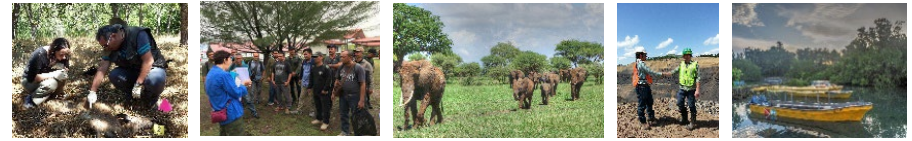




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# Introduction to Wetland Ecosystem Services and Payment for Ecosystem Services

**Regional Flyway Initiative:  
Understanding Wetland Ecosystem Services and How to Assess Them**

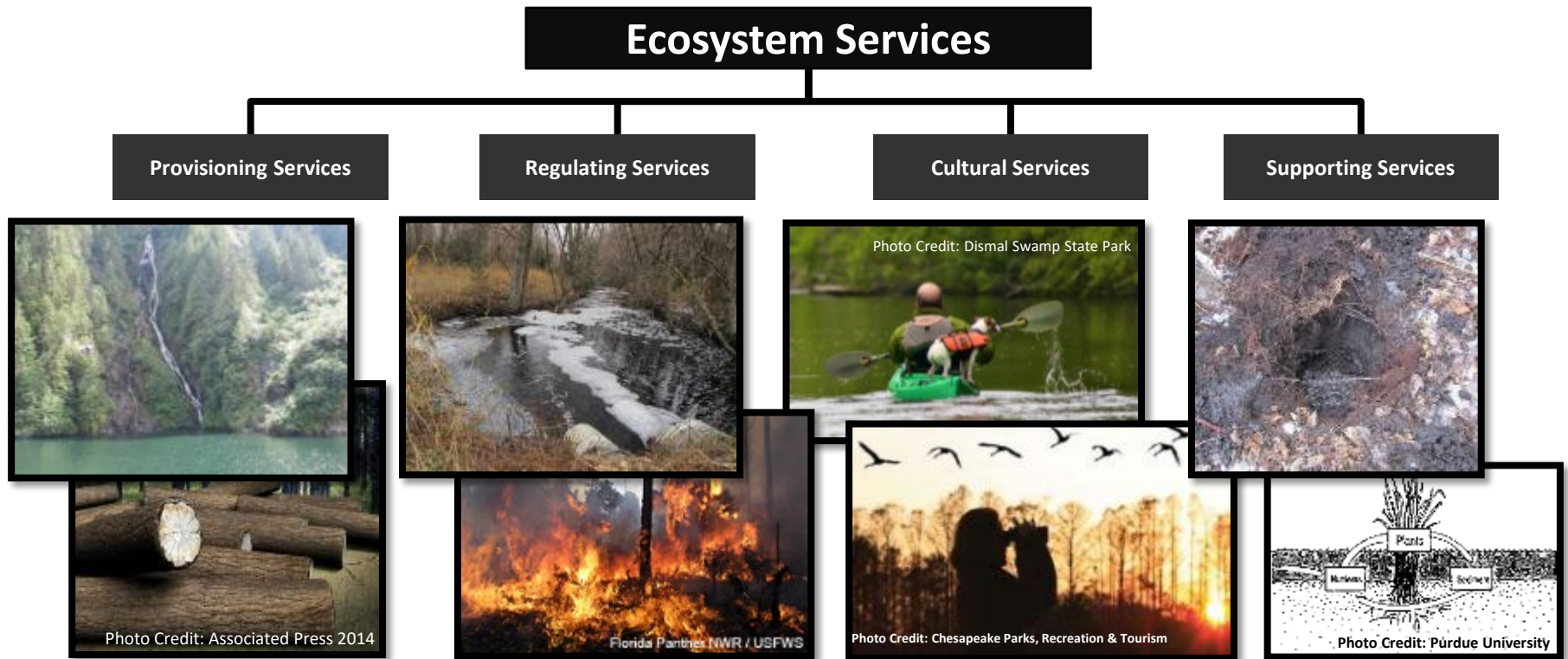
**Training Series at the EAAFP Meeting of Partners (MOP11)  
in partnership with the US Department of the Interior**

