The Economics of Watersheds

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When was the last time an important decision was made that surprised you because you were anticipating a different outcome??

Why?

- Intentionally overlooked evidence
- Evidence missing
- Politics took over

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Natural observations tell only half of the story;

Human observations tell the other half

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Topics

- Watershed Management
- Elkhorn Slough dilemma
- New management strategies
- Where economics comes in
- Solutions are elusive
- The policy caveat
- Summary

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Salinas River Pristine Headwaters

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Elkhorn Slough Main Channel

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THE DILEMMA

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Which Elkhorn Slough?

- **1850's**: a minor tributary to the much larger Pajaro-Salinas River System, which poured into the Pacific north of Moss Landing?

- **1908**: with diverted mouth of the Salinas River southward still pouring into the Pacific?

- **1946**: after the creation of Moss Landing Harbor with construction of jetties allowing the Pacific to flow in?

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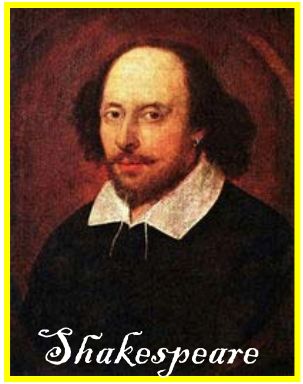
Decisions, Decisions

- **Problems:**
  - Erosion
  - Nutrient Overload
  - Pesticides

To restore
or not to restore?
That is the question!



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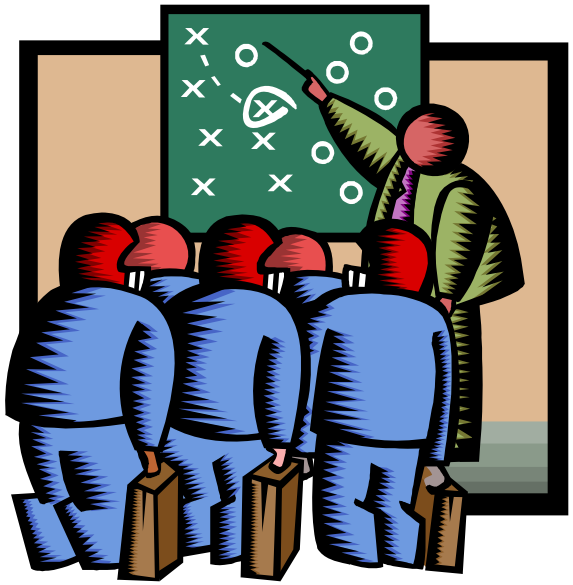
Management Strategies



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Ecosystem-based Management for Decision making

"Ecosystem Based Management is an integrated approach to management that considers the entire ecosystem, including humans. The goal of EBM is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need."

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Ecosystem Based Management Goals

- maintenance of viable populations of native species
- maintenance of ecological and evolutionary processes
- sustainability of human uses beyond these ecological constraints.

(from Ward, 2000)

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Where Economics Comes In

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National Ocean Economics Program

Just Released

"How will climate change affect our coasts?" presentation

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Market
- Ocean Economy
- Coastal Economy

Natural Resource
- Living Resources
- Offshore Oil & Gas

Non-Market
- Valuation Studies
- References & Tools

Population & Housing

Government Expenditures
- OMB Ocean Budgets
- Ocean Time Series

About NOEP

Established in 1999, the National Ocean Economics Program (NOEP) provides a full range of the most current economic and socio-economic information available on changes and trends along the U.S. coast and in coastal waters. The program is funded by federal, state, university, and private grants and contracts.

Market
Ocean and coastal economic data for the U.S. coastal states, counties, and coastal regions.

Natural Resources
Commercial fisheries information and economic data of the offshore oil and gas production of the U.S.

Population & Housing
Population and housing statistics for the coastal states and shoreline regions.

Non-Market
Non-Market valuation research studies about the coastal regions and waters.

Government Expenditures
Historical data of federal marine expenditures for ocean and coastal activities collected from the U.S. Office of Management and Budget.

updated 14-Mar-2007

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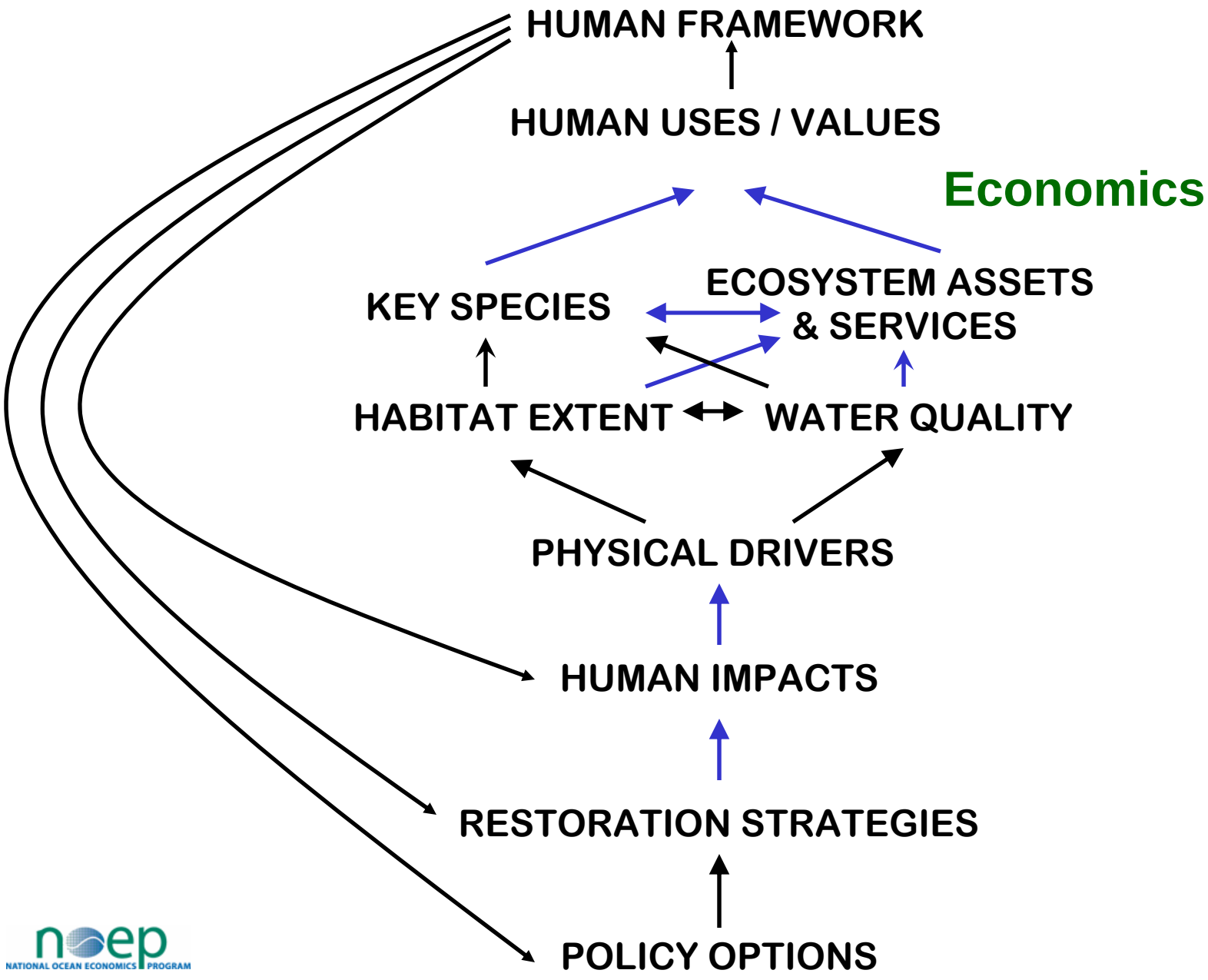
HUMAN FRAMEWORK
HUMAN USES / VALUES
Economics
KEY SPECIES
ECOSYSTEM ASSETS
& SERVICES
HABITAT EXTENT
WATER QUALITY
PHYSICAL DRIVERS
HUMAN IMPACTS
RESTORATION STRATEGIES
POLICY OPTIONS

