Are Blue & Flathead Catfishes Invasive in Tributaries of the Chesapeake Bay?

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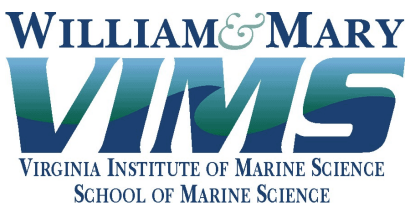
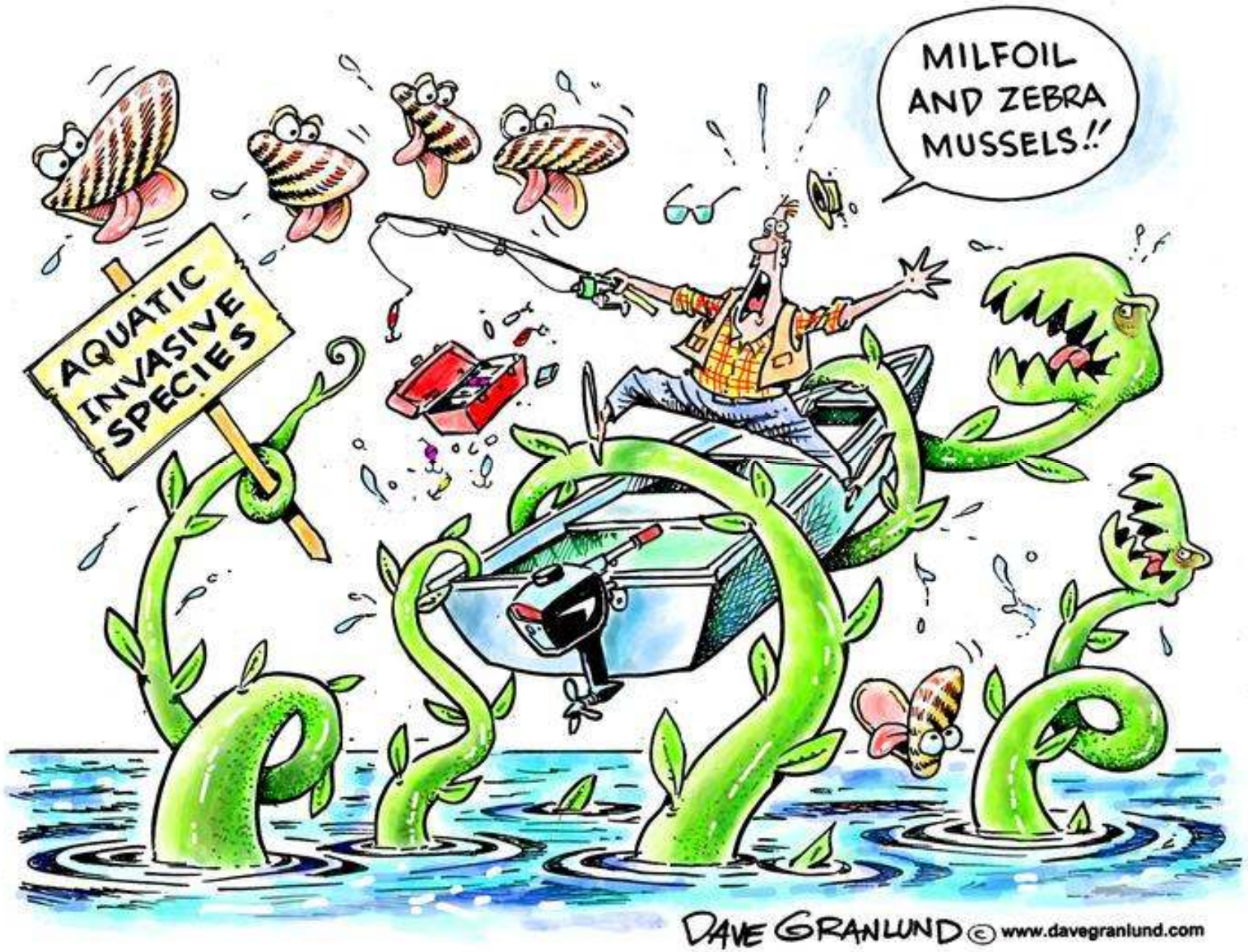


What is an “Invasive Species”?

