RIVER SUMMER CURRICULUM: Biological Sciences
Hudson River Fish Sampling

Fisheries Biology

ABSTRACT:

Fisheries biology is a broad field with many important applications. It is used to monitor the health of the ecosystem, manage an extremely important natural resource, and predict future populations of fish. Although it is impossible to cover all, or even many aspects of fisheries activity in such a brief period of time it is possible to cover some general biology aspects that are essential to good fisheries biology. In this activity, students will be introduced to; 1) an overview of fisheries biology; 2) basic sampling techniques that are frequently employed in fisheries biology; 3) the difference between quantitative and qualitative data and the usefulness of each in fisheries biology; 4) the use of a dichotomous key; 5) use of a beach (haul) seine and data collection.

PROJECT DEVELOPER:

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LEARNING GOALS:

1. **Upon completion students should be able to:**
   A. Define fisheries biology and explain its importance.
   B. Design an experimental protocol to sample fish from various habitats.
   C. Distinguish between quantitative and qualitative data and explain how each are collected and used in fisheries biology.
   D. Effectively use a dichotomous key to identify fish.

2. **Insights gained from completion of this activity (what process or system will they understand from this activity) – please provide specific bullet items.**
   A. Students should have better insight into how sampling techniques can affect results.

B. Students should gain insight into the difference and usefulness of quantitative and qualitative data.
C. After completion of this project students should have better insight into the importance of experimental design to address the correct question.
D. Students should gain insight into the hierarchical organization of animals and how that system can be taken advantage of through the use of a dichotomous key.

MATERIALS & PREPARATION NEEDED:

1. **Special supplies or materials needed and source for any unusual supplies.**
    a. A good beach seine makes a big difference. I have used Netco, LLC (netcollc.com) and been happy. I would recommend giving them a call and telling them what you want to do.
    b. 5 Gallon buckets
    c. Dichotomous keys for the fishes of the Hudson River estuary
        i. Clearwater's key to common Hudson river fishes is a beautiful (but simple) key and is available online at:
http://www.ldeo.columbia.edu/edu/k12/snapshotday/activities/ClearwaterFile2.pdf
        ii. A second option for a fish key is: Haye, JM and N.J. Frisch (1993) Illustrated Guide to Hudson River Fishes. SUNY College at Brockport Press. Brockport, NY.
    d. Waders (depending on the site where you are working hip or chest. I actually prefer bathing suit with old sneakers, but many students prefer waders).
        i. If using chest waders, be aware they present another safety issue as waders full of water are heavy and difficult to move in.
    e. Data record sheets.
    f. Optional;
        i. Handheld refractometer (Available at many aquarium shops, or aquatic eco-systems)
            1. The refractometer will allow you to and your students to measure the salinity of the water you are sampling which will provide information no habitat needs for the fish you catch.
        ii. Calipers
            1. Calipers will allow students to make very accurate anatomical measurements. Calipers take some practice – let students use them prior to heading out to the field.
        iii. Rulers
            1. Rulers are useful if you want to do a study on a single species of fish. You can make measurements like total length or fork length.

2. **Safety issues to be considered andr special preparation on the part of the instructor that would be needed prior to the day (e.g. permissions for use of a field area, permits needed for seining if net size exceeds 36 sf, coordination to meet with a specialist etc.)**

    a. If you are going to complete the field portion of this activity you MUST have or work with someone who has a valid license to posses (or collect) from the state in which you are working. If you are collecting in New York, the Department of Environmental Conservation (DEC) handles the licensing process. Here is a link to their web page -- http://www.dec.ny.gov/permits/25021.html. I would recommend that you call them and apply EARLY. Generally, it is easiest to get a license that allows you only to catch and release fish.
    b. Curiosity (minnow) traps should be set out prior to the exercise.
    c. Seining has inherent dangers. To avoid the most common of these, you should;
        i. Require students wear shoes
        ii. Do NOT seine in areas with sharp drop-off or strong currents unless the seiners are experienced.
        iii. Carefully scout out the area prior to seining. And test it yourself prior to bringing students.
        iv. Handle fish carefully – good quality dish gloves can help prevent injury from sharp spines.
            1. Catfish and Perciform (sunfish, bass, white perch…) are the trickiest. With catfish your hands should be placed firmly behind the spines. With perciform fish, your hand should start in front of the spines and move back.
            2. Do not let lack of experience in handling fish stop you…. Ask for help.
        v. Instruct students to hang on to the seine if they fall in and allow their partner to pull them back to shore.
    d. Students should be instructed to bring dry warm clothes.