Economic Approaches

- Valuing ecosystem services and assets
- Valuing the human activities that occur
- Linking changes in the ecosystem with changes in the economy

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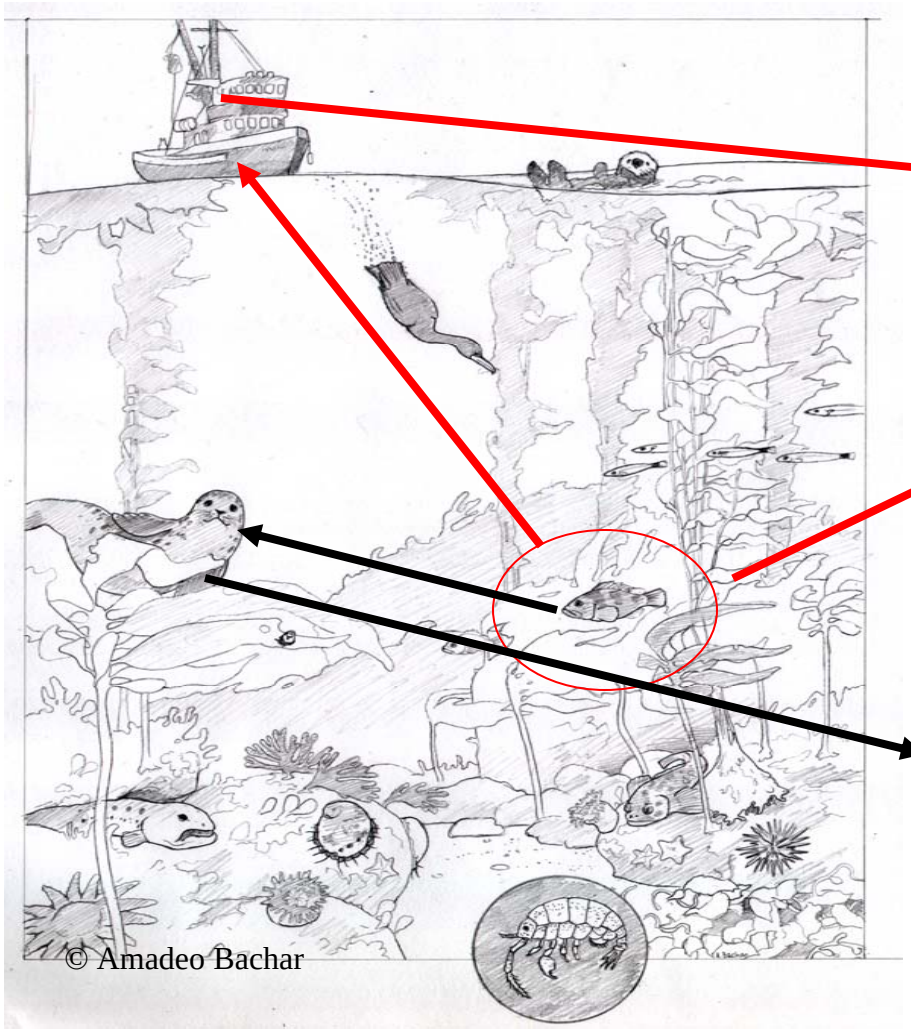
Understanding Economic Uses

Goods and Services

Uses and Users

Economic Impacts and Values

Understanding Values: Example



Direct Uses

Consumptive Uses
(fishing)

Non-consumptive Uses
(e.g. wildlife viewing)

Indirect Uses

-Supporting seal populations

- Supporting ecosystem function

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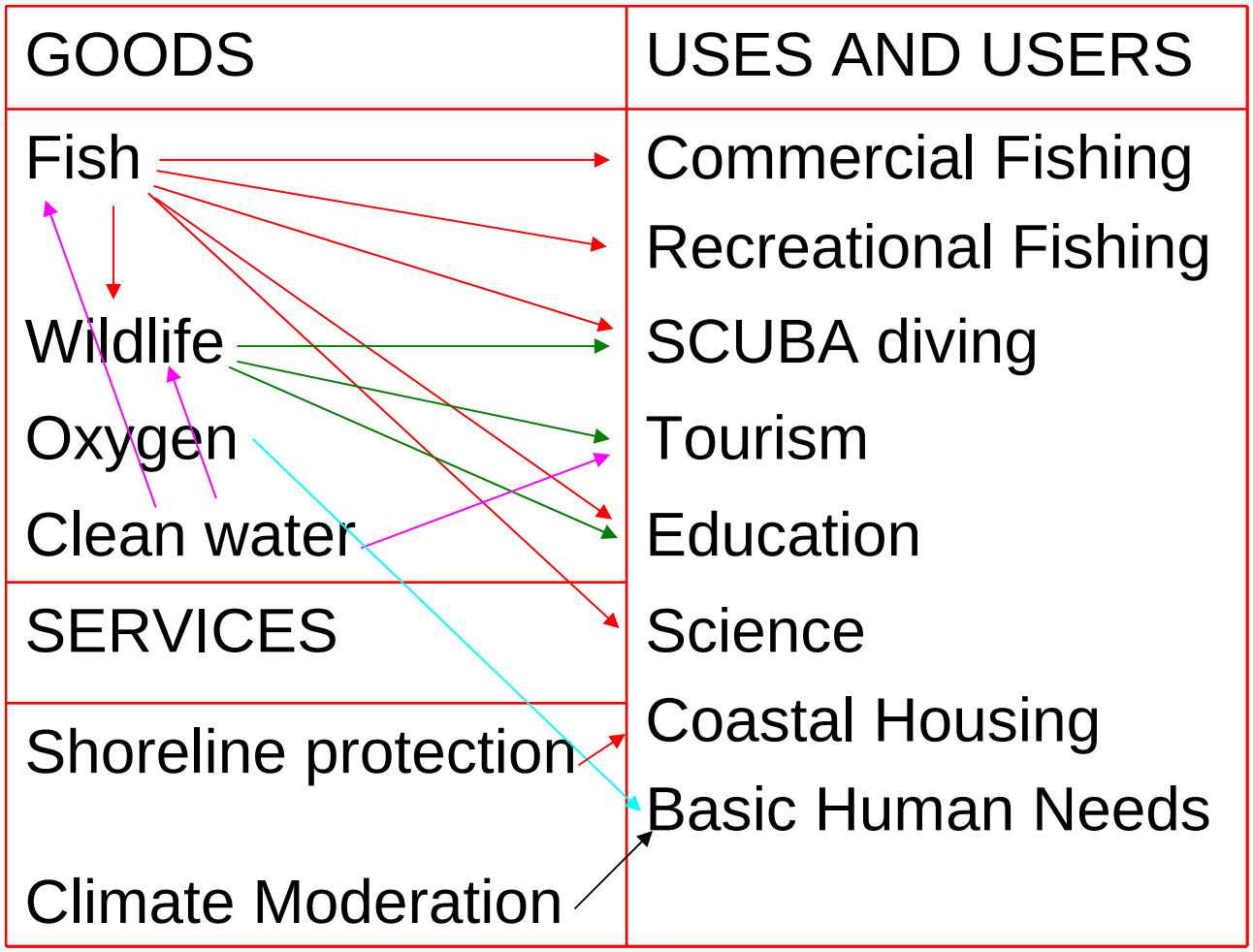
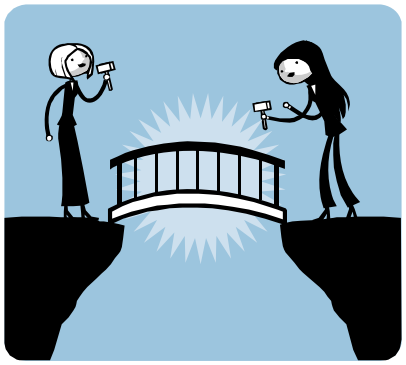
Valuing Ecosystem Goods and Services

