Striper Prey and Salinity
(Follow up to Where in the Bay)

By: Liz Duff
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Grade Level(s): Grade 6-12

Description: Using an on-line database, students will investigate the salinity levels of species known to be prey of a top predator, striped bass.

Essential Questions: Striped bass are not limited by salinity. Is the distribution of striped bass prey impacted by salinity levels. If yes, will this impact the distribution of striped bass?

Time/Duration: 45 minutes –1 hour + optional follow-up

Subject: Earth Systems, Life Science, Ecology, Marine Biology, Inquiry

Next Generation Science Standards:

5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

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

HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

Correlating Ocean Literacy Standards:
http://www.coexploration.org/oceanliteracy/documents/OceanLitChart.pdf

Ocean Literacy Concepts:
5. The ocean supports a great diversity of life and ecosystems.
d. Ocean biology provides many unique examples of life cycles, adaptations, and important relationships among organisms (symbiosis, predator-prey dynamics, and energy transfer) that do not occur on land.

f. Ocean ecosystems are defined by environmental factors and the community of organisms living there. Ocean life is not evenly distributed through time or space due to differences in abiotic factors such as oxygen, salinity, temperature, pH, light, nutrients, pressure, substrate, and circulation. A few regions of the ocean support the most abundant life on Earth, while most of the ocean does not support much life.

Concepts

Students will understand that:

1. Salinity impacts the distribution of fish in an ecosystem.

2. Different fish species are tolerant of different levels of salinity.

3. Adult fish of some species can tolerate different salinity levels than the eggs of the same species.

Skills:

1. Process skills: Observing, inferring, interpreting data, data-base inquiry,
2. Critical thinking Skills: Analyzing, Applying, Generating ideas,
3. Scientific problem solving: Longing to know, searching for data and its meaning,

Prior Knowledge:
It would be great to start students with the Where in the Bay lesson prior to this lesson.

Establish that students know the following

1. Salinity is a measure of how salty the water is.
2. The saltiness of the water is different in different places, and can change in a single place due to tides, rain, storms, and evaporation.
3. Many marine animals are specialized to live most comfortably in a certain level of saltiness.
4. Some marine animals can swim or crawl, and they may move to stay in the most comfortable conditions.

Technology needed to complete lesson:
Multimedia projector,
PowerPoint slideshow (downloaded in advance) or
Internet linking to **Striper Prey and Salinity** PowerPoint
Computers and internet access to National Centers for Coastal Ocean Science Estuarine Living Marine Resources (ELMR) database: http://www8.nos.noaa.gov/biogeo_public/elmr.aspx

To learn more about the ELMR database and additional activities you can do go to
http://pie-lter.ecosystems.mbl.edu/files/3._Exploring_ELMR_Estuary_Data.pdf

Additional Materials:
Striper Prey Salinity Tolerances Student Version (1 per student or team of 2-3 students) for the ELMR data,
Maps of Plum Island Sound (1 per team of 2-3 students),
Essential Questions: Striped bass are not limited by salinity. Is the distribution of striped bass prey impacted by salinity levels. If yes, will this impact the distribution of striped bass?

Introduction/Background Information:

Salinity: Salinity is a measure of how salty the water is. It is one of the abiotic (non-living) factors impacting the distribution of life. The saltiness of the water is different in different places, and can change in a single place due to tides, rain, storms, and evaporation. Fresh water is less dense than salt water, and may form a lens floating on top of salt water, in an estuary, where fresh water is flowing to the sea, and salt water flows in with the tide. Thus surface water may have lower salinity than deeper water. Storms not only provide additional fresh water through precipitation, reducing salinity levels, but also can mix surface water with deeper water through the impact of wind and waves. Many marine animals are specialized to live most comfortably in a certain level of saltiness. Some marine animals can swim or crawl, and they may move to stay in the most comfortable conditions.

Why does salinity changes seasonally?

Salinity levels change seasonally because the amount of fresh water brought by the rivers changes seasonally. There tends to be more fresh water transported in the spring because the snow on the land is melting feeding the rivers. This leads to lower salinity levels. As greater evaporation occurs in the summer and fall, the areas with higher salinity expand.

Striped Bass:

Striped bass are a top predator fish with an interesting lifestyle. They spawn in few areas in the Atlantic, primarily in Chesapeake Bay, Delaware Bay and the Hudson River. They are anadromous fish, laying their eggs in fresh water but living in water with a wide range of salinities during their juvenile and adult life. Striped bass migrate in the summer months to points north as far away as the points within the Gulf of Maine. Some take up residence in the Plum Island Sound Estuary in Massachusetts for the summer months, while others pass through, heading to points further North. Scientists are investigating: Why do they travel so far? Striped bass are commercially harvested in some southern states, and are eagerly sought by sport-fishermen in Massachusetts. Populations of striped bass declined markedly in the 1980s and their populations have increased thanks to conservation efforts. **Striper Prey and Salinity** is the second lesson in the Striper Science curriculum. Using an on-line database, students will investigate the salinity tolerances of a number of species preyed upon by striped bass. Striped bass can tolerate a wide range of salnity levels. Is this true of its prey?

