



Identifying gaps in regulatory prevention: Insights into species of concern, understudied pathways, and the role of climate change

Zoey Hendrickson^{1,2}, Samantha Smith², Katie O'Shaughnessy³, Ashley McDonald², Charles Martin^{1,2}, Wesely Daniel⁴

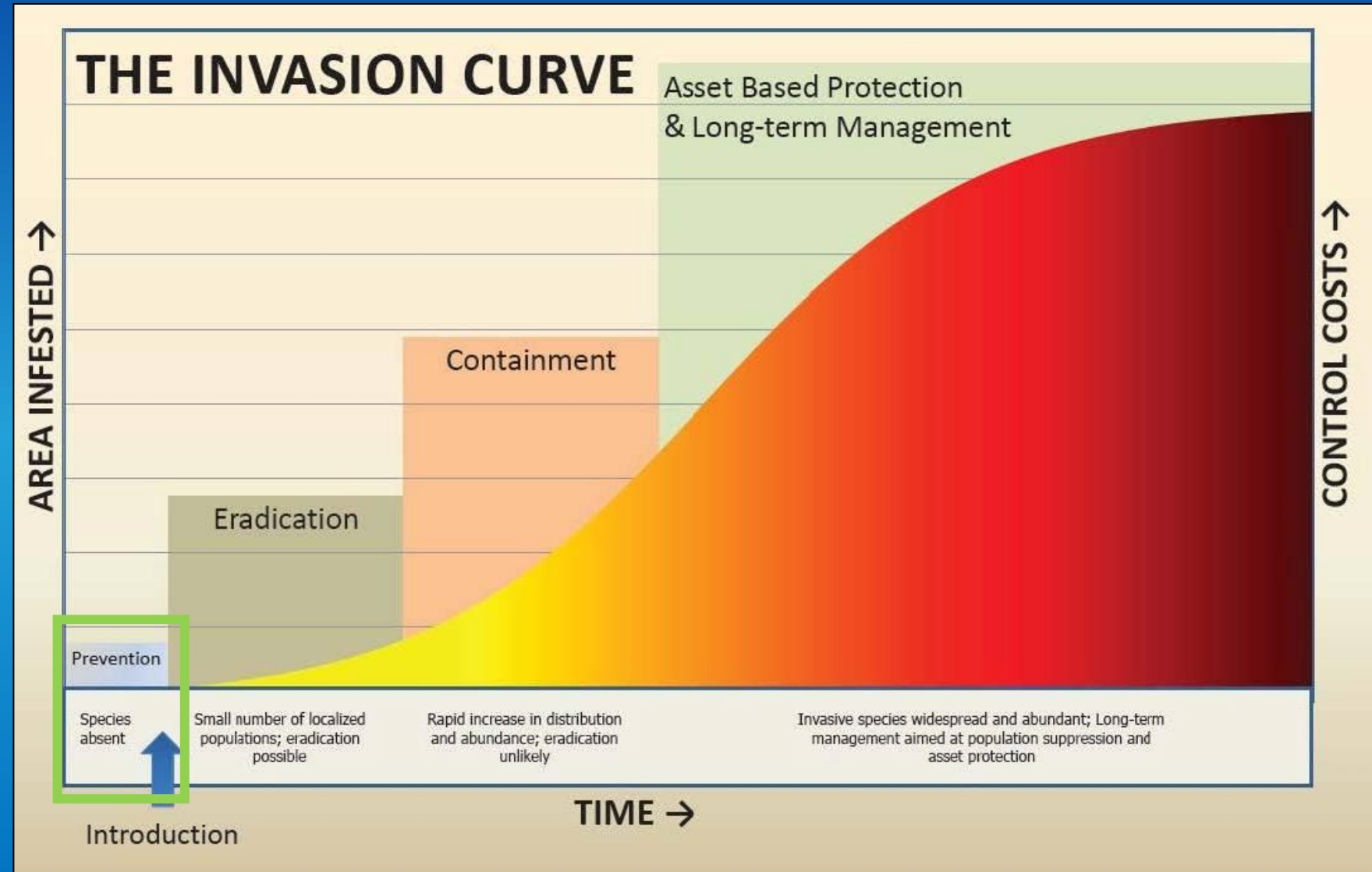
University of South Alabama¹, Dauphin Island Sea Lab², Stellenbosch University³, United States Geological Survey⁴

