Herring River Restoration

Nekton Monitoring 1984 to 2005 and Response to Restoration

Herring River Technical Review Committee

11/30/05(revised 1/3/06)

Presented by Evan Gwilliam

Executive Summary

- The impoundment of the Herring River by the current dike has a negative effect on the nekton community, i.e., reduction in nekton density and diversity through habitat degradation, habitat loss and direct mortality.
- Negative impacts to the nekton community are transmitted up and down “the food chain” i.e., on primary producers (e.g., salt marsh vegetation) and predators (e.g., striped bass).
- Restoration mitigates negative impact on nekton community as evidenced by local Cape Cod restoration projects at Hatches Harbor and East Harbor, and other projects regionally and globally.

Overview

- Introduction of presenter
- What is nekton?
- Why nekton is an effective indicator of estuarine status and restoration effect
- The impact of impoundment on the Herring River nekton with examples from CCNS
- Future of Herring River restoration with examples from CCNS

Griffin Island 1903—NPS files

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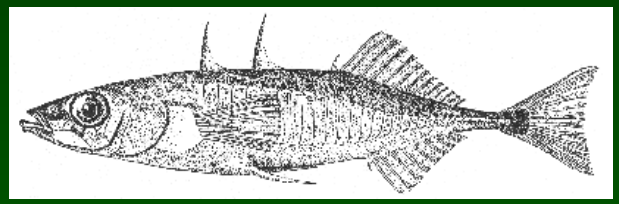
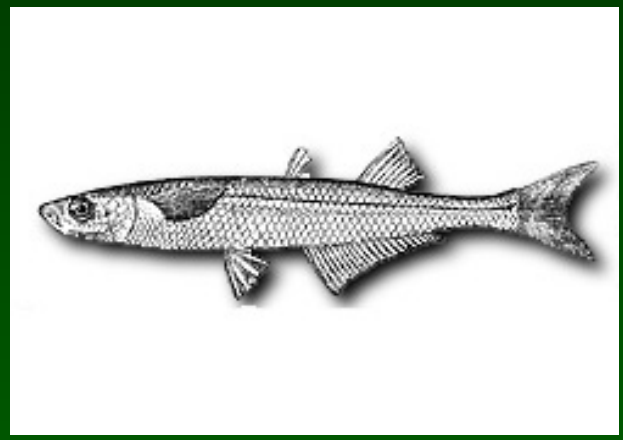
Nekton

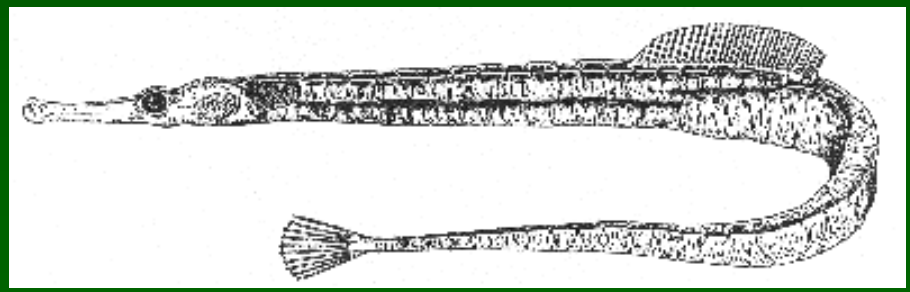
- Free-swimming fishes and decapod crustaceans



Gasterosteus aculeatus (3-spine stickleback)



Menidia menidia (Atlantic silverside)



Syngnathus fuscus (pipefish)

Nekton of the Herring River

Alewife
American eel
Atlantic mackerel
Atlantic menhaden
Atlantic mud crab
Atlantic silverside
Blueback herring
Bluefish
Chain pickerel
Common killifish
Crayfish
Four-spine Stickleback
Golden shiner
Grass shrimp
Green crab
Hickory shad
Hogchoker
Horseshoe crab
Lady crab
Lobster shrimp
Long-wrist hermit crab
Northern pipefish
Pumpkinseed
Sand shrimp
Say mud crab
Sheepshead minnow
Striped killifish
Tidewater silverside
White perch
Winter flounder

Why Monitor Nekton?

Nekton are a valuable resource.

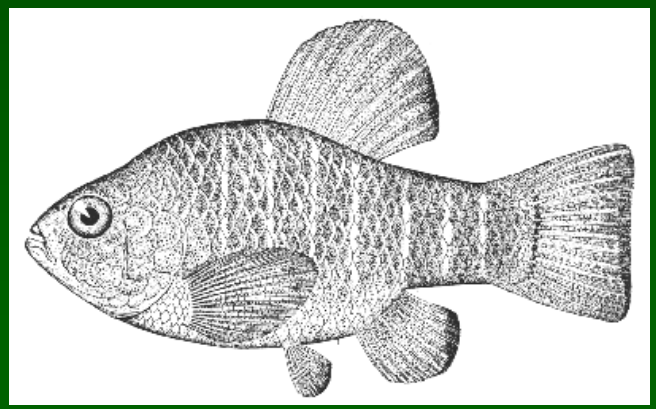
Nekton as effective sample population to monitoring restoration

