Abstract Compilation

The National Conference on Ecosystem Restoration (NCER)

April 13-16, 2026
Omaha, Nebraska
https://conference.ifas.ufl.edu/ncer/

Weight-of-Evidence Approach for Understanding the Recovery of Okanagan Sockeye Salmon

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While many Columbia Basin Sockeye populations declined over the last century, the Okanagan River Sockeye stock has seen a remarkable turnaround in abundance. To understand *why*, we applied a Weight-of-Evidence (WOE) framework that scored seven hypothesized drivers—four within-basin and three out-of-basin—by relevance, explanatory strength, and reliability, and drew on reference-stock comparisons with Wenatchee Sockeye. Our WOE publication (https://doi.org/10.1007/s00267-024-02031-y) and this presentation highlight how the combined effect of (1) increased escapement targets in conjunction with (2) establishing and securing fish-friendly flows using the Fish/Water Management Tool (FWMT) and (3) using Sockeye salmon restocking to further buffer resilience against density-independent mortality events (e.g., 2015 heat)—*all combined*—played a pivotal role in magnifying the recovery trajectory. In particular, fish friendly water operation changes at Penticton Dam (British Columbia, Canada) translated into biology: average smolt production per female nearly doubled post FWMT—from ~35 pre FWMT to ~69 post FWMT. Beginning in 2004, a multi-agency collaboration featuring Indigenous stewardship led a highly innovative effort to build FWMT, an internet accessible decision support system used to set and evaluate "fish friendly" releases from Penticton Dam while balancing flood protection and several other water use objectives. Post FWMT implementation, smolt production also became a more predictable function of spawner abundance ($R^2\_adj \approx 0.77$), indicating better FWMT flow management helped mute avoidable freshwater mortality. Then starting in 2015, hatchery-origin adults began contributing substantially, further increasing resilience. Out of basin influences (better ocean conditions, hydrosystem spill, lower mixed stock harvest rates) also contributed but alone were insufficient to explain the Okanagan Sockeye recovery—consistent with the weaker Wenatchee Sockeye response.

The take-home message for resource managers: **layer resilience** rather than relying on a single action. As shown in the Okanagan, recovery can be accelerated when partners (i) codify life stage flow targets in a operations tool water managers actually use (FWMT) so tradeoffs are explicit and managed in real-time, (ii) managers implement habitat restoration (e.g., removal of migration barriers) that help increase available spawning habitat to support larger escapement targets, and (iii) add redundancy through genetically responsible supplementation that buffers against density-independent shocks. This approach can be adopted in other regulated rivers to ameliorate variability in ocean conditions and deliver durable outcomes.

The spectacular response of the Okanagan River Sockeye salmon to the holistic perspectives and management interventions of Indigenous and other caretakers provides hope that other Pacific salmon stocks can be stabilized and recovered.

Optimizing Multi-benefit ROI: Vision and Strategy Approaches for Nature Positive and Nature-Based Solutions

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The International Union for the Conservation of Nature (IUCN) asserts that Nature Positive and Nature-based Solutions are essential for addressing issues and creating long-term benefits in an array of interrelated critical areas:

- Natural Capital and Biodiversity
- Climate Change Mitigation and Adaptation
- Disaster Risk Reduction
- Water Security
- Human Health
- Economic and Social Development
- Food Security

Project/program owners integrating Nature Positive/Nature-based Solutions are often focused on a single issue or benefit which omits the opportunity for wider value creation and increased stakeholder engagement. This presentation will focus on the process and essential aspects for developing a compelling vision and actionable program/project strategy that can optimize the multi-benefit, stacked-value Return on Investment (ROI) in Nature Positive and Nature-based Solutions.

The Bengal Tiger of the Sundarbans: How Conserving an Apex Predator is a Cost-Effective Solution to Conserve Multiple Ecosystem Services Threatened by Climate Change and Human Activity

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The Bengal Tiger of the Sundarbans, the mangrove forests between India and Bangladesh, is a globally and regionally endangered species with 200 individuals remaining. The mangrove tiger faces a variety of threats including challenges adapting to an island habitat, habitat destruction, tiger-human conflict, lack of prey species, and climate change. The area is a biodiversity hotspot and includes about 76 species of mangrove plants and several endangered and threatened species such as the tiger, Ganges River dolphin, gharial (fish-eating crocodile), and the fishing cat. It caters to two valuable commercial fisheries, the hilsa and the tiger prawn, contributes substantially to state tourism, and provides many valuable ecosystem services such as fisheries, forest products such as timber and honey, nursery services, pollination, water filtration, recreation, hydroelectric power, and storm barrier for the nearby cities.

However, these ecosystem services are characterized by degradation from pollution, impacts of climate change, and unsustainable use, the latter owing to the area's high human density comprising low-income groups dependent on natural resource-based livelihoods. The tiger is dependent on the landscape for its continued survival but the landscape itself including the mangrove ecosystems, species communities, and services are dependent on the continued survival of tigers. In this paper we examine the links between the tiger and its landscape showing this interdependence and conclude that tiger conservation is a more cost-effective solution compared to conserving individual endangered species, providing substantial returns to investment by sustaining multiple ecosystem services on the landscape while mitigating threats from climate change.

Adapting a Bioenergetics-Based Food Web, Ecosystem Model to Inform Nitrogen Management and Ecosystem Restoration in Old Tampa Bay

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Water quality in Old Tampa Bay (OTB), Florida is managed according to nutrient targets and regulatory thresholds that have been developed since the 1990s. A Total Maximum Daily Load (TMDL) equivalent to 486 tons/year for total nitrogen (TN) was approved in 1998 by the USEPA. TN loading was examined within an OTB nutrient management paradigm that statistically related loading to a corresponding annual average chlorophyll concentration of 8.5 μg/L and associated light penetration to restore and sustain seagrass. Recent quantitative evaluations in OTB suggested more nuanced relationships between TN loading, internal N cycling, and production dynamics at sub-basin and monthly scales. These evaluations identified three management interventions to meet nutrient water quality standards: (1) using absolute TN loading not normalized to hydrology, (2) managing flows to OTB from adjacent Lake Tarpon at 40 cfs, and (3) adding 175 acres of restored oysters. A bioenergetics-based Comprehensive Aquatic System Model (CASM-OTB) was customized for OTB to examine the effectiveness of the management interventions in attaining chlorophyll-a water quality standards.

The CASM-OTB represented OTB using six spatial sub-segments and included 30 populations of taxonomically and functionally defined aquatic plants and consumer populations. The CASM-OTB also included detailed biogeochemical formulations for sediment and water column cycling of N and P. Daily growth of aquatic plants in the CASM-OTB was influenced by daily values of surface irradiance, water temperature, depth, salinity, NO_3, NH_4, and PO_4. The CASM-OTB was calibrated to monthly average chlorophyll-a data representative of the OTB sub-segments for 2012-2021, a period relevant to historical TN targets and regulatory thresholds.

The CASM-OTB projected chlorophyll-a concentrations to 2041 for the recommended management interventions compared to the baseline simulation. Capping external TN loads at an absolute 486 tons/yr (the regulatory TMDL) reduced average annual mean OTB chlorophyll-a concentrations by 17 % (range: 0-48%) with 60% reductions in July-September, months with seasonally high TN loadings. Modeled flows from Lake Tarpon to OTB constrained to 40 cfs reduced average monthly chlorophyll-a concentrations by 80% in the northwest sub-segment of OTB, although the remaining modeled sub-segments were not impacted. Oyster restoration modeled with sub-segment oyster biomass initialized at 30 g C/m^2 reduced chlorophyll-a concentrations in several sub-segments after 5 years of modeled oyster growth. After 15 simulated years, chlorophyll-a concentrations increased because oyster N excretion, pseudofeces N, and sediment N inputs stimulated OTB phytoplankton growth beyond that which restored oyster filtration could control. The CASM-OTB provided process-based forecasts of potential OTB chlorophyll-a responses to actions that can help guide N management and attain water quality standards in the OTB watershed.

Klamath Dam Removal; the World's Largest Fisheries Restoration Project Becomes Reality

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In 2000, PacifiCorp began its relicensing process for the Klamath Hydroelectric Project. From the outset of the process, Klamath Basin Tribes and other organizations expressed a desire for dam removal to be a viable alternative to the continued operation of the facilities. The Tribes led the way in developing science, navigating complex regulatory processes, prevailing in court, and incorporating media and direct action. In particular, prescriptive volitional fishway requirements paved the way for a settlement that was in the best interests of indigenous people and PacifiCorp. In 2016, the Amended Klamath Hydroelectric Settlement was signed, which outlined the process by which the dams would be removed. Thus began the long and complex process of doing scientific studies and writing management plans that would all result in the Detailed Plan for Klamath dam removal. As these studies were completed, the full spectrum of possible benefits began to reveal itself. Studies showed that dam removal would result in improvements to fish genetic and geographic diversity, access to stable sources of cold water, restoration of a lost run of Spring Chinook Salmon, water quality improvements, disease reduction, and improvements to the water temperature regime for salmon. As the project progressed, engineering challenges were met and overcome. Restoration plans for reservoir reseeding were implemented, and bigger plans for stream restoration for newly accessible habitats are now being implemented. Today, the Klamath Dam removal is complete, and restoration work has begun in earnest. This presentation will discuss the history, stakeholder engagement, and importantly, the perspective of the Yurok Tribe in the largest fish restoration project ever attempted. Dam removal is an important step in the restoration of the Klamath River, but it is not the end.

Reconnecting Floodplains Along the San Joaquin River, California

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In the Central Valley of California, natural river functions are influenced by cycles of drought and extreme precipitation, as well as the legacy of hydromodification and floodplain disconnection. Increasingly, due to projected increases in flood risk and shortages of water for human and natural communities because of climate change, there is an urgent need for restoration of floodplain connectivity to provide space for floodwater retention and opportunities for groundwater recharge, as well as to restore riverine habitat complexity for native fish species including chinook salmon. Recent cycles of extreme drought and flood, and the passage of the Sustainable Groundwater Management Act provide an enhanced opportunity to strengthen the nexus between flood and groundwater management by using floodwaters for managed aquifer recharge (MAR), allowing floodwater to be “banked” in groundwater aquifers for future use during drought and reducing losses due to evapotranspiration. This nature-based solution approach can be utilized on floodplains to reduce flood risk and increase groundwater recharge potential, as well as provide ecosystem benefits through restored and reconnected floodplains.

The Department of Water Resources’ Flood-MAR Program and the Central Valley Flood Protection Plan Conservation Strategy have partnered to identify the best opportunities to reactivate and expand floodplains to enhance habitat, increase groundwater recharge, reduce flood risk, and provide other benefits. This effort provides a systematic method to evaluate daily flow time series and outputs the acre-days of inundated area, acre-days of suitable salmonid habitat, or potential recharge volumes summarized over a range of water years, with the potential to consider future flow regimes due to climate change or alternative management scenarios. Further, it comprehensively assesses physical opportunities for floodplain reconnection and MAR at the parcel- or river mile-scale, while providing conceptual design analysis at the project scale. The toolset is being applied to the San Joaquin River to identify and develop climate-resilient projects that illustrate a nature-based solution approach to reconnect rivers to their floodplains, restoring valuable terrestrial and aquatic habitat. This presentation will provide an overview of the current technical and planning-level work that is advancing, and the range of floodplain reconnection opportunities that have been identified along different reaches of the San Joaquin River.

Implementation of Adaptive Management Strategies for Conservation Area Established under the Lower Colorado River Multi-Species Conservation Program

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The Lower Colorado River Multi-Species Conservation Program (LCR MSCP) was established to support recovery species listed under the Endangered Species Act and prevent new listings. The program ensures compliance through a 50-year (2005-2055) Habitat Conservation Plan (HCP) that benefits at least 27 species, nine of which are federally endangered or threatened. Covering over 400 miles from Lake Mead to Mexico's border, which includes lakes Mead, Mohave, Havasu, and the historic floodplain along the river.

The HCP will create at least 8,132 acres of habitat for fish and wildlife species and includes Conservation Measures for 21 species, requiring specific habitat elements, such as patch size and vegetation structure, within the planning area. Annually, the LCR MSCP quantifies habitat creation progress by land cover type and species to ensure compliance.

The four land cover types are:

1. Cottonwood-Willow (5,940 acres)
2. Honey Mesquite (1,320 acres)
3. Marsh (568 acres)
4. Backwater (484 acres)

The LCR MSCP Adaptive Management Program is developing Conservation Area Management Plans (CAMPs) to assist to guide adaptive management on Conservation Areas for the duration of the Program. These CAMPs will meet the HCP requirements for Conservation Area management while supporting Monitoring and Research Measures that include surveys and research to better identify species requirements, and management of habitat to provide functional habitat for species. Additionally, the LCR MSCP is implementing habitat manipulation studies to develop tools for maintaining habitat for the duration of the program.

The LCR MSCP is using adaptive management to not only ensure the preservation and enhancement of critical habitats but also deliver a substantial return on investment for their state and Federal stakeholders. By creating and maintaining diverse habitats for fish and wildlife species, the program ensures that covered parties maintain environmental compliance, allowed continued hydropower generation as well as continued delivery of water to all users in the lower basin.

Environmental Graphics as a Tool to Communicate Ecological Complexity in Supporting Resource Management and Public Policy Decision Making

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The scientific community understands its role of conducting and publishing high-quality research, however, the equally important role of scientists in science communication has long been underappreciated and unsupported. Visual communication tools such as infographics are increasingly important to bridge gaps between science and public understanding. Yet, many scientists do not use infographics to communicate their work with the public, limiting the effectiveness of science in supporting informed decision-making. Our work presents two case studies that demonstrate the use of ecologically accurate environmental infographics in economic surveys to depict environmental change, environmental restoration, and management strategies. Case Study 1: Developing Holistic Visual Representations of Water Quality Using the Biological Condition Gradient and Case Study 2: The Value of Preserving and Restoring Migratory Bird Habitat to Residents of the Pacific Flyway. Both case studies were co-developed by ecologists, economists, artists, and resource managers.

Informed by science communication, environmental education, and graphical design, this work focuses on the role of infographics and framing in shaping public understanding. To accomplish this, we developed visual and textual communication tools to clearly and accurately convey environmental restoration issues to the public. This work builds on interdisciplinary approaches to improving the accessibility and credibility of complex environmental information by examining how infographics can effectively communicate important ecological concepts to the general public. While these tools are applicable to many types of science communication, they are especially relevant to resource management, environmental restoration, and public policy decision making.

Through analysis of the processes, we used to develop infographics across our two case studies, we assess how these communication tools can be carefully crafted to inform public understanding of science and support for environmental management. Our findings suggest that science-rich, visually engaging graphics can enhance ecological literacy, particularly when grounded in local context and collaborative design. These cases provide a model for integrating scientific rigor with visual storytelling in environmental communication.

Our research addresses two of the potential themes of NCER: (1) Approaches for using science to inform decision-making and (2) Restoration program external communication strategies for multiple audiences. This interdisciplinary work helps us to understand how restoration work can be communicated to the public – promoting the cross-transfer of scientific knowledge and information needs between the public and the scientific community.

A Restoration Science Framework for Linking Restoration Actions and Ecological Responses at Site to System Scales

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The Upper Mississippi River Restoration Program (UMRR) has had long-standing successes in restoring site-specific habitats and monitoring broad-scale ecosystem change. Over the past ten years, substantial progress has been made developing stronger collaborations across the restoration and monitoring elements of the UMRR and conducting research that is relevant to restoration activities. More recently, the UMRR partnership has indicated a desire to develop a research area that is closely tied to resolving uncertainties that arise during restoration project planning and leveraging restoration projects as learning opportunities. A collaborative effort is underway to develop a science vision for restoration-associated research. Major objectives of this undertaking are to 1) synthesize past and present ways of learning within the program to identify associated limitations and opportunities, 2) develop a participatory approach to outline priority information gaps, uncertainties, and hypotheses, 3) identify future restoration projects that represent learning opportunities with respect to the identified uncertainties, and 4) outline how existing structures and processes could be adapted to improve linkages to monitoring, research, and restoration planning.

In this presentation we share our approach for developing the UMRR Restoration Science Research Framework, an overview of the priority research needs identified, and next steps for implementing the framework. Priority research needs were organized into three overarching themes: 1) refined understanding of required habitat conditions for priority species, guilds, and communities, 2) improved understanding of site-specific ecological responses to restoration actions, and 3) advanced understanding of broad-scale ecological responses to rehabilitation. The intent of the research framework is to guide collaborative research that provides scientific information to the UMRR program, but it is also a resource for others involved in large floodplain-river ecosystem restoration.

The Comprehensive Everglades Restoration Plan (CERP) Water Management & Operations Technical Working Group: A U.S. Army Corps of Engineers Restoration Program Planning Team Perspective

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The U.S. Army Corps of Engineers, Jacksonville District (USACE) and the South Florida Water Management District (SFWMD) are the lead agencies for water management and operations of the Central and Southern Florida Project for Flood Control and Other Purposes (C&SF Project) and the lead, partnering agencies for the Comprehensive Everglades Restoration Plan (CERP). The C&SF Project provides for a network of more than a thousand miles of canals, levees, and water control structures throughout central and south Florida. The CERP was authorized by Congress in 2000 as a plan to "restore, preserve, and protect the south Florida ecosystem while providing for other water-related needs of the region, including water supply and flood protection." At a cost of more than $10.5 billion and with a 35+ year time-line, this is the largest hydrologic restoration project ever undertaken in the United States. Updates to C&SF operations plans occur incrementally to achieve incremental benefits of CERP and non-CERP project features, and coordination and collaboration on those plans involves other federal and state agencies, including the Department of the Interior's (DOI) National Park Service, the U.S. Fish and Wildlife Service, the Florida Department of Environmental Protection (FDEP) and the Florida Department of Transportation (FDOT), and native American tribes (i.e., the Seminole Tribe of Florida (STOF) and the Miccosukee Tribe of Indians (MTI)). During the most recent operations plans update(s) a Water Management and Operations Technical Working Group (TWG) was established to facilitate coordination and collaboration between the USACE, SFWMD, STOF, MTI, FDEP, FDOT and DOI technical team members and agency leaders. Operations with in CERP and the C&SF are complex due to competing needs of the system, including the needs to manage for water supply, flood control, and ecological restoration while reducing, minimizing, and/or avoiding adverse impacts to threatened and endangered species. The TWG met from February to June 2025 and developed a set of recommendations for CERP and C&SF operations to be implemented in the short-term under the Central Everglades Planning Project (CEPP) Increment 1 Operations Plan (CEPP Ops 1.0) (1.5 to 2 years) and long-term (greater than 3 years), to address ecological urgencies identified on the landscape. Recommendations included operational approaches such as prioritizing timing and locations of water releases and structural approaches such as the placement of plugs and culverts in canals to avoid short circuiting of water. The TWG is an example of successful interagency collaboration to address agencies issues and concern related complex water management operations in South Florida. We will highlight how close coordination and collaboration among technical teams and leaders within the agencies led to consensus-based and feasible system operating approaches that can be integrated into future water control plans.

Wind-Driven Sediment Resuspension in the Upper Mississippi River: Understanding Wave Dynamics to Guide Habitat Restoration

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Shallow reaches of large rivers systems are ecologically valuable but vulnerable ecosystems. In the Upper Mississippi River (UMR), these areas often support dense beds of submerged aquatic vegetation (SAV), which stabilize sediments, enhance deposition, and provide critical habitat for fish and waterfowl. Shallow (<2 m) regions with long fetch, such as Navigation Pool 13 of the UMR, pose challenges for resource managers. These areas are highly susceptible to wind-driven sediment resuspension, which can reduce water clarity and light availability, ultimately hindering SAV persistence.

To inform restoration projects in these environments, we investigated the specific wind and wave conditions that drive sediment resuspension. Our approach combined high-frequency turbidity, wind, and wave data from three monitoring stations in Lower Pool 13, which varied in wind exposure and proximity to SAV beds and shorelines. A key objective was to identify critical wave thresholds above which sediment resuspension is likely to occur, allowing us to estimate the relative contribution of wind-induced waves to turbidity compared to other sources such as upstream discharge. To isolate wind-driven effects, analyses focused on low-discharge periods across three seasonal windows in 2025 to assess changes in wave dynamics and sediment resuspension as SAV structure evolved throughout the season.

