Activity 17: To Dam or Not to Dam
- Aquatic WILD-

Age:
Grades 4-12

Time:
Two to three 45 minute periods.

State Essential Learning Requirements
Reading 2.1, 2.1, 3.1, 3.2

Writing: All of 1, 2.2

Communication: All of 1,2 and 3.

Science: 1.2, 1.3, 2.2, 3.2

History: All of 3

Geography: 2.1, 2.2, All of 3.

Civics: All of 4

Economics: 1.1, 1.2, 1.4

Materials:
Aquatic WILD Activity provided: You make role playing cards from template provided.

Overview:
Students role play individuals representing differing perspectives and concerns related to a complex issue.

Washington adaptation provided:
Several articles on dams of the Columbia river system may be used to determine stakeholders and their positions. Research report on the effect of dams on salmonid production (PATH)

Objectives:
- To evaluate statements from stakeholders in terms of beliefs and positions.
- To interpret the conclusions of a panel of scientists on the state of the Columbia River ecosystem for salmon.

Critical Questions Addressed:
2. Endangered

Resources:
Four articles from Metro/Northwest, 4 March 1999 (attached)
- Snake dams supporters prevailing, Gorton says.
- NW starts to worry about running dry.
- Metro/Northwest Editorial - John Day Dam study.
- States brace for water war. Mike Lee

P.A.T.H. document on Columbia River Salmon survival. (attached)

Directions:
- Read the 4 perspectives on dams in Eastern Washington and complete a table to analyze the stakeholders, their positions, and values (table provided with articles).

Extension:
- Craft a plan of action on behalf of a school club to educate the public about the water rights controversy (more instructions attached to articles).

Directions:
- Read the PATH document or go to the PATH website to find conclusions on the likelihood of survival of salmon on the Columbia River System. PATH represents the scientific analysis and conclusions of a large group of scientists from different government agencies.
- What is the purpose of this document: Quote a passage which demonstrates the purpose.
- Simplify in your own words what essential questions (up to 3) the scientists were asking.
- Quote pertinent parts of the document with conclusions which point to the chances of survival of salmon on the Columbia River System.

Extension:
- In your own words what is possible for conservation of salmon in the Columbia River System.

TO DAM OR NOT TO DAM

OBJECTIVE

Students will evaluate potential positive and negative effects from constructing a dam on a river.

METHOD

Students role play individuals representing differing perspectives and concerns related to a complex issue.

BACKGROUND

Hypothetical situation: The town of Rocksburg, population 900, is located along the scenic Jones River approximately 60 miles from the closest big city. The mayor and city council of the big city have proposed that a dam be constructed two miles upriver of Rocksburg. In the Environmental Impact Statement written by the city engineers, the following information was identified.

The dam would meet the area's electrical power demand for ten or more years in the future. It would provide some water for irrigation and would help with flood control problems downriver.

Construction would be of rock-earth fill, 75 feet high and 300 feet across. Seven miles of river would be turned into a lake.

Age: Grades 4-12
Subjects: Social Studies, Science
Skills: analysis, classification, communication, description, discussion, evaluation, generalization, inference, interpretation, invention, kinesthetic concept development, listening, listing, observation, public speaking, reading, synthesis, writing
Duration: two or three 45-minute periods, depending on whether time out of class is used to develop position papers and write essays
Group Size: developed for 30 students; can be modified for smaller or larger groups
Setting: indoors
Conceptual Framework Reference: VI.A., VI.A.2., VI.A.3., VI.A.4., VI.A.5., VI.B., VI.B.1., VI.B.2., VI.B.3., VI.B.4., VI.B.5., VI.B.6., VI.C., VI.C.1., VI.C.2., VI.C.3., VI.C.4., VI.C.6., VI.C.12., VI.C.13., VI.C.15., VI.C.16., VII.A., VII.A.1., VII.A.2., VII.A.3., VII.A.4., VII.B., VII.B.1., VII.B.2., VII.B.3., VII.B.4., VII.B.5., VII.B.6., VII.B.7.
Key Vocabulary: dam, river, costs, benefits, tradeoffs
Appendices: Simulations, Local Resources

The dam construction would take five years to complete and would employ over 2,000 workers. After the dam was finished, approximately 150 workers would be required to keep the plant running.

Wildlife would be affected in the following ways:

- 20% loss to the deer herd that browses the lands alongside the river due to lost forage
- 20% loss to small mammals living in the river valley due to loss of habitat
- 20% loss to the area's songbird population due to lost riverbank nesting sites
- blockage of the upstream and downstream movement of fish that live in the river due to the creation of the lake and dam
- increase of the area's wintering bald eagle population; the dam and lake will increase access to bald eagle prey species, primarily fish; the eagles could winter in the area but would have to migrate to other areas to nest; the dam would reduce riverbank trees suitable for nesting
- reduction and possible elimination of fish species adapted to cooler and/or flowing water including trout, minnows and darters while at the same time increasing warmer, non-flowing water habitat suitable for bass, bluegill and carp
- loss of 10,000 acres of prime timber growing land and wildlife habitat

The people of Rocksburg are concerned about the problems and benefits from the number of people that would come to their town during and after the construction of the dam. For example, they project the arrival of 2,000 workers plus their families during construction for five years and that 150 permanent workers plus their families would stay after the dam was finished. They are concerned about effects on schools, sewage disposal, roads, homesites, property values, and the rural atmosphere, as well as police, fire, and hospital emergency capacities. They see some potential benefits from the development, such as new recreation opportunities for the people of Rocksburg and the city which is only about an hour away (water skiing, sailboarding, motorboating, swimming, fishing,

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camping, picnicking and other lake-related sports). Other impacts could include:

- loss of drinking water quality locally and in the metropolitan area
- flooding of Native American Indian archeological sites
- cultural changes for local Native American tribal people who have fished the river for generations
- water for irrigation at a lower monetary cost
- potentially less (monetarily) expensive power when compared to other forms of power production, e.g., nuclear, coal, oil, fossil fuels
- potentially more (monetarily) total power bills that may be necessary to pay for construction of the dam
- loss of seven miles of prime whitewater; private and commercial raft, kayak and canoe trips would be gone

MATERIALS

role playing cards

PROCEDURE

1. Provide students with the background information. Generate an initial discussion with them about some of the possible costs and benefits from the construction of this dam, considering it from a variety of perspectives.
2. Ask each student to choose the role of an individual to become or represent for the purpose of this activity—or assign roles randomly. Examples of roles are included. Establish a balanced variety of roles with people having conflicting values and concerns relating to the potential impacts of this dam construction.
NOTE: Teachers have copied the role descriptions and cut them apart to pass out to students. Create any additional roles which serve to illustrate a variety of major perspectives and interests.
NOTE: Some students have dressed for their roles to heighten the dramatic quality of the experience.
3. Ask students to prepare for their role, developing a short position paper for use as background for the dramatization of their role.
4. Arrange the classroom to represent a meeting room for the county council in the area in which the town of Rocksburg is located. Students will role-play their position and make a presentation to the five-member Rocksburg County Council. This council will ultimately make a recommendation to the F.E.R.C. (Federal Energy Regulatory Commission) on a siting permit for the dam. (For more detail on procedures that can be adapted for use in this activity, see "To Zone or Not to Zone" in the Project WILD Activity Guide.)
5. After all the students have made their presentations, ask the county council to render a decision.
6. Following the council's decision, have a brief class discussion to summarize the "pros" and "cons" that emerged from the students' presentations. Identify and list the benefits, if any, and costs or liabilities, if any, as a result of building the dam. Include effects on people, plants and animals. The list of "pros," "cons" and effects can be listed visually on a chalkboard.
7. After the role play and class discussion, ask each of the students to write a brief essay describing his or her own personal recommendation for whether or not to build this dam. The students might expand their position papers, or "start from scratch" in writing their essays.

