Management and Trading of Multiple Ecosystem Services

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Research Focus and Experience

- Environmental Conflict Resolution
  - Collaborative, stakeholder-led modeling of environmental problems
  - Evolutionary agent-based modeling
- Urban Growth Modeling
  - How do cities grow?
  - What are the ecological implications of urban change?
  - How do public, private, and institutional decisions affect this?

Research Focus and Experience

- Ecosystem Markets
  - Environmental, land use, equity implications of markets
  - How do markets work?
  - How could we improve the design and institutional structure of markets?
- Combine Research Areas
  - Institutional arrangements and policies that promote sustainable development

Acknowledgements

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Overview

- Environmental/Ecosystem Service Markets
- Drivers and Benefits of ‘Credit Stacking’
- Drawbacks of ‘Credit Stacking’
- Lessons to take away

Environmental Markets

- 1960s regulatory market theory by Ronald Coase and J.H. Dales
  - Use market forces to protect the environment
  - Government allows polluters to negotiate lowest-cost way to compensate for environmental impacts
- Most popular – 'cap and trade'
  - Establish pollution limit, establish rights to pollute, and trade rights
  - EU ETS carbon trading, U.S. SO_2 market – 'acid rain' market

‘Ecosystem Services’

“The benefits people obtain from ecosystems.”

Includes:

- provisioning services – e.g. food and water; regulating services such as flood and disease control;
- cultural services – e.g. spiritual, recreational, and cultural benefits; and
- supporting services – e.g. nutrient cycling that maintain the conditions for life on Earth.

Ecosystem Features	Ecosystem Functions
Ecosystem Services	Ecosystem Values

Other Market Arrangements: Who is buyer/seller?

- Payments for Ecosystem Services (PES) – public pays private
- Voluntary markets
- 'Regulated' offset markets – private-private transactions, buyers/sellers are regulated by governments

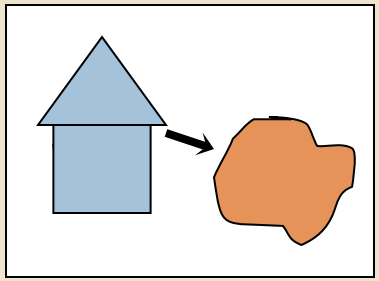
Regulatory Offset Markets

- Regulators require that impacts (environmental damage) be offset
- Offsets are usually environmental restoration/ conservation
  - Sold as 'credits' – linear feet of stream, pounds of nitrogen/phosphorous, acres of wetlands
- Wetland markets – most widely known as 'compensatory mitigation'
  - Wetland 'mitigation banks' – private entities speculatively restoring wetlands/streams to later sell to permittees.

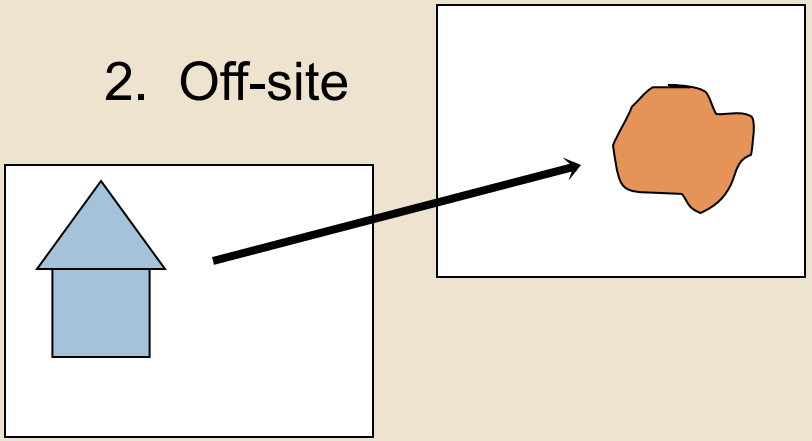
How does policy compensate for loss?