We applied time series analysis, statistical comparisons, and machine learning to explore site-specific turbidity responses to wind and wave characteristics and estimate thresholds for wave-induced resuspension. Preliminary results suggest that sediment resuspension thresholds vary by site and are strongly influenced by wind direction and may shift over the growing season. These findings can inform the habitat restoration design by refining wave orbital velocity thresholds used in wind fetch models that assess the probability of sediment resuspension for potential project designs. This approach also provides a baseline for evaluating the effectiveness of restoration features in reducing sediment resuspension over time.

Using Simple Models to Understand the Distribution of Areas Suitable for Vegetation Restoration in a Large River

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Aquatic vegetation plays a critical role in large river ecosystems. Restoring aquatic vegetation in areas where it has declined or disappeared is a priority for the Upper Mississippi River System (UMRS). To effectively use limited resources to manage and restore rivers there is a need to provide systemic assessments of ecosystem conditions that identify areas where restoration success is likely. To better understand what constrains vegetation distribution in large river ecosystems and inform the location and design of projects intended to restore aquatic vegetation, we identified areas within ~1200 river km of the UMRS where the combined effects of water clarity, water level fluctuation, and bathymetry produced suitable conditions for the establishment and persistence of submersed aquatic vegetation based on a 22-year dataset for total suspended solids, water surface elevation, and aquatic vegetation distribution. We found a large increase in suitable area downstream from Lake Pepin, a large natural riverine lake near the northern end of the UMRS, that functions as a sink for suspended material. Downstream from lock and dam 13 (near Fulton, Illinois), there was much less suitable area due to decreased water clarity from tributary input of suspended material, changes in river geomorphology, and increased water level fluctuation. Modelling a hypothetical scenario of increased water clarity resulted in only minor increases in suitable area in the southern portion of the UMRS, indicating limitations by water level fluctuation and/or bathymetry (i.e., limited shallow area). These results illustrate how water clarity, water level fluctuations, and river geomorphology interact to create complex spatial patterns in habitat suitability for aquatic species and may help to identify locations most and least likely to benefit from management and restoration efforts.

Return on Investment for Missouri River Levee Setbacks

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The Missouri River has been intensively engineered for commercial navigation and flood protection. Engineering civil works, such as levee construction by the US Army Corps of Engineers (USACE), was historically justified with benefit-cost analyses (BCA) that did not comprehensively account for the potential consequences of ecological impairment or the potential flood risks associated with non-stationary flood regimes. Consequently, historical BCAs justified levee construction that has disconnected large portions of the river's floodplain, justified the haphazard placement of levees close to the river, and has resulted in the loss of critical ecosystem services that are derived from ecologically functional floodplains. However, there has been significant growth in the scientific understanding of ecosystem services in the decades since much of the river's levee infrastructure was built. In this talk, we discuss how a more comprehensive accounting of ecosystem services may impact USACE's BCA and investment decision-making outcomes for a modern levee improvement project on the river. The analysis begins by presenting a baseline BCA that follows USACE's flood risk assessment regulations, uses the same software and quantification techniques practiced by the agency, uses the modern flood regime, and assesses alternatives that include strengthening the levee, raising the levee, setting it back from the river, and maintaining the status quo alignment. This baseline BCA is then amended for the inclusion of ecosystem services, such as recreational benefits, climate regulation through carbon sequestration and storage, and others. The resulting economically defensible levee is one that is setback from the river and reconnects a large reach with its floodplain. Much of the return on investment from setting back the levee is derived from a reduction in flood risk due to buyouts, reductions in the likely of levee failure, and reductions in the likelihood of overtopping; though the benefits of ecosystem services are non-trivial and greatly impact the return on investment from constructing a setback levee. In addition, setting back the levee affords opportunities for conservationists to rehabilitate a levee-stressed ecosystem and demonstrates how large-scale river restoration practices – on the order of thousands of acres -- may be economically justified through their ability to mitigate flood risk. Finally, the results of this study have broader implications for levee corridor management along the Missouri River and will hopefully help agencies like USACE meet the modern needs of communities they serve by maintaining essential flood protection services while also helping to restore a beloved riverscape.

Are We There yet? How RECOVER Determines Everglades Restoration Progress and Success

Tasso Cocoves

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REstoration, COordination, VERification (RECOVER) is an interdisciplinary collaboration of agencies, tribes, and institutions that conducts scientific and technical evaluations and assessments to improve the ability of the Comprehensive Everglades Restoration Plan (CERP) to restore, preserve, and protect the Florida Everglades while providing for the region's other water-related needs. To facilitate its mission, RECOVER implements an applied science strategy that organizes how ecological information is produced and used to inform and track ecosystem restoration progress. Within the applied science strategy, the Monitoring and Assessment Plan (MAP) identifies a suite of indicator species representative of foundational ecological processes CERP is expected to promote and restore. Information collected from the MAP is then used by RECOVER to better understand Everglades' ecology, inform CERP project planning through simulation modeling, track real-world indicator responses to CERP implementation, and make recommendations to improve CERP projects through adaptive management.

Because planning and implementation of CERP is incremental, RECOVER is tasked with determining restoration progress along the way to a fully-implemented CERP and conducts system-wide modeling evaluation and real-world assessments at a regular interval. The 2024 System Status Report (SSR) provided RECOVER the first opportunity to compare real-world indicator statuses with a previously modeled expectations from the RECOVER Interim Goals and Interim Targets 2020 Report. Though few CERP components have been constructed, and little change was expected, the exercise of relating indicator evaluations and assessments allowed RECOVER to examine its processes for determining on the statuses of its indicators at a system-wide scale. Key areas RECOVER identified for future work include the alignment of evaluation and assessment methods per indicator and the development of ecologically-informed indicator status, restoration target, and adaptive management criteria. Building on lessons learned from the 2024 SSR, RECOVER is working to improve its capacity to conduct system-wide evaluations and assessments for all its indicators. With a clear applied science strategy, robust and effective MAP, and effective system-wide evaluation and assessment methods for its indicators, RECOVER can inform CERP with the scientific and technical information essential to achieve its goals and objectives.

Mississippi River Fish Passage Design, Construction, & Monitoring

Mark Cornish

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The Lock and Dam 22 Fish Passage Project is the first of a series of projects to restore longitudinal habitat connectivity for the many species of native migratory warmwater fishes in the Mississippi River. The Corps of Engineers is constructing a 200 foot (61 M) wide rock ramp fishway to retrofit a navigation dam that was constructed in 1938. Lock and Dam 22 is located at river mile 301.2 near Saverton, Missouri. The project will increase the opportunity for upriver fish passage and serve as the platform to evaluate, learn from, and adapt future fish passage projects using lessons learned from this initial project. Topics covered in this presentation include fishway design and monitoring, highlighting the collaborative efforts between State and Federal natural resource agencies to advance this project. Construction of the project will be completed in 2026.

L-536 Levee Setback Case Study and Applied Research Integration in New Projects Along the Lower Missouri River

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Historic flooding along the Missouri River has resulted in many repetitive loss areas, with single event repair costs reaching as high as $1 billion. But, since 2011, the U.S. Army Corps of Engineers (USACE) has been improving levee system resilience through levee setbacks as an alternative to the 8+ decades-old practice of repairing flood damaged levees "in line" along the Missouri River. Successful implementation of 3 large-scale levee setbacks in Iowa and Missouri, including the recently completed L-536 project, have inspired other Missouri River communities to pursue levee setbacks proactively. However, proactive planning through the USACE's traditional civil works process involves a wider array of policy requirements than setbacks implemented during emergency levee rehabilitation. In order to develop tools that will highlight the return on investment of NBS such as levee setbacks, and to assist practitioners in implementing future levee setbacks, a partnership between the University of Georgia, the USACE's Engineering With Nature® Program, and others has been formed. Positive levee setback performance during recent flooding, and end user-driven applied research at the completed levee setback sites are contributing to the mainstreaming and upscaling of levee setbacks along the Missouri River, demonstrating a compelling approach to the integration of R&D and project planning.

Collaborative Modelling Improves Floodplain Vegetation Management Actions at Reno Bottoms: from Scenario Building to Flood Inundation Modelling to Forest Succession Model Outputs

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Most of the world's river-floodplain ecosystems are simultaneously undergoing modifications to their hydrological regimes and experiencing vegetation changes, such as species invasions. The simultaneous nature of such changes makes it unclear whether species interactions (e.g., competition, succession) are the main drivers of ecosystem change or whether plant communities are responding to underlying changes in the hydrological regime of rivers. Management actions, as a result, may not address the main causes of changes in plant communities in these systems. We developed a coupled floodplain inundation – forest succession model in collaboration with management agencies and applied it to a 2500 ha portion of the Upper Mississippi River floodplain (Reno Bottoms, IA) as part of the restoration planning process. We evaluated the effectiveness of timber harvest, planting, and suppressing invasive *Phalaris arundinacea* under two different future 100-year hydrological scenarios: a future maintaining the average flooding conditions of the past 40 years (random) and a future that projects an observed upward 40-year trend in flooding conditions forward (trending). By comparing mapped outputs under different scenarios, we were able to locate areas where management actions focused on vegetation could be most successful under the different hydrological regimes. These outputs were further used in cost/benefit analyses to decide among several candidate project configurations and improve the likelihood of restoration success.

Are We Heading in the Right Direction? Evaluating Restoration Progress to Inform Decision Making Along the Way

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Spanning 1.5 million acres, the Florida Everglades is the largest subtropical wilderness in the United States. This unique mosaic of sawgrass marshes, slow-flowing sloughs, prairies, and forested uplands supports a diverse array of flora and fauna, provides clean drinking water to millions of residents, and helps protect South Florida from destructive hurricanes. Following decades of extensive drainage to develop agricultural and residential lands, the Comprehensive Everglades Restoration Plan (CERP) consists of a series of restoration projects designed to improve water flow in the Everglades while also providing for the water supply and flood protection needs of South Florida. The progress of this multi-decadal, multi-billion-dollar restoration effort is regularly tracked as restoration projects are constructed using incremental benchmarks referred to as “Interim Goals” for ecosystem restoration areas and “Interim Targets” for water supply and flood-risk reduction. These Interim Goals and Interim Targets are predictions of how specific indicators of the natural and urbanized systems are expected to respond at specified timeframes as CERP progresses. Future simulations for indicators such as the American alligator, submerged aquatic vegetation, and regional flood protection were developed using hydrological and ecological models and are regularly updated to incorporate new information. These indicators are monitored and compared to the Interim Goals and Interim Targets simulations to gauge progress toward restoration and other water-related needs. Through this process, Interim Goals and Interim Targets guide CERP project design, scheduling, and updates and inform adaptive management, linking science to decision-making and supporting successful restoration through CERP.

Carbon Storage Potential of Native Tree Saplings Surrounding Lake Maurepas, Louisiana, USA

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Lake Maurepas and its surrounding wetlands, historically dominated by bald cypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*), have experienced extensive degradation from past logging and hydrological alterations. Restoration efforts are now underway to re-establish coastal freshwater swamp forests, with anticipated ecological benefits that include carbon sequestration. While carbon storage by wetland soils and mature trees is well documented, little is known about the carbon storage potential of sapling-stage swamp trees.

This study investigates the relationship between abiotic factors and carbon storage efficiency of reforested saplings around Lake Maurepas. A total of 500 two-year-old bald cypress, water tupelo, and red maple (*Acer rubrum*) saplings were planted across five sites with differing levels of swamp degradation. After one growing season, sapling survival, growth, and biomass will be assessed to quantify carbon content and evaluate species-specific performance under contrasting environmental conditions.

By addressing a critical data gap, this work will clarify the early-stage carbon sequestration potential of swamp tree species and highlight the influence of environmental stressors on reforestation outcomes. Anticipated results will inform both regional restoration strategies and broader discussions of the role of wetland forests in climate mitigation.

Forest Dynamics along the Lower Missouri River: Implications for Floodplain Management and Ecosystem Services

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Forests once covered three-quarters of the floodplain along the Lower Missouri River (LMR) but greatly declined in extent with the expansion of agricultural cropland and subsequent construction of river training structures, levees, and upstream dams over the last two centuries. However, small areas of floodplain forest remain, particularly adjacent to the riverbank and elsewhere within the batture zone (area riverward of the levees), and pioneer tree species (willow, cottonwood, sycamore) continue to colonize open areas in former cropland and conservation lands following floods. With increasing societal and agency interest in Nature-based Solutions (NbS), such as levee setbacks, as a way to manage flood risk and enhance ecosystem services, the role of floodplain forests in promoting or hindering these services must be considered. For instance, the area, density, and structure of vegetation affect the hydraulic roughness of the floodplain, which can influence patterns of sediment deposition, flow velocity, and flood levels during overbank flooding. Hence, vegetation management may be important for achieving flood risk reduction goals. However, these effects likely vary with the extent, spatial configuration, geographic location, and age or successional stage of forests, as well as the width of the floodplain. Floodplain vegetation characteristics, including forest extent, age, structure, and composition, also affect wildlife populations, providing habitat for some species and restricting it for other species (e.g., grassland birds). This talk will discuss characteristics of floodplain forests along the LMR, their various – and potentially conflicting – effects on NbS goals, and strategies for enhancing their ecosystem services.

Incorporating Adaptive Management in Ecosystem Restoration and Navigation Projects: Lessons from the Everglades and Application to Coral Reef Environments

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The U.S. Army Corps of Engineers Jacksonville District (Corps) supports a diverse Civil Works mission that includes ecosystem restoration, flood risk management, coastal storm risk management, and navigation. A cornerstone of this mission is the Comprehensive Everglades Restoration Plan (CERP), which is being implemented through a science-based adaptive management (AM) framework. AM provides a structured process for addressing uncertainty by testing hypotheses, linking science to decision-making, and adjusting project implementation to improve restoration outcomes over time. As part of CERP, the Central Everglades Planning Project (CEPP) integrated an AM plan during the early planning stages. This plan provides targeted guidance to inform design, construction sequencing, and operational decisions; ensuring projects evolve in response to new data and improved understanding.

Building on experience from CERP and CEPP, the Corps is applying AM principles to other sensitive environmental contexts, such as deep draft navigation projects. Dredging in coral reef habitats, such as those near Port Everglades, Florida, presents significant ecological risks and uncertainties regarding the effectiveness of measures to reduce and mitigate impacts that demand a rigorous, adaptive approach. The Port Everglades (PEV) Deepening Project AM Plan outlines a formalized, transparent framework for managing dredging activities in coral reef environments. Key components include adaptive monitoring protocols, data collection and analysis strategies, a centralized reporting and communication platform, and actionable corrective actions to continue dredging while reducing stressors on the coral reef. This tiered-response system is designed to detect early signs of environmental degradation and trigger corrective actions before thresholds of unacceptable biological impact are reached. The overarching goal of the PEV AM Plan is to ensure that construction operations are guided by real-time ecological data, minimizing harm to natural communities and water quality. Similar approaches will be applied to timely feedback and correction of one of the largest coral reef mitigation efforts in the world that will attempt to restore hundreds of acres of coral reef. Through integration of observation-based knowledge, timely feedback mechanisms, and responsive management actions, the Corps aims to demonstrate how adaptive management can effectively support both ecosystem restoration and sustainable infrastructure development in sensitive environments.

Learning by Doing: A System-Scale Flow Experiment to Adaptively Manage Habitat for Whooping Cranes

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The Platte River Recovery Implementation Program (PRRIP) is responsible for providing roosting habitat for whooping cranes during migration. A critical component of this habitat is wide, unobstructed river channels. In 2015, wide channels within the Program's Associated Habitat Reach (AHR) formed because of a single high flow event. To maintain these conditions in the absence of high flow events, PRRIP can employ two approaches: mechanical management (disking and vegetation removal) and flow releases designed to suppress vegetation establishment. While the costs and effectiveness of mechanical management are well understood, the role of flow releases required evaluation.

Between 2020 and 2024, PRRIP implemented annual flow releases from the Environmental Account (EA) with a target of 1,500 cfs sustained for 30 days in June. Annual channel widths were measured across the AHR using landcover classifications from LiDAR imagery (2016–2024) and compared to widths from photointerpretation (1998–2015). Flow metrics, mechanical management efforts, and geomorphic attributes were incorporated into a Random Forest modeling framework to predict annual changes in channel width.

Results indicate that flow releases provided substantial, quantifiable benefits to maintain wide channel conditions from 2020–2024. In the absence of annual releases, channel widths likely would have narrowed over this period. These findings highlight how predictive modeling can link management actions with measurable habitat outcomes. The study provides a foundation for weighing the relative costs and benefits of mechanical versus flow-based approaches and informs future adaptive management decisions aimed at sustaining whooping crane habitat on the Platte River.

Adaptive Management in Action: Lessons from the Fort Peck Dam Test Flow for Pallid Sturgeon Recovery on the Upper Missouri River

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In 2024, the U.S. Army Corps of Engineers (USACE) initiated the first in a series of adaptive management experiments to evaluate whether modified releases from Fort Peck Dam could improve recruitment for the endangered pallid sturgeon (*Scaphirhynchus albus*) upstream of Lake Sakakawea. These test flows aim to provide hydrologic and thermal regimes that support attraction, spawning, and larval development. This adaptive management initiative was a scientific experiment and a complex exercise in multi-agency coordination, stakeholder engagement, and risk-informed planning.

Telemetry confirmed upstream migration of 23–25 adult pallid sturgeon during the 2024 test, with at least one spawning event documented (he only documented spawning aside from one instance during the 2011 flood). Real-time adjustments were required due to downstream flow conditions, and some erosion and impacts to irrigation were reported, but the test demonstrated the potential for achieving recruitment while fulfilling eight authorized purposes.

This experiment was guided by the Drift and Settling Model (DSM), which integrates hydrodynamic, thermal, and biological data to predict larval settlement. The DSM was developed using monitoring data and results of targeted research. Concurrently, USACE conducted extensive physical and cultural resource monitoring, including LiDAR surveys and intake inspections, to assess potential impacts on human considerations (HCs).
Stakeholder engagement was central to the process. Through the Missouri River Recovery Implementation Committee (MRRIC) and direct consultations with affected stakeholders and Tribes, USACE refined objectives and constraints to minimize adverse effects. Despite these efforts, concerns remain—particularly among irrigators—regarding unpredictable infrastructure and water access impacts.

This presentation will explore three dimensions of adaptive management emerging from the Fort Peck test: (1) science-informed decision-making and governance, (2) biological response and model validation, and (3) stakeholder engagement and communication. By examining these facets, we aim to provide actionable insights for future river restoration efforts that seek to balance ecological goals with stakeholder needs.

Collaboration of Native Seed Collection for Statewide Impact in Floodplain Reforestation

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The Riparian Lands Native Seed Partnership (RLNSP) was formalized in 2023 after a Statewide Seed Coordinator was hired at the Intervale Center in Burlington, Vermont. Organizations at the core of the RLNSP include the Intervale Center (IC), NorthWoods Stewardship Center (NWSC), Vermont Department of Fish and Wildlife (VFWD), and U.S. Fish and Wildlife (USFWS). The RLNSP is a growing network of organizations dedicated to locally adapted native seed collection in Vermont. Together, we are working to meet the demand for local, source-identified native trees and shrubs for floodplain restoration projects across the state.

A better understanding of the importance of local native plant materials for restoration has created an increased demand for source-identified native trees and shrubs for floodplain restoration projects across Vermont. Many organizations understand that seed collection is crucial for successful restoration because the plants are more likely to persist in face of climate change impacts and Vermont's local environmental stressors. Stressors include severe and frequent flooding, warming temperatures, and the worsening challenges of plant diseases and pests. Native plants help to rebuild healthy riparian buffers, support wildlife and native fish, stabilize stream banks, trap sediment, and reduce the amount of agricultural runoff that enters rivers. Native plants are also the foundation of a healthy, biodiverse ecosystem, providing food and shelter for pollinators, birds, fish, and mammals.

Since formalizing, the RLNSP has refined seed collection, processing, and storage protocols to ensure the viability of seeds for restoration purposes. This has included investment in seed cleaning equipment and hiring skilled, full-time seasonal crews. Through the development of a statewide seed map, we have been able to identify source locations on state, federal, town, and private lands across Vermont. With the map, we have been able to track phenology and seed collection data at a large scale. The RLNSP has hosted webinars, workshops, and shared newsletters to increase the knowledge around native seed handling and share updates on our projects progress.