This lesson is a part of the Striper Science curriculum. Striper Science is a set of lesson plans and resources for upper elementary through high school level based on striped bass research conducted in Massachusetts. Resources include PowerPoint presentations, inquiry lessons based on databases, field studies, and online videos. We are proud to present these lesson plans and resources which are connected to Next Generation Learning Standards. Additional lessons in the curriculum focus further specifically on Striped Bass.

This work was conducted by partners involve in the **Plum Island Sound Long Term Ecological Research (PIE-LTER**). The scientific research was conducted by Massachusetts Cooperative Fish and Wildlife Research Unit, UMass-Amherst (Dr. Martha Mather, Sarah Pautzke and Kristen Ferry) and supported by the Massachusetts Division of Marine Fisheries. Lesson developers and advisors include Liz Duff, Martha Mather, Kristen Ferry, Robert Muth, Jack Finn, Sarah Pautzke, Pat Harcourt and Melissa Sanderson. Striper Science was funded by the National Science Foundation.

Learn about research on striped bass traveling choices and diet done by Kristen Ferry and Martha Mather in Plum Island Sound.
Lesson Plan (PDF)
Why Stripers Go, Part 1 (8 minutes)
Why Stripers Go, Part 2 (10 minutes)>

Learn about striped bass behavior in Plum Island Sound based on research done by Martha Mather and Sarah Pautzke.
Bass Habitat Use Lesson Outline (PDF)
Bass Habitat Use Part 1 (9.5 minutes)
Bass Habitat Use Part 2 (7.5 minutes)

Procedure

Preparation : Review slide show and practice using the ELMR database. Take a look to see which regions correspond with where you live.

Look at http://www8.nos.noaa.gov/biogeo_public/elmr.aspx to practice the activity.

Optional: Go to:http://pie-lter.ecosystems.mbl.edu/files/3._Exploring_ELMR_Estuary_Data.pdf To learn more about the database.

Engaging Discussion: Discuss how many students like to catch fish, and what their favorite fish are. Explain that striped bass is a fish species Native to the North Atlantic, and is a favorite fish of many people. Although it was overharvested in the past, and populations declined, its populations have made a comeback thanks to conservation efforts across states. Scientists have many questions about what fish are doing, what they are eating, and where they spend their time. On-line databases hold data that allow us to ask questions and answer them without having to be the ones to go out and collect all the data. We are going to learn to use a data base to find out more about striped bass and how salinity impacts the things that striped bass eat.

Database Inquiry via Estuarine Living Marine Resource (ELMR) Data Base

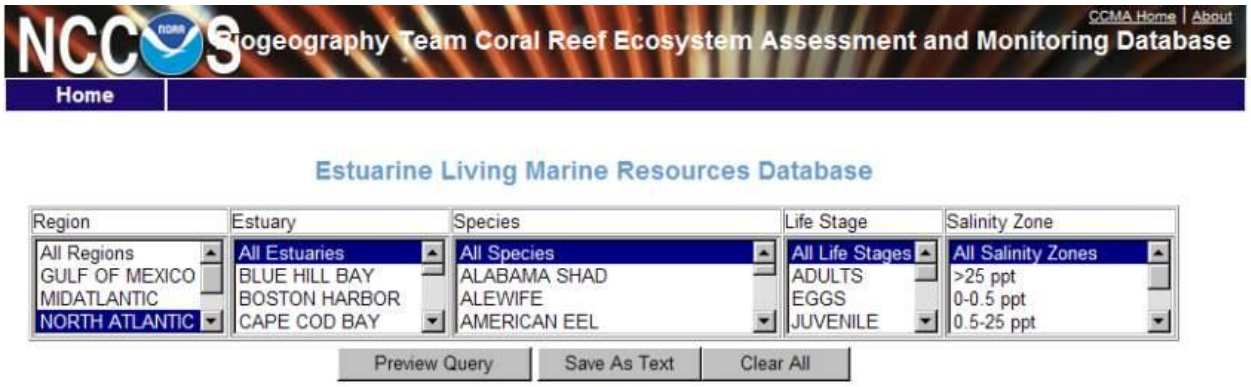
Materials Computer lab. The data base inquiry can be done in the classroom (with teams of students), in a computer lab, or as homework or extra credit, depending on what is available to teachers/students.