**14 & 15 Mar 2023**



# WHAT ARE ECOSYSTEM SERVICES

Ecosystem services are the 'benefits that *humans* derive from nature' and include:



Source: Categories adopted from Millennium Ecosystem Assessment, 2005



# ECOSYSTEM SERVICES FRAMEWORK

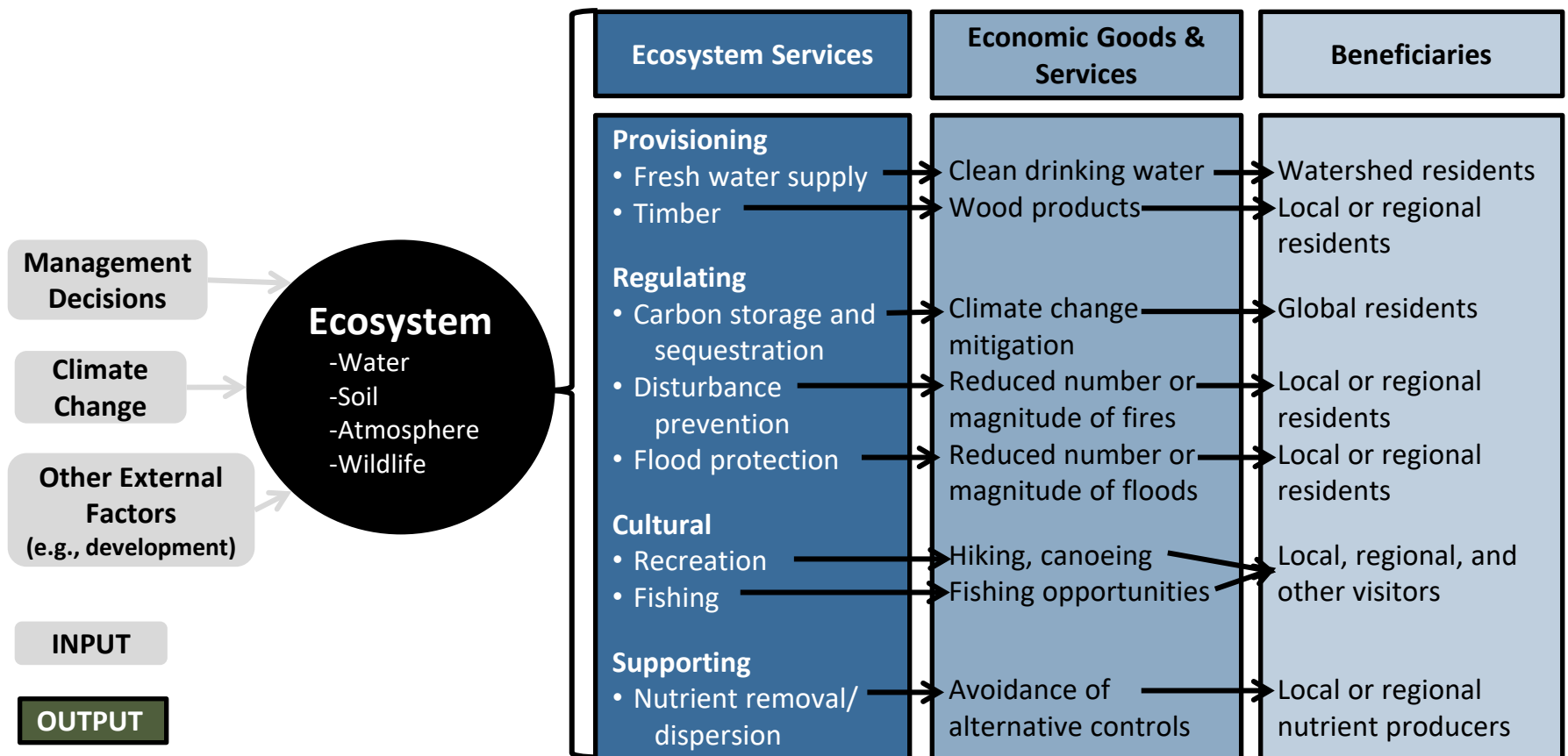


Figure Source: Pindilli



# ECOSYSTEM SERVICES ASSESSMENT

## What:

Estimate quantity, quality, and value of ecosystem services  
