

Four centuries of biological invasions in Chesapeake Bay

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Introduction to the Problem (1)

- **Anthropogenic biological invasions are documented in terrestrial, freshwater and marine habitats on every continent except Antarctica.**
- **Invasions by nonindigenous species (NIS) are a major force of global change, resulting in significant ecological, economic, and human health impacts.**

Introduction to the Problem (2)

- Invasive species are the second most frequently reported cause threatening endangered species in the US (Wilcove et al. 1998).
- The economic cost in U.S. of aquatic invasions is >\$10 billion / year (Pimentel 2003).
- All available evidence indicates the transfer of NIS by human activities has increased dramatically over the past century and continues to do so.

Outline

- Introduction
- Databases
- Questions about Bay invaders- Taxa, Origins, Timing, Vectors, Cryptogenic species
- Overall Conclusions

SERC's Marine Invasion Research Laboratory's National Exotic Marine and Estuarine Species Information System (NEMESIS)- Brian Steves, database designer.

- Relational databases in Microsoft "Access"
- Chesapeake Bay (1994 to present), accessible at: <http://invasions.si.edu/nemesis>
- National Database (1998 to present), multiple coasts, regions and bays
- Global Database, map-based system (2000 to present)

Information Sources on nonindigenous species

- Published literature
- Gray literature & Internet databases
- Museum collections
- Interviews with local scientists
- Field surveys- fouling communities, *Hemigrapsus*, *Carcinus* (unpublished).

Fouling Plate Surveys

PVC Settling plates are suspended from docks, sampled after ~ 3 months, then preserved, and examined by SERC biologists. Unidentified species are sent to world-class taxonomists for identification.



**3 months in
Chesapeake Bay**



16 new Chesapeake invaders found on SERC fouling plates, 1994-2005

- *Blackfordia virginica* (hydroid)*
- *Ficopomatus enigmaticus* (Polychaete)
- *Cuthona perca* (nudibranch)
- *Favorinus auritulus* (nudibranch)**
- *Miasea evelinae* (nudibranch)**
- *Gitanopsis* sp. (amphipod)
- *Amphilochus* sp. (amphipod)*
- *Synidotea laevidorsalis* (isopod)
- *Barentsia benedeni* (kamptozoon)
- *Loxosomatoides laevis* (kamptozoon)
- *Bugula neritna* (Bryozoan)
- *Ascidiella aspersa* (tunicate)**
- *Diplosoma listerianum* (Tunicate)
- *Botrylloides violaceus* (tunicate)
- *Styela canopus* (tunicate)
- *Styela plicata* (tunicate)

•* Medusa not seen since 1920s, 1st record of hydroid on East Coast.

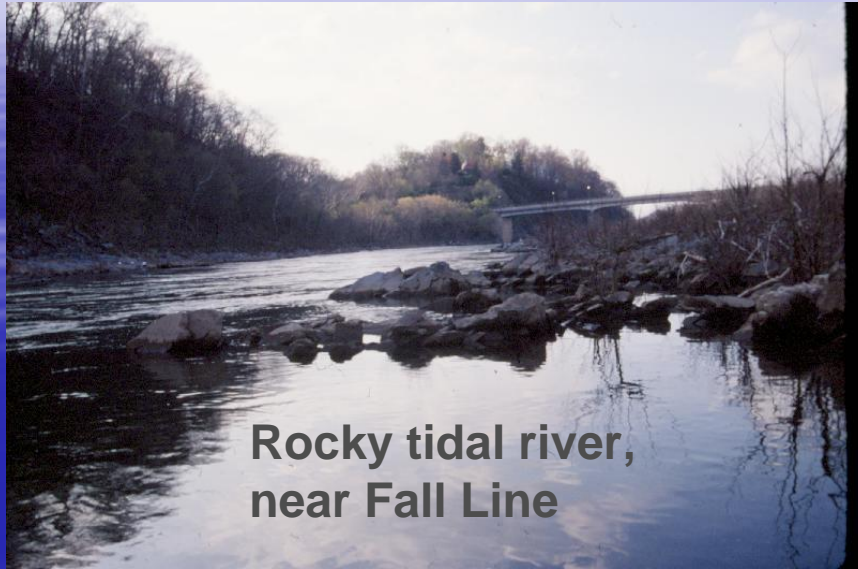
•** Population not known to be established?

Our Study Area

- Tidal waters and wetlands of Chesapeake Bay and Atlantic waters of Maryland and Virginia, including coastal bays
- Shoreward limit is monthly mean high-tide line
- Upstream limit is the head of tide in inflowing rivers and streams
- Some primarily nontidal terrestrial and freshwater species cross the line-
“**boundary residents**”