Background information for ELMR Database:

Project Summary

In 1985, the National Oceanic and Atmospheric Administration (NOAA) launched the Estuarine Living Marine Resources (ELMR) project to develop a consistent data base on the presence, distribution, relative abundance, and life history characteristics of ecologically and economically important fishes and invertebrates in the nation's estuaries. It has been conducted jointly by NOAA's National Ocean Service (NOS), NOAA's National Marine Fisheries Service (NMFS), and other agencies and institutions. The nationwide data base was completed in 1994, and includes data for 153 species found in 122 estuaries and coastal embayments in five regions. Regional revisions were completed for the Gulf of Mexico and Southeast in 1998.

The database is divided into five study regions and contains the monthly relative abundance of each species' life stage by estuary for three salinity zones (seawater, mixing, and tidal fresh), as identified in NOAA's National Estuarine Inventory (NEI) Data Atlas-Volume I and supplement (NOAA 1985). Regional data summary reports have been published for the North Atlantic (Jury et al. 1994), Mid-Atlantic (Stone et al. 1994), Southeast (Nelson et al. 1991), Gulf of Mexico (Nelson et al. 1992), and West Coast (Monaco et al. 1990). Regional life history summary reports have been published for the West Coast (Emmett et al. 1991) and Gulf of Mexico (Pattillo et al. 1997). A National Overview report was completed in 2000 (Nelson and Monaco 2000). All reports are available for free upon request.



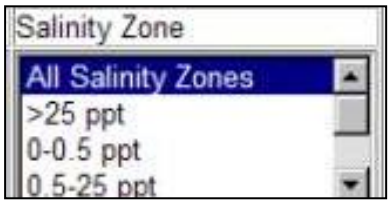
Screen shot from http://www8.nos.noaa.gov/biogeo_public/elmr.aspx

This lesson focuses on striped bass and other species in the Mid Atlantic and North Atlantic.

Instructions:

Go to ELMR Estuarine Living Marine Resources web-site
http://www8.nos.noaa.gov/biogeo_public/elmr.aspx

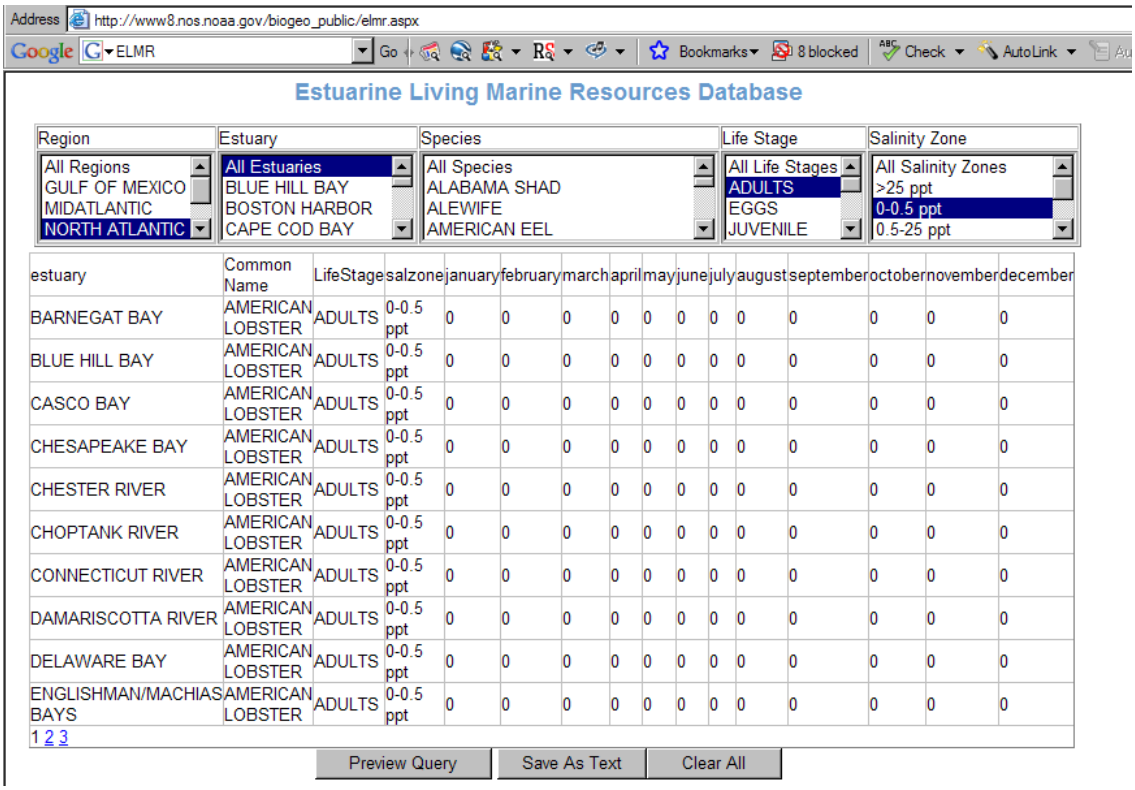
Demonstrate how to use the database. Click on "North Atlantic" and "All Estuaries" and species you want. For the area north of Cape Cod, MA choose "North Atlantic". For Cape Cod south to the Chesapeake, choose "Mid Atlantic". Choose "all estuaries" unless you are very close to one of the estuaries listed. Scroll down the list of species until you get to one on our list. (Demonstrate with "American lobster".) We will assume that the bass are eating adult crabs, shrimp, and lobster. So, in general, choose "Adult" for life stage. Click on the different salinity zones for each species, and record whether that species is present for that salinity range. If it shows numbers other than zeros, it is present. If you see all zeros, it is not present. When you finish that, you can also check to see if "egg" is any different for fish species.