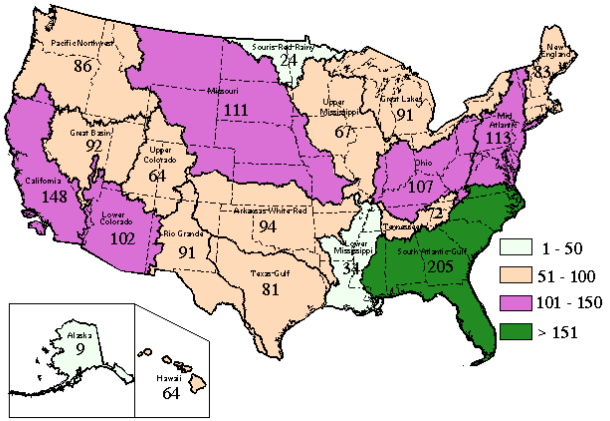
- National Invasive Species Council 2006 – an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health

- National Invasive Species Management Plan – a nonnative species that may prey upon, displace or otherwise harm native species, or alter ecosystem processes


MILFOIL AND ZEBRA MUSSELS!!
AQUATIC INVASIVE SPECIES
DAVE GRANLUND © www.davegranlund.com

Introduced Species

- May not be invasive
- May have the potential for ecological harm, but may not be targeted for management action
- What is degree of harm to the environment, the economy, or human health?
  - Determine prior to implementing a baywide management plan



Number of introduced fish species

(USGS Nonindigenous Aquatic Species Program)