EXTENSIONS

1. Change roles and conduct the council meeting again. Note any differences in the results as well as your perceptions of the process and experience.
2. Find out if there are any proposals to create new dams or any other proposals that will affect wildlife habitat in your region. If so, investigate the "pros and cons" of one or more of these proposals, from your perspective.
3. Is there a dam in your area? Visit it. Find out about its effects on people, plants and animals—both positive and negative, if any.

A.G. "Rick" Ulture: a representative of the local farmers' coalition interested in the dam's potential for protecting crops from floods as well as its ability to provide water for irrigation.

Lotta Power: a lobbyist for the municipal electrical power company interested in developing the dam.

Rob or Marta Kanu: kayaker concerned with the loss of the whitewater stretch for canoeing and kayaking.

Sam N. Fish: a local sporting goods store owner and avid fisherman concerned with the loss of migration routes of the fish on the river.

Dan D. Lion: the president of the "Save Our Native Plants and Wild Animals" organization.

Pat "Pottery" Brusher: an archeology professor from the local university who has done extensive research on the archeological sites of Indian fishing camps along the river.

Lynn Dripper: the director of the municipal water quality authority responsible for providing quality drinking water for the city, and attracted to the dam's potential for providing a reservoir of high quality water useable during long hot summers.

H. M. Owner: a representative for all homeowners in the river valley below the dam who would like to see more flood control.

Bobbie Lawkeeper: the local Rocksburg sheriff concerned about maintaining police protection, peace, health and safety with only a one-person staff as the sole legal authority in the region.

T. M. Burr: the owner of a lumber company whose land would be inundated by the reservoir.

I. M. Floaten: an owner of a whitewater rafting company who uses the river for commercial rafting. Concerned about loss of the "best seven miles of the river," I.M. argues that the best rapids would be submerged by the lake.

"Sky" Soarer: the president of the local bird club who has organized eagle-watching trips to the river every winter for the last 15 years.

Sam Slalom: an avid water skier who sees the new lake as a real boon to skiing interests.

Velma or Virgil Vigil: a local representative of the Gray Panthers, a group of retired people who are concerned about any rise in power bills.

"Boater" Cartop: an older fisherperson who enjoys throwing the boat on the top of the car and putting in at the closest float spot—especially lakes!

Marshal or May Flyfisher: a long-time resident who champions the purity of fly fishing and insists on pristine habitat, noting the necessity of white water riffles.

Col. "Bull" Winkle: the president of "More Moose Now" who believes that with the lake behind the dam, more moose habitat will be created.

Lap Larson: the president of W.O.W. (Watch Our Waves).

Cy or Sy N. Tist: a respected biologist who is prepared to testify about potential effects on wildlife from the building of the dam.

O. L. Slick: a salesperson for motor boats, water skis and other recreational equipment.

Forest or Park Site: a trained forester who has worked in the woods in the area for more than 50 years.

Running Waters: a tribal leader who is concerned about loss of native heritage from flooding the region for the dam.

E. Conomy: a local businessperson who is concerned about the long-range business potential of the area.

C. D. Minium: a wealthy land developer who has architects working on designs for lakeside condominiums and resort homes.

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Washington Environmental Education Assessment Project

Water Shortage

Civic Action
Task Model 3A: Extended Response - Analysis
Task Model 4A: Extended Response - Action Planning

Grade 10

Essential Academic Learning Requirements

Reading EALR 2: Students will understand the meaning of what is read.

- 2.2 - comprehend important ideas and details

Science EALR 2.2: Students will apply science knowledge to solve problems and meet challenges.

- 2.2.3 - propose, revise, and evaluate the possible constraints, applications, and consequences of solutions to a problem or challenge

Science EALR 1.3: Students will understand how interactions within and among systems cause changes in matter and energy

- 1.3.9 - how human societies' use of natural resources affects quality of life and the health of ecosystems.

Geography EALR 3.1: Students will identify and examine people's interaction with and impact on the environment.

- 3.1.2 - analyze how environmental knowledge and responsible action can affect species survival

Writing EALR 1: Students will write clearly and effectively.

- 1.1: develop concept and design
- 1.2: use style appropriate to purpose and audience
- 1.3: apply writing conventions

Writing EALR 2: Students will write clearly and effectively.

- 2.1: write for different audiences (*community, businesses, government agencies)*
- 2.2: write for different purposes (*persuade*)
- 2.3: write in a variety of forms (*policy recommendation*)

Civics EALR 4: Students will understand the rights and responsibilities of citizenship and the principles of democratic involvement.

- 4.3.1 - analyze the influence of a diversity of public opinion on the development of public policy and decision-making.
- 4.2.1 - engage in oral and written civic discourse to analyze pressing controversial issues and evaluate different solutions.
- 4.3.1 - describe how one person can make a difference in school or the local community.

Water Shortage

Read the four perspectives on the water in Washington State. Then do Numbers 1 and 2.

Snake dams supporters prevailing, Gorton says

WASHINGTON— Opponents of a proposal to breach four lower Snake River dams hold the advantage at the moment, Sen. Slade Gorton, R-Wash., said Wednesday. Support for breaching the dams is coming from "outside" groups that aren't concerned about the economic future of the region, headded.

"I believe for the first time we hold the upper hand at the beginning and we need to consolidate our position," said Gorton, who has led the opposition to breaching the dams in Congress. "We can win the struggle against removing the dams."

Gorton also told a group representing the Pacific Northwest Waterways Association he intends to once again tie funding for purchase and removal of two smaller dams on the Olympic peninsula's Elwha River to a requirement that Congress must approve breaching or removing any dams on the Columbia and Snake Rivers.

"I was surprised when the deal was turned down last year," said Gorton, referring to the Clinton administration's opposition to his proposal.

The administration has long supported removing the dams on the Elwha River to restore salmon runs but believes there shouldn't be a link to a prohibition on breaching other dams.

Top administration officials have also said repeatedly it would take congressional approval before removing federal dams on the Columbia and Snake rivers, but they have hedged when asked about such nonfederal dams as those owned by public utility districts upstream from the Tri-Cities.

Removing dams to help restore dwindling runs on the Columbia and Snake rivers was the "position of so many of these outside groups," Gorton said. "Public policy should not be designed for a single goal."

Environmentalists took exception to Gorton's comments. "I think it would come as a shock and surprise to sport, commercial, and tribal fishermen that Senator Gorton considers them outside groups," said Jim Baker, who coordinates salmon issues for the Sierra Club and lives in Pullman.

While it may be possible to lessen some of the economic impacts from breaching dams, Baker said, there may be no other way to keep the salmon from going extinct.

"Senator Gorton may feel he has the upper hand, but the fact is you can't mitigate economic impacts so the Northwest can continue to have salmon and a strong economy into the 21st century," he said. "Salmon extinction, which the senator seems to support, would result in the ultimate lose-lose with no salmon, no fishing and no cheap hydropower."

Gorton's remarks came as the 40 or so people representing the Pacific Northwest Waterways Association and members of other groups fanned out across Capitol Hill this week asking lawmakers to oppose proposals to breach the four lower Snake River dams.

"I'm a dry-land wheat farmer and I raise 100,000 bushels a year," said Skip Mead of Dayton. "I could lose $35,000 to $60,000 a year if those dams were removed."

Mead and other growers say removing the dams would mean they could no longer ship their wheat downriver on barges and would face $60 million a year in additional transportation costs as they turned to rail cars and trucks.