- >25 ppt is High Salinity
- 0-.-0.5 ppt is Fresh water
- .5-25 ppt is Low and Medium Salinity

Ocean salinity is 32-35 ppt.

Example: There are zero adult lobsters at 0-0.5 ppt salinity.



estuary	Common Name	LifeStage	salzone	january	february	march	april	may	june	july	august	september	october	november	december
BARNEGAT BAY	AMERICAN LOBSTER	ADULTS	0-0.5 ppt	0	0	0	0	0	0	0	0	0	0	0	0
BLUE HILL BAY	AMERICAN LOBSTER	ADULTS	0-0.5 ppt	0	0	0	0	0	0	0	0	0	0	0	0
CASCO BAY	AMERICAN LOBSTER	ADULTS	0-0.5 ppt	0	0	0	0	0	0	0	0	0	0	0	0
CHESAPEAKE BAY	AMERICAN LOBSTER	ADULTS	0-0.5 ppt	0	0	0	0	0	0	0	0	0	0	0	0
CHESTER RIVER	AMERICAN LOBSTER	ADULTS	0-0.5 ppt	0	0	0	0	0	0	0	0	0	0	0	0
CHOPTANK RIVER	AMERICAN LOBSTER	ADULTS	0-0.5 ppt	0	0	0	0	0	0	0	0	0	0	0	0
CONNECTICUT RIVER	AMERICAN LOBSTER	ADULTS	0-0.5 ppt	0	0	0	0	0	0	0	0	0	0	0	0
DAMARISCOTTA RIVER	AMERICAN LOBSTER	ADULTS	0-0.5 ppt	0	0	0	0	0	0	0	0	0	0	0	0
DELAWARE BAY	AMERICAN LOBSTER	ADULTS	0-0.5 ppt	0	0	0	0	0	0	0	0	0	0	0	0
ENGLISHMAN/MACHIAS BAYS	AMERICAN LOBSTER	ADULTS	0-0.5 ppt	0	0	0	0	0	0	0	0	0	0	0	0

1 2 3

In the North Atlantic, Adult lobsters can be found rarely or commonly at .5-25 ppt in the months of April through December. They are common to abundant at > 25 every month of the year.

Region	Estuary	Species	Life Stage	Salinity Zone
All Regions GULF OF MEXICO MIDATLANTIC NORTH ATLANTIC	All Estuaries BLUE HILL BAY BOSTON HARBOR CAPE COD BAY	AMERICAN EEL AMERICAN LOBSTER AMERICAN PLAICE AMERICAN SAND LANCE	All Life Stages ADULTS EGGS JUVENILE	All Salinity Zones >25 ppt 0-0.5 ppt 0.5-25 ppt

