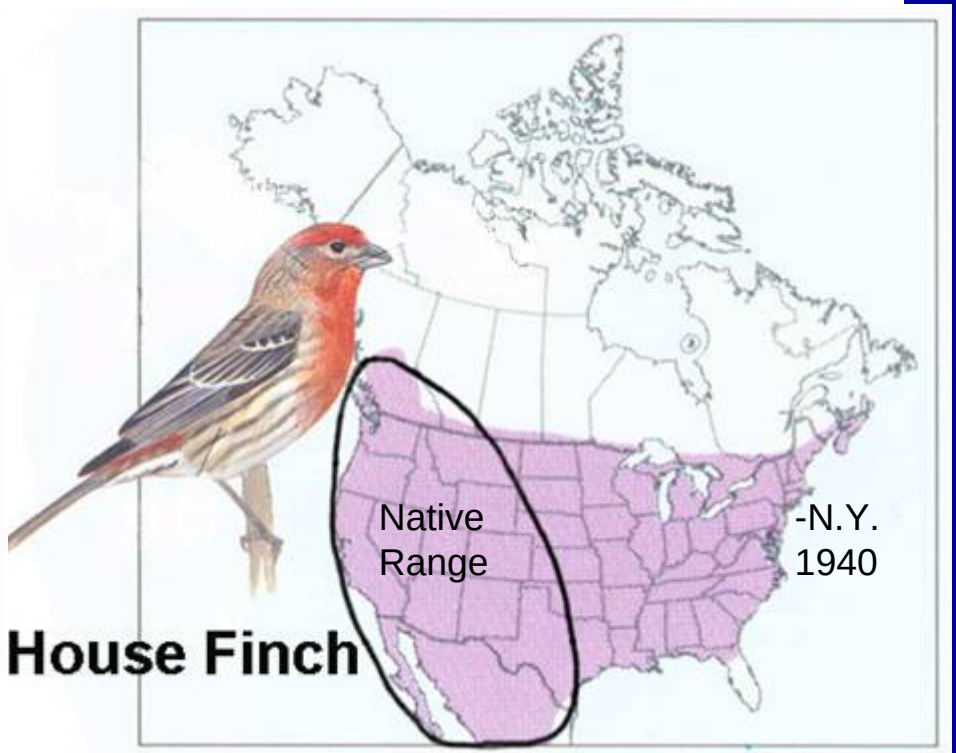
The most common birds in my backyard in South Bend, IN



Desirable Alien Species

Undesirable Alien species

Sea Lamprey in the Great Lakes

U.S. + Canada:
$15 million/year since 1956

Alien Species Established in the N.A. Great Lakes

Cumulative # species discovered

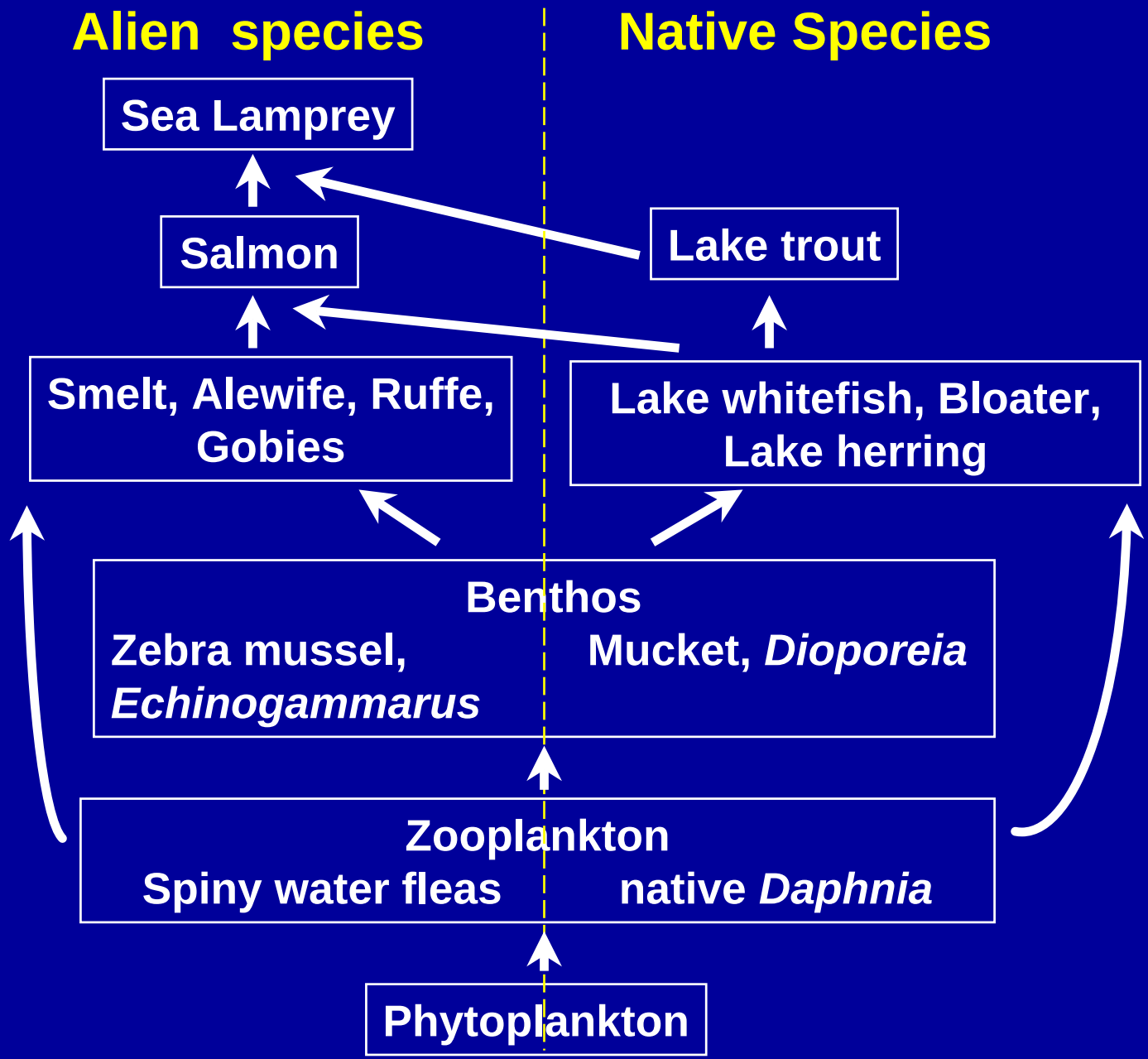
180
140
100
60
20

1800 1850 1900 1950 2000

Year

(from Ricciardi 2001)

Transformation of Great Lakes Foodweb



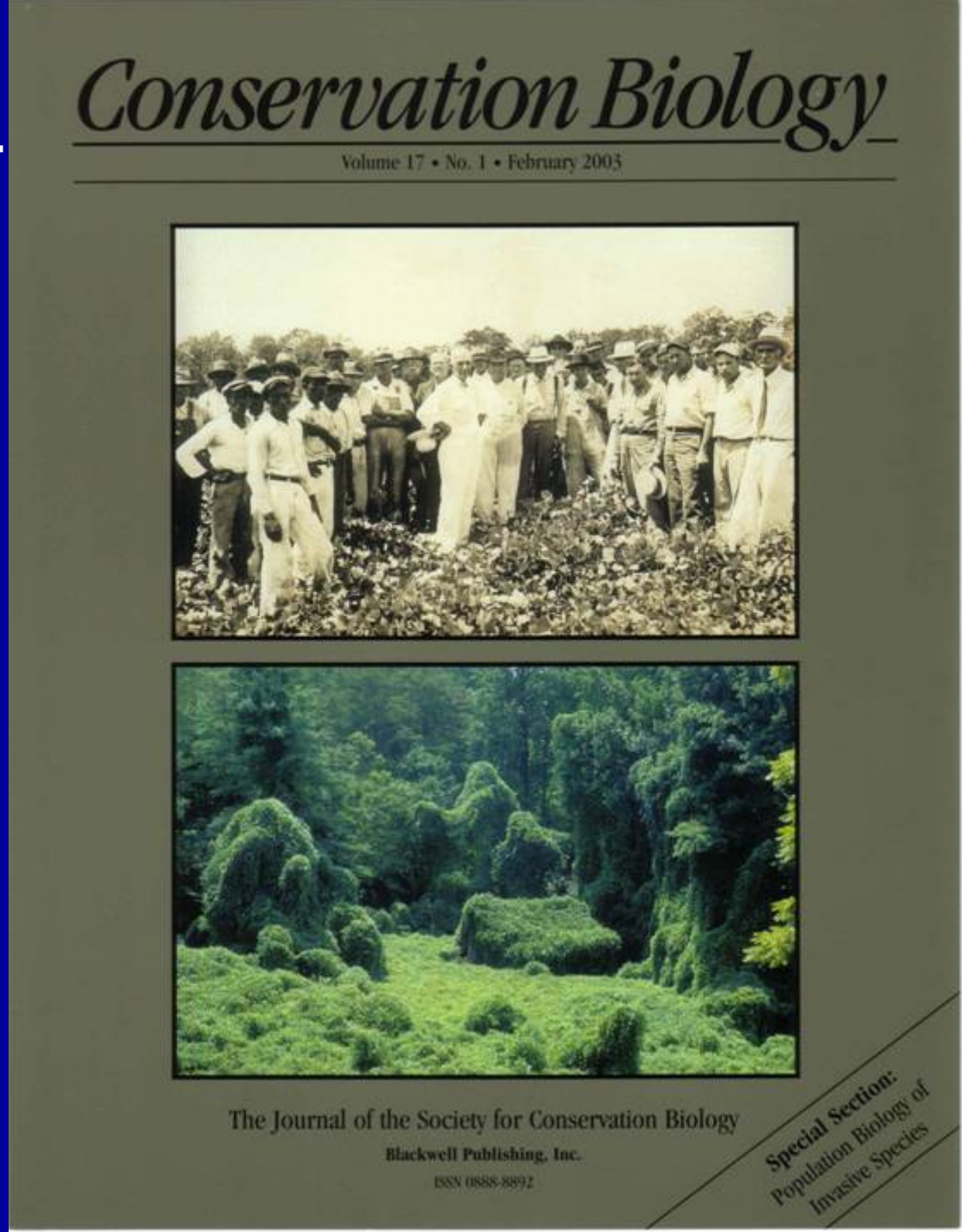
1000s of species, far-reaching impacts

- Cause large local and regional losses of ecosystem goods and services
- Contribute to 46% of imperiled species in US
- 1 of top 5 contributors to biodiversity losses globally, in all ecosystems
- Zebra mussels alone cost $100-200 million per year in Great Lakes region
- Alien agricultural weeds—millions per year, e.g., leafy spurge costs at least $4 million/year in only 4 states
- Costs at least $137 billion per year in US

Difficult Cases

Net Effect = Benefit – Harm

***But* harm often develops slowly, is distributed among millions of people, and human values differ & change.**



Definitions

Alien = exotic = nonindigenous = nonnative

Invasive = spreads and causes (net) harm

Invasive alien = focus of concern

Invasive Species: Ecology and Economics

David M. Lodge
University of Notre Dame,
ISIS and projects

Risk Assessment: what harm has or is likely to result from a species under given assumptions of current human behavior?