We have worked with partners on land access permissions, seed collection, and understanding native plant material demands in the state. The RLNSP has begun supporting this work by distributing seeds to local nurseries at no cost. To date, the Intervale Conservation Nursery has utilized 115 lbs. of seed collected by the RLNSP. Another 100 lbs. of seed have been distributed to seven more local conservation nurseries in Vermont. Since 2023, the RLNSP has supported four direct seeding projects with VFWD by providing tens of millions of seeds each year. Within two years, the RLNSP has collected approximately 100 million (or 800 lbs. of) seeds from 40 species that are being utilized by nurseries to grow planting stock and implemented in riparian direct seeding trials.

By investing in a coordinated effort to collect local native seeds for floodplain restoration projects, watershed groups have begun to shift from sourcing native plant stock from commercial nurseries in the Midwest to local conservation nurseries. What will follow are resilient restoration projects and a robust local economy for native plant materials.

The Lower Colorado River Multi-Species Conservation Program: Lessons from the First 20 Years

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The Lower Colorado River Multi-Species Conservation Program (LCR MSCP) is a multi-stakeholder federal and nonfederal partnership that aims to balance the use of Lower Colorado River water resources with the conservation of native species and their habitats, while satisfying requirements of the Endangered Species Act. This 50-year program focuses on conservation of at least 27 covered species along the lower Colorado River, from Lake Mead to the Southerly International Boundary with Mexico, through a Habitat Conservation Plan (HCP). The HCP provides federal Endangered Species Act (Section 7 and Section 10) coverage as well as California Endangered Species Act compliance.

The Bureau of Reclamation began implementing the HCP in 2005. Early efforts included research and monitoring programs for covered species while planning and initiating several large-scale habitat creation projects. Implementation procedures for the LCR MSCP were also established, including the development of a science strategy and adaptive management program to ensure that conservation measure implementation is based on scientific information, principles, and standards. Now, 20 years into the program, the LCR MSCP has created over 7,500 acres of habitat and is well-positioned to achieve all conservation measures by 2055. The LCR MSCP has completed numerous research projects and developed a robust monitoring and adaptive management framework.

Governance has been key to the program's success. Specifically, the Bureau of Reclamation closely coordinates with the Steering Committee, which includes over 50 members. The Steering Committee reviews and approves actions associated with annual work plans, budgets, land acquisition, and reporting, as specified in the collection of program documents.

The LCR MSCP continues to provide regulatory certainty for over 40 permittees and is adaptable to new information and unforeseen circumstances. For example, a federally threatened species was added to the program in 2012 through an amendment to the HCP; additional species understanding was incorporated through minor modifications to conservation measures in 2020; flow-related coverage was expanded through Biological Opinions in 2022 and 2024. Further amendments will be made as needed to accommodate post-2026 Colorado River operational guidelines for Lake Powell and Lake Mead.

Fusion of Satellite Imagery and Soil Moisture Data

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The US Bureau of Reclamation's Lower Colorado River Multi-Species Conservation Program (LCR MSCP) has developed a soil moisture monitoring network to support the creation and monitoring of landcover types in designated conservation areas. Although soil moisture data loggers provide continuous and accurate information, their use is limited as it is cost-prohibitive and logistically unfeasible to install soil moisture sensors in all areas of interest. Additionally, because monitoring stations are relatively few and far apart, data interpolation techniques do not produce realistic results. Imagery from satellites and airborne platforms cover large areas, are of high quality and spatial resolution, and have numerous applications. However, these data are not always well suited to the areas of interest due to the reflectance characteristics of the landcover itself, primarily in areas of high, dense canopy. Timely, accurate, and large-scale soil moisture information is vital to the effective water management of protected areas which are irrigated throughout the year and have experienced drought for two decades. We therefore tested methods which integrate both data types to leverage the advantages of each in order to identify and model the spatial and temporal characteristics of irrigated water.

Two approaches were investigated: 1) the direct measurement of surface soil moisture and 2) the effect the presence of moisture has on the visual qualities of soil. For the first method, Short Wave Infrared (SWIR) reflectance value is the primary component. Sentinel-2 SWIR2 (Band 12) and Planet Labs Soil Water Content product were the data sources. In method 2), the digital number value of red, green, and blue imagery bands were the inputs; here Sentinel-2 and Planet Labs SkySat platform provided the imagery rasters. This second approach was used in areas of newly planted and/or recently established areas to provide a more direct platform view of the soil surface. For both methods, the in-situ soil moisture data was integrated in a stepwise regression process which created input-specific coefficients that were applied to each imagery pixel to create a soil moisture content value. Given that our soil moisture sensors are often located in areas of high, dense canopy cover, this procedure can mitigate the confounding effect in method 1) of significant SWIR absorption. Images acquired before, during, and after irrigation events at specific sites were processed.

The resulting imagery products identified irrigation events, allowed the tracking of water as it progressed from the irrigation source, and, perhaps most importantly, showed areas of persistently moist and dry soils. These features will allow LCR MSCP managers to adjust irrigation strategies, resulting in more efficient and effective use of water resources. From an adaptive management standpoint, frequent and high-resolution soil moisture data can help determine if irrigation is a significant variable when considering changes in vegetation health. By utilizing low cost or free global imagery, the findings described here allow for analyses at multiple scales that is not feasible using existing ground-based data alone. Furthermore, these methods can be adapted to other correlated onsite/imagery data combinations, presenting opportunities to those entities looking to augment the capabilities of their programs.

Nature Positive Approaches in Rehabilitating Omaha's Cole Creek Watershed

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The City of Omaha Public Works Department recognizes the long-term benefits of managing and rehabilitating critical infrastructure in the Cole Creek watershed. Cole Creek is a tributary to the Little Papillion Creek that ultimately drains to the Missouri River. This system faces persistent challenges including street and private property flooding, severe bank erosion, limited access for channel maintenance, and combined sewer overflows. In response, the City has embraced nature positive strategies alongside traditional civil drainage solutions. Over several years, the City has implemented multiple initiatives such as voluntary buyouts of flood-prone properties, culvert improvements, and rehabilitating and restoring stream channels to improve watershed conditions and resilience.

Jacobs is currently supporting the City on the rehabilitation of Cole Creek at Hillside Drive, targeting a segment of the confined stream corridor experiencing severe bank instability and mass failures that have degraded stream habitat. The proposed design introduces pool-riffle morphology and floodplain benches to restore natural stream functions, enhance stability, and improve aquatic habitat diversity. These features will support varied flow conditions and provide sheltering areas for aquatic life. The removal of the Hillside Drive roadway and its hydraulically restrictive culvert provides lateral space for realigning the historically straightened channel. This allows for the addition of a bankfull bench to increase overbank flow capacity. Neighborhood connectivity will be maintained through the construction of a pedestrian and bicycle bridge, linking community amenities without impeding flow in the channel.

Managing Chinook Salmon Resiliency Under Climate Change: Demonstrating Return on Investment in Ecosystem Restoration and Water Management

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As climate change intensifies hydrologic variability across California's Central Valley, ecosystem restoration programs must prioritize measurable biological outcomes relative to investment. Cold-water species such as Chinook salmon—at the southern extent of their range—provide a performance benchmark for restoration and water management under climate stress. This presentation highlights three applied science case studies that quantify return on investment (ROI) in ecosystem restoration through improved survival outcomes, infrastructure decision-making, and adaptive flow management.

First, the California Department of Water Resources evaluated the feasibility of reintroducing spring-run Chinook Salmon to cold, high-quality habitat upstream of dams in the North Fork Feather River. A key component tested an engineered egg incubation technique designed to mimic natural gravel incubation. By experimentally validating biological feasibility before large-scale implementation, the study reduced uncertainty surrounding habitat reconnection investments. The ROI derives from improving restoration effectiveness per dollar spent and avoiding costly, low-performance interventions.

Second, using acoustic telemetry, we assessed how multi-year drought conditions, compared with one of the wettest years on record, influenced juvenile winter-run Chinook salmon survival during freshwater migration. Mean annual flow exerted the strongest positive effect on survival, and analysis indicated that strategically timed managed pulse flows can partially replicate the benefits of naturally wet years. These findings provide quantitative guidance for reservoir operations to maximize biological return while balancing water-supply objectives. The ROI lies in directing limited water resources toward flow strategies that demonstrably increase survival probabilities.

Third, we evaluated salmon use of the San Francisco Estuary across interannual hydrologic variability to determine how habitat quality and connectivity influence estuarine rearing. Estuarine rearing occurred almost exclusively during the year when rainfall created functional connectivity between natal streams and estuarine habitats. Structural connectivity—not localized habitat quality alone—controlled habitat utilization. These results suggest that restoration investments targeting flow-mediated connectivity may yield greater biological returns than isolated habitat enhancements without adequate hydrologic access.

Collectively, these case studies demonstrate that applied ecological science improves restoration ROI by increasing biological response per unit investment, reducing uncertainty in habitat reconnection projects, optimizing flow management to enhance survival, and prioritizing connectivity-driven restoration strategies. By linking operational decisions to measurable survival outcomes, applied science enables restoration programs to allocate resources more efficiently and achieve greater ecological lift under constrained budgets.

Nationwide Network for Monitoring Ecosystem Recovery

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Long-term, high-quality ecosystem restoration monitoring is essential to achieve recovery and maximize restoration investments. However, there are many challenges associated with restoration monitoring that inhibit effective collection, storage and management, communication, and utilization of ecosystem recovery information. A nationwide monitoring network of restoration and reference sites is needed to generate high-quality, replicated datasets to address large-scale ecosystem restoration challenges. The US Army Corps of Engineers (USACE) makes significant annual investments in ecosystem restoration projects and monitoring for adaptive management under their aquatic ecosystem restoration mission, and thus, is uniquely positioned to lead the development of an ecosystem recovery monitoring network. Investments in large-scale, long-term data collection and management will would allow restoration practitioners and restoration focused organizations to (1) improve data consistency and data replication to reduce uncertainty in ecological recovery assessments, (2) demonstrate the socioecological benefits of restoration to better inform future restoration investments, and (3) improve our ability to publicly communicate returns on investments and the nationwide value of aquatic ecosystem restoration. This presentation will detail the challenges associated with developing a nationwide monitoring network of restoration and reference sites and present a roadmap for how USACE and other organizations can leverage aquatic ecosystem restoration investments to operationalize the Aquatic Restoration Monitoring for Ecosystem Recovery (ARMER) Network and advance the science of aquatic ecosystem restoration.

Watershed-Scale Effects of Floodplain and Stage 0 Restoration on Hydrologic Attenuation

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Increased peak flows and associated flood risk, as well as decreased baseflow and associated impacts to floodplains and aquatic ecosystems, are common effects of human land use (e.g., urbanization, agricultural development, and certain forestry practices) that can be exacerbated by climate change. Enhancing floodplain capacity through river restoration to increase surface and groundwater storage along river networks has potential to mitigate such impacts. Yet this potential has been poorly quantified at the watershed scale. We simulated the effect of varying the amount and location of floodplain and Stage 0 restoration on surface water storage in a series of watersheds using the U. S. Army Corps of Engineers Hydrologic Engineering Center's River Analysis System (HEC-RAS). We modeled a synthetic 4th-order watershed using average stream geometry and hydrology for the Virginia Piedmont with storms ranging in size from the 2-year down to monthly discharges. Model results indicate that Stage 0 techniques (simulated as low banks/shallow channel) were more effective at inducing floodplain exchange and flood wave attenuation than restoring bankfull floodplains (simulated as higher banks/deeper channel). The incremental effect of an individual restoration project varied depending on where it was in the 4th-order channel network, and on the amount of previous restoration that had already occurred in the watershed, with tradeoffs between enhancing flood attenuation and enhancing floodplain exchange. As expected, flood attenuation and floodplain exchange both increased with percent of channel network restored, yet there were conditions in which restoration actually increased peak flows downstream. These increases were likely caused by unintentionally increasing the synchronization of tributary flood peaks with their counterparts in the mainstem. Important future directions include extending this analysis to a) additional processes such as groundwater exchange to evaluate effects of restoration on baseflow between storms, and b) annual timeframes to assess effects on seasonal low flows and potential to mitigate climate impacts on such flows. Overall, our results indicate that floodplain and Stage 0 restoration approaches have substantial potential to reduce peak flows, increase floodplain storage, and increase system resilience to climate change. We emphasize the importance of viewing watersheds as a whole to understand the potential impacts of restoration projects, and watershed level planning to prioritize which stream reaches have the greatest benefit in supporting improved hydrologic response.

I-25 Highway Improvement Project Use of Process Based Restoration Techniques to Provide Wildlife Habitat Connectivity and Mitigation for Federally Threatened Species

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Roadways cause significant habitat fragmentation and barriers to wildlife movement. They also cause Wildlife-Vehicle Collisions (WVCs) which pose inherent threats to wildlife populations and human safety worldwide. Mitigating these effects has become top priorities for Colorado Department of Transportation (CDOT) during the planning, designing, and construction of highway improvement projects throughout the state.

In 2024, CDOT completed construction of the I-25 Gap Improvement Project. The project goals were to improve traveling public mobility through a critical north-south transportation link between Colorado's two largest cities (Denver and Colorado Springs) while also improving perpendicular (east-west) habitat connectivity for wildlife, including the federally listed Preble's meadow jumping mouse (*Zapus hudsonius preblei*), mule deer, elk, black bear, and other native wildlife. The project involved the construction of four wildlife underpasses (three with natural streams) along with restoration of beaver habitat using low-cost process-based restoration to enhance habitat connectivity.

In the first season, the project attracted beavers to the site with the use of beaver dam analogs (BDAs). And the wildlife underpasses saw significant wildlife usage from a variety of target species. The project also installed woody debris windrows to provide cover for small mammal movements under the wide bridges that may be otherwise lacking cover. These important features allow cover obligates and prey species such as the Preble's meadow jumping mouse, to move safely through the large structures under the wide interstate highway.

Monitoring of the restoration effort has compared pre and post-construction conditions, focused on changes to groundwater surface elevations in the riparian zone and associated vegetative response along with wildlife camera traps and live Sherman traps to document wildlife response to the changing site conditions. Despite significant flood damage in 2023, monitoring has shown a significantly positive response including return of beaver to the restoration areas and a correlated positive hydrologic and vegetative improvement to the streams and adjoining riparian areas. Groundwater has risen approximately 16 inches throughout the floodplain, willow growth has increased, and weeds have been suppressed within the lower floodplain terrace.

This project provides a case study of successful integration of muti-species, riparian, and aquatic co-benefits into transportation planning, design, and construction process. It also underscores how low-cost restoration and design approaches can have positive outcomes for wildlife, habitat, and water resources while contributing to enhancing the safety of the traveling public.

A Systems Approach to the Science – Management Interface: Improving Both Research and Decision Making

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There is growing potential to advance knowledge and decision making through scientist and practitioner collaboration as long-term environmental monitoring programs are becoming increasingly established around the world. Collaborative frameworks guide science - management interactions with approaches for "co-creation" of knowledge, where scientists and practitioners work and learn together. Enhancing collaboration between scientists and practitioners in well-established science-management partnerships also requires "systems thinking," which considers how the interconnectedness of program outcomes, structures, processes, and ways of thinking shapes program change, or maintenance of the status quo, through time. We illustrate a systems approach using three case studies of scientist – practitioner collaborations in a well-established (> 35-year-old) interjurisdictional science and restoration program. We demonstrate how modifying program structures while intentionally fostering new program processes and ways of thinking effectively advanced scientist – practitioner collaboration. We synthesize our lessons learned into strategic program changes that may initiate long lasting improvements to other types of science-management partnerships, including: 1) embedding scientists in restoration decision processes, 2) incorporating simulation models in restoration project planning to develop shared understanding of the ecosystem, 3) creating new collaboration platforms, and 4) developing a shared understanding of what science-management collaboration looks like. Overall, these lessons can be applied and further developed in other science-management partnerships that aim to connect long-term monitoring and research programs with environmental decision making.

USACE Sustainable Rivers Program -- Scaling River Restoration through Operational Changes and Adaptive Management: Overview

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The Sustainable Rivers Program (SRP) is a U.S. Army Corps of Engineers initiative with a mission of improving the ecological health of rivers by modifying operations at existing USACE infrastructure, while maintaining or enhancing the authorized purposes for which that infrastructure was built. Established in 2002, SRP is a formal partnership between USACE and The Nature Conservancy (TNC). SRP works by convening water managers, stakeholders, and scientific experts to rethink how infrastructure operations can deliver additional benefits for people and nature. Flow is the master variable in river systems, and small changes in water management can lead to big changes for rivers and the species that they support across the country. SRP has grown from eight initial rivers to 65 rivers in 2025, influencing nearly 15,000 miles of waterways. In these two presentations, Jim Howe (TNC) and Michelle Mattson (USACE) will present an overview of SRP and provide examples of SRP case studies and the program's formula for successfully identifying, testing, and incorporating new flow prescriptions into standard operations at USACE infrastructure.

Hydrologic Connectivity Between the Greater Everglades and Florida Bay Through the Taylor River Slough Modified by Environmental Stressors and Water Management Activities

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Both the water level and water flow within Everglades National Park (ENP) have undergone intensive hydrological modification and disconnection from the Greater Everglades watershed. In 2016, the South Florida Water Management District implemented the Florida Bay Plan to deliver the needed fresh water to Florida Bay and to restore freshwater flow through ENP, particularly through Taylor Slough and into Florida Bay. This study focused on investigating hydrologic connectivity across the land-to-ocean continuum of ENP by examining and quantifying water exchanges across seasons to support the Florida Bay Plan. We obtained seasonal flow and water level measurements around the Taylor River and applied the semi-implicit cross-scale hydroscience integrated system model (SCHISM) coupled with a wave module and a particle tracking module to conduct rigorous numerical modeling of surface water elevation, hydroperiod, current velocity, salinity and temperature along a transect gradient from the watershed to the open ocean. The model results calibrated to field measurements and stage gauges located throughout southern Florida and surrounding coastal areas are used to demonstrate the extreme flooding that occurred in response to several hurricane events, including Hurricane Irma in 2017 and Hurricanes Helene and Milton in 2024. Our work then analyzes how water moves across ENP from canals to estuaries by releasing particles at different time stamps and during different seasons. The results of this work indicate the impact of hydrologic modification by human activities on material exchange between the Everglades watershed and coastal ocean.

Flooding to Renewal: Brentwood Bound Flood Mitigation

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Flooding has long severely impacted the City of Brentwood, MO along Deer Creek between Hanley Road and South Brentwood Boulevard, with 26 floods since 1957. The repeated flooding in this landlocked, urban community of ~8,200 residents in the core of the metropolitan St. Louis region has caused significant public safety issues and property damage. The Brentwood Bound Project is an integrated, comprehensive plan to renew the Manchester Road corridor via three main components: Deer Creek Flood Mitigation, Manchester Road Improvements, and Deer Creek Greenway Connector. The flood mitigation component of Brentwood Bound includes floodplain restoration and mitigation to reduce flood elevations, increase public safety, and provide environmental and recreational amenities.

In addition to the flood mitigation improvements, the City of Brentwood is constructing the Deer Creek Greenway Connector, a new park pavilion with amphitheater, retention ponds and a destination playground. The completed improvements have the potential to connect to more than 28 miles of greenways in the St. Louis region.
A groundbreaking event occurred in April 2022 for the Deer Creek Greenway Connector with many of the project's amenities. The historic St. Louis area floods of July/August 2022, with multiple large rain events (including one with over 8" of rain in 6 hours), tested out the project's effectiveness during construction. Another storm event, which would have required boat rescues in pre-project conditions, went largely unnoticed just before the flood mitigation project was completed and Brentwood Park opened in the summer of 2023.

The Brentwood Bound Project has actively worked with stakeholders and the community over nearly 15 years of project planning, design, and development. The $81M project is funded through a combination of grant funding, partnerships, funding from certificates of participation, and a one-half of 1% economic development sales tax.

