CLASSROOM LESSONS
ABOUT
ECONOMICS AND THE ENVIRONMENT

FISH TALES

By Donald R. Wentworth and Kathryn Ratté

PERC—The Center for Free Market Environmentalism
Bozeman, Montana

. . .

PERC—the Center for Free Market Environmentalism—is a nationally recognized institute located in Bozeman, Montana. The organization's primary goal is to provide market solutions to environmental problems. PERC pioneered the approach known as free market environmentalism and conducts research in the areas of water, forestry, public lands, and endangered species, among others.

Free market environmentalism is based on several tenets: Private property rights encourage stewardship of resources; government subsidies often degrade the environment; market incentives encourage individuals to protect environmental quality; and polluters should be liable for the harm they cause others.

. . . . .

PERC

—The Center for Free Market Environmentalism—

502 South 19th Avenue, Suite 211 Bozeman, Montana 59718-6827
Phone: 406-587-9591 Fax: 406-586-7555
www.perc.org perc@perc.org

CONTENTS

ACKNOWLEDGMENTS

The authors appreciate the support of the M. J. Murdock Charitable Trust of Vancouver, Washington, in the preparation of this curriculum, *Fish Tales*. The content is largely based on work conducted by PERC researchers, especially PERC Senior Associate Donald R. Leal. We also appreciate the assistance of Jane S. Shaw, who edited the manuscript, Dianna Rienhart, who was in charge of production, and Mandy-Scott Bachelier, who designed the publication and artwork.

FISH TALES

Classroom Lessons about Economics and Environmental Protection

Once people truly grasp the fundamentals of scarcity, choice, and cost, and understand the crucial role of incentives in shaping behavior, these become embedded in their thinking. They. . . analyze issues (including environmental issues) in a different way.

— Marc A. Johnson, Economics Teacher
Smoky Hill High School, Cherry Creek School District, Colorado

The current state of fisheries along the Pacific coast, especially the northwestern United States and southern Canada, is troubling. Many fish populations are dwindling in number. Several, including chinook in the Central Valley of California and the upper Columbia and Snake River basins, have been listed as endangered by the U.S. government.

This booklet consists of two lessons (and an appendix) designed to help high school teachers address this key environmental controversy. The second lesson has multiple parts and can be used over a period of days or weeks. The activities begin by examining the decline in specific salmon, shellfish, and halibut fisheries that affect Northwest communities. Then they lead students to a broader focus using examples of fisheries deterioration—and recovery—worldwide. The lessons are formatted to be useful in a variety of disciplines, regardless of whether the teacher's emphasis is on understanding environmental problems, teaching economics, or debating contemporary issues.

Much disagreement exists about the causes of the salmon decline. Over time, various "villains" have been identified, from the system of dams on major rivers, to poor water quality blamed on logging and farming practices, to overfishing by commercial and tribal fishers. While any and all of these factors may have contributed to the problem, economists understand that they are not fundamental causes. The fundamental causes are found in the incentives created by the "rules of the game"—the laws, customs, and norms that form the framework in which decisions are made. Economic reasoning helps students, and the rest of us, understand how the rules affect individuals' decisions. More importantly, it helps us turn attention from finger-pointing to finding solutions.

Through the use of economic reasoning, these *Fish Tales* lessons help students analyze the problem of deteriorating fisheries. While these lessons offer no simple answers for saving the halibut or bringing back the salmon, they do lay a foundation upon which to begin building solutions that work for people and for fish.

HOW TO USE THESE LESSONS

Fish Tales uses economic reasoning to provide a framework for students to solve mysteries surrounding fisheries decline. The deductive reasoning process relies upon four major principles in economics:

FOUR MAJOR PRINCIPLES IN ECONOMICS

Choice: Scarcity forces people to choose.

Incentives: Incentives are the rewards or punishments that influence how people choose to use resources.

Property Rights: Property rights provide important incentives; people tend to take better care of things they own and value.

Voluntary Trade: Individuals trade only when both expect to be better off as a result of the exchange.

Students use these four principles to solve seven mysteries in Lesson 2. Environmental problems usually result from choices made by individuals and groups in light of the incentives they face. Because economics can predict how people tend to respond when choosing how to use scarce resources, the principles help explain the human behavior exhibited in each mystery situation.

Lesson 1 (and the section in this teacher background chapter, "Economic Reasoning: A Brief Primer") introduce the mental tools of economic analysis. While Lesson 1 and the primer are essential for students new to economic reasoning, they are also useful as a review to help economics students transfer their knowledge into the environmental context.

The Appendix provides an opportunity to "play" with the economic principles in a more lighthearted context. It can be a vehicle for teachers to informally assess what their students have learned.

ECONOMIC STANDARDS

Each of the following standards from the Voluntary National Content Standards in Economics developed by the National Council on Economic Education (www.economicsamerica.org) and the Foundation for Teaching Economics (www.fte.org) is addressed in one or more of the lessons:

Standard 1: Productive resources are limited. Therefore, people cannot have all the goods and services they want. As a result, they must choose some things and give up others. (Lessons 1 & 2)

Standard 3: Different methods can be used to allocate goods and services. People acting individually or collectively through government must choose which methods to use to allocate different kinds of goods and services. (Lessons 1 & 2)

Standard 4: People respond predictably to positive and negative incentives. (Lessons 1 & 2)

Standard 5: Voluntary exchange occurs only when all participating parties expect to gain. This is true for trade among individuals or organizations within a nation, and usually among individuals or organizations in different nations. (Lesson 2)

Standard 7: Markets exist when buyers and sellers interact. This interaction determines market prices and thereby allocates scarce goods and services. (Lesson 2)

Standard 10: Institutions evolve in market economies to help individuals and groups accomplish their goals. . . . A different kind of institution, clearly defined and enforced property rights, is essential to a market economy. (Lessons 1 & 2)

NAAEE GUIDELINES

In addition to meeting the Voluntary National Content Standards in Economics, the lessons address several of the Guidelines for Excellence developed by the North American Association for Environmental Education (NAAEE), whose web site is www.naaee.org. Taken as a whole, these lessons meet Key Characteristics 1, 3, and 6:

Characteristic 1: Fairness and Accuracy: Environmental education materials should be fair and accurate in describing environmental problems, issues, and conditions, and in reflecting the diversity of perspectives on them.

Characteristic 3: Usability. Environmental education materials should be well designed and easy to use.

Characteristic 6: Emphasis on Skills Building. Environmental education materials should build lifelong skills that enable learners to address environmental issues.

For more information see the North American Environmental Education Web site at www.naaee.org/npeee/materials.html.

ABOUT THE LESSONS

LESSON 1:

"All the Fish in the Sea" introduces students to economic reasoning and to "the tragedy of the commons," a concept economists find useful in explaining overuse of resources. Use or abuse of a resource, such as a fishery, that is owned by everyone ("in common") is a tragedy in the literary sense. Like the beloved Romeo and Juliet in Shakespeare's play, environmental commons are precious. People value environmental amenities highly, and they value the equal and open access they have to resources like fisheries. Unfortunately, that open access creates incentives that inevitably result in the valued resource being overused and abused, even when people intend no harm. More tragic is that those who put forth their best efforts to conserve and care for the resource find their efforts doomed—just as Romeo's and Juliet's efforts to transcend their families' feud was doomed. In literature it is often fate or fortune that causes the tragic outcome. In economics, as Lesson 1 teaches students, it is often the rules governing behavior that precipitate environmental tragedy.

When students learn about the tragedy of the commons, they begin to appreciate that solving environmental problems requires more than finding bad guys and punishing them. When rivers are overfished, grasslands overgrazed, or hillsides deforested, the cause is rarely immoral behavior. More commonly, the cause is institutional—a situation where the rules cause a tragedy of the commons that has created incentives for abuse. Because an understanding of the tragedy of the commons is key to sorting out so many environmental issues, teachers should use Lesson 1 with students before proceeding with the mystery activities in Lesson 2.

LESSON 2:

"Solving Economic Mysteries" enables students to practice seven economic reasoning and critical thinking exercises. For example, the first mystery, "Do You Always Hurt the One You Love?" asks: Why, given their reputation as lovers of the environment, are fishers along the Pacific Coast destroying the salmon they love and on which many depend for their financial well-being?

Small discussion groups are given a series of clues and assigned two tasks: to solve the mystery and to decide which clues are necessary to reach the solution. (All the clues are factually correct, so that students need not contend with inaccurate information or be suspicious of tricks.)

The second part of the critical thinking task—the selection of the necessary clues—sharpens the students' intellectual skills in using specific criteria to evaluate information. The criteria are given to them—the four economic reasoning principles. As they practice the mysteries, students learn that the useful clues are those that illustrate ***choice***, ***incentives***, ***property rights***, and ***voluntary trade***, the keys to understanding detrimental behavior toward the environment, to resolving environmental conflicts, and to solving environmental problems.

APPENDIX:

"Fishing the World's Oceans: The Problem / A Solution" incorporates the skills and content in lessons 1 and 2, using a creative drama in a regional competition. The play, a takeoff on Dr. Suess's *One Fish, Two Fish, Red Fish, Blue Fish,* illustrates economic reasoning applied to environmental policy. This play offers a refreshingly different and enjoyable opportunity to synthesize the key ideas from *Fish Tales*. It can be presented by the students—or merely read by the students or teacher.

SUMMARY

Each lesson contains background information for the teacher, including the solutions to the mysteries. All the information in the lessons is based on documented research, most of it done by PERC investigators. Where appropriate, data sources are noted at the end of the activity. Those wishing to continue researching the fisheries problem and proposed solutions may find it profitable to begin with the search box on the PERC web site at www.perc.org ("fisheries" and "homesteading" would be words to start with).

WHAT'S HAPPENING TO THE FISH?

Figuring out how to protect the fish populations in the waters of the Pacific Northwest of the United States and coastal British Columbia is a challenge. Solutions are elusive, but research does give us a pretty clear idea of what went wrong.

For years now, residents of this region have been seeing dramatic declines in many species of fish, salmon being most critical. The following chart illustrates the decline in chinook salmon along the Pacific coast, including Alaska, British Columbia, Washington, Oregon, and California.

Pacific Coast Salmon Are Declining

1980	22.4
1985	17.4
1990	17.0
1995	12.5
1999	6.6 (estimated)

Note: Commercial harvest of chinook salmon in millions of tons (includes British Columbia, Washington, Oregon, California).
Source: Pacific States Marine Fisheries Commission

To help salmon numbers recover, state and federal governments have adopted numerous policy changes, and billions of dollars have been spent in sometimes frantic restoration efforts. Recognizing that overfishing is a major problem, government managers have shortened salmon fishing seasons, reduced the allowable catch (the number of pounds that may be caught each year), and restricted fishing locations and types of gear. Many commercial fishers are out of business because of the new policies and declining salmon populations.

The salmon is not the only species that is dwindling in number. Other valuable fish, including ling cod, bocaccio, sea urchin, and shrimp, have experienced severe population declines in recent years.

The situation is discouraging and frustrating for everyone, because all parties want sustainable ocean resources. There is no environmental sociopath systematically killing these species and relishing in their decline! The explanation lies elsewhere.

WHAT HISTORY TELLS US

The historical record offers surprising insight. Native Americans managed and allocated the fish in what is now the Pacific Northwest prior to white settlement through a system of property rights that sustained fish populations. Accounts, passed from generation to generation among tribes in the northwestern United States and southwestern Canada, indicate that for centuries salmon runs were healthy and abundant. Records made by the Hudson's Bay Company beginning in the early eighteenth century confirm the large salmon populations. At times, fish were so plentiful that a person could walk on the backs of the fish to cross some streams and rivers. Some years the salmon runs were smaller than in other years, but they were always much larger than today.

The usual explanation for this long-ago abundance is that fishing pressure was low. The Native American population was small and their fishing tools were primitive and inefficient, the argument goes. Most of the migrating fish could just swim upstream and spawn without interference. Recent historians have argued that this explanation misrepresents reality. Native Ameri-

cans were sophisticated hunters and gatherers. They established fish traps, weirs, and nets to capture fish as they passed narrow areas in rivers and streams. Their ability to catch fish was so great that they could easily have overharvested the fish and destroyed the runs forever. But they didn't. How did they avoid overfishing?

The Native Americans in the Pacific Northwest employed a sophisticated mix of property rights and negotiated treaties that ensured the fish population would be sustainably used. Some fishing rights were held by tribes, some by individuals, and some by clans. A tribe might build a large weir—a system of rocks or posts that funneled the fish to a point where they could be more easily caught by individuals in their fishing spots using their own gear. Specific places in the weir were controlled by families. Rights to fish in these places were generally passed down from parent to child. These individuals and their families treated these places as their property. They invested long-term in the weir by repairing and improving it. They would not have done this work if they did not expect to receive benefits in the form of continuing annual opportunities to catch more salmon.

Tribes and clans avoided conflict most of the time through a strong tradition of property rights. These rights were enforced in several ways. In some cases, tribes might fight over the fishing sites; in other cases, an upstream tribe could simply toss a large log into the river to destroy the downstream fishing devices that were keeping salmon from reaching upstream.

Biologists have found evidence suggesting that this system of property rights and treaties led to an increase in the size and quantity of fish in the streams, as Native Americans harvested salmon selectively, allowing mature fish to move upstream to spawn. This investment in salmon husbandry would only take place if the tribes and families felt that their property rights to the fish and the fishing areas would be protected over time.

When the Canadian and U.S. governments took over management of the fish, a number of things changed. Dams were built, more fishing took place offshore, and water quality problems emerged. Changes in the property rights arrangements may have been the key underlying factor, however. The Native American system of property rights to fishing areas along the rivers and streams was gradually undermined. The fish and their habitat became a publicly owned commons. Everyone had access. No one could be restricted. The "tragedy of the commons" resulted.

This "tragedy of the commons," in which there was no way to protect property rights to the salmon, allowed dams to be built that stopped many salmon runs. Weirs, traps, and fishing wheels were abolished. Now, in place of the careful selection of salmon and the protection of future harvests, the mobile, aggressive harvesting of fish was rewarded. People in gas-powered boats with nets followed the fish into the ocean and large river areas, dramatically increasing the fish harvest and preventing fish from escaping.

LOOKING FOR SOLUTIONS

Fortunately, there is a way to reverse the tragedy of the commons. Establishing property rights in fisheries encourages cooperation, not competition, among fishers. It rewards behavior that improves the size and quality of the fish population. However, establishing property rights in

fisheries requires imaginative approaches. Unlike land, where property rights are easily defined, fish are mobile and migrate extensively.

Property rights solutions are an alternative to the unsuccessful approaches occasionally found in fisheries management. Today, governments limit fishing seasons, set rules on the gear that can be used, and limit the areas where fishing can occur. Such policies have encouraged fishers to work harder to get fish faster so they can maximize their take. The race for the fish because the harvest is up for grabs. This leads to wasteful investment in ultra-sophisticated equipment, to dangerous sea ventures (as in the movie *The Perfect Storm*), and failure to protect the resource.

One experiment, "individual transferable quotas," gives individual fishers a share, usually a percentage, of the total catch allowed in that fishery. Once fishers have ITQs (also known as IFQs or individual fishing quotas), they know how much fish they can catch and they can be confident that their share will not be taken by someone else. Iceland and New Zealand have had much success using this property rights approach.

One result with ITQs is that fishers go after fish at the most suitable times of year. Another is that fresh fish are available all year, not just during a short season. There is no race to fish. Because ITQs are tradeable, fishers can harvest their quota of fish, or they can buy more quota to catch more fish, or they can sell their quota and exit the fishery. The sum total of the quotas is an amount set for biological reasons to ensure sustainable harvests.

To summarize, current fisheries management practices have contributed to the decline in the fish population along the Pacific coast. Specifically, the decision to treat fish as a common property led to overfishing and poor water management. No matter how many resources, money, and habitat-enhancing practices are brought to bear on this problem, success will be limited unless the ownership issue is addressed. The current way that most coastal fisheries are managed rewards aggressive, premature fish catches while penalizing careful stewardship of the fish population.

Policy makers must consider creative forms of property rights to establish a better set of incentives. In particular, they should look "back to the future" and reuse systems established by Native Americans to protect and enhance fish populations. Those systems provided a better set of incentives, protected the fish as a species, and ensured an abundant supply of fish.

ECONOMIC REASONING: A BRIEF PRIMER

Students find it difficult to understand why overfishing by commercial and sport fishers would result in the extinction of a species of fish population. It makes little sense to them that a fisher, crabber, oyster harvester or shrimper would deliberately overharvest a fish population that supports his or her occupation. The *Fish Tales* lessons will help students solve that mystery and also examine ways that some communities have avoided or solved this problem.

The lessons rely on economic reasoning to examine the causes of the problems and to suggest successful solutions. Economic reasoning uses fundamental ideas from economics to guide the student's analysis. It proceeds from basic assumptions about human behavior—made credible by historical evidence—to describe and

even predict human behavior. Four key ideas underlie the analysis in these lessons:

Choice. Natural resources such as fish, human resources of time and talent, and capital resources like equipment and technology are scarce. This reality forces individuals and organizations to choose among alternatives. Analysis of environmental issues must begin by identifying the choices people make and investigating the consequences of those choices.

Incentives. Incentives are the rewards or punishments for behavior. They shape the costs and benefits of available alternatives. Economics teaches us that people are rational decision-makers, choosing the alternative they anticipate will give them the greatest excess of benefits over cost. Changes in incentives alter the costs and benefits, causing predictable changes in the choices people make.

Property Rights. Property rights—the formal and informal rules regarding the use, ownership, and transfer of property—provide important incentives. Analyzing how property rights are defined and enforced allows us to understand the choices people and organizations make about resources and to predict who will benefit and who will bear the costs of use and misuse. For example, ownership generally provides an incentive for people to consider the value of property in the future. Therefore, people tend to take better of things they own and value.

Voluntary Trade. Individuals enter into exchanges only when both expect to be better off as a result of the exchange, a condition that is possible because people's interests and values differ. Voluntary trade won't continue if one party gains and the other loses in the transaction.

TIME ESTIMATE

One class period

MATERIALS

- Handouts/Visuals 1–6
- Fish crackers and coins (or candy)

LESSON OVERVIEW

This lesson introduces students to the intellectual tools they'll use to solve the fishing mysteries that comprise the remainder of the unit.

CONTENT OBJECTIVE

Students will use the four principles of economic reasoning to explain the behavior of their classmates in two simulated situations. The four principles are:

Choice: Because resources (natural, human, and capital resources) are scarce, individuals and organizations must choose among alternatives. Analysis of environmental issues begins by identifying the choices people make and investigating their consequences.

Incentives: Incentives are the rewards or punishments for behavior. They shape the costs and benefits of available alternatives. People are rational decision makers, choosing the alternative they think will give them the greatest excess of benefits over cost. Changes in incentives alter the costs and benefits, causing predictable changes in the choices people make.

Property Rights: Property rights—the formal and informal rules regarding the use, ownership, and transfer of property—provide important incentives. Ownership generally provides an incentive for people to consider the value of property in the future. Therefore, people tend to take better of things they own and value.

Voluntary Trade: Individuals enter into exchanges only when both expect to be better off as a result of the exchange. Trade is possible because people's interests and values differ. Voluntary trade won't continue if one party gains and the other loses in the transaction.

TEACHING PROCEDURES

1. Use Visual 1 to introduce the four tools of economic reasoning to students. Display the overhead and briefly explain each. It isn't necessary to spend a great deal of time with the overhead as students will become more familiar with the tools as they use them during the lesson.

2. Display and read Visual 2. Ask students to hypothesize the reasons for continued overfishing even as fishers run out of fish. Record the hypotheses on the board or an overhead transparency and explain that you'll come back to consider the list later.

3. Announce that the class will observe a brief activity and that you will then ask them to explain the behavior they observed.

4. Turn on the overhead projector. Scatter several fish crackers on a blank transparency and adjust the projector so that seated students can see the fish. Recruit six volunteers to come to the front of the room and gather around the projector.

