UNIT 6F. THE ROLE OF HATCHERIES

LEVEL	TIME (min.)
Advanced	180

BENCHMARKS	
Next Generation Science Standards	MS-LS1-5 MS-LS2-1 HS-LS2-7 MS-LS2.A MS-LS2.C MS-ESS3.C HS-LS2.C HS-ESS3.C
Science & Engineering Practices	**7.** Engaging in argument from evidence. **8.** Obtaining, evaluating, and communicating information.
Common Core State Standards – ELA/Literacy	CCRA.R.1 CCRA.W.7 CCRA.SL.1 CCRA.SL.4 CCRA.SL.5
Oregon Social Sciences Academic Content Standards	HS.19

INTRODUCTION:

The first fish hatchery in the Pacific Northwest opened over 100 years ago on the Clackamas River. Since then, the region has increasingly turned to hatcheries as a way to compensate for the losses in fish populations due to human activities, mainly resulting from dams, habitat destruction and overharvest. Oregon currently operates 34 hatcheries, 15 remote rearing/fish collection facilities, including Salmon Trout Enhancement Program (STEP) facilities and the Clatsop Economic Development committee (CEDC) facilities. In 2001 these operations produced about 53 million salmon, steelhead and trout. The Legislatively Approved Budget for fish propagation for the 2003-05 biennium totaled $43.96 million dollars.

As we have begun to learn more about the ecological effects of hatchery fish on wild salmon populations, many have started to question the use of hatcheries as a catchall solution to fish management problems. There are efforts underway to improve hatchery practices to minimize the negative impacts of hatchery fish on wild stocks. In this unit, students will learn about some of the reasons why hatcheries came into existence, and some of the reasons why fish management is becoming increasingly complex. The following information gives you some base for understanding hatcheries and wild fish.

Some arguments in favor of hatchery fish:

1. Some hatchery fish were intended to compensate for declines in wild fish populations caused by the construction of dams. Dams are not only an important source of energy for the region -- they also allow the rivers to be used as waterways for the transport of crops and other goods throughout the Pacific Northwest. If we remove dams, we will be forced to either be more serious about conservation, or find alternative forms of energy and transportation.

2. Hatchery fish help support the angling industry. Sport fishing is not only a popular hobby, but also supports the economy of the region. In 2003, anglers spent almost $623 million according to the American Sportfishing Association.

3. According to the Pacific Coast Federation of Fishermen's Associations, Incorporated, 80% of the salmon caught by the commercial fishing industry are hatchery fish.

4. The salmon are of great traditional importance to Native Americans. The U.S. government has treaty obligations to the tribes to restore the salmon so that Native Americans may continue to use the salmon both as a food and a spiritual resource. If natural production continues to decline, we may have to increasingly rely on hatcheries to fulfill this treaty obligation.

5. If we catch only the hatchery fish for human consumption, we could leave the wild fish alone to reproduce on their own.

6. Hatchery fish could be used to supplement stocks in serious jeopardy or to reintroduce stocks that have been eliminated from their natural range, given the proper groundwork for habitat improvements and resolution of passage problems.

Some arguments for wild fish:

1. Through a process called natural selection, the wild fish that are best suited to their environment are the fish that survive to spawn. However, hatcheries promote artificial selection, which means that humans choose the fish that will survive to spawn. Sometimes, we have made this decision based on which fish will make a good dinner, rather than on which fish will best be suited to survive in the wild. Another problem is that some hatcheries tend to spawn the first fish to return to the river to ensure that they will be able to harvest enough fish. However, this means that early breeders are more likely to be chosen to spawn. The resulting hatchery offspring tend to return too early. This is a problem if all of the hatchery fish return at the same time, and the weather is too rainy or too dry for the fish to survive.

2. Genes carry pieces of information that allow fish to inherit traits from their parents. In a population of fish with a lot of genetic diversity, there is a greater chance that at least some fish will have the traits necessary to survive if there is a sudden change in environmental conditions. Conversely, in populations of fish without a lot of genetic diversity, there is a greater likelihood of extinction if the fish are faced with a changing environment. Populations of hatchery fish have less genetic diversity than populations of wild fish because hatchery fish have had fewer ancestors than wild fish. Unfortunately, sometimes hatchery fish spawn with wild fish, rather than returning to the hatchery. This means that the genetic diversity of the wild fish populations decreases as well.