Risk Management: what alternative management scenarios exist and which are likely to be cost-effective?

Research collaborators

Biologists: John Drake (NCEAS), Reuben Keller (UND), Cindy Kolar (USGS), Gary Lamberti (UND), Brian Leung (McGill), Hugh MacIsaac (Windsor)
Mathematician: Mark Lewis (Alberta)
Economists: Jason Shogren (U Wyo) David Finnoff (U Wyo)

Funding

EPA, Great Lakes Fisheries Commission,
National Science Foundation, NOAA Sea Grant, US
Department of Agriculture, US Fish & Wildlife Service, NCEAS

Invasion process

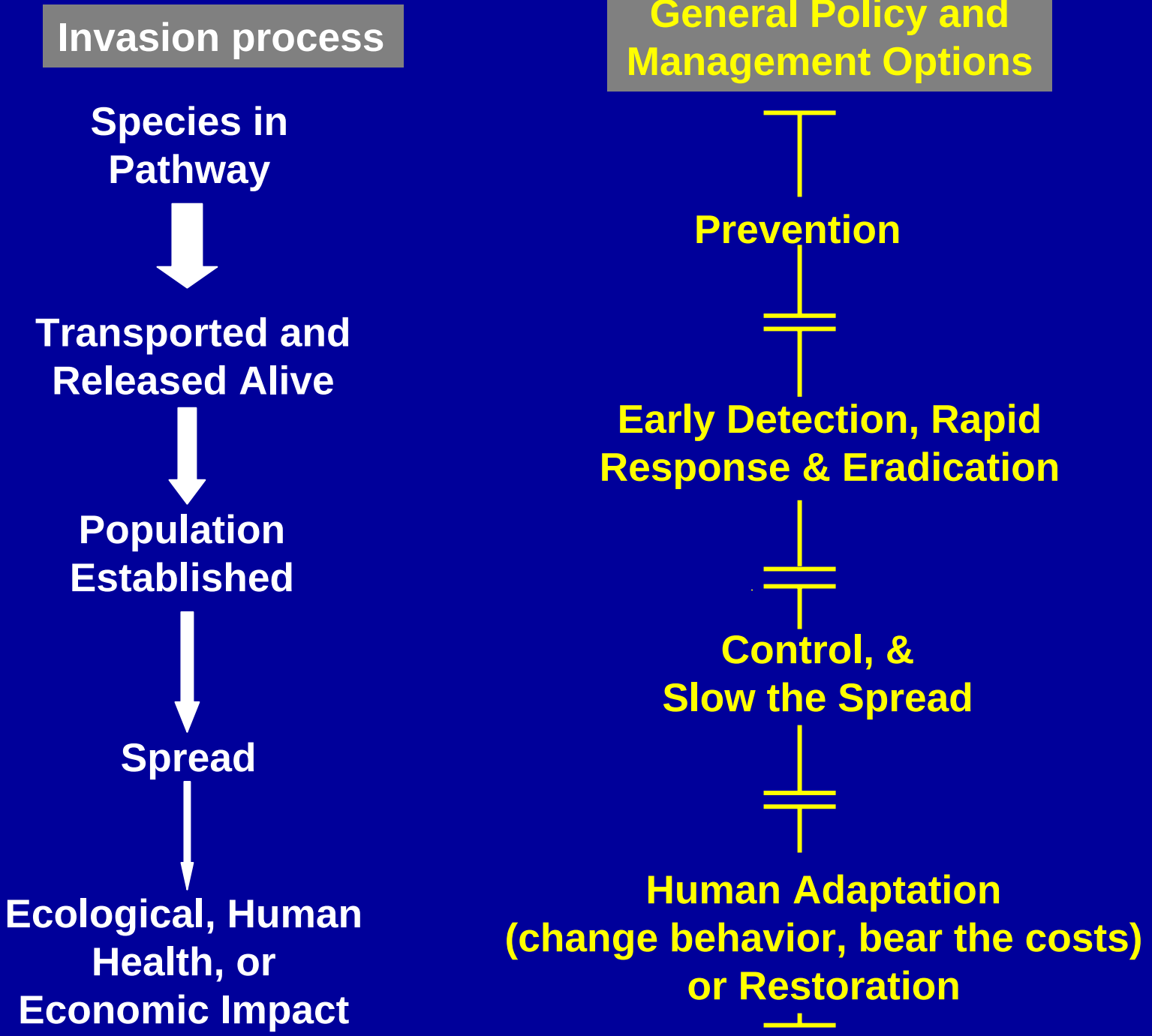
Species in Pathway

Transported and Released Alive

Population Established

Spread

Ecological, Human Health, or Economic Impact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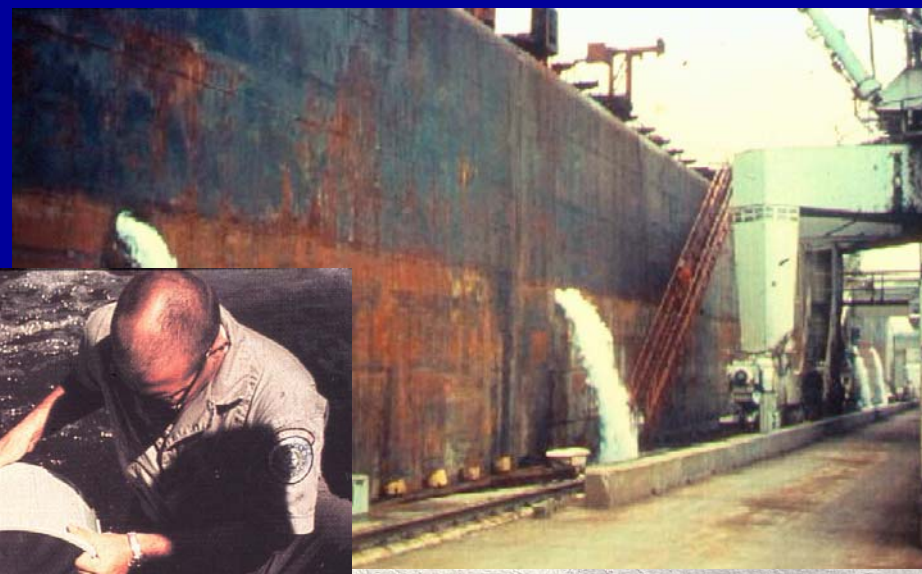
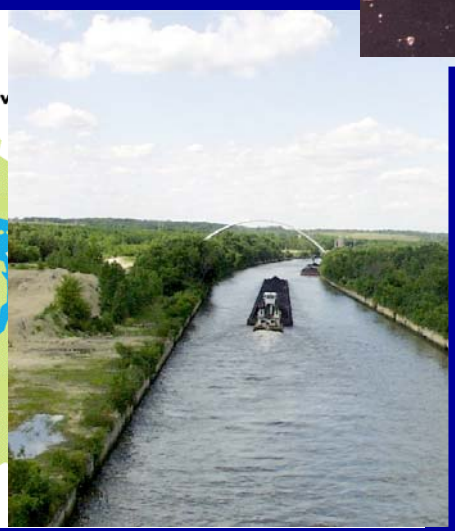
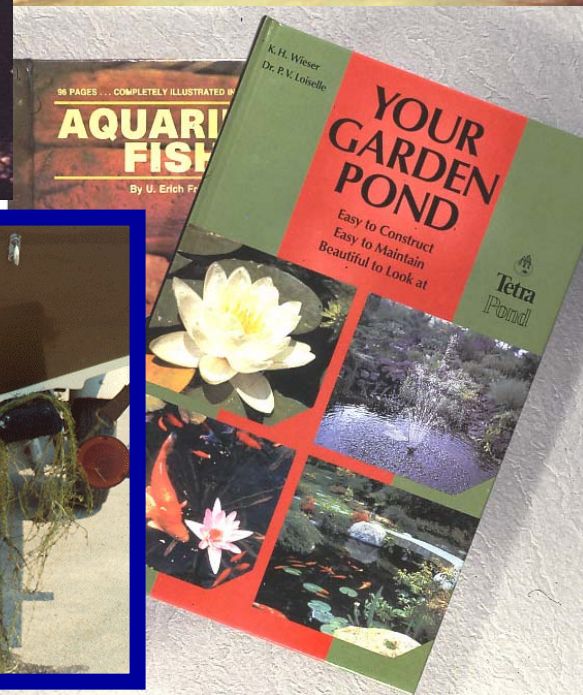
Pathways

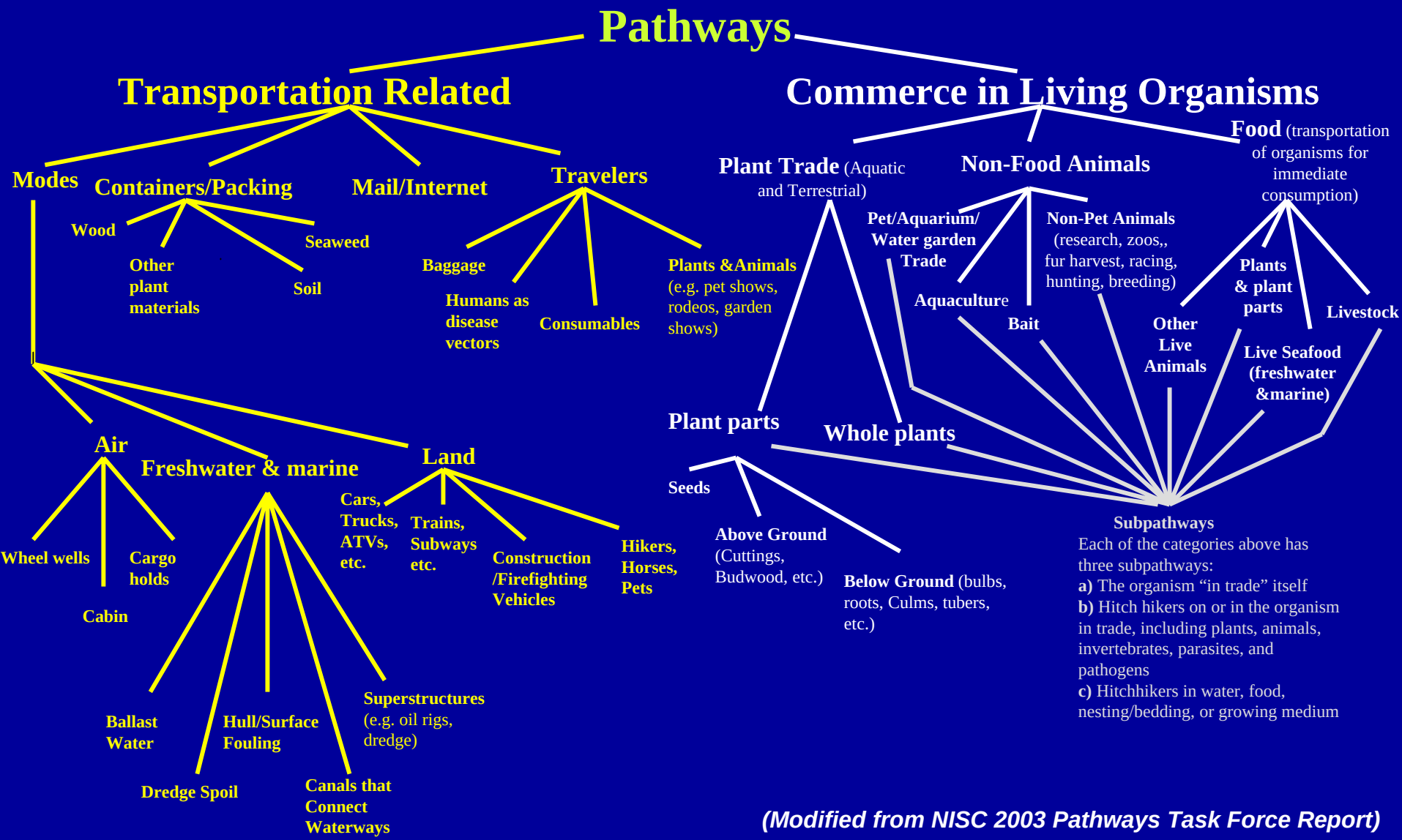
seedman.com
Seeds From Around the World
Jim Johnson, Seedman, 3421 Bream St., Gautier, MS 39553
Phone: 800-336-2064 Fax: 228-497-5488