"You can't pass those costs on to the buyer," said Jack DeWitt of Waitsburg. "You can lose a sale based on just pennies a ton."

Jonathan Schlueter, executive vice president of the Pacific Northwest Grain and Feed Association, said in addition to increased transportation costs for farmers, the act of removing the dams could cost up to $1.2 billion.

The loss of electricity resulting from their removal would cost rate payers about $150 million a year, resulting in an increase of between $3 and $5 a month on the average residential utility bill.

"There is an economic cloud of uncertainty not just over agriculture, but over the entire business climate of the Northwest," Schlueter said. "Advocates of dam breaching are very determined. We are not a group adverse to paying our share. Maybe dam breaching is the best solution for recovery (of salmon), but we think there are others."

Source: Blumenthal, Les. *Metro/Northwest.* Thursday, March 4, 1999, A3.

NW starts to worry about running dry

Breaching the four lower Snake River dams is the Mid-Columbia River's current hot-button controversy. But ask any farmer what the real issue is, and one answer appears time and again:

Water.

Few others seem to notice the issue, however, until residential taps run dry or conservation measures are enforced like they were in parts of Kennewick last summer.

"Running Dry" is a series that will run on three successive Sundays about the West's most precious and contentious topic. The stories are based on reams of reports and interviews with dozens of environmental officials. Whether the Northwest really is running dry depends on your perspective—but clearly, politics can drastically change the use of water as we know it.

During three months of investigating the Northwest's water woes, several problems with the current water allocation system became clear:

- Fish are struggling in river basins that suffer from low stream flows.
- Despite mountains of rhetoric about the need for more water for fish, no one knows how much water is being used for other uses, or how much fish need.
- There's little enforcement of water rights, even though suspicions run high that water stealing is prevalent.
- The federal government is buying water for fish from Idaho farmers even as new development continues upstream.
- There are vast differences in water use and availability between the east and west sides of Washington and Oregon, which can lead to gridlock when legislators from both sides of the mountains take on the issue.
- The public is largely ignorant about water rights and conservation, especially when it comes to rights on paper that may have lapsed.
- The water rights system has been patched together since the turn of the century in ways that are often confusing, leaving decisions about disputed rights slowly meandering through the courts.
- Irrigators currently have an incentive to use all their water—if they don't, it will be taken away. Thus conservation is not rewarded.
- Fear of federal mandates has driven states, irrigation districts, and other water users apart instead of together. The stakes are now so high that cooperation—if it ever existed on water issues—is nearly dead.

But for all the turmoil, several potential solutions are bubbling to the top. New state water rules could curb abuses and promote conservation. At least one private group is buying water for fish. And farmers are making big cuts in their water use with more efficient irrigation systems.

There will be no single solution to the Northwest's water woes, and problems will continue to mount even as the answers are found. But the time is now to keep the region from running dry.

Metro/Northwest Editorial
John Day Dam study reasonable approach

Dams aren't sacred anymore. In fact, the federal government has spent millions and millions of dollars in a long and involved process, studying whether the breaching of the four lower Snake River dams will save salmon.

And McNary Dam is the latest target with President Clinton including $6 million in his budget to study drawdowns in the lower Columbia River.

By comparison to the Snake River study, the Army Corps of Engineers' approach to studying the possible breaching of the John Day Dam on the Columbia seems amore reasonable approach.

The John Day study is directed by the corps' Portland district, while the Snake River dams study is under the jurisdiction of the corps' Walla Walla district.

The corps has divided the John Day study into two sections. Phase I, which is under way now, is examining the economic costs of breaching as well as the probability that the move would save salmon. When it's completed next fall, the district will recommend to the corps whether to end the study or proceed into the more involved Phase II, which will include the logistics of just how to breach the dam.

Already the costs are known to be immense. The Portland district officials acknowledge that the drawdown of either 50 or 100 feet would result in the loss of 150,000 acres of irrigated farmland. Interstate 84 and the railroad tracks that follow the river would need major reinforcement.

Also, if the dam is permanently drawn down to natural river levels, there is a threat of flooding downriver. If the dam is breached, a spillway may have to be built back up to prevent flooding.

And the sediment that has built up behind the John Day could block salmon runs and likely would have to be dredged.

Phase I is a yearlong study, costing $3.3 million. If the corps opts to dive into the Phase II study, the cost would be $20 million by the time it is done.

Of course, it's difficult to imagine the John Day study's Phase I will conclude that more study is necessary, given the huge costs to our regions in infrastructure and commerce.

But in these times when politics—instead of science—drive decisions, it's difficult to bet on a common-sense outcome. At least the John Day study seems to be making a common sense effort.

States brace for water war

The scene is set like an Old West showdown at high noon. Gunslingers from the states stand arrayed against a gang of federal troopers.

The fight?

It's over water.

Idaho and Washington are braced for a showdown with the feds to decide who will control the states' water.

"There probably is no larger issue in the state than water," said Duane Unland, section manager for the Washington Department of Natural Resources in Ellensburg. "There really are no other issues when you only have 7 inches of rainfall."

The showdown will center on whether a state's right to its water will supersede all other water rights as the federal government forces the protection of endangered fish.

The government says the Endangered Species Act gives it priority over all other uses of water, and that means fears run high as development has ground to a halt in many places.

"We may be headed for a civil war," said Sen. Bob Morton, R-Orient, party leader of the Washington Senate's Environmental Quality and Water Committee. "It's going to be a legislative battle."

"What you've set up is one enormous states' rights battle," said Dick Larsen of Idaho Water Resources Department. "There's a lot of people who get really uneasy because they don't know where that might lead.

"The whole trick here is to try to find a way out of this morass. How are we going to get through this, save the salmon, and not destroy our state in the process?"

Signs of a stressed water system already are springing up all over Washington. Take Kennewick General Hospital, which says it has lost roughly $1 million in revenue it could have spent on new equipment because it can't get irrigation water for its Benton County farmland. Or West Richland, which drilled a well 1,252 feet deep in the past year—and still may not have as much water as it hoped to find at 500 feet. Or Randy and Debbie Kulm, whose well in Lind is going dry—reportedly because of illegal water use by others in the area.

In the next 12 months, the region's course regarding water will be set. The Army Corps of Engineers will tell Congress if the four lower Snake River dams should stay or go. Idaho will decide if it will continue giving the federal government water for fish.

Northwest residents will grapple with Endangered Species Act listings. Rules set by the current Washington Legislature could drastically alter water rights. And, perhaps most important, the National Marine Fisheries Service will set its long term Columbia River management policy.

As a result of water management decisions, hydropower rates will likely continue to rise, and city water rates could jump to encourage people to conserve water. And the future of the region's fish runs could well be determined.

"We've got a number of hot spots where water has simply been overappropriated and the fish are hurting as a result," said Jim Baker, with the Sierra Club in Pullman. "We don't really understand. . . that water is a finite, limited resource, and you better be careful before you exceed its limits."

Fisheries managers are most concerned with water levels because more water in a stream generally means cooler temperatures and diluted pollution—therefore better conditions for protected salmon and steelhead.

Most summers, streams in the Walla Walla and Yakima river basins go dry. In other places, they just get so hot fish die by the droves as they try to swim upstream to spawn or migrate downstream to the ocean.

The problem is not one of water quantity, as anyone who's spent time in Western Washington this winter can attest. Rather, the issue is about survival in drought years and the ability to capture rain water and extraordinary amounts of Cascade mountain snow as it melts.

"There may be water there, but it's just not available where it's needed," said Keith Phillips, water resource division manager with the Washington Department of Ecology.

In the foreseeable future, it will remain nearly impossible to get water rights in Washington, slowing rural development and limiting landowners' ability to make the most of their land. Existing water rights could essentially be condemned to provide more water in streams for fish.