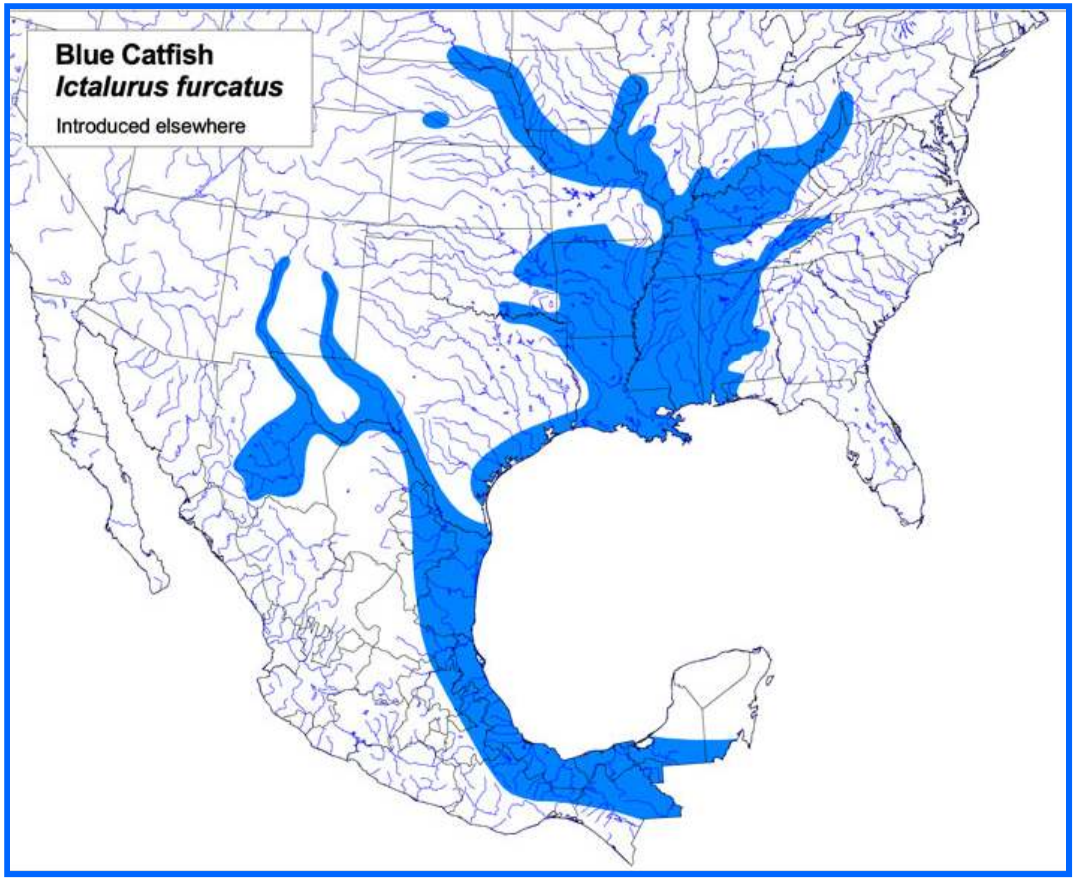
Introduced Catfishes

Blue catfish *Ictalurus furcatus*

Flathead catfish *Pylodictis olivaris*

Blue Catfish

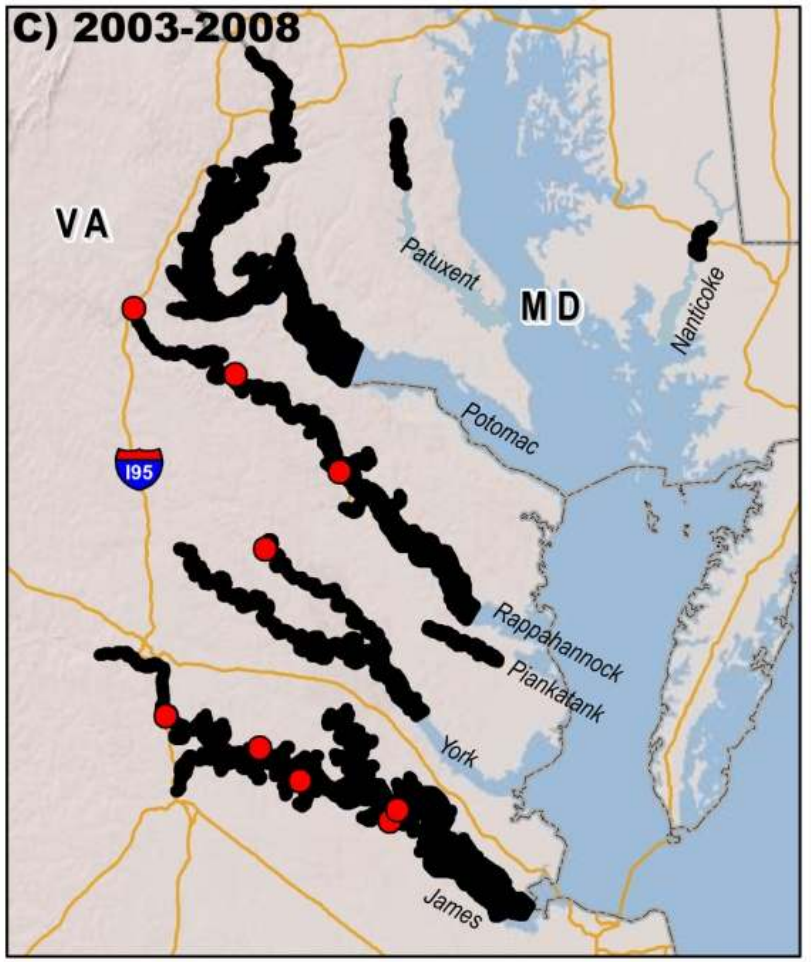
- Native to Mississippi, Missouri, & Ohio River drainages



