CASE STUDY: SCALING UP TO ADDRESS LANDSCAPE-SCALE THREATS TO SPECIES

Cathy Macdonald *Presented by:* ***Garth Fuller***
The Nature Conservancy, Bend, OR, USA

Making mitigation programs effective as a tool for recovering imperiled species requires greater attention to landscape-scale context than has been typical in past approaches. The Nature Conservancy (Oregon) and the Institute for Natural Resources are developing a spatial decision support system to guide conservation and development decisions in greater sage-grouse habitat. Identifying priority areas for habitat protection and restoration activities, as well as for targeting development, facilitates better mitigation outcomes and also provides a framework for strategically coordinating conservation investments from multiple public and private sources.

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HEALTHY LANDS & HEALTHY ECONOMIES: ADVANCING THE APPLICATION OF ECOSYSTEM SERVICES IN CALIFORNIA

*David Batker[1], Rowan Schmidt[1], Aaron Schwartz[1], **Karen Gaffney**[2], Tom Robinson[2], Alex Roa[2], **Andrea Mackenzie**[3], Jake Smith[3], Sacha Lozano[4] and Jim Robins[5]*

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The Resource Conservation District of Santa Cruz County, the Santa Clara Valley Open Space Authority and the Sonoma County Agricultural Preservation and Open Space District all recognize the inter-relationship of public health, the economy, natural areas, water resources and working lands. All three counties are experiencing challenges such as saltwater intrusion into aquifers, sea level rise, water scarcity, threats to agricultural sustainability, endangered species listings, flooding, and rapid rates of population growth. Fortunately, these counties have also been leaders in the conservation of natural and working lands, which contributes to a quality of life that ranks among the top in the world. *Healthy Lands & Healthy Economies: Demonstrating the Economic Value of Natural Areas and Working Landscapes* is a regional collaboration intended to document and articulate the economic value of natural capital and the foundational role it plays in maintaining sustainable local economies and communities in Santa Clara, Santa Cruz and Sonoma Counties. This initiative is the first-ever comprehensive economic valuation of natural capital and ecosystem services completed in the greater San Francisco Bay Area. The project includes a multi-tiered approach ranging benefit transfer studies and primary valuations, coupled with traditional economic planning tools such as benefit-cost analysis and return-on-investment.

Using benefit transfer methodology, preliminary results show that existing natural capital is an economic engine that generates between $4.6 and $12.9 billion per year in ecosystem services for these three greater Bay Area counties. These studies demonstrate that natural capital is an asset that continues to appreciate over time, provides multiple benefits to local communities, and that the conservation and stewardship of these landscapes is a fiscally sound investment. In addition to county-wide valuation studies, these partners are conducting focused research on key natural capital assets within each county. For example, partners in Santa Cruz have conducted a return-on-investment analysis of landscapes that recharge aquifers, which are critical to drinking water supply, agriculture and industry in California and the U.S.

This presentation will describe highlights of this effort, and how the valuation results are being used to support:
1. Inclusion of ecosystem services in return on investment analysis, benefit-cost analysis, funding prioritization and the development of economic indicators.
2. Evolution of integrated, multi-benefit planning in California that includes transportation, housing, public health, water resource management, and economic development.
3. Collaboration with policy-makers and business and community leaders so they can focus on encouraging behaviors and taking actions that restore and protect the full health of their communities.

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COMPARATIVE ANALYSIS & SUPPORT TOOLS FOR SOURCE WATER PROTECTION PROGRAMS AND CREATING A PIPELINE FOR NATURAL INFRASTRUCTURE INVESTMENT

Todd Gartner
World Resources Institute, Washington, D.C., USA

Building on the WRI's 2013 report, Natural Infrastructure: Investing in Forested Landscapes for Source Water Protection in the US, Todd and the Natural Infrastructure for Water Team are conducting a comparative analysis of forest-based source water protection program across the United States. The data will be used to create practitioner-focused "roadmaps" to guide utilities and other stakeholders in developing new, robust and sustainable source water protection programs in their own watersheds. Todd will also highlight WRI's new global mapping platform –Forest for Water. This platform, combining WRI's Aqueduct, a world-leading water risk mapping tool, and the Global Forest Watch, a near-real time forest monitoring platform, is designed to give decision makers and stakeholders the power to recognize water risks related to past and projected changes on the landscape, identify opportunities to protect and restore forest related to water benefits, and facilitate natural infrastructure investment in places where it is most needed.

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DEMONSTRATING THE BUSINESS CASE AND CREATING A PIPELINE FOR NATURAL INFRASTRUCTURE INVESTMENTS

Todd Gartner
World Resources Institute, Washington, D.C., USA

This portion of the panel will highlight the necessary approaches to catalyze a global movement to transform the way the world secures freshwater for human well-being and economic development. Todd will discuss WRI's green vs. grey economic methodology which helps make the business and financial case for natural infrastructure investments. Todd will also highlight WRI's new global mapping platform –Forest for Water. This platform, combining WRI's Aqueduct, a world-leading water risk mapping tool, and the Global Forest Watch, a near-real time forest monitoring platform, is designed to give decision makers and stakeholders the power to recognize water risks related to past and projected changes on the landscape, identify opportunities to protect and restore forest related to water benefits, and facilitate natural infrastructure investment in places where it is most needed.

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SESSION MODERATION – CONTEXT, BACKGROUND, OPPORTUNITIES & CHALLENGES TO SCALE UP WATER QUALITY TRADING

Todd Gartner
World Resources Institute, Washington, D.C., USA

Todd will serve as overall moderator for the panel, providing key background and context regarding the last decade of wqt innovation and what opportunities and challenges lie ahead. Todd will pull from his experience co-coordinating the National Network on Water Quality Trading and efforts to scale investments in ecosystems for improved water quality. As moderator, Todd will also facilitate the Q&A portions of the session, ensuring audience engagement and healthy debate.

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EARLY ADOPTER FORESTS AND ECOSYSTEM SERVICES UNDER THE 2012 PLANNING RULE

***Krista Gebert*[1], *Delilah Jaworski*[2] *and Jennifer Schein Dobb*[2]**

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Thirteen national forests have begun revision of their land and resource management plans under the 2012 planning rule. With little formalized guidance, these forests have adopted diverse approaches to addressing new requirements related to ecosystem services. This latitude has enabled forests to serve as laboratories for implementation of the 2012 planning rule, offering novel approaches to the incorporation of ecosystem services in federal land management. This presentation describes experiences working with forests in several regions that have begun the process of identifying and analyzing the contributions of key ecosystem services to human well-being. We discuss lessons learned and their relevance for other forests embarking on plan revision under the 2012 planning rule.

This presentation also describes challenges and opportunities for incorporating ecosystem services into subsequent stages of the planning process. Early-adopter forests are beginning to consider the role of ecosystem services in identifying desired conditions, developing alternatives, and evaluating tradeoffs. We discuss how constraints related to staff expertise, data availability, and time influence the forests' approaches to the consideration of ecosystem services.

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ASSESSMENT OF THE ECONOMIC VALUE OF REEF FISHING AND DIVE TOURISM IN CARIBBEAN COASTAL COMMUNITIES

David A. Gill[1]*, Peter W. Schuhmann*[2] *and Hazel Oxenford*[1]

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Coral reef fishes provide numerous ecological goods and services to Caribbean coastal communities including food security, income and recreational opportunities, and play important functional roles in maintaining reef ecosystem health. However, the negative effects of reef degradation and unsustainable fishing on Caribbean reef fish stocks have already been observed in many areas, endangering the livelihoods of dependent individuals. For policy makers to implement appropriate management measures, they must first have an understanding of the current levels of reef use and their associated economic values and impacts. They will also require economic data to better understand how changes in the resource could affect stakeholder revenues and use patterns. This research sought to examine the economic value that Caribbean coastal communities currently derive from the direct use of coral reef fishes, namely within the reef fishing and dive tourism industries, and the potential economic gains or losses from effective management or stock decline.

With annual site revenues from reef fishing and dive tourism ranging from US$0.3-11.1 million, the results of this study demonstrate the current economic benefits of reef-associated fishing and dive tourism to coastal communities as well as the diversity of values among Caribbean sites. However, given the current declines in Caribbean reef fish populations due to habitat degradation and unsustainable harvesting, this study also highlights the potential losses in annual income that could accrue in the absence of sustainable management (e.g. average annual losses in diver consumer surplus of US$0.4-$4.1 million per site with severe reductions in large fish). By quantifying the change in economic value associated with changes in reef fish populations, decision makers can be informed as to the potential costs of inaction, and the economic benefits of conservation.

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ECOSYSTEM SERVICES AND CITIZEN SCIENCE: A NEW FRAMEWORK FOR ENGAGEMENT

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We describe a conceptual framework for Citizen Science that can be applied to improving the understanding and management of ecosystem services. For our purpose, Citizen Science represents an engagement from members of the public, usually volunteers, in collaboration with technical experts to observe and understand natural resources and environments for the benefit of science and society. (This includes a wide range of activities, including volunteer monitoring, joint fact finding and analyses, and participatory mapping and modeling). In addition, the application of Citizen Science to understanding and managing ecosystem services requires joint assessments of the present and future value of ecosystem services, and of the spatial distribution and dynamics of the biophysical processes that underlie them.

Our approach seeks engagement from paid professionals as well as from volunteers. The approach provides new opportunities for the lay public but also solicits community and policy interactions by scientific experts and stakeholders. The characteristics of individual engagement are described by a modern version of Maslow's hierarchy of needs. On the science side, observations and monitoring provide a foundation that supports critical analysis (process research) and builds up to information syntheses (e.g. spatial and temporal assessments). As citizens (and experts) move up this pyramid of science needs, the potential exists for more intense engagement and participation. At the same time, there are increased challenges associated with educational and information needs. Knowledge generation is often accompanied by individual and community biases, involving both experts and the lay public. A diversity of perspectives from volunteers, stakeholders and experts can help counter these biases. Structured engagement processes may help recognize systemic human biases that affect our judgments and decision-making. Similarly, structured processes, a multiplicity of perspectives, and recognition of inherent biases also may enable us to improve our understanding, valuation, and management of ecosystem services.

Citizen-supported projects vary widely in purpose, scope and level of engagements. We do not prescribe how our approach might be implemented. However, we suggest that implementation might be facilitated through the involvement of integrating entities, including institutions of learning and agencies with broad science responsibilities. Our approach to improving the understanding and management of ecosystem services empowers and encourages individuals to participate in active learning and to transcend their own immediate and local needs for the benefit of a larger community.

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BRINGING ECOSYSTEM SERVICES INTO REGIONAL MITIGATION AVOIDANCE GUIDANCE

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Over the next two decades, global economic output is projected to double. Trillions of dollars will be invested in energy, mining, and infrastructure development, much of it in undeveloped landscapes and seascapes with high conservation value. The mitigation hierarchy – avoid, minimize, restore, offset – has emerged as a major organizing framework to balance conservation and development objectives. Worldwide, there are at least 45 countries with environmental impact mitigation programs, with another 27 in development. These programs are largely focused on mitigating impacts to biodiversity, and guidance and tools are established and evolving to assess and account for biodiversity impacts in permitting decisions. Largely absent from impact assessment and mitigation decision-making is how development impacts ecosystem-service benefits that matter to people. If the connections between nature and people are not explicitly considered, development can redistribute ecosystem services from one beneficiary group to another.

In this presentation, I will briefly describe an integrated, landscape-scale framework for addressing biodiversity and ecosystem services mitigation that is designed to mesh with existing policy frameworks and is informed by multiple pilot testings. The framework addresses the conceptual and analytical advances needed to establish ecosystem service targets, delineate a spatial extent that captures ecosystem service supply and delivery (servicesheds), establish avoidance thresholds for services, quantitatively estimate impacts on services, consistently construct mitigation replacement ratios, and identify and design potential ecosystem service offsets.

The first step in the mitigation hierarchy of avoidance is critical for delivering upon the promise to balance conservation and development goals. In the remainder of this presentation, I will propose criteria for defining and evaluating ecosystem services avoidance related to landscape considerations, irreplaceability, and vulnerability to mesh with approaches for biodiversity avoidance. I will then describe a pilot application of regional avoidance mapping to inform planning efforts in Gabon, where efforts are underway to advance a national strategy for sustainable development. The analysis explores the complementarities and tradeoffs for regional guidance related to optimizing for biodiversity and ecosystem services targets, independently and jointly.

Evaluation of previous mitigation efforts has largely highlighted that the avoidance step has itself been too often avoided. A key question remains for how to gain better traction with avoidance to prioritize critical areas for biodiversity and ecosystem services that contribute to human wellbeing, as an integral part of a “green” economic development strategy.

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A DYNAMIC ECOLOGICAL AND ECONOMIC MODEL LINKING OYSTER REEF BIOENERGETICS TO FINAL ECOSYSTEM SERVICES

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Ecosystem restoration seeks to restore natural habitats that have been lost due to decades of overharvesting, exploitation, and other detrimental human activities to an undisturbed state. Given the loss of Eastern oyster (*Crassostrea virginica*) reefs and the ecosystem services they historically provided, restoration efforts for this species have increased along the eastern U.S. coast. Previous studies have described the potential ecosystem services provided by oyster reefs. Recently there has been an effort towards measuring and quantifying these services, including evaluation of secondary production provided by restored reefs.

Here, I develop a dynamic bioenergetics model that can be used to measure and predict the impacts of oyster restoration projects on different trophic levels of an ecosystem and subsequent final ecosystem services. Bioenergetic models track energy flows through a system and predict changes in growth and biomass of organisms resulting from changes in the environment and population structures. The model uses current data collected from natural and restored oyster reefs in North Carolina to track energy flows through the system and measure how changes in oyster densities and biomass can impact the amount of biomass in secondary consumers. The output of the model (changes in secondary consumer biomass) is used as an indicator of the potential of the ecosystem asset to provide an increased flow of final ecosystem services (in this case, fish for a range of uses). To understand the interaction between the changes in fish biomass (as predicted by the bioenergetics model) and final ecosystem services, I develop a framework that links this bioenergetics model to economic models that assess the impacts of changes in ecological variables that lead to behavioral responses by human beneficiaries (e.g., how changes in oyster biomass may impact recreational fishers). Local data will allow me to determine the possible uses of the ecosystem assets, and provide a measure of ecosystem services that could result from increasing oyster biomass through restoration projects in this area.

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ECOSYSTEMS, BIODIVERSITY, AND ECOSYSTEM SERVICES

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Climate change affects the living world, including people, through changes in ecosystems, biodiversity, and ecosystem services. Ecosystems entail all the living things in a particular area as well as the non-living things with which they interact, such as air, soil, water, and sunlight. Biodiversity refers to the variety of life, including the number of species, life forms, genetic types, and habitats and biomes (which are characteristic groupings of plant and animal species found in a particular climate). Biodiversity and ecosystems produce a rich array of benefits that people depend on, including fisheries, drinking water, fertile soils for growing crops, climate regulation, inspiration, and aesthetic and cultural values. These benefits are called "ecosystem services" – some of which, like food, are more easily quantified than others, such as climate regulation or cultural values. Changes in many such services are often not obvious to those who depend on them. The key messages related to ecosystems, biodiversity and ecosystem services highlighted in the U.S. National Climate Assessment released in 2014 include: 1) Climate change impacts on ecosystems reduce their ability to improve water quality and regulate water flows. 2) Climate change, combined with other stressors, is overwhelming the capacity of ecosystems to buffer the impacts from extreme events like fires, floods, and storms. 3) Landscapes and seascapes are changing rapidly, and species, including many iconic species, may disappear from regions where they have been prevalent or become extinct, altering some regions so much that their mix of plant and animal life will become almost unrecognizable. 4) Timing of critical biological events, such as spring bud burst, emergence from overwintering, and the start of migrations, has shifted, leading to important impacts on species and habitats. 5) Whole system management is often more effective than focusing on one species at a time, and can help reduce the harm to wildlife, natural assets, and human well-being that climate disruption might cause. Ongoing assessment activities will determine if these effects are sustained or amplified, how communities adapt to these changes, and if other effects emerge.

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PROMOTING BIODIVERSITY-POSITIVE LOANS GIVEN DATA UNCERTAINTY

Duncan Gromko
Inter-American Development Bank, Washington, DC, USA

The Inter-American Development Bank's (IDB) Biodiversity and Ecosystem Services Program helps Latin America and the Caribbean leverage its natural capital to achieve sustainable development. The Program supports measures and projects that integrate the economic value of biodiversity and ecosystem services into key productive sectors and infrastructure, fills in knowledge gaps in priority ecosystems, identifies new biodiversity-friendly business opportunities, promotes south-south exchange of knowledge, and supports private sector investment in biodiversity and ecosystem services.

As part of this effort, IDB is developing a number of different approaches to assess biodiversity and ecosystem services-related risks and opportunities in private sector investments. These assessment tools are being applied to a pulp and paper company expansion project in Uruguay and an Ecuadorian bank's credit requirement that palm oil producers gain certification through the Roundtable on Sustainable Palm Oil (RSPO). The pulp and paper company has an existing program that incorporates nearby small holders into its supply chain, but would like to improve biodiversity and social outcomes associated with the program. By quantifying ecosystem services associated with the program, IDB's assessment will help achieve these goals.

Supported with an IDB credit line, the Ecuadorian bank and an associated palm oil processor will require RSPO certification of palm oil producers in order to be eligible for bank credit. The IDB will support an assessment of biodiversity and business implications of the RSPO requirement. This project has two objectives: 1) compare the environmental and social impacts of palm oil production with and without RSPO certification; and 2) perform cost-benefit analysis of RSPO certification for palm oil producers.

This session will explore the sources of uncertainty that IDB and its clients face in integrating the economic value of biodiversity and ecosystem services in these projects, from data uncertainty, challenges estimating impacts to biodiversity and ecosystem services from agricultural activities and difficulties measuring productivity gains for agricultural producers, as well as IDB's acceptable level of uncertainty given specific types of decisions.

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URBAN TREE CANOPY (UTC) PRIORITIZATION: HOW DECISION TOOLS CAN BRING PEOPLE AND PROGRAMS TOGETHER TO IMPROVE ECOSYSTEM SERVICES

J. Morgan Grove[1] *and Dexter Locke*[2]

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Urban Tree Canopy (UTC) Prioritization tools, used for geographic tree canopy analysis, are unique in that they can serve a broader function of driving and supporting collaborative decision-making. This presentation describes how UTC Prioritization can be used as a planning process to provide decision support to multiple government agencies, civic groups, and private businesses in reaching a tree canopy target aligned with ecosystem services priorities and city-wide sustainability goals. We use our work in Baltimore, MD to illustrate the UTC Prioritization process and its value in ecosystem services decision-making.

UTC Prioritization tools and their use include a combination of spatial data, GIS analyses, key informant surveys, facilitated discussions, and production of reports and maps. Results from the use of UTC Prioritization tools indicate that they can be a powerful way of identifying critical locations for planting and conserving trees, facilitating conservation collaborations among different organizations, and informing science-based strategic plans and proposals. The presentation will introduce new research on how to better match tree planting initiatives to particular neighborhoods' motivations, capacities, and interests in order to improve the adoption of conservation practices and stewardship activity at the neighborhood level.

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ALIGNING ACCEPTABLE AMOUNTS OF UNCERTAINTY WITH SPECIFIC TYPES OF DECISIONS

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The Ecosystem Service Identification and Inventory (ESII) tool, being developed collaboratively by The Dow Chemical Company, The Nature Conservancy, and EcoMetrix Solutions Group, enables corporations to begin quantifying the production of ecosystem services in units of measure that can be easily used to understand ecological performance and provide the basis for monetary and non-monetary valuation exercises. The purpose of the ESII tool is to help corporations understand the benefits produced on a given site so that ecosystem services can be integrated into decision making processes that affect the triple bottom line.

The ESII tool is being constructed around the premise that understanding and measuring the value of ecosystem services requires an understanding of how landscape conditions drive benefit production. Accordingly, the tool includes a series of ecological models that begin to quantify the biophysical processes performed on a site, as well as a series of models that begin to quantify how those processes lead to the production of ecosystem services. Finally, the ESII tool contains an additional set of models that enable the production of ecosystem services to be translated into units of measure familiar to, and useable by, designers and engineers engaged in valuation exercises, such as replacement cost calculations, etc.

This discussion focuses on how the project team is working to align acceptable levels of certainty with users and the types of decisions the outputs are being used to inform. The presentation will describe potential uses for the ESII outputs and summarize key takeaways from Dow's Voice of the Customer study, which was used to identify needs and requirements of Dow engineers, facility managers, and other potential users of the ESII tool. The conclusions will address different opportunities to achieve the desired levels of certainty, from changes in data collection approaches, to developing specific guidance on applications of the ESII tool, to changes in the structure of the ecological models within the tool itself.

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ESTABLISHING THE VALUE OF NATURE: HOW "VOICE OF THE CUSTOMER" INFORMED THE ESII TOOL

***France M. Guertin**, Rebecca J. Currie and Elizabeth M. Uhlhorn*
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In 2011, as Dow and The Nature Conservancy (TNC) launched the first collaboration focused on the value of nature, Dow's CEO, Andrew Liveris stated: "This collaboration is designed to help us innovate new approaches to critical world challenges while demonstrating that environmental conservation is not just good for nature – it is good for business. Companies that value and integrate biodiversity and ecosystem services into their strategic plans are best positioned for the future by operationalizing sustainability."

This vision required a replicable process to evaluate Dow's interaction with nature at multiple sites globally. With that in mind, Dow and TNC, along with ecosystem consulting firm EcoMetrix Solutions Group (ESG), are developing the ESII (Ecosystem Service Identification and Inventory) Tool, a software application that will deliver a rapid, screening level assessment of the ecosystem services present on a site and allow for decision making around the use and enhancement of those services. In addition, the tool will provide support for monetary and non-monetary valuation of ecosystem services.

Development of this tool has focused on the end-user: the engineers, site leaders, and technicians (non-ecologists) who will assess their sites and use that information to inform decisions. With that in mind, Dow carried out an extensive internal Voice of the Customer (VOC) exercise to query potential end users to identify essential outputs of the tool that will contribute to actionable decisions at the site level and business decisions at the corporate level.

This presentation will discuss the main findings from the VOC exercise and the implications for tool design. The VOC provided key information about several areas related to the tool's focus. The first was the desire of users to identify important natural areas on Dow's sites or receive basic education on natural areas by answering questions such as: 1) what natural assets are owned by Dow or occur on adjacent property? 2) how does Dow interface with and depend on nature?, 3) how does Dow receive benefits from natural areas? Another objective of the tool, based on the VOC, is to identify opportunities for investment in natural infrastructure and engineered natural technology projects. Finally, the VOC discussed how the tool may enhance the ability to understand how land use changes might change ecosystem services.

The talk will transition from the VOC exercise to the development of case studies that will support roll out of the ESII tool across the organization and the criteria used in determining these case studies.

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THE ROLE OF ECOSYSTEM SERVICES IN FORESTS OF DEVELOPING AND DEVELOPED COUNTRIES

Vitalie Gulca[1] and *Robert Deal*[2]

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This study assessed the flow of ecosystem services and the role these services provide in both poor and rich countries. This research consisted of two primary objectives. First, we assessed losses of ecosystem function from disturbances including flooding and droughts, wildfire, ice-storms, insects and invasive species. Then we assessed the effect of forest restoration and the positive role that the creation of new forests could provide for a broad suite of forest ecosystem services. To attain these objectives we first describe some of the emerging international issues relating to ecosystem services. Then we assess the role of forest ecosystem services in different regions of the world looking broadly at developing, emerging and fully developed countries. Also, we analyze the differences and similarities in utilization of forest services between poor and rich countries. While most developing countries' economies depend largely on natural resources, the new opportunities with ecosystem services for landowners in the region are not well understood. Finally we propose recommendations to conserve ecosystem services and help rural people in poor countries and suggest proposals to maintain ecosystem services in emerging and developed counties.

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LINKING ECOSYSTEM SERVICES TO EARTH OBSERVATION PRODUCTS

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Decision makers working in ecosystem service assessments might not always know which Earth observation (EO) product is suited for their respective assessment. To link ecosystem services and assessments with EO products a matrix was developed that demonstrates the capability of EO products to inform ecosystem services delivery including the capacity of geographies to produce services and the flow of these services to beneficiaries.

Ecosystem service assessments often start with a quantification and mapping of biophysical or social services. Unfortunately, many ecosystem services cannot be directly quantified at medium-to-large scale (e.g. how much air is purified by a plant each day). Thus, ecosystem service assessments must rely on indicators or proxies for their quantification (e.g. leaf area index).

We have compiled a long list of ecosystem service indicators and have related them to individual EO products that can feed them. The list of ecosystem service indicators does not try to be exhaustive but illustrative, helping practitioners to find potential applications. As illustrated in the matrix, an EO product can serve various ecosystem service assessments, and an ecosystem service indicator can be estimated with various EO products. This matrix can thus be used as a guide to find links between ecosystem services and EO products.

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NATURE VALUED FROM SPACE

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The European Space Agency (ESA) has been increasing its efforts in ecosystem service assessments and valuation. The initiative is showing how nature can be valued from space to support business decision-making and national accounting schemes.

Two projects were funded by ESA to demonstrate the value of Earth observation (EO)-based information products. The Geographic Ecosystem Monitoring and Assessment Service (G-ECO-MON) is extending the use of EO based information for multiple applications that requires ecosystem services information. Wold wide demonstration cases using state of the art remote sensing data and methods highlighted how stakeholders working in the ecosystem service domain can receive customised, best-practice EO information services that meet their needs. The EO Services for Ecosystem Valuation project (Ecoserve) carried out by the same consortium has demonstrated the value of EO based information products for the emerging sector of ecosystem services valuation.

Methods used, results, conclusions and recommendations of both projects are presented, highlighting how nature can be valued from space.

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THE COMMON INTERNATIONAL CLASSIFICATION OF ECOSYSTEM SERVICES (CICES): DEVELOPMENT AND CHALLENGES

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The Common International Classification of Ecosystem Services (CICES, www.cices.eu) developed from the work on environmental accounting undertaken by the European Environment Agency (EEA). Its purpose was to support their contribution to the revision of the System of Environmental-Economic Accounting (SEEA) which is being led by the United Nations Statistical Division (UNSD). The idea of a common international classification is an important one, because it was recognised that if ecosystem accounting methods were to be developed and comparisons made, then some standardisation in the way we describe ecosystem services was needed. Standardisation was seen as especially important where the link to economic accounting has to be made. It has also become increasingly important beyond the requirements of accounting, in the context of mapping ecosystem services in Europe.

In scope, CICES seeks to cover all 'final' ecosystem services. These are regarded as the contributions that living systems make to human well-being. It was developed through an extensive consultation programme with the user community, and is now being tested through a number of different initiatives. These include: the work being led by the European Commission on 'Mapping and assessment of ecosystems and their services' (MAES, http://biodiversity.europa.eu/maes), which will support to the EU's Biodiversity 2020 Strategy, and which includes an accounting component; and, other EU funded projects concerned with operationalising the concepts of ecosystem services and natural capital, such as OpenNESS (www.openness-project.eu/). The conclusions that can be drawn at this stage are that the classification is sufficiently comprehensive to be useful, while suitably flexible so that it can be tailored to meet the needs of particular applications. It has also enabled users to easily cross reference work that has used the MA and TEEB nomenclature for ecosystem services to a common standard. In terms of taking this work forward, it is recommended that future developments should include: linking to a typology of goods and benefits, and where appropriate the values associated with them; and, developing a common approach to the classification of the ecological functions that underpin different services, so that the integrity of natural capital stocks can be assessed.

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NEW ZEALAND WATER QUALITY TRADING MARKETS; LESSONS FROM LAKE TAUPO

Madeline Hall
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The Lake Taupo nutrient trading program in New Zealand is a rare in-place model of a non-point-source water-quality trading program (WQTP). Its operation and evaluation contribute to the understanding of social and technical aspects of WQTP design and implementation. New Zealand, whose economy is dependent on the production and export of agricultural products, is faced with novel water pollution problems due mainly to the expansion of the dairy industry. The increasing eutrophication of waterways poses a threat to the ecological, economic, and cultural wellbeing of the nation, with a >800% increase in nitrogen input over the last 25 years.

The Lake Taupo Catchment WQTP is also an example of local action in the context of larger national policy. The national government recently proposed overarching recommendations for action, specifically the National Policy Statement for Freshwater Management (2014). This has become a highly controversial topic and initial proposals are seen as having a limited scope compared to the magnitude of the problems. In the interim, Regional governments have also been working within their existing regulatory statues under the Resource Management Act of 1991 to implement non-point source reduction strategies. For example, the Waikato Regional Council has worked with farmers and Indigenous Communities to implement a WQTP to reduce inputs into the Lake Taupo catchment, where 90% of the nitrogen impairment is from agricultural sources.

Using evidence from a comprehensive desk review and expert interviews, this presentation will analyze the design, implementation, and evaluation of the Lake Taupo Catchment WQTP. The research presented is part of a larger case study examining New Zealand farmers' willingness to participate in voluntary carbon trading programs in light of their participation in obligatory WQTPs. As a young, yet highly functioning ecosystem service market with high multi-stakeholder involvement, this investigation offers insight into the design and implementation of a WQTP across the globe.

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USING A REVERSE AUCTION TO DYNAMICALLY SOURCE BIRD HABITAT

Eric Hallstein**, Sandi Matsumoto, Paul Spraycar, and **Mark Reynolds
The Nature Conservancy, San Francisco, CA, USA

With 95% of the historic wetland habitat in California's Central Valley destroyed, migratory birds traveling along the Pacific Flyway face a habitat shortage each winter. To address this challenge, The Nature Conservancy of California (TNC) is utilizing a reverse auction to competitively source short-term, temporary wildlife habitat in California's agricultural landscape. This market-based tool was piloted to establish the costs of habitat provision and to optimize an investment in 10,000 acres of habitat in spring 2014. The goal of the program is to run auctions for temporary habitat annually, enabling investments to be adapted over time (seasons and years) according to changes in wildlife populations, habitat availability, farm economics and climate change.

To advance conservation in a region where permanent protection opportunities are capital-intensive and agricultural production highly dynamic, TNC is experimenting with a temporary habitat procurement market, BirdReturns, in which farmers are paid to modify their practices to create bird habitat for a few weeks per year. This temporary approach better matches both the needs of migratory species and the practical reality of sourcing ecosystem services from an intensive agricultural system.

To recruit and select participants, TNC conducted a reverse auction in Fall 2013 in which farmers submitted bids to provide temporary shorebird habitat for up to eight weeks, beginning February 2014. The auction utilized a closed-bid, discriminatory pricing format. TNC evaluated the bids based on timing, habitat quality and cost, and contracted with the most competitive bidders at their stated prices. Farmers submitted over 50 bids comprising nearly 12,000 acres, representing a wide range of prices which varied based on property characteristics, agronomic considerations and willingness to participate. The program's short duration proved attractive to farmers and will allow TNC to remain flexible and adapt its investments to future conditions and priorities.

The pilot demonstrated that temporary habitat can be more cost-effective than permanent protection or even flat-payment incentives for short-term habitat. The program cost less than 1% of the cost of acquiring the same acreage permanently and, after accounting for inflation, could be run for hundreds of years at a lower cost than permanent protection. BirdReturns also effectively delivered bird habitat, with program fields attracting an average of 30 times more shorebirds and a higher diversity of birds than non-program fields.

These findings suggest that precision science, combined with a reverse auction, can result in high-quality habitat on private lands in a cost-effective manner.

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THE ANATOMY OF THE ESII TOOL – A SYSTEM DESIGNED TO MEASURE ECOSYSTEM SERVICE PRODUCTION AND BENEFIT FLOWS IN A CORPORATE ENGINEERING CONTEXT

Kevin Halsey[1], *Kenna Halsey*[1], *Elizabeth Uhlhorn*[2], *France Guertin*[2], *Rebecca Currie*[2], *Jim South*[3], *Jeff North*[3], *Sheila Reddy*[3]

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The Ecosystem Service Identification and Inventory (ESII) tool, which is being developed collaboratively by The Dow Chemical Company, The Nature Conservancy, and EcoMetrix Solutions Group, will enable corporations to begin quantifying the production of ecosystem services in units of measure that can be easily used to understand ecological performance and provide the basis for valuation exercises. The purpose of the ESII tool is to help corporations understand the benefits produced on a given site so that ecosystem services can be integrated into decision making processes that affect the triple bottom line.

The ESII tool is being constructed around the premise that understanding and measuring the value of ecosystem services requires an understanding of how landscape conditions drive benefit production. Accordingly, the tool includes a series of ecological models that begin to quantify the biophysical processes performed on a site, as well as a series of models that begin to quantify how those processes lead to the production of ecosystem services. Finally, the ESII tool contains an additional set of models that enable the production of ecosystem services to be translated into units of measure familiar to and useable by, designers and engineers engaged in valuation exercises, such as replacement cost calculations, etc.

This discussion focuses on the ecological models in the ESII tool and it will illustrate how landscape attributes are analyzed to generate measures of ecosystem service production that can be communicated in terms of traditional units of measure (i.e. decibels of noise reduction provided by natural vegetation, milligrams per liter of nitrogen removed from water by the landscape, pounds/year of airborne contaminants removed by natural habitats, etc.) in support of decision making processes. The scope of the discussion includes describing how the tool balances the need for ease of use with the desire for adequately robust results, how certainty is tracked within the tool using Bayesian belief networks, the ongoing testing and validation process used to establish confidence in the tool outputs, and a description of the sequential process used to measure the production and flow of benefits across the landscape.

The conclusions presented in this discussion will address the feasibility of capturing ecosystem services in units of measure that add value to existing corporate practices and decision making processes. It will also illustrate how the ESII tool will complement and support the *Principles to Guide Assessments of Ecosystem Service Values,* developed by the Cascadia Ecosystem Services Partnership (CESP). Recommendations will focus on several key factors that have been found to be critical for successful adoption of ecosystem service quantification tools: ensuring ease of use, tracking uncertainty, and the need for intensive collaboration with project planners, designers, and engineers to ensure relevance and value to the end user.

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DESIGNING AND DEVELOPING TOOLS THAT TRACK AND REDUCE UNCERTAINTY

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There is an ongoing need for decision support tools to help business decision makers understand the trade-offs and ramifications of their business decisions. A growing number of the decision support tools being developed for these decision makers incorporate ecosystem services models to identify, quantify and evaluate the environmental effects associated with management decisions. Although this is an encouraging development, it raises some important considerations.

First, current regulations and policies have made it very likely that environmental trade-offs associated with business decisions will be scrutinized. As such, it is critical that decision making processes are transparent and defensible. If the uncertainty within the decision support tool being used is too high, then the credibility of the decision will be called into question.

Second, business decision makers, as well as other users of these tools, need to balance simplicity of use with the robustness and quality of the information provided by the tool. Finding the balance between these dynamically opposed objectives requires that we understand the tolerance for uncertainty inherent in application of the models.

In both instances, it is critical to both understand and be able to express the level of uncertainty within the decision support tools being used. The ecosystems and relationships being measured by these tools are inherently complex, and the models that seek to capture them will inevitably include some level of uncertainty. This uncertainty must be identified, documented, reduced where possible, and ultimately managed, so that ecosystem services assessment tools can become more widely accepted and applied across multiple decision making contexts.

This session will explore how ecosystem services assessment tools can be developed to include both a qualitative and quantitative understanding of uncertainty. The discussion will identify specific approaches and tools (e.g., Bayesian Belief Networks) to aid the uncertainty quantification process. It will focus on the unique challenges presented by ecosystem services modeling and the importance of systematic treatment of uncertainty in order to improve the decision making process. The discussion will address specific types and sources of uncertainty within these models, address why assessment of certainty can be difficult, and discuss the use of concept models for defining the complex relationships between the landscape attributes that ultimately provide the benefits being valued by these decision support tools.

The conclusions will address the feasibility of capturing uncertainty within ecosystem services models and providing information on uncertainty in a uniform, consistent manner that is easy to understand. It will show that managing ecosystem services uncertainty in decision support tool models means explicitly addressing uncertainty and providing transparent tools that help decision makers reach more robust and durable decisions. The recommendations will focus on how to achieve a better understanding of uncertainty and how that understanding can be used to strengthen tool user confidence and, ultimately lead to better environmental decisions.

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LEGAL IMPLICATIONS OF ECOSYSTEM SERVICE VALUATION APPROACHES IN NATURAL RESOURCE DAMAGES ASSESSMENT AND OTHER REGULATORY REGIMES

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The classification of "natural resource services" as reflected in natural resource damages assessment regulations [i.e., under the Oil Pollution Act (OPA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)] and the classification of "Ecosystem Services" within the Millennium Assessment and the USEPA Final Ecosystem Goods and Services Classification System (FEGS-CS) are compared earlier in this session, including various methods and metrics for quantifying ecosystem service values. Depending upon the approach, method, and metrics used, the outcomes of attempts to value ecosystem services can vary substantially and in turn, result in significantly different value estimates with significant implications for liability under various environmental regulatory regimes, including NRDA. Using a case study approach, this presentation will focus on the issues relevant to the legal defensibility of various ecosystem service valuation approaches for both ecological and human use services.

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TRIBE/ACADEMIA PARTNERSHIP FORGES NEW FRONTIER IN TRIBAL HISTORIC PRESERVATION & MARINE GEOARCHAEOLOGICAL RESEARCH

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As a part of testimonies during Rhode Island's Ocean Special Area Management Project (OSAMP) preparations for the coming of wind turbines off Rhode Island's coast, the Narragansett Indian Tribal Historic Preservation Office (NITHPO) offered a slice of Tribal oral history handed down by Narragansett Medicine Woman/ethno-historian Ella Sekatau: "More than 15,000 years ago the ancient villages of the Narragansett were out where the ocean is now. The waters began to rise overnight and the people had to abandon their homes." Pursuant to Section 106 of the National Historic Preservation Act, we further asked: "When impacts out on the continental shelf are proposed, how will these federal undertakings determine the presence or absence of those ancient Tribal cultural resources that may still exist at the submerged locations of those ancient communities?" A year and a half later Rhode Island's State Geologist, John Boothroyd, added to the OSAMP assessments that the regional geological record identifies that more than 24,000 years ago off the coast of what is now Rhode Island the continental shelf was an open vegetated plain.

The NITHPO and the University of Rhode Island's Graduate School of Oceanography (URI-GSO), in a four year Bureau of Ocean Energy Management (BOEM)-funded research project, are currently engaged in submerged paleocultural landscape research to develop protocols for determining the "presence" of ancient Tribal resources in areas of potential effect during federal undertakings on the continental shelf. Traditional ecological knowledge, Tribal historic preservation and research science within academia have merged to refine and forge a new frontier in Tribal Historic Preservation and marine geoarchaeological research. Merging traditional ecological/historic knowledge of regional Tribes with the knowledge and techniques of the marine geological and archaeological sciences, the primary goal of this research project is to make available to regulators and industry proponents an advanced historic preservation tool kit for identification and impact avoidance of ancient Tribal cultural resources that may be vulnerable during federal undertakings on the submerged paleocultural landscapes of the Atlantic continental shelf.

The Principal Investigator for the project is URI-GSO Professor, Dr. John King. Co-Principal Investigators are URI-GSO Marine Archaeologist, David Robinson, and NITHPO Deputy THPO and Preservationist for Ceremonial Landscapes, Doug Harris.

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DESIGNING CONSERVATION AUCTIONS FOR AQUATIC ECOSYSTEM SERVICES IN AGRICULTURAL WATERSHEDS

***Leah M. Harris**, Scott M. Swinton, Frank Lupi and Robert S. Shupp*
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Agricultural systems have the potential to provide numerous marketed products and ecosystem services (ES), but improving environmental outcomes can be costly and farmers often require financial incentives to adopt best management practices (BMPs) that enhance ES. Conservation auctions are used to get the greatest impact from limited funds for conservation incentive payments. In a conservation auction, farmers submit bids that reveal the lowest payment that they would be willing to accept in order to adopt a specific BMP on their farmland. Then, ecological models are used to predict ecosystem benefits from adopting the BMP on a specific field. Growers with the most cost-effective bids (i.e., bids that provide the most benefit per dollar spent) are awarded payments to adopt the proposed BMP(s). More research is needed to determine how to best design auctions to maximize cost-effectiveness. Our research experimentally tests two auction design principles by comparing economic and ecological outcomes achieved in two real conservation auctions that pay producers to adopt BMPs.

First, we evaluate the effect of providing bidders with information about the potential environmental impact (reduction in phosphorus runoff) of new BMPs on their land by providing this information to bidders in only one of the auctions. Research suggests that providing environmental information results in bid inflation for parcels with relatively high predicted benefits. But providing environmental information may improve auction participation, thus increasing the likelihood of enrolling land with the greatest potential to enhance ES in an agricultural landscape.

Second we allow participants in both auctions to choose between individual and joint bid submission to compare the cost-effectiveness between bids from individuals versus groups of two or more bidders. Bids are typically evaluated independently, but allowing joint bidding could increase the efficiency of conservation auctions by allowing farmers to take advantage of potential cost and benefit synergies from BMP adoption. Social pressure within groups may also increase participation and impact the cost-effectiveness of bids.

Both auctions are designed to cost-effectively reduce agricultural phosphorus runoff in the Maumee Watershed, which ultimately flows into Lake Erie and causes damaging algal blooms. In each auction, farmers compete to provide the most benefit per dollar of conservation spending by submitting bids for three practices, 1) cover crops, 2) subsurface drainage control structures, and 3) filter strips. Results will suggest cost-effective ways to design conservation auctions that can lead to targeted adoption of agricultural practices that improve aquatic ecosystem services in agricultural landscapes.

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ECOSYSTEM SERVICE PROVISION IN A CHANGING EUROPE: ADAPTING TO THE IMPACTS OF CLIMATE AND SOCIO-ECONOMIC CHANGE

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Climate change will have significant impacts on future ecosystem service provision in Europe. Despite the implications of these changes for society and the environment, few studies have analysed how Europe might adapt to such changes. This paper presents an integrated assessment approach which enables trade-offs between different ecosystem services to be explored, highlighting the importance of taking account of the complex interactions between different sectors under different scenario futures in planning adaptation responses. The CLIMSAVE integrated assessment platform (IAP) has been used to analyse spatial patterns of changes in ecosystem services (food, water and timber provision, atmospheric regulation, biodiversity existence/bequest, landscape experience and land use diversity) in response to different climate and socio-economic scenarios for the 2050s. Different adaptation strategies were explored to determine how these modify ecosystem service supply at the European scale and for five sub-regions, and how this changes with uncertainties in future climate and socio-economic change. The results indicate that future ecosystem service provision will be significantly impacted by climate change (particularly water provision). Socio-economic changes lead to shifting patterns of service provision and more dystopian societies restrict options for other ecosystem services in their focus to meet food demand. Adaptation options offer significant opportunities to decrease pressures on ecosystem service provision, but some will necessitate trade-offs between services. Furthermore, whilst the majority of adaptation options are able to lessen negative impacts across multiple scenarios there are often unavoidable trade-offs between regions. Hence, coordinating adaptation across regions and sectors will be essential to ensure that all needs are met: a factor that will become increasingly pressing under dystopian socio-economic futures where inter-regional cooperation breaks down.

The study also examined whether adaptation responses are 'robust', by looking at whether they reduce vulnerability to climate and socio-economic changes across ecosystem services, scales and scenarios. To assess the robustness of adaptation strategies, the IAP was used to test whether clusters of adaptation options referred to as policy archetypes (i.e. ecosystem-based adaptation, market-based adaptation, technology-based adaptation and people-based adaptation) reduce vulnerability to climatic and socio-economic change for a set of ecosystem service indicators. The results show that the people-based adaptation archetype is the most robust. This is because it reduces vulnerability by increasing coping capacity (people learn) and not only by reducing the impacts of climate and socio-economic change. By allowing comparative levels of vulnerability to be explored across sectors and scenarios, the approach provides a flexible tool for decision-makers and other stakeholders to increase understanding of which mixes of adaptation measures are robust responses to climate change.

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GOVERNMENT'S ROLE IN TOOL DEVELOPMENT FOR ENVIRONMENTAL MARKETS

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Markets for ecosystem services have generated significant interest from public and private sectors and are often viewed as a means to reduce the cost of compliance with regulations and produce substantial environmental benefits. Establishing rigorous standards, tools and methods for calculating performance is critically important to ensuring their success. Credit calculation tools must provide defensible results that incorporate the best available science, and include consideration of accuracy, repeatability, sensitivity, transparency, and cost. Government investments and endorsements can facilitate the adoption of standardized credit calculation tools and quantification methods and greatly reduce market uncertainty; however, it may inadvertently limit opportunities for creativity and innovation. This presentation will focus on the benefits and challenges of government engagement in tool development for environmental markets, and explore how and to what degree public agencies should be involved.

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HOW DOES GOVERNANCE AND SOCIOECONOMIC CONDITIONS INFLUENCE SPATIAL USE AND PRIORITIES OF LOCAL PEOPLE IN THE ARCTIC?

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Local communities in the Arctic experience rapid changes in spatial land use with climate change and resource development playing a major role. These transitions are not only exogenous, but prompt the shift in spatial use and valuation of ecosystem services by residents themselves. While the concept of ecosystem services conveys human dependency on nature, there is limited empirical data on ecosystem services valued by local people and the causal factors explaining change in spatial use. Our research utilizes cross-cultural comparative studies undertaken in 28 arctic communities in Russia, Canada, Alaska and Norway during the TUNDRA project. The study was designed as a natural experiment to evaluate how differences in governance and socioeconomic conditions influence the spatial use and priorities. We hypothesized that residents with higher access to wage labor and cash income would be less dependent on ecosystem services and show different spatial uses and priorities. In total 448 residents participated in the 28 different communities. We found that cultural dependency on harvest is evident for all participants living in the arctic areas despite the reduced importance of wildlife for subsistence or commercial purposes. However there are also large differences. Indigenous residents in North America depend on extensive areas for subsistence harvest, whereas the more densely populated and "urbanized" regions in Norway and Russia engage in more intensive and multiple uses of landscapes. Russia emphasize spiritual values and harvesting of berries and mushrooms to a greater extent than the other countries. In Norway recreation and cabin culture is pronounced, while in North America participants were less keen to identify spatial priorities. We find the cross-cultural comparative design a promising tool for exploring causes of spatial use and priorities, which allow for more rigorous predictions of local ecosystem service use in face of climate change and resource extraction activities.

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PROVIDING SUSTAINABLE WATER SERVICES TO URBAN CENTERS

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Reinvigorating urban centers can help reduce our carbon footprint, reduce pressure on remaining habitat and farmlands, and form vibrant living spaces that encourage healthy and creative lifestyles. Yet a principal challenge is old and failing water and sewer infrastructure. Reinvigorating old infrastructure using natural techniques provides a unique opportunity to strengthen neighborhoods, to connect people to infrastructure that is otherwise unseen, and to improve the environment even as we build and grow. George will describe how DC Water is investing in green infrastructure to achieve all these goals, integrating award-winning external affairs and marketing, technological innovation and novel business and financial techniques – all with the goal of helping to build one of the most sustainable cities in the world.

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ASSESSMENT OF URBAN FOREST ECOSYSTEM SERVICES BY PEOPLE'S SUBJECTIVE VALUE IN JAPAN

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Urban forest provides a lot of ecosystem services including regulating, provisioning, cultural and supporting services. Up to now, several existing studies have already conducted analyses on ecosystem services provided from urban green area and tried to understand the status of provisioning of ecosystem services especially from the perspective of bio-physical phenomenon aspects. Ecosystem services are benefits to human society provided from the nature so that the social aspects of these are also important for understanding the relation between human society and the nature.

This study focused on the following points. First the social value of urban forest was measured based on the people's subjective assessment for selected ecosystem services. Second the weights of each ecosystem service were comprehensively studied and compared with each other. Third in the course of questionnaire survey, quantitative data and information which represented each ecosystem service were visually presented for the answerers to understand the provision of each ecosystem service.

The subjective value assessment of ecosystem services of urban green forest was conducted through the internet web based questionnaire survey which was done from September to December 2013. Higashiyama-Heiwa parks were selected for the case study site in Nagoya city, Japan. In the study, 14 ecosystem services were selected from provisioning, regulating, cultural and supporting services.

As a result, Higashiyama-Heiwa parks have a different role compared with other relatively small green areas surrounding the parks. Citizens understood the importance and values of a variety of ecosystem services provided from the parks. Regulating services have relatively high importance compared with provisioning services. The importance for the society is higher than that for the individuals. Also the statistical analyses were conducted to do factor analysis of each ecosystem service.

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CENTRAL VALLEY HABITAT EXCHANGE: CREATING VOLUNTARY ENVIRONMENTAL MARKETS AND SCIENCE-BASED SOLUTIONS FOR PEOPLE AND THE ENVIRONMENT

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Historically, seasonal floods transformed the California's Central Valley into a vast inland sea of floodplain and riparian habitats – wetlands, forests, and grasslands -- teeming with fish and wildlife. Due to a massive network of dams, canals, and levees, the Central Valley is now one of the world's most productive agricultural regions, producing approximately $17 billion in agricultural products annually. The landscape transformation caused by water management infrastructure has also led to the loss of valuable habitat and declines of numerous threatened and endangered species.

Today, as additional infrastructure projects get underway, significant numbers of listed species will be impacted, requiring millions of dollars in mitigation. In the face of climate change and anticipated conservation and mitigation needs, new policies to address this issue are necessary; these must be rooted in rigorous science and be consistent with existing legal frameworks to create a net benefit to species while promoting California's economic vitality.

Collaboration with private landowners whose agricultural lands have habitat potential is essential to achieving the significant mitigation requirements of state and federal plans. Environmental Defense Fund (EDF) is leading the Central Valley Habitat Exchange (CVHE) in California with other partners. The CVHE is a new habitat market initiative that will leverage habitat that willing landowners can provide. The CVHE will create a mechanism to facilitate investment in conservation and restoration of vital Central Valley floodplain habitats by quantifying and assisting in the exchange of quantifiable habitat credits.

In this session, we will explore the different components of a multi-benefit and multi-species Exchange that is currently in development. The standardized accounting framework, habitat quantification tools and targeted outcomes of this Exchange will be discussed.

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EXPLORING THE DECISION LANDSCAPE: INTEGRATION AND DISPLAY OF ECOSYSTEM SERVICES & INDICATORS USING THE DRIVER-PRESSURE-STATE-IMPACT-RESPONSE FRAMEWORK AND DYNAMIC WEB APPLICATION

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Making decisions to increase community or regional sustainability requires a comprehensive understanding of the linkages between environmental, social, and economic systems. We present a visualization tool that can improve decision processes by enhancing understanding of system contexts and access to pivotal information resources. This allows users to better analyze decision options and tradeoffs.

Stakeholders can use the tool to accomplish their sustainability goals by: Understanding interactions and feedback loops within human-environmental systems; Identifying areas of the system not previously considered and avoiding unintended consequences; Identifying metrics, indicators, and datasets to aid in assessing problems, evaluating options, and measuring performance or progress, and; Identifying pertinent objectives, goals, and corresponding management options. The tool is simple to use and intended for anyone who can benefit from a comprehensive understanding of human-environmental systems, including planners, natural resource managers, policy makers, investigative journalists, scientists, modelers, and many more.

The structure of the tool is based on the Driver-Pressure-State-Impact-Response (DPSIR) framework and is drawn from peer reviewed literature; ecosystem services (ES) compilations, indicators compilations, community-based management plans, and community partners. Within the DPSIR framework, Socio-economic *Drivers* exert *Pressures* on the *State* of natural and human systems. This State *Impacts* human well being directly, or via ecosystem services. *Impact* on human well being triggers *Responses*, which can target any area of the system in order to realize more sustainable outcomes.

Ecosystem services are an integral part of the tool's underlying framework, making the role of ES within human-natural systems explicit. This integration enables a comprehensive and detailed exploration of the natural processes and attributes that contribute to ES as well as the ways that ES benefit humans and support natural systems. Finally, the integration of ES into a comprehensive systems visualization tool lays the conceptual groundwork for ES-based measurement, indicator selection, valuation, modeling, collaborative decision making, and environmental/land use planning.

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BRINGING DRAINAGE WATER MANAGEMENT FOR ECOSYSTEM SERVICES TO MARKET: WHAT FARMERS NEED TO PARTICIPATE

Brian Hicks
Nettiewyynnt Farm, Tracy, MN, USA

Farmers willingly invest in things that add to the economic viability of their operations. Keep in mind that most farms are family owned and operated so not only do farmers put their livelihood at risk but their heritage. Therefore farmers need to have a very sharp pencil in deciding where to invest because if they bet wrong it not only can end their career but can end their family's heritage as farmers and long term association with lands they love.

Farmers can easily connect the need for soil conservation to protect the economic viability of their land. However, delivering ecological outcomes that do not benefit the farm are tougher. You certainly don't expect to buy someone who lives hundreds of miles away a house, and it is economically irrational to expect farmers to invest time and money for offsite benefits – particularly when those benefits show up hundreds of miles away.

The vast majority of farmers want to be leading stewards of their land. They actively engage in environmental management on a daily basis. When the incentives are aligned to strengthen long term economic viability, resilience, reduce regulation, reduce costs etc. farmers move very quickly to make those investments. However, we do not have incentives in place (even COST SHARE does not come close) to provide for large scale adoption of conservation practices that require farmers to make outlays of money and time that do not add to the bottom line. Ecosystem Service Markets offer a key opportunity to create those incentives so that farmers can logically invest in environmental benefits that occur off site.

On our farm we have invested heavily in water quality. Some of those help our bottom line like drainage water management and sub surface irrigation. Some of those may reduce the threat of regulation. However, many of the expenditures of money and labor have no benefit to my farm or my family. While we make those investments we would like to see more operations make investments in things that deliver off site benefits. But to foster that widespread adoption we need to align the incentives so it is rational for farmers.

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INTEGRATING ECOSYSTEM SERVICES WITH LOCAL LAND USE DECISION MAKING

Dianna M. Hogan *and J.V. Loperfido*
US Geological Survey, Reston, VA USA

Accounting for the goods and services provided by local ecosystems and explicitly incorporating those ideas into land use decision making is key to determining how to proceed with local area development. Using an ecosystem services framework in decision making can be an effective approach for balancing diverse and often competing objectives at local and regional levels. This presentation will provide a case study discussion of the barriers, challenges, and opportunities to the use of this type of framework.

Local land use decision makers had to decide how to plan urban growth in Maryland while protecting high quality local streams - as well as the Chesapeake Bay downstream. In recognition of these at-risk water resources, decision makers established a plan to stage development in different areas over time to allow for adaptive management of water quality protection measures and land use controls with the goal of optimizing the protection of water resources during and after development.

Water quality protection measures, referred to as Best Management Practices (BMPs) or Green Infrastructure, are used to provide urban green space while mitigating development impacts on receiving stream water and habitat services. One goal of Green Infrastructure is to mimic natural watershed hydrologic conditions by reducing the volume and mitigating the timing and quality of surface stormwater runoff. It does this by promoting stormwater infiltration, preserving forested riparian zones, and removing and retaining pollutants including excess nutrients and sediment. This extensive management of stormwater is performed using facilities that are distributed on the landscape and techniques including rain gardens, bioretention systems, recharge facilities, storm filters, and volume storage facilities.

Considerable uncertainty exists about the ability of Green Infrastructure to maintain service provisioning during and after development. The adaptive management approach allowed for monitoring and assessment of the ability of the water quality protection measures to protect water-related ecosystem services and the incorporation of lessons learned into the continuing development of the area.

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CLIMATE CHANGE IN SVALBARD – PHYSICAL CHANGES

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The Arctic is in a period of rapid and large change. The Svalbard archipelago is situated between the ice covered interior Arctic Ocean and the temperate realms. The inflow of warm waters in the tail end of the North Atlantic Drift as well as prevailing wind patterns create a dynamic physical environment where we expect large changes from human induced climate change but towards a backdrop of large natural variability from the dynamics of the area. These physical circumstances will be elucidated to place modeling results for expected change in perspective. Within the framework of NorACIA (Norwegian regional Arctic climate impact assessment) model scenarios for climate change in the Svalbard region for the coming century were produced. These model results are compared to the observed trends in Svalbard during the latest decades.

Examples of Fram Centre research results on Svalbard trends in atmospheric temperature and winds, ocean temperature and salinity, sea ice distribution and volume, trends in fjord ice and glacier mass balance are presented. We find a Svalbard that is changing in all these states and at rates that appears to be accelerating in the latest two decades. We also find that the changes in all these physical aspects are internally consistent with each other and with a generally warming Earth. To the extent possible to evaluate based on the differences in time period between the model studies and the measurement record as well as the differences in spatial resolution of the model and our observations the observations are consistent with the model scenarios regarding patterns of change both for the directly modeled entities (e.g. temperature, precipitation) and for the entities not explicitly modeled but where changes are expected as a consequence of changes in the modeled entities (e.g. glacier mass balance and in particular the pattern of mass balance changes). The changes are consistent with the model scenarios for human induced climate change in the Svalbard region. Some observed changes are consistent in pattern of change with the scenarios but indicate earlier and more rapid change than what the model results suggest.

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ECOSYSTEM SERVICES CLASSIFICATION AND ECOSYSTEM ACCOUNTING: PRACTICAL LESSONS FROM THE FIELD

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The measurement of ecosystems and their flow of services to economic activity, as proposed by the SEEA experimental ecosystem accounts, requires a clear and unambiguous classification of ecosystem services. It also requires that the beneficiaries of those services, the economic activities and sectors they support, are represented in a classification scheme that can be mapped to the corresponding classifications in the System of National Accounts (SNA). This creates challenges because classifications of ecosystems and their services have, in the past, been developed for purposes other than the SNA; and the SNA classifications of economic activities, goods and services have not explicitly addressed the concept of ecosystem services. In this presentation, we will address our experience using current approaches for ecosystems such as Common International Classification of Ecosystem Services (CICES) and the Final Ecosystem Goods and Services Classification System (FEGS-CS), to align with SNA classifications, the Central Product Classification (CPC) and the International Standard Industrial Classification of Economic Activities (ISIC). We will discuss the experiences and lessons learned from practical applications of ecosystem accounting for policy decisions in Botswana, Guatemala, the Philippines, and Peru. The first three are implementing countries of the World Bank-led Wealth Accounting and the Valuation of Ecosystem Services (WAVES) Partnership, and Peru is a pilot for the Ecosystem Values, Assessment and Accounting Project, led by Conservation International. Finally, we will propose important considerations for the development of a classification scheme in the accounting context that meets the needs of policy-makers.

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A UTILITY PERSPECTIVE ON WATER QUALITY TRADING

Chris Hornback
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Chris will provide a clean water utility perspective to water quality trading, including the drivers and obstacles for trading with nonpoint sources and examples of utilities who have integrated water quality trading into their regular operations. NACWA has been working with the National Network on Water Quality Trading to help develop a set of shared principles and recommendations for implementing consistent and rigorous water quality trading programs, and Chris will also share his perspective on this effort.

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APPLYING THE NEW TIDAL WETLAND AND SEAGRASS RESTORATION METHODOLOGY

***K. Diane Hoskin[1], Brian Needelman[2]**, Steve Emmett-Mattox[3]*

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There is significant interest from the private sector to offset carbon footprints to mitigate the impacts of climate change: from travel to energy use and more. While forest conservation efforts have long been recognized, the detailed procedures for quantifying the real greenhouse gas benefits from tidal wetland and seagrass restoration now also exist and these efforts can result in significant climate mitigation benefits. This presentation will describe opportunities for connecting carbon finance with coastal restoration and conservation and provide insight into applying a greenhouse gas offsets methodology. With final approval in sight, the voluntary market methodology provides exciting incentives for increased private investment in estuary restoration and conservation.

Coastal blue carbon refers to the ability of seagrass beds, mangroves, salt marshes, and other tidal wetlands to remove carbon dioxide from the atmosphere and store it in the soil, where it can remain for centuries or longer. Blue carbon ecosystems are globally significant carbon stores and sequester CO_2 at rates greater than forests. There is increasing national and international interest in developing blue carbon as a financial mechanism for coastal habitat restoration and conservation.

In addition to developing the needed market incentives, Restore America's Estuaries is advancing blue carbon science and providing tools for local land managers and restoration practitioners to begin incorporating blue carbon consideration into their projects.

The draft Tidal Wetland and Seagrass Restoration Methodology, once approved by the Verified Carbon Standard, will be the first greenhouse gas offsets methodology for tidal wetland and seagrass restoration. It is global in scope, and includes activities that restore mangroves, seagrass beds, salt marshes and other tidal wetlands through enhancing, creating and/or managing hydrological conditions, sediment supply, salinity characteristics, water quality, and/or native plant communities.

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THE MARKET FOR GREEN INFRASTRUCTURE IN PHILADELPHIA

David Hsu
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This talk will discuss current research with the USEPA in Philadelphia, which is designed to assist the city's plans to transform itself using green infrastructure. The City of Philadelphia, as part of their "Green City, Clean Waters" plan to address stormwater runoff, has committed to "greening" more than 10,000 acres in the city through a variety of incentives, user fees, and technical assistance programs that are designed to stimulate private citizens and landowners to retrofit their properties.

The private market for green infrastructure, however, faces a variety of obstacles, including but not limited to: high transaction costs, asymmetric information, a lack of market structures and actors, lack of financing and capital, high upfront and low user costs, and an uncertain regulatory future. These market barriers will need to be addressed and overcome in order to meet the city's commitments under the Clean Water Act.

This talk will summarize our team's research in a number of key areas: 1) sizing the potential market for green infrastructure retrofits in Philadelphia over the next 25 years using methods of contingent and conjoint valuation; 2) analyses that will describe the expected market impact on heterogeneous communities, as well as the overall water quality impacts; and 3), our plan to develop market and information tools intended to stimulate the market for green infrastructure.

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ECOSYSTEM SERVICE VALUE OF CARBON SEQUESTRATION IN THE NATIONAL PARK SYSTEM

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Protected public lands within the National Park System provide many ecosystem service benefits, among which is the capture and storage of atmospheric carbon dioxide. Carbon dioxide capture in the form of net biomass production on NPS units helps regulate the earth's climate by reducing greenhouse gas concentrations in the atmosphere. These climate regulating benefits from carbon sequestration provide economic benefits in the form of avoided future damages and economic losses as a result of climate change. The National Park Service (NPS) has partnered with U.S. Geological Survey (USGS) economists to quantify the ecosystem service value of climate regulation from annual carbon captured on NPS managed lands.

This effort involves first conducting a Geographic Information Systems (GIS) overlay analysis to determine the total acreage by land cover type within each park unit boundary. Acreage by land cover type is then combined with annual carbon sequestration rates published in a series of USGS reports that are national in scope. This combined information results in an estimate of the annual metric tons of carbon sequestered by park unit within the National Park System. These results are then monetized using the social cost of carbon (SCC) estimates provided by the U.S. Interagency Working Group on Social Cost of Carbon. The 2013 SCC estimates per metric ton of carbon are $61.79, $39.32, and $12.36, which coincide with discount rates of 2.5%, 3%, and 5% (in $2013).

The NPS manages the nation's most iconic destinations and natural resources, many of which provide significant ecosystem service benefits to both present and future generations. This study contributes to a more comprehensive assessment of the ecosystem service benefits provided by NPS lands.

