Taking Stock

OBJECTIVES: Students will be able to:

- describe two ways in which a fish population increases and three ways in which a fish population decreases
- provide three reasons why managing fisheries is a controversial and challenging job that is influenced by economic, environmental, and social factors
- relate that managing fisheries is necessary for a sustained harvest
- recognize the limitations of a fisheries model

METHOD: Students will study and take part in a model of the factors affecting fishery populations in Lake Michigan, a resource held in common by all citizens. Through a game they will investigate how decisions by commercial fishermen, recreational anglers, fisheries biologists, and lawmakers influence and are influenced by economics and by the abundance and scarcity of fish.

MATERIALS: For each group of six students:

1) Two open-top containers (large bowls, shoeboxes, or Tupperware®)
2) 1-lb bag of dried pinto or small kidney beans—you'll measure out and divide 500 ml (2 cups)
3) One graduated cylinder (250 ml or larger)
4) Four measuring spoon sets
5) Four cups
6) One piece of paper rolled into a cone or a large funnel

See Appendix I for Balancing Act Game materials: Fishery Factor Cards, Balancing Act Roles with data charts, and Balancing Act Student Instructions.

SETTING: Indoors

DURATION: Two or three 45-minute periods

VOCABULARY: Hatchery, harvest, regulations, moratorium, Tragedy of the Commons

STANDARDS:
Science: A 8.6, 8.7, 12.3, 12.5; B 8.6; F 8.8, 8.10, 12.7, 12.8; G 8.2, 8.7.
Environmental Education: A 8.4, 8.5, 12.3, 12.4; B 8.10, 8.15, 8.16, 8.17, 8.22, 8.23, 12.2, 12.9, 12.10, 12.11, 12.12, 12.19; D 8.1, 12.1.
Social Studies: A 8.11, 12.4.

BACKGROUND: On average, Wisconsin state fish hatcheries raise 3,500,000 walleye, 5,280,000 trout, 1,830,000 salmon, 140,000 muskellunge, 350,000 largemouth bass, and 50,000 northern pike every year. Yet, stocking occurs in less than 10% of Wisconsin's lakes and streams. Most Wisconsin waters support excellent fish populations without the aid of stocking, so management focuses more on habitat protection, regulation, and restoration. Still, stocking is vital to the survival of certain species of fish in Wisconsin, like salmon and certain trout, and is an important way of increasing fishing opportunities.

Stocking decisions, like decisions on fishing regulations, are almost always a contentious topic for citizens, scientists, commercial fishermen, lawmakers, and recreational anglers alike. These groups all want the same thing—sustainable populations of commercial and recreational fish species, yet they have different ideas about how this should be accomplished. The balance between environmental supply and social demand is not an easy one to obtain. The balance is even more challenging to achieve when events like floods, more efficient commercial harvesting gear, or loss of habitat reduce supply but not demand. The tough choices arising from these various factors are at the heart of current fisheries management.

OPENING: Have students read the **Taking Stock** section of the booklet. Have students answer the questions in their booklets about the Bottle Model. Discuss their answers as a group. Let them know that the rest of the activity will be based on this model.

MAIN ACTIVITY: Explain to students that they are going to play a game, Balancing Act, the goal of which is to maintain a fishery that is stable enough to keep everyone in business for at least 10 rounds. Pass the materials to groups of six to eight students. Make sure that each student gets a role card. Each group should have one lawmaker, one fisheries scientist, at least three commercial fishermen, and at least one angler. Clarify roles if students are confused.

The "fisheries biologist" will place 400 ml of beans in one of the containers and label it "lake." The beans in this container represent the stock of beanfish in the lake. The rest of the beans go in the second container, labeled

"extra." To make the harvest more realistic, each group's lake should be covered so that the harvesters cannot tell how many fish are in the lake.