"It's one of those things that has a tremendous impact on people's lives," said Greg Overstreet, lawyer for the Building Industry Association of Washington. "If you don't have any water, you can't build."

Thousands of people in Eastern Washington have claimed water rights that eventually will be ruled illegal—and water cops could soon be out enforcing the laws much more vigorously. "A lot of the cheap water is all gone," Phillips said.

But demand continues to grow—for people, farms, industry, and fish. Washington is the second most crowded Western state after California,

with 5.6 million residents squeezed into 66,000 square miles. That makes the state more than twice as crowded as almost all of the states west of the Mississippi River.

In the last 10 years, Washington's population has grown by 25 percent—although the increase in available water has not. About 80 percent of Washington's water is used by agriculture.

Keith Wolf of the state Fish and Wildlife Department insists agriculture and fish can coexist—with changes in land use and upgrades in technology to allow more water to be left in streams. But there's a sense that the need to protect salmon could kill the whole intricate system of laws, canals, politics, and sprinkler heads that sprang up over the last 150 years.

"Water seems to be the big thing, bigger than salmon—who gets to pull the plug when they want to," said Dennis Harper in Orofiño, Idaho, a town wracked by federal water policy on the Columbia River system.

While the Endangered Species Act threatens the ability of states to control their own water, frustration mounts among residents as states clamp down on water rights. Eastern Washington residents seem to split their waterborne animosity between Governor Gary Locke and the state Department of Ecology. Locke has preached rural economic development but hasn't freed up water rules to allow for it—creating what residents see as a serious disconnect between word and deed.

The fundamental dispute is over the nature of a water right. Environmentalists and government agencies tend to say it's a privilege that must be used in the public good to be valid. But those who use the water say it's theirs—a property right with no restrictions.

"Whoever controls the water controls us," said Franklin County farmer Porky Thomsen. "Whoever controls that (resource) is going to control the politics and is going to control us under regulation not representation."

The sides remain widely divided.

"Right now, nobody is talking," said Katherine Ransel of the conservation group American Rivers in Seattle. "Everybody has got their knives out."

Source: Lee, Mike. *Metro/Northwest.* Thursday, March 4, 1999, A1.

1 Using the information from the reading, complete the table below to show the five different types of individuals, groups, agencies and organizations involved in the water rights and salmon preservation issues, their positions and perspectives on the issues, what they generally value, and the reasons for their demands to control water rights.

Type of Individual, Group, Agency, Organization	Position/ Perspective on Water Rights and Salmon Preservation	General Values	Reasons for Demands to Control Water Rights

2 Look carefully at the ideas given in the three articles and the editorial. Suppose you were the chair of either your school's Future Farmers club or the school's Environmental Awareness club. Devise a plan of action you and your club members could take that would help educate people about the water rights controversy and that would address the requirements of Endangered Species Act's that the salmon be protected and restored. In your plan, be sure to consider:

- objectives or goals for the outcome of the educational plan
- tasks you would undertake
- products (if any) you would create
- timelines for each task
- division of labor
- how you will measure the success of your plan

Write up the plan as a proposal to your club. Be sure to include objectives, tasks, products, timelines, division of labor, and measures of success. Also describe:

- how the proposed plan addresses the Endangered Species Act
- how it will help to improve understanding of the issue by the voters in the community

To Dam or Not to Dam - Aquatic WILD- Student Worksheet

Directions:

- Read the PATH document or go to the PATH website to find conclusions on the likelihood of survival of salmon on the Columbia River System. PATH represents the scientific analysis and conclusions of a large group of scientists from different government agencies.

- What is the purpose of this document: Quote a passage which demonstrates the purpose.

- Simplify in your own words what essential questions (up to 3) the scientists were asking.

- Quote pertinent parts of the document with conclusions which point to the chances of survival of salmon on the Columbia River System.

Reflection:

- In your own words what is possible for conservation of salmon in the Columbia River System.

The Plan for Analyzing and Testing Hypotheses (PATH) Web Page

This page provides public documents generated by the PATH process. Please email editorial comments on these documents to either the contractor (David Marmorek ESSA) or to BPA's PATH project manager (Jim Geisleman BPA).

1999

PATH Decision Analysis Report for Snake River Fall Chinook , October 10, 1999. [pdf, 2.5MB]

PATH scientists July 8, 1999 pleadling to the IT regarding ISRP review of FY2000 PATH proposals.

Documents provided by ESSA to the Independent Scientific Review Panel on CD, June 7, 1999

PATH/Implementation Team (IT) meeting, March 3, 1999

NPPC/NMFS Technical Forum on PATH, February 25, 1999

Overview of the PATH progress to October 26, 1996.

Conclusions from 1996 retrospective analyses. Printed copies of the complete report *Final Report on Retrospective Analyses for FY96* may be ordered by email.

Preliminary Decision Analysis Report on Spring and Summer Chinook- March 16, 1998
with revised executive summary- August 5, 1998

Retrospective and Prospective Analyses of Spring/Summer Chinook Reviewed in FY 1997 - June 1998

"Conclusions and Recommendations from the PATH Weight of Evidence Workshop" , September 8-10, 1998, Vancouver, B.C. Canada. Report released October 1, 1998 or October 8 release correcting pages 17-19. Corrections affect the "General Conclusions" on page 17, Table 3 on page 18, and Figure 1 on Page 18-19. In general the correction results in a modest increase in weighted average outcomes for all actions and does not change the relative ranking of actions. However, the increase is enough to affect the ability to meet the jeopardy standards in marginal cases.

FY1998 Final Report:

- Executive Summary presented to the Implementation Team (IT) December 9, 1998.
- Presentation to the Implementation Team (IT) December 16, 1998.
- Complete PATH FY98 Final Report (1.85MB) released December 16, 1998.
- Review comments by Scientific Review Group (SRG) Members

  Steve Carpenter
  Jeremy Collie
  Saul Saila
  Carl Walters

File http://www.bpa.gov/Environment/PATH/welcome.html
Last modified: June 16, 1998

E-mail comments on this page to: David Askren at BPA

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PATH - Plan for Analyzing and Testing Hypotheses - Conclusions of FY96 Retrospective Analyses

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Status of this Document

The conclusions presented in this document represent our current consensus on the results of retrospective analyses completed in FY96 (Marmorek et al. 1996), focusing on naturally-spawning spring-summer chinook (i.e. stream-type chinook that migrate back past Bonneville Dam in spring or summer). Readers interested in the details of these analyses should read the full report, which is available from the Bonneville Power Administration. This document has been reviewed by the PATH Scientific Review Panel (SRP), core PATH participants, and other interested scientists. We have spent a large amount of time and effort on compiling these conclusions and ensuring that they fairly represent the evidence obtained from retrospective analyses to date. This includes 2 days of discussion at a PATH workshop in early October, 14 hours of conference calls with the PATH Synthesis Group (people indicated with asterisks in the authorship list), reviews by the PATH SRP and others, and a 2-day meeting to assemble and synthesize all comments and proposed revisions. However, we acknowledge that these conclusions and their supporting evidence may change in the future as analyses are completed and extended. Indeed, many of these analyses are already underway. We intend to produce an update to this document in the early spring of 1997.