Change in nekton abundance, density and species composition reflect changes in multiple ecosystem processes

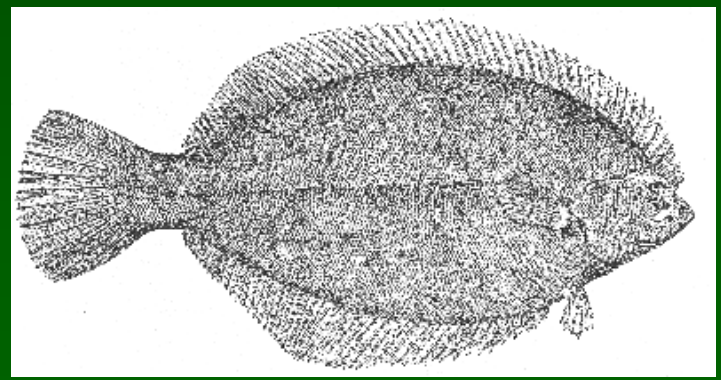
Respond to disturbance in food chain dynamics

<u>Bottom up</u>: e.g., removal/change in primary producer populations by anthropogenic impact to estuarine water quality

<u>Top down</u>: e.g., removal of predator



Cyprinodon variegatus (sheepshead minnow)



Pseudopleuronectes americanus (winter flounder)

The impact of impoundment on the Herring River nekton with examples from CCNS

- Physical barrier to nekton movement
  - Example: river herring
- Multiple impoundments restrict/prevent tidal flow
  - Decreased or no tidal range
  - Decrease or total loss of submerged and inter-tidal habitat
  - Decrease in water quality
    - Low pH
    - Metal toxicity
    - Low dissolved oxygen