Geographic and Historical Context for Levee Setback Decisions, Lower Missouri River

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Understanding of the geography and historical trajectory of a river system can provide information to optimize rehabilitation projects. In the case of the Lower Missouri River, defined as 811 miles from Gavins Point Dam, South Dakota to its confluence with the Mississippi River near St. Louis, Missouri, the biophysical capacity of the river varies substantially with longitudinally varying hydrology, valley width, geomorphic adjustments to altered sediment supply, and engineered structures. In particular, historical changes to the construction reference plane (defined as the water-surface elevation at 75% daily flow exceedance during the navigation season) indicate areas along the channel where incision and channel/floodplain aggradation create conditions with varying floodplain connectivity and associated flood hazard. Ongoing geomorphic adjustments to a sediment deficit are likely to move the Lower Missouri River towards more uniform channel incision, minimizing the areas currently associated with aggradation and increased floodplain connectivity. Other factors influencing floodplain connectivity potential relate to prevailing hydrology, in particular distance downstream from Gavins Point dam, and lateral constraints on inundation due to levees and valley width. Areas where levee setbacks will be most effective in decreasing flood hazard are also areas where wetland rehabilitation projects will be easiest to achieve. Recognition of these interacting factors and how they may change in the future can provide a basis for siting levee setback projects to maximize benefits.

Pallid Sturgeon Reproductive Ecology and Recovery of the Lower Missouri River

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A substantial proportion of the more than $1.0bn spent on recovery of the Missouri River since 1990 has been invested to avoid jeopardy to the endangered pallid sturgeon (*Scaphirhynchus albus*). Conservation actions to support the pallid sturgeon have evolved from holistic attempts to restore some of the natural hydrologic and geomorphic variability of the river system to progressively reductionist attempts to provide specific habitats to support reproductive ecology within the highly engineered channel. Understanding of how pallid sturgeon reproductive behaviors play out on a regional landscape provides context for optimizing the return on investment of recovery actions. Reproductive behaviors of pallid sturgeon typically involve upstream migration of 10's to 100's of kilometers followed by spawning, fertilization, incubation, hatch, and downstream dispersal of free embryos. Dispersal progresses from dominantly passive transport mediated by channel hydraulics to increasing volitional swimming by larvae as they gain ability to hold themselves in the current, feed, and grow. Gavins Point Dam near Yankton, South Dakota, currently limits upstream migration of reproductive adults on the mainstem Lower Missouri River (LMOR). Reproductive pallids also use tributaries like the Platte River for spawning. Pallids are known to select hard, coarse substrate for spawning. Before channelization, spawning in the LMOR was probably anchored at discrete deposits of gravel and cobbles at Yankton, the southernmost extent of the last glaciation, and in the lowermost 150 miles of the river, where tributaries deliver gravel from the Ozarks and older glacial deposits in northern Missouri. Under current conditions, spawning has been documented throughout the Lower Missouri River, mostly on outside bends on revetment, but also on natural deposits and bedrock. The present wide distribution of spawning habitat may contribute to decreased aggregation of reproductive adults, resulting in diminished reproduction (Allee effect from difficulty finding mates) and altered gene flow. Simultaneously, channelization has resulted in median water velocities that are as much as two times greater than those of the natural river. Increased velocities increase energetic costs for upstream migrating reproductive adults (and likely decreases migration distance). Increased velocities also substantially increase downstream larval advection rates (and likely increase dispersal distances). The substantial transport efficiency of the LMOR has been documented in hydraulic models and by captures of larvae seeded near Sioux City, Iowa in the Middle Mississippi River (MMR). The result of channelization is shortened upstream migrations of reproductive fish and longer, faster downstream dispersal of larvae – a net transfer of fish downstream with decreased probabilities of returning. This landscape scale understanding supports investment in channel re-engineering to decrease downstream dispersal rates through increased channel complexity. Increased channel complexity may also decrease energy expenditures of upstream migration.

ClearWater-Riverine

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The ClearWater-riverine package is a two-dimensional (2D) water quality transporter model to calculate conservative advection and diffusion of constituents from an unstructured grid of flows within complex river systems and floodplains. It is developed with modern Python by the U.S. Army Engineer Research and Development Center (ERDC), Environmental Laboratory (EL), and LimnoTech Inc.

The goal of this model is to simulate the transport (advection and diffusion) of heat and water quality constituents in riverine systems by coupling it to ERDC's ClearWater (Corps Library for Environmental Analysis and Restoration of Watersheds) modules that simulate water quality processes and kinetics. At present, the Temperature Simulation Module (TSM) and Nutrient Simulation Module (NSM) have been successfully coupled to HEC-RAS-2D models via ClearWater-Riverine, simulating fundamental eutrophication processes such as the interactions between temperature, nutrients, algae, dissolved oxygen, and organic matter.

ClearWater-Riverine assumes vertical homogeneity. Therefore, it is best suited for evaluating riverine systems during conditions where vertical stratification does not contribute significantly to the water quality dynamics, but where the longitudinal and lateral changes of water quality are important.

This poster presentation will focus on model capabilities and example projects.

Small Changes Big Impact: Making Operational Changes at USACE Infrastructure on the Mississippi River to Create Ecosystem Benefits

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The US Army Corps of Engineers (USACE) is one largest water resource management agencies in the United States, managing over 460 reservoirs and providing over 50% of the nation's entire flood storage capacity. In addition, the Corps manages over 230 navigable locks throughout the country. In total, USACE infrastructure directly impacts over 52,000 miles of rivers. Within the Upper Mississippi River USACE operates a series of locks and dams from St. Paul Minnesota to St. Louis Missouri with the primary mission of providing dependable commercial navigation. Partnering with state and federal natural resource agencies, and utilizing support from USACE's Sustainable Rivers Program, the USACE St. Louis District has evaluated and implemented operational changes at their locks and dams to derive additional ecosystem benefits, while maintaining or enhancing the other project missions. Consistent with the conference theme on return on investment, in this case large scale federal water infrastructure, we will discuss two cases where modifying existing operation resulted in meaningful ecologic responses and outcomes. In one case, through collective action and subsequent monitoring we have been able to repeatedly create, and document, directly below a USACE lock and dam, successful spawning conditions for the Lake Sturgeon (*Acipenser fulvescens*), a species of regional and national concern. In the other case, through making small but conscious changes in how the navigation pools are operated, the St. Louis District has been able to create over 1000 acres of moist soil habitat annually, including the return of perennial aquatic plants to areas where they had not been documented in over two decades. The presentation will focus on the role of collaboration, monitoring, and adaptive management in the success of these two efforts and discuss ongoing efforts to replicate these successes in other locations with the Upper Mississippi River and throughout the country.

Enhancing Habitat Quality in Restoration Sites Along the Colorado River: A Case Study for the Lower Colorado River Multi-Species Conservation Program

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The Lower Colorado River Multi-Species Conservation Program (LCR MSCP) is a 50-year multi-stakeholder Federal and non-Federal partnership created to balance the use of Lower Colorado River (LCR) water resources with the conservation of native species and their habitats in compliance with the Endangered Species Act. MSCP's goal is to conserve at least 27 covered species along the LCR from Lake Mead to the Southerly International Boundary with Mexico through implementation of the Habitat Conservation Plan (HCP). A primary component of the HCP is habitat creation: developing conservation areas and the application of adaptative management on over 8,300 acres of restored habitat.

The majority of MSCP sites have been developed on land once used for agriculture purposes and were designed and planted using farm machinery and mechanical transplanters. While covered species have extensively used these created habitats, mechanical planting creates a uniform distribution of riparian vegetation growth, often with a single dominant species. Development of Dennis Underwood Conservation Area incorporated various planting designs that were applied to encourage the development of heterogeneous habitat. The restoration design included low and high-density riparian areas, high-density willow stands, honey mesquite forests ("bosques"), and topographical features that will improve soil moisture. Applying new planting methods and designs such as these are anticipated to enhance habitat use by covered species such as the federally endangered southwestern willow flycatcher and improve the overall quality of the habitat.

Post-development monitoring, including wildlife response monitoring, remote sensing-based analysis of vegetation structure and greenness, and in-situ monitoring of soil moisture levels, will determine if the restoration design is having the desired effects. Results will be used for application of the adaptive management process to adjust site stewardship, if needed, to ensure that the project satisfies the requirements of the HCP in 2055.

From Cypress–Tupelo to Tallow: Landscape-Wide Monitoring of Tree Assemblages Across the Lake Maurepas Wetlands

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The wetlands surrounding Lake Maurepas form a critical transition zone where freshwater inflows converge with tidal exchange from Lake Pontchartrain. This hydrologically dynamic setting produces steep spatial gradients in forest condition, from resilient cypress–tupelo (*Taxodium distichum*, *Nyssa aquatica*) swamps in the southwest to increasingly open, marsh-dominated landscapes in the northeast. To evaluate how these gradients shape forest health and to guide large-scale reforestation and hydrological restoration efforts now underway, we have initiated a new, landscape-wide monitoring program of natural tree assemblages across the basin.

We established 24 permanent plots (25 × 25 m) at 12 locations, paired by replicates, where quarterly surveys document herbaceous vegetation, litterfall, and seedling recruitment, alongside annual assessments of tree diameter growth, canopy cover, and species composition. Preliminary observations show southwestern forests dominated by canopy-forming cypress and tupelo, with red maple (*Acer rubrum*) and green ash (*Fraxinus pennsylvanica*) in the understory. In contrast, northeastern sites are characterized by sparse trees, reduced regeneration, and encroachment by disturbance-adapted species such as black willow (*Salix nigra*), wax myrtle (*Myrica cerifera*), and invasive Chinese tallow (*Triadica sebifera*).

Expected findings include quantification of species-specific growth and survival across stress gradients, identification of thresholds where swamps transition to marsh or invasive-dominated assemblages, and detection of early indicators of restoration success. Integration of soil and water sensors with long-term elevation change measurements will further link vegetation dynamics to hydrologic regimes. By delivering the first coordinated, basin-wide baseline of forest condition, this program provides essential context for evaluating the outcomes of ongoing reforestation and hydrological restoration and will directly inform adaptive management of swamp forests under future climate and sea-level rise.

Nature's ROI: Quantifying the Economic Value of Ecosystem Restoration

*Ben Eubanks[1], Dr. Paul Hindsley[2], **Maya Kocian[3]** , Bryan Van Stippen[4], Dr. Harry Stone[5], and Kelly Watkinson[6]*

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[6]Land Trust Alliance

Restoring natural ecosystems delivers measurable economic returns. Drawing from recent Earth Economics studies, five partners representing diverse ecosystems across the US will discuss how they have used ecosystem services valuation to further their conservation and restoration goals.

Topics covered will include valuing ecosystem services across regions (the Greater Everglades and the Ohio River Basin), tools to help tribes and land trusts articulate the value of their stewardship efforts, and how project developers are considering co-benefit values.

Attendees will gain insights into valuation methods, public and private sector use of valuation, and how to communicate nature's ROI to decision-makers.

Central Valley Project Salmonid Habitat Structured Decision Making Process

Rodney J. Wittler[1], Steve Whiteman[2], Jenna L. Paul[1] *Presented by:* ***Daniel Levish***

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Reclamation & the Service use a Structured Decision Making process to set priorities for expanding salmonid and sturgeon habitats available to fish stocks in the Central Valley of California. We began by clarifying the fundamental objective. In this case, in 1992 Congress set the fundamental objective as doubling the natural production of anadromous fishes in the Central Valley. We continued by distinguishing between fundamental objectives and means objectives. We then described a conceptual life-cycle model for salmonids and sturgeon species in the Central Valley. We bound the set of management actions that we will simulate in the model. We set the scale and domain of the decision support model(s). We seed the models with three types of data: 1. Empirical or observed; 2. Synthesized by a process-based model; 3. Expert Elicitation. We developed alternatives to test in the models, ascertaining which alternatives best achieve our fundamental objectives. The Science Integration Team provides experience, expertise, and data to the decision making process. Through facilitated, iterative dialogues, participants describe sets of management actions available to Reclamation and the Service. The SIT also provides their opinions on both the formulation of the conceptual model, inputs, and the alternatives. They then discuss the model outputs, tempering the results based on their expertise and experience. Reclamation and the Service take SIT input and set priorities for on the ground actions, as well as directed studies that reduce key uncertainties in the process. Reclamation and the Service has used this science-based structured decision making approach to competitively fund more than $190M in river restoration and uncertainty reduction efforts over the past 10 years.

Unoccupied Aerial Systems for Bridging Scale Gaps in Adaptive Management of River Systems: Opportunities and Challenges

Quinn W. Lewis
Headwaters Corporation, Lakewood, CO, USA

River processes and landforms are characterized and influenced by a complex assemblage of scales. From bedform-induced turbulence to climatic and geologic controls on watershed morphology, river managers must constantly consider scale in both theory and practice. This presentation focuses on recent efforts by the Platte River Recovery Implementation Program to bridge scale gaps in the management of the Platte River in Nebraska with Unoccupied Aerial Systems (UAS). I discuss opportunities to supplement and improve upon traditional remote-sensing tools and methods, with emphasis placed on the flexibility and high spatial and temporal resolution of UAS data. I then describe challenges and difficulties associated with practical and technical limitations of UAS. Specific examples from Platte River Recovery Implementation Program projects are put into the general context of how UAS have been used to bridge scale gaps in cross-discipline adaptive management of rivers. The presentation concludes with a dialogue on the future of integrating UAS with adaptive river management.

All Hands on Board: Partnering with the U.S. Army Corps of Engineers on Aquatic Ecosystem Restoration

Andrew J. LoSchiavo

U.S. Army Corps of Engineers, South Atlantic Division, Atlanta, GA, USA

The U.S. Army Corps of Engineers Jacksonville District (Corps) aquatic ecosystem restoration mission is one of the newer missions in the Corps portfolio. The Corps can only complete ecosystem restoration projects as part of a 50-50 cost share with local sponsors to complete the study (planning), design, construction, and operations and maintenance phases of the project. Typically, sponsors have been state agencies that have many authorities that are necessary to be able to not only fund part of the restoration project, but to also acquire the lands necessary for the design and construction activities. However, not every state has the resources to cost-share on these types of projects. More recently, the Corps has partnered with non-governmental organizations who share a common mission in restoring aquatic ecosystems and have the resources to cost-share. This presentation will cover the requirements for partnering with the Corps on ecosystem restoration, some lessons learned from recent efforts with county and NGO sponsors and explore potential future opportunities to expand this important mission for our Nation.

Lake Rehabilitation: Enhancing Water Quality, Habitat, and Recreation

Robb Lutz*, P.E*

EA Engineering, Science, and Technology, Inc., PBC, Lincoln, NE, USA

Lakes face persistent challenges such as nutrient enrichment, algal blooms, sedimentation, shoreline erosion, invasive species, and habitat loss. These impairments reduce ecosystem health, recreational opportunities, and the long-term value of public investments. Rehabilitation provides strong returns by restoring ecosystem function, improving resilience, and generating lasting social and economic benefits.

This presentation highlights rehabilitation efforts at Pickle Pond in Superior, WI and in numerous lakes throughout Nebraska. Strategies include dredging to restore depth and water quality, sediment basin design to reduce inflows, shoreline stabilization, habitat enhancement using both natural and artificial structures, and invasive species management. Recreation-focused improvements such as new boat ramps, ADA-compliant trails, and fishing piers further demonstrate the integration of ecological and community benefits.

By combining upstream conservation with in-lake restoration, these projects show how targeted interventions address system-wide problems. Outcomes including healthier fisheries, reduced nutrient loading, improved recreation, and extended infrastructure service life underscore the value of lake rehabilitation as both an ecological and economic investment. Experience from these projects offers practical guidance for balancing water quality, habitat diversity, and recreation in aquatic systems.

What Insights Do the Second Periodic CERP Update Modeling Results Provide About CERP?

Pierre Andre Massena[1], *Jaime Gralau Santiago*[1], *Sandeep Dabral*[1], *Raul Novoa*[2]

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The Comprehensive Everglades Restoration Plan (CERP) is a large-scale effort to restore the Everglades ecosystem. As part of the CERP Programmatic Regulations, the Second Periodic CERP Update (SPCU) is a recurring evaluation that leverages advanced modeling tools and the latest scientific data to assess the plan's progress and inform future decision-making. Building on the 2005 Initial CERP Update and the 2018-2020 Interim Goal and Interim Target (IGIT) effort, the SPCU utilizes the Regional Simulation Model (RSM) to simulate all 68 components of CERP. Recent model development efforts have enhanced RSM's capabilities to accurately represent CERP's foundation projects, including the Kissimmee River Restoration, Water Conservation Areas, Stormwater Treatment Areas, and Lake Okeechobee operations. This presentation will share preliminary results from key model runs, including existing conditions, future without CERP, and future with CERP completion under various operational scenarios and varying levels of aquifer storage and recovery. The results will provide valuable insights into the effectiveness of CERP's restoration objectives, identify areas for improvement, and inform future modeling efforts, which will include simulations of the future with CERP utilizing USACE intermediate sea-level change projections.

USACE Sustainable Rivers Program -- Scaling River Restoration through Operational Changes and Adaptive Management: Case Studies

Jim Howe[1]*, and* ***Michelle Mattson***[2]

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[2] U.S. Army Corp of Engineers, Institute of Water Resources, Alexandria, VA, USA

The Sustainable Rivers Program (SRP) is a U.S. Army Corps of Engineers initiative with a mission of improving the ecological health of rivers by modifying operations at existing USACE infrastructure, while maintaining or enhancing the authorized purposes for which that infrastructure was built. Established in 2002, SRP is a formal partnership between USACE and The Nature Conservancy (TNC). SRP works by convening water managers, stakeholders, and scientific experts to rethink how infrastructure operations can deliver additional benefits for people and nature. Flow is the master variable in river systems, and small changes in water management can lead to big changes for rivers and the species that they support across the country. SRP has grown from eight initial rivers to 65 rivers in 2025, influencing nearly 15,000 miles of waterways. In these two presentations, Jim Howe (TNC) and Michelle Mattson (USACE) will present an overview of SRP and provide examples of SRP case studies and the program's formula for successfully identifying, testing, and incorporating new flow prescriptions into standard operations at USACE infrastructure.

Assessing and Communicating Stepwise Gains in Large Restoration Efforts

Jenna May

U.S. Army Corps of Engineers, Jacksonville District, Jacksonville, FL, USA

Authorized by Congress in 2000, the Comprehensive Everglades Restoration Plan aims to balance flow characteristics throughout the Florida Everglades by modifying the quantity, quality, timing, and distribution of water. This effort seeks to enhance ecosystem health and improve quality of life in South Florida. REstoration, COordination, VERification (RECOVER) is an interdisciplinary collaboration of agencies, tribes, and institutions that conducts scientific and technical evaluations and assessments to improve the ability of the Comprehensive Everglades Restoration Plan to restore, preserve, and protect the south Florida ecosystem while providing for the region’s other water-related needs. RECOVER takes a system-wide approach to planning and implementation, communicating modeling and real-world monitoring results to managers, decision-makers, and the public. RECOVER monitors indicator species to track actual restoration progress and communicates the results in the System Status Report, which is produced every five years. The System Status Report compares expectations from modeling of future increments of restoration project implementation with real-world data from monitoring, providing an opportunity to report on restoration progress and inform adaptive management actions, as appropriate. Specific examples of assessment methods, communication approaches, and lessons learned will be highlighted to showcase the utility of periodic assessments throughout restoration project implementation.

Aerial and Terrestrial LiDAR and Time Series of Multispectral Satellite Imagery for Characterizing Bird Habitat Structure and Composition on the Santa Clara River

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Across drylands in the Western United States, riparian woodland ecosystems house disproportionately high biodiversity and productivity relative to adjacent uplands. In the most arid regions, a high proportion of overall vertebrate organisms rely on riparian woodlands for some phase of their life cycle. Unfortunately, these ecosystems are also disproportionately threatened by development, climate change, drought, and loss of groundwater, and as a result many of their characteristic species are now threatened or endangered at the federal or state level. The Santa Clara River is one of the last relatively intact and free-flowing riparian woodland habitats remaining in Southern California and it provides habitat for several listed species, including the Least Bell's Vireo. However, the ecosystem and birds face ongoing challenges from historic drought, floods, and groundwater decline.