5. Explain to the volunteers that they are fishers and you are a fish buyer. You will give them two 20-second fishing rounds and will purchase any fish they bring to you in good condition. (You will *not* purchase fish that are crushed or broken.) You will buy fish caught in the first 20-second round for 10¢ (or 25¢) each and any fish caught in the second 20-second round for 25¢ (or 50¢) each.

   (***Note:*** Consider ahead of time how many fish to put on the screen and how much you're willing to pay for them. Generally, the fewer fish and the older the students, the higher the pay must be to provide an effective incentive to participate. With younger students, use individually wrapped pieces of candy and candy bars instead of coins.)

6. Immediately after clearly giving the instructions, say "Go!" and watch the time carefully. Do not give students time to consider the possibilities or talk over the problem before you say "Go."

   (*Students tend to grab the fish crackers immediately, although there may be an initial, brief hesitation until one student reaches in. Some fish will be destroyed and only a couple of students will earn money. Usually no fish are left for the second episode.*)

7. Pay the students for their catch. Announce that there can be no second round because the fish are all captured or crunched. Ask the six students if they understood that the fish would have been worth more in the second round.

   (*Usually, this misunderstanding does not occur. But, if it does, consider running the experiment again, particularly if no student has tried to organize the others to wait. If you decide to run it again, do so quickly. The result—grabbing, damaged fish, and nothing left for the second round—will be the same.*)

8. Ask the fishers why they didn't wait for the second round.

   (*Anticipate that they may "blame" whoever jumped in first, but all will comment that they couldn't afford to wait for the second fishing round because they were afraid everyone else would take them all.*)

9. Display Visual 3. Remind students of the four economic reasoning tools and debrief, using the overhead questions.

Choice:
What was scarce in this situation?
(*The fish, the time for fishing.*)

What alternatives were available to the fishers?
(*To fish now, to fish later, to not fish at all.*)

What choice did they make and what was the consequence of their choice?
(*To fish now. The fish disappeared.*)

Did any of the fishers set out to deliberately destroy the fish population?
(*It's important to emphasize that the destruction of the fish population wasn't a deliberate choice, nor was it something the students considered ahead of time. It was an unintended consequence.*)

Incentives:
Was there a reward for fishing in the first round?
(*Yes—the money or candy the fish buyer was offering.*)

Was there a punishment for fishing in the first round?
(*No.*)

Was there a reward for waiting to fish in the second session?
(*Yes—more money or a bigger candy bar.*)

Was there a punishment for waiting to fish in the second round?
(*Yes—the very strong chance that the fish would be gone because other fishers didn't wait.*)

What behavior did the incentives—the set of rewards and punishments—encourage?
(*Immediate fishing and no conserving of fish.*)

Property Rights:
Who owned the water where the fish lived?
(*Students may either say that they don't know or that they all own it. They may use words like "public." If they assumed it was the ocean, they may say that nobody owns it. If no one asked before the activity, point out this fact and that they acted as if no one or everyone owned it. If they say they thought you owned it, comment that you didn't say that, you only said you'd buy what they caught. Don't belabor this because the contrast will be made in the next round, but do make sure the impression is left that the property rights are at the very least, unclear.*)

Did the rules of ownership affect the incentives? If so, how?
(*Yes. Because ownership is unclear, the incentive is to grab the fish before someone else gets them.*)

Voluntary Trade:
What voluntary exchange took place in this activity?
(The fish buyer exchanged money for fish.)

Who benefited from the exchange and how?
(Both parties benefited. The fishers gave up the fish because they valued the money more. The fish buyer valued the money less than the fish—or less than the lesson taught with the fish.)

Is this exchange likely to continue?
(Students should realize that once the teacher—fish buyer—no longer sees a benefit, or once the fishers no longer think the price

or the candy worth their effort, the exchange will stop.)

IN SUMMARY

What caused the overfishing that destroyed the fish population?

(*Help students to articulate that the fish depletion was not the result of "bad" people doing "bad" things. No one set out to destroy the fish; people were pursuing their own best interests given the incentives they faced. Depending on the rewards and punishments offered, the problem of excessive use and abuse can arise even though no one wants it to.*)

Suppose that one or two of the people realized that if everyone jumped in and took the fish, there wouldn't be any left for the second round. Would it have made any difference in the outcome?

(*No.*)

If you had stopped fishing, would it have changed the incentives for the other people, more likely to stop?

(*No.*)

10. Place Visual 4 on the overhead and scatter some fish on the transparency, but do not turn on the overhead yet.

    Announce that you are going to run the experiment again and explain that the time rounds and pay rate will be the same—10¢ (or 25¢) each for the first 20-second fishing round and 25¢ (or 50¢) each for the second round.

    Recruit six new volunteers and as they come up to the projector, turn it on and explain that there will be one new rule.

    Assign one rectangle to each student and explain that he or she owns the fish in that rectangle. Go around the circle and point out clearly which student owns which fish. Also, explain that the fine for taking someone else's fish is $1 and the loss of future fishing rights.

11. Make sure that students understand the new rule. Remind them that there will be two 20-second rounds, say "Go," and start timing.

    (*Usually, students will not harvest the fish. Some who are confused by the rules may try to harvest others' fish; be sure to stop this and take away that student's fishing privileges.*)

12. After 20 seconds, call "Stop." Pay for any harvested fish. Remind students of the price in the second round.

    (*If anyone asks about a third round, ignore the question or shrug, and go on with the activity.*)

    Quickly start the second fishing round.

    (*Many students will carefully harvest their fish and sell them. It's likely that no fish will be damaged. Don't be surprised if a student chooses not to harvest his or her fish or to harvest only some of them.*)

    When the round ends, call, "Stop," pay for harvested fish, pick up any remaining fish, thank the volunteers and send them back to their seats.

13. Ask students to identify the similarities and differences in the first and second experiments, both in terms of setup and in terms of results.

    (*Students' answers should include the idea that people chose to harvest early in the*

first experiment because they were afraid someone else would take the fish if they let them remain on the glass. In the second experiment, that wasn't the case.)

Encourage students to try to use the economic vocabulary of choice, incentives, property rights and voluntary exchange to explain the differences and similarities.

14. Conduct debriefing with the class as a whole or divide students into small discussion groups.

Display Visual 5 on the overhead. Point out that the questions are similar to those discussed after the first experiment but that there is an additional concern with how the first and second experiments differed.

Choice:
Were the alternatives and the choices different in the two experiments?
(*Yes.*)

What was scarce?
(*The fish, the time for fishing—no difference from the first experiment.*)

What alternatives were available to the fishers?
(*To fish now, to fish later, to not fish at all—no difference from the first experiment.*)

What choice did they make and what was the consequence of their choice?
(*A different choice. Most—all?—chose to wait until the second round to fish. The consequence was that the fish were harvested later rather than earlier, few—none?—were damaged, and perhaps some were not harvested at all.*)
Did any of the fishers set out to deliberately destroy the fish population?
(*No difference in motive from the last time, but if the fish were overharvested, it didn't happen as quickly.*)

Incentives:
Were the incentives the same or different this time?
(*Some were different.*)

Was there a reward for fishing in the first round this time?
(*Yes—the money or candy the fish buyer was offering.*)

Was there a punishment for fishing in the first round this time?
(*Yes, because the fisher would give up the higher price that was a certainty in the second round. This* IS *different.*)

Was there a reward for waiting to fish in the second round this time?
(*Yes—more money or a bigger candy bar.*)

Was there a punishment for waiting to fish in the second round this time?
(*No—because the fisher owns the territory, there's no chance that others will harvest the fish first. This* IS *different.*)

Did the incentives—the set of rewards and punishments—encourage different behavior than when we ran the activity the first time?
(*Yes, fishers had an incentive to conserve their fish for later harvest. Note that some people may not have harvested all their fish even in the second round, anticipating that they would be even more valuable later on.*)

Property Rights:
Did the changed property rights rules affect

the behavior of the fishers?
(*Yes.*)

How did the property rights rules differ?
(*In the second activity the fishing territory was not held in common. Ownership was clearly assigned and everyone knew who owned what. Also, everyone knew that the ownership rights would be enforced.*)

Did the changed rules of ownership affect the incentives? If so, how?
(*Yes. The student's right to own fish before and during harvesting was protected. No one could take the fish while it was growing more valuable. Because the fisher didn't have to worry about other fishers, he or she thought about the future value of the fish, and conserved them and waited to harvest them. Additionally, when a student did harvest them, he or she was careful not to damage them.*)

Voluntary Trade:
Was there a change in the trade arrangements?
(*No.*)

What voluntary exchange took place in this activity?
(*No difference. The fish buyer exchanged money for fish. However, note that this time, both parties received more value in the exchange.*)

Who benefited from the exchange and how?
(*No difference. Both parties benefited.*)

Is this exchange likely to continue?
(*No difference. Exchange will continue as long as both parties anticipate that the benefits of exchange outweigh the costs.*)

CLOSURE

15. If the class has been working in small groups, bring them back together to end the lesson. Ask:

    Why was the outcome of the second experiment different from the first?

    Which economic reasoning tool was most valuable in explaining the different outcomes?

16. Display Visual 6 on the overhead projector. Read the definition of the tragedy of the commons.

    Which of our two experiments suffered from the tragedy of the commons?
    (*The first one. Because ownership wasn't defined, no fisher was willing to risk waiting because other fishers would take all the fish.*)

    Why wasn't there a tragedy of the commons in the other experiment?
    (*Because ownership was clearly defined; each owner was secure in making decisions about the value of fishing now vs. conserving the fish for later.*)

    Offer an explanation as to why the phenomenon is called the *tragedy* of the commons rather than, say, the *sin* of the commons.
    (*It's called a tragedy rather than a sin because the consequence—the disappearance of the fish—wasn't the result of any deliberate or sinful action on anyone's part. People were engaged in pursuing beneficial activities—providing food for others to eat—*

and the depletion of the fish played no part of their intent.)

Which of the tools of economic analysis was most valuable in explaining the different outcomes?

(*Property rights. The change in ownership changed the incentives, which changed the choices individuals made.*)

17. Let's return to our original question: Why do people who care about and even depend on the health of fish populations participate in the overfishing that is destroying many fish stocks? What do you think about your list of hypotheses? Were any of them correct or helpful?

(*Before taking part in this lesson, students have a tendency to explain the overfishing problem by assuming people are greedy, ignorant, or stupid. The activity illustrates that those ideas do not explain the behavior very well. The problem isn't the people; it's the rules of the game. The character, morals, knowledge, and mental capacity of the people in the two experiments weren't significantly different. However, people behaved differently when the property rights rules changed the incentives. The tools of economic reasoning provide a causal explanation that is both more practical and more accurate than speculations about flaws in human character.*)

Can you think of other environmental issues in which the tragedy of the commons plays an important role?

(*Students should be able to recognize several local and international issues. Most endangered species problems are tragedies of the commons. Trash in public parks, lakes, restrooms, and even the mess in school cafeterias are commons problems, as is the pollution of the greatest commons of all—the air.*)

ENDNOTE

Remind students that the mysteries that follow are most readily solved with economic reasoning. Encourage students to look for clues that incorporate the four economic tools—choice, incentives, property rights, and voluntary trade—rather than relying upon preconceived notions about other people's character and behavior.

FOUR TOOLS OF ECONOMIC REASONING

Choice: Because resources (natural, human, and capital resources) are scarce, individuals and organizations must choose among alternatives. Analysis of environmental issues begins by identifying the choices people make and investigating the consequences of those choices.

Incentives: Incentives are the rewards or punishments for behavior. They shape the costs and benefits of available alternatives. People are rational decision makers, choosing the alternative they think will give them the greatest excess of benefits over cost. Changes in incentives alter the costs and benefits, causing predictable changes in the choices people make.

Property Rights: Property rights—the formal and informal rules regarding the use, ownership, and transfer of property—provide important incentives. Ownership generally provides an incentive for people to consider the value of property in the future. Therefore, people tend to take better of things they own and value.

Voluntary Trade: Individuals enter into exchanges only when both expect to be better off as a result of the exchange. Trade is possible because people's interests and values differ. Voluntary trade won't continue if one party gains and the other loses in the transaction.

"ALL THE FISH IN THE SEA"

"More than all the fish in the sea" is a traditional way of expressing numbers too large to count. Unfortunately, the number of fish in the sea has declined noticeably in recent years.

Overfishing is the cause of the decline in many valuable fish stocks. In many of the world's fisheries, there are too many fishers in too many boats, using too much gear to catch too many fish. The reproductive capacity of fish cannot keep up with the ability of fishers to harvest them.

The evidence is in the catch. The 1980 harvest of Pacific chinook salmon was 22.4 million tons. In 1999, it was a mere 6.6 million tons in 1999. Shrimp in the Gulf of Mexico, oysters in the Chesapeake, trout in Colorado, and lobster in the North Atlantic are all in decline.

Why do fishers continue to overharvest when they know it threatens their very livelihood?

Brainstorm some hypotheses that might explain the continuing rapid decline of fish stocks due to overfishing.

CHOICE

- What was scarce in this situation?
- What alternatives were available to the fishers?
- What choice did they make and what was the consequence of their choice?
- Did any of the fishers set out to deliberately destroy the fish population?

INCENTIVES

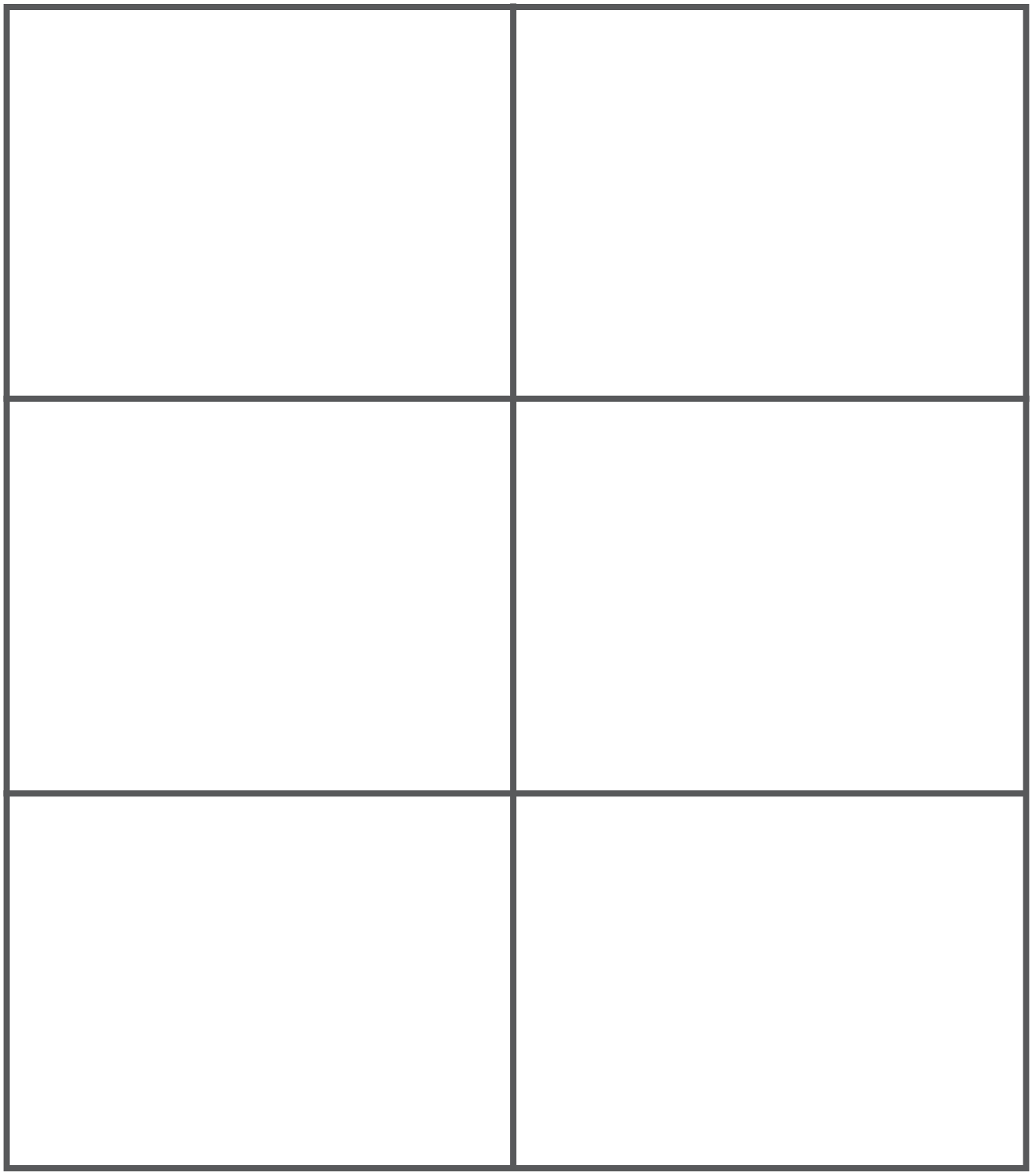
- Was there a reward for fishing in the first round of this activity?
- Was there a punishment for fishing in the first round?
- Was there a reward for waiting to fish in the second round?
- Was there a punishment for waiting to fish in the second round?
- What behavior did the incentives—the set of rewards and punishments—encourage?

PROPERTY RIGHTS

- Who owned the water where the fish lived?
- Did the rules of ownership affect the incentives? If so, how?

VOLUNTARY TRADE

- What voluntary exchange took place in this activity?
- Who benefited from the exchange and how?
- Is this exchange likely to continue?



CHOICE

- Were the alternatives and the choices different in the two experiments?
- What was scarce in this session?
- What alternatives were available to the fishers?
- What choice did they make and what was the consequence of their choice?
- Did any of the fishers set out to deliberately destroy the fish population?

INCENTIVES

- Were the incentives the same or different this time?
- Was there a reward for fishing in the first round this time?
- Was there a punishment for fishing in the first round this time?
- Was there a reward for waiting to fish in the second round this time?
- Was there a punishment for waiting to fish in the second round this time?
- Did the incentives—the set of rewards and punishments—encourage different behavior than when we ran the activity the first time?

PROPERTY RIGHTS

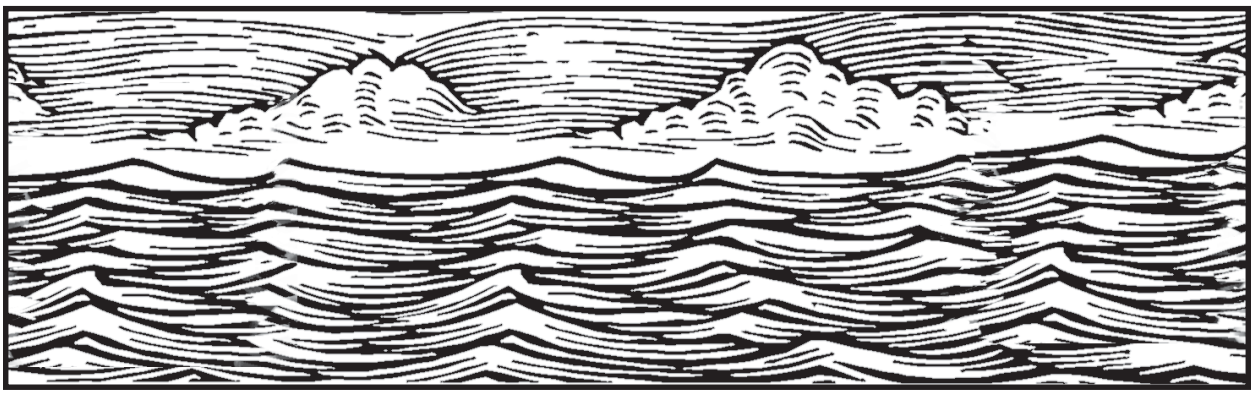
- How did the changed property rights rules affect the behavior of the fishers?
- How did the property rights rules differ?
- Did the changed rules of ownership affect the incentives? If so, how?

VOLUNTARY TRADE

- Was there a change in the trade arrangements?
- What voluntary exchange took place in this activity?
- Who benefited from the exchange and how?
- Is this exchange likely to continue?

