Level 3: Water Bugs in Native & Invasive Plant Beds

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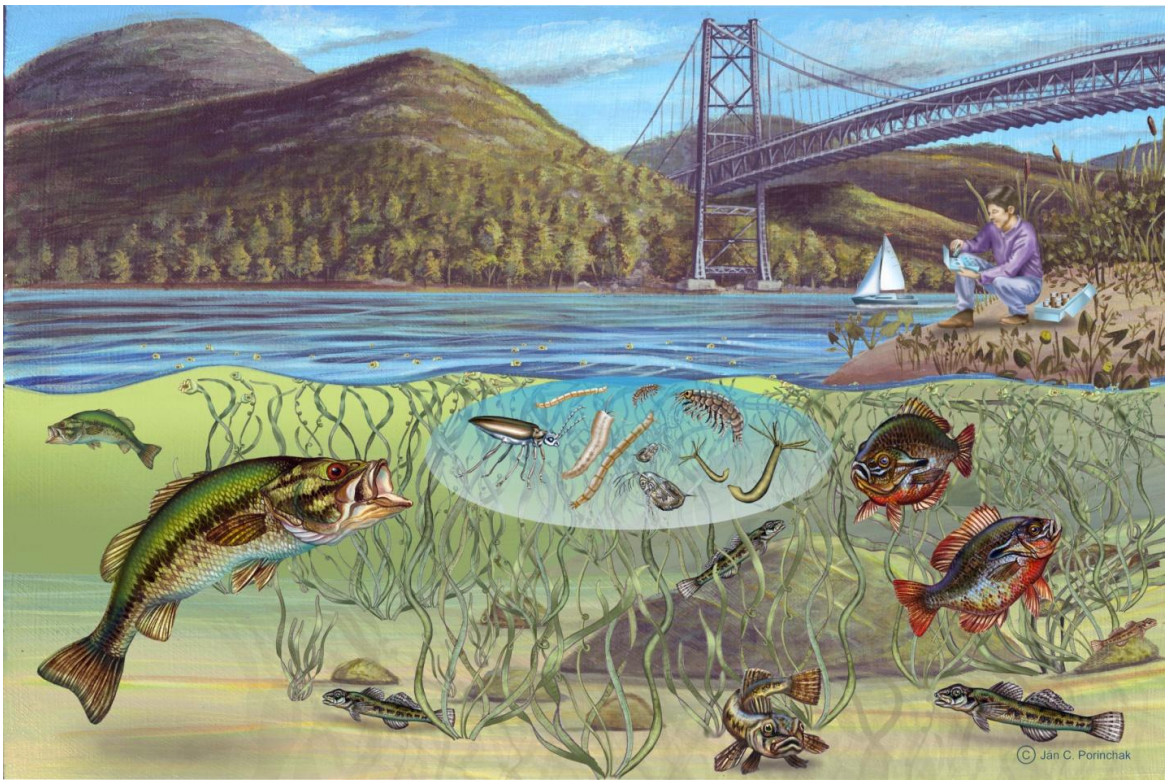


A sample community of fish and macroinvertebrates living within a water celery bed.

❖ Background Information

Invasive versus native species - Invasive species are organisms that move outside of their native range (often because of human activity), start to reproduce quickly, and cause dramatic changes in the ecosystem they now consider home. They may cause economic damage and harm to human health. Native species are those that are historically part of the ecosystem, and may be threatened when invasive species arrive.

Trapa natans (water chestnut) is an aquatic plant native to Western Europe, Africa, and northeast Asia that was first cultivated in botanic gardens and ponds in the US in the late 1800s. It escaped into the nearby ecosystem and was introduced into the Hudson in the early1900s. Since then it has taken hold and spread throughout the river.

This plant floats on the surface of the water in shallow areas and creates large, densely packed mats that then block the sun from reaching submerged species such as *Vallisneria americana* (water celery or eelgrass). *T. natans* has reduced the amount of oxygen being released into the river since it is found on the surface of the water. Unlike submerged plants like water celery, *T. natans* releases oxygen into the atmosphere rather than into the river water. If stands of water chestnuts are large enough, they may create areas underneath with little to no dissolved oxygen (DO). Even though there may be plenty of prey living in these water chestnut beds, these low-oxygen areas are largely unsuitable for most fish species.

A floating water chestnut bed.
Source: John M. Randall, The Nature Conservancy

Aquatic macroinvertebrates are organisms that lack a backbone and are large enough to be seen with the naked eye. They spend part or all of their life cycle underwater. Examples of aquatic macroinvertebrates include flatworms, crayfish, snails, clams and insects, such as dragonflies and midges. Many spend their juvenile phase in the water as nymphs or larvae, and become flying insects as adults. For example, damselflies spend their nymphal stages underwater and their adult stage on land. Aquatic macroinvertebrates are an important part of both aquatic and terrestrial food chains. They prey on smaller invertebrates, graze on algae, and break down leaves and sticks that fall into the water. They are an important food source for larger organisms such as fish, birds, and other macroinvertebrates.

