LESSON 2

POPULATION WAVES

Activity 3: Predicting Populations

Students will estimate sturgeon populations using beans to understand how harvest quotas are set.

Activity Preparation

Prepare a set of four cups (year one, year two, marked, and replaced) for each group. Be sure to label each cup or use different colored cups.

The "first-year" cups should contain 100 black or brown beans.

The "second-year" cups contain 200 black or brown beans.

(Or 75 black or brown beans, or 50 black or brown beans for differentiated instruction – see note.)

The "marked" cups contain 50 white beans.

The "replaced" cups are empty.

Note: There is not a cup for "recaptured." This number is simply recorded on the data sheet.

Note: If differentiated instruction is desired for some groups, the number of starting beans in the year-two cup would be reduced to 50 beans (half the original population rather than double the original population) to reduce the activity time. Alternatively, the number of starting beans in the year-two cup could be altered to 75 beans to create a more complex ratio than the original one-to-two ratio. Additionally, providing different year-two starting populations across the groups could support a more robust discussion about how availability of resources impacts population size.

About Mark and Recapture

How do you count the number of fish in a population? You can't catch them all, so you need to estimate how many are out there. One common way is a mark and recapture study. A scientist will catch fish in an area and then mark them. The mark can be a fish clip, a color under the skin, or a tag. The fish are then released back into the system. Fish are then captured again at a set interval. The number of marked fish and unmarked fish are counted. That ratio can be used to estimate the whole size of the population. It is an estimate, but it is useful.

Pre-Reading

Have students read Chapter 4: Sturgeon by the Numbers in "Saving Our Sturgeon," p. 38 to 58.

Objectives

After participating in this activity, students can:

Estimate population size using the mark and recapture methodology and conceptual framework.

Next Generation Science Standards

Covered

NGSSMS-LS2-1

Wisconsin Academic Standards

Covered

Science

SCI.SEP4.m, SCI.SEP5.m, MS-LS2-1

Mathematics

M.6.RP. A.1, M.7.SP. A.1, M.7.SP. A.2

Great Lakes Literacy Principles

Principle 6

The Great Lakes and humans in their watersheds are inextricably interconnected.

Principle 8

The Great Lakes are socially, economically, and environmentally significant to the region, the nation, and the planet.

Prior Knowledge

Government regulations (harvest caps) determine the number and physical size of a particular fish species that may be harvested from a specified location.

How to calculate a ratio.

Key Vocabulary

Abundance estimates: the estimate of the number of fish in a given area.

Harvest cap: a limit on the total allowable number of fish that can be caught in a specific population or area.

Juvenile: a young fish similar to an adult in form but not yet sexually mature.

Mark and recapture: a technique used to estimate the size of a population by marking individuals, releasing them back into the environment, and resampling.

Files Needed

- Predicting Populations Datasheet (handout)
- Winnebago System Sturgeon Spearing Datasheet (handout)

Materials Needed

- Black or brown beans and white beans
- Cups
- Paper plates
- Spoons

Activity Steps

Total estimated activity time – 60 minutes

Explain why scientists might use mark and recapture techniques to estimate population size prior to harvest cap setting.

Split students into groups, providing each with a printed handout, a year-one cup of 100 brown or black beans and two extra cups (one labeled "marked" and the other labeled "replaced"), a spoon, and paper plate. After students complete their year-one calculations, bring the students back together.

Set up for year two by telling the students that the researchers are doing another population estimate the following year. Distribute year-two cups to each group. Have students repeat the exercise using the year-two cups.

If the year-two population size varied across the groups (i.e., not all groups started with the same number of beans in their cups), then facilitate a discussion of how resource availability may affect population. For some geographic areas the conditions are favorable, and the population expanded; while in other geographic areas the conditions were less favorable, and the population declined.

Have students write their year-one and year-two population estimates, their year-one to year-two ratios, and their harvest regulations on the board. Discuss.