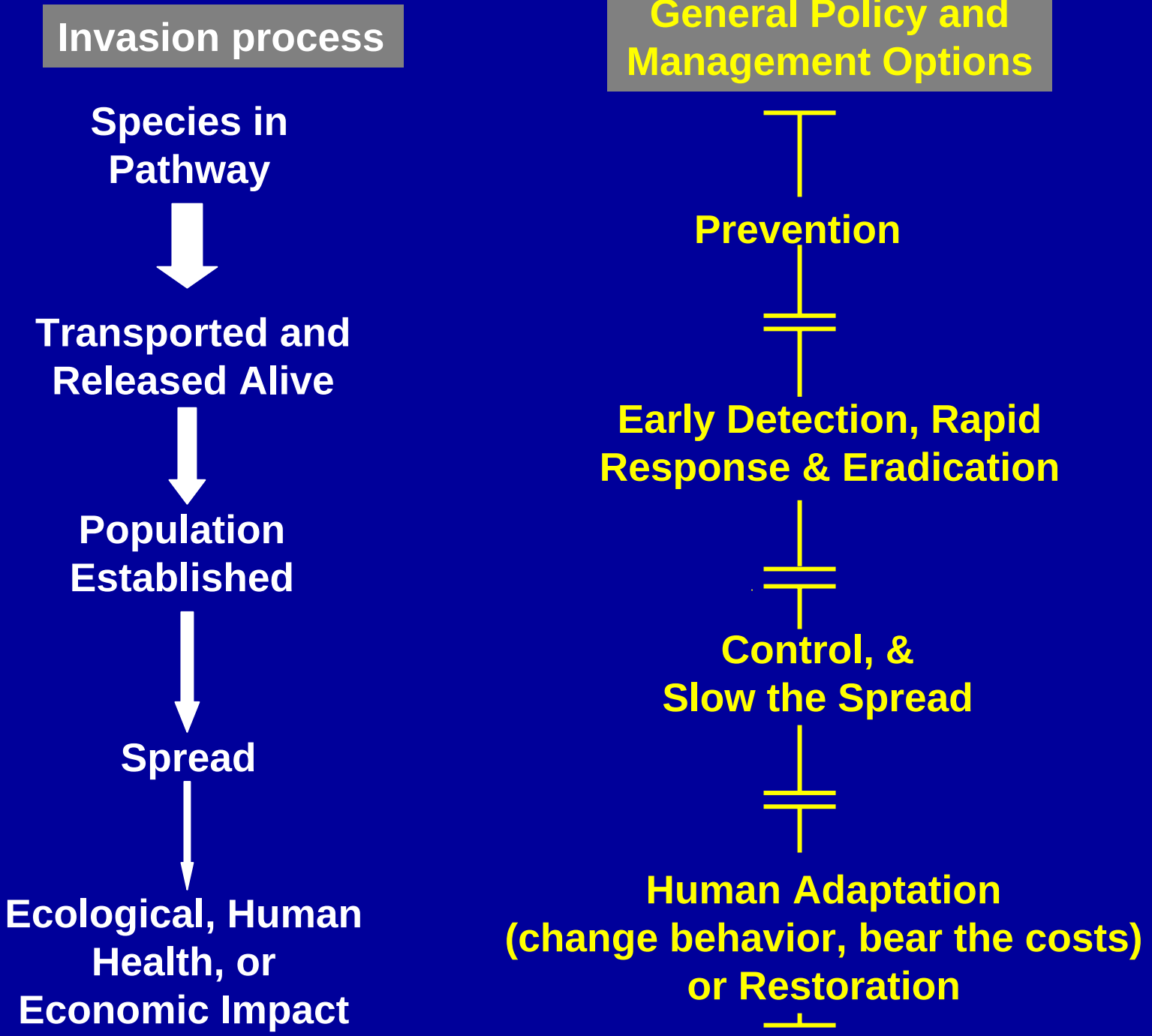




Pathways of Nonindigenous Species in the US



(Modified from NISC 2003 Pathways Task Force Report)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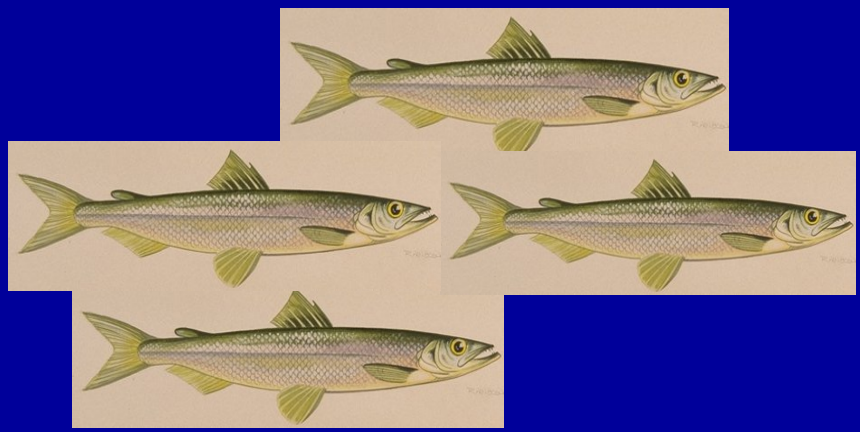
How is risk of pathway related to . . .

- **Identity and characteristics of species?**
- **Number of organisms released?**

How is risk related to species traits? Successful vs. failed fishes

Successful (24 species)

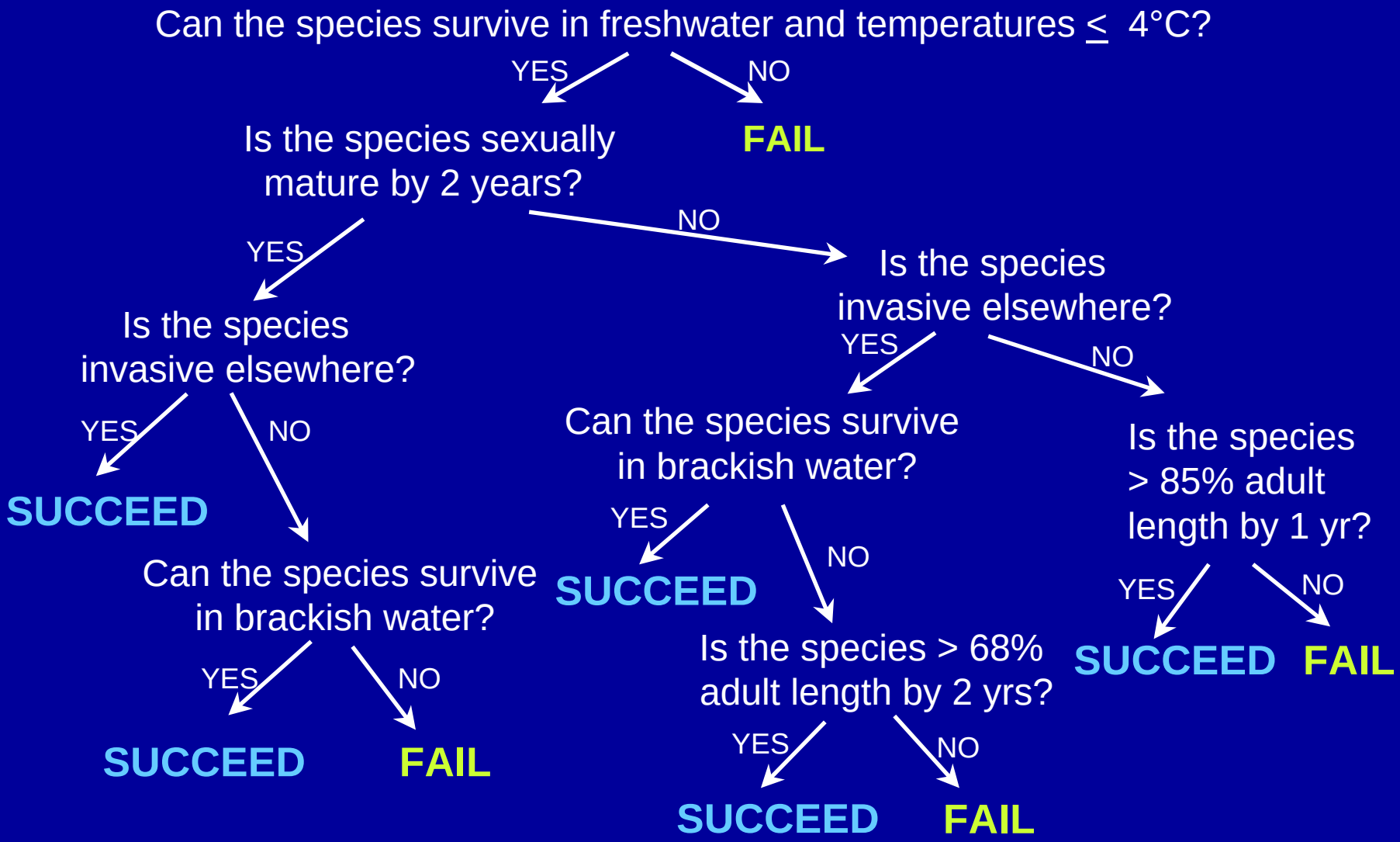


***e.g.*, rainbow smelt**

Failed (21 species)

