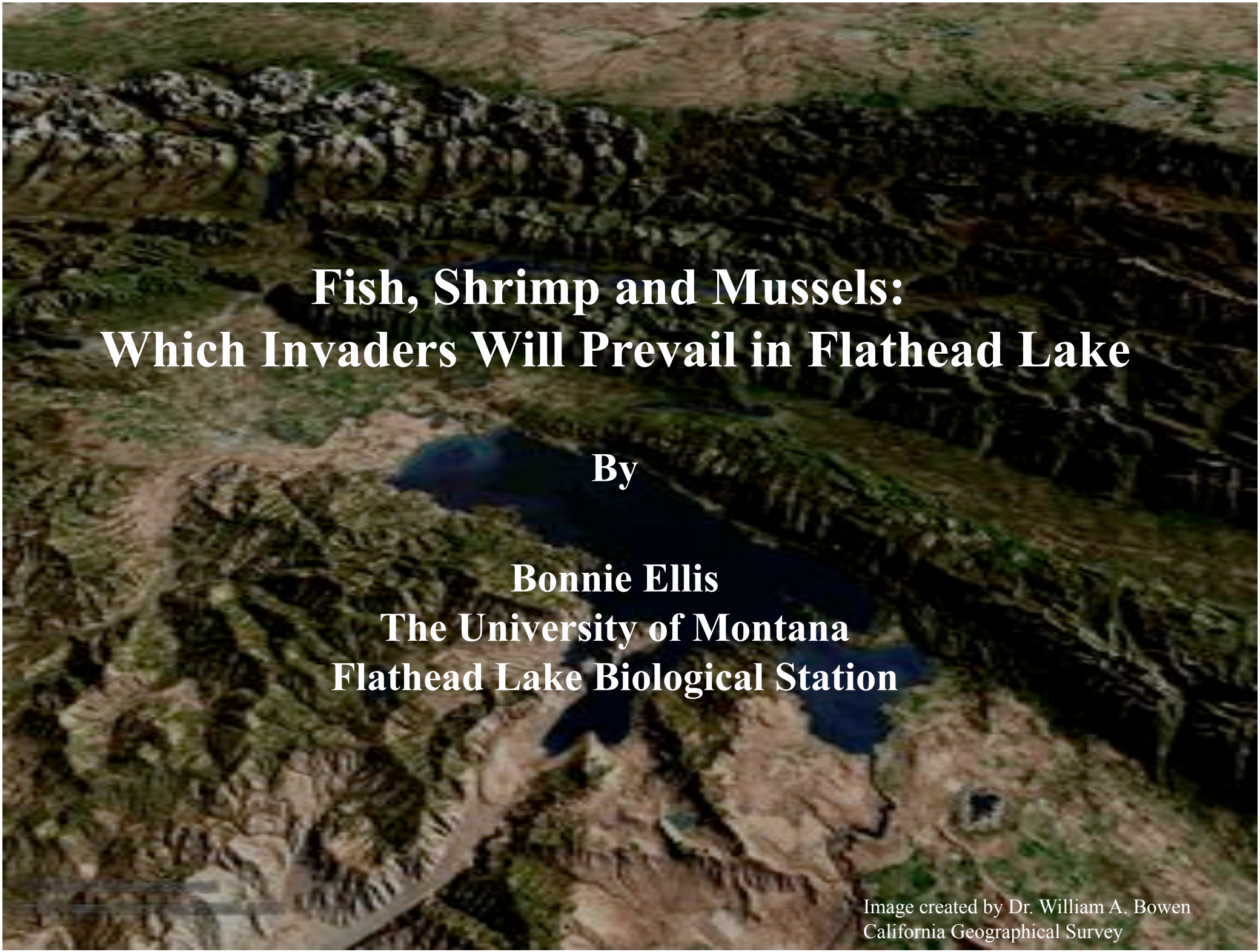
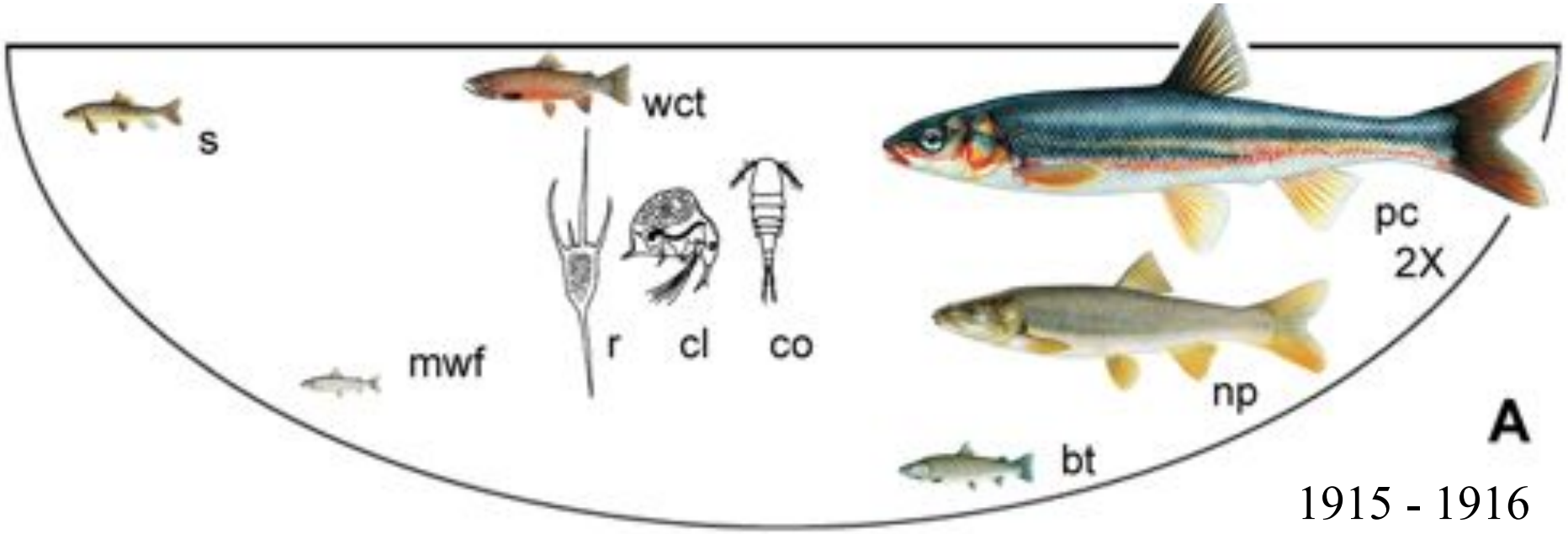


Fish, Shrimp and Mussels: Which Invaders Will Prevail in Flathead Lake

By

Bonnie Ellis
The University of Montana
Flathead Lake Biological Station

Image created by Dr. William A. Bowen
California Geographical Survey



1915 - 1916

From Ellis et al. (2011), Proc. Nat. Acad. Sci.