Chesapeake Bay's varied habitats-1



Rocky tidal river,
near Fall Line



Tidal fresh swamp



Tidal fresh marsh

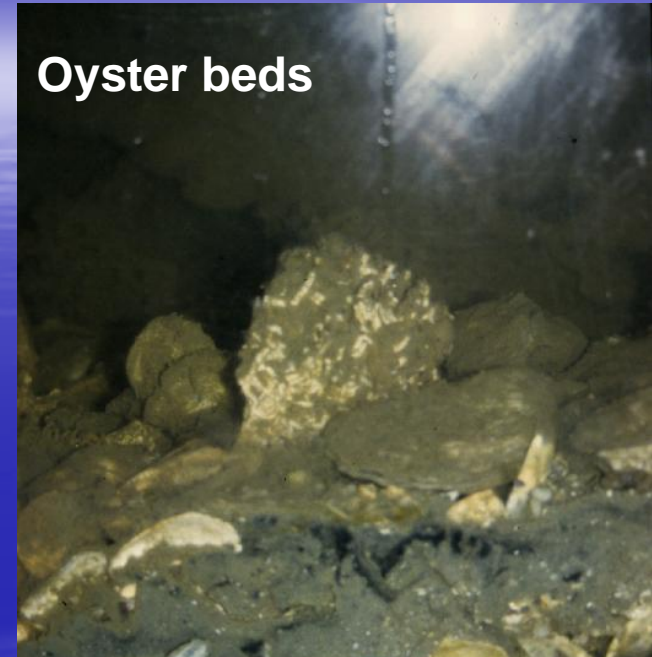


Freshwater
"grass" bed

Chesapeake Bay's varied habitats-2



Brackish & salt marshes



Oyster beds



Harbors & Ports



Adjacent Atlantic waters

Human features

- 1st European Settlement at Jamestown, 1609
- Since then:
- Population in watershed has grown to 15 million.
- Expanding shipping, chiefly at Baltimore and Norfolk
- Expanding fisheries
- Agriculture, gardening, Pet-keeping, etc.

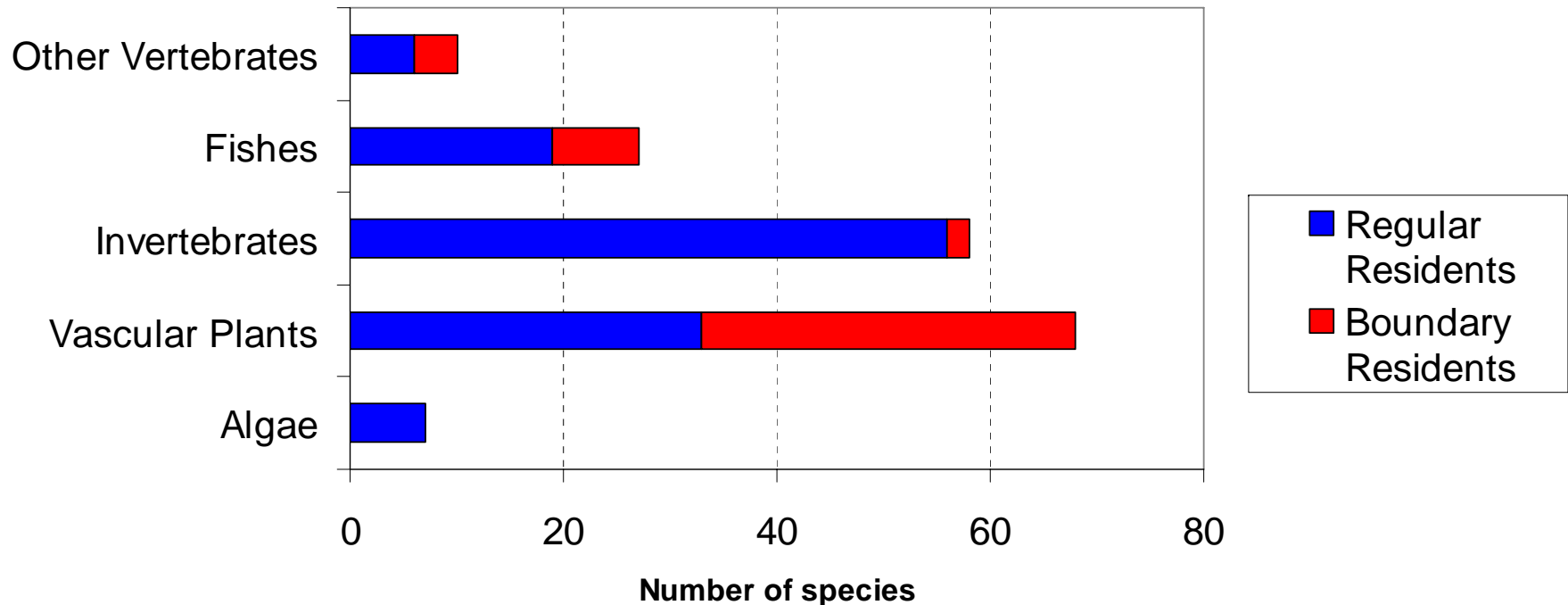


Questions-

- Who are the invaders?
- Where did they come from?
- When did they get here?
- How did they get here?
- What have they done?
- Conclusions

Taxonomic Composition of Nonindigenous species (NIS) introduced to the Chesapeake Bay region (n=170), 17 phyla