The damselfly spends its larval phase in the water and its adult phase on land.
Source: Creative Commons

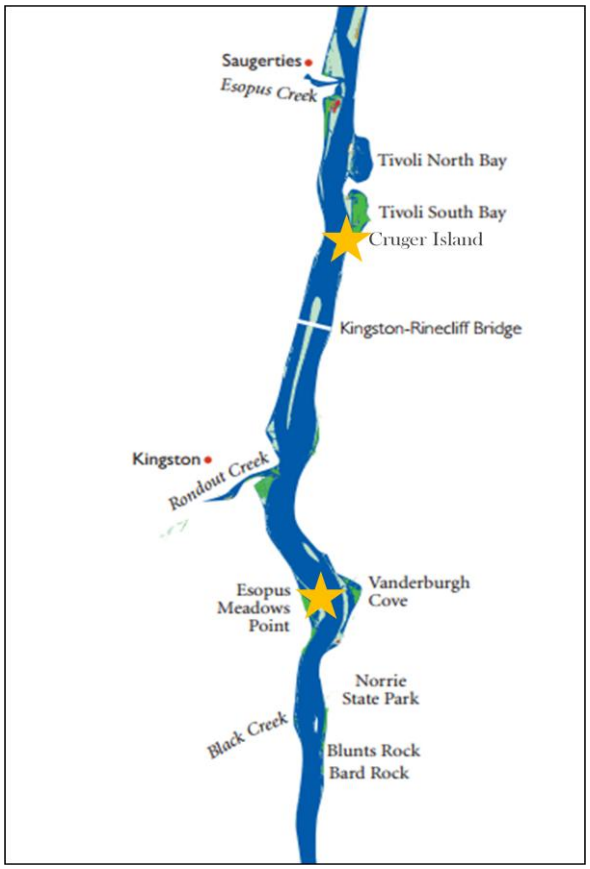
Scientists often use the presence and diversity of macroinvertebrates within a waterway as an indication of the health of the waterway. With that in mind, this study was conducted to investigate the macroinvertebrate communities present in stands of the native *V. americana* and the introduced *T. natans*. The study determined that *T. natans* and *V. americana* supported very different macroinvertebrate communities, as you will see when you investigate this dataset.

❖ **Dataset Timeframe**

Data was collected twice in 2000 - first in July as plants were developing and again in August as plants neared their peak biomass for the summer.

❖ **Information About Sites**

The two sites are located on the Hudson River in the Kingston area. Cruger Island is a peninsula along the east bank of the Hudson River at river kilometer (RKM) 158. Esopus Meadows is a large shallow-water area along the west bank of the river at RKM 138. Each area has sites where *T. natans* and *V. americana* are prevalent as well as sections without vegetation. All four beds are dominated by either *T. natans* or *V. americana* with very few other plant species mixed in, as is typical of the tidal Hudson.



- Water Conditions:
  - This area of the Hudson contains fresh water with tidal currents.
  - Depth at both sites was <1m at low tide and fully fresh (<100 ppm salt).
- Sediments: Study sites were soft sands and muds, averaging 44% sand, 43% silt and 14% clay.

❖ **Data Collection Methods**

At both Cruger Island and Esopus Meadows, data was collected from six spots in each vegetation bed, and three spots from the unvegetated area. The samples were taken at the edges and the interior of the plant bed, so you will notice quite a bit of variability in the macroinvertebrate densities within a vegetation type. Generally, more macroinvertebrates live in the middle of the bed than the edges.

The samples were collected using three different methods. Macroinvertebrates in shallow sediments were sampled using a hand-held coring tube of 20 cm^2. Deeper sediments were sampled using a PONAR grab, which scoops sediment up like a large, metal fist. Invertebrates living on the plants were sampled using a Downing box sampler. The samples were pooled and sieved in the field to remove sediment and then preserved so they could be counted back in the lab.

Clockwise from left: A PONAR grab ready to deploy; Dr. Dave Strayer bringing a Downing Box sample up onto the boat; Researchers using a sieve to remove macroinvertebrates from sediment samples.