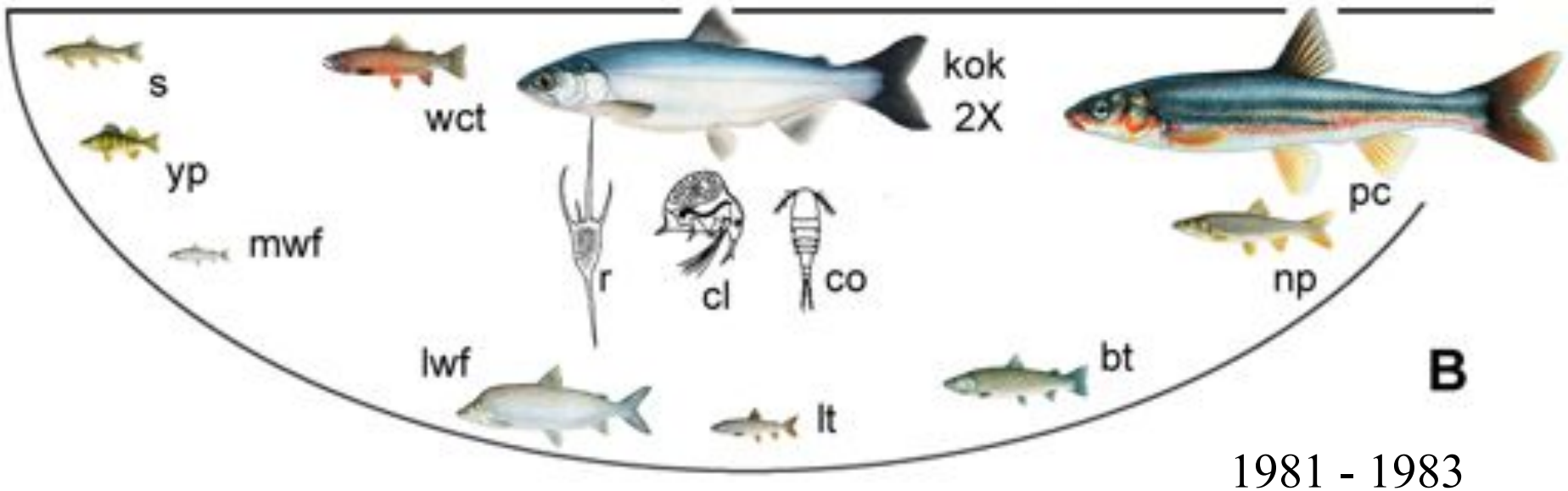
Flathead Lake Fish Species

Native

- bull trout
- cutthroat trout
- Rocky Mt whitefish
- pygmy whitefish
- longnose sucker
- largescale sucker
- northern pikeminnow
- peamouth chub
- redside shiner
- sculpin (3 species)

Introduced

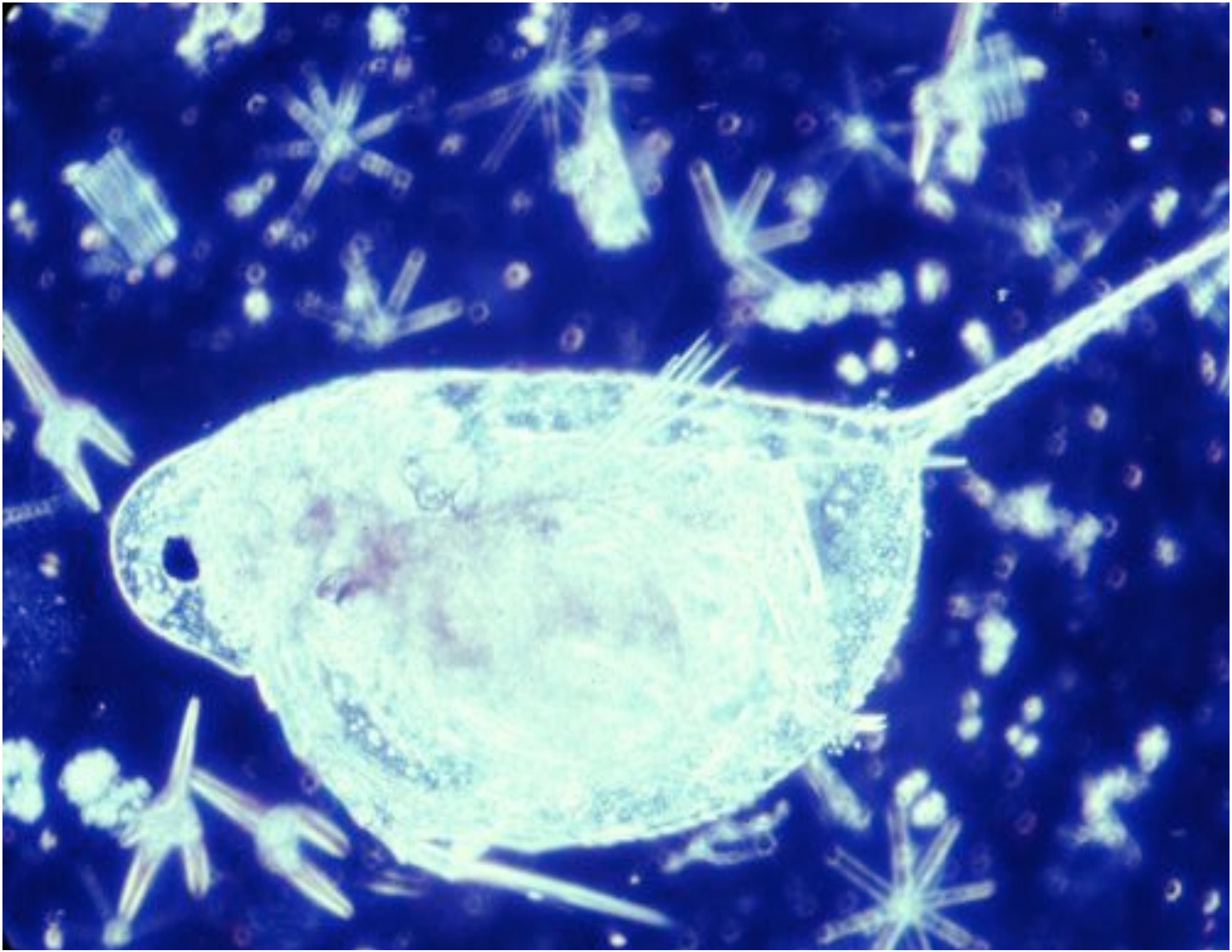
- *lake trout* (1905)
- *lake whitefish* (1890)
- *yellow perch* (1910)
- kokanee salmon (1916)
- northern pike (1960s)
- rainbow trout (1914)
- brook trout (1913)
- largemouth bass (1898)
- pumpkinseed (1910)
- black bullhead (1910)