FL Museum of Natural History

Blue Catfish

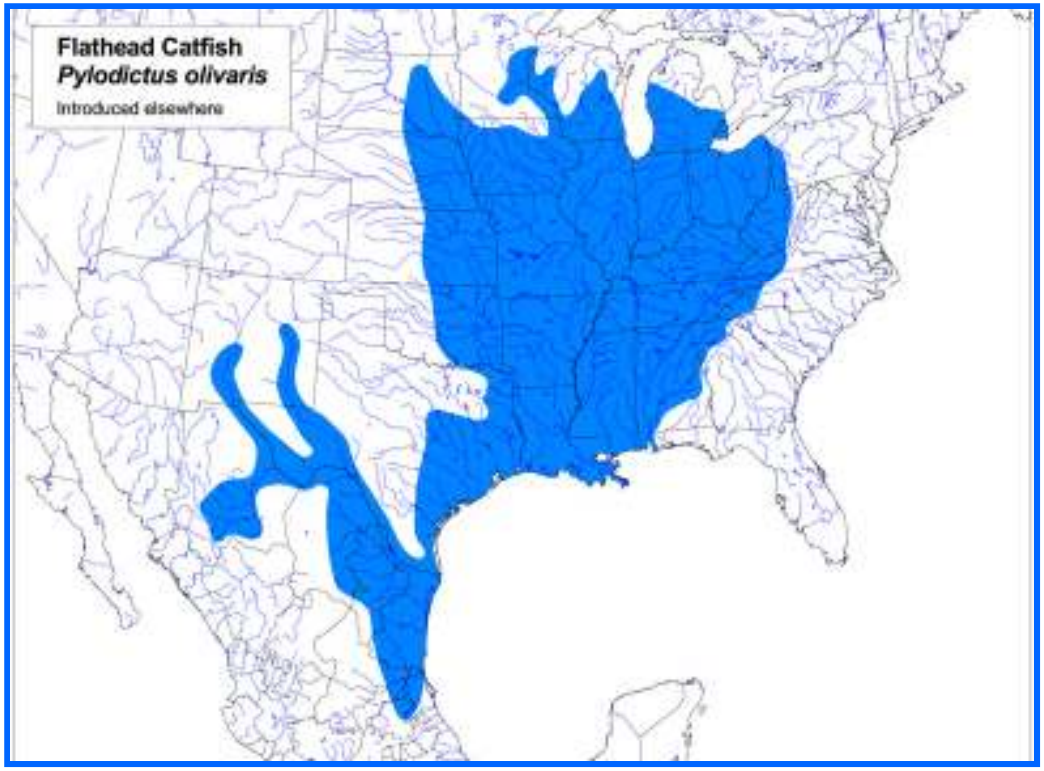
- Native to Mississippi, Missouri, & Ohio River drainages
- Introduced in 1970s, 1980s



Current distribution of blue catfish
(not shown: Susquehanna River)

Flathead Catfish

- Native to Mississippi, Missouri, & Ohio River drainages



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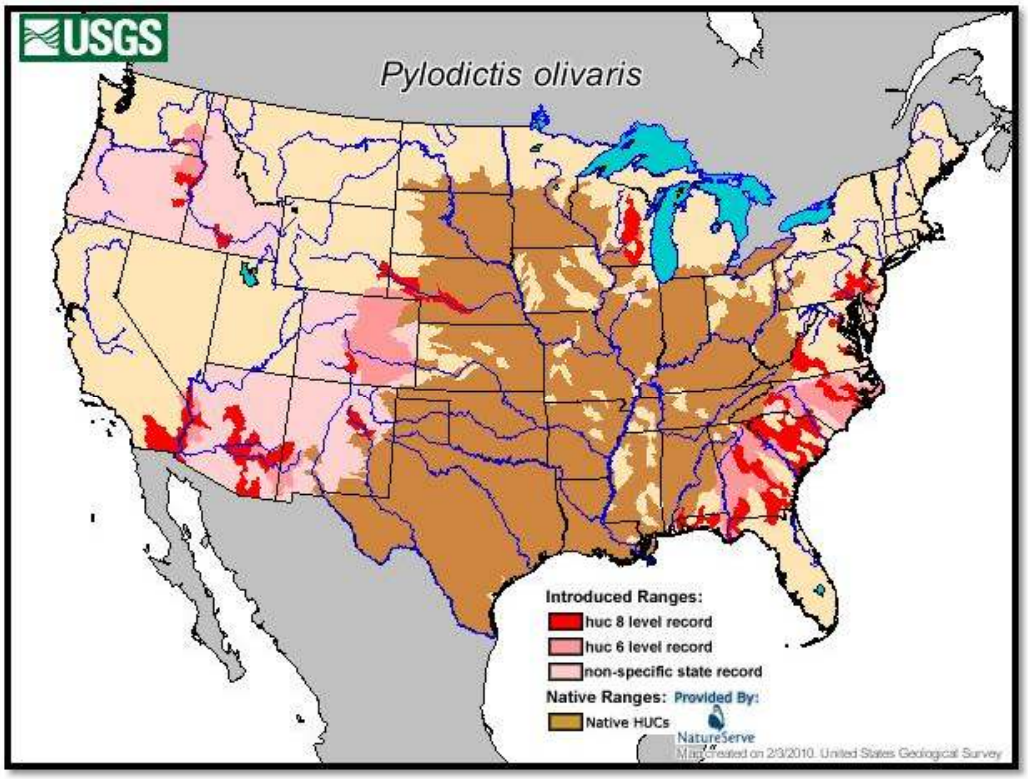
Flathead Catfish