Essentially, an inventory

## Why:

Understanding benefits provided by natural environment improves  
our ability to preserve benefits or understand the trade-offs  
*If we don't put a 'value' on nature, it defaults to zero*

## How:

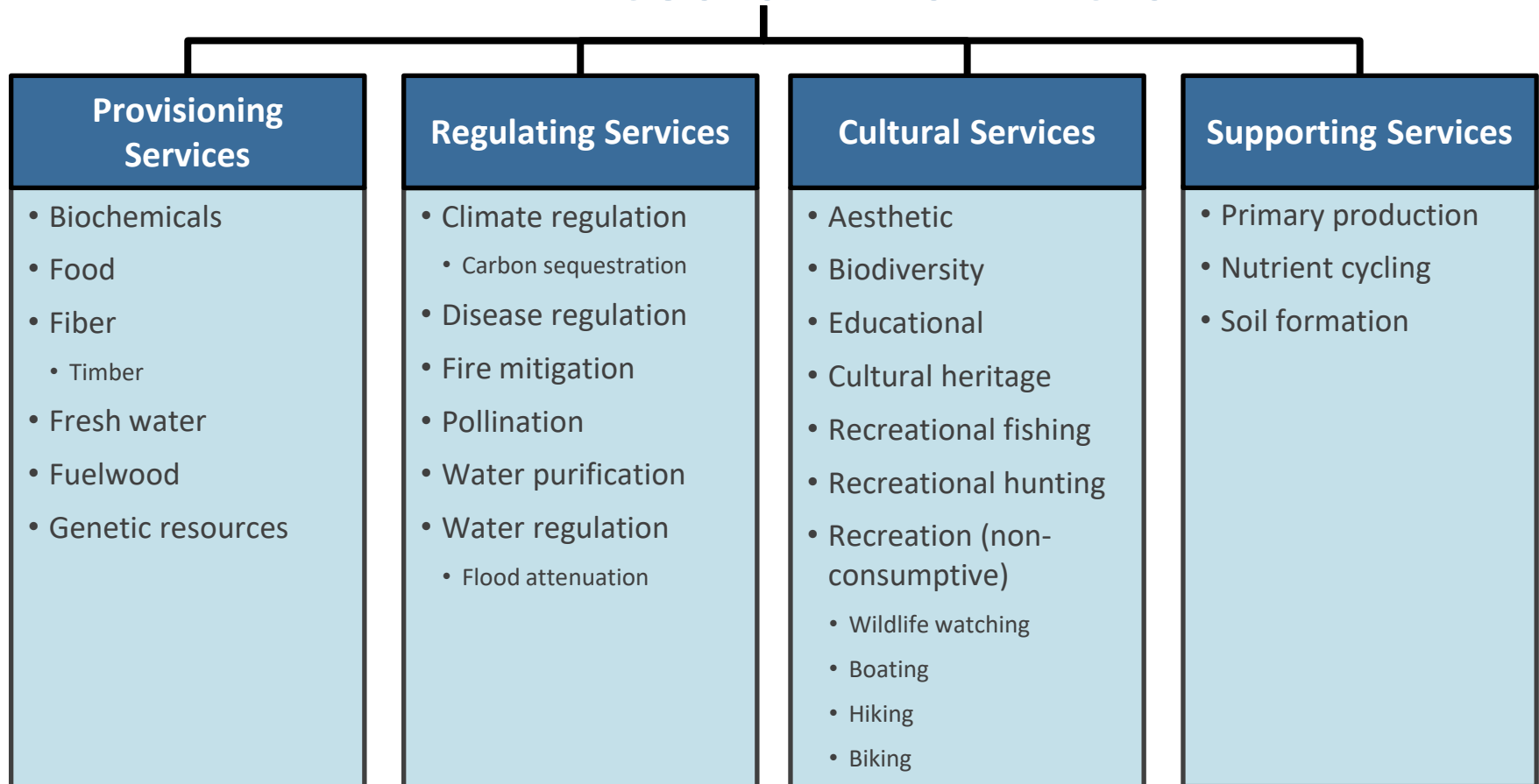
Integrated ecologic-economic analysis for a given area  
GIS-based  
Benefits/Function Transfer