THE TRAGEDY OF THE COMMONS

When property is held in common, it tends to be overused and/or degraded. Each person who uses it gains the full benefit of use. However, he or she does not bear the full costs of this use; the costs are shared by other users and the common owners. Additionally, no one has a strong incentive to conserve because a person who tries to conserve cannot prevent others from using the property instead.



WHEN FISH ARE A COMMONS

If a fishing territory is open to all fishers, then each fisher captures all the benefits of harvesting more fish. However, each fisher bears only a small portion of the cost—which is the reduced fish population available for future harvests.

NOTES

LESSON OVERVIEW

This lesson contains a series of mysteries that students solve using the four tools of economic reasoning they developed in Lesson 1.

CONTENT OBJECTIVE

Students will practice using four key tools of economics to analyze clues and solve mysteries. Those key ideas are:

Choice: People choose.

Incentives: Incentives influence how people choose to use resources.

Property Rights: People tend to take better care of things they own and value.

Voluntary Trade: Voluntary trade benefits both parties in the trade.

CRITICAL THINKING OBJECTIVE

Students will distinguish between clues that are most useful and clues that are least useful as evidence for solving the mystery. They will also distinguish which clues are consistent and which inconsistent with the key economic principles.

TIME ESTIMATE

Varies from 10–30 minutes per mystery

MATERIALS

- Handout / Visual 1

PREPARING MATERIALS

1. Copy each mystery onto an overhead transparency. For Mystery 1, also copy the clue pages onto transparencies.

2. For Mystery 2, copy three sets of clues. Cut the clues into strips. Staple or clip together all strips that have the same clue.

3. For Mysteries 2–7, determine the most workable discussion group size for your students, making sure that the number of students in the group doesn't exceed the number of clues in the mystery. Copy one set of clues for each discussion group. For example, with 24 students and a 12-clue mystery, use two discussion groups and make two sets of clues—one clue per student for each discussion group. If you prefer smaller groups, divide the class into four discussion groups, make 4 sets of clues and distribute 2 clues to each student.

4. Copying each set of clues on a different color paper helps keep the discussion groups separate.

5. After copying the clue pages, cut the clues into strips and clip or staple so that each set contains one copy of each clue.

TEACHING PROCEDURES

TRAINING STUDENTS

1. Conduct the first mystery exercise with the class as a whole. There are 12 clues, so divide the class into 12 small groups of two or three students. Instruct group members to sit together, where they can see the overhead.

2. Explain to students that the purpose of the activity is to sharpen their critical thinking skills by analyzing some fishy-sounding stories. They will be presented a series of clues and will use their four tools of economic reasoning to explain the puzzling behavior described in the stories.

3. Using Handout / Visual 1, outline the purpose of the exercise:

   A mystery will be displayed on the overhead.

   Each group will be given at least one clue. Give a copy of the clue to each person in the group, or place the clue where everyone can see it.

   You have two tasks:
   1) determine the solution to the mystery, and
   2) decide which clues are *necessary* to reach the solution.

   The fewer clues, the better.

   Tell students that all of the clues are true; there is no intent to trick or mislead them with false information. However, not all of the clues are important or necessary to solve the mystery.

4. When students understand the nature of the task, explain the procedures:

   I'll display a mystery on the overhead and we'll read through it together. I will answer only clarification questions and will not add any information to that given in the mystery.

   In your group, read your clue and discuss whether you think it is relevant and important to solving the mystery. Choose someone to explain your reasoning to the class.

   Starting with Clue 1, small groups will share their clues and their thoughts with the class.

5. Display Handout / Visual 1 from Lesson 1 and ask students to get out their handout copies. Remind them to apply these tools to solve the mystery.

6. Distribute one clue per group. (With smaller classes, it may be necessary to give some groups or pairs two clues. Discussion is key to the activity, so it is preferable to have two clues for two students than to have one clue for one student.)

7. Display the mystery on the overhead and read aloud. Give students 3–5 minutes to talk with their small group partners about their clue.

8. Reconvene the class. Proceed in round-robin fashion, with each group reporter reading the clue aloud and telling the others whether the group thought it was important and why.
   (*Help students track the discussion by displaying the clues transparency. Uncover each clue as it is presented by a group. Use colored overhead pens to designate clues as "necessary," "unnecessary," or "not sure yet."*)

9. When all clues have been presented, open the discussion. Continue until the class reaches consensus on the solution to the mystery.

10. With the class as a whole (or after directing students to return to their small discussion groups), focus the discussion on which clues were absolutely necessary to solve the mystery. Consider the color coding marks on the overhead transparency and discuss any disagreements. Instruct students to connect their arguments for or against individual clues to at least one of the four tools of economic analysis.

    Note: This discussion is the most important part of the activity, for it is here that teachers will be able to most accurately assess students' understanding of choice, incentives, property rights, and voluntary exchange. There is no absolutely correct number of necessary clues. The number of necessary clues depends on students' level of understanding and their experience with economic reasoning. Some students may need very few clues; others will need more, perhaps even clues that seem redundant.

    While there is no single "right" answer, there are wrong answers, clues that add nothing to the analysis despite being true. Expect that many students will be eager to have their clues matter. Some will go to extremes of tortured logic to argue that their information is crucial. Remind them that this exercise involves sorting out the useful from the not useful. Not all information is of equal value.

    The goal is that as students continue to work with the mysteries, they select fewer irrelevant clues and need fewer "necessary" clues to reason their way to an explanation.

STUDENT PRACTICE

1. Use the remaining mysteries for student practice with the tools of economic reasoning. Assigning mysteries to small discussion groups rather than leading a whole-class exercise involves more students in critical thinking.

   Mysteries are a great way to start class. Train students to look for the sets of colored clue strips on your desk when they come into class. The sets of clue strips are the signal to form discussion groups, distribute the strips, and solve the mystery. Challenge students so that by the last mystery, all groups reach the correct solution before you finish taking roll.

2. Plan a schedule and prepare the materials for the remaining mysteries. Consider using Mystery 2 for all discussion groups in the next mystery session. After that, you may want to give different mysteries to different groups, and then compare and contrast them in a large group.

   Start with a group size of 5 to 8 pupils, depending on students' previous experience in group work, ability to stay on task, and enthusiasm for the mystery activity.

   Regardless of group size, it is important that the clues be distributed relatively evenly, so that each student is holding at least one clue and is responsible for working it into the discussion. Do not allow students to turn over all clues to one or two students to complete the task.

3. Teacher background and a discussion of the clues accompany each mystery.

SOLVING ECONOMIC MYSTERIES

A mystery will be displayed on the overhead. Each group will be given at least one clue. Distribute a copy of the clue to each person in the group, or if there is only one copy, place it where everyone can see it.

YOU HAVE TWO TASKS:

- find the ***solution*** to the mystery, and
- decide which clues are ***necessary*** to reach the solution.

(The fewer clues, the better.)

All of the clues are true; there is no intent to trick or mislead you with false information. However, not all of the clues are important or necessary to solve the mystery.

TIME ESTIMATE

10–30 minutes

MATERIALS:

- Handouts / Visuals 1–2

THE MYSTERY

Do You Always Hurt the One You Love?

People living in the Pacific Northwest are justifiably proud of their coastal homeland and love to show visitors its beauty and unique wildlife. The region has developed a "green" reputation and has long attracted people willing to put their environmental concerns into action. Chief of the natural wonders of the Northwest are the salmon, known for their yearly pilgrimage from the ocean to their freshwater spawning grounds. Every fall the viewing platforms of Washington and Oregon fish ladders are crowded not only with tourists but with native Northwesterners welcoming the salmon's return. But wait a minute; there aren't all that many salmon to see! Under the stewardship of these same Northwesterners, salmon populations have declined by 75 percent over the past twenty years.

Given their reputation as lovers of the environment, why are Northwesterners destroying the salmon they love and on which many depend for their financial well-being?

THE CLUES

The following statements provide students with information that may help them solve the mystery.

1. The estimated number of Pacific salmon declined from 22.4 million in 1980 to less than 6.6 million in 1999.

2. According to the "rule of capture," any licensed owner of a fishing boat operating out of a port town like Anacortes, Washington, owns any wild Pacific salmon caught in the ocean or the mouth of the Columbia River.

3. During the 1800s, cattle branding identified owner's property. Branding of buffalo wasn't allowed; the only way to own buffalo was by the rule of capture.

4. While alive, wild Pacific salmon may not be owned by individuals or companies.

5. Aquaculture firms like Skyline Farms supply salmon to restaurants and grocery stores throughout the West. The company raises salmon in net pens constructed in permanent locations in creeks or ocean bays. They maintain the habitat and control access to the pens. In contrast to wild salmon, populations of farm salmon are stable or increasing.

6. Companies like Heritage Salmon farm fish in Chile, the Pacific Northwest and off the New England coast. They sell all over the world. Their ability to protect the fish means that, in general, they can harvest selectively. They get a higher price because their fish are older, larger, and healthier than many of the wild salmon caught by commercial fishing companies.

7. Because the commercial fishing season is short, owners of Washington fishing fleets generally don't sort their catch by size. It's too costly to spend that much time. Instead of releasing the small ones, they catch as many fish as they can and sell them all by weight to fish processors.

8. According to surveys, the owners of the fishing fleets are not fish-haters, or "enviro-sociopaths." They have no desire to contribute to the extinction of fish species. It's not uncommon for the fishers to say something like: "I do love the salmon; fishing's my life. I know we probably shouldn't catch so many, but hey, my kids need to eat."

9. "Save the Salmon" activities are common in the Northwest. Even if commercial fishers are sympathetic, however, they do not want to reduce the size of their catch. Every fisher knows that if he or she fishes less to aid salmon recovery, someone else will catch the ones that remain. A single fisher can't make a difference to the Pacific salmon, so he or she might as well keep income coming.

10. The only way many fishers can stay in business is to take out loans to buy faster boats, better equipment, and more technology so they can compete better in the race for the fish.

11. The groundfish fishery off the coast of Washington, Oregon, and California has 82 different species of fish.

12. A tragedy occurs when people harm and/or destroy the very thing they care about without intending to do so. For example, the activities of Romeo's and Juliet's quarreling families caused the couple's death, a consequence they never anticipated or intended.

SAMPLE STUDENT ANSWER

A correct student solution to the mystery of why the Northwesterners can't seem to stop the destruction of the salmon population they care about should resemble this statement:

> *People in the Northwest will be unsuccessful in restoring the wild Pacific salmon as long as the fish are common property. In a commons fishers are rewarded for harvesting fish but not rewarded for conserving them. Fishers also know that their own individual conservation efforts would be useless because nothing would stop someone else from catching the salmon they didn't catch.*

WHICH CLUES SOLVE THE MYSTERY?

Clues that offer information to solve the mystery include 2, 4, 6, 7, 8, 9. These clues deal with the property rights in the wild salmon fishery and the system of incentives they create.

Clues 3, 5, and 10 offer interesting information that may help some students make connections.

Clues 1, 11, and 12 do not help to explain why the salmon are in decline.

During the debriefing, ask students how each of the four tools of economic analysis is involved in this situation:

> ***Choice:*** People are choosing to catch the fish because they want to earn income for themselves and their families. They are not choosing to destroy the salmon population. That is, however, one of the consequences of their choice.

Property Rights: Review from Lesson 1 the term "commons." It describes situations in which property rights are given to a group of people as a whole, rather than to specific individuals or organizations. Wild salmon, like most wild animals, are a commons. They are not owned by anyone, but "belong" to all of us. They are, therefore, subject to the tragedy of the commons in the form of overfishing.

When animal populations are a commons, people obtain individual ownership through the rule of capture. The person who catches the animal becomes its owner. Generally, the best way to capture fish is to kill them. (This same situation occurred historically on the Great Plains. Bison were a commons and no individual person—or Indian tribe—could claim ownership to live bison. Dead buffalo, however, were owned by whoever killed them.)

Incentives: Remind students that identifying the rewards and punishments usually allows us to predict very accurately how people will behave. In a common fishery, the reward is the revenue from selling the fish. The incentive is to kill fish, because that is the only way to capture the reward.

Point out that because the property rights are different, the system of incentives is different for farm fish, which aren't declining in numbers. For a fish farmer, the reward is also sales revenue, but the bigger the fish, the better the reward. Thus, there is an incentive to keep fish alive. An aquaculturalist receives a higher price for selling a large fish than for selling a small fish.

In an area of open access (a commons), fishers are penalized for saving fish for the future. If one or even a few individual fishers restrict their fish harvest, someone else will catch the fish. A decision to conserve by one user has no impact on total use of the resource. The anti-conservation incentive goes further in that it encourages *overuse* because each user knows that in order to claim some of the harvest, he or she must beat other potential users who have the same idea. In common fisheries, this means that an individual who engages in aggressive, premature harvesting is rewarded. It also means that fishers see an advantage to bigger boats and better fishing technology that help them to harvest fish faster.

Fishers in a commons gain the full benefit of catching a fish and selling it but they only bear part of the cost of the declining fish population. They share the cost with all the people working in the commons area, while they keep the total benefit of any fish they catch.

ADDITIONAL COMMENTS

In most ocean regions around the world commercial fish populations are declining rapidly due to overfishing. There are too many boats and too much gear, and they harvest too many fish, leaving too few to mature and reproduce. Governments often adopt policies intended to maintain fish populations, but they have had little success.

Often, policy makers mistakenly attribute the problem to ignorance or greed of the fishers. They suggest that better education, strict enforcement of fishing rules, or more generous human nature would solve the problem. The persistence of overfishing in the face of these efforts is evidence of how misguided they are. Although there are exceptions, overfishing is not usually the result of fishers' stupidity or ignorance, or the

result of deliberate actions by enviro-sociopaths who want to destroy the fish population. Overfishing results from the incentives of common ownership and is independent of the character and wishes of individual fishers. The problem occurs because the property rights arrangements eliminate incentives to conserve the fish and thus it is very difficult to enforce rules requiring people to do so.

MORE INFORMATION

For background on the tragedy of the commons, see:

Garrett Hardin, "The Tragedy of the Commons," in *The Fortune Encyclopedia of Economics*, edited by David R. Henderson, Time Warner Books, 1993, pp. 99–91, or in *The Concise Encyclopedia of Economics* on the Liberty Fund Website at www.econlib.org.

For suggestions on how to better preserve wild fisheries, consult:

Donald R. Leal, "Community-Run Fisheries: Avoiding the 'Tragedy of the Commons,'" *PERC Policy Series*, PS-7, September, 1996. Online: www.perc.org/publications/policyseries/community_full.html.

Donald R. Leal, "Homesteading the Oceans: The Case for Property Rights in U.S. Fisheries," *PERC Policy Series,* PS-19, August, 2000. Online: www.perc.org/publications/policyseries/homestead.html.

Donald R. Leal, *Fencing the Fishery—A Primer for Ending the Race for Fish*. Bozeman, MT: PERC, 2002. Online: www.perc.org/publications/guidespractical/fence_fishery.html.

MYSTERY 1:
DO YOU ALWAYS HURT THE ONE YOU LOVE?

People living in the Pacific Northwest are justifiably proud of their coastal homeland and love to show visitors its beauty and unique wildlife. The region has developed a "green" reputation and has long attracted people willing to put their environmental concerns into action. Chief of the natural wonders of the Northwest are the salmon, known for their yearly pilgrimage from the ocean to their freshwater spawning grounds. Every fall the viewing platforms of Washington and Oregon fish ladders are crowded not only with tourists but with native Northwesterners welcoming the salmon's return. But wait a minute; there aren't all that many salmon to see! Under the stewardship of these same Northwesterners, salmon populations have declined by 75 percent over the past twenty years.

Given their reputation as lovers of the environment, why are Northwesterners destroying the salmon they love and on which many depend for their financial well-being?

CLUES

1. The estimated number of Pacific salmon declined from 22.4 million in 1980 to less than 6.6 million in 1999.

2. According to the "rule of capture," any licensed owner of a fishing boat operating out of a port town like Anacortes, Washington, owns any wild Pacific salmon caught in the ocean or the mouth of the Columbia River.

3. During the 1800s, cattle branding identified owner's property. Branding of buffalo wasn't allowed; the only way to own buffalo was by the rule of capture.

4. While alive, wild Pacific salmon may not be owned by individuals or companies.

5. Aquaculture firms like Skyline Farms supply salmon to restaurants and grocery stores throughout the West. The company raises salmon in net pens constructed in permanent locations in creeks or ocean bays. They maintain the habitat and control access to the pens. In contrast to wild salmon, populations of farm salmon are stable or increasing.

6. Companies like Heritage Salmon farm fish in Chile, the Pacific Northwest and off the New England coast. They sell all over the world. Their ability to protect the fish means that, in general, they can harvest selectively. They get a higher price because their fish are older, larger, and healthier than many of the wild salmon caught by commercial fishing companies.

CLUES

(continued)

7. Because the commercial fishing season is short, owners of Washington fishing fleets generally don't sort their catch by size. It's too costly to spend that much time. Instead of releasing the small ones, they catch as many fish as they can and sell them all by weight to fish processors.

8. According to surveys, the owners of the fishing fleets are not fish-haters, or "enviro-sociopaths." They have no desire to contribute to the extinction of fish species. It's not uncommon for the fishers to say something like: "I do love the salmon; fishing's my life. We probably shouldn't catch so many, but hey, my kids need to eat."

9. "Save the Salmon" activities are common in the Northwest. Even if commercial fishers are sympathetic, however, they do not want to reduce the size of their catch. Every fisher knows that if he or she fishes less to aid salmon recovery, someone else will catch the ones that remain. A single fisher can't make a difference to the Pacific salmon, so he or she might as well keep income coming.

10. The only way many fishers can stay in business is to take out loans to buy faster boats, better equipment, and more technology so they can compete better in the race for the fish.

11. The groundfish fishery off the coast of Washington, Oregon, and California has 82 different species of fish.

12. A tragedy occurs when people harm and/or destroy the very thing they care about without intending to do so. For example, the activities of Romeo's and Juliet's quarreling families caused the couple's death, a consequence they never anticipated or intended.

NOTES

TIME ESTIMATE

10–30 minutes

MATERIALS

- Handouts / Visuals 1–4

THE MYSTERY

If We're So Smart . . . ?

For centuries the Southern Kwakiutl of the Pacific Northwest harvested salmon with nets, weirs, traps, and spears. Despite their simple appearance, these tools were extremely effective, especially when the Native Americans concentrated their efforts on the narrower portions of rivers and streams. Many people assume that because the tribes' tools were simple, the Indians had no ability to affect the size of the salmon population, but this is a misconception. Historians tell us that the Kwakiutl were accomplished fishers who could have reduced salmon populations to the level of extinction. But they didn't.

Why is it that the Kwakiutl, with their simple technology and unsophisticated knowledge of biology, were able to maintain abundant salmon populations for centuries, while today, our extensive knowledge and complex technology seem powerless to stop their decline?

THE CLUES

The following statements provide students with information that may help them solve the mystery.

1. Look at the salmon fishing tools of Northwestern tribes like the Southern Kwakiutl (Handout / Visual 3). The Native Americans had no motorized fishing boats until the 1920s, and it was mid-century before more than a few individuals could afford such equipment.

2. Look at the modern boats in Handout / Visual 4. Even though the law prohibits them from netting salmon, modern fishers have the ability to overharvest salmon, using powerful boats and high-tech fishing gear.

3. In the Washington fishery today, about 10,000 fishers catch about 6 million salmon yearly. Before World War I, the number of fishers was about the same, but they caught between three and four times that many salmon. And, they did so using one-fourth of the equipment used today.

4. The Kwakiutl claimed portions of rivers and streams on salmon spawning routes as tribal fishing territory. Individual tribesmen and families claimed specific locations within the tribal territory, and their claims were respected within the tribe and protected from outsiders by the tribal chief. While the Kwakiutl cooperated in building larger traps and weirs, other fishing equipment, including nets and harpoons, was often the property of individuals or families.

5. Like the Kwakiutl, modern fishers own their equipment. Tradition is very strong in some fishing families and communities, so knowl-

edge, practices, and the location of favorite locations are passed from one generation to the next, but fishers today can't legally claim specific "spots" in the salmon fishery.