- Native to Mississippi, Missouri, & Ohio River drainages
- Introduced 1965-1970
- Currently found in
  - James River
  - York River
  - Potomac River
  - Susquehanna River



Predictors of Invasiveness

Predictor	Blue Catfish	Flathead Catfish
High propagule pressure	?	?
Prior invader	X	X
Large native range	X	X
Environmental tolerance	X	X
Long life span	X	X
Large body size	X	X
High adult trophic status	X	X
Broad diet	X	
Fast growth		X
High fecundity	X	
Parental care	X	X

Other predictors: short distance to native source; young age at maturity; large egg diameter; long reproductive season

Expansion of Established Populations

- Aided by tolerance for wide range of environmental conditions

- Aided by high densities of fish in new environment + high river flow

- Aided by angler redistribution

MD

MD, VA

Blue & Flathead Catfishes in the Chesapeake Bay Region

- MAPAIS recognized both as invasive species of interest in 2007
- Outside of their native range, both species are considered 'biologically harmful' (Fuller et al. 1999; Pine et al. 2005)
  - Potentially negative effects on native fauna

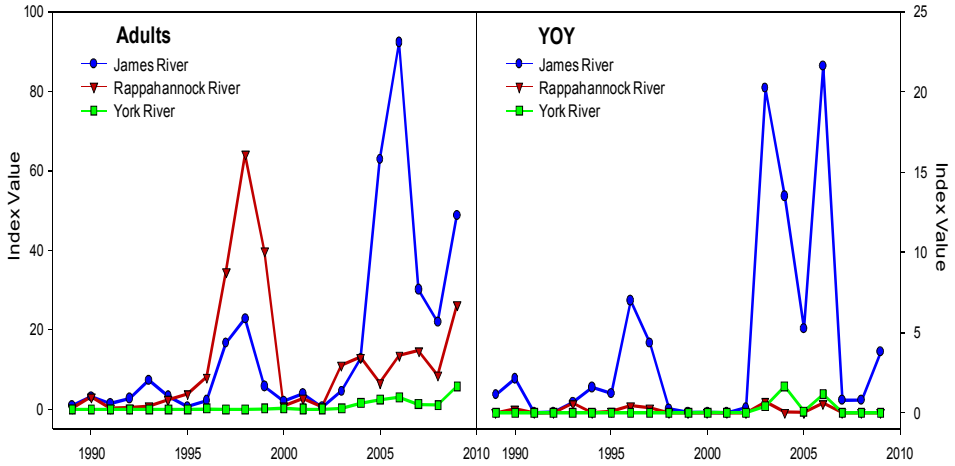
Potential Negative Effects on Native Fauna?

- Blue catfish:
  - Expanded into mesohaline habitats
  - Large size (130 lbs, Missouri River, Jul 2010)
  - Long lived (30+ years)
  - Include fish in diet

- Flathead catfish:
  - Confined to nontidal & tidal FW and oligohaline habitats
  - Large size (123 lbs 9 oz, Kansas reservoir, May 1998)
  - Long lived (30+ years)
  - Include fish in diet

What Do We Know About the Invasiveness of These Catfishes?