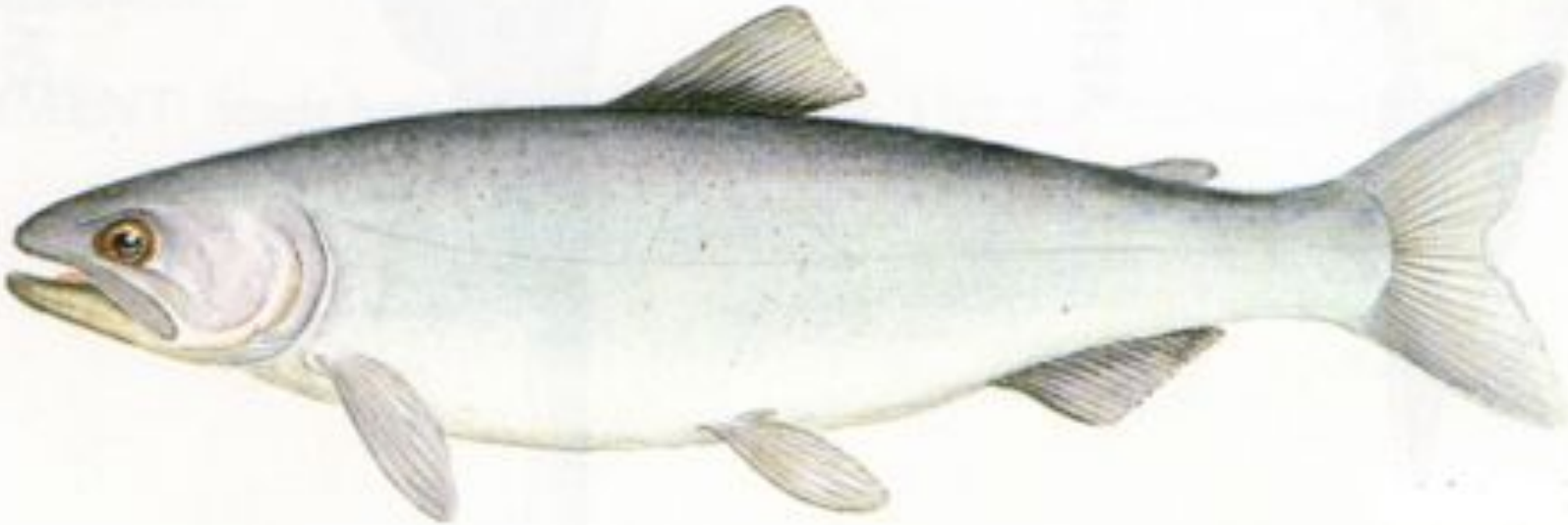


1981 - 1983

From Ellis et al. (2011), Proc. Nat. Acad. Sci.

