RIVER SUMMER CURRICULUM: Natural Sciences
Biological Sciences - Hudson River Marsh Ecology

Impact of a Nonnative and Invasive Plant Species on the Structure & Function of Tidal Marshes

ABSTRACT: During the past century, a nonnative genotype of the grass *Phragmites australis* has aggressively invaded and expanded in tidal marshes, displacing native species. This project involves field sampling of *Phragmites* and native species in a marsh using a line transect and quadrats. The number of stems of each species is counted within the quadrats and compared by plotting either the number of stems or the percentage of total stems of each species along the line transect. The differences in habitat created by *Phragmites* relative to other species will be readily apparent in the field.

PROJECT DEVELOPER: Carol S. Rietsma, Ph.D., Biology Department, SUNY New Paltz, 1 Hawk Drive, New Paltz, NY 12561

LEARNING GOALS:

Skills

- Set up and use a transect line and quadrats to sample species
- Identify common marsh plants
- Plot, analyze, and interpret field data in the format of a bar graph or histogram
- Describe the changes in marsh habitat caused by *Phragmites*
- Provide arguments for and against managing *Phragmites* in marshes

Insights

- Identify other systems in which a transect line and quadrats would be appropriate to sample species
- Develop a relative time line of invasion and establishment of a marsh by *Phragmites*

MATERIALS & PREPARATION NEEDED:

Supplies and materials:

- 30 or 50-meter Keson fiberglass tape measure(s), graduated in meters on one side and feet on the other (from Forestry Suppliers)
- Flagged PVC or metal stakes (PVC is better because it doesn't rust.) (from Forestry Suppliers)
- Field guide for identification of marsh plants, e.g., Hudson River Guide published by the New York Department of Environmental Conservation (See reference below.)
- Chest-high waders, knee-high rubber boots, or old sneakers (I prefer old sneakers,)
- Long pants and long-sleeved shirt to protect legs and arms
- Data sheets for recording field data and pencils/pens

Safety issues:

- For tidal freshwater marshes, collect data during low water of the tidal cycle, that is, from about 3 hours after high water to 3 hours before next high water. Consult http://tidesandcurrents.noaa.gov/tide_pred.html; select the year-2008; select the state-New York; select Hudson River; select the location closest to the tidal marsh of choice, e.g., Peekskill for Iona Island Marsh; select-predictions for the corrected times of low and high water.

- Work on a marsh that is accessible from land unless canoes or kayaks are available.

- Work on a marsh that is relatively stable. It may be squishy and students may sink into the sediment a little but they won't sink in to their knees/hips.

- **Visit the marsh before taking students there**.

Sites:

- Iona Island Marsh, a tidal freshwater marsh on the west side of the Hudson River, is a good choice because it is accessible, stable, and has relatively few plant species, primarily *Typha angustifolia* and *Phragmites australis*. Iona Island is located about six miles south of West Point. It is one mile south of the Bear Mountain Bridge on the east side of Route 9W. The marsh is to the west of the railroad tracks on Iona Island. There is ample parking space. A letter of permission is required from the park manager of the Palisades Interstate Park Commission, Bear Mountain, NY 10911-0427. In my letter, I briefly describe the fieldwork, where it will be carried out, and on what dates with alternate rain dates. I also give the course and number of students. I carry the letter of permission with me when I am there.

- One alternative site is Piermont Marsh, a tidal freshwater marsh on the west side of the Hudson River at the southern edge of the Village of Piermont. Entry is through Tallman Mountain State Park. *Phragmites* and *Scirpus* are the important species. To get to a suitable place for fieldwork, it is necessary to bushwack through a large expanse of tall dense *Phragmites*. It is easy to get disoriented in the *Phragmites*, there are tidal

creeks and ditches to cross, and timing of the tides is crucial to avoid getting stranded when the tide starts to rise. Contact person: Margie Turrin at 845-365-8494 at Lamont-Doherty.