Overview

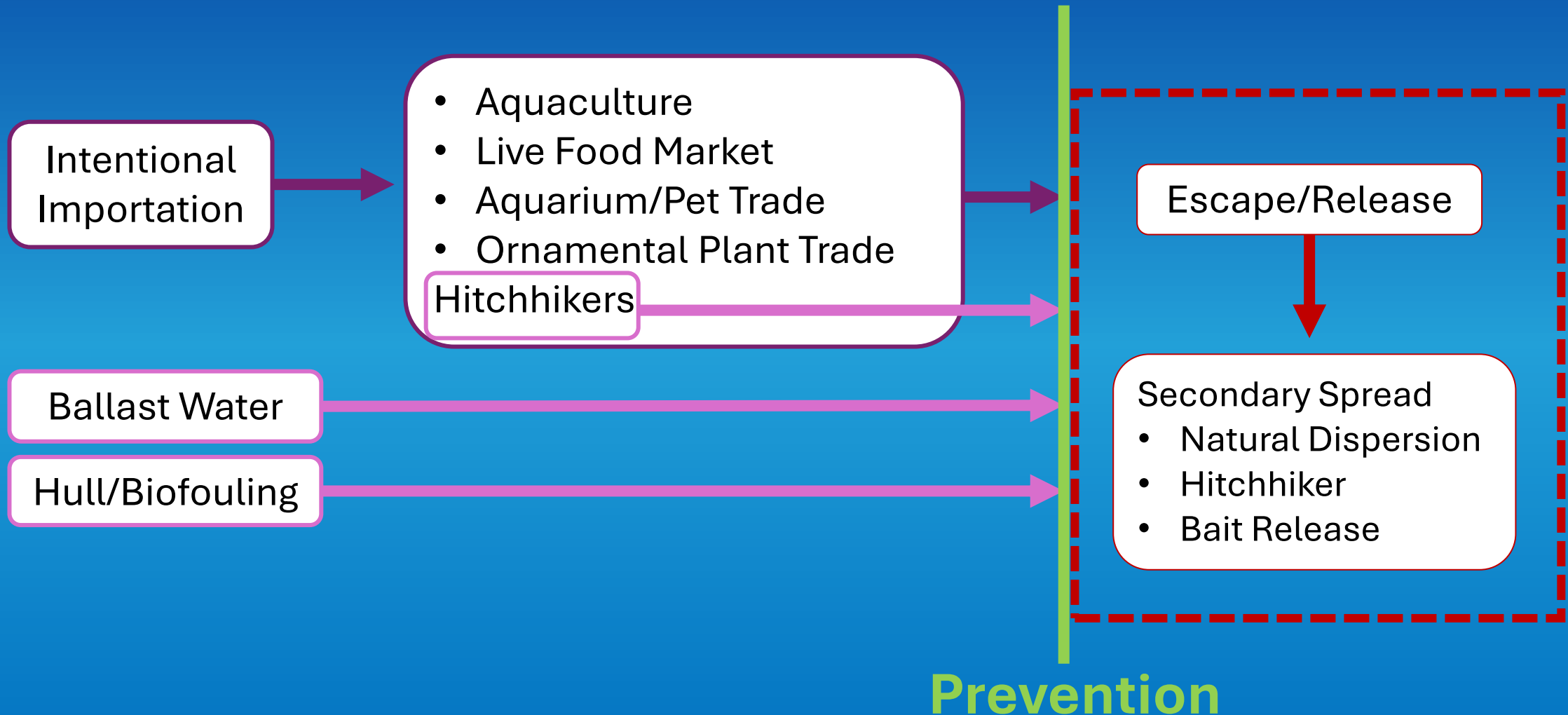
- Gap Analysis of Federal Regulatory Authority
- How these results inform us about understudied pathways and species of concern
- Hitchhiking organisms in trade
- Climate Change