Photo by Joe Giersch

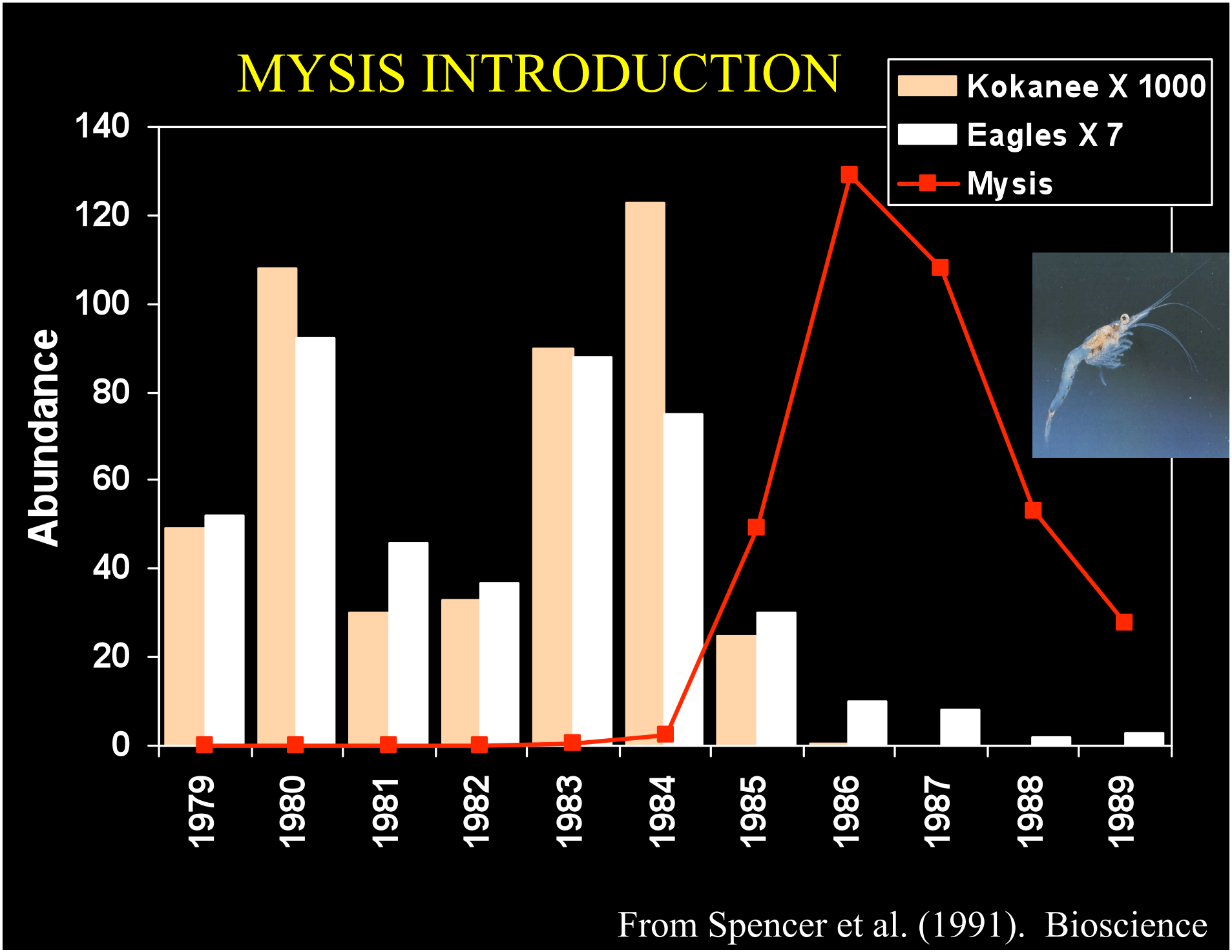




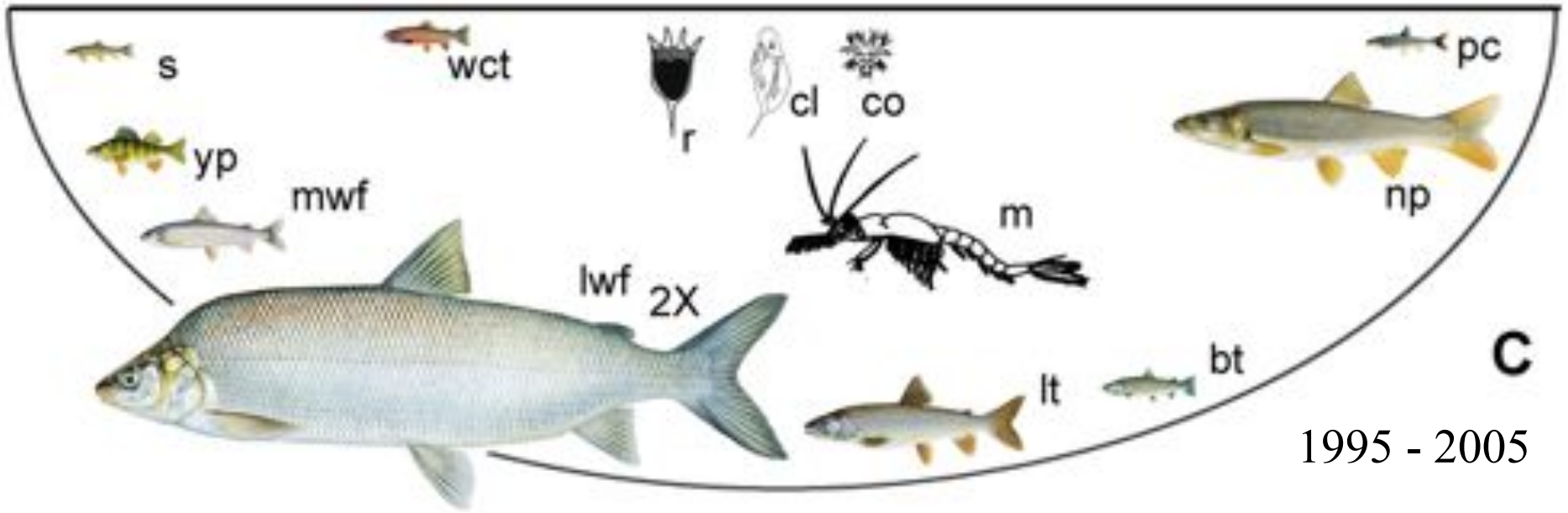
KOKANEE

breeding male

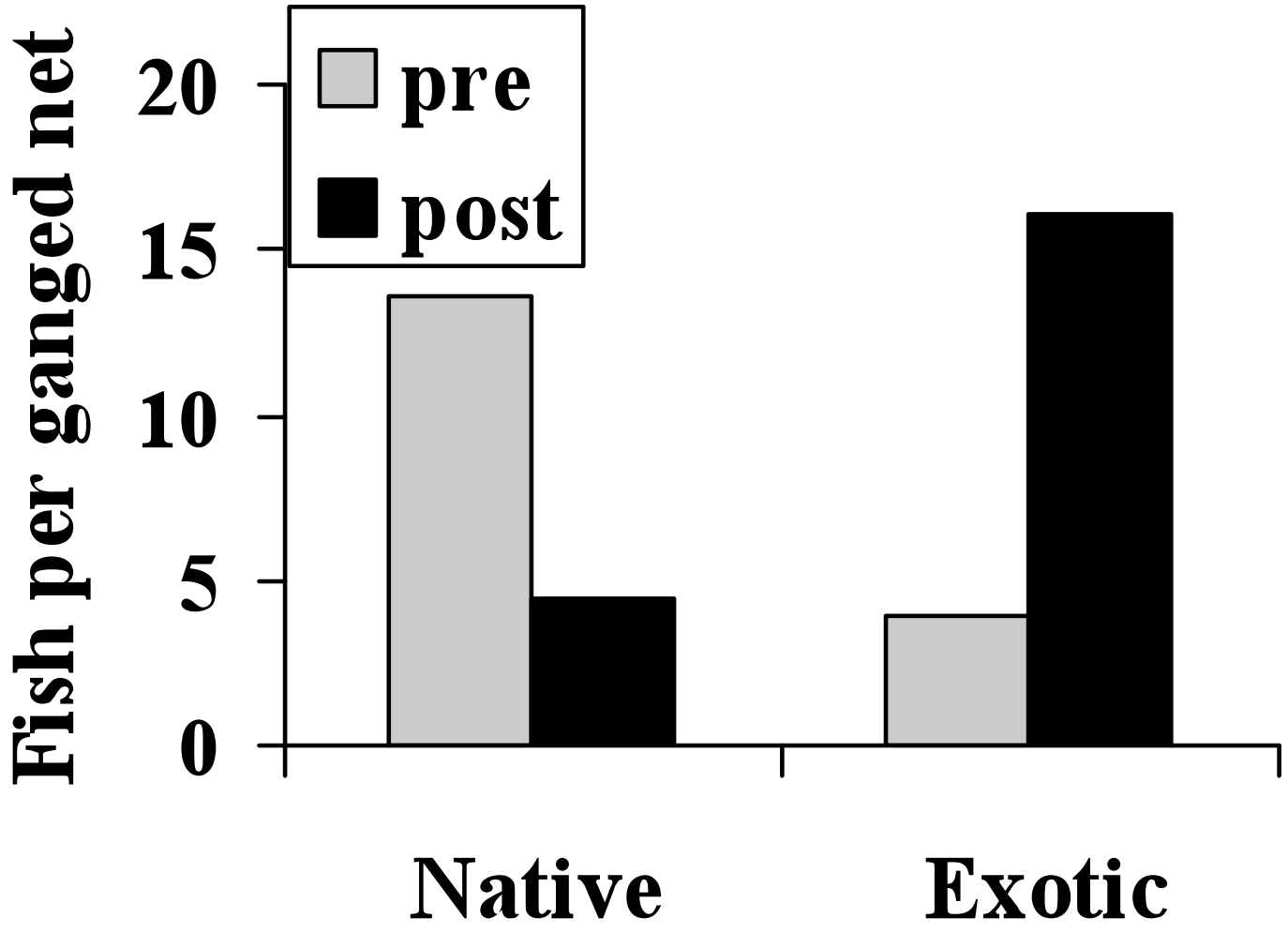
MYSIS INTRODUCTION



From Spencer et al. (1991). Bioscience



From Ellis et al. (2011), Proc. Nat. Acad. Sci.


