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Valuing Ecosystem Services:
The U.S. Geological Survey Experience

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National Conference on Ecosystem Restoration

U.S. Department of the Interior
U.S. Geological Survey

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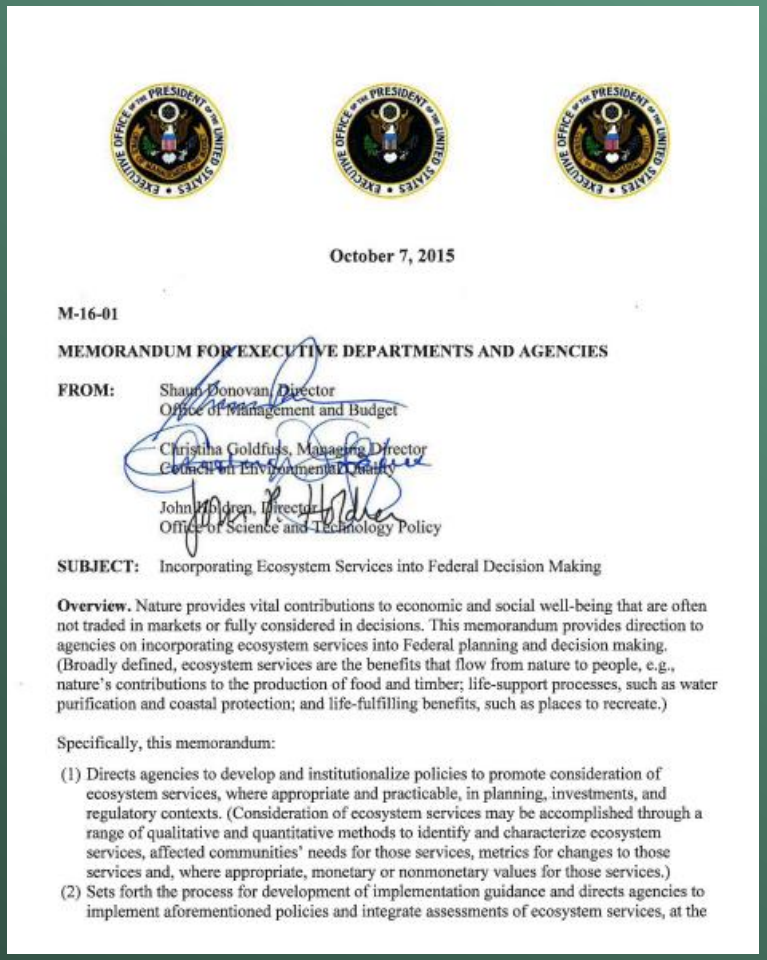
Incorporating Ecosystem Services (ES) in Decision-Making



October 7, 2015

M-16-01

MEMORANDUM FOR EXECUTIVE DEPARTMENTS AND AGENCIES

FROM: Shaun Donovan, Director
Office of Management and Budget

Christina Goldfuss, Managing Director
Council on Environmental Quality

John Holdren, Director
Office of Science and Technology Policy

SUBJECT: Incorporating Ecosystem Services into Federal Decision Making

Overview. Nature provides vital contributions to economic and social well-being that are often not traded in markets or fully considered in decisions. This memorandum provides direction to agencies on incorporating ecosystem services into Federal planning and decision making. (Broadly defined, ecosystem services are the benefits that flow from nature to people, e.g., nature's contributions to the production of food and timber; life-support processes, such as water purification and coastal protection; and life-fulfilling benefits, such as places to recreate.)

Specifically, this memorandum:

(1) Directs agencies to develop and institutionalize policies to promote consideration of ecosystem services, where appropriate and practicable, in planning, investments, and regulatory contexts. (Consideration of ecosystem services may be accomplished through a range of qualitative and quantitative methods to identify and characterize ecosystem services, affected communities' needs for those services, metrics for changes to those services and, where appropriate, monetary or nonmonetary values for those services.)
(2) Sets forth the process for development of implementation guidance and directs agencies to implement aforementioned policies and integrate assessments of ecosystem services, at the

- **October 2015 federal agencies directed to "…promote consideration of ecosystem services…in planning, investments, and regulatory contexts."**
- **Ecosystem restoration can benefit from an ecosystem services approach**