- **Dataset Variables:**
  - **Location:** Cruger Island or Esopus Meadows.
  - **Plant Dry Biomass:** Plant biomass is the average weight of several samples of vegetation growing in one square meter of an aquatic habitat. The researchers collected samples at the different sites by clearing a square meter of area, taking the vegetation back to the lab, and drying it in a special oven to remove the weight of the water. When they weighed the plants, they only got the total dry mass in grams (g), which makes it easier to compare the two types of plants. A biomass of $1 g/m^2$ means that it's hard to find plants, while a plant bed with 500 g/m^2 is too thick to walk through. *You will only see this variable in the plant biomass data sheet.*
  - **Month**: July (before the vegetation was completely developed) and August (near peak biomass) 2000
  - **Habitat Type:** *Trapa* (*T. natans), Vallisneria (V. americana),* or unvegetated sediment

- **Replicate:** Each time the scientists sampled macroinvertebrates in *Trapa* or *Vallisneria*, they sampled six sites within the plant bed. These replicates were sampled exactly the same way, and the replication helped control for macroinvertebrate variability within the plant bed. Some samples were taken from the interior of the bed, and some were taken from the edge. *You will only see this variable in the raw data sheet.*
- **Macroinvertebrate groups:** These are grouped together into units of similar species. Some are epiphytic (living on the plants) and others are benthic (living on or in the sediments). See the macroinvertebrate guide for more information on each group. *These are averaged on all sheets except the raw data sheet.*
- **Sum of all macroinvertebrate densities:** total macroinvertebrates. This is the sum of the average densities, so you can see the average macroinvertebrate density per m^2.

❖ Data Source

- Dr. Dave Strayer, Cary Institute of Ecosystem Studies. An analysis of these data was published in: "Invertebrate communities associated with a native (*Vallisneria americana*) and an alien (*Trapa natans*) macrophyte in a large river" by David L. Strayer, Colleen Lutz, Heather M. Malcom, Krista Munger, and William H. Shaw in Freshwater Biology (2003) 48: 1938-1949.
- Researchers involved in this study include:

Dr. David Strayer, Freshwater Ecologist

Heather Malcom, Senior Research Specialist

- If you have specific questions about this research that you would like to ask the scientists, please email caryeducation@caryinstitute.org and we will be happy to contact the scientists on your behalf.

❖ Inquiry Idea Starters

Here are some sample questions you could ask using these data. These are just suggestions, and we hope you'll come up with many more interesting questions of your own!

- Was there more water chestnut or water celery biomass at the two sites? When did the plants have the most biomass?

- Which habitat had the highest invertebrate densities: water chestnut, water celery, or unvegetated?
- Did invertebrate densities change over the course of the summer?
- Which invertebrate group was most common? Which habitat did it prefer? Which invertebrate group was least common? Which habitat did it prefer?
- Do water chestnut and water celery have the same types of invertebrates?
- Are scud populations equally found in all habitats?

❖ Additional Resources:

- Search the large collection of Hudson River lessons (including several on water chestnuts and invasive species in the Hudson) that are available through the Hudson River Ecology section of the Cary Institute "Teaching Materials" page: http://www.caryinstitute.org/educators/teaching-materials/hudson-river-ecology
- This interactive animation illustrates the interaction between water celery, water chestnut, and their surrounding environment: http://bit.ly/2AQYhDt
- The Stroud Water Research Center is an authority on freshwater macroinvertebrates and has a useful online macroinvertebrate key: https://stroudcenter.org/macros/key/

❖ Extension

- Use the Macroinvertebrate field guide that goes with this dataset to determine which macroinvertebrates live in the sediments (benthic) and which live on the plants (epiphytic). Investigate the data to see if there are differences between the benthic and epiphytic communities in water chestnut and water celery.
- Collect macroinvertebrates in your local stream or pond and compare your results to this experiment.
- Investigate the Level 1 dataset on "Oxygen Levels and Invasive Aquatic Plants". Does this information help explain any of your findings?
- Discuss the following: Water chestnut is an invasive plant that is bad for recreation and bad for the native plants that it crowds out, but good for at least some kinds of invertebrates. Can you think of other examples of invasive plants or animals that have some good effects and some bad effects?
- A study by Feldman (2001) in the journal *Hydrobiologia* found very different results. Feldman studied a site in the upper, non-tidal portion of the Hudson River, and found that the water celery beds supported two- to six fold more invertebrates than the water chestnut beds. Check out this paper and propose a hypothesis about why the results are so different from the study you examined.

❖ References:

"Hudson River Habitats: Submersed Aquatic Vegetation." Science Program, Cary Institute of Ecosystem Studies, 11 Aug. 2015, www.caryinstitute.org/science-program/research-projects/hudson-river-habitats-submersed-aquatic-vegetation.

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“Macroinvertebrates.” Document Library, Bay Area Restoration Council, http://hamiltonharbour.ca/resources/documents/Macroinvertebrates.pdf.

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A sample community of fish and invertebrates found in a water celery bed at night.