- Distribution
- Diet & trophic status
- Growth
- Recruitment
- Age & size structure



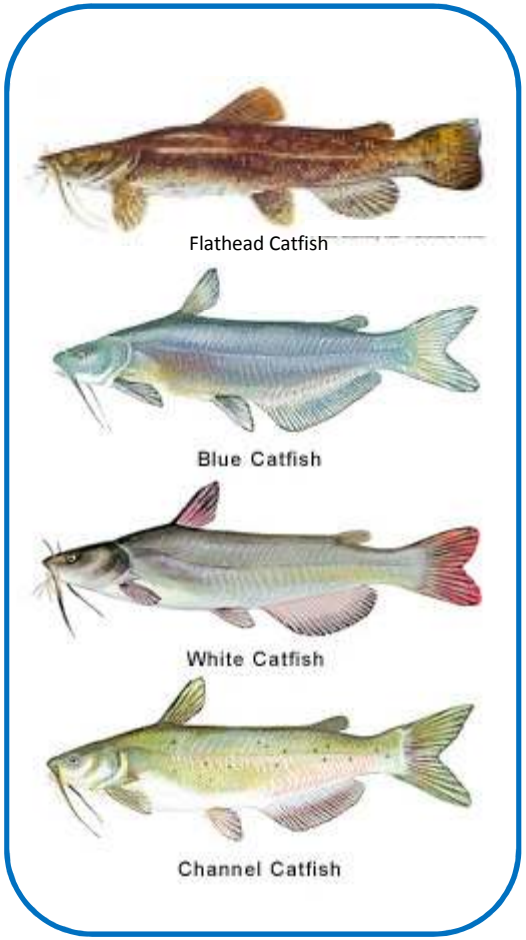
- Caveat: information varies in terms of spatial and temporal coverage

Somewhat Limited Information

- Examine potential mechanisms that may lead to environmental or economic harm
- Identify critical knowledge gaps that warrant research

Potential Interactions Leading to ‘Environmental Harm’

- Predation
- Competition



Predation Effects

- Blue catfish consume:
  - Crustaceans, worms, bivalves
  - Fish (>30 cm): American shad, Atlantic croaker, Atlantic menhaden, bay anchovy, blueback herring, blue catfish, gizzard shad, hogchoker, white perch
- Flathead catfish consume:
  - Fish (>20-25 cm)
- Both species:
  - Top predators
  - Feed on anadromous fishes (stable isotope analyses; MacAvoy et al. 2009)

Piscivory by Introduced Catfishes

- Extent and effects on native fish populations in Chesapeake Bay tributaries are poorly understood
- NC, GA: predation by flathead catfish associated with declines in native fishes (Pine et al. 2005; Bonvechio et al. *in press*)
- Blue catfish piscivory is size-dependent:

Proportion containing fish (number of non-empty stomachs)

Size class (cm FL)	James River 2002	James, York, Rappahannock rivers 2004 – 2007	Potomac River 2008 – 2010
<30	0 (52)	0.10 (765)	--
30 – 60	0.05 (92)	0.28 (265)	0.21 (108)
> 60	0.48 (61)	--	0.41 (108)

Effect of Size on Piscivory in Blue Catfish

- What proportion of the population consumes fish?
  - In James, only 7% of population exceeded 61 cm FL (2010 data; N=6,275)
- What is size structure of population?
  - Electrofishing not effective for sampling large catfishes
  - Bottom trawl not effective for sampling large catfishes
- Does size structure in freshwater and estuarine habitats differ?