GOODS	USES AND USERS
Fish Wildlife Oxygen Clean water	Commercial Fishing Recreational Fishing SCUBA diving Tourism Education Science Coastal Housing Basic Human Needs
SERVICES	
Shoreline protection Climate Moderation	

Understanding Uses: multi-dimensional



Ecosystem Health



Economic Activity and Value

- ***Valuation*** **studies**
  - Not precise
  - Expensive
  - Valuation estimates do not exist over time
- ***Indicator*** **studies**
  - Need to change over time (flows versus stocks)
  - Data already collected
  - Collected with precision and frequency
  - Easily interpreted

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Indicators

Human uses and values

– Economic impacts from changes in ecosystem assets and services in the Slough

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Economic Stakeholders

Market-based

- Railroad owners
- Fishermen, bait shops and ice providers
- Moss Landing Harbormaster
- Farmers
- Boaters
- Tour companies
- Sporting equipment rentals and sales
- Lodging and restaurant owners





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Economic Stakeholders

Non-Market based

- Kayakers
- Recreational Fishing
- Birdwatchers
- Wildlife viewers
- Hikers

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What's the status of Elkhorn Slough's Coastal Economy?

NOEP provides industry data,
but
what about …

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Indicators

- Need to change over time
  - (flows versus stocks)
- Data already collected
- Collected with precision and frequency
- Easily interpreted
  - Do we know what the data mean?

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Indicators of the Economic Activity

Indicators	Measurement
Commercial fishing	Landings, revenue, # of vessels (per yr)
Commercial Passenger Fishing Vessels	# of trips, # of vessels (per yr)
Dredging	Volume
NERR (education and scientific)	# visitors
Recreational Fishing	Visits and catch per effort
Kayaking	# visits, expenditures
Birdwatching	# visits, expenditures

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Indicators of the Economic Activity

Indicators	Data Sources
Commercial fishing	CA Dept of Fish and Game
Commercial Passenger Fishing Vessels	CA Dept of Fish and Game
Dredging	US Army Corp of Engineers
NERR (education and scientific)	NERR visitor registration
Recreational Fishing	Pacific States Marine Fisheries Comm
Kayaking	Working with local business, survey
Birdwatching	Survey

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Possible Ecological Indicators

- Eel Grass Cover
- Nutrients
- Dissolved Oxygen
- Temperature
- Salinity
- Fecal Indicator Bacteria
- Sediment loads
- Otter Counts
- Bay circulation
- Christmas bird counts (proxy for birdwatching)
- Power plant cooling water intake (volume)

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Time Series Data Helps to…

- Estimate a baseline
- Understand change

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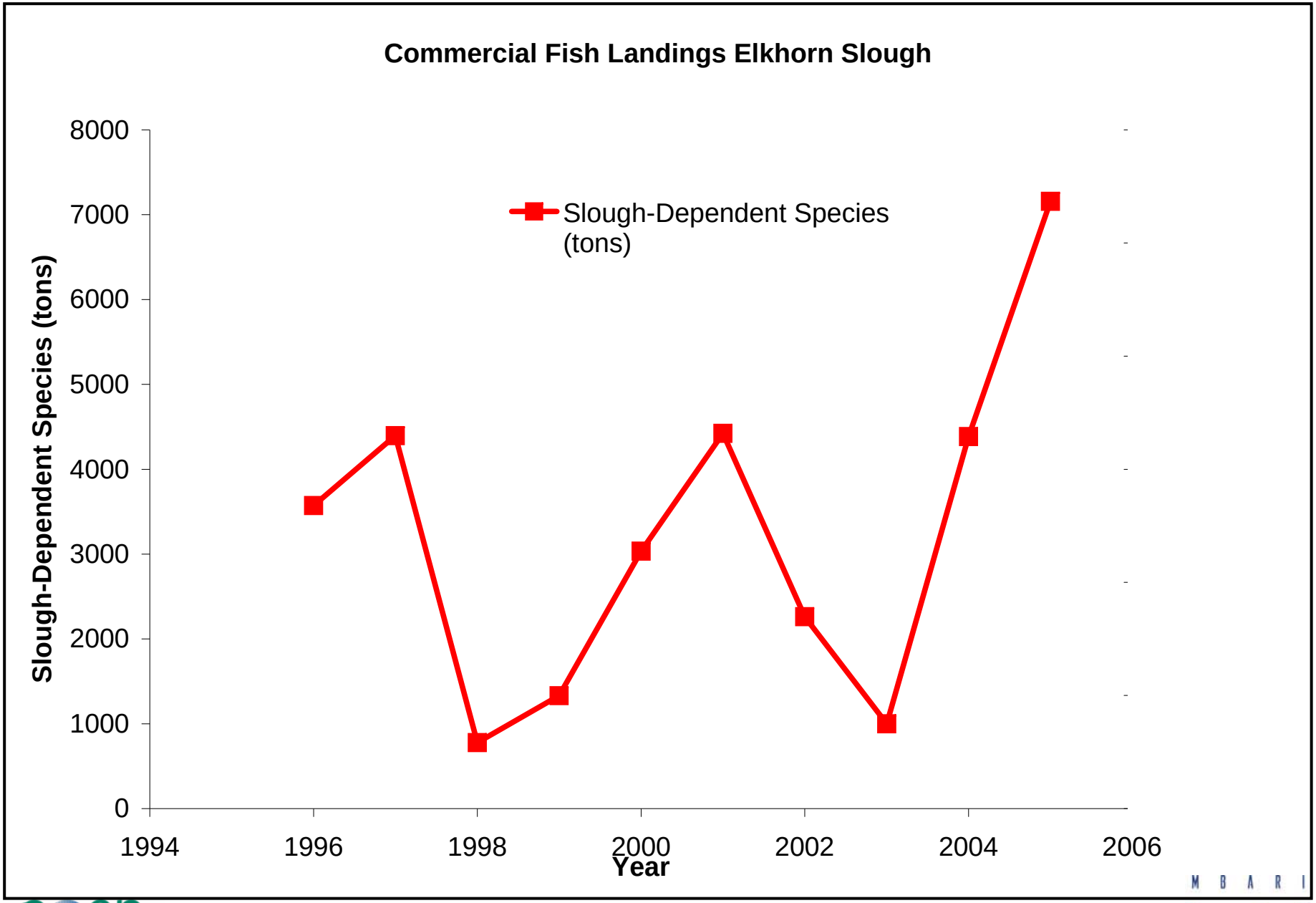