3. **Information on site selection for the activity:**

Seining is strongly influenced by season. So, although location is very important, the season will also determine what you catch. Many of the fish caught in more open areas are young of the year (YOY). If you seine in the spring, these fish either have not been born, or are too small to catch. In late summer to early fall these fish tend to be most abundant before moving out of the river.

    a. Site selection is important. Ideally, the instructor will be able to spend some time in the area where they plan to work to find a suitable area. Some indications that a site is suitable for seining include:
        i. A boat ramp (actually great places to seine)

ii. Sandy Beach
    1. Sandy beaches can be pretty barren, so you will want to work along the edges of the beach.
    2. Kingston Point Beach, Croton Point Park, George's Island Park and many more
iii. "Coble" Beach
    1. OK, in the Hudson these tend to be rip-rap more than coble, but they can be great places to seine.
iv. Mud flats
    1. Need to check that the bottom is not too soft, or it will quickly become frustrating.

b. Areas with Large Boulders, sharp drop-offs or strong currents should be avoided by inexperience seiners.
c. There are lots of great educational resources in this area. If you are unsure of where to go, here is you chance to meet someone new and get information on where to seine. It would be worth trying;
    i. The Hudson River Sloop Clearwater (www.clearwater.org)
    ii. Margie Turrin (mkt@ldeo.columbia.edu)
    iii. Steve Stanne, Hudson River Estuary Program of the DEC (spstanne@gw.dec.state.ny.us)
    iv. Me (jensenb@strose.edu)

SKILLS & UNDERSTANDINGS NEEDED:

1. Before completing this activity students should have an understanding of the following concepts :

None. This activity was originally designed for students that lacked a strong science background.

PRE-ACTIVITY READINGS: The following is a list of suggested pre-activity readings:

Depends on the level of the student, but again, there it is not necessary to have pre-activity reading.

1. List of suggested readings & resources for the instructor

Murphy, BR and DW Willis (1996) Fisheries Techniques. American Fisheries Society Publications.

If the instructor is not very familiar with the fishes they will likely find in the Hudson River, I would also recommend a illustrated guide to fishes they will likely encounter. Some (but certainly not the only options) are:

Eo, M, R.S. Birdsong. (2002) Fishes of Chesapeake Bay. Smithsonian. (Lots of similar fish and really beautifully done)

Peterson's guide to freshwater fish and Peterson's guide to Atlantic Coast fish.

2. List of suggested readings for the students.

For introductory students, no readings are necessary. For advanced students, Science has published several excellent articles recently. These include:

Current Problems in the Management of Marine Fisheries
Beddington, J.R., D. J. Agnew, and C. W. Clark
Science 22 June 2007 316: 1713-1716 [DOI: 10.1126/science.1137362]

Ecosystem-Based Fishery Management
Pikitch, E.K., C. Santora, E. A. Babcock, A. Bakun, R. Bonfil, D. O. Conover, P. Dayton, P. Doukakis, D. Fluharty, B. Heneman, E. D. Houde, J. Link, P. A. Livingston, M. Mangel, M. K. McAllister, J. Pope, and K. J. Sainsbury
Science 16 July 2004 305: 346-347 [DOI: 10.1126/science.1098222]

The Future for Fisheries
Pauly, D., Jackie Alder, Elena Bennett, Villy Christensen, Peter Tyedmers, and Reg Watson *Science* 21 November 2003 302: 1359-1361 [DOI: 10.1126/science.1088667]