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INVESTMENTS IN WATERSHED SERVICES AND SUSTAINABLE INSTITUTIONS: SURVEY RESULTS AND CASE STUDIES FROM THE WESTERN US

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In a time of intensifying natural resource concerns, interconnectedness of public and private lands, and diminished funding and capacity, there is movement toward cross-sector collaborations to address water quality and quantity concerns in the western United States. The complexity of water resources are resulting in more adaptive and collaborative governance; incorporating both cross-sectoral and hierarchical integration to address ecological, social and political concerns. Investments in Watershed Services (IWS) are part of this emerging field of environmental governance.

IWS is not a single neutral environmental institution; its design and performance are shaped by its embeddedness in larger architectures. Our research demonstrates that geography and institutional interplay shape IWS programs. Even within the western US, IWS takes on different shapes across the landscape, affected by preexisting geographic, political, and administrative contexts and vertical interplay.

We focus our research on: 1) quantitative data collected for the Western US in Ecosystem Marketplace's State of Watershed Payments report, comparing changes between the 2012 to 2014 data sets; and 2) qualitative case studies of federal agency-water utility partnerships aimed at risk reduction, source water and infrastructure protection in the arid western US (CO, NM, AZ). The survey data collected identifies the major structure of over 60 programs in the western US, from regulatory in-stream flow programs, to nutrient trading, and voluntary watershed health/risk reduction. The case studies involve interviews with all project partners, including federal agencies, water utilities, local and national NGOS, and private landowners, to better understand the perspectives of each participant group.
We use the survey data to show the changes in IWS programs over the past five years, and to better understand what type(s) of programs are being developed, and the key motivating factors. We then use the case study data to understand in depth, how and why water utilities are increasingly investing in their watersheds, and the key challenges and successes that come with these partnerships.
We present these findings through both an academic lens (institutional sustainability and environmental governance changes), and a practitioner lens (key lessons learned for program development, insights and helpful resources). Our research provides: 1) understanding of how relatively new IWS conservation mechanisms interact within preexisting multilayered institutional systems; 2) examples of how IWS-driven transformations across sector and scale are addressing environmental governance, and 3) key components of success (and challenges) for ecosystem services beneficiaries and stewards considering voluntary source water protection programs like IWS.

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NUTRIENT BIOEXTRACTION WITH SHELLFISH, A VIABLE COMPONENT OF WATER QUALITY TRADING FOR THE PUGET SOUND REGION, WASHINGTON STATE

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When shellfish or plants are cultivated and subsequently removed from a natural system for the purpose of their nutrient removal ecosystem services, it is termed nutrient bioextraction. Nutrient bioextraction can help address eutrophication, low dissolved oxygen and reduced light availability in the water column. To attempt these objectives, the Pacific Shellfish Institute conducted pilot-scale nutrient bioextraction using wild set of blue mussel (*Mytilus trossulus*) in Budd Inlet, southern Puget Sound, Washington State. Our research purpose was to: 1) implement demonstration systems for nutrient bioextraction with shellfish; 2) determine the nitrogen removal services of the cultivated blue mussels; 3) assess the feasibility of producing soil compost from the demonstration systems; and 4) increase awareness of, and engagement in, urban water quality mitigation. Over 225 nylon straps were placed under 3 existing dock structures in May 2013 to provide a suitable substrate for mussel recruitment and settlement. By September 2013, over 3,600 kg (8,000 lbs) of mussels were filter-feeding on these straps. Analysis by AmTest Laboratories in Kirkland, Washington confirmed nutrient content of 0.8 -1.2% N and 0.06-0.08% P wet weight (ww), previously estimated from published literature and earlier nutrient removal with shellfish research in Puget Sound. Mussels from this project's 3 Budd Inlet sites resulted in a range of 0.81-1.08% N ww (0.07-0.12 sd, n=50 per site) and 0.06-0.09% P ww (0.001-0.005 sd, n=50 per site). Mussels were harvested, chipped, and delivered to The Evergreen State College's Organic Farm, Washington State University's Puyallup Research and Extension Center, and the Washington State Cedar Creek Correctional Center for compost trials. The mussels removed an estimated 36 kg (80 lbs) of N (ww) from lower Budd Inlet over the course of 4 months. In addition, this research provided a platform for extensive outreach efforts focused on improving public understanding of local water quality issues, ecosystem services of shellfish, and controlling upland sources of nutrients that flow into Puget Sound. Furthermore, the project facilitated dialogue surrounding nutrient bioextraction among regulatory agencies and potential buyers of water quality trading units. Nutrient bioextraction with shellfish could therefore be a viable component of water quality trading schemes for watersheds with TMDLs for nutrients in the Puget Sound region, including the water quality trading program under development by the Washington Department of Ecology and the State Conservation Commission under SHB 2454 of the 2014 Washington State Legislature. This research project was made possible through USEPA funds under the Puget Sound Ecosystem Restoration and Protection cooperative agreement PC-00J20101 to the Washington Department of Ecology.

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A PARTICIPATORY TOOL FOR ESTIMATING FUTURE IMPACTS ON ECOSYSTEM SERVICES AND LIVELIHOODS IN TORRES STRAIT

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In an era of change it is increasingly urgent to practically co-ordinate adaptive responses to currently unfolding and potential future impacts to our environment. This compels the development of effective decision support tools that are practical in tackling the challenges of exploring future natural resource trends in data-poor situations. When data is lacking yet management decisions are required, the development of a co-learning approach provides a way forward. In this study, co-learning was built upon 1) involvement of locals and policy makers, 2) viewpoints elicited from expert knowledge, 3) semi-quantitative valuation of local ecosystem goods and services (EGS) using a livelihood approach, 4) potential for iterative decision-making based on transparency and repeatability, and 5) engagement to allow for scrutinising. Here we present a case study showing how a participatory tool, the Asset Driver Well-being Integrative Matrix (ADWIM), is used in the Torres Strait, Australia, for estimating future impacts on ecosystem services and livelihoods. We use this semi-quantitative tool to conduct a comparative analysis of the potential impact to livelihoods derived from local ecosystem goods and services (EGS) given consideration of cumulative threats. The potential impact scoring is considered in relation to the local stakeholder views and values sought within a participatory workshop. The results produced are used to provide an assessment of the relative impacts on EGS and human well-being under the 'business as usual' scenario of climate change and human population growth. We discuss the relative merits and limitations of the tool for participatory livelihood adaptation planning.

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LINKING STRUCTURAL AND PROCESS-BASED ATTRIBUTES OF SALT MARSHES AND MANGROVES TO ECOSYSTEM SERVICE PROVISION

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In the northern Gulf of Mexico, mangroves are projected to expand their range northward due to increasing temperatures and decreases in the frequency and duration of freezes. With a 2 °C to 4 °C increase in mean annual minimum temperature, 95-100% of salt marshes in Texas and Louisiana will be vulnerable to displacement by mangroves. This projected transition of habitat types could have cascading ecosystem effects, thus affecting the supply and resiliency of ecosystem services and, consequently, coastal communities that depend upon these habitats.

Here we present the results of a meta-analysis of existing studies conducted to link structural and process-based attributes of salt marshes and mangroves to the provision of ecosystem services. Structural (e.g. density, biomass, spatial complexity) and process-based (i.e. rates of carbon and nitrogen cycling, productivity, trophic connectivity) measurements reflective of ecosystem function were compiled for marshes and mangroves. The variability in these attributes in relation to geographical area (e.g. latitude and temperature), type of dominant plant, biodiversity, colonization stage (age of the stand), and level of anthropogenic pressure was analyzed using several statistical techniques including structural equations and hierarchical modeling. The most important sources of variability for system attributes were identified and, based on this, salient environmental and biological controls of ecosystem services (e.g. storm protection, carbon sequestration, and nutrient filtration) are suggested.

The results of this study help our understanding of the mechanisms that regulate ecosystem service provision and contribute important information to inform policies of coastal management as human occupation of coastal watersheds increases. These results also provide information to models of future changes in coastal communities that may occur with climate change, in particular regarding what shifts in ecosystem service provision could ensue.

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INTEGRATING ECOSYSTEM SERVICES INTO URBAN PARK PLANNING & DESIGN

Dorothy C. Ibes
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Urban parks, which include a variety of green, brown, and gray infrastructure (greenways, desert parks, plazas, and other civic spaces), are key providers of a range of ecocentric and anthropocentric ecosystem services within cities. Given the importance of urban ecosystem services to the social and ecological health of urban ecosystems, and evidence that urban form significantly impacts service provisioning, there is growing consensus that ecosystem service considerations should be integrated into urban park planning, policy, and design. Yet this integration is limited by a lack of relevant, accessible tools and standards for implementation. To address these deficiencies, this study analyzed planning documents and synthesized multidisciplinary literature-- from urban planning, public health, geography, urban ecology, climatology, and landscape architecture-- on urban ecosystem services to inform the development of the Urban Park Ecosystem Services (UPES) tool. UPES is an accessible and geographically contextualized planning tool and site design guidelines for systematically integrating multiple ecosystem service considerations into urban park planning practice. To maximize relevancy and accessibility to practitioners, the tool was based on an existing planning ordinance, already in use by planners, that organizes urban elements (including parks) along a gradient of urban-to-natural zones. The tool was then adapted specifically to arid urban ecosystems using Phoenix, Arizona as a case study, but can be customized for use in other cities based on their specific geographic conditions and policy goals. UPES provides a starting point and foundation for the integration of ecosystem service considerations into civic space planning and design to maximize their benefits across an urbanized region.

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ENERGY, POLICY, AND ECOSYSTEMS SERVICES ON A NINE BILLION PERSON PLANET: WHAT'S AHEAD?

Marc L. Imhoff

Pacific Northwest National Laboratory's Joint Global Change Research Institute, College Park, MD

With the prospects of a 9 billion plus person planet by 2050 there will be enormous pressure on ecosystems to provide food, fabrication materials, and fuel as well as maintain reservoirs for the cycling of carbon and water at quantities and rates that are needed to sustain prosperity. With growing affluence and an awareness of climate change driven by GHG in the atmosphere, these critical ecosystem services will be put under increasing pressure by the competing demands for food and carbon-neutral energy sources such as biofuels. Policies favoring biofuels will greatly increase conversion of land to agro-ecosystems resulting in the loss of other non-agricultural ecosystems as well as increase competition between food and biofuel as marketable crops. Competition for land between urbanization and agriculture, increasing consumption by urban populations, and competition for water across sectors will further complicate choices. Understanding the complex and linked socio-economic and ecological implications of these competing choices will require appropriate tools and methods for research that can produce actionable science. One promising approach employs satellite observations, statistical data and integrated assessment modeling (IAM). Here we show results that begin with an historical satellite-based examination of the rate at which humans use ecosystem services to provide food, fiber, and wood-based fuels compared to what the Earth can provide and then apply the Global Change Assessment Model (GCAM) a leading IAM to explore biofuel policy implications on land use, food prices, and climate out to 2100. Results show that continued growth and economic prosperity will have significant implications for land conversion with complex impacts on regional water scarcity and global climate.

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ECOSYSTEM SERVICES PROVIDED BY TERRESTRIAL HABITATS IN THE ARCTIC

Rolf A. Ims

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The state of terrestrial arctic ecosystems (i.e. Arctic tundra), including all components of their biodiversity and ecosystem services, has just been comprehensively reviewed by the Arctic Biodiversity Assessment (http://www.arcticbiodiversity.is/the-report). In this presentation I first summarize the key findings of this assessment, focusing on how structural aspects of biodiversity is intimately related to ecosystem functioning and ultimately the services these ecosystems provide to community at local to global scales. I then go on to discuss recent trends in biodiversity and ecosystem services that could be attributed to climate change. A key finding is that the trends in the same biodiversity parameters and ecosystem services are often heterogeneously distributed across the circumpolar arctic, probably both trivially connected to regionally different degrees of climate change and more intriguingly (but not surprisingly) connected to complex indirect responses and interactive effects in the ecosystem. The latter issue causes difficulties for robustly predicting how ecosystem services will respond to future climate change. Moreover, the high likelihood that the Arctic within this current century rapidly will develop both novel climates (i.e. climate with no current analogues) and novel/unstable ecosystem (i.e. non-equilibrium ecosystems that are structurally and functionally different from any known ecosystem) makes robust predictions impossible to derive. I conclude by advocating for intensive adaptive ecosystem-based monitoring as the most robust means for developing adequate strategies of rational use and management that maintain arctic ecosystem services under global warming. New plans for such a climate- ecological observatory tailored for the Norwegian terrestrial arctic will briefly be outlined.

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ECOSYSTEM SERVICES VALUE AT RISK: A NEW APPROACH FOR SUSTAINABILITY

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A new approach to valuing ecosystem services termed "ecosystem services value at risk" is shown to be promising as a way to guide policy towards sustainability, efficiency and fairness in the human use of natural ecosystems. This research is an extension of the valuation of ecosystem services of Costanza et al. (1997) and de Groot et al. (2012). Ecosystem services value at risk integrates ecosystem services valuation with a financial risk measure called value at risk to provide an estimate of a "worst likely loss" in the benefits people receive from natural ecosystems under alternative policies. This new approach is a way of characterizing the uncertainty around ecosystem services values from human activities. By framing the risk to ecosystem services in terms of loss, this risk measure conveys a more powerful message about the need to protect nature; through prospect theory, we learn that people tend to value losses more than gains.

Ecosystem services value at risk is built upon multidisciplinary research, drawing insights from ecological economics, finance, fisheries economics, ecological modeling and decision analysis. The core elements of an ecosystem services value at risk framework include: ecosystem services valuation, total economic value, stochastic ecological resource use modeling, a loss distribution, financial value at risk, intergenerational discounting, society's time frame for evaluation and decision rules. The relevant decision rule for ecosystem services value at risk is minimax, that is, minimize the maximum possible loss, with a focus on the lower left tail of the loss distribution. This rule is analogous to the safe minimum standard espoused by Bishop (1978) and extended by Farber et al. (2002), an approach to decision making thought to be necessary for resource management problems involving the risk of a significant magnitude loss which may be irreversible.

To show that the new approach is meaningful in resource management, a simple marine example is presented. Marine ecosystems which provide valuable and essential benefits to humankind are being severely altered all over the world from overfishing, climate change, marine pollution and habitat destruction. A simple fisheries model, the stochastic version of the Schaefer surplus production model, is integrated with an economic valuation sub-model as a basis for the computation of ecosystem services value at risk. An application of the new approach to the case study of the collapsed Georges Bank yellowtail flounder demonstrates its usefulness to marine policy evaluation by focusing decision making toward ecosystem resilience.

A simple risk measure based on the market values of catch provisioning services leads to selecting conservative harvest policies, ruling out high levels of fishing intensity. Considering the nonmarket values of a second type of ecosystem service, the regulating services from conserved biomass allows for even more precautionary strategies that favor marine conservation. The market and nonmarket values taken together provide a distribution for a lower bound estimate of the ecosystem services value at risk for the marine ecosystem. The ecosystem services value at risk approach thus supports sustainability and intergenerational equity, promising to help protect the flow of benefits from nature for current and future generations.

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ECOLOGICAL KNOWLEDGE AND TOOLS FOR ENHANCING ECOSYSTEM SERVICE INCENTIVES AND MARKETS

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Multiple types of financial and market-based incentives have matured and been implemented as effective mechanisms for conserving biodiversity and ecosystem services, alongside compensating the stewards or managers who help secure or generate desired benefits from nature. Payments for Ecosystem Services, environmental markets, and natural resource based enterprises are all such mechanisms. Yet, the growth and interest in these approaches may have outpaced the increase in knowledge and information on the biodiversity and ecosystem functions they target, especially in many tropical, developing countries where these mechanisms have high potential for reconciling the tradeoffs between conservation and income generation and poverty reduction.

Here, we examine several types of innovative financing mechanisms, specifically Payments for Ecosystem Services and nature-based enterprises, that have been implemented in multiple countries, possessing high biodiversity, intact, functional ecosystems and different degrees of economic development, and ask several critical questions pertinent to the effectiveness of these mechanisms: 1) What have been the major knowledge gaps in establishing these projects?; 2) What are the biggest obstacles to sustainability?; 3) What kinds of scientific information and tools were most useful and/or accessible to project developers, investors and buyers during design and implementation?; and 4) What, if any, ecological science, tools and guidelines would better support growth and persistence of these initiatives? The results of this analysis will be contextualized within a broader initiative that is focused on understanding the scientific information that is most needed and would be most useful for enhancing the effectiveness and sustainability of market-based mechanisms for ecosystem service conservation and management.

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EVIDENCE FOR NEAR-ROAD AIR POLLUTION ABATEMENT BY TREE COVER

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Urbanized areas represent concentrated demand for ecosystem services to buffer hazards and promote healthful lifestyles. Urban tree cover has been linked to multiple local health benefits including clean air and water, flood and drought protection, heat mitigation, and opportunities for physical activity, social engagement, exploration, and play. Sensitive and vulnerable populations have been shown to benefit disproportionately from nearby ecosystem services; these populations include those who live, work, and go to school near busy roadways.

Globally, populations with regular exposure to the near-road environment exhibit more respiratory and cardiovascular illnesses, adverse birth outcomes and developmental problems, cancers, and premature mortality. Vehicular emissions elevate near-road concentrations of many air pollutants including carbon monoxide, nitrogen oxides, and fine particles. Near-road research has begun to explore tree cover for its ability to block or trap toxic particles, and to absorb or neutralize harmful gases. Laboratory experiments under idealized conditions have demonstrated the potential for tree leaves to collect particles, and for tree buffer strips to divert gaseous plumes into the upper air column, where concentrations are diluted through turbulence.

Preliminary field studies in central North Carolina and Detroit, Michigan, used stationary and mobile air monitors to compare particle concentrations behind near-road tree buffers with concentrations in nearby roadside clearings. Data revealed large variability in the clean air benefits of near-road tree cover, even showing some higher particle concentrations behind tree buffers than in open roadsides. Wind speed and direction were the most significant mediators. In downwind and low wind conditions, the effect of tree buffers included up to 30% lower concentrations of ultrafine particles (< 0.5 ug) and up to 22% lower concentrations of black carbon (an indicator of diesel exhaust). Evergreens were more effective buffers than deciduous trees.

Findings suggest that tree cover can significantly moderate ambient concentrations of harmful airborne particles adjacent to busy roadways. However, effectiveness is highly dependent on site conditions, which can negate or even reverse expected clean air benefits. In addition, buffers may merely deflect roadway particles from the immediate near-road zone to more distant areas or back onto the roadway itself, transferring rather than reducing health risks. This area of research is still emerging and more analyses are needed. Buffer species, height, depth, and porosity are critical design variables that require further study. Epidemiology research is also recommended to assess health outcomes in near-road populations under buffered versus open roadside conditions.

Although this material was reviewed and approved by EPA, it does not necessarily reflect official Agency policy.

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INTEGRATING ECOSYSTEM SERVICES INTO HEALTH IMPACT ASSESSMENT

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Health Impact Assessment (HIA) provides a methodology for incorporating considerations of human health into planning and decision-making processes. HIA promotes interdisciplinary action, stakeholder participation, and timeliness and takes into account equity, sustainability, and best available evidence. Tools and methods for quantitatively and qualitatively evaluating associations between the environment and health are necessary for understanding the potential impact of decisions and plans on health. EnviroAtlas is one resource that can be used by planners, researchers, public health professionals and engaged citizens to gain a greater understanding of linkages between ecosystems, ecosystem services, and health.

EnviroAtlas is a suite of tools and resources that includes an ecosystem services mapping application and an Eco-Health Relationship Browser. Hundreds of data layers for the conterminous US and select communities can be viewed in an interactive mapping application or downloaded for further analysis. Data for natural resources, potential stressors, and demographics are available, lending support to a systems approach to considering health in decision-making. Additionally, the Eco-Health Relationship Browser provides an up-to-date review of the current state of eco-health science, focusing on the hazard buffering and health promotional benefits of green infrastructure.

A guide for using EnviroAtlas to integrate ecosystem services into HIA was developed through an interactive process of literature and HIA report review, conversations with practitioners, and field and retroactive testing. The guide aims to close data gaps and increase the utilization of available tools, improvements that were identified in an EPA review (2013) of best practices in HIA. The guide will aid HIA practitioners in identifying regions of disparate burden and possible points of intervention and health promotion by linking ecosystems, ecosystem services and human health.

Next steps include identifying test communities for integrating ecosystem services into HIA processes and bundling the guide into training tools available through EnviroAtlas. Resources like EnviroAtlas can help facilitate the inclusion of environmental health considerations into decision making and aid in understanding the pathways through which health outcomes occur.

Although this material was reviewed and approved by EPA, it does not necessarily reflect official Agency policy.

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USING WATERSHED-SCALE RESTORATION FOR HYDROPOWER COMPLIANCE

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Putting policy and science into practice is not a simple task. Protecting and restoring watersheds that cross state lines, are governed by multiple agencies, and represent complex environmental interactions present a particular challenge. This presentation will examine a proposed multi-decade restoration program of multiple Snake River watersheds that is built using components of successful water quality trading programs.

The Idaho Power Company is working toward meeting the obligations of its Hells Canyon Complex relicensing with the Federal Energy Regulatory Commission while also aiming to address the more holistic issue of returning a heavily used and degraded waterway to a more healthy state. The main questions guiding this program have been: Is it possible to restore ecosystem function to a historically important reach of the Snake River in order to support native fish habitat *and* meet federal regulations? And can a regulated entity translate the benefits of restoring functional riverine conditions into parameters that matter to regulatory agencies and a complex variety of stakeholders?

We will discuss The Freshwater Trust's recent experience designing a multi-faceted ecosystem services approach to restoring river function and counting benefits towards Clean Water Act compliance. LiDAR, FLIR, flow, temperature and sediment data have been collected to guide program development and set goals, and models such as Surface Irrigation Soil Loss (SISL) and Shade-a-Lator have been used to gauge site-specific restoration opportunities.

Program components include:
Under the flow constraints of a 'working river,' adapting the Snake River channel to promote more natural function by constructing new floodplain and wetlands and augmenting existing islands – thereby increasing river depths and flow velocities while decreasing surface area.
Working with agricultural producers to dramatically reduce sediment and nutrient loading throughout the watershed using voluntary incentives to on-farm upgrades and BMPs.
Restoring miles of riparian zone on key tributaries above the Hells Canyon Dam.
Developing a relational model to translate instream processes (such as hyporheic connectivity) into units of temperature for regulatory compliance.

Beyond the science behind the proposed restoration program, we will step through the process of facilitating inter-agency cooperation to build a policy foundation that supports such a program for compliance. We will also discuss lessons learned in bringing together diverse stakeholders to address fundamental natural resource issues, and describe both the path forward and applicability to other environmental issues.

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FLOODPLAINS BY DESIGN: VALUING NATURAL INFRASTRUCTURE IN THE CONNECTICUT RIVER BASIN.

Kris Johnson
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The Connecticut River and its floodplain are of significant ecological value and provide important ecosystem services by filtering polluting nutrients from water, providing areas for hunting and recreation, and serving as natural sponges that can reduce downstream flooding. However, the multiple benefits provided by floodplains often are overlooked and unaccounted for in decision-making. For example, a 1994 US Army Corps of Engineers study found that floodplains in the Connecticut River provided insufficient flood mitigation services to justify the costs of conservation. In this presentation we share results from an analysis that revised that 1994 USACE study by quantifying and monetizing several additional ecosystem services provided by conserved floodplains in the Connecticut River Basin. We find that inclusion of these additional ecosystem services significantly increases the estimated value of conserved floodplains and that protection of natural floodplains along the Connecticut River can, in some cases, generate benefits that exceed the costs of conservation.

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FLOODPLAINS BY DESIGN: A TOOL TO SUPPORT MULTI-OBJECTIVE DECISION-MAKING IN FLOODPLAINS.

Kris Johnson *and Chris Zganjar*
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Puget Sound's major rivers and their floodplains deliver a wealth of ecosystem services. They support diverse and productive agriculture, sustain important fisheries, enable recreation and provide other functions essential to quality of life in the region. However, development and other activities in Puget Sound have degraded more than 70% of floodplains threatening salmon populations and limiting the extent to which these areas can regulate flood waters and provide other important services. The variety of problems caused by the loss and degradation of floodplains has triggered responses from an array of stakeholders and interests, resulting in uncoordinated and often conflicting efforts to manage these critical areas. To address this challenge the Nature Conservancy launched *Floodplains by Design*, a collaborative effort to improve decision-making by providing information to align isolated objectives and integrate disconnected stakeholders. A key component of this strategy is the development of a decision support tool designed to provide data and data visualizations that can support prioritization and implementation decisions and improve floodplain management. The Floodplains by Design tool has been developed both at a regional scale with state and federal agency partners and at a river reach scale in Snohomish County, WA. In this presentation, we will describe the design and content of the Floodplains by Design decision tool and discuss the intended audiences and relevant decision-making applications.

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ENHANCING THE GEOSPATIAL VALIDITY OF META-ANALYSIS TO SUPPORT ECOSYSTEM SERVICE BENEFIT TRANSFER

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Meta-regression models (MRMs) are commonly used to evaluate systematic influences of study, economic, resource and population attributes on comparable measures of ecosystem service value, and to generate benefit functions for use in applied benefit transfer. Within these models, the dependent variable is a comparable measure of economic value drawn from existing primary studies, and independent moderator variables represent factors hypothesized to explain variation in these values across observations. A potential advantage of such MRMs is the ability to forecast comparable and internally consistent measures of ecosystem service value across sites and scales. However, the accuracy of these forecasts depends on both metadata content and model specification.

Despite recent advances in benefit transfer MRMs, a common limitation of these models is an inability to capture the dual effects of variations in geographic scale of affected resources (where resources change) and sampled populations (where the sampled population lives), as well as related variations in the availability of regional substitutes. For example, the geographical scale of a water quality change would reflect the size of the water body or area affected by the change (e.g., the size of the affected river or lake). The scale of sampled populations would reflect the location of households for which values are measured (e.g., were values measured for residents of the surrounding community or watershed, state, region or entire US). Availability of substitutes would reflect the number of unaffected substitute resources in the surrounding geographical area.

All of these factors are relevant for forecasting ecosystem service value, and at least in principle should be incorporated in benefit functions. However, the capacity of MRMs to incorporate these measures has thus far been limited. Because these and other geospatial characteristics of studied sites seldom vary within original ecosystem service valuation studies, few primary studies report these characteristics. Hence, inclusion of detailed, quantitative geospatial data within MRMs typically requires the meta-analyst to reconstruct these measures for each primary study site, using information from outside geospatial data sources. These geospatial data are used to augment study-reported information in the final metadata. Such metadata augmentation enables benefit transfer MRMs to capture a wider range of relevant geospatial effects than is possible using study-reported metadata alone.

This presentation reports on the development, estimation and results of MRMs for US water quality valuation that better incorporate geospatial patterns and data, including more accurate measures of geospatial scale and regional substitutes. Observations in the metadata are drawn from studies that estimate WTP for water quality changes in US water bodies (e.g., rivers, lakes and bays). Results illustrate numerous intuitive scale and substitution effects that have not previously been identified by the MRMs, allowing transfers that enable adjustments for geospatial factors. The result is a set of benefit functions better able to accommodate the effects of geospatial scale and regional substitution predicted by theory, yet often overlooked by prior valuation MRMs. Discussion highlights the implications of these results for the development of metadata and MRMs to support nationwide ecosystem service assessments.

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ENSURING THE JOINT ECOLOGICAL AND ECONOMIC SALIENCE OF ECOSYSTEM SERVICE VALUES: AN APPLICATION TO RIPARIAN RESTORATION

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Modeling of ecosystem service values often suffers from a lack of salience in ecological or economic aspects, leading to imprecise or biased estimates. For example, many ecological indicators proposed as measures of ecosystem services do not correspond to outcomes that directly benefit human populations, or result in a double counting of ecosystem benefits. Among the principle problems in this area is ambiguity between intermediate and final ecosystem services. At the same time, economic valuations are often grounded in imprecise or invalid ecological indicators, yielding benefit estimates that have unclear interpretations and cannot be linked to measurable ecological outcomes. These issues are particularly germane for stated preference valuation, which due to its flexibility is among the most promising methods for assessing many types of ecosystem service values, but is also among the valuation methods most subject to invalid and unreliable applications.

This presentation discusses the errors that can occur due to a lack of ecological or economic salience in stated preference valuation of ecosystem services, and provides concrete recommendations and steps to mitigate these errors. Concepts and methods are illustrated using a multi-disciplinary case study of riparian restoration that quantifies households' willingness to pay (WTP) for ecosystem service outcomes of riparian land restoration in the Merriland, Branch Brook, and Little River (MBLR) watershed in south coastal Maine. The approach is grounded in an ecological/economic model linking ecosystem services influenced by riparian land restoration to benefits realized by area residents. The associated choice experiment survey was developed and tested over more than 3 years in a collaborative process involving interactions of economists and ecologists; meetings with managers, natural scientists, and stakeholder groups; and multiple focus groups. The resulting data enabled estimation of the WTP of area residents for options that would restore between 0 and 500 acres of riparian land in the watershed, along with associated changes in recreational fish abundance, swimming safety, river ecology, and riparian development restrictions.

Results quantify use and nonuse values realized by different beneficiary groups and demonstrate the unambiguous linkage of these values to well-defined, readily-measurable ecological indicators. Results also illustrate the use of coordinated theoretical and empirical models to ensure the economic validity of resulting welfare estimates – including mechanisms to test for, and mitigate potential double counting. Discussion highlights the challenges involved in the development of empirical models with joint ecological and economic salience, methodological recommendations to help ensure this salience, and the risks of ecosystem service valuation that overlooks these issues. From a policy perspective, results also quantify (sometimes unexpected) tradeoffs in riparian land restoration and implications for benefits realized by area residents.

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INTEGRATING SOCIAL VALUE THROUGH ECONOMIC VALUATION

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Economic valuation quantifies the social value provided by ecosystem services, along with tradeoffs in these values associated with regulatory alternatives, investments in protection and restoration, and other types of management or policy actions. Economic valuation implies a systematic quantification of benefits realized by society in commensurable and consistent (typically monetary) units, using methods grounded in economic welfare theory. A basis in economic welfare theory is one of the primary distinguishing features of economic valuation. This underlying theory provides the formal structural necessary to link estimated monetary values with changes in net well-being or social welfare. The strengths of economic valuation, including the ability to aggregate benefits and compare benefits and costs in easily understood and theoretically-defensible units, has led to widespread use and acceptance of valuation by governments and decision-makers worldwide. Economic valuation is also supported by over four decades of methodological development and validation. At the same time, ecosystem service valuation faces numerous challenges related to the integration of economic and ecological methods required to ensure validity, and many attempts at ecosystem service valuation have applied invalid or unreliable methods. The use and interpretation of economic values is also frequently misunderstood.

This workshop presentation introduces the theory and methods used for economic valuation of ecosystem services. The presentation begins with a review of the underlying theoretical framework that distinguishes economic valuation, provides the basis for empirical valuation methods, and enables validation and testing of empirical measures. This is followed by an introduction to empirical methods for market and non-market valuation (including both revealed and stated preference methods), emphasizing applications, results, interpretations and data requirements. This includes a discussion of issues to be considered when choosing a valuation approach, including the valuation context and type(s) of economic values to be measured. The presentation will also discuss the differences between primary valuation analyses and benefit transfer, including situations when each may be suitable. Empirical examples will be used to illustrate methods, results and challenges. Particular attention will be given to the scope and scale of ecosystem services and the relevance of these issues for economic values, along with the challenges of coordinating ecological and economic methods. The presentation concludes with a discussion of approaches that can be used to assess the methods, results and validity of ecosystem service valuation. General recommendations will also be presented for those who wish to conduct or commission assessments of ecosystem service values.

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USING AN EXPERIMENTAL AUCTION PROCESS TO IDENTIFY PUBLICLY VALUED ECOSYSTEM RESTORATION PROJECTS

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Understanding public preferences through assessing values and priorities for ecosystem goods and services may provide environmental managers with an important input to design better public policies for managing these goods and services. Discrete choice experiment (DCE) is a non-market valuation method used by environmental economists to estimate values and preferred tradeoffs of various dimensions of these ecosystem goods and services. Employing the DCE, this study strives to develop a decision support tool for environmental managers to prioritize future ecosystem restoration projects for managing invasive plants in the Nature Reserve of Orange County (NROC), California.

We employed field experimental settings and invited local residents living around the NROC, who are affiliated to local conservation groups, to participate in "Ecosystem Restoration Decision-Making Workshops". Participants in these workshops were asked to evaluate both real choices, that have direct financial consequences on participants, as well as hypothetical choices of future restoration priorities and were asked to indicate their preferred restoration projects. The restoration projects were described by a bundle of restoration attributes covering various aspects or dimensions of the restoration activities including level of restoration actions, habitat types to restore, size of the restoration site, level of public access allowed, involving trained volunteers in restoration activities, likelihood of restoration success. Participants' responses to these choices of restoration projects were used to develop a statistical model of values and preferences for prioritizing future ecosystem restoration actions.

In addition to developing the statistical model of values and preferences for restoration actions, we examined whether participants respond consistently to the choices under alternative provision rules-majority vote and single decision-maker's choice rules. A provision rule is a process or mechanism by which participants' responses to the choices determine the provision of ecosystem restoration projects and provides an explicit nexus between choices and outcomes of the choices. This is an important methodological exploration for researchers in the non-market valuation. We fit a mixed logit model to estimate values of and preferred tradeoffs among ecosystem restoration attributes.

Our results suggest that participants respond consistently to choices under the alternative provision rules, which is a very important conclusion for methodological aspects of the DCE supporting the use of the model for benefit-cost analysis. Our study demonstrates an approach by which public values and priorities, as an input to consider, can be incorporated into a decision support tool to help environmental managers to prioritize future ecosystem restoration decisions.

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BUILDING MIDSCALE DATASETS TO SUPPORT ECOSYSTEM SERVICES ASSESSMENTS

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A significant challenges to implementing ecosystem services assessments is having adequate data to ensure assessments can be comparable between sites, while providing information that can inform regional and watershed level decision making. In particular, national datasets are often too course to provide the resolution or detail needed to address regional decisions, such as those made by national forests, BLM districts, or Watershed Councils. Local datasets on the other hand are generally too expensive, big, detailed and variable to allow for compilation over larger areas needed for regional, state or watershed assessments.

Recent work in the western U.S. has led to the development of some mid-scale datasets that provide the detail needed to address many ecosystem service assessment questions. In particular, the vegetation and terrestrial ecological datasets were created over large, multi-state areas; designed to be created from national-level monitoring systems, such as the U.S. Forest Services' Forest Inventory and Analysis Program, creating detailed information which can be updated to provide analysis of change in services being provided. Recent regional projects in the Sky Islands of Arizona, the Rogue River Basin of southwestern Oregon and northwestern California, and in much of the intermountain west for the range of the Greater sage grouse (*Centrocercus urophasianus*) provide examples of the utility of this information, which can be affordably developed across the country, and which can be tied to land management related state-and-transition models. To date, developing mid-scale data to inform regional assessments of services related to water, has proven to be a greater challenge.

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ECOSYSTEM SERVICES CREDITING STRATEGIES FOR TRANSPORTATION AGENCIES

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Ecosystem services measurement and crediting tools are emerging as important components of the planning and project implementation process in transportation. These tools aid in designing effective mitigation of environmental impacts, reduce transaction costs through shortening the time needed to implement projects and contributing to improved environmental outcomes. While there are successful programs in California, North Carolina, and Oregon developed cooperatively with regulatory agencies, and state and non-governmental conservation programs actively involved in mitigation banking and organizations funding restoration activities, there are currently no straightforward methods for creating ecosystem crediting strategies for implementation by Metropolitan Planning Organizations (MPOs), Department of Transportation agencies (DOTs) or other land use planning agencies.

The Federal Highway Administration (FHWA) has funded an effort to improve the ease of developing transportation and infrastructure-focused crediting strategies. This work includes the evaluation of existing projects and programs, the opportunities and obstacles agencies may encounter when designing or participating in an ecosystem crediting strategy, a description of the ongoing state of the transportation crediting practice, and a detailed stepwise manual for DOTs and MPOs to create an ecosystem services crediting strategy. It is based on previous research to integrate planning and mitigation tools and to address crediting for impacts to multiple ecosystem types. The presentation will highlight findings of the research project, including a description of the design process and the state of the practice across the country. The barriers to creating viable strategies and ways to overcome them will also be discussed.

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MEASURING ECOLOGICAL INTEGRITY ACROSS JURISDICTIONS AND SCALES

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Although scientists and resource specialists in the United States have generated voluminous data on elements of biodiversity, we lack the ability to determine the overall status of ecosystems and how they are changing over time in response to climate change and other stressors. Without this information, it is difficult to understand trends, assess ecosystem outputs, develop landscape-scale conservation plans and management actions, or adapt to environmental changes.

A diverse group of non-profit organizations, natural resource agencies and researchers has been working together for several years to develop a conceptual framework that can be applied across different ownerships, programs, and geographic scales to measure ecological integrity. The framework includes five different themes: Landscape features, habitat characteristics, representative species, at-risk species, and nature's benefits. This model assumes that it is essential to understand the capacity of the ecosystem to provide ecosystem services as a first step in determining what services can be delivered and to whom in a given landscape.

An explanation of the proposed framework, along with recommendations for implementation and application through public-private partnerships are contained in a white paper. The paper addresses the benefits and challenges associated with a developing a more comprehensive, consistent, and transparent approach to the collection, management, and distribution of ecological information. It also highlights the importance of developing a common language to communicate with and engage a broader audience in monitoring and conserving biodiversity.

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HOPES AND FEARS REGARDING THE IMPLEMENTATION OF THE ECOSYSTEM SERVICES CONCEPT IN SWITZERLAND

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As other signatory states of the Convention on Biological Diversity Switzerland has established a Biodiversity Strategy with goals to be reached by 2020. One of the goals of the Swiss Biodiversity Strategy is dedicated to the quantification of ecosystem services – in order to implement them into policy. But how can or should the ecosystem services concept be implemented into Swiss policy and practice? In the presented research project, different opinions of professionals from various areas are being analysed. The focus lies on opportunities and risks related to the implementation of the ecosystem services concept.

Besides public strategy documents, the main data source for this research are qualitative structured expert interviews. The experts work for public authorities, nongovernmental organizations, science, politics, economy, conservation areas and interest groups. The interviews are being analysed through a descriptive data analysis. This data is then being compared to findings from other research projects outside Switzerland in order to establish theoretical generalisations.

The first results show a very heterogeneous situation: Some experts attach high expectations to the implementation of the ecosystem services concept while others fear that the economic argumentation could be counterproductive for the biodiversity and landscape policy.
The hopes are mostly related to the anticipated advantages of a better sensitization because of the emphasizing of human benefits. Those in favour hope to generate more financial support for the protection of nature and landscapes.
Others fear that ecosystems could be seen as commodities. They argue that nature has intrinsic and ethical values but these values should not be expressed in economic values, because all numbers are subject to political tampering and should therefore be avoided.

I will illustrate possible implementations of the ecosystem service concept in Switzerland with example cases. Together with the Swiss Federal Office for the Environment – responsible for the Swiss Biodiversity Strategy – those example cases and the final results of the interview analysis will be discussed in order to establish recommendations for different stakeholders.

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BIGGER IS BETTER: BENEFITS TO BUSINESS AND CONSERVATION FROM LANDSCAPE-LEVEL MITIGATION PLANNING

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Purpose/Scope

Sustainable development should improve the lives of people while simultaneously protecting nature's assets. Because economic development often comes at the expense of the environment, impact mitigation is high on the global policy agenda, with interest increasing to advance public policy, lending standards, and corporate practices. Mitigation programs are calling for moving away from traditional, site-based mitigation to broader, more comprehensive landscape-level mitigation that is expected to provide more effective conservation returns, reduce regulatory hurdles, and potentially offer cost savings to private developers (permittees). However, the extent to which joint conservation and business benefits are produced with this new approach has never been assessed in a real mitigation context. To address this gap, we quantified the benefits of implementing Brazil's Forest Code at a landscape (watershed) scale as opposed to the current parcel-by-parcel (farm) compliance requirement. We further examined the relative benefits of different landscape-level mitigation compliance actions: habitat protection, restoration, or a combination of both.

Methods

We modeled land use planning around the expansion of sugar cane production in the Cerrado biome in southcentral Brazil. We examined planning scenarios that differed in their spatial scale (landscape vs. parcel-level), mitigation options (protection, restoration, and combination thereof), and production targets (2.5 vs. 8.5 million tons of sugar cane) that met agricultural production targets while minimizing costs from production and from compliance with the Forest Code. We compared the scenarios in terms of the monetary costs to business and the ecological benefits to people and nature (i.e. biodiversity, water quality, and carbon storage/sequestration).

Results/Conclusions/Recommendations

We found that Forest Code compliance comes at a small cost to business (i.e. increasing annual sugarcane production costs by only 3.6-8.7%) but can generate significant benefits to people and nature: it can support 73-82% of all possible bird and mammal species in the region, store 57,000-2,279,000 additional tons of carbon, and provide marginal improvements in water quality. Relative to parcel-level, landscape-level mitigation reduced businesses costs regardless of the production target or how the Forest Code requirements were met. It also supported greater biodiversity on average (by reducing habitat fragmentation), provided more carbon storage when based on habitat restoration, but had negligible effects on water quality. Among the landscape-level planning options, restoration-based mitigation tended to provide the largest benefits. Our findings indicate that landscape-level (watershed-based) mitigation planning, if implemented effectively, should generate greater business and conservation returns than has materialized with traditionally based impact mitigation.

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SCENARIO ANALYSIS: EVALUATING BIODIVERSITY RESPONSE TO FORECASTED LAND-USE CHANGE IN THE SAN PEDRO RIVER BASIN (U.S.-MEXICO)

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Envisioning and evaluating future scenarios has emerged as a critical component of both science and social decision-making. The ability to assess, report, map, and forecast the life support functions of ecosystems is absolutely critical to our capacity to make informed decisions to maintain the sustainable nature of our environment now and into the future. Evaluating trade-offs in terms of ecosystem services and human well-being provides an intuitive and comprehensive way to assess the broad implications of our decisions and to help shape policies that enhance environmental and social sustainability. In answer to this challenge, the U.S. Environmental Protection Agency (EPA) has created a partnership with other Federal agencies, academic institutions, and Non-Governmental Organizations to develop the *EnviroAtlas*, an online national Decision Support Tool that allows users to view and analyze the geographical description of the supply and demand for ecosystem services, as well as the drivers of change. As part of the EnviroAtlas, an approach has been developed to quantify and map various metrics within an ecosystem services framework that are representative of vital functions and support services such as A) Biodiversity Conservation; B) Food, Fiber, and Materials; and C) Recreation, Culture, and Aesthetics. This approach is being further tested in regard to future long term land-use change scenarios to characterize ecological impact from future urban growth. Future growth is represented by housing density maps generated in decadal intervals from 2000 to 2100 derived from the EPA Integrated Climate and Land-Use Scenarios (ICLUS) national database. ICLUS developed future housing density maps by adapting the Intergovernmental Panel on Climate Change- Special Report on Emissions Scenarios social, economic, and demographic storylines to the conterminous United States. The first level of futures testing has been conducted in the San Pedro River along the U.S.-Mexico border, a watershed that is world renowned for its species richness and an area where economics and population growth present significant challenges to environmental decision-making related to sustainable future conditions. Selected metrics, e.g. total species richness, harvestable species, and threatened and endangered species, were composed from 452 deductive terrestrial vertebrate models derived from the U.S. Geological Survey Gap Analysis Program data and utilized to examine ICLUS change scenarios for urban and residential development across the watershed. The A2 Scenario is characterized by the highest human population growth, greatest land conversion, and highest domestic migration resulting in new population centers and typically represents the greatest loss in the metrics examined. Although natural area was lost under all ICLUS scenarios throughout the 100-year study timeline and geographic patterns varied among metrics across the study area, the approach appears to demonstrate great promise for examining long-term change and make predictive inferences about future conditions over broad geographical areas, such as watersheds.

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COST COMPARISON OF DWM ECOSYSTEM SERVICE DELIVERY WITH CONVENTIONAL STRATEGIES

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Drainage water management (DWM) technology has the potential to substantially reduce nitrate losses from farm fields, thus improving water quality. Adoption could expand where the technology has the potential to generate on-farm economic benefits, in addition to off-site environmental benefits. Specifically, increased crop yields associated with DWM could offset implementation costs and increase farm profitability. During dry periods, DWM technology can be used to retain moisture in the soil profile, reducing crop stress and potentially boosting yields.

A preliminary analysis evaluated the potential economic benefits of DWM and the conditions under which the technology might be cost-effective. This evaluation calculated the break-even point when installation costs would be recovered under multiple scenarios in corn and soybean production systems. Estimated costs used in the assessment were $93/acre for DWM retrofits and $88/acre for new installations. These costs were compared to additional profit generated by potential yield increases of 5 and 10 percent at a range of crop prices for corn and soybeans.

This analysis found that yield increases associated with DWM potentially could cover the costs of technology installation well within the expected lifetime of the device. For example, a 5 percent yield increase would generate sufficient additional profit to offset the installation cost of either a retrofit or new DWM device within four years at all selected crop prices. The producer potentially could recover installation costs within two years if yields increased by 10 percent. These years do not need to be consecutive but rather reflect the total number of years where the necessary factors are present for yield boosts to occur. Actual on-farm economic benefits of DWM will depend on the site-specific characteristics, as well as weather conditions in a given season. Yield effects observed through field trials are highly variable and additional research is needed to determine long-term averages.

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EVALUATING GREEN INFRASTRUCTURE FOR PUBLIC AND PRIVATE INVESTMENT: LESSONS FROM LIMA, PERU

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Aquafondo is the water fund for Lima, the world's second largest desert city. In 2011, Forest Trends and Kieser & Associates began a collaboration with Aquafondo to design a framework for cost-effective watershed investments, based on each project's water quality and quantity benefits. The framework builds on the experience of water quality trading and other performance-based watershed investment programs in North America and elsewhere to bring accountability to water funds that had not been seen in Latin America.

In 2013, building on this framework, the project team partnered again with CONDESAN, an NGO with expertise in Andean hydrology, to build a cost curve that would compare the cost-effectiveness of green and gray investments in Lima's most important watershed, the Rimac. The goal of the exercise was to convince public and private sector actors to direct investment dollars toward green interventions – such as wetland restoration and improved pasture management – based on their cost effectiveness compared to gray investments, such as ongoing diversion projects that pump water from the Amazon and over the Andes to the Pacific coast.

The core of the evaluation was the development and application of calculation methodologies for estimating the impact of green interventions on base flow, one of the most highly-prioritized indicators among local stakeholders and potential investors. CONDESAN worked with Kieser & Associates to apply calculation methodologies which had been developed and primarily used for North American systems, to the dry, Andean coast.

Alongside the technical evaluation, the team engaged potential investors, including the National Water Authority and the water utility for Lima. Discussions with these actors began with communicating that it is possible to evaluate the cost-effectiveness of watershed investments, and continued through presentation of the study's results.

The presentation will briefly review the methods employed as well as the results of the analysis, but will focus on the lessons and unexpected results that engaging decision-makers and potential investors in the process yielded, touching in particular on the following areas:

1. Cultural translation of the cost-effectiveness framework: hits and misses
2. Working with uncertainty; communicating uncertainty to non-technical stakeholders
3. Value of the process for organizing available data and identifying knowledge gaps (e.g., to inform future research and monitoring focal areas)
4. Communicating results within a limited scope
5. Impact of the study: investment and policy decisions

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FORWARD-LOOKING OPPORTUNITIES AND OBSTACLES FOR WQT

Mark S. Kieser
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Mark will speak on forward-looking opportunities and obstacles for WQT, and what will be needed for continued and expanded success of this water quality tool. Obstacles that have to date impeded progress include nagging questions on how to set baselines, how much science is enough to move forward, and the nitty-gritty details that inevitably arise with implementation. Broader utilitarian uses for trading and similar instruments reveal how this approach is being considered in many new applications beyond traditional visions. These include stormwater trading, bacteria offsets, and achieving voluntary water resource goals. Concluding thoughts will focus on key needs for advancing opportunities based on two decades of work on WQT.

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NEW NATURE OF BUSINESS: HOW COMPANIES INTEGRATE BIODIVERSITY

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Two years ago the National Socio-Environmental Synthesis Center (SESYNC) initiated a pursuit to explore adaptive uses for biodiversity and ecosystem services data by businesses. The principal investigators, Sally Duncan and Steve Elliott, assembled an international team of 21 subject experts, including specialists in the fields of biodiversity conservation, ecosystem services assessment, business intelligence, decision support tools, policy analysis and the sociology of innovation. Through a series of workshops plus 16 business case studies, the team assembled a framework to facilitate the integration of biodiversity and ecosystem services concepts into business culture and practice.

Our analysis of the case studies found that profound change rarely happens without a champion, usually at or near the top of a company, regardless of the size. Once a company begins to contemplate how it might respond to biodiversity and ecosystem service challenges, its leaders arrive sequentially at a set of insights. These include the fact that all aspects of internal management, external supply, distribution and marketing intersect with the company's dependence on ecosystem services. And thus, many new parameters need to be monitored and reported as part of adaptive management.

In the spring of 2014, the team launched a website, the *New Nature of Business* (http://www.newnatureofbusiness.org/report/) to highlight initial results and seek feedback on the draft framework. This session will review the findings regarding what pioneering companies are doing to address challenges related to biodiversity and ecosystem services, why they are doing it, and how other companies can use the New Nature of Business framework to emulate the successes of these pioneers.

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TIMBER, CARBON STORAGE, AND HABITAT PRODUCTION POSSIBILTIES

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Since the advent of "multiple-use" as a guiding principal in public lands management in the US, forest managers have sought ways to consider socioeconomic and ecological tradeoffs associated with timber harvesting and other forestry activities. Despite progress, development of ways to depict joint production possibilities likely to result from forest management for more than two ecosystem services has been limited. Complexities owe to a frequent lack of information about the expected effects of forest management on ecological conditions and processes and their resulting influence on valued services, and from difficulty in representing in economic models the complex temporal and spatial interactions among ecological conditions and processes that influence joint production relationships. We address these challenges by combining detailed fine-scaled simulation models describing vegetation structure, forest sector carbon, and wildlife habitat to describe and examine joint production outcomes likely to result from alternative forest management regimes at a landscape-level. Our pilot study region includes a mix of public and private-owned land characterized by a range of environmental conditions typical of forests in the western Cascades range of Oregon (US).

Specifically, we use LandCarb to simulate vegetation growth, mortality, decomposition, harvest, and wood manufacturing and use, and to track carbon stores contained in the forest ecosystem and in wood products. We used LandCarb outputs as input to several habitat suitability indicator models to describe joint production outcomes for select bird and mammal species that respond to different landscape characteristics, including stand openness, live and dead tree sizes, and edge contrast, among others. Our combined models enable us to account for key interactions among landscape outputs across space and time, and offer an alternative to optimization approaches for describing and examining landscape-level tradeoffs associated with forest management. We use our combined models both to display joint production outcomes and to examine the sensitivity of outcomes to ranges of key management variables, including harvest interval, size, and intensity, harvested wood utilization, and snag retention, among others. Our combined models and analysis enable forest managers to test assumptions about the influence of different management regimes on valued forest ecosystem services, and could facilitate discussions with stakeholders and the public concerning national forest plan revisions, among other uses.

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MEASURING THE SOCIAL VALUE OF ECOSYSTEM SERVICES BY COUPLING THE SOLVES TOOL WITH ECOLOGICAL DATA

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This multidisciplinary study aims to assess the social value of ecosystem services (the benefits people obtain from ecosystems) possessed by inhabitants of the Mission-Aransas NERR area while also assessing how those values are related to the physical and biological components of the NERR. These goals will be accomplished by gathering and transforming environmental data for the study site into the SolVES model along with the responses from a social survey currently being conducted at the site. SolVES is a GIS application developed to quantify and map social values for ecosystem services. The model accomplishes this by applying statistical techniques to the two types of input provided by the user: social value points and physical habitat maps. Detailed habitat and land cover maps will be created as well as abiotic aquatic maps to be used as the physical habitat maps for the model. A map of diversity index scores measuring the biological diversity of the study area will also be created against which results of the SolVES model run will be analyzed. Results of this analysis will be used to determine the spatial relationship existing between the social value of ecosystem services in the study site and biodiversity occurring at the site.

It is difficult to project the results of such a model run, because this is the first application of SolVES in this manner. However, I expect results similar to those of past SolVES studies on different ecosystems, which show a strong relationship between environmental parameters and the areas for which people hold the highest value. I also anticipate a strong correlation between areas of greatest perceived social value and those of greatest diversity. The concept of biodiversity's connection to ecosystem services is one that is often cited, but lacks empirical evidence. The results of this project have the ability to unveil the connection existing between the ecosystem services of protected areas, the biodiversity that fosters those services, and the way these services are valued by the inhabitants of such areas. Developing a spatial component to couple social values and biodiversity will yield a resource for analyzing spatially important areas for biodiversity maintenance as well as areas to enhance social value, while limiting impacts to the ecosystem service of biodiversity. The final product will allow both social values and ecological metrics to be incorporated into the decision-making process for land managers in order to add efficacy and potency to that process.

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LINKING ECOSYSTEM SERVICES BENEFIT TRANSFER DATABASES AND ECOSYSTEM SERVICES PRODUCTION FUNCTION LIBRARIES

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The economic and non-economic values of ecosystem services can be quantified or estimated using a variety of distinct approaches. For example, practitioners may use ecosystem services production function models (ESPFMs) for a target location, or alternatively, deploy benefit/function/value transfer from one location to other Areas of Interest (such as with Benefit Transfer Methodology). Each method has advantages and disadvantages, but practitioners have historically tended to use one or the other approach to the exclusion of the other. This presentation will discuss collaboration between the US Environmental Protection Agency (EPA) and Earth Economics (EE) to explore cross-linking ESPFMs and Benefit Transfer Databases in order to allow a multivalent approach to valuation. In particular, we will share efforts EPA and EE have taken toward and progress to-date in exploring cross-linking and integration of EPA's ESPF-L (Ecosystem Services Production Function Library) and EE's Ecosystem Valuation Toolkit (EVT) and the possible utility to practitioners of Ecosystem Services valuation.

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ESTIMATING THE 'RETURN ON INVESTMENT' IN NATURAL INFRASTRUCTURE: RIO CAMBORIÚ WATERSHED, SANTA CATARINA STATE, BRAZIL

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The idea of deploying "natural infrastructure"—ecosystems or their components—to solve environmental problems is eliciting widespread interest. This is certainly true in the freshwater area, where watershed conservation and restoration are frequently promoted for purposes of regulating water flows and improving water quality.

Three arguments commonly advanced for investing in natural infrastructure solutions are its cost-effectiveness, that is, its cost-competitiveness with conventional, manufactured "gray" infrastructure; its co-benefits, which result from the additional environmental services natural infrastructure provides beyond the target service(s), and which gray infrastructure generally does not provide; and the precautionary principle, specifically, in the case of watersheds, the fact that intact natural infrastructure can increase overall resilience of human freshwater supplies in the face of uncertain climate change impacts and increasing future demand.

The first two of these arguments require sufficiently reliable, quantitative information about the benefits or "returns" a particular natural infrastructure solution delivers in a given place for a given level of investment. Generating such reliable return on investment (ROI) assessments in turn requires application of a rigorous analytical framework. Key components of such a framework are the identification of relevant service metrics; the selection of appropriate simulation models that relate natural infrastructure to target service flows; the use of empirically-based benefit functions for key service beneficiaries; and the development of counterfactual scenarios for key drivers of service flows, to allow attribution of changes in service flows via construction of a true baseline. We present the application of such a framework to a recently created payment for watershed services (PWS) program for the Camboriú River in Santa Catarina State, Brazil.

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COWS FOR CONSERVATION

Nancy Labbe
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WWF's Sustainable Ranching Initiative works with farmers and ranchers around the world to identify and accelerate the use of more ecologically and economically sustainable management practices. The initiative focuses on issues that bridge opportunities to collaborate with the farming and ranching community to make livestock production more sustainable, for the environment and contribute to increased vibrancy of rural communities. It is the first step in bringing the Global Roundtable for Sustainable Beef (GRSB) to life on the ground and to engage with local efforts in North America, Brazil, Argentina, Australia and Southern Africa. The GRSB facilitates a global dialogue on beef production that is socially responsible, economically viable, and environmentally sound.

WWF strives to uphold the tradition of cattle ranching and production, while improving lands and waters for wildlife and people. Nonetheless, beef production has an impact on the environment. Improperly managed cattle can harm watersheds and grasslands. Beef production is known to be a high driver of deforestation globally. Additionally, it has a major impact on biodiversity, and on land and water resources, and is a major factor when considering the equitable sharing of the world's natural resources. Consequently, it is a key element affecting the realization of WWF's goals which are aimed at reducing humanity's footprint and biodiversity impacts and staying within the ecological limits of one planet. Beef is also an important, protein- and nutrient-rich food source, and an important element of many cultures and land use systems. Additionally, grazing is a natural process with which certain ecosystems have evolved, and is critical for maintaining the health of grassland ecosystems – by sustaining wildlife habitat, biological diversity, and functioning watersheds. Furthermore, grasslands sequester more carbon then any other terrestrial ecosystem which emphasizes the importance of maintaining grassland health. With some studies indicating that beef will continue to gain importance as a food source in a world with a growing and increasingly affluent population, and potentially with a consequent increasing footprint on the planet, it is imperative that WWF participates in this significant commodity/footprint issue.

WWF's strength is its ability to work at both the global and local levels. The Sustainable Ranching Initiative works from the ground up, partnering with ranchers and landowners. By engaging cattle ranchers and farmers in North America, Brazil, Argentina, Australia and Southern Africa, WWF seeks to partner with stakeholders to make positive continuous improvement and inform the efforts of the GRSB.

The Initiative's first pilot projects are underway in key beef production areas where WWF operates around the world. WWF is developing pilot projects throughout these regions to identify, demonstrate and scale the uptake of better management practices. These techniques will help accelerate the implementation of more ecologically and economically sustainable resource and cattle management practices. We are working to promote grasslands ecology important for both ranching and wildlife and develop community-based conservation efforts that promote sustainable ranching.

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AIR POLLUTION TOLERANCE INDEX OF PLANTS - A TOOL FOR URBAN GREENING

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Trees and shrubs have been recognized as carbon sink. However, plants have different responses to air pollution. They exhibit varying levels of tolerance/sensitivity to pollutants. This study presents different levels of tolerance/sensitivity of trees and shrubs in the University of the Philippines Manila-Philippine General Hospital (UPM-PGH) campus by determining Air Pollution Tolerance Index (APTI). For each plant sample, ascorbic acid content (ACC), total leaf chlorophyll content (TLC), pH of the leaf extract and relative water content (RWC) of leaf samples were determined to compute for APTI. A total of 57 species, 41 trees and 16 shrubs were included in the study. Results show that 11 of the tree species were tolerant and 13 were sensitive to air pollution. *Bauhinia variegata* (Fabaceae), *Pithecellobium dulce* (Fabaceae), *Ficus benjamina* (Moraceae), *Diospyrus discolor* (Ebenaceae) and *Tabebuia pallida* (Bignoniaceae) were among the most tolerant tree species. On the other hand, *Psidium guajava* (Myrtaceae), *Pterocarpus indicus* (Fabaceae), *Phyllanthus acidus* (Phyllanthaceae), *Delonix regia* (Fabaceae) and *Annona squamosa* (Annonaceae) were among the most sensitive tree species. Among shrubs, five species including *Malpighia emarginata* (Malpighiaceae), *Vitex negundo* (Lamiacea), *Graptophyllum pictum* (Acanthaceae), *Citrus microcarpa* (Rutaceae) and *Polyscias balfouriana* (Araliaceae) were found to be tolerant. Five other shrub species including *Hibiscus rosasinensis* (Malvaceae), *Jatropha integerrima* (Euphorbiaceae), *Blumea balsamifera* (Asteraceae), *Bougainvilla spectabilis* (Nyctaginaceae) and *Euphorbia milii* (Euphorbiaceae) were found to be sensitive to air pollution. While the four leaf parameters interact with each other, AAC was the most influential in determining APTI. APTI determination makes a useful tool in selecting which species are ideal for urban greening projects. Though sensitive species may not be ideal for urban greening, these can be used as biomonitors for air pollution.

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MODELING LAND USE/LAND COVER AND CORRESPONDING CHANGES IN ECOSYSTEM SERVICES

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Urban watersheds are dynamic. With changes in land use there is a corresponding change in ecosystem services; however, modeling these changes can be daunting. To gain a better understanding of how ecosystem services change with changing land use, we propose a methodology that adapts the CLUE-S (Conversion of Land-use and its Effect at Small region extent) Model, by incorporating ecological data. For our analyses, we focused on carbon storage as our ecosystem service. To parameterize the ecological component of the model, we used permanent plot data collected in the Hillsbourgh sub-basin of the Tampa Bay Watershed (TBW) in west-central Florida. We projected changes in carbon storage over a 10-year period by integrating LULC change with tree growth. This was accomplished by estimating the change in aboveground carbon stored for trees across sample plots over a six-year period (2007-2012); adapting and parameterizing CLUE-S to project landscape composition, distribution, and quantity in the TBW over a 10-year period (2013-2022); and estimating aboveground carbon at the landscape level by combining observed changes in tree carbon with modeled LULC change. The results can help decision-makers determine how LULC changes affect desirable future conditions.

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USEPA'S FINAL ECOSYSTEM GOODS AND SERVICES (FEGS) CLASSIFICATION SYSTEM: CONCEPT TO IMPLEMENTATION AND LINKS WITH ENVIROATLAS

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For the last decade ecosystem services have received increasing focus, yet the natural and social scientists working on mainstreaming these concepts are still struggling with the basic issues. One of which is developing a framework that avoids double counting, provides explicit guidance on what should be measured and connects to human well being. FEGS (Final Ecosystem Goods and Services) is an informative and useful concept as it embodies both biophysical components of nature and human beneficiaries. We present a FEGS Classification System (FEGS-CS), that explicitly links the goods and services produced by the environment with potential human beneficiaries. We explore approaches to demonstrate application of FEGS to several place-based community studies implemented by the USEPA Office of Research and Development. The current FEGS-CS web site connects defined environmental classes with potential beneficiaries and provisional FEGS. We intend to add a geospatially explicit component by linking the FEGS-CS with the EnviroAtlas which contains a wealth of spatially explicit ecosystem services potential indicator data. By integrating and using the two products together, a user may benefit from a standardized classification framework which can be connected to spatially explicit information relating to a particular place. EnviroAtlas data includes percentages of area in different land cover classes, condition of stream buffer areas, water consumption, demographic (beneficiary) data, as well as many other ecosystem services related data. We expect the products of these efforts to more precisely identify and measure who uses which ecosystem services in what places than we have seen previously in the ecosystem services literature.