The game is played in 10 rounds, with each round representing a year. In each round, the commercial fishermen and recreational anglers harvest from the lake, abiding by current harvesting laws. For the first round, commercial fishermen are allowed to scoop three tablespoons of beans into their cup. The recreational anglers, who each represent 25 people, are allowed to take two tablespoons. These harvesting levels will change in subsequent rounds.

At the end of the round, harvesters count their catch and the fish biologist calculates the amount of beanfish reproduction for that round and adds the appropriate quantity of beans to the lake. (For every one ml remaining in the lake, the stock reproduces one ml). All students except the lawmaker record their actions for this round on their record sheets. Each bean harvested is worth $100 in the first round. Once recorded, the harvests are emptied into the "extra" bin.

After the first round, the effects of supply and demand enter the game. If fewer than 150 beans are caught commercially, then the price per fish rises to $110. If more than 210 beans are caught commercially, the price per fish falls to $90. Knowing this, all harvesters and the fish biologist make verbal recommendations to the lawmaker as to the type and extent of regulations they feel should be in place in the upcoming year. The lawmaker records everyone's recommendations on the lawmaker's record sheet. Based on the recommendations, lawmakers make laws that must be followed by all of the harvesters in the next round.

The round ends with the lawmaker drawing a Fishery Factor card that introduces additional and unexpected occurrences. If the instructions on the card conflict with the lawmaker's decision, the instructions on the card override the lawmaker's decision. Otherwise, both card instructions and laws apply. Repeat for 10 rounds.

Special reminders: Students must keep their roles in mind when making recommendations, and commercial fishermen must make $6,000 each round to stay in business. Broken beans do not count toward the total—they are under legal harvest size. Any beans that fall off the spoon during harvesting go back into the lake and do not count. To make sure the harvesters are recording their catch accurately, fish biologists may count any person's harvest at any time. Anyone who has counted half beans or has more beans than he or she recorded is fined $1,000. If anglers have trouble calculating the percentage of anglers who caught more than one beanfish, offer them this formula: Percentage of anglers who caught more than one fish = (# of beanfish caught - 25) x 4.

CLOSING: After 10 rounds, have the students answer the follow-up questions for **Balancing Act** in their booklets.

ASSESSMENT QUESTIONS: How are introduction stocking and rehabilitation stocking different? Provide an example of when and why each might be used. What are the ways in which a lake may be depleted of fish?

ANSWERS: Introduction stocking puts a species of fish in a waterbody that had never held that species before. Example: putting bass in a new pond or putting muskellunge in southern Wisconsin lakes. Rehabilitation stocking follows an event such as overfishing or winterkill to bring a species back into a waterbody after it has disappeared. Example: stocking lake sturgeon in many of Wisconsin's rivers and lakes. Depletion (refer to Bottle Model): harvest pressure, natural mortality, habitat loss or competition with invasives, poor water quality.

EXTENSIONS:

In Depth: Have students graph the data they collect to investigate the following question: Does looking at harvest data really tell you how a species is doing?

Students can further explore the Tragedy of the Commons as it relates to sustainable fish harvests online, in "The Fish Game," **sustainabilityed.org/games**.

Field: Have your class visit one of Wisconsin's state fish hatcheries. Look for locations and visitation hours on the DNR's Website.

If you have downloaded this booklet, please see the appendix that follows for additional materials.

Taking Stock

In the first scenario of this booklet, you were asked to think about what factors might determine whether or not to stock walleye and yellow perch in Linnie Lake. These decisions are actually a part of the job description of DNR fisheries biologists who manage this resource for the common good (more about that later.) The DNR uses science to determine what goes into (stocking quotas) and comes out of (bag limits) Wisconsin's lakes.