6. Kwakiutl fishing gear was very efficient, but it didn't have the sturdiness of modern metals and plastics. It was easily destroyed and took a long time to fix, a serious concern for people who depended on salmon runs that lasted only a few weeks each year. For example, heavy logs or big tree limbs felled into the river by an angry tribe upstream could badly damage downstream weirs.

7. Because salmon was their most important food source, tribes learned about the fish and gathered information about the size and condition of spawning runs from season to season. Claims to fish and fishing territory were a constant topic of communication, argument, and treaty negotiation among tribes along each spawning stream or river.

8. Salmon is a multimillion dollar industry, a major source of income for tens of thousands of people in the Northwest today. It's also a vital part of our national economy. Both Pacific Coast state governments and the National Marine Fisheries Service, an agency of the federal government's Department of Commerce, collect and make available information and research studies about salmon fisheries.

9. One of the key issues in agreements—and disagreements—between the Kwakiutl and upstream tribes was escapement, the number of fish allowed to pass upstream. As white settlement moved into the Northwest in the mid-nineteenth century, neither the U.S. nor Canadian governments recognized or enforced treaties among Native American tribes.

10. The Kwakiutl knew from long years of observation that unless enough salmon passed by the traps to spawn in the gravel beds upstream, there would be fewer fish the next year. They and their neighbor tribes learned to harvest selectively, letting enough fish escape upstream to reproduce future populations. Their fish management was sophisticated enough that they could create different average fish sizes in different streams.

11. Modern knowledge has progressed beyond just recognizing that some salmon need to escape to breed. Both Canada and the United States operate expensive hatcheries to enlarge salmon populations for commercial and sport fishing.

12. Five species of Pacific salmon—chinook, coho, sockeye, pink, and chum—and steelhead trout are native to the waters of the Pacific Northwest coast. Salmon live between 2 and 6 years. Hatchery-raised fish are easier to catch than the wild salmon.

13. Current law does not allow anyone except some Northwest Native American tribes to use traps or large nets to fish for salmon in rivers and streams. This is one source of conflict among groups within the salmon fishery today. Currently gill-netters, purse seiners, commercial trawlers, sport fishers, and tribal fishers harvest salmon. Each group is convinced the other groups harvest too many fish.

SAMPLE STUDENT ANSWER

A correct student solution to the mystery of why the Kwakiutl were able to maintain salmon populations while we, with all our modern knowledge and technology, cannot seem to do so should resemble this statement:

> *Because the Native Americans defined personal property rights and negotiated tribal property rights to salmon fishing in Northwest spawning streams, they were able to manage the fish population. To keep their property rights valuable, they allowed fish to escape the traps, which provided food for upstream tribes and allowed enough fish to reproduce. The property rights to fish were enforced internally by the tribe and externally by the threat of damage to equipment or by war. Today, fishers cannot claim property rights to salmon, so they can't use their knowledge and technical skills to safeguard the salmon population.*

WHICH CLUES SOLVE THE MYSTERY?

Clues 4, 5, 6, and 9 address these property rights and their enforcement. Clue 1 establishes that the Native Americans were capable of reducing the salmon populations.

Clues 7 and 10 indicate that maintaining the salmon population was a deliberate, not accidental practice.

Clue 9 indicates what happened to the original rights and why indigenous practices cannot be followed today: The rights are not protected by law.

Clues 2 and 5 indicate that the property rights incentives are very different in modern times and do not encourage investment in the future stock of salmon.

Clues 2, 8, and 12 are interesting facts but they do not help explain why the Kwakiutl maintained the salmon population better than we do today.

During the debriefing, ask students how each of the four tools of economic analysis is involved in this situation:

> ***Property rights*** is the most important of the four economic reasoning tools for solving this mystery. Clues 4, 5, 6, and 9 provide the information students need to determine that the Kwakiutl's structure of property rights to the salmon fishery has been replaced today by a commons.
>
> ***Choice:*** The consequence of the choice by the American, Canadian, and Washington state governments not to recognize property rights to living salmon has been to create a tragedy of the commons and overfishing that threatens the existence of wild salmon. On the other hand, the Kwakiutl made a deliberate choice to maintain the salmon population. See clues 3 and 9.
>
> ***Incentives:*** Implied but not stated in clues 7, 8, 10, 11 is the fact that the lack of private property rights in the salmon fishery means there is no incentive to act in the way that our sophisticated knowledge indicates we should if we want to preserve the salmon.

ADDITIONAL COMMENTS

Accounts, passed from generation to generation among Native Americans, indicate that for hundreds of years salmon runs were healthy and

abundant. Early eighteenth century records of the Hudson's Bay Company confirm that at times fish were so plentiful that a person could walk on their backs to cross some streams and rivers. Although salmon runs were smaller in some years than others, well into the twentieth century they were always much larger than they are today.

The usual explanation for the abundance of salmon through the centuries was that fishing pressure was low, the Native American population was small, and their fishing tools primitive and inefficient so that most salmon swam upstream to spawn without interference. However, this explanation misrepresents reality.

Tribes like the Kwakiutl were sophisticated, efficient hunters and gatherers whose expertise allowed them to live lives of relative abundance and comfort. Their ability to catch fish was so great that they could easily have overharvested and destroyed the salmon runs forever. They didn't because they had a system of property rights that prevented that tragedy. They were efficient, knowledgeable fishers who avoided overfishing through elaborate tribal and individual property rights. The rights provided incentives for individuals to invest in good equipment (traps, nets, weirs) in good locations (narrow areas), to learn about the fish, and to let adequate numbers of the fish escape for spawning.

MORE INFORMATION

For more information about early American and Canadian fishing practices, see:

Robert Higgs, "Legally Induced Technical Regress in the Washington Salmon Fishery," *Research in Economic History*, Vol. 7, 1982, pp. 82–95.

D. Bruce Johnsen, "The Formation and Protection of Property Rights among the Southern Kwakiutl Indians," *Journal of Legal Studies*, January, 1986, pp. 41–67.

D. Bruce Johnsen, "Customary Law, Scientific Knowledge, and Fisheries Management among Northwest Coast Tribes," *New York University Environmental Law Journal*, Vol. 10, No. 1, 2001.

Hilary Stewart, *Indian Fishing: Early Methods on the Northwest Coast*. University of Washington Press, 1977.

MYSTERY 2: *IF WE'RE SO SMART . . . ?*

For centuries the Southern Kwakiutl of the Pacific Northwest harvested salmon with nets, weirs, traps, and spears. Despite their simple appearance, these tools were extremely effective, especially when the Native Americans concentrated their efforts on the narrower portions of rivers and streams. Many people assume that because the tribes' tools were simple, the Indians had no ability to affect the size of the salmon population, but this is a misconception. Historians tell us that the Kwakiutl were accomplished fishers who could have reduced salmon populations to the level of extinction. But they didn't.

Why is it that the Kwakiutl, with their simple technology and unsophisticated knowledge of biology, were able to maintain abundant salmon populations for centuries, while today, our extensive knowledge and complex technology seem powerless to stop their decline?

CLUES

1. Look at the salmon fishing tools of Northwestern tribes like the Southern Kwakiutl (Handout / Visual 3). The Native Americans had no motorized fishing boats until the 1920s, and it was mid-century before more than a few individuals could afford such equipment.

2. Look at the modern boats in Handout / Visual 4. Even though the law prohibits them from netting salmon, modern fishers have the ability to overharvest salmon, using powerful boats and high-tech fishing gear.

3. In the Washington fishery today, about 10,000 fishers catch about 6 million salmon yearly. Before World War I, the number of fishers was about the same, but they caught between three and four times that many salmon. And, they did so using one-fourth of the equipment used today.

4. The Kwakiutl claimed portions of rivers and streams on salmon spawning routes as tribal fishing territory. Individual tribesmen and families claimed specific locations within the tribal territory, and their claims were respected within the tribe and protected from outsiders by the tribal chief. While the Kwakiutl cooperated in building larger traps and weirs, other fishing equipment, including nets and harpoons, was often the property of individuals or families.

5. Like the Kwakiutl, modern fishers own their equipment. Tradition is very strong in some fishing families and communities, so knowledge, practices, and the location of favorite locations are passed from one generation to the next, but fishers today can't legally claim specific "spots" in the salmon fishery.

CLUES

(CONTINUED)

6. Kwakiutl fishing gear was very efficient, but it didn't have the sturdiness of modern metals and plastics. It was easily destroyed and took a long time to fix, a serious concern for people who depended on salmon runs that lasted only a few weeks each year. For example, heavy logs or big tree limbs felled into the river by an angry tribe upstream could badly damage downstream weirs.

7. Because salmon was their most important food source, tribes learned about the fish and gathered information about the size and condition of spawning runs from season to season. Claims to fish and fishing territory were a constant topic of communication, argument, and treaty negotiation among tribes along each spawning stream or river.

8. Salmon is a multimillion dollar industry, a major source of income for tens of thousands of people in the Northwest today. It's also a vital part of our national economy. Both Pacific Coast state governments and the National Marine Fisheries Service, an agency of the federal government's Department of Commerce, collect and make available information and research studies about salmon fisheries.

9. One of the key issues in agreements—and disagreements—between the Kwakiutl and upstream tribes was escapement, the number of fish allowed to pass upstream. As white settlement moved into the Northwest in the mid-nineteenth century, neither the U.S. nor Canadian governments recognized or enforced treaties among Native American tribes.

CLUES

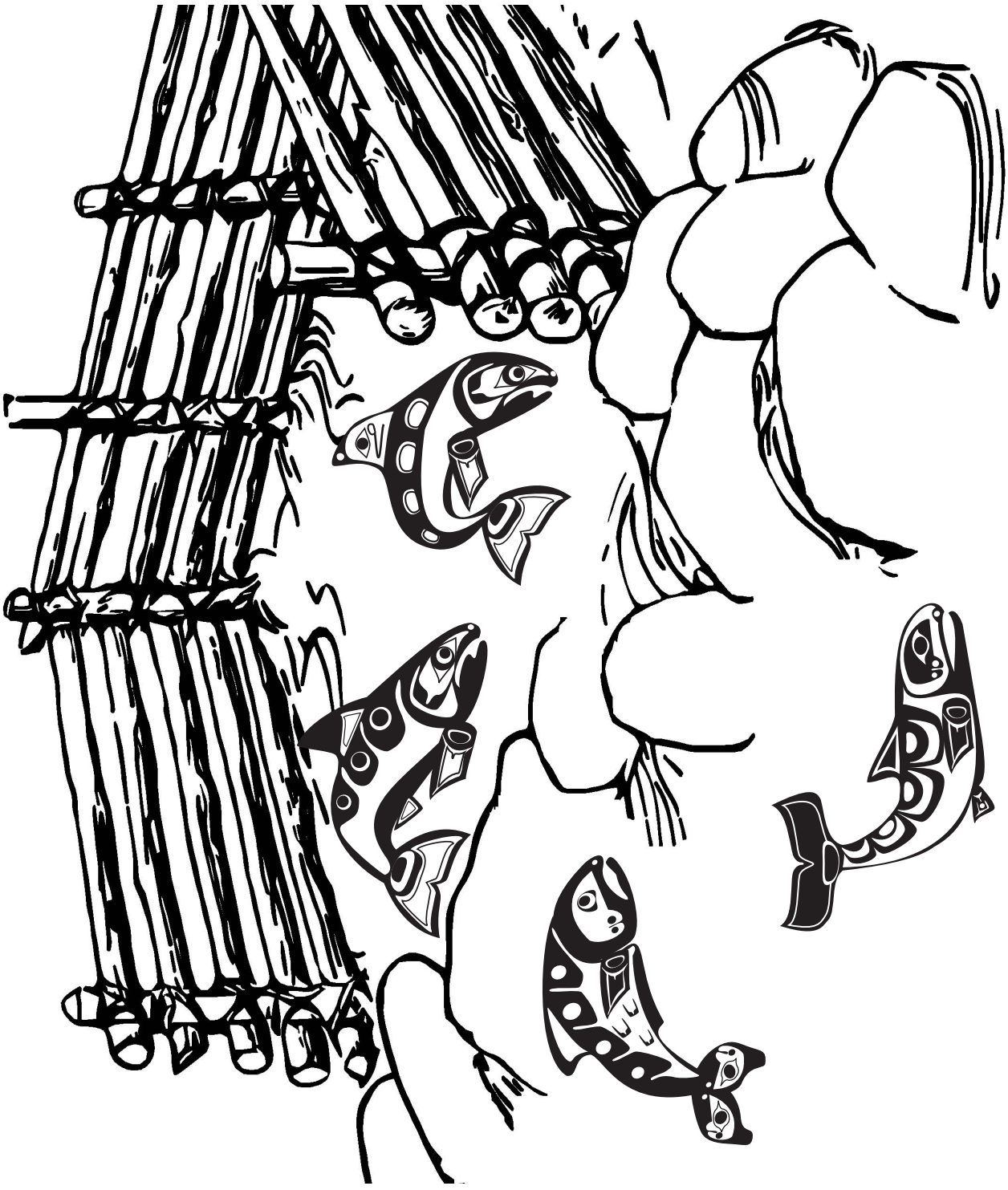
(CONTINUED)

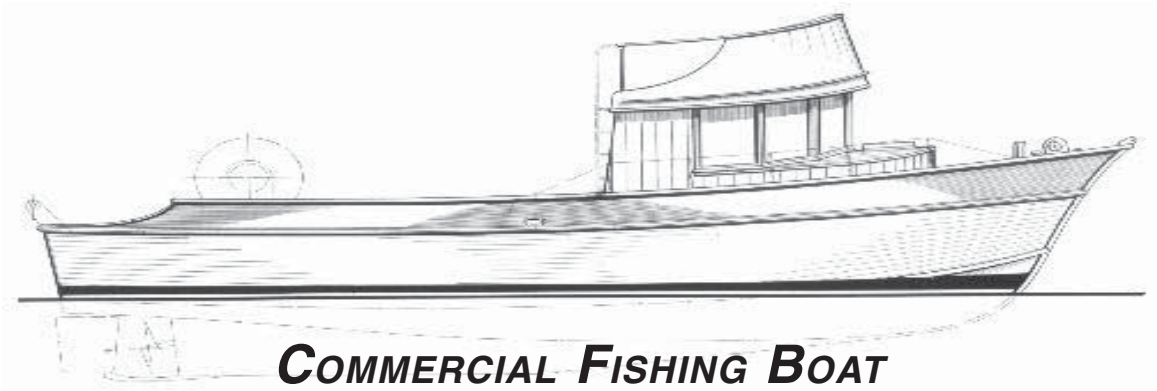
10. The Kwakiutl knew from long years of observation that unless enough salmon passed by the traps to spawn in the gravel beds upstream, there would be fewer fish the next year. They and their neighbor tribes learned to harvest selectively, letting enough fish escape upstream to reproduce future populations. Their fish management was sophisticated enough that they could create different average fish sizes in different streams.

11. Modern knowledge has progressed beyond just recognizing that some salmon need to escape to breed. Both Canada and the United States operate expensive hatcheries to enlarge salmon populations for commercial and sport fishing.

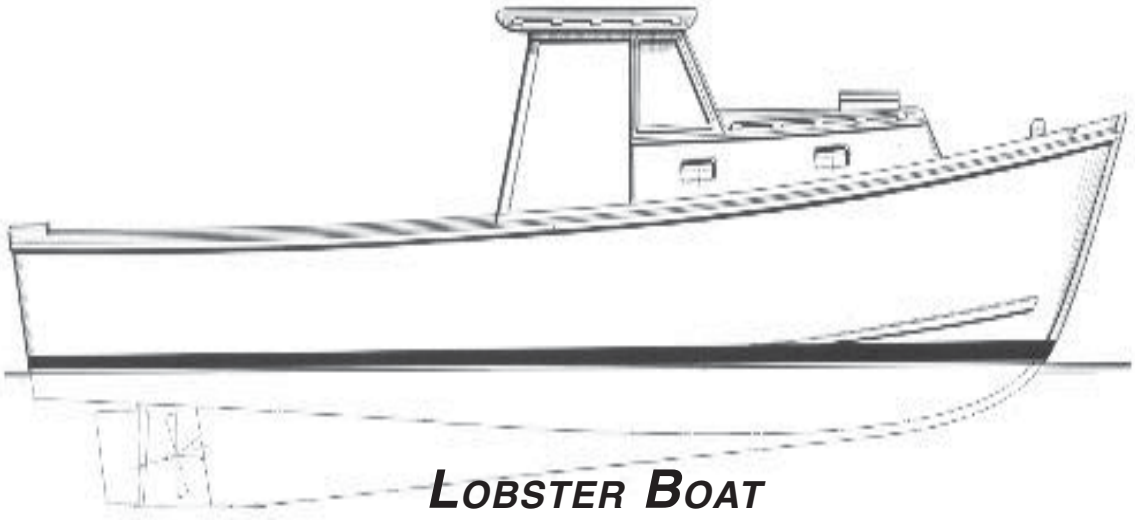
12. Five species of Pacific salmon—chinook, coho, sockeye, pink, and chum—and steelhead trout are native to the waters of the Pacific Northwest coast. Salmon live between 2 and 6 years. Hatchery-raised fish are easier to catch than the wild salmon.

13. Current law does not allow anyone except some Northwest Native American tribes to use traps or large nets to fish for salmon in rivers and streams. This is one source of conflict among groups within the salmon fishery today. Currently gill-netters, purse seiners, commercial trawlers, sport fishers, and tribal fishers harvest salmon. Each group is convinced the other groups harvest too many fish.

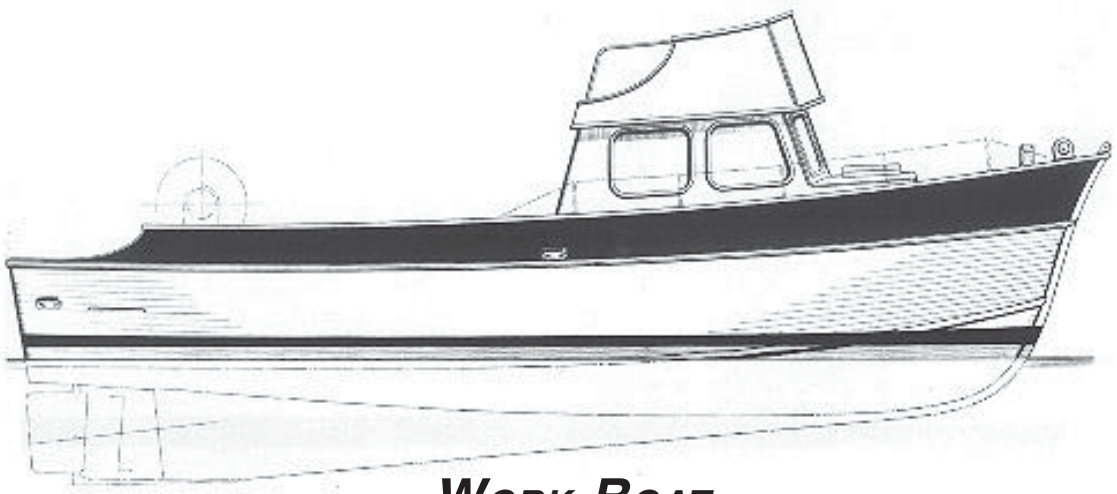




COMMERCIAL FISHING BOAT



LOBSTER BOAT



WORK BOAT

TIME ESTIMATE

10–30 minutes

MATERIALS

- Handouts / Visuals 1–3

THE MYSTERY

Old MacDonald Had a (Fish?!) Farm

For people who are health conscious, salmon is one of the few "miracle" foods—it's not only good for you; it actually tastes great! Therefore, it's hardly surprising that demand is big enough for many people to make a living providing salmon to markets, delis, and restaurants. If you think about it, making a living off salmon can seem pretty miraculous, too. Wild Pacific salmon are anadromous. They spawn in fresh water and migrate to the ocean where they travel long distances as they grow to adulthood. In a few years, they mature and return to the stream where they were born to swim upstream and spawn before they die. Talk about a perfect setup! They hatch; they take off; you don't have to take care of them or figure out where they are; and presto, magic-o! You just wait and they come back, practically begging to be caught. For hundreds of years, thousands of people have happily done exactly that.