121 regular residents, 49 boundary residents



**“Boundary Residents”, 47 spp.
Terrestrial and freshwater species
crossing the line into tidal waters & wetland**

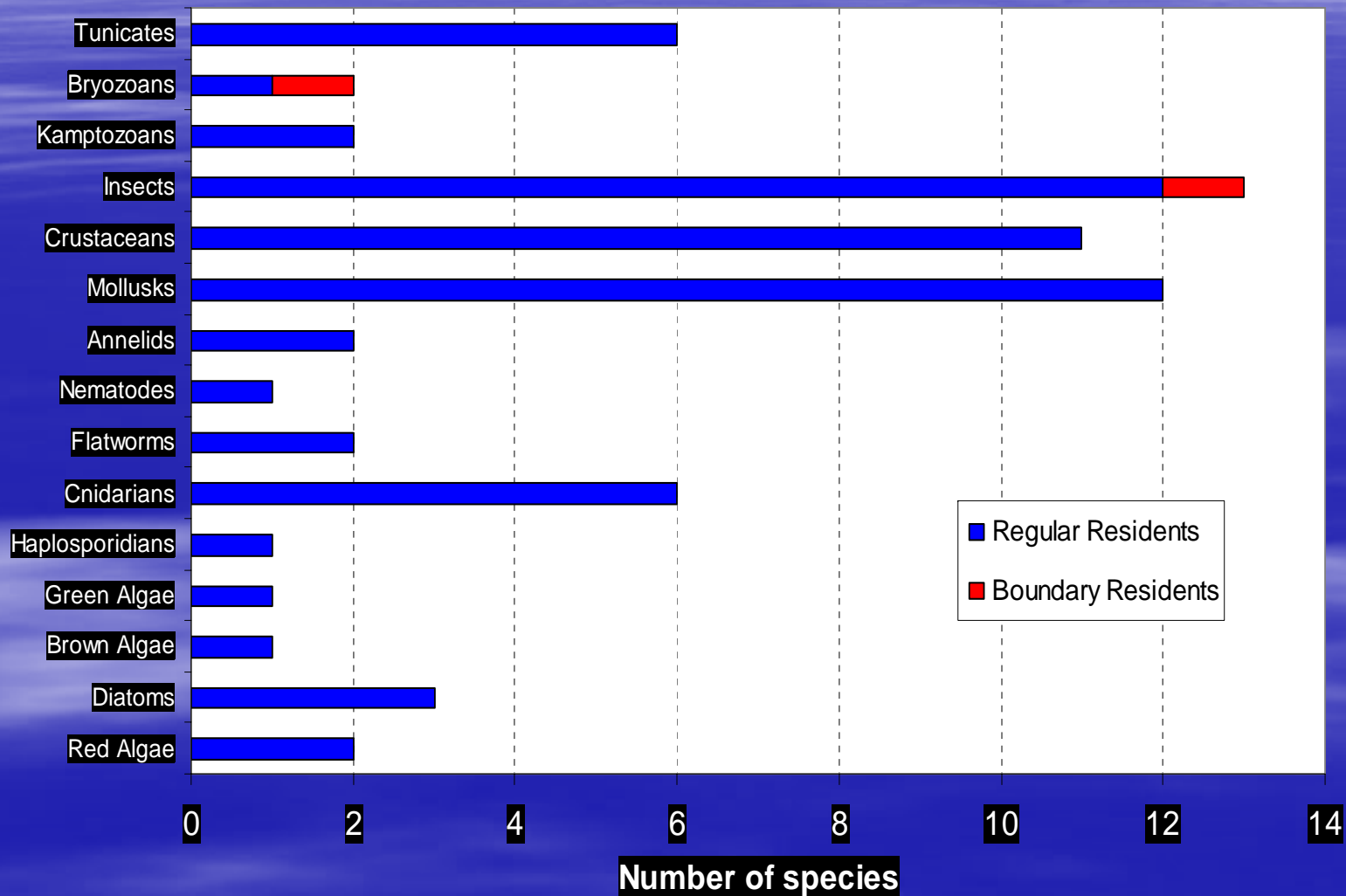


***Polygonum cuspidatum*-
Japanese knotweed**



***Cervus nippon*- Sika Deer**

Taxonomic Composition of Invertebrates & Algae NIS in the Chesapeake Bay region



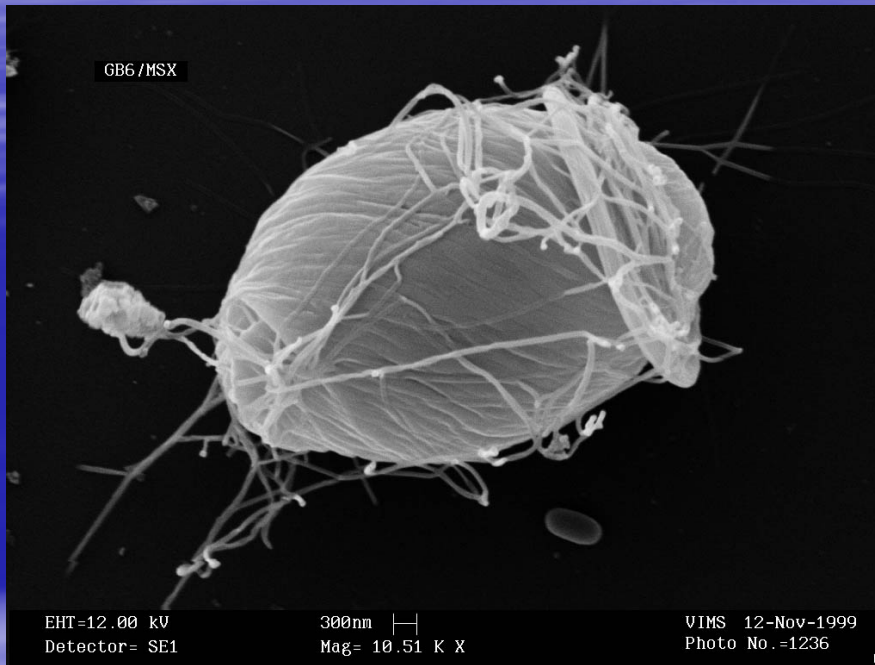
Phragmites australis- a cryptic invasion