Prevention → High Priority

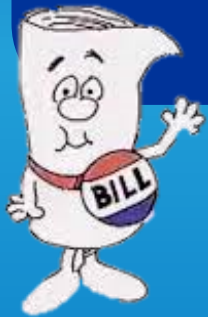
- Prevention - the most effective way to avoid negative impacts that NAS may potentially impose



NAS arrive via multiple **pathways** of introduction



The Basics of Federal Prevention



New NAS introductions occur in the U.S. annually
→ Indicates current prevention measures may be ineffective or non-existent

Identifying Gaps in Federal Authority through Gap Analysis

Our focus
strength
at the fe
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- Comprehensively review federal authorities among agencies



Management of Biological Invasions (2025) Volume 16, Issue 2: 313–339



Research Article

Identifying gaps in regulatory prevention measures for nonindigenous aquatic species in the United States

Zoey Hendrickson¹, Charles Martin¹ and Wesley Daniel²

¹University of South Alabama, 600 Clinic Dr, Mobile, AL 36688, USA

²United States Geological Survey Wetland and Aquatic Research Center, 7920 NW 71 St, Gainesville, FL 32653, USA

Corresponding author: Zoey Hendrickson (zcwhendrickson@gmail.com)





The Nonindigenous Aquatic Species (NAS) Database

- Eight taxonomic groups chosen
- Added algae (info sourced from NEMESIS)
- Excluded bryozoans, coelenterates, and mammals due to low records

Vertebrates



Amphibians



Fishes



Mammals



Marine Fishes



Reptiles

Invertebrates



Bryozoans



Coelenterates



Crustaceans



Mollusks



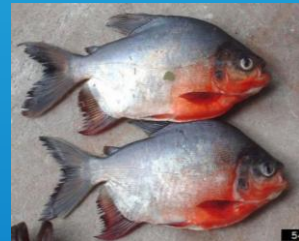
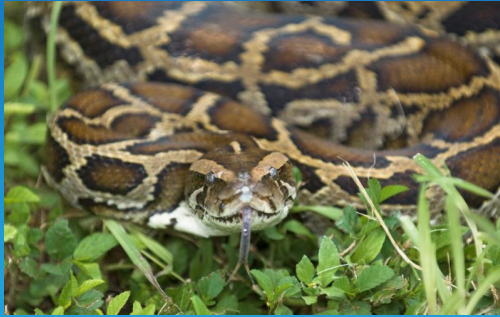
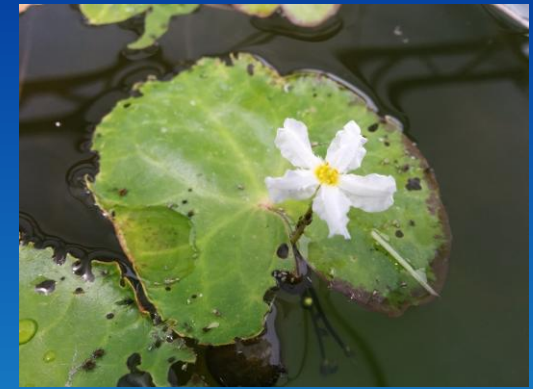
Plants

+



Algae

Step 1: Gather Case study species → 8 Taxonomic Groups, 18 species, 8 primary pathways