- Compensation of wetland (and now stream) damage through restoration/creation/preservation of alternate wetlands by each developer
  - "Permittee Responsible Mitigation" (Single Project)

1. On-site

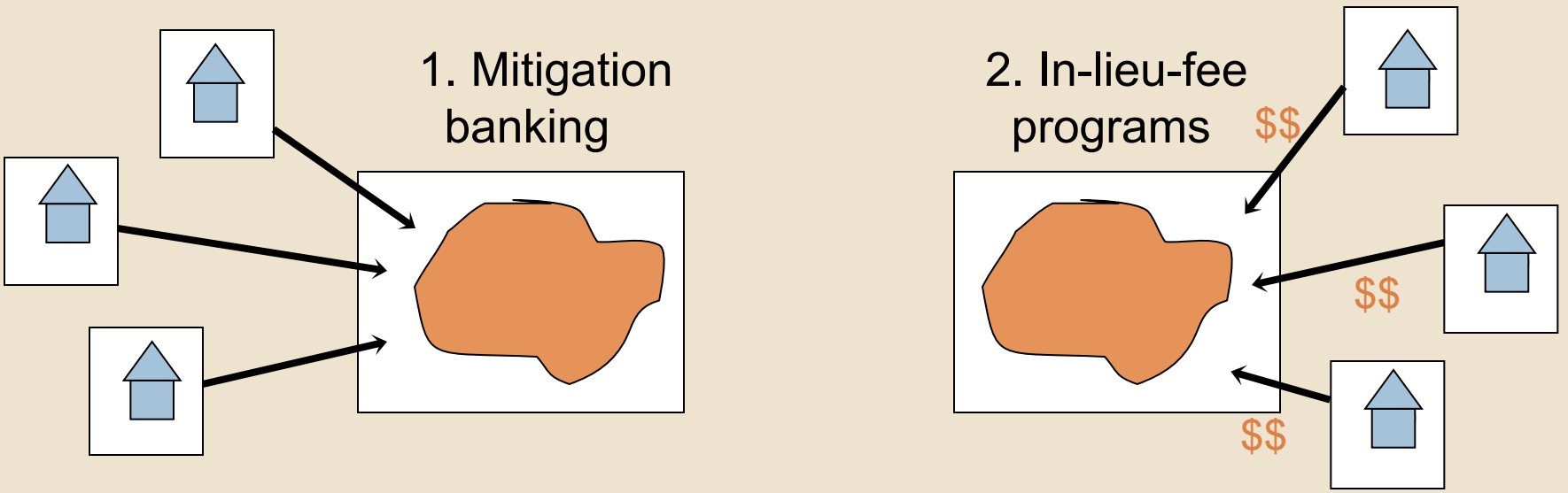


2. Off-site