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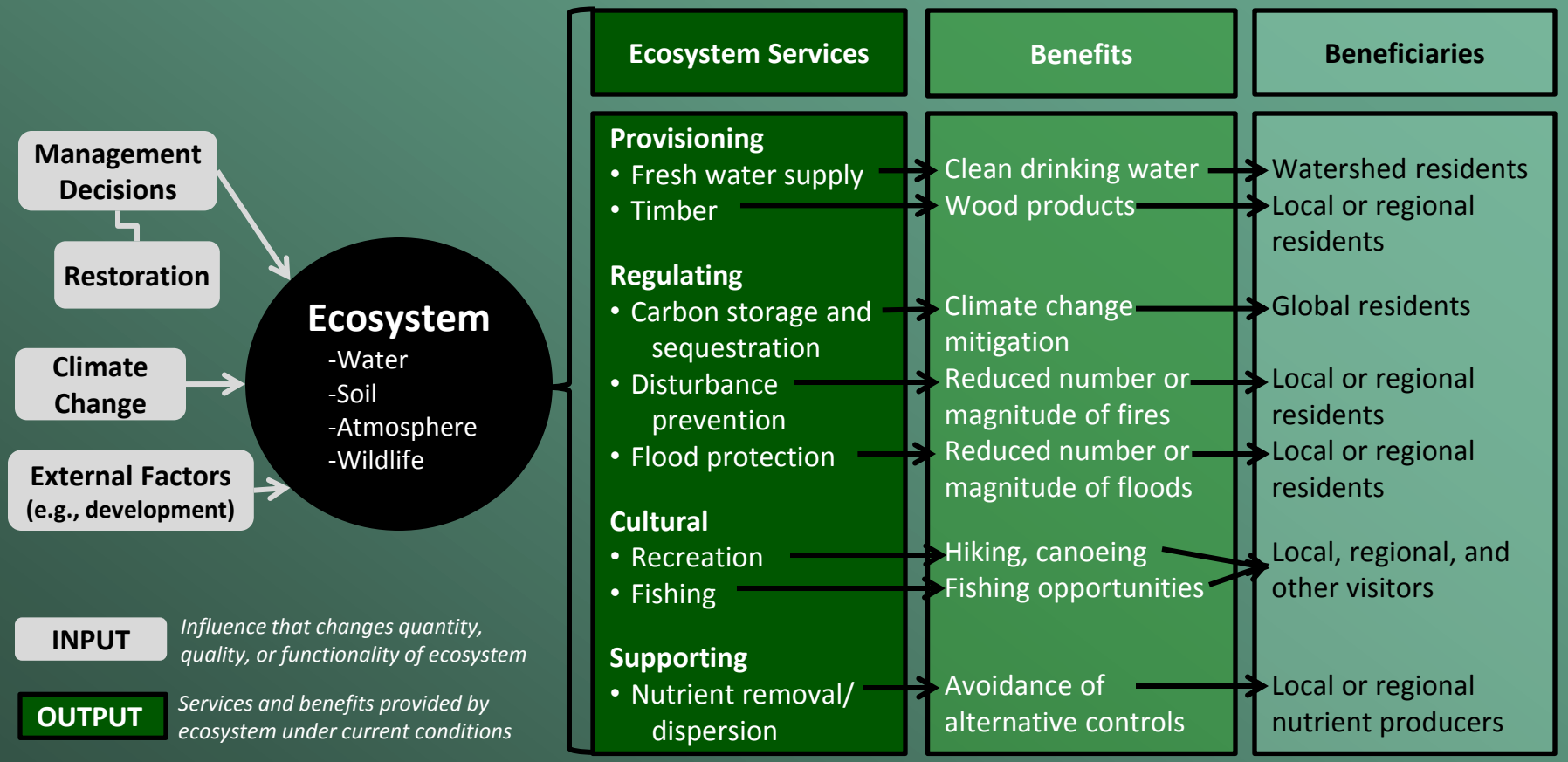
Ecosystem Services Conceptual Framework



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Natural Resources Conservation Service (NRCS) Sage-Grouse Initiative (SGI)

- Evaluation of impacts of juniper removal and prescribed grazing
- Ecosystem services:
  - Wildlife habitat
  - Forage
  - Soil quality
  - Water quantity and quality
  - Aesthetics
  - Recreation
  - Open-space
  - Cultural values

- Utilized State-and-Transition and Linear Programming Models
  - Juniper removal on forage production and rancher income (provisioning service quantification)
- Literature for all other services

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Example Rangeland ES and Values

- Forage (livestock harvests)
- Non-Forage ES: 37-68% of value of western rangelands (Rashford, 2012)
- Recreation
  - Hunting: rancher survey - elk, deer, turkey
  - Wildlife Viewing: Oregon: $450 million in annual spending
- Open space: Colorado (Routt County): $42 million/year
- Aesthetic Benefits: Colorado: $2.7 million/year
- Wildlife Passive Use Values: Bird species similar to sage grouse: $15-$58/household WTP for restoration