Preview Query | Save As Text | Clear All

estuary	Common Name	LifeStage	salzone	january	february	march	april	may	june	july	august	september	october	november	december
BLUE HILL BAY	AMERICAN LOBSTER	ADULTS	0.5-25 ppt	0	0	0	3	3	3	3	3	3	3	3	2
BOSTON HARBOR	AMERICAN LOBSTER	ADULTS	0.5-25 ppt	0	0	0	3	4	4	4	4	4	3	3	2
CAPE COD BAY	AMERICAN LOBSTER	ADULTS	0.5-25 ppt	0	0	0	3	3	3	3	3	3	3	3	2
CASCO BAY	AMERICAN LOBSTER	ADULTS	0.5-25 ppt	0	0	0	3	3	3	3	3	3	3	3	2
DAMARISCOTTA RIVER	AMERICAN LOBSTER	ADULTS	0.5-25 ppt	0	0	0	3	3	3	3	3	3	3	3	2
ENGLISHMAN/MACHIAS BAYS	AMERICAN LOBSTER	ADULTS	0.5-25 ppt	0	0	0	3	3	3	3	3	3	3	3	2
GREAT BAY	AMERICAN LOBSTER	ADULTS	0.5-25 ppt	0	0	0	2	3	3	3	3	3	3	3	2
KENNEBEC/ANDROSCOGGIN RIVERS	AMERICAN LOBSTER	ADULTS	0.5-25 ppt	0	0	0	3	3	3	3	3	3	3	3	2
MERRIMACK RIVER	AMERICAN LOBSTER	ADULTS	0.5-25 ppt	0	0	0	2	2	2	2	2	2	2	2	2
MUSCONGUS BAY	AMERICAN LOBSTER	ADULTS	0.5-25 ppt	0	0	0	3	3	3	3	3	3	3	3	2

1 2

Instructions:

1. Ask: Will salinity affect the location of their striped bass prey species?
2. Use the Striper Prey and Salinity Slideshow to introduce the questions.
3. Pass out Striper Prey Salinity Tolerances Handout, and Plum Island Sound Maps
4. Have students log onto the ELMR Estuarine Living Marine Resources web-site

http://www8.nos.noaa.gov/biogeo_public/elmr.aspx to see which prey species can tolerate each salinity level.

Ask students to use the database to find the answers to the "Striper Prey Salinity Tolerances" student handout. To focus on Plum Island Sound, choose "North Atlantic" "All estuaries" "Adults" each time for the first table. Choose "North Atlantic" "All estuaries" "Eggs" each time for the second part of the table.

Explain: If you see all zeros in the chart, the species cannot tolerate that salinity level. Write "NO" to indicate it cannot tolerate that level. If you see all 2s, the species is RARELY found there. Write "Yes" next to the levels each species is common or abundant. One has been done for you. Put RARE if it is rarely found.

Be sure to choose "North Atlantic" "All estuaries" "Adults" each time. If you finish early, check to see if eggs have the same results.

5: Highly Abundant
4: Abundant
3: Common
2: Rare
0: Not Present

Discussion:
Most of the prey species are found in a wide range of salinities. These include Alewife, blueback herring, daggerblade grass shrimp, green crab, mummichog, sand shrimp and silverside.

The species that are not found in fresh water as adults include: American Sand Lance, American Lobster, (daggerblad) grass shrimp, Green crab, Atlantic Menhaden, Sevenspine Bay Shrimp and Silversides.

The American Sand Lance is not found in fresh water and is rare at salinities less than 25 ppt. Adults and eggs of these species are not found in fresh water. Lobster and menhaden eggs are not found in the .5> 25 range. Sand Lance are rarely found there (only in the Merrimack River). On the Spring map in the PowerPoint, the red arrow shows the lobster range in the spring. The brown arrow shows the sand lance range in the spring. These ranges increase in the summer and fall as there is less precipitation, and more evaporation going on, increasing the salinity (salt content) levels. If sand lance is a preferred food item for striped bass, this would support the hypothesis that striped bass may increase their ranges within Plum Island Sound in those months. If not, the prey species are not impacting striped bass distribution. New question: What are striped bass eating? Do they prefer sand lance? How do PIE-LTER scientists know? Listen to **Why Stripers Go** to learn about striped bass preferred diet.
Why Stripers Go, Part 1 (8 minutes)
Why Stripers Go, Part 2 (10 minutes)>

Discuss as a class: What besides salinity might impact the location of Striped Bass and Striped Bass prey. (Temperature is one thing. Bigelow and Schroder Fishes of the Gulf of Maine http://www.gma.org/fogm/ has information about temperature listed with fish species).

Extensions:
Investigate temperature ranges for individual species through reading Bigelow and Schroder Fishes of the Gulf of Maine http://www.gma.org/fogm/.

Learn about Striped Bass preferred temperatures in Why Stripers Go, Part 1 (8 minutes)

Investigate additional questions on the ELMR database. Ask students: What other questions can this data base help you answer? In your science journal, or on the back of this paper, list your questions. Choose one and investigate. Write down your question and its answer. Some possible questions: Striped Bass Adults survive at a wide range of salinity levels. Is this true for Bass at all life stages? Investigate. What estuaries can they be found in the egg stage? What species do you see have different salt tolerances at different life stages? You could have each student investigate the life cycle of the prey of striped bass. What stages do they go through? What salinity tolerances do they have? Is there an optimal salinity for their species?

