



Here a Fish, There a Fish: Educator Guide

This educator guide includes NGSS alignment information for middle school and high school, and an educator key to graphs and their interpretation.

Overview

Fish use estuaries for breeding and as safe nursery areas. Small nearshore fish are also an important part of the diet for larger fish important to shallow subtidal ecosystems as well as to recreational anglers and commercial fishers. In this virtual field trip, students will learn about a seining study in which student researchers used seine nets to capture nearshore fish along the Poquonnock River. Students will then tackle a dataset from that study. You can allow students to choose their research focus from the list provided, or you can assign them to ensure the class as a whole covers all the species. Students will use their scientific skills to make predictions, construct a graph, analyze their results, and construct explanations.

I. NGSS Alignment for Middle School and High School

Science and Engineering Practices

Students will **Develop Models** in the form of graphs that show how fish populations vary in the estuary. They will **Analyze and Interpret their Data** to **Construct Explanations** for what physical and biological factors are influencing fish populations, and then **Engage in Argument from Evidence** as they rely on their data and their graphs to explain and defend the explanations they have constructed.

Crosscutting Concepts

Students will learn about **Cause and Effect** as they try to explain how fish populations might be affected by physical and biological aspects of the estuary, they will look for **Patterns** in their data using their graphs, and they will think about what their findings mean for **Stability and Change** in estuaries. They will also practice **Communicating Information** to their teachers and classmates as they explain their results.

Disciplinary Core Ideas

LS2.A: Interdependent relationships in ecosystems

LS2.C: Ecosystem dynamics, functioning, and resilience

Nature of Science

Scientific knowledge is based on empirical evidence



Performance Expectations

This activity supports progress toward the following performance expectations

MS-LS2-1 Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

HS-LS2-6 Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

HS-LS4-5 Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

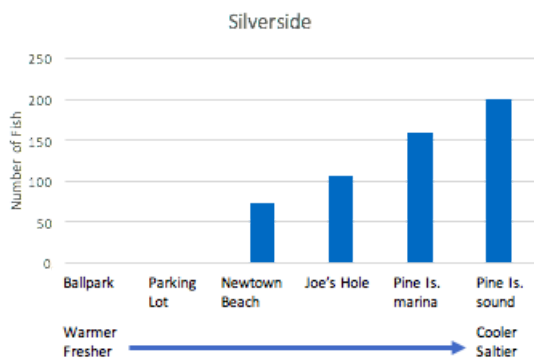
Students will use empirical data about fish populations and background information on habitats to construct explanations about how resource availability and physical ecosystem components affect nearshore fish population dynamics and biodiversity.



II. Educator Key to Graphs and their Interpretation

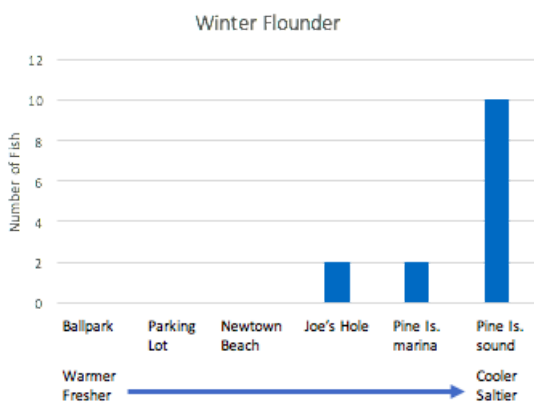
There is more than one right way to make graphs; educators are encouraged to give students more detailed guidelines if they are looking for a specific type. Here, we provide simple column graphs that show the expected patterns, as well as a discussion of connections that can be made to habitat and fish ecology.

Basic Research Projects:



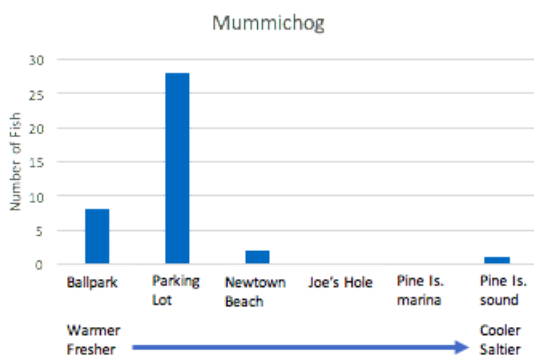
Silversides

Students should be able to identify a clear pattern in which silversides are more abundant closer to the sound. The background information tells us that silversides hatch out of eggs stuck to marsh grasses, and then like to school together and feed in submerged grassy areas. The Pine Island sites are the only sites with eelgrass beds, so this may explain why silversides are most abundant at the Pine Island sites.



