# Trawling for Sustainability

***What does science have to do with seafood?***

*Module 13:*

## Grade Level

Middle School

*Module Created by:*

New England Science & Sailing

## Subject Areas

Life Science, Engineering, Math (Statistics, data)

## Duration

Preparation time: 30 minutes
Lesson Time: 120 minutes

| | |
|---|---|
| Part I: Resource: Fish Frenzy Activity | 30 minutes |
| Part II: Fishing Methods: How do fishermen catch fish? | 30 minutes |
| Part III: Fishing Methods: How many fish are in the ocean? | 30 minutes |
| Part IV: Sustainability: Engineer a sustainable fishery | 30 minutes |

## Setting

Indoor/Outdoor Classroom

## Skills

Prediction, Construction, Design, Analyze, Graphing, Organizing, Marketing

## Vocabulary

Resource, Sustainable, Carrying Capacity, Fishery, Bycatch, Natural selection, Competition, Predation

## Standards

NGSS Scientific Engineering (1,3,4,5,6,7,8) NGSS Cross-Cutting Concepts (1,2,3,5,7)
NGSS Disciplinary Core Ideas (MS-LS2-1, MS-LS2-2, MS-LS2-5, MS-ESS3-3, MS-ESS1-2)

## Summary

As sailors, we find that the ocean is a source of inspiration, recreation, rejuvenation and discovery. From the ocean and inland waters we also get foods, medicines, and mineral and energy resources. In addition, it provides jobs, supports our nation's economy, serves as a highway for transportation of goods and people, and plays a role in national security. In fact, fish supports 1 billion people around

the world for protein! Through the following fishery activities, students will gain a broad understanding of just how important seafood is in our life. Students will explore sustainable ways to determine the amount and the way we can harvest fish where it does little to no harm to the environment, but leaves enough fish in the water for the population to renew itself.

## Objectives

Students will:

- Understand that the ocean and humans are inextricably connected
- Define carrying capacity
- Graph humans vs resources in the "Fish Frenzy" Activity
- Compare and contrast different Fishing Methods
- Design and engineer a  trap to target a specific species

## Materials

- Fish Frenzy worksheet
- Clipboard
- Pencil
- Cones or boundary markers
- Fishing Methods Fact Cards
- Large piece of paper or whiteboard to chart/graph data from the game
- One fish, two fish, Go Fish activity
- Butcher paper with 5x5 local
- Butcher paper with Grid
- Poker chips or Fish Fetch Images

## Procedure

### Part I: Resource: Fish Frenzy Activity

### Indoor/Outdoor Classroom Activity 30 minutes

#### Classroom Activity *5 minutes*

1. **Access Prior Knowledge** by asking the class "What is a Resource?" Have the group brainstorm examples of what a resource is on a piece of paper. Have one student be the spokesperson to explain the group's answers.
2. Now that the students have given examples of resources, **ask the students** to define a resource. A resource is a place or a thing that provides something useful. Have students examine what might three main resource groups that would be important for all animals or fish to use for survival. Try to categorize the students' responses in terms of the three main resources that we will discuss today: food, water and shelter.

#### Indoor/Outdoor Activity 2*5 minutes*

1. **Fish Frenzy Activity***:* Break up the group to fill the following roles human (1) and resources (remainder of students) and demonstrate and explain the movements associated with the role.

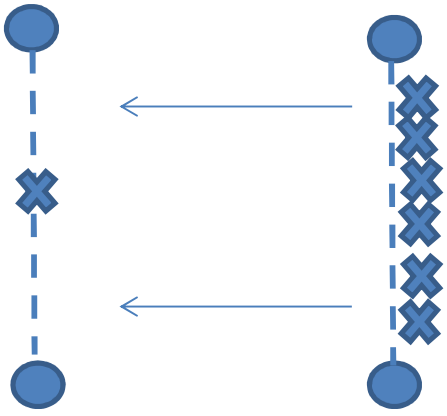
   ***Water*** *= rain gesture with arms and hands moving up and down*