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Juniper Removal Ranch Model Results

- Treatment model (with SGI treatment to date) resulted in ~3% increase in available Animal Unit Months
- Representative ranch would make an additional ~$19,500 over 40 years in NPV terms (~$500 per year)
- Across study area, positive impacts on ranching operations valued at over $3.6 million over next 40 years

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Prescribed Grazing Impacts

- 2.1 million acres (mostly Montana)
- Based on a set of *principles*, not specific management practices
- Tremendous amount of ecological and management variability among ranches makes it difficult to value ES benefits over a large areas
- Impacts based on literature review and rancher interviews
- How do we scale up biophysical and monetary benefits of ranch-level practices to the program level?

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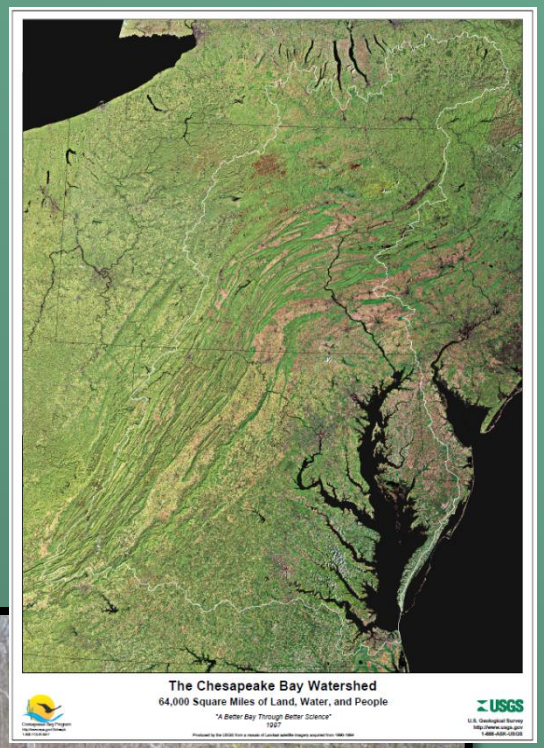
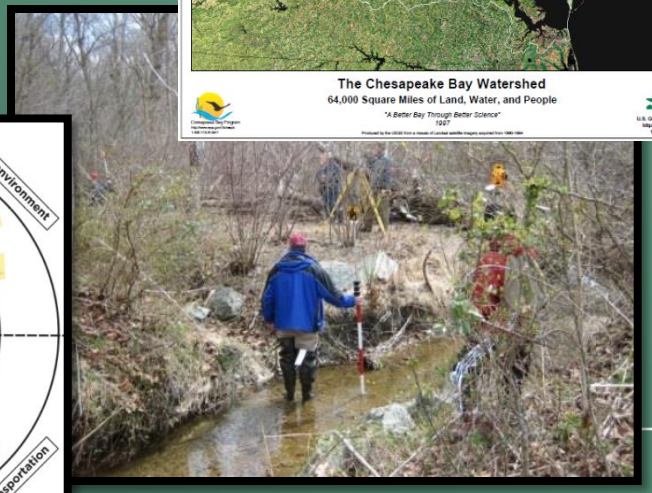
Chesapeake Bay (CB) Floodplain Project

- Sustaining Environmental Capital (SEC) case study
- Multi-partner, multi-disciplinary project
- Integrated field work, remote sensing, and ecosystem services assessment
- Initialized based on observations of local land use decisions; officials tried to use ES concepts (not explicitly):
  1. Ecologic
  2. Economic
  3. Social
  4. Traffic/transportation