Remote sensing tools are capable of tracking long-term shifts in vegetation composition and structure over regional spatial scales but application in conservation contexts has lagged some other fields due partly to challenges in implementation and data availability, and the need for methods which are easily extensible to new systems. We have recently developed a new set of tools for characterizing seasonal patterns of vegetation density and relative canopy temperature which give insights into plant composition and water utilization and which can be quickly and easily re-applied in any dryland setting. We have also contracted repeated aerial LiDAR surveys of the Santa Clara River over the last decade, providing a unique dataset tracking long-term vegetation structure. Here, we combine those datasets with recent bioacoustic monitoring data on bird communities to demonstrate the utility of remote sensing tools for mapping vegetation as bird habitat. Our results include discussion of the relative influence of vegetation structure and canopy composition and temperature on bird community richness and relative rates of vocal activity by protected species. These methods are extensible to other riparian contexts and will become even more relevant in the near future as upcoming remote sensing satellite constellations (including the planned NASA Surface Biology and Geology Mission) continue to launch, expanding the availability of input data.

The Benefits of Riparian Restoration During Floods: From Drinking Water Quality to Wider Society

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Riparian restoration can improve water quality, reduce sources of risk and pathogen load in raw drinking water, sequester carbon, and increase biodiversity. These ecosystem services are of interest to private companies such as water supply utilities, and policy makers interested in environmental public goods. However, ecosystem service studies rarely convert benefits into monetary values, rarely consider the delivery of benefits to specific human populations, and typically focus on a limited number of benefits accruing to a single beneficiary. Studies that place flood-related benefits from riparian restoration alongside other benefits are particularly rare. Consequently, it can be difficult for private and public decision makers to estimate their return on investment (ROI) in riparian restoration through a cost-benefit analysis (CBA).

We used high-resolution time-series data to establish the baseline cost and risk to the drinking water of Brisbane (population ~1 million), Australia, due to variation in turbidity during floods with a range of magnitudes. Subsequently, the merits of approximately 100 km of riparian restoration were explored from the perspective of: 1. A cost-benefit analysis (CBA) for the water utility that included expected avoided treatment costs, and revenue from the sale of carbon sequestration and biodiversity enhancement credits to established markets; 2. A risk analysis for the water utility using reduced standard deviation of expected treatment costs and disaster risk following riparian restoration; 3. A CBA for the region that included avoided population disease burden; and 4. A CBA for society that included avoided social cost of carbon.

After riparian restoration, the expected avoided treatment costs were higher during moderate floods than during major floods, due to the low probability of major floods occurring. However, in these major floods, riparian restoration substantially reduced multiple aspects of risk to the water utility. The upfront costs required for riparian restoration were particularly influential on the return on investment (ROI). Substantial time was required before trees delivered maximum water quality benefits, however the carbon sequestration and biodiversity enhancement benefits delivered value while trees were growing. Including these carbon sequestration and biodiversity enhancement benefits allowed a positive ROI to the utility based on avoided operating costs alone. Including regional benefits from avoided population disease burden, and social benefits from avoided social cost of carbon, further increased this ROI. Results demonstrated that if riparian restoration was appropriately targeted, it could address complex water challenges and achieve both water supply and wider social goals.

Everglades Restoration – Where Are We Headed?

Christopher W. McVoy

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All environmental restoration projects are fraught with questions. How well do we know the original, pre-disturbance conditions? Are the resources needed to restore—seed banks, water quantities, land, water quality, etc.,—all available in sufficient quantities? How distant are current environmental conditions from the originals?

Everglades restoration, a spatially, hydrologically, and financially huge undertaking, faces all these questions and more. Twenty-five years in, we are now at a crossroads, facing a choice between two fundamentally different approaches, a physics-based approach or a site-specific approach.

The pre-drainage Everglades was unusual as a sloped wetland. That slope, though slight, meant that water was always in disequilibrium; continually draining out to Florida Bay. The slope of the flowing water surface paralleled the downstream slope of the ground surface. The continual outflow was replenished seasonally by a combination of wet season inflows from the upstream watershed and direct wet season rainfall. While the outflow was year-round, the seasonality of inflows created a pulsed system, leading to typical annual water depth swings of about 60 cm. Despite these flows having been generally very low in velocity and energy, through some as yet not fully understood mechanism, they created a strongly patterned landscape. Unlike string bogs, the patterning was oriented parallel to flow. Intriguingly, both the regional slope and the relative elevation differences of the elements forming the highly directional patterning were based on the accumulation of peat soils.

Early uncontrolled drainage of the Everglades led to oxidation of peat soils, diminishing the elevation differences between the patterned elements: sloughs, sawgrass ridges and tree islands. Subsequent compartmentalization created large reservoirs. Reservoirs, by impeding flow, created “water wedges,” impounding water such that the water surface is no longer parallel to the ground surface. The water depth at the upstream end of the reservoir can be as much as 1.5 m shallower than close to the dam.

Proponents of a physics-based approach recommend restoring the Everglades by “decompartmentalizing,” that is, by removing as many internal barriers to flow (i.e., levees, dams) as possible and at the same time adding sufficient clean water (<10 ppb P) upstream to approximate as closely as possible pre-drainage water flows and depths.

Proponents of site-specific approaches argue that the system has been too greatly altered to allow unrestricted flows. Instead, they recommend managing for differing water depths in specific areas to achieve spatially different ecological goals.

Interestingly, a physics-based approach leans more toward how the system *was*, pre-drainage; while a site-specific approach leans more toward how the system *is*, currently.

Leveraging Federal Partnerships to Meet Global Ecosystem Restoration Goals

Heidi Mehl

The Nature Conservancy, Great Plains Division, Lawrence, KS, USA

The Nature Conservancy (TNC) has set ambitious 2030 goals to address climate change and biodiversity loss. Our goals include metrics for land, oceans, greenhouse gases, people, and freshwater. Freshwater systems have experienced more than double the rate of biodiversity loss than lands and oceans, and the causes are especially difficult to address at scale. Conservation practices on land, while important to pursue, provide incremental progress on lower-order streams and don't address the impacts of infrastructure to biodiversity on our large rivers. Our best opportunity to improve freshwater biodiversity on our larger rivers is to partner with the nation's largest water manager, the U.S. Army Corps of Engineers (USACE), to manage water infrastructure to benefit aquatic biodiversity. The Sustainable Rivers Program, a nationwide partnership between TNC and USACE, seeks to improve the health and life of rivers by changing infrastructure operations to restore and protect ecosystems, while maintaining or enhancing other project benefits. This presentation will discuss TNC's 2030 goals and our important partnership with USACE to achieve ecosystem benefits on large rivers. We will also showcase successes from this partnership from across the United States.

Collaborative Modelling Improves Evaluation of Proposed Floodplain Vegetation Management Actions At Reno Bottoms: Forest Succession Modeling, Habitat Evaluation, and Incremental Cost Analysis

Andrew R. Meier[1], *Megan B. McGuire*[2], *Nathan R. De Jager*[3] *and Molly Van Appledorn*[3]

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Across the nation, the US Army Corps of Engineers (USACE) develops large scale ecosystem restoration projects focused primarily on aquatic and wetland habitats. USACE uses cost-effectiveness and incremental cost analysis (CE-ICA) to evaluate habitat gain per dollar spent across a range of project alternatives. Historically, to meet USACE policy requirements for CE-ICA, project planners have forecasted future habitat conditions largely using professional judgement. These future conditions are used to evaluate habitat value, quantified as habitat units, produced under different project alternatives relative to cost and inform alternative selection. However, increasingly complex projects in increasingly unpredictable systems have led to questions about the validity of professional judgement to forecast future conditions in large-scale restoration affected by changing hydrology, geomorphology, invasive species, and other complex ecological processes.

The Reno Bottoms Habitat Rehabilitation and Enhancement Project on the Mississippi River between Reno, MN and New Albin, IA, funded by the Upper Mississippi River Restoration program, provided an opportunity to evaluate an alternative method for evaluation of habitat benefits. This project is the first in the USACE St. Paul District with a primary objective of floodplain forest enhancement and restoration and the first within the district to evaluate alternatives at the scale of a small landscape (approximately 14,000 acres). We utilized a custom formulation of the De Jager LANDIS floodplain forest succession model (as detailed in the preceding presentation by De Jager et al.) and a new Upper Mississippi River Floodplain Forest Habitat Suitability Index (HSI) to evaluate and forecast habitat changes over a 100-year period. The Reno Bottoms project team developed a set of three potential forest management measures (planting and seeding, vegetation control and planting, forest thinning) and identified large areas within the project boundary where those management measures were likely to provide at least a minimal level of floodplain forest improvement. The qualitative measures were then parameterized into a quantitative format and input into the custom LANDIS forest succession model. Within the model, seven scenarios were evaluated with various combinations of management measures and two hydrologic regimes. Resulting LANDIS model outputs, in pixel level biomass (g/m^2), were then converted to approximate Floodplain Forest HSI variable equivalents for each scenario. These landscape-level, spatially explicit HSI data layers were then used by the project team to identify a set of 13 distinct project alternatives with high potential to improve forest. Within the footprint of each alternative, HSI values were averaged and multiplied by total acreage to calculate habitat units. Based on the estimated cost per alternative, the annualized cost was divided by the annualized habitat units to determine the cost per habitat unit for each of the project alternatives over a fifty-year period of analysis.

With this process, we were able to develop a quantitative evaluation of project costs and benefits over the 50-year project period based on the site-specific customization of the LANDIS floodplain forest model. This approach substantially reduced dependence on professional judgement of changes in forest condition over the evaluation period and provided a robust framework for justification of alternative selection, helping answer the question of which project measures were effective and efficient.

Vision for an Ecologically Sound Platte River (VESPR): Building Resilience Through Informal Collaboration

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The Platte River Basin—spanning Wyoming, Colorado, and Nebraska—is essential to wildlife, agriculture, industry, and communities, yet its long-term sustainability is constrained by management systems designed without ecosystem resilience at their core. Current conservation efforts are often reactive, species-specific, and tethered to regulatory requirements. To meet future uncertainties in water availability, climate variability, and ecological shifts, a new approach is needed—one that looks beyond regulations and embraces ecosystem functionality, social resilience, and shared values.

VESPR (Vision for an Ecologically Sound Platte River) is an informal coalition of conservation organizations, agencies, and academic institutions working to advance a 50-year vision for Platte River management. What makes VESPR unique is its reliance on informal collaboration: participants commit time and expertise based on their strengths rather than formal mandates. This flexible structure fosters trust, leverages complementary resources, and creates space for innovative, cross-disciplinary problem-solving. By combining partner capacity—time, research, funding, and on-the-ground work—VESPR achieves a better return on investment than any one organization could alone, turning shared priorities into scalable, durable outcomes.

By sharing lessons from VESPR's early progress, this presentation will illustrate how informal collaboration can offer fresh pathways to landscape-scale conservation, broaden partner engagement, and build durable political and social support. VESPR demonstrates that when diverse stakeholders unite around a shared long-term vision, conservation planning can transcend regulatory limitations and secure a resilient future for both people and wildlife in the Platte River Basin.

Flow and Salinity: Understanding the Dynamics of Freshwater Inflow on Florida Bay's Ecosystem

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The Environmental Fluid Dynamics Code (EFDC) model is used to assess the ecological impacts of the Comprehensive Everglades Restoration Plan (CERP) on Florida Bay. The EFDC is a key tool for RECOVER (REstoration COordination and VERification), a program that supports CERP by evaluating restoration projects and monitoring ecological conditions. The EFDC model helps researchers and decision-makers understand how different water management strategies affect the ecosystem and guides efforts to restore the South Florida ecosystem.

Florida Bay is a key component of the South Florida ecosystem and CERP. Restoring historical patterns of freshwater inflow are essential to the ecological health of the Bay. Inflows to some areas of Florida Bay, including Taylor Slough are highly managed. Restoration success depends on understanding and optimizing the QQTD (Quantity, Quality, Timing, and Distribution) parameters that govern salinity dynamics and habitat viability. To support this effort, the Environmental Fluid Dynamics Code (EFDC), a three-dimensional hydrodynamic and water quality model, has been developed and calibrated/validated for Florida Bay. The model incorporates seven years of field data, including measurements from 34 tidal stations, 42 current meters, and 14 temperature and salinity monitoring sites.

EFDC's long-standing application in Florida Bay and its integration with RECOVER's performance measures make it uniquely suited for Everglades restoration. EFDC enables RECOVER to simulate salinity gradients under varying freshwater flow scenarios, helping to identify if ecological thresholds for indicator species such as seagrass, spotted seatrout, and American crocodiles will be met. Furthermore, EFDC allows RECOVER to validate restoration performance by comparing model outputs with field observations. Model results have shown that salinity in Florida Bay is primarily influenced by rainfall, net freshwater inflows from canals (e.g., C-111), wind-driven mixing, estuarine circulation, and exchange with the coastal ocean.

Recent applications of EFDC focused on evaluating the ecological impact of doubling freshwater input to Florida Bay. Simulations revealed that directing increased flow to Taylor Slough yields greater ecological benefits than routing it to Shark River Slough. This redistribution improves salinity balance across both wet and dry seasons and supports the recovery of sensitive habitats. Model-predicted salinity indicated that rainfall caused the largest reduction (10–15 ppt) followed by Taylor River discharges. None of the predicted salinity scenario means exceeded 38 ppt. The salinity restoration target was achieved more than 70% of the time, by doubling the Taylor River freshwater discharges. These findings underscore EFDC's utility as a decision-support tool for optimizing water delivery strategies and achieving restoration targets.

In summary, the EFDC model is a critical asset for evaluating project impacts, assessing ecosystem responses, and guiding adaptive management within the CERP and RECOVER frameworks. Its predictive capabilities enable researchers and decision-makers to refine restoration strategies, improve ecological outcomes, and advance the long-term goal of restoring the South Florida ecosystem.

Bringing the Salmon Home: An Indigenous-Led Approach to Pacific Salmon Reintroduction in the Columbia River

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The Columbia River was once the source of some of the greatest Pacific salmon runs in the world. Almost 40% of the length of this transboundary river originates in the south-eastern region of British Columbia, Canada. Massive dams, approved by Crown governments without consultation with Indigenous Nations, have blocked salmon from returning to the Columbia's headwaters for over 86 years. As a result, the ecosystem and generations of Indigenous People have been deprived of the cultural connection to salmon.

Despite their absence, salmon remain central to the wellbeing, culture, spirituality, sustenance, and livelihoods of Syilx, Secwépemc, and Ktunaxa Peoples. Since time immemorial these Nations have persisted in their shared and sacred responsibility as Salmon Peoples to protect and sustain salmon as the ancestral source of life and culture. They continue to this day to practice cultural ceremonies that support salmon across their life cycle.

Bringing The Salmon Home: The Columbia River Salmon Reintroduction Initiative is the Indigenous-led collaboration of the Syilx Okanagan, Secwépemc and Ktunaxa Nations, working with the crown governments of British Columbia and Canada. The shared vision for restoration is to return a harvestable abundance of salmon for Indigenous food, social and ceremonial needs, and to benefit the region's people and ecosystems.

The Initiative represents a multi-generational approach to restore a complex ecosystem impacted by hydro-electric dams, habitat disruption, industrial use and settlement on both sides of the Canada-USA border. A broad portfolio of scientific studies are currently underway to explore the feasibility of salmon reintroduction and inform restoration options. These studies include:

- Using experimental releases of juvenile and adult salmon to understand movement patterns and habitat use;
- Developing a conservation hatchery program to kick-start and support long-term reintroduction goals;
- Exploring the development of interim and long-term fish passage options;
- Evaluating the availability and productive capacity of existing habitats to support salmon populations;
- Understanding the vulnerability of salmon to future climate impacts; and
- Developing quantitative models to explore reintroduction scenarios and restoration options.

Indigenous leadership is foundational to the cultural strength, stewardship, and long-term commitments required to support the technical success of salmon reintroduction. In its relatively short existence, the Initiative has proven to be a model of restoration success for Indigenous-led ecosystem co-management through the Nations' combined scientific, cultural, and youth engagement efforts. It has demonstrated that while salmon reintroduction in the upper Columbia will take decades, success is achievable and imperative enabled by the leadership of the Nations to implement the necessary scientific studies and have a leadership role in decision-making.

Monitoring the Forested Wetlands of the Seminole Tribe of Florida's Big Cypress Indian Reservation in Anticipation of Hydrologic Restoration

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Restoration of degraded wetlands at large regional scales is complex because of the many factors that play into it. Monitoring the effects of incremental restorative actions can help make restoration successful, especially when these are supported by a strong sense of stewardship.

Rehydration of Southwestern Florida is currently being planned, and a monitoring effort is being carried out inside the natural area of the Seminole Tribe's Big Cypress Indian Reservation, which should be greatly affected by the rehydration actions. Water convection through the canal system has dried the area, causing, on a big portion of the landscape, transitions from cypress (-17 %) and marsh (-85 %) communities to pine (+192 %) or to oaks and other hardwood species (+397 %) communities. On the other hand, data collected in the last decade show surface water total phosphorus and total Kjeldahl nitrogen concentrations of 16.0 ± 3.3 and 945.3 ± 1515.3 μg L^{-1} (geometric mean ± standard deviation), respectively, reflecting partially intact water quality conditions. Extensive soil sampling within the natural area showed mean total organic carbon, total Kjeldahl nitrogen, and total phosphorus concentration of 27513 ± 44430, 3178 ± 3952, and 160.1 ± 252.3 μg g^{-1}, respectively, for the top 20 cm of the soil profile. Soil chemistry conditions varied substantially with hydrologic conditions and habitat type. As expected, soil bulk density correlated with soil total organic carbon (r^2 = 0.60), varying between 0.86 ± 0.19 g cm^{-3} in the shallow, mineral pineland soils and 0.47 ± 0.14 g cm^{-3} in the deep, peat slough soils.

Hydrologic conditions, estimated through interpolation of water stages and a newly acquired LIDAR dataset, fire history of the last 15 years, soil chemistry conditions, and a plant species presence database were used to identify ecological niches of plant species and to generate suitability maps.

With this monitoring effort, we hope to inform restoration actions with a much larger vision for the regional system.

Linking Environmental Fit and Genetic Diversity to *Phragmites australis* Restoration Outcomes in the Bird's Foot Delta

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Phragmites australis is a widespread perennial grass that forms extensive stands across Louisiana's Bird's Foot Delta (BFD). Four lineages occur in the region, with the Delta type (Haplotype M1) being the most broadly distributed and exhibiting strong tolerance to salinity, prolonged flooding, and herbivory by the non-native scale *Nipponaclerda biwakoensis*. Despite these traits, extensive dieback has been observed since 2016, driven by scale infestation and environmental pressures including saltwater intrusion, subsidence, and rising sea levels. These dieback zones often appear as mudflats or bare areas near channels and dredge sites locations that are highly susceptible to erosion. The continued decline of *P. australis* contributes to long-term land loss in the Delta, estimated at 62 km^2 annually, with subsidence (≈10 mm/year) playing a major role. To inform restoration strategies in this rapidly deteriorating landscape, we established stem-planting trials at four sites differing in genotype composition, planting density, and planting method. Survival and growth are being tracked through drone imagery and field assessments to identify environmental drivers of early establishment. Because restoration success may hinge on the genetic characteristics of source populations, we also assessed the genetic diversity of high-performing Delta lineage stands by collecting leaf and rhizome material across the region. Through integrated 2024 restoration trials and monitoring, this study examines how genetic diversity, site-level salinity, and hydrologic conditions interact to shape establishment outcomes across selected restoration sites.