How does policy compensate for loss?

- Compensation of wetland damage by paying other people to restore/create/preserve alternate wetlands
  - "Third Party Mitigation" (Multiple projects)



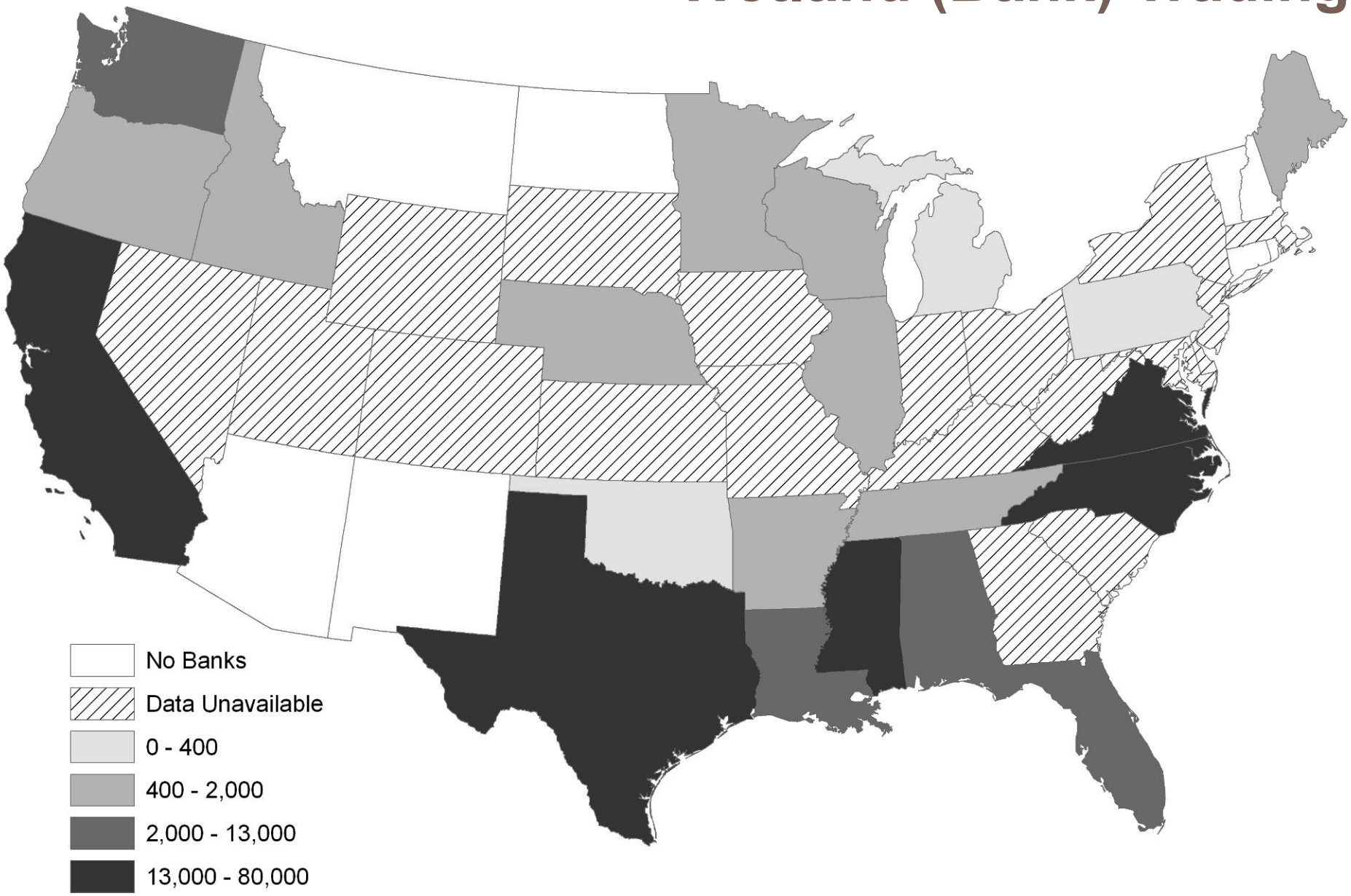
Operating 'Ecosystem Markets'