So why, over the last decade, have more and more people decided to "farm" salmon rather than just catch them?

THE CLUES

The following statements provide students with information that may help them solve the mystery.

1. Northwestern commercial fishers catch Pacific salmon by trolling. Recreational fishers use hook-and-line gear. Fish farmers raise and harvest their fish in high-tech net pen structures. (See Handout / Visual 3 for a picture of these structures.)

2. Many fish farms along the Pacific coast raise *Atlantic* salmon and sell them to restaurants and consumer markets. Pacific salmon die shortly after spawning; however, Atlantic salmon are capable of surviving and spawning again.

3. To become an aquaculturalist—the technical term for a fish farmer—Old MacDonald has to jump through lots of hoops. In Washington, for example, he must secure permits and demonstrate compliance with environmental regulations before he's allowed to lease marine sites from the state. If he gets a permit, however, Old MacDonald can exclude other users—recreational boaters and fishers, for example—and he can depend on law enforcement agencies and courts to defend his property from theft or damage. True, he must bear the costs of constructing and maintaining the net pens where the fish live, but the rule of capture doesn't apply to his farm fish!

4. Fish farms have salmon living close together in large net pens. This makes them relatively easy to harvest, but because there are so many fish in close proximity, the risk of disease is much greater than for wild fish. Raising healthy farm fish is no easy task.

5. Wild salmon have about the same life span as farm fish—three to seven years. A mature salmon produces from 2,500 to 7,000 eggs or roe, depending on the species and the size of the individual fish. Chinook, one of the five species of wild Pacific salmon, is the greatest roe producer.

6. Today, most wild fish are caught and sold for food before they grow to full size. Farm fish are usually older when harvested because the farmer waits until they reach the size that brings the best market price.

7. On the Web site for the Washington Fish Growers Association, Executive Director Dan Swecker proudly declares that: "Washington produces approximately 12,000,000 lbs. of fresh Atlantic salmon and steelhead. The Atlantic salmon have been farmed extensively in saltwater pens in Puget Sound and other state waters for about fifteen years. . . . [T]he industry has grown into a stable, vital part of . . . local economies . . . [contributing] about $30 million in wholesale income. . . ."

8. During the 1990s, the estimated worldwide population of farm salmon increased by 300 percent. The Pacific States Marine Fisheries Commission tracked the *commercial harvest* of wild chinook salmon during the same period. Chinook are only one of five species of Pacific salmon, all of which exhibit similar population trends.

Commercial Harvests of Pacific Salmon

1980	22.4 million tons
1985	17.4 million tons
1990	17.0 million tons
1995	12.5 million tons
1999	6.6 million tons (estimated)

9. In 1976, Congress passed the Magnuson Fisheries Act which established a 200-mile "exclusive economic zone" (EEZ) off the U.S. coast. Within that zone, the U.S. claims the right to control commercial and recreational fishing activity. The law reduced competition from foreign commercial fishers and also began to restrict the open access that U.S. fishers have traditionally enjoyed. Today, licensing and permitting increasingly reduce American fishers' access to U.S. fisheries.

10. Twenty years ago, Chile started a fish farming project in an attempt to diversify its economy. Today that project is a major industry, the world's second largest salmon producer. In a recent year, the industry totaled revenues of $964 million, and industry representatives brag that it still has room to grow.

11. The growing harvest of farm fish from Chile and Norway has affected Pacific salmon exporters. Growing demand is for boneless, skinless fillets, and commercial fishers find it increasingly hard to provide the large (over 6 lb.) fish desired in these specialty markets. Fish farmers are more than happy to step in, meet the demand, and ring up the higher prices the specialty markets offer.

12. Because of regulatory restrictions, there are only nine major salmon aquaculturalists in the state of Washington (compared to more than 100 in neighboring British Columbia), but these businesses produce 2 percent of the world's supply of farmed salmon.

13. The number of fishers in the Washington commercial salmon fishery has remained relatively constant over most of the last

century, but in the early twentieth century the total catch was 3 to 4 times what it is today. Fishers today use 3 to 4 times the equipment used those fishers.

SAMPLE STUDENT ANSWER

A correct student solution to the mystery of why anyone would go to the trouble of farming fish instead of waiting to capture wild salmon should resemble this statement:

> *People who choose aquaculture (fish farming) over commercial fishing do so because they believe that the benefits outweigh the costs. They are convinced by conditions they see that it would be more costly to be commercial fishers than to be fish farmers. They also see evidence that the significant costs of aquaculture are worth bearing because there's a growing market where they can make good money.*

WHICH CLUES SOLVE THE MYSTERY?

Choice: Choice is the most important of the four economic reasoning tools for solving this mystery. Choice involves comparing expected costs and benefits. Clues 3 and 4 outline the considerable costs of aquaculture, but 9, 11, and 13 suggest that the costs of the commercial fishing alternative are both significant and growing. It's not just a case of sitting around and waiting for the fish anymore. Clues 6, 7, and 10 detail the potentially great benefits of fish farming, while clue 8 suggests that the benefits of commercial fishing aren't what they used to be.

Incentives: Clues 7 and 10 also tell us that there are significant rewards for successful fish farming. The existence of large and potentially growing revenues is an incentive to bear the hassles and costs of aquaculture.

Property Rights: Clue 9 tells us that the property rights of commercial fishers to use the ocean are being increasingly restricted. Clues 3 and 6 indicate that the property rights of fish farmers can be secured and that there is a benefit in being able to conserve the fish for later harvest without worrying that someone else will take it first.

Voluntary Trade: Fish farming exists because consumers are willing to pay for the products fish farmers are willing to provide (Clue 11).

Clues 1, 2, 5, and 12, while interesting, don't directly address the fish farming dilemma.

ADDITIONAL COMMENTS

Wild salmon along the Pacific coast are declining in numbers. They are losing habitat, and they are overfished. Too many are caught before they can spawn and create a new generation of salmon. Commercial fishers are not rewarded for conserving salmon populations and are finding it harder and harder to earn a living.

In contrast, aquaculture farmers are rewarded for creating salmon habitat and maintaining salmon populations on their farms. They can wait for the fish to reach the best size for market sale. They can also limit the number they sell to an amount that can be sustained into the future. While it's true that keeping penned fish healthy can be difficult, increasing numbers of farmers find the rewards of doing so worth the effort. Incentives encourage farmers to take good care of salmon and salmon farm habitat, and property rights allow them to secure the rewards of their care.

Commercial fishers, with no property right to wild fish, tend to harvest immature fish because conserving a wild fish is not rewarding and because someone else will harvest it if they don't.

MORE INFORMATION

For more background on this issue, access the National Marine Fisheries Web site at www.nmfs.noaa.gov/.

For more information about salmon farming, visit the Washington Fish Growers Association's Web site: www.wfga.net.

For suggestions on how to better preserve wild fisheries, consult:

Donald R. Leal, "Homesteading the Oceans: The Case for Property Rights in U.S. Fisheries," *PERC Policy Series,* PS-19, August, 2000. Online: www.perc.org/publications/policyseries/homestead.html.

MYSTERY 3:
OLD MACDONALD HAD A (FISH?!) FARM

For people who are health conscious, salmon is one of the few "miracle" foods—it's not only good for you; it actually tastes great! Therefore, it's hardly surprising that demand is big enough for many people to make a living providing salmon to markets, delis, and restaurants. If you think about it, making a living off salmon can seem pretty miraculous, too. Wild Pacific salmon are anadromous. They spawn in fresh water and migrate to the ocean where they travel long distances as they grow to adulthood. In a few years, they mature and return to the stream where they were born to swim upstream and spawn before they die. Talk about a perfect setup! They hatch; they take off; you don't have to take care of them or figure out where they are; and presto, magic-o! You just wait and they come back, practically begging to be caught. For hundreds of years, thousands of people have happily done exactly that.

So why, over the last decade, have more and more people decided to "farm" salmon rather than just catch them?

CLUES

1. Northwestern commercial fishers catch Pacific salmon by trolling. Recreational fishers use hook-and-line gear. Fish farmers raise and harvest their fish in high-tech net pen structures. (See Handout / Visual 3 to see a picture of these structures.)

2. Many fish farms along the Pacific coast raise *Atlantic* salmon and sell them to restaurants and consumer markets. Pacific salmon die shortly after spawning; however, Atlantic salmon are capable of surviving and spawning again.

3. To become an aquaculturalist—the technical term for a fish farmer—Old MacDonald has to jump through lots of hoops. In Washington, for example, he must secure permits and demonstrate compliance with environmental regulations before he's allowed to lease marine sites from the state. If he gets a permit, however, Old MacDonald can exclude other users—recreational boaters and fishers, for example—and he can depend on law enforcement agencies and courts to defend his property from theft or damage. True, he must bear the costs of constructing and maintaining the net pens where the fish live, but the rule of capture doesn't apply to his farm fish!

4. Fish farms have salmon living close together in large net pens. This makes them relatively easy to harvest, but because there are so many fish in close proximity, the risk of disease is much greater than for wild fish. Raising healthy farm fish is no easy task.

CLUES

(continued)

5. Wild salmon have about the same life span as farm fish—three to seven years. A mature salmon produces from 2,500 to 7,000 eggs or roe, depending on the species and the size of the individual fish. Chinook, one of the five species of wild Pacific salmon, is the greatest roe producer.

6. Today, most wild fish are caught and sold for food before they grow to full size. Farm fish are usually older when harvested because the farmer waits until they reach the size that brings the best market price.

7. On the Web site for the Washington Fish Growers Association, Executive Director Dan Swecker proudly declares that: "Washington produces approximately 12,000,000 lbs. of fresh Atlantic salmon and steelhead. The Atlantic salmon have been farmed extensively in saltwater pens in Puget Sound and other state waters for about fifteen years. . . . [T]he industry has grown into a stable, vital part of . . . local economies . . . [contributing] about $30 million in wholesale income. . . ."

8. During the 1990s, the estimated worldwide population of farm salmon increased by 300 percent. The Pacific States Marine Fisheries Commission tracked the *commercial harvest* of wild chinook salmon during the same period. Chinook are only one of five species of Pacific salmon, all of which exhibit similar population trends.

Commercial Harvests of Pacific Salmon

1980	22.4 million tons
1985	7.4 million tons
1990	17.0 million tons
1995	12.5 million tons
1999	6.6 million tons (estimated)

CLUES

(continued)

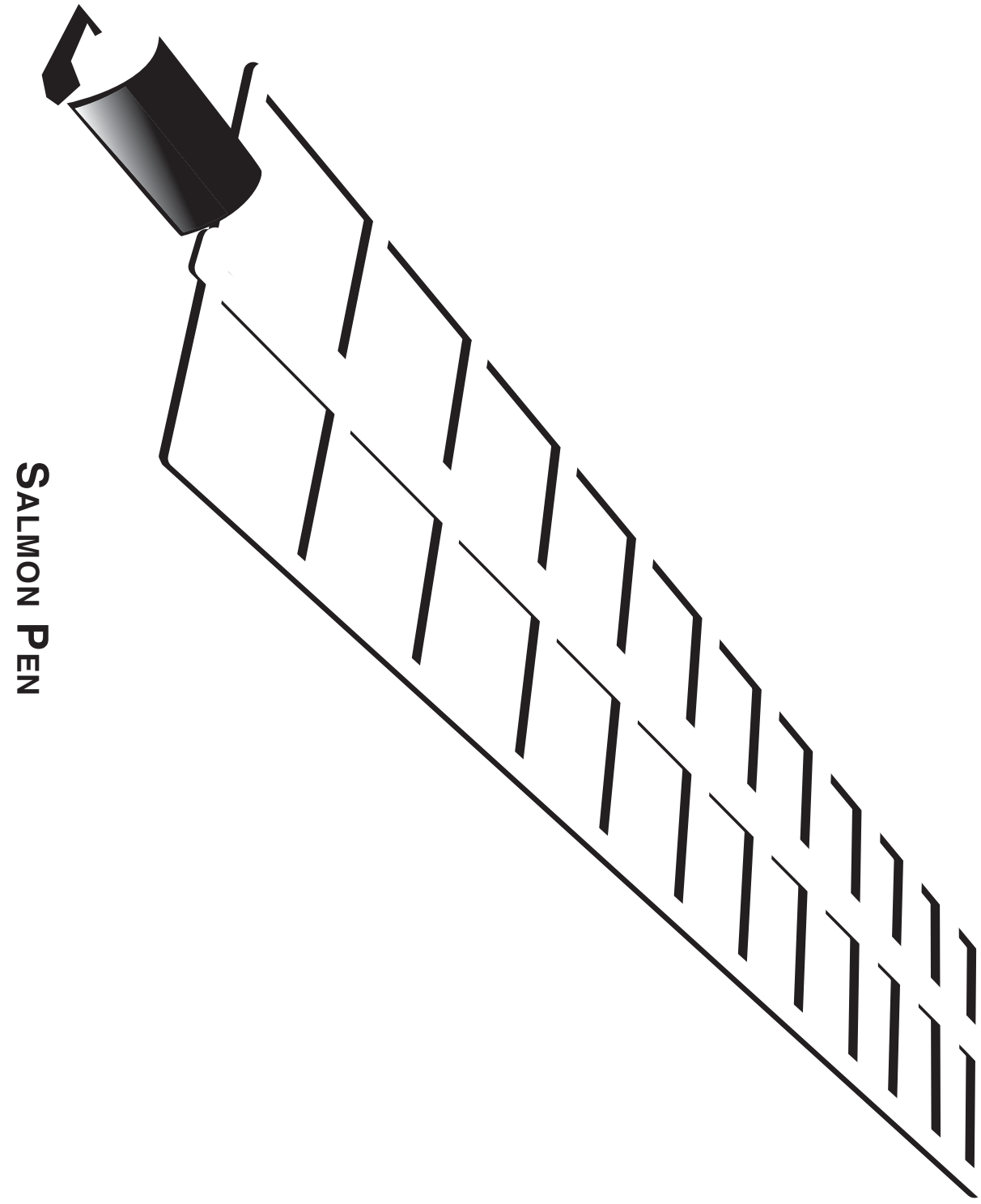
9. In 1976, Congress passed the Magnuson Fisheries Act which established a 200-mile "exclusive economic zone" (EEZ) off the U.S. coast. Within that zone, the U.S. claims the right to control commercial and recreational fishing activity. The law reduced competition from foreign commercial fishers and also began to restrict the open access that U.S. fishers have traditionally enjoyed. Today, of licensing and permitting increasingly reduce American fishers' access to U.S. fisheries.

10. Twenty years ago, Chile started a fish farming project in an attempt to diversify its economy. Today that project is a major industry, the world's second largest salmon producer. In a recent year, the industry totaled revenues of $964 million, and industry representatives brag that it still has room to grow.

11. The growing harvest of farm fish from Chile and Norway has affected Pacific salmon exporters. Growing demand is for boneless, skinless fillets, and commercial fishers find it increasingly hard to provide the large (over 6 lb.) fish desired in these specialty markets. Fish farmers are more than happy to step in, meet the demand, and ring up the higher prices the specialty markets offer.

12. Because of regulatory restrictions, there are only nine major salmon aquaculturalists in the state of Washington (compared to more than 100 in neighboring British Columbia), but these businesses produce 2 percent of the world's supply of farmed salmon.

13. The number of fishers in the Washington commercial salmon fishery has remained relatively constant over most of the last century, but in the early twentieth century the total catch was 3 to 4 times what it is today. Fishermen today use 3 to 4 times the equipment used by pre-WWI fishers.



NOTES

TIME ESTIMATE

10–30 minutes

MATERIALS

- Handouts / Visuals 1–2

THE MYSTERY

Rules or Rights?

For several decades, governments around the world have been attempting to stave off a disaster by regulating the fisheries through "limited entry." The limited entry approach combines fisher licensing with restrictions on: maximum allowable catch, types and quantity of gear, the number of fishers and/or fishing vessels, and length of fishing season. Overall, limited entry policies have been dismal failures, ineffective in stopping overfishing or the decline in fisher income.

During the 1980s and 1990s the governments of Canada, New Zealand, Iceland, Australia, and the United States abandoned limited entry regulation in some fisheries. The results have been spectacular. For example, since New Zealand abandoned limited entry regulation in 1986, fishers in the groundfish fishery have caught more and bigger fish, have tripled their revenues *and* have seen the condition of the snapper population steadily improve.

How can removing protective government regulation improve fishers' bottom line and help fish populations?

THE CLUES

The following statements provide students with information that may help them solve the mystery.

1. In 1980, the Canadian government's limited entry policy restricted the number of fishing boats in the British Columbian halibut fishery to 435 and the length of the halibut season to 65 days. By 1990, the season had been reduced to 6 days, but the fishers caught 50 percent more halibut than they had in 1980.

2. A limited entry system was instituted by the Pacific Fishery Management Council for the groundfish fishery off the coasts of Washington, Oregon, and California in 1994 to reduce the number of fishers and boats. Only six years later, in 2000, the Council reported that it would only take between 9 and 41 percent (depending on the type of fish) of the current fishing fleet to harvest the allowable catch in that fishery.

3. Individual transferable quotas (ITQs, also called IFQs or individual fishing quotas) allow a specific fisher to catch a specific percentage of the total allowable catch of a specific species. For example, a commercial fisher who holds 0.1 percent of the Southern Atlantic wreckfish fishery can catch 740 lbs. of red snapper if the total allowable catch is 740,000 pounds. Only holders of quotas can fish in the fishery. New fishers who want to enter the fishery or fishers who want to catch more than their quota must buy unused ITQs from other fishers.

4. In 1991, British Columbia began using IVQs (individual vessel quotas, which are similar to ITQs). Soon, the halibut fishing season expanded from 6 days per year to 245 days

without further depleting the fish population. Quota holders can fish whenever they want to during the extended season as long as they don't catch more fish than their quota allows. The U.S. northern Pacific halibut fishery did not use ITQs at that time.

5. During the period from 1991 to 1993, the market price (adjusted) of Canadian halibut was $.77 per lb. above the U.S. price. Because of the long (8-month) ITQ-based season, 94 percent of the British Columbia halibut was sold fresh. The regulated Alaska halibut fishery season became shorter and shorter as fishers reach the total allowable catch more quickly. Because most fish was harvested in a short (2 to 3 day) frenzied season instead of being spread out over a longer period, it had to be marketed frozen.

6. Before Australia adopted ITQs in the bluefin tuna fishery, fishers didn't wait for fish to mature. Only 13 percent of the tuna caught were of the large class size favored by the Japanese sashimi tuna market. After the adoption of ITQs, 35 percent were in that class, greatly increasing fisher income.

7. In the regulated Gulf of Mexico fishery, the number of shrimp boats doubled to 16,000 between 1966 and 1991. During that time, the boats became bigger, more powerful, and more technologically sophisticated as shrimpers raced to the catch, but yearly revenue still decreased by 75 percent to about $25,000 per year Analysts believe that it would only take one-third of the 16,000 vessels in that fishery to harvest the shrimp.

8. Endangered sea turtles are one of the casualties of the shrimp industry. Tangles with fishing nets and other gear or collisions with power boats exact a toll, and until the mid-1990s, large numbers were killed by shrimp trawlers. The results of a study of turtle excluder technologies were adopted by the U.S. shrimp industry and reduced turtle mortality rates by 97 percent.

9. From 1977 to 1990, no new entrants were allowed into the Mid-Atlantic surf clam fishery off the coast of New Jersey. In order to protect the clam population, a total allowable catch was instituted. Still, the remaining fishers competed furiously for the limited catch and by the late 1980s, surf clam boats were allowed to operate only 6 hours every other week. Boats and equipment sat idle in marinas the rest of the time.

10. ITQs were issued in the surf clam fishery in 1990. From 1990 to 1997, the number of active surf clam vessels declined from 128 to 50. From 1990 to 1994, the fishing hours per vessel increased from 154 hours to 1,400 hours. From 1990 to 1992, catch per vessel almost doubled.