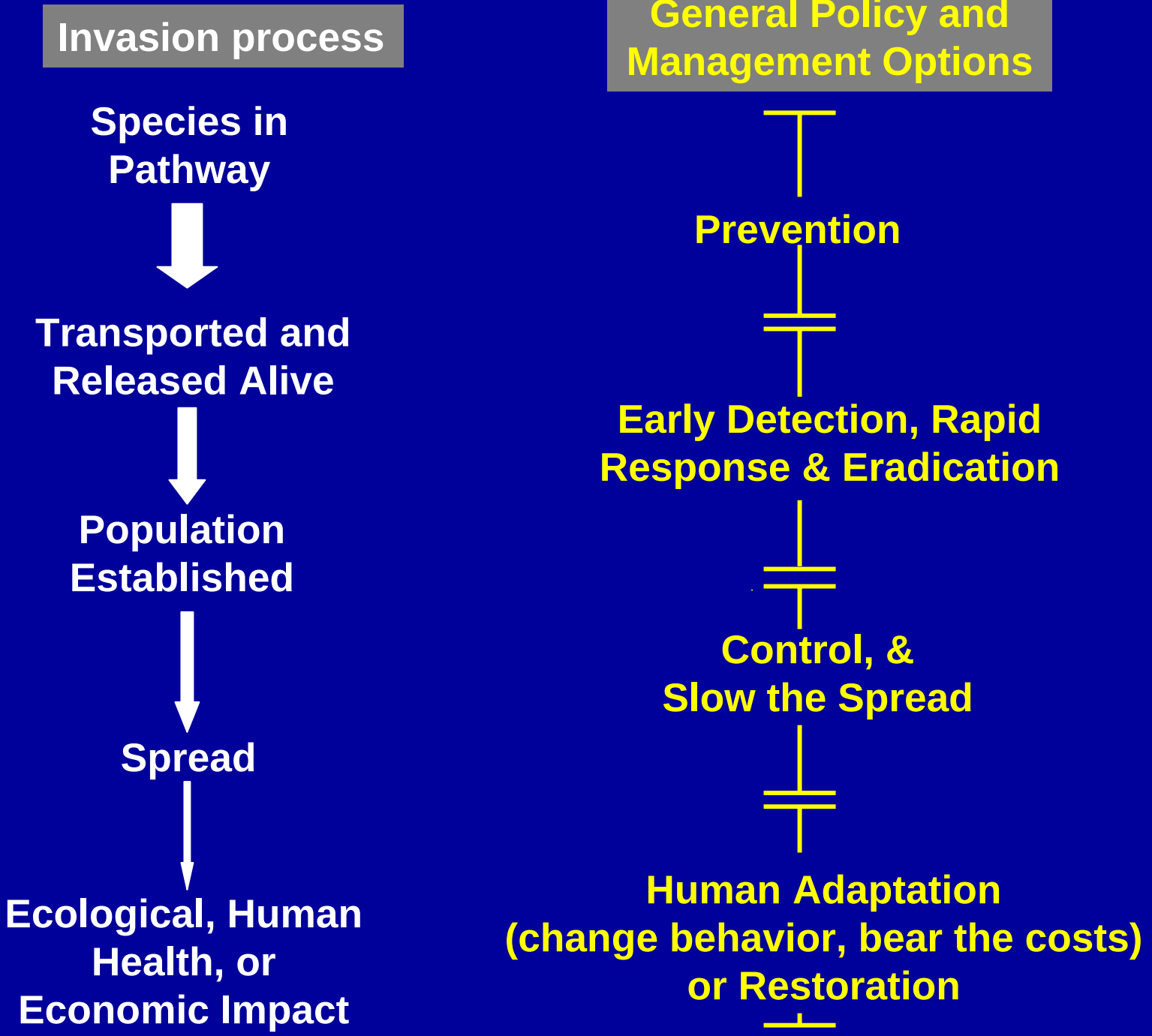
***e.g.*, Atlantic salmon**

Results: Decision tree for establishment



(Kolar & Lodge 2002)

Overall correct classification rate 91%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How is risk of pathway related to . . .

- Identity and characteristics of species?
- Number of organisms released?
  - How many individuals are released?

Pathways

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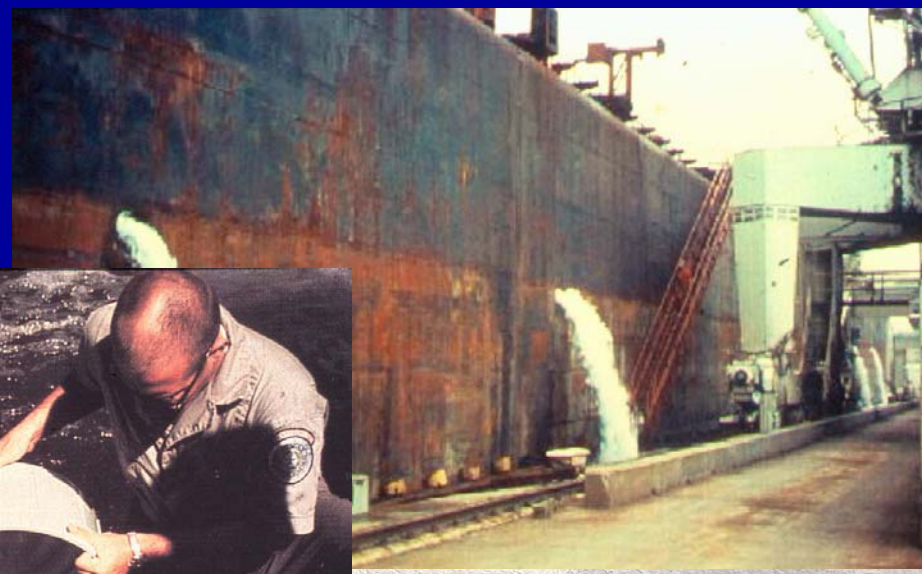
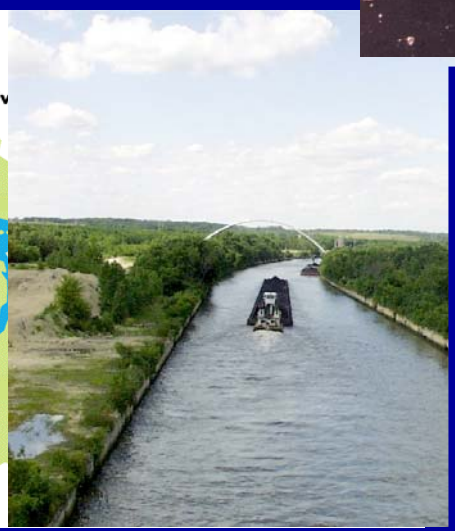
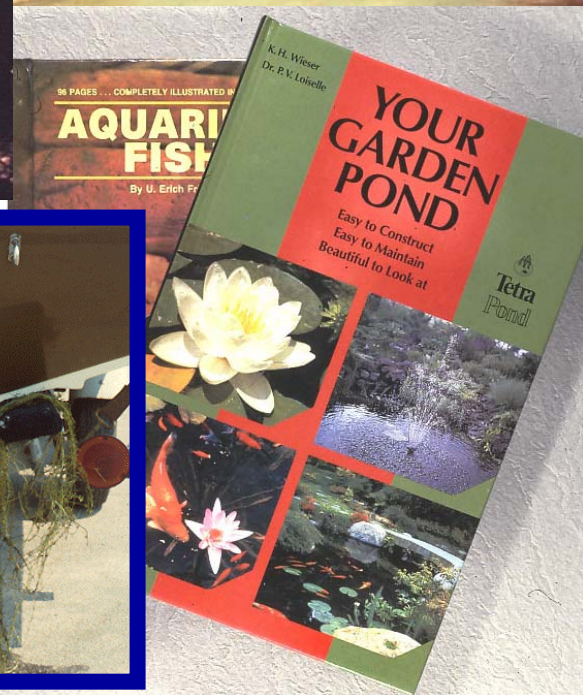
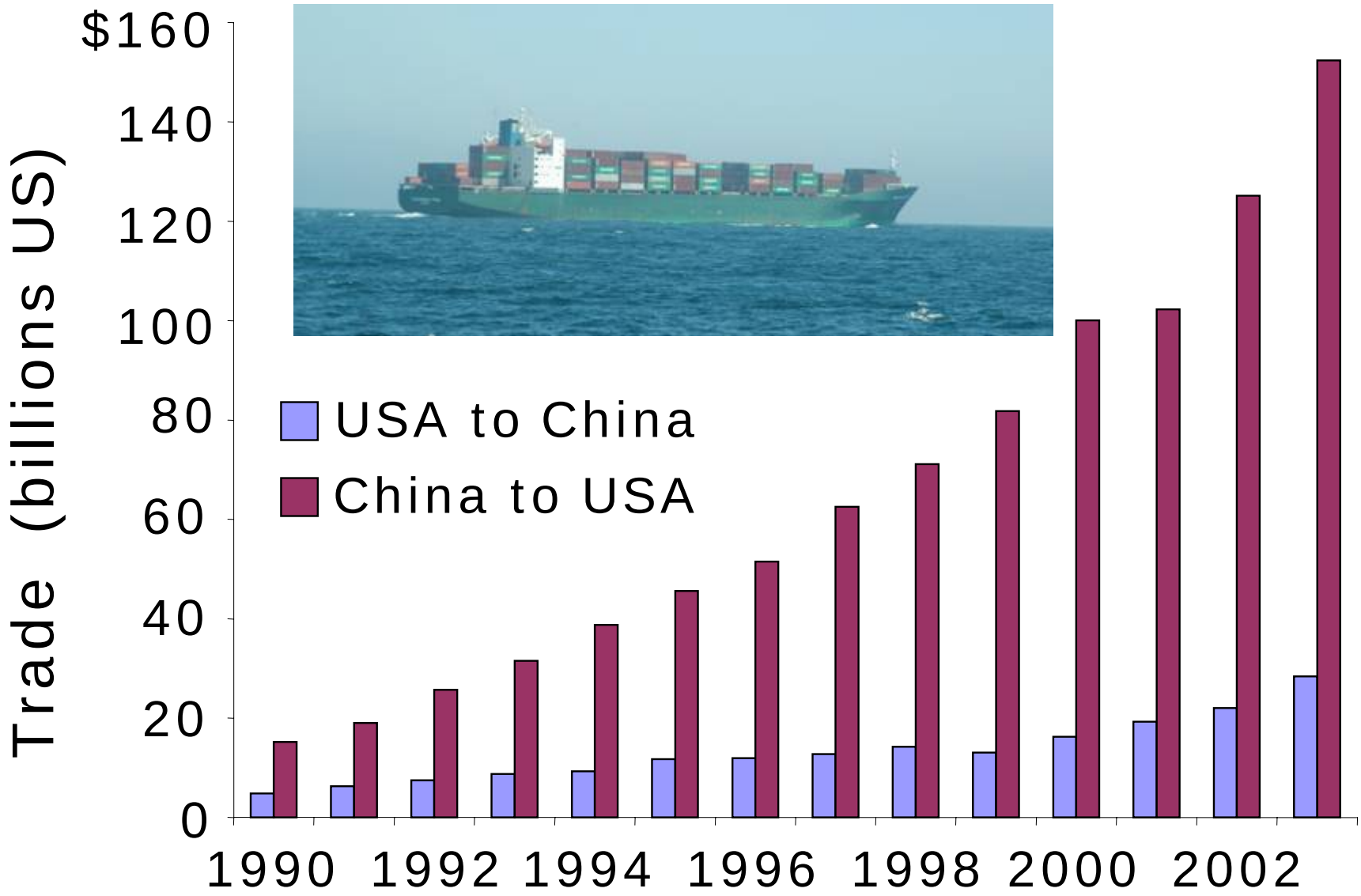