RECOVER's Scientific and Technical Evaluation of the Second Periodic CERP Update. (CERP Goal 1, Enhance Ecological Values)

Gina Paduano Ralph
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The Everglades ecosystem, including Lake Okeechobee, encompasses a system of diverse wetland landscapes that are hydrologically and ecologically connected across more than 200 miles from north to south and across 18,000 square miles of southern Florida. In 2000, the U.S. Congress authorized the Federal government, in partnership with the State of Florida, to embark upon a multi-decade, multi-billion dollar Comprehensive Everglades Restoration Plan (CERP) to further protect and restore the remaining Everglades ecosystem while providing for other water-related needs of the region. Through construction and operation of 68 interdependent components, CERP aims to restore natural hydrology through removal of more than 240 miles of internal levees and canals, improving the health of over 2.4 million acres by allowing water to flow nearly unobstructed throughout the south Florida ecosystem. CERP focuses on quantity, quality, timing, and distribution of water flow, given modern constraints, to recover critical ecological functions that characterized the historical Everglades and other portions of the south Florida landscape. Since 2000, much progress has been made, including record construction of CERP projects, collection of new data and science through REstoration, COordination, VErification's (RECOVER) Applied Science Strategy, along with new modeling and tool development. The Second Periodic CERP Update (SPCU) is an opportunity to reevaluate whether the goals and purposes of the Plan are being achieved, to ensure that new information is regularly considered and incorporated, and to update the total quantity of water expected to be generated by implementation of the Plan, including the quantity generated for the natural system and the quantity generated for use in the human environment. In support of the SPCU, RECOVER conducted a systematic comparison and evaluation of hydrologic parameters across specified Indicator Regions and transects for a set of baselines and alternatives. The baselines examined include the pre-CERP baseline (2000), a snapshot of the system in 2023, and several alternatives to include the future with and without CERP, including alternatives with projected sea level change. RECOVER used a suite of ecological and hydrologic performance measures and ecological planning tools to evaluate performance on regional and system-wide scales. The RECOVER Scientific and Technical Evaluation will be used by the CERP Implementing Agencies to help inform decisions regarding whether a change in course is needed (i.e., adaptive management) to achieve CERP goals and purposes. This presentation will focus on RECOVER's preliminary findings and recommendations and address whether CERP Goal 1, Enhance Ecological Values, is met.

Multi-Benefit Solutions: Crafting an Integrated Plan for the Chehalis Basin

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Washington's Chehalis Basin Strategy is an innovative, basin-wide approach that unites Tribal Nations, local communities, and state partners in a framework to reduce flood risk, recover salmonid habitat, and improve climate resilience. This presentation will highlight how continuous collaboration and system-scale analysis are producing measurable ecological and social returns on investment—helping guide state investments for decades to come.

Located between Seattle and Portland, the Chehalis Basin is the second-largest watershed in Washington and supports critical habitat for salmon, steelhead, native fish, and Washington's greatest diversity of amphibians, including the federally endangered Oregon spotted frog. Both the Quinault Indian Nation and the Confederated Tribes of the Chehalis Reservation have stewarded these waters for millennia, and today their leadership is central to recovery efforts.

After the 2007 flood caused nearly $1 billion in damages, a dual-purpose initiative was launched: reduce flood risks while restoring aquatic ecosystems. From this, the Aquatic Species Restoration Program (ASRP) was formed—a science-driven, adaptive program designed to restore habitat while supporting resilient communities and economies.

Since 2015, the State of Washington has invested more than $72 million in ASRP projects. Outcomes to date include:

- 285 acres of aquatic habitat restored
- 295 acres protected
- 111 river miles reopened to fish passage
- 17 river miles restored

By combining rigorous science, innovative engineering, and deep collaboration with Tribal and local partners, the Chehalis Basin Strategy is showing how integrated investments deliver ecological, cultural, and economic value. This session will share lessons learned and explore how these approaches can inform large-scale restoration and climate adaptation efforts nationwide.

Monitoring and Predicting Biodiversity Conservation Benefits of Levee Setbacks

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Levee setbacks are quickly becoming a flagship nature-based solution (NbS) to managing flood risk due to their multiple co-benefits beyond flood management, including nutrient reduction, and groundwater infiltration, and space for recreation. From an ecological perspective, these levee realignments, undertaken by infrastructure agencies like the U.S. Army Corps of Engineers (USACE), are large-scale, high-budget floodplain restorations. Given the high importance of floodplain ecosystems for supporting biodiversity and their large extent of historic loss, levee setbacks may have critical biodiversity conservation benefits. However, these benefits have not been comprehensively assessed. Here, we describe an ongoing, NASA-funded effort leveraging remote sensing, hydrological modeling, artificial intelligence, automated recording units, and field biology to quantify and predict the conservation benefits of levee setback projects along the Lower Missouri River. Through both in-person surveys and automated recording units, we have monitored the diversity of plant, anuran (frog and toad), bat, and bird species in levee setbacks along the Lower Missouri River while generating a high-thematic-resolution habitat classifier using remote sensing and over one thousand ground-truthed habitat points. By quantifying habitat cover and the species composition in existing floodplains and setbacks, we are training linked ecological models to predict habitat creation and species conservation benefits from planned and future levee setbacks. This collaborative work will allow USACE and other organizations to account for biodiversity in large-scale water management infrastructure decisions.

Using NOFOs as an Instrument to Improve Performance of Decision Support Models

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This presentation explores the strategic use of a Notice of Funding Opportunity (NOFO) as a tool to enhance data-driven decision-making within the Central Valley Project Improvement Act (CVPIA) Structured Decision-Making (SDM) framework. The CVPIA's Science Integration Team (SIT) manages decision support models (DSMs) that evaluate restoration actions aimed at recovering key fish species, including Chinook salmon, steelhead, and Green and White sturgeon. These models rely on empirical fish data, making their reliability highly dependent on the quality of input data. Through sensitivity analyses, the SIT identified and prioritized critical fish information needed to reduce uncertainty and improve model performance. To address these data gaps, the U.S. Bureau of Reclamation's Bay-Delta Office, working in collaboration with the U.S. Fish & Wildlife Service's Pacific Southwest Regional Office, developed a NOFO to solicit proposals for projects that would collect this targeted fish information. This presentation provides an overview of the SIT's decision support models, details the NOFO development, application, review, and award processes, and concludes with a summary of outcomes and next steps.

Sustainable Rivers Program E-Flow and E-Pool Efforts on the Kansas and Osage River Basins

Margaret Pemberton *and Marvin Boyer*

U.S. Army Corps of Engineers, Northwestern Division, Kansas City District

The Nature Conservancy (TNC) and U.S. Army Corps of Engineers (USACE) have partnered to form the Sustainable Rivers Program (SRP) to examine opportunities to optimize reservoir releases and river flows to benefit river ecology while maintaining the federal mandates of the reservoir systems within the United States. The mission of the SRP is to improve the health and life of rivers by changing water infrastructure operations to restore and protect ecosystems, while maintaining or enhancing other project benefits. SRP offers a high return on investment by aligning ecological restoration with existing water management infrastructure.

The USACE Kansas City District (KCD) and TNC Kansas and Missouri added the Kansas River and the Osage River to the SRP. Workshops were held with regional biology and hydrology experts to help guide the process of identifying environmental flow (e-flow) and environmental pool (e-pool) management measures. Literature reviews and data mining exercises were undertaken for the Kansas and Osage River systems to identify flow-dependent fish, mussels, and other species and their habitats, examine changes in these species over time, and propose the likely causes of these changes. This information was used to better understand reservoir operation impacts and examine opportunities for reservoir management modifications within the range of authorized reservoir releases that would create flows beneficial to the ecosystems of the Kansas and Osage Rivers.

SRP expanded from traditional e-flows work and began funding projects that target managing pool levels at USACE reservoirs, raising and lowering the water surface elevation of wetlands, lakes, or river pools for the purpose of stimulating aquatic seed germination, improving aquatic plant and animal diversity, consolidating wetland soils, and other ecological and environmental effects. The Kansas River SRP Environmental Pool Management (EPM) objectives are to maximize ecological function within six USACE KCD reservoirs and their outlet rivers.

Collaboration among universities and partnering agencies is critical for the SRP process, particularly in monitoring and adaptive management for fish, mussels, and habitat creation. The USACE KCD SRP team is currently implementing and monitoring test flows at multiple District Lakes, with the support of partners who collect and analyze monitoring data. Together, we look for ways to accomplish overlapping goals and by utilizing shared resources, expertise, and data to advance both ecological restoration and agency mission needs. Currently, the USACE KCD SRP team is incorporating Kansas and Osage Rivers e-flow and e-pool information into ongoing reservoir water control manual updates. This aligns with the final phase of the SRP environmental flows process, “incorporation,” which involves embedding environmental flow strategies in reservoir operations policy, such as water control manuals. This ensures that ecological considerations are not just experimental but formally integrated into long-term water management decisions.

Don’t Mind the Crowd: Smooth Cordgrass Density Did Not Hinder Seed Germination, but Limited Seedling Survival and Growth

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Salt marshes dominated by smooth cordgrass (Spartina) are essential coastal ecosystems distributed in the temperate and subtropical portions of the northern hemisphere that provide a wide range of ecosystem services that benefit both human and natural communities. They sequester and store carbon, buffer shorelines from erosion and storm surge, improve water quality by filtering nutrients and sediments, and provide nursery habitat for commercially and recreationally important fish and shellfish species. These systems and these plants because of their functions are often used in restorations and ecosystem engineering projects like living shorelines; however, key aspects of its biology remain poorly understood especially at the southernmost edge of the species range. Our goal was to better understand limits to successful sexual reproduction in northern Florida, near the Southern geographical limit of this plant. We investigated seed and vegetation density influence on germination, seedling survival, and early performance in a greenhouse common garden experiment where density treatments included six variations of seed density (0,3,6) and adult stem density (3,8) combinations. Seed germination was high regardless of treatment, but survival, seedling size, and vegetive reproduction were higher when adult stem density was reduced. These findings indicate that existing vegetation structure can strongly mediate recruitment success, with direct implications for seeding strategies in restoration and ecosystem engineering design.

By further investigating the role and extent that existing vegetation has on Spartina seed biology in a controlled environment, our work provides actionable guidance for future researchers, practitioners and policymakers designing and implementing cost-effective engineering or restoration interventions. Seed-based approaches offer scalability, genetic diversity benefits, and reduced labor costs compared to planting adult culms; however, their success hinges on our understanding of foundational seed biology. Moreover, these findings are transferable across systems and regions where seed-based restoration of foundation species is considered. Integrating this science into decision-making frameworks can improve project efficiency, enhance ecosystem service delivery, and maximize the return on investment for coastal protection and habitat restoration. Our study therefore not only advances ecological understanding of intraspecific interactions in Spartina but also contributes to the science–practice interface critical for resilient, economically efficient, and sustainable restoration outcomes.

Nebraska's Watershed-Based Approach for Water Quality and Quantity Management

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Nebraska uses a unique system for managing its most important natural resource – water. The backbone of this system is rooted in a watershed-based approach through the establishment of Natural Resources Districts. This system of locally driven decision-making and integration with Nebraska's state agencies provides the framework for state water planning. Our panel participants represent the entities actively involved in state-wide water resource planning. This panel will showcase how Nebraska's multi-disciplined planning efforts are integrated to meet agricultural, environmental, and human needs. The panel discussion will include an overview of the history of water management in Nebraska, moderator guided discussion, and open questions for our panelists.

Developing Realistic Science-Based Performance Standards for Coral Mitigation/Restoration Projects

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NOAA-NMFS is considering a performance standard requirement of "no net tissue loss" over two years for corals following coral outplanting and relocation efforts on mitigation projects in Florida. This is not an attainable target for most branching species, especially the ESA-Listed corals *Acropora palmata* and *A. cervicornis*. For instance, a brief compilation of monitoring data assessing the efficacy (survivorship) of *A. cervicornis* outplants show dismal results. These data include outplanting (translocation) of nursery reared corals as well as the relocation of wild colonies. Thus, the results compiled to-date are contrary to the standard proposed by NMFS. In fact, no *A. cervicornis* projects in Florida have come close to a no-net loss standard over two years. Most transplants of wild corals and nursery outplants have had poor survival rates, often >50%, during the first two years following relocation with mortality increasing through time.

To date, there are no published records of long-term, successful nursery outplant projects, or transplanting of *Acropora* spp. into natural reef habitats, or successful *Acropora*-based reef restoration programs to offset (mitigate) anthropogenic impacts in Florida. While there has been exceptional success in growing and propagating *Acropora* in both land-based and in-water nurseries, and initial transplantation or relocation efforts have been successful, the long-term monitoring of outplanted colonies have shown poor results.

For instance, analysis of early CRF outplants in the FKNMS noted there is high initial survivability of *Acropora* outplants from nursery grown corals (generally the first 12 months), however, fewer than 20% of these corals have lived longer than about four years and those that survived also have exceedingly high levels of tissue loss and partial mortality. Interestingly, fate tracking of wild colonies throughout Florida shows an almost identical pattern of establishment, growth, brief expansion, and then colony collapse. Observed causes of mortality include disease, bleaching, storm fragmentation resulting in sediment burial, and predation. If local coral populations are unable to attain the "no net tissue loss" standard, why should there be an expectation for coral outplants to perform better that their native counterparts? These results have now been further exacerbated by the catastrophic levels of (generally >95%) mortality of both nursery corals and outplants associated with the summer 2023 marine heatwave. Subsequent to this event, both species of *Acropora* are now considered functionally extinct (extirpated) throughout south Florida.

It is hoped that understanding the cause of potential outplanting bottlenecks in coral mitigation and restoration projects can be unraveled through hypothesis-driven adaptive monitoring and experimental programs. Unfortunately, requiring a strict performance standard as proposed will dissuade many of these projects from being pursued, ultimately hindering the progress of restoration science. Until many of these questions are answered, and climate resistant genotypes are successfully identified, restoration and mitigation using *Acropora* species in Florida will be at best a Sisyphean task.

Modeling the Return to a Living River: Groundwater–Surface Water Dynamics in the Kissimmee Basin, Florida

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The Kissimmee River Restoration Project, which forms the headwaters of the Florida Everglades, was authorized by Congress in 1992 to restore natural hydrologic patterns and ecological function in South Florida. Channelization of the river in the 1960s significantly changed surface water flow, surface water–groundwater interactions, overland flow, reduced floodplain inundation, and affected aquatic habitats. An integrated groundwater–surface water modeling framework has been utilized for years to evaluate hydrologic effects of restoration measures such as channel backfilling, flow restoration, and floodplain reconnection, structure operations and assess success of restoration and progress towards the restoration goals.

The model setup included detailed topography, soil and aquifer characteristics, land use, historical hydrometeorological data and other datasets. Calibration and validation were completed using measured streamflow, river stage, groundwater levels, and climate records over multiple years, and for storm events.

Simulations indicate that restoration efforts have increased hydraulic connectivity between the river channel and the surficial aquifer, resulting in greater groundwater recharge and ongoing floodplain inundation during wet periods. These modifications contribute to longer wetland hydroperiods, changed habitat conditions, and reduced peak flow events. Sensitivity and scenario analyses highlight that structure operations, hydraulic conductivity, riverbed leakage rates, and floodplain roughness are key factors controlling how water moves between the river and groundwater system. Additionally, it indicated the sensitivity of the model results to computation parameters, particularly in the overland computation. Uncertainty in these parameters will be considered during alternatives simulations and predictions.

Model results also provide insights into the potential impacts of climate variability and water management operations on restoration outcomes. The model has also been applied to simulate storm events and evaluate the flood protection provided by the primary conveyance system.

The integrated modeling framework not only analyzes hydrologic and ecological changes under various management scenarios but also directly supports informed decision-making for the Kissimmee River and the broader Everglades ecosystem. By quantifying the outcomes of restoration actions, the model enables managers to evaluate the effectiveness and efficiency of different strategies. This evidence-based approach ensures that investments in restoration yield measurable ecological benefits and improved water management outcomes. Ultimately, the ability to link scientific insights with policy and operational decisions using the model development and application, maximizes the return on investment by guiding adaptive management, reducing uncertainty, and ensuring that resources are allocated to actions that deliver tangible improvements to ecosystem health and resilience.

Managing Evolving Priorities: System-Scale Adaptive Management on the Upper Mississippi River

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The Navigation and Ecosystem Sustainability Program (NESP) is a dual-purpose authority to improve navigation and ecosystem sustainability concurrently on the Upper Mississippi River. The NESP authority spans five states (Minnesota, Wisconsin, Iowa, Illinois and Missouri) and includes just under 1,200 miles of the Upper Mississippi and Illinois Rivers. Under NESP, the U.S. Army Corps of Engineers (Corps) is authorized to construct over 200 ecosystem restoration projects across a variety of aquatic and floodplain habitat types. In order to manage restoration on such a large scale, Congress authorized the ecosystem restoration element of NESP to develop and implement a system-scale adaptive management framework.

Over the past two years, the Corps, in collaboration with federal, state, and non-governmental partners, has worked to establish and refine an explicit hierarchy for managing ecosystem restoration activities at three distinct spatial scales: system, reach and project. Adaptive management activities at each scale are managed through spatially linked organizational structures and processes, with the goal of ensuring that site-specific actions achieve both the intended local benefits while also contributing to the achievement of overarching reach and system objectives. Planning processes at the system and reach scale are iterative, allowing for the continuous integration of new scientific data and engineering advancements. Iterative planning processes at higher spatial scales allow the adjustment of future decisions based on the outcomes of completed projects, providing the opportunity to adjust the identification and sequencing of future projects to leverage learning opportunities and address key uncertainties.

This presentation will offer an overview of the NESP authority, with a focus on the program's systemic adaptive management framework. We will examine the organizational structures and processes across spatial scales, discuss key challenges and lessons learned from preliminary implementation efforts, and summarize future steps to refine processes and improve restoration outcomes.

Ecosystem Restoration Planning for the Atchafalaya River System: Models and Metrics to Assess Project Performance

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The Atchafalaya River System (ARS) is the largest distributary of the Mississippi River, and its interdistributary basin comprises the largest river swamp in the United States. The ARS boasts a large diversity of habitats ranging from bottomland hardwoods to backswamps and river delta ecosystems. In addition to a diversity of plants, the ARS provides habitat to over 300 wildlife species and over 100 fish and shellfish species. The ARS changed dramatically after the Great Flood of 1927 when the ARS became a floodway system to manage potential flooding of the Mississippi River. Since the construction of the Old River Control Structure in 1963, the Atchafalaya River annually receives 30 percent of the combined flows of the Mississippi and Red Rivers. Flood control measures and the increased flow into the Atchafalaya River have resulted in excess sedimentation of approximately 2.5 billion m^3 since 1932 within the floodway. This has filled in lakes, reduced habitat, and led to the replacement of cypress swamps with bottomland hardwood forest. The hydrologic modification of the ARS has interrupted the natural north-south flow of water. Lack of proper drainage has led to standing water and the development of hypoxic conditions in some areas. Logging and land clearing for agriculture and flood control projects has fragmented the forests and reduced the habitat and biodiversity of the ARS, threatening the endemic species.

The Louisiana Coastal Protection and Restoration Authority is developing a new Atchafalaya Master Plan that uses hydrodynamic and habitat analyses to assess various restoration projects and evaluate them in relation to planning targets, quantified using a variety of metrics. The four plan objectives (natural processes, habitats, cultural resources, and working river) will be addressed in different ways across the basin based on the character of 11 Watershed Planning Units (WPUs).

Metrics have been identified to reflect how projects change the system in relation to the objectives, relative to a Without Project condition. These include habitat suitability for a variety of important species (e.g., crawfish, bald eagle, the extent of vegetative communities such as swamp forest) and maintaining aspects of the ARS that support a working river system (e.g., navigational channels, access to areas important for commercial harvest).

As each of the objectives, and thus the metrics, reflect different aspects of the ARS, they cannot be readily combined to provide an overall assessment of how well a project meets the plan's objectives. To address this, quantifiable targets have been identified for each WPU for each metric. Projects are then evaluated in terms of how the projects change outcomes with respect to achieving the WPU target for that metric (e.g., increase in habitat units for bald eagles). Progress toward the target then becomes commensurate across the metrics and objectives enabling an overall assessment of a project's 'value'.

Analytical Capabilities of the Soil Analysis Service Center Supporting Environmental Research

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The Soil Analysis Service Center (SASC) at the University of Kansas provides analytical support for soil and environmental research by offering quantitative measurements of key elemental and nutrient parameters. The facility specializes in the analysis of carbon, hydrogen, nitrogen, and sulfur (CHNS) in solid samples using a Thermo FlashSmart elemental analyzer, which employs high-temperature combustion (>1000 °C) followed by gas chromatographic detection of combustion gases. This method enables the accurate determination of percent carbon and percent nitrogen in soils and other solid materials. Additional measurements include total organic carbon (TOC), inorganic carbon (TIC), and carbonate content expressed as $CaCO_3$ equivalent.