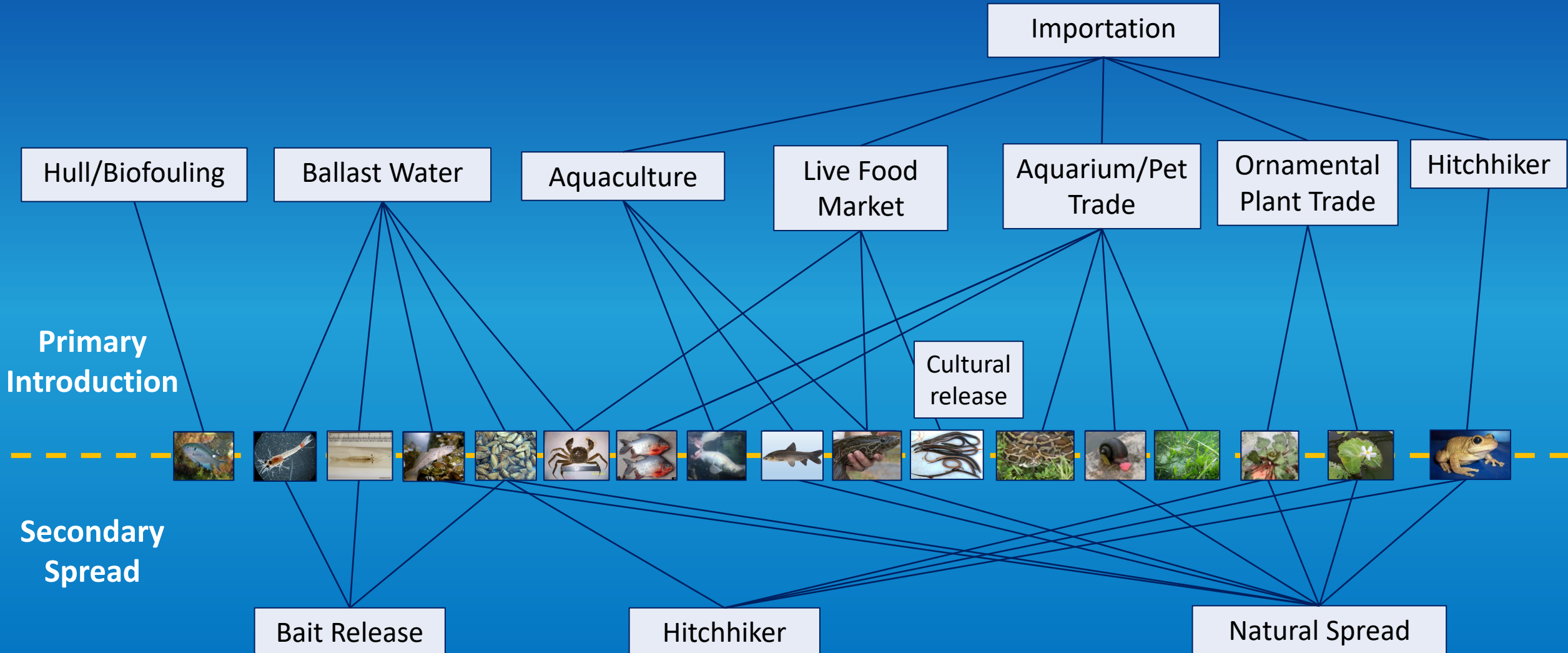
	Taxonomic Group	Common Name	Scientific Name	Primary pathway
1	Algae	Caulerpa	<i>Caulerpa taxifolia.</i>	Aquarium/Pet Trades
2	Amphibians	Cuban Treefrog	<i>Osteopilus septentrionalis</i>	Hitchhiker
3	Reptiles	Burmese Python	<i>Python bivittatus</i>	Aquarium/Pet Trades
4	Crustaceans	Bloody Red Shrimp	<i>Hemimysis anomala</i>	Ballast Water
5		Siberian Prawn	<i>Exopalaemon modestus</i>	
6		Chinese Mitten Crab	<i>Eriocheir sinensis</i>	
7	Freshwater Fishes	Pacu	<i>Piaractus sp.</i>	Aquarium/Pet Trades
8		Arapaima	<i>Arapaima sp.</i>	Aquaculture
9		Cuchia	<i>Monopterusuchia</i>	Cultural/Prayer release
10		Round Goby	<i>Neogobius melanostomus</i>	Ballast Water
11		Black Carp	<i>Mylopharyngodon piceus</i>	Aquaculture
12		Northern Snakehead	<i>Channa argus</i>	Aquaculture, Aquarium/Pet Trades
13	Marine Fishes	Regal Demoiselle	<i>Neopomacentrus cyanomos</i>	Biofouling
14	Mollusks	Quagga/Zebra Mussels	<i>Dreissena sp.</i>	Ballast Water, Biofouling, Hitchhiking
15		Apple Snails	<i>Pomacea cf. canaliculata/maculata</i>	Aquarium/Pet Trades
16	Plants	Crested Floating-heart	<i>Nymphoides cristata</i>	Ornamental plant trade
17		Water Chestnut	<i>Trapa bispinosa</i>	