Learn more about PIE-LTER research by listening to their videos.
Learn about striped bass behavior in Plum Island Sound based on research done by Martha Mather and Sarah Pautzke.
Bass Habitat Use Lesson Outline (PDF)
Bass Habitat Use Part 1 (9.5 minutes)
Bass Habitat Use Part 2 (7.5 minutes)

Evidence of Understanding / Assessment(s):

5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

Striped bass and their prey are part of the biosphere. They live in they hydrosphere and are impacted by salinity from the geosphere. Based on this lesson and what you know about salinity, draw a diagram and label it to describe ways they interact.

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

Explain how salinity changes affect fish populations. Be sure to describe what you know seasonally and different life stages.

Based on this lesson- what are three species that can tolerate different salinity levels at different stages of their lives?

HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

Use the ELMR data base and a mathematical representation to show when striped bass prey are most abundant in a specific estuary.

Striper Prey Salinity Tolerances **Teacher Version**

Answer Sheet for Adult Prey

Prey Species	Fresh	.5-25	>25
Alewife	Yes	Yes	Yes
American Sand Lance	No	Yes-RARE	Yes
American Lobster	No	Yes	Yes
Blueback Herring	Yes	Yes	Yes
(Daggerblade) Grass Shrimp	No	Yes	Yes
Green Crab	No	Yes	Yes
Atlantic Menhaden	No	Yes	Yes
Mummichog	Yes	Yes	Yes
Sevenspine Bay Shrimp (Sand Shrimp)	No	Yes	Yes
Silversides	No	Yes	Yes

Answers for Eggs

Prey Species	Fresh	.5-25	>25
Alewife	Yes	Yes	No
American Lobster	No	No	Yes
American Sand Lance	No	Yes - Rare	Yes
Blueback Herring	Yes	Yes	No
Atlantic Menhaden	No	No	Yes
Mummichog	Yes	Yes	Yes
Silversides	Yes	Yes	Yes

Striper Prey Salinity Tolerances **Student Version**

Name(s) _____ Date: _____

Will salinity affect the location of their prey species? Young striped bass called "schoolies" eat the species listed below. Check ELMR Estuarine Living Marine Resources web-site http://www8.nos.noaa.gov/biogeo_public/elmr.aspx to see which prey species can tolerate each salinity level. If you see all zeros in the chart, the species cannot tolerate that salinity level. A 2 means it is rare. Write "NO" to indicate it cannot tolerate that level. Or Yes-RARE, if you see all 2s. Write "Yes" next to the levels each species are common or abundant. One has been done for you.

Be sure to choose "North Atlantic" "All estuaries" "Adults" each time.
If you finish early, check to see if eggs have the same results.

Results for Adults

Prey Species	Fresh	.5-25	>25
Alewife			
American Sand Lance			
American Lobster	No (0)	Yes	Yes
Blueback Herring			
(Daggerblade) Grass Shrimp			
Green Crab			
Atlantic Menhaden			
Mummichog			
Sevenspine Bay Shrimp (Sand Shrimp)			
Silversides			

Results for eggs (Be sure to choose "North Atlantic" "All estuaries" "eggs" each time.)