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A NEW TOOL FOR QUANTIFYING FORESTED WETLAND RESTORATION EFFECTS AND ENHANCING IMPLEMENTATION

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Wetlands can improve water quality and provide other ecosystem services. Wetlands in the Chesapeake Bay Watershed are especially vital as they help to maintain water quality and aquatic habitat in one of the largest and most productive estuarine ecosystem in the United States. Due to the substantial effect of agriculture on the ability of wetlands to function, the U.S. Department of Agriculture (USDA) serves a key role in wetland conservation and restoration. In order for the USDA to best allocate funds to manage wetlands, a better understanding of wetland conservation practice effects and effectiveness is needed. Assessment of hydropattern change with wetland restoration is important for understanding the effects of this commonly used conservation practice on wetland area and function. However, hydropattern assessment is difficult, especially for large areas where the forest canopy precludes viewing of the ground surface and wetland soils are saturated, instead of inundated. We investigated the ability of synthetic aperture radar (SAR) data to quantify changes in inundation and soil saturation before and after restoration of an 809 hectare forested USDA Wetland Reserve Program site in Somerset County, Maryland. Field data on hydrology and vegetation were collected during the acquisition of three Radarsat-2 images before (2010/11) and after restoration (2013; 6 images total) and were used to calibrate soil moisture, inundation and groundwater change maps. Relationships between the SAR signal and inundation and soil moisture were robust, while the relationship with groundwater depth was less significant. Wetland acreage and functional gains were quantified. Results will help guide future restoration planning and implementation, and should lead to increased support of wetland restoration efforts in wetlands with saturated soils where restoration effects have been especially difficult to quantify.

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DRAINAGE WATER MANAGEMENT: IMPACTS ON DRUGS, BUGS, AND GREENHOUSE GAS EMISSIONS

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It is becoming increasingly important to understand some of the 'non-traditional' benefits and side effects associated with beneficial management practices (BMPs). Since rectifying one problem may exacerbate or expose another. This study builds upon a suite of long term projects and programs that examine production and environmental benefits/side effects that result from tile drainage water management examined at river basin, experimental watershed, field, and plot scales. Specifically, we discuss how tile drainage water management impacts: 1. The fate and transport of pharmaceutical compounds that result from land application of human and animal waste products, 2. Exposure of pathogens and the presence of microbial source tracking markers in open watershed settings, 3. Greenhouse gas (GHG) emissions, and 4. User and non-user benefits associated with prolific upstream use of tile drainage water practices. Findings to date indicate that positive benefits of tile drainage water management practices (eg., yield boosts and nutrient/water conservation benefits) often outweigh negative impacts such as potential for enhanced GHG emissions (i.e., carbon sequestration). Also, tile drainage management can reduce on farm pathogen inputs to surface water but may augment concentrations of some bacteria and pathogens in response to reduced dilution and flushing imposed by restricting tile drainage. Tile drainage water management can significantly reduce pollution of surface water by nutrients and pharmaceutical compounds that result from application-induced manure leaching to tile. It was also estimated that significant user and non-user benefits can be attained by tile drainage water management employed *en mass* at the river basin scale. We also documented that increased adoption of tile drainage management practices in many regions in Canada, will likely involve better educating producers, drainage contractors, and environmental stewards on both the traditional and 'non-traditional' production and environmental benefits/side effects of this tile drainage BMP.

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EVALUATING ECOSYSTEM SERVICES PROVIDED THROUGH CONSERVATION EASEMENTS

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Conservation easements are voluntary agreements between landowners and government or non-profit organizations which restrict landowner actions in return for financial and lifestyle benefits to the landowner. While easements are often used to purchase the development rights of a property, conservation easements can also be used as part of a payment for an ecosystem services scheme. Typically, those who supply ecosystem services are not rewarded for all of the benefits they provide to others because markets for their services have not been developed. Arguably, the most prominent reasons why markets for ecosystem services rarely exist are the uncertainty about ecosystem processes, an inability to define market and non-market services, and a lack of funds with which to compensate ecosystem service providers.

In order to assess the potential for payments for ecosystem services to be included in the price of future conservation easements, we evaluated the current value of ecosystem services provided by rangeland properties with conservation easements in Sonoma County, CA. A basic evaluation of the multiple benefits of current conservation easements was conducted, qualifying the economic return on investments of these purchased easements. In addition, we developed an assessment tool to support the structuring of future conservation easements such that they take into account measurable increases in ecosystem services provided by rangeland owners. This tool can be used by both private and public lands owners to apply the incremental value received by conservation easements.

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EVALUATING ADDITIONALITY AND LEAKAGE ISSUES FROM VOLUNTARY PARTICIPATION IN FOREST CARBON OFFSET PROGRAMS

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Market models have been widely used to simulate U.S. climate policy impacts on the forest and agricultural sectors. A consideration rarely addressed is the voluntary nature of landowner participation in either the existing or proposed markets for carbon emissions reductions. We modify an intertemporal partial equilibrium model of the U.S. forest sector to assess the market, land use, and greenhouse gas (GHG) implications of a voluntary carbon offset program for improved forest management. Results over a range of carbon prices and offset program rules are evaluated for market participants as well as non-participants. In our modeling exercise additionality is demonstrated by landowners who enroll at low carbon prices with no management change while leakage is calculated as the ratio of the carbon change on non-participating lands divided by the carbon change on participating land over the full range of prices. We examine the implications restricting offset allocations to carbon fluxes in forests with greater than average carbon stocking levels as well as including payments on project initiation to participants with initial stocks greater than average stocking. In addition to quantifying additionality and leakage impacts to the U.S. forest sector, our results highlight the complexity of accounting for those interactions in methodologies aimed at quantifying improved forest management emissions reductions.

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ENVIRONMENTAL ACCOUNTING AND FOREIGN ASSISTANCE: INCREASING ACCOUNTABILITY AND IMPROVING RESULTS

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The 2005 Paris Declaration on Aid Effectiveness brought together more than 100 donor and recipient countries to improve the practice and results of foreign assistance programs, in part by holding signatories accountable to manage for results in designing and implementing their foreign aid investments. This commitment to managing for results requires donors to use program outcomes to systematically improve decision-making and strengthen performance, and it holds donors accountable for sharing results of their assistance with taxpayers, host countries, and other donors. In response to the Paris Declaration, leading bilateral donors, including USAID, Britain's Department for International Development (DfID); AusAID; the Swedish Aid agency (SIDA), and the Danish aid agency (DANIDA), are using performance management systems that include core principles of environmental accounting to measure results of their investments and use evidence to improve the returns on those investments.

Environmental accounting programs commonly feature two core principles: first, a "common currency" or set of clearly defined benefits (and beneficiaries) that can be used in a standard way across projects, geographies, and actors. The second common feature of environmental accounting programs is the adaptive management system that drives improved performance and systematic refinement of project implementation to better achieve desired outcomes. In the context of international development, environmental accounting is a tool that bilateral donors can use in managing for results, allowing them to (1) clearly articulate environment and human wellbeing outcomes; (2) measure progress against those goals; (3) adjust course; (4) report results to taxpayers, host countries, and other donors.

The US Agency for International Development has made recent investments to revamp internal policy and processes across sectors to align more closely with environmental accounting principles and improve project outcomes. In the biodiversity sector, USAID is developing new tools to accurately define the causal relationships between humans and the environment. Understanding the complex and dynamic situations in which the Agency is often working will help environment practitioners to select more impactful interventions. Second, USAID has prioritized development hypotheses, stated as theories of change, as a critical function in defining the desired outcomes of their investments. Establishing key indicators and monitoring systems that test a particular theory of change are generating the evidence and learning needed to inform adaptive management at multiple scales across the Agency.

USAID's application of these environmental accounting principles and drive for better results in its biodiversity programs is informed by the *Open Standards for the Practice of Conservation* as well as the Agency's strategic planning process (the USAID Program Cycle).

In this talk, I will describe application of environmental accounting and the *Open Standards* to an international conservation and development project. The application of this approach allows donors and their program managers to articulate what is trying to be achieved (the outcome) and how it will be achieved (the theory of change or development hypothesis). Environmental accounting provides donors, implementers, and host countries with a common framework for measuring progress in implementing that theory of change and, in turn adapting implementation to achieve more effective results.

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MODELING VISTA AND LANDSCAPE AESTHETICS FOR NATURAL RESOURCES DECISION MAKING

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The EcoAIM™ geospatial tool was used to evaluate the aesthetic benefits of natural areas at a military installation. Decision makers indicated that an underlying mission for the installation was to attract and retain talented personnel by offering a world-class work environment that included good visual aesthetics. Two models were developed. The vista aesthetics model measures the area of the viewshed, and the diversity and richness of different land-use types in fields of view greater than 100 m. The interactive feature of the vista model allows the user to simulate the viewshed from any point on a land-use/land-cover map by indicating the elevation, direction, and sweep angle. The landscape aesthetics model evaluates wetland, forest, and grassland habitat patches in spaces less than 100 m from the observer, with nine variables that have been shown to be important determinants of landscape aesthetic quality in the environmental and social sciences literature. Geospatial analysis is used to measure the following variables: land-form contrast, edge complexity, surrounding land-use contrast, surrounding land-use diversity, size, vegetative interspersion, forest density, water-body size, and associated water-body diversity.

The baseline conditions of a natural area on the installation were determined first. A scenario was developed in which a portion of each natural area was removed and replaced with an office complex and new road. The vista model results show that, with all else being equal, a greater viewshed area generally produces a greater overall vista aesthetics value. Based on the hypothetical scenario, there were no significant changes to the patch diversity and richness scores. However, results varied depending on the point of view of the observer and preference weighting of patch types by the user. The landscape aesthetics model results of the baseline indicated that contiguous wetlands, especially those near Chesapeake Bay and isolated forests with high tree densities, scored high. The overall landscape aesthetics score increased by 10% with the hypothetical scenario, due to increases in the patch richness and diversity scores. Further scenario building and results from the two models allow decision makers to make explicit tradeoffs among ecosystem services, and thereby support planning for natural resource management.

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A QUANTITATIVE REVIEW OF RELATIONSHIPS BETWEEN ECOSYSTEM SERVICES

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Each decision in natural resources management can generate trade-offs with respect to the provisioning of ecosystem services (ES). If the increase of one ES happens directly or indirectly at the cost of another ES, an attempt to maximize the provision of a single ES will lead to suboptimal results. However, decisions in natural resources management are often made without considering such trade-offs, despite their crucial role toward supporting better decision-making.

The research on trade-offs between ES has gained some attention in the scientific community. However, a synthesis on existing knowledge and knowledge gaps is missing so far. We aim at closing that gap by a quantitative review of recent literature on trade-offs of ES.

We looked at the pairs of ES that have been studied in ~100 case studies that report on trade-offs between ES. If a case study analyzed more than one ES pair, we looked at all pairwise combinations. We categorized relationships between these pairs of ES into the categories “trade-off”, ”synergy” or “no-effect”. Most pairs of ES (e.g. carbon sequestration vs. food provisioning) had a clear association with one category: the majority of case studies that studied a specific pair of ES identified the same category of relationship between the two ES. Pairs of regulating services were typically synergetic in relationship, whereas provisioning services and regulating services typically showed a trade-off. However, for several pairs of ES we were not able to identify a dominate category of relationship. Our hypothesis is that this relates to either the scale of the analysis, the land system where the analysis took place or the method used to quantify the relationship. The number of case studies for each pair of ES was spread unevenly. This hinders the support for a conclusive statement drawn for the pairs. Water regulating services, for example, were studied more frequently than other services. Our results showed further that the method used to identify the relationship between services had a strong effect on the direction of the effect. This suggests that researchers should consider their method carefully.

We believe that our results are of use for the scientific community as well as for practitioners since they provide helpful information about which services to include in ES assessments. Furthermore, they allow a first check if critical trade-offs have been considered in an analysis.

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ECOSYSTEM SERVICES VALUATION

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For Puerto Rico's coral reef ecosystems, five major ecosystem services were identified that could be quantified economically: 1) recreation-tourism, 2) food supply (commercial fisheries), 3) ornamentals (aquarium trade), natural products (pharmaceuticals) and shoreline protection (property values). The definition of ecosystem services for economic valuation are final ecosystem services and are based on attributes of the coral reef ecosystem that people care about and can therefore value. Economic values will be estimated for each of the five ecosystem services and how those values change with changes in coral reef ecosystem attributes.

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BEYOND BENEFITS FOR HUMANS: HOW CITIES CAN SUPPORT ECOSYSTEM SERVICES FOR WILDLIFE

Susannah B. Lerman

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Urbanization profoundly transforms landscapes. A major consequence of increasing urbanization is the loss of essential wildlife habitat, which has led to a steep decline in urban wildlife diversity and subsequent loss of critical ecosystem services, such as pollination. Healthy urban forests (including parks, yards, street trees, remnant forests, and vacant lots) have the potential to alleviate some of the detrimental impacts of urban and suburban development for wildlife by providing critical habitat. This presentation identifies strategies for quantifying habitat quality and habitat requirements necessary for vibrant urban wildlife populations – both of paramount importance for conservation initiatives and policy. Three distinct lines of inquiry will be described: First, by developing habitat assessment tools to integrate into *i-Tree*, an urban forest assessment tool, we increase the capacity to quantify available habitat and make detailed recommendations for habitat improvement projects. Second, by engaging with citizen scientists through *Neighborhood Nestwatch*, a project that assesses the health and vitality of backyard bird populations, we expand our conservation partners while strengthening scientific literacy. Third, by testing how different yard management behaviors, such as lawn mowing frequency, influences bee diversity, we identify immediate and short-term solutions for providing wildlife habitat and improving biodiversity in private yards. Involving the public in scientific research can generate additional conservation interest within communities, and help build a stronger base of support and action for local sustainability efforts.

This presentation highlights urban wildlife research at the USDA Forest Service and current efforts to develop decision support tools, identify new conservation partners, and provide habitat recommendations for enhancing the urban forest and the many benefits it provides for both people and wildlife. Key research gaps in urban wildlife research will be addressed.

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A FARM-LEVEL ASSESSMENT OF THE POTENTIAL FOR MANAGING CROP PRODUCTION SYSTEMS, LIVESTOCK PRODUCTION SYSTEMS, AND AGRICULTURAL LAND FOR GREENHOUSE GAS MITIGATION WITHIN THE UNITED STATES

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Purpose: This presentation describes results from a study that assesses the greenhouse gas (GHG) mitigation potential of US agriculture using a Marginal Abatement Cost Curve (MACC) framework.

Scope: The MACC framework used in this study begins with a set of farms differentiated by region, size, and commodity produced; a set of about 20 specific GHG mitigating production and land management technologies and practices; associated sets of farm-level adoption costs and resulting GHG mitigation quantities; and for each unique farm–technology/practice combination, the CO_2 price that would just cover the costs of adoption (i.e., the CO_2 break-even price). The MACC framework combines the information with various data and assumptions describing how current technologies, practices, and land uses are distributed across US agriculture and estimates how much GHG mitigation would result from adopting these technologies and practices for a schedule of CO_2 prices.

Methods used: A specific set of GHG mitigating technologies and practices and their associated farm-level adoption costs, GHG mitigation quantities, and CO_2 break-even prices were obtained from the ICF report, *Greenhouse Gas Mitigation Options and Costs for Agricultural Land and Animal Production within the United States* (ICF, 2013). Data on the distribution of existing tillage, nutrient, and manure management systems were obtained from the USDA ARMs data base and augmented with other data. ICF's MACC tool combined the farm-level data on adoption costs and GHG mitigation with the region and sector level distributions of current practices to develop supply curves for GHG mitigation for manure management systems, tillage and nutrient management systems, and changes in land uses.

Results: The results provide insights into how much GHG mitigation US agriculture could economically supply at CO_2 prices between \$0 and \$100 per mt CO_2, as well as, the how this mitigation would be distributed across technologies and practices, farm regions, farm sizes, and/or commodities.

Conclusions: The mitigation level associated with a CO_2 price of \$20 per mt, 55 Tg CO_2 e, is consistent with the GHG benefits USDA estimated for its Conservation Reserve Program when enrollment was 36 million acres. The implied total cost, a little over \$1 billion, is well within the range of costs associated with various components of USDA's conservation programs. The mitigation level associated with a CO_2 price of \$36 per mt is about 83 Tg CO_2 e. This is a little under 17 percent of agriculture's total GHG emissions, which mirrors the Administration's goal of reducing national GHG emissions by 17 percent below 2005 levels by 2020.

Recommendations: Significant opportunities exist to cost-effective mitigate U.S. GHG emissions in the within the agricultural sector. The lowest cost options are dominated by land retirements, changes in manure management, shifts to no-till, and adoption of precision agriculture.

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THE POTENTIAL TO USE SUBSIDIES AS "ASSURANCE PAYMENTS" TO ATTRACT DONATIONS IN SUPPORT OF ECOSYSTEM SERVICES: THE "PARTICIPATION CHALLENGE FUND" APPROACH

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In provision point mechanism, the cost threshold for provision introduces incentives for individuals to contribute toward the public good and, in general, the Pareto efficient outcome is a subset of equilibrium outcomes. However, the threshold cannot eliminate the pure free-rider equilibrium unless stronger refinements are used. In this paper, we examine a set of assurance payment schemes for multi-unit public good provision using individualized price auction (IPA). The assurance payments could be useful in establishing markets for a previously non-marketable good, and thus improve the efficiency regarding the provision of various types of public good currently funded only by government or through traditional non-profit donations. This assurance payments come from the "participation challenge fund" where we set up to encourage individual contributions.

Our results suggest that the theoretically, assurance payment significantly eliminates non-provision equilibria, and reduces the multiplicity of provision equilibria suffered by most discrete public good provision games, especially in a multi-unit setup. This theoretical advantage is supported by our lab experiment results: we use measures such as provision rate, group value revelation, or realized social surplus, and find out that a positive assurance payment always performs better than no assurance in terms of those measures.

Our results have two important policy implications. First, the provision-point based mechanism with assurance payment provides a powerful tool for non-market valuation and for cost-benefit analysis, since the assurance payment could significantly reduce the free-riding incentive and induce a more accurate preference measure. Second, it may provide a feasible framework to establish a decentralized ecosystem service market, backed by a relative high provided success rate, which can be further optimized by flexible payment schemes. This is especially true if we are in a market lack of valuation information, in which multiple rounds of assurance payment contract would reveal much of the information and improve the contract design with the development of the market.

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A CLASSIFICATION SYSTEM FOR PAYMENT FOR ECOSYSTEM SERVICES PROGRAMS

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While the literature on payment for ecosystem services (PES) programs is developing rapidly in response to increased interest in PES as a tool for conservation, many gaps remain. One of these gaps is a clear understanding of the institutional arrangements of successful and unsuccessful PES programs. While some analyses are available, these initial efforts often lack consistent application of a clear framework for analysis. As a result, studies are difficult to compare and lack generalizable results.

To address this gap in the literature, we studied the institutional arrangements of PES programs, especially rules-in-use, and how these institutional arrangements compare across programs. Rules-in-use are the prescriptions used to govern interaction between actors; they are the backbone of an institution. We will present a new classification system for payment for ecosystem services programs based on the rules utilized by individual programs and apply the classification system to categorize PES programs in the United States. Our definition of PES - voluntary transactions, both market and non-market, between actors buying and selling defined ecosystem services, with or without strict conditionality – limits the range of PES institutions included in our study.

Our study utilizes Ostrom's Institutional Analysis and Development (IAD) Framework to structure our analysis and define key variables of interest. The IAD Framework defines institutions as "…the prescriptions that humans use to organize all forms of repetitive and structured interactions…" While there are examples in the literature of PES classification systems, there is currently no classification based on the rules-in-use by PES programs.

Consistent classification of programs by rules allows comparison of similarly structured programs across different biophysical settings and with different community attributes and contributes to increased understanding of the conditions related to success and failure of PES schemes. This work improves our understanding of the wide diversity of institutions used to implement PES on the ground and allows for systematic evaluations of the effectiveness of different institutional structures.

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A NATIONAL SOCIAL AND ECONOMIC SURVEY OF PUBLIC LANDS RANCHERS: A SURVEY PROCESS TO BETTER DEFINE ECOSYSTEM GOODS AND SERVICES SUPPORTED BY RANCHING OPERATIONS

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Quantifying cascading benefits that flow from grazing on public and private rangelands is critical to accurate assessment of traditional production agriculture's contributions to food security, and also associated rangeland ecosystem goods and services and the socio-economic benefits to society that flow from these diverse resources. Better information to more completely characterize broad management decisions is needed to conserve rangeland resources and provide for social, economic and ecological sustainability of rural communities who depend on these systems. Such information will be useful in addressing issues related to public land grazing in various decision documents (e.g., EIS, EA) as well as broadening discussion about ecological, social and economic interrelationships and the well-being of socio-ecological communities. We will supplement the national survey on social and economic characteristics of ranchers grazing livestock on public lands to more fully understand the ecosystem services they are producing, if management has changed or is anticipated to change to produce more non-livestock ecosystem services, and whether that occurs on public or private lands.

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HISTORICAL ECOSYSTEM SERVICE FEATURE EXTRACTION AND LANDUSE CHANGE IN POCATELLO, IDAHO

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A pilot study investigating the interaction between ecosystem services, landscape change and associated socio-ecological systems in Pocatello, Idaho is currently underway. The ultimate goal of this study is to create predictive models and decision support tools to inform policy makers. Engaging with local stakeholders is vital to identify priority ecosystem services and linked anthropogenic landscape changes over time. Very few landscape features in Pocatello are as ubiquitous and as significant as the Portneuf River, which is heavily used by the community for agriculture and recreation. A major alteration to this complex system was the channelization of the Portneuf River in 1965 as part of the 1950 Flood Control Act. Crucial ecosystem services impacted by the use and alteration of the Portneuf River corridor identified by the research team and stakeholders are riparian habitat, recreation, aesthetic quality, and biodiversity.

Establishing a spatial database of historically documented observations and records for the Portneuf River corridor and outlying areas is time consuming and can be difficult to interpret. Geospatial tools have the ability to extract information useful for identifying change in the physical environment and the resulting impacts, as manifested in ecosystem service flows across the landscape. National environmental datasets are generally at scales too coarse to produce meaningful predictive models of future ecosystem services at a local scale. High resolution historical imagery offers a unique opportunity to gain a clear picture of physical landscape change over time and can collect spatial data on a fine scale for locally based studies. Individual aerial images stitched together create spatially accurate orthomosaics on a decadal scale that can be interpreted and compared to determine trends.

This study uses landscape features extraction, pattern recognition, and object based classifications to create valuable input data consisting of urban structures, roads, green spaces, water, and agricultural lands. These extracted landscape geodata layers can then be used to investigate wide ranging impacts on crucial ecosystem services in the Pocatello area. With the availability of historical aerial photos for many parts of the United States, extracting features from these orthomosaics is a cost effective approach in collection of historical and modern environmental data for use in ecosystem service modeling.

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UNDERSTANDING A FIELD AUCTION FOR ECOSYSTEM SERVICES USING THE EXPERIMENTAL ECONOMICS LABORATORY

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The problem of public good provision has attracted many of attentions from both theoretical and experimental economists. One important barrier of establishing ecosystem service market is due to its public good properties. We explore potential solutions to this problem by testing different pricing rules on the public good using laboratory experiments. Based on the Lindahl (1919) and the more structured presentations from Samuelson (1954, 1955), the Lindahl pricing turns out to be an efficient solution to implement public good by balances the marginal social cost (MSC) of delivery against the marginal social benefit (MSB). In this research, we widen the applicability of Lindahl pricing by experimentally studying Lindahl-based pricing mechanisms in delivering multi-units of a public good.

We propose a new set of auction approaches to provide multi-units of a public good, which we call the individualized pricing approach (IPA). Our IPA approach can be useful in establishing markets for previously non-marketable good, and thus improve the efficiency regarding the provision of various types of public good, previously fundable only by government through tax. For example, a successful functional ecosystem market can induce individuals to "buy" specific type of ecosystem service toward which they hold positive values. In this paper, we consider public good that is discrete in nature.

Our results suggest significant differences between these auction approaches in terms of provision success, value revelation, as well as the social efficiency. We find significant improvement in social efficiency for individualized pricing approaches. Our research brings new provision mechanisms to the multiple units public good provision and we expect more studies, either experimental or theoretically, on the multiple public good provision, since a successful mechanism can be crucial in raising private donations to establish a functional environmental market that can incentive payments for ecosystem services.

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ECOSYSTEM SERVICE ASSESSMENTS FOR WATER RESOURCES MANAGEMENT: A COMPARISON OF TWO MODELS

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We present a comparison of two ecohydrologic models used for planning land management to ensure the production of hydrologic ecosystem services: the widely-used Soil and Water Assessment Tool (SWAT) and the simple annual water yield model within the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) toolbox. We investigate two questions for each model: (1) how accurately does each modelestimate annual water yield on a subbasin scale?; and (2) under which of three distinct water resources decision contexts does each model provide useful guidance for hydrologic ecosystem services-focused land management? Here we define a model as providing useful guidance for a decision if it supplies estimates of the ecosystem production of a service at appropriate spatial and temporal scales. We compare two distinct study sites in the US: the Wildcat Creek Watershed (2083 km^2) in Indiana, a largely agricultural watershed in a cold aseasonal climate and the central lowlands physiographic province; and the Upper Upatoi Creek Watershed (876 km^2) in Georgia, a mostly forested watershed in a temperate aseasonal climate and the piedmont and coastal plains physiographic provinces.

Both SWAT and InVEST models provide similar estimates of subbasin water yields in Wildcat Creek, but very different estimates in Upper Upatoi Creek when calibrated based on outlet water yields. The Upper Upatoi Creek Watershed has a significant amount of baseflow due to the sandy, highly-drained soils found in the watershed, which may explain the discrepancy. The simple seasonality terms in the InVEST annual water yield model may not accurately estimate the results of the complex storage processes in baseflow-dominated sites.

We also compare the ability of these two models, as well as one newly developed set of ecosystem service indices, to provide useful guidance for land management decisions focused on providing hydrologic ecosystem services in three particular decision contexts: environmental flow ecosystem services, ecosystem services for potable water supply, and ecosystem services for irrigation. We focus on the water quantity component of these ecosystem services for simplicity. We plot both the temporal and spatial scales of these models'/indices outputs and the temporal and spatial scales at which these ecosystem services are produced to determine whether particular models/indices can address particular decision contexts. We suggest that this formalization is useful to inform scientists and managers on when particular models can be used to provide useful guidance on decisions about land use management for hydrologic ecosystem services.

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EVALUATION OF ECOSYSTEM SERVICES UNDER VARYING CLIMATE AND GRAZING SCENARIOS: THREE RIVERS SOURCE REGION, CHINA

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China's Three Rivers Source Region (TRSR) located in the southern Qinghai Province, hosts the beginnings of three of its major rivers: the Huang He (Yellow River), the Chang Jiang (Yangtze), and the Mekong /Lancang River. Although scarcely populated, the grasslands of the TRSR play many important roles in providing ecosystem services both locally and regionally. Locally, they provide food and erosion control, and regionally they play important roles of carbon storage, and freshwater provision. This important ecosystem service provisional area, however, is facing many challenges such as warmer temperatures, shrinking of wetlands, and species loss. Also, as in many parts of China, overgrazing of the grasslands has resulted in losses of soil carbon and declines in biomass production. The objective of this research was to evaluate the impact of grazing and climate scenarios on ecosystem services in the TRSR. The Soil and Water Assessment Tool, a semi-distributed, watershed-scale, hydrologic model, was applied to the TRSR to evaluate a combination of three different grazing scenarios (light, current, high) and three climate scenarios (current, A1B, B1). The ecosystem services evaluated for each of the nine scenarios were freshwater provision, food provision, flood regulation, and erosion regulation. The results will help to improve our understanding of the impacts of grazing management on the future provision of ecosystem services in the Three Rivers Source Region in China.

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“FLOODING” THE INSURANCE MARKETS: HOW ARE FLOOD MITIGATION SERVICES PERCEIVED?

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Climate change predictions for increased precipitation and storm event uncertainty in the Northeast have produced a greater need for flood mitigation consideration and action within the region. These projections alongside planned changes to the National Flood Insurance Program have created a situation for revaluation of ecosystem services that bestow flood mitigation benefits. This is especially so in the Upper Valley region of the Connecticut River, which currently experiences a high degree of flooding. Working within the Upper Valley, this research uses a social-ecological systems approach to consider environmental management inputs, flood related ecosystem services, and human well-being outputs as part of a cycle of influence (Reyers et al. 2013). This approach is being used to test how perceived values of flood mitigation services shift as a result of changes to flood insurance policies. Utilizing both expert and non-expert stakeholder groups, we are administering surveys following the presentation of various flooding and insurance policy scenarios. Survey mechanisms included preference rankings, tradeoff selection, willingness-to-pay, and Likert scale responses. Results illustrate the ways predicted climate change outcomes influence flood risk perceptions and valuation of flood mitigation ecosystem services, as well as stakeholder willingness to adopt new insurance rates. Such information will be key to crafting environmental management regimes in flood prone regions, and the methodology used can inform climate adaptation and preparedness initiatives around the globe.

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USING SOCIAL VALUATION TO ASSESS ECOSYSTEM SERVICES IN THE MA-NERR

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Ecosystem services are the benefits humans are provided by nature, which are necessary to live a full and healthy life. These services include food, storm protection, and recreation. Unfortunately, it is often difficult to value ecosystem services in a manner that conveys their importance to local resource managers and communities. To inform management practices undertaken by natural resource managers and policy-makers, we utilized social valuation of ecosystem services. Social valuation is a method of valuating ecosystem services which uses survey responses to rank ecosystem services.

Surveys were administered online and in-person between June and July of 2014. For the in-person surveys, a total of twelve sampling sites were chosen in areas within the Mission Aransas National Estuarine Research Reserve (MA-NERR). Survey sites were chosen based on ecosystem service importance to both active and passive users. The survey was designed by researchers at the Hollings Marine Laboratory and asked respondents about changes to natural resources, how people utilized areas within the MA-NERR, if people believed more public access sites were needed, and if more land was needed to be acquired for public use.

Data were analyzed using ArcGIS and SolVES (Social Valuation for Ecosystem Services). SolVES is a USGS application for the assessment, mapping, modeling, and quantification of ecosystem services. This methodology allowed for the identification of areas of importance on heat maps and for the ranking of locations by ecosystem service importance. Social valuation of ecosystem services provides useful information to resource managers, as well as encouraging public participation to provide a sense of democracy and legitimacy to the decision-making process.

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A PUBLIC HEALTH PERSPECTIVE ON URBAN TREES AND GREEN SPACES

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Public health effects of urban green spaces have been studied with increasing frequency and methodological sophistication over the past decade. Trees, public parks, and total vegetation cover have potentially important implications for human health. Multiple pathways discussed focus on air quality, physical activity, and psychosocial exposures. The health effects of urban tree planting in particular are of interest in light of ongoing massive tree planting projects in multiple sites around the world. Evaluating the health benefits from such tree planting efforts is important given that knowledge in this area is still emerging.

To provide a balanced and realistic assessment, such evaluations should also be attentive to unintended negative consequences such as allergic responses to tree pollen. Our work in New York City (NYC) has suggested that early life residence in areas with more tree canopy coverage is associated with increased risk of allergic sensitization to tree pollen and other allergens by age 7. We are now engaged in monitoring pollen across 45 sites in NYC to better understand the relationship between tree canopy, tree pollen, and the development and exacerbation of allergic disease (e.g., asthma, rhinitis).

Trees also function as part of a pedestrian supportive environment, and we have shown street trees in New York City are associated with early childhood physical activity as measured by accelerometer, and self-reported walking and bicycling for transportation among adults. In addition, we have seen that street trees are associated with lower body mass index among adults, but the association is primarily among those who live in otherwise highly walkable neighborhoods. Further, there are emerging findings on the role of exposure to natural environments in human microbiota and immune regulation.

By sharing these highlights from our published and emerging work, we hope to stimulate a conversation about further evidence needed, and strategies to evaluate and maximize health benefits from green spaces wherever they are implemented. Increased street trees and selection of less allergenic species may be considered to maximize health benefits while avoiding negative effects.

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THE USEPA FINAL ECOSYSTEM GOODS AND SERVICES CLASSIFICATION SYSTEM (FEGS-CS): IMPLICATIONS FOR CORPORATIONS

Doug MacNair, *Ted Tomasi, and Miranda Freeman*
Environmental Resource Management, Raleigh, NC, USA

The USEPA has developed the Final Ecosystem Goods and Services Classification System (FEGS-CS) as a step towards providing a framework and common language for evaluating ecosystem goods and services. It is possible that the FEGS-CS could become the de facto standard for classifying and ultimately valuing ecosystem services and natural capital. Given the potential for the FEGS-CS to be applied in a variety of regulatory contexts as the standard for ecosystem valuation, it is important to evaluate its potential uses, limitations, and reach for corporations.

This presentation describes the risks and opportunities posed by FEGS-CS. The FEGS-CS may be the first step to a greater understanding of the financial contribution of ecosystem services to long-run profitability, which can provide companies with information to find new opportunities and better manage risks. The presentation will describe an approach for using the FEGS-CS to evaluate long-run profitability issues surrounding natural resource impacts and dependencies.

Conversely, corporations are also facing increasing pressure to measure and report how their operations affect the environment. Governments, NGOs, and lending institutions are pushing for valuing and publicly reporting such effects in monetary terms. The FEGS-CS could become a part of that reporting environment. Unnecessary financial burdens and unanticipated liability impacts might result from onerous reporting requirements, unreliable valuation methods, and the regulatory or other requirements based on them. The presentation will describe some of potential pitfalls and limitations of the system and offer constructive ideas on how the framework can be improved.

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IMPACTS OF UNCONVENTIONAL ENERGY DEVELOPMENT ON WESTERN US RANGELANDS: AN EVALUATION FRAMEWORK

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The United States needs more diverse energy sources to make substantive progress towards energy independence. The USA Task Force on Strategic Unconventional Fuels found that achieving this objective requires development of a domestic unconventional fuels industry. Rangelands cover as much as 70 percent of the earth's terrestrial surface and dominate large areas of the western US, representing a major source of alternative energies as well as other ecosystem goods and services. The Integrated Social, Economic and Ecological Conceptual (ISEEC) framework was developed by the Sustainable Rangeland Roundtable (SRR) to identify biophysical-socioeconomic links that influence delivery of ecosystem services affected by alternative uses of rangelands. The framework is also useful for selecting suitable indicators to monitor changes associated with energy development. Use of an approach incorporating the framework and standardized indicators may enhance coordination to set policies and regulations for sustainable development of unconventional energy resources on rangelands. This poster summarizes the potential of western rangelands for future production of three energy technologies; natural gas, biofuel and wind energy. These energy sources are vertically distributed - below, at, and above ground level. Their respective development will likely affect rangeland ecosystems, and the ecosystem goods and services they provide, in different ways. After establishing key links affecting delivery and use of ecosystem services from rangelands with respect to alternative energy sources, changes in these links must be monitored. The SRR ISEEC framework is used to hypothesize 10 biophysical and socio-economic links. By identifying SRR criteria and indicators to monitor each link, a mechanism is provided for systematically testing the hypothesized effect of each link and tracking changes in these links over time. This work can be viewed as a first step toward implementation of energy development approaches designed to minimize impacts on rangeland ecosystems. It also may facilitate introduction of responsive management practices to mitigate impacts.

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SCALE AND CONTEXT DEPENDENCE IN MULTICRITERIA ANALYSES OF ECOSYSTEM SERVICES

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Multicriteria decision analysis (MCDA) integrates information about values decision makers and stakeholders want to enhance through management, including ecosystem services, with information about how alternative actions are likely to affect what is of value. It is used to inform decision making when trade-offs must be made among conflicting goals, as might happen if increasing water quality came with some loss of timber revenues, and for displaying the effects of differences in preferences and priorities among stakeholders on management choices, a common source of disputes.

By design, MCDA is subjective, context-dependent, and comparative. The ability of MCDA to represent inherently subjective judgments of decision makers and stakeholders explicitly is one of its strengths. Preferences (i.e., relative satisfaction with various levels of performance of a management action) and priorities (i.e., willingness to trade off lower performance on one goal to gain higher performance on another) depend on decision context, including the temporal and spatial scales to which a decision applies. The suite of decision makers and stakeholders whose preferences and priorities are relevant will also vary with decision context. MCDA helps decision makers create management strategies to meet a suite of goals (including ecosystem services), choose actions from a menu of potential strategies, and set priorities among candidates for management attention (e.g., land parcels or species). It produces relative measures of the degree to which particular strategies satisfy a suite of desirable characteristics.

The inherent scale and context dependencies of MCDA are important contributors to its ability to inform decision making but, at the same time, they create tension when decision makers and analysts want to use information about preferences and priorities, as well as information about likely effects of management actions, in decision contexts other than those for which the information was generated. It is easiest to think of implementing MCDA in relatively small-scale and near-term decision contexts, where it often obvious whose values matter and not too hard to project short-term effects of management actions. It is harder, but still relatively straightforward, to design MCDA for larger-scale and longer-term decisions by incorporating public participation processes to inform and engage stakeholders distant from the site of management actions, and this has been done at national and even international scales. Many federal land management planning processes have faced this challenge, with attendant disputes about how much local values should "count" compared to those of distant participants and about how to incorporate obligations to future stakeholders.

Still more challenging is applying preferences and priorities obtained in one context and for one set of decision makers and stakeholders to another decision with a context that may differ considerably in temporal and spatial scales and where a different menu of management choices is under consideration. There is no *a priori* reason to assume that such a transfer is defensible, requiring those who would attempt it to demonstrate why the contexts are similar enough to warrant re-using previously generated information. In addition, attempting to "scale up" preferences and priorities by averaging across stakeholders and across decision contexts obscures meaningful differences that are at the heart of many land management decisions and is thus of questionable merit.

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CONSIDERING ECOSYSTEM SERVICES IN FISH AND WILDLIFE REFUGE OPERATIONS

Edward Maillett
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This presentation will summarize how three refuges in the U.S. Fish and Wildlife Service National Wildlife Refuge program (NWR) consider ecosystem services in their operations. The first two examples, Great Dismal Swamp NWR and San Diego NWR, lie outside large metropolitan areas (Virginia Beach-Norfolk-Newport News, Virginia and San Diego-Carlsbad, California) and constitute relatively large areas of protected public lands in densely populated areas. The third case-study is the Silvio O. Conte NWR. In contrast to the first two case-studies, the Silvio O. Conte NWR covers the greater Connecticut River watershed but manages relatively little land and as a result must work to form strong coalitions with a multitude of stakeholders from rural and urban communities throughout four different States (Vermont, New Hampshire, Massachusetts, and Connecticut) in order to achieve successful conservation.

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ACCOUNTING FOR OUTCOME UNCERTAINTY IN ECOSYSTEM SERVICE VALUATION: THE CASE OF COASTAL ADAPTATION

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The protective services of coastal ecosystems are being increasingly recognized by decision-makers seeking a more sustainable means to adapt to the increasing threats of sea level rise, coastal storms and flooding. However, the value of these ecosystem services is contingent on multiple uncertainties associated with outcomes such as coastal storms of varying intensities. Disregarding or oversimplifying this outcome uncertainty (e.g., by modeling only the expected or average outcome) can lead to biases when estimating associated economic values. This can contribute to misguided adaptation decisions.

Despite these concerns, the ecosystem services valuation literature largely applies ad hoc risk communication and modeling approaches when seeking to estimate ecosystem service values subject to outcome uncertainty. The attention given to the subtleties and nuances of risk analysis in other areas of economics (and other disciplines) has not been matched in the ecosystem services literature. For example, the stated preference literature quantifying values for ecosystem services subject to outcome uncertainty often: a) presents only expected (mean) outcomes, or communicates objective risk to survey respondents using binary, all-or-nothing probabilities that oversimplify real-world conditions, b) ignores differences between subjective and objective risks, and c) models value using ad hoc behavioral assumptions with little correspondence to the economic theory of value under risk. This yields ecosystem service values of questionable validity and meaning, with unclear implications for policy.

This presentation reports on the development, application and testing of a novel stated preference choice experiment (CE) designed to provide more realistic and accurate assessments of ecosystem service value subject to outcome uncertainty. The survey and model are applied to the estimation of values related to coastal adaptation, including the protection of at-risk homes, infrastructure, and natural systems such as beaches and coastal marshes. Specific attention is given to tradeoffs between engineered (e.g., sea walls) versus natural (e.g., wetlands) adaptation. The CE survey, *Adapting to Coastal Storms and Flooding*, was developed and tested over two years in a collaborative process involving economists and natural scientists, and 13 focus groups with residents, stakeholders and policymakers. The resulting CE presents a more realistic, continuous distribution of uncertain outcomes and tests for risk-related scenario adjustment by systematically comparing models estimated using subjective (perceived) versus objective (actual predicted) risks. The survey was implemented by mail over a sample of 2,881 randomly-selected residents of Old Saybrook and Waterford, Connecticut (USA), two communities facing considerable risks due to sea level rise, coastal storms and flooding. Models are estimated using specifications that are fully consistent with the economic theory of behavior under risk.

Model results suggest a more sophisticated influence of outcome uncertainty on preferences and values than is reflected in standard approaches to ecosystem service valuation. These effects are particularly relevant for cases such as climate change adaptation, in which ecosystem service values depend on outcomes that are subject to considerable risk and uncertainty. These and other findings suggest that common, less rigorous treatments of outcome uncertainty may generate misleading inferences concerning ecosystem service values, and perhaps contribute to misguided adaptation decisions.

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FOCUSING ON OUTCOMES: NEW POLICIES AND OPPORTUNITIES TO TURN AROUND DECLINING CANDIDATE SPECIES

Timothy D. Male
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'Candidate species' is a term with two important conceptual definitions. It is currently used under the Endangered Species Act (ESA) to apply to species whose status already warrants their protection under the ESA, but lack of resources prevents the agency from doing so. Second, many members of the public, regulated businesses and wildlife management field think of candidates as species that might become endangered or threatened in the future if action is not taken to change a pattern of decline or to lower threats. These distinct definitions have important ramifications for the goals of conservation programs designed to conserve both formal and informal candidate species.

In the early 1990s, the U.S. Fish and Wildlife Service began formalizing guidance on agreements to benefit candidate species, primarily by public agencies. By 1999, they added policy for agreements that, in exchange for conservation action, provided assurances to non-federal participants that would limit their future regulatory responsibilities if the species were listed as threatened or endangered. Since then, approximately 100 agreements with federal agencies, state agencies and private landowners have been developed, benefiting many species and keeping dozens off of the endangered species list. In 2014, federal agencies proposed a new policy to allow states to start tracking and crediting beneficial actions for any formal or informal candidate species that are taken by non-federal or federal parties and which can be used after listing to compensate for or offset potentially harmful actions. This policy promises to dramatically expand the importance of goal-setting and environmental accounting in the field of candidate conservation and will allow advanced compensatory mitigation to take place on a large scale.

State-run registries of candidate species credits are more likely to be a conservation success if they operate under a set of principles developed through wetland and species banking efforts and a diversity of other compensatory mitigation programs in use around the country. In particular, such programs need 1) objective and time-specific goals, 2) accounting frameworks that allow states to accurately but cheaply quantify credits, and 3) systems to track credits to make them easier to monitor and accessible to future buyers. Program success could be limited if agencies seek to set and fix prices for credits, credit accounting practices are not also adopted by U.S. Fish and Wildlife Service to measure debits, and if agencies fail to define distinct roles for oversight of the registries versus ownership of the credits. The presentation will summarize the new policy and opportunities to improve its implementation, based on lessons learned through accounting systems that have succeeded or failed under other programs.

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INTEGRATING ECOSYSTEM SERVICES INTO IMPACT ASSESSMENT AND OFFSET SITING IN COLOMBIA AND BEYOND

Lisa Mandle

The Natural Capital Project, Stanford University, The Nature Conservancy, World Wildlife Fund and the University of Minnesota, Stanford, CA, USA

Globally, infrastructure development – from energy to mining to transportation – is expected to more than double in the coming decade, reaching $9 trillion in spending per year in 2025. Environmental impact and mitigation requirements, intended to minimize the negative consequences of development to the environment and people, have been widely adopted by governments and lending institutions. However, existing approaches to offsetting have generally focused on mitigating impacts to ecosystems or ecological processes. These approaches often do not explicitly consider the links between ecosystems and people and, consequently, can fail to return ecosystem service benefits to those people harmed by development. There is therefore a growing interest in accounting for and offsetting ecosystem service losses. As countries like Colombia add ecosystem services to impact assessment and offset policies initially focused on biodiversity, the question remains how to put these policies into practice and address the additional level of complexity from ecosystem services in a feasible way.

The Natural Capital Project, together with partners at The Nature Conservancy, has developed an approach and decision support tool for 1) quantifying development impacts on both biodiversity and ecosystem services and 2) selecting offsets to mitigate impacts to biodiversity and to people affected by development. Our approach integrates information on where and how ecosystems provide benefits to people (servicesheds) with biophysical information (e.g., land use, soil, topography, climate) to trace the effects of development and associated offsets to people. We applied this approach to case studies of coal mine development in Colombia and a proposed road through the Peruvian Amazon. Based on these experiences, we developed OPAL (Offset Portfolio Analyzer & Locator), a tool for impact assessment and offset selection that tracks impacts both to biodiversity (the area and quality of ecosystems) and to ecosystem services (carbon storage, sediment and nutrient retention). OPAL supports offset selection in accordance with Colombia's terrestrial biodiversity and ecosystem services mitigation policy and has the flexibility to be used for offset siting decisions elsewhere in the world. In Colombia, it will be integrated with marine- and freshwater-focused tools for offset selection being developed by The Nature Conservancy with support from the Colombian government.

In this presentation, I will demonstrate the approach and how OPAL can be used to assess mitigation options and select a mitigation portfolio that addresses both biodiversity and ecosystem services losses. The approach and tool make the consequences of development's impacts to people and nature more transparent in Colombia and beyond. Incorporating ecosystem services into the impact assessment and offset process can help maximize the benefits of development and enable more effective and equitable allocation of offset activities.

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BUTTERFLY-SAFE WINE? LAYERING INCENTIVES TO MAXIMIZE SPECIES BENEFIT ON PRIVATE LANDS

Nicole Maness *and Bobby Cochran*
Willamette Partnership, Portland, OR, USA

With the majority of habitat for federally listed species found on private land, engaging landowners in habitat restoration and protection is key for threatened and endangered species recovery. Willamette Partnership's Incentives Trifecta program is working with landowners, scientists, and regulatory agency staff to develop a suite of market-based tools that will allow landowners, actively creating or restoring habitat for imperiled species, to access a suite of conservation incentives. By incorporating species-level science into the performance standards for eco-label certification, ecosystem service credits and regulatory assurances, the Incentives Trifecta links delivery of these incentives through common metrics, accounting systems, and policy templates.

This talk will describe the pilot application of Incentives Trifecta program in Oregon's Willamette Valley where vineyard owners and managers are participating in the recovery of the endangered Fender's blue butterfly. Under the pilot, a Programmatic Safe Harbor Agreement will allow landowners who meet Salmon-Safe's management standards for Fender's and use Willamette Partnership's Upland Prairie Credit Calculator to measure benefits to the species, to receive formal assurances from the US Fish and Wildlife Service that their effort to conserve prairie habitat will not lead to additional regulatory burdens under the Endangered Species Act. Anticipated benefits of the Incentives Trifecta approach include greater interest and participation of private landowners in conservation management, and ideally a more rapid recovery and potential down or delisting of an endangered species.

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USING AN ECOSYSTEM SERVICES FRAMEWORK TO RESTORE AQUATIC HABITAT IN OREGON

Nicole Maness
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How are things working in Oregon? Pretty well actually! Implementation of wetland mitigation banking and water quality trading programs in the state has paved the way for widespread interest in developing an ecosystem services approach to support restoration of aquatic resources. Driven by regulations that permit compensatory mitigation as a means to address impacts, state agencies are actively building the tools and frameworks to be able to quantify gains and losses in ecosystem function, track progress towards meeting environmental and policy goals, and verify that conservation benefits promised by this approach are being delivered on the ground. This presentation will describe the efforts of Oregon Department of State Lands (state permitting agency) in partnership with the U.S. Environmental Protection Agency, U.S. Army Corps of Engineers and Willamette Partnership to develop a science-based mitigation framework which provides for more function-based mitigation for unavoidable impacts to the stream and wetland resources in Oregon. It will highlight the outcomes and lessons learned from this multi-agency initiative to develop function-based assessment methodologies to quantify credits and set performance standards, site selection criteria based on watershed goals, and accounting structures to improve functional replacement of resources.

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CITIZEN SCIENCE AND CROWD-SOURCED DATA TO ASSESS CULTURAL GOODS AND SERVICES

Barbara T. Martinez[1] *and Marc Russell*[2]

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Attributes of nature -- such as aesthetically pleasing viewscapes and places of cultural or spiritual significance -- are difficult to assess using current methods. Preliminary data on the use of, travel to, or relative interest in cultural goods and services could be useful as preliminary information for assessment. With a majority of the U.S. population owning smart phones (about 61%), one potential idea is to engage those mobile smart phone users to crowd source data collection. Researchers in the Office of Research and Development (ORD) of the Environmental Protection Agency (EPA) and partners are exploring the users, uses, and the types of data that are possible to collect via a mobile smart phone app. This presentation will explore the important issues associated with developing such an app, including considerations about the nature and quality of the data, sampling bias, continued engagement of data collectors, and ideas to integrate existing apps and data sources.

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PARTICIPATORY SELECTION OF ECOSYSTEM SERVICES – INSIGHTS FROM LISBON METROPOLITAN AREA

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Research and societal interest on ecosystem services has been increasing in the last years, as illustrated by major global initiatives like the Millennium Ecosystem Assessment or the TEEB initiative (The Economics of Ecosystems and Biodiversity). A great deal of research has focused on the biophysical quantification and economic valuation of ecosystem services. Several tools serving those purposes through modelling, mapping and analysis of scenarios were developed and are continuously being tested and improved. Despite considerable advancements, it is still difficult to comprehensively assess a large suite of ecosystem services, therefore a selection of the ones considered more relevant, on which to focus in a given assessment, is usually done. However, this selection process has received less attention in research. Selection of ecosystem services is often done based on data availability, abundance of studies covering similar ecosystem services or on the state of development of existing tools. Still, documented and tested procedures to select ecosystem services, namely through participatory processes are scarce.

The notion of an ecosystem service implies that someone is benefiting from a given ecosystem process or function, which means there is an offer and a demand-side. Hence the value of an ecosystem service is not only dependent on ecosystem structures, functions and processes but also on human preferences, cultural factors, institutions and other societal features. In this context, faced with a need to select (most relevant) ecosystem services, a participatory selection, engaging key stakeholders, is particularly important. It also helps increasing the usefulness of ecosystem services assessments to stakeholders and policy processes, therefore increasing its impact on society.

The aim of this research is to explore the participatory selection of ecosystem services, through the case of the Metropolitan Area of Lisbon in Portugal, southwestern Europe. Drawing from a spatial planning context, different types of stakeholders were involved and different participatory techniques were used. Stakeholders working at regional and local scale were included, which allows drawing some insights over views of different types of stakeholders across different governance scales. Results of the participatory selection are discussed against an analysis of other possible selection criteria such as biophysical features of the region, existing planning goals or degree of coverage by other studies.

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HOW APPROPRIATE IS YOUR FRAMEWORK FOR CONDUCTING ECOSYSTEM SERVICES ASSESSMENTS?!

Simone Maynard
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Globally the most notable and applied of all ecosystem services assessment methodologies is the one supporting the Millennium Ecosystem Assessment (MA). The MA states one of its intents is to be used 'as a framework and source of tools for assessment, planning and management'. Yet since its release there has been exponential growth in ecosystem services framework development. There are now numerous ecosystem services frameworks available for use and being applied. They have been developed by various stakeholders with different disciplines, from different cultures, to address specific issues, for application at different scales and by different end-users. As a result, the process applied to develop the frameworks and the information and tools supporting them differ. There exists no systematic or agreed framework from which to consistently assess ecosystem services across sites, ecosystems, catchments, a region, state or nation. A lack of analysis into existing initiatives, particularly the drivers underpinning the choice of process applied to develop the frameworks and why the information and decision support tools differ so much, hinders the potential for researchers and decision makers to make informed decisions on an appropriate framework to adopt, adapt or how to develop a more relevant framework without presupposition.

This presentation provides a set of Guiding Principles for determining an appropriate framework for use in single or multi-scale ecosystem services assessments; or from which researchers can assess their applied framework to determine its appropriateness. The Principles were developed by analysing frameworks developed at different scales and in different contexts since the MA's release in 2005. Documents and literature were reviewed to assess a wide range of frameworks and their components, including the MA, TEEB, UN SEEA and CICES to name a few. Applied research was conducted to develop an actual framework at the regional scale in South-East Queensland, Australia, capturing and creating an understanding of the constraints and opportunities that might arise in everyday practice when developing a framework. Multiple case study analysis was applied to analyse in depth two frameworks developed, one at the national scale (the US EPA's Ecosystem Services Research Program) the other at the multi-national scale (the UK National Ecosystem Assessment), in which 33 interviews were conducted with program Leads. Constraints and opportunities provided by drivers underpinning the programs were identified; and how these influenced the processes applied and the information and decision support tools developed. This presentation is a must for any researcher developing a framework for ecosystem services assessments, or already applying a framework! How appropriate is your framework for conducting ecosystem services assessments?!

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THE BENEFITS OF RESTORATION IN URBANIZING WATERSHEDS: DEVELOPING VALUE INDICATORS AND UNDERSTANDING SOCIAL BARRIERS AND OPPORTUNITIES

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Ecological restoration can reestablish ecosystem services (ES) that provide important social benefits, but managers with limited funds and resources are forced to prioritize potential restoration sites. Prioritizing restoration sites based on ecological functioning and expected ES production alone neglects vital information for evaluating tradeoffs: who benefits from the resulting ecosystem services, and by how much. We present a rapid assessment approach for ranking restoration options based on evaluating both the ecological functioning and the magnitude of social benefits from resulting ES, and contextualize the approach by attending to the social barriers to and opportunities for restoration.

Our research has three primary objectives: advancing methods for developing and applying non-monetary indicators of non-market economic values; improving understanding of social aspects of restoration planning and management, focusing on communication between managers and the public, and public engagement in the restoration process; and providing guidance to users for applying our approach to understand and evaluate the suite of ecosystem services provided by restoration projects. We are conducting our research in the Woonasquatucket Watershed in Rhode Island, USA—an urbanizing watershed with a wide range of both ecological quality and sociodemographics—but our methods will be transferable to other urbanizing watersheds.

We are developing our ecosystem service benefit indicators approach and selecting indicators through a structured framework of theoretical modeling, empirical research, and literature review. We are using more sophisticated modeling to develop indicators of flood risk reduction and aesthetic benefits. The end product will be a step-by-step guide to applying the benefit indicators approach, with associated spreadsheet-based tools. It is intended to be used by a broad range of stakeholders to justify restoration budgets by demonstrating benefits gained; to compare proposals when awarding restoration funds for specific projects; to pre-screen projects that require further evaluation; or to serve as a template for discussion when making mitigation decisions.

The second part of our research— improving understanding of social aspects of restoration planning and management—focuses on communication between managers and the public, and public engagement in the restoration process. We have conducted interviews with restoration managers to explore both public perceptions of services and disservices associated with ecological restoration, and how various approaches to stakeholder interaction may influence the probability of successful outcomes. Our findings from these interviews will be incorporated into the guide for decision-makers, to provide context and guidance regarding successful strategies for public engagement in restoration planning and decisions.

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NON-MONETARY BENEFITS WITHOUT APOLOGY: THE ECONOMIC THEORY AND PRACTICE OF ECOSYSTEM SERVICE BENEFIT INDICATORS

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Values for changes in ecosystem services (ES) are required or desired in many policy and management contexts. Often, appropriate monetary values are not available or are infeasible to estimate. Fortunately, in many contexts—e.g., cost-effectiveness analysis of programmatic mandates, discourse-based decisions, advocacy or educational efforts—monetized values are not necessary. In these instances, information on public preferences, demand, and values can be important, particularly when determining how to allocate scarce collective resources among competing priorities and uses.

This paper presents a framework and practical advice, based on economic theory and concepts, for developing and compiling non-monetary indicators of ES benefits (or costs). I first present a bio-economic model of ES supply, demand, and value; then describe approaches that decision makers can use to apply this model to develop robust benefit indicators to evaluate the ES benefits (or costs) of policies and management decisions. The approach is illustrated with real-world examples.

A benefit indicator is defined as a variable that represents an aspect of demand, preferences or value for a particular ES. Robust indicators should be developed and selected based on a theoretically sound link between the indicator and the aspect of the system that it represents. Indicators grounded in accepted theory will be more defensible than more ad-hoc metrics. Thus, the framework uses economic models of demand and value to systematically develop and select indicators based on their ability to predict changes in demand and value across policy options. For example, a set of economic demand and value indicators would include measures of the extent of the market and the number of beneficiaries; indicators of scarcity and availability of substitutes; and indicators of the elasticity of demand.

Decision makers can benefit in several ways by using theoretically-sound and practically relevant ES benefit indicators. Indicators can be more easily compiled than monetary measures, and are amenable to telling a theoretically consistent and understandable story about benefits of policies or actions that affect ES. Indicators can remain disaggregated, thus allowing individual aspects of tradeoffs that may be masked in a single money metric to remain transparent. Indicators can be useful in systems models where many important aspects of the system must be included but acceptable money measures are not readily available for all of the important benefits and costs. If evaluations include only those monetary measures that are readily available, the resulting incomplete assessment of the system can lead to poorly informed decisions. Thus, benefit indicators may allow ES benefits to be included in more decisions and can support more complete assessments of those decisions.

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LESSONS LEARNED FROM AN ECOSYSTEM SERVICES PILOT IN CA WATERSHED

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Purpose: Sustainable Conservation and the partners have been working to develop a pilot Payment for Ecosystem Services (PES) program in the Mokelumne Watershed in northern California. We plan to share lessons learned to inform future efforts that seek to create ecosystem service markets.

Scope: The purpose of our pilot was to develop a voluntary PES program to target, leverage and attract private and public sector investments in watershed restoration activities in the Mokelumne Watershed. Specifically, we used a stakeholder-driven process to develop a program that 1) accelerates community-based restoration; 2) connects investment from public and private sector funders to the communities and people who implement restoration actions; and 3) quantifies the environmental outcomes for the funders.

Methods: A stakeholder working group evaluated the current watershed conditions and major environmental issues facing communities. The group advised two approaches for a PES program. In the upper watershed, the partners modeled wildfires with and without fuel treatment scenarios. Using the results, they quantified the financial costs and benefits of fuel treatment, focusing on those elements to which a dollar value can readily be assigned. In the lower watershed, we developed performance metrics to predict and measure riparian habitat functions resulting from restoration projects.

Results: The economic benefits analyzed in the forest and fuel treatment models mainly accrue to the public making public agencies the primary investor. In the lower watershed, the benefits accrue to both the public and private sectors. However, the primary beneficiary is the public sector. Thus public agencies are the target for funding, because they have goals to meet regarding riparian habitat ecosystem health. The private sector is not motivated to invest in the water quality and habitat outcomes we modelled. There may have been greater interest on the part of the private sector had we modelled water supply.

Conclusions: We learned that the long-term success of a non-grant funded PES program is dependent on three factors: 1) sufficient volume of projects producing environmental benefits; 2) significant and sustained investment from public and private sectors; and 3) overall administrative feasibility and viability. It is vital to have these components in place before developing a PES program.

Recommendations: Identify the drivers that will motivate public and private investors before designing a Payment for Ecosystem Services program. Agree upon an entity that can articulate the program vision, coordinate with stakeholders across the watershed, and engage private and public investors. Seek to balance investors' motivations and stakeholders' environmental goals in order to prioritize metrics development.

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QUANTIFYING THE RELATIONSHIP BETWEEN NATURAL LANDSCAPES AND TREATMENT TECHNOLOGY AND COSTS

Rob McDonald
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In this talk, I discuss a unique global dataset, the City Water Map, that has information on the water sources for more than 500 cities globally. Hydrologic models of surface and groundwater supplies were used to quantify the risk of water quantity shortages, while erosion and nutrient loading models were used to quantify water quality risks. These same models were used to quantify the ability of six common conservation strategies to reduce water quantity or quality risk, in physical terms. For a subset of 130 cities, information was available on water treatment plant technology and costs (O&M and capital costs), and this information was used to develop average global costs curves of how changes in water quality affect water treatment costs. These costs curves allow us to evaluate the ROI of our conservation strategies in economic as well as physical terms.

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BRINGING DRAINAGE WATER MANAGEMENT FOR ECOSYSTEM SERVICES TO MARKET: BRINGING AGRICULTURE AND MUNICIPALITIES TOGETHER TO IMPROVE THE ENVIRONMENT AND SAVE MONEY FOR TAXPAYERS

Andrew McElwaine
American Farmland Trust, Washington DC, USA

Years ago EPA Administrator William Reily said, "Our Nation's rivers and streams may not be fishable and swimmable but at least they're no longer flammable." The Cuyahoga River's spontaneous combustion was the trigger for action forty years ago. Toledo and Lake Erie may become that trigger to address urban and rural nutrient loading.

Nutrient pollution remains the great, unresolved issue in US water quality. The Clean Water Act with its emphasis on identifiable outfalls of pollution remains ill-equipped to deal with the problem of non-point sources. Despite multiple efforts dating to the 1988 reauthorization of the Act, federal and state authorities are still not in a position to implement long-term regulatory solutions. Many TMDLs, and even numeric nutrient standards, if they survive legal challenges, will take time, perhaps years, to be effective

All agree we have to get a handle on nutrients – but how? Non-point sources have been difficult to regulate and additional controls may be problematic – particularly given the election outcome. But we all know that we need to do something. We need a new approach.

Markets for environmental performance reverse the historical relationship between the environment and opportunity. Well structured markets encourage environmental performance rather than penalize it. Well developed environmental markets promote early actors. They can reap financial rewards and increase their opportunity. As H. J. Heinz said, "we can do a common thing uncommonly well."

Municipalities and industry may face increased expenses to meet increased performance standards for sewerage and storm water discharge. State Revolving Funds don't have the kind of capacity they did thirty years ago. So increasingly municipalities and other point sources such as electric power stations are interested in working with other sectors to "buy" environmental performance credits. Agriculture is interested in diversifying its "commodities" and has tremendous capacity to improve water quality.

The problem as in any environmental market program is leakage and additionality. Leakage implies there are reductions that are credited in a transaction that failed to occur, such as getting air quality credit for closing a power plant only to buy the same dirty power from a neighboring state that is not subject to a cap. Additionality deals with whether an action that receives environmental credit is doing something in addition to what was going to be done anyway. To prevent these problems one can require additional monitoring or reduce the amount of the credit given in order to mitigate risk. But such steps increase transaction costs and can drive buyers and sellers out of the market.

Drainage Water Management strategies may offer some hope if properly implemented. The potential advantage of the Drainage Water Management (DWM) strategy we are talking about today is that environmental performance from this sector is relatively quantifiable. It is comparatively easier to measure above and below treatment. So performance can potentially become transparent and reliable. DWM may be cost effective at reducing nutrient loading and delivering environmental performance for less than the cost of traditional control technologies.

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ACADEMIC INSTITUTIONS AS PARTNERS IN DEVELOPING WORLD PES PROGRAMS: CARBON SEQUESTRATION AND LIVELIHOOD IMPROVEMENTS IN HAITI'S CENTRAL PLATEAU

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Payment for Ecosystem Services (PES) has been heralded as a promising mechanism for alleviating poverty and restoring degraded environments in the developing world. However, often the scale at which small farmers can participate in the sale of ecosystem services is not large enough to compensate for the high costs of certifying and managing PES schemes. We will present preliminary findings over the past two years from an alternative model to market--based PES schemes in which farmers partner with an academic institutions to sell both enhanced ecosystem services and educational opportunities for institutions actively seeking novel ways to couple sustainability education with best practice.