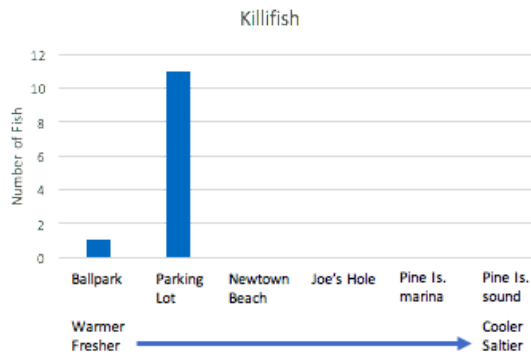
Winter Flounder

Winter flounder are most abundant on the exposed side of Pine Island, with a few also present on the north side of Pine Island and at Joe's Hole. This pattern may surprise students, since the background information suggests they would prefer low-flow muddy and sandy areas. Pine Island south and Joe's Hole are the most exposed/highest flow areas. It's possible the flounder prefer the fine sand present at the pocket beach on Pine Island, or that these flounder are migrating out of the estuary to deeper waters as they grow.



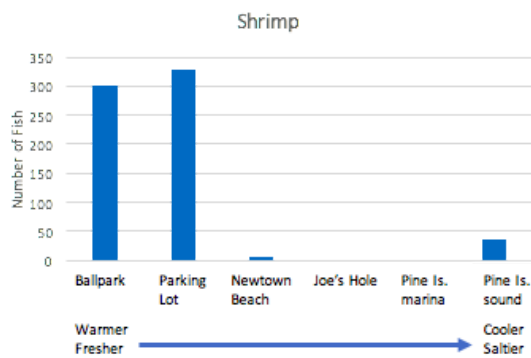
Mummichog

Mummichog are most abundant upriver, at the Ballpark and Parking Lot beaches. We know from the background information that mummichog are often found in low salinity environments, so they may prefer the fresher water up river. They lay their eggs in the high marsh, so students may be surprised they were most abundant at the Parking Lot beach, which is not adjacent to a marsh.



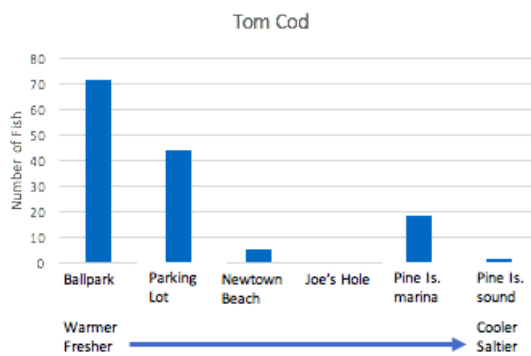
Killifish

Students may express frustration that the researchers did not distinguish between the killifish species - but this is a good reminder that it can be hard to think of everything ahead of time! The fact that more killifish were found upriver where the water is less salty may suggest these are banded killifish. However, they could easily have been striped killifish, which might be attracted to the parking lot beach area for egg laying in July, or for foraging.



Shrimp

Shrimp were extremely abundant upriver. This makes a lot of sense at the Ballpark site, which has a lot of dense vegetation. They also like eelgrass, which helps explain their presence at one of the Pine Island sites. It's a little surprising we didn't see more grass shrimp at Joe's Hole, which is close to a very large marsh. They may be present in the marsh, but just not in the channel where the student seined, since the channel has higher water flow.