- Trading ecosystem services quantified through ecological metrics
  - 'Ecosystem services' - beneficial functions of ecosystem features
- Wetlands and Streams
  - U.S. Clean Water Act (1972/1977), Section 404
- Water Quality
  - Clean Water Act, Section 401/402/303
- Endangered Species Habitat
  - Endangered Species Act (1973), Section 7/10

Array of Potential Markets

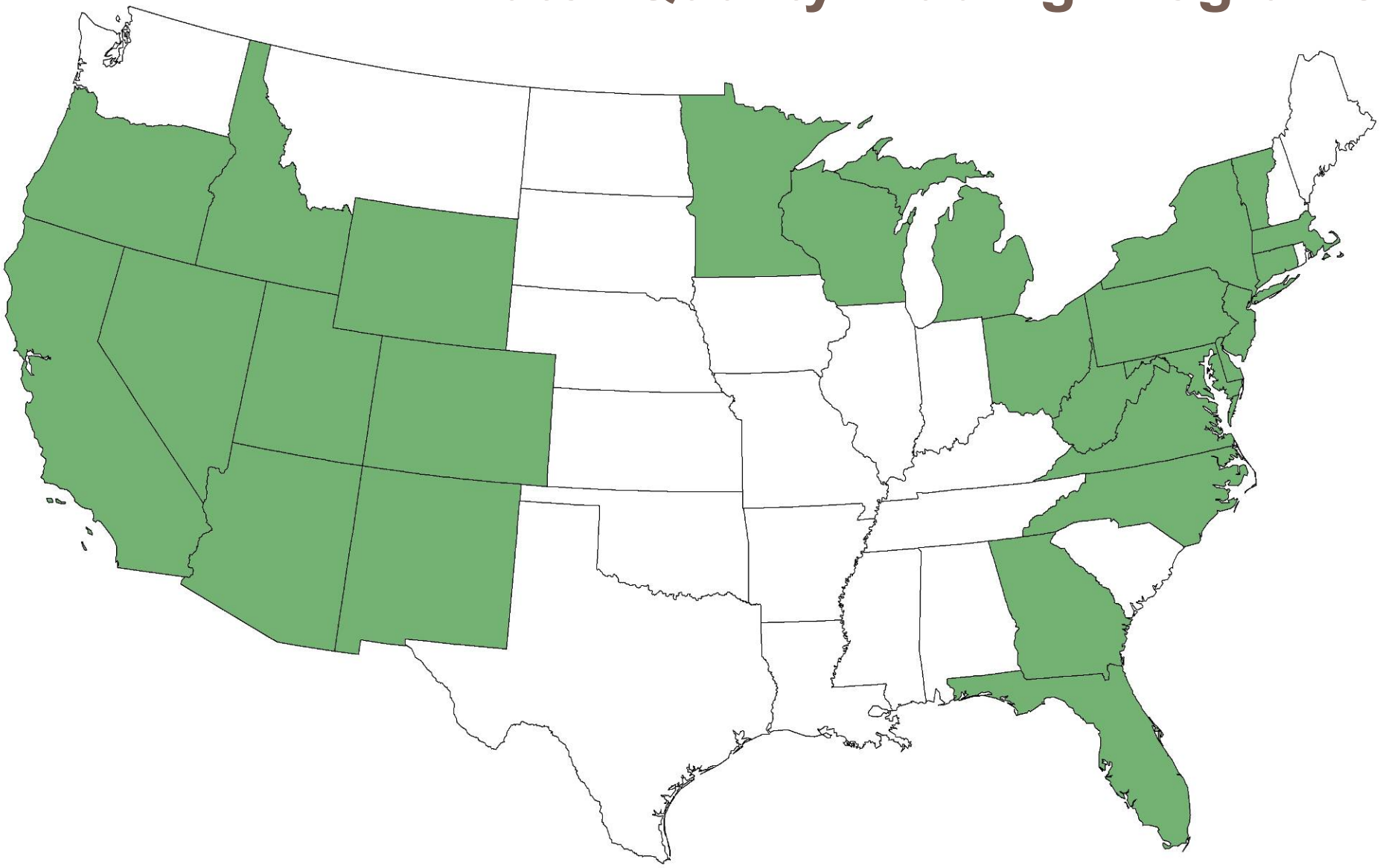
- Wetlands/Streams
- Phosphorus
- Nitrogen
  - Point source
  - Non-point source
  - Floodplain sources
    - Proposed IL Hennepin Levee District Floodplain market
- Endangered Species Habitat
  - Wide variety of species
- Sediment trading
- Thermal trading
- Wetland Functions
- Hydrologic Function
- Upland Prairie
- Water Quality Functions
  - Fish Support - anadromous and non-anadromous fish habitat
  - Aquatic Support - Amphibian, invertebrate & waterbird Support
  - Terrestrial Support - Plants, Pollinators, Songbirds, Raptors & Mammals Support
- Salmonid Habitat
  - Connectivity Anadromous Fish Biotic Support
  - Cover/refugia for Insect/ invertebrate Biotic Support
  - Nesting for Insect/invertebrate Biotic Support
  - Habitat Formation
  - Temperature Regulation
  - Channel Diversity