Foto: Ame Anderberg

- Native to 6 continents, including North America and Chesapeake.
- But in 20th century, drastic increase in range, invasiveness, and abundance on East Coast and Chesapeake Bay.
- Chloroplast DNA analysis indicates replacement of many native genotypes by a single Eurasian genotype (Saltonstall 2002)

Haplosporidium nelsoni, MSX oyster disease



Siddall et al., American Museum
of Natural History

- Discovered in Delaware Bay (1957)
- In Chesapeake Bay, 1959, causing devastating oyster mortalities
- Genetically identical to a parasite of the Pacific Oyster (*Crassostrea gigas*) from Japan & Korea
- Believed to have been introduced with transplants of *C. gigas* (Burreson et al. 2000)

Rapana venosa - Veined Rapa Whelk



- Native to the NW Pacific- Vladivostok to Hong Kong
- Introduced to the Black Sea, ~1946, with shipping or oysters.
- Spread to Adriatic and Aegean by 1970s (ballast water?)
- In 1998, collected near Norfolk VA- ID'd at NMNH
- Abundance increasing in lower Chesapeake Bay- Roger Mann, VIMS

Hemigrapsus sanguineus

Asian Shore Crab



- Native to northwest Pacific (Hong Kong-Russia)
- 1st collected in New Jersey in 1988.
- Now ranges from North Carolina to Maine; very abundant on rocky shores
- In Chesapeake, restricted to riprap and jettiles in lower Bay.

Styela plicata- Pleated Tunicate



- Described from a ship in Philadelphia PA (1823)
- Not regarded as native in the Mediterranean, Atlantic, Australia (Monniots, Carlton, Kott)
- Origin unknown
- Introduced in California by 1915; Australia by 1870s
- Found on East and Gulf coasts (NC-TX) in 1880s.
- On Chesapeake Bay fouling plates, 2002

Ictalurus punctatus- Channel Catfish



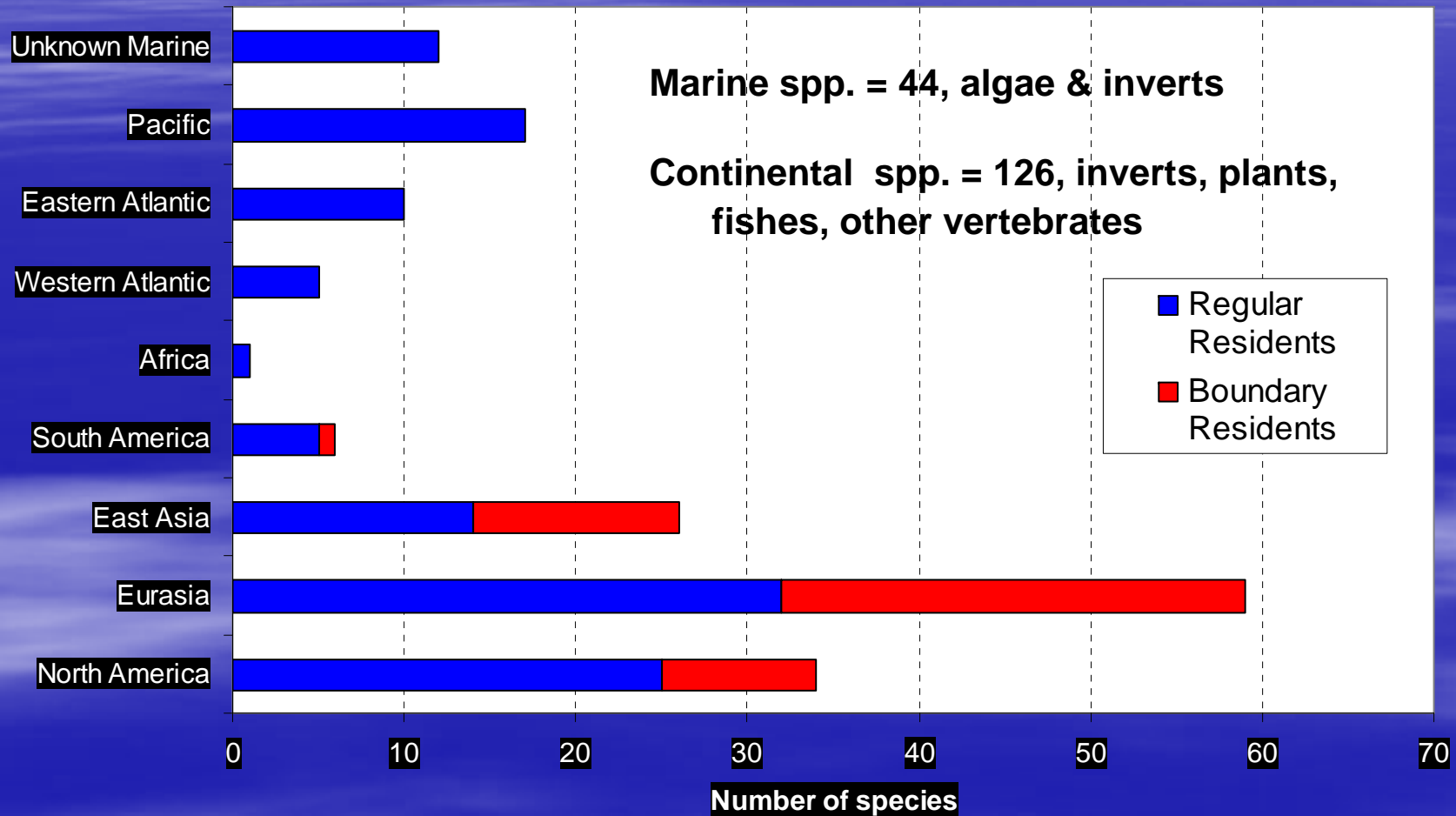
- Native to Mississippi-Gulf & Great Lakes basins.
- Introduced on East Coast from NC (possibly SC-GA) to MA.
- First stocked by US Fish Commission in Potomac, 1889.
- Now established in all major Chesapeake tributaries