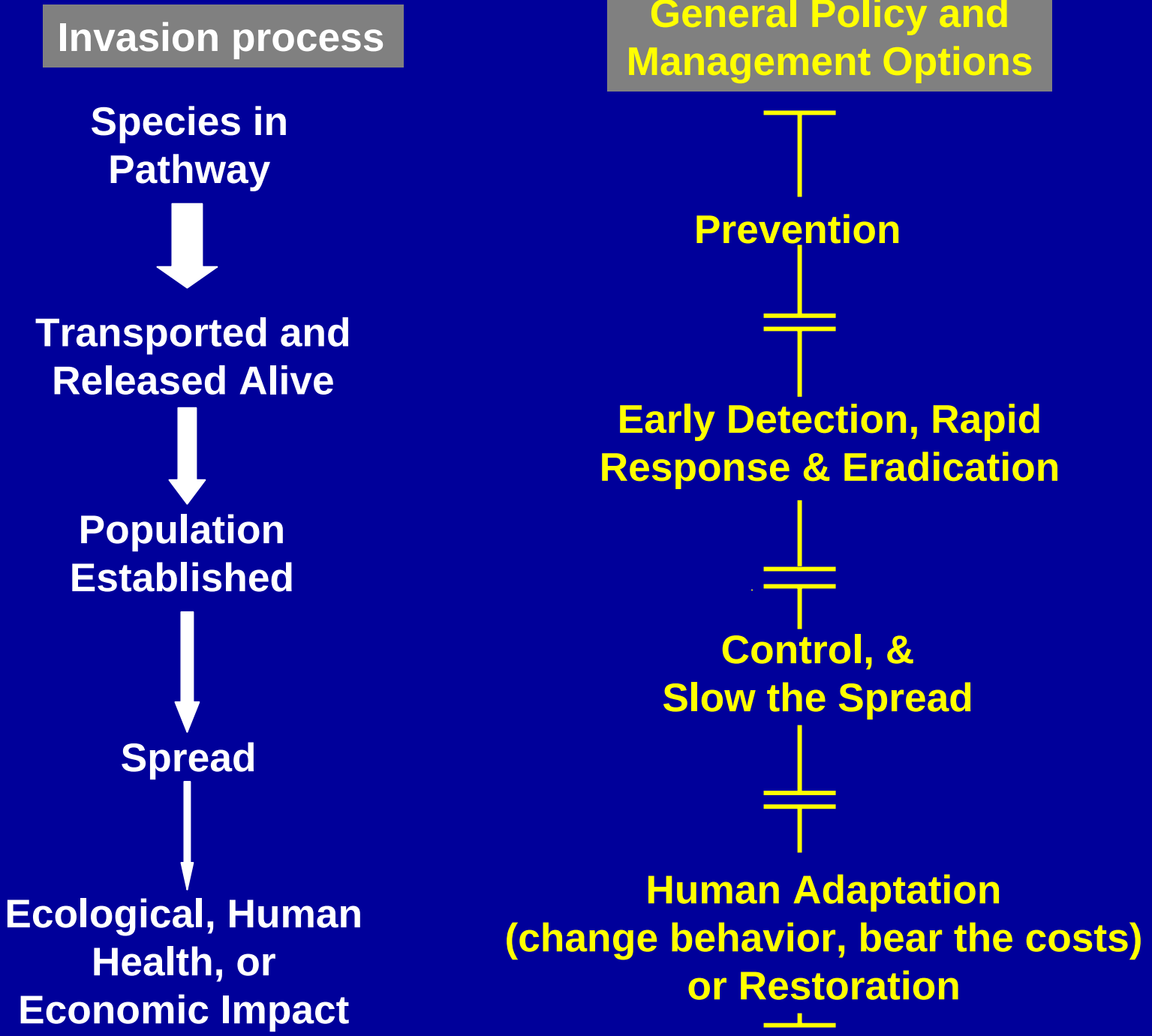




Total Trade Between China and USA



http://ese.export.gov/SCRIPTS/hsrun.exe/Distributed/ITA2003_NATIONAL/MapXtreme.htx;start=HS_Page4Chart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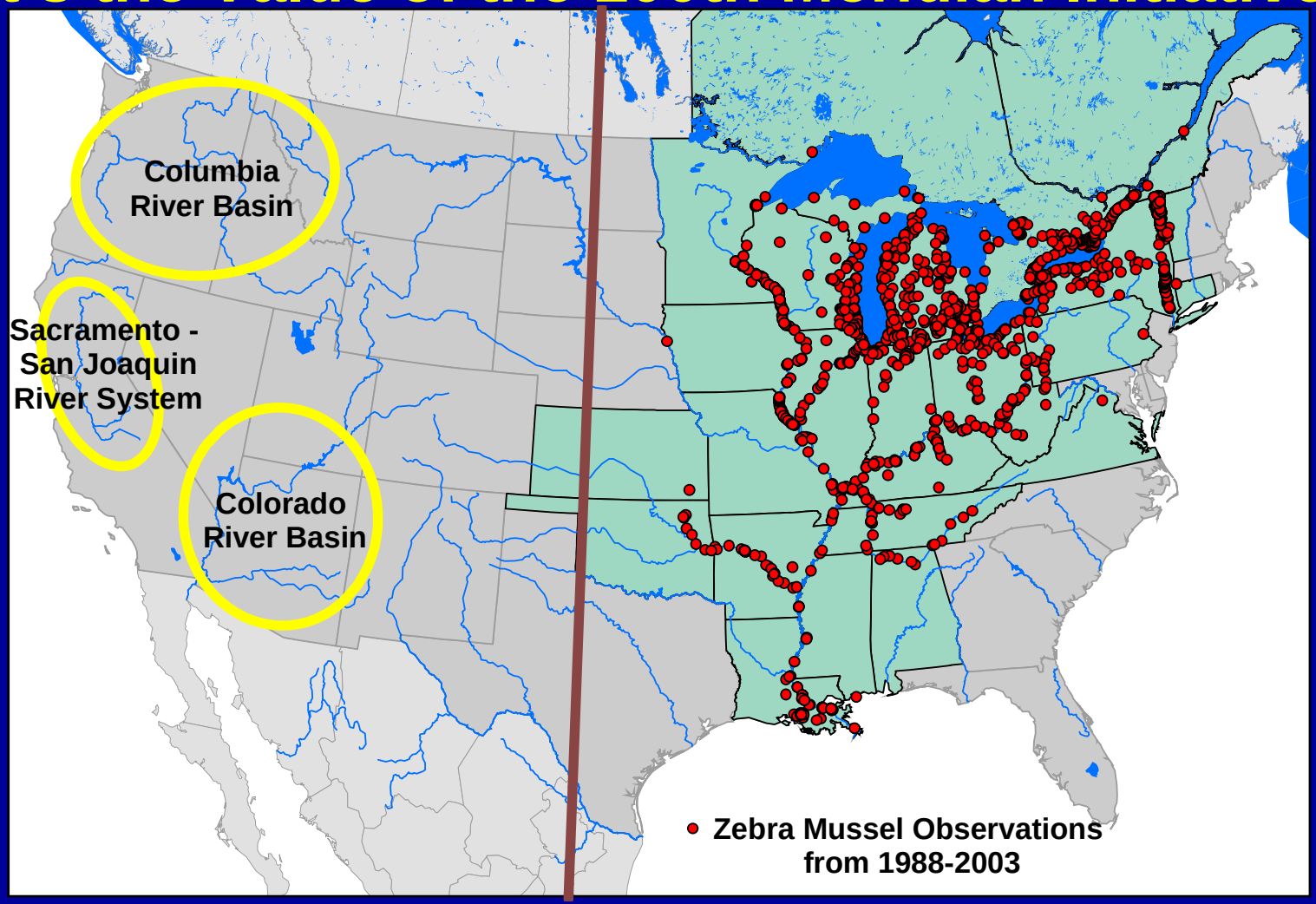
How is risk of spread related to . . .

- Suitable habitat?
- Post-establishment pathways?
- Human perception of risk of impact?

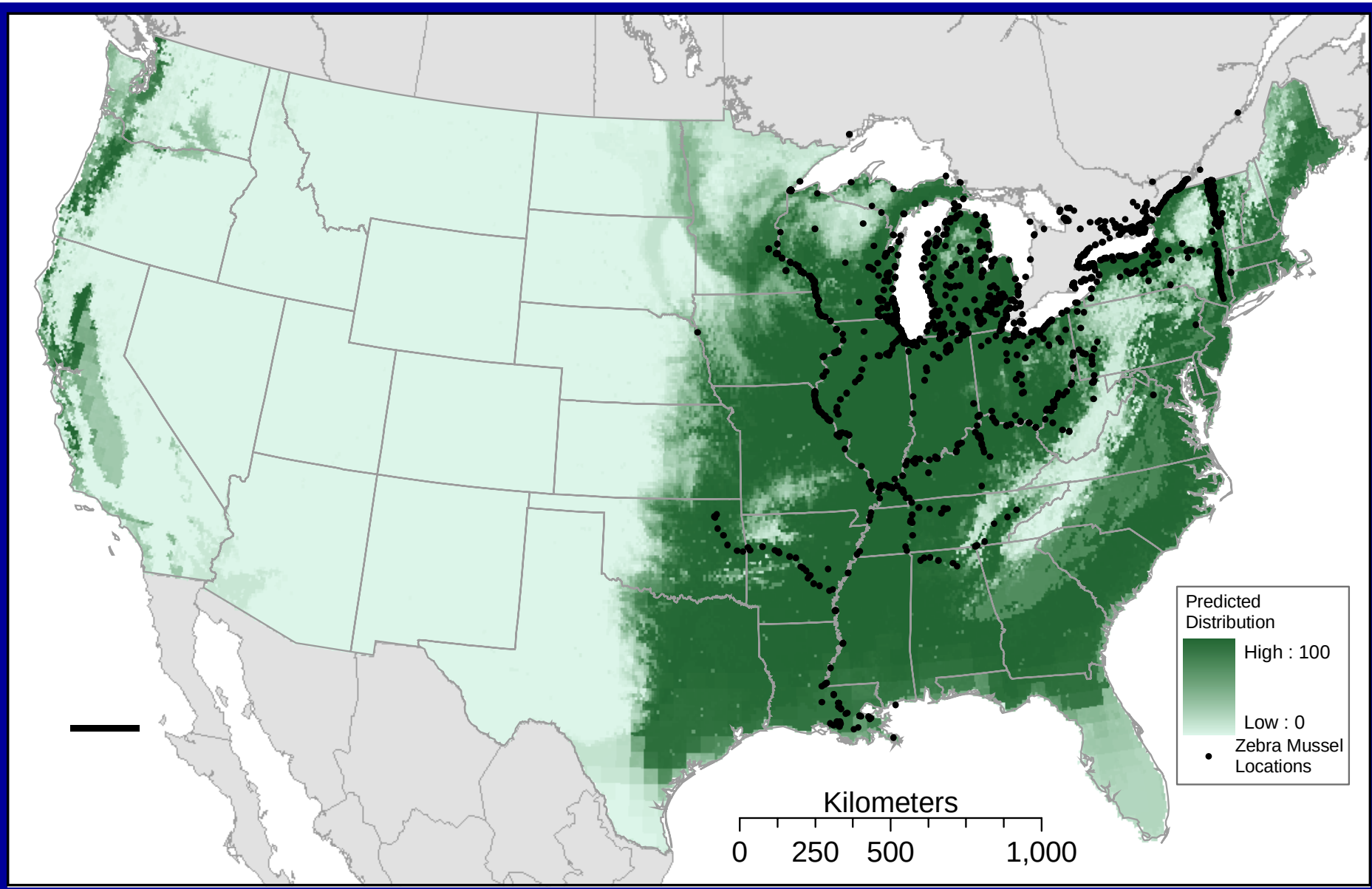
On-going Zebra Mussel Invasion: What's the Value of the 100th Meridian Initiative?