Wetland (Bank) Trading



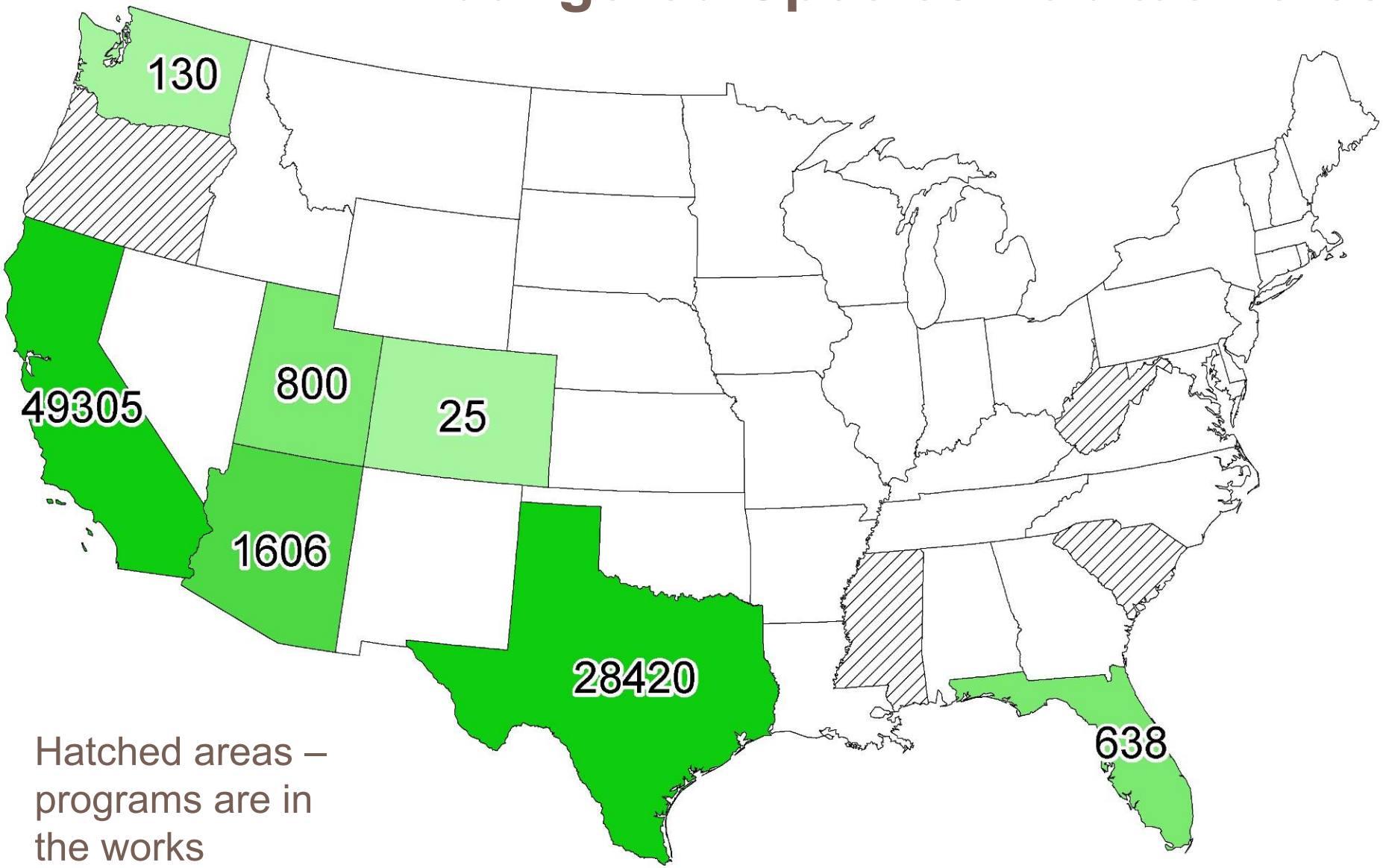
Source: Madsen et. al (2010)

Water Quality Trading Programs



Source: U.S. Environmental Protection Agency

Endangered Species Habitat Acres



Hatched areas – programs are in the works

Source: http://www.speciesbanking.com

Credit Stacking Terminology

- **Ecosystem unbundling:** distinguishing an ecosystem as a bundle of ***individual services***
  - Services can be identified and quantified
- **Credit stacking:** selling these separated ecosystem services into multiple, separate markets

Rationale for Credit Stacking

- Increased incentive to restore
  - Greater return on fixed cost investments
  - Known scale economies to environmental restoration
- Regulatory incentives
  - Unbundling ecosystems allows regulators to more clearly meet specific policy goals
    - Forest vs. Red Cockaded Woodpecker Habitat
  - *Ecosystems* as integrated wholes
    - Markets less responsive to specific policy goals

Rationale for Credit Stacking

- Legal Incentives
  - Long precedent in property law – separable property rights
    - Bundle of sticks
    - E.g. Can sell mining rights and timber rights as long as they do not conflict

Problems with Stacking: Ecology

- Commodification of nature
- What do we transact?
- Buy pork bellies, get pork bellies
- Buy forest carbon, not getting forest carbon – we are getting a forest that produces carbon
  - Forest is carbon capture device
  - Not necessarily a healthy forest