Fish per ganged net
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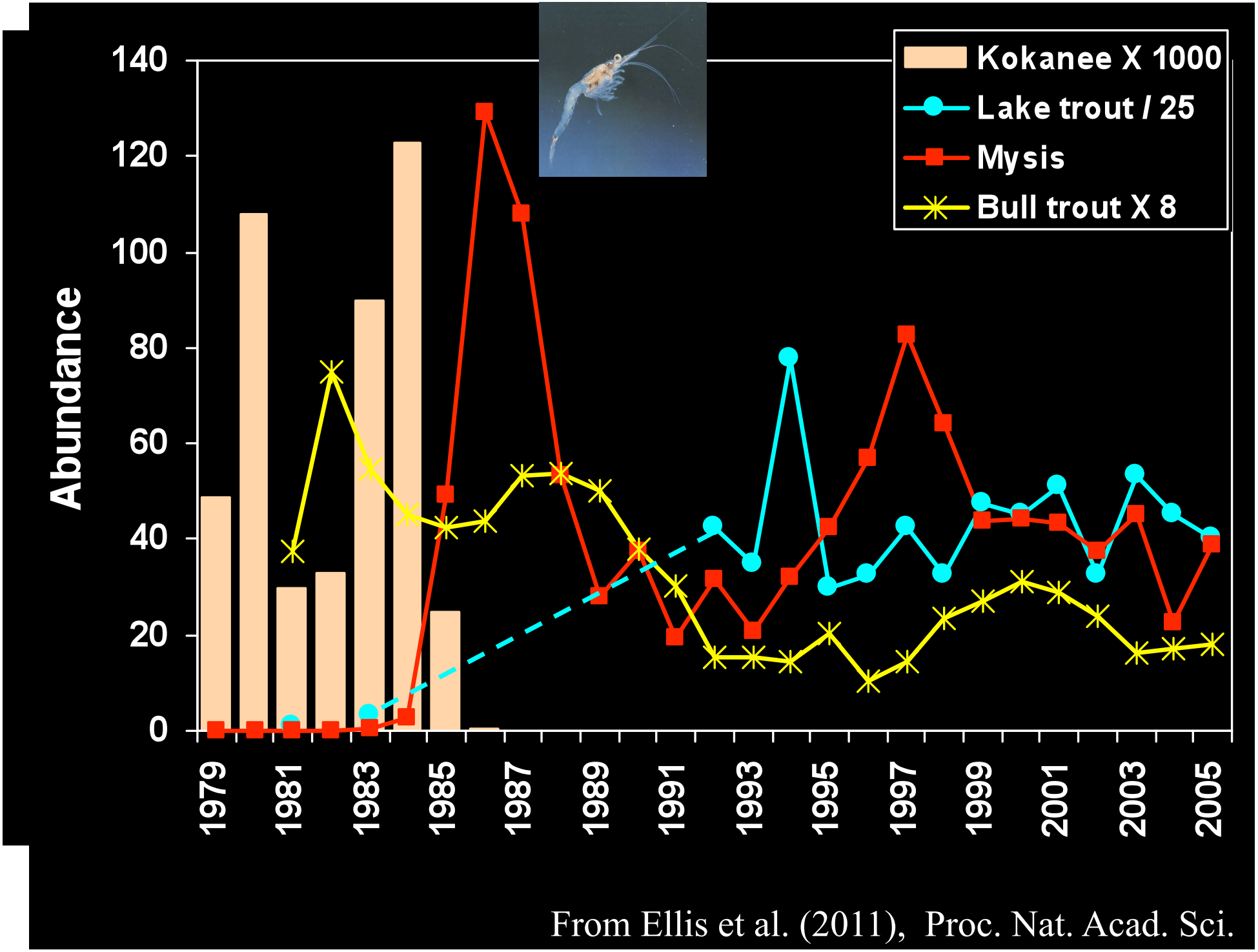
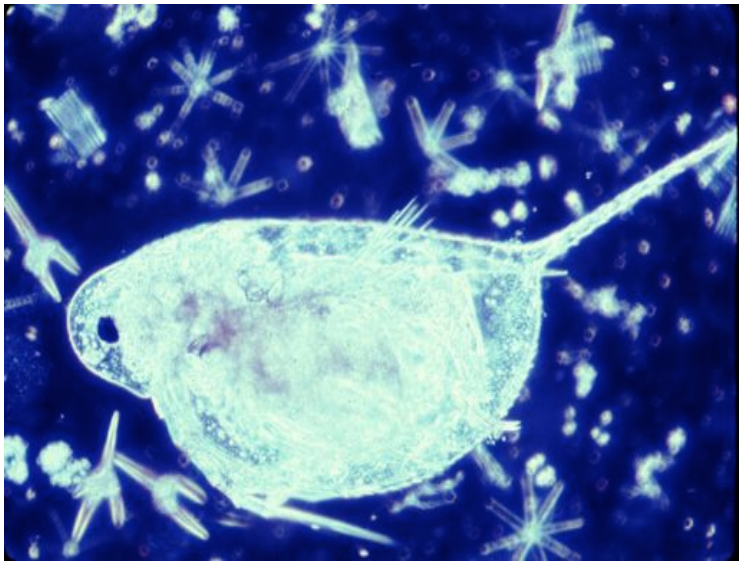
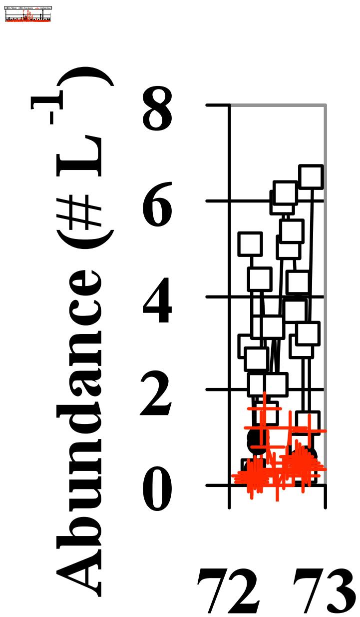
pre
post
Native
Exotic

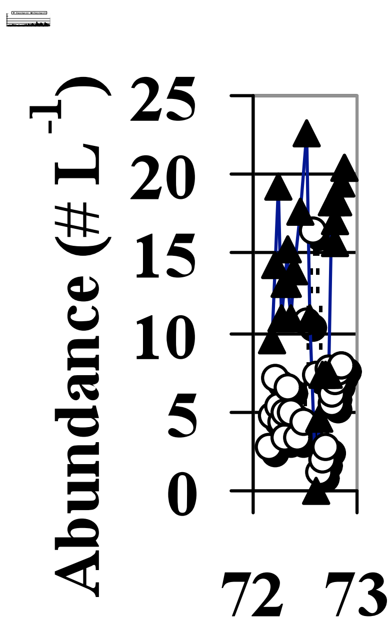


From Ellis et al. (2011), Proc. Nat. Acad. Sci.