Step 2: Understand the current state of Federal regulatory authority

Agency	Regulatory Authority	Federal Law
USFWS	Injurious species listing	The Lacey Act
USDA	Agricultural pests and diseases (protect animals/plants), noxious weed listing, etc.	Animal Health Protection Act, Plant Protection Act
CDC	Disease prevention	Public Health Service Act
EPA	Regulation of discharges into U.S. waters, includes ballast water, biofouling, and aquaculture facility effluent	Clean Water Act, Vessel Incidental Discharge Act (VIDA)
USCG	Ballast water and biofouling regulation	VIDA, National Invasive Species Act, National Aquatic Nuisance Species Prevention and Control Act
NOAA	Protection of marine resources	Multiple laws, National Marine Sanctuaries Act

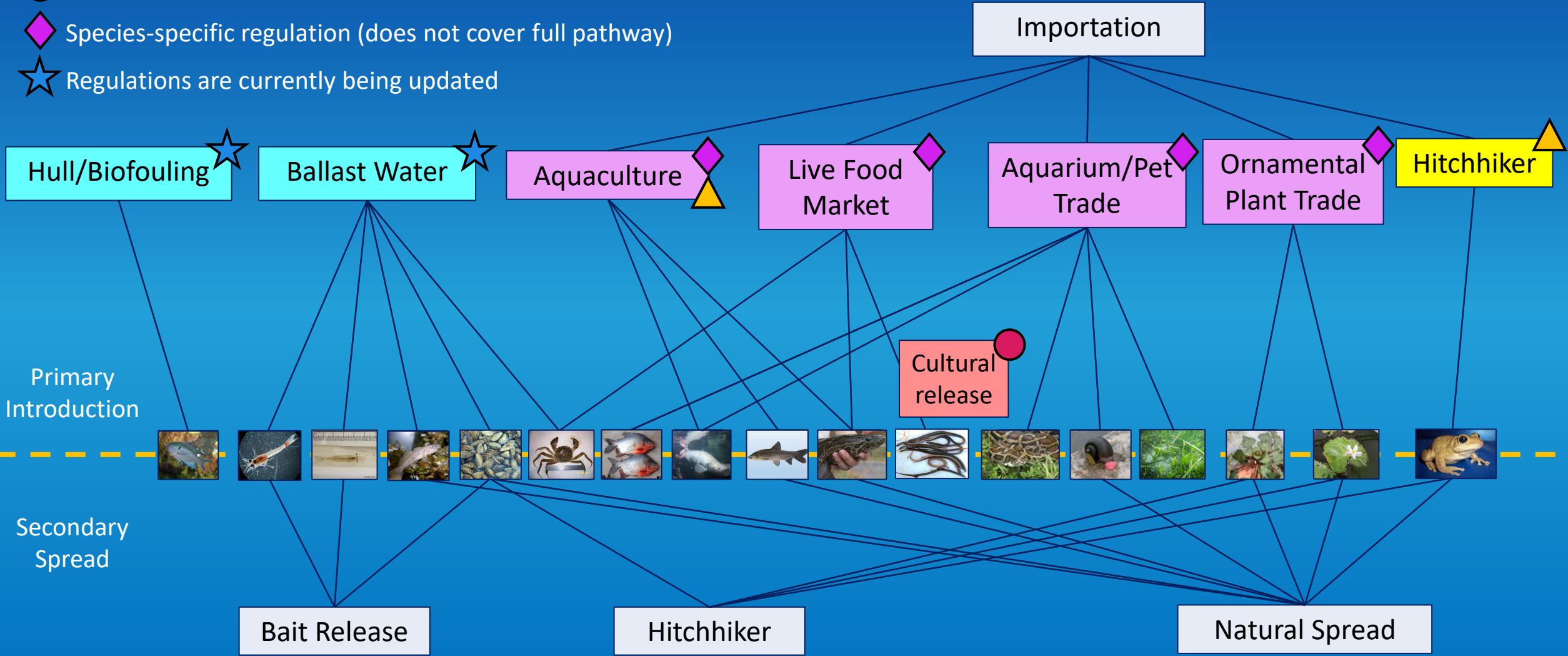


Understanding pathway-species connections



Connecting the dots: Pathway-species interactions

- ▲ The pathway falls under federal authority, but regulations are weak or absent
- There is little to no federal regulation of the pathway
- ◆ Species-specific regulation (does not cover full pathway)
- ★ Regulations are currently being updated



Who has the authority to regulate?