11. In the 15 years after ITQs were instituted in the Icelandic herring fishery, the size of the fishing fleet was reduced by 85 percent as the less-efficient fishers found it more profitable to sell their ITQs than to continue fishing.

12. ITQs slowed the frenzy in the New Zealand fisheries. New Zealand snapper fishers now have the time to respond to the Japanese demand for high-quality whole fish through careful handling and sorting and the use of styrofoam containers with a water supply to deliver live fish.

13. From 1980 to 1994, the heavily regulated Alaskan halibut fishery was only open two or

three days a year. On those days, fishers with the best boats and equipment won the race for fish. However, damaged and lost gear, and even lost vessels and crew weren't uncommon because with such a short season, no one dared wait for storms to pass.

SAMPLE STUDENT ANSWER

A correct student solution to the mystery of how removing protective regulations can help a fishery should resemble this statement:

> *Because fishers in regulated fisheries have no right to part of the catch, they have to compete with each other to make a living. As a result, they race to get the fish and invest a great deal in boats and equipment that sits idle most of the time. When the fishery changes to ITQs, the better fishers buy out the others and because they no longer have to race to get the fish before someone else does, they don't fish in dangerous conditions and they can catch the bigger, older fish that bring more money in the market.*

WHICH CLUES SOLVE THE MYSTERY?

Property Rights: Property rights is the most important of the four economic reasoning tools for solving this mystery. ITQs, IFQs, and IVQs eliminate the rule of capture, in effect giving the fishers property rights to fish before the fish are dead. Clues 3, 4, 5, 6, 10, and 11 give examples of the beneficial changes that occur in fisheries in which fishers are given property rights to fish. In ITQ fisheries, the fish are no longer a commons and the tragedy of the commons is averted.

Incentives: The clues also highlight the perverse incentives that undermine the good intentions of regulated fisheries—even when entry into the fisheries is limited. Because fishers must compete with others to get any of the catch, there are huge incentives to invest in bigger, faster boats and more equipment. This phenomenon, called *overcapitalization,* is described in clues 1, 2, 5, 7, and 9. The regulators would reduce the length of the season and the fishers would buy more equipment to catch the fish more quickly.

Choice: An interesting consequence of the choice to run a regulated fishery instead of using ITQs is described in clue 5 which explains why Americans eat frozen fish instead of fresh. Clue 13 describes a more troubling consequence—the tendency of fishers to go out in dangerous conditions because the cost is too great to forgo any time in the very short fishing season.

Voluntary Trade: As indicated by clues 10 and 11, voluntary trade in ITQ-based fisheries allows the overcapitalization problem to solve itself. When a fisher owns a share of the fish population, he or she can compare costs and benefits and decide whether or not it's worthwhile to continue to fish, to sell quota shares or to buy more. When an exchange is made, both parties are better off—and the fishery benefits in a way that it could not with limited entry regulation. Clue 12 offers an example of how ITQs enhance the voluntary trade that makes both New Zealand fishers and Japanese consumers better off.

Clue 8 does not help to explain how substituting ITQs for regulations benefits the fishery or the fishers.

ADDITIONAL COMMENTS

The New Zealand and Iceland offshore fishing

areas are unusual because of their large and expanding fish populations. In most ocean fisheries the fish populations are declining rapidly due to overfishing. In the territorial waters of New Zealand and Iceland, and in some fisheries off the west coast of the United States, fish populations that were once dwindling have recovered. Individual transferable quotas (ITQs) were introduced in the early 1980s. These ITQs give fishers in a particular region the right to catch fixed percentages of the total population of a single species of fish, and those without ITQs cannot enter the fishery. Since the introduction of the ITQs, the race to capture has slowed, allowing fish populations to begin recovery.

Quite simply, an ITQ transfers a property right in fish from the state to the fisher. The fish remain wild, but fishers have a property right to harvest a percentage of the catch. These property rights can be traded or sold, so those who wish to enter the fishery or fishers who want a larger catch can purchase quota rights. Additionally, the ITQs tend to end overcapitalization and give fishers an incentive to help protect the fish from overharvesting. Because they have a stake in the condition of the fish population, fishers turn in others who threaten the value of the ITQs.

MORE INFORMATION

For suggestions on how to better preserve wild fish populations through use of ITQs and voluntary arrangements, teachers can consult *PERC Policy Series* papers PS-7 and PS-19:

Donald R. Leal, "Community-Run Fisheries: Avoiding the 'Tragedy of the Commons,'" *PERC Policy Series*, PS-7, 1996. Online: www.perc.org/publications/policyseries/community_full.htm.

Donald R. Leal, "Homesteading the Oceans: The Case for Property Rights in U.S. Fisheries." *PERC Policy Series*, PS-19, 2000. Online: www.perc.org/publications/policyseries/homestead.html

Donald R. Leal, *Fencing the Fishery: A Primer on Ending the Race for Fish.* Bozeman, MT: PERC, 2002. Online: www.perc.org/publications/guidespractical/fence_fishery.html.

For further discussion of property rights-based fisheries projects and proposals, see:

Terry L. Anderson and Donald R. Leal, "Homesteading the Oceans," in *Free Market Environmentalism*, revised ed. New York: Palgrave, 2001, pp. 107–21.

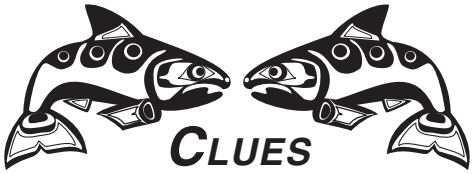
Kent Jeffreys, "Rescuing the Oceans," in *The True State of the Planet*, edited by Ronald Bailey. New York: Free Press, 1995, pp. 296–338.

MYSTERY 4: *RULES OR RIGHTS?*

For several decades, governments around the world have been attempting to stave off a disaster by regulating the fisheries through "limited entry." The limited entry approach combines fisher licensing with restrictions on: maximum allowable catch, types and quantity of gear, the number of fishers and/or fishing vessels, and length of fishing season. Overall, limited entry policies have been dismal failures, ineffective in stopping overfishing or the decline in fisher income.

During the 1980s and 1990s the governments of Canada, New Zealand, Iceland, Australia, and the United States abandoned limited entry regulation in some fisheries. The results have been spectacular. For example, since New Zealand abandoned limited entry regulation in 1986, fishers in the groundfish fishery have caught more and bigger fish, have tripled their revenues *and* have seen the condition of the snapper population steadily improve.

**How can *removing*
protective government regulation
improve fishers' bottom line
and help fish populations?**



1. In 1980, the Canadian government's limited entry policy restricted the number of fishing boats in the British Columbian halibut fishery to 435 and the length of the halibut season to 65 days. By 1990, the season had been reduced to 6 days, but the fishers caught 50 percent more halibut than they had in 1980.

2. A limited entry system was instituted by the Pacific Fishery Management Council for the groundfish fishery off the coasts of Washington, Oregon, and California in 1994 to reduce the number of fishers and boats. Only six years later, in 2000, the Council reported that it would only take between 9 and 41 percent (depending on the type of fish) of the current fishing fleet to harvest the allowable catch in that fishery.

3. Individual transferable quotas (ITQs also called IFQs, or individual fishing quotas) allow a specific fisher to catch a specific percentage of the total allowable catch of a specific species. For example, a commercial fisher who holds 0.1 percent of the Southern Atlantic wreckfish fishery can catch 740 lbs. of red snapper if the total allowable catch is 740,000 pounds. Only holders of quotas can fish in the fishery. New fishers who want to enter the fishery or fishers who want to catch more than their quota must buy unused ITQs from other fishers.

4. In 1991, British Columbia began using IVQs (individual vessel quotas, which are similar to ITQs). Soon, the halibut fishing season expanded from 6 days per year to 245 days without further depleting the fish population. Quota holders can fish whenever they want to during the extended season as long as they don't catch more fish than their quota allows. The U.S. northern Pacific halibut fishery did not use ITQs at that time.

CLUES

(continued)

5. During the period from 1991 to 1993, the market price (adjusted) of Canadian halibut was $.77 per lb. above the U.S. price. Because of the long (8-month) ITQ-based season, 94 percent of the British Columbia halibut was sold fresh. The regulated Alaska halibut fishery season became shorter and shorter as fishers reach the total allowable catch more quickly. Because most fish was harvested in a short (2 to 3 day) frenzied season instead of being spread out over a longer period, it had to be marketed frozen.

6. Before Australia adopted ITQs in the bluefin tuna fishery, fishers didn't wait for fish to mature. Only 13 percent of the tuna caught were of the large class size favored by the Japanese sashimi tuna market. After the adoption of ITQs, 35 percent were in that class, greatly increasing fisher income.

7. In the regulated Gulf of Mexico fishery, the number of shrimp boats doubled to 16,000 between 1966 and 1991. During that time, the boats became bigger, more powerful, and more technologically sophisticated as shrimpers raced to the catch, but yearly revenue still decreased by 75 percent to about $25,000 per year Analysts believe that it would only take one-third of the 16,000 vessels in that fishery to harvest the shrimp.

8. Endangered sea turtles are one of the casualties of the shrimp industry. Tangles with fishing nets and other gear or collisions with power boats exact a toll, and until the mid-1990s, large numbers were killed by shrimp trawlers. The results of a study of turtle excluder technologies were adopted by the U.S. shrimp industry and reduced turtle mortality rates by 97 percent.

CLUES

(continued)

9. From 1977 to 1990, no new entrants were allowed into the Mid-Atlantic surf clam fishery off the coast of New Jersey. In order to protect the clam population, a total allowable catch was instituted. Still, the remaining fishers competed furiously for the limited catch and by the late 1980s, surf clam boats were allowed to operate only 6 hours every other week. Boats and equipment sat idle in marinas the rest of the time.

10. ITQs were issued in the surf clam fishery in 1990. From 1990 to 1997, the number of active surf clam vessels declined from 128 to 50. From 1990 to 1994, the fishing hours per vessel increased from 154 hours to 1,400 hours. From 1990 to 1992, catch per vessel almost doubled.

11. In the 15 years after ITQs were instituted in the Icelandic herring fishery, the size of the fishing fleet was reduced by 85 percent as the less-efficient fishers found it more profitable to sell their ITQs than to continue fishing.

12. ITQs slowed the frenzy in the New Zealand fisheries. New Zealand snapper fishers now have the time to respond to the Japanese demand for high-quality whole fish through careful handling and sorting and the use of styrofoam containers with a water supply to deliver live fish.

13. From 1980 to 1994, the heavily regulated Alaskan halibut fishery was only open two or three days a year. On those days, fishers with the best boats and equipment won the race for fish. However, damaged and lost gear, and even lost vessels and crew weren't uncommon because with such a short season, no one dared wait for storms to pass.

TIME ESTIMATE

10–30 minutes

MATERIALS

- Handouts / Visuals 1–2

THE MYSTERY

What's Wrong with These Pictures?

Picture 1: Rocky Webb, farmer, and Andrew Purkey, environmentalist, shaking hands and grinning on the banks of Buck Hollow Creek. The creek, a tributary of the Deschutes River in Oregon, used to boil with the annual steelhead spawning run, but by 1990 there were fewer than 30 pair of fish. Rocky Webb irrigates hay fields with water from Buck Hollow Creek, drawing down the flows needed to sustain the steelhead runs. Andrew Purkey represents the Oregon Water Trust, an organization dedicated to restoring the steelhead population. Shouldn't these guys be enemies?

Picture 2: Rancher Tom Milesnick looks up from work on his ranch to wave at a fisherman traipsing across his field. On Milesnick's ranch near Belgrade, Montana, the Thompson and Benhart spring creeks rise to the surface. Too busy raising cattle to do much fishing himself, Milesnick nonetheless spent six years and $70,000 renovating the streams. Since the 1980s, he's welcomed fly-fishing strangers from anywhere to fish his five miles of prime trout habitat.

The pictures seem strange because history has proven the truth of the last half of a saying attributed to Mark Twain, "Whiskey is for drinkin' and water is for fightin'." Water wars are the modern version of the old range wars between cattle and sheep men. Rural farmers and ranchers use the water for their herds and crops. Environmentalists and tourists from the cities want it left in the streams. Throughout most of the late twentieth century, farmers and fishers have been opponents as western state legislatures wrangle over water issues.

The issues haven't changed, and there's no more water than there has ever been, so why aren't the fishermen and farmers in these new "pictures" fighting instead of friendly?

THE CLUES

The following statements provide students with information that may help them solve the mystery.

1. Rocky Webb likes steelhead. Like other ranchers in the area, he remembers seeing steelhead runs in the creek when he was a kid.

2. West of the Mississippi River, water law in the United States is based on prior appropriation, also known as first-in-time, first-in-right. It means that regardless of location upstream or downstream, rights to water must be satisfied in the order that the claims were established. To establish a prior appropriation right, a user must divert the water from the streambed. Western farmers often do this by opening headgates and flooding their fields.

3. It is typical for western states to have use-it-or-lose-it provisions in their water law, meaning that a rights holder who doesn't use

his or her water loses the right to it. The right reverts back to the state.

4. Along the Ruby River in Montana in 1987, a dry winter meant no snow-melt runoff. That combined with little spring rain resulted in heavy diversions of Ruby River water by irrigators along a one-and-a-half-mile stretch of prime trout habitat. Thousands of trout stranded in overheated pools died while water stood inches deep in flood-irrigated fields along the river. The water that would have saved the trout was worth about $4000 in crop losses. A major trout fishing organization would have gladly paid the price, but the irrigators didn't sell.

5. In 1988, the Montana legislature passed a law allowing the Department of Fish, Wildlife and Parks to suspend the use-it-or-lose it requirement so wildlife officials could bargain with farmers to leave their water in the stream to improve fish habitat. Farmers first opposed this legislation because they were afraid that environmental and recreational interests would buy up all the agricultural water. The final legislation allowed leasing rather than purchase of water, reducing the farmers' fear.

6. Most western states allow water rights only for beneficial uses. Beneficial uses generally include things like public water supply, agriculture, industrial use, mining, etc. Only recently have a few states added recreation and conservation as beneficial uses and only 5 western states include instream use. Montana added it in 1988. Only Alaska allows individuals to hold instream use rights. Washington and Colorado allow some transfer of rights for instream use, but instream rights can only be held by state agencies.

7. Water rights are use rights rather than ownership rights. Holders of water rights usually are not allowed to resell them or to sell any surplus water. Idaho state law prohibits *any* transfer of water rights to out-of-state users, even to protect fish populations.

8. The Oregon Water Trust (OWT) was formed in 1993 with the specific mission of restoring water flow and protecting fish habitat. OWT is funded by private donations such as a $370,000 grant from the Northwest Area Foundation of St. Paul, Minnesota.

9. Ed Mayfield's main interest isn't fish; it's quarter horses. He raises show horses on his ranch on Little Butte Creek in Oregon. The creek is a tributary of the Rogue River and an important spawning stream for steelhead. When Mayfield bought the ranch, it came with water rights that dated to 1895. A water right that old puts him pretty high on the prior appropriation list. Since he didn't have to worry about getting water, Mayfield flood-irrigated about 20 acres of hay to feed his horses. Despite his secure water right, he recently switched to more efficient sprinkler irrigation from the Medford Irrigation Canal because the Oregon Water Trust (OWT) paid the $20,000 to switch his equipment. In return, he gave OWT his 1895 water right. OWT intends not to use the water but to leave it in Little Butte Creek.

10. Representing the Oregon Water Trust, Andrew Purkey bought $6,600 worth of hay for Rocky Webb. In return, Webb agreed *not* to irrigate one of his pastures. Oregon law allows Webb to make the lease without losing his future claim to the water.

11. The Nature Conservancy (TNC) is a nonprofit

organization that funds its activities with private donations. TNC prefers to purchase or lease land and water rights rather than lobby legislatures or fight with those who don't share its environmental priorities. Therefore, the organization's success in preserving what it calls the Earth's "Last Great Places" depends on the framework of property rights where those great places are located.

12. The Nature Conservancy (TNC) recently purchased a Colorado ranch that had water rights for irrigation. TNC wanted to leave the water in the river to improve the environment, but that would have caused the loss of its water right because the right required diversion. Changes in the Colorado law allowed the organization to contract with the state; it will hold the instream right for TNC and not appropriate the water to another user.

13. Most rivers in the western United States are over-appropriated. This means that water rights have been distributed as if the rivers were always at flood stage rather than based on normal flow rates. During years of normal or below-normal precipitation and runoff, water rights with the most recent dates usually aren't filled.

14. Rod fees for one day of fishing on private property in Montana range from $50 to $100 per rod per day and access is limited. There are no rod fees to fish in rivers and streams on public lands and any licensed fisherman may participate.

SAMPLE STUDENT ANSWER

A correct student solution to the mystery of why the farmers and fishermen aren't fighting should resemble this statement:

> *The farmers and fishermen were able to make voluntary exchanges in which both received benefits. Rocky Webb received hay in compensation for his lost crop, and environmentalists gladly paid to gain the benefit of helping restore steelhead. Tom Milesnick gets at least $50 a day to let fishers use his property and the fishers gladly pay because they value the fishing opportunity so highly. In both cases, these voluntary trades were possible because the law allowed the exchanges without a loss of rights.*

WHICH CLUES SOLVE THE MYSTERY?

Voluntary Trade: Voluntary trade or exchange is the most important of the four tools of economic reasoning in solving this mystery. Clues 9, 10, 12, and 14 tell stories of conditions that allowed voluntary exchanges in which both parties benefited. Clue 4 tells of a voluntary exchange that did not take place (and clues 5 and 6 tell why one party saw no benefit in making the exchange). Increasingly, we are beginning to see efforts to restore fish populations based on what are called "willing-buyer, willing-seller" exchanges rather than the acrimonious public disputes that were common in the 1970s and 1980s. Instead of arguing in the media and lobbying government, environmental organizations are looking for ways to advance their agenda without shifting the burden of cost to others who don't want to bear it.

Property Rights: Property rights shape the "rules of the game" that determine whether the volun-

tary exchanges that will improve fish habitat will take place. Clues 2 and 3 explain the rules that prevented exchanges between water rights holders and environmentalists, and clue 4 shows the consequences of those rules. Clues 5, 6, and 11 tell of changes in the rules of the game that facilitated voluntary exchanges between farmers and fishers.

Incentives: Clue 14 describes the strong incentive Tom Milesnick has for investing time and money to improve trout habitat on his land. Clues 9 and 10 outline the incentives OWT is able to offer farmers to reduce their water usage for irrigation.

Clues 1, 7, 8, and 13 offer interesting (and related) information, but don't contribute directly to solving the mystery.

ADDITIONAL COMMENTS

The environmental movement of the last quarter of the twentieth century tended to polarize opinion and divide communities. Discussions degenerated into argument and accusation rather than efforts at problem solving. Fish kills like that on the Ruby River were often blamed on bad people committing immoral acts. In reality, many failures like declining fish habitat were stymied by the "rules of the game." The framework of water law and property rights that served the West well in the nineteenth century didn't provide for the new interests and priorities of the twentieth.

As people and organizations looked for ways to achieve their goals while avoiding conflict, they proposed changes in the laws and rules that interfered with constructive relationships. That process of experimentation and legal evolution continues and shows great promise. We have long recognized the wealth-creating potential of voluntary exchange, but we're just beginning to explore its promise for enhancing our environmental wealth.

MORE INFORMATION

For further discussion of "enviro-capitalism" and "willing-seller, willing-buyer" environmental exchanges in trout, steelhead, and salmon fisheries, see:

Terry L. Anderson and Donald R. Leal, *Enviro-Capitalists: Doing Good While Doing Well.* Lanham, MD: Rowman & Littlefield Publishers, Inc., 1997.

Terry L. Anderson and Donald R. Leal, *Free Market Environmentalism*, revised ed. New York: Palgrave, 2001.

Kris Kumlien, "How the Milesnicks Found Markets." *PERC Reports*, June, 2002, pp. 11–13. Online: www.perc.org/publications/percreports/summary_june2002.html.