   ***Fish*** *= Fish face with lips and flapping hands on side of head like a fins*

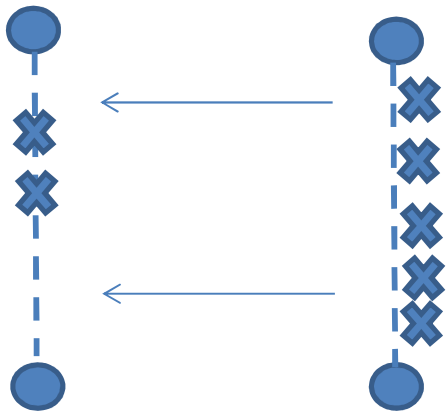
   ***Shelter*** *= put your hands above your head for cover*

   Have all resource students line up facing the one human student at boundaries. Have the students turn around so they cannot see each other and the human can think of the resource he wants, while the resources are thinking of the resource they want to be. Then count down slowly 3-2-1 and have all students face each other. If the resource students match what the human resource needs, they must try to move to the other side of the course. The human must try to tag the resource that matches and that resource will then become a human. Record the amount of humans and amount of resources for each round. The next round should have more humans. This will lead the humans to have to begin to compete for resources. If the human does not find a resource match, they will become a resource again. After each round, have students' record data in a chart either individually or as a group. Once you have completed at least 5 rounds (you can do more!) have students individually graph the data. Students must label the x-axis and y-axis with labels "round #", " # of humans" and "# of resources".

**Round 1 example:**



**Round 2 example:**

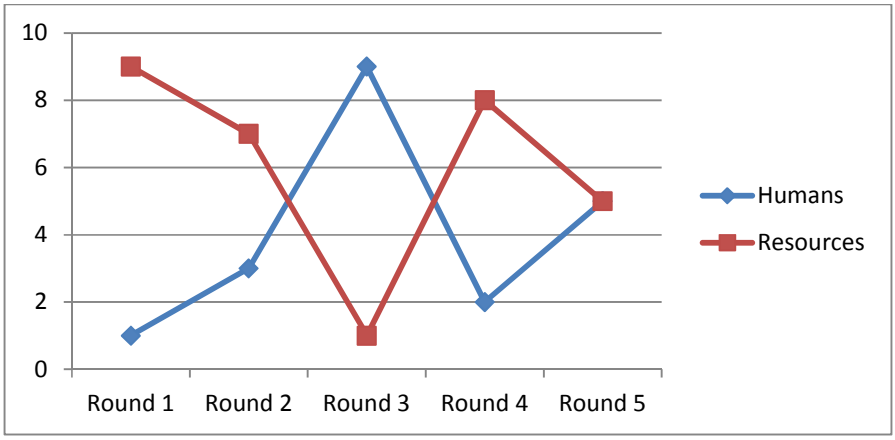


*Example of data that you might find throughout the activity:*

| | # of humans | # of resources |
|---|---|---|
| **Round 1** | 1 | 9 |
| **Round 2** | 3 | 7 |
| **Round 3** | 9 | 1 |
| **Round 4** | 2 | 8 |

| | | |
|---|---|---|
| **Round 5** | 5 | 5 |

*Example of graph that you might find throughout the activity:*




**Some things to think about:**

- What trends did we see happen with the humans and resources for each round?
- Why do you think the human population gained with multiple resources?
- Can we think of any real life situations?
- Why did the human population deplete with the lack of resources?
- What was the most frequent number of humans in each round of this activity? This number is called the carrying capacity – the number of species that the habitat in a region can support based on its resources.

**Try additional rounds that add these natural variables into the mix:** Natural disasters, droughts**,** disease**,** hurricanes**,** oil spills – eliminate a resource based on the natural variable.

2. **Calculate Carrying capacity**: Have students determine the carrying capacity of humans in the "Fish Frenzy" activity or the number of species that the habitat in a region can support based on its resources. This number is the most frequent number of humans What is a carrying capacity? We might have seen "carrying capacity" posted on the side of a school bus or an elevator. This is not all that different from carrying capacity in reference to a population. On a school bus, the carrying capacity would be the maximum number of people that could safely fit. In ecological terms, carrying capacity is defined as the maximum number of a species that can sustainably live in a given area. In other words, a population's carrying capacity is the size at which a population can no longer grow due to lack of supporting resources. All populations have a carrying capacity, whether bacteria in a bottle or crabs on the rocky shoreline. If we were referring to a crab population on the shoreline, the carrying capacity would refer to the maximum crab population that can be supported by that shoreline's resources.