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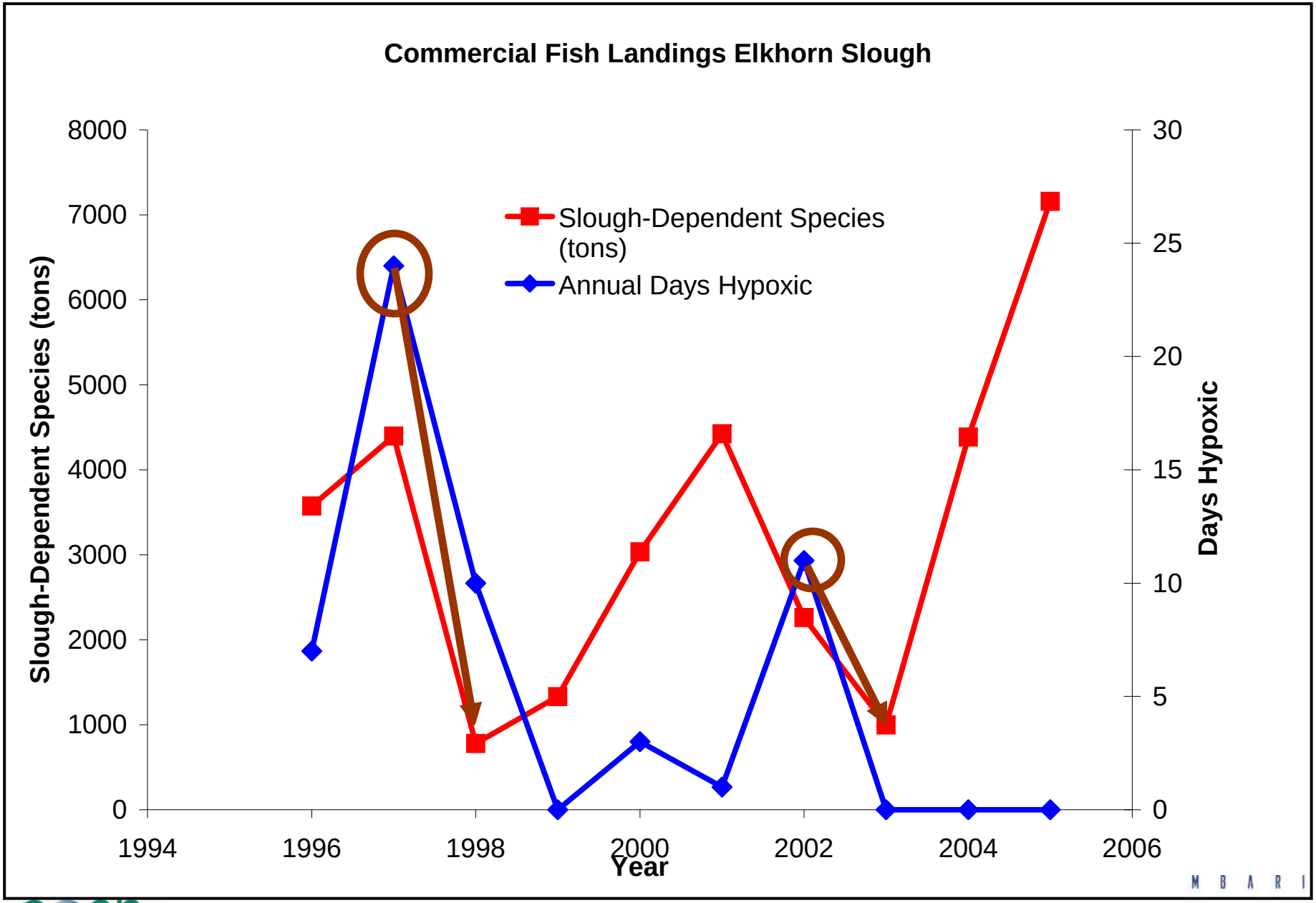
Commercial Fish Landings Elkhorn Slough
Slough-Dependent Species (tons)
Annual Days Hypoxic
Slough-Dependent Species (tons)
Days Hypoxic
Year
8000
7000
6000
5000
4000
3000
2000
1000
0
30
25
20
15
10
5
0
1994
1996
1998
2000
2002
2004
2006
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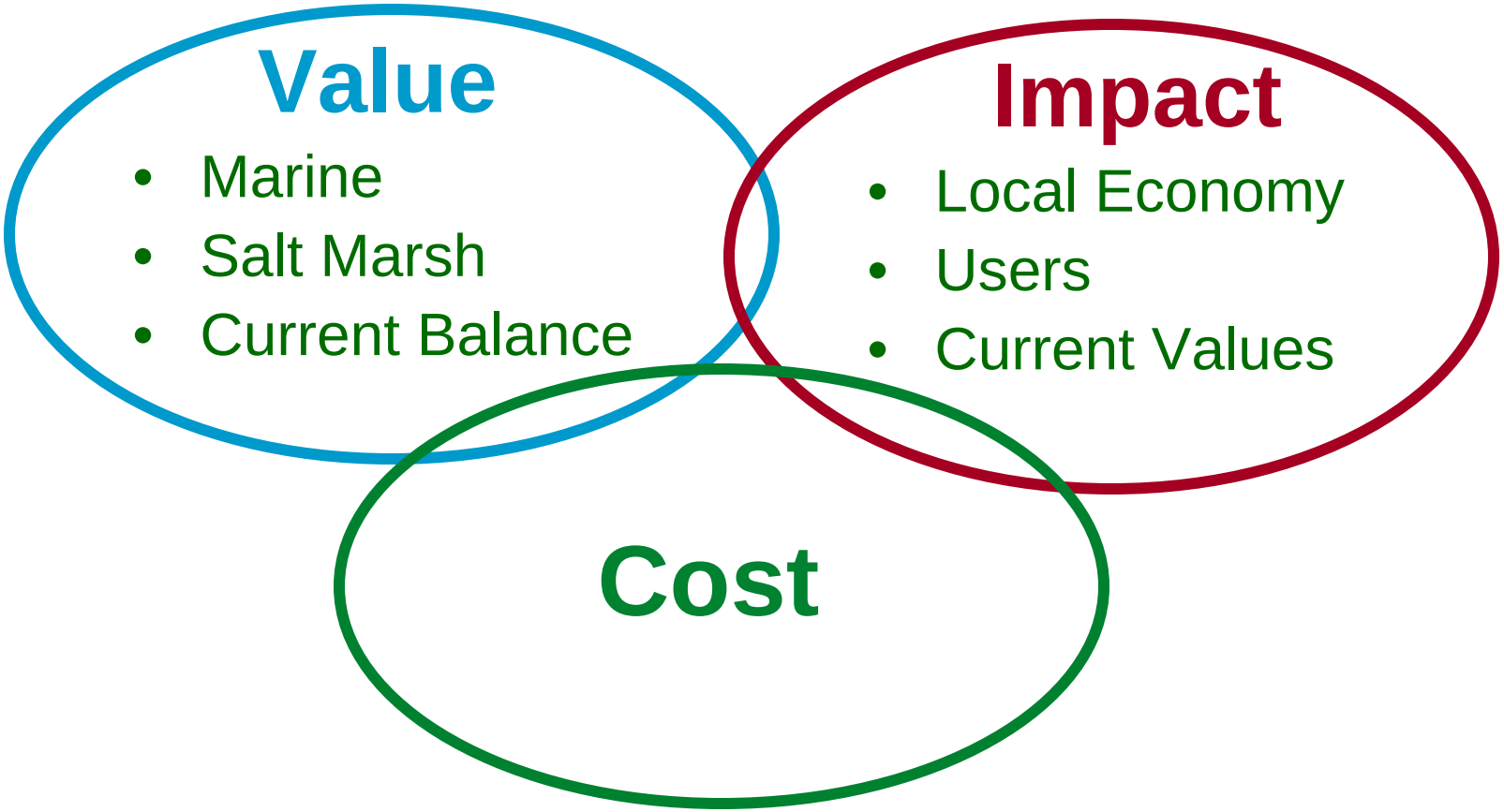
Valuing of the Slough