- A second alternative site is Tivoli North Bay, a tidal freshwater marsh on the east side of the Hudson River north of Bard College. Canoes or kayaks are needed to access islands with *Typha angustifolia* and *Phragmites australis*. Purple loosestrife, *Lythrum salicaria*, another nonnative and invasive plant species, is also present. There is a canoe launch in North Bay located off Kidd Lane, off Route 9G, in the Town of Red Hook. An effort to control *Phragmites* with herbicides has taken place there. Contact person: Sarah Fernald at 845-889-4745 X111 at Norrie Point.

- A third alternative site is a pocket marsh on the east side of the Hudson River at the mouth of the Indian Kill and near the headquarters of the Hudson River National Research Reserve at the Norrie Point Environmental Center. The Center is in the Margaret Lewis Norrie State Park in Staatsburg. Contact person: Chris Bowser at 845-889-4745 X104 at Norrie Point.

See http://www.nerrs.noaa.gov/Hudson River/ for background information on Iona Island, Piermont Marsh, and Tivoli Bay.

- Yet another alternative would be any local tidal or nontidal marsh in which *Phragmites* has become established.

Time of year: summer or early fall e.g. September when plants are flowering and/or setting fruit

SKILLS & UNDERSTANDING NEEDED:

Concepts:

- Past and present uses of *Phragmites*
- Differences between native, nonnative or exotic, and invasive species. Mechanisms by which invasive species become established and displace native species. Consider *Phragmites*.
- History of *Phragmites* at marsh chosen, if known
- Factors involved in expansion of *Phragmites*
- Positive and negative impacts of *Phragmites* on marsh ecosystems
- Options for managing marshes with *Phragmites* along with the pros and cons of each option

Readings:

For instructor:

- Able, K. W. & S.M. Hagan. 2003. Impact of common reed, *Phragmites australis*, on essential fish habitat: Influence on reproduction, embryological development, and larval abundance of mummichog (*Fundulus heteroclitus*). Estuaries 26(1):40-50.

- Able, R.W., S.M. Hagan, & S.A. Brown. 2003. Mechanisms of marsh habitat alteration due to *Phragmites*: Response of young-of-the-year mummichog (*Fundulus heteroclitus*) to treatment for *Phragmites* removal. Estuaries 26(2B):484-494.

- Blossey B. 2003. A framework for evaluating potential ecological effects of implementing biological control of *Phragmites australis*. Estuaries 26(2B):607-617. Control of *Phragmites* by herbicides & mowing/burning, reintroduction of tidal flooding, & biocontrol is discussed.

- Chambers, R.M., L.A. Meyerson, & K. Saltonstall.1999. Expansion of *Phragmites australis* into tidal wetlands of North America. Aquatic Botany 64:261-273.

- Chambers, R.M., D.T. Osgood, D.J. Bart, & F. Montalto. 2003. *Phragmites australis* invasion and expansion in tidal wetlands: Interactions among salinity, sulfide, and hydrology. Estuaries 26(2B):398-486.

- Fell, P.E., R.S. Warren, J.K. Light, R.L. Rawson Jr., & S.M. Fairley. 2003. Comparison of fish and macroinvertebrate use of Typha angustifolia, *Phragmites australis*, and treated *Phragmites* marshes along the lower Connecticut River. Estuaries 26(2B):534-551. The mummichog, grass shrimp, and fiddler crab are discussed.

- Ludwig, D.F., T.J. Iannuzzi, & A.N. Esposito. 2003. *Phragmites* and environmental management: A question of values. Estuaries 26(2B):624-630.

- Minchinton, T.E. & M.D. Bertness. 2003. Disturbance-mediated competition and the spread of *Phragmites australis* in a coastal marsh. Ecological Applications 13:1400-1416. Effects of disturbance-mediated competition & fertilization are discussed.