## Part II: Fishing Methods: How do fishermen catch fish?
## Indoor Classroom 20 minutes

Fishermen from different regions use a wide variety of gear to target and capture their catch. Each and every type fishing gear has its own effects on the ocean. By selecting the right gear for the right species, the fishing industry can help minimize its impact on the environment.

1) **Ask students**, "What is your favorite fish?" and make a list on the board. Try to access prior knowledge and try to determine what types of fishing methods students think are used to harvest their favorite seafood. If you don't have any idea on how the particular seafood was caught, create a "must research" column. Once you have brainstormed what you think might happen, students will need to do research to determine how their favorite foods were actually caught and begin to determine if those methods impact the environment. Examine issues that may effect:
   **Habitat**: a place fish (and other animals) need to feed, breed, seek shelter and raise young
   **Bycatch**: unwanted fish and animals caught accidentally in fishing gear and discarded overboard, dead or dying
   **Stock**: A biological fish stock is a group of fish of the same species that live in the same geographic area and mix enough to breed with each other when mature.
   **Overexploitation**: refers to harvesting a renewable resource to the point of diminishing returns. Sustained overexploitation can lead to the destruction extinction of the resource.

**Option 1:** Have students research in groups or independently the different types of fishing on an iPad or Computer and report back. Have students determine the equipment needed, what species each method would catch and what are the issues with each of the methods.

- Fish Farming
- Commercial Fishing
- Recreational Fishing
- Substinence Fishing
- Artisinal fishing

**Option 2:** Break students into groups of 2-3 students and use Monterey Bay Fishing Method Fact Cards to research different methods of fishing. Have students report back on the equipment needed, what species each method would catch and what are the issues with each of the methods.

- Longlining
- Traps & Pots
- Gillnetting
- Hook & Lining
- Purse Seining
- Trawling & Dragging
- Dredging
- Harpooning
- Trolling

**Option 3:** Watch Monterey Bay http://www.seafoodwatch.org/ocean-issues/fishing-and-farming-methods to

## Part III: Fishing Methods: How many fish are in the ocean?

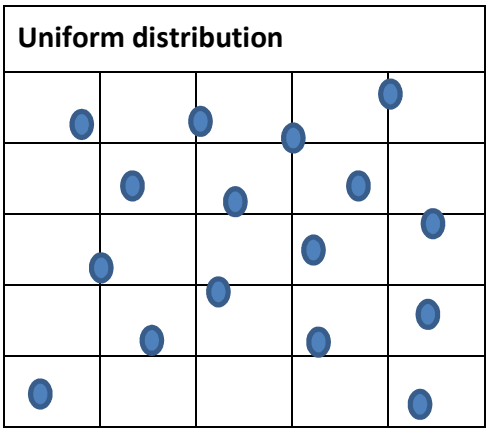
Grab your fishing gear and take your class fishing with a mock scientific survey. Students will be faced with the challenges of trying to count fish in the ocean, learn how fishery scientists use basic math skills and simple statistics to estimate the abundance of fish populations. (Setup for the "One fish, two fish, GO fish" activity grid must happen before the program begins)

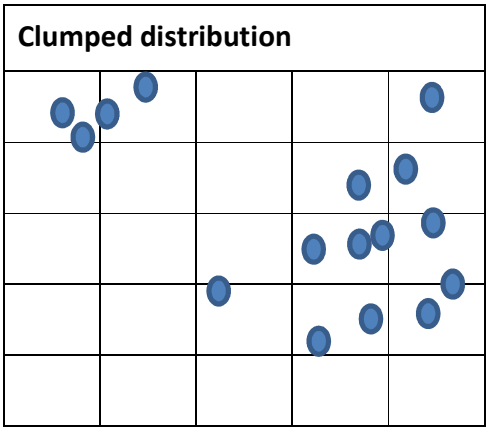
**One fish, two fish, GO Fish Activity**