Image source: Hansen, B., Menkhorst, P. and Loyn, R. 2011. Western Port Welcomes Waterbirds: Waterbird usage of Western Port



# WETLAND ECOSYSTEM SERVICES





# COMMERCIAL & RECREATIONAL FISHING

## Ecosystem Function



## Ecosystem Service



**Wetlands provide nursery  
habitat for estuarine-  
dependent fish**



**Increases/sustains fish  
population**



**Increases catch rates or  
reduces effort per catch**

**Utility can also change  
other than catch rate**



# FLOOD ATTENUATION: Linking Functions to Services

**Ecosystem  
Function**



**Ecosystem  
Service**



**Floodplains store water  
during precipitation events**



**Stream peak flows  
are reduced**



**Adjacent community  
flooding reduced**

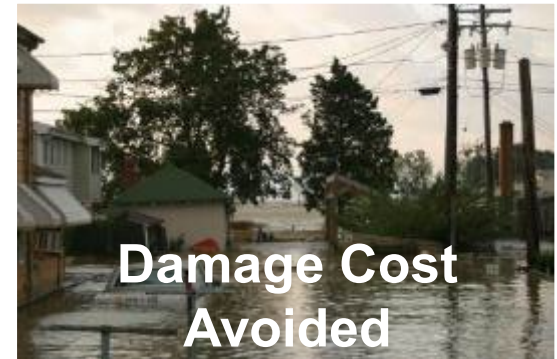


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## FLOOD ATTENUATION: Translating Services to Values

Link water storage  
to flood attenuation

Link flood attenuation  
to avoided damages



Photos courtesy of Chesapeake Bay Program





## FIRE MITIGATION



### 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

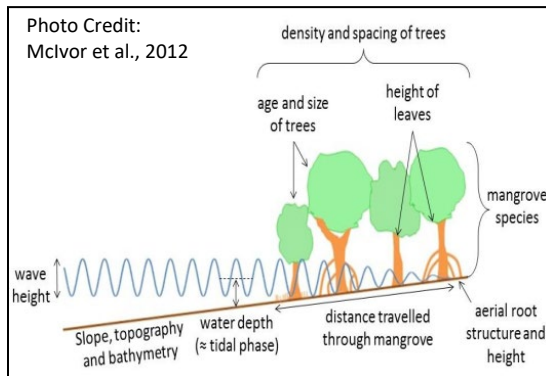


### Fire damages reduced

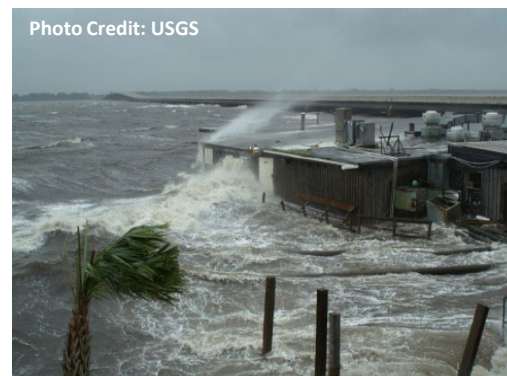
- property damage
- safety implications
- air quality
  - health effects
  - visibility
- tourism