One-year survey

- Who uses the Slough?
- What do they do there?
- Where do they go while there?
- How much do they spend?
- How often do they come?
- etc

Restoration Considerations



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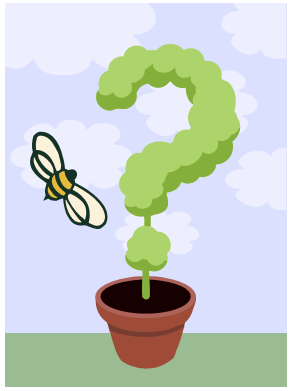
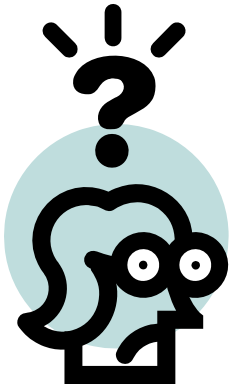
What would you do?





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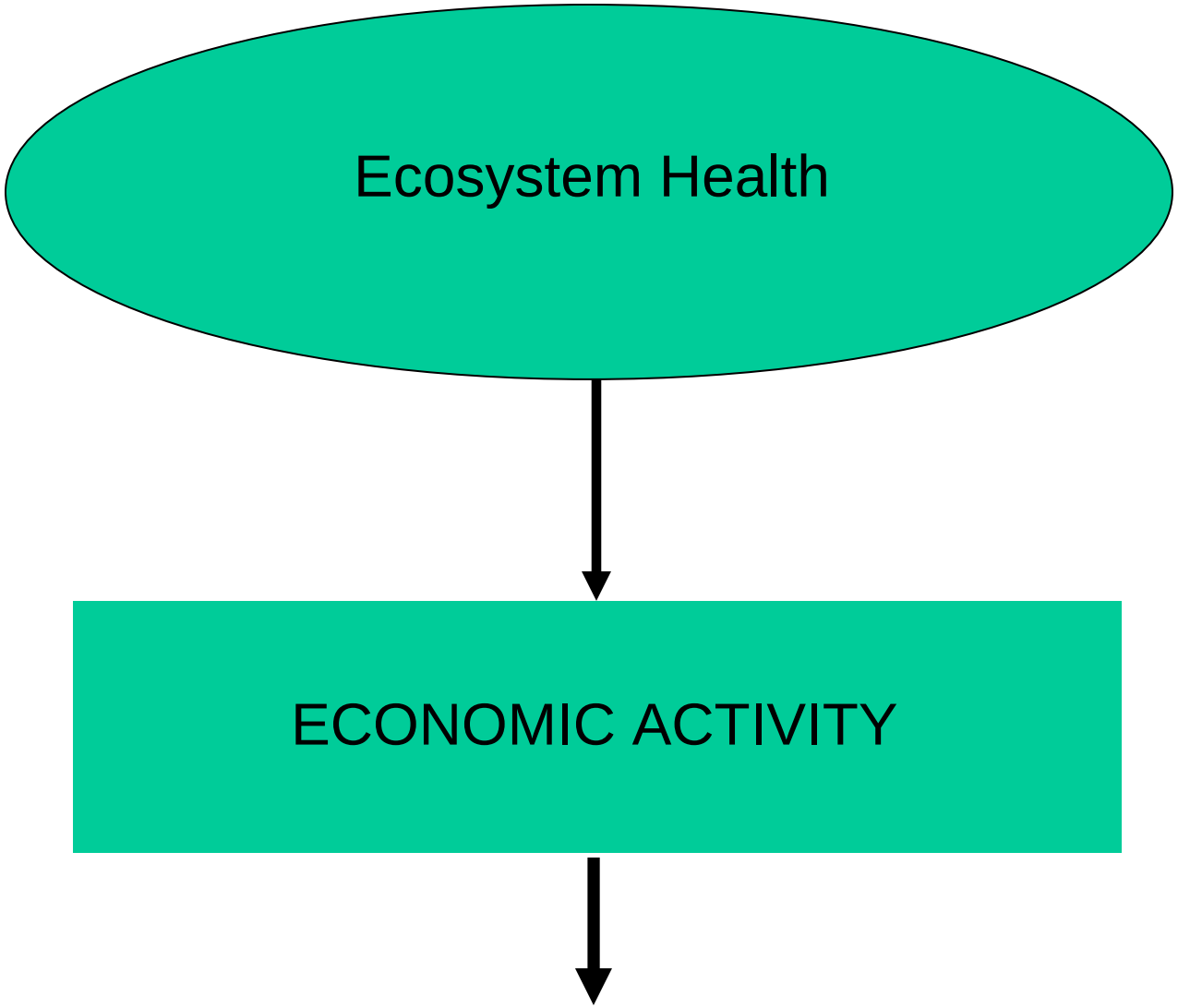
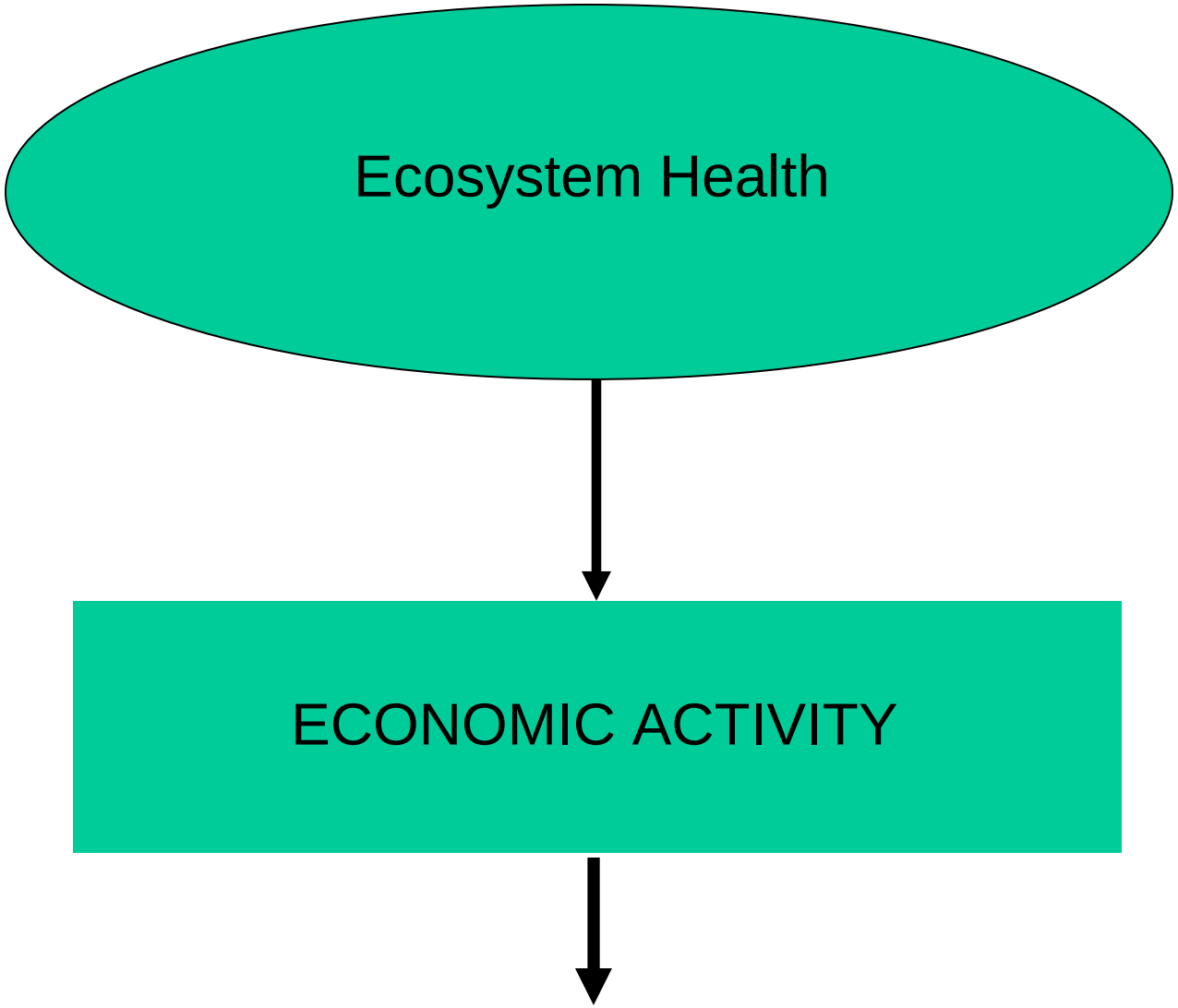