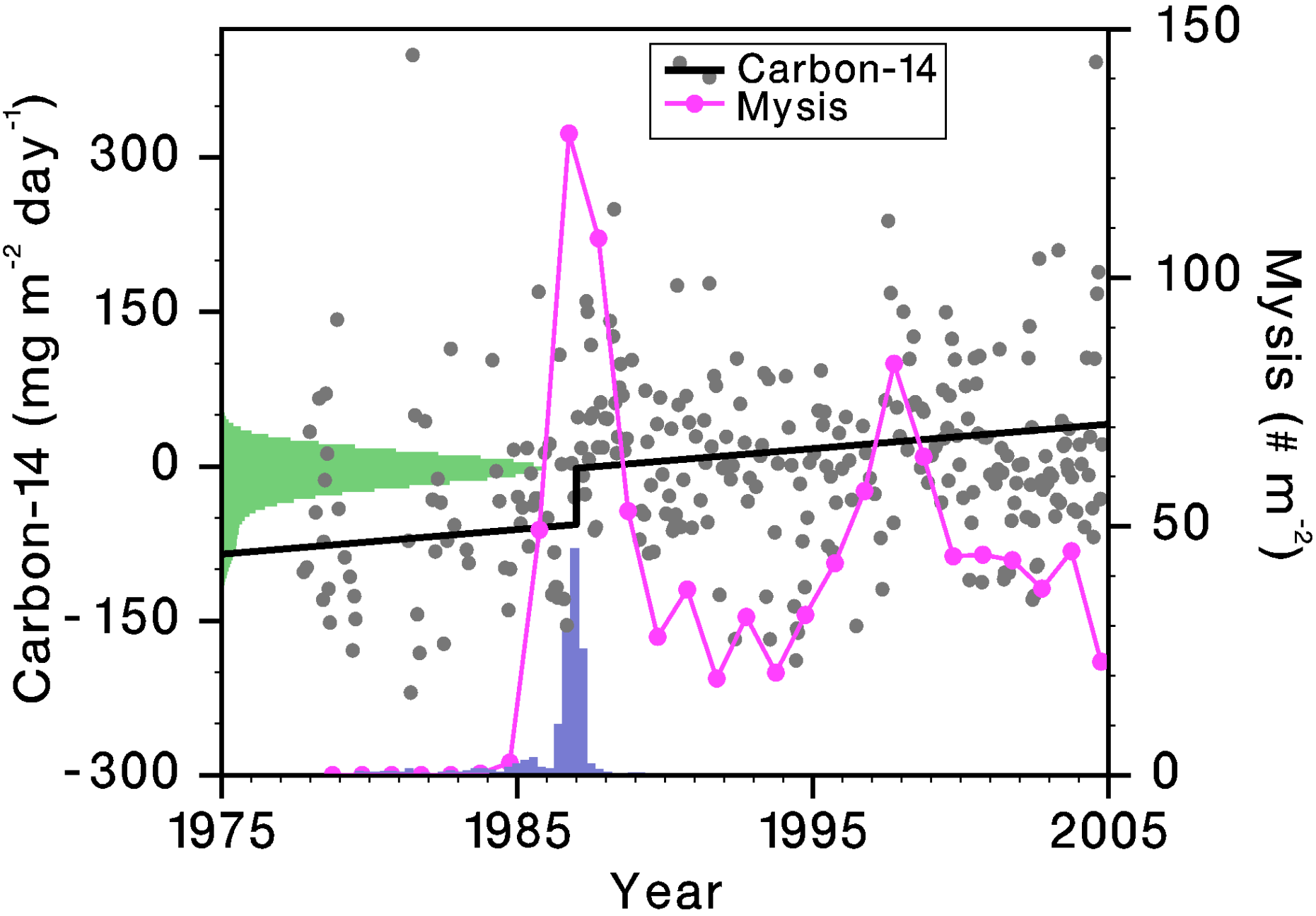




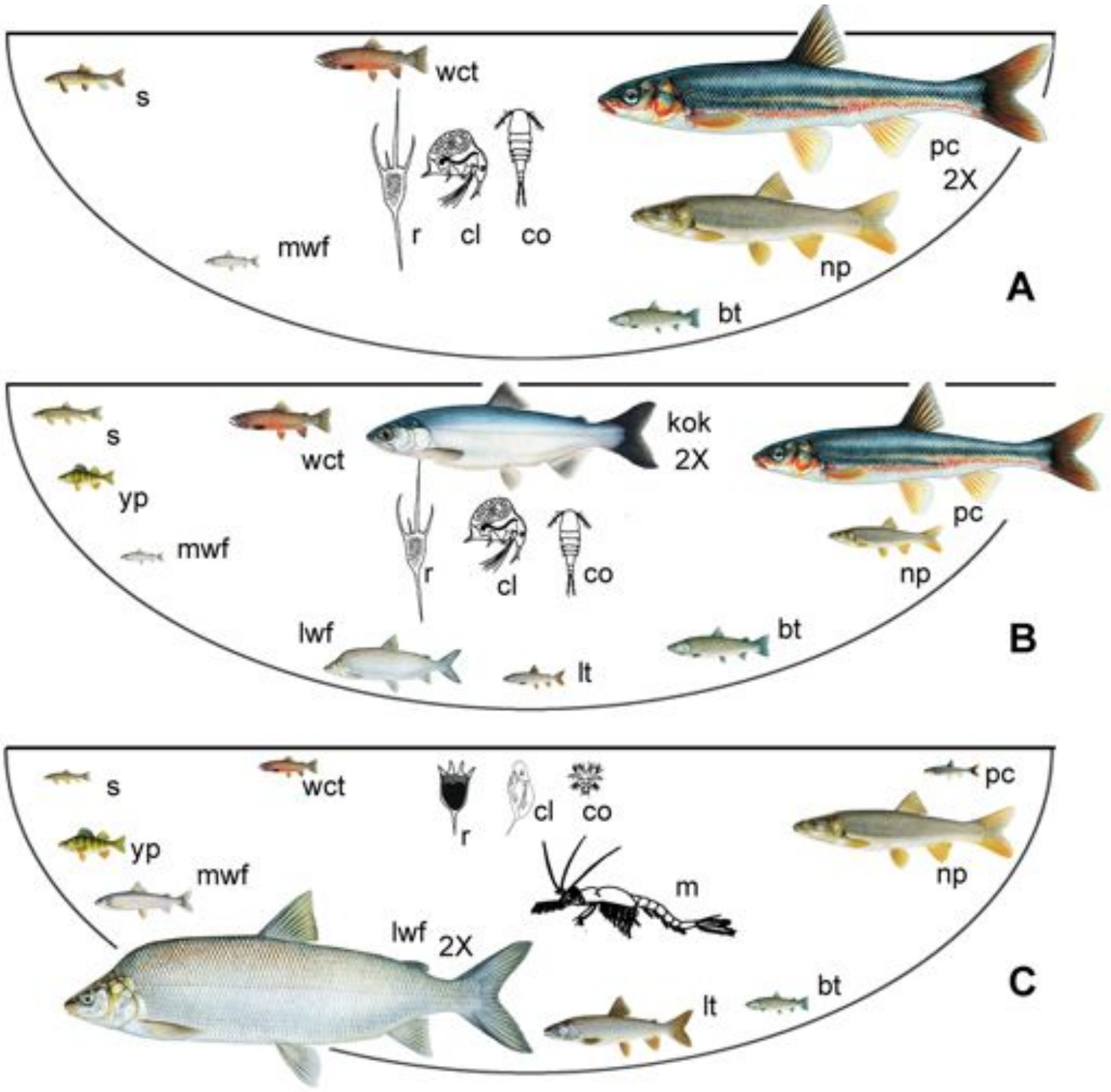
Abundance (# L^{-1})
8
6
4
2
0
72
73



Abundance (# L^{-1})
25
20
15
10
5
0
72
73



From Ellis et al. (2011), Proc. Nat. Acad. Sci.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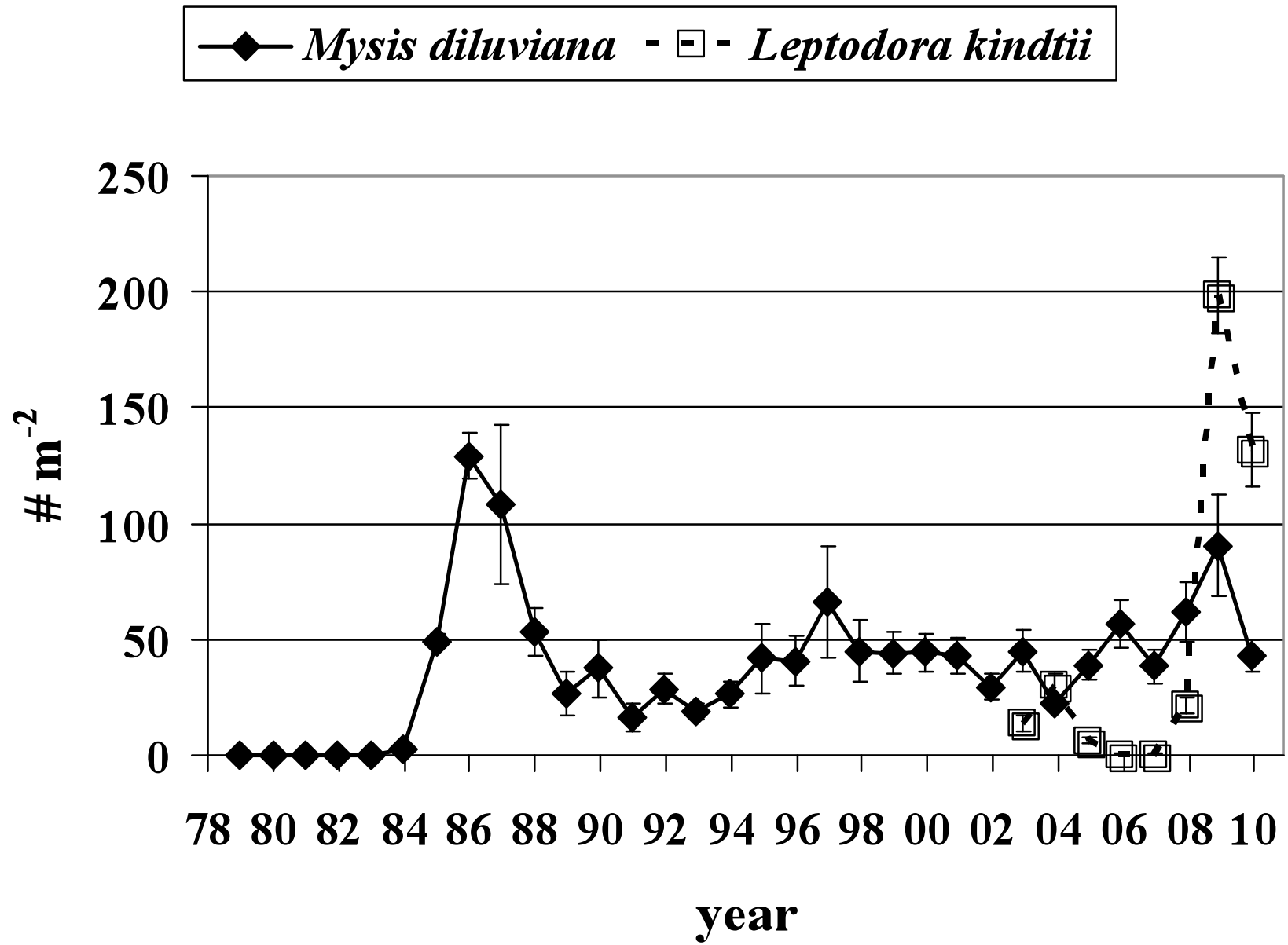
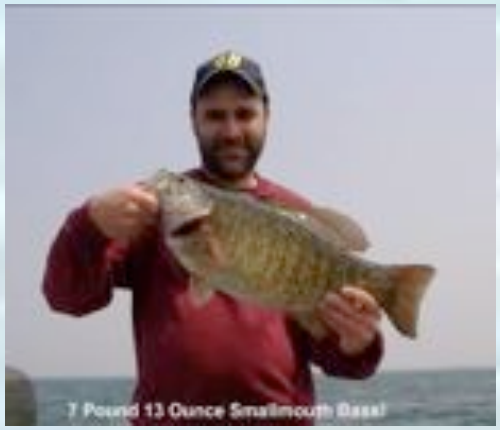
Mysis diluviana
abundance in Flathead Lake



RECENT ILLEGAL INTRODUCTIONS

Black crappie – Stillwater, Flathead

(eastern MT, Missouri R.)



Smallmouth bass – Flathead Lake

(1914 – Loon, Horseshoe)

White sucker – Lion Lake

(1853 – Milk R., eastern MT)

Zebra and Quagga Mussel Facts

- Relatively small (grain of sand to about 2 inches long).
- Can attach to almost anything (boats, trailers, docks, rocks, mud) b/c of byssal threads (Native mussels do not have).
- Can grow in dense congregations (up to 100,000/sq meter)
- Can reproduce in water over 52 deg F
- An adult female can produce more than 1 million eggs in a 4-5 year lifetime.
- Each one can filter more than 1 liter of water/day
- Adults can survive in air for days. Larvae can survive in water for weeks.
- Have not been eliminated in any large bodies of water.