3. When wild fish die, their carcasses provide nutrients to the rivers and streams where they spawned. Hatchery fish are often removed from the stream to be spawned, depriving the habitat of precious nutrients.

4. We have a moral obligation to do something to repair the habitat that we have destroyed in order to assure that wild fish can continue to survive in the future.

5. Hatcheries create a false sense of abundance for people who consume fish and utilize their habitat, meaning that people are less concerned about conserving the habitat that remains. It also means that harvest

levels are often based on numbers of hatchery fish. Since there are often some wild fish that are caught along with the hatchery fish, harvest can drive dwindling numbers of wild fish into extinction.

6. Wild fish use precious energy competing against hatchery fish for limited resources. Hatchery fish are more prone to disease than wild fish because they are raised so closely together. Diseases from the hatchery stock can then be passed on to wild fish. This means that the presence of hatchery fish can actually weaken wild fish populations.

7. Wild fish learn to avoid predators, or they get eaten. They also learn to find food in their natal stream efficiently, or they starve. Hatchery fish, on the other hand, are hand-fed by humans. They learn to approach humans (who would normally be predators) and eat fish pellets. Then, when they are released, they are less able to find food and are less afraid of predators than wild fish. This means that, once they are released into the wild, hatchery fish are less likely to survive than wild fish.

8. Raising hatchery fish is very expensive. According to Sterne, the average cost of producing a spring chinook salmon in a state run hatchery is $27.43, although this number can reach as high as $228.93 per fish. Some might argue that this money could be better spent on habitat restoration to improve survival rates for wild chinook.

OBJECTIVES:

For students to know and understand:
• The difference between hatchery fish and native fish.
• Some of the complexity surrounding fish management decisions.

MATERIALS

- STUDENT HANDOUT 6F-1: A History of the Hatchery System
- STUDENT HANDOUT 6F-2: The Trask Hatchery Scenario
- STUDENT HANDOUT 6F-3: Profiles of Hatchery Roles

PROCEDURE:*

1. Distribute copies of STUDENT HANDOUT 6F-1: A History of the Hatchery System and STUDENT HANDOUT 6F-2: The Trask Hatchery Scenario. You may want to read this aloud with students so that you can respond to questions and facilitate discussion about the scenario and about their task.

2. There are five roles in this activity. Divide the class into five small groups. Give each group a different role from STUDENT HANDOUT 6F-3: Profiles of Hatchery Roles.

3. Allow students time to review their profiles, research their roles, and decide which of the hatchery options their character would prefer. Have them create a coherent presentation of their point of view for the rest of the class. Encourage students to create charts, graphs, or any other visual aids that might enhance their presentation.

4. Allow each group of students to make an opening presentation to the rest of the class. Post any visual aids in the classroom.

5. Give students time to meet with one another. Is it possible for some groups to form alliances or coalitions with one another? Students with very different characters might find that they have similar opinions about hatchery issues.

6. Allow students to make proposals to the rest of the class. Have students write the options that they prefer on the board. Open the floor to a debate of the options.

7. Allow students to argue for or against the options listed on the board, but provide a time limit on their arguments so that all students have a chance to present their ideas.

8. Take a vote on the options.

9. Facilitate a discussion. Is there an easy solution to the fish hatchery dilemma? Is it possible to compromise? Who should be responsible for making decisions about hatcheries?

* If you prefer to have a governing body facilitate the debate, refer to the procedure set up in the John Day Dam Drawdown role-play. The dam role-play procedure creates a Council to facilitate a debate and make a decision based on students' presentations.

Some additional resources:

• A Common Fate, Joseph Cone. Oregon State University Press
Contains a chronology of the decline of the Pacific Northwest salmon runs, the construction of dams and hatcheries, and the fishing industry in the region.

• Oregon's Wild Fish Management Policy: Balancing Oregon's Fishery Future. Oregon Department of Fish and Wildlife or background publication.
Contains a background on the use of hatcheries as a fish management policy.