Ecosystem Health
ECONOMIC ACTIVITY
$$$ Value $$$


Ecosystem Health
ECONOMIC ACTIVITY
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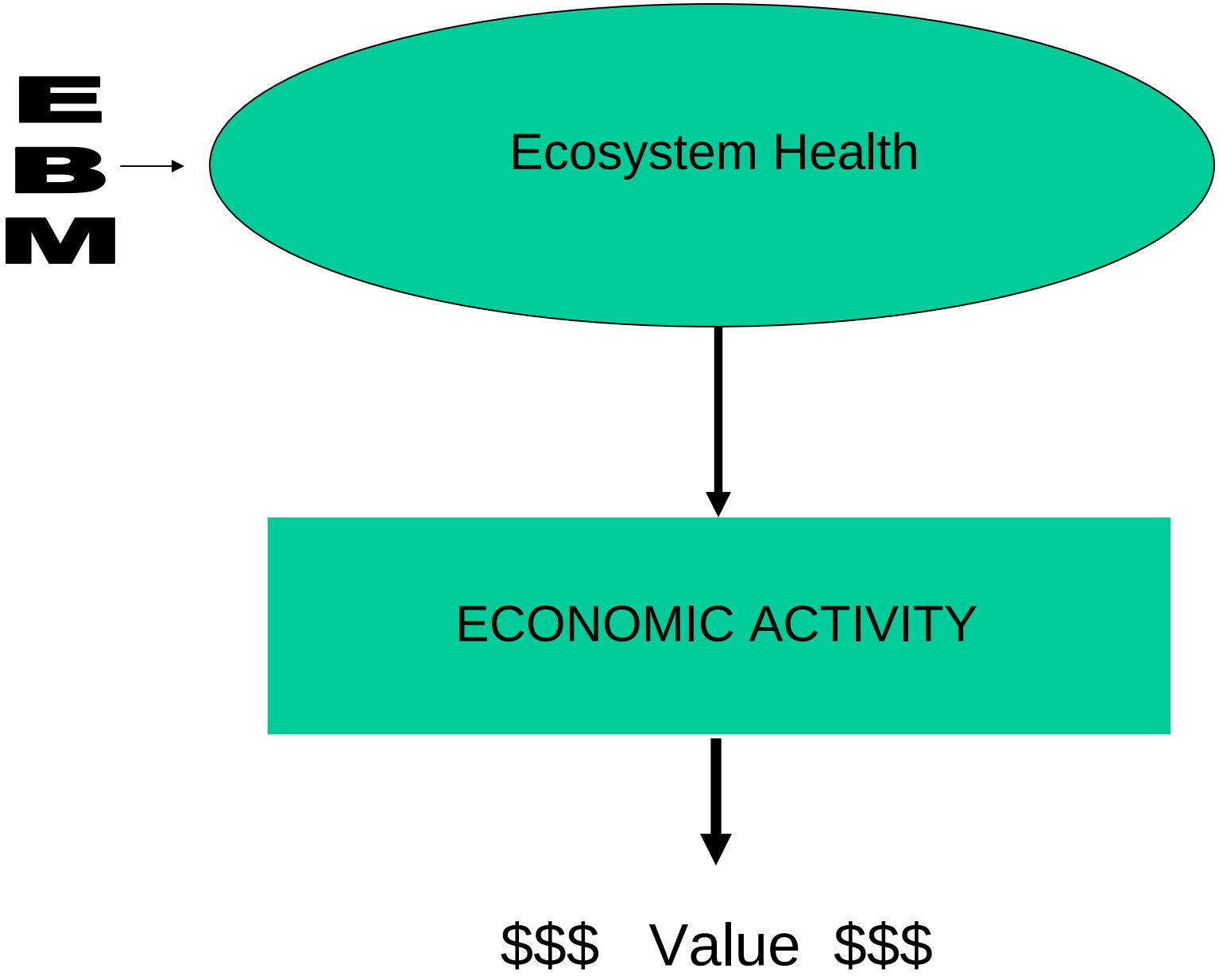
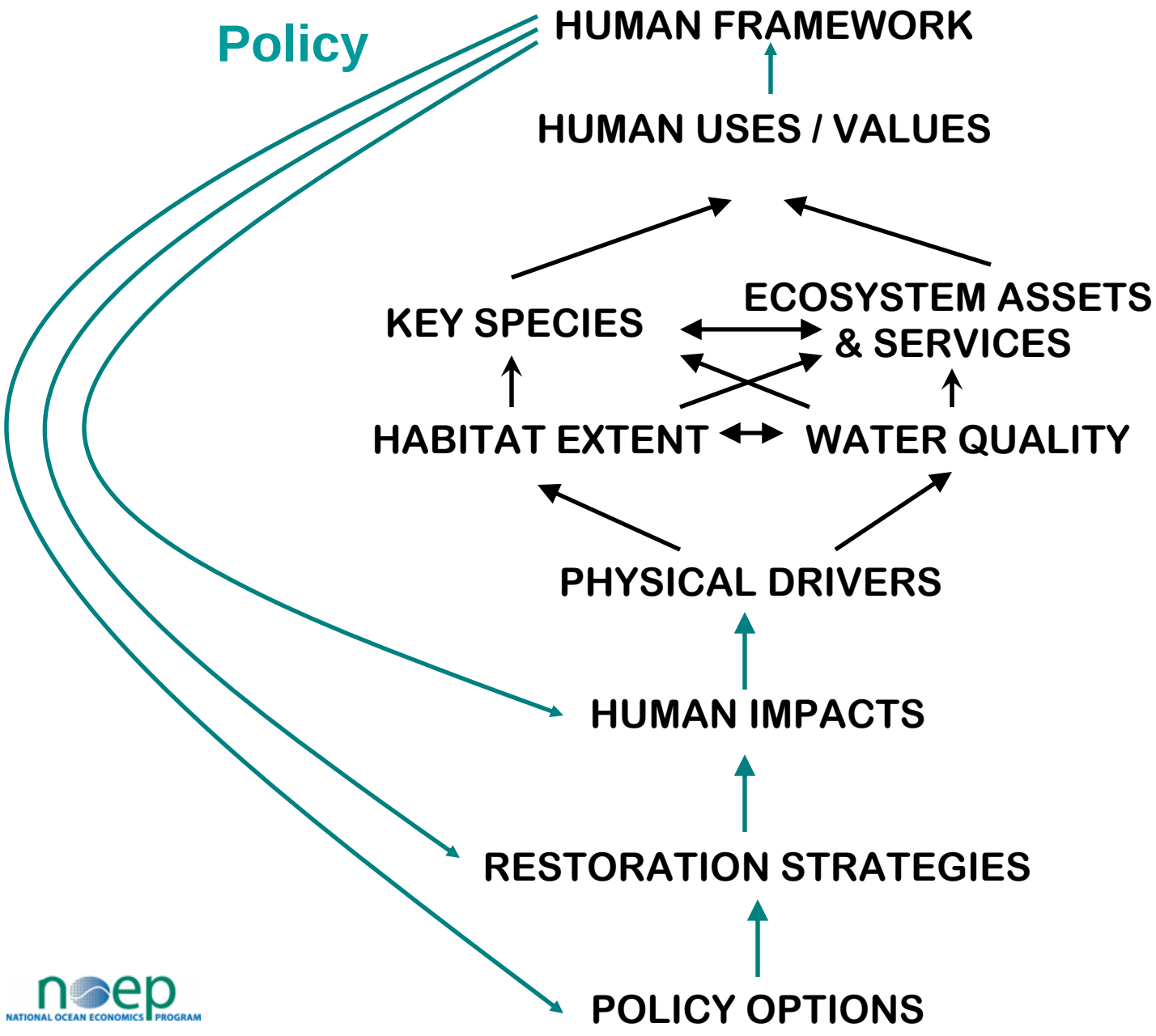