Myocastor coypus- Nutria

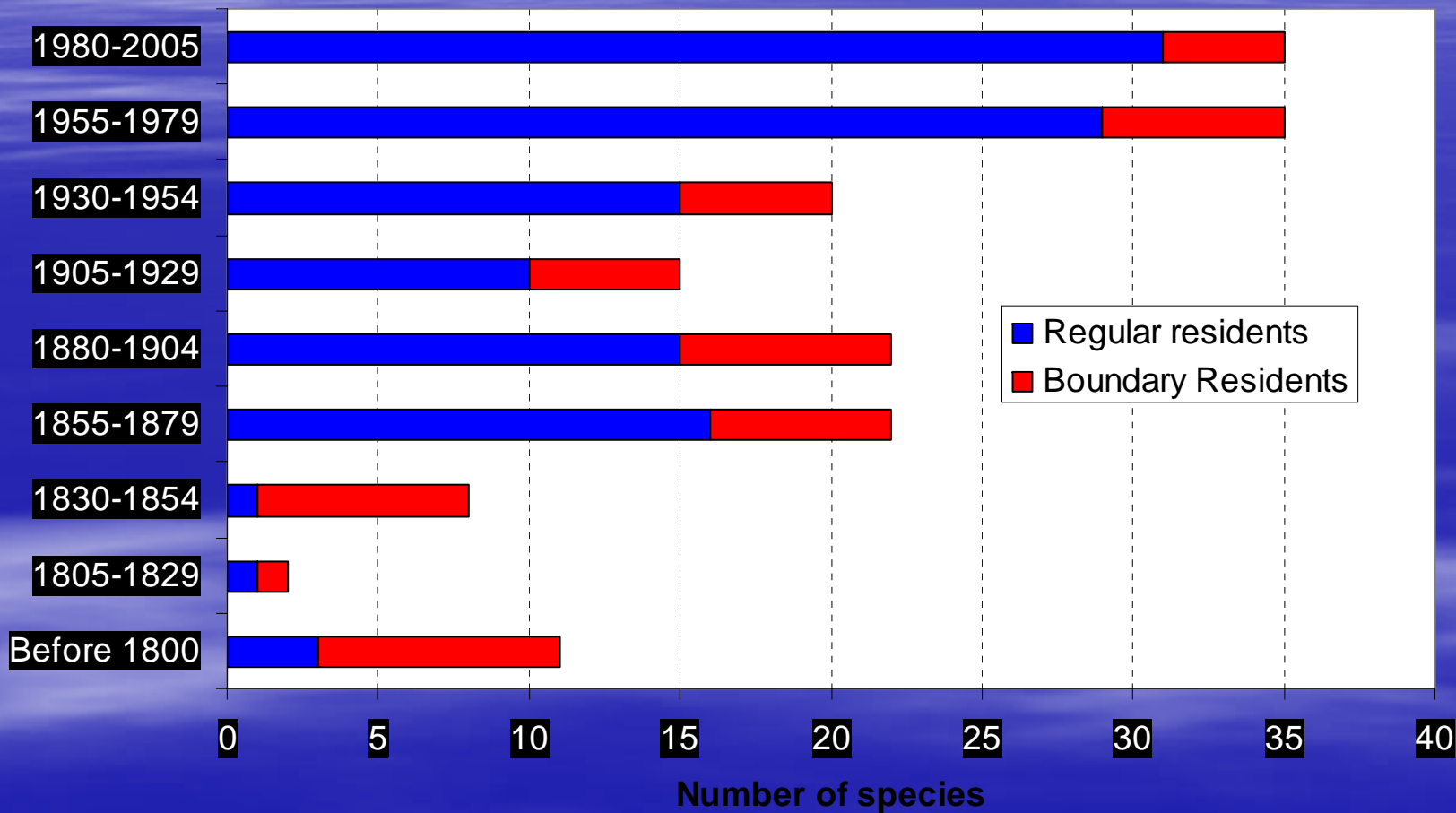


- Native to southern South America
- Widely imported for fur-farming in the 1930s; widespread releases on East, Gulf, West Coasts.
- Escaped from a USFWS lab, Blackwater NWR by 1943.
- Now abundant in SE Maryland. **Eradication program underway.**