Objectives of PATH

PATH is an iterative process of defining and testing a logical framework of hypotheses relating to the Columbia River anadromous salmon ecosystem, while moving towards stock recovery and rebuilding. PATH's objectives are to:

> 1. Determine the level of support for key hypotheses based on existing information, and provide guidance to management agencies on the implications of these analyses for key management decisions [retrospective analyses]. Propose other hypotheses and/or model improvements that are more consistent with the data.
>
> 2. Assess the effects of alternative future management actions on salmon stocks, and the ability to distinguish among competing hypotheses from future information [prospective analyses]. Advise various institutions (NMFS, NPPC, BPA, USFW) on the consequences of alternative future management actions for salmon stocks, and the types of research, monitoring and adaptive management experiments which could maximize the rate of learning and clarify decisions.

Iteration within the PATH process occurs as this logical framework is revised over time in response to improvements in both information and analytical methods, and changing management questions. The framework is intended to provide guidance to the development of regional programs that would stabilize, ensure persistence, and eventually restore depressed salmon stocks to self-sustaining levels. It is also meant to provide a structure for an adaptive learning approach to development and implementation of a regional salmonid recovery program. PATH takes a whole life-cycle approach to developing this framework to encompass potential delayed effects of stressors or processes in one life stage on subsequent life stages.

Work in FY 96

In its first year of existence, PATH has already made considerable progress. Specific achievements include:

- clarification of management decisions with senior policy makers;
- development of hypotheses relevant to those decisions;
- considerable data reconnaissance, acquisition and refinement;
- detailed retrospective analyses related to hydrosystem, habitat and hatchery management decisions;
- three workshops and many technical meetings to help design approaches and review pilot results;
- development of novel analytical tools to assist in decision making;
- recommendations for future research, monitoring and experimentation that arise out of the retrospective analyses;
- eight reports;
- presentations on PATH to the Implementation Team (IT), members of the NPPC, and the public; and
- meetings with the Research Review Group of the IT and the Independent Scientific Group (ISG; now the Independent Scientific Advisory Board) to coordinate our activities.

External peer reviews of PATH were conducted in March/96 and September/96, and have been both very helpful and consistently positive. In addition to advancing this work to the prospective domain, major goals for the next fiscal year are to complete similar analyses for fall chinook and begin to assemble data for steelhead. The current workplan does not include any analyses of Columbia River sockeye stocks.

Structure of this Document

The PATH Final Report on Retrospective Analyses is over 600 pages long, and consists of 13 chapters. To synthesize our results across chapters, we have developed a set of questions in the form of a flow chart (Figure 1). The first question, "Do all stocks show a similar pattern of recent change in stock indicators?" is important for understanding whether the trends in recent decades in endangered salmon stocks are affected by region-wide forces (e.g. climate), or stresses specific to those stocks. It is also of interest to understand the spatial scale of the observed patterns: basin (including all of the Columbia River and its tributaries); regions (portions of the Columbia such as the upper-Columbia, or tributaries to the Columbia such as the Snake River); or individual sub-basins (e.g. Middle Fork Salmon River and Grande Ronde River, each containing several index streams), and whether the different patterns that are observed correlate with geography or other obvious environmental characteristics.

The second question focuses on the nature of differences among stocks. We address two questions:

1) Have productivity and survival rates of spring chinook changed, and if so, when? (Question 2a)

2) Is the difference between productivity indices in pre-1970 and post-1974 periods the same for upstream and downstream stocks? (Question 2b)

The two time periods chosen for comparison were selected because a number of changes occurred in the 1970's. These changes include completion of 3 of the 4 lower Snake River Dams (Lower Monumental, Little Goose, and Lower Granite) and one lower Columbia River dam (John Day), concurrent declines in stock indicators (i.e. survival rates and productivity parameters), a shift from a cool/wet to a warm/dry oceanographic regime in the Northeastern Pacific Ocean around 1977, increases in production of hatchery fish, and changes in the seasonal distribution of flows in the Columbia River estuary. Stock groups were defined geographically. Upstream stocks include 7 Snake River index stocks and 3 stocks that originate in the Upper Columbia River (above the confluence of the Columbia and Snake Rivers, including the Methow, Entiat, and Wenatchee Rivers). Downstream stocks are those that originate between the confluence of the Snake River and Bonneville Dam. Index stocks in this group include stocks from the John Day, Warm Springs, Klickitat, and Wind Rivers. The three John Day stocks were the only lower river stocks for which pre-1970 data were available.

The third set of questions consists of two parts:

a) What do the retrospective analyses indicate about the contribution of each of five factors (hydro, habitat, hatchery, harvest and climate) to the observed spatial and temporal differences? Note that analyses to date refer primarily to freshwater spawning and rearing habitat. However, we acknowledge that effects in other habitats, such as the estuary, may be common factors that affect the temporal pattern of change in both upstream/downstream stocks.
b)To what extent can management actions under consideration within each of these factors compensate for past impacts? We have only begun to address this question seriously for hydrosystem management actions, and expect to provide more insights during the next year's work. For the hydrosystem, we address four questions:

1) Can **transportation of fish to below Bonneville Dam** compensate for the effect of the hydrosystem on juvenile survival rates of Snake River spring/summer chinook salmon during their downstream migration? (Question 3b(i))
2) Can **modifications to in-river passage**, other than drawdown, compensate for the effect of the hydro system on juvenile survival rates of Snake River spring/summer chinook salmon during their downstream migration? (Question 3b(ii))
3) Can a **combination of transportation under some conditions and in-river passage under other conditions** compensate for the effect of the hydrosystem on juvenile

survival rates of Snake River spring/summer chinook salmon during their downstream migration, if **improvements to transportation and modifications to in-river passage, other than drawdown,** are made? (Question 3b(iii))
4) Can **drawdowns to spillway crest or natural river level** compensate for the effect of the hydro system on juvenile survival rates of Snake River spring/summer chinook salmon during their downstream migration? (Question 3b(iv))

Answers to the questions in Figure 1 are presented by summarizing our overall conclusions to date, the evidence for these conclusions, and the information required to address remaining uncertainties. There are varying amounts of uncertainty surrounding both the conclusions and the individual pieces of evidence. The degree of scientific consensus associated with the evidence is indicated in most cases by a Astar system:

o- unsupported hypothesis
*- best judgement - low confidence
**- best judgement - limited confidence
***- reasonable confidence
****- high confidence

This approach was successfully applied to a broad range of impacts in the final report to the U.S. Congress on the National Acid Precipitation Assessment Program. The degree of uncertainty in the conclusions is indicated verbally in the text of the conclusion by stating whether there is "low confidence", "reasonable confidence", or "high confidence" in the conclusion. The degree of confidence in a conclusion is determined by the strength of the evidence on which it is based. For example, conclusions in which there is reasonable or high confidence require strong empirical support (i.e. evidence with 3 or 4 stars). Where our analyses allow for alternative hypotheses, we have described those alternatives and their supporting evidence.

Information needs for each conclusion summarize what is required to reduce the uncertainty in that conclusion and its underlying evidence, addressing both data and conceptual gaps (e.g. absence of hypothesized mechanisms) that prevent a full understanding and rigorous quantitative description of the relationships between natural and human-induced stressors and salmon populations. For each information need, we also provide a rough estimate of when this information might be available given the constraints on either collecting or analyzing relevant data. In some cases, research designs that will generate this information have already been identified. **Information needs that are marked with "P" in the margin are tasks that PATH will carry out in its FY97 Work Plan.** PATH has only begun to explore alternative research designs. The development of these designs, including the design and implementation of an adaptive management framework, remains one of the major objectives of PATH.

Question 1

Do all wild yearling-migrant spring/summer chinook salmon stocks above Bonneville Dam show a similar pattern of change in stock indicators since the late 1950s?