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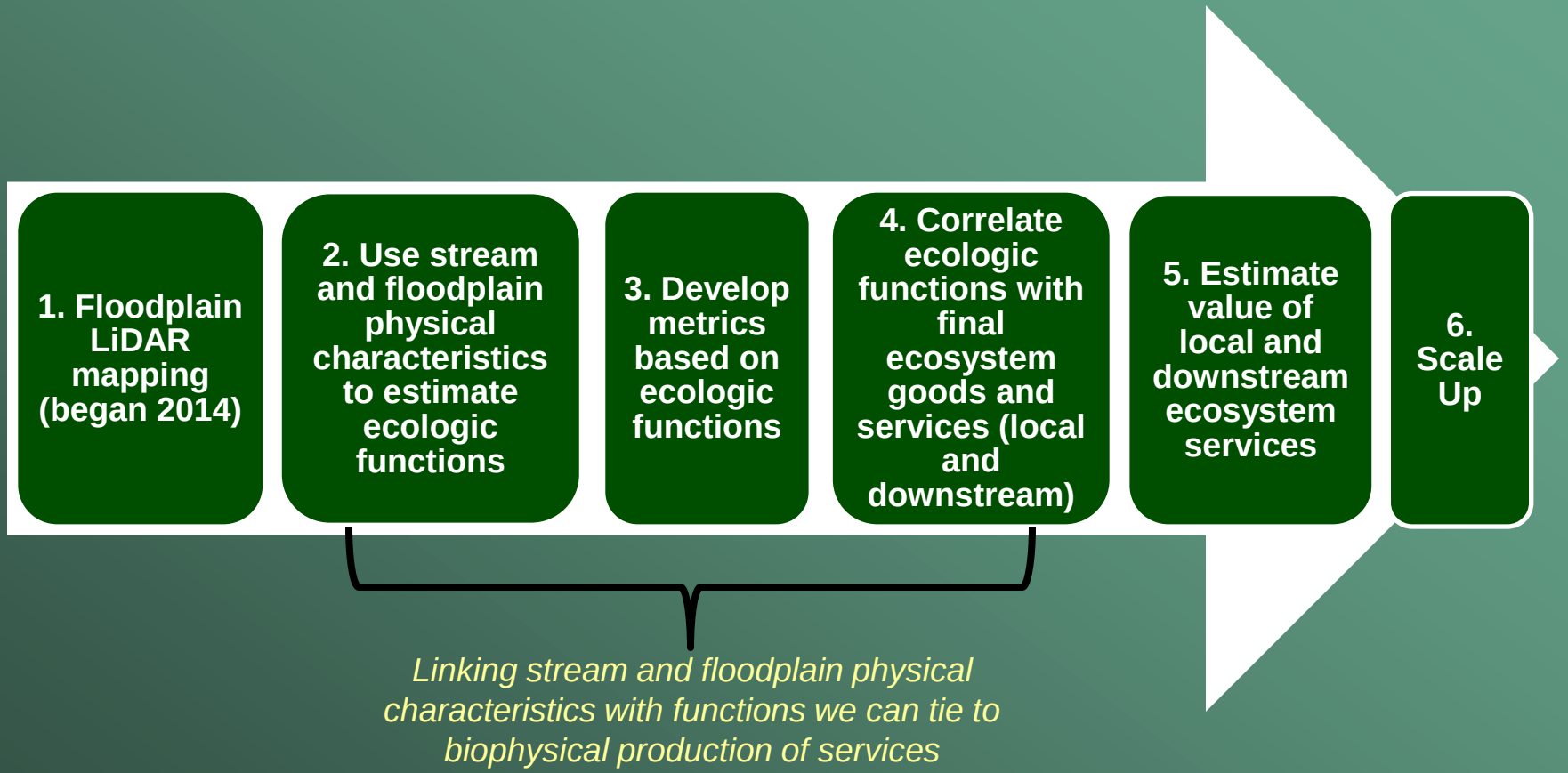
CB Integrated Approach



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CB Priority ES

Ecosystem Service	Ecological Function	Human Benefits
Nutrient/Sediment Retention	Nutrient/sediment retention	Water clarity, recreation, commercial fisheries
Flood Attenuation	Watershed surface flow regulation	Avoidance of safety and property damage
Wildlife Viewing	Provision of wildlife habitat	Recreation - wildlife viewing (local focus)
Carbon Sequestration	Carbon sequestration	Reduced climate change impacts to health, property, agricultural yield, etc.
Water Supply	Surface and groundwater storage	Water consumption (domestic, agriculture, industry, etc.)
Enhancement of Soil Fertility	Sediment and nutrient deposition	Improved soil quality, increased crop yield
Medicinal Resources	Provision of habitat for species with medicinal properties	Pharmaceuticals
Water Purification	Removal of toxic substances	Pollution control, detoxification

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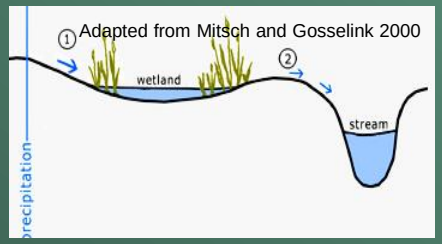
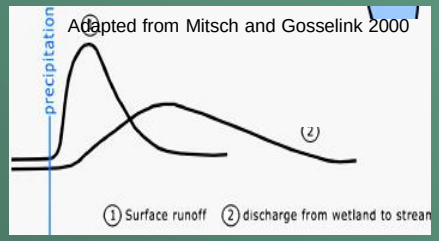
CB Floodplains and Flood Mitigation ES