 Under federal authority, but regulations are weak or absent.

 There is little to no federal regulation of the pathway.

 Species-specific regulation (does not cover full pathway).

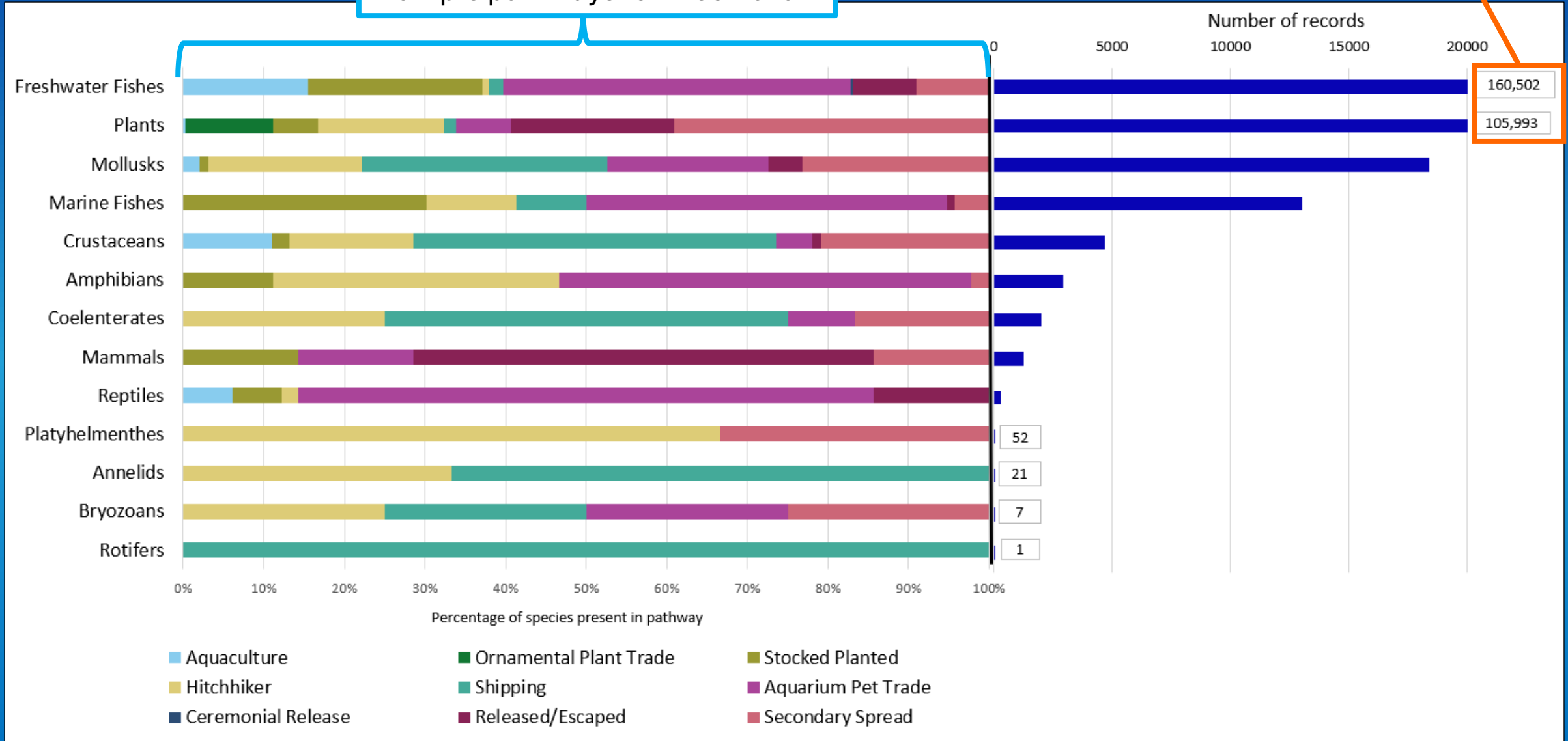
 Regulations are currently being updated.