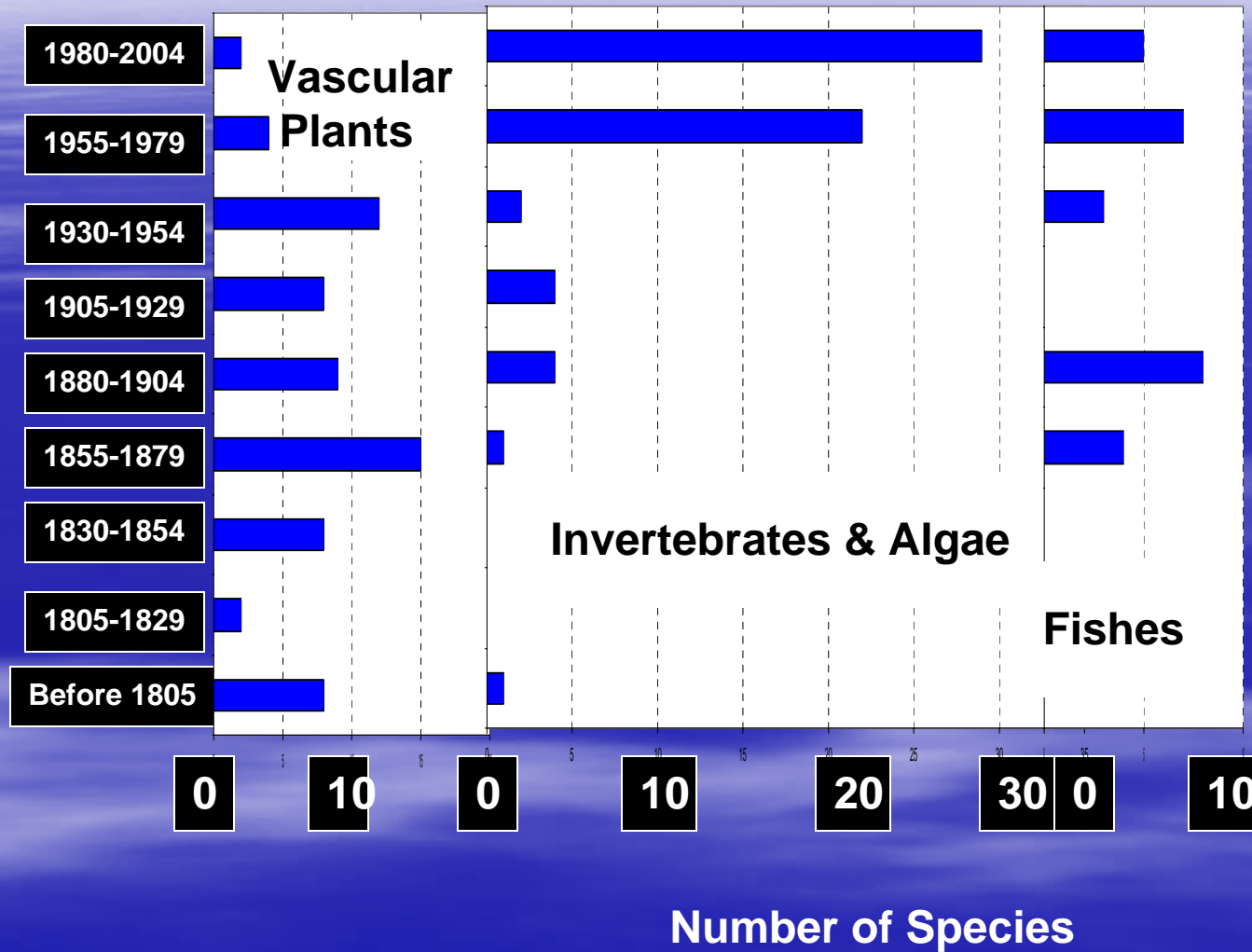
Native regions of species introduced to Chesapeake Bay (n=170)