• Supplementation of Wild Salmon Stocks: A Cure for the Hatchery Problem or More Problem Hatcheries?
Jack K. Sterne Jr. Coastal Management. Volume 23, pp. 123-152

INTERDISCIPLINARY INTEGRATION IDEAS

1. Examine the history of salmon decline due to human population pressures: Review Where Have All The Salmon Gone? Project Wild Aquatic with Math and Social Studies teachers, then do an interdisciplinary unit in which students learn, through graphical analysis techniques, how to comprehend the data presented in the unit, and through historical analysis techniques, how to make sense of this data in terms of human actions.

2. Have an English teacher help your students to write legends about salmon. Investigate traditional words for salmon, rivers, and land. An Art teacher can help them create Native American masks and other artwork to illustrate and amplify their legends. Then, work with a Social Studies teacher to place these learnings in a context, which integrates the history of regional Indian tribes, immigrants from other nations and Pacific Northwest salmon.

3. Work with an English teacher when you prepare this section, integrating the book, Winterkill, by Craig Lesley, into your students' English class reading.

4. Review this section with an English and/or Social Studies teacher, and use the book, Mountain in the Clouds, by Bruce Brown, as the focus of an interdisciplinary unit. Explain the book and share your lesson plans for the section with them. Develop reading and writing extensions of the section, which are based upon an understanding of the historical and cultural roots of the story.

EXTENSION CURRICULUM

1. Philosophical Differences, Project Wild, Students select a wildlife issue or other environmental issue in the community, and correspond with representatives of a range of interest groups about their philosophical positions concerning the issue. They learn to identify points of view and describe possible effects of various groups and organizations having differing points of view about wildlife, natural resources and environmental issues.

2. Students use the Food Web exercise to explore what might happen when a species is eliminated from a food web. Each group of students receives a scenario in which they eliminate one organism from the food web, and then describe the immediate, intermediate, and terminal effects of eliminating their particular organism. Blue Ribbon Niche, Project Wild Aquatic, explores the effects of food webs in riparian areas. You might adapt this activity to the food webs activity.

3. Invite a representative of a local Indian tribe to come to your classroom. Have your students prepare questions to ask him or her. If you are doing Salmon Watch as an interdisciplinary unit, have your students work with a social studies teacher to learn the history of that person's culture. Ensure that student questions will elicit information about the place of salmon in Native American culture, salmon fishing sites in the area you will be visiting, and the effects of salmon stock depletions on his or her society today.

4. California's Salmon and Steelhead, Our Valuable Natural Heritage, pp. 141-145, contains reading and art activities based on Native American salmon creation myths. These activities make a good supplement to the core curriculum in this section. If you review this curriculum, look at the story writing activity in which students learn to express their personal feelings about salmon, pp. 146-149.

5. Review the information and the table Chinook Salmon Spawning Density, John Day District, 1967-1989 (Stream Scene, pp. 191-192) for this activity. This represents a portion of a 29-year study of 116 total miles of index streams in the John Day River Basin (pp. 2.81-2.84).

Have the students calculate the average number of redds per mile in the right hand column for each year (see p. 197).

Ask your students to create a line graph by plotting the number of redds per mile for each of the 23 years of data. (Ask them to use the entire sheet of paper for the graph axes so that it will be easier to interpret.) Repeat the process for each of the three streams and the average. NOTE: Use a different color for each of the four lines, and a legend with the color representing each line. Have the students complete the worksheet, answering the questions about the John Day River Basin on p. 198.

Review the information and Clackamas River map on pp. 199-200, then have them complete the worksheet, answering the questions about the Clackamas River Basin on pp. 205-207. (Extra Credit Opportunity: Have your students research data on the number of salmon in this fishery from 1980 to date.)

6. Do the activity "Where Have All the Salmon Gone", Project Wild Aquatic. Information is supplied for five species of salmon caught from 1870 to 1989, and explores possible effects of an expanding human population on numbers of salmon caught.

7. Look up the World Wide Web address, http://www.streamnet.org/, for a very useful source of information about salmon. This is the StreamNet home page that contains an online database of information about salmon, the life history and ecology of species, color species of a male and female of each species listed, and extensive data on salmonids and their habitats. It might be used to organize Units 1-3 for your students.