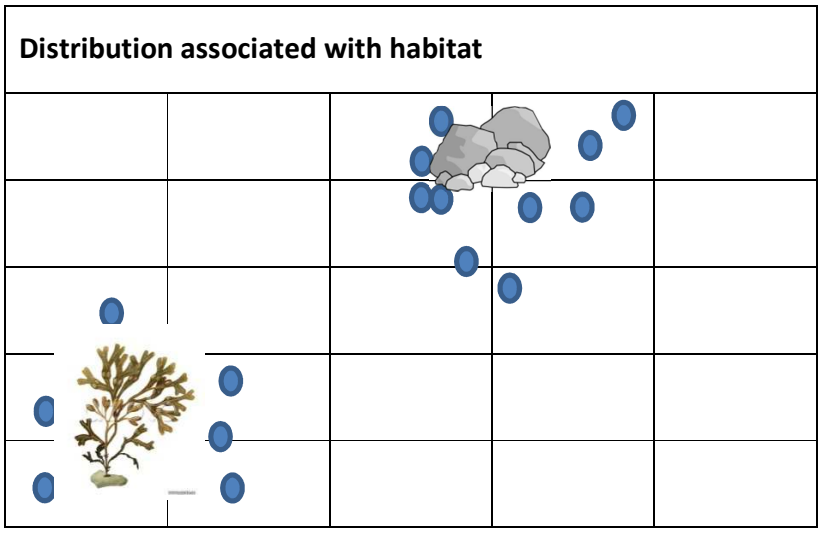
1) **Ask Students**, What challenges would you have in trying to determine where to catch fish and how many fish are in the waters? How are we to determine how many fish we should catch? What method is best to catch the fish? What method minimizes the impact on the environment? How can we create a sustainable fishery?
2) **Challenges include:**
   - The ocean is huge! – it covers about 70 % of the Earth
   - Much of the ocean is dark
   - Some parts of the ocean are very COLD
   - Fish are always moving around
   - Waters are murky and filled with plankton blooms
3) **Introduce** the idea that populations can be estimated without counting every fish. How could we determine the amount of fish in the sea? Fisheries scientists use samples.
4) **THE GAME**: Organize students into pairs and assign the following roles of captain and fish sampler. Students will need the "One fish, two fish, GO fish" student worksheet and a pencil to record data.
   - **Determine student roles** in each group (Captain, Fish Sampler**)**
     **Role of Captain**: oversees operations and determines where to sample using random sample method (tossing beanbag)
     **Role of Fish Sampler**: Will collect sample from grid and record data
   - **Pick which fishing method** you will describe first out of the 4 different options described below (Recreational, Purse Seine Net Fishing, Pelagic Long line, or Demersal Trawling or Dragging)

| | |
|---|---|
| **Recreational Fishing: (minimal bycatch fatality with catch and release)**<br>Catch Yellow – stripers<br>Bycatch Red – juvenile stripers<br>Bycatch Green – bluefish<br>Bycatch Orange – rockfish<br>Bycatch Purple – sea robin | **Purse Seine Net Fishing: (significant bycatch fatality)**<br>Catch Yellow – tuna<br>Bycatch Red – juvenile tuna<br>Bycatch Green – turtles<br>Bycatch Orange – whales<br>Bycatch Purple – sharks |
| **Pelagic Long line: (significant bycatch fatality)**<br>Catch Yellow – tuna, swordfish, Patagonia toothfish<br>Bycatch Red – hake<br>Bycatch Green – seabirds<br>Bycatch Orange – sea turtles<br>Bycatch Purple – sharks | **Demersal Trawling or Dragging (significant bycatch fatality)**<br>Catch Yellow – shrimp, hake, sole, scallops<br>Bycatch Red – monkfish<br>Bycatch Green – seals<br>Bycatch Orange – turtles<br>Bycatch Purple – habitat destruction |

- **Set up** the appropriate percentage of "Catch" to "Bycatch" units with **33% Catch / 66% Bycatch** (do not tell students)
    - **Example**: 18 total pieces = 6 yellow pieces, 4 red pieces, 3 green pieces, 3 orange pieces, 2 purple pieces
- **Set up** the distribution method that will be used for the first round of the activity (Uniform distribution, Clumped Distribution, Distribution associated with habitat)




2) **Playing the game**: Have the captain in each group randomly toss their sampling gear (bean bag) onto the grid to find out which square to sample. Fish sampler will check under the grid and count the fish catch and the bycatch and record. Do this for 5 rounds and then take the average of catch to bycatch. Round 2 should be set up with clumped distribution. Round 3 should be set up with distribution associated with habitat.