Zanmi Kafe (Partners in Coffee) is a collaboration between the Haitian nongovernmental organization, Partners in Agriculture (Zanmi Agrikol) and Sewanee, the University of the South, a small liberal arts institution. We have implemented a PES program to encourage the establishment of diverse resilient shade coffee agroecosystems that sequester carbon, protect watersheds, improve livelihoods and offer unique hands--on problem--solving educational opportunities for Haitian and American students. Using an established "green fee", Sewanee is the first buyer of bundled services provided by farmers in Haiti's Central Plateau. Sewanee students can opt to use the fee to offset airline--related carbon emissions and invest in Haitian farmers. This year, families in one mountain village have planted 16,000 seedlings of coffee and other multipurpose trees that will yield diverse products. Payments to farmers for carbon sequestration provide incentives to protect seedlings while they are most vulnerable to fire, grazing and competing land uses. Sewanee and Haitian students are trained to survey farms to verify tree plantings, measure baseline carbon stocks and biodiversity indices, as well as interview households to establish economic indicators, all of which contribute to long--term monitoring and research on the effectiveness of PES in alleviating poverty and restoring degraded lands. The advantages of this PES alternative model are many: the green fee--supported program serves as a campus--wide consciousness--raising tool about the impact of lifestyles on climate and how sequestration can help reduce carbon footprints in a meaningful way. As students monitor the project yearly, buyers of environmental services have an intimate knowledge of the product they are purchasing. As part of the service bundle, unique educational opportunities attract a higher price from academic institutions than could the sale of carbon sequestration alone. Without the high cost of third party certification, farmers can reinvest a larger portion of the proceeds back into the program, which is designed to enhance agricultural productivity and environmental resilience and improve livelihoods over the long-term.

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SWARM TECHNOLOGY AND DRAIN MANAGEMENT TO IMPROVE ENVIRONMENTAL PERFORMANCE

Dennis McGrath
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Real time drain water management (RT DWM) coupled with swarm technologies may improve upon centuries-old drainage in agricultural production, help manage risk and increase farm profits. RT DWM also shows potential for reducing nutrient movement from agricultural lands to streams, rivers lakes and estuaries.

Coupling "swarm" optimization algorithms with RT DWM may create even more potential for farmers, individually and collectively, by allowing them to manage for nutrient reduction at a watershed scale. Swarm/RT-DWM applications will anticipate, measure, integrate and distribute information from farm fields in a given watershed to control the network of drain tile outlets across multiple farm fields to optimize ecological and agricultural benefits.

The swarm optimization programming uses real-time sensors and historical data to determine "optimal" flows in the drain control structures. These computed flows will be "optimal" in the sense of minimizing the nutrient exported over the instrumented watershed subject to upper bounds on field soil moisture for crop growth, treatment and harvest.

Discussion of preliminary analysis results in the Great Lakes basin.

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TOOLS TO MEASURE WATER QUALITY: THE NUTRIENT TRACKING TOOL

Shaun McKinney
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The success of Water Quality Trading hinges on buyers and a seller exchanging the elements of water quality; but what is traded and how is it measured? The Nutrient Trading Tool (NTT) was built to easily access the rigorous, analytical Agricultural Policy Extender (APEX) tool. Thus the research grade tool is now accessible to a wide audience of users including those interested in water quality trading through the NTT interface. NTT is a single tool that addresses the needs of ecosystem services, conservation outcomes and planning as well as primary research. Two significant advances exemplify NTT, 1) the automatic data provisioning afforded by integrated web-services for soils and climate data and 2) the reporting structure of delivering the "delta" value or difference between an existing condition and a proposed one. The results included delta values for:

Nitrogen

Phosphorus

Sediment

Runoff

Crop Yield

The United States Department of Agriculture (USDA) is facilitating water quality trading by providing the science behind water quality assessment and modeling. Markets can rely upon USDA tools to provide transparent algorithms and current constituent data to drive these models. The NTT application is currently being completed including model parameterization with the assistance of the Agricultural Research Service. NTT will soon be available for conservation planning as well as water quality trading.

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BRINGING DRAINAGE WATER MANAGEMENT FOR ECOSYSTEM SERVICES TO MARKET: THE OPPORTUNITY TO REDUCE MUNICIPAL COSTS FOR CLEAN WATER BY PARTNERING WITH AGRICULTURE

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Municipalities currently face billions of dollars in costs to meet various environmental requirements that include nutrient reduction standards for waste water and storm water systems. Rather than just invest in conventional pollution control strategies they are interested in exploring more cost effective methods such as partnering with agriculture to achieve at least a portion of these performance standards.

Cities are in a unique position as being active regulators of water quality under pre-treatment permits as well as members of the regulated community under discharge permits, and users of "waters of the United States" as drinking water sources, so cities care deeply about the quality of water. These entities operate with strict performance requirements for a multitude of regulated elements. If these requirements are not met, permittees face severe liability and may be subject to fines or other enforcement action. For municipalities and permitted facilities to develop compliance strategies with agriculture, they certainty that the performance requirements are met.

Municipalities in Iowa are at the beginning stages of development of a nutrient system in a state with over 93 million acres of highly productive agricultural acres. In other states it has been shown that several agricultural conservation practices can deliver nutrient load reductions at a fraction of the cost of conventional pollution control technologies. This creates an opportunity for municipalities to reduce the burden on taxpayers by partnering with agricultural producers to deliver the performance requirements contained in the permit requirements. However, these actual pollution reductions need to be documented, verified and available over a long time.

Some agricultural conservation strategies have been shown to consistently produce quantifiable reductions in nutrient loading year to year, while others experience great variability in performance. Agronomic practices are typically less reliable in performance than management of hydrology (drainage water management etc.). Municipalities need to consider performance, price per environmental service delivered and reliability to select potential ecosystem services to "purchase" from agriculture.

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THE WATERSHED APPROACH: LEVERAGING WATERSHED OUTCOMES FROM SITE MITIGATION

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Since 2008, a "watershed approach" has been required under §404 of the federal Clean Water Act program, to improve the ecological outcomes and sustainability of wetland and stream compensatory mitigation. This has provided opportunities to (1) align regulatory and non-regulatory conservation goals, (2) unite diverse partners around shared goals and desired ecosystem services, (3) increase the success of individual projects through watershed-wide advance identification and prioritization, and (4) maximize the cumulative outcomes of projects across a watershed.

In 2009 The Nature Conservancy (TNC) and Environmental Law Institute (ELI) began to explore and design approaches to meet these opportunities and goals. Three "watershed approach" pilot projects in diverse ecological and socio-political settings were launched in Georgia, Tennessee, and Wisconsin. Lessons learned from these pilots were aggregated with lessons from over 60 additional watershed planning methodologies from around the nation and the input of a team of technical experts from partner agencies and organizations. Based on these collective experiences, a Watershed Approach Handbook was created to guide others seeking to implement a "watershed approach."

At heart, the Watershed Approach Handbook links the prioritization of suitable sites to watershed-specific needs (e.g., abating flooding problems, meeting water quality goals, increasing certain wetland types). Major components of the Handbook include: 1) a "spectrum" of watershed planning approaches, from decision frameworks to watershed plans with prescribed outcomes; 2) key "elements" of good watershed planning, from identifying watershed needs to assessing the potential of sites to meet those needs; and 3) case studies highlighting real-world examples of these approaches and elements.

Of the examples in the Watershed Approach Handbook, the Wisconsin TNC/ELI pilot project uses ecosystem service assessments to define watershed needs and also to prioritize sites to meet those needs. Because the goals of many stakeholders – both inside and outside of the regulatory arena – can be expressed in terms of ecosystem services (water purification, flood abatement, shoreline protection, etc.), this approach has the potential to unite, inspire, and focus collective efforts, increasing the potential for watershed-scale outcomes. Efforts are proposed and underway to apply this approach at state and regional scales.

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LINKING PUBLIC WELFARE AND PAYMENTS FOR ECOSYSTEM SERVICES: FLAGSTAFF WATERSHED PROTECTION PROJECT

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Forested ecosystems of the southwestern United States have undergone significant alterations in composition and ecological process due to misguided forest management practices and climatic conditions over the past century. Consequently, land management agencies in this region are searching proactively for viable funding sources for forest restoration treatments, which reduce small diameter trees and debris, thereby mitigating the effects and likelihood of high-severity wildfires. The Flagstaff Watershed Protection Project (FWPP) is a Payment for Watershed Services project that seeks to reduce fuels on 11,000 acres of public lands in the Rio de Flag and Lake Mary watersheds in order to prevent high-severity wildfire and subsequent risk of post-fire, catastrophic flooding. FWPP began as Proposition 405 on the November 2012 general election ballot and passed with 73% of Flagstaff voters' approval, and it represents a new model of forest restoration efforts that contrasts with traditional, USFS led forest restoration management, as it incorporates $10M initial bond investment and property tax remuneration from a municipal body with collaborative agency partnership to accomplish watershed protection goals. The purpose of this research will be to document and understand how FWPP represents a unique example for financing forest restoration treatments in the Southwest. We hypothesize that success of FWPP will depend upon timely and collaborative completion of NEPA and appropriate definition of roles and rules for interaction among stakeholders. Researchers will employ a mixed method approach to determine the role and level of stakeholder participation in the planning stage of the project, in order to ensure accountability and efficient allocation of public resources. Quantitative and qualitative data collection approaches will hopefully allow key participant perspectives to be considered in order to promote development of proactive ecosystem services policy alternatives and research in communities facing similar risks.

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UTILIZING ECOSYSYTEM SERVICES TO GENERATE SUPPORT FOR ENDANGERED SPECIES RECOVERY

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The recovery of an endangered species often requires the initiation of actions to improve the habitat upon which a species depends. As such, the benefits of recovery often extend beyond the subject species to all organisms, including humans, that utilize a particular ecosystem. The purpose of the project was to generate support for funding of a long-term common carp (*Cyprinus carpio*) removal program by utilizing an ecosystem services analysis to communicate the benefits of this recovery action. The results of the analysis were intended for presentation to state legislators, however the analysis also facilitated communication of project benefits to stakeholders and the public.

The direct and passive use services of an improved Utah Lake ecosystem were analyzed to identify values associated with improvements in water quality, angling catch rates, and other expected benefits of the recovery action. Once the direct and passive use services were quantified and monetized, the total service value was estimated through time and presented in net present value terms. These values were presented to local legislators and also provided to targeted legislators in key committee positions. Additionally, the information was provided to media outlets and to project stakeholders for communication to their constituents.

The results of the analysis were useful in communicating project benefits and aided in illustrating the financial improvements possible through this particular recovery action. Some individuals expressed confusion regarding the valuation methods and questioned the overall valuation of the recovery action. Such questions allowed for more in depth conversation regarding the ecosystem services approach and provided insight into how benefits could be better identified. In many cases, the presentation of the results served to broaden the perspective of the intended audience and allowed them to identify the numerous benefits and far reaching effects of the recovery action. Similar analysis of other recovery actions would be useful in comparing the benefits of multiple recovery actions. While the results of the analysis were not immediately accepted by all, the project did allow the introduction of ecosystem service concepts and methods to new audiences and broadened their thinking about project benefits. The continued use of ecosystem services'' concepts and methods would improve the communication of benefits associated with endangered species recovery.

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THREE BUSINESS CASES FOR NATURE FROM THE DOW CHEMICAL COMPANY'S FREEPORT, TX FACILITY

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In January 2011, The Nature Conservancy and The Dow Chemical Company formed a six-year collaboration to incorporate nature into global business goals, strategies, and decisions. The collaboration is motivated by the hypothesis that better information on the value of nature will lead to better business and conservation outcomes. This presentation shares three business cases that tested this hypothesis at Dow's largest facility in Freeport, TX.

Dow's facility in Freeport is situated south of Houston on the Gulf of Mexico at the mouth of the Brazos River. The facility is responsible for more than a third of Dow's sales globally. Scientists, engineers, and mangers from TNC and Dow assessed the facility's impacts and dependencies on ecosystem services and identified three business decisions that could be informed by information on the value of nature: 1) is large-scale reforestation a cost-effective solution for ozone mitigation?, 2) does accounting for the role of coastal marshes in hurricane risk mitigation inform levee design and reduce expected costs and damages?, and 3) what is the value of water rights to business, how will the value of water rights and the price of water change, and what are the best green and collaborative options for sustaining water supplies? These questions were addressed with integrated biophysical and economic analyses that considered future scenarios of climate change, economic development, and governance. Each business decision was evaluated based on the value to the business, the community, and the effects on ecosystems.

The results were mixed. The air pollution mitigation analysis revealed that large-scale reforestation may be a cost-competitive alternative to traditional air scrubbers, while producing additional health and ecosystem benefits. Importantly, there is a policy opportunity to leverage this strategy across the United States. In contrast, the coastal protection analysis indicated that marshes had little protective value in this context, despite large recreational value and support for migratory birds, although the model is being applied at other locations that offer more potential value. The freshwater valuation helped shift managers from thinking of water as a utility to an asset, uncovered hidden risk from development trends, and identified three out of five green or collaborative solutions as cost-competitive with a traditional solution.

These analyses, produced by an interdisciplinary and cross-sectoral team, established a credible business case for the value of nature at Dow and other companies. In addition, they informed actionable decisions, such as the efforts to pursue large-scale reforestation for ozone pollution mitigation, and provided replicable methods for incorporating the value of ecosystem services into business decisions at Dow and other businesses.

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INCORPORATING COASTAL BLUE CARBON INTO THE IMPLEMENTATION OF U.S. FEDERAL POLICIES

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The purpose of this presentation is to describe how U.S. federal policies can incorporate the carbon sequestration and storage ecosystem services known as "coastal blue carbon" into decision-making and provide a couple of case studies of where this is being done.

Many agencies and organizations, including in the United States federal government, are expressing interest in the measurement and valuation of ecosystem services. Despite this interest, specific guidance on whether and how to incorporate ecosystem services into federal activities remains scarce. To address this gap, NOAA helped lead an analysis examining six federal policies (including National Environmental Policy Act (NEPA), Clean Water Act, and Natural Resources Damage Assessment) to determine whether and how carbon services of coastal ecosystems could be included in the implementation of these policies. The results of this analysis were published in two peer-reviewed publications. Based on this initial analysis, we determined that it is possible to incorporate the carbon services into existing processes without statutory changes. But, to the best of our knowledge coastal carbon is not currently included in the implementation of any of the regulations studied.

One of the most exciting conclusions of this analysis is that there is the potential for big impacts in decision making if carbon services were included in implementation. This is because coastal ecosystems sequester and store a lot of carbon, and most of the stored carbon is belowground in the soils. As a result, outcomes incorporating carbon into decisions from these policies might be significantly different from current implementation efforts which tend to focus primarily on living resources. Therefore, including carbon services in implementation could lead to more habitat conservation, both protection and restoration, such as higher mitigation ratios. These outcomes would result in a "win-win" for both climate regulation and habitat conservation and would preserve not only the carbon services, but also the many ecosystem services these habitats provide.

Building on this analysis, NOAA is currently working on pilot efforts to incorporate coastal blue carbon into federal regulations. One pilot effort is exploring how to incorporate carbon services into the NEPA process including incorporating carbon services into the discussion of alternatives as well as the affected environment. The pilot efforts will help NOAA assess whether including carbon services can change either the decision making process and/or outcomes.

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USING ECOSYSTEM SERVICES TO DEMONSTRATE THE ENVIRONMENTAL SUSTAINABILITY OF ARCTIC OIL AND GAS EXPLORATION: A PROJECT LIFE CYCLE EXAMPLE

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Within recent and developing guidelines for siting and decommissioning of offshore platforms and associated infrastructure, sustainable development is an obligation incorporated into alternative decision-making throughout a projects life-cycle. This obligation focuses on balancing the economic, environmental and social factors associated with the selected siting and decommissioning alternatives. In order to meet this obligation, we present a net environmental benefit analysis (NEBA) approach that is used to balance the risks, benefits and tradeoffs associated with competing management alternatives. Throughout a projects life-cycle (i.e., from siting through development and decommissioning), alternatives will be considered to manage the platform and jacket, pipelines and associated infrastructure, and sea bed deposits. The NEBA approach focuses on the environmental, economic and social factors inherent within potential alternatives. It incorporates ecosystem service valuation concepts and provides a non-arbitrary, transparent, and quantitative approach to compare between alternative actions using litigation-tested technical and scientific methodologies. The approach helps stakeholders to manage site risks, create environmental, social and economic value, and providing a demonstrable net benefit to the public (e.g., documenting environmental sustainability and stewardship). The approach can be used to support baseline information collection, understand a projects environmental footprint, compare between the environmental footprint of various alternatives, support scaling of mitigation where necessary, and support end of project (i.e., decommissioning) decisions to stakeholders. The authors will discuss the overall approach and provide an example of concepts to be considered to demonstrate net project benefits and overall sustainability from a life-cycle perspective.

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PREFERENCES FOR STREAM HEALTH IMPROVEMENTS IN MACON COUNTY, NC

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This presentation describes a choice experiment developed as part of an interdisciplinary research effort examining the impacts of land use change on stream health at the NSF-funded Coweeta Long Term Ecological Research site in North Carolina. Despite extensive hydrological, ecological, and social science research in this area, key knowledge gaps make it difficult to determine the effect of changing stream conditions on stream-based ecosystem service values. While existing research can estimate the biophysical implications of removing riparian buffers or restricting development on steep slopes, the effect of such changes on the community remains unclear.

To meet this need, we conducted a stated choice experiment via mail survey of 3,500 Macon County, NC, residents. The stated choice questions asked respondents to participate in a hypothetical referendum that would affect future stream health in Macon County, NC. Six stream attributes defined the alternatives: water quality, muddiness, livestock access, vegetation around streams, aquatic animals, and cost. Because the survey was not assessing preferences for a specific proposed policy, we used a split sample design to consider the effect of implementation mechanism on preferences. Half of the surveys explained that stream health standards would be reached by establishing *mandatory* regulations. The other half explained that stream health standards would be reached by *voluntary* regulations providing incentive payments to landowners.

This presentation will present the estimated willingness to pay for each stream health attribute and discuss the effect of the implementation mechanism on preferences. One key conclusion is that the mechanism can have surprising effects on preference estimates, beyond the expected result that willingness to pay is higher in this area for a voluntary program. Separate latent class logit models were estimated for the "voluntary" and "mandatory" implementation groups, identifying two preference classes for each group. However, the characteristics defining the classes are not consistent between the groups. Preferences for those asked about a mandatory program are determined by tenure in the area, with a division between long term residents and new arrivals. For those asked about a voluntary program, preference class was defined by attitudes towards environmental regulation, with a division between land rights advocates and zoning supporters.

There is an increasing need for estimating nonmarket values of changes in ecosystem services that are not tied to a specific policy or program. Stated choice methods are useful in this context because of the hypothetical scenario used, but economists have been somewhat resistant to such applications because the policy context and details of the ecosystem service change affect willingness to pay. This paper provides further evidence that policy context, specifically the mechanism of implementation, can significantly affect preference estimates. Still, this provides an example of how a generic scenario can be written that acknowledges this impact and still provides bounds on willingness to pay that can aid decision-making.

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SUPPORTING THE SCIENCE NEEDS FOR REVITALIZING URBAN RIVERS AND COMMUNITIES THROUGH THE URBAN WATERS FEDERAL PARTNERSHIP

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The Urban Waters Federal Partnership, (UWFP), was initiated in 2011 and is comprised of an innovative coalition of fourteen Federal agencies that focus on both natural resources and economic development. The UWFP's purpose is to increase collaboration across the federal government and with local partners to revitalize polluted urban waterways in under-served cities nation-wide. Its goal is to improve environmental quality and local economies. To date, eighteen partnerships have been created in diverse watersheds and urban environments. Restoring environmental services to these highly impacted aquatic ecosystems and adjacent communities requires integration of aquatic science, urban ecology, social science, socio-economic knowledge and engineering. The purpose of this paper is to identify approaches that successfully engage local communities to identify their priority science needs and to increase their knowledge and understanding of environmental services. The second and key step is to deliver science products back to communities and federal and local agencies and organizations that can apply science to meet their urban waters and community restoration goals. The scope of science needs discussed are divided into five categories: 1) climate change impacts and how they uniquely effect urban landscapes;, 2) water resources, including water quality, quantity, impacts of floods and drought, aquatic biota, 3) urban terrestrial resources associated with urban river corridors and in the context of creating sustainable cities and economically viable urban forests; 4) socio-economic issues; maximizing benefits to human welfare, as economic, recreational, and educational resources in cities and 5) green infrastructure and how buildings, transportation, stormwater and other "built" elements of urban landscapes can be designed and integrated to improve urban waters and create more healthy communities. However, urban areas are complex systems with both natural and human components that interact and are likely to require interdisciplinary approaches that span multiple disciplines and all five of the categories named above. The method used to identify science needs in support of the UWF was a carefully planned and structured national workshop of UWFP practitioners and experts entitled "Creating Resilient Rivers for Sustainable Cities: The Urban Waters Federal Partnership". The workshop was convened as part of the National Conference and Global Forum on Science, Policy and the Environment, "Building Climate Solutions" sponsored by the National Center for Science and the Environment" January 28-30, 2014. The workshop integrated plenary presentations and breakout discussion groups that identified key environmental services needed to sustain urban rivers and communities and priorities for research, coordination and outreach that have been incorporated into the activities of the UWFP at the partnership and national level.

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LINKING SCIENCE AND PRACTICE: THE IMPORTANCE OF KNOWLEDGE-ACTION SYSTEMS FOR ACHIEVING SUSTAINABLE SOLUTIONS

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This presentation describes knowledge-action systems analysis (KASA) as a tool to design and implement effective arrangements for linking science and practice. Linking science and practice is a centerpiece of promoting sustainable solutions, but multiple barriers exist to achieve this integration. Many social and political scholars now recognize that one-way, or even two-way, interactions are not enough to achieve successful linkages between science and practice because of the complexity of actors, and ways of knowing beyond scientific knowledge, that are involved in producing policy-relevant knowledge for sustainability. Decision-makers now have the challenging task of understanding which actors are producing relevant knowledge for sustainability, based on what knowledge systems (e.g., data, models, knowledge networks, tacit or experiential knowledge), and whose knowledge or expertise should count in decision-making.

Knowledge-action systems define this complex network of actors, their visions of the future, and the knowledge systems underlying the production of knowledge to advance specific policies, decisions, and actions related to sustainability. The KASA includes a combination of surveys and analytical tools from social network and governance approaches into an interdisciplinary methodology that stakeholders and decision-makers can use as part of their tool-kit in understanding, designing, and implementing successful knowledge-action systems. This presentation draws on work in San Juan, Puerto Rico that implements the KASA tool for urban land use sustainability to illustrate the process of analyzing knowledge-action systems and their value in addressing challenges and opportunities for linking science and practice. The presentation includes a discussion of the value of KASA to address multiple dimensions of sustainability, including urban ecosystem services decision-making.

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COASTAL COMMUNITY PLANNING – CHALLENGES AND OPPORTUNITIES

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Coastal communities are facing challenges due to climate change and are evaluating numerous opportunities to create regional solutions. In many cases they are evaluating vulnerable coastal areas that are include issues dealing with water supply, energy infrastructure and evacuation routes increasingly vulnerable to rising sea levels, storm surge , inland flooding , erosion and other climate – related changes. Nationally important assets such as ports, soci0-economic disparities for some coastal communities and the exposure of valuable coastal ecosystems all need to be addressed. Leaders and residents of coastal regions are increasingly aware of the high vulnerability of coasts to climate change and are developing plans to prepare for potential impacts on citizens businesses, and environmental assets. The Southeast Florida Regional Climate Change Compact is a joint commitment among Monroe, Miami-Dade, Broward and Palm Beach Counties to partner in adaptation to climate change. Through collaboration of county, state, and federal agencies, a comprehensive plan was developed that includes hundreds of specific actions.

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AN ASSESSMENT OF EXISTING TOOLS FOR ADDRESSING ECOSYSTEM GOODS AND SERVICES IN THE CONTEXT OF CORPS PLANNING

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The Corps of Engineers is exploring the potential for using Ecosystem Goods and Services (EGS) assessment to illustrate the value of Corps Civil Works projects, particularly restoration projects, in ways that are more meaningful to the public than the habitat metrics currently employed. Part of this research investigated EGS assessment tools that were previously developed by universities, public, or private entities, in order to assess the utility and sufficiency of these tools in evaluating EGS in Corps projects. Seventy-three assessment tools, models, and data sets were screened using criteria derived from Corps needs and interests: relevance, transparency, transferability, sensitivity, and scientific and technical quality.

Twenty-three tools were found to meet the screening criteria and to provide metrics for which the Corps did not already have approved tools. These tools were compiled into a searchable catalogue available to any Corps planner. The catalogue provides key information on each tool, including technical specifications, ecosystems addressed, EGS addressed, costs, training, data requirements, inputs and outputs, and where the tool output would fit into the overall Corps EGS Assessment Framework, which is in development. Reports can be generated based on queries.

A synthetic analysis of the readily available tools indicates that few address all EGS of potential Corps interest. In addition, many employ methods that are inconsistent with Corps economics and planning guidelines, and therefore inappropriate for use in Corps projects. However, many tools address specific EGS or specific steps of an EGS assessment (i.e., ecosystem production functions) and could be used in combination with a Framework to address a wider suite of benefits than is typically addressed during alternatives analysis. In addition, our research identified key areas of need that are not met by existing tools, thus informing future tool-development and research projects.

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LAND-USE AND CLIMATE CHANGE IMPACTS ON ECOSYSTEM SERVICES IN THE NORTHERN GREAT PLAINS, USA

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The intermixed grassland and wetland ecosystems of the northern Great Plains perform a suite of services of value to society. However, land-use change associated with agricultural crop production coupled with a variable and rapidly changing climate has had a marked influence on the region's ecosystems and their ability to continue providing valued services. We used the Integrated Valuation of Ecosystem Services and Tradeoffs model (InVEST) to explore how recent (2007-2012) conversion of large tracts of conservation grasslands to croplands (primarily for corn and soybean production) have impacted the provisioning of key ecosystem services within the Prairie Pothole Region (PPR) of the northern Great Plains. The Prairie Pothole Region is a geologically young, glacially formed landscape that covers approximately 700,000 km^2 of the northern Great Plains on the North American continent. Due to the habitat provided by a dense intermixing of grassland and wetland habitats, the PPR is especially well known for its value in maintaining continental populations of waterfowl.

From 2007 to 2012, approximately 1.2 million ha (35%) of conservation grasslands (i.e., former croplands that were returned to permanent cover for conservation purposes) within the United States portion of the PPR were returned to crop production. When grasslands are lost from the landscape, not only are the services provided directly by those grassland ecosystems lost, but also the services provided by embedded wetland ecosystems are markedly altered. Our InVEST modeling results revealed that over the six year period from 2007 to 2012, high quality wetland and grassland amphibian habitat across the PPR was reduced by 22%, from 3.8 million ha in 2007 to 2.9 million ha in 2012. The floristic quality of wetland plant communities was also significantly degraded due to the loss of grassland buffers surrounding wetlands. Carbon sequestration services were markedly reduced within both grassland and wetland ecosystems resulting in increased societal costs as a consequence of CO_2 emissions from ecosystems that previously functioned as carbon sinks. Further, the functional lifespan and therefore ability of PPR wetland ecosystems to provide other services valued by society was greatly reduced through increased sedimentation rates resulting from the loss of permanent cover on sloping uplands surrounding most PPR wetland basins. Model simulation runs using various future scenarios of continued conservation grasslands loss in the PPR of the northern Great Plains quantified the potential for additional losses of valued ecosystem services and the resulting societal costs.

Climate variation affected the year-by-year provisioning of services. Several wet years during our study period lessened the impact of grassland losses on amphibian habitat quality, but those losses quickly returned during subsequent years of more normal precipitation patterns. While our modeling effort revealed that changes in climate have the potential to positively influence the provisioning of some ecosystem services, others will undoubtedly be negatively affected. What we can be sure of is that all will change in some way if future climate change projections are realized. Modeling ecosystem services using tools such as InVEST allows for evaluations of tradeoffs and the making of more informed decisions when faced with the uncertainties of change.

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ADDRESSING THE IMPACTS OF CLIMATE CHANGE ON ECOSYSTEM BENEFITS IN A MANAGEMENT CONTEXT

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Multiple agencies and organizations in southwestern Oregon have made significant progress in collaborative restoration of forest landscapes and in projecting climate change effects and adaptation responses. Climate change threatens the Rogue Basin with increased severity and frequency of wildfires, decreased snowpack and earlier snowmelt affecting water quality and quantity, floods and drought, and increasing stream temperatures. These concerns compelled the Southern Oregon Forest Restoration Collaborative (SOFRC) to partner with the Rogue River Siskiyou Forest Service (RRSFS) to create a climate adaptation plan through Model Forest Policy Program's Climate Solutions University: Forest & Water Strategies to increase local resilience to climate change. One of the primary goals that emerged from this plan is to use an ecosystem services approach to incorporate values into planning outcomes and provide an economic rationale for restoration/resilience focused management.

Successful partnerships can make the difference in plans getting implemented and those that sit on the shelf. Organizations working together achieve greater buy-in, create momentum, and expand the resources available to address challenges. The RRSFS partook in the plan development to help meet the FS climate scorecard requirements. As we continue to take steps to implement components of the plan, we build upon the science-management partnership developed by SOFRC. The project involves the following federal and non-governmental organizations: U.S. Forest Service, Bureau of Land Management, The Nature Conservancy, Institute for Natural Resources, Lomakatsi Restoration Project, and others. This diversity is possible because the SOFRC has created an environment in which these organizations are already working together. The disciplinary expertise of participants includes ecology, forestry, hydrology, wildlife biology, social science, and planning. By bringing together diverse participants to review the climate plan and other assessments in the region, we improve understanding of the potential effects of climate change on ecosystem services in the Rogue Basin, and evaluate proposed restoration activities in the context of climatic stressors and ecosystem services.

Collaboration across ownerships and mainstreaming of climate-smart management as part of agency operations will increase implementation of restoration projects, especially in critical locations of the Basin. Incorporating ecosystem services into the management process will help to identify and prioritize areas to manage, gain public support, and explicitly link climate change impacts on ecosystem services and how to manage for optimal resilience and adaptive capacity to changes in the climate. In order to build resilience, we must perceive projects through the lens of ecosystem services. A shared vision for creating resilient landscapes exists throughout the Rogue Basin. Through coordination of multiple efforts across different land ownerships, we will (1) implement "shovel-ready" restoration projects using climate-smart management practices, (2) prioritize additional proposed restoration projects informed by a recent climate change assessment and ecosystem services assessment, and (3) mainstream climate-smart thinking and ecosystem services in federal planning efforts. These activities will poise southwestern Oregon to be resilient and adaptive to future climatic variability and change.

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SCHOOL GARDENS + CHILDREN'S PHYSICAL ACTIVITY: AMONG THE MECHANISMS LINKING GREEN SPACE TO HEALTH?

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Purpose. This study examines a relatively under-appreciated ecosystem service of school gardens: the promotion of children's physical activity. The specific aims of this study are to examine:

- the effects of school gardens on physical activity levels during the school day
- the effects of school gardens on children's general activity and sedentary behavior patterns
- among children in the intervention group, differences in activity and movement patterns during an outdoor, garden-based lesson compared to an indoor, classroom lesson.

Scope. Twenty-one classes, comprised of 234 children at 12 low-income New York State schools participated in this study.

Methods. This 2-year randomized controlled trial examined the effects of a school garden intervention on elementary school children's physical activity. Schools were randomly assigned to receive school gardens or to serve as wait-list control schools that received gardens at the end of the data collection period. Physical activity was operationalized with three measures. Actigraph GT3X+ accelerometers worn during the school day for three days at each of four waves of data collection indicated children's levels of vigorous, moderate, and light physical activity as well as sedentary activity. Lux measures from the accelerometers provided a measure of children's time spent outdoors. The GEMS Activity Questionnaire (GAQ) (Treuth et al., 2003) documented changes in overall physical activity behaviors over the 2-year period. The PARAGON direct observation measure (Myers & Wells, in press) was used to characterize the postures and movement associated with indoor versus outdoor learning.

Results. Accelerometry results indicate the intervention group increased proportion of time spent in moderate physical activity (MPA) compared to pre-garden baseline and to the non-garden control group. Results from the GAQ survey suggest that over time, children in the garden intervention were less sedentary in their overall activities than the control group children. Lastly, direct observation data suggest that while participating in a garden-based outdoor lesson, children engage in less sitting and in more walking and standing than while participating in an indoor lesson in the classroom.

Conclusions. Physical activity is among the mechanisms linking green space and health. School gardens appear to be a potent intervention to increase children's physical activity and may also contribute to reduction of overall sedentary activities. Lessons delivered in the garden are associated with more movement than are indoor lessons.

Recommendations. School gardens should be included in our toolkit of intervention strategies to employ green space to promote health.

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CAN WE MEASURE PUBLIC VALUES FOR PROTECTING ECOSYSTEM SERVICES? : A CASE STUDY OF PRESERVING MIGRATORY BIRD HABITAT

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The goal of the US EPA's classification system for final ecosystem goods and services (FEGS-CS) is to "Identify, measure, and quantify FEGS in a scientific, rigorous, and systematic way that can be aggregated from local to regional and national scales." Under the existing framework, the general public, or people who do not directly "consume, use or enjoy" ecosystem services are included as having measurable value for them. The techniques used to measure public values remain controversial at best and subject to a great deal of controversy. This is largely due to the fact that the values are derived from people's responses to survey questions based on hypothetical scenarios. Therefore, it is important to explore the extent to which the public can provide meaningful responses to hypothetical scenarios "in a scientific, rigorous, and systematic way that can be aggregated from local to regional and national scales."

Our research is motivated by the results of a contingent valuation (CV) survey pretest. The CV was intended to determine the public value of protecting migratory bird habitat. In our pre-test, we found that a large percentage of respondents (nearly 30%) were voting yes to the highest bid amount offered in the survey ($300). The bid here was a hypothetical tax that a household would have to pay if a protection plan were to pass. We launched two subsequent pre-tests using $500 and $1000 as the highest bids and found the same result. Given the size of these bid amounts and the consistent willingness of a third of the respondents to vote "yes," the results seemed to suggest the presence of hypothetical bias rather than true resource value.

To further investigate this phenomenon, we purposefully sought to drive people to vote against the protection plan by offering high, what seem like impossibly high, bid levels to find the dollar amount to which no one would vote yes. We do this using an internet-based survey and follow the standard protocol for state-of-the-art CV studies. Our result seems to defy credibility insofar as many people vote "yes" to seemingly any bid amount offered regardless of how high.

We also find that willingness to pay is quite sensitive to the highest bid offered - so much so that choice of highest bid nearly dictates outcomes. We suggest this as a manifestation of hypothetical bias - the tendency of people to report a value other than their true value due to the hypothetical nature of a survey. Our findings indicate that including public values in the FEGS-CS could significantly overstate the true value of the resource in question.

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CONFLICTS, COMPATIBILITIES, AND COHERENCIES BETWEEN NATURAL SCIENCE AND PAYMENT FOR ECOSYSTEM SERVICES

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Ecosystem services, the benefits people derive from nature, are critical to human well-being, but environmental degradation has led to dramatic declines in the majority of services nature provides. Such degradation is often prevalent in rural areas of developing countries where few economic alternatives to traditional development often lead to the kind of unsustainable use of natural resources that degrades ecosystems and the services they provide. Payments for Ecosystem Services (PES), however, represent a rapidly growing mechanism for conservation and sustainable development that provides economic incentives to secure ecosystem services. Because PES has extraordinary potential to limit or even reverse environmental degradation, PES projects have sprung up around the world and are fast becoming a dominant mechanism for bringing ecosystem services into local and international markets. PES is also becoming the foundation of major international environmental agreements such as the Convention on Biological Diversity 2020 Targets and the Intergovernmental Panel on Biodiversity and Ecosystem Services.

The rapid rise of PES, however, is marked by enormous heterogeneity among programs in their scientific foundations which threatens the durability, effectiveness, and success of many projects.

A broad, coordinated, participatory effort aimed at deriving science-based standards for PES projects can help resolve these issues and bring the needed coherency among PES projects, but conflicts between natural and social science principles and incompatibilities between managing ecosystems for conservation and ecosystem services need to be resolved. We consider three examples and provide some recommendations for moving forward. The first example is that meeting science standards can be costly which can generate conflicts between both buyers and sellers of ecosystem services. A second example is the incompatibility of management strategies required for biodiversity conservation at local versus regional or global scales. A third example is the inequality and inequity inherent in ecological processes (most species live in the margins) that are anathema to PES projects designed to reduce poverty, improve livelihoods, and redress income inequality.

Fortunately, these issues are readily addressed, but need to be part of the process of establishing science standards.

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EPA'S ENVIROATLAS AS A RESOURCE FOR NATIONWIDE ECOSYSTEM SERVICES ASSESSMENTS

Anne Neale

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EnviroAtlas is a collection of interactive tools and resources that allows users to explore many of the benefits people receive from nature. This collaborative project was developed by the Environmental Protection Agency in cooperation with the US Geological Survey, the US Department of Agriculture's Natural Resources Conservation Service and Forest Service, and Landscope America. EnviroAtlas seeks to measure and communicate the type, quality, and extent of the goods and services that humans receive from nature so that their true value can be considered in decision-making processes. Much of the data in EnviroAtlas illustrates ecosystem services, the populations who benefit from these services, and the factors that may stress or influence an ecosystem's ability to provide these benefits. Users of this resource can access, view, and analyze diverse information to better understand how various decisions can affect an array of ecological and human health outcomes. This presentation will review how EnviroAtlas can support ecosystem services assessments, including an overview of the data available and an introduction to some of the new methods being tested to develop data layers relevant to nationwide applications.

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RAPID ASSESSMENT OF ECOSYSTEM SERVICES FOR SITE PRIORITIZATION

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Purpose: Global and national conservation goals increasingly include socioeconomic benefits from ecosystems (ecosystem services). There has been an explosion of literature on incorporating the value of ecosystem services (ES) into decision making processes. Such processes tend to be rapid and have limited funding, however. This poses a challenge to ES assessment: provide information that is spatially explicit and rigorous enough to support a given decision making process, but that does not require extensive resources, time, or primary data collection, and is at a spatial scale that is relevant to the decision being made. *Scope and Methods:* We conducted a rapid (six-month), spatially explicit, national-scale ES assessment in Madagascar, to inform site prioritization for conservation investment. Information on ecosystem services were needed to inform the next generation of investments by one of the largest global conservation funds, the Critical Ecosystem Partnership Fund, and the spatial priorities of a major international conservation organization, Conservation International. Our analysis relied only on existing global and national datasets, limited desktop analyses, and brief expert consultation (two half-day workshops). We used a combination of biophysical and socioeconomic data and spatial modeling to map important areas for provisioning services (hunting, non-timber forest products, fisheries, and water for domestic use and irrigation), regulating services (carbon storage, avoided emissions from deforestation, protection from coastal storm surge, water quality, and inland flood regulation), and cultural services (ecotourism). *Results*: Our analysis demonstrated that virtually all remaining natural ecosystems provide important ES in Madagascar. The humid dense forests of the eastern highlands are important for climate mitigation, flood control, and provision of fresh water for domestic use, irrigation, and generation of hydropower. Dry forests regulate water flows and improve water quality for domestic use and irrigation in the arid north and southwest of the country. Coastal and marine ecosystems provide fish for both commercial and small-scale fisheries. Virtually all terrestrial and marine ecosystems provide important services to households that are food insecure, including hunting, fishing, and fuel wood collection. *Conclusions*: While this approach to ES assessment is limited when compared to sophisticated, data-intensive modeling and field-based data collection, it provides a useful, rapid, policy-relevant approach that can be applied at any scale, anywhere in the world. *Recommendations*: We recommend additional testing and refinement of low-cost methods for assessing ES in different regions, biomes, and at different spatial scales, to ensure that future ES assessments can keep pace with the speed of decision making.

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CONSIDERING ECOSYSTEM SERVICES AND ECONOMIC SUSTAINABILITY IN FOREST PLANNING: FEASIBLE OPTIONS

Chris Miller and ***Kawa Ng***
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This presentation discusses the application of ecosystem service and sustainability concepts to forest plan revisions under the 2012 National Forest Land Management Planning Rule. The 2012 rule seeks to ensure that ecosystem services are not overlooked by requiring forest plans to include components, such as desired conditions, that provide for ecosystem services and guide contributions to social and economic sustainability. It is expected that as part of the plan revision process, social, cultural, and economic impacts, including the provision of ecosystem services and contributions to social and economic sustainability, will be evaluated. Different approaches for evaluating the array of market and non-market impacts and benefits associated with ecosystem services include focusing on 'final ecosystem goods and services' (FEGS), adopting a range of qualitative, quantitative, and monetary indicators, and integrating ecosystem services into measures of social and economic sustainability. This presentation discusses evolving processes for evaluating and documenting ecosystem service benefits and tradeoffs in the context of social and economic sustainability, and the feasibility of using those processes based on recent forest planning assessments.

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OPTIMIZATION OF ECOSYSTEM SERVICES FOR LAND MANAGEMENT AND RESOURCE ALLOCATION IN AGROECOSYSTEMS

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Agricultural systems are important for the provisioning of many ecosystem services (ESs), however, long-term ecosystem health and the ability to sustain food production are often ignored under current management practices. Life cycle assessments (LCAs) have been widely used to evaluate environmental impacts of agro-products along their supply chains. Nevertheless, LCAs are insufficient to assess the total sustainability of agro-ecosystem production due to the lack of a systematic consideration of ecological aspects. This paper integrates the concept of ES into LCAs to support multi-level decision making in land use, land management, and resource distribution. We accomplish this by combining DAYCENT, a biogeochemical model, with GMOS/NetSim, a network optimization tool, using these tools to evaluate the sustainability of different land management practice scenarios. Our methodology is illustrated with a case study on a spatially-explicit corn agro-ecosystem in Fort Collins, Colorado. It is possible to assess and optimize for all combinations of detailed management practices (fertilization, irrigation, biomass removal, etc.) and distribution of ESs under well-defined management objectives. The trade-offs between different spatial and temporal scales, ESs, and beneficiaries are also discussed. This powerful tool can be used in a wide range of agroecosystems allowing the quantification of ecosystem functions and services, their ecological and economic values, and the stakeholders/beneficiaries that would be important in implementing these changes.

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THE INFLUENCE OF SENSE OF PLACE ON THE WILLINGNESS TO PAY FOR ECOSYSTEM SERVICES

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Sense of place refers to the symbolic meanings and values people associate with specific locations or broad landscapes. The purpose of this presentation is to demonstrate to the influence of sense of place on the willingness to pay for the ecosystem services. We use a developing payment for ecosystem services (PES) program in Oregon's (USA) McKenzie River watershed as a case study to establish the link between one's psychological connection to a place and their willingness to pay for ecosystem services in that place. We report on both the current status of the Eugene Water and Electric Board's (EWEB) Voluntary Incentives Program and the results of a mail and internet-based questionnaire of EWEB water customers (n=421). The results establish that the emotional, cognitive, and behavioral connection between EWEB water ratepayers and their drinking water source watershed influences both the likelihood they are willing to pay, and the dollar amount they are willing to pay, for a program designed to benefit drinking water quality and other secondary ecological objectives. Regression results suggest that EWEB ratepayers' sense of place for the McKenzie River watershed exert an influence that is nearly equal in magnitude, but in the oppositie direction, to their political ideology, indicating that ideological opposition to PES programs may be overcome by appealing to a target population's emotional, cognitive, or behavioral connections to the landscape. Connecting conservation actions to specific landscapes that are meaningful to people may increase political and financial support for these efforts. Further, appealing to and enhancing people's sense of place may result in an increase in resources available for PES and other conservation programs. Although program managers have little or no influence over other significant predictors of willingness to pay, such as political ideology, gender, and income, we suggest that program managers may be able to influence prospective ecosystem service buyers' connections to certain places. Targeted marketing, education and outreach, and experiential outings may all increase support for place-based conservation of ecosystem services.

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OVERVIEW: ECOSYSTEM SERVICES IDENTIFICATION & INVENTORY (ESII) TOOL

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The Collaboration between The Dow Chemical Company (Dow) and The Nature Conservancy (TNC), in its mission to bring the value of nature into business decisions and strategies, added a new project in 2013. The Ecosystem Services Identification & Inventory (ESII) tool will assist Dow and other corporations in modelling the production of ecosystem services in units of measure and increase understanding of business and community value from nature on and adjacent to their sites. EcoMetrix Solutions Group (ESG) is supporting the Collaboration effort, bringing tool-building experience and additional capabilities for identifying and quantifying ecosystem services.

The vision for the ESII tool is to develop software for a mobile device that will enable a non-ecologist technician at a site to collect relatively simple ecological data for subsequent modeling of the complex production of ecosystem services. The ESII tool, 1) identifies and measures the ecological attributes and models ecological functions and ecosystem services at a business site, 2) translates the production of services into initial estimates of financial value to the business by providing data in units of measure that engineers and finance staff can apply to their existing financial models, and 3) supports estimates (external to the tool) of economic benefits to the surrounding community. The tool initially covers eight priority ecosystem services: air quality control, climate regulation, erosion control, flood hazard mitigation, water provisioning, water quality control, water quantity control, and aesthetics.

Pilot site testing took place at several Dow facilities in 2013, with beta testing beginning in 2014. The ESII tool has demonstrated the capability to provide screening-level assessments of ecosystem services. The fully developed ESII tool will provide Dow staff with a greater awareness and understanding of the benefits that Dow receives from nature. It will help inform decisions regarding changes in land use, plant expansion or site alterations, land conservation efforts or property disposition, community engagement initiatives, and contribute to future sustainability goals.

This overview session will outline the current state and development roadmap for the ESII tool. The team will also present related sessions on the development and the underpinnings of the ESII tool, including, *The Anatomy of the ESII Tool – A System Designed to Measure Ecosystem Service Production and Benefit Flows for Corporate Engineering* (Kevin Halsey[3]), *Supporting Business To Value Nature At and Around a Site* (Sheila Reddy[1]), *Aligning Acceptable Amounts of Uncertainty with Specific Types of Decisions* (Elizabeth Uhlhorn[2]) and *Establishing the Value of Nature: How "Voice of the Customer" Informed the ESII Tool*, (Elizabeth Uhlhorn[2]).

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RECOVERY POTENTIAL SCREENING: A COMPARATIVE WATERSHED ASSESSMENT TOOL

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The U.S. Environmental Protection Agency (EPA) developed Recovery Potential Screening (RPS) to enable states and other restoration planners to systematically compare relative differences in the restorability of watersheds as a strategic planning and prioritizing technique. The RPS approach measures restoration-relevant indicators from readily-available GIS data and other geo-referenced monitoring information, and uses these metrics to compile ecological, stressor and social indices on individual watersheds or hydrologic units (e.g., HUC12s), from a perspective that emphasizes watershed ecosystem structure and natural processes. Originally developed to support the prioritization of restoration projects as part of the Clean Water Act Total Maximum Daily Load (TMDL) and impaired waters listing programs, the tool may also be applied to support a variety of other programs including nonpoint source control, healthy watersheds protection planning, and fisheries management.

The main RPS tool is a custom-coded spreadsheet that allows users with basic spreadsheet skills to select and weight metrics most relevant to their assessment purpose (e.g., where best to implement nutrient runoff controls, or protect specific ecological services). The tool then auto-calculates indices of ecological capacity, stressor exposure, and social context, and an integrated overall score. These four indices and their component indicators provide a basis for the user to compare relative differences among watersheds within a larger geographic unit (e.g., HUC8, ecoregion, state). In addition to compiling index scores, the RPS tool rank-orders watersheds by each of the four indices, and provides user-customizable bubble plotting and mapping options within the same spreadsheet file for visualizing and using the screening results. As of mid-2014, RPS statewide projects have been completed in 11 states and are underway or requested in over twice that many more. State-specific RPS tools for the lower 48 states were completed in 2014 based on the HUC12 scale, and an online library of ecological, stressor and social indicators along with an online version of the RPS tool (Watershed Index Online) are being deployed to support user-definable project areas and provide the most commonly used indicator data.

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VALUING URBAN FOREST ECOSYSTEMS: A SNEAK PEAK AT i-TREE LANDSCAPE

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Trees in cities ("urban forests") provide numerous benefits or ecosystem services (and costs) to city residents. Proper vegetation management and designs can enhance these services and values to society while minimizing costs. i-Tree, a free suite of tools (www.itreetools.org), was developed to improve the management of urban forests by multiple land owners. These tools aid in assessing local tree populations and their associated ecosystem services and values. The purpose of this presentation is to overview: a) urban forests nationally and their ecosystem services and values, and b) the i-Tree modeling suite, particularly a new tool within the suite: i-Tree Landscape.

State urban tree cover data have been combined with field data from numerous cities and local environmental data to estimate urban forest ecosystem services and values nationally. These data reveal how urban forests vary across the nation and produce billions of dollars of benefits annually. However, to aid local management decisions, local data are required. The i-Tree modeling suite combines local tree data with local environmental data to assess tree and forest ecosystem services and values. Services and value estimates include air pollution removal and associated health impacts, carbon storage and sequestration, effects on building energy use and effects on runoff and water quality. The i-Tree software suite is developed through a consortium of partners including: USDA Forest Service, Davey Tree Expert Company, National Arbor Day Foundation, Society of Municipal Arborists, International Society of Arboriculture, Casey Trees, and SUNY College of Environmental Science and Forestry.

A new model in development, i-Tree Landscape, combines tree cover maps with i-Tree field data and human population data to help map ecosystem services and determine the best locations to plant or protect urban forests to optimize services for city residents. By understanding the best locations and species to provide various ecosystem services, and current threats to urban forests, managers can better design and plan for sustaining urban forests to improve human health and environmental quality in cities. Gathering local urban forest data is the first step to understanding these ecosystem services and toward developing better management plans to sustain these services for current and future generations.

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LINKING SPECIES-, SITE-, AND LANDSCAPE-LEVEL INFORMATION IN SAGE-GROUSE MITIGATION

Sara O'Brien
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A rigorous, quantitative, landscape-scale approach to mitigation can be an important tool in moving imperiled species toward recovery. In Oregon, efforts to build a mitigation approach for the greater sage-grouse have highlighted the need to explicitly link species-level science with landscape-scale habitat prioritization and policy tools for addressing cumulative impacts. The state's approach uses state and transition models of sage grouse habitat and a multi-faceted policy framework to achieve those goals.

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IDENTIFYING MODELING GAPS AND BUILDING BETTER TOOLS THROUGH PARTNERSHIPS

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In a recent report academic and federal agency experts worked together to identify ways to refine models for quantifying potential water quality benefits associated with improved animal management for use in water quality trading. The study provides an overview of models used to estimate various aspects of animal management-water quality relationships, describes how direct measurement and monitoring of nutrient losses is evolving and how it can improve modeling and recommends approaches to update and improve existing models and tools. While there is definitely room for improvement in modeling and quantification, water quality trading programs can and do continue to develop by incorporating their level of uncertainty in water quality benefits in the program design.

This presentation will review the gaps and limitations identified in current models and tools, highlights opportunities for using new monitoring technologies to improve quantification of water quality changes. Monitoring can provide data to improve nutrient modeling efforts, measure cumulative changes in water bodies, and potentially even quantify edge-of-field losses. The presentation will also discuss the uncertainties in groundwater and emissions modeling, presenting the idea that such models be used primarily to indicate potential risks and areas for additional assessment when designing programs or projects.

Creating robust tools to quantify ecosystem services may best be accomplished by collaboration across public and private entities to develop methods, assess models, and verify results. Collaborations would ideally include academic and agency experts as well as practitioners and state officials who are working on the ground to implement water quality trading programs. Such collaborative efforts can share resources and expertise to improve model accuracy and usefulness.

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MANAGING RISKS AND LIABILITIES IN ENVIRONMENTAL MARKETS IN THE US

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Across the United States established environmental markets like wetland mitigation and species banking, and emerging markets like carbon offsets and water quality trading, are finding different ways to address the various risks and liabilities inherent in the human and natural systems that underlie them. Concern over various risks and liabilities can restrict participation in existing markets and may limit the development of new markets. This raises the question of whether insurance or other financial mechanisms could be applied to help reduce these concerns and facilitate market participation and development.

This work reviews and compares the risks associated with the different environmental markets in the US, exploring how they are different or similar and how the liability for these risks is currently being addressed. Risks include under performance, natural disturbances like fires or floods, and failures in design or management of a project or activities being credited in one of these markets. Liabilities for these risks vary in whether they are explicitly covered, whether the buyer, seller or program is held liable, how the risks or tracked, how compliance is handled (required replacement of credits, payment of a fine, etc…), and how enforcement is addressed. Sometimes liability is addressed in the design of these market programs, other times liability is addressed in the specific contracts between buyers and sellers.

Given the benefits and limitations of each of these approaches for addressing liability, in some cases additional insurance or financial mechanisms might help to reduce barriers coming from risks that are difficult to address in individual contracts or in programmatic design, but might be well suited to external mechanisms for pooling risk.

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USING MODELING APPROACHES TO UNDERSTAND AND RESPOND TO LAND-BASED SOURCE POLLUTION IMPACTS ON CORAL REEF ECOSYSTEM SERVICES

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In Hawaii, coral reefs provide important benefits to society, including shoreline protection, recreational opportunities, food, income, and places for cultural practices, but those ecosystems are under threat from growing anthropogenic stressors, including overfishing, land-based pollution, and climate change. In response to those stressors and in order to restore reef health and their services, the West Maui Ridge-2-Reef initiative is managing watersheds to minimize land-based source pollution.

To support these efforts, we are developing an ecosystem services trade-off decision support tool that is appropriate for island systems. The tool uses the best available quantitative methods to quantify, map, and value changes in ecosystem services from mountain to reef under alternative policy and climate change scenarios. The tool will estimate impacts on sediment and nutrient loads of specific management actions, and translate those into changes in reef services supply. This presentation will summarize our lab's efforts to-date in building, adapting, and linking appropriate models to estimate (i) how land use, land cover change, and management practices will impact water, sediment, and nutrient runoff into coastal waters; and (ii) how changes in these stressors will impact the delivery of coral reef ecosystem services. We will also discuss efforts to develop valuation methods to assess the consequences for human well-being of ecosystem service changes.

Gaining an understanding of the impacts of land management on ecosystem service delivery will promote a shift towards an ecosystem-based management approach, and improve the social outcomes of management. There is a paucity of decision-support tools, however, to support this type of management approach.

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ASSESSING REGIONAL SOIL ORGANIC CARBON STOCKS FROM TOPSOIL MEASUREMENTS USING HISTORICAL PROFILE DATA AND A DEPTH EXTRAPOLATION MODEL

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Ecosystems contribute to the regulation of the global climate through soil organic carbon (SOC) storage and sequestration. To assess the magnitude of this ecosystem service, most studies focus on organic carbon stored in the topsoil (upper 15/30 cm). However an equal amount of the total SOC-stock is estimated to be stored in the 30-100 cm depth layer. The aim of this research is to estimate SOC-stocks and fluxes in the upper 100 cm of agricultural soils in Flanders, Belgium. It is hypothesized that these stocks changed in the period 1960-2010, through altered land use distribution, different land management practices regarding the tillage depth and the input of manure and overall milder winters and higher minimum daily temperatures.

An extensive historical soil dataset is available for the region of Flanders in Belgium (13,512 km²). The Aardewerk-Vlaanderen-2010 database comprises the location and descriptive data (e.g. land cover) of 7,020 soil profiles and descriptive and analytical data (e.g. horizon depth and %OC) of 42,529 associated horizons, sampled between 1947 and 1974. In order to assess the historical stock, each soil map unit (SMU) was associated with at least one profile, using a multi-level, both spatial and semantic, generalization approach. This method allows to preserve the highest possible spatial and semantic detail by working with detailed SMUs in regions where sufficient data is available and with generalized units elsewhere. More recent %OC data of agricultural soils (2008-2010) are only available for the topsoil: 0-23 cm for cropland and 0-6 cm for grassland. Based on the exponential SOC depth distribution model of Hilinski (2001) we estimated the SOC-stock of the upper 100 cm stored in agricultural soils in Flanders. Hereby we assumed that the %OC at the profile base (100 cm) remained the same between the period 1947-1974 and 2008-2010. The k-parameter of Hilinski's model was calibrated on the historical dataset. To cope with an overestimation of stocks, the model was applied to the changes between the historical and the recent %OC of the horizons in the profile.

Ecosystem service research benefits from SOC-assessments extended to the upper 100 cm. Comparing the estimated stocks (i) quantifies the changes over a 50-year period resulting from land use and management change under the observed climate trends and (ii) confirms the usability of Hilinski's model, when applied to relative rather than absolute SOC-data.

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PERCEPTION OF URBAN RESIDENTS' TO BENEFITS AND PROBLEMS ASSOCIATED WITH URBAN TREES IN SELECTED CITIES OF ONDO STATE, NIGERIA

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Perception of the residents of three urban cities in Ondo State, Nigeria was surveyed about the benefits and problems of trees in urban areas. The data were collected using semi-structured questionnaire and key informant interview. The results revealed that, social, environmental and economic benefits of trees were highly rated. The ability of trees to shade, serve as windbreak and cool surroundings was the highest-ranked benefit. About 90 percent of the respondents strongly agreed that trees were important to their quality of life; there were variations in responses across the urban cities and socio-economic characteristics of the respondents. Only 43 percent of the respondents were interested in planting trees in their compound. Meanwhile, a higher percentage (57%) indicated interest in tree planting if the seedlings will be given out to them at no cost. The preferred major tree species that respondents are interested in were *Citrus spp*. (Orange), *Anarcadium occidentalis* (Cashew), *Terminalia cattapa* (Almond) and *Tectona grandis* (Teak). The study also indicated that limitation of land, lack of awareness, fund, and grazing by animals were the major constraints for urban forestry development in the cities. The greenery in the surrounding was decreasing due to unplanned urbanization. The present study recommends that government should take immediate steps to facilitate urban forestry programs in urban infrastructural development.

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INSURANCE & CLIMATE CHANGE: RISKS, OPPORTUNITIES AND THE USNCA3

Lindene Patton
Risk Management Consultant; Frmr Chief Climate Product Officer Zurich Insurance

This presentation will discuss how climate change impacts affect the insurance industry; the risks and opportunities for the insurance industry in the face of climate change; and how the US NCA and research materials and data evaluated by the NCA3 are and can be applied to expand risk comprehension and management.

Climate change impacts insurance operations from underwriting, to risk engineering, claims, facilities management and investment management. Otherwise stated, climate change impacts affect both internal institutional risk management, as well as the exposures and risk management needs of customers. Impacts affect the exposures for insurance underwriting, individually and in the aggregate. Different lines of businesses and geographies are affected differently. Understanding of risks associated with the geography of the insured is no longer sufficient to quantify risks when events a world away can trigger interruptions to business, suppliers, investments and customer revenue.
Integrated models of exposure from disparate sources with temporal inconsistencies are essential to risk comprehension and profiling. Risk profiles may be adjusted in response to climate change. Needs for claims response may change in type and duration in the face of climate change. Accountabilities for loss and standards of care may change in the face of a greater understanding of climate change impacts.

NCA3 and associated and ongoing research provides a unique overview of climate change science and impacts relevant to risk assessment for US geographies. Decision support analysis tools which integrate data for economic impact analysis are of great import in both the insurance and community risk management practice.

Some of the climate change related risks and impacts may be insured, while many others are 'externalities' not considered within the insured risk profile but are important to impacted communities as uninsured risks which may affect the long term sustainability of the individuals or community.

Insurance can play an important role in climate change risk management, but it is just one part of the solution that emerges from proper application of decision support analysis tools.

The session should clarify the role of insurance and the NCA.

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BUILDING THE TOOLS TO LINK URBAN DEMAND FOR WATER QUALITY CREDITS WITH AGRICULTURAL SUPPLIERS

Susan Frick Payne
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Urban-based water quality trading adds a significant level of complexity to trading systems. To facilitate water quality trading between urban stormwater buyers and agricultural sellers of credits, it is necessary to translate on-the-ground conditions and best management practice (BMP) installations into nitrogen and phosphorus reductions and provide a central site where those with credit needs can be connected with those having credit generation capacity.

The Maryland Nutrient Trading Program is expanding its highly sophisticated trading platform to provide the capability to assess on and off-site needs for offsets required by state regulation and the Chesapeake Bay Total Maximum Daily Load (TMDL) to accommodate new growth and development. The current platform consists of a suite of tools for use by those interested in producing and selling nonpoint agricultural credit: a farm-scale assessment tool to determine baseline compliance, estimate nutrient loads and reductions, and calculate credits generated by agricultural BMPs; a registry to catalogue certified credits and completed trades; a marketplace to enable participants to post and track credits and manage individual accounts; an administrative module to assist in the supervision of the overall program and the generation of relevant data and reports, and an interactive mapping feature to delineate field boundaries and retrieve and forward allied information. A complementary site-specific assessment tool now under development will incorporate a variety of land uses and different baseline requirements (TMDL or other) and will be calibrated for urban stormwater BMPs and their approved load reduction efficiencies. In addition, each of the other modules will be modified to provide appropriate functionality for a range of users, including builders, jurisdictions, state entities, and the public. The new tool will provide a “one-stop shop” for trading between non-point sources in the state of Maryland and could serve as a prototype for other programs with similar needs.

Poster will have graphics and schematics depicting the functions, capabilities, and applications of the new expanded platform.

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A FRAMEWORK FOR DETERMINING CAUSES OF ECOSYSTEM SERVICE IMPAIRMENT AT CONTAMINATED SITES

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Expensive remediation and litigation decisions are often based on an assumption that a specific contaminant caused the impairment of services observed in an ecosystem. In order to ensure that remediation or management actions result in intended recovery of ecosystem services, it is essential that site investigations (e.g., ecological risk assessments (ERAs) and remedial investigations) establish cause-and-effect relationships between stressors and responses. A framework for assessing causality (http://www.federalcontaminatedsites.gc.ca/default.asp?lang=En&n=B15E990A-1.) was recently issued under Canada's Federal Contaminated Sites Action Plan (FCSAP). The objective of the framework is to provide guidance for evaluating causation – to help differentiate ecosystem service impairment due to chemical stressors from natural variability and from impairments due to other stressors, such as biological or physical stressors.

The FCSAP framework focuses on chemical and non-chemical stressors and methods for determining the causation of impairments to ecosystem services. The approach is scaled to the complexity and relatively small size of most FCSAP sites. It is based on the U.S. Environmental Protection Agency's Stressor Identification guidance and is consistent with practices recommended by Suter, Cormier and other leaders in the field. Modifications were made to previously published methods to more fully extend its use to terrestrial sites and to simplify the process so that it is better suited to the small sites that are prevalent under FCSAP. Causality assessment is comprised of four steps. Step 1 is to identify candidate causes of the impairment, often with the help of stakeholders and risk managers. Because causality assessments conducted under FCSAP are for contaminated sites, chemical exposure is always among the candidate causes. Additional candidate causes of ecosystem service impairments may include biological or physical stressors, such as invasive species, eutrophication, habitat destruction, and flooding. In Step 2, the risk assessor evaluates the sufficiency of the available data for confirming or refuting the roles of each candidate cause, and develops and implements a study plan to fill any data gaps. In Step 3, evidence across the full range of candidate causes is compared, data are analyzed, and information linking the biological impairment to the candidate causes is considered. In Step 4, a weight-of-evidence approach is used to evaluate the evidence that one or more of the candidate causes has indeed caused the observed ecosystem service impairment.