Floodplains act as 'sink' during precipitation events

Reduces peak flow

Flood probability reduced:
- **Magnitude, and/or**
- **Frequency**

Flood damages reduced:
- **Property damage**
- **Safety implications**

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Valuing Flood Mitigation from CB Floodplains

- Ongoing evaluation, utilizes damages avoided technique in conjunction with an innovative hydrologic simulation exercise
  - Assess geospatial extent of flood damages using historical events
  - Simulate flood damages with and without floodplains
  - Assess monetary value of marginal damages avoided attributable to floodplain storage capacity

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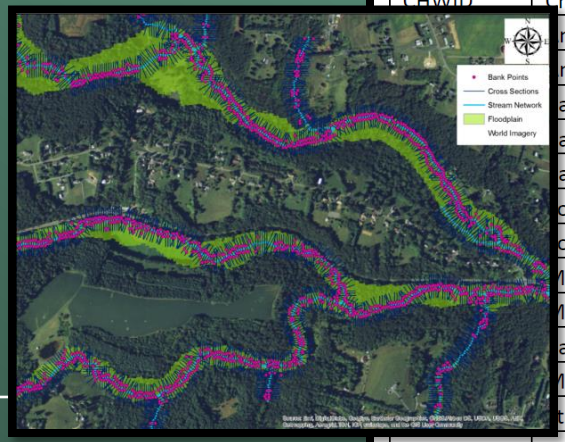
Extrapolation and Application of CB Approach

- Developing correlations between physical floodplain features and ecosystem services
  - Linking LiDAR imagery to physical characteristics and validating with field work
- Potential to apply this approach to other floodplains where LiDAR is available
- By assessing heterogeneity in floodplain function in an ES framework, supports identification of high value areas for preservation and restoration



Field Name	Description
LINKNO	Unique ID corresponding to TauDEM streams layer
LOCALID	Unique ID for each reach (1 = most upstream)
GLOBALID	Unique ID for shed
BNKHT	Bank height (m)
CHWID	Channel width (m)
	ngle from vertical of left bank (deg)
	ngle from vertical of right bank (deg)
	ankfull area (m^2)
	atio of bankfull width to width just over banks
	atio of total area under cross section to bankfull area
	otal floodplain width (m)
	otal floodplain width minus channel width (m)
	Minimum elevation along FP Xn (m)
	Max elevation along FP Xn (m)
	ange of elevation along FP Xn (m) (max minus min)
	Mean elevation along FP Xn (m)
	tandard deviation elevation along FP Xn (m)
FPSUM	Sum elevation along FP Xn (m)

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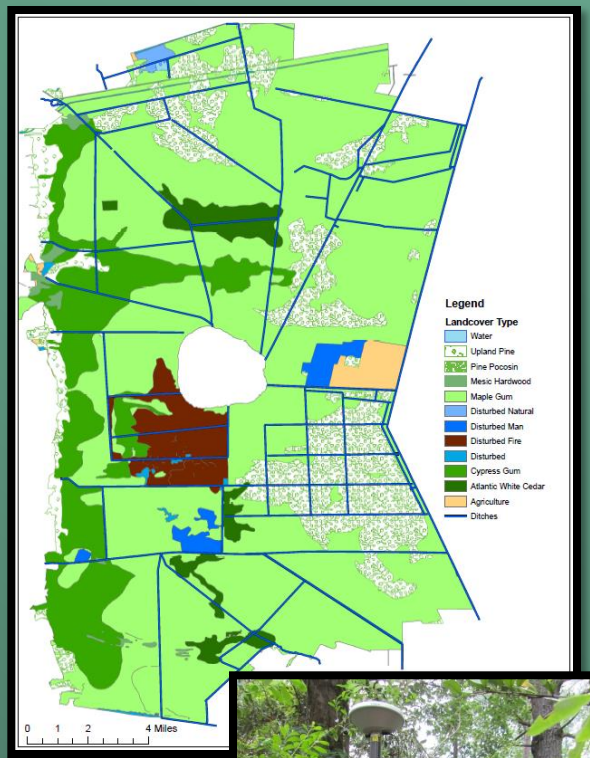
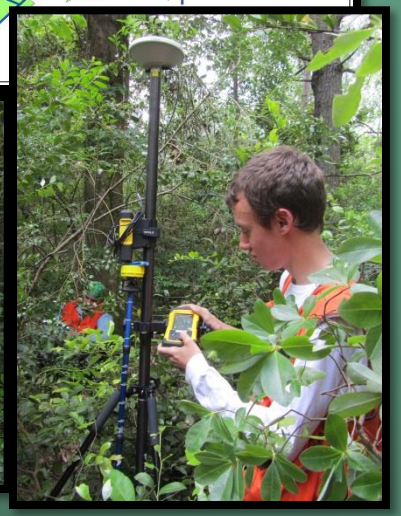
Great Dismal Swamp (GDS) Project