Pathway	Federal Authority	Case Study Species	Reliant on State Regulation
 Biofouling	USCG, EPA, NOAA	Regal Demoiselle, Dreissenid Mussels	Yes/No
 Ballast Water	USCG, EPA, NOAA	Bloody Red Shrimp, Siberian Prawn, Round Goby, Chinese Mitten Crab, Dreissenid Mussels	No
  Aquaculture	USDA, USFWS, CDC, EPA, NOAA	Black Carp, Northern Snakehead, Arapaima	Yes
 Aquarium/Pet Trade	USFWS, USDA, CDC	Burmese Python, Pacu, Apple Snails, Northern Snakehead, Caulerpa	Yes
 Live Food Market	USDA, USFWS, CDC	Cuchia, Northern Snakehead, Chinese Mitten Crab	Yes
 Ornamental Plant Trade	USDA	Water Chestnut, Crested Floating-heart	Yes
 Cultural Release	USFWS	Cuchia, Northern Snakehead	Yes
 Hitchhikers	USDA, USFWS	Cuban Treefrog, Dreissenid Mussels	Yes

Applying quantitative data to the gap

Freshwater fish: 160,502
Plants: 105,993

Multiple pathways for most taxa



Understudied Pathways: Hitchhiking Organisms



Understudied Pathways: Hitchhiking Organisms

Understudied Pathways: Hitchhiking Organisms



- Hitchhikers: incidental transport, stowaways, contaminant
→ Arrive **unintentionally** via an intentional vector (trade)
- Usually only regulated if the pose significant agricultural (pests) or infrastructure (Dreissenids) risk
- Reactive v.s. Proactive management in most cases

Aquarium trade: vector for invertebrate hitchhikers

- Very understudied, we don't know what is coming in
- Snails, amphipods, emergent insects, worms, etc.
- Hitchhikers in trade: Current project!



Examining plants in trade for non-native hitchhikers



Italian Vallisneria



Java Fern



Bacopa sp.



Egeria densa



Red Ludwigia



Carolina
Fanwort



Parrot
Feather



Moss Ball



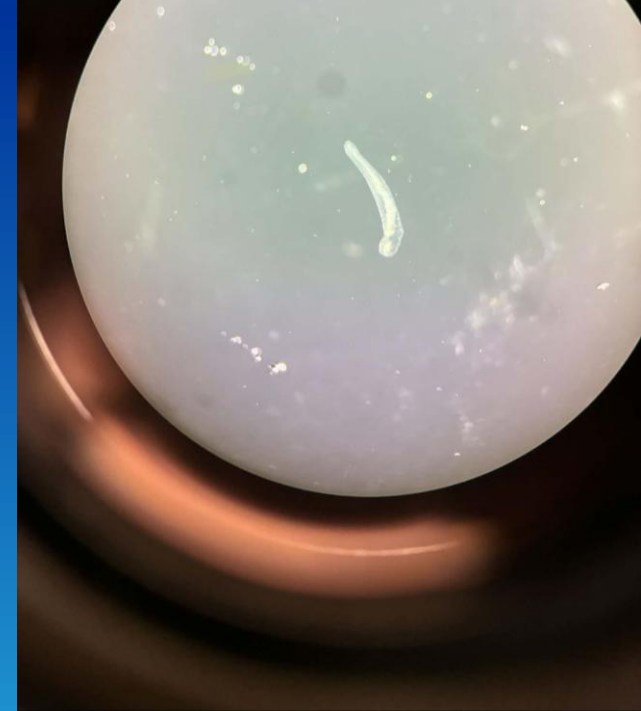
Java Moss

Order plants:

- T1: Dissect/inspect for HH
- T2: Place in grow out, see what emerges
- T3: photograph for morphology metrics → does structural complexity influence HH presence