The guidance module and other sources offer case examples of the application of causality assessment. Even with the efforts made by FCSAP to streamline the approach, it is difficult and time consuming to fully implement causality assessment. Although causality assessment is not warranted at every site, there are cases where it is particularly valuable, such as in litigation that hinges on causality and aquatic sites where remediation for one stressor has the potential to exacerbate overall conditions or conditions specific to other possible causes of impairment. Thus, broader use and acceptance of systematic assessment of causality is encouraged.

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IPBES AND PAYMENTS FOR ECOSYSTEM SERVICES IMPACTED BY BIODIVERSITY CHANGE

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PES schemes offer incentives to landholders to adopt land management practices that generate public goods at various scales. Benefits range from localized water quality enhancement from the management of riparian zones or catchments to the mitigation of global climate change. At the global scale, the best-known example is the REDD+ scheme, but payments made by the Global Environment Facility to cover the incremental cost of national projects that generate global benefits can also be thought of as a form of PES scheme. In all cases there is a presumption that a change in land management generates offsite benefits that would be ignored by the landholder in the absence of payments. It follows that scientific understanding of the biophysical mechanisms involved, and the value of the offsite benefits are both critical to development of effective payment schemes.

The establishment of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) has the potential to inform PES schemes for the management of global biodiversity change at many scales. I consider how this might be done, and what implications it has for the design and implementation of assessments at diferente scales.

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ECONOMIC VALUE OF IMPLEMENTING THE CHESAPEAKE BAY CLEAN UP PLAN

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In response to continuing water quality issues in the Chesapeake Bay, the U.S. Environmental Protection Agency (EPA) in collaboration with the six watershed states and the District of Columbia, has finalized the Chesapeake Bay Total Maximum Daily Load (TMDL) for nitrogen, phosphorus and sediment and the jurisdiction-specific clean up plans to attain these limits. The present study evaluates the ecosystem service benefits that would accrue in the Chesapeake Watershed as a result of implementing these clean up plans.

We focus on the dollar value of eight ecosystem services originating, and largely enjoyed, in the Chesapeake Bay watershed region: food production (crops, livestock, and fish), climate stability, gas regulation, water supply, water regulation, waste treatment, aesthetics, and recreation. These were evaluated for baseline, TMDL, and business-as-usual (BAU) scenarios (future without TMDL implementation). Ecosystem service benefits accrue in the TMDL scenario in two complementary ways. First, land use shift from less to more ecosystem-service-productive uses. Second, land in any land use can become more productive as a result of management actions designed to reduce nutrient and sediment pollution.

We employed a four-step process to estimate these benefits: 1) Assign land and water in the Chesapeake Bay watershed to one of seven land uses (forest, wetlands, open water, urban open space, other urban land, agriculture, and other) based on EPA Chesapeake Bay Program data and remotely sensed land cover data. Land use was estimated for each of the three scenarios. 2) Adjust baseline (2009) health / productivity for land use based on a geospatially explicit index derived from pollution, population density and other indicators of human impacts on ecosystems. 3) Estimate changes from baseline ecosystem health for the TMDL and BAU scenarios, using projected changes in total suspended solids loads as a proxy for improvement/degradation for the non-tidal portion of the watershed. For the tidal portion, improvement in attainment of dissolved oxygen standards serves as the proxy. 4) Calculate the dollar value of eight ecosystem services in each scenario using the benefits transfer method with region-specific values drawn from thousands of possible source studies.

Detailed estimates by land use, state and ecosystem service will be publically released in the fall and presented at ACES, but in general, the majority of benefits involve the water supply, waste treatment, and aesthetic services. For land uses, forests, open water and agricultural lands supply the majority of these benefits. Relative to the size of the regional economy, the magnitude of these estimates compare with previous studies. And relative to the projected cost of TMDL implementation, these estimates suggest that complete implementation is a worthwhile financial investment.

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ECOSYSTEM SERVICES ASSESSMENT AND PRIORITIZATION: A TOOL FOR DECISION-MAKING IN THE REAL WORLD.

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If, as suggested at a previous ACES conference, ecosystem services is to be the way we transition from the Anthropocene to an ecozoic era, it will have to become much more accessible, user friendly, and (consequently) actionable for land management, economic and community development, and conservation advocacy organizations, and for the individual and collective stakeholders in improved relationships between human and natural systems. Ecosystem Services (ES) must overcome a) apprehension that ES is either too scientific or not scientific enough to be of much use; b) suspicion that ES is nothing more than the sheep's clothing to the wolves of the same unsustainable resource extraction that has made a mess of the Anthropocene in the first place; and c) simple bewilderment and confusion among the plethora of typographies, conceptual frameworks and evaluation / assessment methods available for making (some) sense of natural-to-human community relationships.

At the risk, perhaps, of adding to this third problem, Key-Log Economics and the Model Forest Policy Program have developed, tested and refined a simple but robust tool by which non-expert practitioners and stakeholders can use the ecosystem services framework. The tool entails assessing current ES production capacity of a defined geographic area, based on several ecosystem processes, and then evaluating the impact of a defined stressor (e.g., climate change) on that capacity. Next, users consider how those capacity changes would affect the output of various ecosystem benefits and the consequences for the welfare of the stakeholders in those benefits. By virtue of the tool's simple interface and graphical display of assessment results, users can quickly understand the process-benefit connections where action could most effectively be targeted. Combined with group and one-on-one coaching, the tool supports priority setting for actions ranging from further study, including monetary valuation, to informing land use and economic development planning, to the design and launch of payment-for-ecosystem-services programs.

Our experience to date indicates that not only does the tool and accompanying process help stakeholder groups make sense of the ecosystem services framework, it also helps them make sense of what might otherwise be a disjointed assessment of seemingly unconnected portions of the biophysical, social and economic landscape. We have found, moreover, that the approach retains enough of ES concept's richness and potential rigor without overwhelming lay users with unnecessary complexity.

In this presentation, we will introduce the tool and share results and lessons learned from its use in the context of climate adaptation planning by six test communities across the U.S. and perform a brief interactive demonstration using an issue of interest to the ACES audience.

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BLUE CARBON: A TRANSFORMATIONAL TOOL FOR MARINE MANAGEMENT AND CONSERVATION GLOBALLY

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Coastal "blue" carbon – carbon stored in the coastal ecosystems of mangroves, seagrasses and tidal marshes – has strong potential to transform management and conservation of coastal ecosystems. Coastal ecosystems are the fastest disappearing ecosystems on Earth - on average 2 % are lost every year - a result of poorly-managed development, clearing for aquaculture and pollution. Losing these ecosystems means losing the coastal protection and food security that they provide, services that are the foundation of resilience to climate change for the over 20 % of the world's population that live within 20 miles of a coast. In addition, current rates of degradation and loss of blue carbon ecosystems are resulting in globally significant emissions of carbon dioxide into the ocean and atmosphere and contributes to climate change.

Over the last decade, global recognition of the climate mitigation importance of forests and other terrestrial ecosystems has focused international policy and management on restoration and conservation of these ecosystems. Scientific understanding of carbon sequestration and storage in coastal ecosystems is now sufficient that similar approaches are rapidly developing for mangroves, salt marshes and seagrasses. A growing number of organizations are exploring mechanisms for implementing blue carbon-financed and motivated conservation activities. National governments and international bodies, such as the United Nation Framework Convention on Climate Change (UNFCCC), are considering how coastal ecosystems can and should be integrated into coastal and carbon policy and regulations.

Partnerships such as the Blue Carbon Initiative, convened by Conservation International (CI), the International Union for Conservation of Nature (IUCN), and the Intergovernmental Oceanic Commission (IOC) of UNESCO, are currently working to support and accelerate these efforts. Realizing the potential for blue carbon to moderate losses of coastal ecosystems, however, will require significant scientific focus on issues such as global assessments of carbon in these systems and development of remote sensing approaches for monitoring. In addition, significant education and capacity building is needed within the scientific, policy and coastal management communities globally. This will require broad investment – financial and programmatic - by NGOs, governments, private funders and multi-lateral donors.

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THE ROLE OF QUANTIFICATION TOOLS IN BIODIVERSITY AND HABITAT MARKETS: AN EXAMINATION OF METRICS AND TOOLS TO ASSESS BIODIVERSITY AND HABITAT QUANTITY AND QUALITY

Emily J. Pindilli

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The United States is home to a remarkable variety of wildlife. However, the rate of loss of biodiversity and unique habitats is significant. The federal government along with states, localities, academia, business, non-governmental organizations, and individuals are engaged in a variety of activities to protect and conserve biodiversity and habitats. The United States Geological Survey (USGS) recently examined market-based approaches to protect and conserve biodiversity and habitats on private agricultural lands in the United States. To conserve or enhance biodiversity and habitats, it is vital to understand the quantity and quality of species or habitat and how those translate into the specific benefits desired. Not unlike carbon, water quality, or nutrient markets, transparency and consistency in the methodologies used to assess biodiversity and habitat can support functional markets.

This presentation examines the methods of biodiversity and habitat quantification used by the various types of markets and market-based approaches that have been implemented to benefit biodiversity and wildlife habitat. The content draws on recent research, highlighting the importance of effective measurement. A variety of available tools used for quantification of habitat benefits will be introduced. There are currently a number of efforts to develop tools that will be used for specific species across large landscapes. These efforts will be discussed as well as the unique challenges of developing tools faced by the biodiversity and habitat community. The discussion will include efforts to standardize metrics, examples of tools and metrics being deployed in the field, and the associated risk and uncertainty associated with environmental markets.

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MARINE AND COASTAL ECOSYSTEM SERVICES IN DAILY EXPERIENCES OF CITIZENS OF GULF OF GDANSK, SOUTHERN BALTIC

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Ecosystem services provided by marine and coastal ecosystems are vital for social and economic well-being of coastal communities. Increased anthropogenic pressures, pollution, and unsustainable use of marine resources urge for long-term ecosystem-based governance. Such governance requires wide inclusion of diverse values, understandings, opinions, and interests of social actors. Legitimate governance needs to involve not only institutional stakeholders, but also citizens whose daily lives and well-being is affected by conservation and management decisions, and whose opinions are so far often neglected in management routine. In this study, I use the citizens' jury type of workshop to investigate how ecosystem services are defined and prioritized, and which are close or distant to every day experience. The workshop engaged 20 initially uninformed citizens from the Gulf of Gdansk (Southern Baltic) area. The participants were requested to create individual and common rankings of their most preferred services and to discuss the trade-offs between these services. The local people ranked high the cultural services, and judged fisheries as a sector in decline. They recognized the threats of mass tourism, but still believed that its development should be prioritized. Participants supported environmental protection, provided it ensures egalitarian access to marine areas, but many of them rejected the concept of intrinsic value of nature. Water purification and biological control were highly valued, while habitat services were almost completely ignored. The workshop participants recognized the trade-off between area closures and restrictions concerning fishing, shipping, and industry, and social and economic development. They asked for more ecological education and better management practices, and they considered them crucial for sustainable development. The topics explored during the workshop showed that people living in the same place can see this space in different ways, and that direct consumptive values override the benefits distant in time and space. The difficulties the participants faced in producing a final group ranking proved that it would be extremely difficult to propose a commonly accepted ecosystem-based spatial or management plan. Developing such a plan would require not only traditional ecological education focused on providing information on ecosystem services, but also collaborative tools based on mutual learning and knowledge exchange.

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MAKE IT FIT

***Steve Polasky**, Peter Hawthorne, Joey Reid, Jeff Bielecki, Seth Binder, Kate Brauman, Matt Burgess, Emily Cassidy, Adam Clark, Forest Isbell, Marc Metian, Chris Tessum*, and *Max Troell*
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The twin challenges posed by sustainable development are how to provide all people with a decent standard of living in a world with a population growing to 9 or 10 billion, while simultaneously maintaining ecosystem processes and environmental quality necessary to support human well-being and sustain productive capacity over the long-term. Successfully achieving sustainable development requires tackling a number of specific interconnected challenges: how to produce enough food (crops, meat, fish), energy, timber, and consumption goods and services to achieve a decent material standard of living while also conserving biodiversity, maintaining water and air quality, and limiting atmospheric greenhouse gas (GHG) concentrations. Here we develop an integrated modeling approach that tackles the simultaneous challenge of meeting multiple objectives within the finite resources of the earth system. We explore a range of assumptions on population growth, target per capita income, and technological change to find conditions that "make it fit," i.e., simultaneously achieve the multiple economic and environmental objectives described above, and what types of unavoidable tradeoffs among objectives are likely when conditions are such that it is impossible to make it fit.

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MAKING ECOSYSTEM VALUATION COUNT FOR NATIONAL ACCOUNTING

Steven Polasky *and Heather Tallis*
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National governments are increasingly interested in capturing natural capital in their national accounts. While standards exist for national accounting of assets and flows within the formal economy, standards are still not clarified and adopted for capturing natural capital. In particular, there has not been agreement on how to capture the monetary value of natural capital and ecosystem services in asset and income accounts, especially for capital and services outside the formal economy. We will present the first attempt to align common monetary valuation methods for non-market goods and services with accounting principles used throughout the system of national accounts. We suggest that replacement cost methods most closely follow accounting principles for non-market regulating and provisioning services, while avoided cost methods may be applicable in some contexts. Benefit transfer methods applied to studies using these two approaches may also be an option under certain conditions. We will discuss the opportunities or challenges with using other valuation methods, as well as the rationale for these recommendations.

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LIVELIHOOD ACTIVITIES, ACTIVITY SATISFACTION AND WELL-BEING: EXAMPLES FROM COASTAL FISHERIES

Richard Pollnac

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A great deal of time is devoted to livelihood activities in all societies. Research has shown that degree of satisfaction with attributes of these activities can have an influence on both individual and societal well-being. Impacts arising from low levels of livelihood activity satisfaction can range from job performance and mental health to hearty disease, longevity, family violence and other antisocial behaviors (Palmore 1969, HEW 1973, Pollnac & Poggie 1988); hence, having negative impacts on individual, family, and social well-being. A non-economic fishery social impact assessment model developed by Pollnac, et al. (2006) illustrates interrelationships between local ecosystems (social and natural), resource management, livelihood activity attributes, individual and social-community attributes, social problems and well-being as related to both subsistence and commercial fisheries. This presentation illustrates the use of this model with data and information from a wide range of fisheries and describes methods necessary to assess well-being impacts of changes in fishery activities caused by either natural or human factors.

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CONDITIONS THAT FACILITATE THE USE OF ECOSYSTEM SERVICE KNOWLEDGE IN DECISION-MAKING

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Decision-makers are increasingly asking for scientifically credible information about ecosystem services. But, if communities of research and practice aim to influence policy decisions, they need to better understand *how* and *why* decision-makers use certain kinds of knowledge. In this talk, I will describe how decision-makers use ecosystem service knowledge in three international cases: national coastal planning in Belize; regional marine spatial planning on Vancouver Island, Canada; and regional land use planning on the island of Oahu, Hawaii (McKenzie, Posner, et al. 2014). I will present evidence of 'conceptual', 'strategic' and 'instrumental' use of ecosystem service knowledge, and highlight factors that affect how the knowledge is used. I will also report on a study that evaluates the enabling conditions for ecosystem service knowledge to have a policy impact across a range of international cases. I will describe methods that test variables related to the knowledge produced, the science-to-policy process, and the decision context to see which can predict impact. Important themes emerge for ecosystem services science and policy: the value of scientists and decision-makers co-producing knowledge, the effect of integrating local and traditional knowledge, and the importance of the salience, credibility, and legitimacy of scientific outputs.

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MAINSTREAMING ECOSYSTEM SERVICES AND NATURAL CAPITAL

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In Europe, there is at present significant investment in operationalising the concepts of ecosystem services and natural capital in decision making, with several large consortia funded through the EU 7th Framework Programme. This paper describes the approach taken in one of these, OpenNESS (www.openness-project.eu/), and focusses in particular on the role of conceptual frameworks in helping mainstream the ideas. If concepts such as these are to be successfully used, then they must be theoretically robust, relevant and easily understood by those seeking to apply them. Moreover, in a large consortium involving many disciplines and practitioners, the development of a common understanding of the core concepts is essential if an integrated approach is to be achieved. In this paper we discuss how this has been achieved in OpenNESS, and what the difficulties were found.
The work in OpenNESS is structured around four 'operational challenges'. They involve examining the practical potential of the concepts of ecosystem services and natural capital for: promoting human well-being in different place-based contexts; developing strategies for sustainable ecosystem management; designing new modes of good governance; and, promoting EU competitiveness at different geographical scales. Although the challenges partly overlap, they offer a way of helping to identify and communicate how the concepts of can be 'mainstreamed' into management and policy. This paper presents preliminary findings on the question of whether a common conceptual framework can be developed that spans these four areas of concern.

The 'cascade model' was used as a starting point for the work, because it captured something of the trans-disciplinary nature of the four challenges. We found that many ideas about the four areas of concern could be accommodated by modifying the cascade in various ways. The framework was also tested practically with case study partners, and this confirmed its adaptability the platform it provided for discussion. Our analysis of suggests that in the context of 'mainstreaming', the process of building a conceptual frameworks is probably as important as any final product, in terms of social learning, and so we recommend a deliberative approach to exploring the practical aspects of the concepts. An important additional finding to emerge is that to accommodate the challenges within the cascade, it is useful to consider them as 'outputs' or 'performance characteristics' of the socio-ecological system represented by the model, and then use it to trace the implications of different kinds of relationship within the cascade for a given situation.

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BALANCING BUSINESS NEEDS WITH MEASURES OF ECOLOGICAL SERVICES

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Applications of the ecological or ecosystem services concept as a construct for corporate governance, environmental policy and decision-making are continuing to grow. Commensurate with the multidisciplinary nature of ecosystems and their contributions to humans, a wide array of conceptual models and an even greater variety of quantitative methods have been proposed for analyzing and measuring ecosystem services. From the standpoint of business management, this variety offers opportunity for customization to suit specific needs, though sifting through available tools and making sense of them can be a challenge.

Using provisioning and regulating services as an example, we have evaluated how analysis of food webs and ecological modeling at various biological scales could be used to understand ecosystem services and prioritize metrics for measuring services. Ecosystem services can be understood only through an analysis of ecological structure and function, including elucidating relationships among key species in food webs. Because empirical measures of relationships among ecological variables are limited, we maintain that attempts to assess ecosystem services in the absence of modeling populations, food webs, and/or landscapes may lead to erroneous conclusions and ultimately poor decision making.

We present an overview of concepts for moving beyond simple qualitative analyses of ecosystem services. We focus on ecological concepts and do not address economic ones (e.g., methods for valuing ecosystem services), recognizing that the former constitute the foundation for any assessment of ecosystem services. The pressing issue is which of these metrics are most useful and cost-effective for specifically meet the needs of corporate governance. Ecological models can aid in identifying and prioritizing metrics for assessing ecosystem services, as well as in identifying key structures, processes, and functions that support the provisioning of ecosystem services. Strategic use of ecological modeling complemented by perturbation experiments is essential to science-based ecosystem services assessment.

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TAKING WATER QUALITY TRADING TO THE NEXT LEVEL: UNIFYING THE MESSAGE AND SCALING UP

David Primozich
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David Primozich will contribute to this panel discussion by speaking on building and implementing specific water quality trading programs in NPDES permits. From the Pacific Northwest, David will share examples of a successful on-the-ground project for temperature trading and a developing watershed restoration program that is addressing temperature, sediments and nutrients. For these programs, supportive policy is just as important as sound program design. Therefore, David will also address the importance of clear standards and protocols to make trading viable as a compliance alternative for regulated water and electric utilities.

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CLIMATE CHANGE AND THE GROWTH OF OIL AND GAS EXPLORATION IN THE ARCTIC

Brad Raffle [1] *and Joseph Nicolette* [2]

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As Arctic sea ice melts in response to global warming, the energy industry is poised to further extract the region's vast oil and gas resources. The US Geological Survey has estimated that the Arctic contains over 400 billion barrels of oil and oil equivalent, representing 30% of global undiscovered natural gas and 13% of global undiscovered oil. These figures point to the inevitability of future expansion of oil and gas exploration and development in the region. In April 2014, the US National Research Council (NRC), an arm of the National Academy of Sciences, released a report that comprehensively evaluates the impact of oil and gas development in the Arctic. The Report calls for upgrading oil spill response infrastructure, additional studies, and far more coordination between government agencies, industry and academia. This presentation summarizes the Report's key findings and describes the unique applicability of Net Environmental Benefit Analysis (NEBA) in responding to oil spills in this fragile part of the world. Oil spill response in the Arctic is challenging for a number of reasons, not just due to the extreme weather conditions. These include intensifying sea traffic in parts of the region, the lack of high-resolution topography and bathymetry along the coasts, uncertainties regarding ice/oil interaction and the shortage of data on the distribution of the region's fish, birds and marine mammals. The presentation focuses on the increased access to the Arctic Region for exploration and shipping due to sea ice melt and challenges and uncertainties in environmental management.

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BANKING ON CONSERVATION: MARKET RECONSTRUCTION AND ENVIRONMENTAL PROTECTION IN AN ERA OF EXCHANGE

Chris Rea
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American regulatory approaches to ecosystem service (ES) provision have taken a decidedly market-oriented turn over the last 20 years. Explaining this development requires moving beyond either celebrations of market efficiency or lamentations of neoliberalization and privatization. Through an investigation of the development of species conservation banking, a novel market-oriented means to protecting endangered species, this paper argues that market-oriented regulation and ES provision develops from reconstructions of extant configurations of economic embeddedness driven by four interrelated processes: a) contention and contingent interaction in fields which leads to blocked exchanges; b) demand for new institutional means to settle conflicts and circumvent blockages; c) consonant movements of commodification; and d) pro-market mobilization in favor of alternative exchanges. This approach, termed market reconstruction} highlights the ways that contention and contingency play crucial roles in institution building, sheds light on the ways ES are being integrated into markets, and provides a robust framework for understanding the development of state-centered but market-oriented modes of social-environmental regulation.

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LINKING WATERSHED AND COASTAL ECOSYSTEM MODELS TO ASSESS HARMFUL ALGAL BLOOM PRODUCTION IN THE WESTERN LAKE ERIE BASIN

***Todd M. Redder**, J.V. DePinto, E.M. Verhamme, and D.A. Schlea*
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The Western Basin of Lake Erie (WLEB) is subject to high loadings of nutrients derived from tributary watersheds that are dominated by agricultural land uses. Over the past decade, harmful algal blooms (HABs) have become increasingly common in the WLEB as a result of excessive bioavailable phosphorus loadings delivered via spring and early summer storm runoff events in these watersheds. Excessive HAB production negatively impacts WLEB ecosystem services by diverting nutrients from the upper food web and degrading beach aesthetics and safety. Addressing this challenging regional issue requires developing a quantitative understanding of the relative impact of specific nutrient sources on HAB production and the impact of improved best management practices (BMPs) on nutrient delivery from those sources. Because monetary resources to support BMP implementation are limited, it is crucial that well-constrained modeling tools be developed and applied to target specific practices and implementation areas to optimize the investment of those resources.

LimnoTech has investigated the occurrence of and drivers for HABs under a series of recent projects by utilizing monitoring data and modeling. Our efforts have included the development of a "Western Lake Erie Ecosystem Model" (WLEEM), which is specifically designed to simulate the combined impact of nutrient loadings and climatological conditions on HAB production. The WLEEM is a linked hydrodynamic – sediment transport – eutrophication model that relies on the specification of external loads from the Maumee River, the Detroit River, and other tributaries to the WLEB. In parallel to the development and calibration of the WLEEM, LimnoTech has developed complementary SWAT models that represent the landside sourcing of nutrient loads within the Maumee basin and their delivery to the WLEB. The Maumee River is specifically targeted because it represents the dominant tributary loading source to the WLEB, delivering approximately 50% of the total phosphorus loading to the WLEB.

The calibrated SWAT and WLEEM models have been linked to create an integrated tool that can be used to connect actions at the watershed scale to ecological health within the WLEB. Specifically, the linked modeling framework translates nutrient reductions at the local farm scale to corresponding reductions in HAB production within the WLEB under a range of climate conditions. Optimization of BMP types and implementation locations can be accomplished by ranking simulated cropland land units based on their *effective* bioavailable phosphorus yield at the mouth. Based on the predicted reductions at the Maumee River mouth, the WLEEM can then be used to simulate the expected reduction in HAB production under a range of BMP implementation scales. The results of the BMP "upscaling" evaluation will be presented to demonstrate the level of BMP implementation that would ultimately be required to accomplish a reduction in HAB production necessary to significantly improve ecosystem services within the WLEB. A key recommendation for furthering the evaluation is to expand the modeling framework to include an economic component that would estimate the cost per unit area for BMP implementation within specific regions of the Maumee watershed. This "bioeconomic model" would provide an invaluable tool for optimizing BMP implementation to achieve an optimal cost-to-benefit ratio.

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PUBLIC TRANSACTIONS COSTS OF NUTRIENT TRADING PROGRAMS

Kurt Stephenson and ***Gwendolen Rees***
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This research examines the public transactions costs incurred in the design and implementation of nutrient trading programs in the Chesapeake Bay watershed. Chesapeake Bay states have implemented trading programs to help achieve the water quality goals outlined in the Chesapeake Bay Total Maximum Daily Load. While each program is different, each grants regulated point sources (PS) varying levels of flexibility to maintain regulatory compliance by purchasing nutrient credits from unregulated agricultural nonpoint sources (NPS). Relatively little research has been devoted to quantifying and analyzing the transaction costs involved in nutrient trading programs, particularly in relation to costs borne by the public sector (e.g. state administrative agencies).

Public transactions costs ('administrative costs') are an important consideration for public agencies given increasingly limited staff time and limited opportunities for increased state funding. This tension raises several policy issues. First, to what extent to do administrative costs vary with the scale of trading? Some types of administrative costs have characteristics of fixed costs, while others are closely linked to the commodity creation (credit certification) and transfer. Second, to what extent do administrative costs differ across trading program type? Given that trading requires equivalency in water quality outcomes, significant additional administrative costs may be incurred to ensure water quality goals are maintained when trades across different source types occur. Third, to what extent can administrative costs be lowered through improved trading infrastructure designs? Program features such as trade tracking, certification and verification processes can all impact administrative costs.

This research develops a conceptual framework for quantifying and analyzing the public administrative costs of designing, implementing, and maintaining nutrient trading programs. Secondly, we estimate the level of different types of public transactions costs currently experienced in Chesapeake Bay nutrient trading programs via a detailed case study of the current state trading program in Virginia. Drawing from the case study, interviews, comparative case analysis and associated literature synthesis, we identify the relationship of administrative costs to trading program expansion, the level and types of costs incurred in the implementation and maintenance of infrastructure necessary for defining, certifying and transferring credits across different source types; and the program design features that have the potential to increase administrative cost effectiveness. Comparisons are also made between administrative costs of nutrient trading programs and other conservation service payment programs.

A meta-analysis of empirical studies in the literature together with preliminary case study results indicates that administrative transactions costs can comprise a large proportion of total program costs (transactions costs plus transformation costs), particularly in the regulatory design and early program implementation phases. Costs of PS-NPS trading differ substantially to those incurred for PS-PS trading in terms of the types and levels of administrative costs incurred. Further case study work will yield estimates of the level of transactions costs for the Virginia program. Recommendations identifying where administrative 'bottlenecks' are likely to occur as programs expand and design features that may increase administrative cost effectiveness will be formulated once the case study is complete.

This research was funded by the USDA Office of Environmental Markets.

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ECOSYSTEM SERVICES, HABITAT BANKS AND THE ENDANGERED SPECIES ACT

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Thurston County is one of the fastest growing counties in the state of Washington. It also hosts a majority of the imperiled prairie ecosystem across the region where grassland remnants represent approximately eight percent of historic prairie. Three prairie species have recently been listed under the Endangered Species Act (ESA) including Taylor's checkerspot butterfly, Mazama pocket gopher and streaked horned lark. Several other species are under consideration for ESA listing. Thurston County is working with U.S. Fish and Wildlife Service, Washington Dept. of Fish and Wildlife, private landowners and other stakeholders to develop a Habitat Conservation Plan (HCP). This presentation will provide an overview of the methods and challenges with integrating public policy, science, economics and stakeholder interests into the Prairie Habitat Assessment Methodology, underlying the HCP.

The purpose of the Assessment Methodology (methodology) is to provide a framework that leverages the best available science to meet ESA standards required for an HCP and address agency concerns while providing a flexible program that is acceptable to affected land owners. The major objectives are to (1) protect and maintain prairie ecosystems in perpetuity, (2) provide a mechanism to maintain local control over permitting decisions related to habitat, and (3) allow for long-term economic certainty and responsible economic development. The methodology adapted an existing ecosystem services-based model that quantifies the impacts (debits) to species from different activities in the county and benefits (credits) from habitat restoration and conservation for prairie species and ecosystems. The methodology also includes the development of a framework to mitigate impacts through an in-lieu fee habitat banking approach. While scientific uncertainty, regulatory approval mechanisms, and recovery targets presented key challenges throughout the process, close facilitation and iterative model/process testing brought partner and stakeholder buy-in.

The results include a framework to establish habitat banks that supports land acquisition within a reserve design network geared for eventual species recovery. Using the HCP process, the methodology creates a predictable and organized process for land use applications that are affected by listed species. The methodology outlines the threats and opportunities for each species and determines an acceptable level of impact that will not put the species or its habitat at risk. As **required under HCP requirements,** impacts to species (take) related to proposed land use actions, and benefits from mitigation or other conservation strategies are quantified to demonstrate overall benefits to the listed species. In conclusion, the framework provides quantification methods for one of the first habitat banking systems used in HCP compliance under ESA regulations while allowing the County to maintain local control of land use decisions.

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THE LINKAGE BETWEEN THE ENERGY-FOOD-WATER NEXUS AND ECOSYSTEMS

James Dalton *Presented by:* ***Aaron Reuben***
International Union for Conservation of Nature, Gland, Switzerland

"Ecosystems provide a critical linkage within the emerging energy-food-water nexus"

Healthy ecosystems have become increasingly recognized as a necessary element to underpin water, energy and food security. James will highlight key examples of ecosystems providing benefits to a range of sectors, and will identify challenges when ecosystems are not adequately considered in infrastructure development. He will use global examples from the agriculture and energy sectors, and also from the disaster risk reduction community. Examples will be provided from the global dialogue on Water Infrastructure Solutions in the Nexus.

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USING BIG DATA ANALYTICS TO TARGET CONSERVATION INVESTMENTS

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The Nature Conservancy of California (TNC) is using big data analytics and emerging precision science tools to enable more precise habitat valuations and conservation investments in California's agricultural landscape. These emerging tools were used to identify habitat needs and to optimize a privately funded investment in more than 10,000 acres of temporary habitat for migratory birds in spring 2014.

Big data and dynamic market-based approaches are enabling new methods for matching conservation investments with the highest-value ecosystem needs. For birds and other migratory species, "home" can mean something different every year and traditional protected areas conservation has not matched the scale and dynamics of these habitat needs.

By applying models for predicting bird occurrence based on millions of crowd-sourced bird sightings from the Cornell Lab of Ornithology's eBird program, TNC scientists can predict where and when birds are likely to be found, and then ask farmers to provide habitat in weekly increments. Given the high inter-annual variability of wildlife populations and water availability, as well as long-term changes in farm economics and climate, TNC's approach offers the flexibility to adapt conservation investments in the future.

This program, known as BirdReturns, enabled TNC to source over 10,000 acres of temporary bird habitat last winter. The fields are used to grow rice in summer and, now, bird habitat in winter. With compensation from TNC and its private funders, participants modified their winter farming practices – most importantly the timing of winter water management – with guidance from TNC scientists. The results: participating fields attracted over 200,000 birds, on average 30 times more than were observed in neighboring control fields.

Across 10,000 acres, the costs of habitat provision varied dramatically, and these precision science tools informed better decisions about where larger per-acre investments would be justified. TNC paired its precision science tools with a reverse auction to facilitate competitive bidding by farmers. Over time, a larger program will attract more farmers and enable better habitat valuations and higher return on investment in terms of habitat per dollar invested.

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METHOD EVALUATION FOR ITINERANT ECOSYSTEM SERVICE PROVIDERS

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The purpose of this of this study is to improve the understanding of inputs that go into configuring the ecosystem service value of the Mexican Free-tailed bat and other itinerant "Ecosystem Services". It is well understood that the Mexican Free-tailed bat provides services to cotton field producers. However, cotton only covers a portion of all crop acres that are receiving biological services. In order to create a method that can be applied across crops that receive biological services, essential criteria needs to be met.

Since the value of the service provided by itinerant species fluctuates throughout time and space, mapping out when and where the species will be present is most indispensable. Crop seasons and other migrating species also need to be mapped out to determine the overlap. In order to improve on previous methods used to determine ecosystem services of itinerant species, specific data has been collected to customize for the crop that is under evaluation. Determining (1) what service is being provided to crop producers by the mobile species, (2) the pests (if present), (3) market information, (4) private and social costs, and (5) technology that interferers with the biological service provider, all provides customization. In the case for corn crops, which, to my knowledge have not been evaluated before, subtle differences in avoided cost due to the Mexican Free-tailed bat can be observed, for instance (1)the amount of pesticides used (social & private cost), (2) prices for crops, (3) acreage, (4)pest thresholds, and (5) growth season.

In conclusion, an extensive method that can be broken down into sections and used to identify biological service value across multiple crops can determine the overall value of itinerant ecosystem service providers. Having a comprehensive value for an itinerant species will improve conservation efforts, goals, and connectivity throughout space and time. Since the pest-control value has been determined for Mexican Free-tailed bats in cotton fields, it is time to use this successful method and expand in order meet the entirety of the capabilities the method has to offer.

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FACILITATING THE INCLUSION OF NONMARKET VALUES IN BLM PLANNING

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While the economic value for many of the resource uses and ecosystem services provided by lands administered by the Bureau of Land Management (BLM) are not expressed in the marketplace, the consideration of such nonmarket values could lead to more informed decision-making by the BLM by creating a more holistic picture of the economic implications of resource tradeoffs. Given requests from field staff for information on how to incorporate these values into plans and projects, BLM recently released an updated instruction memorandum on estimating nonmarket values. To support this guidance, BLM's socioeconomics program partnered with U.S. Geological Survey (USGS) and Colorado State University economists to further evaluate the use of nonmarket values in BLM decision-making, update existing technical resources for measuring those values, and provide practical guidance to BLM staff and managers on the use of nonmarket values.

Four BLM pilot sites are participating in this effort, including the St. George Field Office, the Taos Field Office, Canyons of the Ancients National Monument, and the Tuscarora Field Office. The team is working closely with field staff at each site to introduce them to the concepts and terms associated with nonmarket valuation and tie this language to the issues the field staff are thinking through. A review of the nonmarket valuation literature is being conducted to determine the extent to which values for particular resource uses and ecosystem services specific to BLM managed lands are available and in turn, identify priority uses and regions for which there are currently large data gaps. Based on these findings, USGS economists will update and expand a web-based Toolkit* designed to facilitate benefit transfers of nonmarket values, which will be made publically available at a USGS managed Drupal site. The team will work with field staff at each pilot site to walk through the process of using existing data to incorporate non-market values in planning and project assessments.

This pilot study will demonstrate the process of considering nonmarket values in BLM's decision processes and will highlight both the successes and difficulties that arise when framing this economic information for decision-making. The results will be documented in a guidebook for BLM resource planners and field staff, which will include lessons learned from the effort, as well as practical guidance on empirical application of nonmarket valuation and when to rely on existing data to consider these values in BLM decision-making. It is anticipated that this guidebook, along with other comments from state and field office staff, will be incorporated into BLM's revised instruction memorandum on estimating nonmarket values.

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*The existing toolkit can be found at: http://dare.agsci.colostate.edu/outreach/tools/

KEY LESSONS LEARNED FROM PRACTITIONERS ON ECOSYSTEM SERVICES AT THE URBAN SCALE

***Jenn Richkus**, Mary Barber, and Emily Zhang*
RTI International, Washington, DC, USA

The use of urban ecosystem services as a management approach is promoted as a way to help cities evaluate environmental and economic benefits and tradeoffs as well as assist urban practitioners to assess, manage and enhance urban ecosystem services. Although there is much literature on why ecosystem services should be accounted for, few studies have evaluated the usefulness that the concept has had on local resource management projects. We interviewed urban environmental specialists and planners from ten cities in the U.S. to gather information on their experiences and on-the-ground efforts to utilize ecosystem services in urban management frameworks. Results are intended to gain an understanding of the opportunities and challenges experienced by decision makers and practitioners incorporating ecosystem services in an urban context. Key successes, lessons learned and recommendations for future incorporation and expansion of ecosystem services approaches in local management are discussed.

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SHOW ME MORE THAN THE MONEY: ECOSYSTEM SERVICES AND HEALTH

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The promise of an ecosystem services approach is its ability to link ecosystems with human well-being. To date, most ecosystem service assessments have estimated benefits to people in monetary terms - dollars. It has become clear, however, that financial values are an incomplete, messy, and controversial way to measure the benefits from nature. Here we present two studies from a broad effort to understand ecosystem effects on another, hugely important component of human well-being: health. In the first study, we ask how pollinator declines would affect diets, nutrient deficiency, and risk of disease in four developing countries. We find that animal-pollinated foods are an important source of nutrients all countries, but the health effects of pollinator declines varied importantly with local diets. In the second, we use a unique global database of household surveys (100,000's of individuals in more than 40 countries) to ask how the incidence of waterborne disease depends on the ecological condition of the upstream watershed. We find that, while watershed disturbance can affect health outcomes downstream, the magnitude of the effect depends on household wealth, sanitation, and other social factors. Both of these projects are components of broader initiatives aimed at understanding the effects of ecosystem change on concrete, measurable health outcomes. Both projects show that nature can contribute to human health, but typically as one of many interacting factors. Despite this complexity, estimating these health benefits can complement monetary valuations, broaden our understanding of how ecosystems contribute to human well-being, and strengthen our arguments for conservation.

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RESEARCH QUESTIONS TO IDENTIFY ECOLOGICAL INDICATORS MOST USEFUL FOR LINKING ECOSYSTEMS AND HUMAN WELL-BEING

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The identification of ecological indicators effectively connecting ecosystems to social science interpretation would facilitate analyses important to public deliberation. However, guidelines for developing meeting this need are not well developed. In the past few years, economists have identified principles that serve as a useful guide to identifying ecological indicators that most effectively link ecosystems to human well-being and social analysis. These principles are grounded in the idea that the direct and indirect effect of ecosystems on humans may be characterized using production function theory. The resulting indicators are termed linking indicators or indicators of final ecosystem goods and services (FEGS). The term "linking indicators" reflects the idea that these indicators provide the immediate link between natural and social systems. The term "FEGS," in contrast, clarifies that these indicators quantify the last steps in ecological "production" before an ecological system affects humans. We have explored these concepts in evaluations of indicators for regional aquatic monitoring and in case studies of benefits analyses. Through this process we have identified provisional indicators and gaps in data and understanding that limit our capacity to represent these indicators. We also suggest research questions. Addressing these questions will help inform indicator development and data collection efforts necessary to link ecosystems to human well-being and social analysis.

The key questions that we have identified are:

1. What are the performance metrics for distinguishing between linking indicators that "work"?
2. Do linking indicators more proximate to individual experience perform better than those more distal?
3. Are preferences similar enough across beneficiaries that no special targeting of linking indicators for specific groups is necessary?
4. For any specific linking indicator, do more aggregate descriptions (e.g., fish) perform better than less aggregate descriptions (e.g., trout)?
5. Do indicators that aggregate over multiple categories (*out of category* indicators, e.g. a fishing quality index) perform better than indicators that focus on specific ecological elements (e.g. fish and site appeal)?
6. What are the temporal and spatial dimensions of specific ecosystem-beneficiary pairings that matter to people?
7. Does the existence value context present any specific complications in indicator design relative to the use context?

We will develop ecological illustrations of some of these questions and suggest that although these are mainly social science questions that they can only effectively be pursued by teams of natural and social scientists.

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COMPARING CLASSIFICATIONS OF ECOSYSTEM SERVICES UNDER NRDA, THE MILLENNIUM ASSESSMENT, AND THE USEPA

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The classification of "natural resource services" as presented in natural resource damage assessment regulations [i.e., under the Oil Pollution Act (OPA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)] will be compared to the classification of "Ecosystem Services" within the Millennium Assessment and the USEPA Final Ecosystem Goods and Services Classification System (FEGS-CS). The overarching classification of services between these three frameworks differs and as such, can present issues when applying the classifications to a particular purpose. For example, the NRDA framework is based upon a specific legal framework focusing on making the public whole for impacts to ecological and human use services. The term "public" infers a public interest value consideration when compared to the Millennium Assessment and the USEPA classification that inherently considers both public and private interest values associated with ecosystem services. In the latter two classification schemes there is little attempt to distinguish between private and public interest values although the FEGS-CS does attempt to avoid double counting of ecosystem services in the production of goods and services whereas the Millennium Assessment does not. The USEPA FEGS-CS specifies a Leontieff production function that is designed to be readily incorporated into the North American Industrial Classification System (NAICS) which implies economic impact analysis may be possible. This presentation will outline the various classification systems, highlight outstanding questions associated with each of the classifications, and identify appropriate and inappropriate applications of the classification systems to particular issues.

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CLEAN WATER ACT PERSPECTIVE: WATER QUALITY TRADING

Bob Rose
US Environmental Protection Agency, Washington, DC

Presented will be the Clean Water Act (CWA) authorities under which water quality trading takes place. Audience members will gain an understanding of water quality trading as a compliance tool for CWA permitted entities, such as wastewater plants. Why it is that US EPA allows states to design and manage their own water quality trading programs will be discussed, which has ramifications on the wide diversity of water quality trading programs seen to date. US EPA's role in overseeing water quality trading will be explained, along with an overview of US EPA's 2003 Water Quality Trading Policy. Recent coordination with US Department of Agriculture will be summarized.

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ESV AND NOAA'S RESTORE PROGRAM: DEVELOPING ACTIONABLE INFORMATION FOR LOCAL DECISION-MAKING

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Though each coastal community faces unique challenges in becoming more resilient, there are many examples of success stories and best practices that have the potential to be adopted elsewhere or scaled up. Success requires actionable and appropriate information communicated in the right way to the right stakeholders. It requires close coordination and the development of partnerships across geographies to adapt management efforts to the particular needs and context of each community. We will discuss ecosystem service valuation (ESV) approaches that the RESTORE Program can apply in the Gulf, Gulf efforts that can inform other geographies, challenges to information transfer, as well how to overcome them through targeted partnerships.

There are many success stories and best practices in ESV that can aid local decision-makers and enhance resilience. In this presentation, we will discuss ESV practices and community adaptation approaches that are relevant to the NOAA RESTORE Act Science Program. The mission of the National Oceanic and Atmospheric Administration's (NOAA's) RESTORE Act Science Program is to initiate and sustain an integrative, holistic understanding of the Gulf of Mexico ecosystem and support, to the maximum extent practicable, restoration efforts and the long-term sustainability of the ecosystem, including its fish stocks, fishing industries, habitat, and wildlife through ecosystem research, observation, monitoring, and technology development.

This presentation will address the following questions:

1. What are some of the most current and relevant efforts on ecosystem service valuation and community adaptation and why are they important?
2. What are the similarities and differences between these case studies and how can they be applied in the Gulf of Mexico?
3. Are there existing Gulf cases that might benefit from ESV and/or Community adaptation?
4. What are the potential needs and challenges that might arise from the translation of these efforts to the Gulf of Mexico?

We will concentrate on examples of ecosystem services valuation that have regional and local significance. To conclude, we will review a set of ESV guidelines that will be incorporated in the RESTORE Science Program in the Gulf of Mexico. Expected outcomes of the talk will be:

A better understanding of ecosystem service valuation and community adaptation practices that can be of relevance to the Gulf of Mexico (lessons learned).

An understanding of successful efforts in the Gulf that can be translated across the Nation.

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LESSONS FROM THE SHORE: INTEGRATING ECOSYSTEM SERVICES INTO OCEAN AND COASTAL MANAGEMENT OBJECTIVES

Tracy Rouleau
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The National Oceanic and Atmospheric Administration (NOAA) serves the American public by providing environmental intelligence from the outer edges of the solar system to the very depths of Earth's oceans. Through NOAA's science, service, and stewardship, the agency provides information on a wide swath of ecosystem services critical to management efforts aimed at protecting and enhancing these services for current and future generations. For example, sea level rise projections inform coastal planning to protect valuable infrastructure and recreational opportunities; climate and weather forecasts enable farmers to maximize their land's productivity and shipping companies to navigate safely; stock assessments help provide fishermen with access to productive fishing grounds now and in the future; and habitat protection and restoration results in the direct production of many important ecosystem services as well.

NOAA's ecosystem services work supports ocean and coastal decision contexts at regional, state, and local scales. NOAA-sponsored projects and programs enhance and value a broad range of ecosystem services that support its mission, including commercial and recreational fisheries, water quality, coastal green infrastructure, and coastal blue carbon. NOAA is developing a strategic approach for advancing the valuation of ecosystem services at the agency, and integrating this knowledge into its mission of science, service, and stewardship. Discussion will highlight projects, at various levels of implementation across the nation, that exemplify guiding principles and best practices for ecosystem services research and valuation such as making more explicit ties to decision-making, using scenarios to measure trade-offs in terms of societal and environmental benefits, strong stakeholder engagement, and advancing ecological and economic tools and needed data. We will review the findings of a project in Maine, where NOAA scientists are applying an integrated, spatially-explicit framework to characterize and quantify the impact of riparian management on ecosystem services identified as important by local stakeholders; explore how American Recovery and Reinvestment funds were used to establish a living shoreline (artificial oyster reef) along highly eroding marsh coastline in southeast Louisiana; and examine work in the Great Lakes and New York/New Jersey shoreline to assess the economic value of coastal green infrastructure in protecting coastal communities from weather and climate hazards, among others.

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EMPOWERING EUROPEAN COMMUNITIES TO IMPROVE NATURAL RESOURCE MANAGEMENT FOR HUMAN WELL-BEING: THE OPPLA WEB PORTAL & COMMUNITIES OF PRACTICE

Mark Rounsevell[1]*, Claire Brown*[2]*, Marta Pérez-Soba*[3]*, Marc Metzger*[1]*, Peter Verweij*[3]*, Ben Delbaere*[4]*, George Cojocaru*[5]*, Heli Saarikoski*[6]*, Paula Harrison*[7] *and Katharina Zellmer*[8]

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The ecosystem services concept is seen by many as a useful paradigm to support decision-making at the complex interface between science, policy and practice. However, to be successful, it requires a strong willingness for collaboration and joint understanding. In support of this aspiration, OPPLA is being developed as a web portal to enable European communities to better manage ecosystems for human well-being and livelihoods. OPPLA will provide access to a variety of online resources such as tools, case studies, lessons learned, videos, manuals and training and educational materials. It will also provide expert forums and spaces for discussions between researchers, practitioners and decision makers. Hence a critical aspect of the success of OPPLA is the co-evolution of communities of practice that link best practice experience with knowledge on ecosystem services and natural capital.

An example of a community of practice is the recently launched Ecosystem Services Community – Scotland (ESCom-Scotland). ESCom-Scotland aims to support better management of Scotland's natural resources by helping to establish a community of practice between individuals and groups involved in the science, policy and practice behind sustainable ecosystem management. It aspires to encourage the sharing of ideas, increase collaboration and to initiate a support network for those engaging with the ecosystem services concept and it will use the OPPLA resources to support these activities. Further details can be found at: escomscotland.wordpress.com.

OPPLA is currently at the developmental stage and was instigated by two large European Commission funded research projects: OPERAs (www.operas-project.eu) and OpenNESS (www.openness-project.eu), with a combined budget of ca. €24m. These projects aim to improve understanding of how ecosystem services contribute to human well-being in different social-ecological systems. Research will establish whether, how and under what conditions the ecosystem services concept can move beyond the academic domain towards practical implementation in support of sustainable ecosystem management. New insights, and improved or novel tools and instruments, will be tested in practice in case studies that cover a range of socio-ecological systems across locales, sectors, scales and time. This presentation will discuss the development of OPPLA and the communities of practice that are emerging around it.

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QUANTIFYING THE UNCERTAINTIES WITHIN A CROSS-SECTORAL, INTEGRATED ASSESSMENT OF THE IMPACT OF CLIMATE CHANGE ON ECOSYSTEM SERVICES IN EUROPE

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Many models have been used to explore the likely course and magnitude of the consequences of climate change for ecosystem services. However, individual models tend to focus on single socio-economic sectors that are implicitly assumed to operate in isolation, neglecting the many feedbacks that occur between sectors in reality. The CLIMSAVE Integrated Assessment Platform (IAP) seeks to overcome this limitation by combining 10 different sectoral, meta-models to simulate cross-sectoral impacts of climate change on ecosystem services in Europe. Integrating disparate models has, however, the potential to introduce errors and uncertainties that arise from the design of the models themselves, including the underlying data used, the parameters that are included, and the treatment, simplifications or assumptions concerning the interactions of these parameters. It is crucial, therefore, to understand model-based uncertainties, especially where such uncertainties could combine with one another in previously unconsidered and potentially unpredictable ways (Brown et al., 2014).

The IAP has many potential sources of uncertainty that affect confidence in the results and hence the use of the IAP in support of decision making. We present the results of a quantitative uncertainty analysis of the IAP, which investigated aggregate uncertainties in the IAP outputs for ecosystem service indicators caused by uncertainties in input parameters (and therefore in the underlying model and scenario uncertainties). Probability density functions (PDFs) were created for each of the IAP's input variables and for four scenarios with Monte Carlo sampling across these PDFs used to explore the ranges of uncertainties in IAP outputs. A limited set of indicators were used to capture the range of impacts of climate change on ecosystem services, including food production, flooding, water availability, landscape diversity, land use intensity and biodiversity. The aggregate outputs of the IAP at the European scale were found to have limited uncertainties, which allow specific impacts to be predicted with definable levels of confidence. There was substantial overlap between different socio-economic scenarios, suggesting that changes in socio-economic conditions cannot reliably overcome climate-related uncertainty. The range of climate change impacts on biodiversity, for example, was found to be more negative than positive. Nevertheless, there is evidence to suggest that particular adaptation actions may significantly alter the impacts of climate change, especially at local or national scales. This was evident in the case of flooding, where flood protection measures were crucial in not only reducing impacts, but also in reducing impact uncertainties and hence flooding risks.

Brown, C., Brown, E., Murray-Rust, D., Cojocaru, G., Savin, C. & Rounsevell, M.D.A. (2014). Analysing uncertainties in climate change impact assessment across sectors and scenarios. *Climatic Change*, DOI 10.1007/s10584-014-1133-0

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METER-SCALE URBAN LAND COVER MAPPING FOR EPA ENVIROATLAS

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US EPA EnviroAtlas is an online collection of tools and resources that provides geospatial data, maps, research, and analysis on the relationships between nature, people, health, and the economy (http://www.epa.gov/research/enviroatlas/index.htm). Using EnviroAtlas, you can see and explore information related to the benefits (e.g., ecosystem services) that humans receive from nature, including clean air, clean and plentiful water, natural hazard mitigation, biodiversity conservation, food, fuel, and materials, recreational opportunities, and cultural and aesthetic value.

EPA developed several urban land cover maps at very high spatial resolution (one-meter pixel size) for a portion of EnviroAtlas devoted to urban studies. This urban mapping effort supported analysis of relations among land cover, human health and demographics at the US Census Block Group level. Supervised classification of 2010 USDA NAIP (National Agricultural Imagery Program) digital aerial photos produced eight-class land cover maps for several cities, including Durham, NC, Portland, ME, Tampa, FL, New Bedford, MA, Pittsburgh, PA, Portland, OR, and Milwaukee, WI. Semi-automated feature extraction methods were used to classify the NAIP imagery: genetic algorithms/machine learning, random forest, and object-based image analysis (OBIA).

Here we present our image processing methodology, report on some sustainability and ecosystem service metrics computed using this land cover as input (e.g., carbon sequestration from USFS iTREE model; health and demographics in relation to road buffer forest width), and compare estimates of ecosystem services from the 1m land cover to 30m NLCD.

While this material was reviewed and approved by the U.S. EPA, it does not necessarily reflect official Agency policy.

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THE IMPORTANCE OF CONTEXT IN DEVELOPMENT AND APPLICATION OF ECOSYSTEM SERVICES PRODUCTION FUNCTIONS

***Marc Russell**, Richard Fulford, and Susan Yee*
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The task of estimating ecosystem service production and delivery deserves special attention. When approached as a function of land cover at any given time, context driven facets of ecosystem service production, delivery, and resulting effects on human well-being can be overlooked. These include the potential dependence of production on ecosystem condition, processes or scale; its susceptibility to stressors; as well as beneficiary driven influences on valuation of said production. Modeling can help overcome these problems, but raises new issues of how models fit when applied in different contexts than they were originally designed. The context within which ecosystem services production functions are determined is itself multifaceted; including social as well as environmental factors. Here, ecosystem services production modeling approaches, and the context of modeling, are examined using case study assessments in Florida and Puerto Rico. In Tampa, population growth over the next 20-50 years is expected to bring large changes in regional land use and a key management objective is to plan for these changes in the context of maximizing ecosystem service production from natural capitol, particularly from the adjacent bay. In Southwestern Puerto Rico, a watershed management plan is currently being implemented to reduce threats of sedimentation to declining quality of coral reefs. However recent workshops with stakeholders indicated there is still a great deal of uncertainty on the degree to which proposed actions could benefit the local community, including unintended benefits or tradeoffs to the provisioning of ecosystem services in the watershed. These varied examples help inform our understanding of how context influences the application of ecosystem services production modeling, and helps position it within the larger project of understanding how environmental change affects human well-being.

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THE USE OF A NEW ECOSYSTEM SERVICES ASSESSMENT TOOL, EPA H2O, FOR IDENTIFYING, QUANTIFYING, AND VALUING ECOSYSTEM SERVICES PRODUCTION

Marc Russell

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The task of estimating ecosystem service production and delivery deserves special attention. Assessment tools that incorporate both supply and delivery of ecosystem services are needed to better understand how ecosystem services production becomes realized benefits. Here, we demonstrate the use of a new ecosystem services assessment tool, EPA H2O, for identifying, quantifying, and valuing ecosystem services production in the Tampa Bay, Florida region. In Tampa, population growth over the next 20-50 years is expected to bring large changes in regional land use and a key management objective is to plan for these changes in the context of maximizing ecosystem service production from natural capitol, particularly from the adjacent bay. We generated several case study reports summarizing both user generated and computer modeled scenarios, which are available within the tools database, of land use development for this region over the next 20-50 years. We also demonstrate the tool's ability to incorporate user specified valuation information; a key context driven factor influencing ecosystem services assessments. The tool is designed to be scalable from neighborhood to regional assessments and transferable to different regions of the US or the world. Our examples illustrate how our freely available ecosystem services assessment tool can help land use planners and natural resource managers understand how environmental change affects human well-being through the production and delivery of ecosystem services.

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HOW ENVIRONMENTAL ACCOUNTING PROVIDES FOR INCREASED PRIVATE SECTOR CAPITAL INVESTMENT IN ECOSYSTEMS

Jerome Ryan
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The following is taken from the Foreword to the Credit Suisse, WWF and McKinsey&Company Report "**Conservation Finance:** Moving beyond donor funding toward an investor-driven approach" (Jan 2014):

Valuable ecosystems are today undergoing rapid degradation and depletion in many parts of the world. Natural capital and the services that ecosystems provide are still poorly understood and rarely monitored. Unlike in the case of traditional commodities, the value of these natural resources is not recognized by today's markets. It is, however, crucial that we understand the interrelationship between environmental quality and economic profitability. This information needs to be integrated into macroeconomic analysis and included in decision-making processes in the areas of financing and investment.

To preserve the health of natural ecosystems, a significantly larger amount of capital investment is required than the sums currently being allocated to conservation. Private sector investment is needed, not to replace but to supplement traditional sources of conservation capital such as public funding or philanthropy, which have been impacted by the global economic downturn.

Against this backdrop, environmental accounting is key to enabling private sector capital investments to efficiently and effectively meet this need for greater conservation funding. Environmental accounting, if based on a standard metric that does not change and is logical in its measurement, provide the foundation by which ecological attributes can be consistently measured. With an established environmental accounting standard, environmental attributes such as wetlands and riparian areas, carbon, forests, grasslands, etc. can be measured and we can then move toward creating value for the protection of these areas in the form of "currencies" that can be traded or reported such as: wetland credits, carbon credits, area of protected lands (forests, grasslands, etc.). These "currencies" (wetland credits, carbon credits, water quality, acres of forest protected, miles of stream preserved, etc.) can be and in some cases, have become the basis by which these ecosystem services can be monetized. This ability to monetize ecosystem values provide for an additional means to create financial value from the enhancement of our environment.

Environmental accounting, like financial accounting, also provides the ability to audit whether the ecosystems are in fact improving or not and how particular investment strategy is performing in this area as compared to other investment strategies. As with financial investment, those strategies that provide the best return, will attract the most capital. This need for a common language and accounting methodology has in turn prompted the creation of the Impact Reporting and Investment Standards (IRIS), Global Impact Investing Network (GIIN), Global Impact Investing Rating System (GIIRS) and B Lab.

In this talk I will describe how we are measuring our environmental impact through the implementation of our strategy, and how we see this potentially enhancing our financial return in the future.
Specifically I will discuss two case studies. The first will be an overview of one of Conservation Forestry Partners' (CFP) current investments and discuss their investment strategy and management plan for the property as they relate to environmental accounting. Second I will discuss a wetland mitigation banking project that I worked on prior to joining CFP. This project will highlight the difficulties that project proponents can face when the environmental accounting methodology in terms of the "currency" had yet to be defined.

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CONTROLLING DRAINAGE WATER OUTFLOWS: ONCE I HAVE CONTROLLED THIS WATER, WHAT SHOULD I *DO* WITH IT?

Rob Sampson
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NRCS began to focus on water quality as a resource of concern in the late 1980's and early 1990's, initially focusing on surface runoff carrying nutrients and sediment from agricultural fields. Trapping this surface water is easy, and a staple in the NRCS bag of planning tricks, but simply capturing nutrient-laden water meant that you had to do something to remove the nutrients, and find some use for the water.

In a similar timeframe, NRCS and the general public began to recognize the impacts of increasing nutrients in receiving waters, like lakes and estuaries. Excessive nutrients generated algal blooms and increased other vegetation through uptake of the additional nutrients. When these large masses of vegetation died, the decomposition used all the oxygen in the water, killing fishes, invertebrates, and most everything else that needed oxygen from the water. A significant part of this increase was coming from tile drainage systems.

Groundwater moving off a field through underground drain pipes is simple enough to treat during the growing season. Drainage Water Management (DWM) plans call for installation of structures that effectively shut off the drains and raise the water table, leaving the nutrient rich water available for crop use, and thus lowering the load of water and nutrients exiting the field into streams and lakes. But how could water be treated outside the growing season, or in topography or soils that generated a drain pipe layout that made DWM out in the field impossible?

Several types of treatments located at the outlet of the drainage pipes have proven effective. NRCS, with the help of willing landowners, has developed standards and specifications for improving drainage water quality. For example, Denitrifying Bioreactors (NRCS Conservation Standard 747) have been shown to remove up to 80 percent of the nitrogen in drainage effluent. Phosphorus treatment systems, using tanks filled with iron or some other reactive metal have shown removal of over half the phosphorus in drainage water. But these practices, while very effective, do not directly add to the landowners bottom line profit or risk reduction. Without some value, either from environmental services trading or avoidance of strict regulation, these treatments cost the landowner in time and maintenance, despite being the 'right' thing to do.

To provide value AND continue nutrient load reductions, farmers and researchers have been testing irrigation systems that use the existing drains and DWM control structures. In certain combinations of soil and slope, landowners add water into the upper portion of the drainage collection system routing the water back into the slotted drainage pipes. The drain pipes exfiltrate the water and raise the water table to the roots of the crop, effectively irrigating the crop. This version of Subsurface Irrigation (NRCS Conservation Standard 443) can provide distinct monetary benefits for the farmer in the form of insurance against drought, increased yield and nutrients available to the plants that would otherwise be lost. Constraints such as water rights and potential storage of drain discharge during winter months need careful planning consideration, but in several parts of the country, subsurface irrigation through drain systems is getting a serious look from producers. By presenting real examples of subsurface drainage benefits such as reduced nutrient application and increased yield, the stage can be set to find the market value of subsurface irrigation.

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HUMAN HEALTH CONNECTIONS TO ECOSYSTEM SERVICES, NATURE, AND BIODIVERSITY

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Although a number of reviews have separately addressed some associations between nature, biodiversity, ecosystem services and human health, comprehensive assessments of types of effects, research needs, and policy opportunities are generally lacking. Here we explore connections among **nature** (defined broadly as the non-human-built world, and specifically including living components, land- and seascapes, parks, managed and more natural forests, etc.), natural **biodiversity** (defined as the variety of life from the gene to species levels and biologically-derived habitats), **ecosystem services** (the benefits humans derive from nature), and **human health and well-being** (defined as including not only the absence of disease or disability but also physical, mental, emotional, and social well-being). We see the sum total of human health and well-being as the ultimate or cumulative ecosystem service in that many, if not all, services are needed to fully support a broad definition of human health and well-being. We summarize recent findings connecting natural biodiversity with production of ecosystem services to humans and the importance of conserving natural biodiversity to ensure sustained delivery of such services. We then examine the following questions: (1) Is there convincing evidence that experiencing more natural settings, even briefly or vicariously, can improve psychological and physical health? (2) Does exposure to biodiverse nature result in measurable health responses? (3) Can biodiversity provide humans and animals protection from infectious and/or allergic and inflammatory diseases? (4) Is there evidence that experiencing coastal nature or marine biodiversity has health effects?

We found strong evidence of positive relationships between nature exposure and human health and well-being, particularly psychological health (cultural services), and we provide an extensive summary of types of effects. But while the evidence is indicative, it is not conclusive, especially for physiological effects. There is much less data available concerning connections between biodiversity, ecosystem services, and human health and well-being parameters. However, there is some good information indicating that biodiversity exposure can improve health and well-being, especially in reducing certain allergic and respiratory diseases (regulatory services). We conclude that there remain significant gaps in our knowledge, particularly regarding likely mechanisms of action, and suggest that new research and policy strategies involving collaboration among ecological, environmental health, biomedical, and conservation scientists as well as urban, land and coastal planners, are needed to make critical progress toward a much deeper understanding of health-nature-biodiversity-ecosystem services linkages. We also conclude that sufficient weight of evidence already exists to justify use of human health benefits as an additional, and potentially very strong, argument for the conservation of natural biodiversity and use of an ecosystem services framework for decision-making.