Herring River fish kill—NPS photo

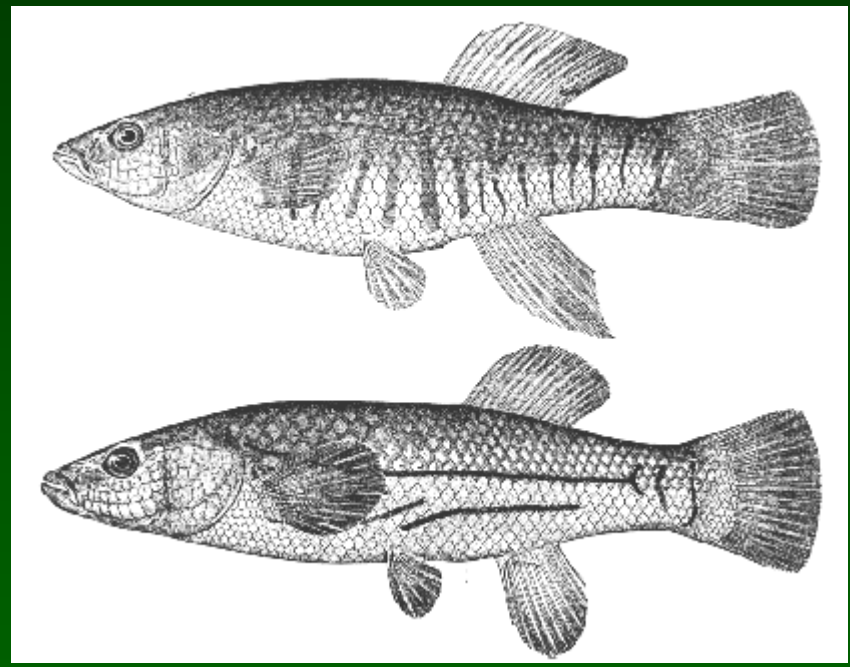
Example of impact: River Herring

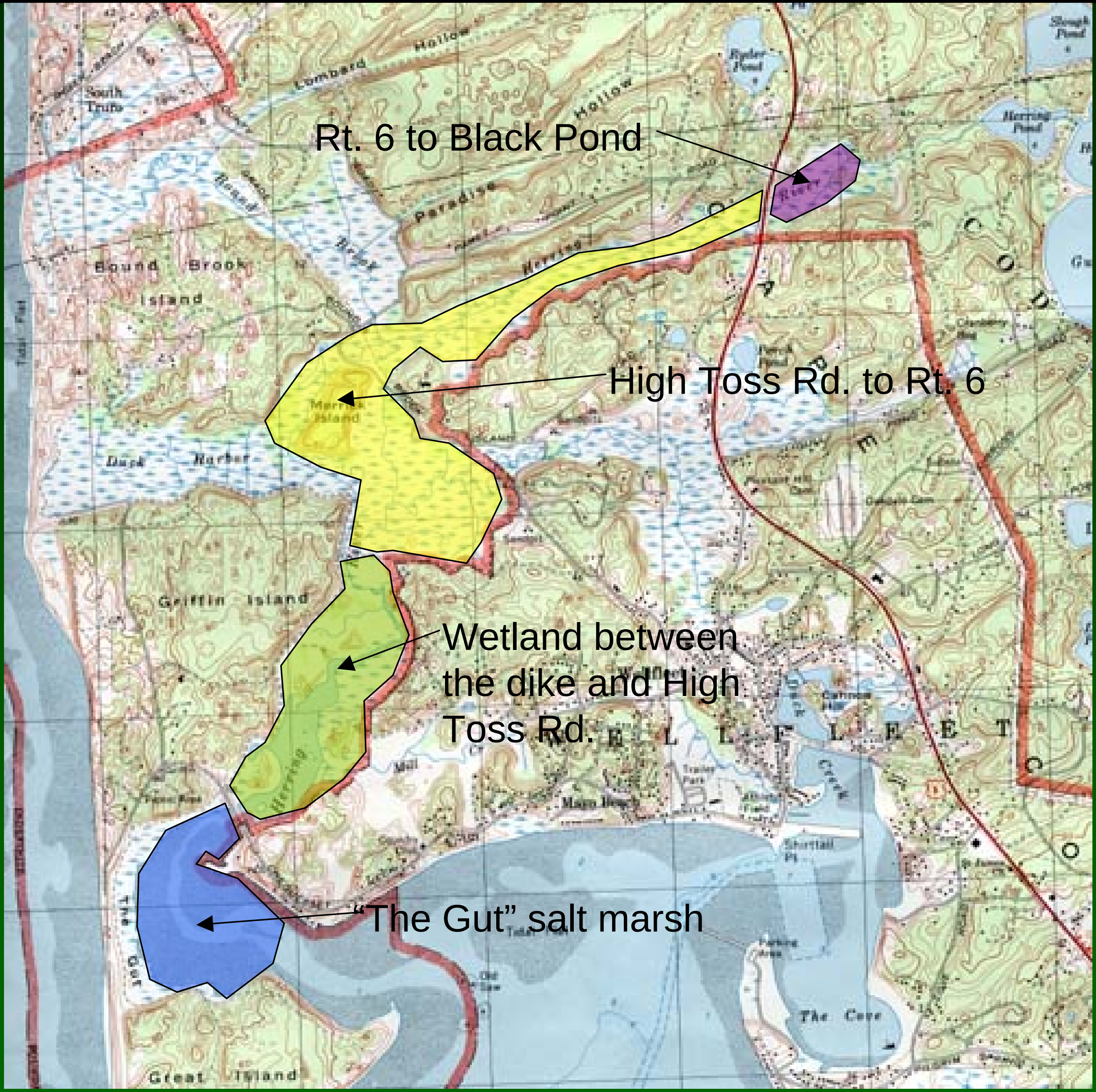
- Restricted migration route; dike and accumulation of debris → Increased mortality of spawning and post spawning adults
- Restricted tidal range and reduced habitat → Limited nursery grounds
- Poor water quality: low DO, low pH, high concentrations of suspended solids → Increased mortality of migrating adults and juveniles. Reduced viability of embryos

from Roman 1987 *An Evaluation of Alternatives for Estuarine Restoration Management: The Herring River Ecosystem CCNS* NPS report

Three examples from studies of Herring River nekton

- Decrease in total number of nekton and shellfish
- Decrease in nekton density
- Decrease in nekton species diversity




Rt. 6 to Black Pond
High Toss Rd. to Rt. 6
Wetland between the dike and High Toss Rd.
"The Gut" salt marsh
Bound Brook Island
Griffin Island
Great Island
Duck Harbor
Lombard Hollow
Paradise Hollow
The Cove
W E L L F L E E T

Example 1: Decrease in total number of nekton and shellfish--impoundment results in loss of fish and shellfish fauna