Goals

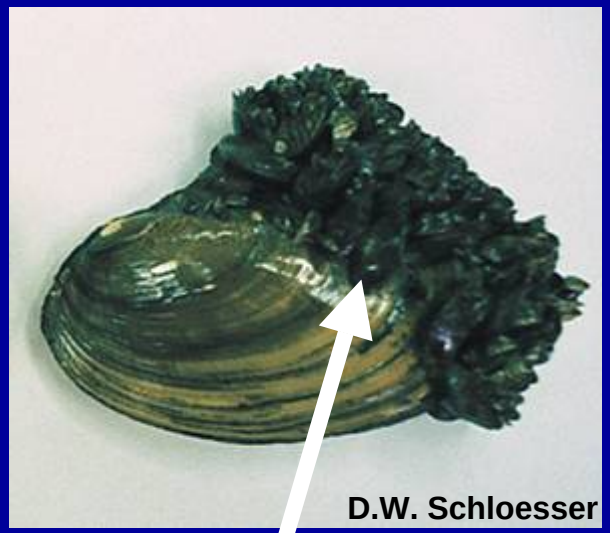
- Estimate pathways & potential habitat of ZM in the West
- Determine biota & economic services at risk
- Calculate cost & effectiveness of education and control efforts

GARP Prediction: Potential Distribution of Zebra Mussel

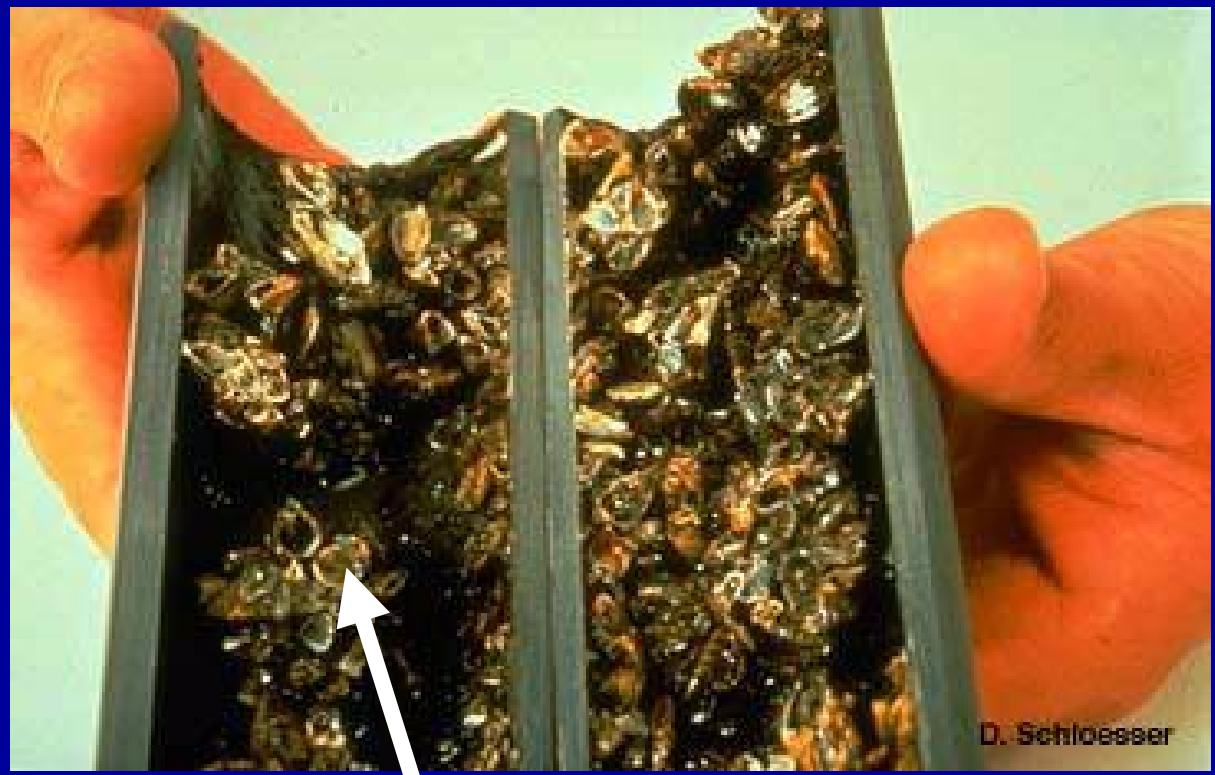


(*From Drake & Bossenbroek 2004 BioScience*)

Zebra mussel damage

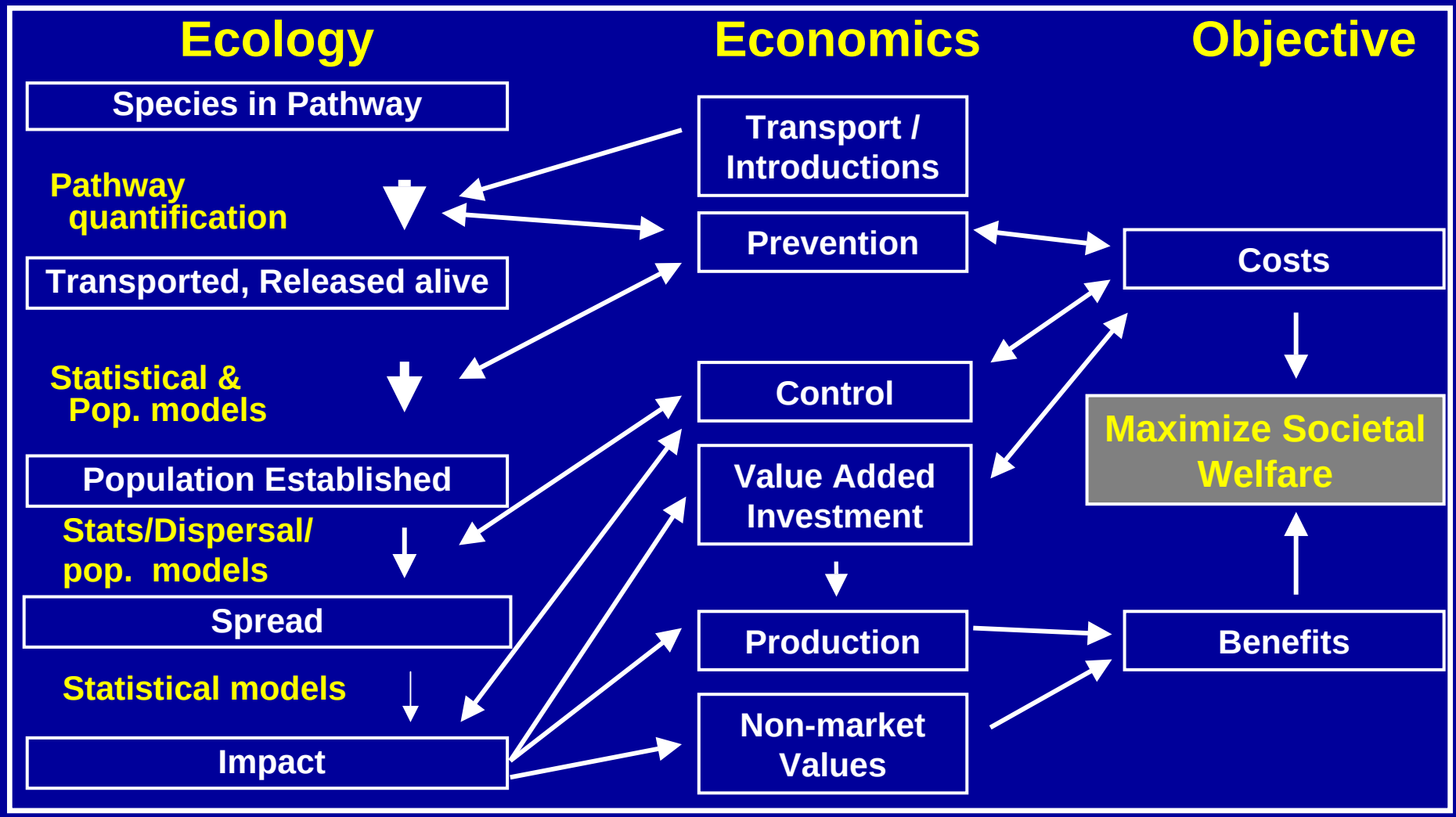


Non-market costs: extirpation of native clams and other undesirable environmental changes



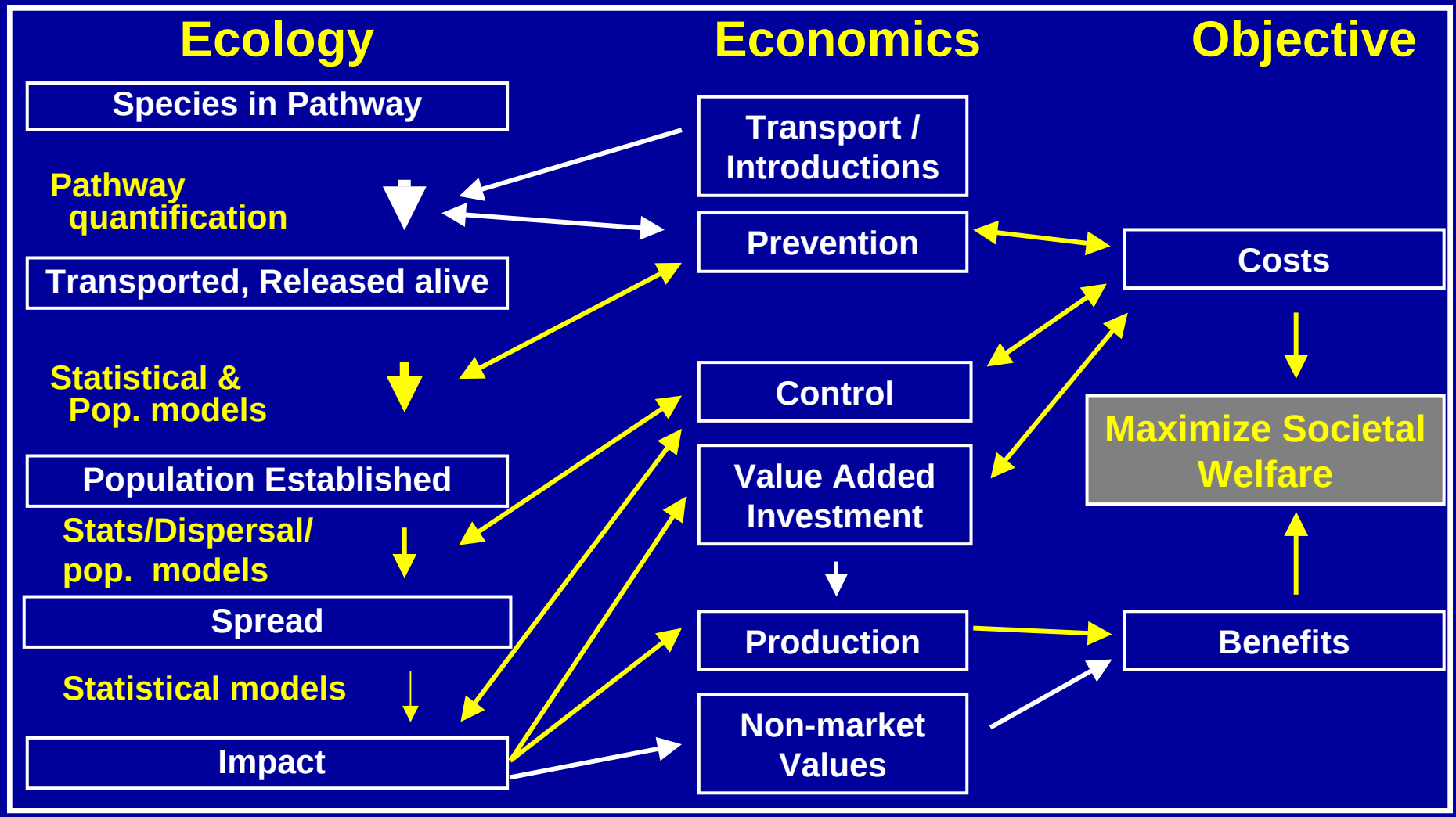
Market costs: clog water intake pipes, at a cost of millions annually around Great Lakes