Donald R. Leal, *Fencing the Fishery: A Primer on Ending the Race for Fish*. Bozeman, MT: PERC, 2002. Online: www.perc.org/publications/guidespractical/fence_fishery.html.

MYSTERY 5:
WHAT'S WRONG WITH THESE PICTURES?

Picture 1: Rocky Webb, farmer, and Andrew Purkey, environmentalist, shaking hands and grinning on the banks of Buck Hollow Creek. The creek, a tributary of the Deschutes River in Oregon, used to boil with the annual steelhead spawning run, but by 1990 there were fewer than 30 pair of fish. Rocky Webb irrigates hay fields with water from Buck Hollow Creek, drawing down the flows needed to sustain the steelhead runs. Andrew Purkey represents the Oregon Water Trust, an organization dedicated to restoring the steelhead population. Shouldn't these guys be enemies?

Picture 2: Rancher Tom Milesnick looks up from work on his ranch to wave at a fisherman traipsing across his field. On Milesnick's ranch near Belgrade, Montana, the Thompson and Benhart spring creeks rise to the surface. Too busy raising cattle to do much fishing himself, Milesnick nonetheless spent six years and $70,000 renovating the streams. Since the 1980s, he's welcomed fly-fishing strangers from anywhere to fish his five miles of prime trout habitat.

MYSTERY 5:
WHAT'S WRONG WITH THESE PICTURES?

(continued)

The pictures seem strange because history has proven the truth of the last half of a saying attributed to Mark Twain, "Whiskey is for drinkin' and water is for fightin'." Water wars are the modern version of the old range wars between cattle and sheep men. Rural farmers and ranchers use the water for their herds and crops. Environmentalists and tourists from the cities want it left in the streams. Throughout most of the late twentieth century, farmers and fishers have been opponents as western state legislatures wrangle over water issues.

The issues haven't changed, and there's no more water than there has ever been, so why aren't the fishermen and farmers in these new "pictures" fighting instead of friendly?

CLUES

1. Rocky Webb likes steelhead. Like other ranchers in the area, he remembers seeing steelhead runs in the creek when he was a kid.

2. West of the Mississippi River, water law in the United States is based on prior appropriation, also known as first-in-time, first-in-right. It means that regardless of location upstream or downstream, rights to water must be satisfied in the order that the claims were established. To establish a prior appropriation right, a user must divert the water from the streambed. Western farmers often do this by opening headgates and flooding their fields.

3. It is typical for western states to have use-it-or-lose-it provisions in their water law, meaning that a rights holder who doesn't use his or her water loses the right to it. The right reverts back to the state.

4. Along the Ruby River in Montana in 1987, a dry winter meant no snow-melt runoff. That combined with little spring rain resulted in heavy diversions of Ruby River water by irrigators along a one and a half mile stretch of prime trout habitat. Thousands of trout stranded in overheated pools died while water stood inches deep in flood irrigated fields along the river. The water that would have saved the trout was worth about $4000 in crop losses. A major trout fishing organization would have gladly paid the price, but the irrigators didn't sell.

5. In 1988, the Montana legislature passed a law allowing the Department of Fish, Wildlife and Parks to suspend the use-it-or-lose-it requirement so wildlife officials could bargain with farmers to leave their water in the stream to improve fish habitat. Farmers first opposed this legislation because they were afraid that environmental and recreational interests would buy up all the agricultural water. The final legislation allowed leasing rather than purchase of water, reducing the farmers' fear.

CLUES

(continued)

6. Most western states allow water rights only for beneficial uses. Beneficial uses generally include things like public water supply, agriculture, industrial use, mining, etc. Only recently have a few states added recreation and conservation as beneficial uses and only 5 western states include instream use. Montana added it in 1988. Only Alaska allows individuals to hold instream use rights. Washington and Colorado allow some transfer of rights for instream use, but instream rights can only be held by state agencies.

7. Water rights are use rights rather than ownership rights. Holders of water rights usually are not allowed to resell them or to sell any surplus water. Idaho state law prohibits *any* transfer of water rights to out-of-state users, even to protect fish populations.

8. The Oregon Water Trust (OWT) was formed in 1993 with the specific mission of restoring water flow and protecting fish habitat. OWT is funded by private donations such as the $370,000 grant from the Northwest Area Foundation of St. Paul, Minnesota.

9. Ed Mayfield's main interest isn't fish; it's quarter horses. He raises show horses on his ranch on Little Butte Creek in Oregon. The creek is a tributary of the Rogue River and an important spawning stream for steelhead. When Mayfield bought the ranch, it came with water rights that dated to 1895. A water right that old puts him pretty high on the prior appropriation list. Since he didn't have to worry about getting water, Mayfield flood-irrigated about 20 acres of hay to feed his horses. Despite his secure water right, he recently switched to more efficient sprinkler irrigation from the Medford Irrigation Canal because the Oregon Water Trust (OWT) paid the $20,000 to switch his equipment. In return, he gave OWT his 1895 water right. OWT intends not to use the water but to leave it in Little Butte Creek.

CLUES

(continued)

10. Representing the Oregon Water Trust, Andrew Purkey bought $6,600 worth of hay for Rocky Webb. In return, Webb agreed *not* to irrigate one of his pastures. Oregon law allows Webb to make the lease without losing his future claim to the water.

11. The Nature Conservancy (TNC) is a nonprofit organization that funds its activities with private donations. TNC prefers to purchase or lease land and water rights rather than lobby legislatures or fight with those who don't share its environmental priorities. Therefore, the organization's success in preserving what it calls the Earth's "Last Great Places" depends on the framework of property rights where those great places are located.

12. The Nature Conservancy (TNC) recently purchased a Colorado ranch that had water rights for irrigation. TNC wanted to leave the water in the river to improve the environment, but that would have caused the loss of its water right because the right required diversion. Changes in the Colorado law allowed the organization to contract with the state; it will hold the instream right for TNC and not appropriate the water to another user.

13. Most rivers in the western United States are over-appropriated. This means that water rights have been distributed as if the rivers were always at flood stage rather than based on normal flow rates. During years of normal or below-normal precipitation and runoff, water rights with the most recent dates usually aren't filled.

14. Rod fees for one day of fishing on private property in Montana range from $50 to $100 per rod per day and access is limited. There are no rod fees to fish in rivers and streams on public lands and any licensed fisherman may participate.

NOTES

TIME ESTIMATE

10–30 minutes

MATERIALS

- Handouts / Visuals 1–2

THE MYSTERY

They Can't Run and They Can't Hide—So Why Are They Still Here?

The United Nations Food and Agricultural Organization has sounded the alert: About 75 percent of the world's commercial fish populations are either fully fished or overfished. What's surprising is that two exceptions—fisheries that aren't declining, that is—are oysters and lobsters. Neither of those species is noted for speed or for traveling great distances! It might be reasonable to expect that fish populations escaping the threat of commercial extinction are the fastest swimmers or those that roam the farthest, but oysters and lobsters?! What's up with that? It's not that oyster beds and lobster fisheries are well-kept secrets. Both communities have active commercial fisheries.

Why are the populations of oysters in Willapa Bay, Washington, and lobsters off Matinicus Island, Maine, healthy and thriving when swifter, farther-ranging salmon and cod are in serious decline?

THE CLUES

The following statements provide students with information that may help them solve the mystery.

1. Willapa Bay, off the southwest coast of Washington state, has a long history of oyster harvesting. From 1850 to 1870, Willapa Bay produced most of the oysters eaten in San Francisco. Oysterville, the first city in the Willapa Bay region, was incorporated in 1852. During the 1850s and 1860s, it was the wealthiest town in Washington and was nicknamed the "Baltimore of the West."

2. Oysters are an important commercial product in the Chesapeake Bay near Baltimore. The total number of oysters in the Chesapeake has fallen drastically over the years and, despite the efforts of governments and environmental organizations, has not recovered.

3. By the late 1860s, the shiploads of oysters sent to San Francisco were beginning to take a toll on the Willapa oyster beds. The population declined rapidly and oysters were nearly extinct in the bay by 1870.

4. The life cycle of the oyster begins with a free-swimming larval stage that eventually attaches to a hard substance like discarded oyster shells and forms an oyster embryo called a spat. Some spat grow into adult oysters capable of reproducing.

5. A 1979 economic analysis looked at data gathered from 1945 to 1970 in Louisiana and Mississippi. Oystermen in Louisiana, where beds are private leases, earned an average of $3,207 per year. Their Mississippi counterparts, working in open-access public beds under government management, averaged

$807 per year. The data also showed that the Mississippi beds were harvested earlier in the season than the Louisiana beds.

6. As the native oyster beds in Willapa Bay declined near the end of the nineteenth century, some oystermen began staking areas of the tidelands and cultivating oysters. They imported large Pacific oysters from Japan. They experimented, attaching oysters to wooden stakes driven into the tidelands, or to suspended nets. Some even started hatcheries.

7. Washington became a state in 1889. In 1891 the state legislature passed the Callow Act, which allowed oyster growers to purchase the tidelands they had been harvesting. Before the program ended, 60 percent of the tidelands available for shellfish production had been purchased.

8. During the last decades of the twentieth century, the Pacific Oyster Growers Association dedicated both time and money to inform and then work with the Washington legislature to control discharge into Willapa Bay from lumber companies and pulp mills. Additionally, sewage discharge into the bay was reduced after the threat of lawsuits from private oyster bed owners.

9. Today, one of every six oysters produced in the United States is a Pacific oyster from Willapa Bay. However, there are no oysters on public coastal lands. They were harvested to extinction years ago.

10. Most of the lobstermen in the Matinicus Island, Maine, lobster fishery work alone in small boats, using their specialized knowledge of the area to place their traps. Although they work alone, they belong to harbor gangs. These gangs damage or cut loose the lobster pots of outsiders who intrude on the fishery.

11. An economic study of the Matinicus fishery suggests that among the reasons it hasn't been overharvested are: the predictable habits and distribution of the lobsters; the relatively small geographic size of the fishery; and the fact that local knowledge of the fishery keeps the Matinicus fishers' costs low.

12. In 1983, the U.S. government limited to 15 the number of permits to trap in the 1000-mile-long Hawaiian lobster fishery. To further protect the lobster population, total allowable catch limits were set, beginning in 1991. Fishers could set traps anywhere in the fishery so opening day was always a race with the biggest, fastest vessels getting the best spots. Predictably, to protect the population, the season became shorter and shorter. By 1997 it lasted only 22 days.

1 3. Economist Frederick Bell conducted a 1966 study of a declining New England northern lobster fishery. He calculated that the fishery could produce 17.2 million pounds of lobster on an ongoing basis—an amount that could have been efficiently harvested with 433,000 lobster pots. His data revealed that the lobstermen invested in too much capital (891,000 traps) and harvested about 50 percent too many lobster (25 million pounds).

SAMPLE STUDENT ANSWER

A correct student solution to the mystery of why the Willapa Bay oysters and Matinicus Island lobsters haven't disappeared should resemble this statement:

> *In both the Willapa and Matinicus fisheries property rights have been established. Because the fishers don't have to worry about someone else taking the oysters or lobsters, they avoid the tragedy of the commons and manage the fisheries to sustain the populations.*

WHICH CLUES SOLVE THE MYSTERY?

Property rights and incentives are the tools of economic reasoning most useful in solving the mystery of the nondisappearing lobster and oysters. Because students are aware of the tragedy of the commons from earlier mysteries, they know that the absence of overfishing indicates the existence of secure property rights.

Property Rights: Clues 7 and 10 establish that property rights—formal in one case and informal in the other—do exist. Clues 3, 5, and 9 reinforce student understanding that common property arrangements lead to overharvesting, regardless of the species.

Incentives: Clues 2, 12, and 13 establish that in commons or regulated lobster and oyster fisheries perverse incentives encourage both overharvesting and overcapitalization, neither of which is present in Willapa Bay or Matinicus Island. Clues 5, 6, and 8 provide evidence that ownership creates incentives to care for the fishery.

Choice: Clue 8 tells us that one of the consequences of people's choice to farm oysters in Willapa Bay is a cleaner bay for all users.

Clues 1, 4, and 11 don't aid in solving the mystery.

ADDITIONAL COMMENTS

Oysters in Willapa Bay were a commons from 1850 to the 1880s, and they were predictably overharvested. In the 1880s, some oystermen began using areas of the Willapa Bay to plant and nurture oysters for harvesting even though they didn't own the tidelands they were using. After Washington became a state, oyster farmers successfully lobbied the state legislature to let them purchase their "squatter rights" to the land; thus, property rights were legally established.

Because the farmers had property rights and could prevent others from harvesting, they had an incentive to care for the oysters and to sustain the population instead of overharvesting. They also had an incentive to experiment and improve their product and to oppose pollution of the water in the bay because it harmed their oysters.

While the Willapa Bay oystermen had *formal* property rights, harbor gangs effectively established *informal* property rights in the Matinicus Island lobster fishery. Like the oystermen, they felt secure in their control of the catch, so they didn't overharvest the lobsters. Also, they didn't fall victim to the overcapitalization that lowers the income of fishers who must race to harvest the stock before someone else does.

MORE INFORMATION

For more background on property rights in oysters, see:

Michael De Alessi, "Oysters and Willapa Bay." Washington, DC: Competitive Enterprise Institute, 1996. Online: http://www.cei.org/gencon/025,01364.cfm.

For more background on lobster fisheries and property rights in fishing generally, see:

Donald R. Leal, "Homesteading the Oceans: The Case for Property Rights in U.S. Fisheries," *PERC Policy Series,* PS-19, August 2000. Online: www.perc.org/publications/policyseries/homestead.html.

Donald R. Leal, *Fencing the Fishery—A Primer on Ending the Race for Fish*. Bozeman, MT: PERC, 2002. Online: www.perc.org/publications/guidespractical/fence_fishery.html.

MYSTERY 6:
THEY CAN'T RUN AND THEY CAN'T HIDE—SO WHY ARE THEY STILL HERE?

The United Nations Food and Agricultural Organization has sounded the alert: About 75 percent of the world's commercial fish populations are either fully fished or overfished. What's surprising is that two exceptions—fisheries that aren't declining, that is—are oysters and lobsters. Neither of those species is noted for speed or for traveling great distances! It might be reasonable to expect that fish populations escaping the threat of commercial extinction are the fastest swimmers or those that roam the farthest, but oysters and lobsters?! What's up with that? It's not that oyster beds and lobster fisheries are well-kept secrets. Both communities have active commercial fisheries.

Why are the populations of oysters in Willapa Bay, Washington, and lobsters off Matinicus Island, Maine, healthy and thriving when swifter, farther-ranging salmon and cod are in serious decline?

CLUES

1. Willapa Bay, off the southwest coast of Washington state, has a long history of oyster harvesting. From 1850 to 1870, Willapa Bay produced most of the oysters eaten in San Francisco. Oysterville, the first city in the Willapa Bay region, was incorporated in 1852. During the 1850s and 1860s, it was the wealthiest town in Washington and was nicknamed the "Baltimore of the West."

2. Oysters are an important commercial product in the Chesapeake Bay near Baltimore. The total number of oysters in the Chesapeake has fallen drastically over the years and, despite the efforts of governments and environmental organizations, has not recovered.

3. By the late 1860s, the shiploads of oysters sent to San Francisco were beginning to take a toll on the Willapa oyster beds. The population declined rapidly and oysters were nearly extinct in the bay by 1870.

4. The life cycle of the oyster begins with a free-swimming larval stage that eventually attaches to a hard substance like discarded oyster shells and forms an oyster embryo called a spat. Some spat grow into adult oysters capable of reproducing.

5. A 1979 economic analysis looked at data gathered from 1945 to 1970 in Louisiana and Mississippi. Oystermen in Louisiana, where beds are private leases, earned an average of $3,207 per year. Their Mississippi counterparts, working in open-access public beds under government management, averaged $807 per year. The data also showed that the Mississippi beds were harvested earlier in the season than the Louisiana beds.

CLUES

(continued)

6. As the native oyster beds in Willapa Bay declined near the end of the nineteenth century, some oystermen began staking areas of the tidelands and cultivating oysters. They imported large Pacific oysters from Japan. They experimented, attaching oysters to wooden stakes driven into the tidelands, or to suspended nets. Some even started hatcheries.

7. Washington became a state in 1889. In 1891 the state legislature passed the Callow Act, which allowed oyster growers to purchase the tidelands they had been harvesting. Before the program ended, 60 percent of the tidelands available for shellfish production had been purchased.

8. During the last decades of the twentieth century, the Pacific Oyster Growers Association dedicated both time and money to inform and then work with the Washington legislature to control discharge into Willapa Bay from lumber companies and pulp mills. Additionally, sewage discharge into the bay was reduced after the threat of lawsuits from private oyster bed owners.

9. Today, one of every six oysters produced in the United States is a Pacific oyster from Willapa Bay. However, there are no oysters on public coastal lands. They were harvested to extinction years ago.

10. Most of the lobstermen in the Matinicus Island, Maine, lobster fishery work alone in small boats, using their specialized knowledge of the area to place their traps. Although they work alone, they belong to harbor gangs. These gangs damage or cut loose the lobster pots of outsiders who intrude on the fishery.

CLUES

(continued)

11. An economic study of the Matinicus fishery suggests that among the reasons it hasn't been overharvested are: the predictable habits and distribution of the lobsters; the relatively small geographic size of the fishery; and the fact that local knowledge of the fishery keeps the Matinicus fishers' costs low.

12. In 1983, the U.S. government limited to 15 the number of permits to trap in the 1000-mile-long Hawaiian lobster fishery. To further protect the lobster population, total allowable catch limits were set, beginning in 1991. Fishers could set traps anywhere in the fishery so opening day was always a race with the biggest, fastest vessels getting the best spots. Predictably, to protect the population, the season became shorter and shorter. By 1997 it lasted only 22 days.

13. Economist Frederick Bell conducted a 1966 study of a declining New England northern lobster fishery. He calculated that the fishery could produce 17.2 million pounds of lobster on an ongoing basis—an amount that could have been efficiently harvested with 433,000 lobster pots. His data revealed that the lobstermen invested in too much capital (891,000 traps) and harvested about 50 percent too many lobsters (25 million pounds).

TIME ESTIMATE

10–30 minutes

MATERIALS

- Handouts / Visuals 1–3

THE MYSTERY

Strange But True

By now you've solved enough mysteries to qualify as the Sherlock Holmes of fishing, but here's one last challenge. Below are several paragraphs describing laws, regulations, policies, and practices that give new meaning to the term "fish stories"—and the new meaning is "ridiculous!" These stories about various U.S. fisheries may sound like bad fiction, but rest assured that they're not. They really happened!

Read the "Strange But True" fish stories (Handout / Visual 2). They will seem odd at first glance, but consider them carefully. Your task is to figure out the single cause for all the bizarre behavior. Following the stories is a list of clues that will help you tie together the different situations and reason out the shared cause.

Are these fish stories really as nutty as they sound?

Fish Stories

A. Oysters are harvested by dredges pulled behind boats. At one time, Maryland law required that the dredges be towed behind sailboats except for two days a week when motorboats could be used.

B. Consumers generally prefer fresh to frozen halibut, as indicated by their willingness to pay a higher price. From 1970 to 1984, Alaskan halibut fishery managers continually shortened the season until it was reduced to two or three 24-hour periods each year. As a result, halibut fishers could only provide fresh fish a couple times a year. Most halibut from Alaska was marketed frozen.

C. In the southeastern U.S. Gulf of Mexico shrimp fishery, the season is short, so shrimpers race to the catch, scooping up everything they can. It is estimated that 10 pounds of bycatch, most of it dead, is discarded for every pound of shrimp caught.

D. Many fisheries continue to shorten fishing seasons although studies show that longer seasons reduce the hazards of fishing—for both people and equipment. For example, when the Alaskan halibut season went from a few days to 245 days, search and rescue missions by the U.S. Coast Guard fell by 63 percent, and fish mortality due to lost or abandoned gear dropped 77 percent in one year. (Lost and abandoned gear will continue to catch fish, but nobody is there to take the fish in.)

E. To protect small commercial fishers, the U.S. Commerce Department decreed that all halibut caught by big factory trawlers fishing for other fish—like pollock—must be re-

turned to the sea. Unfortunately, most of the netted fish are already dead.