8. Use the World Wide Web address, http://www.nwp.usace.army.mil/co/fishdata/daily.htm. This web site provides daily updated fish passage data, by dam, and by ladder. It also provides water turbidity data (secchi units), water depths by ladder bay, water temperature, total discharge, and fish counts and totals by species. Daily and annual total passages for chinook and coho at all dams are provided at the end of reports. This data presents an interesting set of information for engaging your students in the critical thinking which scientific inquiry excels in. Are fish numbers distributed evenly among the ladders at a particular dam? Are their distributions associated with any of the other parameters provided in the data set? Can you, using the information available, explain the reported fish passage patterns? What other inferences can you make from the data? What further information would you like to know?

STUDENT HANDOUT 6F-1

History of the Hatchery System

How a hatchery works:
As hatchery salmon return from the ocean, they are collected in large cement ponds. When the salmon are ready to spawn, they are anesthetized and then killed by a sharp blow to the head. The eggs are removed from the female with a special knife. The milt, or sperm, is taken from the male by applying pressure to the underside of the fish. The eggs and sperm are then combined to fertilize the eggs. The fertilized eggs are placed in an incubator to allow them to develop. Conditions at the hatchery are closely monitored to ensure that the eggs develop at the desired rate. After six weeks, the eggs are resilient to handling. At this point, humans can remove any dead eggs to prevent fungus from spreading to live eggs.

After the eggs hatch they are put into ponds, or "raceways". The fry are generally fed a special fish feed to allow them to grow at the greatest rate possible. Fall chinook are released into the main river after 90 days of rearing. Spring chinook are released after 12-18 months.

Information taken from The Fish Hatchery Next Door

A timeline of the Northwest hatchery system:
• 1877- Chinook are released into the Rogue River at the Hume cannery.
• 1878- The first hatchery on the Columbia system is opened on the Clackamas River by cannery owners. The hatchery is intended to augment fish catches, which are already declining as a result of overfishing.
• 1907- 12 Oregon hatcheries are producing 27 million salmon fry.
• 1938- Bonneville Dam is constructed, originally without fish passage.
• 1941- Completion of the Grand Coulee Dam completely prevents salmon passage on the upper Columbia River.
• 1948- Widespread construction of federal fish hatcheries to make up for losses in the fish populations caused by dam construction and other human influences.
• Late 1980's- In Washington State, 360 million salmon and trout are stocked each year from over 120 state, federal and tribal hatcheries and at least 150 volunteer managed facilities. In Canada, 180 million Pacific Salmon are being released annually.
• 1996- 76 million salmon, steelhead, and trout are produced at 34 state operated hatcheries throughout Oregon.
• 1997- Hatchery closures due to Endangered Species Act listings.

Information taken from the Oregon Department of Fish and Wildlife; A Common Fate, by Joseph Cone; and Salmon Fact Sheet, by Guido Rahr.

STUDENT HANDOUT 6F-2

The Trask Hatchery Scenario

INTRODUCTION:

There is controversy about how hatcheries should be run, and whether they should exist at all. There are many different people with a variety of opinions on the issue. Your task will be to research at least one of these perspectives in order to learn more about the complexity of the situation.

TYPES OF HATCHERIES:

According to the National Research Council report, Upstream: Salmon and Society in the Pacific Northwest, there are two main types of hatcheries:

1. Catch-Augmentation Hatcheries: Catch-augmentation hatcheries try to raise and release the greatest possible number of fish as a way to try to compensate for the fish lost to harvest and habitat destruction. In an attempt to ensure that at least some fish survive to adulthood, these types of hatcheries put so many fish in a river that they often exceed the carrying capacity of the habitat, especially if the habitat has been degraded by human activity. Many of these hatcheries raise fish under artificial conditions and feed the fish by throwing them pellets from above. However, in recent years, the Native American Indian tribes have attempted to run production hatcheries that mimic natural spawning conditions.
2. Temporary Hatcheries: Temporary hatcheries are used to rehabilitate the original wild stocks of an area. They are to be used in the short term while habitat is being restored. They place a higher priority on restoring the watershed, rather than on relying on hatcheries long into the future. Since the main concern of these hatcheries is restoration of watersheds and original populations, temporary hatcheries do not attempt to improve catches for human consumption by exceeding the carrying capacity of the habitat. Once the hatchery has re-established the wild stock, the hatchery is phased out, and the fish are left to survive on their own. Temporary facilities would be much less expensive than permanent catch-augmentation hatcheries.