Conceptual Approach



(From Leung, Lodge et al. 2002. Proc Royal Soc London B 269: 2407-2413)

Zebra Mussels: Conceptual Approach



(From Leung, Lodge et al. 2002. Proc Royal Soc London B 269: 2407-2413)

The Value of Prevention: What's it worth to keep zebra mussels out of the next lake?

Up to $324,000 per year *per lake* to prevent invasion —to protect power plants alone.

For comparison, in FY2001, the USFWS distributed to the States $825,000 in response to *all aquatic invasive species in all lakes in all states*.

(From Leung, Lodge et al. 2002. Proc Royal Soc London B 269: 2407-2413)

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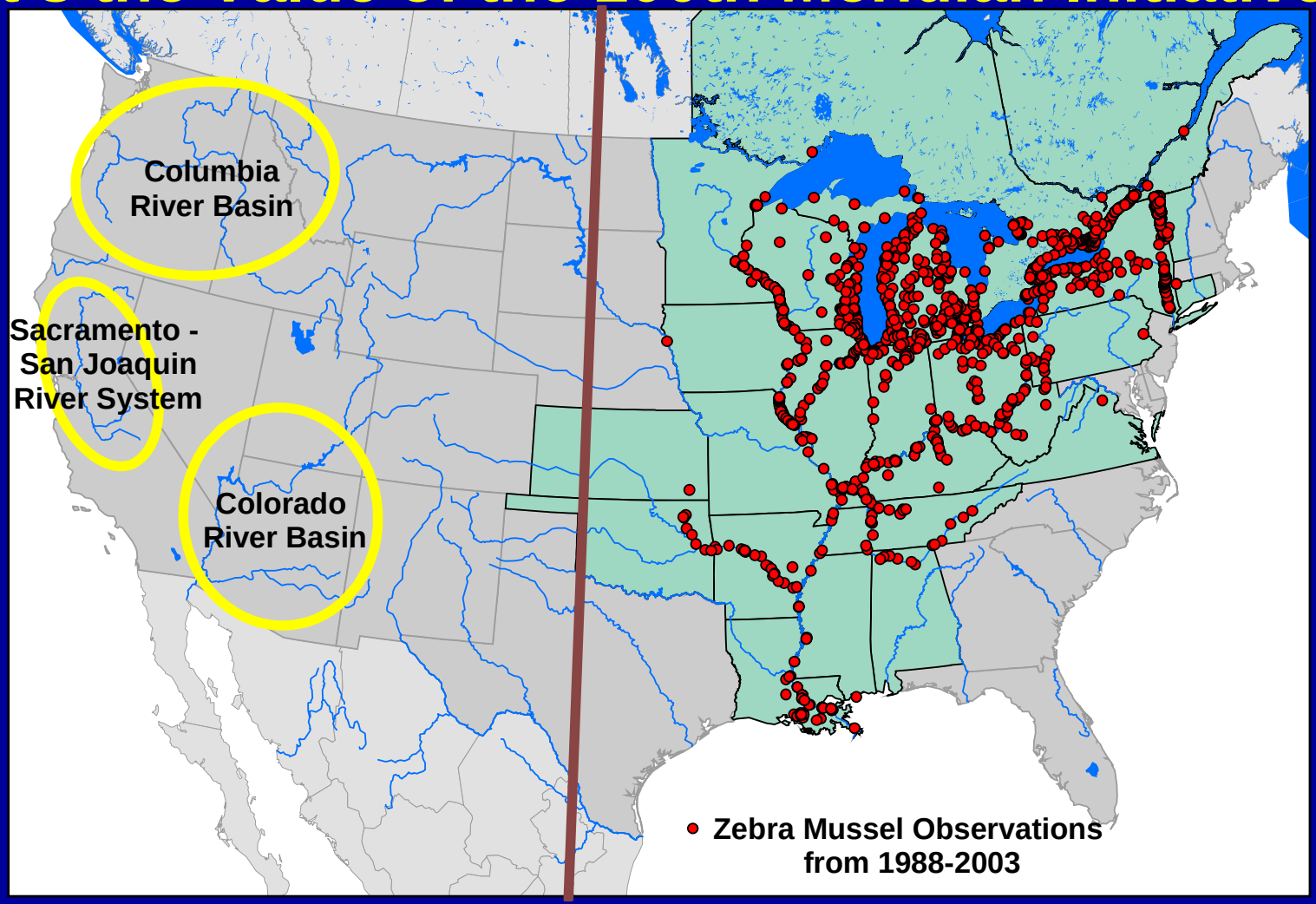


Goals

- Estimate pathways & potential habitat of ZM in the West
- Determine biota & economic services at risk
- Calculate cost & effectiveness of education and control efforts

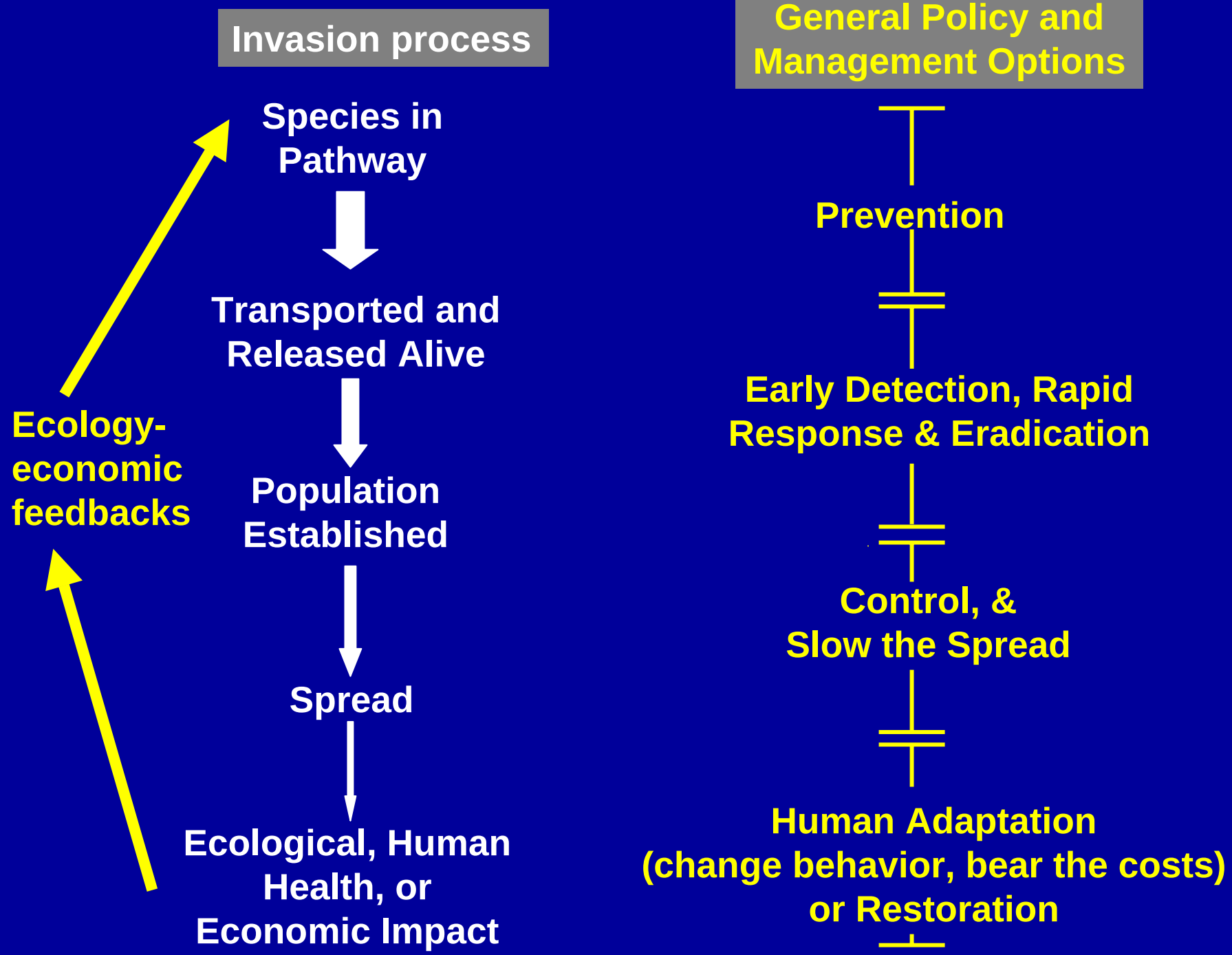
How is risk related to . . .

- Human desires for trade

- Suitable habitat?
- Population biology?
- Secondary spread?

- Human perception of risk

Ecology-economic feedbacks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Frontiers in economic analysis of invasions

			Net costs		
			Market	Non-market	Total
	Pathway	Species			
Current	Ships	1			
		2			
		. . .			
	Pet industry	1			
		2			
		. . .			