Fish Nurseries

Hatchery
a place where eggs are hatched

Nature provides the best fish **hatchery** (a place where eggs are hatched) and stocking program. In a healthy aquatic ecosystem, all of the elements are in place for a productive fishery: the eggs hatch on their own and fish grow to normal adult sizes in healthy numbers. Not all of our lakes and streams, however, have healthy fisheries. In some instances, we need to supplement and enhance fisheries through artificial hatcheries and wild releases (stocking programs) in order to provide anglers with fish to catch or to reintroduce species after a habitat has been restored. Wisconsin has been stocking hatchery-raised fish since the late 1800s. Today, anglers help fund state-operated hatcheries through license sales, trout and salmon stamps, and taxes on fishing tackle, boats and boat fuel.

Many egg collection facilities, hatcheries, and fish rearing stations are open to the public for tours during certain times of the year. Check the Website for information on locations, hours and visitation policies, **dnr.wi.gov/fish/hatchery/hatcheries**.

Who pays? You do!

Anglers fund a large share of the fisheries habitat work the DNR does through the Sport Fish Restoration (SFR) fund. This fund is generated by a 10% federal tax collected on fishing gear, tackle, baits, motors, and motor boat fuel. The tax money is divided among states for education programs, fisheries habitat work, stocking, and fishing access development. Each state's share of funding is based in part on how much water a state has and how many licenses are sold. Wisconsin is near the top in both categories! Anglers also support fisheries programs through the purchase of licenses and stamps, which you'll learn more about later.

Wisconsin Fish Hatcheries

Wild Rose State Fish Hatchery opened an education center in 2008 as part of a three-phase renovation project.

When stocking a waterbody, a biologist has to consider more than just the physiology and habitat requirements of a species of fish. Ecological balance, cost, and angler needs are also important considerations. Biologists stock a waterbody for one or a combination of the following reasons:

1. **Rehabilitation stocking.** Rehabilitation stocking is a top priority for biologists. In this type of stocking, biologists reintroduce a species of fish that used to exist in a waterbody, but that was extirpated or became too scarce to effectively reproduce. This method of stocking usually follows a catastrophic natural event like a winterkill, disease, or dam failure. It can also follow human-caused events like overfishing or chemical spills. The species is re-introduced to the waterbody with the goal that it will soon become a self-sustaining population again. The DNR is currently using rehabilitation stocking to return lake sturgeon to many rivers and lakes in Wisconsin.

2. **Research and Evaluation stocking.** In this type of high-priority stocking, biologists experiment with putting different species or sizes of fish in a waterbody to determine the most cost-effective or most successful way to manage the lake. For example, biologists are experimenting with stocking small walleye fingerlings (young fish) instead of large walleye fingerlings to see which size is more likely to survive.

3. **Recreation stocking.** Recreation stocking either creates or maintains a fishing opportunity that did not previously exist. A wide array and volume of fish are stocked in urban waters, for example, to provide local residents with the opportunity to fish. If these waters were not stocked, limits on the number of fish caught would have to be lower. Coho and Chinook salmon are stocked in the Great Lakes partly to provide a recreational fishery.

4. **Remediation stocking.** Sometimes an event extirpates or severely lowers a fish population, such as the loss of spawning habitat or the invasion of an exotic species. If the event that caused the problem cannot be readily fixed, the DNR will use remediation stocking to maintain a species of fish that is ecologically or recreationally valuable. For example, the draining of wetlands has greatly reduced northern pike spawning habitat in some areas of Wisconsin. The northern pike are necessary to maintain a predator/prey balance in many inland lakes. Even if the drained wetlands will not be restored, the DNR will continue to stock northern pike as a last resort to maintain a fishery. The stocking of once-abundant lake trout along the offshore reefs of Lake Michigan is also an example of remediation stocking.

Photo: Alisa Santiesteban, July 2009.

Wisconsin DNR Fisheries technician Tom Burzynski stocks young lake sturgeon into the Milwaukee River, a tributary of Lake Michigan, below the Thiensville Dam. The sturgeon were raised at a streamside rearing facility, located at Riveredge Nature Center in Newburg, Wisc. Learn more about this exciting rehabilitation project and take a tour of the facility on the DNR's Website: **dnr.wi.gov/fish/lakemich/LakeSturgeon**.