“Mat” forming
species

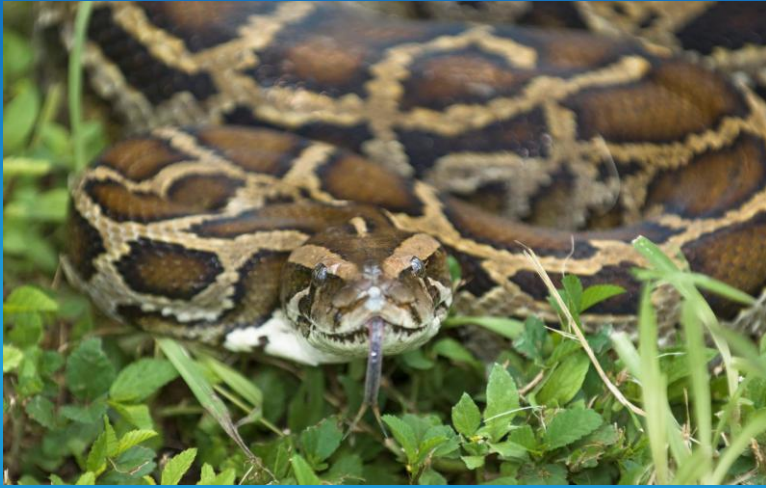
Increasing Complexity



Hitchhikers identified so far

- Ramshorn snails
 - Springtails
 - Midge
 - Platyhelminthes
- Grow out and inspection

Species of concern: climate change and range expansion



Burmese Python
(*Python bivittatus*)



Cuban Treefrog
(*Osteopilus septentrionalis*)



Giant Applesnail
(*Pomacea maculata*)

Invasion Risk in a Warmer World: Modeling Range Expansion and Habitat Preferences of Three Nonnative Aquatic Invasive Plants

Authors: Koncki, Natalie G., and Aronson, Myla F. J.

Source: Invasive Plant Science and Management, 8(4) : 436-449

Published By: Weed Science Society of America

URL: <https://doi.org/10.1614/IPSM-D-15-00020.1>

ECOGRAPHY

Review

Powerful yet challenging: mechanistic niche models for predicting invasive species potential distribution under climate change

Erola Fenollosa¹✉, Sean E. H. Pang², Natalie J. Briscoe³, Antoine Guisan^{4,5}, Roberto Salguero-Gómez¹

¹Department of Biology, University of Oxford, Oxford, UK

²Center for Ecological Dynamics in a Novel Biosphere (ECONOVO), Department of Biology, Aarhus University, Aarhus, Denmark

³School of Agriculture, Food and Ecosystem, University of Melbourne, Melbourne, Australia

⁴Department of Ecology and Evolution, University of Lausanne, Lausanne, Switzerland

⁵Institute of Earth Surface Dynamics, University of Lausanne, Lausanne, Switzerland

Correspondence: Erola Fenollosa (erola.fenollosaromani@biology.ox.ac.uk)

RESEARCH ARTICLE OPEN ACCESS

Climate Change Enhances the Success of Marine Invasive Species

Nicola S. Smith¹✉ | William W. L. Cheung²✉

¹Department of Biology, Concordia University, Montreal, Quebec, Canada | ²Institute for the Oceans and Fisheries, The University of British Columbia, Vancouver, British Columbia, Canada

Correspondence: Nicola S. Smith (nicola.smith@concordia.ca)

Received: 30 August 2025 | Revised: 7 May 2026 | Accepted: 26 June 2026



Journal of Environmental Management

Volume 398, 15 January 2026, 128353



Research article

Human activities and climate change facilitate the expansion of a notorious invasive snail (*Pomacea canaliculata*) in a subtropical biodiversity hotspot

Chunjing Huang^{a,d,1}✉, Jieyu Yao^{a,d,1}✉, Jing Xiong^b✉, Xin Luo^{a,c}✉, Phillip J. Haubrock^{e,f,g}✉, Ismael Soto^g✉, Jiali Yang^a✉, Zhi Zhang^h✉, Zhicai Xie^a✉, Zhengfei Li^a✉, Junqian Zhang^a✉

Climate Change in Southeastern US

Annual Temperature



We need more research!



Vose, R.S., Easterling, D.R., Kunkel, K.E., LeGrande, A.N. and Wehner, M.F., 2017. Temperature changes in the United States. *Climate science special report: Fourth national climate assessment*, 1(GSFC-E-DAA-TN49028).

Thank You!



Dauphin Island Sea Lab



USGS NAS Database Team
Martin Lab

Any and all who helped make
this research possible!