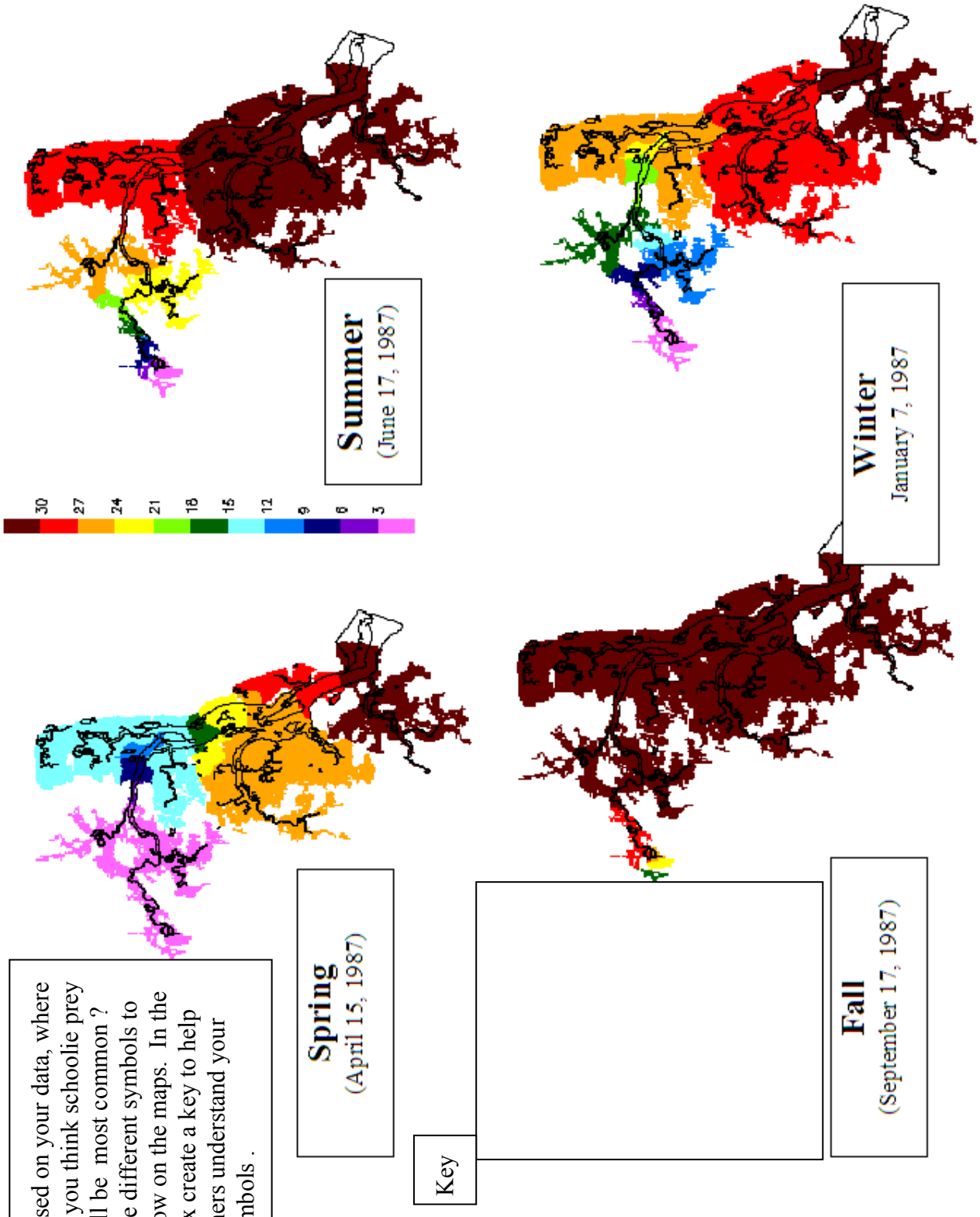
Prey Species	Fresh	.5-25	>25
Alewife			
American Lobster			
American Sand Lance			
Blueback Herring			
Atlantic Menhaden			
Mummichog			
Silversides			

What other questions can this database help you answer? In your science journal, or on the back of this paper, list your questions. Choose one and investigate. Write down your question and its answer.