# STORM SURGE MITIGATION

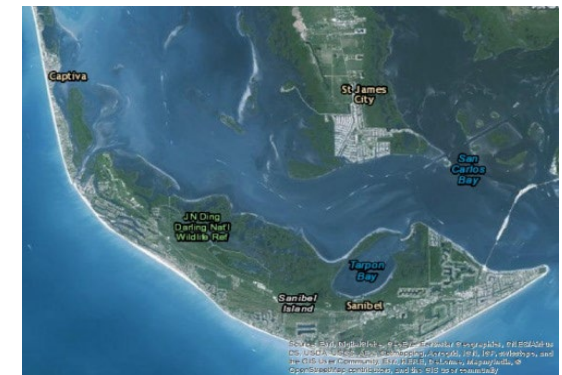


**Wave energy  
dissipation**



**Coastal protection from**

- wind and swell waves
- storm surges
- tsunamis
- erosion



**Reduced damages**

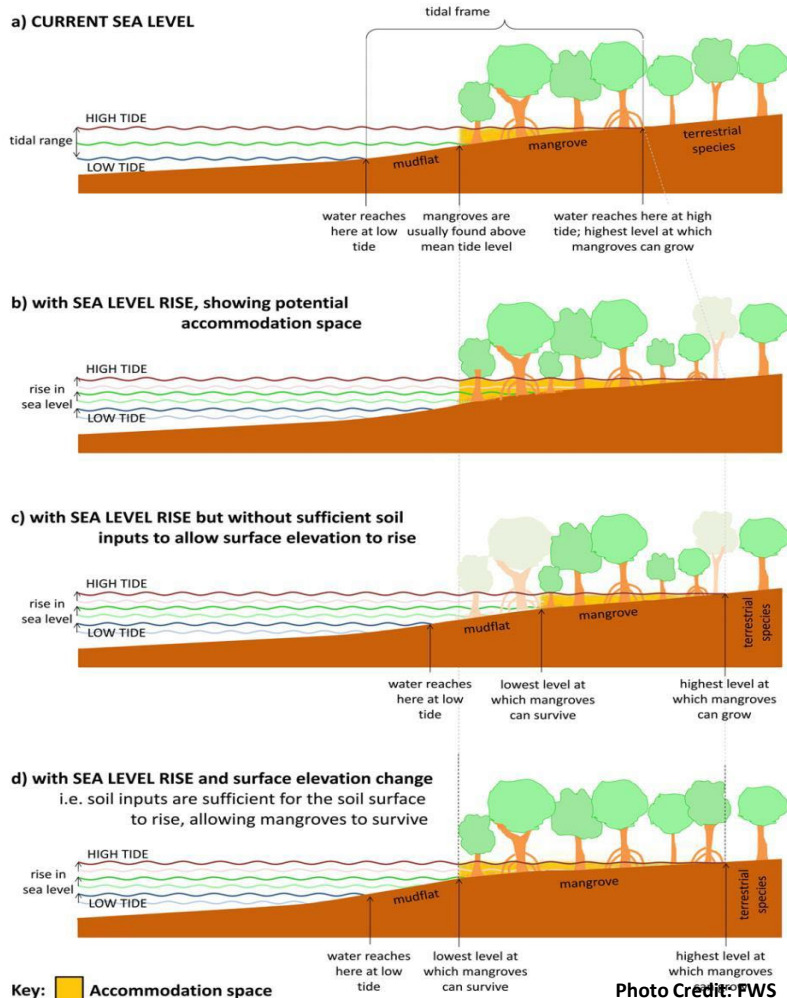
- reduced property damage
- reduced loss of life
- reduced loss of agricultural yield

**On average, mangroves provide US\$3,116/Ha/yr in coastal protection**

(source: 2012. Marwa E. Salem and D. Evan Mercer. The Economic Value of Mangroves: A Meta-Analysis.)



