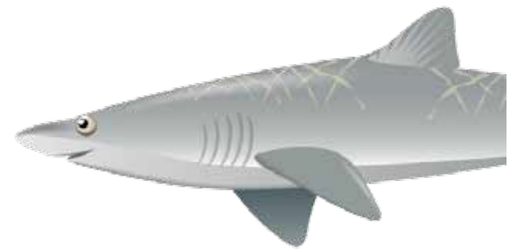
Mark-Recapture Activity Sheet

Name: Teacher Guide

Date: ____________________

1. Gather the following materials:
    - Original and Colored Goldfish crackers
    - Paper bag or small bowl (ocean)
    - Paper plate
    - Paper cup (net)

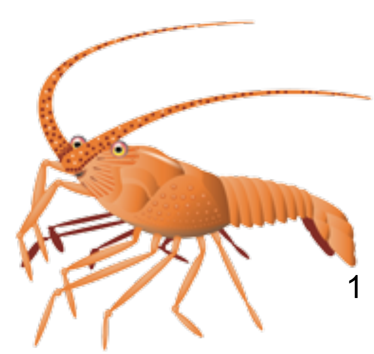


2. Place Original Goldfish in the paper bag or small bowl.
3. How many fish do you think are in your population? Look for students to make effort in their guesses, or base their guess on prior knowledge.
4. **Capture a sample** of goldfish from the brown bag (one cup full), and place them on the paper plate to count. Record this number of fish captured on your data table (represented as **M**).
5. Tag/mark these captured fish by replacing each one with a colored fish (marked individuals). *(Since in this lesson we are tagging by replacement, the goldfish replaced by colored fish can no longer count as part of the population and MUST be discarded or eaten)*
6. Put the colored (marked) fish back into the bag and shake the bag (or stir the fish in the bowl) to distribute them.
7. **Recapture** another sample from the bag using the cup and pour onto the plate.
8. Record the number of color and non-color fish in the appropriate columns. Return the entire sample to the bag.
9. Shake the bag to distribute them.
10. Repeat steps 7-9 two or more times. (The first capture (**M**) remains constant for all samples.)
11. This Population Proportion allows you to estimate the total fish in the population **(N)** for each sampling. Fill in the column on your data table that solves for N (N = C x M/R).

$$\frac{\mathbf{N}\ \text{(Total Fish in Population)}}{\mathbf{M}\ \text{(Total Marked Fish)}} = \frac{\mathbf{C}\ \text{(Total Fish Captured in Sample)}}{\mathbf{R}\ \text{(Marked Fish Recaptured in Sample)}}$$

12. Calculate the average of your population estimations (average of N).

13. Finally, count the actual number of fish in the population (marked fish included!) and record it on your data table.



DATA TABLE

Original number of fish marked (M): ______________ This is the number of orange crackers they replaced with colored crackers. For example, 20

Sample Time	Number of fish captured in sample (C)	Number of marked fish recaptured in sample (R)	Write the Population Calculation N = C x M / R	Estimated Population (N)
1	The number caught after the initial marking. 22	5	N = 22 x 20 / 5	88
2	18	4	N = 18 x 20 / 4	90
3	25	7	N = 25 x 20 / 7	72
4	23	5	N = 23 x 20 / 5	92
5	30	8	N = 30 x 20 / 8	75
			Average of X:	84

Count of Total in Actual Population: ______________ The number counted after the trials are finished.

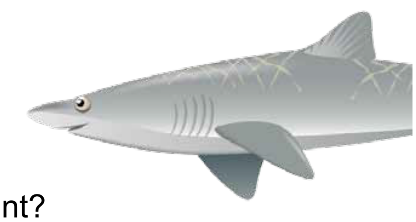
NOTE since we are estimating the number of fish, we have rounded up for all decimal estimates over 0 (for example 71.4 rounds up to 72). You might want to have your students round according to their current mathematical lessons. This is also an opportunity to discuss why we round numbers and what is meaningful (for example, you cannot have a population of 71.4 fish).