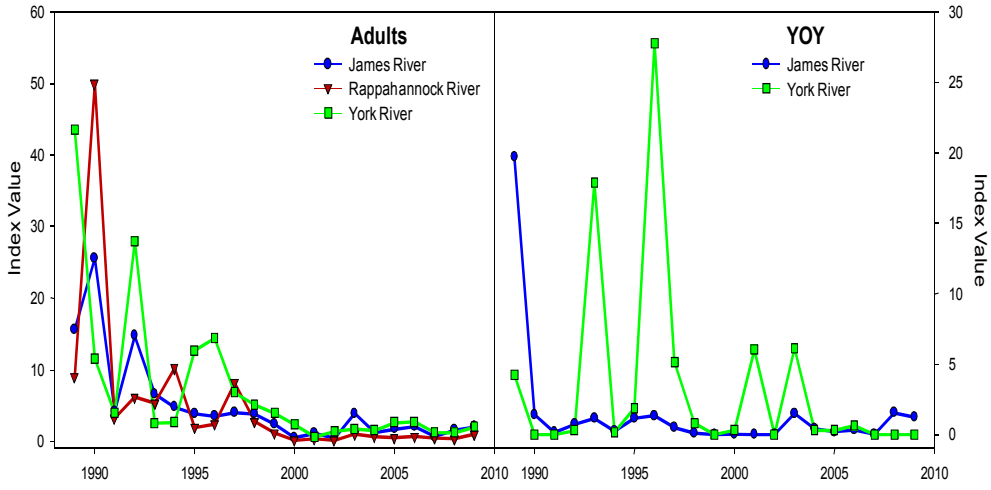
Predation Effects or Scavenging?

- Flathead catfish prey only on live fish, but blue catfish are scavengers
- Is ingestion of fish due to directed predation or from scavenging of fish carcasses?
  - Spines, scales of large adult fish found in stomachs of small blue catfish

Competition

- Competition between native species and blue or flathead catfishes is not well documented
  - Native white catfish – rarely exceed 24” or 6 lbs
  - White catfish abundance in James, York, and Rappahannock rivers declined (Schloesser et al. *in press*)
  - White catfish abundance in Piankatank River declined
  - Cause & effect?

White catfish *Ameiurus catus*
(Illus. by Duane Raver)



White catfish

Potential ‘Economic Harm’?

- Blue catfish as bycatch in gillnet fisheries in the Potomac River
  - Reduce gear efficiency for target species
  - Similar interactions in the James River?
- What is economic value of foregone harvest?

Conclusion

- Not possible to unequivocally demonstrate ‘ecological harm’ associated with these nonnative fishes
  - Such impacts have been documented in other systems

Flathead catfish (Photo: VA Tech)

Critical Knowledge Gaps

1. Zoogeographical studies
2. Population dynamics
3. Community-level effects
4. Control

Critical Gaps: Zoogeographical Studies

- Determine colonization rates of down-estuary sites by blue catfish in coastal tributaries; identify proximal stimulus for **down-estuary range expansion** of blue catfish; investigate effect of population density on colonization rates and range expansion
- Investigate effect of **population density in freshwater habitats** on abundance of blue catfish in lower reaches
- Determine **migration and movement** patterns of blue and flathead catfishes in tidal tributaries, especially movements associated with spawning and colonization (dispersal into estuarine reaches)
- Investigate **site fidelity of trophy-sized blue catfish**
- Identify critical **nursery areas in estuarine reaches** of the coastal tributaries
- Determine **salinity tolerance** of all life stages (eggs, larvae, juveniles, adults)

Critical Gaps: Population Dynamics

- Develop **sampling design and methods** to permit estimation of abundance (density) in freshwater and estuarine reaches; calibrate methods using estimate of population abundance derived from mark-recapture study
- Assess temporal **changes in biomass and fish community composition** for major tidal tributaries of the Bay; provide information to EcoPath models
- Determine **biomass, growth, and recruitment** of blue and flathead catfishes in major tidal tributaries of the Bay
- Determine **fecundity, maturity schedules, and spawning frequency** for these species in tidal tributaries
- Determine amount of **harvest** necessary to reduce population densities in tidal tributaries
  - estimate **exploitation rates** of the commercial and recreational fisheries and evaluate these relative to necessary harvest levels