- Application of USGS LandCarbon
- Multi-partner, multi-disciplinary project
- Integrated field work, remote sensing, and ecosystem services assessment
- Research and analyses directly informing management decisions
- http://www.usgs.gov/climate_landuse/lcs/great_dismal_swamp/default.asp





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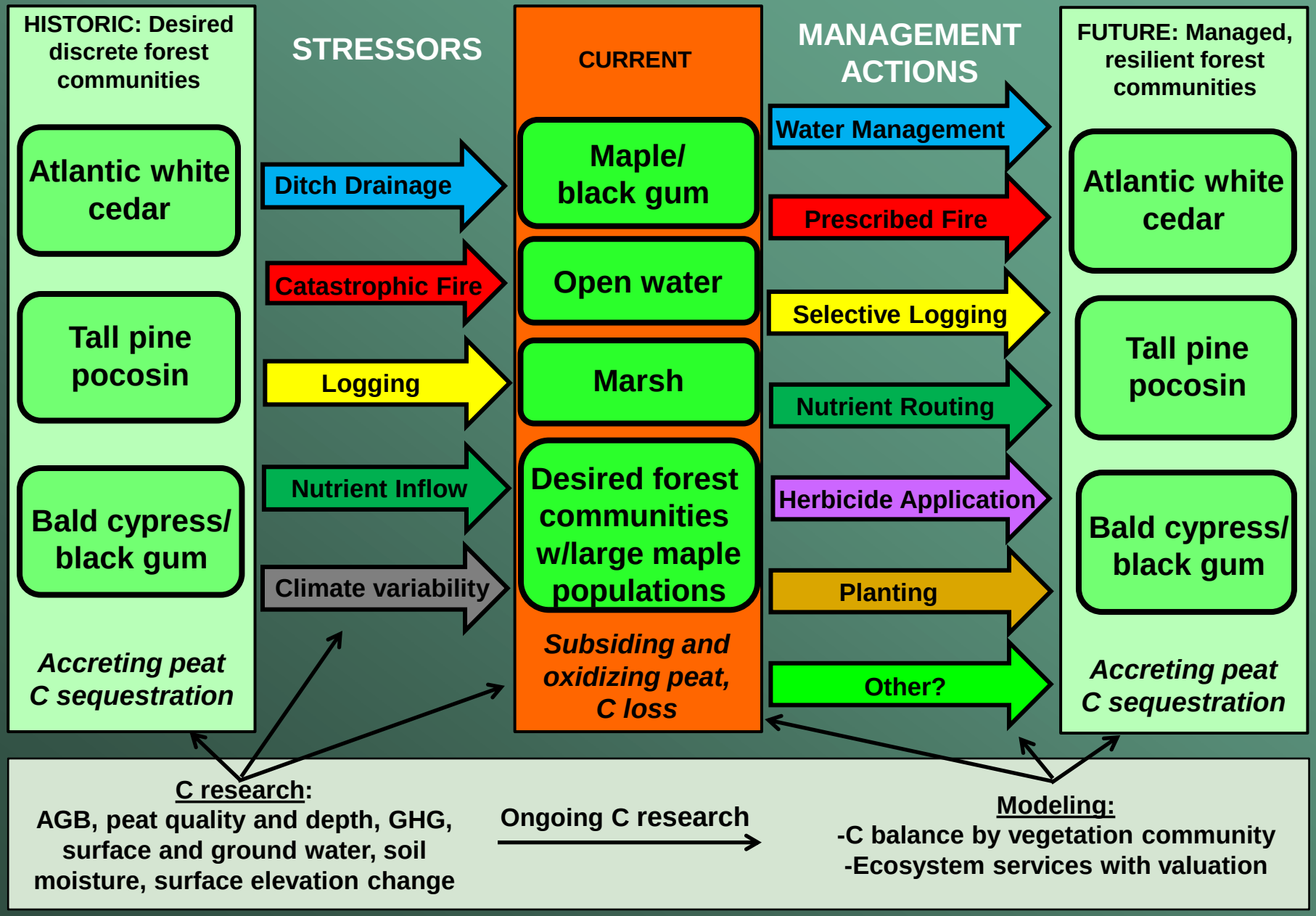
GDS Management and Research Conceptual Model