For liquid samples, a Shimadzu Total Organic Carbon (TOC-L) analyzer coupled with a Total Nitrogen (TNM-L) module allows precise quantification of dissolved total organic carbon (TOC) and total nitrogen (TN) in aqueous samples. The center also has the capacity to analyze soil extracts and environmental samples for automated determination of nitrate-N, nitrite-N, ammonium-N, and Phosphate-P using a Flow Solution continuous-flow analyzer.

Collectively, these analytical services support research and monitoring efforts in soil biogeochemistry, nutrient cycling, ecosystem ecology, environmental assessment, and agricultural systems. The Soil Analysis Service Center provides reliable measurements and technical expertise to academic researchers and industry partners, supporting data-driven decision-making in environmental monitoring, restoration assessment, and project evaluation. This poster highlights the facility’s capabilities and its role in supporting cost-effective environmental monitoring and restoration efforts.

Restoring Fluvial Stability and Mitigating Flood Hazards in the Upper Amite River Through Ecosystem Restoration of Sand & Gravel Mines

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The Upper Amite River Flood Risk Reduction and Restoration Project targets severe geomorphic instability and flood vulnerability within the Upper Amite River in southeastern Louisiana, USA. Historic channel widening exceeding 100%, reduced sinuosity, and elevated velocities driven by excess sand availability near mining operations have increased erosion, downstream sediment delivery, and floodplain disconnection. Major storm events over the last 50 years, including the flood of 2016, have further accelerated channel bank instability.

A plan is being developed to restore an array of interconnected sand and gravel mines adjacent to the Amite River to maximize ecosystem services and flood risk reduction. Restoration of sand pits will provide floodplain connectivity and off-channel floodwater storage during larger storm events. Channel and bank stabilization, as well as stabilization of excess sediment in and around sand mines, will serve to decrease excess sediment loading downstream and promote natural river morphology. Preliminary estimates show an average reduction of approximately 10,200 tons/year of sediment transported downstream between 2025 and 2050.

Flood hazard mitigation benefits include reduced flood elevations at key downstream locations during 10-year and 100-year storm events, removal of 670–1,500 structures from the 10% and 1% annual chance floodplains, and avoidance of $19.8M–$33.1M in annual economic losses.

Environmental benefits include restored habitat, improved vegetation communities, enhanced surface water–groundwater interaction, increased resiliency against increases in flow, and reduced sediment delivery to downstream reaches and Lake Maurepas. It is envisioned that multiple sand and gravel mines throughout the upper basin will be acquired and restored, creating a system of restored sites that provide stacked environmental, flood risk reduction, and recreational benefits. These sites will be interconnected by waterways of the Amite River system, as well as trails and parks, to create enhanced recreational and social benefits for the region. The project is currently in the planning phase, with an estimated cost of $500M and partial funding through State Capital Outlay. Site acquisition is underway and supplemental restoration assistance will be provided by the USDA-NRCS.

The Future of Florida Bay: Modeling and Managing Flow for Healthy Bay

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Florida Bay, a vital estuary at the southern tip of the Everglades, is at a critical juncture. Its ecological health is intrinsically linked to the quantity, timing, and distribution of freshwater inflow from the upstream ecosystem. Decades of water management have altered this natural flow, leading to hyper salinity, seagrass die-offs, and algal blooms that threaten the delicate balance of this iconic ecosystem and the regional economy it supports. The Florda Bay Plan uses structures to transport water into the ENP marshes and Taylor Slough. However, a major concern with hydrologic configurations is that these waters may or may not reach Taylor's Slough. Thus, this research quantifies additional flows reaching Florida Bay through implementation of the Florida Bay Plan using high-resolution models. The tasks involve determining whether the Florida Bay Plan was able to deliver freshwater to Florida Bay when needed using an existing M3ENP (Mike+/MikeSHE) high-resolution model. We will discuss how these models simulate the complex interactions between freshwater delivery and key ecological indicators. By translating complex scientific data into actionable performance measures and targets, this modeling work provides a critical foundation for adaptive management, helping to navigate the challenges of climate change and steer policy decisions toward securing a resilient and healthy future for Florida Bay.

Refining the Trinity River Restoration Program to Improve Collaboration and Outcomes

Chadwin Smith

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Since 2000, the Trinity River Restoration Program (TRRP) in northern California has implemented a Department of Interior (DOI) Record of Decision (ROD) with the purpose of mitigating the impacts of the Trinity River Diversion (TRD) of the Central Valley Project on anadromous fish populations in the Trinty River. Through two Phases of implementation, the TRRP focused on a set of management actions comprised of annual flow releases from Lewiston Dam, a set of channel rehabilitation projects, and sediment management. The TRRP is governed by the Trinity Management Council (TMC) comprised of member and partner federal, state, local, and Tribal entities; the Hoopa Valley Tribe and the Yurok Tribe provide a deep Tribal foundation for the TRRP both in decision-making and in implementation. Stakeholders within the Trinity River basin beyond the TMC entities have been engaged directly and indirectly in the process of implementing the TRRP and evaluating its success.

Starting in 2017, the TRRP undertook a process to consider refinements in program structure and function to more clearly articulate the goals of the TRRP, implement adaptive management as called for in the ROD, and foster a more collaborative approach to decision-making. The results of that refinements effort led to a process from 2020-2023 to develop a TRRP Program Document (including clear and agreed-upon goals) and a TRRP Science Plan to help the program move forward into Phase 3 of implementation. This presentation will focus on the results of the Program Document and Science Plan development effort and what has happened thus far within the TRRP as it attempts to put these efforts into motion.

Early Detection and Rapid Response - Determining the Formula for a Successful Eradication

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It is widely recognized in the field of invasive species management that Early Detection and Rapid Response (EDRR) is the most cost-effective strategy to control these problematic species and limit their impacts. There are many factors to take into consideration when deciding whether or not to initiate an EDRR to a new invasive species population. Verification of the species ID, determination of the extent of the population, identification of possible sources of the introduction and performing a risk assessment are some of the preliminary steps needed to determine whether an EDRR strategy is appropriate. This poster will highlight several EDRR examples and explain the factors that led to success and those that led to failure.

Scaling Up Swamp Reforestation: Annual Plantings of Native Trees in the Maurepas Wetlands

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Many swamps of coastal Louisiana were extensively logged from the late 1800s to the mid-1900s and have been slow to recover due to persistent inundation, saltwater intrusion, nutrient limitations and lack of freshwater input. The Maurepas Swamps, located in the upper Pontchartrain Basin in southeast Louisiana, represent one of the most heavily impacted areas, having lost much of their canopy-forming bald cypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*). With the added pressures of relative sea-level rise and increasingly intense storms, restoring these coastal forested wetlands is both urgent and challenging.

In 2025, Southeastern Louisiana University initiated a long-term swamp reforestation program designed to scale up planting efforts across the Maurepas Wetlands while integrating monitoring and adaptive management. Across this region, previous reforestation efforts have produced mixed results. This program grows native tree saplings from locally collected seed in university greenhouses, with a goal of planting 2,000 two-year-old trees annually in collaboration with student and community volunteer groups. Current species include bald cypress, water tupelo, and swamp red maple (*Acer rubrum var. drummondii*), with future expansions planned for swamp black gum (*Nyssa biflora*), sugarberry (*Celtis laevigata*), and green ash (*Fraxinus pennsylvanica*).

To assess performance, a statistically significant subset of individuals planted were and will be tagged and monitored for survival and growth after planting across multiple years. These data will be coupled with findings from a concurrent basin-wide natural swamp monitoring program and ongoing graduate studies to identify the environmental conditions most conducive to reforestation success. By combining large-scale planting with research-driven adaptive management, this program seeks to expand the spatial extent of coastal freshwater swamps in the Pontchartrain Basin and provide guidance for future restoration initiatives across coastal Louisiana.

Identifying Local Area Inundation Expectancy, Drainage Capacity, and Geomorphology Conditions to Correlate Suitable Forest Community Type to Manage

Brian Stoff

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Disturbance in floodplain ecosystems is driven by inundation regimes, which influence habitat types across the Upper Mississippi River system. The natural hydrology of this system is uniquely impacted by impoundment as well as regional fluctuations in inundation regimes. Forest communities that are most common in this ecosystem include Silver Maple, Maple/Ash/Elm/Boxelder, Cottonwood/Sycamore, Oak/Hickory, Willow, Swamp Shrubland, and Mixed forest. Some of these communities are proliferating throughout the region, while other communities are declining and require hands-on management.

When implementing forest management within a large river floodplain, land managers consider many factors such as current forest conditions, inundation regimes, elevation variability, geomorphology (landform position and local area post-inundation drainage), and non-native invasive species. By utilizing inundation models, LiDAR data, historic habitat conditions, and current forest inventory, managers can make informed decisions to achieve habitat goals and objectives. Forest management goals typically include maximizing species composition, community distribution, and structural diversity. Implementing sound management promotes the potential for natural regeneration, improved forest health, and reducing non-native invasive species.

By understanding the relationship between specific forest community types and local environmental conditions, forest managers can make informed management decisions when seeking to restore and maintain resilient floodplain forest ecosystems. This presentation will explore how this knowledge can influence adaptive management to address the impacts of inundation, including increased frequency and intensity of flood events, on the long-term health, growth development, and forest diversity of Upper Mississippi River floodplain forests.

Predicting Upper Mississippi River Backwater Fish Community Attributes from Site- and Patch-Scale Characteristics to Inform Restoration Decision-Making

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Navigation control measures in large rivers often alter backwater habitats that are important for fish and other organisms. In the Upper Mississippi River, substantial restoration activities have been undertaken for decades to re-establish functional backwater ecosystems. A goal of many Upper Mississippi River backwater restoration projects is the creation of overwintering habitat for lentic fish like bluegill (*Lepomis macrochirus*). There is also substantial interest in understanding and predicting how restoration projects will affect the broader fish community, including species of conservation concern, but few analytical tools to generate such predictions. In this analysis, we use long-term monitoring data and machine learning algorithms to establish empirical relationships between environmental predictors and the presence of 42 fish species found in backwater habitats in three navigation pools of the Upper Mississippi River. We also compare the predictive capacity of models that use different environmental covariates, including site-scale predictors, larger-scale aquatic area characteristics, and habitat features commonly manipulated by restoration, thus enabling predictions both across Upper Mississippi River locations and at potential restoration sites. Single-species model outcomes are aggregated to generate predictions of community attributes such as species richness and diversity of different fish guilds. Utilizing these predictive models gives a comprehensive assessment of the relationship between backwater habitat characteristics and fish and provides decision makers with more holistic predictions of the outcomes of different restoration actions.

Developing a Near Real-Time Information Platform to Monitor and Assess Hydrological Performance of Conservation Lands

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Effective monitoring and assessment of wetland habitats are critical for conservation efforts but often demand significant time and resources. Current environmental monitoring relies on satellite imagery, aerial surveys, and fieldwork, with near real-time data from Sentinel-2 satellites playing an increasingly vital role due to high temporal resolutions. This study aims to develop a sustainable, cost-effective methodology for monitoring and evaluating surface water inundation conditions across conservation lands, while also mapping and analyzing hydrological changes using machine learning models within the Google Earth Engine (GEE) and other GIS tools. Additionally, it evaluates the effectiveness of various conservation practices implemented under different programs. Focusing on conserved lands in Nebraska, the research classifies surface water cover across multiple conservation program types and confirms strong hydrological performance in conserved wetland areas. Wildlife Management Areas (WMAs) had the highest mean inundation rate at 16.41%, indicating active surface water presence in core conservation zones. In comparison, Wetlands Reserve Program (WRP) and Waterfowl Production Areas (WPAs) sites showed average annual surface water coverage of 8.07% and 7.51%, respectively, reflecting occasional flooding or periodic inundation. These results demonstrate that conservation practices are functioning well where inundation rates are higher, although additional hydrological restoration at the watershed level could enhance outcomes across broader landscapes. The findings provide compelling evidence for integrating surface water inundation data into conservation assessments and support prioritizing frequently inundated sites for future wetland conservation initiatives, aligning with the long-term objectives of conservation easements.

Changing Hydrologic Conditions in the Collier Seminole State Park as a Result of the Picayune Strand Restoration Project: A Monitoring and Adaptive Management Case Study

Sarah Tevlin

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The Picayune Strand Restoration Project (PSRP), the first of the Comprehensive Everglades Restoration Program (CERP) to begin construction, is scheduled to reach completion in December 2025. This project, which involves plugging 48 miles of canals, removing 260 miles of roads from the abandoned Southern Golden Gate Estates development, and constructing three large pump stations, will restore more than 55,000 acres of wetland habitat, reduce over-drainage of wetlands in adjacent Fakahatchee Strand State Preserve, Florida Panther National Wildlife Refuge, and Collier Seminole State Park, and restore historic water flows to the Ten Thousand Islands National Wildlife Refuge. Because of the scale of geographic areas affected, as well as the presence of Outstanding Florida Waters (OFW) to the south of the project area in Collier-Seminole State Park, water quality and hydrologic monitoring are key components of the project. To help track changes to these components and guide the project towards its restoration objectives, the PSRP Monitoring and Assessment Group (MAG) was established. This interagency team of scientists, engineers, and technical experts has served as one of the primary guiding bodies for adaptive management recommendations through nearly two decades of project construction. Now, with project completion immanent, the role of the MAG is expected to evolve into assessing operations and project-driven changes to the environment and providing recommendations to the PDT when challenges arise. Using monitoring within the adjacent Collier Seminole State Park (CSSP) as a case study, this poster will examine the role of the MAG in PSRP as the completed project enters its operations, the status of project-driven hydrologic changes in CSSP, and possible future opportunities and challenges for adaptive management and the MAG to overcome.

Implementing Lake Okeechobee Recovery Operations: A Chance to Improve Ecology in the Heart of the Everglades

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Lake Okeechobee is a large freshwater lake located at the center of the south Florida ecosystem, an internationally recognized and valued aquatic ecosystem which stretches from the Kissimmee River through the Everglades and finally into Florida Bay. The lake provides important habitat for fish and wildlife species, is an essential water supply for local communities and agriculture, and among other uses, serves as a significant recreational area, in part due to its high-quality largemouth bass and black crappie fisheries. In recent years, the health of the lake has declined due to storm events and higher than desired lake stages. This has led to degraded ecological conditions within the lake such as decimation of submerged aquatic vegetation (SAV), high turbidity and nutrient concentrations, and adverse changes in emergent vegetation. The loss of SAV is particularly concerning due to its critical role in the overall health of the lake, where it provides fish spawning habitat and extracts nutrients from the water. The Lake Okeechobee System Operating Manual (LOSOM), the regulation schedule and water control plan for Lake Okeechobee, includes a Recovery Operations (RO) tool that can be employed to reduce the adverse ecological effects of prolonged high lake stages. RO consist of a lake drawdown to benefit lake ecology, while minimizing effects to other resources. In late 2024 at the start of the south Florida dry season, the U.S. Army Corps of Engineers (USACE), Jacksonville District conducted RO to lower lake levels and maintain stages within a defined “ecological recovery envelope” for a minimum period of 60-90 days to allow for recovery of SAV. Maintaining coordination, communication, and transparency with partner agencies and other relevant parties throughout implementation of the RO was key in successfully meeting the desired targets. Preliminary monitoring data shows an increase in SAV coverage in Lake Okeechobee. The USACE will continue to assess effects of the RO to determine the effectiveness of the operation, means to improve for future needs and whether there were any unanticipated effects to resources within Lake Okeechobee and the south Florida ecosystem.

Increasing Accessibility and Utilization of Remote Sensing Tools for the Lower Colorado River Multi-Species Conservation Program

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The Lower Colorado River Multi Species Conservation Program (LCR MSCP) represents a major federal investment in combined federal and non-federal resources designed to mitigate impacts from hydropower generation and water management operations while ensuring regulatory compliance for a 50-year Habitat Conservation Plan. To maximize return on investment and support evidence-based decision-making across 7,500+ acres of created habitat, the program has developed an innovative remote sensing framework that provides unbiased tools for both tracking regulatory compliance and adaptive management.

Our pilot implementation at Palo Verde Ecological Reserve demonstrates how remote sensing technology can transform operational efficiencies. The framework integrates LiDAR-derived canopy height models and multispectral analysis using both high-resolution (0.5m) LiDAR and orthoimagery products and open-source (Landsat, 30m) imagery to derive quantitative vegetation metrics—canopy height, canopy closure, and Enhanced Vegetation Index (EVI2). These objective performance indicators enable program managers to track restoration success, identify emerging challenges requiring intervention, and adapt management strategies based on long-term trend analysis and early detection of rapid environmental changes.

The approach delivers significant operational advantages over traditional ground-based monitoring: comprehensive spatial coverage, temporal consistency for regulatory reporting, minimal field costs, and rapid assessment capabilities that support timely adaptive responses. Data visualization tools—including summary charts, static images, and dynamic GIFs—effectively communicate complex remote sensing results to diverse stakeholders, from project managers and engineers to regulatory agencies, facilitating informed decision-making across administrative levels.

Our in-house Vegetation Monitoring Experience (VME) data platform puts actionable information directly into the hands of MSCP project managers, biologists, and engineers, enabling real-time data exploration and analysis. This accessible monitoring data supports both site-scale management decisions and program-wide strategic planning, ensuring efficient allocation of resources while maintaining regulatory compliance.

Future developments will focus on incorporating enhanced canopy structure metrics, integrating wildlife survey data, and establishing management trigger thresholds for automated early warning workflows. This presentation will demonstrate how strategic implementation of remote sensing technology can improve program efficiency, optimize return on investment, and support adaptive management in large-scale environmental programs operating under regulatory constraints.

Leveraging Big Data and Expert Knowledge to Develop a Forest Classification System for Improved Stewardship of Mississippi and Illinois River Floodplain Ecosystems

Molly Van Appledorn[1], *Aiman Raza*[1], *Nathan De Jager*[1], *Lyle Guyon*[2], *Andrew Meier*[3], *Benjamin Vandermyde*[4], *Brian Stoff*[5], *Ryan Swearingin*[5], *Tate Sattler*[4], *Shelby Weiss*[2], *Matthew Trumper*[1]

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Floodplain forest communities of the Upper Mississippi and Illinois Rivers are a restoration priority for state and federal natural resource managers because of the many ecological, economic, and societal benefits they provide. Forest management and restoration activities have largely been guided by relatively coarse land cover datasets and qualitative assessments that leave fundamental questions about the character, amount, and distribution of key forest types unanswered. Here, we discuss how scientists and managers co-produced a floodplain forest classification that leveraged a detailed systemic forest inventory dataset, machine learning tools, and expert knowledge. The classification used species composition and structural attributes from 18,967 plots to identify 17 unique forest types found across the Upper Mississippi and Illinois Rivers. The forests likely represent different developmental stages, 7 of which were heavily dominated by silver maple. Snags were an important component of many forest types, and there was evidence of recent increases in the prevalence of snag-dominated forest types across the landscape. We conclude by discussing how the results will be used to set overall restoration targets and desired conditions, guide prioritization of work among sites, and inform management actions.

Landform Alteration to Enable Natural Function of Ridge and Swale Geomorphology to Establish Suitable Conditions for Forest Community Types

Benjamin Vandermyde

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Floodplain forest community types in the Upper Mississippi River (UMR) system establish naturally with direct correlation to seasonal disturbance events. A common disturbance event, inundation, is typically characterized by depth and duration alone, however, additional factors contribute to the impact of growth response. Variability in timing and frequency of inundation events during each growing season may be beneficial or hinder tree establishment or growth. Additionally, those impacts will vary for different species across cohorts and landform position on the UMR. Survivorship and/or productive growth of young saplings is limited and influenced by a multitude of temporally factors that will vary by season and landform position. Natural variability needed to overcome these complicated factors where there is wide array of forest community types are found most readily in landforms that have diverse micro topographical changes in elevation. An understanding of how natural function capabilities vary across a mosaic of geomorphologic types is necessary to illuminate the most diverse and productive growing conditions required to support healthy and diverse forest community types.