- Rudrappa, T., J. Bonsall, J.G. Gallagher, D.M. Seliskar, & H.P. Bais. 2007. Root-secreted allelochemical in the noxious weed *Phragmites australis* deploys a reactive oxygen species response and microtubule assembly disruption to execute rhizotoxicity. Journal of Chemical Ecology 33: 1898-1918. A potential mechanism by which *Phragmites* displaces other species is discussed.

- Saltonstall, K. 2002. Cryptic invasion by a non-native genotype of the common reed, *Phragmites australis*, into North America. Proceedings of the National Academy of Science 99(4):2445-2449.

- Warren, R.S., P.E. Fell, J.L. Grimbsy, E.L. Buck, G.C. Rilling, & R.A. Fertik. 2001. Rates, patterns, and impacts of *Phragmites australis* expansion and effects of experimental *Phragmites* control on vegetation, macroinvertebrates, and fish within tidelands of the lower Connecticut River. Estuaries 24(1):90-104. Decomposition rates are discussed.

- Winogrond, H.G. & E. Kiviat. 1997. Invasion in tidal marshes of the Hudson River. Section VI: 29pp. In W. C. Neider and J.R. Waldman (eds.). Final Reports of the Tibor T. Polgar Fellowship Program, 1996. Hudson River Foundation, New York. Past & present cover of marshes by *Phragmites*, invasion rates, and colonization rates of *Phragmites* are discussed. See attached file Winogrond.pdf.

For students:

- Hudson River fieldguide to plants of freshwater tidal wetlands. 1998. New York State Department of Environmental Conservation. Contact person: Jean MacAvoy at 845-889-4745 X105 at Norrie Point.

- Kiviat, E. 2005. What reed (*Phragmites*) ecology tells us about reed management. Part 1. Confronting reed's lurid reputation. News from Hudsonia 20:1-4. See attached file Hudsonia1.pdf.

- Kiviat, E. 2007. What reed (*Phragmites*) ecology tells us about reed management. Part 2. Optimizing reed values. News from Hudsonia 21:1-5. See attached file Hudsonia2.pdf.

DEVELOPMENT OF ACTIVITY:

Time to be allocated: 2-4 hours excluding travel time

Motivation: visual estimation of the amount of marsh covered by *Phragmites*

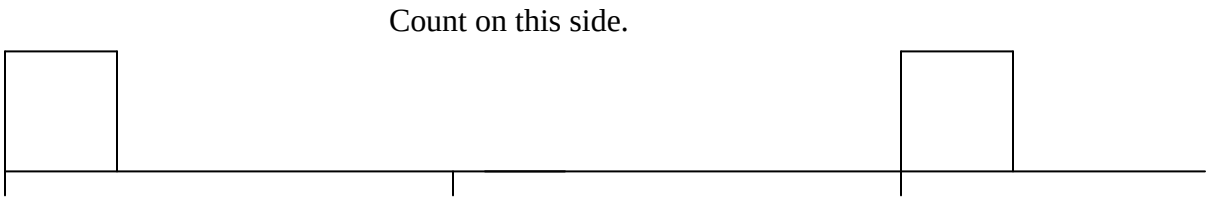
Step by step directions:

1. Lay out a transect line of specified length by extending a meter tape near the soil surface. Leave the tape in place.
    - Starting point: at border of marsh and tidal creek and extended landward or within a marsh and spanning different plant species including *Phragmites*
    - Length: 30-50 meters
    - Number: one transect line along which all students will collect data or several separate transect lines with one pair of students per line.

2. Stand on one side of the transect line and sample plants on the other side to avoid trampling the plants. At 0 meters along the transect line, lay out a square quadrat so that one side is on the transect line; mark the corners with flagged stakes.
    - Size: 25 cm (0.25 m) on each side if time is limited to 50 cm (0.5 m) to include more plants

3. Count the number of live stems of each plant species within the quadrat; record the number on a data sheet. Any unknowns can be numbered and placed in plastic bags for identification later. Usually the entire plant is needed for identification. If the species is not one of the most abundant, it may be adequate to identify it by number. A digital photograph could also be taken.