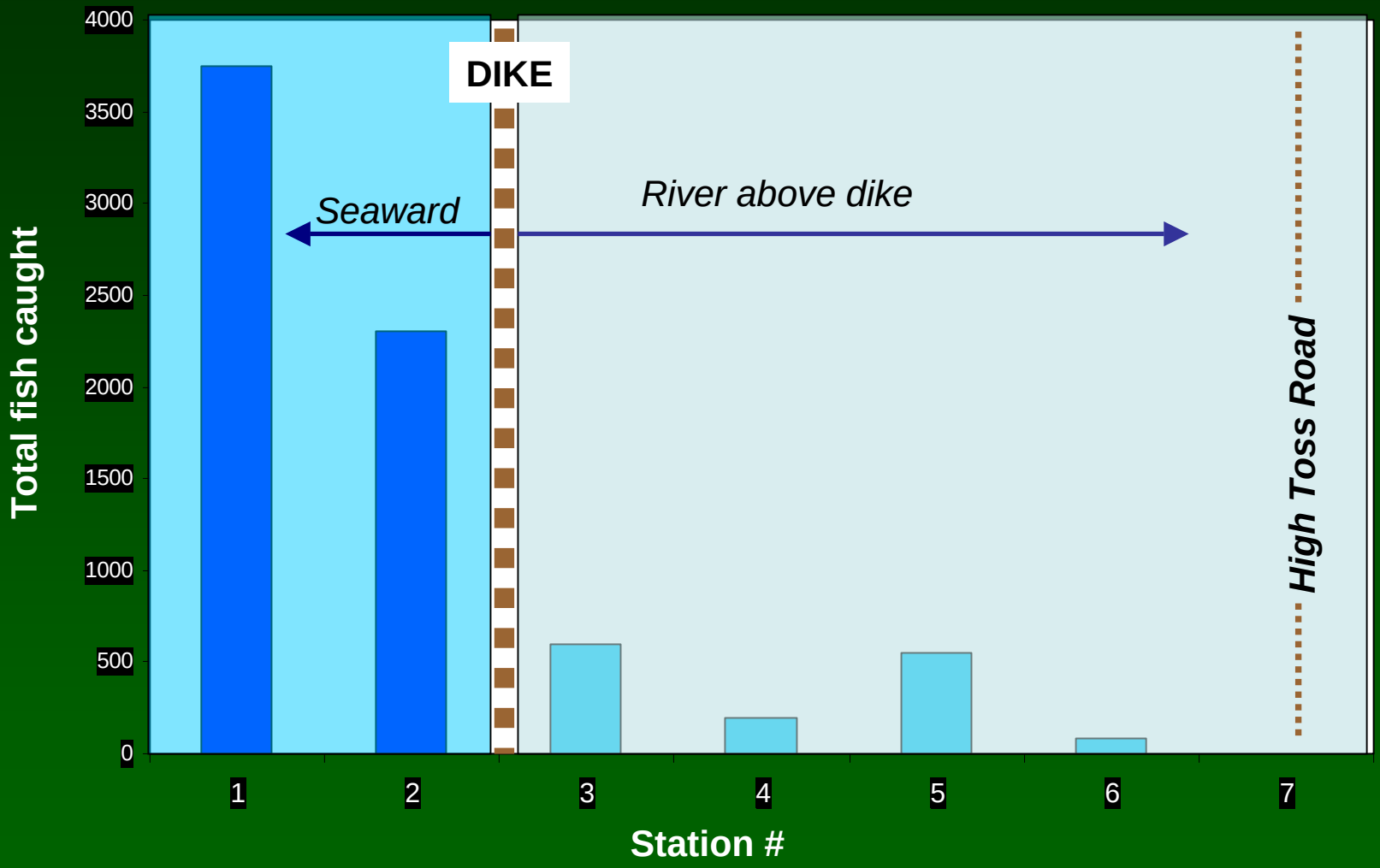
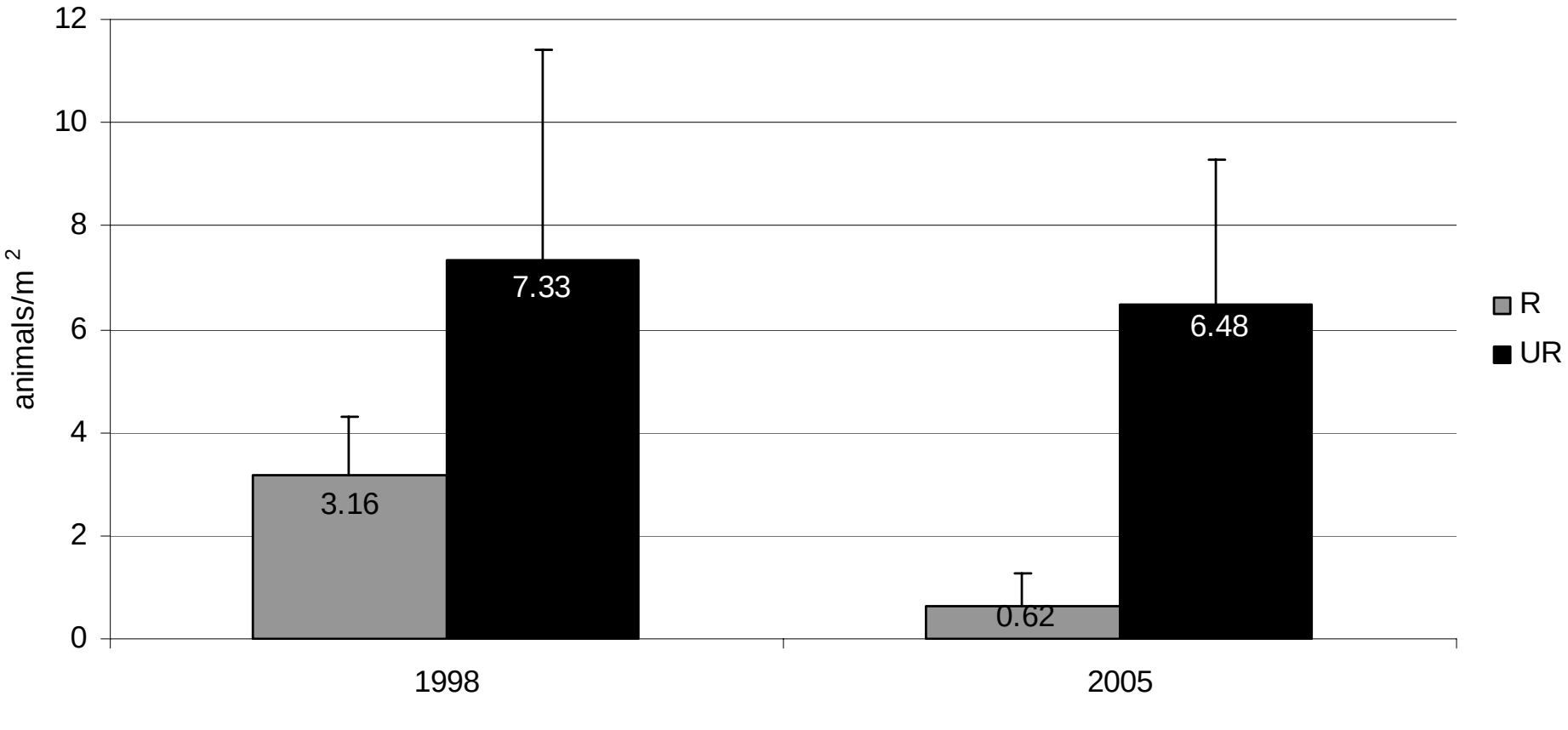