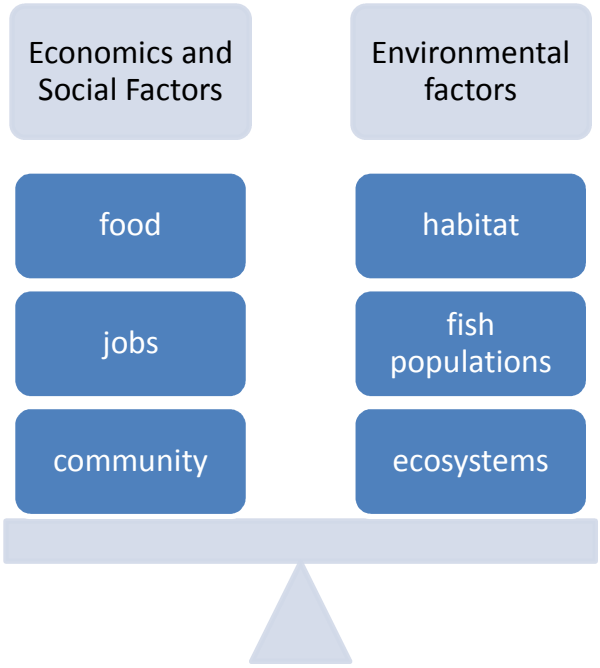
3) **Analysis**: Teams should total up there total catch and bycatch for the day. Compare results with other groups. Ask students to analyze and compare results using some of the following questions:

    - How did your results vary with another group?

- How did your results vary based on the distribution of the species?
- How did your results compare with the fishing method?
- What is the best method for reducing bycatch?

## Part III: Sustainability: Engineer a sustainable fishery

Now that we have done our research to understand fishing methods and some of the negative impacts, we understand that there is a delicate balance between the economic and social factors of fisheries as well as the environmental factors. It is your turn as a fishery engineer to create a net that targets a specific species with minimal impact on its local ecosystem. Review the different factors that explain why sustainable fisheries are a complex issue.




1. **Ask students** what are the important factors in creating net? (Mesh Size, Strength, Weight). Next bring out/show some examples of nets (Seine, Hand, Cast), Ask which fisheries do we think these nets are targeted for?
2. **Introduce** the goals of the challenge to catch the species (floating ping pong balls, rubber ducks, sinking marbles" in a tub of water.
3. Have the students then **brainstorm** how they are going to make their nets with simple recycled materials including string, water bottles, sticks, and mesh (not all need to be used)
4. Once they have created their design they will able to **test** it in the tub of water. **Ask the students** did your method design target the specific species? Did you catch anything you didn't want? Did you catch too much for that species to repopulate?
5. In the next sequence we will double each species in the tub to show importance of a sustainable ecosystem. Ask students what will happen if we went out and caught everything in the tub? Would there be anything left?

6. **Modify**: Conclude with what you can do to make your method better. What are ways you can reduce bycatch or unwanted species?

**Extension Activities:**

1) Play **Rate Your Plate** Monterey Bay Aquarium Seafood Watch Curriculum
2) **Watch TED-Ed** http://ed.ted.com/on/8hq5SaLG "Can the Ocean keep up with the hunt?"
3) Using local menus from restaurants or your school cafeteria, and the Seafood Watch Pocket Guide, determine the sustainability of the menu and write a letter to offer better alternatives.
4) Visit local grocery stores and seafood markets and interview employees on how their products are caught. Are they caught sustainably? Recommend potential alternatives based on the Seafood Watch Pocket Guides.

