Level 1: Oxygen Levels and Invasive Aquatic Plants

- **Background Information:**

Like many lakes and rivers, the shallow margins of the Hudson River are filled with beds of water celery (*Vallisneria americana*) and other submersed and floating plants. Most of the early ecological work on the Hudson ignored these plant beds, focusing instead on the open waters of the river. In more recent years Cary scientists and their collaborators at DEC, EPA, and research universities have realized that coastline vegetation beds are important contributors to water chemistry and habitat structure in the Hudson, and are indicators of river health.

Top: Submerged water celery (*V. americana*) bed, **Bottom:** Floating water chestnut (*T. natans*) bed

About 13% of the area of the freshwater tidal Hudson River is occupied by rooted vegetation. Beds of the submerged native water celery (mixed with small amounts of other submersed species) cover 3/4 of this area, and beds of the floating alien water chestnut (*Trapa natans*) cover the remaining 1/4. These plant beds are choice habitats for invertebrates. Invertebrate population densities are much higher among plants than on unvegetated sediments, and greater plant biomass tends to lead to greater invertebrate density. Many kinds of aquatic invertebrates (such as damselflies, the cladoceran *Sida crystallina*, several kinds of snails, and many kinds of chironomid midges) live only among plants, and not in open water. Very different invertebrates live in the native water celery than in the introduced water chestnut (Strayer 2003). When the alien zebra mussel invaded the Hudson River in 1991 and destroyed much of the planktonic food web, the plant beds increased in importance and buffered the ecosystem from the full effects of this invader.

Like the zebra mussel, the water chestnut has dramatically impacted the Hudson. It was introduced to North America in the late 19th century by a well-meaning botanist who thought the plant was beautiful and useful as potential wildlife food. The chestnut quickly escaped the lakes where it was introduced, becoming a nuisance in the Hudson in the 1950's. Due to the thick beds that water chestnut forms, the plants are an obstacle for boaters and people who want to use the river recreationally. The main ecological concern with water chestnut is that it has displaced native aquatic plants, especially water celery.

Researchers are still trying to understand and evaluate the impacts of water chestnut on the other parts of the Hudson River ecosystem. While water celery is struggling to co-exist with water chestnut, some other species are readily adapting. This dataset will help you explore the mechanism by which water chestnut is changing shoreline communities. You will investigate how oxygen levels change in a water chestnut bed, water celery bed, and open river channel over the course of 24 hours, which should help you think of plants as "engineers of oxygen" in the Hudson River.

Water celery underneath the water's surface, with a water chestnut plant floating on top.

- **Dataset Variables:**
  - **Time:** The time (based on the military clock) when each data point was taken.
  - **Water Chestnut *(T. natans)* DO%:** the average dissolved oxygen level in the invasive water chestnut beds, recorded in percent saturation.
  - **Channel (River Channel) DO%:** the average dissolved oxygen level in the unvegetated river channel, recorded in percent saturation.
  - **Water Celery *(V. americana)* DO%:** the average dissolved oxygen level in the native water celery beds, recorded in percent saturation.

- **Dataset Timeframe:**
  These data were collected over the course of 24 hours on June 29, 2003.

- **Data Collection Methods:**
  Data were collected using a submerged probe that recorded oxygen saturation levels in the water every 30 minutes. The three habitats were sampled simultaneously.

- **Information About Sites:**
  This experiment was performed in water chestnut and water celery beds and in open river channel in the freshwater tidal portion of the Hudson River.

- **Source of Dataset:**
  - Data were published in "Vascular Plants as Engineers of Oxygen in Aquatic Systems" by Nina Caraco, Jonathan Cole, Stuart Findlay, and Cathleen Wigand in Bioscience (2006) 56(3): 219-225.
  - 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.

Water chestnut seeds disperse by floating. Each plant rosette produces up to 20 seeds, which can survive in the sediment for up to 12 years.

❖ 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 interesting questions of your own!

- ➢ How does oxygen saturation change over the course of the day?
- ➢ Does oxygen saturation follow the same pattern in each habitat?

❖ More Information

- ➢ There have been attempts to eradicate water chestnuts from the Hudson River, but, they are now more abundant than ever. When water chestnut first became a major problem, the Department of Environmental Conservation (DEC) attempted to manage it using a chemical herbicide and hand-pulling. Negative side-effects such as the contamination of the river led the DEC to abandon this practice. Now, some places use an aquatic 'lawn mower', while other places use hand-pulling or cutting Research is taking place on the viability of using biological controls.
- ➢ In 2011, Hurricane Irene dramatically reduced the population of water celery and some other aquatic vegetation in the Hudson. The hurricane swept away plants and seeds and buried many plants by depositing five times the annual Hudson sediment load in less than one month (USGS). Surveys have showed that water celery is coming back in patches, with some areas recovering more rapidly than others.
- ➢ Water celery and other submersed aquatic vegetation (SAV) are monitored in the Hudson by a combination of professional researchers and citizen science volunteers. Researchers measure SAV beds through aerial photos, and citizen scientists both confirm results and fill in the gaps between surveys. These volunteers monitor over 100 sites via canoes and kayaks. To get involved with this project visit: http://bit.ly/2ijz2Rx.
- ➢ Researchers involved in this study include:

Nina Caraco, Research Ecologist

Dr. Cathleen Wigand, EPA Research Ecologist

Dr. Jonathan Cole, Limnologist

Dr. Stuart Findlay, Biogeochemist

❖ Additional Resources

- Search the large collection of Hudson River Ecology lessons (including a few on water chestnuts) that are available on the Cary Institute "For Educators" page: http://www.caryinstitute.org/educators/teaching-materials.
- Read about current SAV research on the Cary Institute "Submerged Aquatic Vegetation" page: http://www.caryinstitute.org/science-program/research-projects/hudson-river-habitats-submersed-aquatic-vegetation
- The New York Invasive Species Information page gives a detailed history of the water chestnut invasion: http://nyis.info/?action=invasive_detail&id=39
- The NYS Department of Conservation has a brief page on aquatic habitats in the Hudson River Estuary, including SAV beds: http://www.dec.ny.gov/lands/87297.html

❖ References

Caraco N., Cole J., Findlay S, and Wigand C. 2006. Vascular Plants as Engineers of Oxygen in Aquatic Systems. Bioscience 56: 219-225.

Strayer, D.L., C. Lutz, H. M. Malcom, K. Munger, and W. H. Shaw. 2003. Invertebrate communities associated with a native (Vallisneria americana) and an alien (Trapa natans) macrophyte in a large river. Freshwater Biology 48: 1938-1949.

Citizen scientist volunteer sampling SAV on the Hudson.
Photo credit: Emerich AmRhein