# SEA LEVEL RISE MITIGATION



Mangroves accrete soil reducing net sea level rise and associated effects

Site	Hydro-geomorphic setting	Dominant species	Mean surface elevation change (mm/yr)
Rookery Bay, Florida	Fringe	R. mangle	1.4
Rookery Bay, Florida	Basin	A. germinans	3.7
Rookery Bay, Florida	Overwash forest	R. mangle	2.5
Rookery Bay, Florida	Overwash forest	R. mangle	0.6
Shark River, Florida	Basin	R. mangle	0.9
Shark River, Florida	Basin	R. mangle	3.6
Shark River, Florida	Basin	R. mangle	1.4
Shark River, Florida	Basin	R. mangle	6.2
Rookery Bay, Florida	Basin	A. germinans	3.9
Rookery Bay, Florida	Basin	A. germinans	1.1
Rookery Bay, Florida	Fringe	R. mangle	0.6
Rookery Bay, Florida	Basin	R. mangle	9.9

Table adapted from: Sasmito et al., 2015, a meta-analysis on mangroves ability to keep up with sea level rise



# NUTRIENT RETENTION: Linking Functions to Services

## Ecosystem Function



**Floodplains retain  
sediment and  
nutrients**



**Loads of sediment  
and nutrients are  
reduced**



**Improved water  
quality**

## Ecosystem Service



**Opportunity to:**

- view the environment
- to swim, wade, boat
- catch fish

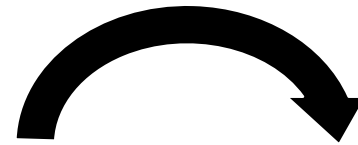


# NUTRIENT RETENTION: Translating Services to Values

Link loads  
to water quality

Link water quality  
to ecosystem services

Valuing  
ecosystem services



**Lower nutrient and sediment loads**



**Improved water quality**



- Opportunity to:**
- view the environment
  - to swim, wade, boat
  - catch fish



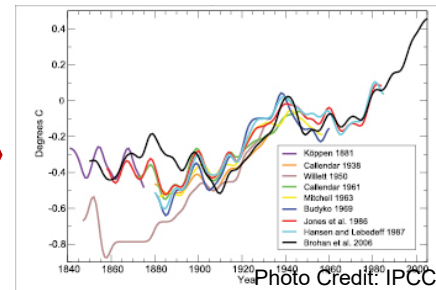
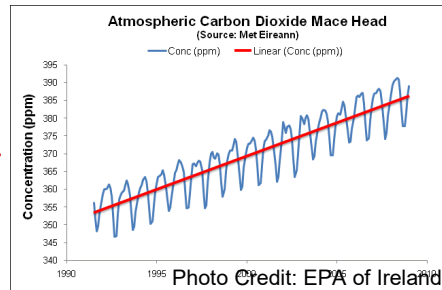
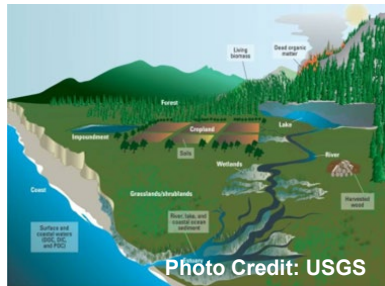
**Willingness to Pay for recreation**



**Proxy Replacement costs of wastewater treatment**



# CLIMATE REGULATION: Linking Functions to Services



## Carbon sequestration:

- in vegetation
- in soil (peat)
- in water

## Lower atmospheric carbon

## Reduced climate change

## Reduced damages (social cost of carbon)

- reduced health effects
- reduced property damage
- reduced loss of life
- reduced loss of ecological functions
- avoided lost agricultural yield

For more on climate regulation ecosystem services assessment see: Carbon Sequestration in National Wildlife Refuge System (<https://doi.org/10.1371/journal.pone.0262218>)