Effects of Marine Reserves on Adjacent Fisheries
Roberts, C.M., James A. Bohnsack, Fiona Gell, Julie P. Hawkins, and Renata Goodridge *Science* 30 November 2001 294: 1920-1923 [DOI: 10.1126/science.294.5548.1920]

The Impact of United States Recreational Fisheries on Marine Fish Populations
Coleman, F.C., Will F. Figueira, Jeffrey S. Ueland, and Larry B. Crowder
Science 24 September 2004 305: 1958-1960; published online 26 August 2004

PRE-ACTIVITY EXERCISES:

For the basic program, nothing is necessary. If you plan on collecting data as part of a long-term project, students should have an introduction to type of data that they will be collecting prior to heading out. For example, if you plan on targeting a single species, students should be able to quickly identify the appropriate species and make quick accurate measurements (fork-length, total length….). To do this you will need some fish on hand beforehand.

If you plan on completing a survey, it is useful to have students be able to identify multiple species of fish, BUT it is more important that students can work effectively as teams to accurately collect data. One possible activity is to name m&m's (green is mummichog, red is menhaden…..) and have the students work in teams to quickly count the number of each "species" in a bowl of M&M's.

When I teach this at the college level, I have students put together research proposals. On the lab day, we run the experiments, then they write up the papers.

1. **Focusing on the active/fieldwork emphasis of this product, is there a hands on classroom based pre-activity exercise that you would recommend – a sample exercise that illustrates key concepts? (*e.g. provide a sample data set that students could chart)***

See above and very basic data collection sheet at the end

DEVELOPMENT OF ACTIVITY(S):

1. **Time to be Allocated for the Activity**

4 Hours

2. **Motivation: A starting focus to engage the students in the activity**

Generally, motivation is less of a problem than is restraint. Usually, I make one pull of the beach seine prior to "real" data collection so students can get some of the excitement out of them.

3. **Step by Step explanation of how to run the activity and as needed "take home points" from each piece.**

LECTURE PORTION OF ACTIVITY

Overview – basically, I like to tell them what I am going to tell them before I tell them:

1) Importance of fisheries
2) Basic Sampling
    a. Passive vs. Active Techniques
        i. Passive tends to work better in highly structure habitats.
        ii. Active tends to work better in open area
    b. Qualitative vs. Quantitative Data
3) Dichotomous Key/Fish Anatomy
4) Hudson River/Estuary fisheries

Importance of Fisheries

1) Who Cares? Why Study It At All?

STOP – I like to try and get students thoughts on this topic before I move on. I generally try and ask leading questions – do you like to eat fish? Do you like to go fishing?

Bottom line here is to try and get the students to think about how they have interacted with fish (and thus fisheries biology in the past). Outside of fisheries biology, few think of recreational reasons, but this is an extremely important aspect (whether you agree with it or not) of fisheries biology. The three points I make below are not mutually exclusive. Obviously, feel free to make this yours…..I combine Aesthetic and ecosystems because I generally find students come in with a strong understanding of ecosystems.

a. Aesthetic/Ecosystem Reasons
b. Economic Reasons
    i. Traditional Fisheries
    ii. Emergent Fisheries
    iii. "Disruption" of Industrial Facilities
    iv. Tourism
c. Recreational Reasons

STOP – Depending on how this goes, I like to get an idea about what students think is most important here. If this section is a portion of an interdisciplinary project, there is an ideal link to world health.

Fisheries Techniques and the UN (http://www.fao.org/fishery/geartype/search) have lots more information on the types of gear found below. Very generally speaking, passive gear has been for much longer. It is very effective in areas with a great deal structure (think lobster traps in rocky inland waters, or seabass traps around reefs). In some ways this gear is favorable because damage to habitat can be limited.

Again, very generally, active gear is more efficient. It is used in commercial operations in fairly open areas – although with improvement of gear rougher and rougher terrain can be harvested.