Critical Gaps: Community-Level Effects

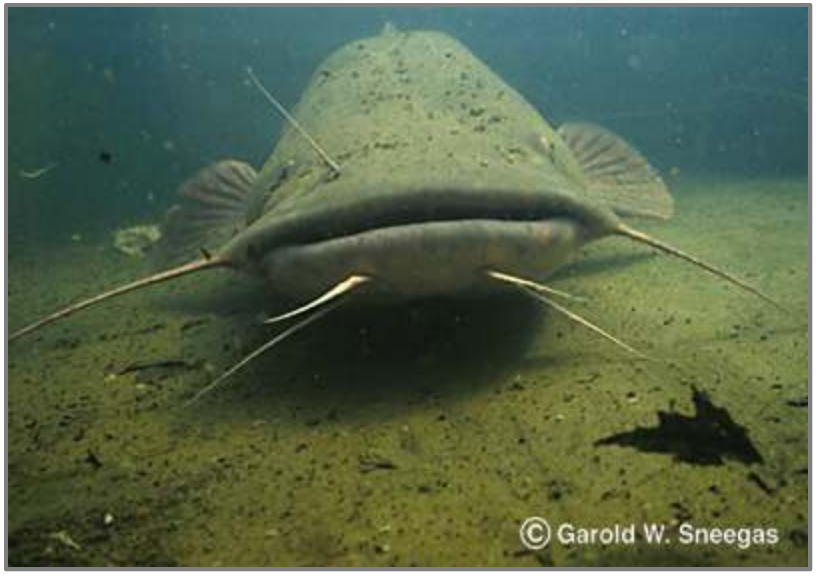
- Determine **nature of interaction** of blue catfish and flathead catfish **with native fishes** such as white catfish and blueback herring
- Determine **trophic status** of blue and flathead catfishes with adequate **seasonal, regional, and fish size** considerations
  - investigate **size-dependent feeding habits** and relate these to **habitat** (e.g., salinity regime, depth)
  - explore the use of **bioenergetic models** to understand consumptive needs of nonnative catfishes
  - use **Ecopath models** to determine population-level effects of predation by nonnative catfishes
  - evaluate the **impact of catfish predation on native species** (e.g., river herring, American shad, white catfish, blue crabs, and freshwater mussels) relative to the impact of other predators (e.g., striped bass)
  - evaluate the prevalence of **scavenging** (relative to predation) in blue catfish

Critical Gaps: Community-Level Effects

- Determine the effect of **natural or man-made impediments** that concentrate catfishes and their prey; such impediments include dams, the base of rapids, and constricted reaches below the fall line
  - **non-random distribution** of predators and prey may constitute an inordinately large proportion of the total predation mortality on native species
  - determine **sources of mortality on key native fishes** in order to evaluate effect of catfish consumption (e.g., bycatch mortality, predation by native fishes, etc.)
- Determine the role of blue and flathead catfishes in **nutrient cycling** in the system (consider catfish as predator and prey)
- Determine extent of blue catfish **bycatch in gillnet** and other fisheries
  - assess **economic impact** of foregone harvest

Critical Gaps: Community-Level Effects

- Determine economic and societal **values of trophy fishery** for blue catfish in the James River
- Investigate the **relationship between size and** concentrations of **toxic substances** in blue and flathead catfishes (e.g., Hg, PCBs)
  - investigate human **consumption risks** for all sizes of catfishes



Critical Gaps: Control

- Identify blue and flathead catfish **refugia** and likely **dispersal mechanisms**
- Assess **feasibility of removal strategies** including development of fishery on small individuals (but note consumption concerns due to contaminants)


Photo: TX Parks & Wildlife


Photo: Eric Engbretson


Thank You

Sequence of Phases for Biological Invasions

1. Transport to a new region
   - No studies on this
2. Release or escapement to the wild
   - Poorly documented
3. Establishment
   - Most studied phase
   - Important factors:
     - reproductive variables,
     - diet breadth,
     - environmental tolerance
     - species-specific climate and environmental matching
4. Dispersal or spread
   - Little work on this: more complex than generally acknowledged
5. Integration or impact

NOTE: different factors mediate each phase (Garcia-Berthou 2007)

Further Thoughts On Eradication

- "Perhaps the greatest truism in invasion biology is that species invasions are generally irreversible and that once a new non-native species establishes, it is almost impossible to eradicate without excessive **collateral damage** on native species" (Cucherousset & Olden 2011)

- "Because the eradication of established species is so difficult, agencies should be cautious about promising success if they wish to **maintain credibility**….In some cases, slowing the rate of spread may be more feasible and cost effective for an established species than eradication" (Myers et al. 2000)