Specialized Selective Nets

Name: ____________________

Using the same materials as above plus Cheese-Its, create a model of a specialized net!

1. Replace one-fourth of the gold fish with Cheese-Its. The goldfish are now the juvenile fish and the Cheese-Its are the larger, more mature fish.
2. Gently shake the bag (or stir the contents of the bowl) to insure randomness.
3. Cut two dime sized holes in the bottom of the paper cup (net). The holes should be large enough to enable the smaller fish to slip through but not so large as to allow the larger fish to escape.
4. Capture a sample of fish from the bag (ocean) using the net (cup). Shake gently to allow the smaller fish to slip through.
5. Repeat as needed.



Activity Questions:

1. How do your population estimates (N) compare to the actual population count?

Look for students to compare their estimates and their average estimate to the actual count of the population. They should be able to say how far their estimate is from the actual population, if it is larger or smaller, and how close their trial estimates were from each other.

2. What may account for differences between your count and the actual population?

The population estimate is only an estimate. Students may report that some fish have a higher probability of being captured. Maybe the colored an orange fish were not mixed well each time. Maybe they tried to get the colored fish.

3. In step #13, you counted all of the fish in the bowl. How does this compare to real life (Hint: could you count all the fish in real life)?

When researchers estimate a real-life population, they cannot count every individual. Even in a census, which is supposed to count every single person, some people are missed. However, researchers do use trials like this to test methods and to test computer model programs. When you can try out a method and then compare it to a known value, it helps you to refine the method and to have an estimate of how accurate your method is.

4. How might calculations of population size assist scientists and fish regulators determine fish regulations and fish catch limits?

If you know how many fish are in a population, and you have some information about how fast the fish grow and reproduce, you can make more informed decisions about how many fish can be removed from the population before the population becomes too small to keep reproducing or being productive.

5. How do selective nets work?

Specialized nets are designed to catch only the species of interest. The net might have holes large enough to let small fishes through. Or, the net might have special devices that allow specific species to escape (like turtle exclusion devices).

6. Can a specialized net be successful in releasing smaller juvenile fish?

Yes. We saw that in our trials. The small fish got out, but the large ones stayed. This is similar to the way many Hawaiian fish ponds work; they allow small fish to go in and out, but large fish are trapped inside.

7. What are factors that may prevent the smaller fish from escaping?

Small fish may fit out the openings, but they may have a hard time finding the openings. This is especially true if the net is large (so the fish would have to swim very hard or very far to escape), and if the net is full of fish, the small fish might get trapped by all the other fish.

8. How might a device such as a specialized net be improved?

Scientists use engineering design principles to test and refine fishing gear to make it appropriately selective. The type of net material, the size of the net holes, the size of the net itself, the place where it is used, the length of time it is in the water, and the speed it is towed through the water all affect the net's ability to catch only the species the fishers want.

9. Why is it important to implement specialized nets?

It is important to use specialized nets so that bycatch (unintended species) are not caught. Bycatch can be wasteful by killing fishes that are not eaten. Bycatch can also result in killing young fish that have not had a chance to reproduce, old fishes that are key reproducers, and/or very rare fishes whose population is at risk.

10. Why is it important to sustain fish populations in terms of food chains and food webs?

Ecosystems are made of many species that each play a role in terms of energy acquisition and transfer. If some populations of fishes are depleted, there are trickle-down and trickle-up effects on other species (sometimes scientists call this a cascade effect). Often the impacts of over fishing are not completely known at the time, and often the effects are unexpected. For example, when herbivorous reef fish are overfished, algae can overgrow corals and have major detrimental impacts on the whole reef. Overfishing in the ocean can also affect birds and land animals. For example, tiger sharks prey on sea birds, which in turn prey on juvenile tunas. Overfishing of tiger sharks and result in less predation on sea birds, resulting in less tuna. It is important to try to understand food web connections, but it is also important to recognize that we may never fully understand the complicated relationships and that scientists and managers are often working off of their best available information and try to err on the side of not overfishing.