THE TRASK HATCHERY SCENARIO:

The Trask fish hatchery is a large production hatchery run by the Oregon Department of Fish and Wildlife along a coastal stream. Assume that the funding for this hatchery is being re-evaluated. Consider the options listed below for the future of Trask hatchery.

OPTIONS:

1. Allow the hatchery to continue to function as a catch-augmentation hatchery. This will have no immediate effect on the employment of hatchery workers, commercial fishermen and people in the recreational angling industry. This will eventually have an effect on the wild fish populations of the region.
2. Convert the hatchery into a temporary hatchery. As the hatchery is slowly phased out, there will be gradual effects on the employment of people whose jobs depend on the stocking or harvest of fish. The interactions between hatchery and wild fish will gradually be reduced.
3. Eliminate the hatchery entirely. This will have immediate effects on employment of hatchery workers and people who catch fish. The interactions between hatchery and wild fish will be dramatically reduced.

STUDENT HANDOUT 6F-2

YOUR TASK:

You will be assigned one of the following roles to research and represent:
• Wild fish advocate
• Sport Angler
• Commercial fisherman
• Hatchery employee
• Native American

1. After reading you role, conduct further research.
Which of the Trask hatchery options would your character feel most comfortable with?

2. Create a brief presentation to share your perspective and your position with others in your class. Be sure to back up all statements with facts. Create charts, graphs, or any other visual aid that might enhance your position.

3. Make an opening presentation to the class about your perspective. Post any visual aids that you have prepared.

4. While listening to other presentations, think about whether any other groups have similar positions on the Trask hatchery scenario. Consider meeting with other groups to form coalitions with them.

5. Make a proposal to the class detailing your position on the Trask hatchery scenario. Write your proposal on the board.

6. Debate the options on the board. You may argue for or against any of the options listed.

7. Take a vote to determine which of the options is most popular amongst the roles.

8. Think about the outcomes of the Trask hatchery scenario. Is there an easy solution to the fish hatchery dilemma? Is it possible to compromise? Who do you think should be responsible for making decisions about hatcheries?

STUDENT HANDOUT 6F-3: Profiles of Hatchery Roles

WILD FISH ADVOCATE PERSPECTIVE

Wild fish learn the necessary skills to survive in the wild. Hatchery fish, on the other hand, do not. They learn to approach humans (who would normally be predators) to eat fish pellets. Then when they are released, they are less able to find food than wild fish, and less afraid of predators.

In a hatchery, humans artificially select the fish that spawn. Natural selection is more successful because the fish that are best suited to their environment are those that survive to spawn.

As a result of artificial selection, there is less genetic diversity in a hatchery fish population than there is in a wild fish population. In a population of fish with a lot of genetic diversity, there is a greater chance that at least some fish will have the traits necessary to survive if there is a sudden change in environmental conditions. Considering the amount of tinkering that humans like to do to their environment, these sorts of changes in environmental conditions seem quite likely. Therefore, wild fish are less likely to become extinct than hatchery fish because their populations have greater genetic diversity. Unfortunately, sometimes hatchery fish spawn with wild fish, decreasing the genetic diversity of wild fish populations.

Besides, hatchery fish actually hurt wild fish. Hatchery fish are more prone to disease because the fish are so crowded in the hatchery. Then, when the hatchery fish are released into the wild, the wild fish run the risk of catching those diseases from the hatchery fish. Wild fish also have to use a great deal of energy to compete against hatchery fish, which are normally bigger than wild fish because they have been hand fed since they were hatched.

SPORT ANGLER'S PERSPECTIVE

I like to fish purely for the sport of fishing, and because I love to be outside. I do not keep the fish that I catch, but release them live.

I am very concerned about the health of wild stocks. I want to see the fish that have lived in these rivers and streams for hundreds of years continue to survive in this area. Salmon have spawned in this area for a very long time, and I think they should be able to spawn here long into the future.

I have been fishing for many years, and, unfortunately, I have noticed that the number of salmon has been declining. Worse still, the proportion of wild fish in comparison to hatchery fish has been declining, too. I know that hatchery fish can harm wild fish and that hatchery fish can sometimes interbreed with wild fish. It's a shame that wild fish have to compete with hatchery fish to survive in an already severely degraded habitat. I am worried that hatchery fish will eventually do enough damage to wild fish populations that wild fish will become extinct.