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SCALING UP WATER QUALITY TRADING THROUGH A NATIONAL NETWORK APPROACH

Carrie Sanneman
Willamette Partnership, Portland, OR, USA

Carrie will highlight efforts of the new National Network on Water Quality Trading to collaborate with a range of practitioners and stakeholder groups to articulate shared principles, core trading program design elements, and recommendations for implementing trading programs in a consistent, rigorous, and credible way. Carrie will bring perspective from shaping water quality trading policy at three scales: co-coordinating the National Network effort, co-facilitating a regional process to developed shared trading policy in the Pacific Northwest, and verifying individual trades for point sources in Oregon.

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DEVELOPING A BIOLOGICAL CONDITION GRADIENT FOR THE PROTECTION OF CORAL REEFS IN GUÁNICA BAY

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The biological condition gradient (BCG) is a conceptual model that describes how biological attributes of coral reef ecosystems might change along a gradient of increasing anthropogenic stress. Under authority of the Clean Water Act, EPA is committed to protecting the biological integrity of the Nation's waters, including marine coastal habitats such as mangroves, seagrasses and coral reefs. Coastal resource managers routinely conduct biological assessments to evaluate the condition of a water body using direct measurements of the resident biota to integrate the cumulative impacts of chemical, physical, and biological stressors on aquatic life. A missing component is a scientifically derived process for identifying thresholds that can be coupled with management objectives and used to evaluate alternative decision options.

EPA assembled 30 coral reef scientists with expertise in coral reef taxonomic groups (stony corals, fishes, sponges, gorgonians, algae, seagrasses and macroinvertebrates), specializing in community structure, organism condition, ecosystem function and ecosystem connectivity. These experts are developing a BCG for the coral reefs of Puerto Rico. They will design the BCG so it will be broadly applicable to many Caribbean reefs with the process and framework transferable to other geographic regions.

During a series of facilitated workshops and webinars the experts evaluated photos, videos and data collected from coral reefs exhibiting a wide range of conditions. The experts defined ten attributes each of which provides information about the biological condition of a coral reef (including aspects of community structure, organism condition, and ecosystem function and connectivity). The experts are using those attributes to define levels of biological condition along an anthropogenic stressor gradient, including criteria to identify reference condition (a natural fully-functioning system of reef organisms and communities).

Results of this research will include: 1) the BCG conceptual model for coral reef ecosystems, 2) a database of coral reef species from Puerto Rico and USVI that defines the tolerances/sensitivities to different anthropogenic stressors, and 3) an integrated coral reef database for Puerto Rico and USVI. The coral reef database will reside on EPA's STORET (STOrage and RETrieval) Data Warehouse which includes data in the original format, a 'crosswalk' with translations for normalizing data, and the final standardized format.

The application of the BCG to coral reefs demonstrates that the BCG framework can be successfully used by managers to define biological expectations for: designated aquatic life uses; to interpret current condition relative to management goals; to track system responses to management actions; and to communicate environmental condition and outcomes to the public.

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GULF OF MEXICO OFFSHORE ECOSYSTEM SERVICES: STAKEHOLDER VALUATION WORKSHOPS

*David Yoskowitz[1], Sandra Werner[2], Gary Isaksen[2], Cristina Carollo[1], **Carlota Santos[1]**, and Travis Washburn[1]*

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Preserving the ability of the environment to provide valued ecosystem services is one of the overall objectives of environmental management. International standards and policies are being developed to meet this goal, but often lack a structured framework for engaging stakeholders in the decision-making process. In particular, the integration of ecosystem services into the management of deep-water marine systems has been limited by the absence of organized forums where stakeholder groups can communicate their values and expectations, and where the input provided by stakeholders can be used to determine ecosystem services priorities as perceived by the wider ocean user community.

To begin closing this gap, the Harte Research Institute in partnership with ExxonMobil held two stakeholder workshops on September 29th in Houston, Texas and on November 21st in Tampa, Florida. The workshops were designed to engage participants in a discussion on ecosystem services provided by the deepwater Gulf, and to facilitate the relative valuation (or ranking) of offshore ecosystem services using a non-monetary valuation scheme (Relative Valuation of Multiple Ecosystem Services Index/RESVI approach). Stakeholders that participated in the workshops included representatives from commercial and recreational fishing, oil and gas, diving, aquaculture, wind energy, pipeline industry, federal agencies, and non-government organizations. Both workshops were held independently of each other, i.e., participants did not overlap between the two workshops, and results from the first workshop were not shared during the second workshop prior to completion of the valuation exercise.

The following important findings were made during the workshops: (1) stakeholders took a holistic approach, i.e., recognized the importance of multiple ecosystem services instead of assigning value only to those services that were closely related to their respective constituents; (2) both workshops yielded similar results, with food, raw materials, and recreation being among the top ranked ecosystem services; (3) stakeholders in both workshops distinguished between direct (provisioning and cultural) and indirect (regulating and supporting) services; (4) there was a preference among stakeholders to rank only the direct services, as these are the services directly used by stakeholders; and (5) stakeholders further expressed that the role of indirect services needed to be considered when designing monitoring and/or mitigation measures to ensure the sustainability of the direct services.

The workshop results provide a first step toward defining and understanding priority ecosystem services in the deepwater Gulf as perceived by the wider ocean user community. Future steps will depend on the willingness of all stakeholders, including industries, scientists and government entities, to share into collaborative efforts that ensure the sustainability of ecosystem services for all ocean users.

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CONFLICT AND FRAGMENTATION IN LAND MANAGEMENT – CAN AN ECOSYSTEM SERVICES APPROACH SUPPORT LANDSCAPE SCALE PLANNING AND IMPLEMENTATION ON LANDS IN THE PUBLIC-PRIVATE INTERFACE?

Jodi Schoenen
Dynamic Ecosystems and Landscapes Lab, Portland State University, Portland, OR USA

Land management in the Rogue Basin of Southwest Oregon has a complex, layered history that has led to contemporary patterns of use and ownership across the Basin. Climate change predictions indicate this region will experience increases in wildfire, changes to regional hydrology and biodiversity, and shifts in vegetation composition and cover – all of which affect social and ecological resiliency of the region. Our research considers the intricate interplay of ownership and management patterns on the landscape, increased risk for catastrophic wildfire due to a changing climate, and barriers and opportunities for collaboration via public-private partnerships within an ecosystem services framework.

This discussion highlights current research focusing on both the social measures and ecological measures of ecosystem health and function. Relationships between areas of social conflict and areas of spatial fragmentation are drawn using a landscape resiliency approach. Additionally, the perceived barriers and opportunities to working at a landscape scale on climate change adaptation planning are considered in light of catastrophic fire risk and loss of biodiversity. We pilot emerging methodologies for blending quantitative and qualitative data collection and spatial analysis with the intent that these tools will be useful for land managers interested in ecosystem service assessments.

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PAYMENT FOR ECOSYSTEM SERVICES AS A MEANS TO PROMOTE SOCIO-ECOLOGICAL CONNECTIVITY

Mary Schorse
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Growing recognition of the post-normal context in which current sustainability interventions such as payment for ecosystem services (PES) operate is encouraging new thinking about the fundamental goals and objectives of sustainability (Meppem and Gill, 1998). A post-normal world is one characterized by fact uncertainty, value disputes, urgency of action, and the high stakes associated with ineffective and inappropriate policies, strategies and interventions (Funtowicz and Ravetz, 1993). Climate change and global deforestation epitomize post-normal socio-ecological problems. A framework for socio-ecological connectivity (SEC) is proposed to address values plurality in post-normal problem-solving. The SEC framework argues that continued unsustainability is more a function of unresolved socio-ecological value disputes in lieu of the more widely adopted view that unsustainability is a function of a misguided economic growth model or limited understanding of the biophysical impacts of anthropogenic activity. At the center of the SEC framework, therefore, is the goal of mutual learning via self-reflective processes of pluralistic engagement. The framework adopts a transdisciplinary approach to socio-ecological knowledge production. It further proposes a sustainability assessment methodology as an effective process for reflective dialogue (Gibson, 2006, Bond et al, 2013).

The ecosystem services concept offers a valuable point of departure for pluralistic engagement. An ecosystem approach to sustainability recognizes the highly variable, uncertain and co-evolutionary characteristics of complex socio-ecological systems. Economic valuation of essential ecosystem goods and services, however, limits the capacity of the ecosystem services model to enhance social awareness of ecosystem 'value'. This presentation highlights findings of ongoing research into the potential application of the socio-ecological connectivity framework to emerging PES initiatives within the Latin American and Caribbean context.

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THE VALUATION OF MARINE ECOSYSTEM GOODS AND SERVICES IN THE CARIBBEAN: A LITERATURE REVIEW AND FRAMEWORK FOR FUTURE VALUATION EFFORTS

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Marine ecosystems supply a variety of goods and services that provide direct and indirect contributions to human well-being. These include goods traded in formal markets such as food and materials as well as non-market goods and services such as waste regulation, climate regulation, coastal protection and opportunities for recreation. The countries of the WCR are highly dependent on marine ecosystems for a variety of goods and services. These ecosystems are known to be under significant threat, and many of these threats are transboundary in nature. The need for, and interest in, policy advice based on valuation of marine ecosystem goods and services was identified in a region-wide survey of policy advisers and provided the impetus for this study. Economic valuation of marine ecosystem goods and services forms an essential part of ecosystem-based management by (a) informing us of the gains to be obtained from improved marine resource management; (b) indicating what will be lost through inaction; and (c) indicating the true costs of development options.

This presentation will provide an overview of economic analyses of marine ecosystem services for the three major marine ecosystem types in the Wider Caribbean Region (WCR) - reef, pelagic and continental shelf (CLME Project, 2011). Gaps, deficiencies and unknowns in the extant literature are discussed as a basis for a framework for valuation in the WCR so that future work can be directed toward areas of policy importance.

A review of over 200 value estimates suggests that marine economic valuations in the WCR have focused on a limited number of benefits derived from marine ecosystems, primarily those that are relatively easy to measure and convey, such as recreation opportunities in protected areas, and benefits that are ascribed to easily measured market indicators.

Values associated with reefs have received far more attention than those associated with the pelagic or shelf ecosystems. The economic impacts of overfishing remain largely unexplored. Regulating and maintenance services provided by the marine ecosystems of the WCR have been recognized as important, but have not been linked to valuation. Finally, estimates of non-use values for WCR marine ecosystem goods and services are few.

It is suggested that future work on valuation be coordinated among countries and agencies so that gaps can be prioritized and valuation studies can be directed toward a more comprehensive understanding of the full value of the goods and services provided by marine ecosystems in the WCR.

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NEAR ROAD TREE COVER IN THE TAMPA, FL ENVIROATLAS COMMUNITY AREA

***Alexandra Sears*[1], *Laura Jackson*[2], *and Tim Wade*[2]**

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Through EnviroAtlas, EPA and its partners seek to effectively measure and communicate the type, quality, and extent of services that humans receive from ecosystems so that their true value can be considered in decision-making. One of the ecosystem services examined in the community component of EnviroAtlas is potential vehicular pollutant buffering by near-road trees. Harmful air pollutants such as airborne particles, nitrogen dioxide, and carbon monoxide are found in high concentrations along busy roadways. Tree cover adjacent to busy roadways has been shows to alter concentrations of ultrafine particles and other hazardous air pollutants emitted by traffic. The purpose of this analysis is to quantify and visualize the amount of woody vegetation near roadways, and the population living along heavily-traveled roads for greater Tampa, FL a US EPA EnviroAtlas pilot community.

To create these map layers, land cover was classified from 1-meter resolution aerial photography, and was then used to quantify the amount of tree cover along interstates, arterial roads, and connectors within a focal community. The amount of tree cover within twenty-six meters from the edges of these busy roadways was calculated using a moving window approach. The final products include both a visual representation of the near-road tree cover summarized into five percentage classes, and a summary at the Census block-group scale of the population with and without significant tree buffer.

The map layers created in this analysis can be used to assess the extent of buffered roadways across a community and the disparities in benefits between neighborhoods. When overlaid with socio-economic layers available in EnviroAtlas, this map can highlight specific age groups and other populations who are differentially vulnerable to the adverse health effects of near road air pollution. The threshold value and buffer depth in this analysis are based on plausible assumptions and preliminary field studies. Further analysis is necessary to validate and or refute these estimations. As EnviroAtlas grows, a cross-city comparison would further inform the utility of this ecosystem service.

This material has been reviewed and approved by the U.S. EPA. However, it does not necessarily reflect official Agency policy.

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PROXIMITY TO PARKS IN THE PHOENIX, AZ ENVIROATLAS COMMUNITY AREA

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Through EnviroAtlas, EPA and its partners seek to effectively measure and communicate the type, quality, and extent of services that humans receive from ecosystems so that their true value can be considered in decision-making. One of the ecosystem services examined in the community component of EnviroAtlas is the intrinsic value of access to nature and green space with a focus accessibility of parks. In urban areas, parks provide much-needed green space and are often used to recreate, providing opportunities to socialize with others, participate in physical activity, and engage with nature. The purpose of this analysis is to quantify and visualize the proximity of parks, and the population living within walking distance of a park in Phoenix, AZ a US EPA EnviroAtlas pilot community.

To create these map layers, park entrances were derived based on available federal, state, county, and local data, as well as aerial photography. The distance to each park entrance was then calculated along walkable roads for up to 5 kilometers. Using the distance calculation, proximity zones were interpolated across the selected area. From these distance zones, the residential population within easy walking distance (500 meters) of a park entrance was calculated for each Census block group.

The map layers created in this analysis can be used to identify neighborhoods that are underserved in terms of park access and may benefit from additional parks or new park entrances. When overlaid with socio-economic layers available in EnviroAtlas, this map can highlight park proximity for specific age groups and other populations for whom access could be especially beneficial. As EnviroAtlas grows, a cross-city comparison would further inform the utility of this ecosystem service.

This material has been reviewed and approved by the U.S. EPA. However, it does not necessarily reflect official Agency policy.

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VALUATION OF ECOSYSTEM SERVICES FOR ENVIRONMENTAL DECISION MAKING IN SOUTH FLORIDA

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The Greater Everglades system imparts numerous, vital ecosystem services (ES) to South Florida residents including high quality drinking water supplies, a habitat for threatened and endangered species, opportunities for recreation and much more. The system is currently undergoing restoration on which the provision of these ES is highly dependent. As a result of the altered Everglades system and regional ecological and socioeconomic dynamics, restoration may either improve the provision of these services or impose a tradeoff between enhanced environmental goods and services and competing societal demands. The current study aims at understanding public preferences for restoration and generating willingness to pay (WTP) values for restored ES through the implementation of a discrete choice experiment. A previous study (Milon et al., 1999) generated WTP values amongst Floridians of up to $3.42 -$4.07 billion for full restoration over a 10-year period. As such, a key component of the current study involved replicating some components of the Milon et al. (1999) study to see whether or not temporal stability of preferences exists for Everglades' restoration. We have collected data from 1,843 respondents based on two samples (*n*= 970 within the general public and *n*= 873 amongst licensed saltwater anglers in Florida) who participated in an online survey designed to elicit the WTP values for selected ecological and social attributes included in the earlier study (Milon et al. 1999). We also included new attributes designed to consider effects of Everglades Restoration that were not previously investigated. In order to accommodate for the low-levels of scientific knowledge regarding the Everglades, the survey contained informational videos to provide key information on the past, present, and proposed flow within the Everglades and set up a broader context for the choice experiments. Preliminary analyses based on multinomial logit models indicate that income and price of restoration plans significantly affected choice for each plan. Certain ecological attributes also significantly influenced respondents' choice for restoration including varying levels of restoration of the hydrological flow within the Everglades National Park and Lake Okeechobee and also possible inland mangrove expansion. Considering that South Florida depends significantly on the services afforded by the Everglades, assessing public preferences is necessary for a comprehensive view of the social dynamics of Everglades Restoration. The analysis from this study will provide some tangible estimates of economic values of these ES for policy analysts and decision makers. Future research includes further sampling amongst non-English speaking communities in South Florida and covering more targeted stakeholder groups such as freshwater anglers.

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INTEGRATING MULTIPLE STAKEHOLDERS IN THE ECOLOGICAL RESTORATION OF AN IRON ORE MINE IN INDIA

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The policy context in India has incentivized open cast Iron ore mining by large corporations along with corporate social and environmental responsibility. We discuss the practical implications of this dynamic policy context through the case of Ecological Restoration of degraded areas in the Iron Ore Mines at Bolani, Odisha, India.

The restoration experiment engaged a multidisciplinary team of social and natural scientists to undertake Ecological Restoration of a 75-acre area bounded by active Iron ore mines, tribal villages and the mining township. The restoration plan involved an ecological description of the experimental site, target conditions, and control site by vegetation and soil surveys. Protocols were developed for monitoring vegetation, groundwater and weather conditions of the microhabitats at the experimental site. The end goals of restoration were also informed by independent studies of two tribal settlements adjoining the experimental site.

Synergies among Ecological Restoration, generation of Ecosystem Services and sustainable livelihoods were identified for the long run. However, in the initial stages of Ecological Restoration, the recovery of supporting ecosystem services at this highly degraded site led to an increase in resource extraction activity. Studies of the various social groups revealed fragmented societies that elicited the need for different ecosystem services. At the local scale, the supporting and provisioning services were of greater importance to tribal households, regulating services of importance to the mining company or restoration project proponents, and contrasting cultural services to the mining township. Although prevention of access and extractive activities was critical in the early stages of Ecological Restoration, it led to conflicts with members of local society that were most dependent on these resources for their livelihood.

The multiplicity of objectives, stakeholders, disciplines and methods yielded rich insights for the ongoing restoration project. The lessons from this case study contribute to the discussion on the science and public policy of Ecological Restoration.

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A RESEARCH SYNTHESIS ON THE SPATIAL ECOLOGICAL AND ECONOMIC SUBSIDIES OF MIGRATORY SPECIES

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Migratory species are economically and culturally important; the benefits they provide include food for millions of people, regulation of agricultural pests, pollination, recreation (wildlife viewing, hunting), seed dispersal, etc. The regular movement of migratory species between landscapes can result in a mismatch between the areas that most support a species' population viability and those areas where the species provides most benefits to society. These spatial linkages can be quantified as ecological and economic subsidies through the integration of biological and socioeconomic information about the species and the provision of various types of ecosystem services to human populations. A multi-year interdisciplinary working group aimed at operationalizing this spatial subsidy concept has quantified multi-million dollar subsidies for three North American migratory species: northern pintail ducks, monarch butterflies, and Mexican free-tailed bats. We present a synthesis of lessons learned and the methods developed in the course of this working group. We further explore the implications of this information to inform and fund cross-jurisdictional cooperative management and conservation of migratory species.

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STATE OF THE SCIENCE: WETLAND NITROGEN, CARBON AND PHOSPHORUS CYCLING MODELS

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Wetlands cover a small fraction of the terrestrial land surface (less than 8%); however, they possess qualities that characterize them as the most important influencer of the global carbon (C) budgets. Wetlands are the greatest single source of methane emission to the atmosphere, they contain one third of the terrestrial soil carbon globally and act as a primary source of humic substances to freshwater aquatic systems. In recent years, the global problem of eutrophication has resulted in an increased interest in wetlands as natural and effective measures for reducing nitrogen (N) and phosphorus (P) loads in streams and other water bodies. Riparian wetlands have received more attention than other wetland types since they often have a more direct impact on stream water and nutrient balances. Due to the afore mentioned facts, considerable scientific effort has been devoted to building wetland C, N and P models over the past three decades. Wetland models allow scientists and environmental managers to estimate wetland nutrient transformations and storage, and exchanges between wetlands, other ecosystems, and the atmosphere. This presentation will provide a review of a number of prominent wetland N, P and C cycling models. The selected models are process-based, fairly recent and tailored for natural wetlands. The governing relationships used by different models are examined and suggestions are made regarding model suitability for different applications. Models varied in the type of wetlands represented, complexity, and scale of application.

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IMPROVING SOCIAL-VALUE TRANSFER THROUGH SOCIAL-CONTEXT MATCHING

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Ongoing efforts to explicitly incorporate social values, the perceived nonmarket values the public ascribes to ecosystem services such as aesthetics and recreation, into ecosystem service assessments have been dependent upon the availability of value and preference data elicited through surveys of the general public. However, various constraints limiting the regular collection of these data have required the development of alternative approaches to reliably estimate social values in areas where such data are unavailable. Our work has focused on applying and validating the nonmarket-valuation method of benefit transfer to a spatially explicit and quantitative indicator of social values as operationalized by Social Values for Ecosystem Services (SolVES) http://solves.cr.usgs.gov.

Critical to the success of benefit transfer is ensuring sufficient similarity of the physical and social contexts between the study (source) and policy (target) sites to provide reasonably accurate value estimates. An initial attempt to validate the SolVES implementation of benefit transfer for social-value transfers between national forests in the Rocky Mountain region indicated that performance was, as expected, related to the relative physical and social similarities between forests. However, the analysis focused on adjusting environmental variables included in the transferred social-value models to improve performance while simply observing the differences in social contexts.

The current study examined various approaches for how social contexts might be implemented by SolVES to improve social-value transfer performance. Demographic variables collected as part of public value and preference surveys including age, gender, income, and education levels were compared between social-value models from each forest using various statistical tests to identify similarities. Social-value models reflecting a range of possibly relevant social contexts were also generated for subgroups of survey respondents based on factors such as length of residency in the community and importance of ski areas. The transfer performance of each model was calculated according to the simple difference between maps generated from transferred value models and those produced from actual survey data. Transfer performance was also ranked along a continuum which included the performance of models generated from a split of socially similar survey groups within the same forest.

Explicit consideration of social contexts clearly demonstrates the importance of their similarity to improved social-value transfer performance in general; however, the ability of SolVES to realize this improvement by singling out a specific model judged to be more similar is currently limited. The application of a model selected based on measurably greater social-context similarity did not consistently improve performance. In many cases this was due to a difference in the relationship between social-value intensity and selected environmental variables that was not apparent from any social-context metrics that were used. Future work will need to explore alternative methods for effectively distinguishing existing survey data by social context as well as consider additional variables in the design of future surveys that would assist with these distinctions.

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TEXAS STATEWIDE ASSESSMENT OF FOREST ECOSYSTEM SERVICES

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A 2011 Texas A&M Forest Service report estimates the total, traditional economic contribution of the forest sector at $27.1 billion annually. Texas forests also provide numerous ecosystem services that are essential to the survival and well-being of all citizens in the state. Yet, because markets are generally not established, these services are not appropriately valued. For these reasons, an assessment was conducted to estimate the conservative economic value (2011 USD) of forest-based ecosystem services in Texas, develop a web application to display results, and raise the awareness of the overall importance of Texas forests. This assessment focused on the cultural and regulating (biodiversity, climate, and watershed) services provided by the sixty million acres of forestland within the state (USDAFS - FIA).

Biodiversity regulating services were quantified for all forested acres in the State, with special attention given to the top ten percent of ecologically significant acres as designated by the Regional Ecological Assessment Protocol (EPA Region 6). Climate regulating services were based on carbon storage (FIA) and accumulation rates (literature) and air pollutant removal rates of forests in urban areas using the UFORE model. Watershed regulating services were measured using a spatial distribution of available water supply in Texas and estimates of forest cover types (non-riparian, riparian, and wetland forests in rural and urban areas). The benefit transfer method was used to value the regulating services, while an original, stated-choice survey and econometric modeling were used to quantify and value the cultural services. A web application (*Forest Ecosystem Values*) was developed on www.texasforestinfo.com to enable users to view maps, obtain ecosystem service values, and print reports for customized areas of the State.

Results from this assessment estimated forest based ecosystem services in Texas are valued at $92.9 billion annually. Cultural services, at $60.4 billion/year (65%), by far, made the greatest economic contribution to the overall value, followed by biodiversity ($14.8 billion/year; 16%), and watershed regulating services ($13.2 billion/year; 14%). Climate regulating services provided $4.4 billion/year, 5% of the overall value, and consisted of $4.2 billion/year in carbon storage and accumulation and $190.3 million/year in air quality regulation.

Texas forests are critically important not only for their currently marketable goods, but also the life sustaining services they provide to all Texans. This assessment has helped raise the overall importance of Texas forests, and can be used as a critical resource to support smart land-use planning, forest conservation efforts, and assessments of the impacts of natural disasters and conservation programs. It is also being used as the foundation for creating a regional template for the Southern Group of State Foresters to aid in conducting state level ecosystem service assessments.

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NATIONAL ECOSYSTEM SERVICES CLASSIFICATION SYSTEM (NESCS): CONCEPTUAL FRAMEWORK AND ILLUSTRATIVE APPLICATION

Paramita Sinha *and George Van Houtven*
RTI International, USA

Understanding the ways in which ecosystems provide flows of "services" to humans is critical for environmental decision making; however, the linkages between natural and human systems are complex and multi-faceted. A well-defined classification framework for ecosystem services is essential for systematically identifying and tracing these linkages. NESCS is designed to address these needs. Its main objective is to provide a framework that will aid in analyzing the human welfare impacts of policy-induced changes to ecosystems. In particular, it is intended to support different types of policy impact analyses, such as cost-benefit and distributional analysis.

The conceptual framework for NESCS was developed by applying the principles underlying existing classification and accounting systems for economic goods and services, such as the North American Industry Classification System (NAICS), the North American Product Classification System (NAPCS), and the National Income and Product Accounts (NIPA). As others have done using these economic principles (e.g., Boyd and Banzhaf [2007]), it draws a key distinction between intermediate and final services. In particular, the NESCS classification focuses on flows of final ecosystem services (FFES), which it defines as the direct contributions made by nature to human production processes or to human well-being. FFES are identified by linking the ecological systems that supply final ecosystem services with the human systems that directly use or appreciate these services (i.e., market production systems and households).

To uniquely identify final ecosystem services, the NESCS system comprises two complementary tools. The first tool is the NESCS classification structure that consists of four groups : (1) environmental classes dividing up the earth's surface; (2) classes of ecosystem end-products, which are the biophysical components of nature directly used or appreciated by humans; (3) classes of direct human use (or non-use appreciation) of end-products; and (4) classes of direct human users of end-products. The second tool is the NESCS conceptual framework that provides a way to systematically link and combine utually exclusive categories from each of these four groups. Each combination defines a FFES and represents a unique pathway for linking changes in ecosystems with human welfare.

To demonstrate NESCS, we provide examples illustrating how the framework and classification system can be applied to identify potential pathways through which policy changes ultimately result in human welfare changes. We specifically examine a hypothetical policy that reduces atmospheric deposition of nitrogen and sulphur, and focus on pathways that link changes in acidic deposition to services provided by forest ecosystems.

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TAKING WATER QUALITY TRADING TO THE NEXT LEVEL: UNIFYING THE MESSAGE AND SCALING UP

Brooks M. Smith
Troutman Sanders LLP, Richmond, VA, USA

Brooks Smith will speak on the efforts of the new National Water Quality Trading Alliance, which is a consortium of leaders from the business, governmental, non-profit and regulated community focused on enhancing and expanding market-based opportunities for improving water quality. The NWQTA will work to support comprehensive and coherent government rules and policies on trading as well as the development of new and existing state and regional trading markets, while serving as a platform to advance the science and ecological effectiveness of water quality trading.

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DEPLOYING PRIVATE SECTOR CAPITAL TO SCALE NATURAL INFRASTRUCTURE OPPORTUNITIES

Kevin Smith
Goldman Sachs, New York, NY, USA

This portion of the panel will highlight how private sector capital and innovative financing structures can be deployed to scale natural infrastructure approaches. Kevin will discuss innovations in finance such as the social impact bond, pay for performance structure and green bonds and how they can potentially open up greater flows of private capital towards natural infrastructure opportunities.

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APPLICATION OF ECOLOGICAL, SOCIAL AND ECONOMIC VALUES TO LAND MANAGEMENT PLANNING AND IMPLEMENTATION

Nikola Smith
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Assessments of ecological, social and economic values in the Rogue Basin of Southwest Oregon can be applied to critical resource decisions at various scales. Ecological information related to geology, soils, hydrology, vegetation and disturbance regimes can strengthen understanding of a landscape's capacity to provide ecosystem services and identify site-specific management that is needed to restore or sustain that capacity over time. This ecological context coupled with social and economic assessments can guide priority-setting and shape desired management outcomes.

Application of these assessments includes Basin-wide prioritization across jurisdictions to encourage more streamlined and efficient management on public and private lands. Implementation at the watershed scale can include Adaptive Management Areas which were established by the Northwest Forest Plan and are comprised of U.S. Forest Service, Bureau of Land Management, and privately-owned lands. Case studies on Ranger Districts can apply ecosystem services concepts to the National Environmental Policy Act process. Ecosystem services objectives are identified through workshops with subject matter experts and stakeholders and can be addressed across program areas (vegetation and watershed management, recreation, fish and wildlife, fire and fuels) in accordance with the ecological setting of target watersheds. The cross-jurisdictional nature of these projects and collaborative approach to design and implementation are critical to their success.

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ECOSYSTEM SERVICES AND U.S. FOREST SERVICE LAND MANAGEMENT

Nikola Smith[1]*, Krista Gebert*[2]*, Kawa Ng*[3]*, Robert Deal*[4]*, and Emily Weidner*[5]

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The U.S. Forest Service (USFS) mission to "sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations" aligns closely with the ecosystem services concept. Connections between forests and people is central to USFS policy and land management planning. Most recently, the 2012 Planning Rule requires land management plans to provide for ecosystem services and multiple uses. Agency leaders championed an ecosystem services approach to planning under this rule as an opportunity for innovation, integration and improved public engagement. Thirteen national forests have applied the 2012 rule and addressed ecosystem services components using diverse approaches that represent a spectrum of resource investments and analytical intensity.

Prior to the approval of the 2012 Planning Rule, individual national forests and ranger districts experimented with applications of ecosystem services concepts to project-level planning. These case studies resulted in participatory and integrated decision-making processes and helped illustrate the rationale for management proposals. Projects applied tools and methods readily available to USFS staff and explored qualitative as well as quantitative approaches to addressing ecosystem services in smaller-scale planning processes. National forests are also using ecosystem services to frame larger-scale, cross-jurisdictional planning efforts in collaboration with adjacent agencies and land managers to improve management outcomes.

In recognition of the growing but informal nature of the agency's ecosystem services programming, the USFS Associate Chiefs established the National Ecosystem Services Strategy Team (NESST) in 2013 to collaboratively develop national strategy and policy around ecosystem services and integrate the concept into Forest Service programs and operations. Working toward the objectives outlined in its charter, NESST is working to identify growth opportunities for ecosystem services programming in the USFS as well as barriers and needs to fully take advantage of these opportunities.

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PRINCIPLES OF ENVIRONMENTAL ACCOUNTING

Jeremy Sokulsky *and Katie Riley*
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Federal agencies spend $10 billion annually, with states and private companies spending billions more, to protect and restore ecosystem services. In the past, there has rarely been a strong understanding of the environmental improvement that resulted from these investments. Thus, it was not possible for grant managers, regulatory agencies, or fund administrators to meaningfully report how funded projects achieve stated goals. Without a focus on outcomes and clear accountability in project selection and execution, the effectiveness of conservation investments was significantly reduced or simply unclear. The application of environmental accounting is profoundly changing this dynamic and improving the effectiveness of conservation activities across the country.

Central to environmental accounting are quantified ecosystem service credits that integrate both quantity and quality of environmental conditions. These credits create a currency that can be used to evaluate the effectiveness of projects and investments. Environmental accounting also includes an adaptive management system that ensures that new information is incorporated to improve program implementation and results over time. The knowledge that all projects within a region or program will be compared based on effectiveness and cost increases the rigor of project selection and drives accountability in implementation. Direct purchase of verified credits and contracts that are based on quantifiable outcomes can 1) ensure that public and private investors receive defined environmental return for their investments, and 2) allow programs to strategically invest limited funds into the most effective projects, resulting in the most efficient use of limited resources.

Environmental Accounting is an approach that is applicable and increasingly used in a variety of ways to improve public and private conservation investments - both domestically and abroad. Environmental accounting allows regulatory agencies and other policymakers to define rigorous and consistent standards for conservation programs and ensure environmental benefits are achieved on-the-ground. One current application includes mitigation programs related to the Endangered Species Act (ESA) that are incorporating environmental accounting principles within programmatic regulatory instruments, such as Habitat Conservation Plans. These regulatory instruments are gaining popularity as a way to protect habitat and provide certainty to industry and agriculture. Regulatory agencies are also including environmental accounting principles to candidate species policy to ensure that robust mechanisms are in place to protect species under consideration for ESA listing. Federal agencies are also utilizing environmental accounting to improve the effectiveness of public spending - the US Agency for International Development is using environmental accounting to improve the delivery of $200 million per year of investments in forestry and biodiversity projects in developing countries. Finally, conservation investment funds are applying the concepts of environmental accounting to achieve important conservation outcomes while seeking competitive financial returns for their investors.

Panelists will discuss these examples in greater depth and discuss how environmental accounting is being applied to significantly benefit these efforts. Participants will be invited to engage in discussion of additional ways that environmental accounting can be applied to conservation programs.

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INTEGRATING THE VALUE OF NATURE INTO BUSINESS DECISIONS

Jim South[1], *Elizabeth Uhlhorn[2], Jennifer Molnar[1], Jeff North[1], Sheila Reddy[1], Rebecca Currie[2], France Guertin[2], Timm Kroeger[1], Christina Kennedy[1], and Leandro Baumgarten[1]*

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Nature underpins business – companies are realizing that as the health of natural ecosystems declines, it can increase business risk and impact their bottom line. However, new opportunities are also emerging to create economic value for companies through nature based solutions.
In 2011, The Nature Conservancy and The Dow Chemical Company began a 6-year, $10M collaboration to build the tools and the business case for conserving nature and demonstrate that nature may provide new solutions to ensure business sustainability. Through this oral session, the project leads from The Dow Chemical Company and The Nature Conservancy will present detailed technical results, lessons, and future plans for the TNC-Dow Collaboration.

In the first three years, the collaboration team focused on testing how conservation science and data can be used to help address four specific business decisions at two Dow sites – in Freeport, TX and Santa Vitória, Brazil. For example, at Dow's Freeport site (Dow's largest facility worldwide), analyses showed that planting native bottomland hardwood forests could potentially be as cost effective as scrubbers in removing air pollutants (ozone and NOx). The collaboration will work with the US EPA and the Texas Council on Environmental Quality to determine if reforestation can be included in the suite of business options for meeting air quality compliance in the region. If successful, this strategy could potentially be applied in other urban areas around the US.

Since the mid-point of collaboration, the collaboration team has been seeking to learn from 1st and 2nd pilot sites and to apply the lessons to find ways for Dow and other companies to account for and integrate the value of nature in their decisions. Current efforts include:

- **Ecosystem Services Identification and Inventory (ESII) tool development**– The Collaboration is developing a site-level tool for non-ecologists to assess nature's value in business-relevant units. For example, for a forest on site, the tool could estimate the amount of stormwater reduction provided to the site and/or neighbors. The tool would help value this reduction using avoided cost or replacement cost approaches by providing novel ecosystem service data to input into the company's cost models. Thus, engineers would be able to include the forest in planning for stormwater management – and understand that flooding impacts could increase with forest removal.

- **"Value of nature" goal** – TNC is working with Dow to include a nature goal in Dow's Next Generation Sustainability Goals as a way to drive incentives and innovation.

Ultimately, this work is contributing to a framework for how the value of nature can be integrated into business – hopefully leading to improved business performance and increased investment in conservation.

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AN ECOLOGICAL AND ECONOMIC APPROACH TO ECOSYSTEM SERVICES IN RIVERS

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Globally, nutrient recycling represents over half the economic value of all ecosystem services. Surprisingly, these highly cited estimates omit the value of nutrient cycling in freshwater; which is likely considerable. An emerging strategy to mitigate ecosystem health involves re-establishing natural biological processes, which in the past likely served to intercept, transform, and manage nutrients prior to wholesale landscape alterations related to human activities. Aside from estimates that value "use" for water related activities (i.e. fishing and swimming), currently there are few tools linking biophysical properties of streams (nutrient retention/cycling) to value-based economic models. We are using the American eel-freshwater mussel (affiliate-host) relationship as a model system to evaluate the economic and ecological significance of natural capital in two economically critical U.S. watersheds with divergent ecological health trajectories. Migratory barriers (impoundments) have dramatically limited the distribution and abundance of both species. American eels facilitate ecosystem level nitrogen removal via outward migration and serve as primary hosts for native freshwater mussels, a group of invertebrates that can also dominate benthic biomass. Through their filtration activities, mussels are known to facilitate the growth and biodiversity of bacteria, algae, invertebrates and fish contributing to the overall health of ecosystems.

We conducted laboratory and field experiments and evaluated the results within the context of river-specific nutrient export models parameterized for the Delaware and Chesapeake Bay watersheds. We estimate that on an annual basis in pristine portions of the Delaware River, mussels alone can retain and/or remove between 11.1% and 32.2% of nitrogen and phosphorus delivered from the surrounding watershed. We are currently using shadow market techniques to estimate the comparable value of such services to wastewater treatment costs. Our preliminary estimates suggest that up to $59 million dollars worth of annual ecological services can be obtained within the confines of a single 80 mile stretch of healthy river. Our work also demonstrates, however, that the ecological benefits observed in a pristine system may not easily translate to those that are degraded. For example, our experiments indicate that along a continuum of disturbance (nutrient loading), the economic and ecological benefits resulting from natural capital (mussels and eels) become less predictable and often significantly diminished. These results illustrate an important distinction between the cost-benefits associated with conservation (pre-stressor) versus restoration (post-stressor) interpretations of ecosystem services. This economic/ecosystem approach will be further applied to other biological systems (stream biofilms) in other geographic regions (Chattahoochee River, Atlanta) where demands for clean, abundant water must be balanced with the economic realities associated with human population growth.

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CONNECTING LANDOWNERS TO FOREST MITIGATION BANKING IN MARYLAND

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The Maryland Forest Conservation Act and Critical Area Preservation Act are two of the oldest market-based mechanisms in Eastern United States. The regulations require residential and commercial developers to avoid forest loss and mitigate any unavoidable losses. The state law is implemented at the county-level and this has led to several innovations including allowing private landowners to establish forest mitigation banks.

In exchange for permanently protecting new tree plantings and/or existing forest, landowners can generate credits that can then be sold to developers. Credit prices vary due to demand from developers and the overall supply of credits, but in Prince George's County credits can sell for around $20,000 per acre. Landowner involvement can be limited, however, due the up-front costs required to establish forest mitigation banks. These costs include developing natural resource inventories, tree conservation plans, surveys, planting trees, and obtaining financial assurances.

Kim Finch, Woodland Conservation Program Coordinator with the Prince George's County Planning Department, will give an overview of the off-site banking program which has been in operation for over 20 years, and discuss the current state and future prospects of the forest mitigation banking market.

Eric Sprague, Alliance for the Chesapeake Bay, will demonstrate how they are working with Maryland counties to help private landowners more easily access these opportunities and other emerging markets including water quality growth offsets. The Alliance's Forest for the Bay program has developed a methodology and tools to connect landowners to conservation programs based on their management objectives. Forests for the Bay is also establishing a private investment vehicle to help landowners pay for the initial transaction costs involved with mitigation bank set-up.

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MARKETS, DRIVERS, DEMANDS AND SERVICES – MEETING MULTIPLE ECOSYSTEM FUNCTIONS AND MARKETS ON A SHRINKING LANDSCAPE

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Solving the numerous issues of compensatory and voluntary ecosystem offsets must necessarily begin by recognizing the many benefits and values a single acre (the right acre for example) of conservation may potentially represent.

Putting the environment first, good ecology would also in fact suggest that we do all we can to manage our land and water holistically, that we work to restore and enhance biodiversity, that we protect the two resources critical to our survival – air and water. Like the economic 'diversity' enabled by access to multiple markets through stacked ecosystem market credits (payments for ecosystem offsets), biodiversity too represents stability, integrity and resiliency for our environment.

While early attempts at credit 'stacking' may have been misunderstood as 'double-dipping,' there seems little remaining disagreement that multiple ecosystem services representing differing types of ecosystem credits should become the future standard for private banking – our future best practice.

Population growth, infrastructure, energy, and other interests are continuing to exert pressures and impacts on the U.S. landscape, increasingly reducing the public and private lands and water where conservation simply must take place if we are to maintain our basic ecosystem services and precious things like drinking water. So, we simply must find a way to maximize ecological values and benefits on each and every restoration project and for each stream, wetland, species, carbon, nutrient or other bank.

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SUSTAINABILITY ASSESSMENT OF BEEF PRODUCTION

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The beef industry has defined sustainability as meeting the growing demand for beef by balancing environmental responsibility, economic opportunity and social diligence. Accurately measuring sustainability is challenging, as the beef supply chain is one of the most complex food systems in the world. As the first and largest research project of this kind, this study represents an innovative approach toward creating a more sustainable beef product.

Our objective is to establish a sustainability baseline (including environmental, economic, and social footprints) for the US beef industry by quantifying life cycle inputs and outputs for beef production over time. Our approach is to use a combination of models. The USDA-ARS Integrated Farm System Model (IFSM) is used to simulate the environmental and economic footprints from cradle to farm-gate. The socio-eco-efficiency tool (SEEBALANCE®) extends this analysis by determining the environmental, economic, and social impacts of beef from cradle to grave providing a comprehensive assessment of sustainability.

As an initial step, the environmental impacts and economics of beef production at the U.S. Meat Animal Research Center were determined through simulation with the IFSM. These results were combined with primary data from the packer, case ready, retail, and consumer segments of the beef value chain for 2005 and 2011 using SEEBALANCE®. This approach quantified sustainability considering economic, social and ecological impacts along all segments of the beef value chain expressed in 0.45 kg of minimally processed boneless edible consumed beef. Environmental impacts included solid waste contributions, greenhouse gas emissions, ozone depleting potential, photochemical ozone creation potential, acidification potential, emissions to water, resource consumption, land use and energy consumption. Social impacts were measured using toxicity potential, occupation illnesses and accidents, and risk. Economics for the full chain were expressed in consumer price. Overall, the sustainability of the U.S. beef industry, given the present assumptions, has improved by 9% in 6 yr.

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ATTENTION RESTORATION AND STRESS REDUCTION: TWO MECHANISMS UNDERLYING THE HEALTH BENEFITS OF EXPOSURE TO GREEN SPACES

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Green spaces provide an array of ecosystem services (e.g., reductions in the urban heat island effect, habitat for a range of species, flood reduction). Among the least appreciated of these are what have been called psychological ecosystem services (Barman, Hamilton, & Daily, 2012). Psychological ecosystem services include a range of human cognitive and psycho-physiological outcomes that stem from two different mechanisms: the restoration of our ability to pay attention, and a more rapid reduction in the psychological and physiological signs of stress. In this paper, I describe both mechanisms and summarize empirical evidence in support of each.

Attention Restoration Theory

Our capacity to pay attention, that is to focus our mind on some particular topic, requires that we exclude from our thoughts stimuli from the nearby environment (e.g., sounds, smells, visual cues), and ideas that we might contemplate (e.g., "don't forget to buy milk on the way home"). Attention Restoration Theory (ART) (Kaplan, 1995) posits that the mechanism that inhibits these other stimuli from being part of our conscious thought process fatigues with use. That is, over a relatively short period of time, it becomes increasingly difficult to suppress and ignore these other stimuli and keep our train of thought directed to one particular thing such as the papers we are grading, the proposal we are writing, or the vacation we are planning.

ART also posits that being in or viewing green spaces provides this inhibitory mechanism an opportunity to rest, or restore, and in doing so, allows us to focus our attention again. Many dozens of studies have produced empirical evidence in support of ART. The evidence demonstrates that exposure to green settings consistently boosts a person's capacity to pay attention. The findings come from very green settings such as large and small forests, rural areas, wilderness settings, and prairies. But also from more modestly green settings such as community parks, schools, and neighborhoods.

Stress Reduction Theory

Our capacity to recover from a stressful event is enhanced by exposure to green spaces. That is, some types of green spaces have calming effects on people who have experienced stress. Stress Reduction Theory (SRT) (Ulrich, 1983) posits that landscapes containing vegetation, water, modest depth and complexity would have been, for hundreds of thousands of generations, beneficial to human survival because such settings provided resources and the capacity to anticipate the arrival of predators. Such landscapes help moderate and reduce states of arousal and negative thoughts and thus reduce the psychological and physiological symptoms of stress.

A variety of studies have demonstrated that managed green landscapes (e.g., urban parks, community streets planted with mature trees) are associated with reduced blood pressure, lower levels of the stress hormone Cortisol, a decrease in self-reported stress, and increases in positive mood. I conclude by considering these findings in light of our understanding of the ecosystem services provided by managed green spaces

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ECOSYSTEMS AND HUMAN HEALTH? A SKEPTIC'S ASSESSMENT

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For centuries, philosophers, poets, and priests have tried to convince us that our growing disconnection from nature costs individuals and society. The concept of *psychological ecosystem services* (Barman, Hamilton, & Daily, 2012) reflects these same suggestions. But on what scientific basis can we claim that exposure to nature impacts human wellbeing? It is one thing to have a philosophical argument that something exists, it is quite another to describe mechanisms by which one thing impacts another and to produce the empirical evidence that demonstrates causal mechanisms. What is the scientific evidence that exposure to nature, especially nature in urban contexts, impacts human psychological health?

Given the diversity of human conditions on earth, and the diversity of ways one could become exposed to urban nature, a skeptic would expect that evidence regarding the impact of exposure to nature on human psychological health would come from physically observable outcomes associated with rigorous studies conducted under a wide range of physical and social conditions. A couple of positive associations here and there will not convince careful scientists that there is an underlying relationship.

It turns out that empirical evidence in support of psychological ecosystem services has a 40-year history. The evidence comes from direct and indirect exposure to a wide variety of forms of nature and demonstrates that experiences in urban nature provide a variety of benefits to psychological health. When individuals are exposed to urban nature on a regular basis, they reliably show an enhanced capacity to concentrate and pay attention, greater ability to cope with the stressors in their lives, stronger neighborhood social ties, higher levels of life satisfaction, and increased levels of psychological well-being.

The studies that produced these findings were conducted under a great diversity of conditions. The settings varied from places along the rural-urban fringe to urban public housing neighbor-hoods. The participants varied in gender and ethnicity and represent individuals from most stages across the lifespan. The methods of investigation varied among experiments, field experiments, observation and mapping, face-to-face interviews, and mail-back questionnaires. Even the operational definitions of nature varied. That this diversity should lead to consistent findings demonstrating the salutary benefits of urban nature gives us considerable confidence in their validity. It is clear that exposure to nature where people work, reside, and recreate, as well as where individuals are hospitalized or educated, leads to a variety of psychological benefits that the vast majority of individuals would welcome in their own lives.

In this paper, I summarize the state of the science that underpins the notion of psychological ecosystem services and suggest several areas ripe for new investigations. Perhaps the most interesting gap in our knowledge concerns the extent to which exposure to ecologically healthy places impacts human psychological heath. Biologically diverse, native landscapes contribute a great deal to the overall ecological integrity and resilience of a setting, but to what extent do these aspects of healthy landscapes also promote human psychological health?

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CONNECTING STRESSORS, OCEAN ECOSYSTEM SERVICES, AND HUMAN HEALTH

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Ocean and coastal ecosystems provide many critical ecosystem services that support human health and well-being including providing food, storm protection, and carbon sequestration. Environmental stressors acting individually or concurrently and synergistically are reducing the ability of coastal ecosystems to provide key ecosystem services that may result in decreases in human health and well-being. We outline some impacts to human health and well-being that may result from the effects on coastal and ocean ecosystem services of five example stressors: rising temperatures, nutrient enrichment, ocean acidification, habitat destruction and the concomitant loss of biodiversity, and extreme weather events. These include impacts to fisheries and thereby to food supply; distribution, abundance, and virulence/toxicity of harmful algal blooms, water-borne pathogens, and zoonotic diseases and potentially increased disease exposure for humans; and loss of storm/inundation protection, water filtration, and carbon sequestration through degradation of coastal habitats and natural biodiversity. We provide a general conceptual model of how cumulative impacts of multiple stressors may reduce the amount, quality and stability of ecosystem service provision, with a broad range of potential impacts to human health and well-being. We conclude with suggestions for research and related actions to improve our understanding and management of coastal ecosystems. These include the need for natural and biomedical/public health scientists, and their respective professional organizations, to work together to increase understanding of the connections between healthy and degraded coastal and marine ecosystems and human health, and for policy- and decision-makers to account for these impacts when considering trade-offs among management alternatives. We propose that human health and well-being should be the central focus in application of ecosystem services approaches to decision-making.

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UNDERSTANDING RANCHERS' PREFERENCES FOR CONSERVATION INCENTIVES

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Semi-arid rangelands in southern Arizona and southwestern New Mexico provide a wide variety of ecosystem services, including forage for domestic livestock and wildlife, regulation of soil erosion and flooding, and aesthetic value for rural and urban residents. The predominant land use in this mostly rural region is cattle ranching, which takes place on a complex matrix of federal, state, and private lands. Ranchers play a critical role in the provision of ecosystem services through implementation of sustainable ranch management and maintenance of large tracts of unfragmented landscapes.

In March 2014, the United States Fish and Wildlife Service (FWS) designated critical habitat for jaguar (*Panthera onca*) on approximately 765,000 acres in southern Arizona and southwestern New Mexico. Some ranchers and ranching organizations expressed concern that critical habitat would lead to curtailment or elimination of ranching on public lands in the region, result in additional regulation of public lands grazing allotments, and questioned the scientific and legal validity of critical habitat for jaguars in the region. In response, we investigated ranchers' willingness to participate in a payment for ecosystem services (PES) program that would provide incentives for support of jaguar habitat and how incentives might help ranchers counter their concerns.

We interviewed nine leaders in the ranching community and distributed a written survey to all ranches operations (n=289) in southern Arizona and southwestern New Mexico. Questions addressed the following topics: participation in existing conservation incentives programs, existing management practices that benefit wildlife and jaguars, willingness to participate in conservation incentive programs, and preferences for program structure.

We will present the findings from interviews and our survey and discuss their implications for establishment of a conservation incentives program in southern Arizona and southwestern New Mexico. This study provides an indication of the willingness of a ranching community in one location to participate in an incentives program that would improve provision of ecosystem services, while potentially reducing traditional production-based income sources. Rangelands in the Intermountain West provide critical ecosystem services, but there are few examples of working PES programs targeting ranchers. This work is a first step toward understanding the preferences of this community, which may aid in the establishment of PES programs in the southwest and beyond.

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UNDERSTANDING THE SOCIAL BENEFITS OF URBAN GREEN SPACE: COMMUNITY STEWARDSHIP AND RESILIENCE IN NYC

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In an era of climate change, urban green space is increasingly viewed by policymakers and land managers as a site for investment in green infrastructure and as a natural buffer to help mitigate storm surges, sea level rise, and combined sewer overflow (see, e.g., City of New York SIRR Report 2013). While biophysical functions are crucial, urban green spaces are also sites of social meaning and places for cultivating social resilience through civic engagement, use, and stewardship (Chapin et al. 2010; Gomez-Baggethun et al. 2013). Urban parks, for example, are a form of 'nearby nature' that provides space for recreation, socialization, and engagement with the environment and fosters social ties and place attachment. Urban green space is also a critical component in the chronic and acute cycles of disturbance and recovery (Pierre-Louis 2013; Svendsen et al. 2014). Our research suggests that green spaces serve as catalyzing mechanisms within systems that confer resilience across scales and over time—including immediately post-disturbance, during stages of recovery, and over long-term processes of neighborhood and community change.

This presentation describes tools to assess the public use and meaning of urban green space in an effort to strengthen the capacity of civic and government institutions to prepare for and mitigate disturbance. First, we will present a mixed-method approach for rapid assessment of urban parkland, developed for an assessment of 4,500 acres of parkland in waterfront neighborhoods surrounding New York City's Jamaica Bay, and subsequently used on a city-wide assessment. Applied one year post-Hurricane Sandy in a highly affected area, this work inherently explores a post-disturbance context; at the same time, results reveal timeless socio-cultural values that explain why and how people engage with their local environment. Next, we will present a tool to map the stewardship potential in a given neighborhood or city. STEW-MAP (Stewardship Mapping and Assessment Project) was developed in order to understand the network of civic environmental groups that help steward and sustain the local environment. Stewardship maps tell us about the presence, capacity, geographic turf, and social networks of environmental stewardship groups. STEW-MAP can highlight existing stewardship gaps and overlaps in order to strengthen organizational capacities, enhance citizen monitoring, promote broader civic engagement with on-the-ground environmental projects, and build effective partnerships among stakeholders involved in urban sustainability.

Together these applications are designed to be spatially explicit, scalable, and replicable, in order to inform decision-makers throughout an adaptive management process. Both tools produce data that can be combined with ecological or other spatial datasets. Data generated from these applications can inform resiliency theory as well as assist, in real time, with local community resilience planning.

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GENERATING REVENUE FROM "CONSUMERS" FOR ECOSYSTEM SERVICES: LESSONS FROM BOBOLINK FARMING

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Agriculture plays a significant role as a managed ecosystem, producing ecosystem services through effects on water quality, landscape aesthetics, and services such as wildlife habitat. The service of hayfields as habitat for grassland nesting birds represents cultural or aesthetic ecosystem services characterized as a public good. This presentation reviews several aspects of the Bobolink Project from Rhode Island and Vermont that asks non-farm residents to donate in support of offsetting the costs that farmers face in scheduling their harvesting practices outside the critical nesting season. The series of field experiments reported here provide a background for some of the economics laboratory experiments reported later in this session. With this foundation, the audience can anticipate the performance of alternative economic mechanisms and incentives that are intended to translate a higher proportion of individual willingness to pay for grassland nesting bird habitat into actual donations to support sustainable bird-habitat management. The presentation will compare donations to support a single field with donation processes designed to support a larger number of fields and consider incentives to increase individual participation. Also, the Bobolink Project can provide conservation managers with insights to the advantage of using a uniform price reverse auction to procure contracts with farmers providing habitat. While it is likely that communications or marketing details of our novel donations or auction processes pose substantial obstacles to improving performance of fundraising approaches, results suggest that offering rebates of excess funds may encourage donations.

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OVERCOMING BARRIERS TO IMPLEMENTING PAYMENT FOR ECOSYSTEM SERVICE PROGRAMS FOR PRIVATE FORESTLANDS IN THE PACIFIC NORTHWEST, USA

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There have been several attempts to create ecosystem service markets or payment for ecosystem service (PES) programs that apply to both industrial and non-industrial private forestlands in Washington State and Oregon over the past six years (2008-2014). None have been successful either at all or at the intended scale. I review four such efforts covering carbon sequestration, water quality, and restoration of habitat using mitigation banking under the Endangered Species Act for the Northern Spotted Owl (*Strix occidentalis caurina*). Based on the author's firsthand knowledge from participating in these efforts as well as using data from publicly available reports, I describe barriers encountered in both design and implementation of these programs, analyze common features of the barriers, and recommend potential solutions to overcome these barriers in order to create incentives for private forestland retention and ecological restoration.

Older (i.e., greater than 80 years old), structurally complex forests of the Pacific Northwest when present on a landscape scale tend to be more optimal for provision of carbon sequestration, water filtration, water flow moderation, and habitat for hundreds of native fish, wildlife, and plant species than young, plantation forests or forests converted to other uses. Markets or PES programs whose intent is to provide these services all share a goal of paying landowners to retain or restore this ecosystem type as at least one goal. Preventing conversion of working forests, regardless of their developmental stage is frequently another goal.

Common difficulties encountered across all three types of services include: 1) hesitancy on the part of landowners to make long-term commitments to maintain services where such commitments are required to adequately provide the desired service; 2) lack of willingness on the part of many industrial owners to enter into agreements that could affect actual or perceived re-sale value of the land, regardless of size of payment; 3) high project maintenance costs; 4) high opportunity cost of selling less commercial timber or agreeing not to convert to a non-forest use given market values of forest products and real estate; and 5) low actual available payment amounts and/or market prices for the desired service.

Potential solutions to these barriers include 1) creation of new ownership types, like community forests, where there are local and long-term interests in managing forests for ecosystem services; 2) creation of unified, state-based funding pools that pay landowners for the provision of multiple services at once, rather than multiple individual credit or payment systems in order to reduce transaction costs; 3) scaling payments to more closely match opportunity costs; and 4) more aggressive public education on the services that forests provide in order to increase support for adequate funding sources.

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IMPROVING ECOSYSTEM SERVICES FROM AGRICULTURAL LANDS; MODERN TECHNOLOGY AND MARKETS

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There is extrodinary potential to expand ecosystem services on agricultural lands focusing mainly on the new technologies and techiques being imployed to reduce nutrient loads using drainage water management (DWM) and its associated practices. This technology empowers producers to manage their water resources on their farm. The primary opportunity is managing subsurface drainage occurring on cropland rather than simply draining the water into downstream water ways thereby losing any opportunity to use it for subirrigation, reduce the risk and effects of drought, and also expand the land's production capabilities. At the same time the producers are achieving these benefits in managing their farming operation, they are reducing nutrient loading that would otherwise take place. These nutrient load reductions are measureable and occur in real time.

Much of the most productive land in the United States already benefits from some form of drainage system. These acres contribute to nutrient loading but also have the potential for major benefits in water management and nutrient reductions. In the ten states in the Upper Mississippi River, Great Lakes and Red River of the North Basins alone, the USDA – NRCS estimates that nearly 30 million acres of cropland is suitable for drainage water management if it is artificially drained.

What is drainage water management? DWM is the process of managing the timing and amount of water discharges from agricultural drainage systems. The DWM plan provides the target water table level settings needed at specific dates or seasons. Season long control is the goal.

Golden Rule of Drainage Water Management: Only release the amount of water necessary to ensure trafficable conditions for field operations and to provide an aerated crop root zone. Any drainage in excess of this rule likely carries away nutrients and water that is no longer available for crop uptake.

While cover crops and nutrient management reduce nutrient losses at a substantial rate (20% and 25% respectively), drainage water management achieved average nutrient loss reductions of 43% in studies on 19 sites covering 51 crop years. Any combination of these practices under a systems approach can result in significant reductions of nutrient loads.

Another major benefit of reduced nutrient loading under drainage water management is that the reductions are immediate whereas reductions under other practices may take several years to achieve. The calculation of load reductions is rather simple and accurate – nutrient concentration X volume of drainage reduced = load reduction.

Millions of acres of cropland have been artificially drained in the past and many more will be in the future. The use drainage water management as a component of a systems approach to reducing nutrient transport from drained water is very important. The opportunity to establish criteria to quantify reductions in nutrient loading under drainage water management and integrate this into ecosystem markets has great potential. There can be benefits achieved by both the farmer and the public as a whole. Without some additional value though, either from environmental services trading or avoidance of strict regulation, drainage water management costs the landowner incur in time and maintenance are not wholly realized, despite being the 'right' thing to do.

There is a need for the establishment of a panel made up to ecosystem services, technical, government and academic staff to further develop the concept of using DWM water quality credits; identify barriers and how to overcome those barriers; pilot the use of DWM in a high priority ecosystems.

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ECOSYSTEM SERVICES APPLIED TO GRADUATE LEVEL EDUCATION IN ENERGY AND MINERAL RESOURCES

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Examination of natural resource management issues through the lens of ecosystem services has often come from what has traditionally been considered the environmental side of an organization or enterprise, rather than from the resource development side. Professionals with careers in such fields as petroleum geology and mineral exploration have typically been educated in the pertinent geoscience, geotechnical, and engineering applications more so than the environmental, economic, or societal aspects of resource development. This has begun to change with the recognition of a growing need for more educational opportunities that strengthen competencies in designing, implementing, learning from, appraising, and improving more holistic and truly integrated approaches; approaches that encompass a full life cycle understanding of natural resource development and use. Applying concepts of ecosystem services as a discipline of practice in natural resource-related project planning and execution can serve as a catalyst for such competency development. Consideration of the value (both monetary and non-monetary) of all products, services, and processes related to the life cycle of a resource, or multiple inter-connected resources and their associated cycles, will foster skill development for professionals working in the natural resource field.

Graduate programs are recommended that allow participants, especially early to mid-career professionals, to consider a wide range of factors including geoscience and engineering, as well as business, economic and financial analysis, environmental impact, stakeholder engagement, and relevant policy and regulatory issues. Studies in these programs will improve participants' on-the-job ability to make sound decisions in the face of the uncertainty and complexity accompanying real-world natural resource development and management. In addition to these topical aspects, certain cross-cutting skills, including decision analysis, risk assessment, using data in a spatial context, and using an ecosystem services framework, are essential to include in graduate-level programs designed to build on existing undergraduate education, while also integrating work experience. Such graduate degree programs will develop the enterprise leader of the future who will be responsible for wise decisions that increasingly enable more sustainable energy, mineral, and related water resource development and management.

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A SYSTEMS APPROACH TO EXPLORING SUSTAINABLE SOLUTIONS: WATER RESOURCES, ECOSYSTEM SERVICES AND OPTIONS

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Many regions and municipalities in the United States are challenged by a deteriorating water infrastructure that can compromise water quality, public health, and recreational amenities. At the same time, the health of many watersheds is jeopardized by excessive releases of nutrients from agriculture, wastewater treatment, and other sources, which cause algal blooms that degrade or destroy aquatic ecosystems. Due to wide regional variations in economic, geographic, and climatic conditions there is no universal approach to protecting water resources from the challenges of decaying infrastructure and rising nutrient impairment. Moreover, effective interventions require cooperation across a multitude of local jurisdictions and stakeholder groups, including government, business, and community organizations. To develop practical solutions, it is necessary to understand the intricate linkages among water and energy resources, human health, ecosystem functions, and commercial activities.

The speaker will describe progress at U.S. EPA's Office of Research and Development in applying sustainability science to integrate environmental, economic, and social issues at a watershed scale. This "systems approach" is based on dynamic, interactive modeling tools that have been used to analyze energy and environmental policies in the State of Ohio. These innovative tools enable investigation of alternative strategies aimed at creating a resilient system of water resources that serves the needs of a growing population with a minimal ecological footprint. Potential strategies include utilization of "green infrastructure," alternative water supply systems to reduce potable water consumption, water quality protection through stormwater management, and mitigation of nutrient releases through improved industrial technologies and practices.

Analysis of these opportunities should evaluate not only affordability and effectiveness, but also the potential for indirect consequences such as increased greenhouse gas emissions or displacement of jobs. EPA is currently applying this approach to develop practical, sustainable solutions for the problem of reducing nutrient impairment in coastal watersheds while meeting societal and economic needs of affected communities. Examples from projects in New England, the mid-Atlantic, and the northwestern US will be discussed.

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DEVELOPING TRIBAL WELL-BEING INDICATORS FOR THE PUYALLUP INDIAN RESERVATION

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Tribal well-being indicators project goal: The goal of the project is to identify natural resource-based well-being indicators for the Puyallup Indian Reservation using Puyallup tribal member recommendations so that they can be contrasted with those that were suggested for all stakeholders of the entire Puyallup river watershed. Puyallup members will be prompted to suggest well-being indicators for the Reservation using a group discourse process.