# CLIMATE REGULATION: Translating Services to Values

**Table ES-1: Social Cost of CO<sub>2</sub>, 2020 – 2050 (in 2020 dollars per metric ton of CO<sub>2</sub>)<sup>3</sup>**

Emissions Year	Discount Rate and Statistic			
	5% Average	3% Average	2.5% Average	3% 95 <sup>th</sup> Percentile
2020	14	51	76	152
2025	17	56	83	169
2030	19	62	89	187
2035	22	67	96	206
2040	25	73	103	225
2045	28	79	110	242
2050	32	85	116	260



# RECREATIONAL WILDLIFE WATCHING



Photo Credit: Swede 56  
<https://flic.kr/p/6VTKGp>

**Wetlands provide  
habitat for local  
and migrating  
species**



<https://flic.kr/p/29DdAxU>

**Increased  
biodiversity**



Photo Credit: NPS

**Increased enjoyment  
(‘utility’) from  
biodiversity**

- sitings
- ‘library’ value





## QUANTIFICATION

- Ecosystem services can be estimated in terms of biophysical quantities (some studies stop here)
- Biophysical quantities can be valued using several approaches, largely geospatial
- Not all services may be possible or necessary to estimate and value
- Site-specific physical and socio-economic data and preferences provide the most accurate and precise results, but are not always feasible or necessary
- Multi-disciplinary teams provide expertise on physical and social sciences
- Stakeholder engagement is critical as it informs analyses and provides outreach



## VALUING ECOSYSTEM SERVICES

- Valuing ecosystem services is based in welfare economics; different from economic activity or economic contributions
- Value should be measured on the margin; i.e., what is the increase in value provided by the ecosystem function including consideration of substitutes and opportunity cost
- There is rich literature on valuation approaches, the field continues to develop.