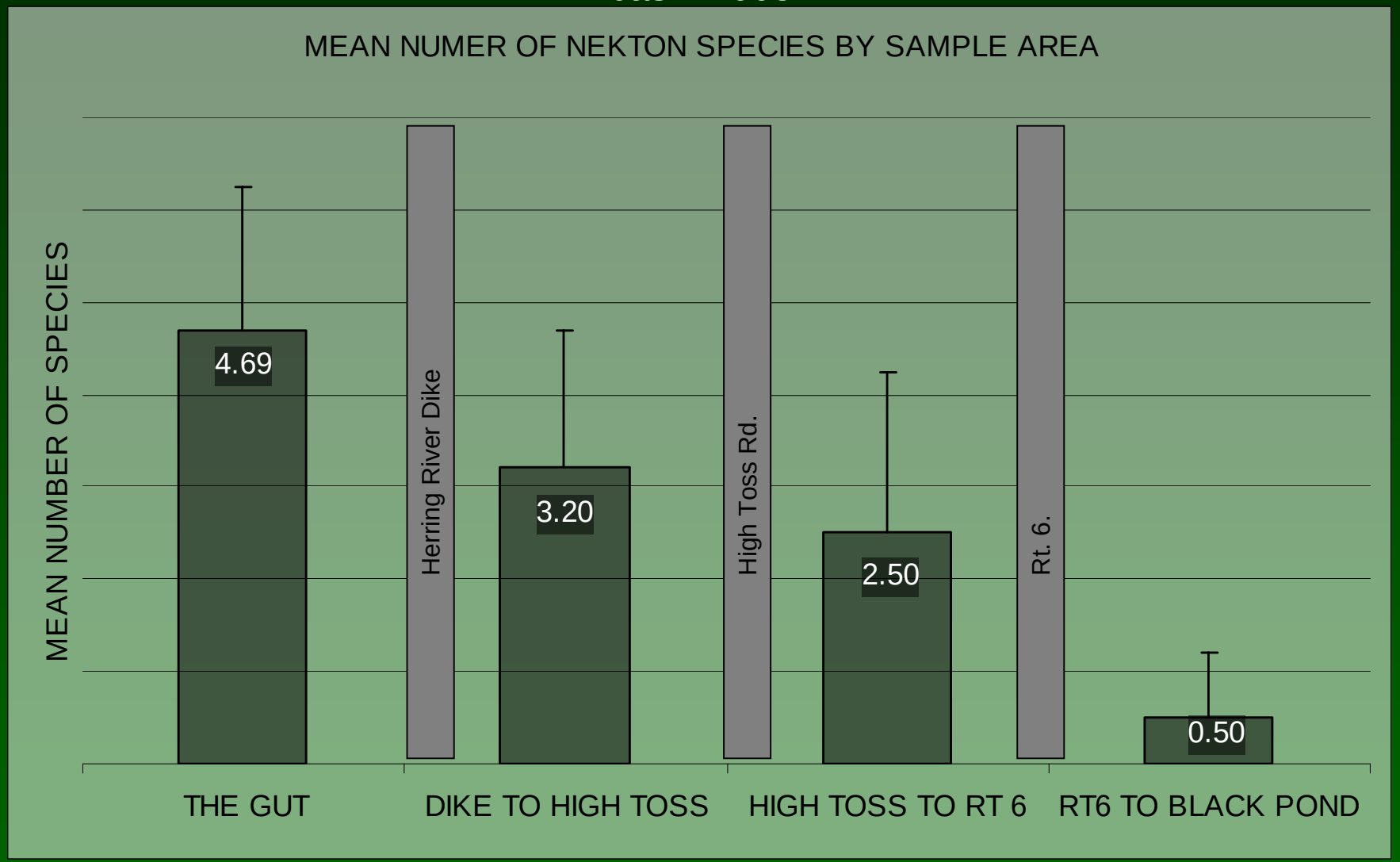
Figure illustrating decrease in total nekton and shellfish caught above and below the Herring River dike (from Roman 1987).