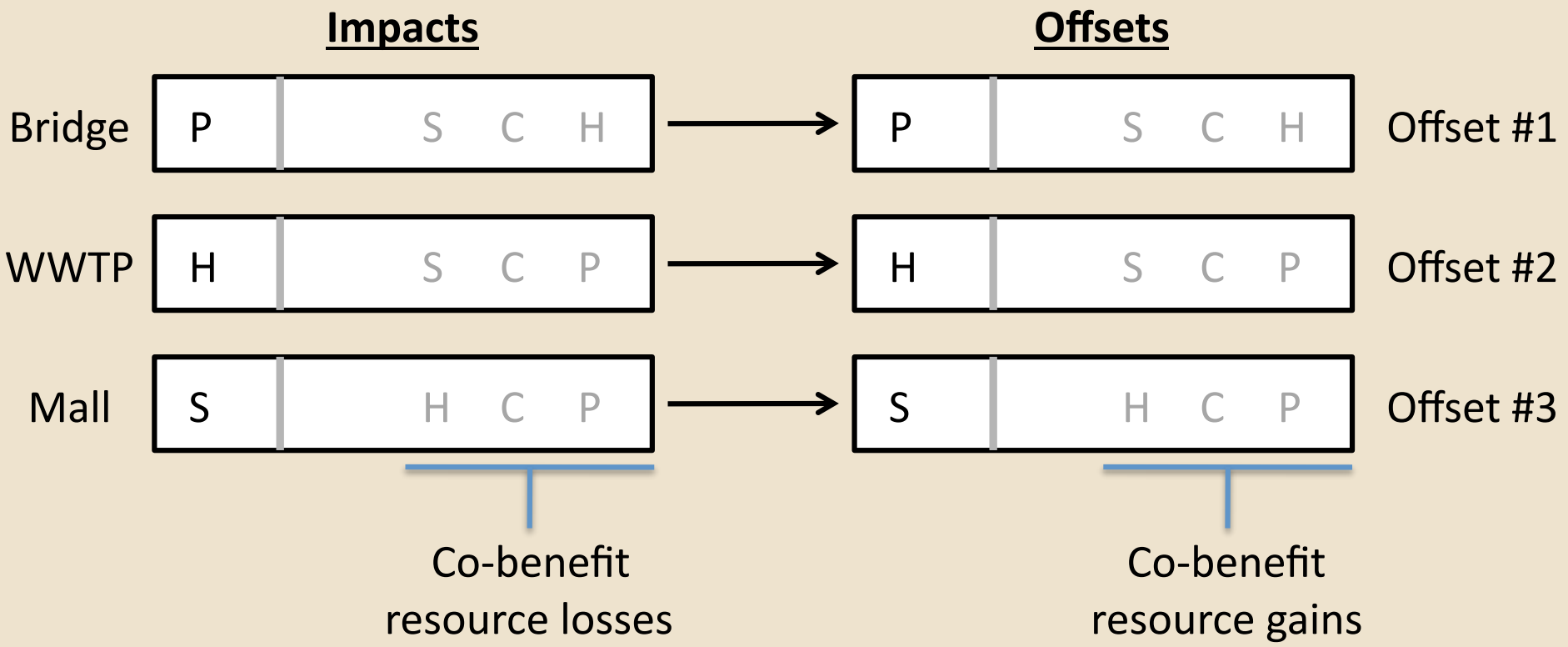
Problems with Stacking: Ecology

- Ecosystem functions are not cleanly distinguishable
  - Organisms, populations, and biogeochemical cycles are ***interconnected***
- Nutrient retention is closely related to biotic community composition
  - Selling biodiversity and water quality credits from a single site
    - Involves unbundling habitat and nutrient retention
- Carbon, nitrogen and phosphorus have intertwined ecological and chemical behaviors

Problems with Stacking: Accounting Symmetry

- Stacking is a 'joint production' issue
- Several outputs emerge together from a single productive activity (i.e. hides and meat)
- Trading forest carbon means we get a forest
  - **Carbon**, water quality (P, N, S), habitat, flood storage, etc.
  - Co-benefits (co-services) to carbon