5. **Introduction stocking.** When a fish is placed in a newly created waterbody, like a small pond or reservoir, or when a species is put in a waterbody it has not previously inhabited, the DNR has conducted an introduction stocking. The DNR generally discourages introductions unless done on a new pond or reservoir where the species could soon develop a self-sustaining population. Stocking of muskellunge into southern Wisconsin lakes to expand musky range could be considered introduction stocking, because it is unlikely muskies occurred in these lakes prior to European settlement.

Moratorium
a period of time when a certain activity is not allowed

Managing the Commons

Fish, like air and water, are resources held in common by all citizens. In other words, no one person owns them, but all share them. The "tragedy of the commons, "a phrase coined by Garrett Hardin in 1968, refers to unsustainable rates of use or abuse of a resource held in common. Fisheries biologists attempt to manage the commons by considering how many fish anglers and commercial fishermen should be allowed to harvest (keep) from Wisconsin's waters to ensure a fair, equitable and sustainable distribution of the resource.

Sustainable Harvest Rates

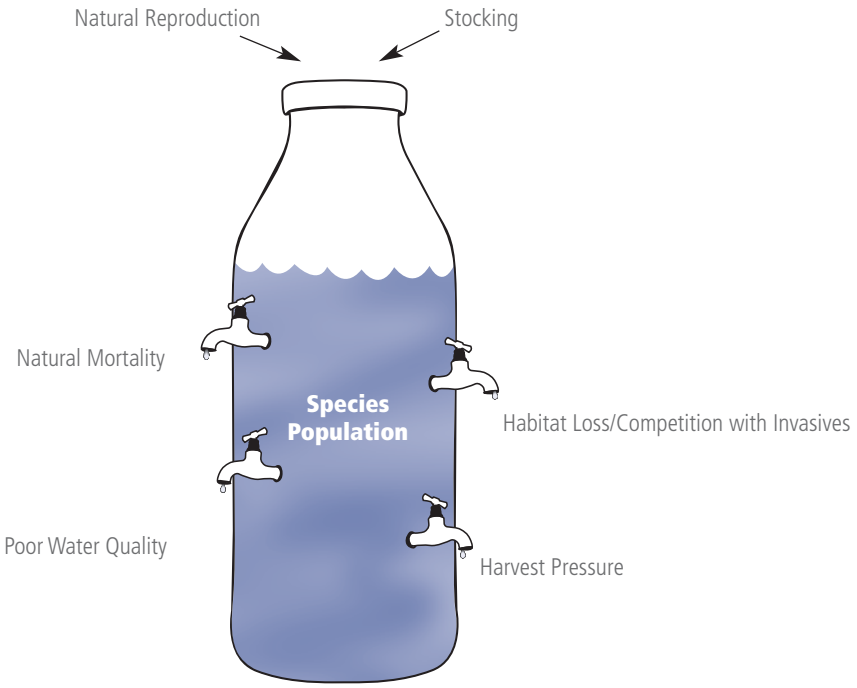
Imagine if every single angler and commercial fishermen were able to harvest as many fish as they wanted, regardless of species. Overfishing, especially on smaller lakes and with popular fish, could rapidly eliminate certain fish populations. Historically, many species of fish suffered because of overharvest. To sustain our diverse fish populations, and the ecosystems they are a part of, the DNR makes. Although some lakes, regions, and fish have special **regulations**, in general the DNR defines how many fish of a certain species you may catch in one day from all waters as the "total daily bag limit."

Occasionally fisheries managers may recommend a **moratorium** (a period of time when a certain activity is not allowed) on fishing for a certain species of fish in a certain lake to allow its population to grow. Whether fish managers are restoring streams, putting fish in the water, or regulating how you take them out, they have a fascinating job that mixes science and policy to help create a sustainable fishery.