Overall Conclusions

1.1 Although all stocks have declined somewhat since the late 1950's, we conclude with high confidence that these stocks do not all have the same long-term trends in number of spawners (S) or recruits (R) per spawner (R/S: # of adults returning to the mouth of the Columbia River per spawner in the parent generation)

1.2 We conclude with reasonable confidence that stocks originating from the Salmon River sub-basin and from the upper-Columbia sub-basin show steeper patterns of decline since the

late 1950's than do stocks originating from the lower Columbia sub-basin. Patterns of decline are similar within the Salmon River stock group and within the upper-Columbia stock group. Patterns of decline are not similar within the lower river stocks. In addition, the lower river stocks show a decline that is less steep than the upstream stocks.

1.3 We conclude with reasonable confidence that year-to-year fluctuations about the trends are strongly similar within the Salmon River, Oregon tributaries of the Snake River, and Upper Columbia River sub-basins. In addition, there are many similarities across sub-basins.

Since sub-basins differ in trends in number of spawners and R/S, long term declines were more likely associated with factors affecting stocks which originate in those sub-basins, rather than some common factor affecting all monitored stocks within the Columbia Basin. Year-to-year changes about these trends, however, showed some similarities among both upper and lower river stocks, suggesting that some common environmental forces may have been operating.

Note on Spawner and Recruit Data

There is uncertainty and variability in the expansion of redd counts to spawners and recruits. Further review of the expansions of redd counts to Spawner and Recruit estimates should be completed in FY97, including the effects of uncertainty and potential bias on analyses. This review may lead to changes in the conclusions presented herein, or their associated levels of confidence.

Evidence for Conclusion 1.1:

Correlation and cluster analyses of spawning escapement (ln(R/S)) from 16 stocks (Ch. 2; Botsford (1996)) suggest that:

The five spring-summer chinook index stocks within the Salmon River sub-basin covary significantly. The three upper-Columbia River index stocks also covary significantly with one another. Both of these groups of stocks are distinct from those within other sub-basins (Botsford 1996 Tab. 2). (***)

Analysis of Covariance tests for differences in productivity (measured as the intercept in the relationship of ln(R/S) versus S) between the pre-1970 and post-1974 periods were significant for 12 out of 14 index stocks. The two exceptions were the Poverty Flat (on the Snake River) and Middle Fork John Day stocks (Ch. 3 Tab. 3-4). (**)

Evidence for Conclusion 1.2:

Analyses of stock-recruitment data (where recruits are the number of adults returning to the mouth of the Columbia River) for upstream and downstream index stocks indicate that:

The survival rate (measured as ln[(observed R/S)/(predicted R/S)]) of upstream stocks show different long-term trends than downstream stocks (Ch. 3, Figs 28, 29, 30). (**)

Evidence for Conclusion 1.3:

Correlation and cluster analyses of spawning escapement (ln(R/S)) from 16 stocks (Ch. 2; Botsford (1996)) suggest that:

In terms of rapid variability about trends, many stocks throughout the interior Columbia River basin covary significantly (Botsford 1996 Tab. 4). (***)

The Wind River and Warm Springs River stocks each show unique patterns of year-to-year

variability, different from all other stocks (Botsford 1996, Tab. 4 and p. 8). (***)

The three John Day River stocks show distinct patterns of short-term (year-to-year) variability from one another (Botsford 1996 Tab. 4). (***)

There are some intriguing similarities among stocks from different regions in their year-to-year variability. For example, the North Fork of the John Day River and the Klickitat River both covary significantly with the Salmon River stocks (Botsford 1996 Tab. 4). (***)

Information Needs

The analysis should be extended to stream-type chinook salmon stocks outside the Columbia River Basin to better assess the geographic scale at which stocks covary (<1 year to collect additional data and complete analyses).

The analysis should also extend to Columbia River ocean-type chinook salmon and steelhead and hatchery stocks of these species and areas, although some analyses (e.g. discriminant analysis) may not be possible because of the small number of stocks. Data for these stocks may be obtained by reconstructing runs for more stocks or by using St+T/St as an index of recruitment (where T is based on the appropriate maturity schedule). Caution should be used in applying St+T/St when harvest rates vary, particularly for ocean-type chinook. The estimated time before this information is available will depend on availability of data.

Question 2a

Have productivity and survival rates of spring chinook stocks changed, and if so, when?

Overall Conclusions

We conclude with a high degree of confidence that the stock productivity and survival rate of the aggregate of spring chinook stocks have decreased over time, especially between the pre-1970 and post-1974 periods.

Evidence

Estimates of productivity (i.e. Ricker 'a' parameter) for each decade for the aggregate of natural-spawning spring chinook stocks (from above Bonneville Dam) show similar values for the 1940s, 1950s, and 1960s ('a ' = 1.8 - 1.98), but then a large and significant decrease in the 1970s ('a' = 0.63) and 1980s ('a' = 0.37) (Ch. 3, Tab. 9). Survival rate indices for the aggregate of spring stocks that reflect survival rate deviations from those defined by the best-fit Ricker curve (i.e. *ln[(observed R/S) / (predicted R/S)]*) are also lower beginning in the 1970s than in the previous period (Ch. 3, Tab. 7 and Figs. 28 and 29).

Information Needs

Review spawner-recruit estimates (see Note on Spawner and Recruit Data under Question 1; <1 year).

Use different time periods from 1939 - 1990 in applying the Analyses of Covariance in Chapter 3 to evaluate more precisely when changes in stock indicators occurred (<1 year).

The decrease in productivity and survival rates starting in the 1970s suggests that future analyses should focus on hypotheses relevant to that period.

Continue stock identification program at Bonneville Dam, and expand to Lower Granite Dam to get better data on age structure and stock composition.

Question 2b

Is the difference between productivity indices in pre-1970 and post-1974 periods the same for upstream and downstream stocks?

Overall Conclusions

2b1. We conclude with a reasonable degree of confidence that the stock productivity (defined below) decreased between the pre-1970 and post-1974 periods more in the upstream than in the downstream stocks.

2b2. We conclude with a high degree of confidence that the survival rate index (defined below) decreased more between the pre-1970 and post-1974 period in the upstream than in the downstream stocks.

2b3. We conclude with a high degree of confidence that the variability in survival rate index increased for the Snake River stocks in the post-1974 period compared to the pre-1970 period.

*2b4. We conclude with a reasonable degree of confidence that the variability in the survival rate index did **not** increase between pre-1970s and post-1974 periods for the Upper Columbia River stocks (above the confluence of the Snake River) and for the lower Columbia River stocks.*

2b5. We conclude with a reasonable degree of confidence that the estimates of productivity became more uncertain in the post-1974 period for most of the upstream stocks, due to wider variation in (R/S) ratios. This uncertainty did not increase for the downstream stocks.

Evidence

Analyses of stock-recruitment data for upstream and downstream index stocks indicate that:

Productivity (measured as the Ricker >a= parameter in the ln(Recruits/Spawner) versus Spawner relationship) declined more from the pre-1970 period to the post-1974 period in the upstream stocks than in the downstream stocks (Ch. 3, p. 15). Tests justified the assumption that the Ricker >$= parameters for each stock were the same in both time periods (Chap 3, Tab. 4, Equation 3-2). (***)

A survival rate index, measured as ln[(observed R/S) / (predicted R/S)], also declined significantly more from the pre-1970 period to the post-1974 period in upstream than in downstream stocks (Ch. 3, p. 15-16, Tabs. 7 and 8). (***)

Variability in the survival rate index increased more in the post-1974 period for Snake River stocks than in all other index stocks (Ch. 3, Fig. 28). (**)

Productivity (Ricker >a= parameter) of upstream chinook stocks declined abruptly, beginning around 1970 (Ch. 3, Tab. 9). Survival rate decreased for the upstream stocks between 1960 and 1990 (Ch. 3, Figs. 28 and 29), but not for the downstream stocks (Ch. 3, Fig. 30). Productivity remained fairly stable for the aggregate spring chinook stocks above Bonneville from about 1930 to 1970 (Ch. 3, Tab. 9) and survival rate remained fairly stable from about 1950 to 1970 (Ch. 3, Figs. 29 and 30). (***)

For conclusion 2b5, standard errors on estimates of the Ricker 'a' parameter were larger for all upstream stocks in the post-1974 period than in the pre-1970 period, except for Bear Valley/Elk and Johnson stocks (Ch. 3, Figs. 25, 26). This pattern did not hold as clearly for the downstream stocks (Ch.3, Fig. 27). (**)

Information Needs

Review spawner-recruit estimates (see Note on Spawner and Recruit Data under Question 1; <1 year).