STUDENT HANDOUT 6F-3: Profiles of Hatchery Roles

COMMERCIAL FISHERMAN PERSPECTIVE

I work on a commercial fishing boat. Hatcheries are crucial to my way of life. So much habitat has been lost that without a hatchery program, there would be no salmon fishing at all. Some say that 80% of the fish that are caught by commercial fishermen are hatchery fish. By catching mostly hatchery fish, we are able to allow more wild fish to spawn. Since hatchery fish cannot be listed under the Endangered Species Act, the presence of hatchery fish provide some job stability at a time when more and more fish are being considered for listing.

Without a fish hatchery, there wouldn't be enough fish for everyone to continue to catch fish at the current levels. If the hatchery were to close, there would be two main problems. First, if salmon populations were to fall drastically enough, the industry wouldn't be able to meet the demand for this Important food resource.

Second, the number of fishermen who can support themselves by catching salmon has already fallen drastically from historic numbers. According to the Oregon Coastal Zone Management Association, the commercial fishing industry was expected to generate $4 million in personal income in 1998. While this is a very significant contribution to the economy of the region, it is still a massive decrease from the annual average of $41 million just 20 years ago. Entire coastal cities have become ghost towns as a result of the dwindling numbers of fish. Without a hatchery to supplement the salmon population, those few commercial salmon fishermen who remain will be out of work.

HATCHERY EMPLOYEE PERSPECTIVE

The press is overly critical of hatchery production. It does not fully take into account the fact that hatcheries play a critical role in making up for habitat that was lost to dam construction. A massive amount of habitat was lost when we built dams on all the major rivers. Transporting fish above the dams has been only marginally successful, and hatcheries are the only other way to compensate for the number of fish that cannot make it to their historical spawning grounds.

I understand the appeal of wild fish, but conservationists need to be realistic about the likelihood that people in the Northwest would not be willing to live with the consequences that would result from eliminating fish hatcheries. If we were to eliminate hatcheries, Northwesterners would have two options. The first option is to make important changes in lifestyle in order to conserve the few wild fish that remain. The second option is to live with the risk of extinction of some species.

Hatcheries create jobs, too. People ranging from commercial fishermen to the owners of tackle shops along the river all benefit from the fact that there are fish to be harvested.

Besides, hatcheries have made big improvements in the management of their fish in recent years. Our understanding of fish biology has changed greatly since the opening of the first fish hatchery, and our hatchery practices have changed accordingly.

STUDENT HANDOUT 6F-3: Profiles of Hatchery Roles

NATIVE AMERICAN INDIAN PERSPECTIVE

In 1855, the tribes of the Columbia River signed over title to about 40 million acres of our lands in exchange for, among other things, a guarantee that we would be able to fish at all of our "usual and accustomed fishing places in common with citizens." Salmon are of great importance to us, spiritually, culturally, and as a food resource. It would be tragic if the salmon were to be driven to extinction. Unfortunately, native salmon populations are simply unable to sustain themselves, so great is their habitat loss and so high is the rate at which they are killed by dams on the way to the ocean. Our hope is that we can use hatcheries to help keep salmon from becoming extinct altogether while we try to fix these problems.

Salmon have a very high rate of survival in the hatchery setting. It is important to us not only that we have salmon to catch, but for the fish to return and spawn naturally. In contrast to non-tribal hatcheries, whose only purpose is to produce salmon for fishermen to catch, our hatcheries are also meant to be used to help rebuild naturally spawning salmon populations. Our driving goal is to "put the fish back in the rivers."

Many of our hatcheries are much less artificial than non-tribal hatcheries. For example, food is released from the bottom, so fish learn to look for food under more natural conditions. In other hatcheries, salmon learn to rely on humans to feed them from above. Also, the walls of our pens are painted in camouflage colors mimicking natural streams. This causes the salmon fry to develop camouflage markings, enabling them to blend into the river systems where they are released. By creating a hatchery that mimics nature more closely, our fish are more likely to survive in the wild.

Maintaining our hatcheries helps make up for the salmon habitat that humans have destroyed. We realize that under the existing conditions that salmon face, they can’t survive on their own. That’s why we need to use hatcheries to give them a boost.