This presentation will explore the concept of engineering with nature to build landforms that are, by natural function, the best solution to improve growing conditions for a spectrum of forest community types. Key talking points discussed previously during this session should be considered as foundational background to explain the importance of altering the landform in specific locations of the UMR. The locations identified to reshaping the landform consist of areas flattened or perched by a century of sedimentation, as a result from the construction of navigation structures. Locations that are void of micro topographical changes in elevation or prevent adequate surface water drainage are prone to be chronically wet post inundation events. Establishing ridge and swale landform dynamics improves the growing conditions for native vegetation and reduces negative impacts of non-native species encroachment to the UMR system will be discussed.

The primary goal of this presentation is to convey the benefits of understanding individual tree species physiology and their relationship within the local system ecology in making management decisions. As land managers, applying what is known and understanding the limitations of what is unknown will improve our ability to focus more on natural process requirements instead of focusing solely on an individual species need. Instead of planning for continual operations and maintenance over time to establish desired habitat conditions, incorporate as much natural process as possible to reduce the need for traditional means to achieve the same result. For the UMR, reshaping the landform without bringing in additional material into area that has lost the mosaic of micro topographical variability is a new approach. This method attempts to address and restore the missing natural function that would have otherwise been in place to promote diverse UMR forest community types.

Assumptions for a Projected CERP in the Second Periodic CERP Update

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The Everglades ecosystem is a diverse south Florida landscape with unique hydrologic and ecological characteristics, making this region in south Florida one of the most valuable ecosystems in the world. For this reason, in 2000, the U.S. Congress authorized the U.S. Army Corp of Engineers and the South Florida Water Management District to pursue the protection and restoration of the Everglades ecosystem through the Comprehensive Everglades Restoration Plan (CERP). CERP focuses on the restoration of the quantity, quality, timing, and distribution of water flow critical to re-establish and conserve the historic ecosystem functionality of the Everglades while integrating the evolving water-related needs in the region. This restoration is projected to be accomplished by constructing, implementing, and operating a series of components in the landscape to promote hydrologic connectivity, resulting in a healthy wetland landscape. Since 2000, the concept of those components has evolved as portions are constructed, and new science, technology, and data are gathered. All this new information is periodically translated into assumptions aiming to simulate the projected implementation of CERP through computer modeling. This periodic CERP Update is not a reformulation or a modification of the authorized CERP, but an effort to evaluate that the goals and purposes of the authorized CERP are being achieved, to ensure new information is regularly incorporated, and to update the quantity of water expected to be generated through CERP implementation for the natural systems and the human environment. The most recent version of this effort will be the Second Periodic CERP Update (SPCU), a robust technical evaluation of the Plan performance at the projected implementation of CERP. This presentation provides a synopsis of the assumptions included in the SPCU using the information available today to evaluate the CERP performance towards achieving its restoration goals.

Vision in Fruition: Envisioning and Evaluating the Future with CERP

Eva Velez

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To ensure that the goals and purposes of the Comprehensive Everglades Restoration Plan (CERP) are achieved, CERP programmatic regulations direct the South Florida Water Management District and the U.S. Army Corps of Engineers to conduct an evaluation of CERP using new or updated modeling that includes the latest scientific, technical, and planning information. It is not a reformulation or a modification of the authorized CERP. These periodic evaluations are intended to provide information to determine if the goals and purposes of CERP are being achieved, to ensure new information is regularly incorporated, and to update the quantity of water expected to be generated through CERP implementation for the natural systems and the human environment. The initial phase of the second periodic CERP update (SPCU) was a substantial endeavor that included application of the latest model and extended period of record, updating performance measures, and determining how full CERP implementation would be represented. While it may sound straight forward, given the components were conceptualized in 2000, the large spatial scale, broad temporal span of project implementation, and changes to the landscape over the last 25 years add as complexity in how to envision the future with CERP scenario at a current snapshot in time. The second phase of the SPCU includes modeling the future with and future with CERP, including sea level change, and the technical evaluation comparing the scenarios, which is conducted in coordination with subject matter experts from the multi-agency Restoration Coordination and Verification (RECOVER) team. This presentation provides an overview of the periodic CERP update objectives, the approach to envision full CERP implementation for the SPCU, and the challenges navigated through the process.

Building Ecological Tools to Aid in Determining Everglades Restoration Success

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Large-scale ecosystem restoration requires long-term investment of knowledge, resources, and patience. Within the long-term outlook, incremental steps are taken along the way to establish appropriate goals, identify methods for determining progress and status of the system, and build teams of experts. REstoration, COordination, VERification (RECOVER) is an interdisciplinary collaboration of agencies, tribes, and institutions that conducts scientific and technical evaluations and assessments to improve the ability of the Comprehensive Everglades Restoration Plan (CERP) to restore, preserve, and protect the south Florida ecosystem while providing flood protection and water supply. RECOVER supports CERP goals and objectives by maintaining a system-wide and integrative perspective through modeling (evaluations), monitoring (assessments) and synthesis of ecological and hydrological indicators to inform managers, decision-makers, and the public of current conditions and future expectations. As part of this effort, RECOVER scientists identify a diverse set of ecological indicators and desired restoration conditions for each indicator that will support a healthy and sustainable South Florida ecosystem. Successfully restoring Everglades ecological processes and reaching restoration success necessitates continual review and refinement of these indicators and their desired restoration conditions.

RECOVER identified submerged aquatic vegetation as an essential ecological indicator for tracking restoration success because it is representative of key coastal Everglades processes and influenced by changes in timing, quality, quantity, and distribution of freshwater. Tool development for submerged aquatic vegetation first occurred in 2004 and primarily focused on assessing conditions in Florida Bay where responses to CERP implementation were anticipated to occur first. In 2025, RECOVER initiated updates to the existing framework of ecological tools to integrate new science, ecosystem knowledge, and expand spatial extent to incorporate Florida Bay, Biscayne Bay, southwest coast, and the freshwater to marine transition zone. The tool update improves RECOVER's capabilities to model and monitor submerged aquatic vegetation in sub-regions with differing hydrologic conditions and ecological influences, which, in turn, informs identification of desired restoration condition, targets, and meaningful ecological thresholds for each sub-region.

Combining Qualitative and Quantitative Data to Measure the Unrecorded Costs of Invasive Species Management in the U.S. Army Corps of Engineers, Mobile District

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The U.S. Army Corps of Engineers (USACE) is tasked with managing projects across approximately 12 million acres of public lands and waters across the United States. Invasive species pose significant challenges to USACE land management efforts, including degraded ecological processes, reduced habitat availability, reduced quality of recreational experiences, reduced capacity and effectiveness of hydropower and flood risk reduction structures, and disrupted navigation operations. These impacts are a direct threat to USACE programmatic aims, which include aquatic ecosystem restoration, environmental stewardship, flood damage reduction for coastal and riverine systems, hydropower, coastal and inland navigation, recreation, and water supply provisioning.

The National Invasive Species Council (NISC) is a consortium of land management-based federal agencies focused on providing high-level vision and leadership to sustain and expand federal efforts to prevent, eradicate, and control invasive species. As a participating agency, USACE is tasked with reporting costs associated with invasive species on a yearly basis. However, estimates of invasive species costs across the USACE enterprise are difficult to accurately quantify. Challenges include invasive species costs recorded as part of regular operation and maintenance, continued introduction of new species, and irregular funding. As a result, yearly reporting to NISC is based on estimated proportional invasive species costs to total budgets using best available knowledge.

This pilot study conducted in one USACE district attempted to improve and refine NISC cost reporting estimate methodology using a combination of qualitative interview data with on-site land managers and quantitative data collected from budget analysts. The USACE Mobile District in the southeastern USA was chosen as the study area due to its eleven civil works projects with a variety of programmatic aims, ecoregions, and invasive species proliferation levels. The research team, comprised of USACE economists and invasive species experts, traveled to all civil works projects in the Mobile District and interviewed project managers, park rangers, hydroelectric dam operators, and navigation structure operators. Interviews explored employee labor hours spent on invasive species problems, equipment and supplies purchased, and invasive species encountered at project sites. Interview data was then translated to estimates of invasive species costs and compared to known budget data provided by Mobile District budget analysts.

Interviews with land managers revealed previously unrecorded invasive species costs across all Mobile District business lines. Environmental stewardship managers revealed labor hours discussing invasive species with the public, regular operations partially driven by invasive flora management, and labor hours approving invasive species treatment permits. Recreation managers discussed the impacts of feral hogs and fire ants in campgrounds. Hydroelectric dam and navigation structure operators raised concerns about clogged pipes and risks to operations. Interviews also revealed common management themes including lack of information on new treatment strategies, labor capacity concerns, public input and interaction, and shifting project management priorities. Future studies should target additional USACE districts, paving the way for accurate NISC invasive species cost reporting.

RECOVER's Scientific and Technical Evaluation of the Second Periodic CERP Update (CERP Goal 2: Enhance Economic Values and Social Wellbeing)

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The Everglades ecosystem, including Lake Okeechobee, encompasses a system of diverse wetland landscapes that are hydrologically and ecologically connected across more than 200 miles from north to south and across 18,000 square miles of southern Florida. In 2000, the U.S. Congress authorized the Federal government, in partnership with the State of Florida, to embark upon a multi-decade, multi-billion-dollar Comprehensive Everglades Restoration Plan (CERP) to further protect and restore the remaining Everglades ecosystem while providing for other water-related needs of the region. Through construction and operation of 68 interdependent components, CERP aims to restore natural hydrology through removal of more than 240 miles of internal levees and canals, improving the health of over 2.4 million acres by allowing water to flow nearly unobstructed throughout the south Florida ecosystem. CERP focuses on quantity, quality, timing, and distribution of water flow, given modern constraints, to recover critical ecological functions that characterized the historical Everglades and other portions of the south Florida landscape. Since 2000, much progress has been made, including record construction of CERP projects, collection of new data and science through REstoration, COordination, VErification's (RECOVER) Applied Science Strategy, along with new modeling and tool development. The Second Periodic CERP Update (SPCU) is an opportunity to reevaluate whether the goals and purposes of the Plan are being achieved, to ensure that new information is regularly considered and incorporated, and to update the total quantity of water expected to be generated by implementation of the Plan, including the quantity generated for the natural system and the quantity generated for use in the human environment. A periodic CERP Update is not a reformulation or a modification of the authorized CERP. In support of the SPCU, RECOVER conducted a systematic comparison and evaluation of hydrologic parameters across specified Indicator Regions and transects for a set of baselines and alternatives. The baselines examined include the pre-CERP baseline (2000), a snapshot of the system in 2023, and several alternatives to include the future with and without CERP, including alternatives with projected sea level change. RECOVER used a suite of ecological and hydrologic performance measures, ecological planning tools, water supply, flood control, recreation and cultural/archaeological performance metrics to evaluate performance on regional and system-wide scales. The RECOVER Scientific and Technical Evaluation will be used by the CERP Implementing Agencies to help inform decisions regarding whether a change in course is needed (i.e., adaptive management) to achieve CERP goals and purposes. This presentation will focus on RECOVER's preliminary findings and recommendations and address whether CERP Goal 2, Enhance Economic Values and Social Wellbeing, is met.

Continuous Improvement in Our Understanding of Future Restoration Performance

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The Comprehensive Everglades Restoration Plan (CERP) was approved by the U.S. Congress in 2000 to restore, preserve, and protect the existing Florida Everglades while providing for other economic and cultural water-related needs of the region. This multi-decade plan includes construction and operation of 68 components focused on improving the quantity, quality, timing, and distribution of water throughout the system to recover critical ecological functions that characterized the historical Everglades and other portions of the south Florida landscape. Periodic CERP updates are required by the programmatic regulations for CERP, as part of the adaptive management process, to ensure that new information is regularly considered and incorporated into Plan implementation. Periodic CERP updates evaluate restoration progress using updated model simulations of the Everglades system's hydrological responses to CERP, and performance measures and targets, which represent continued research and improved understanding of species and ecosystem requirements. Since the Initial CERP Update (ICU) was prepared in 2005, significant progress has been made on many CERP components. The Second Periodic CERP Update (SPCU) will be supported by REstoration, COordination, and VERification (RECOVER), an interdisciplinary collaboration of agencies, tribes, and institutions that conducts scientific and technical evaluations and assessments to improve the CERP. The SPCU RECOVER Scientific and Technical Evaluation is a comparison of future with and without CERP scenarios as simulated in regional hydrologic models. This evaluation is an opportunity to assess whether the goals and purposes of CERP have been achieved and update the total quantity of water expected to be generated by CERP, including the quantity generated for the natural system and the quantity generated for use in the human environment. The SPCU resulted in a report that included revised projections used for adaptive management and refinement of CERP implementation. The SPCU Report, including revised projections used for adaptive management and refinement of CERP implementation, is offered to decision-makers within the U.S. Army Corps of Engineers and South Florida Water Management District for their consideration in determining the future courses of action taken to improve CERP performance.

Leveraging Advanced Remote Sensing and Machine Learning Data to Inform Ecological Restoration, Design, and Monitoring

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Ecological Restoration requires a firm understanding of the complex existing baseline conditions of the study area as well as reference sites. The need for recent and accurate high-resolution natural resource surveys is critical for site evaluations. Remote sensing and machine learning is an important tool in understanding baseline conditions. Advanced remote sensing technologies, using drones, aircraft, and satellites with various high resolution multispectral sensors and LiDAR, paired with machine learning and automation, are transforming environmental data collection and analysis.

These technologies offer several advantages over traditional field investigation methods: comprehensive, high-resolution datasets are developed that cover the entire project study area, high-quality digital records are created that can be reused throughout the project's lifecycle, and enhanced data accuracy and consistency is independent of field staff experience and seasonal variations.

This innovative solution addresses the limitations of traditional methods by providing efficient and comprehensive mapping of wetlands and streams, high-resolution data for threatened and endangered species habitat assessments, ecosystem health evaluations, resilience monitoring, and invasive species detection, and improved data quality and consistency, facilitating the development of robust and resilient solutions for natural resources management.

CDM Smith continues to develop and refine remote sensing and machine learning technologies for use in a variety of site assessment, restoration, and monitoring efforts. For example, at an ash disposal site in Florida, the technology was used to accurately determine tree species and monitor restoration success. High-resolution data was collected and analyzed, providing detailed insight into the health and diversity of the vegetation. Other case studies will be explored that include native and invasive plant species mapping, measuring cut and fill for wetland mitigation, erosion and biomass monitoring for ecological restoration, field planning and detailed data collection for an abandoned mine lands reclamation program, as well as ongoing wetland and stream mapping for various locations across the United States.

The integration of advanced remote sensing and machine learning technologies offers a promising solution to the challenges faced by various stakeholders in natural resource mapping, assessment, restoration and monitoring. Sky Wave® exemplifies the potential of these technologies to revolutionize environmental data collection, providing detailed high-quality, reusable digital records that enhance and inform ecological restoration planning, design, implementation, monitoring and adaptive management. These technologies help us better understand complex existing baseline conditions in new ways and with a more efficient timeline, to inform decision-making earlier on in the process to improve restoration outcomes and success.

Implementing On-the-Ground Salmon Habitat Projects Based on Priorities Derived from the CVPIA Structured Decision Making Process

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The primary product of Reclamation and the Service's Central Valley Project Salmonid Habitat Structured Decision Making process is the Near Term Restoration Strategy (NTRS). The NTRS is produced on a 5-year cycle. This year (2026) sees the beginning of the third cycle. The NTRS contains two sets of priorities – On-The-Ground (OTG) Habitat Restoration priorities and Information Needs priorities. This presentation describes the On-The-Ground priorities. Another presentation by Jenna Paul describes the Information Needs priorities.

The NTRS OTG priorities specify the location (watershed or mainstem reach) and type (spawning, perennial rearing, seasonally inundated rearing) of habitat restoration that most likely will result in the greatest increase in anadromous fish production.

Reclamation & the Service jointly issue and manage Notices of Funding Opportunity (NOFOs) aimed at accomplishing the OTG priorities using available funding under CVPIA (P.L. 102-575 Title 3406(b)) authorities. The OTG priorities published in the NTRS are listed in the NOFOs as the objectives of the NOFO. Evaluation criteria use the common medium of suitable salmonid habitat area created by the actions proposed by applicants to the NOFO.

Reclamation and the Service have used this science-based approach to competitively fund more than $190M in salmonid habitat restoration over the past 10 years.

The Role of Compensatory Mitigation in Ecosystem Restoration – A Candid Conversation Between Practitioners, Bankers, and Local and State Government

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The Sackett ruling reduced the extent of what is considered waters of the U.S. regulated under the Clean Water Act. Now many states are concerned about how to protect wetlands and streams moving forward, especially in the western U.S. where these important ecosystems are scarce and play a critical role in supporting communities through ecosystem benefits. In 2024, Colorado passed House Bill 24-1379, creating a State Dredge and Fill Program to regulate impacts to wetlands and open water no longer regulated under the Clean Water Act. The program also regulates impacts to isolated wetlands that have not been regulated under the Clean Water Act since 2001. There has been extensive stakeholder involvement in developing the Colorado program, particularly in how the compensatory mitigation program can both expand and improve on the federal program to create an approach that incentivizes restoration projects and streamlines permitting requirements for restoration projects. Through this dialogue, there have been discussions on the types of restoration that can occur (banking, in lieu fee, permittee responsible), and the pros and cons of each method. This session will include a diverse panel to discuss the role of compensatory mitigation in ecosystem restoration and how states, including Colorado, can encourage an array of mitigation methods to promote stream and wetland restoration at the watershed level. Panelists will include representatives from the conservation sector, mitigation banking sector, local governments, and practitioners. Questions would include "how can mitigation banks and in lieu fee programs incentivize ecosystem restoration and create science-backed restoration initiatives at the local level"? "How can permittee responsible mitigation by local watershed managers be encouraged to protect vital aquatic resources"? "What role should state governments play in incentivizing ecosystem restoration projects"?

Assessing the Impact of Delta Science Program Funded Research on Decision Making in the Sacramento-San Joaquin Delta

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The mission of the Delta Science Program (DSP) is to provide the best possible unbiased scientific information to inform water and environmental decision-making in the Sacramento-San Joaquin Delta (Delta). One avenue to achieve this mission is to fund research that aids in decision-making in the Delta. However, how DSP-funded science impacts decision making in the Delta is currently not well defined. Therefore, we are utilizing research impact assessment (RIA) framework to assess the impacts of the DSP-funded research, beginning with the 2019 Delta Research Awards and 2020 Delta Science Fellows, as it commonly takes up to nine years for management and policy impacts to arise from research. RIA is similar to assessing return on investment, but instead of assessing financial returns of funded research we instead focus on broader societal benefits of funded research. While there is no single process or checklist for evaluating research impact, one established method is to utilize a logic model to break down the impact process. To do this, we defined a logic model that outlines inputs, activities, outputs, outcomes, and impacts of DSP-funded research. For each step of the logic model, we identified key metrics that measure progress towards impact in the Delta. For example, for each project we tracked the money allocated, scientists funded, institutional affiliations, project topic, presentations, publications, reports, earned media, broader impacts, whether the funded research influenced Delta restoration projects, policy, or management, and more. Overall, we believe that the RIA framework allows the DSP to track the ultimate impacts of funded research and demonstrate the DSP's benefits to the Delta. Measuring the impact of DSP-funded research will not only document the benefits of funding research but will also help the DSP to adaptively manage funding solicitations to maximize impacts to the Delta in the future.

Integrating Geophysical and Remote Sensing Techniques to Model Peat Stability in the Everglades

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The objective of this project is to create targets across the freshwater to saltwater transition ecotones and coastal waters within Everglades National Park (ENP) that account for ongoing and future restoration implementation and changes due to sea level rise induced saltwater intrusion. Previous laboratory-based studies have shown the correspondence between increases in porosity and hydraulic conductivity in peat soils when salinity is increased, and its potential to compromise soil stability. Ground-based geophysical measurements of subsurface electrical conductivity (EC) are proposed as a proxy for peat stability in the coastal Everglades. Since application of such field approach is challenging at larger scales, we explored linking geophysical measurements with remote sensing observations to map and monitor peat stability in the Everglades and identify the most vulnerable zones at a larger scale. In this study, we integrated geophysical, remote sensing and modern Artificial Intelligence (AI) based techniques to estimate soil EC and evaluate the capacity of fine resolution airborne and spaceborne remote sensing products for mapping soil stability at experimental sites in the Everglades. Preliminary results are encouraging at one test site, with remote sensing observations able to explain over 70% variance of field measured EC.