GDS Priority ES and Evaluation Methods

Ecosystem Service	Methodology	
	Biophysical	Economic
Carbon Sequestration	• Plot data on biomass scaled up to GDS NWR via ST-SIM • Converted to carbon biomass using literature values • Will be improved with carbon values from monitoring as available	• Interagency Working Group on Social Cost of Carbon (SCC) applied to INCREMENTAL CO_2 emissions (tons per year) • 2014 value is $42.55 (adjusted using BLS info)
Wildlife Viewing	• Using visitation rates provided by GDS NWR (2014) • Assuming all "non-consumptive" visitation	• Valuation based on consumer surplus or "willingness to pay" above actual costs incurred • Using FWS survey (2006) data
Fire Mitigation	• Only considers "catastrophic fire" • Determined by annual probability of fire and effects of catastrophic fire • Effects considered: air quality/human health impacts, carbon emissions, recreation lost, and tourism lost	• Human health impacts value based on Cost of Illness • Carbon emissions - SCC • Recreation lost due to full or partial closures during event • Tourism lost in communities considered qualitatively
Nutrient Cycling	• Methods under development	• Methods under development
Flood Protection	• Methods under development	• Methods under development

GDS Restoration and Fire Mitigation ES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Hydrologic balance:
- Reduces dry vegetation/ignition material
- Reduces infiltration of fire to deep peat
- Allows for prescribed burn

Fire probability reduced:
- Magnitude, and/or
- Frequency

Fire damages reduced:
- Air quality/human health impacts
- Carbon emissions
- Recreation lost
- Tourism lost

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Valuing Wildfire Mitigation ES in the GDS

- **Wildfire smoke exposure increases incidence of:**
  - Asthma
  - Chronic Obstructive Pulmonary Disease (COPD)
  - Pneumonia/acute bronchitis
  - Heart failure (CHF)
  - Cardiopulmonary symptoms

- **Valuation uses Cost of Illness (COI)**
  - Focuses on HIGHEST costs
  - Includes actual costs incurred (medical bills)
  - Includes opportunity cost (lost wages/value of time lost)

- **Other studies have indicated a willingness to pay to avoid health effects that is substantially higher than COI** (see Richardson et al. (2012) ***The Hidden Cost of Wildfires: Economic Valuation of Health Effects of Wildfire Smoke Exposure in Southern California***)

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Preliminary Results of Wildfire Mitigation ES

- Preliminary results suggest catastrophic wildfire has COI greater than $8 million (currently only direct costs)*
- Catastrophic wildfire has annual probability of 2% (2 events in 100-year period)
- Annual COI under current conditions $160,000*
- Does not include other costs of catastrophic wildfire:
  - Reduced tourism (nearby)
  - Reduced recreation (on refuge)
  - Carbon emissions
- Management (rewetting) can reduce the risk of catastrophic wildfire – by how much is still being assessed

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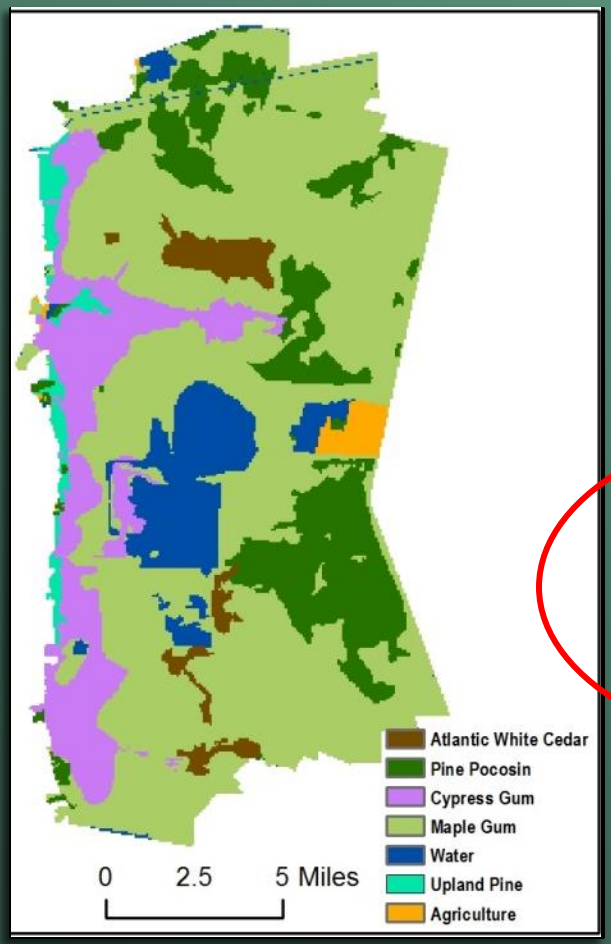
*These data are preliminary and are subject to revision. They are being provided to meet the need for timely 'best science' information. The assessment is provided on the condition that neither the U.S. Geological Survey nor the United States Government may be held liable for any damages resulting from the authorized or unauthorized use of the assessment.