Ecological Effects of Zebra/Quagga Mussels

- Outcompete and kill native mussels and clams
- Filter-feed on algae and animals (zooplankton) from water column
  - Can remove 80% of edible plankton
  - Deprive juvenile and smaller fish of food
  - Disrupt entire aquatic foodweb
  - Cause crash in fish populations
- Concentrate toxins in their tissue and waste
  - Aquatic invertebrates and fish feed and pass toxins up through the food web
  - Can contribute to toxic algal blooms
- Increase water clarity
  - Can cause more algal or macrophyte growth along shorelines
- Cover all available substrate

Potential Ecological Effects of Dreissenid Mussels on Flathead Lake

Pelagic/Profundal Zone:

↓ **Overall, decreased production in pelagic and profundal zones**

↓ Less particulate nutrients; less phytoplankton production and biomass (although faster production rate); less zooplankton production and biomass (esp. rotifers, flagellated protozoans, cladocerans and copepods); less *Mysis* shrimp (b/c less food for them); less fish species that require *Mysis* (e.g., lake trout); less fish species that require pelagic plankton as juveniles (e.g., pygmy whitefish, lake whitefish, perch, redside shinner, peamouth chub, n. pikeminnow); less fish dependent upon native benthos; less open water angling opportunities.

↑ More water clarity (b/c less particulates); larger epilimnion (b/c of deeper light penetration; reduction in habitat for coldwater fishes); more soluble nutrients; more toxic algae blooms (b/c of shift in N:P ratio, and preferential consumption of non-toxic taxa)

Benthic/Littoral Zone:

Overall, increased production in benthic and littoral zones

More water clarity (b/c of less particulates); more soluble nutrients (N, P); more benthic bacteria; more benthic algal production (b/c more nutrients and more hard substrate); more macrophytes including flowering rush (b/c more nutrients and deeper light penetration); more benthic invertebrate biomass (natives and dreissenid, but order magnitude more dreissenid); more littoral fishes (b/c more food and cover for them; eg, suckers, mountain whitefish, pike, bass, black crappie); more shallow water angling opportunities (esp. nonnatives).

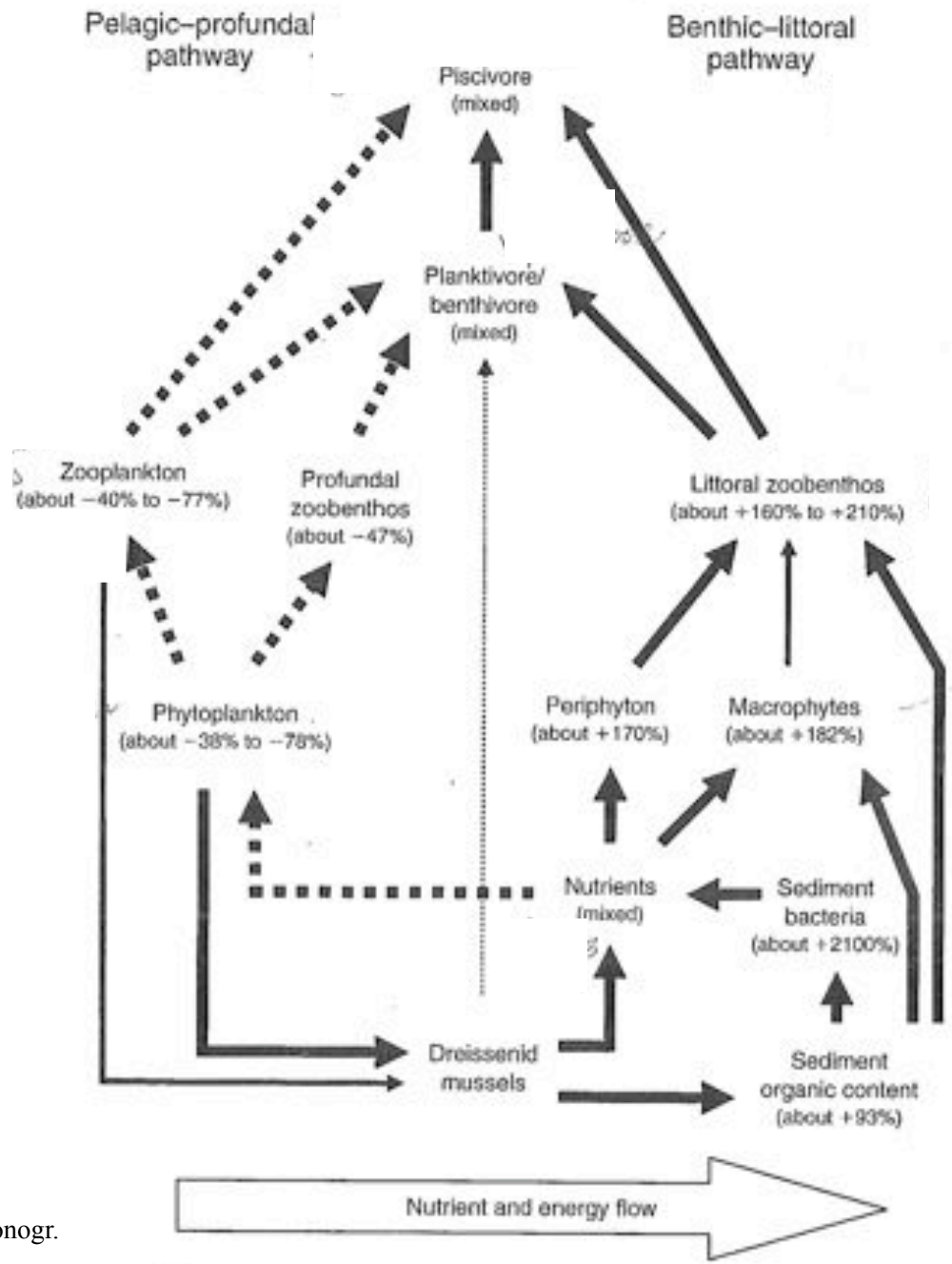
Less enjoyable shoreline experience (bacterial mats, slimy green algal mats, toxic algal blooms, rough/sharp mussel shells.

May 2008, Flathead Lake

Flowering Rush and Reed Canary Grass in Backwater Area, North Shore of East Bay

Overview:

Past introductions (fish and Mysis shrimp) to Flathead Lake have caused a shift of the foodweb and lake production from being based in the Pelagic zone (open water/surface) to one dominated by profundal (deep water) organisms such as mysis shrimp, lake trout and lake whitefish. The addition of dreissenid mussels to the mix would likely shift the foodweb and lake production away from the profundal zone towards the littoral zone. In short, most of the production and biomass would be located in the near shore environment. Although it is unknown how this shift would affect the native trout (bull and cuts), several non-native species (eg, perch, pike) would likely benefit from this shift. Major increases in bacterial, algal and mussel growth in the nearshore would decrease the enjoyment of Flathead Lake by recreationists.



Higgins and Zander (2010), Ecol. Monogr.