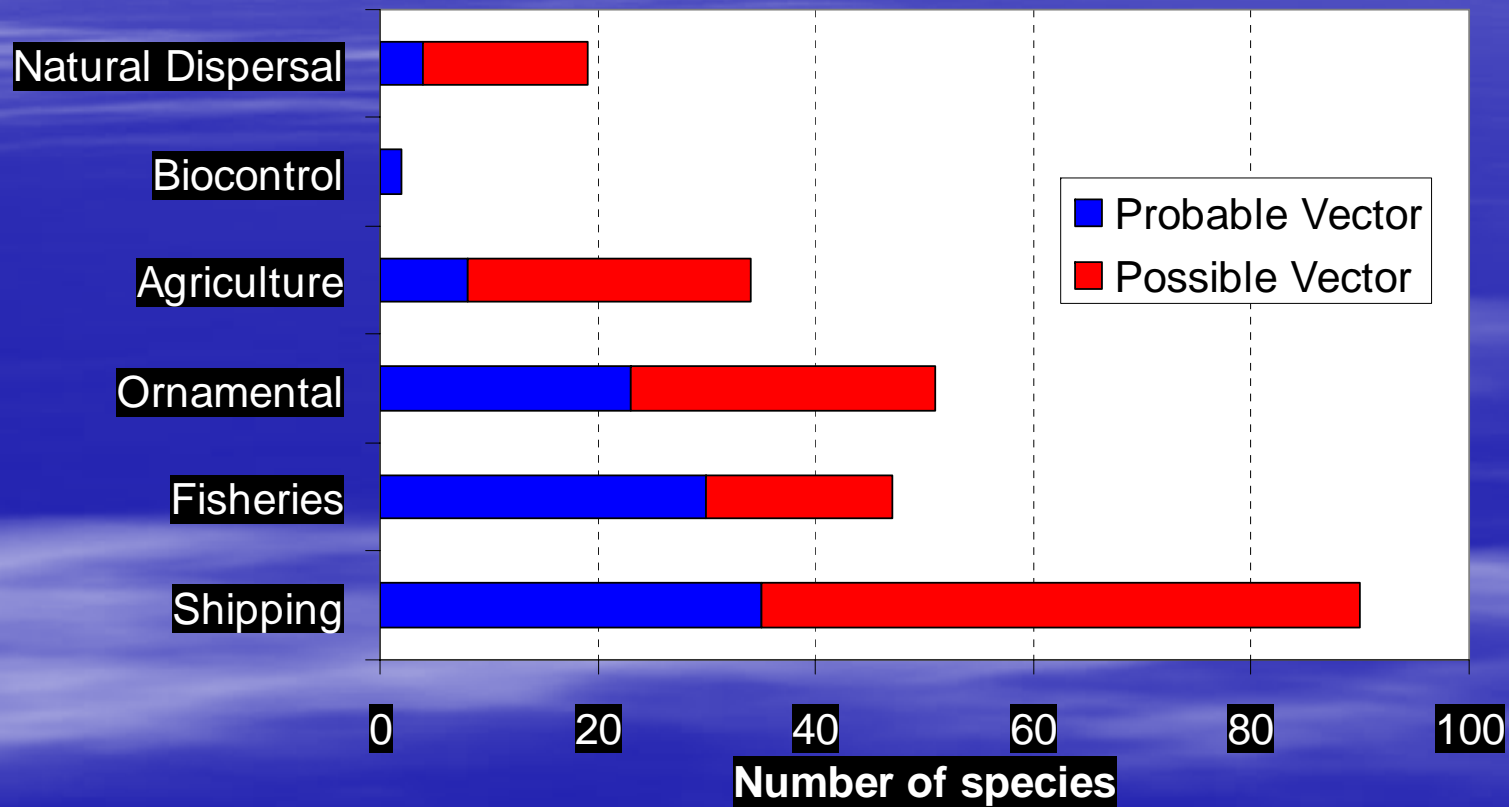
Dates of first record for Chesapeake Bay region NIS (n=170)



Dates of 1st Record, by Taxonomic Group



Vectors for transport of NIS into the Chesapeake Bay region



Shipping as a vector for:

Taxonomic Groups	Probable	Possible
Vascular Plants	6	11
Invertebrates & Algae	25	25
Fishes	0	0
Other Vertebrates	0	1