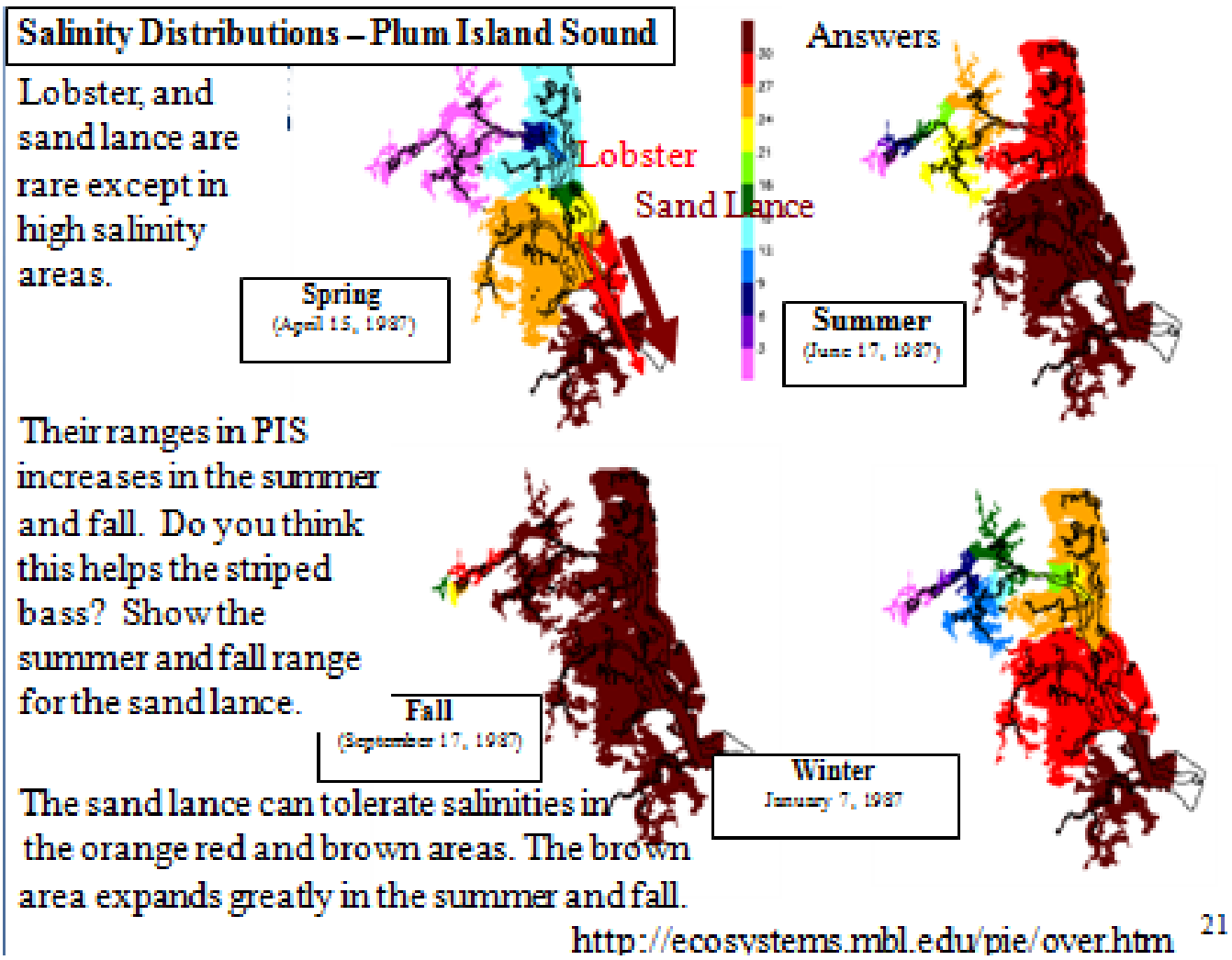
Name(s) _____ Date: _____

http://ecosystems.mbl.edu/pie/over.htm

Salinity Map Plum Island Sound, MA



Based on your data, where do you think schoolie prey will be most common ? Use different symbols to show on the maps. In the box create a key to help others understand your symbols .



Discussion:

Most of the prey species are found in a wide range of salinities. These include Alewife, blueback herring, daggerblade grass shrimp, green crab, mummichog, sand shrimp and silverside.

Only three species have a more limited range: American lobster, Atlantic Menhaden, and American Sand Lance. On the Spring map above, the red arrow shows the lobster range in the spring. The brown arrow shows the sand lance range in the spring. These ranges increase in the summer and fall as there is less precipitation, and more evaporation going on, increasing the salinity (salt content) levels. If sand lance is a preferred food item for striped bass, this would support the hypothesis that striped bass may increase their ranges within Plum Island Sound in those months. If not, the prey species are not impacting striped bass distribution. New question: What are striped bass eating? Do they prefer sand lance? How do PIE-LTER scientists know? Listen to **Why Stripers Go** to learn about striped bass preferred diet.

Why Stripers Go, Part 1 (8 minutes)

Why Stripers Go, Part 2 (10 minutes)> In part 2 around minute 4.54-6.09 they discuss seasonal diet including sand lance. Sand lance are an important part of striped bass diet in Plum Island Sound, in the fall.

References:

Plum Island Ecosystems Long Term Ecological Research web-site
http://ecosystems.mbl.edu/pie/over.htm

National Centers for Coastal Ocean Science Estuarine Living Marine Resources (ELMR)
http://www8.nos.noaa.gov/biogeo_public/elmr.aspx

Duff, Elizabeth B. and Harcourt, Pat *Striper Science Curriculum*
http://pie-lter.ecosystems.mbl.edu/content/striped-bass-curriculum

Bigelow, Henry B. & Schroeder, William C. *Fishes of the Gulf of Maine* United States Government Printing Office. Washington: 1953. Print.
Electronic Version http://www.gma.org/fogm/

Glossary:

Anadromous: Migrating up rivers from the sea to breed in fresh water. Used of fish.

Distribution: The arrangement of items over a specified area.

Estuary: The wide part of a river where it nears the sea; fresh and salt water mix.

Fish migration: Movement of fish from one aquatic habitat to another. For example, anadromous fish move from estuarine and marine habitats to freshwater to breed.

Juvenile: Fish from one year of age until sexual maturity.

Predator: An animal that lives by killing and eating other animals.

Prey: An animal hunted or caught for food.

Salinity: The concentration of mineral salts dissolved in water.

Schoolies: Young striped bass, typically 3-5 years old.