Basic Science of Sampling

1) Passive Capture Techniques
    a. Gear is not actively moved
        i. Easy to use
        ii. Can be used in "rough" terrain
        iii. Good Year to Year Comparison of Data
        iv. Simple Gear
            1. Gill Nets
            2. Trammel Nets
            3. Fykes
            4. Weirs
            5. Pot Gear
                a. Lobster Traps
                b. Curiosity Traps
                c. Crab Pots
                d. Eel Pots
2) Active Gear
    a. Gear is moved

i. Can Be More Efficient – more fish less time
ii. Includes
    1. Beach or haul seine
    2. Purse Seine
    3. Otter Trawl

STOP – try to get the students to think about when each technique is most useful (one their own) and what problems there are with each. For example, some fish (gobies and blennies) like to stay under their rocks and are tough to catch because they do not want to move into the open and then into a trap. Therefore, one tends to underestimate their populations unless they are specifically targeted.

Again, if this is a portion of an interdisciplinary project, there is great opportunity to make a link to historical fisheries. Fykes, Weirs, and Pot Gear have all been used for a long time.

Data Data Data

3) Quantitative Data is specific
    a. Catch Per Unit Effort -- which is the number of fish caught standardized for effort. So, with passive gear, how many fish did you catch over a given amount of time. With active gear, how many fish did you catch in a given area. For seining exercises, we make a rough estimate of the distance we pulled the net and multiply by the length of the net to estimate the amount of bottom we covered.
4) Qualitative Data is general

STOP – The difference between Quantitative and Qualitative data is essential. I give examples and ask the students if I am giving them quantitative or qualitative data. One tougher example is – we caught 23 flounder today – is that quantitative or qualitative data – qualitative because there is no indication of effort.

5) Different Data for Different Projects
    a. Between Species/ Within Species

STOP – I try and get students to think about when qualitative data can be useful (biodiversity studies for example). Generally, less effort is needed for students to be able to think of an example of when quantitative data is more useful (setting catch limits).

Use of a Dichotomous Key

1) A dichotomous key is a tool to identify organisms
    a. Uses yes or no questions based on morphology
    b. Basic **Fish Anatomy** –

STOP – Must cover basic anatomy in order to have the dichotomous work. I usually include a handout here to make sure that the students have the important anatomy at hand.

The minimum information needed can be found in "Clearwater's key to common Hudson river fishes." For more details on fish anatomy, try:

Peterson's field guide to Atlantic Coast Fishes.
Wikipedia – Fish Anatomy
Any Ichthyology text (Moyle and Cech: An Introduction to Ichthyology)

STOP – I just love dichotomous keys. They are arcane and they are beautiful. Although, I rarely persuade students of their beauty, I am usually successful in convincing them of their usefulness. There are great links here to evolution, and our hierarchical scheme of classification of organisms.

Hudson River/Estuary Fisheries

1) What do you expect to find and where?

STOP – I try and get the students to come up with all of the variables mentioned below on their own. What do you think will affect where fish live?

a. Thinking about where fish live
    i. Salinity
    ii. Temperature
    iii. Dissolved Oxygen
    iv. Current
    v. Turbidity

STOP – QUESTIONS?

What We are Doing Today

1) Check Curiosity Traps
2) Pull the Seines a Several Locations
3) Data Collection

STOP – QUESTIONS COMMENTS CONCERNS?
STOP – Ideally the lecture is about one hour (or less)

FIELD PORTION OF THE EXERCISE

Curiosity traps

Curiosity traps are ideally collected at the beginning of the field portion. Mummichog are one of the most common species caught in the traps and are about the most hardy of any of the fish you will encounter. The fact that the fish are so hardy makes them perfect for the students to handle first. It is hard to kill a mummichog.

Depending on the level you are teaching at, you can begin thinking about CPUE here. Should also begin using the dichotomous key here. When starting students of with the key, I like to identify the fish myself, and pay careful attention to potential mistakes the students are making. The first few tries with the key, I will redirect students. For example if I know a group has mistakenly said a fish has a forked tail, I will ask "are you sure that tail is forked?" As students progress, I like to let them find their own mistakes.

Students frequently have difficulty with the lateral line and adipose fin. All fish have some form of lateral lines, but basic keys (like the one I suggest you use here) ask if a lateral line is present or not. Look carefully, if you see a lateral line count it. In the Clearwater key, killifish and Clupeids (herring, menhaden…) are identified as having no lateral line (they actually both have very sensitive lateral lines, but they are very difficult to see).