F. In the 1980s, the law allowed surf clam boats to fish for six hours every other week. The large, sophisticated vessels were idle the rest of the time.

G. The least-cost way to harvest salmon is to wait until they migrate upstream toward their spawning beds and catch them in traps, weirs, or nets as the Native Americans did. In the Pacific salmon fishery, this practice has been banned for about a century, so fishers practice more expensive and dangerous ocean fishing—chasing fish.

H. In the Northwest herring roe fishery, it is not uncommon for the season to last as little as 40 minutes—per year! Herring brought in $4,000 per ton, so 20 minutes of fishing could yield $200,000. But one economist found example after example of costly practices like fishing vessels with multiple radar scanners and fishermen helicoptering their boats from one location to another—for a 40-minute fishing season?!

I. The National Resources Council reported that in the northern Pacific fishery in 1991, the total allowable catch was exceeded, more than 50 percent of the halibut caught were never iced, and one third were not even cleaned. Great way to stop the population decline!

THE CLUES

The following statements provide students with information that may help them solve the mystery.

1. Estimates suggest that many fishing fleets could be reduced by two-thirds in number of vessels and still harvest the same number of fish.

2. An economist writing in the *Washington Post* estimated that bycatch—the netting of species other than those for which permits are held—of 2 billion pounds of potential food is thrown back into the oceans every year. Preventing bycatch or insuring that the bycatch is returned to the ocean in good condition increases costs.

3. Trying to help small fishing operations and to protect fish populations, Norway permitted only trawlers smaller than 300 gross registered tons (GRT) to fish within 12 miles of shore. Over the years, as commercial fishers replaced their boats and equipment, the most common size of new boats was 299.9 GRT.

4. Technical leaps in fishing can drastically affect a fishery. For example, the power block was introduced in the Northeast Atlantic herring fishery in the 1960s to pull in purse seines (nets) that had previously been pulled in by hand. This innovation increased the capacity of the fleet so quickly that by 1970 commercial fishing collapsed because the herring population was overfished.

5. Many modern Icelandic fishing boats have computers that control automatic jigging machines that attract fish. The resulting increase in productivity means that a fisher simply takes the fish off the hooks, throws them in storage, and puts the lines out so the computer can fish again.

6. Between 1980 and 1990, the British halibut season was restricted to 435 vessels, but in order to prevent overfishing the season had to

be reduced from 60 days to 6, as the fishers built faster boats, used GPS technology to find schools, and adopted more efficient circle hooks to catch fish and disgorgers to remove them from the lines.

7. Iceland's National Bureau of Statistics reports that in 1990 fishing crews of 6,500 harvested 1,502,000 metric tons of fish. By 1999, significantly more fish (1,730,000 metric tons) was harvested by only 4,400 fishers.

8. None of the fish stories (A-I) occurred in fisheries leased privately or with ITQs or similar quota mechanisms. All the fisheries in the stories are regulated fisheries with a various combinations of restrictions including: number of permits; types of vessels and equipment; total allowable catch limits; and/or length of season.

SAMPLE STUDENT ANSWER

A correct student solution to the mystery of the "Strange But True" fish stories should resemble this statement:

> *No, the laws and practices described aren't the result of stupidity. Instead, they are rational responses to incentives that exist within regulated fisheries. Without clearly defined property rights to fish, the rule of capture takes over. The incentives in the system undermine efforts to regulate the fishery in what would seem to be a logical manner. Because fishers must compete with others for the fish, they are rewarded for acquiring more and more capital (fishing equipment)—even if the capital sits useless much of the time. The fishers' ability to harvest more quickly leads to increased regulation and shorter seasons, but those adjustments don't work either, because they don't change the incentives. In this situation, the only way to stop the fishers from fishing faster is to force them to use less efficient methods.*

WHICH CLUES SOLVE THE MYSTERY?

Incentives matter—big time! Many of the world's fisheries suffer problems of overfishing, overcapitalization, low productivity, and low income for fishers not because people are stupid, but because they are reacting to the incentives the system places before them.

Incentives: Stories C, F, and H result from incentives to overcapitalize. If a fisher wants to keep making a living fishing, he or she has to have the biggest boat and the best equipment. Clues 1, 3, 4, 5, 6, and 7 show that fishers understand that they are rewarded for finding faster ways to harvest fish. Stories C and I and clue 2 remind us that fishers have to be concerned about cost and that they will avoid costs when they can—sometimes with disastrous consequences for the fishery.

Choice: Stories A, D, E, and G are examples of the unintended consequences of the choice to maintain public fisheries. Clue 8 reminds us that fisheries in which private property rights are institutionalized tend not to suffer the problems of overfishing and overcapitalization that plague government-regulated fisheries. Government officials certainly didn't choose to destroy the fisheries or cause the technology of fishing to regress, but as the stories show, again and again, incentives trump intentions.

Voluntary Trade: Story B describes what happens when rules and regulations undermine voluntary exchange. Maintaining the fishery as a

commons destroys the incentives that would reward fishers for responding to consumers' preferences. The exchange that takes place provides fewer rewards for both consumer and producer than the exchanges that occur when producers have clear property rights.

ADDITIONAL COMMENTS

The solutions tried by government agencies to preserve declining fish populations and shore up the incomes of commercial fishers have fallen far short of success. They fail largely because of reluctance to grant private property rights to a resource we've been used to thinking should belong to the public. The failure to designate property rights leaves us with incentives that encourage overfishing and inefficient allocations of capital on the part of fishers. Government regulators respond by trying to make it harder to catch fish—shortening the season and prohibiting the use of efficient equipment and technology. We don't need smarter fishers or government officials; within the restrictions of the system, both have shown creativity in responding to circumstances. What we need is the will to change the rules so that the incentives reward behavior that preserves fish populations while sustaining the fishing industry. Experiments with formal and informal designation of property rights show promising outcomes.

MORE INFORMATION

For more examples of property-rights based incentives in fisheries, see the following sources:

Terry L. Anderson and Donald R. Leal, *Enviro-Capitalists—Doing Good While Doing Well*. Lanham, MD: Rowman & Littlefield Publishers, Inc., 1997.

Terry L. Anderson and Donald R. Leal. *Free Market Environmentalism*, revised ed. New York: Palgrave, 2001.

Donald R. Leal, "Homesteading the Oceans: The Case for Property Rights in U.S. Fisheries," *PERC Policy Series,* PS-19, August, 2000. Online: www.perc.org/publications/policyseries/homestead.html.

Donald R. Leal, *Fencing the Fishery—A Primer for Ending the Race for Fish*. Bozeman, MT: PERC, 2002. Online: www.perc.org/publications/guidespractical/fence_fishery.html.

MYSTERY 7: *STRANGE BUT TRUE*

By now you've solved enough mysteries to qualify as the Sherlock Holmes of fishing, but here's one last challenge. Below are several paragraphs describing laws, regulations, policies, and practices that give new meaning to the term "fish stories"—and the new meaning is "ridiculous!" These stories about various U.S. fisheries may sound like bad fiction, but rest assured that they're not. They really happened!

Read the "Strange But True" fish stories. They will seem odd at first glance, but consider them carefully. Your task is to figure out the single cause for all the bizarre behavior. Following the stories is a list of clues that will help you tie together the different situations and reason out the shared cause.

Are these fish stories really as nutty as they sound?

FISH STORIES

A. Oysters are harvested by dredges pulled behind boats. At one time, Maryland law required that the dredges be towed behind sailboats except for two days a week when motorboats could be used.

B. Consumers generally prefer fresh to frozen halibut, as indicated by their willingness to pay a higher price. From 1970 to 1984, Alaskan halibut fishery managers continually shortened the season until it was reduced to two or three 24-hour periods each year. As a result, halibut fishers could only provide fresh fish a couple times a year. Most halibut from Alaska was marketed frozen.

C. In the southeastern U.S. Gulf of Mexico shrimp fishery, the season is short, so shrimpers race to the catch, scooping up everything they can. It is estimated that 10 pounds of bycatch, most of it dead, is discarded for every pound of shrimp caught.

D. Many fisheries continue to shorten fishing seasons although studies show that longer seasons reduce the hazards of fishing—for both people and equipment. For example, when the Alaskan halibut season went from a few days to 245 days, search and rescue missions by the U.S. Coast Guard fell by 63 percent, and fish mortality due to lost or abandoned gear dropped 77 percent in one year. (Lost and abandoned gear will continue to catch fish, but nobody is there to take the fish in.)

FISH STORIES

(continued)

E. To protect small commercial fishers, the U.S. Commerce Department decreed that all halibut caught by big factory trawlers fishing for other fish—like pollock—must be returned to the sea. Unfortunately, most of the netted fish are already dead.

F. In the 1980s, the law allowed surf clam boats to fish for six hours every other week. The large, sophisticated vessels were idle the rest of the time.

G. The least-cost way to harvest salmon is to wait until they migrate upstream toward their spawning beds and catch them in traps, weirs, or nets as the Native Americans did. In the Pacific salmon fishery, this practice has been banned for about a century, so fishers practice more expensive and dangerous ocean fishing—chasing fish.

H. In the Northwest herring roe fishery, it is not uncommon for the season to last as little as 40 minutes—per year! Herring brought in $4,000 per ton, so 20 minutes of fishing could yield $200,000. But one economist found example after example of costly practices like fishing vessels with multiple radar scanners and fishermen helicoptering their boats from one location to another—for a 40-minute fishing season?!

I. The National Resources Council reported that in the northern Pacific fishery in 1991, the total allowable catch was exceeded, more than 50 percent of the halibut caught were never iced, and one third were not even cleaned. Great way to stop the population decline!

CLUES

1. Estimates suggest that many fishing fleets could be reduced by two-thirds the number of vessels and still harvest the same number of fish.

2. An economist writing in the *Washington Post* estimated that bycatch—the netting of species other than those for which permits are held—of 2 billion pounds of potential food is thrown back into the oceans every year. Preventing bycatch or insuring that the bycatch is returned to the ocean in good condition increases costs.

3. Trying to help small fishing operations and to protect fish populations, Norway permitted only trawlers smaller than 300 gross registered tons (GRT) to fish within 12 miles of shore. Over the years, as commercial fishers replaced their boats and equipment, the most common size of new boats was 299.9 GRT.

4. Technical leaps in fishing can drastically affect a fishery. For example, the power block was introduced in the Northeast Atlantic herring fishery in the 1960s to pull in purse seines (nets) that had previously been pulled in by hand. This innovation increased the capacity of the fleet so quickly that by 1970 commercial fishing collapsed because the herring population was overfished.

CLUES

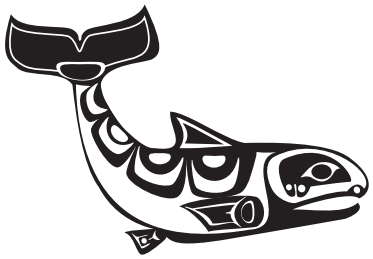
(continued)

5. Many modern Icelandic fishing boats have computers that control automatic jigging machines that attract fish. The resulting increase in productivity means that a fisher simply takes the fish off the hooks, throws them in storage, and puts the lines out so the computer can fish again.

6. Between 1980 and 1990, the British halibut season was restricted to 435 vessels, but in order to prevent overfishing the season had to be reduced from 60 days to 6, as the fishers built faster boats, used GPS technology to find schools, and adopted more efficient circle hooks to catch fish and disgorgers to remove them from the lines.

7. Iceland's National Bureau of Statistics reports that in 1990 fishing crews of 6,500 harvested 1,502,000 metric tons of fish. By 1999, significantly more fish (1,730,000 metric tons) was harvested by only 4,400 fishers.

8. None of the fish stories (A–I) occurred in fisheries leased privately or with ITQs or similar quota mechanisms. All the fisheries in the stories are regulated fisheries with a various combinations of restrictions including: number of permits; types of vessels and equipment; total allowable catch limits; and/or length of season.



NOTES

OVERVIEW

This appendix consists of a one-act drama written by students of Smoky Hill High School in Aurora, Colorado, under the guidance of economics teacher Marc A. Johnson. It illustrates how one group of students used many of the concepts introduced in the lessons. Teachers may wish to have their students present this play—or simply read through it to see how the ideas can be incorporated. We offer it to stimulate your thinking.

Note: The group of twelve students who first presented this play participated in the 2001 World Affairs Challenge conducted by the Graduate School of International Studies at the University of Denver. Their task was to write a 15-minute skit about water issues in the world today. They were to identify a particular dimension of the problem and propose solutions.

The Smoky Hill team did not win the competition. One of the three judges included a note explaining why she had given the students a low score. It read, "Establishing private property rights and relying on markets just is not a realistic solution." It would be interesting to have your class react to the judge's statement after they read or present the play. Was the judge right in using that criterion to rate the skit lower than that of other contestants? To assess students' individual understanding of economic reasoning, assign them to write a response to the judge's note explaining how and why property rights solutions may offer viable alternatives to current practice.

MATERIALS

- Script: "Fishing the World's Oceans: The Problem / A Solution" (Handout)
- Props for Daddy and Daughter: pajamas, slippers, bathrobe
- Props for Fisher 1: hip waders for fishing, small inflatable swimming pool, life-size paper fish cut from colored paper
- Props for Captain Environment: green leotards and a sweat shirt with a capital E
- Props for the Global Alliance Representative: three-piece suit, shirt, tie
- Props for the Regulatory Representative: tape measure, magnifying glass, clipboard
- Props for the Free Market Environmentalist: plaid shirt, jeans, hiking boots
- Other props:
  big sign that says: FREE MARKET
  big sign that says: ILLEGAL MARKET

FISHING THE WORLD'S OCEANS: THE PROBLEM / A SOLUTION

A play written by Steve Abbott, Dan Corren, and Eric Shoup
of Smoky Hill High School, Aurora, Colorado

[Dad and very young daughter in pajamas, who is getting ready for bed and being tucked in.]

Daddy: Time for bed!

Daughter: I'm not tired! Do I have to?

Daddy: Yes.

Daughter: Will you read me a story?

Daddy: Okay, but then you have to go to bed.
How about *Three Fish, Two Fish, One Fish, No Fish*, by Dr. Loose?

Daughter: I like that story!

[A single fisher in hip waders enters, sets down a children's swimming pool at an angle, so audience can see inside, with cut-out fish inside; he or she acts out the following scene as Daddy reads.]

Daddy: Once there was a great big lake,
And in that lake were all the fish you could take.
One day a man caught a fish,
And decided it would make a really good dish,
So the man cooked the fish and found it quite yummy;
He told all his friends and they offered him money.

[enter student with FREE MARKET sign; he or she begins exchanging fish for money with others]

Soon a whale of a business he had built,
And competition soon started to move at full tilt.

[enter two more fishers, who fish and trade]

Everyone fished and fished some more,
And making a profit was never a chore.

The number of fish in the lake soon went down;
Everyone stared at this change with a frown,
But nobody stopped; the money was fine.
They knew they'd lose their place in the line.
It was clear to them all that the fish would soon disappear.
But they still wanted the money and the dish every year,
No one would stop, the fish were fallin',
A sad story for sure; a tragedy of the commons.

Daughter: Oh, that's so sad!

Daddy: But some people were mad.

[Captain Environment enters, in green leotards and sweatshirt with a capital "E" on the front]

Captain Environment: I am Captain Environment!
I speak for the fish and the rest of creation.
You're all fools; you should stop this desecration.
The fish in the lake are all running low;
It's your moral obligation to stop this show.
For the good of the planet and all living things,
Try to be more humble and stop living like kings.
Is it worth it to destroy the lake?
To fill your bellies and profits make?

Daddy: For just a brief moment they lent him their ears,
But now it was time to vent all their fears.

Fisher 1: The words ring true but I'm in a tight jam;
If I give up, someone else will take those fish, wham bam!
[augmented by hand motions]
My family won't eat and I'll have no money;
Therefore my future just won't be that sunny.

[Captain Environment shakes his head]

Captain Environment: The fish will all soon be dead.
They'll have no more income or food,
And so very little to support their brood.

Daddy: So nothing changed, they continued to fish,
'Cause after all, fish is a really good dish.
They felt it was better to stay in the black,
So they continued to fish without looking back.

Daughter: But if Captain Environment was right, why are there fish today?
Did someone more powerful have something to say?

Daddy: They continued to fish—it's sad but quite true—
So some big global alliance thought of something to do.

[Global Alliance Representative (GA Rep) enters, in three-piece suit with cigar]

GA Rep: I'm the Global Alliance Representative, GA Rep for short!
My fellow world citizens, I bring you bad news;
Your fishing is bad, a horrible abuse;
Therefore we've created a sort of solution,
To help put an end to this profit pollution.
Our solution is simple—just wait till you hear—
If you cut back on fishing there's nothing to fear,
To insure that you are going to follow our plan,
Allow me to introduce. . . . Regulatory Representative, Reg Rep for short!

[enter Regulatory Representative (Reg Rep), with tape measure, magnifying glass, clipboard]

Reg Rep: I'm Regulatory Representative!
You've fished far too much and will now do as we say.
These new rules, as of now, will save the day.
We tell you: to fish or not to fish, who can fish, what to fish, when to fish, where to fish, why to fish, how to fish, how much to fish, fish fish fish fish.

Daddy: So the fishers meekly gave these new plans a try,
Unaware that it would hang them out to dry.
They went and fished as much as they could,
But people wanted more because fish were so good.

Fisher 2: Prices are high, and there are many markets,
If we fish in secret, we can still line our pockets.

[enter student with ILLEGAL MARKET sign; begins exchanging fish for money surreptitiously]

Daddy: Regulations were set, so they fished behind Reg Rep's back,
And sold all their fishes in the market that is not legal.
The regulations didn't work, quite obviously;
There were still fewer fishes out there in the sea.

Daughter: That's terrible, Daddy. What else could they do?
I'm sad for the world and all the fish too.

Daddy: The problem was just as persistent as ever.
A solution was needed, one that was clever.
Captain Enviro came to peddle his wares,
But the fishers found they just couldn't care.

[Captain Environment pantomimes pleas]

They found themselves in quite a pickle;
They stood to lose all and gain very little.
Then Reg Rep stepped into the scene,
He was a nonstop, restriction machine.

[Reg Rep examines fish with magnifying glass & tape measure]

But the illegal market price was incentive so strong
That fishers kept it up even though it was wrong.
But then someone wise came along one day,
And offered advice for an alternate way.

[enter Free Market Environmentalist]

Free Market Environmentalist: I'm Free Market Environmentalist!
What people don't own they quickly destroy.
Fish shouldn't be just anyone's toy.
I have a plan—it could surely save the day.
Private property rights, now there's the way!
Each fisher here will own a number of fish,
Based on historical production, which they can use as they wish.
They can fish, they can trade, they can eat, they can sell,
Or if they like, they can wait, which is just as well.

Fisher 3: You're saying these are mine to use as I wish?
Nobody but me can fish these fresh fish?

Captain Environment: And you're saying if I want even I can buy shares,
So the fish that I buy will always be there?

Reg Rep: And you're saying we won't need to patrol with a magnifying glass,
Thank goodness, that job was really a pain in the . . . neck.

Free Market Environmentalist: Right, right, right and doodily doo,
So our kids won't see fish just in the zoo.

Daddy: All in all by the end of the day,
Everyone was able to get part of their way.
The fish they survived; there are always some left.
The fishers even stopped other people from theft.
They all made money and had something to eat.
Wow, that last guy's plan, how very neat.

Daughter: Gee, Daddy! That was a great story!

Daddy: Yes it is. But it's not just a story. . .

[Daddy leaves narrator role, faces the audience, and explains the analogy of the lake to the world's oceans; each actor in order of appearance will explain his or her particular perspective in the real world; narrator summarizes and makes segues in between speakers; finally, when all have spoken and narrator makes a final summation, the little girl speaks up.]

Daughter: Wow, Daddy, I've learned so much . . .
About free market environmentalism and private property rights!
But can I ask you one last question?

Daddy: Of course, dear.

Daughter: What are all these people doing in my room?

–The End–