Example 2: Decrease in nekton density--mummichog density above and below Herring River Dike 1998 and 2005



There are significantly less mummichog in the restricted area of the Herring River (R vs. UR) in both sample years. There was also a significant decrease in densities in the restricted areas (R) between sample years.

Example 3: Decrease in nekton diversity in several impoundments in the Herring River basin 2005



The diversity (mean # of species captured) of nekton species is significantly lower in all the restricted marsh areas between the Herring River dike and Black Pond compared to nekton diversity in the unrestricted area (“The Gut” marsh).

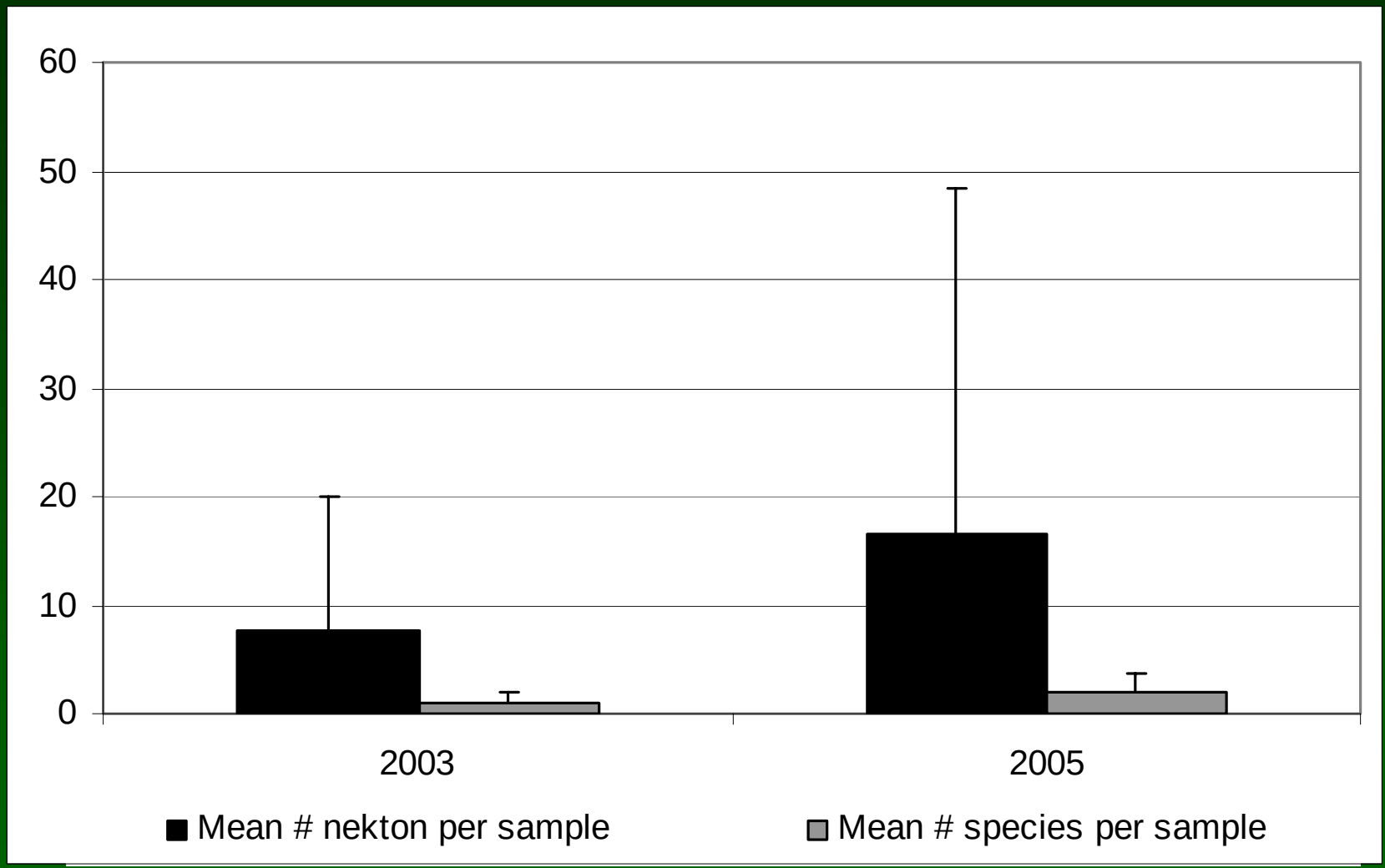
Summary: Result of Herring River impoundments on nekton community

- Significant decrease in nekton total numbers, density and diversity
  - Adult, juvenile and larval mortality
  - Decrease in embryonic viability
  - Loss or limitation of spawning habitat
  - Loss or limitation of nursery habitat