The adipose fin is different than other fins in that it lacks cartilaginous (or bony) rays. It is easiest to see if the fish is in water. Otherwise, if you GENTLY look for a small fin halfway between the dorsal fin and the caudal fin you will find the adipose fin.

Beach Seine

I generally begin with an overview of how the beach seine works and go over the terminology at this point. I pick one student to do the first pull with me and away we go. We do not collect data on the first pull, but rather we have what I call "Key Races." Teams of students each receive the same fish and try and key it out as quickly as possible. As mentioned above, I do my best to catch student mistakes their first time through. As they progress, I allow them to work things out on their own.

Students now run the show. Depending on the number of students, I will assign students roles – two data recorder, two seiners, two identifiers. If you are attempting to collect quantitative data, be sure to determine CPUE.

Some tips:

1) For seining to work well;
    1. Bottom of the net (lead line) stays on the bottom. I have students tap the bottom the entire time they pull the net
    2. As the net is pulled it should form a pocket. Students should be about ½ the length of the net away from one another.
    3. The net needs to keep moving. If you stop, fish will just swim out of the net.
    4. When you reach the shore, the bottom of the net must come out of the water first AND remain on the bottom. If this is done properly, a pocket will form in the middle of the net.
2) Start out in open areas (where there tend to be fewer fish, but are easier to work in). Move to more structured areas if you do not have success in the open. Structure can be the edge of grass beds, dock, rock walls….
3) Try to get Atlantic Silversides, and juvenile fish and "threatened" (sturgeon, striped bass) fish back quickly.
4) Be patient. If you are not getting fish, poke carefully through the seaweed, you will likely find a fairly diverse group of invertebrates, and potentially some neat fish like pipefish.

5) As a last resort you can try a modified version of kick seining. In this technique, one or two student work just in front of the seine to disturb the bottom. In theory, this spooks fish from under rocks into the seine. In practice it works poorly in slow water, but it keeps the students engaged.
6) Have fun.

FOLLOW UP:

1. **Any additional work that needs to occur post activity to complete the activity**

1. There are endless possibilities for follow up. When I do this at the college level I have them write formal scientific papers. We frequently discuss what we found in relation to what we expected as well.

2. Creating charts and graphs of total catch will assist in visualizing the distribution of species. Comparing this composition of catch in different areas of the river will provide some information on different species preferences and habitat needs.

OTHER OPTIONS OR ADJUSTMENTS

1. If you do not have access to the equipment needed for this activity consider contacting some of the educators up and down the Hudson River who do have equipment and are available to partner in events. Many have a small fee for their time so be sure to check when you contact them – here is just a small sampling:

Hudson River Sloop Clearwater: www.clearwater.org
The Clearwater runs programs both on land and on the water. The land based programs can include seining if you request this, and the boat based programs can include a trawl if you request.

Beczak Environmental Education Center in Yonkers: www.beczak.org
The Beczak Center runs a variety of education programs from their site on the waterfront in Yonkers – Habirshaw Park. Beczak will seine with school groups and has all the necessary equipment.

Columbia County Soil & Water Conservation District: www.ccswcd.org (Leanne O'Grady). Columbia County runs a variety of environmental education programs including several focused on the Hudson River and its fish species.

Forsyth Nature Center in Kingston: www.forsythnaturecenter.org
Forsyth Nature Center runs a wide variety of programs including programs focused on the Hudson River and its fish communities.

2. Join in to the Annual Hudson River Snapshot Day event that is organized each fall to look at the biology, chemistry and physical parameters of the Hudson River. Participants contribute fish collection data through their participation.
www.ldeo.columbia.edu/edu/k12/snapshotday/

RECORDING SHEET FOR FISHERIES ACTIVITY

Location:
Date:
Time:
Tide:

Phase of Moon:
Air Temperature:
Water Temperature:
Salinity:

FISH #	COMMON NAME	TOTAL LENGTH (MM)	HEAD LENGTH (MM)

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