Symmetry of bundled impacts and offsets

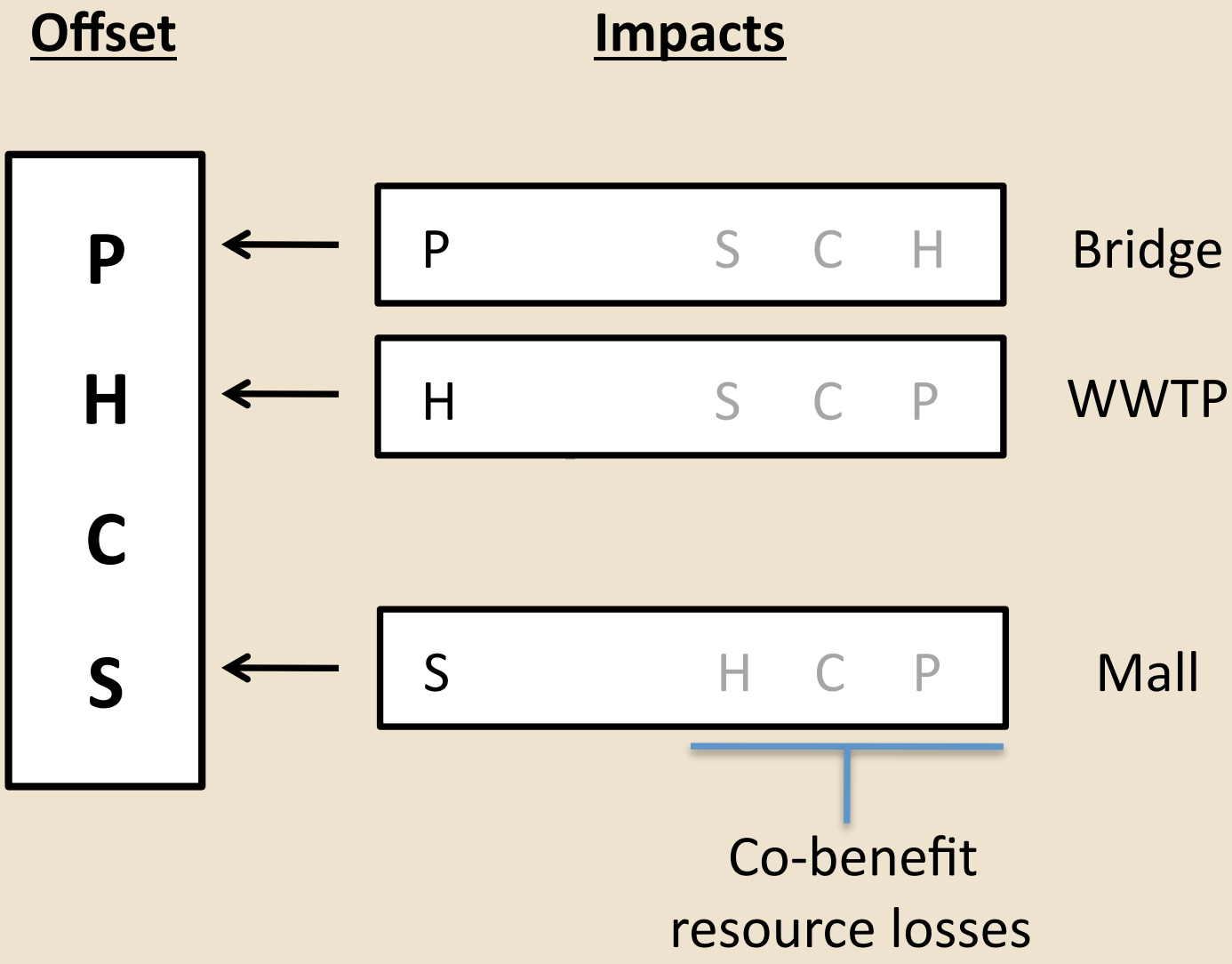


Phosphorous (P), sediment (S), carbon (C), and habitat (H) impacts and offsets

Problems with Stacking: Accounting Symmetry

- Stacked credit scenario
  - Loss of co-benefits at impact sites
  - All co-benefits are accounted for at offset sites
- 'Asymmetry' of stacking – systematic loss of co-benefits
- Internalize all service value at offset site, not at impact site
- Why?
  - Geography of markets
  - Different thresholds for different impact types

Asymmetry of bundled impacts offset at unbundled site



Worst Case Scenario

- 'Additionality' - adding value to a site by doing additional restoration
  - Adds time dimension: What should we count as new credits?
- Retroactive additionality
  - Sell a new credit type from an old restoration project

EBX Neu-Con

- 1999 - Environmental Banc and Exchange, LLC sold $7.1 million of wetland and stream credits to NC government (Transportation Dept.)
- 2009 - Division of Water Quality (DWQ) bought $698,372 worth of nitrogen credits (nutrient offset market)