Hull fouling

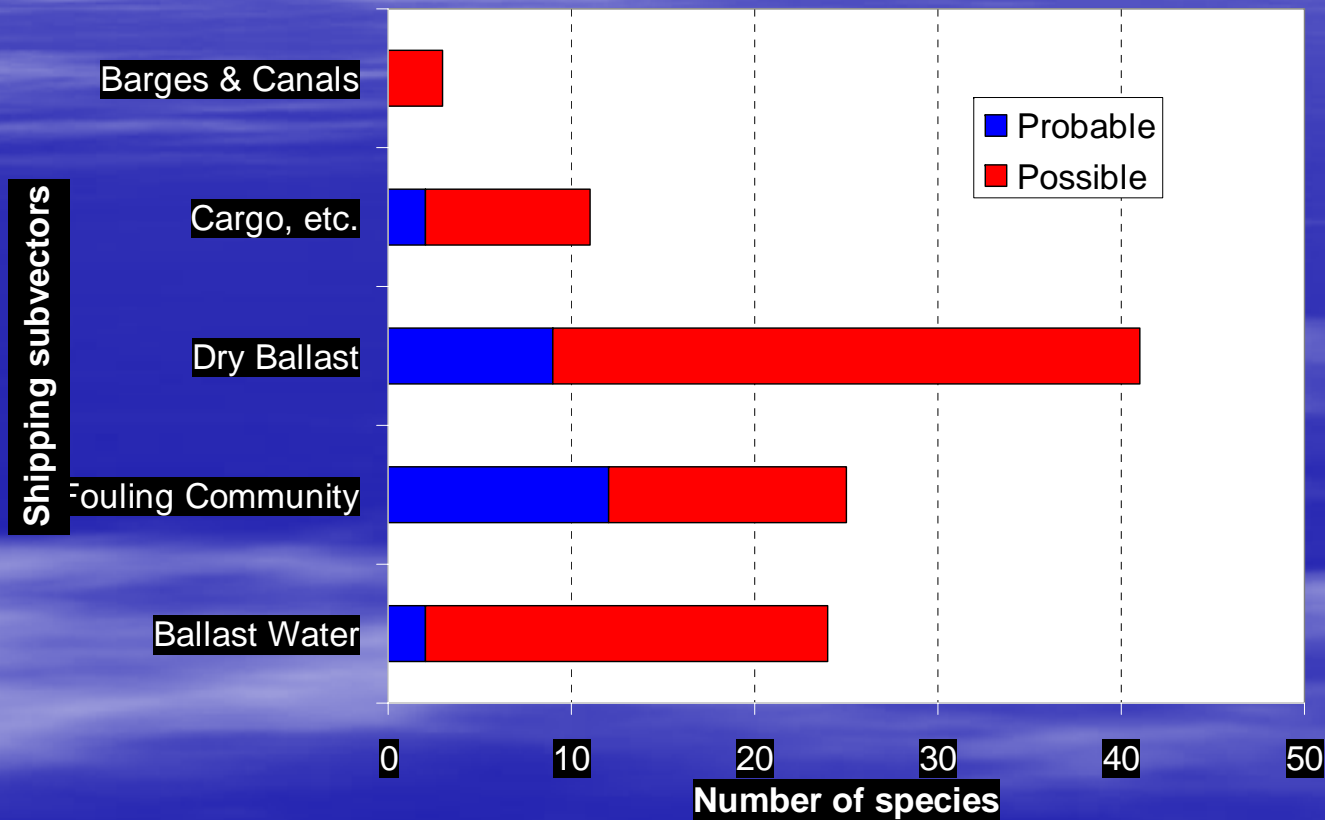


Ship in dry dock with fouled hull.

Bulk carrier, discharging ballast water, Chesapeake Bay



Modes of shipping transport of known introduced species in Chesapeake Bay



And invaders keep on coming!

Northern Snakehead Distinguishing Features

Long dorsal fin • small head • large mouth • big teeth •
length up to 40 inches • weight up to 15 pounds

HAVE YOU SEEN THIS FISH?



The northern snakehead from China is not native to Maryland waters and could cause serious problems if introduced into our ecosystem.

**If you come across this fish,
PLEASE DO NOT RELEASE.**

**Please KILL this fish by cutting/bleeding
as it can survive out
of water for several days and REPORT all catches to
Maryland Department of Natural Resources
Fisheries Service. Thank you.**

Phone: 410 260 8320
TTY: 410 260 8835
Toll Free: 1 877 620 8DNR (8367) Ext 8320
E-mail: customerservice@dnr.state.md.us



Crassostrea ariakenisis

Suminoe Oyster; Chinese River Oyster



Jodie Dew, Virginia Polytech

- Native to China-Japan
- Cultured since 1970s in Oregon & Washington
- Sterile triploid oysters tested in Virginia waters grew well, little disease.
- 700,000 triploid *C. a.* planted in 2003
- **Now do we let them breed?**

Recent Chesapeake invaders with potential impacts



Daphnia lumholtzi African water-flea
Rapana venosa Veined Rapana Whelk

Anguillicola crassus
Eel Swimbladder
Nematode

Recent Chesapeake invaders with potential impacts

- *Gyrodactylus anguillae*, *Pseudodactylogyrus anguillae*, *Anguillicola crassus*- eel parasites
- *Rapana venosa*- Veined Rapa Whelk, Shellfish predator
- *Daphnia lumholtzi*- African Water-flea, avoided by juvenile fishes?, replacing native prey?
- *Botrylloides violaceus*, *Diplosoma listerianum*- Tunicates, hull foulers
- *Chaetococcus phragmitis*, *Lasioptera hungarica*, *Lipara rufitarsis*, *Tetramesa phragmitis*; *Sclerocona acutella*- *Phragmites* insect herbivores

Potential Bay invaders in the watershed-

Fofonoff et al. unpublished data; USGS NAS Database; USDA Plants Database

- 26+ freshwater invertebrates (e.g. *Dreissena polymorpha*- Zebra Mussel)
- 15+ freshwater fishes (e.g. *Scardinius erythrophthalmus*- Rudd)
- 18+ aquatic and wetland plants (e.g. *Marsilea mutica* - Water Fern)

Conclusions

- Chesapeake Bay is heavily invaded.
- Invasions by marine algae and invertebrates are mostly shipping-related and appear to be increasing.
- We have under-estimated the number of introduced invertebrate and algal species in Chesapeake Bay.
- Comprehensive surveys of the Bay's biota are desirable for monitoring invasions and detecting other human impacts on the Bay's biodiversity.
- Invader impacts vary greatly in type and magnitude; many species may have a mixture of perceived costs and benefits.