If possible, data for other downstream stocks (e.g. McKenzie River in the Willamette basin and coastal North Umpqua spring-run) should be included to strengthen some of the conclusions about geographical differences (<1 year). However, caution should be used when comparing these stocks to above-Bonneville spring-summer stream type stocks, as the McKenzie and N. Umpqua stocks have different juvenile life histories and ocean distributions from the above-Bonneville stocks. Similar analyses should be done for fall chinook (<1 year) and possibly steelhead (< 2 years), although the quantity and quality of population data for these stocks is poorer than for spring-summer chinook.

To enhance future analyses, full spawning ground monitoring (redd counts, age structure, hatchery percentages) of all spring-summer index stocks should be maintained, and expanded to include additional index stocks.

Question 3a

*What do the retrospective analyses indicate about the contribution of the **hydrosystem** to observed spatial/temporal differences in stock indicators?*

Conclusion 3a.1

We are highly confident that the differences (identified in Question 2) in stream-type chinook indicators of productivity and survival rates between upstream (Snake River sub-basins) and downstream (lower-Columbia sub-basin) stocks are coincident in space and time with development of the hydrosystem.

We are reasonably confident that on a decadal scale, the differences (identified in Question 2) in stream-type chinook indicators of productivity and survival rates between upstream (Upper Columbia sub-basins; i.e. Methow, Entiat, and Wenatchee) and downstream (lower-Columbia sub-basin) stocks are coincident in space and time with development of the hydrosystem.

We have low confidence that on a finer time scale, changes in productivity and survival of upper Columbia stocks (Methow, Entiat, and Wenatchee) are coincident with an increase in the total number of dams through which these fish migrate.

Evidence

Between the 1953-69 period and the post-1970 period, there was a larger increase in the **average** number of dams encountered by the Snake and upper-Columbia stream-type chinook stocks than for the lower river stocks (Ch. 3, Fig. 6C, Ch. 4, p. 16-17, Tabs. 4.1 and 4.6). (****)

There was a significant decrease in the water velocity and an increase in water velocity variability encountered by Snake River stream-type chinook stocks after 1970 (Ch. 3 Fig. 6d). (***)

Conclusion 3a.2

We are reasonably confident that the aggregate effects of the hydrosystem have contributed to reduced survival rates of Snake River stocks (from spawners to adults returning to the mouth of the Columbia River), during the post-1974 period, as compared to the pre-1970 period. Hydrosystem effects include both direct (e.g. turbine mortality) and indirect effects (e.g. delayed mortality, due to such mechanisms as changes in estuary arrival times).

Evidence

Maximum likelihood estimation (MLE) analyses were completed using upstream/downstream stock comparisons for Snake River stocks (Ch.5). A detailed MLE analysis has not yet been completed for Upper Columbia stocks (Methow, Entiat, and Wenatchee). These analyses show that after removing common effects affecting the year-to-year patterns in all stocks, and differences in productivity among stocks, the remaining differences between Snake River and downstream stocks in their recruitment to the mouth of the Columbia River are consistent with the following *hydrosystem impact hypotheses* (**):

$ The 1952 to 1970 brood years of Snake River stocks passed through 2-7 dams, consistent with the hypothesis that there was a 40-84% reduction in recruitment (respectively; average= 65%) associated with the hydrosystem. Down-river stocks passed through 1-3 dams, consistent with the hypothesis that there was a 23-54% reduction in recruitment (respectively) associated with the hydrosystem (average for stocks passing through 2 dams was 40%) (Ch. 5, Tables 5-4 and 5-5).

$ The 1975 to 1990 brood years of Snake River stocks either passed through or were transported around 8 dams. This is consistent with the hypothesis that there was an 89% reduction in recruitment of Snake River stocks associated with the hydrosystem. Down-river stocks passed through up to 3 dams, consistent with the hypothesis that there was up to a 54% reduction in recruitment of these stocks associated with the hydrosystem (Ch. 5, Tables 5-4 and 5-5).

One of the main mechanisms by which dams can affect salmon is by reducing water velocity. As indicated above in Conclusion 3a1, there was a significant decrease in water velocity and an increase in water velocity variability encountered by Snake River stream-type chinook stocks after 1970 (Chap. 3, Fig. 6d). Between 1970 and 1990, upstream stocks experienced greater reductions in brood year recruitment when outmigration water velocities were slower (Ch. 5, Fig. 5-5). Low to negligible reductions in recruitment occurred for 6 brood years 1970, 1973, 1980-1983, five of which had water velocities faster than the average for that period (Ch. 5, Figure 5-6). (**) This statistical association does not imply that average water velocity is the sole factor responsible for increased mortality; many other factors are believed to be important. The hydrosystem also changed conditions within the estuary, including flow and the arrival times of both in-river and transported fish.

An alternative explanation for observed upstream-downstream differences in recruitment patterns is that some non-hydro mortality factor (e.g. ocean mortality) differentially affected upstream/downstream river stocks in a large enough way to coincide with and account for the estimated mortality attributed above to the hydrosystem.There is strong evidence for common year/climate effects that affect all index stocks= recruitment (Ch. 5, Fig. 5-2). Though it is clear that survival patterns vary among stocks on both decadal and year-to-year time scales (Ch. 2, 4, 5), there are differences of opinion in the level of evidence for systematic, regional differences in ocean distribution or mortality between upstream and downstream stocks. Other factors may have contributed to upstream/downstream differences, but their coincidence in space and time with changing recruitment patterns has not yet been investigated.

Conclusion 3a.3

We are reasonably confident that the hydrosystem has contributed to decreased juvenile survival in the downstream corridor for Snake River stocks in the post-1974 period.

Evidence

Juvenile tagging studies indicate:

Survival from the area of the head of Lower Granite (LGR) pool to Ice Harbor (IHR) pool (96 miles) declined from the pre-1970 period to the post-1974 period (from Ch. 6, p. 30-31) (**):

Brood Years Ave. surv LGR to IHR

1964-1966: 95%

1974-1982: 55%

1991-1994: 73%

There are various differences among these three time periods. First, the middle period is longer and therefore likely encompasses a wider range of environmental conditions. Also, the proportion of hatchery fish in the population increased through time. (Ch. 3, Fig. 6a).

Estimates of per-mile survival in free-flowing reaches of the Snake River based on recent pit-tag data suggest that survival over the Lower Granite to Ice Harbor reach in the absence of dams would remain comparable to the 1964-1966 period. (**) (Ch. 6, p. 6-30).

Adult upstream passage

Retrospective analyses have not been completed for adult upstream passage, but are planned for inclusion in FY97. The following data will be used in PATH retrospective analyses of adult passage:

1. Estimated upstream conversion rates

2. Adult radiotracking data

Information Needs (for all of question 3a, also relevant to question 3b)

It is critical to maintain and expand the monitoring of index stock spawning and recruitment throughout the Basin, and expand to other species (i.e. fall chinook and steelhead). Multiple surveys over time and area should be maintained to estimate the errors associated with peak redd counts.