- Both purchases from the same sites

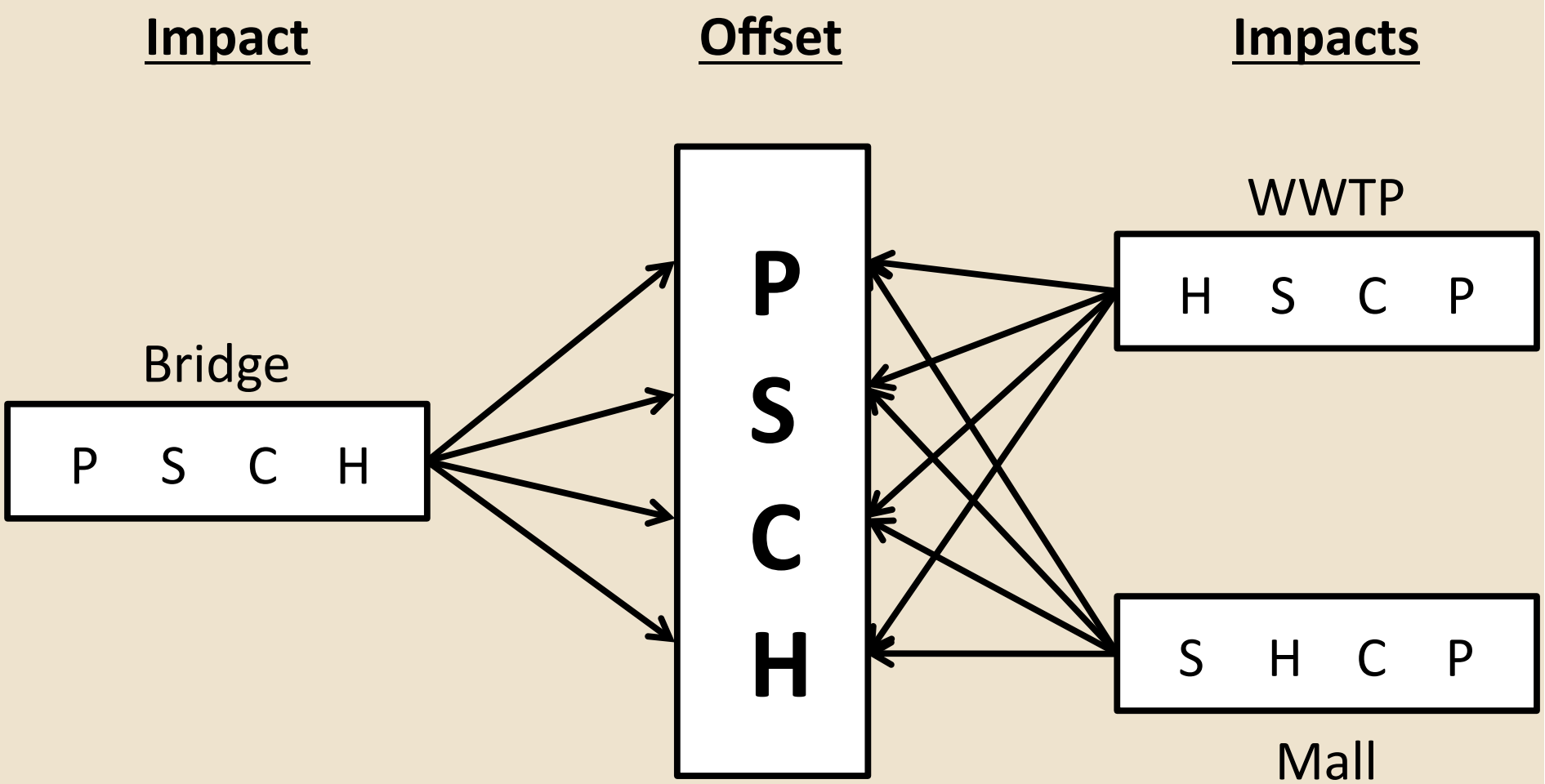
Worst Case Scenario: EBX Neu-Con

- Restoration assets in Neuse River Basin (2009 annual report)
  - 160,577 ft of stream credits
  - 6725.9 acres of wetland credits
- Totals: 15,448,439.3 lbs of Nitrogen credits in the Neuse Basin
- ~5-17 times total program offsets (898,072 lbs) since program started (1998)

Potential Unintended Effects

- Retroactive sale of credits flood market
- Lots of available (low quality) credits makes polluting cheap
- Cheap credits creates disincentive to restoration

Symmetry of unbundled impacts and unbundled offsets



Stacking - Lessons to Take Away

- No policy currently exists to guide credit stacking practices
- Few environmental economists and ecologists have addressed legitimacy of unbundling ecosystem services
- Is the science ready? Is there measurement technology to make stacking work?
- Economists and ecologists must be involved in designing market policies
  - Currently monitors/observers of active programs

Stacking - Lessons to Take Away

- Ecosystem markets are not land transfers, but are transfers of certain development/use rights
- Market policies must define ***exactly*** what is sold into the market
  - E.g. Selling wetlands (i.e. a conservation easement) does not prohibit sale into carbon markets, biomass markets, habitat markets, etc.
- Concern for carbon markets – policies must prohibit retroactive re-sale
- Streamlined regulatory system is necessary