The Puyallup Indian Reservation is a permanent land base for the Puyallup tribal community that was reserved through the Medicine Creek Treaty of 1854. Puyallup Indians have always occupied the lands within the Reservation, and the natural resources of the Reservation were held to be of immense cultural value during early Treaty times. The Puyallup people still hold these values for the Reservation today, and expect to continue holding these values for the Reservation on into the many future years. Current problems include needing to ensure that tribal members can access Reservation resources and are not marginalized from Reservation planning and policy development, and ensuring that historically important cultural landscapes and/or culturally significant species are suitably maintained. Local science needs to incorporate Puyallup tribal values, Puyallup tribal knowledge and scientific knowledge need to be integrated, and explanations of how Reservation biophysical processes should be viewed as having value are needed. Ecological identity and identification with nature need to be highlighted, as do the facets of tribal well-being that are directly related to the condition of the natural environment, and Puyallup tribal well-being needs to receive attention during Reservation decisions as well.

Tribal Well-Being Indicator Uses: The relevant, practical, robust and important aspects of tribal well-being[B] and of sustainable development[49] need to be monitored for the Puyallup Reservation - and basic strategies for evaluating how tribal cultural values are identified[12], how community discourse procedures shape Puyallup Reservation biophysical processes[19], and/or how tribal stakeholders might be empowered to participate in decisions[12] are all vitally needed. Tribal well-being indicators can provide a specific means of assessing Puyallup Reservation environment-related well-being[B], selecting recovery strategies that enhance tribal well-being[B], and prioritizing Reservation scientific research[B]. Tribal well-being indicators can provide a means for examining whether Puyallup tribal stakeholders possess enough power to influence what happens[41] upon the Reservation and whether power imbalances and paradigm shifts[5] are ongoing critical topics for the Reservation. Puyallup well-being indicators can highlight that the value of local green areas for strengthening community life[19] is clearly referenced in ancient up through contemporary information[49], and that Reservation policies need to be strengthened[4] using the cultural values that are being measured[27]. Developing tribal well-being indicators for the Puyallup Indian Reservation will demonstrate that tribal member views on managing the Reservation[34], multi-functional cultural landscape needs[20], geo-databases with contextual data[34], and Puyallup tribal cultural values[34] are all in need of highlighting.

Tribal well-being indicators may also be used to promote environmental options using participatory deliberative decisions or for presenting Reservation tradeoffs and synergies, and/or for using tribal traditions as a foundation for ecological restoration upon the Reservation – and well-being indicators could be used to monitor tribal community eco-cultural impacts, as well as evaluate the impacts of Reservation recovery strategies. Tribal well-being indicators might even be used to ensure: 1) tribal health and environmental professionals are coordinating effectively, 2) tribal community organizations are being collaborated with and their responses to change being considered, 3) tribal socio-cultural drivers of natural resource health and benefits to future tribal populations are being evaluated, and/or, 4) hypotheses about ecological variability or future Reservation management decisions - including environmental justice concerns for the Puyallup Tribe – are being furthered.

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GETTING THE SCIENCE RIGHT MEETING CORPORATE DEMAND: NEEDS, CHALLENGES AND OPPORTUNITIES FOR PAYMENT FOR ENVIRONMENTAL SERVICES (PES) TO MEET CORPORATE DEMAND

Gabriel Thoumi
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Clear and consistent scientific standards for payment for environmental services (PES) result in developing a framework by which corporate financing of PES projects and programs and corporate demand for PES goods and services can increase.

The presentation will include a summary of the state-of-play of incentives for corporate participation in PES projects and programs. US-based corporate case studies will be discussed and described summarizing risks and opportunities from a corporate perspective in participating in PES projects and programs. Emphasis will be made on how effective and clear communication between science and business professionals can galvanize corporate demand and participation in PES.

Descriptions of effective communication pathways for science professionals to engage their corporate business counterparties will be described. Finally, recommendations and templates for engaging corporates in promoting their participation and / or financing of PES programs and projects will be included.

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ECOSYSTEM SERVICES ON FOREST AND AGRICULTURAL LANDS OF MARYLAND: A SURVEY OF MARYLAND TREE FARMERS AND AGRICULTURAL LANDOWNERS

***Bob Tjaden*[1], *Adan L. Martinez-Cruz*[2], *Seth Wechsler*[2], *and Richard Pritzlaff*[3]**

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An analysis of Maryland farmers and Tree Farmers knowledge, attitudes and entry point into a Maryland payment for ecosystem service (PES) program. A contingent valuation and conjoint analysis study was developed and a mail survey was designed. A mail survey was sent to 1,000 Maryland farmers and 800 Maryland Tree Farmers April 2012. Focus groups, expert consultants, and pretests were used to develop the 33 question mail survey. This survey was modeled after two similar studies: *"A Survey on Conservation Payments on California Rangelands"* performed by Defenders of Wildlife, Duke University, California Rangeland Trust and California Cattlemen Association, 2008; and *"Conservation Programs on Private Lands: Eastern North Carolina Survey"* performed by Defenders of Wildlife and The Nicholas School of the Environment-Duke University, 2008. This survey will serve as a foundation for future educational grants and policy recommendations.

Key results indicated: 29% response rate; less than 50% of respondents familiar with the term ecosystem services; Tree Farmers appear more willing than agricultural landowners to participate in a PES program; respondents prefer shorter contract lengths (5 yrs. vs. 30 yrs.); agricultural landowners prefer PES programs administered by NGO's, while Tree Farmers prefer PES programs administered by the state and federal government; evidence suggests having heard or being familiar with the term ecosystem services increases probability of participation in PES programs, suggesting that education may increase the probability of participation; most important reason to reject participation in a PES program is lack of information; and payments appear to increase participation.

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ECOSYSTEM SERVICES AND HUMAN USE AND NONUSE LOSSES IN NATURAL RESOURCE DAMAGE ASSESSMENT

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The framework for valuation of Ecosystem Services (ES) is related to, but different than, that for measurement of damages for service losses in Natural Resource Damage Assessment (NRDA). The ES framework is focused on final services, while, as traditonally applied, the NRDA framework addresses both final (direct human use) and intermediate (ecological) services. ES valuations (ESVs) rely on both revealed preference (RP) valuation methods, as well as stated preference (SP) surveys. Most NRDAs use RP and combined RP/SP methods for direct human use service losses, but equivalency analyses (EAs) (habitat equivalency or resource equivalency analyses) for indirect human use and ecological services; which may or may not closely comport with economic analyses.

In this paper I explore the economic relationship between NRDAs and ESVs regarding the conditions under which they would provide similar outcomes, the information requirements of the approaches, and the defensibility of the methods in different settings.

I exploit that fact that ESVs are focused on the measurement of benefits, while NRDAs are focused a comparison of two situations: one absent any spill or release and one with the release of oil or hazardous substances plus restoration actions. I demonstrate that, whenever the decision context is one of ranking two or more projects that affect the environment (always with NRDA but often in ESVs):

(1) an EA approach that focuses on intemediate services can be fully consistent with a full economic ESV;

(2) the information requirements of an EA are less than for an ESV and so more applicable when the bio-physical system is less well understood;

(3) when the ecological systems are understood and reliable RP or joint RP/SP methods can be used, NRDA and ESVs approaches coincide and give a more cost-effective outcome than EA methods;

(4) the ESV framework is not restricted to valuing final goods or services and can be used to evaluate intermediate services in a NRDA if sufficient information is available; and

(5) there are situations where EA methods are more likely to provide reliable rankings of projects that ESV approaches.

Thus, this paper shows that the two perspectives are not incompatible, and in fact are complementary to one another, when the decision context is one of establishing rankings. The paper further provides guidance on the situations where one approach may be favored over another.

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USING CHOICE-BASED CONJOINT ANALYSIS TO ESTIMATE DIFFERENT GROUPS' PREFERENCES FOR WATER ENVIRONMENTAL CHANGES

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It is important for water policy makers to know whether the downstream urban residents are sensitive to the environmental change in the upstream of a river as drinking water source. A sample of 1040 urban households in the downstream of Zhelin Lake, a drinking water source for Jiujiang Municipality, were interviewed for their willingness to pay for changes in the water environment of the Zhelin Lake.

Choice-based Conjoint (CBC) analysis was used for the first time in China to estimate urban households' willingness to pay (WTP) for the environment change. It indicated that CBC could better estimate the marginal WTP. Clogit modeling results showed that downstream households were more sensitive to the water quality improvement rather than stability of water supply. Inclusion of cross-term of income and changes in environmental attributes in the model analysis has little impacts on the valuation of willingness to pay.

WTP varies across groups and contributing factors include environmental awareness for one's own interests, altruist environmental awareness, whether or not from a family with chronic patients, income, gender, hukou, age, whether or not from a family with old members or kids, stable job, decision making in a family. The WTP of not environment-friendly group was higher than that of environment-friendly group. The WTP of low-income group was higher than that of the whole sample. These did not conform to expectations and more study is needed. The effects of other factors were the same with the predictions.

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ASSESSING THE BENEFITS OF OYSTER REEF RESTORATION IN THE CHESAPEAKE BAY

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The once abundant Eastern Oyster population of the Chesapeake has declined to less than 1% of historic levels because of decades of overharvest, disease, poor water quality, and the loss of hard bottom habitat. Federal and state agencies, industry, academic institutions, and non-profit groups are all working in collaboration to implement unprecedented, large-scale restoration of the native oyster population. As we move towards restoration goals, we are monitoring our progress in improving the oyster reefs and beginning to account for the oyster reef ecosystem services that will be re-established. Beyond the value of the oyster for commercial fisheries, major ecosystem services from oysters in Chesapeake Bay include fish and invertebrate utilization enhanced by habitat complexity, water filtration, nutrient sequestration and removal, shoreline and habitat stabilization. To assess the benefits of oyster restoration, we have embarked upon a long-term project to quantify the ecological production functions and estimate the value of these re-established ecosystem services – the Oyster Reef Ecosystem Services (ORES) project. Within the ORES project, several academic partners have been funded to assess a range oyster reef ecosystem services throughout the Chesapeake. This presentation is focused on the value of oyster reefs for fish biomass production in the mid-Eastern shore of the Chesapeake Bay.

We have developed a generalized oyster reef ecosystem model (OREM) of a Chesapeake oyster reef based on literature review. This model in combination with habitat suitability models will be used to create ecological production functions for oyster reef fish production. In turn, this model will provide input for economic models to estimate the commercial and recreational value of fish production associated with oyster reefs. To assess differences in oyster reef fisheries production before and after restoration implementation, we are conducting studies of the fluid and hard bottom habitat around the reefs and sampling finfish associated with the reef. The finfish sampling data will be used to modify the generalized OREM to be representative of mid-Eastern shore reefs.

In the first year of the study, we have conducted baseline assessments of the habitat and finfish communities in mid-Eastern shore reefs before the implementation of restoration in control sites and sites where restoration will begin. As would be predicted in the “before” portion of a before-after control-intervention study design, no appreciable difference in habitat or finfish community structure are observed between treatment and paired controls. However, we anticipate that after the restoration implementation is completed, appreciable differences will be measured.

After the completion of this project, integration with partners’ projects, and completion of economic valuation work, we will be able to produce reasonable quantitative estimates of some key oyster reef ecosystem services. These estimates should be useful for providing guidance to policymakers about future restoration efforts as well as guide restoration managers on site-selection for future restoration implementation.

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THE CHALLENGE OF APPLYING THE ECOSYSTEM SERVICES FRAMEWORK ACROSS THE SETTLEMENT SPECTRUM

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This paper synthesizes the findings of several ecosystem service assessment projects to address the following question: Is the framework of ecosystem service quantification equally practicable or meaningful in all contexts? It shows how the ecosystem services framework as currently practiced, with its roots in utility maximization, is heavily biased towards contexts with a large base of beneficiaries: namely ecosystems near cities or in locations that draw many visitors. Ecosystems with few beneficiaries nearby, for instance large remote wilderness areas, may be recognized for global services, such as greenhouse gas regulation, and the few recreational visits they receive, but beyond that their values are relegated to the nebulous realms of existence and option value. Given the lack of confidence generally placed in these types of values relative to more directly utilitarian values—for instance, the multi-billion dollar replacement cost value of New York City's Catskills supply watersheds—it is not surprising that such a bias exists. The paper illustrates the logic behind these biases through several case studies from past or ongoing project the author worked on in Hawaii and Ontario, case studies that stretch from one extreme to the other of this spectrum. In Oahu, for instance, tiny watersheds, large spatially contained groups of beneficiaries, severe water supply issues, and dependence on water-based tourism make the application of the ecosystem services framework ideal and its results easy to communicate. In remote areas of Ontario, by contrast, attempts to apply the ecosystem service valuation framework to some of the province's vast protected areas ran into far greater challenges, even though these lands are widely considered by Canadians to be assets of vast biological, social, spiritual and cultural importance. By contrast, the Province's popular Algonquin Provincial Park, although relatively remote, did lend itself better to ecosystem service valuation due to the large number of beneficiaries visiting it. Based on these findings, a matrix is presented showing how the level of suitability of applying ecosystem service quantification varies with several contextual variables.

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LINKING ECOSYSTEM SERVICES, CLIMATE, AND PUBLIC HEALTH: CHANGES IN RISK, EXPOSURE AND IMPACT

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Ecosystem services and public health are unequivocally linked and the connections are broad, multifaceted, and fundamental to our health and well-being. How will a changing climate affect these dynamics in both coastal and terrestrial systems and ultimately our health? This talk will provide an overview of the potential public and human health implications of climate driven changes in coastal and terrestrial ecosystems. Healthy coastal and oceanic ecosystems provide harbor and habitat for fish, recreational opportunities, livelihoods, and are often central to local culture. Changes in vegetation and habitat affect mosquitoes and other vectors that transmit diseases such as Lyme disease and West Nile. These water-borne, vector-borne, and zoonotic diseases clearly have an ecosystem component, and changes in these ecosystem services affect our health--both positively and negatively. This talk will also cover additional climate-related health outcomes not as well understood or commonly studied, including changes in marine biodiversity and the potential for discovery of curative agents from the sea; and the cultural and aesthetic values, as well as physical and mental health benefits, of engaging with healthy coastal and terrestrial ecosystems. Climate affects ecosystem services across time scales from seasonal to decadal and beyond. While climate is often one of many change drivers, understanding the role of climate is critical to prospective, predictive, and proactive action that protects both ecosystem health and human health. This talk is designed to describe the ecologically mediated health-related findings in the recent National Climate Assessment Report, to expand the conversation to other health impacts, and to stimulate both research and action.

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INTEGRATING HYDROLOGY AND ECONOMICS IN ENVIRONMENTAL DECISION MAKING FOR IMPROVED WATER QUALITY

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Keywords: hydrologic ecosystem services, public goods, reverse auction, individualized price auction, improved water quality, payment for ecosystem services

We present an interdisciplinary project that integrates watershed hydrology and economics to improve our understanding of the sequential linkages between (1) behavior of private landowners, (2) the resultant production of ecosystem services from farmland and forests, and (3) associated social values for these services in the northeast US. We demonstrate a market process by integrating farm suppliers of the ecosystem services with the potential consumers benefiting from provision of such services. To do so, we develop a spatially-explicit watershed simulation model to assess the interrelationships between climate variability, land management decisions, and changes in water quality of a reservoir system. We then use economics field experiments to create a market-like process for improved water quality. On the supply side, we operate a reverse auction with small-scale livestock owners to estimate costs of site-specific manure management practices to reduce phosphorus loadings to a major reservoir. On the demand side, we implement a multi-unit public good auction to assess consumers' willingness-to-contribute to support manure management. Our framework links cost-effective actions to supply ecosystem services with the associated social values. We discuss the practical challenges of integrating watershed hydrology and economics for micro-level decision making on both the supply and demand sides of a market process for ecosystem services.

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STRATEGY FOR IMPLEMENTATION OF ECOSYSTEM SERVICES VALUATION AT THE DOW CHEMICAL COMPANY

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As a part of the session entitled "Private Sector 'Uptake' of Ecosystem Services Metrics & Analytical Approaches: The Current State of Play," the purpose of this topic is to discuss the strategy that is being employed by The Dow Chemical Company (Dow) to implement ecosystem services valuation into the decision-making processes of the company.

Dow realizes that our company has impacts and dependencies on ecosystem services for our operations and products. We further recognize that these impacts and dependencies are often undervalued in the processes that we use to make various business decisions, e.g., capital authorization, new product development, business options analysis. Decisions at our company are made using "work processes:" a combination of written and unwritten standards that guide our people to approrpriate actions. These work processes need to be modified to include effective consideration of ecosystem services values over relevant time periods.

Dow is collaborating closely with others in developing and implementing our strategy – most notably, with The Nature Conservancy in a 6-year, $10M collaboration begun in 2011. During this panel, we will discuss our current overall plans, the learnings from the perspective of our company, and recommendations for other organizations.

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EXPANDING ECOSYSTEM SERVICES USING A NETWORK BASED APPROACH TO GREEN INFRASTRUCTURE

Julie Ulrich
The Nature Conservancy, Arlington, VA, USA

With increased stormwater regulation requirements and changing patterns in rainfall intensity, municipalities are facing greater pressures to develop effective stormwater management strategies. There is growing concern about flooding and increased demand for identifying potential mechanisms for better managing the urban landscape to improve hydrologic connectivity and reduce damaging flooding events. As such, there is need for effective models which can aid municipal decision makers in the design and execution of strategies to help meet these challenges.

As part of its Nature Based Solutions Initiative, The Nature Conservancy (TNC) is developing an innovative watershed based approach to assess brownfield properties for green infrastructure potential in Camden, NJ with regional implications for the nearby cities of Philadelphia, Pa, Chester, PA, and Wilmington, DE. This presentation will provide a methodology to quantify and map the value of implementing green infrastructure projects in strategically selected brownfield locations along the urban-suburban gradient of the Cooper River Watershed, a key tributary in the highly urbanized lower third of the Delaware River Basin. TNC is quantifying significant ecological, social, and economic value in utilizing overlooked brownfield parcels as a green infrastructure network rather than the more typical, project-by-project opportunistic approach. TNC will test whether these optimally configured networks have the potential to help improve the water quality of the watershed and reduce localized flooding while providing opportunities for much needed neighborhood revitalization.

This talk will summarize our work in developing these network-based assessment methods and discuss the challenges for transforming the current dialogue of converting brownfields solely for traditional economic development to an expanded approach which considers a systems-based strategy that includes long-term benefit for both watersheds and people. Further, this presentation will review the prospects for this ongoing project for promoting future research that advances the emerging environmental field of urban ecosystem services while inspiring new tools and methodologies that can be used by city managers and planners to address both water quality and quantity issues in urban watersheds.

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DATA AND INFRASTRUCTURE NEEDS FOR ECOSYSTEM SERVICES ASSESSMENT

Dean Urban *and Lydia Olander*
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This session complements the introduction of the Federal Resource Management and Ecosystem Services (FRMES) guidebook at this conference. The guidebook provides guidance on incorporating ecosystem services into the planning for agencies managing natural resources. Our vision for this process is a distributed implementation model, in which standardized methods are used across a variety of decision contexts (agencies, resources) in various locations across the United States. This implies a set of models that are sufficiently robust that they can be used in a range of applications by a variety of end-users, and data sets that are readily available nationally and of appropriate scale and resolution to support the modeling. In this session, we address our capacity to implement this ambitious plan. In this presentation, we present the FRMES methodological framework for integrating ecosystem services for decision support, and provide an overview of the current state of data and models necessary for key modeling steps in the process. We also suggest crucial needs for of model standardization and generalization, and data development and curation, to support and sustain this process. In subsequent presentation in this session, we address these key issues in greater detail, highlighting models and data needed to scale up the ecological and social analyses that define the FRMES assessment framework.

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ECOSYSTEM SERVICES AND CLIMATE CHANGE ADAPTATION: TOWARDS AN INTEGRATED MODEL OF OPTIMAL ROTATION LENGTH

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Climate change is expected to increase the frequency of storms and other extreme events. Wind risk is one of the most significant threats to Europe's forests, with storms currently responsible for over 50% of all primary damage by volume from catastrophic events.

This poster presents preliminary results of an integrated stand level model of optimal rotation which is being developed in part to assist with deciding how best to adapt forest management in the UK to climate change. The model currently accounts for timber and carbon benefits in the presence of windthrow risk, with potential extensions to other ecosystem services and biodiversity, as well as wider climate change related risks (e.g. drought, pests and diseases), currently under consideration. The approach combines estimates from Forest Research's timber yield, carbon accounting, and wind-risk models with information on prices, costs and discount rates, estimating the rotation length that maximises economic returns.

Allowing an economic assessment of different scenarios, the results provide an indication of the likely magnitude of associated changes in optimal rotation length. Preliminary sensitivity analysis indicate that at sites with relatively low windthrow risk, for instance, optimum rotation length is very sensitive to the price of carbon sequestered, but not to the price of carbon substitution. At a long-run average timber price of around £15/m3 overbark, initial results suggest that the optimal harvesting decision is not to harvest at all at such sites if carbon prices are towards the middle or higher end of the range for market prices of £3/tCO2e to £10/ tCO2e thought to apply currently to carbon sequestration from projects certified under the UK Woodland Carbon Code.

At sites with low windthrow risk the preliminary results also suggest that changing the discount rate has a moderate impact on the optimal rotation length: for a reduction in the rate from 3.5% to 1% the optimal rotation length increases by about 5 years.

By contrast, at windy sites where wind risk is a major factor determining optimal rotation length and windthrown timber is of little value, the preliminary results suggest that inclusion of carbon benefits, or changing the discount rate, has a negligible effect on the optimal rotation length.

The model currently focuses on single species and single age stands. If the model is to be extended to cover these options mixed species stands, further experimental research on yields, carbon benefits and windthrow risks associated with mixed species stands would be needed to underpin the evidence base.

Potential practical applications of the model as a tool to aide decisions are being explored through in-depth interviews with public and private sector forest planners, and by trialing the model in a case study in southern Scotland.

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INSIGHTS FROM BEHAVIOURAL ECONOMICS FOR GLOBAL SUSTAINABILITY?

Gregory Valatin
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This paper explores insights from behavioural economics for global sustainability agendas, drawing upon literature reviews and work in game theory.

A recent literature review highlights insights from behavioural economics for valuation of ecosystem services and ecosystem sustainability. A growing body of evidence demonstrates the influence of cognitive factors – including framing and various biases, as well as the role of learning, in shaping values – especially in relation to complex issues. Once it is recognised that individual preferences are not fixed but influenced by framing, cognitive biases and learning, aggregating existing individual preferences – the approach conventionally used in economics, appears more questionable as a basis for guiding societal choices. Akin to public health strategies to reduce smoking and lung cancer, the paper argues that tackling ecosystem sustainability issues such as global climate change may require directly influencing values and behaviour, rather than simply relying upon more traditional approaches and institution building.

Institution building to form lasting international environmental agreements is often viewed as a prerequisite to achieve a level of concerted international action consistent with sustaining global ecosystems and tackling associated environmental problems such as climate change. Early results in the game theory literature suggest international environmental agreements do not generally lead to significant environmental improvements beyond those expected in the absence of agreements. However, more recent work illustrates how the way this problem is approached can dramatically alter these conclusions. Modifying the underlying framework used in one of these early models to assume countries adopt an environmental security perspective focusing on preventing 'dangerous' climate change (e.g. limiting average global temperate rise to less than 2 degrees Centigrade above pre-industrial levels), in place of basing decisions on a standard maximisation approach, leads to concluding that a binding agreement can lead to significant environmental improvements. While such theoretical arguments seem far removed from the practical negotiations, the paper argues that a less pessimistic assessment of the prospects for agreement could alter how negotiators frame their task, and might alter prospects of reaching an agreement. If, partly related to early theoretical results, negotiators do not believe a meaningful deal is possible, they may see little reason to try. The paper does not argue that difficulties involved are easily overcome, but that understanding insights from behavioural economics such as on the importance of framing and tendencies towards self-serving bias in perceptions of fairness, may help in overcoming bargaining impasse and help provide pointers to approaches that increase the likelihood of success.

Drawing upon a recent review on the potential for using nudge-type measures in meeting environmental goals, the paper further argues that information dissemination may be key in altering public attitudes if popular misconceptions, optimism bias and fatalistic attitudes affecting willingness to undertake mitigation activities are to be overcome.

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ECONOMIC AND ECOSYSTEM SERVICE TARGETING OF NUTRIENT CONTROL EFFORTS TO MEET THE GOALS OF THE CHESAPEAKE BAY TMDL

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To address growing concerns about poor water quality conditions and ecosystem degradation in the Chesapeake Bay, in 2010 the US Environmental Protection Agency (USEPA), using its regulatory authority under the federal Clean Water Act (CWA), established a Total Maximum Daily Load (TMDL). This TMDL "nutrient diet" sets limits (to be achieved by 2025) on allowable loads of nitrogen, phosphorus, and sediment to the Bay from each of its main tributaries. Given these limits, the seven jurisdictions within the Chesapeake Bay watershed must establish plans to define how the load reductions responsibilities will be allocated across sources. This study expands on previous work to examine how consideration of both the costs and ecosystem service co-benefits of nutrient control efforts would affect these allocative decisions.

Previous studies have found that the overall costs of achieving the TMDL goals could potentially be substantially reduced through more cost-effective targeting of nutrient control efforts across the watershed. However, implementing these lower cost approaches for restoring the Bay would also alter the spatial patterns of load reductions and water quality improvements in rivers and streams across the watershed. Therefore, a more comprehensive approach to targeting load reductions would be to consider both the costs and the freshwater ecosystem service co-benefits of nutrient control efforts.

For this analysis, we expand an existing least-cost optimization model for the Bay by including monetized estimates of freshwater quality co-benefits. In particular, we first use results from a watershed-wide analysis to estimate average (dollar per pound) load reduction benefit for each river segment. We then apply these unit values to corresponding point and nonpoint source control options in each segment, and we re-optimize by accounting for both costs and benefits. Using the Susquehanna and James River Basins as specific examples, we examine how a combined targeting approach affects the spatial pattern of load reductions, water quality changes, and the costs and co-benefits of meeting the TMDL goals. In both cases, we examine how the inclusion of freshwater co-benefits shifts the distribution of load reductions towards more upstream river segments in these basins.

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MONITORING AND VERIFICATION OF ECOSYSTEM SERVICES MARKETS: POSSIBILITIES FOR PARTICIPATION

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The practical starting point for this analysis and subsequent suggestions regarding oversight of ESMs is the observation that currently, in Oregon and the Chesapeake Bay, the efforts to create ESMs have met with significant resistance, and once they are created many of the problems that complicated their design persist, including disagreements over the siting of restoration efforts, the appropriateness of measurement tools and the desirability of markets altogether. One of the central arguments emerging from my research on the efforts in the Willamette River Basin and the Chesapeake Bay Watershed is that the creation of ESMs potentially affects a broad range of stakeholders in these watersheds by (re)moving places that are cherished for a variety of reasons, only some of what are strictly "environmental." Based on this analysis, this paper suggests that a new, more integrative form of oversight that takes into account social and economic effects of markets, would improve these institutions. This oversight should consist of regular, like annual or biannual, meetings of all relevant stakeholders, during which they discuss and assess the developments of relevance to the ESM. The first element of this kind of review is thus that it has to be participatory, with effective representation of the relevant stakeholders, including both proponents and opponents of the institutional design itself. This would enable stakeholders to get together to review the whole range of emerging outcomes of the trading schemes, including spatial justice aspects, the quality of biophysical monitoring (like actually measuring the temperature in the streams as opposed to a narrow review of the performance of the riparian reforestation) and the role of the brokers, to name a few. The second design element for this new form of oversight is based on the notion that a concentration of legitimate expertise makes effective oversight and d*ouble loop learning* (Argyris and Schon, 1978) more difficult. To develop and maintain additional and alternative forms of knowledge about the effects of the markets for institutions would be a central goal of these events. Monitoring and verification of ESM-based trading should not only be focused on the purely technical assessment of whether or not a tree is producing the correct amount of shade or a buffer the right level of nutrient reduction, but also on questions about the aggregate effect of an ESM on publicly accessible green spaces in a city, and if economic development goals can be achieved as a result of the ESM.

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THE BIOENERGY POTENTIAL OF INVASIVE ALIEN PLANT SPECIES CONTROL

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Invasive alien species (IAS) are one of the most important drivers of species loss, causing biotic homogenization of the global biodiversity. There is evidence that this decline in diversity affects the performance of ecosystems. Altering ecosystem properties can in turn have an effect on services and goods delivered by ecosystems, which often involves significant harm to society, economy and environment. The total costs of the damage and the control measures are already enormous. But instead of considering invasive plant species and their control as a burden, their biomass production can be considered as an ecosystem service.

We assessed the bioenergy potential for anaerobic digestion and combustion of four herbaceous alien plant species that are widely known to be invasive outside their native range: *Fallopia japonica, Heracleum mantegazzianum, Impatiens glandulifera and Solidago gigantea*. The first objective was to quantify the annual biomass production of the different species. Second, the gross calorific value and biomethane potential was determined through a combustion analysis and batch anaerobic digestion tests. To assess the risk of dispersal due to the valorization process, we also performed viability tests on the digested propagules.

Without any optimization of the crops or the application of fertilizers or other inputs, *H. mantegazzianum* and *F. japonica* had an average biomass yield of more than 22 ton dry matter per hectare. *Impatiens glandulifera* and *S. gigantea* had a significant lower biomass yield (5.78 and 8.64 ton DM ha^{-1}), but still produced more than the most productive Low-Input High-Diversity systems in conservation areas in the same study area. The observed methane yields were comparable to those of bioenergy crops and the studied IAS achieved equal or higher energy outputs per hectare (70-225 GJ ha^{-1}) than some of the current bioenergy systems. The risk of further dispersal after the digestion process is limited, because none of the digested propagules were viable.

The valorization of the biomass of IAS can create an economic incentive for the control of invasive species and offers the opportunity to reconcile the restoration of the invaded habitats and renewable energy goals. However, caution during harvest and transport is required to prevent the spread of new propagules. An optimal organization of the biomass-to-bioenergy supply chain is therefore necessary. Furthermore, a legal framework on the use of present invasive species as a source for bioenergy is needed to prevent agricultural exploitation and further spread of the IAS. We do not see our results as an argument to cultivate or further spread IAS.

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ASSESSING ECOLOGICAL VALUES IN THE ROGUE BASIN OF OREGON

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The Rogue Basin of Southwest Oregon offers a unique opportunity to test the application of an ecosystem service framework to a large landscape with diverse ownerships. The region has a history of adversarial relationships over resource management issues – especially timber harvest. But the local communities and agencies have also found common ground with a few projects that have the potential to address restoration and economic needs simultaneously. There is an emerging consensus around using vegetative treatments to increase the resilience of ecosystems to climate change and catastrophic fire.

The ecosystems of the Rogue Basin suffer from decades of ecological damage caused by fire suppression, improper management of vegetation, hydrologic modifications, and development – all exacerbated by the effects of climate change. The Basin also offers biodiversity of international importance, beautiful and abundant natural lands and waters that are highly desired for recreation, and other amenities.

A unique partnership has evolved that includes Forest Service, Bureau of Land Management, Portland State University, Defenders of Wildlife, and community groups such as the Southern Oregon Forest Restoration Collaborative and Applegate Partnership. The project, called People and Ecosystems of the Rogue Basin has several components.

The first is a basin-wide ecological assessment. This effort, led by the Oregon Institute for Natural Resources, will apply an ecological integrity model to determine the status of biodiversity in the area. The assessment will cover landscape features, habitat characteristics, representative species, and at risk-species – all essential to understanding what benefits (or services) can be sustainably provided. The assessment includes both terrestrial and aquatic features.

The project also includes consideration of the social and economic values associated with the natural resources of the Basin. It will reveal what people value, what they expect the Basin to look like in the future, and what management actions are most likely to provide those benefits in a sustainable way.

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VISUAL RESOURCE MANAGEMENT UNDER ALTERNATIVE OIL AND GAS DEVELOPMENT SCENARIOS IN THE MOAB, UT REGION

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Land-use planning and resource management protocols are increasingly considering the value of ecosystem services (ES) to regional economies as part of the overall decision making process. The Bureau of Land Management (BLM), the U.S. Geological Survey and the University of Vermont are engaged in the second phase of a pilot project to assess the feasibility of incorporating ES valuation into BLM's planning and decision-making frameworks. This presentation details the results of collaborative effort aimed at quantifying changes in the provision of recreation-based ES under alternative oil, gas and potash resource management scenarios in east-central Utah as part of the BLM's Moab Field Office Master Leasing Plan (MLP).

The Moab region supports a large and diverse tourist economy that draws visitors from around the globe and provides both direct (e.g. guides) and indirect (e.g. hotel and restaurant employees) impacts on regional employment. The number, location and scale of energy and mineral development sites are a primary concern in the region because inappropriate development may lead to visual impacts that have adverse effects on recreational resources and the industries they support. Stakeholders, including local employers and a broad range of recreationists (e.g. hikers, mountain bikers, OHV drivers, campers, and boaters) are considered in this analysis. Simulation modeling and scenario analysis, using the Artificial Intelligence for Ecosystem Services (ARIES) modeling platform, were coupled with spatial analytical techniques to lend support for the development of management alternatives and the identification of minimally intrusive resource development sites through the MLP process.

This project assembled a database of publically available spatial, quantitative and qualitative data to: 1) develop Bayesian models of the sources of scenic beauty and visual blight; 2) identify trail networks and viewpoint locations sought by recreationists (i.e. users or beneficiaries) for their iconic views and sweeping panoramic landscapes; and 3) model and map the spatially explicit pathways that link the source, sink and use locations (i.e. ES flows). A viewshed analysis was conducted for approximately 9,500 discrete locations along nearly 1400 km of trails. Viewshed extent, density and quality were estimated under baseline conditions. These results were used to identify scenic locations and corridors that are integral for maintaining the iconic views of the region and inform the development of alternative minerals development scenarios for further evaluation and public comment. Scenario analysis is currently underway and the results will be included in the formal MLP document that defines the leasing and resource development priorities for the region.

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VALUES IN MODELING: MAKING ECOSYSTEM SERVICES OPERATIONAL

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Numerous examples show that societies are very slow in reacting to the rapid depletion of natural resources and to the degradation of ecosystem services. The concept of valuation of ecosystem services, designed to enhance the understanding of the role of ecosystems in providing livelihoods and the many benefits that are often naturally provided is still rarely appreciated and properly used. There is a lack of translation, and therefore a lack of public understanding, of scientific results, analysis, and modeling into corrective actions. One of the reasons for this is the traditional workflow of applied scientific research in general and environmental modeling in particular, which assumes that the purpose, the goal formulation is endogenous and is decided outside of the research process. Later, the research, which is expected to be value neutral and objective, ends with problem solutions or decision support tools, which are then again expected to be used (or not used) beyond science by managers or policy makers. Instead, modeling, and applied science in general, has to enhance its scope beyond the problem solving stage, to do more on the problem definition and solution implementation phases. This can be achieved only if scientists act along with stakeholders, as stakeholders, admitting that they also carry certain values and openly discussing and communicating these values to the general public. We need to go beyond the traditional engagement and recruitment of stakeholders and members of the public to participate in the scientific process. Instead, scientists need to engage with the stakeholders to jointly formulate the goals of research and then oversee the translation of the scientific results into action. This enhanced participatory modeling process is especially relevant for ecosystem services valuation, which will never be objective and which always depends on appropriate identification of societal values and their adjustment by means of effective communication of the scientific knowledge, the modeling process and results. I believe this approach for modeling can impact and bring the social values to the forefront of socio-environmental debate and hence turn scientific results into actions sooner rather than later. Instead of being separated from the modeling process, the translation of scientific results, and the integral engagement of interested citizens and stakeholders, should be an intrinsic part of it. I discuss several challenges for recent socio-environmental modeling and conclude with ten propositions that modelers and scientists in general can follow to improve their interaction with the society and produce results that can be understood and used to improve awareness and education and spur action. These 'ten commandments' are similarly useful for increasing the interaction with stakeholders and the public in assessing and understanding Nature's benefits, the ecosystem services that it provides, and the tradeoffs that frequently have to be made to balance our immediate and local human needs and actions with longer-term and larger-scale needs.

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LAKE ERIE 4R NUTRIENT STEWARDSHIP CERTIFICATION: WATER QUALITY MARKETS

Carrie Vollmer-Sanders
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Lake Erie is a source of drinking water for millions, home to more than half of all the fish in the Great Lakes, and an attraction for both in-state and out-of-state tourists. Unfortunately, the increasing occurrence of harmful algal blooms over the last five years is threatening Lake Erie, leading to increased water treatment costs, reductions in fish production, and poor water quality that has negative impacts on fishing and recreation. Agricultural nutrient loss is one of the primary contributors to harmful algal blooms and other water quality problems in the Western Lake Erie Basin. We need fertilizers to produce the crops that we depend on for food and farmers have taken a number of actions to improve soil health and reduce fertilizer runoff, but excess nutrients are still leaving fields and entering our streams and lakes.

The 4Rs of nutrient stewardship, using the Right Source @ Right Rate, Right Time, and Right Place®, is a foundation for science-based sustainable plant nutrition which considers the social, environmental and economic implications. Significant reductions of nutrients entering our freshwaters and crop nutrient use efficiency can be achieved by ensuring nutrient applications follow the 4R principles.

One way to encourage adoption of the 4Rs is to define and recognize good nutrient stewardship through a credible certification program. The 4R Certification Program Advisory Committee, led by members of the agricultural industry and supported by The Ohio State University, grower industry representatives, state governments and The Nature Conservancy, have been meeting since the spring of 2012 to create a program that identifies best practices which encourages agricultural retailers, Certified Crop Advisors, and nutrient service providers to adopt the 4R Nutrient Stewardship concepts.

The 4R Certification Program has three components which must be completed prior to certification: 1) Initial Training and Ongoing Education, 2) Monitoring of 4R Implementation, and 3) Nutrient Recommendations and Application. A third-party audit occurs every 3 years to ensure adoption; certification is on-going and continually adapting/improving as new advancements in research and technology prescribes.

After conducting the pilot audits with four agri-businesses in 2013 the Program Standard was modified and launched in March 2014 and the first audits occurred in July 2014. In March 2014, the White House awarded the Carrie Vollmer-Sanders with the Champion of Change award for her role in facilitating the broad partnership working to develop a targeted program that can be implemented throughout Lake Erie basin that addresses the excess nutrient concerns. The agri-business community has shown tremendous support for this Program and 51 nutrient service providers have signed up to become certified. Research regarding the impact the 4R Certification Program will have on society, the environment, and economics is ongoing for the next five years.

In this session, we will discuss how the Program was developed, what partners have learned about working with each other, accounts of becoming 4R Certified, and what research is underway to evaluate the impact of the Program in the Lake Erie basin.

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TAKING THE 'PULSE' OF THE LEADING EDGE OF ASSESSING BUSINESS RISK & OPPORTUNITY: INTEGRATING ECOSYSTEM SERVICES INTO DUE DILIGENCE & CORPORATE MANAGEMENT

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Given that all companies do business, in the most fundamental sense, our natural world—which is marked by climate change, species loss, deforestation, and water scarcities—there are multiple 'drivers' that are likely to accelerate 'uptake' of ecosystem services assessment. The financial service sector's inclusion of ecosystem services into the International Finance Corporation's and Equator Banks' due diligence protocols signals a shift in how risk related to businesses dependencies on ecological systems is understood. A growing set of actors are seeking to transition is away from focusing on singular corporate metrics, and towards assessing metrics within the context of systems and dynamics.

Ideally, robust assessments of a business' impacts on ecosystem services will be clear analytical approaches that can inform decisions. The methods should enable 'seeing' the inter-connections between return on investment (ROI) and other key measures of business success, in terms of projections for access to water, reliable climate, and well-functioning ecosystems (such as, forests, wetlands, grassland, coral reefs, etc.), among other ecological factors.

For corporate managers, a key question is ***how*** to both rigorously and feasibly integrate biodiversity and ecosystems services perspective into business decision-making processes, including on assessment of risk.

This question cannot be viewed as starting from scratch within companies. A considerable body of work—as well as corporate policies and protocols—already exists on both proactive and negative strategic risk review based on reputational risk, creditworthiness, and other approaches. In addition, over the past few years, a parallel area of work has emerged around assessing corporate impacts on biodiversity and ecosystem services. For example, methods for enterprise-level risk review include the Natural Value Initiative's (NVI) Ecosystem Services Benchmark—which asks whether or not key processes are in place—as do new structured assessment methods, such as the World Resource Institute's (WRI's) Corporate Ecosystem Services Review (ESR), and numerous other ecosystem services tools, as described in both BSR's annual comparative tool assessment as well as an overall tool tracking reports.

The challenge is that applying these tools requires budget for personnel and potential external expertise and data. Budget requires justification. And compelling justification is contingent upon showing that current systems are lacking or somehow deficient for addressing key issues, as well as showing that new issues are indeed key (or even "material" within the legal definition of the word). Even once an internal business case for either expanding existing protocols to thoroughly consider ecosystem services impacts, or applying a purpose-built tool is made, the question immediately becomes: What analytical approach? Requiring what new data? What new analyses? Conducted in what ways? With what human resource demands?

Given the current lack of clarity on the state of corporate application of ecosystem services analytical approach, this paper will present the leading edge of business practices on considering impacts and dependencies related to biodiversity and ecosystem services. It is based on interviews and a 2013 survey, as well as discussions during, BSR-convened roundtables in2013 and 2014. These interviews, survey, and roundtable discussions all sought out the leading practitioners to lay out the emerging state of practice related to applying ecosystem services to due diligence and assessment requirements.

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ADVANCING ECOSYSTEM SERVICE INCLUSION IN BENEFIT-COST ANALYSIS AT THE LOCAL LEVEL: FEMA POLICY IMPACTS IN SOUTHERN WISCONSIN

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Flood losses in the United States can be expected to exceed $25 billion annually in the coming years. Recently the economic assessments of flood damage and actions to reduce flood damages included only a narrow range of costs and benefits. This limited legal framework precluded federal grant funding of innovative flood-risk reduction projects and hindered comprehensive flood management. This led to unsustainable flood management projects that undervalue natural systems' ability to mitigate flood hazards and resulted in the loss of valuable natural capital through the construction of levees, conveyance channels, and other structural means of flood risk mitigation.

With support from Earth Economics, the Federal Emergency Management Agency (FEMA) recently incorporated ecosystem service values in the benefit-cost analyses that determine eligibility for Disaster Mitigation Grants. This public policy integrates the natural beneficial functions of floodplains into the Benefit Cost Analysis (BCA) Toolkit used to evaluate acquisition mitigation projects. It is hoped that this policy change will be broadened to include all flood mitigation actions that enhance natural capital, including channel rehabilitation, levee setbacks, and green infrastructure applications for stormwater management. These changes to the calculation of costs and benefits for flood mitigation projects could assist local governments with funding and implementation of sustainable flood mitigation projects to reduce flood risk.

Earth Economics, with the support of the Association of State Floodplain Managers, evaluated the effect that calculating ecosystem benefits could have in two mitigation case studies in Wisconsin. The first, a stormwater mitigation project in the City of Portage; the second, a property acquisition project in Jefferson County. Both projects had been denied funding by FEMA using a traditional BCA. The purpose of this analysis was to demonstrate the impact of FEMA's policy changes on acquisition projects and to show the potential utility of ecosystem benefits to stormwater mitigation projects.

Further goals of this project were to increase federal and state funding for nonstructural flood risk mitigation projects in the Rock River Basin as well as create familiarity with ecosystem service concepts and applications among local, state and flood (emergency) management professionals throughout Wisconsin. Integrating ESV numbers will enable local and state flood and emergency management professionals and stakeholders groups to use FEMA policy updates on cost benefit to fund innovative flood-risk reduction projects. The local community will know about how to use natural capital valuation and concepts in decision making, federal grant applications and hazard mitigation planning. Wisconsin communities will begin the flood risk mitigation process with exemplary case studies that include the natural value of wetlands and green infrastructure for flood protection.

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DESIGNING NON-MONETARY BENEFIT INDICATORS THAT REFLECT USE AND PREFERENCES

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Not all ecosystem service benefits can be robustly monetized and, for some decisions, the services that can be monetized are not the primary goals for a project. Thus, analysts may find a mismatch between project goals and measured benefits. Further, some of the largest benefits created by ecological preservation and restoration may fall into the category of "difficult to monetize" because of the challenges that individuals face in deciding the worth of preserving species, genetic diversity or any number of ecosystem services that are appreciated but not directly used.

When services cannot be monetized, they can still be quantified in ways that convey clear benefits to decision makers and the public. Such metrics may be preferred in cases where the primary goal is to compare potential benefits across sites or where social equity concerns cause monetary values to be inappropriate (e.g., when evaluating effects on aboriginal peoples). I will present a framework and examples to demonstrate an approach to creating non-monetary metrics that is consistent with economic values. Case studies for ecological restoration projects in wetlands and stream ecosystems will be used to explain these concepts, demonstrate analysis methods, and identify useful data sources.

The framework is grounded in principles, derived from market behavior and economic theory, that are used to contextualize ecological indicators in order to relate them to social well-being. The conditions that tend to contribute to greater value of a good or service fall into several categories: 1) quality of the service for its intended use, 2) availability of capital and labor that complement the ecological outputs in order to create goods and services, 3) number and characteristics of users or beneficiaries, 4) reliability of the future stream of services, and 5) scarcity and substitutability. Thus, site and landscape conditions are used to determine whether a service will be derived from an ecological feature or output and, if so, the relative magnitude of benefits.

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A FRAMEWORK FOR INTEGRATING ECOSYSTEM SERVICES IN CORPS PLANNING

***Lisa Wainger*[1]*, Anna McMurray*[1]*, Elizabeth Murray*[2]*, and Janet Cushing*[3]**

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This talk will describe ongoing work to advance the Corps' capabilities to maximize beneficial socio-ecological outcomes of aquatic ecosystem restoration by using ecosystem goods and services. A framework has been developed to delineate the steps needed to connect proposed restoration actions with biophysical responses and socio-ecological benefits, within the Corps' decision making process. A goal of the framework is to clearly separate the ecological production functions from the functions used to determine the benefits of a change in ecosystem goods and services in order to clarify where and when ecological changes are generating high levels of benefits.

Examples will be used to demonstrate how ecological production functions are developed in ways that are consistent with Corps modeling approaches and guidelines. For restoration projects, the Corps avoids monetizing ecosystem service benefits. Thus, a major thrust of this work is to generate biophysical outcomes that convey social relevance, in order to provide the most useful information for comparing the returns of alternative restoration investments.

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MAKING ECOSYSTEM VALUATION COUNT FOR DECISION MAKING IN THE CARIBBEAN

***Richard Waite**, Lauretta Burke, and Erin Gray*
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Caribbean economies depend heavily on coastal ecosystem services, including tourism, fisheries, and shoreline protection. However, coastal ecosystems continue to degrade across the region due to human pressures. Many pressures arise from short-sighted decisions that fail to take long-term ecosystem values and the full range of ecosystem benefits into account.

Economic valuation can contribute to better-informed decision making about coastal resource use and development. However, only a minority of valuation studies have had an observable influence on policy, management, or investment decisions.

In this session, WRI will discuss results of recent research on ecosystem valuation in the Caribbean in the context of how to inform decision making. We will discuss results from two papers: (1) "Influence of Coastal Economic Valuations in the Caribbean: Enabling Conditions and Lessons Learned"; and (2) a guidebook on ecosystem valuation, "Coastal Capital: Ecosystem Valuation for Decision Making in the Caribbean."

The first paper assesses the influence of previous coastal ecosystem valuations in the Caribbean and identifies the key "enabling conditions" for valuations to influence policy, management, or investment decisions. The World Resources Institute and the Marine Ecosystem Services Partnership conducted a literature review of valuation studies, and semi-structured interviews with more than 30 marine conservation and valuation experts, to identify cases of influence and the conditions enabling influence. We found only 16 coastal ecosystem valuation studies in the Caribbean that had a direct influence on decision making. Our findings suggest that valuation practitioners can and should do more to ensure that valuation studies inform decision making. WRI will discuss these findings on key enabling conditions that likely led to success in informing decision making (e.g., a clear policy question, local demand for valuation, strategic choice of study area, strong stakeholder engagement, effective communications, access to decision makers, and transparency in reporting results).

WRI will also review major lessons and guidance from the Coastal Capital guidebook, which draws on lessons learned from the first paper, and leads valuation practitioners—both economists and non-economists—through the three phases of a valuation effort to inform decision making: 1. Scoping, 2. Analysis, and 3. Outreach and Use of Results.

While the two papers focus on the Caribbean, our results and methods are applicable to a wide variety of ecosystems, regions, and development contexts.

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CHESAPEAKE BAY NUTRIENT TRADING TOOL: ESTIMATING ON-FARM CREDITABLE NUTRIENT AND SEDIMENT REDUCTIONS

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Our presentation will demonstrate the functionality of the Chesapeake Bay Nutrient Trading Tool (CBNTT) as an on-farm nutrient and sediment reduction and credit estimation tool. Water quality trading is gaining traction around the world. It is a market-based approach that works alongside water quality regulation to improve water quality. Many Chesaepake Bay states including Marland, Virginia, and Pennsylvania have developed point to nonpoint source nutrient trading policies that enable regulated point sources to meet permit limits and/or offset new and expanding discharges in the watershed. However, the manner in which states estimate nonpoint source credits varies widely among programs, creating inconsistencies in the definition of a credit. To create consistency and transparency in credit estimation, the World Resources Institute (developers of NutrientNet) and Tarleton State University (developers of the Nutrient Tracking Tool) in coordination with the Chesapeake Bay states and other stakeholders, developed a watershed-wide tool that can be used by all of the Bay states to estimate on-farm nutrient and sediment reductions. Furthermore, the tool places those estimates within the policy context of each state's trading program to estimate eligibility and credit quantities. In addition, CBNTT features a cost tool allowing users to evaluate the economic impacts of implementing their management practices to meet state trading obligations (i.e., trading baseline) and generate credits.

Typically, estimating pollutant reductions from nonpoint sources has been problematic within the context of water quality trading programs as no simple estimation tools have been developed, and site-specific monitoring is often unrealistic. CBNTT uses a dynamic, biophysical model as the basis of its calculations. This online tool incorporates a map, the Nutrient Tracking Tool (which incorporates the APEX model), and region-specific delivery and BMP calculations to estimate current on-farm nutrient and sediment loads. Users then propose alternate future management scenarios to estimate the potential decrease in nutrient and sediment loads and the potential number of credits that can be generated based on state-specific policy considerations. In order to create alignment and consistency with the Chesapeake Bay TMDL, WRI and Tarleton State have worked with EPA Chesapeake Bay Program modelers to calibrate CBNTT to the Chesapeake Bay Waterhsed Model. Alignment between these two models is essential in order to create agreement between credit estimates and the metrics used to track the Bay TMDL progress.

CBNTT is now being used across the Chesapeake Bay watershed to estimate farm-scale nutrient and sediment pollution loads, determine if agricultural TMDL goals are being met, and estimate nutrient credits. More outreach and understanding of CBNTT is necessary in order to gain more public trust and stakeholder buy-in and better utilize the tool's potential as a farm evaluation and agricultural credit estimation tool.

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BLUE CARBON ECONOMICS OF SALT MARSH RESTORATION

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Restoration of historic flows to tidally restricted salt marshes has the potential to yield valuable greenhouse gas (GHG) benefits. The available literature indicates that conversion of freshwater or brackish marshes to higher salinity systems can significantly reduce methane emissions. On a per hectare basis, reducing methane emissions is a potentially important blue carbon opportunity given its relatively high global warming potential (approximately 35x that of CO_2 according to the most recent IPCC report). And unlike carbon accumulation in wetland soils, which is vulnerable to loss through inundation of wetlands due to sea level rise, methane reductions represent permanent reductions in GHGs. Initial research for this effort suggests that when economic valuation techniques are applied to these GHG reductions, the resulting dollar benefit values on a per hectare basis are relatively high when compared with soil carbon accumulation, and may represent a relatively cost-effective coastal blue carbon approach.

To illustrate the potential value of methane reductions from tidal restoration projects, a case study is being conducted for a restoration project currently under development at Cape Cod's Herring River. Using estimates of flux rates before and after restoration, the study considers the value of these methane reductions from two economic perspectives. First, per hectare and total project carbon values are being developed based on the social cost of carbon (SCC) approach developed to support benefits estimation for federal regulatory analyses. Second, an evaluation is being prepared of the economic potential and value of carbon offsets sold under the Verified Carbon Standard (VCS) requirements, taking into account carbon market prices net of the fixed and variable costs of complying with VCS requirements for project preparation and verification.

The analysis is intended to provide restoration practitioners with an approach for evaluating the economic value of blue carbon from salt marsh tidal restoration projects. Estimates based on the SCC approach can be added to other ecosystem service values and, in some cases, have the potential to improve the benefit-cost relationship for tidal restoration projects. The analysis based on market prices for carbon offsets and VCS implementation costs will provide project developers with indications of the potential net contribution of offset sales to project costs once fixed and variable implementation costs are taken into account. Ability to sell carbon offsets for tidal restoration projects may also depend on project scale, and the analysis presented will provide restoration practitioners with information allowing them to evaluate whether a project is large enough to benefit from sale of VCS issued offsets.

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WATER QUALITY AND PROPERTY PRICES IN THE CHESAPEAKE BAY

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The Chesapeake Bay and its tributaries provide a range of recreational and aesthetic amenities, such as swimming, fishing, boating, wildlife viewing, and scenic vistas. Despite a range of restoration efforts over the last three decades, the Bay and its tidal tributaries are still plagued by poor water quality and pollution problems. In order to better understand the value of recent efforts to cleanup the Bay, EPA is undertaking a multidimensional effort to value water quality and other improvements in the Bay. This paper explores one dimension of that effort: property price impacts.

Living in close proximity to the Bay improves access to numerous recreational and other amenities, and this proximity and the characteristics related to the amenities should be capitalized into local housing markets. This paper investigates some of those benefits through a large hedonic analysis of water quality in the Chesapeake Bay Area. This is the largest hedonic analysis of water quality ever done, with over 200,000 property sales across 14 Maryland counties. This paper discusses the results and methods of the hedonic analysis. In such a large effort, a range of modeling, data, and other methodological decisions were made, which we present here. By transparently discussing these choices, we hope to assist with future hedonic efforts.

The project uses a spatially explicit water quality dataset from EPA's Chesapeake Bay Program Office, along with a wealth of landscape, economic, geographic, and demographic variables. The water quality parameter of interest is light attenuation (K_D), which is a measure of transparency. We run a separate hedonic model for each county, which allows an extensive comparison of results across areas. Spatial econometric regressions are used, where the exact spatial specification is allowed to vary across counties.

Our results indicate that water quality has a positive and significant impact on property prices in a majority of the counties examined. We find that the impact of water quality can extend well beyond the waterfront, since homes as far as 4,000 meters from the shore were included in the analysis. These results were robust to a variety of specifications.

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BEHAVIORAL SCIENCE OF NATURAL INFRASTRUCTURE INVESTMENTS

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Coastal floods are among the costliest natural disasters in the U.S, comprising nearly one third of all billion-dollar disasters in the past decade. Hazard mitigation policy at the federal, state and local level has historically focused investment in construction of hardened, or gray, infrastructure for shoreline protection. Increasing public interest and new legislation related to using habitats to enhance coastal resilience, such as Maryland's 2008 Living Shoreline Protection Act, suggests a shift towards investment in natural infrastructure (NI). While there is increasing ecological, engineering, and economic evidence for NI, we hypothesize that this trend is driven more by behavioral factors (e.g., social networks, social norms, emotional associations, and heuristic short-cuts).

We used a mix methods (qualitative and quantitative) approach to understand the role of behavioral factors in these NI investments and characterize the trend in NI investments in three coastal regions in the US: North Carolina, Maryland, and California. We conducted semi-structured interviews with 16 individuals associated with one of the NI cases in each region. These individuals were government officials, engineers, citizens, or NGO staff. Our grounded theory analysis of the interview transcripts revealed four common themes across the decisions. These themes suggest that natural infrastructure investments are driven by innovators who are influenced by NI successes elsewhere, perceive NI benefits, and act as local champions. To understand whether these qualitative results reflect regional-scale, quantitative trends, we conducted a text analysis of 10 years of county commissioner meeting minutes from case and control counties in each of the three regions. We found that county commissioners have been talking about and planning for coastal hazards with increasing frequency over the last 10 years. The results suggest that natural infrastructure is increasingly viewed as a potential or recommended solution in some counties. We found evidence to suggest that this trend is driven in part by trends in public opinion on NI. Yet, government recommendations do not necessarily translate into investments, which is consistent with local-scale behavioral factors being at play.

These results suggest that the diffusion and adoption of natural infrastructure for coastal resilience, and other societal challenges, depends critically on human behavior and institutions. This finding has important implications for conservation strategies. The conservation community has focused on building the ecological, engineering, and economic evidence base for NI, while largely ignoring human behavior. To address this gap, we propose a new focus on what we call "behavioral conservation science." Now that governments, businesses, and individuals are looking for new options to help replace aging infrastructure and prepare for future natural hazards, our need for behavioral conservation science is urgent.

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THE ECOSYSTEM SERVICES IDENTIFICATION AND INVENTORY (ESII) TOOL: SUPPORTING BUSINESSES TO VALUE NATURE AT AND AROUND A SITE

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Businesses are increasingly recognizing the value of nature, but they do not have tools to help them rapidly assess the business and community value from nature on and adjacent to their sites. To address this challenge, The Dow Chemical Company, The Nature Conservancy, and EcoMetrix Solutions Group have collaboratively developed the Ecosystem Service Identification and Inventory (ESII) Tool. The tool enables businesses to model the production of ecosystem services in units of measure that can then be input into valuation models as part of an initial assessment of ecosystem service values. This talk focuses on how the tool supports businesses to value nature.

Businesses have the potential to use their existing cost models to estimate the value of nature to the business in terms of the replacement cost or avoided cost. However, this requires having ecosystem service data in compatible units and practical guidance. Compatible units of measure were identified through semi-structured interviews with engineers and revised through model validation. Analysis of valuation scenarios revealed critical challenges and resulted in a set of guidelines for taking these methods from theory to practice.

In contrast, businesses do not have models to estimate the value of nature to surrounding communities. Semi-structured interviews were conducted with corporate citizenship experts and engineers to understand information needs on the value of nature to the community. Valuation models were identified that 1) estimate value based on changes in ecosystem service production and site attributes, 2) could be tailored to specific geographic areas, and 3) represented the best available science.

The result of this process is that businesses are now enabled to use ecosystem service production data from the ESII Tool to estimate the value of nature to the business and the community using existing cost and valuation models. Engineers can now leverage their expertise in evaluating the cost of alternative technologies to value ecosystem services. This is made possible by practical guidance using real examples. Engineers or sustainability experts are also enabled to understand the value of nature to the community using a range of indicators, including service-specific units (e.g., gallons of water) and monetary estimates of economic value.

The ESII Tool has the potential to transform businesses' ability to integrate the value of nature into their decision making by creating in-house quantification and valuation capacity. Implementing the ESII Tool across Dow and others businesses will not only build awareness and establish a baseline for ecosystem services, but it will also inform actionable decisions on site infrastructure, site placement, real estate, and corporate citizenship.

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INTEGRATING ECOSYSTEM SERVICES IN PROJECT AND MITIGATION DECISIONS AT THE INTER-AMERICAN DEVELOPMENT BANK

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Ecosystem services have become an important organizing framework for sustainability linking ecosystem processes, natural capital, and biodiversity to human well-being. The need to assess, understand and manage impacts on "ecosystem services" is implicit in the Inter-American Development Bank Environment and Safeguards Compliance Policy. The need for analysis of ecosystem services is described in Directive B5 Environmental Assessment and Directive B9 Natural Habitats. The ecosystem services concept is also implicit in the Indigenous Peoples Policy and the Resettlement Policy.

International financial institutions are working together to ensure improved assessment and more effective management of biodiversity impacts in projects. The main challenges to incorporating ecosystem service analysis into environmental assessment include: 1) poor understanding among practitioners; 2) absence of regulatory requirements; and 3) poor data. Despite these challenges, qualitative ecosystem service analyses during scoping can enhance an integrated understanding of project impacts. In addition, the incorporation of quantitative and monetized ecosystem service analyses in project cost benefit analyses can better internalize project externalities.

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INTERACTIONS BETWEEN PUBLIC PREFERENCES, LAND DEVELOPMENT, AND MUNICIPAL LAND USE POLICIES – IMPLICATIONS FOR DESIGN OF WETLAND COMPENSATION POLICIES TO SUPPORT ECOSYSTEM SERVICES

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We develop an agent based model to explore interactions between public preferences, municipal zoning and housing development, and the Alberta wetland policy in order to understand implications for maintaining wetland ecosystem services in the Beaver Hills Cooking Lake Moraine, a peri-urban area in Alberta Canada. The wetland policy is based on maintaining the wetland functions of biodiversity, hydrologic function (storage and retention), water quality, and human use. The question is how to prioritize and compensate for multiple wetland functions bundled in the same wetland when functions are connected to the spatial abundance and configuration of wetlands and land uses in upland areas, and will change over time. Furthermore, first generation wetland banks created under the US Clean Water Act 1990 Mitigation Guidance were criticized for focusing on large wetlands in distant locations, removing wetland ecosystem services from the communities that used them. This raises the question of how, under an ecosystem services approach, public preferences might influence the prioritization and evolution of wetland functions over time. Most procedures for prioritizing wetlands are based on aggregated indices which assume that functions are substitutes and seek to find replacement sites of the same aggregated value. On the other hand, it is possible to unbundle the functions at individual sites and replace them through a combination of created and restored wetlands at different sites, or even with non-natural infrastructure. Both developers and municipalities would like created wetlands (e.g. storm water ponds) that provide flood protection and human use benefits to be considered as compensation for wetland loss. While this could lead to loss of some wetland functions, the public might support such a policy. Through agent based simulation we explore the effects of alternative aggregations and weightings of wetland function on development and replacement of wetland ecosystem services over time, and consider implications for the design of compensatory mitigation policies that take an ecosystem services approach.

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CONTENT ANALYSIS TO DOCUMENT PUBLICLY VALUED ECOSYSTEM SERVICES OF RIVERS AND STREAMS

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While much ecosystem services research focuses on analysis such as mapping and/or valuation, fewer research efforts are directed toward in-depth understanding of the specific ecological quantities people value. Ecosystem service monitoring and analysis efforts and communications could be enhanced by such knowledge. For example, small changes in the way ecosystems are described can impact relevancy to the general public and improve the reliability of valuation estimates. Research on river and stream attributes considered important by the public is particularly important for nonmarket ecosystem services, since the characteristics that are valued cannot be readily observed as with goods and services bought and sold in traditional markets.

We conducted content analysis of media publications to document the breadth and frequency with which various measureable attributes of rivers and streams appear in news outlets. Media publications consumed by a given audience are one way to gather insight on perspectives held by that audience. Due to the potential impacts of material written for different audiences, two pools of river and stream news are analyzed: general public sources; and environmentalist sources.

Content analysis allows for a team-based approach through the use of standardized codes. These codes are systematically linked to passages that reference a concept (e.g. “Water Supply Scarcity” or “Recreational Contact Health Risk”) allowing researchers to compile and analyze all examples of a specific code. The initial codebook was based on prior focus group and interview research with the general public in two separate locations of the US on the same research topic. Coding of content during the pilot phase allowed for refinement of standardized codes and assessment of inter-coder reliability. During the operational phase of the project, two independent coders evaluated a large sample of articles from both general public and environmentalist pools.