Frontiers in economic analysis of invasions

			Net costs		
			Market	Non-market	Total
	Pathway	Species			
Trajectory of existing species: Current	Ships	1			
		2			
		. . .			
	Pet industry	1			
		2			
		. . .			
Future					

- Ecological forecasting
- Bioeconomic modeling approaches
  - General Equilibrium Models (GEM)
  - Endogenous Risk Optimization (SDP, OCT)
  - Real Options

Frontiers in economic analysis of invasions

Net costs

	Pathway	Species	Market	Non-market	Total
Current trajectory of existing species	Ships	1			
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Frontiers in economic analysis of invasions

Net costs

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	2			
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Trajectory of existing species: Current → Future

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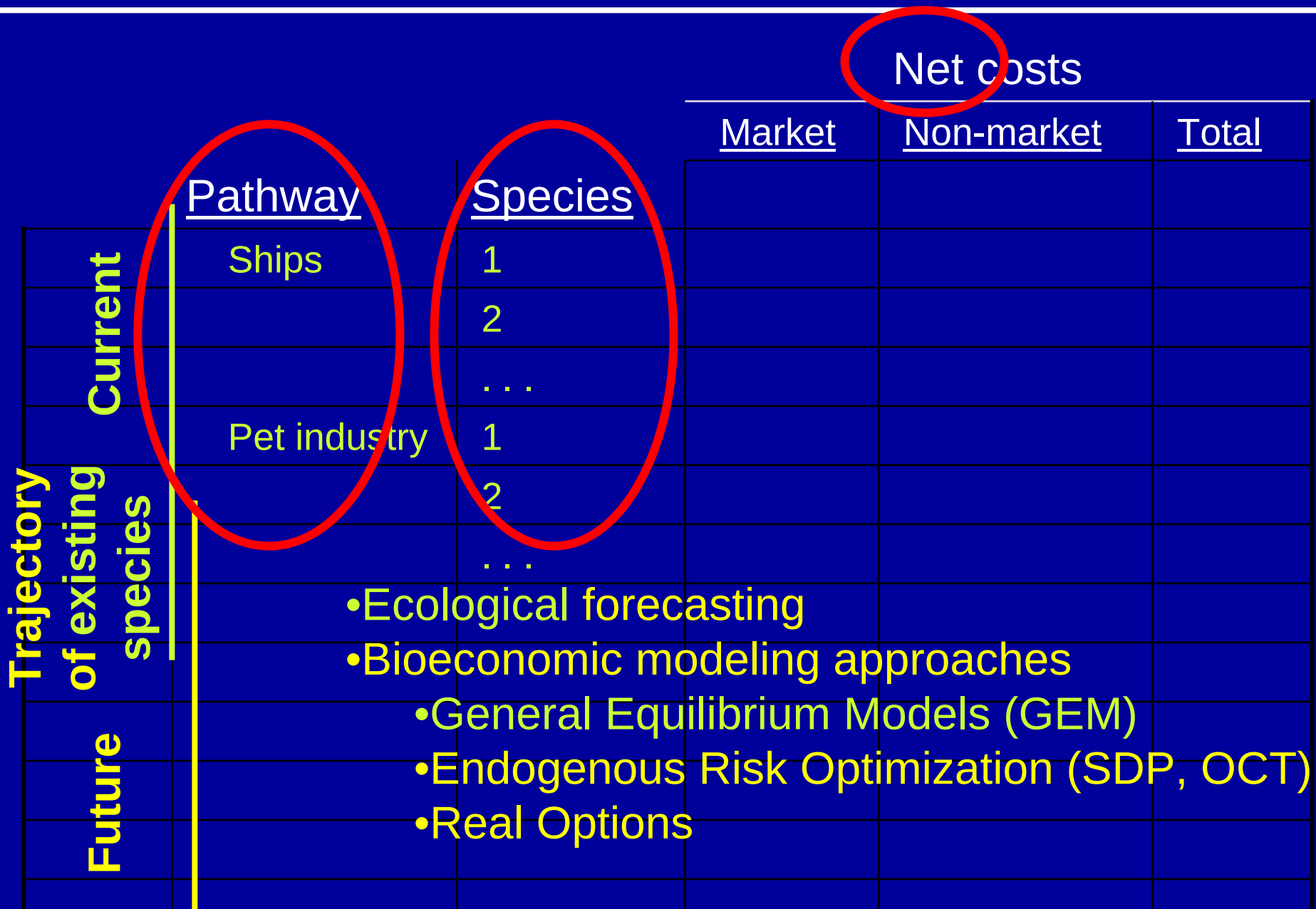

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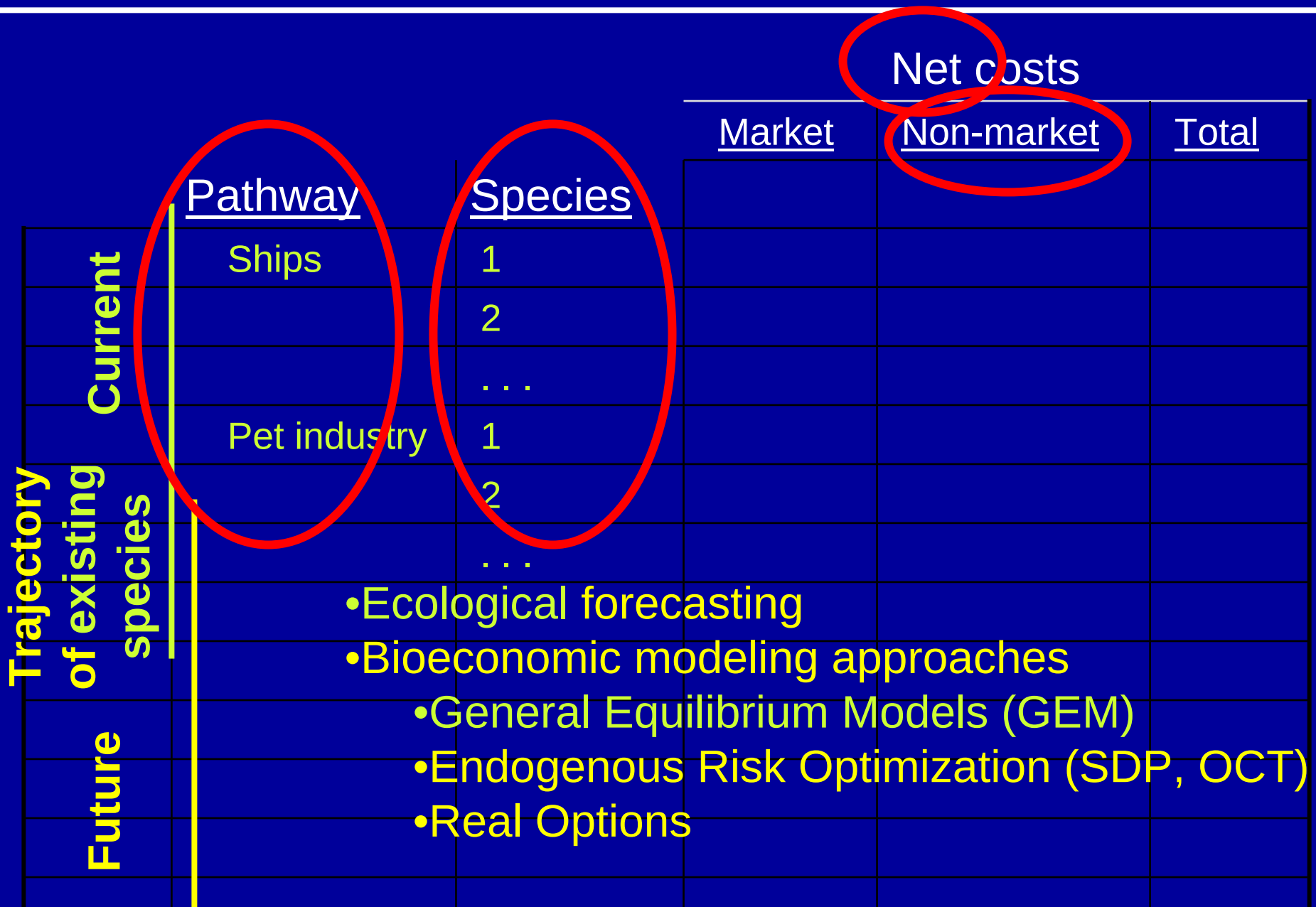
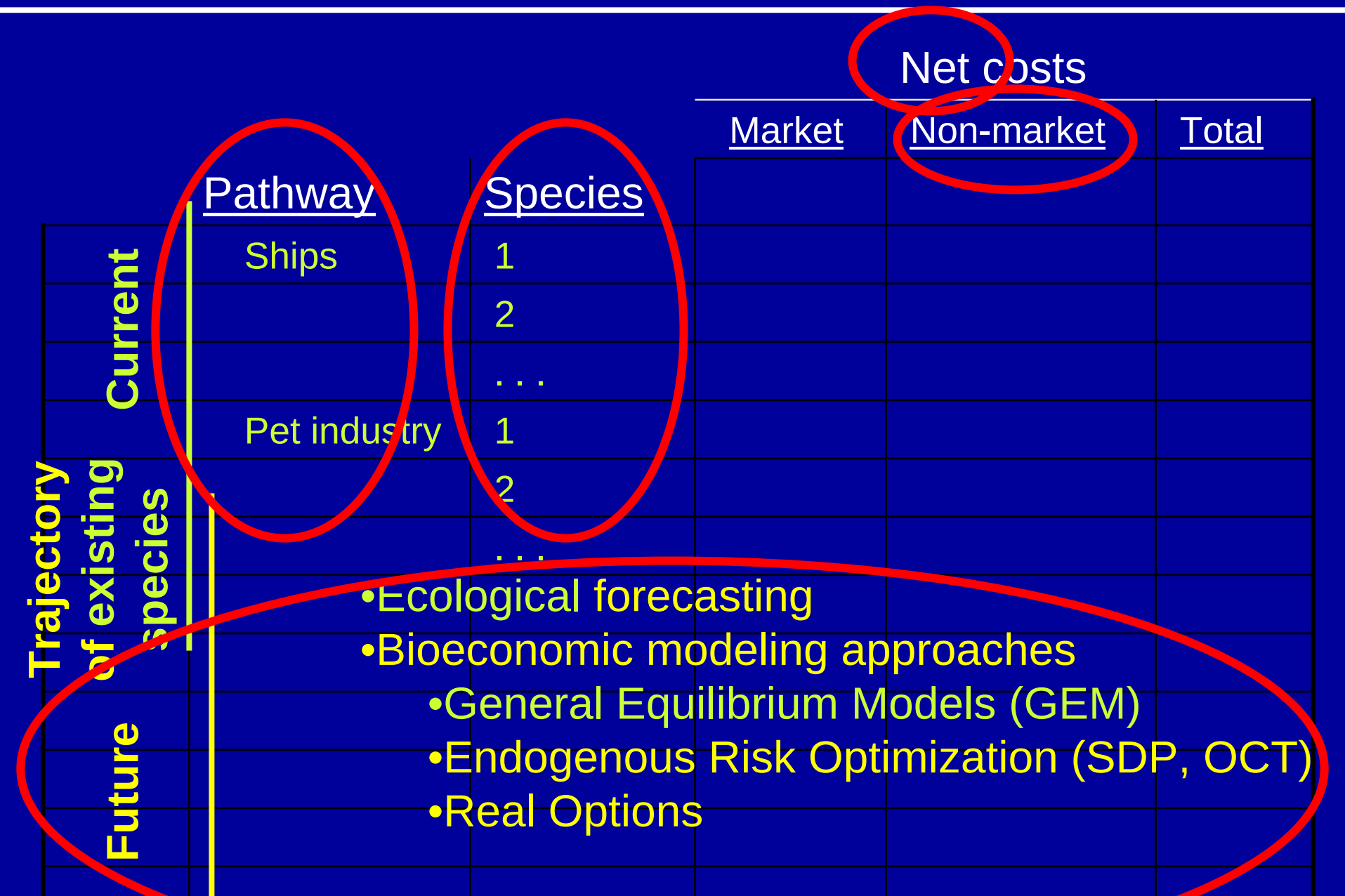
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