EBM
Ecosystem Health
ECONOMIC ACTIVITY
$$$ Value $$$

BUT....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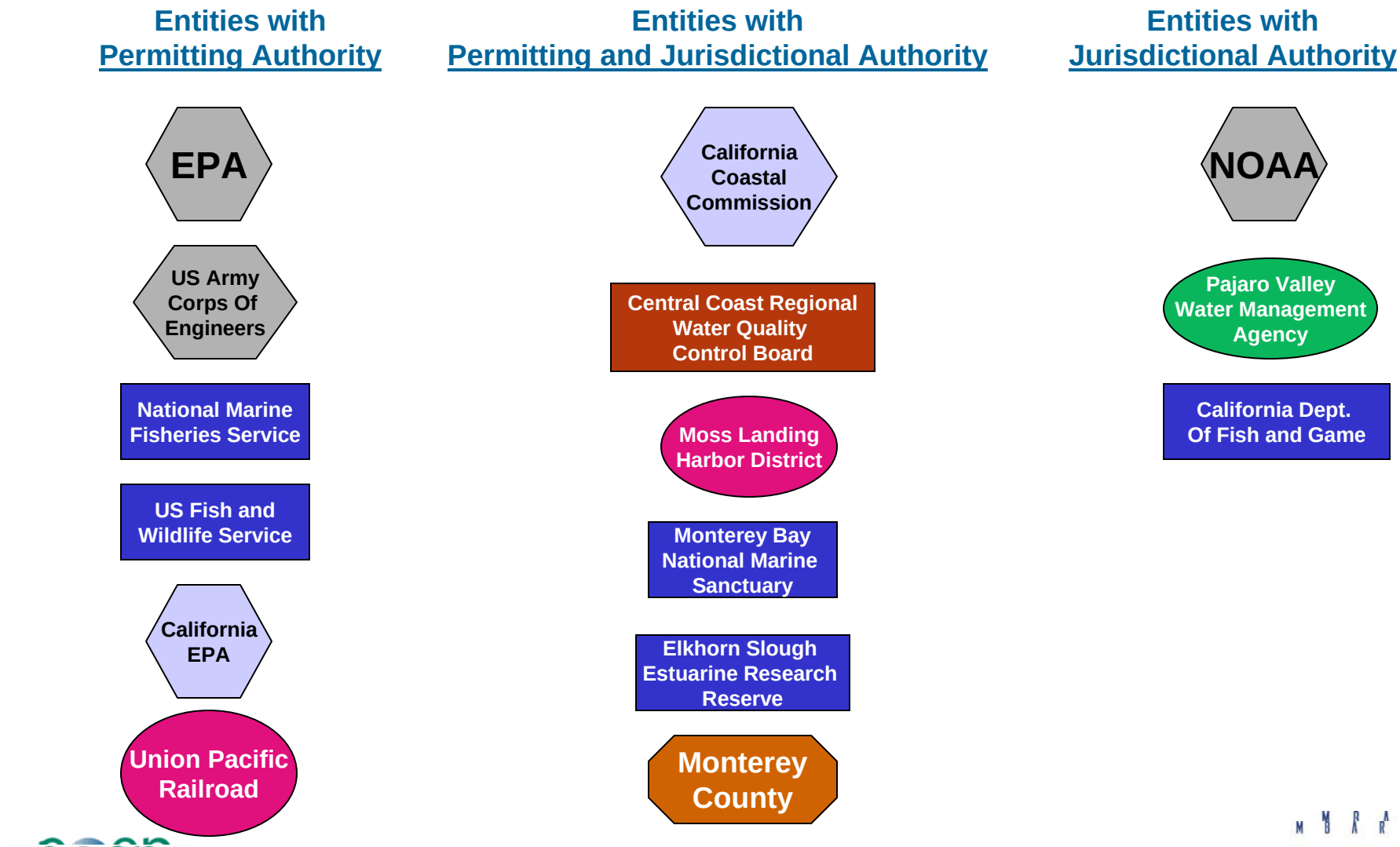
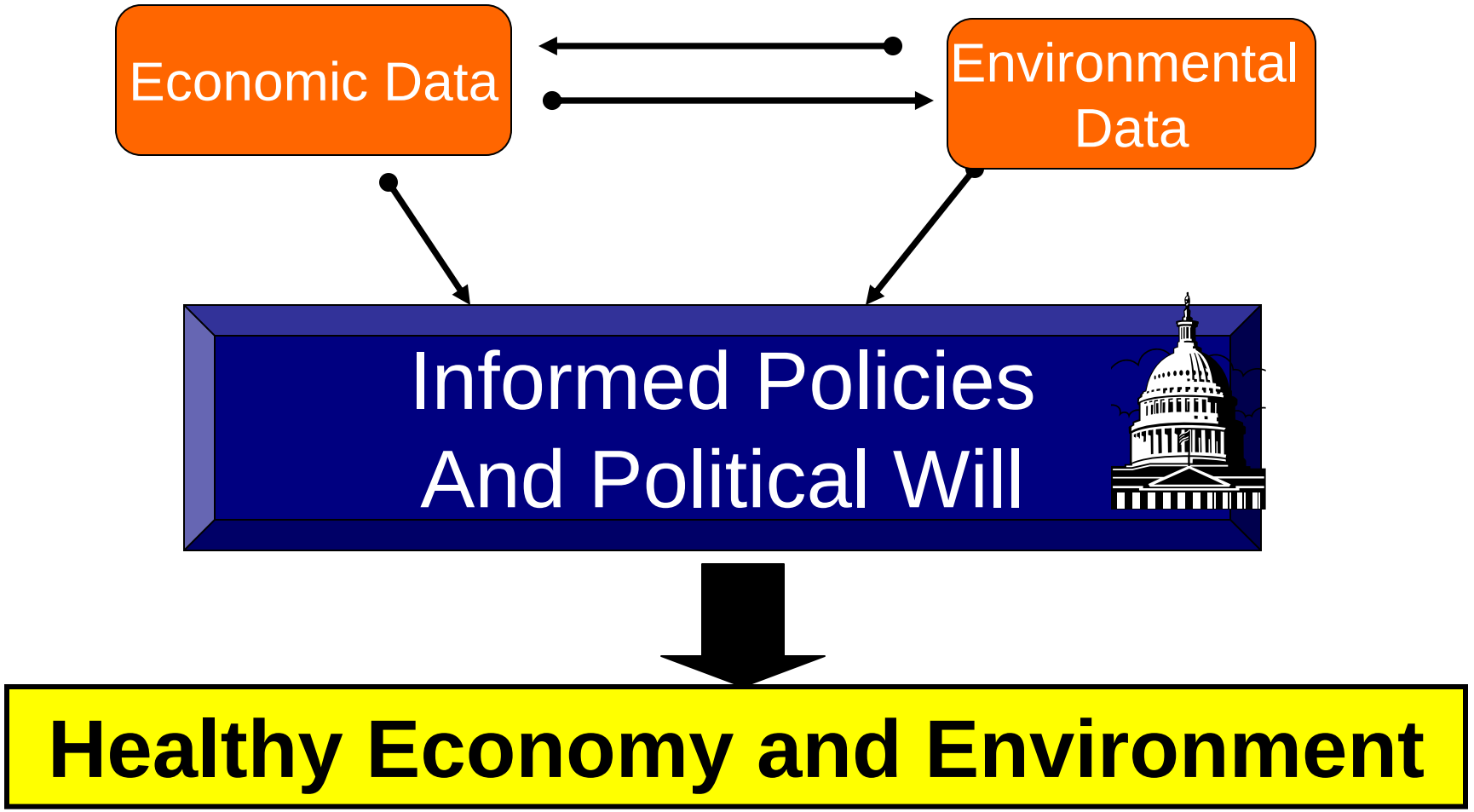
Elkhorn Slough Regulatory Framework