Modeling Baseline and Future Conditions

2015 ← 50 YEARS → 2065



SCENARIO ASSUMPTIONS:

CURRENT VEGETATION AND CARBON BIOMASS

SOIL MOISTURE:

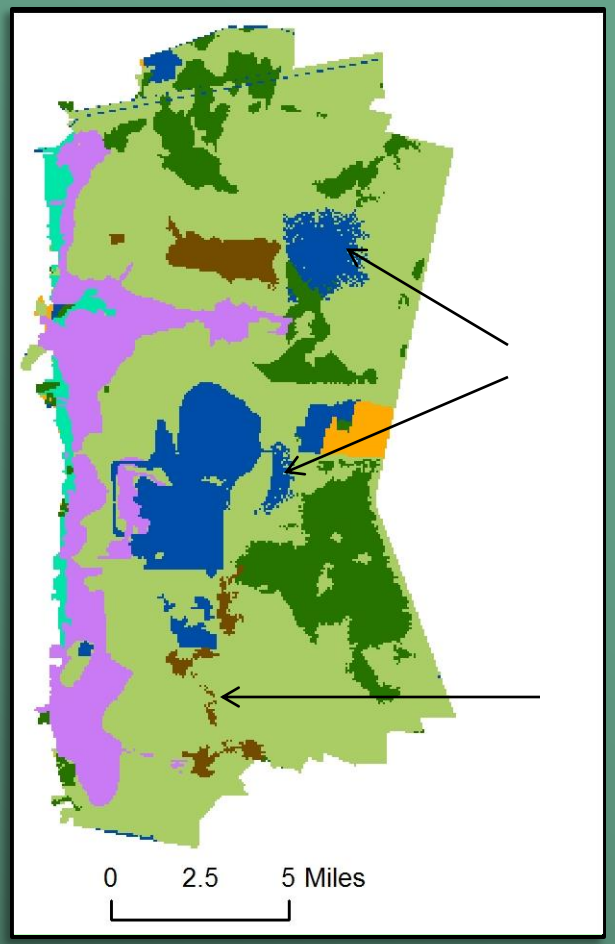
- ~ 65% DRIER; ~35% WETTER (RELATIVE)

NATURAL DISTURBANCE:

- WIND/STRESS
- **FIRE – 2 LARGE FIRES OCCUR ON SAME PATCH WITHIN 5 YRS**
- INVASION OF UNDESIRED SPECIES (MAPLE GUM)

NO MANAGEMENT

- **NO** FIRE SUPPRESSION (PRESCRIBED FIRES OR THINNING)
- **NO** REWETTING
- **NO** FOREST RESTORATION (THINNING, REPLANTING, HERBICIDE)



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Challenges and Outstanding Questions

Challenges

- Research, data, tools to associate marginal impacts of practices on various ES on specific locations over time is limited (geographic and time scales): But this costs a lot!!
- There is only so much that can be done with Benefit Transfer
- Lack of site-specific primary and secondary studies on impacts of practices

Outstanding Questions

- Is there a way to value conservation program benefits without having to value the marginal changes of specific practices?
- Can conservation or mitigation banking, or other market mechanism “prices” act a surrogate for “valuing” a suite of ecosystem services?

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Synthesis

- A lack of biophysical data/understanding impacts capability to conduct valuation studies
  - Collaborating with biophysical scientists from project inception facilitates getting the right kind of data that can be used in ES framework
- Science takes a long time
  - Utilizing models and updating inputs as best science becomes available can help decision-makers with timely information requirements
- Valuation provides a common metric to consider multiple ES and support decisions when comparing management options

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Acknowledgements

- Frank Casey and William Gascoigne were principal investigators for the SGI study
- Dianna Hogan is overall lead and biophysical technical expert for the CB and GDS studies
- Many others provided and are continuing to provide indispensable support for all three projects

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Questions?
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