Elements of an Invasive Species Strategy

- Prevention
- Rapid Response
- Control
- Adaptation

Prevention

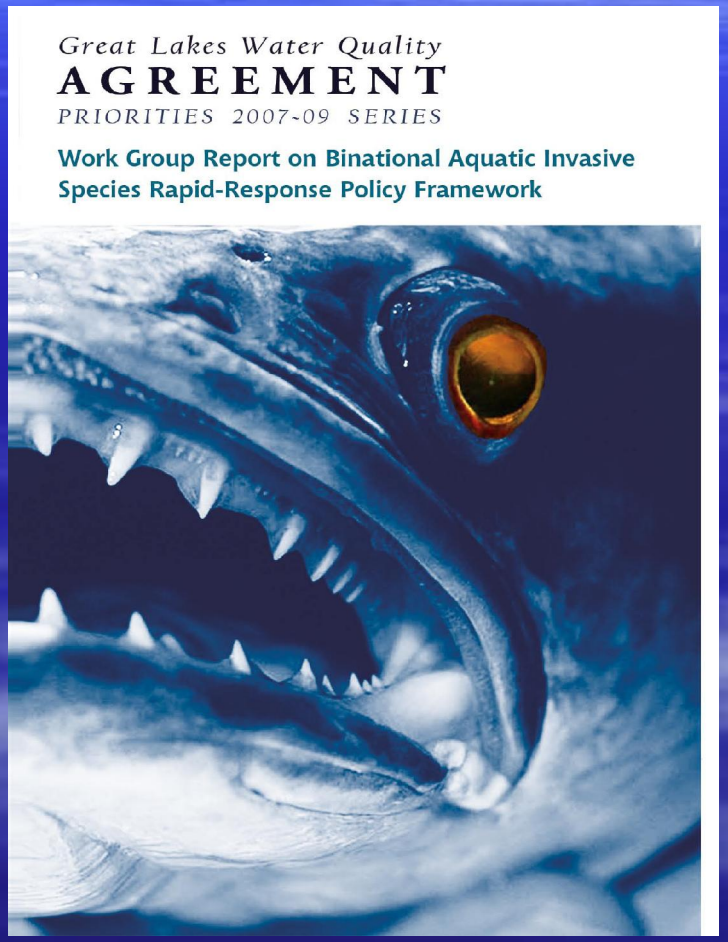
- Hard to argue against prevention targeting major pathways (eg. ballast water) as a main strategy, but can it really be effective?
  - Non-major pathways (aquarium trade, ethnic markets, etc.)
  - Unpredictable , improbable or catastrophic event pathways

Question: For the Great Lakes, we have already detected 180 aquatic invasive species, about 10% of which are said to be of significant concern. What are we trying to protect or prevent at this stage?

Rapid Response

- IJC recently produced a recommended AIS rapid response framework, targeted on how to improve response to a detection.
- However, recent scientific studies on detection of AIS question whether current monitoring program design is can achieve detection early enough for a rapid response strategy to be effective. (Harvey *et al., 2009. Diversity Distrib.* **15:** 429-437)

Question: Can we design and implement a risk-based sampling design to increase feasibility of detecting AIS establishment?



Control Programs

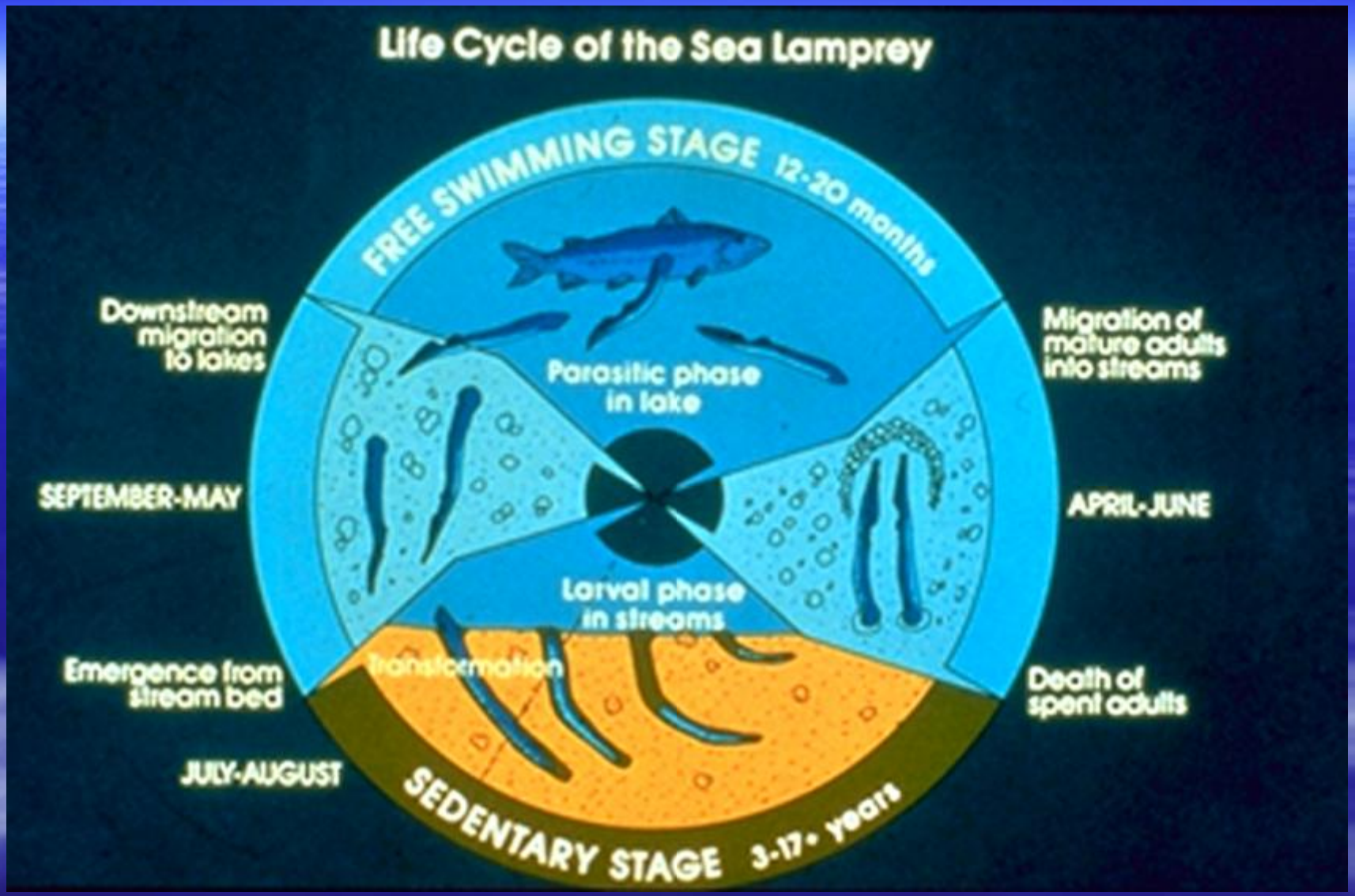
- Some times we get lucky and the life history of an AIS provides an opportunity for control (eg. Sea lamprey in the Great Lakes).
- However, this requires a significant resource commitment to design and develop the program and an indefinite resource commitment to implement it.