The Dam Problem

Dams have had an enormous effect on stream habitats; about 3,700 were built in Wisconsin to grind flour, saw lumber, and power other early Wisconsin industries. Dams **fragmented** (divided) fish communities and blocked fish movement essential for reproduction during spawning time. Paddlefish, sturgeon, and other river species that swim upstream to spawn declined in population, partly as a result of dam construction. Dams also created stagnant millponds that became clogged with algae. To remedy some of these problems, Wisconsin has been leading the nation in dam removal. As of 2008, about 100 dams have been removed. Dam removal projects are major community efforts the DNR supports. Once a community removes a dam, it is rewarded with a return of cool sparkling waters and native catchable fish.

Bottle Model



Look at the Bottle Model diagram above. This model represents the interaction among ways in which species are removed from and added back to Lake Michigan.

1) Explain what you think the model illustrates about the factors that bring fish into the lake and that take fish out of the lake.

Students should recognize that there are only a few supplies of fish and many demands.

2) Describe an event that could make one faucet flow faster, and name the affected faucet.

An example could be a heat wave which depletes the oxygen in the lake and increases natural mortality. Many other answers are possible.

INSTRUCTORS: Underlined content is not provided in student manual.

3) If the event you described above did happen, what would happen to the population level in the bottle? Would the population be able to return to its original level after the event? How?

The population would drop. It might recover if temperatures returned to normal and other pressures were reduced until the fish had time to recover.

Balancing Act

Your teacher will provide you with instructions to play a game that illustrates the way that people, fish populations, and laws interact and influence each other. In the game, you will represent some of the people—lawmaker, scientist, anglers, and commercial fishermen—who influence and are affected by fisheries regulations. You can play a similar on-line version, The Fish Game, by the Cloud Institute, that demonstrates how individual actions affect a resource held in common, **sustainabilityed.org/games/**.

After you have played 10 rounds of Balancing Act, answer the following questions.

PLEASE SEE APPENDIX I
Taking Stock: Balancing Act Student Materials

1) Summarize the results of the game. What trends did you see in the beanfish population over time?

Depends on the group

2) Of the factors that increase and reduce species in the water, which can we control? Look back at the Bottle Model and record here the factors that people can control. Under each factor, provide an example of an action that you, or others, do or could do to decrease the flow of the faucet.

Humans can control harvest pressure and, to some extent, habitat loss/invasive competition and water quality.

Natural mortality is uncontrollable. Students should come up with many creative answers for how they can make a difference in the flow of the faucets.

3) What would happen to the fishery if commercial fishermen or anglers "cheated" on their fish counts when fisheries scientists weren't watching?

Cheating could lead to destruction of the fishery if enough people consistently under-reported their catch.

INSTRUCTORS: Underlined content is not provided in student manual.

4) Describe three events, actions, or decisions in the game that most influenced the health of your fishery.

Depends on the group.

5) List and explain three things that you would do differently if you were to play Balancing Act again. How do you believe these actions would affect the outcome of the game?

Depends on the group.

6) Because this was a game, or a model of a real-life process, there were many things that were not quite realistic. Even so, this game should have given you a good sense of the challenges, cooperation, and compromise involved in fisheries management. What other factors might influence populations and catches in real life that this model does not account for?

Climate and climate change, weather patterns, exotic species, more.

7) This game deals with a very real issue: the role of laws in fisheries management. Think about how laws or regulations affected the commercial fishermen and anglers in your game. How did the regulations affect the fish population? Write a persuasive paragraph to a classmate explaining whether or not you think we need laws, such as those you saw in the game, to manage fisheries. Use examples and evidence from the Bottle Model, the game, and any other knowledge you have to support your perspective.

Students should recognize that laws were necessary in regulating the actions of multiple user groups.

INSTRUCTORS: Underlined content is not provided in student manual.