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Elkhorn MastCam Fri Dec 09 2005 343 05:05:52 PM
System Uptime 0+04:34:13
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Questions
www.OceanEconomics.org
Luke Coletti, 2005

Millennium Assessment (MA) 2003 Typology of Ecosystem Goods and Services

Provisioning	**Regulating**	**Cultural**
Goods produced or provided by ecosystems	Benefits obtained from regulation of ecosystem processes	Non-material benefits from ecosystems
• food • fresh water • fuel wood • genetic resources	• climate regulation • disease regulation • flood regulation	• spiritual • recreational • aesthetic • inspirational • educational

Supporting

Services necessary for production of other ecosystem services

•Nutrient Cycling
• Soil Formation
• Wildlife Habitat

Adapted from: Millennium Ecosystem Assessment *Ecosystems and Human Well Being* (2003)

	DESCRIPTION	EXAMPLES
Supportive Functions and Structures	*Ecosystem structures and functions that are essential to the delivery of ecosystem services*	
Nutrient cycling	Storage, processing & acquisition of nutrients	Net Primary Productivity
Soil formation	Capture of sediments and accumulation of organic matter	Formation of wetlands substrate and soils
Biological regulation and biodiversity	Species interactions including pollination	Control of pests and diseases Reduction of herbivory Pollination of wetlands plants
Habitat	The physical place where organisms reside	Refugium for resident & migratory species Spawning and nursery grounds for shrimp
Hydrological cycle	Movement and storage of H_2O through the biosphere	Aquifer recharge Maintain salinity gradients

Regulating Services		*Maintenance of essential ecological processes and life support systems*	
1	Gas regulation	Regulation of the chemical composition of the atmosphere and oceans	Biotic sequestration of CO2 Vegetative absorption of VOC's
2	Climate regulation	Regulation of local and global energy balance & hydrological cycle, and other biologically mediated climate processes.	Direct influence of land cover on temperature precipitation, wind, humidity, etc.
3	Disturbance regulation	Dampening of environmental fluctuations/disturbance	Storm protection (eg. by barrier islands) Flood protection (eg. by wetlands and forests)
4	Soil retention	Erosion control and sediment retention	Prevention of soil loss by from wind, wave action, runoff or other removal processes by wetlands and barrier islands
5	Waste Assimilation	Removal or breakdown of nutrients and compounds	Pollution detoxification and sequestration Water purification

Provisioning Services		*Provision of natural resources and raw materials*	
6	Water supply	Filtering, retention and storage of water	Provision of potable water and water purification Medium for Transportation Provision for irrigation and industrial use
7	Food	Edible plants and animals Arable land	Hunting, fishing, crops, grazing and aquaculture
8	Raw materials	Building & Manufacturing	Lumber, skins, plant fibres, oils, dyes, etc.
		Fuel and energy	Fuel wood and organic matter
		Fodder and fertilizer	Leaf litter, salt hay, excrements, etc
9	Genetic resources	Genetic resources	Variety of gene pools in fish species
10	Medicinal and Plant Disease Resources	Biological and chemical substances for use in agriculture and human treatment	Medicines and pest control chemicals obtained from estuarine dependent species
11	Ornamental resources	Resources for fashion, handicraft, jewelry, pets, worship, decoration & souvenirs	Shells used as jewelry Dried grasses

Cultural Services		*Enhance emotional, psychological and cognitive well being*	
12	Recreation	Opportunities for rest and enjoyment	Eco-tourism, birdwatching, outdoor sports
13	Aesthetic	Enjoyment of landscape and its elements	Coastal beaches and wetlands Clean water
14	Science & Education	Development of knowledge	A “natural field laboratory” for understanding coastal biological and physical processes
15	Spiritual & Historic	Spiritual or historic information	Use of estuaries as motif in books, film, painting, folklore, national symbols, architect., advertising, etc
			Natural features with religious or historic values