Examples of successful restoration on Lower Cape Cod

- East Harbor restoration project is similar—multiple impoundments
- Responding positively on multiple levels
  - Vegetation
  - Nekton species diversity and density
  - Improved water quality
- Positive nekton response in similar restoration projects in region and around country
  - Examples:
    - Sachuset Point salt marsh, Middletown, RI
    - Galilee salt marsh, Narragansett, RI
    - Sweetwater Marsh National Wildlife Refuge, San Diego, CA

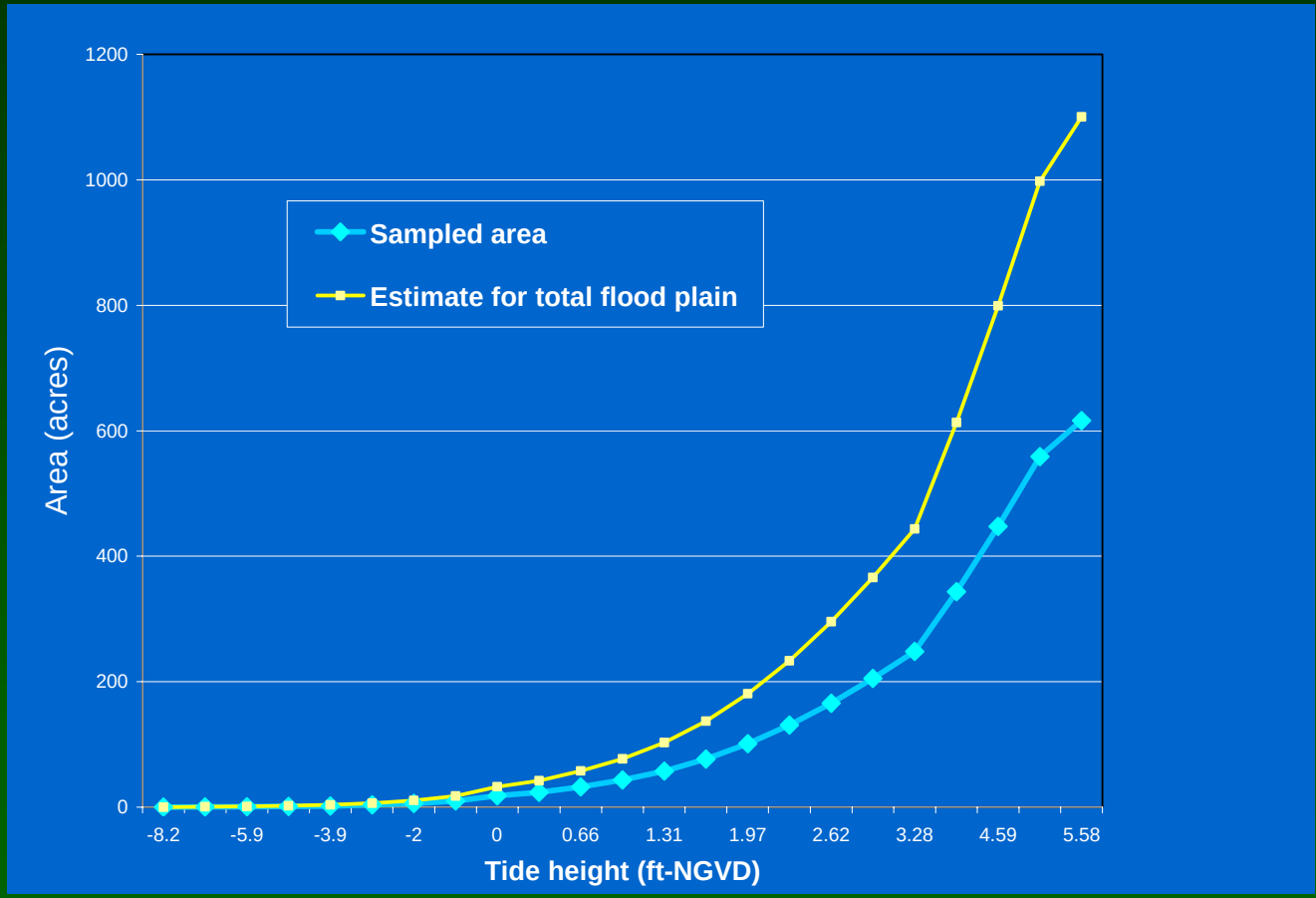
Example 4: Increase in nekton density and species richness 2003 and 2004 East Harbor Lagoon, North Truro & Provincetown



Between 2003 and 2005 (post-restoration), there was a significant increase in the number of species per sample. An increase in nekton numbers per sample should be noted, however, it was not significant.