**Resources:**

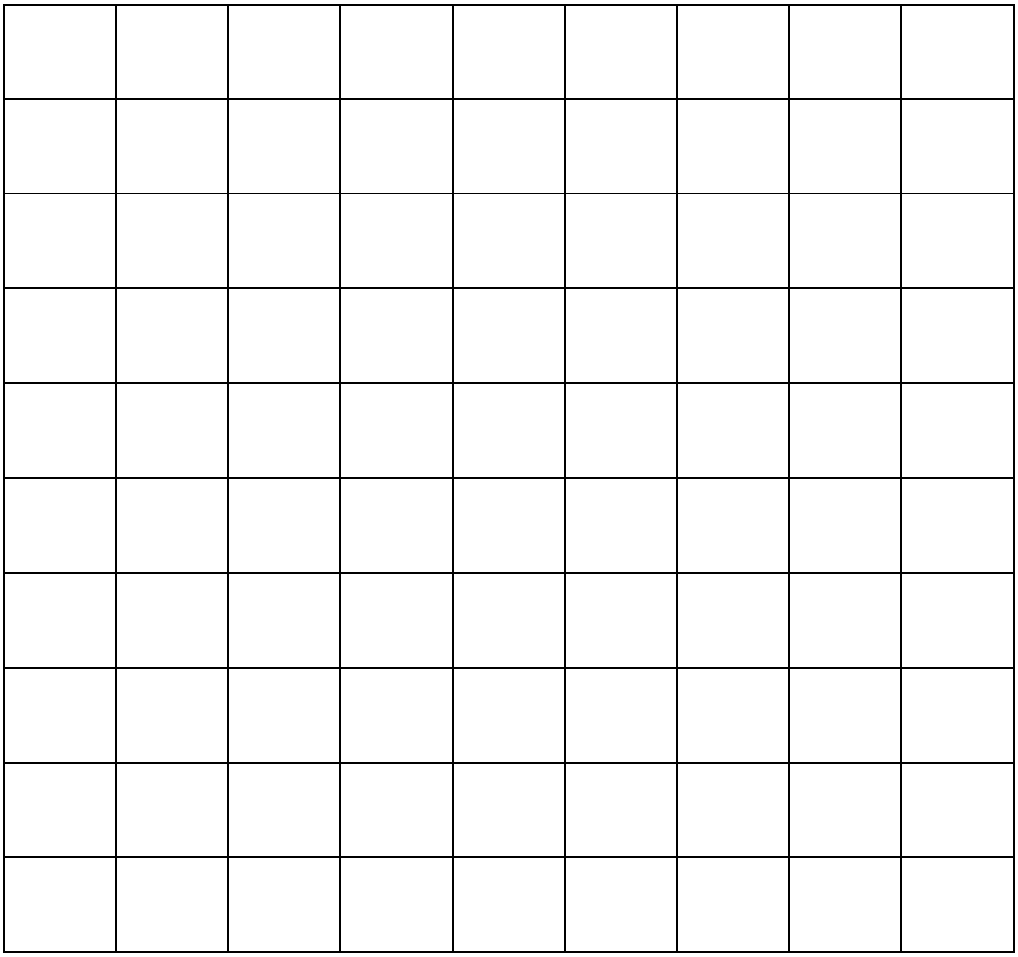
1. **European Fisheries Commission**-"Ending Overfishing Video" (https://www.youtube.com/watch?v=F6nwZUkBeas)
2. **Monterey Bay Seafood Watch-** Seafood Recommendations (http://www.seafoodwatch.org/seafood-recommendations)
3. **PBS/Empty Oceans-** Do you know what fish you are eating? (http://www.pbs.org/emptyoceans/educators/activities.html)
4. **NOAA Fisheries Alaska Fisheries Science Center** "Science Behind Sustainable Seafood" (http://www.afsc.noaa.gov/education/)

# Fish Frenzy

Student Sheet 1

| FISH FRENZY DATA | # of humans | # of resources |
|---|---|---|
| Round 1 | | |
| Round 2 | | |
| Round 3 | | |
| Round 4 | | |
| Round 5 | | |

## FISH FRENZY GRAPH



y-axis label _____

x-axis label _____

# One fish, two fish, GO fish!

**Student Sheet 2**

| | |
|---|---|
| **VESSEL NAME** | |
| **CAPTAIN** | |
| **FISH SAMPLER** | |

## UNIFORM DISTRIBUTION POPULATION SAMPLE

| SAMPLE LOCATION | CATCH | BYCATCH |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | Average : | Average: |

## CLUMPED DISTRIBUTION POPULATION SAMPLE

| SAMPLE LOCATION | CATCH | BYCATCH |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | Average : | Average: |

## DISTRIBUTION ASSOCIATED WITH HABITAT POPULATION SAMPLE

| SAMPLE LOCATION | CATCH | BYCATCH |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | Average : | Average: |