Question: How can we apply adaptive management to such control programs to ensure that the resource commitment is justified under changing ecological or social conditions?

Sea Lamprey Control Program

- Established in 1955 at annual cost of $10M.
- Involves
  - Great Lakes Fishery Commission
  - Fisheries and Oceans Canada
  - U.S. Fish and Wildlife Service
  - U.S. Army Corps of Engineers
- The control program uses several techniques to attack sea lampreys.
  - lampricide control
  - sea lamprey barriers
  - sea lamprey traps
  - the sterile-male-release-technique

Credit: Great Lakes Fishery Commission



Source: Great Lakes Fishery Commission

Sea Lamprey Control Program

- Lampricide control
  - Targets larval stage in ~175 tributaries and bays
  - 3-trifluoromethyl-4-nitrophenol (TFM) chosen from 6000 chemicals tested based on selectivity towards lamprey
  - 2',5-dichloro-4'-nitrosalicylanilide (Bayer 73), a non-selective chemical is also used.
  - First used in Lake Superior (1958), then Lakes Michigan and Huron (1960), Lake Ontario (1972) and Lake Erie (1986).
  - The overall effect of TFM was the reduction of the sea lamprey population by 90% of its 1961 peak
  - Problems
    - High cost
    - Not selective enough (American brook lampreys and endangered silver lamprey; fishes like walleye, pickerel, northern pike, bullhead, catfish, logperch; and invertebrates like hydra, turbellarians, burrowing mayflies, blackflies, aquatic worms, eropdellid leeches, caddisflies, pink heelsplitters, snails, and clams)

Sea Lamprey Control Program

- Barriers
  - Targets spawning stage in ~75 tributaries
  - Replaced weirs, including electrical weirs
  - Low head (2-4 ft) barrier dams on 52 tributaries in Canada and 19 in U.S.
    - Low non-target mortality but impedes movement of some species
  - Adjustable crest or inflatable barriers
    - Temporary barrier during lamprey spawning period reduces impact on other species
  - Velocity barriers
    - Targets lamprey's poor swimming ability.

Adaptation

- For most of these species once they are established, our only real option is to learn to live with them.
- But, is there any real possibility to mitigate ecosystem impacts or should we accept that ecosystems have to manage themselves?
- Should our adaptation focus on strategies to mitigate AIS impacts on us and the things we care about the most
  - Eg. Dual intake pipes so one can be cleaned without shutdowns
- Don’t ecosystems respond and adapt to invasive species in the long term by themselves? Aren’t some ecosystem responses to AIS positive?

Zebra Mussels in the Great Lakes

- Clogged pipes
- Mussel shells on beaches
- Diversion of nutrients
  - Lower productivity for some species
- Clearer water
  - Macrophyte growth
  - HABs?
- Native mussel declines (eradication) in open waters of Lake Erie

- Changes in bird migrations
- Food source for some native species
  - Eg. Sturgeon, yellow perch, freshwater drum, catfish, sunfish
  - Larger salmon on Lake Ontario
- Macrophyte beds nurseries for young fish
  - Eg. Smallmouth bass in Lake St. Clair

Zebra Mussels

Question: Are high zebra mussel populations sustainable or to what extent will they decline due to lower planktonic productivity?