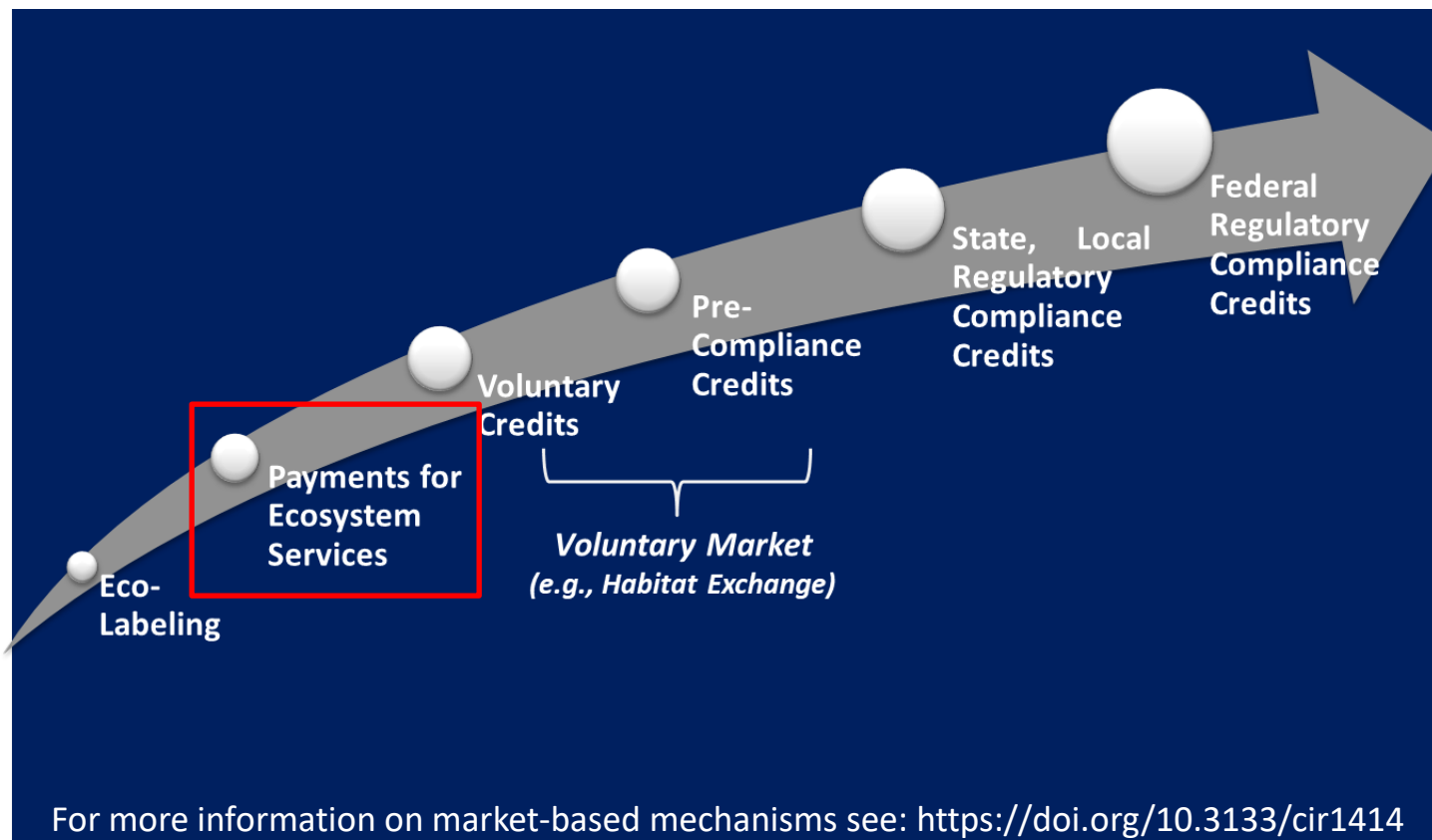


## VALUING ECOSYSTEM SERVICES

- Major approach types include:
  - Primary Valuation (site-specific)
    - Revealed preference (such as travel-cost methods, damages avoided, price-based and cost-based derivation)
    - Stated preference (surveys including contingent valuation and choice experiments)
  - Benefits Transfer – using best practices, can utilize functions or values from one site and transfer to another (see <https://doi.org/10.1016/j.ecolecon.2014.02.018> for more on benefits transfer best practices)
    - Benefit Transfer Toolkit: <https://sciencebase.usgs.gov/benefit-transfer/>



# MARKET-BASED MECHANISMS





## PAYMENTS FOR ECOSYSTEM SERVICES (PES)

- **Voluntary agreement where ‘buyer’ pays ‘seller’ to provide a well-defined environmental service, often by implementing a best management practice**
- **Viability of sustained conservation relies on ongoing funding to incentivize behavior**
- **Often ‘practice-based’ where outcomes are assumed rather than ‘performance-based’**
- **Example: The Bobolink Project**
  - **Started in 2007 in Jamestown, Rhode Island**
  - **A private initiative by the University of Rhode EcoAsset Markets Inc.**
  - **In 2007 and 2008, community payments preservation of five fields during breeding season helping hatch an estimated 40-60 bobolinks**





## UNITED STATES FEDERAL GOVERNMENT PES PROGRAMS

- **Long history as part of federal conservation approach**
  - Department of Agriculture's Conservation Reserve Program has paid farmers to plant permanent vegetation on environmentally sensitive cropland since the mid-1980s
  
- **Highly invested**
  - The Environmental Quality Incentives Program budget in 2015 was \$1.6 billion
  - In 2007 government PES for forestlands that benefit biodiversity totaled about \$31.7 million (Mercer et al., 2011)
  
- **PES programs include:**
  - Conservation Reserve Program (CRP)
  - Conservation Stewardship Program (CSP)
  - Environmental Quality Incentives Program (EQIP)
  - Agricultural Conservation Easement Program (ACEP)
  - Regional Conservation Easement Program (RCEP)
  - Forest Legacy Program
  - Partners for Fish and Wildlife Program





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