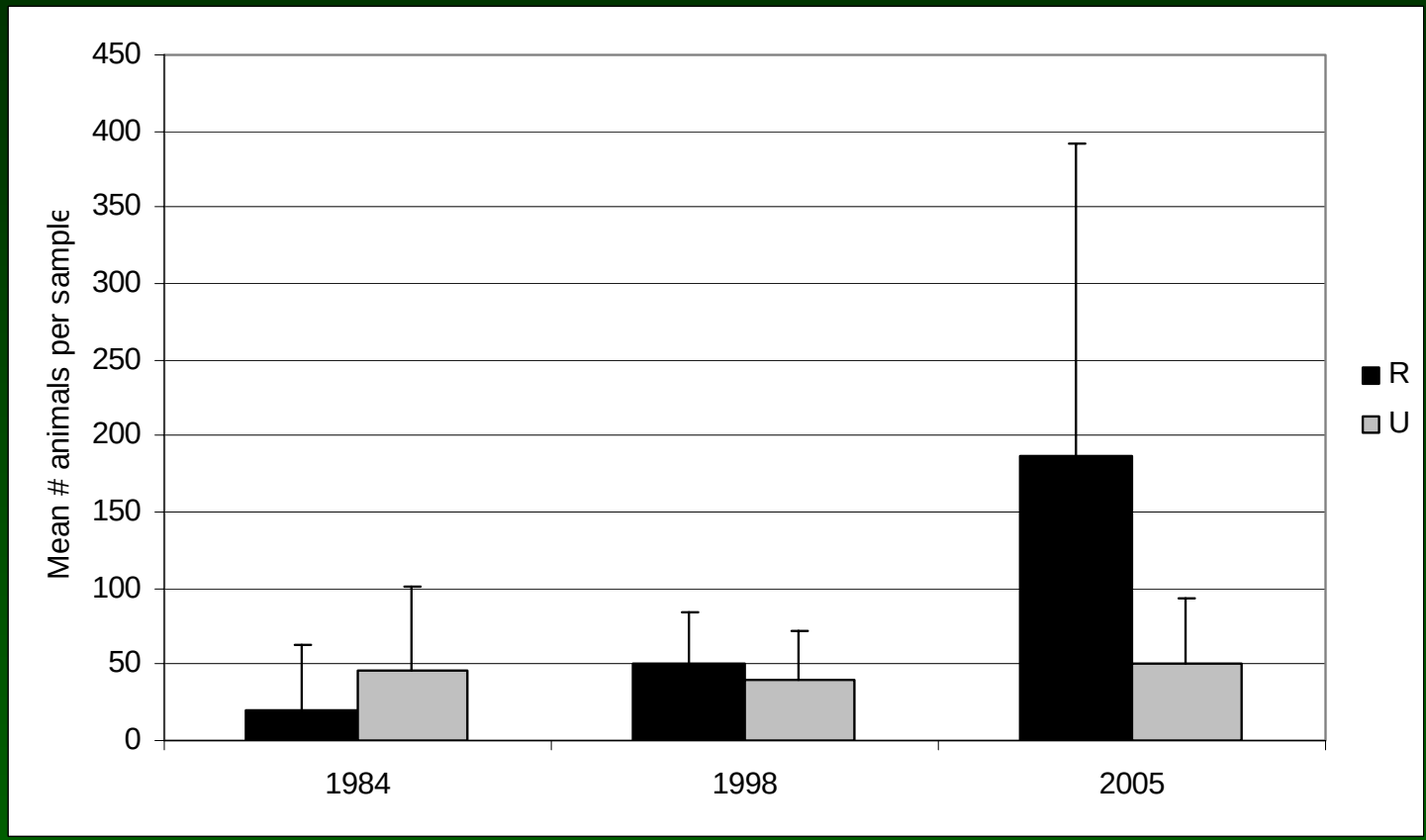
As restoration progresses…

- Mitigation of impact of tidal restriction
- Less impediment to migrating species (e.g., river herring)
- Increase in water quality
- Increase in spawning and nursery habitat



This graphic illustrates the increase of possible nekton habitat (i.e., restored tidal areas) as restoration progresses (i.e., increase in tide height).

Example 5: Increase in Herring River grass shrimp density 1984 to 2005—Result of increase in salinity after 1984 opening of sluice gate?



The culvert in the Herring River was opened slightly 1984, increasing the salinity of the restricted area directly adjacent to the dike. There was a significant increase in numbers of grass shrimp collected in this area in the years subsequent to the small increase in the Herring River dike sluice gate. This is a powerful example of what restoration, even a small amount (the sluice-gate was raised only a few inches), can do. Grass shrimp are prey for many important fish, like the striped bass, and may indicate improvement in water quality and an increase in abundance of aquatic macrophytes. Grass shrimp numbers in “The Gut” area (U) did not change.

What can be expected?

- Literature indicates that greatest change in nekton diversity and abundance will occur at the most impacted sites
- Literature indicates an increase in nekton abundance and diversity in restoration projects regionally, nationally and globally.
- Change can be rapid, and highly variable and take time to stabilize
  - As tidal range, chemistry and marsh morphology change
    - Shifts in community composition and dominance
    - Density, size and distribution
  - Example: East Harbor

Conclusions

- The Herring River dike has resulted in a decrease in nekton abundance and diversity.
- Habitat restoration will improve nekton abundance and diversity
- Positive examples exist from the Herring River (e.g., increase in grass shrimp abundance) and other local restoration projects (e.g., East Harbor).