Results document not only prevalent attributes of rivers and streams, but also motivations, including recreation, public health, or preservation of resources for future generations. Comparisons between general and environmentalist news can be made, as well as co-occurrence of specific river and stream attributes with specific motivations. The project demonstrates a qualitative social science research technique that can be applied to draw insights from preexisting data.

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PUBLIC INPUT ON STREAM MONITORING FROM RESIDENTS OF THE WILLAMETTE VALLEY, OREGON, US

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The goal of environmental monitoring is to track resource condition, and thereby support environmental knowledge and management. Judgments are inevitable during monitoring design regarding what resource features will be assessed. Constraining what to measure given a complex environment is a crucial question since it delimits analysis potential of the resulting data. Although public resources are managed for diverse public interests, difficult monitoring design choices are often left to natural scientists, although such decisions could represent a wider set of interests. We used focus group and interview techniques to gather public input on what data is important to collect on rivers and streams. Sessions were conducted in urban and rural locations of the Willamette Valley, Oregon. Input was obtained from nearly one hundred participants of diverse sociodemographic and geographic backgrounds. We used qualitative data analysis techniques to identify prevalent themes of public interest. These themes were then translated into specific river metrics useful for monitoring or other applications. Our goal is to establish river themes and metrics of high relevance to the public in order to contribute to a stronger basis for river management.

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VALUING ECOSYSTEM SERVICES OF AN IMPACTED WATERWAY IN THE SOUTHWESTERN US

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While many studies of ecosystem services focus on unaltered areas such as wilderness, management insight is also needed for those more impacted. This case study values ecosystem services of the Santa Cruz River, an effluent-dominated waterway in southern Arizona. Wastewater treatment outfalls along the Santa Cruz currently re-create, to some degree, the riparian ecosystems that were prevalent in the Sonoran Desert region before large scale groundwater mining began in the 1940's. Due to water scarcity in the area, society is presented with management questions for waterways containing effluent, such as whether they have recreational potential, and whether water consumed by riparian ecosystems is a worthwhile use of a precious resource.

To investigate public preferences on this topic, a stated preference valuation survey was developed by an interdisciplinary team. First, baseline perennial river flow length and associated acres of cottonwood-willow gallery forest were established, as well as diminished levels that would be associated with scenarios of reduced flow volume. Furthermore, improved water quality conditions allowing safe full body contact recreation in the river were included in scenario options. These ecological and recreational attributes were then incorporated into a choice experiment mail survey instrument with a willingness-to-pay elicitation framework. Background text as well as photos were used to describe the influence treated wastewater has on the ecosystem. Statistically designed tradeoff questions, with options to maintain flow length and forest, or increase effluent water quality, were posed along with increases in a yearly household tax. The questions collect information on the public value regarding these options as if they were being raised for a public vote. Each choice question allows a zero cost "opt out" option. The choice experiment methodology has the capacity to isolate the value of each specific marginal change considered.

The instrument was pretested and refined through focus groups and individual interviews with residents of Tucson and Phoenix, the two major metropolitan areas of southern Arizona. Results of the survey allow comparison of public interest in river reaches at varying distances of the household from the river, river reaches of varying riparian forest quality, and ecological versus safe water contact attributes. Additional questions to further understand resident knowledge of the Santa Cruz River, their river-related recreation behavior, as well as general motivations for their valuation responses are included. Limited sociodemographic questions allow comparing sample respondent sociodemographics with the target urban populations. The project contributes to US EPA research on community sustainability and ecosystem service identification and valuation.

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LINKING ECOSYSTEM SERVICES TO BUSINESS RISK: AN OIL AND GAS PERSPECTIVE

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Environmental and socio-economic risk management is an important element of oil and gas activities during all stages of an asset's lifecycle. Beginning with the planning phase, environmental and socio-economic considerations influence potential business solutions and concepts. During oil and gas exploration, project development and production, interactions with the environment and people shape everyday business decisions and practices.

Many examples can be given to illustrate how oil and gas activities are designed, adapted and implemented to limit environmental or socio-economic impacts, ranging from large-scale mitigation measures to technical solutions associated with specific project components or aspects. Underlying all of these examples is a rigorous risk assessment process that considers the environmental and social setting in which activities occur, defines possible risk scenarios, analyzes their potential consequences on people and the environment, and develops alternatives for risk reduction. Through this process, ecosystem services are inherently linked to business risk considerations, as well as to the decisions made as a result of these considerations.

We will introduce the environmental and socio-economic risk management process through a combination of concept and real-life examples, which will outline the principles associated with risk identification, evaluation and mitigation. Emphasis will be placed on linkages to ecosystem services, where they are captured in the risk assessment process and how they are considered in risk management decisions. We hope that this information will stimulate discussions among industry and non-industry audiences and enhance the understanding of best industry practices in an ecosystem services context.

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BRINGING DRAINAGE WATER MANAGEMENT FOR ECOSYSTEM SERVICES TO MARKET: WHY DRAINAGE WATER MANAGEMENT IS WELL POSITIONED TO ENTER ECOSYSTEM SERVICE MARKETS

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From the Great Lakes to the Gulf of Mexico – from the Chesapeake Bay to the Gulf of California, nutrient loading is substantially degrading our marine and fresh water ecosystems. But how do we develop reliable and cost effective strategies to address these large scale problems? How do we deal with the variability and vagaries of big swings in precipitation, temperature and the social conditions like price of commodity crops and social infrastructure to implement controls on point source and non point source sources of nutrients? The key, and vastly overlooked solution, is to look at how water moves off of agricultural lands and building cooperative linkages between the Ag sector and communities to improve water quality.

Virtually all communities are strapped for funds, and at the same time are facing the need for massive new investments to meet National Pollution Discharge Elimination System permit requirements. Tough new standards for sanitary and storm water discharge are going into place and communities will have to find a way to pay to meet these standards. An innovative strategy is needed to dramatically hold down costs, speed implementation, save ratepayers money, and provide improvements throughout the watershed instead of just below discharge pipes.

While there is no single solution to solve the nutrient over enrichment issue, a key, highly reliable and exceptionally cost effective strategy is to focus on how nutrients move off the land. We have the technology to hold, treat, and quantify drainage water; keeping the nutrients in the field where they provide a value instead of contributing to environmental problems. The Natural Resources Conservation Service, as part of its systems approach to nutrient management, has advanced a strategy known as Drainage Water Management (DWM). DWM is not an expansion of drainage; instead it looks at how to manage waters on Ag lands to hold the water and nutrients where they are needed for agricultural production and prevent them from reaching public waters.

A series of practices – Tile Drainage Water Management, Saturated Buffers, and Bio Reactors – have been proven to be highly reliable in reducing nutrient loss to waters and are well accepted by farmers. These practices have the advantage in entering ecosystem service markets because the actual environmental performance is measurable, highly reliable, and easily verified by third parties. Buyers of ecosystem services and be assured that what they are buying is actually delivered. In addition, these practices are extremely cost effective in reducing nutrient loss to waterways and can dramatically reduce compliance costs.

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DOES GREEN INFRASTRUCTURE AFFECT AIR QUALITY AND HUMAN HEALTH?

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Ecologists have embraced the concept of ecosystem service valuation because it explicitly includes natural capital along with human-built capital in decision-making and policy formulation. Yet this approach was originally intended as a tool for consciousness-raising, not as an explicit tool for the planning and design of green infrastructure at scales most relevant to our daily experience of the built environment. As such, this useful tool can actually interfere with effective policy by creating false confidence in the accuracy of the many detailed calculations that comprise the ultimate estimates. It also shifts attention from prevention to mitigation, perpetuates misunderstanding of basic mechanisms, and short circuits the process of translating broad policy to local scales. Nowhere are these unintended effects more apparent than at the interface of urban greening and human health.

Successful integration across the fields of epidemiology, immunology, urban forestry, plant ecology, atmospheric science, economics, planning and landscape architecture is daunting. The Tower of Babel Effect, where different disciplinary vocabularies, research approaches, and means objectives, can subvert effective public health policy. Contributing to this outcome is our collective fascination with the mechanics of solving complex puzzles in a given field. Each factor in a valuation model is accepted on good faith, with little or no attention to uncertainty of the estimate. When the individual quantitative estimates are combined in a valuation model, a very precise answer is obtained and although the answer may be “right”, the question may be inappropriate. This is what to what statisticians call Type III error: getting the right answer for the wrong question.

At a national scale, complying with standards for criteria pollutants under the Clean Air Act has proven difficult despite the strides that have been made. This is frustrating and disappointing. Demonstrating an unambiguous relationship between marginal improvement in air quality and life expectancy has proven to be elusive as well despite the consensus that there is a causal link between the two. Economic approaches to monetizing the link between green infrastructure, air quality improvement human health is accordingly hard to establish with any certainty.

This emerging picture should not be interpreted as all bad news. Our field studies point to novel approaches for engineering small-scale landscapes to reduce the risk of exposure to local air pollution events, especially in the vicinity of roads and highways. We are on the verge of being able to develop design specifications to move toward achieving operationally defined, empirically verifiable goals.

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REVEALING CULTURAL ECOSYSTEM SERVICES AT THE COAST AND IN THE SEA: LESSONS FROM CORNWALL, UK

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The concept of cultural ecosystem services has gained currency in recent years as a legitimate way to understand, describe and variously communicate the non-material benefits of nature (MEA, 2005; UKNEA, 2011, 2014). Despite this increased legitimacy afforded to such benefits, they remain the least explored and understood beyond the level of the intuitive, due largely to their apparent resistance to measurement (Bieling & Plieninger, 2013; Chan, 2012; Hernandez-Morcillo, 2013). At the same time, coastal and marine environments are widely recognised to play a vital role in cultural ecosystem services provision and offer enhanced opportunities to experience benefits important for human well-being such as relaxation, reflection, a sense of identity and spiritual experiences (Wheeler et al., 2012; White et al, 2010). This paper explores cultural ecosystem services in a case study area from Plymouth Sound to Fowey (Cornwall, UK) in terms of how they are experienced by residents. It extends existing conceptual frameworks by interpreting benefits as the result of the interplay between cultural spaces and cultural practices. The paper describes a methodology for revealing benefits in this area through a survey and participatory mapping exercise. Results indicate that the case study area is associated with a range of culturally valued attributes and activities that give rise to many and diverse cultural, health and well-being benefits for people. The paper argues that increasing the visibility of cultural services in this way can initiate a step change in thinking around coastal and marine management to better take account of cultural ecosystem services.

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CONSIDERING ECOSYSTEM SERVICES AT THE BUREAU OF LAND MANAGEMENT

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This presentation summarizes some of the key issues involved in making the consideration of ecosystem services a routine element of decision-making at the Bureau of Land Management (BLM), U.S. Department of the Interior. In managing over 245 million acres (99 million hectares) of lands from the Arctic Ocean to the Mexican border, the BLM routinely faces trade-offs between competing land uses. The agency manages lands that provide conventional and renewable energy, mining, grazing, timber, and recreation, while aiming to conserve environmental, cultural, and historic resources. Ecosystem service metrics provide an important tool for evaluating such trade-offs. Nonetheless, the quantity and scope of BLM's resource management decisions is very large – in a recent year the Bureau initiated over 40 environmental impact statements and completed nearly 3,000 environmental assessments. Because of this workload, making ecosystem services data a routine part of BLM's decision processes is extremely challenging.

The operational issues to be described in this presentation include:

- the need for cost-effective tools and procedures;
- the advantages and disadvantages of qualitative, quantitative, and monetary expressions of changes in ecosystem service provision;
- ecosystem service analysis as a potentially integrative factor in land use planning; and
- strategies to provide needed capacity, within and outside the agency, for the analysis of ecosystem service provisioning and benefits.

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HUMAN HEALTH AND METRO NATURE VALUATION LIMITATIONS

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Scientific evidence demonstrates that contact with nature generates a substantial and varied collection of ecosystem services which includes extensive psychosocial and physical human health and well-being benefits. However, economic valuations of these benefits have lagged similar valuations for other ecosystem services. In particular, there are limited studies associated with the linkages between public health/epidemiology (PHE) and valuations of nature benefits in a metro nature context. A thorough literature review revealed more than a dozen global themes of services and benefits associated with nature contact and human health and well-being, supported by more than 2,800 scholarly publications from multiple disciplines spanning four decades. Based on this review, we identified 15 health and well-being benefits to which economic valuations could be applied. However, most source studies were not designed to include a valuation component, thus conversion to economic terms is not straightforward. Limitations include: 1) geographic scope or scale of measurement variations between the urban natural resources (UNR) and PHE fields, 2) outcome measures vary substantially across studies, 3) few studies acknowledged potential confounding factors (i.e., mitigating or mediating variables), and 4) other limitations such as small sample sizes, lack of comparability between human populations studied, studies crossing cultural boundaries, as well as nature vegetation implementation and management actions that confound the ability to assess valuation techniques to human health and well-being issues.

It appears there are different fundamental assumptions between the UNR and PHE fields concerning metro nature research. The prevailing focus of PHE is potential risks, toxin exposure, or environmental decline, and this has shaped research questions and analysis approaches in the PHE field. When PHE investigators do study benefits, measures of association between simplistic expressions of nature – a dichotomous variable being whether vegetation or a park is present or not – are correlated with more detailed health outcomes. UNR investigators, on the other hand, tend to detail vegetation and nature presence with more specificity (e.g., large versus small trees, park elements), but may use *ad hoc* health measures that do not align with the conventions of public health research. A new inter-disciplinary approach that combines public health, natural resources, and economics is necessary to gain a greater appreciation of related societal benefits. Certain economic methods and results are shared between medical and resource economics, providing the initial integration. Additional conceptual work is needed to develop a more productive nexus of public health and urban greening. One opportunity would be to promote data consistency at state and federal levels for U.S. studies, and advocate for similar consistencies from other nations. One of the federal agencies that address either natural resources or public health could launch a small pilot program and dedicate an office or team of scientists to review both domains of science and make recommendations; the National Academies of Science would be another option. With increasing populations worldwide and more attention being focused on health and diseases, it is clear that there is now an urgent need for improved, integrated research methods linking the fields of natural resources, public health/epidemiology, and economic valuations.

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METRO NATURE DESIGN FOR PUBLIC HEALTH – URBAN ECOSYSTEM SERVICES

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Metro nature is an inclusive term, describing the diversity of nearby nature in cities that contributes to the quality of everyday lives of urban residents and supports livability on multiple levels. The Green Cities: Good Health web site is a review of publications about the relationship between metro nature and human health and well-being. The literature search has revealed more than a dozen themes of public health services and benefits, supported by more than 2,800 scholarly publications. This evidence base spans nearly 40 years and includes the contributions of multiple disciplines, including various social sciences, epidemiology, and public health.

Green infrastructure is an increasingly important element of urban services and facilities operations. For many urban residents the term infrastructure brings to mind roads, pipes, and power lines. Green infrastructure systems, however, are practical integrations of built and ecological systems, that can incorporate all natural, semi-natural and constructed green spaces within, around, and between built areas, to replace or augment more traditional gray infrastructure.

Stormwater systems planners and engineers are incorporating green infrastructure, including bioswales and vegetative systems, to reduce flow to pipes and drains. Meanwhile, park planners and managers are integrating larger park parcels, conservation lands, and community open spaces into nearby nature systems that are accessible and likely improve public health. Can these two efforts be combined? In many cities, land for public use is expensive or difficult to repurpose. Every parcel or easement is ever more valuable. The use and public value of each bit of urban public land must be optimized. While performing the primary purpose of stormwater or ecological management, green infrastructure can also be designed to provide health and well-being co-benefits.

The purpose of this presentation will be to report on a project in the Seattle/King County area that is an integration of green infrastructure installation and public health ecosystem services. The scope of the project is a one-county pilot, but principles and design development are generalizable to cities throughout North America (and perhaps other nations). The methods include public health evidence review for planning and design recommendations, combined with review of green infrastructure best practices for science and practice linkage. The results are prototype designs that promote urban ecosystem services for biophysical and social co-benefits. The conclusions and recommendations will address: 1) planning and design best practices, 2) example prototypes, 3) proposed metrics for outcome evaluations, and 4) contributions of this project to the theory and praxis of urban ecosystem services.

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INCORPORATING ECOSYSTEM SERVICES INTO NEPA SOCIOECONOMIC ANALYSES

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As currently practiced, environmental impact analyses conducted to comply with the National Environmental Policy Act (NEPA) typically analyze environmental impacts separately from economic and social impacts. In these traditional NEPA analyses, the biological and physical science sections usually identify potentially adverse project impacts while the socioeconomics section usually identify potentially beneficial project economic impacts on jobs, income, and taxes. Rather than silos of information on biological, physical, and social effects, using an ecosystem services approach integrates information and translates environmental impacts into socially and economically meaningful terms that people can understand.

This presentation will present the case for an integrated ecosystem services approach in which the social and economic implications of environmental impacts are identified. In addition, the presentation will provide an overview of how to implement such an approach. A comprehensive ecosystem service approach falls in line with NEPA guidance to "*utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences…in planning and decision making*" (Section 102(2)(A)). Such an approach also provides the public and decision-makers with more meaningful information, and avoids the dichotomy of many traditional NEPA documents that identify positive economic effects and adverse environmental effects. Methods to implement an ecosystem services approach in a NEPA context will be discussed, including 1) identification of key services, 2) establishing analysis boundaries, 3) selecting metrics, and 4) economic valuation and quantification methodologies.

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WATERSHED RESTORATION: VALUATION OF WATER SUPPLY BENEFITS

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The purpose of this study was to determine whether water supply districts in the Santa Ana Watershed, California should invest in upper watershed forest restoration. Specifically, the study focused on two types of forest restoration: forest road retrofitting and forest thinning to restore stand density, and then estimated the associated economic benefits related to water quantity and water quality improvements. Additional economic benefits related to avoided fire damage to infrastructure and private property, recreation, species habitat, and human health would also result but were not estimated in the study. Based on the expected value of water supply and water quality benefits, the study revealed that the expected value of ecosystem service benefits outweigh the cost of restoration.

Methods used in the study include @Risk modeling to identify most likely hydrologic and economic values, benefits transfer from existing literature regarding changes in fire risk and hydrologic effects of forest thinning and forest road improvements, and replacement and avoided cost methods of determining economic value. Using data from the local area, we developed three @Risk models that addressed uncertainty and estimate the most likely value of ecological and economic benefits.

Three models in the study include:

- Water Quantity Benefits of Thinning. This model quantifies the relationship between thinning and increased streamflow volume due to reduced water use by vegetation (i.e., reduced evapotranspiration). The model then translates this increased streamflow into cost savings by water districts based on reduced requirement for imported water (increased use of natural stream flows results in less spending on water that would be purchased from outside the basin from such sources as the State Water Project).

- Water Quality Benefits of Thinning. This model quantifies the relationship between thinning and decreased severity and frequency of forest fires. As forest fires increase sediment loads in streams, the model quantifies how a reduction in forest fire risk decreases sediment loading. The model then quantifies the economic benefits of reduced sediment loading by estimating the cost savings of reduced sediment removal in Santa Ana River Watershed recharge basins.
- Water Quality Benefits of Road Retrofitting. Road retrofitting reduces sedimentation in nearby streams and rivers by stabilizing soils along roadways. This model estimates how road retrofitting would reduce sediment loads in the Santa Ana River Watershed. Similar to the water quality benefits of the thinning model, this model then quantifies the economic benefits of reduced sediment loading by estimating the cost savings of reduced sediment removal in

The study reveals the potential benefits of water supply districts investing in upper watershed restoration, and also highlights the key sources of uncertainty, and recommended additional hydrological and economic research.

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ON QUANTIFYING THE VALUE OF STREAMS PURIFICATION SERVICE

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Nutrients purification is a natural service of stream ecosystems that can improve water quality, by reducing nutrient loads in downstream waters. This capacity has been ignored so far in water management strategies, mostly due to a lack of quantification and translation of this ecological process into economic value.

The value of this service is estimated, according to the cost-benefit model, to the benefits of nutrients removal by self-purification of stream minus the costs to conserve or restore this service. Objectives of this study are: 1.The estimation of the benefits due to nutrient retention and 2. The demonstration of the required biodiversity to support this service for further cost assessment. The used database came from the STREAMES project (5th PCRD), based on 11 streams representative of a range of water qualities from 8 European countries. $NH4^+$, $NO3^-$ and $PO4^-$ retention rates were measured between 2001 and 2003 during contrasted hydrological conditions and by slug or short-term addition experiments. Invertebrate diversity was simultaneously investigated at the taxonomic and functional traits level in the same stream reaches.

Benefits associated to this service are estimated by the methods of replacement applied on the quantity of removed nutrients by the stream. Retention rates (U) varied from 0.16 to 2.48 mg N/m2/min for the 11 streams. The price to remove nutrients by the streams is estimated equal to the price to remove the same amount of nutrients in a wastewater treatment plant. Taking the Leze stream as an example (discharge = 0.16 ± 0.075 m^3/s), the benefits for removing 412 kg N-NO3 in a 100 m reach and per year are about 3705 euros, according to 9 euros per kg of TN in WWTP.

The cost to maintain this service will be emphasized by the price of stream reaches restoration projects that include sediments and biodiversity issues. However, it appears necessary to firstly identify biodiversity-function relationship to give evidence of the required biodiversity as purification providers. The final cost of this natural service will be equal to the management investment applied on the correct time duration to conserve or restore this biodiversity.

Our approach demonstrated that the most suitable diversity index to reflect retention capacity was Rao's quadratic entropy of 11 bio-traits (rang from 40.2 to 76.6). Both $NO3^-$ and $PO4^-$ retentions are positively correlated to this index, but there is no significant relationship with $NH4^+$ retention rates. When bio-traits diversity lost 10 units, $NO3^-$ retention velocity decreased by 2.68E-07m/s. Key bio- and eco-traits that characterize the most efficient invertebrate community for nutrients retention were identified, and feeding habits was found to be the most relevant. Biomass of deposit feeder was positive related with $NH4^+$, $NO3^-$ and $PO4^-$ retention. Predator and shredder contributed to $NH4^+$ and $PO4^-$, respectively. Our findings underlined the implication of invertebrates' diversity in this service thereby facilitating the cost-benefits assessment.

A strong inter-disciplinary collaboration from economists, ecologists is now expected to get further in this value estimation.

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ASSESSING SUSTAINABILITY OF CORAL REEF ECOSYSTEM SERVICES USING A SPATIALLY-EXPLICIT DECISION SUPPORT TOOL

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Forecasting and communicating the potential outcomes of decision options requires support tools that aid in evaluating alternative scenarios in a user-friendly context and that highlight variables relevant to the decision options and valuable to stakeholders. *Envision* is a GIS-based tool for scenario-based community and regional planning and environmental assessments, created to allow examination of the nature and properties of coupled human and natural environmental systems. We have integrated models of watershed-based threats and coral reef dynamics with ecosystem service production function models into *Envision* to assess the sustainability of coral reef ecosystem services under alternative scenarios of watershed management. We focus on the Guánica Bay watershed in Southwestern Puerto Rico, where deforestation and drainage of a large lagoon have led to sediment, contaminant, and nutrient transport into the bay, resulting in declining quality in coral reefs. A watershed management plan is currently being implemented, however recent workshops with stakeholders indicated there is still a great deal of uncertainty on the degree to which proposed actions could benefit the local community. We apply the Envision tool to address two key areas of uncertainty: 1) the potential effects of sediment on coral reef condition and 2) the potential socio-economic benefits of watershed management on coral reef ecosystem services, including fisheries production, shoreline protection, and recreational opportunities. Inclusion of coastal ecosystem services and benefits is needed for a balanced consideration of trade-offs when decisions are made in the watershed.

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LINKING ECOSYSTEM SERVICES SUPPLY TO STAKEHOLDER VALUES IN GUÁNICA BAY WATERSHED, PUERTO RICO

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Policies to protect coastal resources will be more effective when they account for the social and economic concerns of stakeholders in the coastal zone and watershed, and are responsive to potential tradeoffs between benefits offered by both land and sea. We focus on the Guánica Bay watershed in Southwestern Puerto Rico, where deforestation and drainage of a large lagoon have led to sediment, contaminant, and nutrient transport into the bay, resulting in declining quality in coral reefs. A watershed management plan is currently being implemented, however recent workshops with stakeholders indicated there is still a great deal of uncertainty on the degree to which proposed actions could benefit the local community beyond protecting coral reefs, including unintended benefits or negative consequences for agricultural and tourism economies, drinking water supply, human health, and the ecological integrity of non-reef ecosystems. A first step is to calculate baseline measures for valued services in order to better understand the potential risk of decisions. Ecosystem services indicators were identified that reflected stakeholder objectives in the watershed (terrestrial) and coastal zone (marine). Production functions were applied to quantify and map ecosystem services, and spatial analysis allowed comparison between services provided in the upper and lower Guánica Bay watershed and across 23 other watersheds (HUC 10) in Puerto Rico. The upper Guánica watershed is dominated by forest and the lower portion dominated by agriculture. Coral reefs and mangroves are found in shallow nearshore waters which support fisheries and recreation. Compared to other watersheds in Puerto Rico the upper Guánica watershed had high air pollutant removal rates, forest habitat area, and biodiversity of charismatic and endangered species, but low farmland area, and sediment and nutrient retention. On the other hand, the lower Guánica watershed had high rates of denitrification, sediment and rainwater retention compared to other watersheds, but low air pollutant removal, carbon sequestration, nutrient retention, and biodiversity. Characterizing the relative provision of different ecosystem services can inform and clarify decision options that occur in different areas of the watershed or different regions of Puerto Rico.

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ECOSYSTEM SERVICES AND NOAA'S RESTORE ACT SCIENCE PROGRAM: INFORMING MANAGEMENT DECISIONS IN THE GULF OF MEXICO

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The Deepwater Horizon oil spill will leave a lasting effect on the Gulf of Mexico; affecting both environmental conditions and economic and policy decisions. It presents numerous opportunities to assess conservation and management efforts, to introduce best practices, and to share lessons learned at the regional and national scale. The mission of the National Oceanic and Atmospheric Administration's (NOAA's) RESTORE Act Science Program is to initiate and sustain an integrative, holistic understanding of the Gulf of Mexico ecosystem and support, to the maximum extent practicable, restoration efforts and the long-term sustainability of the ecosystem, including its fish stocks, fishing industries, habitat, and wildlife through ecosystem research, observation, monitoring, and technology development. The NOAA RESTORE Act Science Program is supported by goals, guiding principles and focus areas which are captured in the Program's Science Plan Framework. This Framework is serving as the foundation for the development of a full Science Plan for the Program.

This presentation will focus on two RESTORE Science Program priorities in the Focus area "Periodic state of health assessments, incorporating environmental, socioeconomic, and human well-being benefits and elements." These priorities and the Draft Science Plan contain key management needs, activities, outputs and outcomes related to advancing the science of ecosystem services. The goal of this focus area is to develop the knowledge base necessary to make management decisions that are informed by how those decisions impact ecosystem services and, more broadly, society. This focus is reflected in the two priorities aimed towards advancing Gulf-specific

1) Ecosystem services science and its applications to management, and
2) The identification and/or development of quality indicators of ecosystem health.

This presentation will review this focus area and its accompanying priorities, activities, and outcomes and describe elements necessary to develop a foundation of ecosystem services-related information. In addition, it will explore the following questions:

- How do ecosystem health indicators feed into the development of ecosystem services science?
- What are the specific management contexts where ecosystem services valuation information can help to fill existing information gaps?
- Which approaches to stakeholder engagement should we pursue, and which partners should we collaborate with to accomplish this?
- What ecosystem services projects, in the Gulf or elsewhere, are considered most successful, and what were the keys to their success?

The expected output of the talk will be:

- Feedback on the content and clarity of the Science Plan as well as suggested modifications
- A better understanding of the decision contexts within which ecosystem services information, once developed, can be applied
- A list of projects and partners to consult
- A clearer sense of the ACES community's level of support for the Ecosystem Services Focus Area work and the RESTORE Science Plan more generally.

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OLD WORLD VULTURES AND CARCASS POISONING: AN ECOSYSTEM SERVICE UNRAVELED

Steve Zack *and Jane Carter Ingram*
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Ecosystem services are natural processes that benefit humans. This anthropocentric lens on natures sorts processes and biodiversity into categories of potential benefit, or detriment, or as neutral (without apparent value). Such "services" and their perceived value may change (or emerge) depending on context. Beaver activities in a floodplain may be perceived as a service or a "disservice" depending on whether humans are attempting to control floodplain processes, for example. Here and in other cases, the perception of "service" may undermine biodiversity goals like that of the widely extirpated Beaver. The loss of "beneficial" species due to human influence may unravel an ecosystem service, as in the case of Old World Vultures. Vultures engage in one of the more conspicuous ecosystem services among birds: they are obligate scavengers of large vertebrate carcasses and respond quickly and in large numbers such carcasses. Vultures of several species can find carcasses from long distances, reacting to first responders. As a group they have high pH stomachs that break down pathogens and thus reduce disease risk of rotting carcasses. Old World Vulture species (16 species, part of the Accipitridae) have exhibited dramatic population declines in recent years due to poisons in carcasses (12 species now Red-listed by IUCN). In the Indian sub-continent, a veterinary drug, diclofenac, given to cattle later proved fatal to vultures later consuming their carcasses. Three species' populations declined more than 95% since the 1990s. In Africa more recently, the intentional poisoning of carcasses is likewise causing alarming population declines of several species across the continent. The poisons are often carbofurans, toxic and dangerous pesticides banned in Europe and the U.S., but cheap and widely available in Africa. Poisoning has many contexts, including lion-livestock conflict, elephant poaching, and subsistence "hunting". Finally, witchcraft practice in West Africa includes killing of vultures (often with poisons). The effect across these continents is the collapse of an ecosystem service with dramatic health implications for wildlife and humans alike. Rabies may become more prevalent with carcasses left for facultative scavengers, including feral dogs. The consequence to local peoples using of poisons for subsistence and witchcraft is not known. Confronting this crisis requires widespread engagement with local communities to reduce the use of poisons, and political engagement across countries to remove or regulate access to diclofenac and potent pesticides.

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GREEN FARM: HARMONIZING SOCIAL RESPONSIBILITY, ENVIRONMENTAL SUSTAINABILITY AND PROFITABLE BUSINESS PRACTICES

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Green Farm CO2free operates a 10,000+ acre piece of property in Mato Grosso do Sul, Brasil. They execute several ecosystem services according to their strategic plan in order to create the most efficient ecosystem possible. The project is then divided into individual 'shares' represented by a 10+ acre piece of the property (1000 total shares). The share is actively managed by GreenFarm according to their strategic plan. Clients purchase a 'share 'of the project through an annual 'membership 'fee. Each share represents the needs of each client as they can choose exactly to which ecosystem services their investment will be directed. Clients are provided with an annual report detailing the results of their investment. Currently there are 8 ecosystem services credits being offered include carbon sequestration and storage, biodiversity (gene banks, rehabilitation and breeding of wild flora and fauna species – including 5 threaten by extinction), habitat (recreation, rehabilitation and preservation), water (quality and quantity), Pollinators (wild and domesticated bees and others), scenic beauty (forest architecture principles), Research & Development (MRV methodologies), Environmental Education (Green Education program with CO2FREE association). There are other 23 ecosystem services provided by the area that will generate credits in the near future, including soil erosion control, superficial flows abatement, cultivation of fragrances, and preservation of sounds and so on. Green Farm covers some 18 miles of riverfront at three distinct biomes: Atlantic Forest, Cerrado and Pantanal, Integrated to Parana River International biodiversity corridor and at the buffer zone of Ilha Grande National Park. The area has been developed to manage and supply ecosystem services to clients following transparent and accountable procedures to meet Corporate Socioenvironmental Responsibility – CSR demands according with ISO 26000 guidelines. It has established the first biodiversity bank in South America with existing credits for 5 species, the Harpia harpjia eagle credits is estimated at US$ 150,000 per unit, the first ever evaluation of this kind done in Brazil. Today more than 30 companies are Green Farm partners and some other 300 are in the process of becoming members. The project has won a national and an international awards in 2012 and was recognized as one of the best Private Sector Initiatives – PSI/UNFCCC on climate change adaptation.

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APPLYING ENVIRONMENTAL ACCOUNTING PRINCIPLES TO IMPROVE THE EFFECTIVENESS OF LARGE-SCALE HABITAT CONSERVATION PLANS

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Habitat conservation plans (HCPs) as a tool under the Endangered Species Act (ESA) have been in existence since the ESA was amended in 1982 to allow them. To date, almost 700 plans have been approved on close to 50 million acres. Increasingly, HCPs are being undertaken on large scales to address the conservation needs of multiple species, watersheds, ecosystems, and in some cases classes of activities (e.g., wind energy, forestry, gas pipelines, water infrastructure) that span many states. There are many advantages of these large-scale HCPs including the ability to obtain permits for non-listed species; increasing local control of endangered species permitting; regulatory certainty; reducing ESA compliance costs; and increasing the effectiveness and efficiency of conservation. Because of these efficiencies, many applicants are attempting to integrate these large-scale HCPs with a variety of other federal and state laws, increasing permit streamlining even further. An unprecedented wave of federal species listings has begun as a result of a 2011 Settlement Agreement with the U.S. Fish and Wildlife Service to consider over 700 species nationwide, most of which occur in aquatic environments in the southeast United States. These new listings will increase the need for conservation planning tools that address multiple listed species, including HCPs.

Although HCPs have not explicitly adopted the principles of environmental accounting, many plans use similar techniques. For example, HCPs function in ways similar to large mitigation banks with their own "credit" system, currency measures, and credit valuation process. Also, many plans include measures of species' habitat quality in their biological goals and objectives or even their conservation targets. Adaptive management and monitoring programs are required elements of HCPs, which allow these plans to monitor and improve their performance over time—a key element of environmental accounting. HCPs offer an established model in which to apply environmental accounting principles on a large scale across multiple species. In turn, environmental accounting principles offer a promising approach to improving the consistency and rigor in HCPs with respect to measuring their conservation outcomes. I will discuss how environmental accounting principles could be applied to large-scale HCPs, citing examples in development such as the Bay Delta Conservation Plan in California, Pennsylvania State Forest Land HCP, Multi-State Wind Energy HCPs in the Midwest and Great Lakes, and the Massachusetts Beaches HCP.

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Author Index

Accatino, Francesco 346
Adams, Darius 171
Agardy, Tundi **3**, **4**
Alamgir, Mohammed **5**
Alfieri, Alessandra 55
Allen, Karen 215
Alphin, Troy 100
Aman, Jake 147
Amman, Mike 253
Ancona, Zachary H. **6**, 291
Anderson, Christopher M. 309
Andreu, Michael G. 166
Andriamaro, Luciano 226
Anguita, Juan 352
Appels, Lise 330
Arceo, Patricia **7**
Armillo, E. B. 165
Armstrong, Claire W. **8**
Awkerman, Jill 361
Babu, Suresh 288
Bagstad, Kenneth J. 6, **9**
Baker, Justin 171
Bakker, V. J. 67
Baldauf, Richard W. 141
Balogun, Lafemiwa B. **10**
Ban, Suzanne M. **11**
Baraso, Sam **12**, 259
Barber, Brad L. 292
Barber, Mary 264, 266
Barcan, C. 303
Barclay, Pamela 142
Barnes, Eric **13**
Barnes, Tomma 59
Bassi, Andrea **14**, 313
Batker, David **15**, 92
Battagliese, T. 303
Battin, T. J. 359
Bauer, Dana Marie **16**, **17**
Baumgarten, Leandro 154, 299
Baynes, Jeremy 273
Beach, Robert 171
Behe, Carolina 61
Beier, Colin 52
Bekele, Elias G. **18**
Bello-Pineda, Javier 7
BenDor, Todd **19**
Bennett, Drew E. **20**, 229
Bennett, Genevieve **21**
Bennett, Karen **22**, **23**
Bennett, Ryan **39**
Bentrup, Gary **24**
Berg, C. **25**
Bernazzani, Paola **26**
Berry, Walter 200
Besedin, Elena **27**, 146
Bhat, Mahadev G. 58
Biddinger, Gregory R. **28**
Bielecki, Jeff 248
Binder, Seth 248
Bingham, Andrew **29**
Blahna, Dale J. **30**
Blainski, Everton 163
Blockstein, David **31**
Bohensky, E. 134
Bond, Julia **32**
Bondo, Torsten 107, 108
Booth, Pieter N. **33**, **34**, 173
Borrett, Stuart 100
Bottrill, Madeleine 226
Boucher, Timothy 163
Boumans, Roelof J. M. **35**
Bousquin, Justin 83, 200
Bowles, Joe 86
Boyd, James 34, 266
Boykin, Kenneth G. **36**, 155
Bradford, David F. 36
Bradley, Patricia **37**, 280
Brand, Peter 38
Brandt, Brian **39**
Branosky, Evan **40**
Brantley, Halley L. 141
Brauman, Kate 248
Bridges, Todd S. 47
Bright, Larry **41**
Brinkley, Weston 30
Brown, Calum 272
Brown, Claire 271
Brown, Evan 272

Brubaker, Michael 84
Bruce, David 319
Bruel, Aurélien **42**
Bruggeman, Doug **43**
Bruins, Randall J. F. **44**, 65, 162
Bryan, Keri L. **45**, 205
Buonagurio, John 173
Burgess, Matt 248
Burke, Lauretta **46**, 339
Burks-Copes, Kelly **47**
Bush, Kathleen F. **48**
Butler, J. 134
Butsic, Van 170
Byers, Bruce A. **49**
Caballero, Luis A. 49
Cain, John 122
Campbell, Elliott **50**
Campbell, Lindsay K. 308
Campbell, Tom 114
Camus, Lionel **51**
Cano, C. Andres 226
Caplan, Shannon 347
Caputo, Jesse **52**
Carollo, Cristina **53**, 281
Carr, Kim 202
Carriger, John 37
Carroll, Nathaniel 21
Carver, Linnea 205
Cassidy, Emily 248
Cebrian, Just 135
Chakrabarti, Anwesha 309
Chase, Lisa 309
Chaubey, Indrajeet 183, 184
Cheng, Antony 132
Chennault, Carrie M. **54**
Chow, Julian **55**
Christin, Zachary **56**
Christy, Aimee 133
Clark, Adam 248
Cochran, Bobby 12, 151, 195
Cojocaru, George 271, 272
Colas, F. 359
Cole, Jefferson 171
Conkle, Pete **39**
Cook, Philip S. 9
Cooley, Corinne 15, 162
Cooper, Emily C. **57**
Corrales, Juliana **58**
Crawford, Chris 202
Creed, Irena 346
Csuti, Blair 160
Cundiff, Amanda 202
Currie, Rebecca J. 104, 105, 112, 230, 299, 344
Cushing, Janet A. **59**, 219, 338
Cutlac, Marius 346
Dacol, Kelli 163
Dalton, James 260
Daniel, Jessica **60**
Daniel, Raychelle **61**
Dannenberg, Matthew 273
Davies, Christian 228
Dávila-Camach, Claudia 7
Davis, Adam 19
Deal, Robert **62**, 106, 297
Deerhake, Marion E. **63**
Delbaere, Ben 271
Delevaux, Jade M. 236
Dell, Randy **64**
Delparte, Donna 181
Dennedy-Frank, P. James 163, 183
DePinto, J. V. 257
Dewil, Raf 330
DeWitt, Theodore H. 44, **65**, 162
Diamond, Jerry **66**
DiDonato, Eva 9
Diffendorfer, J. E. 289
DiMuro, John 212
Dionne, Michele 147
Doak, Daniel F. **67**
Dobb, Jennifer Schein 96
Donatuto, Jamie **68**
Dosskey, Mike 24
Druschke, Caroline 200
Duke, Clifford S. **70**, 189
Duncan, Sally 159
Dunford, Richard W. **57**, 253
Dunford, Robert 117
Dunne, Jarlath Oniell 45
Dupont, Valerie **69**
Dupras, Jérôme **71**
Dvarskas, Anthony **72**, 100
Dyson, Bryan 123

Echols, Alex **73**
Edelson, David 202
Edwards, David 326
Edwards, Mark 169
Edwards, Sharon 48
Ehrich, Dorothee 119
Eigenraam, Mark **55**
Eisenman, Theodore S. **74**
Elliot, Steve 159
Ellis, Alicia 265
Ellis, Chad R. **75**
Elsen, Annemie 237
Emmett-Mattox, Steve 129
Endres, Keith 273
Enstice, Nic 202
Errend, Melissa N. 44, 65
Espie, Matthew 40
Estelí-Méndez, Linda 122, 202
Eve, Marlen D. **76**, **77**
Fales, Mary 64
Falinski, Kim 236
Fauchald, Per **78**, 119
Feurt, Christine **79**, 147
Fiksel, Joseph 313
Finch, Kim 301
Finisdore, John **80**
Finley, Tim 212
Fish, Rob 353
Fisher, Adlai 139
Fisher, Brendan 265
Fisher, Heather **81**, **82**
Fisher, Jonathan 163
Fisher, William S. 37, **83**, 361
Flensburg, Susan **84**, **85**
Flores, Lola 56, 336
Foley, Gary J. 313
Foley, Tim **86**
Fontaine, Thomas D. 35
Fowler, David 336
Fox, Jessica **87**
Fox, William E. **88**, 189
Frahm, Ryan 54
Freeman, Miranda 188
Frey, Steve 169
Friedrich, Carla **89**
Fripp, Geanina 205
Fulford, Richard S. **90**, 274
Fuller, Erin 64
Fuller, Garth **91**
Gaffney, Karen **92**
Gafny, S. 359
Galford, Gillian 45
Gammie, Gena 157
Gartner, Todd **93**, **94**, **95**
Gebert, Krista **96**, 297
Gergely, Kevin J. 36, 155
Gerino, M. 359
Gerritsen, Jeroen 280
Gill, Carrie Anne 322
Gill, David A. **97**
Gilliam, Nancy 244
Glynn, Pierre D. **98**
Godlewski, S. 185
Goines, Bruce 202
Gold, Arthur 322
Goldstein, Alisha 82
Goldstein, B. E. 67
Goldstein, Joshua H. **99**
Gomez, Elizabeth **100**
Gosnell, Hannah 229
Gottschall, Natalie 169
Govoni, David 98
Grado, Stephen C. 355
Granger, Julien 228
Grantham, Hedley 226
Gray, Erin 339
Gray, Miranda E. 44, 65
Green, M. 185
Greene, Gretchen 211, 214
Greenwalt, Travis 358
Griffiths, Charles 342
Griscom, Hannah 219
Groffman, Peter 52, **101**
Gromko, Duncan **102**
Grove, J. Morgan **103**
Guertin, France M. **104**, **105**, 112, 230, 299, 344
Guignet, Dennis 342
Guillaume, Bertrand 42
Guimaraes, João 163
Guise, Amy M. 47
Gulca, Vitalie **106**
Haas, Eva Maria **107**, **108**

Haase, Dagmar 198
Hagler, Gayle S. W. 141
Haines-Young, R. **109**, 252
Hair, Lisa 82
Hale, B. 67
Hall, Kim 266
Hall, Madeline **110**
Hallstein, Eric **111**
Halsey, Kenna 112, 230, 344
Halsey, Kevin **112**, **113**, 230, 344
Halter, Amanda **114**
Hamilton, Don 300
Hantush, Mohamed M. 290
Harmon, Mark E. 160
Harris, Doug **115**
Harris, Leah M. **116**
Harrison, Paula A. **117**, 271, 272
Harter, Thomas 234
Hartley, Christopher **118**
Hausner, Vera H. 78, **119**
Havinga, Ivo 55
Hawkins, George **120**
Hawthorne, Peter L. 154, 248
Hayashi, Kiichiro **121**
Hayden, Ann 202
Hayden-Peridas, Ann **122**
Hecht, Jonathan 26
Heffernan, Jim 234
Heilke, Ingrid **123**
Henderson, C. 222
Henderson, Charlotte 205
Hendren, Zach 63
Henery, Rene 122
Henning, Miranda 241
Hermy, Martin 237, 330
Hicks, Brian **124**
Hickson, Patricia 202, 229
Hidinger, Lori A. 189
Hogan, Dianna M. 98, **125**
Hogervorst, Johan 22
Hole, David 226
Holland, Ben 147
Holmén, Kim J. **126**
Honzák, Miroslav **127**, 226
Hoover, Coeli 77
Hornback, Chris **128**
Hoskin, K. Diane **129**
Howard, Jennifer F. 245
Hsu, David **130**
Htun, Hla 236
Huber, Chris **131**, 263
Huber-Sannwald, Elisabeth 70
Huber-Stearns, Heidi **132**
Hudson, Bobbi **133**
Hunter, Cass M. **134**
Hutchison, Lauren M. **135**
Hychka, Kristen 200
Ibes, Dorothy C. **136**
Imhoff, Marc L. **137**
Ims, Rolf A. **138**
Infante, Maria Cristina **139**
Ingram, Jane Carter **140**, 224, 363
Irving, Meghan 241
Isaksen, Gary 281
Isbell, Forest 248
Isenberg, B. J. 303
Jackson, Laura 48, 60, **141**, **142**, 285, 286
Jäger, Jill 117
Jaworski, Delilah **96**
Jenter, Harry 98
Jewkes, Holly 86
Jin, Gan 236
Johnsen, Nils Arne 214
Johnson, Alex **143**
Johnson, Kris **144**, **145**
Johnson, Michelle L. 308
Johnston, Robert J. 27, **146**, **147**, **148**, 192, 266
Julien, F. 359
Kafle, Achyut **149**, **322**
Kagan, James S. **150**, **151**, **152**
Kalin, Latif 290
Kapustka, Larry 70
Kebreab, Ermias 234
Keller, Roger **153**
Kelling, Steve 261
Kennedy, Christina M. **154**, 299
Kenney, Pat 9
Kepner, William G. 36, **155**
Kerr, John 64
Khan, Izhar 169
Kiesecker, Joe 154
Kieser, Mark S. **156**, **157**, **158**

King, John **115**
Kinney, Patrick 187
Klavon, Philip 319
Klein, Mary **159**
Klemick, Heather 342
Klemz, Claudio 163
Kline, Jeffrey D. **160**
Knapp, Landon C. **161**
Kochmer, Jonathan **162**
Kochnower, Dana 343
Koenig, Kellee 226
Komlos, Shawn B. 59
Koontz, Lynne 131
Krause, Paul R. 57
Kreuter, Urs P. 88, 189
Kroeger, Timm **163**, 212, 299
Krupnick, Alan 53, 266
Labbe, Nancy **164**
Lacdan, Natividad **165**
Lagrosa, John J., IV **166**
Landers, Dixon H. **167**
Lang, Megan W. **168**, 290
Lange, Glenn-Marie 127
Lapen, David R. **169**
Larson, Stephanie **170**
Latta, Gregory **171**
Lauck, Elizabeth **172**
Lautenbach, Sven 174
Lavallee, Philip 180
Law, Sheryl A. 33, 34, **173**
Lazar, Jay 319
Le, Lena 9
Leach, Anita 22
Leathers, Gená 212
Lee, Heera **174**
Leeworthy, Vernon R. (Bob) **175**
Leonard, Carrie 32
Leong, Kirsten 9
Lerman, Susannah B. **176**
Leshan, Jin 318
Lester, T. William 19
Lewandrowski, Jan **177**
Li, Yanshu 292
Li, Zhi **178**
Lien, Aaron M. **179**, 307
Lind, Brianne N. **180**
Lipple, Brock **181**
Liquete, Camino 107
Liu, Pengfei 178, **182**, 309
Livengood, Avery 19
Locke, Dexter 103
Loerzel, Jarrod 161, 186
Logsdon, Rebecca A. **183**, **184**
Lomnicky, Gregg 44
Loomis, Ross 63
Loos, J. **185**
Loperfido, J. V. 125
Lopez, Mayra **186**
Lopez-Hoffman, Laura 179, 262, 289, 307
Lovasi, Gina S. **187**
Lovelace, Susan 161, 186
Lozano, Sacha 92
Lupi, Frank 116
Ma, Jane 173
Macdonald, Cathy 91
Mackenzie, Andrea **92**
MacNair, Doug **188**
Maczko, Kristie A. 180, **189**
Madsen, B. 87
Maguire, Lynn A. **190**
Mahon, Robin 284
Maillett, Edward **191**
Makriyannis, Christos **192**
Male, Timothy D. **193**
Maltba, Ryan 364
Maltby, Lorraine 70
Man, Derina 177
Mandle, Lisa **194**
Maness, Nicole 151, **195**, **196**
Manson, Paul 113
Marti, E. 359
Martinez, Barbara T. **197**
Martinez-Cruz, Adan L. 316
Mascarenhas, André **198**
Matsumoto, Sandi 111
Maxson, Pamela 48
Maynard, Simone **199**
Mazcko, K. 88
Mazzotta, Marisa J. **200**, **201**
McCarty, Gregory W. 168, 290
McCollum, Daniel W. 189
McComb, Brenda C. 160

McCune, Kelli **202**
McDonald, Rob **203**, 212
McElwaine, Andrew **204**
McGee, Beth L. 243
McGrath, Deborah A. **205**
McGrath, Dennis **206**
McGrath, V. 134
McKinney, Shaun **207**
McMurray, Anna 338
Measells, Marcus K. 355
Meersman, Matt 64
Meixner, Thomas 349
Mendoza, Guillermo 219
Merrifield, Matt 261
Merrill, Nathaniel 322
Mesagan, O. Olutola 238
Metian, Marc 248
Metzger, Marc 271
Michaud, Clayton 322
Miller, Chris 227
Miller, Dustin **208**
Miller, Jeremy 147
Miller, Nicholas **209**
Miller, Roy **210**
Mills, Michael D. **211**
Mineau, M. 25
Miralles-Wilhelm, Fernando 58
Miranda, Marie Lynn 48
Mitchell, John E. 189
Miteva, Daniela 154
Molnar, Jennifer **212**, 230, 299, 344
Moon, Jessica B. 44, 65
Moore, Amber **213**
Moore, David 70, **214**
Moore, Rebecca **215**, 263
Morais, M. 359
Morris, Chelsea 234
Morzillo, Anita T. 160
Mountjoy, Daniel 202
Mozumder, Pallab 287
Muir, Rachel **216**
Mullin, Joseph 51
Munns, Wayne R., Jr. 70
Muñoz-Erickson, Tischa A. **217**
Murley, Jim **218**
Murray, Brian 171
Murray, Brian C. 235
Murray, Elizabeth 59, **219**, 338
Mushet, David M. **220**
Muys, Bart 330
Myer, Gwyneth **221**
Myers, Beth M. **222**
Myers, Kelley H. **223**
Myers, Sam 265
Naeem, Shahid 140, **224**
Nahlik, Amanda M. 167
Naja, G. Melodie 58
Neale, Anne C. 36, 155, 167, **225**
Neau, Jordan L. 220
Needelman, Brian **129**
Nemetz, Peter N. 139
Neugarten, Rachel A. **226**
Ng, Kawa **227**, 297
Nguyen, Trung **228**
Nicolette, Joseph 51, 214, 255, 267
Nielsen, Erik 210
Nielsen-Pincus, Max **229**
North, Jeffrey 112, **230**, 299, 344
Northrop, Robert 166
Norton, Douglas J. **231**
Nowak, David J. **232**
O'Brien, Sara **233**
Oakleaf, James R. 154
Ogle, Stephen 77
Ohrel, Sara 171
Ojo, Claudette 123, 200
Olander, Lydia P. **234**, **235**, 325
Oleson, Kirsten L. L. **236**
Olsen, Keith 160
Ooba, Makoto 121
Opaluch, James 322
Orlando, Jessica L. 360
Ottoy, Sam **237**
Oxenford, Hazel 97
Oyerinde, Olubukola V. 10, **238**
Pabilona, N. J. 165
Pabst, Robert J. 160
Pape, Diana 77, 177
Papenfus, Michael 266
Parcerisas, Lluìs 71
Parker, Robert 229
Parman, Joe 64

Parsons, George R. 223
Pastorok, Robert 253
Patton, Lindene **239**
Paustian, Keith 228
Payne, Susan Frick **240**
Pearce, Duncan 205
Pelletier, Derek M. **241**
Pérez-Soba, Marta 271
Perrings, Charles **242**
Pert, Petina L. 5
Perzanowski, Matthew 187
Peter, Christopher 147
Peters, Jeremy **39**
Petersen, Jan-Erik 109
Peterson, Bradley 100
Petry, Paulo 163
Phillips, Donald L. 35
Phillips, Spencer R. **243**, **244**
Phuong, Vu Tan 23
Pidgeon, Emily **245**
Pilant, Andrew N. 273
Pindilli, Emily J. **246**
Pintar, Katarina 169
Piwowarczyk, Joanna **247**
Podolak, Kristen 202
Polasky, Steven 45, **248**, **249**
Pollak, E. J. 303
Pollnac, Richard **250**
Portela, Rosimeiry 127
Porter, Ellen 29
Posey, Martin 100
Posner, Stephen **251**
Potschin, Marion 109, **252**
Pouyat, Richard V. 352
Powers, Wendy 77
Preziosi, Damian V. **253**
Primozich, David **254**
Pritzlaff, Richard 316
Puig, M. A. 359
Pusch, M. 359
Raffle, Brad **255**
Rainbird, J. 134
Ramenzoni, Victoria 269
Ramos, Tomás B. 198
Rasolohery, Andriambolantsoa 226
Rea, Chris **256**
Reagan, J. O. 303
Redder, Todd M. **257**
Reddy, Sheila 112, 212, 230, 299, **343**, **344**
Rees, Gwendolen **258**
Reid, Joey 248
Reub, Greg **259**
Reuben, Aaron **260**
Reyna-González, Pedro 7
Reynolds, Mark **111**, **261**
Reynoso, Claudia 179, **262**
Rhodes, Charles 167
Ribaudo, Marc 234
Richardson, Leslie 131, **263**
Richardson, Robert 64
Richkus, Jenn **264**
Ricketts, Taylor H. 45, **265**
Riegel, Josepth 273
Rikard, Michael 9
Riley, Katie 122, 202, 298
Riley-Gilbert, Marybeth 177
Ringold, Paul **266**, 347, 348
Rizzo, Albert D. 168
Roa, Alex 92
Robbins, Alicia S. T. 355
Robbins, David W. 47
Robins, Jim 92
Robinson, David **115**
Robinson, Tom 92
Rockel, Mark **267**
Rogers, J. 90
Rogers, S. 25, 185
Rose, Bob **268**
Rotz, C. A. 303
Rouleau, Tracy L. **269**, **270**
Rounsevell, Mark 117, **271**, **272**
Rudder, Charles **273**
Ruder, Eric 313
Rundle, Andrew 187
Russell, M. 90
Russell, Marc 197, **274**, **275**, 361
Ruyle, George 307
Ryan, Jerome **276**
Ryan, Kevin 72
Saarikoski, Heli 271
Sabater, F. 359
Saleh, Ali 340

Samartano, Luiz 364
Samonte, Giselle 319
Sampson, Rob **277**
Sanchez Perez, J. M. 359
Sandifer, Paul A. **278**, 306
Sanneman, Carrie **279**
Santavy, Deborah L. **280**
Santos, Carlota **281**
Santos, Rui 198
Saraev, Vadim 326
Sauvage, S. 359
Savin, Cristina 272
Schlager, Edella 179
Schlea, D. A. 257
Schmidt, Jennifer I. 78, 119
Schmidt, Rowan 15, 92
Schnekenburger, Frank 160
Schoenen, Jodi **282**
Schorse, Mary **283**
Schuhmann, Peter W. 97, **284**
Schulte, Lisa A. 54
Schulze, I. 303
Schwartz, Aaron 92
Sears, Alexandra 48, 273, **285**, **286**
Seavy, Nat 122
Seeteram, Nadia A. **287**
Sega, Elizabeth 205
Sehgal, Shaina **288**
Seimon, Anton 49
Selman, Mindy 340
Semmens, Darius J. 6, **289**, 291
Setala, Heikki 352
Shapiro, Carl 98
Sharifi, Amirreza **290**
Shemie, Daniel 163
Sheng, Ming 44
Sherrouse, Benson C. 6, **291**
Shupp, Robert S. 116
Sidon, Josh 263
Siikamäki, Juha 53
Silva, J. 303
Simpson, Hughes S. **292**
Sinha, Paramita **293**
Sirina, Natalia 42
Skarada, Jennifer 84
Skewes, T. 134
Smith, Alison 117
Smith, Amelia 361
Smith, Brooks M. **294**
Smith, Jake 92
Smith, Jessika Rose 17
Smith, Jonathan 82
Smith, Kevin **295**
Smith, Mark P. 209
Smith, Nikola 22, 86, **296**, **297**
Smith, Tin 147
Sochi, Kei 154
Sokulsky, Jeremy 122, 202, **298**
Solimini, A. G. 359
Somor, Andrew 231
Sonti, Nancy F. 308
Soulard, François **379**
South, Jim 112, 212, 230, **299**, 344
Souza, Paul 41
Spies, Thomas A. 160
Spooner, Daniel E. **300**
Sprague, Eric **301**
Sprague, Michael **302**
Spraycar, Paul 111
Stackhouse-Lawson, K. R. **303**
Stanton, Tracy 30, 56
Stapler, Ryan 27, 146
Starek, Michael 186
Stein, Susan 24
Steininger, Marc 226
Stephenson, Kurt 258
Stockton, Thomas 123
Strachan, Brian 202
Strano, Stephen V. 168
Stromberg, Juliet 349
Strong, Allan 309
Suhrbier, Andrew 133
Sullivan, Brian 261
Sullivan, Katrina 241
Sullivan, William C. **304**, **305**
Sumaila, U. Rashid 139
Summers, Scott 205
Sunohara, Mark 169
Sutton-Grier, Ariana E. 213, 278, **306**
Svancara, Colleen M. **307**
Svendsen, Erika S. **308**
Swallow, Stephen K. 149, 178, 182, **309**, 322

Swedeen, Paula **310**
Sweeney, Paul J. **311**
Swinton, Scott M. 116
Tallis, Heather 249
Tanaka, John A. 88, 180, 189
Tanners, Nadav 313
Taylor, Eric L. 292
Taylor, Ione L. **312**
ten Brink, Marilyn Buchholtz 123, **313**
Tessum, Chris 248
Thomas, Jeffrey **314**
Thoumi, Gabriel **315**
Thuy, Pham Thu 23
Tjaden, Bob **316**
Tomasi, Ted 188
Tomasi, Theodore D. **317**
Tong, Zheming 352
Tongyang, Wei **318**
Topp, Edward 169
Torres, Ricardo Balam Castro 179
Townsend, Howard **319**
Troell, Max 248
Troll, Tim 85
Troussier, Nadège 42
Troy, Austin **320**
Trtanj, Juli **321**
Turner, Andrew 319
Turner, Will 226
Turnley, Jessica 34
Turton, Stephen M. 5, 134
Tyndall, John C. 54
Uchida, Emi 322
Uhlhorn, Elizabeth 104, 105, 112, 154, 230, 299, **323**, 344
Ulhman, B. 303
Ulrich, Julie **324**
Urban, Dean **325**
Vaché, Kellie 360
Vadas, Peter 234
Valatin, Gregory **326**, **327**
Van Dyk, John K. 54
Van Houtven, George 63, 293, **328**
Van Maasakkers, Mattijs **329**
Van Meerbeek, Koenraad **330**
Van Orshoven, Jos 237
van Wensem, Joke 70
Vanasco, Wendy 307
Varga, Alex T. 140, 224
Verhamme, E. M. 257
Vervier, P. 359
Verweij, Peter 271
Vickerman, Sara 152, 159, **331**
Victery, Winona 35
Viippola, Viljami 352
Voigt, Brian **332**
Voinov, Alexey **333**
Vollmer-Sanders, Carrie **334**
Voreadou, C. 359
Waage, Sissel **335**
Wade, Tim 285
Wagner, Paul W. 47
Wahlund, Nora **336**
Wainger, Lisa 219, **337**, **338**
Waite, Richard **339**
Waldron, Janice 212
Walker, Sara **340**
Walker, Thomas **341**
Walsh, Patrick **342**
Walter, Todd 234
Washburn, Travis 281
Watkins, Graham **345**
Weber, Jean-Louis 109
Weber, Kristy J. 168
Weber, Marian **346**
Weber, Matt 266, **347**, **348**, **349**
Wechsler, Seth 316
Weick, Mark 323
Weidner, Emily 62, 297
Weinberger, Kate 187
Wells, Nancy M. 222
Werner, Sandra R. 281, **350**
White, Dave **351**
Whitlow, Thomas H. **352**
Wierderholt, Ruscena 262, 289
Wiley, Peter C. 147
Wilgis, Ted 100
Wilkes, Graham 169
Wilkinson, Jessica 209
Willis, Cheryl **353**
Wilson, John 44
Wilson, Kristin 147
Wing, Ian Sue 16
Winthrop, Robert **354**

Wise, Jatara 228
Wolf, Kathleen L. 30, **355**, **356**
Word, Jack **51**
Wright, Timothy Max 226
Wyse, Barbara **357**, **358**
Yao, J. M. **359**
Yee, Susan H. 274, **360**, **361**
Yli-Pelkonen, Vesa 352
Yngve, Leah 142
Yonavjak, Logan 19
Yoskowitz, David W.... 53, 90, 135, 186, 281, 350, **362**
Zack, Steve **363**
Zanetti, Ederson A. **364**
Zellmer, Katharina 271
Zganjar, Chris 145
Zhang, Emily 264
Zhang, K. Max 352
Zhang, Yongyong 184
Zipperer, Wayne C. 166
Zippin, David **365**
Ziv, Guy 183

Late Abstract Submissions

Listed alphabetically by presenting author last name.
Presenting author names appear in **bold**.

ECOSYSTEM ACCOUNTING IN CANADA

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Environment, Energy and Transportation Statistics Division, Statistics Canada.

The Measuring Ecosystem Goods and Services (MEGS) project was a two-year interdepartmental initiative that developed and put into practice innovative methods to measure ecosystems and their goods and services, an important but challenging area in which to establish sound statistics. Statistics Canada teamed up with six policy departments and agencies (Agriculture and Agri-Food Canada, Environment Canada, Fisheries and Oceans Canada, Natural Resources Canada, Parks Canada and Policy Horizons Canada) to tackle government-wide policy priorities and create cutting edge products using spatial analysis and ecosystem accounting techniques that are still in the process of being developed and tested by the international community (ref. System of Environmental-Economic Accounting – Experimental Ecosystem Accounting). Statistics Canada recently released a report of its findings, titled "Human activity and the environment 2013; measuring ecosystem goods and services in Canada". This was followed up by the release of a Teacher's kit, an educational resource that provides instructors with innovative materials, lesson plans and case study assignments to teach ecosystem accounting.

The 2013 report contains several of the results achieved during the project. However, many of the more technical aspects of the findings are not discusssed in the publication, but will be adressed in the presentation. For example, the usefulness of integrating census and survey data to complement remotely sensed data in order to produce four dimensional land cover / land use data. And, the necessity of producing contextual variables prior to attempting valuation work; finally, how the Land Account is the essential foundation for any ecosystem accounting effort. This presentation will end on some of the key results of the project, and propose next steps.

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