Share with the students that the Wisconsin Department of Natural Resources uses a similar process of mark and recapture when estimating sturgeon populations and considering annual harvest regulations. Teacher can refer to and share elements of the annual Winnebago System Sturgeon Spearing Final Harvest Report. (Note the harvest report does not indicate how many of the fish were previously marked and recaptured.)

Some overview elements of an annual report to share with students:

- The Winnebago System is divided into two main geographic areas: Lake Winnebago and Upriver Lakes.
  - **a.** Lake Winnebago is further divided into six areas.
  - **b.** The three Upriver Lakes are Lake Butte de Morts, Lake Poygan, and Lake Winneconne.
- Ask student why they think the Wisconsin Department of Natural Resources would subdivide the Winnebago System into smaller geographic areas when reporting sturgeon spearing harvest information.

Share the following information from the 2024 Winnebago System Sturgeon Spearing Final Harvest Report (or update with information from the most current year).

1. The harvest caps for the 2024 spearing season were determined using the 2023 abundance estimates for the Lake Winnebago system lake sturgeon population (about 24,000 males and 16,099 adult females). The 2024 system-wide harvest caps were 350 juvenile females (<55"), 805 adult females (>55"), and 1,242 males.
2. Ask students to calculate (for 2024) the a) percent of estimated 2023 male populations; b) percent of estimated 2023 female population that could be harvested as juvenile females; and c) percent of the estimated 2023 female population that could be harvested as adult females. Correct calculations are:
   - **a.** (1,242/24,000) x 100 = 5.175 or about 5%.
   - **b.** (350/16,099) x 100 = 2.174 or about 2%.
   - **c.** 805/16,099) x 100) = 5.00 or about 5%.
3. Ask the students why they think the harvest cap percentages may differ for various sexes and age groups and how their harvest compare to those set by Wisconsin DNR.
4. Share the 2024 (or current year) actual harvest data for males, juvenile females, and adult females. (See the Lake Sturgeon Harvest for Lake Winnebago and Upriver Lakes.) Ask students to compare the number of total sturgeon that were actually harvested that year to the harvest cap.

2024 Actual Harvest Data For Juvenile Females, Adult Females, and Males

Juvenile Female

- Harvest Cap: 350
- Actual Caught: 136

Adult Female

- Harvest Cap: 805
- Actual Caught: 71

Male

- Harvest Cap: 1,242
- Actual Caught: 225

Ask students: What factors may have led to the harvest cap not being reached that year? Also, discuss with the students the appropriate harvest limit for the current year, reminding them to reflect on the 2024 harvest caps and use their collective data obtained through the mark-recapture activity.

Optional Extension

The Predicting Populations activity serves as a model of a sturgeon population. It represents a sturgeon population at a single point in time and does not account for sturgeon births or deaths.

In the real world, estimating sturgeon populations is more complicated. The actual population of sturgeon is constantly changing. When there are plenty of resources, more adult sturgeon are likely to survive. More eggs are likely to be released, and more juveniles are also likely to survive. When conditions deteriorate (e.g., from pollution, habitat loss, disease, or overfishing), more sturgeon are likely to die.

Furthermore, the activity models a sturgeon population within a given area, assuming no sturgeon are swimming into the area and no sturgeon are swimming out of the area. In the real world, sturgeon are moving about constantly. Thus, determining the exact parameters of the measurement area (both area and location) is extremely important when conducting a mark-recapture population estimate.

Furthermore, the activity does not account for conditions, such as ice thickness and water clarity, that may influence the ability to capture sturgeon.

The Challenge for This Optional Extension

Students design a modification (or series of modifications) to the above activity that could incorporate one, or more, of the above real-world considerations into the model. Explain the modifications you made and how these modifications might result in a more realistic population count.

An example: To represent the impact of poor water quality, perhaps modify the activity so the individual taking the sample from the cup is blindfolded prior to removing the sample.