4. Repeat the process at 2-meter intervals along the transect line.



FOLLOW UP:

1. Plot a bar graph or histogram with the number of stems of each species on the vertical or y-axis against distance along the line transect on the horizontal or x-axis. Label the axes and provide a legend for each species.

   Alternatively, convert the number of stems of each species per quadrat to the percentage of total stems of each species per quadrat and plot the percentages.

2. Describe the general trends in the data.

3. Would you manage the vegetation to reduce *Phragmites*? If so, how? (Review Blossey (2003) for a discussion of some available methods.) As a group list and discuss the positive and negativeeffects of each method.

OTHER POSSIBLE ITEMS:

Changing the level:

Less rigorous:

- Use one transect line along which students work in pairs. When each pair completes its work, it leapfrogs past the last pair to the end of the transect line.
- Count only *Phragmites* and a second abundant species such as *Typha*.
- Reduce the size of the quadrat to 25 cm on each side.

More difficult:

- Use several transect lines with one pair of students per transect line.
- Count all plant species.
- Increase the size of the quadrat to 50 cm on each side.

Adaption for a younger age:

- For students who have limited identification skills, countscan be madeoftotal stems of *Phragmites* in a quadrat *versus* any other plant(s). This will still provide information on the monoculture that *Phragmites* tends to become.

If a group has time constraints that do not allow access to the interior of a marsh:

- Set up edge transects along the perimeter of a marsh and compare transects in different edge areas. Transects can be taken on north side *versus* south side of the marsh, or on trail side *versus* river side etc.
- Note that data from edges can not be equated to data taken in marsh interiors.

Supplementary activities:

Comparison of arthropod faunas of *Typha* and *Phragmites*

- Collect one stem of each plant species somewhere along the transect line.
- Cut each stem at the base close to the soil surface. Then, cut each stem into five sections from the bottom (section 1) to the top (section 5).
- Place each section in the separate ziplock bag. Label each bag with the species, section position, student names, and date of collection.
- Refrigerate the plant sections until ready to look at arthropods.
- Put each section in a white plastic or enamel pan on the stage of a dissecting microscope.
- Carefully pull apart the section looking for arthropods. They will be small.
- Identify each one and record the number for each plant and section.
- Pool the student data.
- Compare the arthropods found on the two plant species. How will wildlife be affected?
- References:
  - Krause, L., C. Rietsma, and E. Kiviat. 2007. Terrestrial insects associated with Lythrum salicaria, Phragmites australis, and Typha angustifolia in a Hudson River tidal marsh Section V: 35pp. In W. C. Neider and J. K. Waldman (eds.). Final Reports of the Tibor T. Polgar Fellowship Program, 1996. Hudson River Foundation, New York. See attached file Krause.pdf.

Johnson, N.F. & C.A. Triplehorn. 2005. Borror and DeLong's introduction of the study of insects (7th ed.). Brooks/Cole Pub. Earlier editions are often available.

Combine a marsh plant species assessment with a count of bird and/or mammals spotted during the field visit

- There has been discussion in the science community about the impact of *Phragmites* on the number and types of birds and mammals using *Phragmites*for food and shelter. If time allows, a supplementary countcould be madeof the total number of birds and/or mammals spotted AND potentially the total number of species.

Common misconceptions and mistakes:

- Counting dead stems along with live stems; count only live stems.
- Identification of plant species. *Phragmites* and *Typha* are relatively easy to identify in the summer and early fall. If species cannot be identified, a specimen with all parts can be collected outside the quadrat and identified later. Assign a letter to it temporarily. Good pictures of species can be found on Google Image, but be forewarned that some identifications are incorrect.

- Walking in quadrats and trampling the plants.
- If an obvious error is made, e.g., one quadrat is inadvertently not counted or counted incorrectly, assuming that none of the data can be used. The solution is to not use the data for that one quadrat; the rest of the data are still valid and should be included

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