Tom Cod

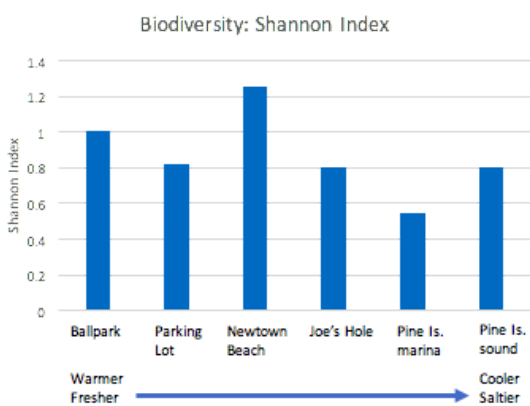
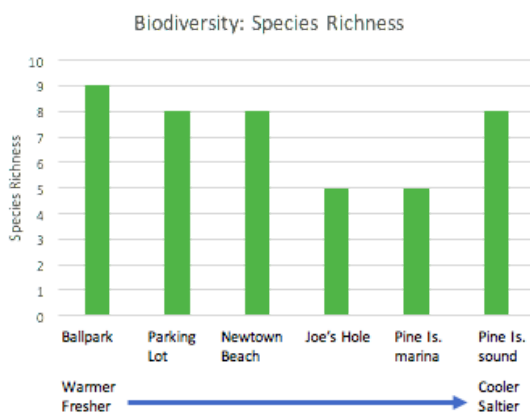
Young tom cod hatch in fresh or slightly brackish water, which may explain why the students found the most tom cod farther up the river. They also like eelgrass beds, which may explain why the students also found them near Pine Island. Tom cod are known to migrate down to saltier, more open waters as they grow, so this may also be what is happening here.



Deep Dive: Biodiversity

Biodiversity Table:

Location	Species Richness	Shannon Index
1. Baseball Field	9	1.00
2. Parking Lot Beach	8	0.82
3. Newtown Beach	8	1.25
4. Joe's Hole	5	0.80
5. Pine Island (marina side)	5	0.55
6. Pine Island (sound side)	8	0.80



The two measures of biodiversity are similar: both identify relatively high biodiversity at the Ballpark and Newtown Beach, and low biodiversity at Pine Island (marina side). However, there are some interesting differences.

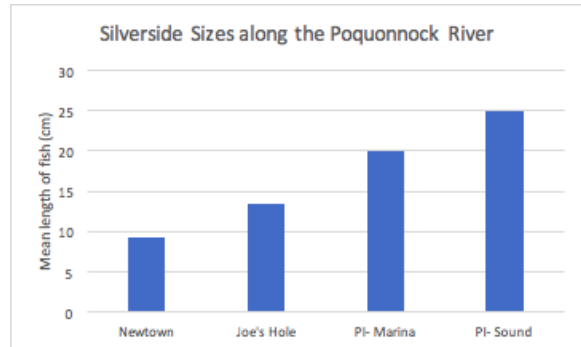
Newtown beach has lower species richness than the Ballpark, but a higher Shannon Index. This is because Newtown Beach has a more even spread of species, while the Ballpark (and the Parking Lot beach) are both dominated by one very abundant species (shrimp). Similarly, Joe's Hole and Pine Island (marina side) have the same species richness, but Joe's Hole has a higher Shannon Index because the catch there was not dominated by a single species.

Why is biodiversity so high at Newtown Beach and the Ballpark, and low at Pine Island on the marina side? There's no easy explanation. Newtown beach is mid-river, and may be an area of overlap between species that prefer the upper river and species that prefer habitats closer to Long Island Sound. We know that sites with a diversity of habitats and lots of productivity (i.e. lots of vegetation) tend to have higher biodiversity. This may explain the Ballpark because it has lots of vegetation, mud, and a nearby salt marsh. The low biodiversity on Pine Island is harder to explain, particularly because those are the only two sites close to eelgrass beds. The Pine Island sites are the farthest from salt marshes, which may make them less favorable for salt marsh loving species.



Deep Dive: Atlantic Silverside Life Stages

Students may choose to plot these data in several ways. One of the simplest ways is to calculate average size at each location:



Another effective strategy is to plot histograms and line them up next to one another to show how the size structure varies between location:

The overall result is clear: silversides are smaller at locations up in the river, and larger at locations closest to Long Island Sound. This is consistent with what we know about silverside biology - they hatch out in salt marshes, and then move around in shallow coastal waters in schools of similarly aged fish. In the Poquonnock River, it appears that the silversides are migrating down the river to deeper/more open locations as they get larger.