We also need to develop a system-wide, ecosystem approach to estimating migratory corridor juvenile survival rates of upstream and downstream stocks through tagging experiments of both hatchery and wild fish. The data should be collected over a number of years to include a wide range of environmental conditions. The ability to make these estimates from tagging data is currently constrained by the limited collection opportunities in the JMC for downstream stocks (those that enter the mainstem below John Day Dam), and by the small number of adults that survive to adulthood. These juvenile survival rates should be compared to estimates of the spawner to recruit survival rates of both up-river and down-river, stream type stocks. Both juvenile and spawner-recruit survival rates should be compared to hydrosystem, fish condition, and river/estuarine indices (e.g. conditions in estuary, timing of arrival of different stocks to the estuary, spill, temperature, flow, water transit time, % transported) to better elucidate the reasons for year-to-year variation in survival rates (>10 years to collect data).

Review spawner-recruit estimates (see Note on Spawner and Recruit Data under Question 1; <1

year).

Use CRiSP and FLUSH to explore hypotheses about delayed mortality and compare to MLE and other data (i.e. PIT-tag passage survival estimates, SAR estimates) (<1 year).

Attempt to explain year-to-year variation in delayed mortality as functions of climate and other variables (<1 year).

Clarify dip in net dam passage mortality from the Snake River sub-basins to John Day Dam in early 1980's (<1 year).

Estimate net dam passage mortality for upper-Columbia stocks (Methow, Entiat, and Wenatchee) and compare to downstream and upstream estimates (i.e. perform MLE analyses for these stocks; <1 year).

Various tasks to assess the degree of association between habitat, hatchery, climate changes, and changes in recruitment (see Information Needs under sections 4a, 5a, and 7a).

Question 4a

*What do the retrospective analyses indicate about the contribution of **habitat changes** to the difference in upstream vs downstream stocks and between pre-1970 vs post-1974 conditions?*

Conclusion 4a1

We conclude with reasonable confidence that habitat degradation affected many Columbia River salmon stocks before 1975. Such past changes may still be affecting some stocks, though the habitat of other index stocks remains in high quality condition.

Evidence

Descriptions of historic land use activities (Ch. 10, Appendix 5; Beamesderfer et al. 1996). (***)

Conclusion 4a2

Though changes in the quantity and quality of freshwater spawning and rearing (FSR) and pre-spawning (PS) habitat may have contributed to production declines in some index streams, we conclude with reasonable confidence that changes in adult-to-smolt survival (presumably related to the quantity and quality of FSR habitat) do not appear to be of a great enough magnitude alone to explain the post-1974 decline in spring and summer chinook index stocks.

We have not yet examined upstream-downstream differences in habitat, but intend to do so.

Evidence

FSR productivity and survival of the aggregate of Snake River index spring/summer chinook stocks, as inferred from ln(smolts/spawner) vs spawners, does not appear to have declined since hydrosystem completion (Ch. 9, p. 11). Tests of FSR survival had adequate statistical power to detect declines in spawner-to-smolt survival of > 25%. Therefore, declines in spawner-to-smolt survival (presumably due to declines in quantity and quality of FSR habitat) must have been less than 25%, which is well below the magnitude of observed declines in spawner-to-adult recruit survival rates (e.g. ln(R/S)). (***)

Observed changes in patterns of survival rates (e.g. ln(R/S)) over time are similar among stocks in different habitat conditions (Ch. 3). (**)

Changes to physical habitat within the index sub-basins (i.e. losses of quality pools, temperature increases, point-source discharges) throughout the Snake River Basin that are known to be associated with reduced survival and production of riverine salmonids occurred primarily before 1975 (Ch. 9, p. 2). (**)

Life history and PIT tag studies suggest that mortality during FSR is habitat-specific (Ch. 10, p. 14, 15). (***)

Information Needs

The conclusion applies primarily to the index spring/summer chinook stocks for the time period for which runs can be reconstructed. However, the aggregate, long-term impacts of the degradation on the productivity of the basin as a whole are unknown.

Determine whether the changes in productivity among index populations are representative of the response in populations across the available spectrum of FSR and PS habitat conditions (i.e. pristine to degraded). Habitat contrasts within regions and sub-basins will provide the best tests of habitat quality effects. This may be done using PIT-tag and radio-telemetry studies in ranked quality habitats surveyed under standardized indices or variables (2-3 years).

Review spawner-recruit estimates (see Note on Spawner and Recruit Data under Question 1; <1 year).

Identify habitat changes in the migratory corridor that are not related to the hydrosystem and their potential effects on observed differences between upstream and downstream stocks (duration depends on availability of data).

Identify changes in the estuarine habitat and their potential effects on temporal patterns in observed declines of both upstream and downstream stocks (duration depends on availability of data).

Derive rules for systematically assigning habitat ratings to index stocks and to currently unoccupied habitats that are known to have produced chinook in the past (<1 year).

Compare changes in Ricker alphas (from Ch. 5) over time among stocks with different habitat ratings (include other stocks beyond index stocks) to estimate effects of habitat on productivity (<1 year).

Use the parr density data base to measure differences between good and bad habitats (<1 year).

Examine other habitat models (e.g. from ISG report) and case studies (<1 year).

Continue analysis of parr-to-smolt PIT tag data in relation to habitat conditions (<1 year; already started in Ch. 10 Appendix 4).

Extend analyses in Chapter 4 to assess statistical association between ln(R/S) and land use data (<1 year)

Question 5a

What do the retrospective analyses indicate about the contribution of artificial propagation to the

observed spatial/temporal differences?

Overall Conclusions

Preliminary results suggest that artificial propagation of spring/summer chinook has not significantly contributed to declines in wild populations of spring/summer chinook in upstream areas (Snake and upper Columbia River) between pre-1970 and post-1974 periods.

These results, which must be considered highly tentative given the limited amount of data analysis completed to date, imply that the hatchery programs have not been a major cause of the continued decline of endangered spring/summer chinook stocks in the Columbia River.

Evidence

Declines in the productivity and abundance of the listed Snake River chinook stocks preceded the initiation of most Snake River hatcheries (Ch. 3, p. 5; Ch. 11 Imnaha River analysis). (**)

Lower Columbia naturally-spawning spring/summer chinook stocks (e.g. Klickitat, Warm Springs), which have been influenced by artificial propagation for a longer period of time than Snake River stocks, have not exhibited declines in productivity and abundance of the same magnitude as Snake River stocks (Ch. 3, p. 7). (**)

Interaction between wild fish and hatchery fish during mainstem smolt migration is likely greater for listed Snake River stocks than for downstream stocks because of increased contact between fish during barging and dam passage. The resulting opportunities for disease transmission and competition could adversely affect smolts originating in the Snake River basin. (*)

Information Needs

Review spawner-recruit estimates (see Note on Spawner and Recruit Data under Question 1; <1 year).

Complete/extend multiple regression analysis in Chapter 11 (<1 year):

C add additional stocks and species

C analytical refinements (e.g. correction for autocorrelation bias)

C add other hatchery production variables (e.g. number, method, and timing of releases, number of releases per spawner)

The MLE approach in Chapter 5 could be modified to incorporate hatchery data to test hypotheses about hatchery impacts (< 2 years). Since many hatchery programs were instituted in response to declines in populations, there will be some confounding between hatchery effects and hydro effects. However, there may be some opportunity for partitioning these effects.

Many of the specific hypotheses discussed in Chapter 11, section 1, which allude to possible mechanisms for hatchery effects on wild populations, require further examination. In many cases, empirical/statistical analyses may not be possible because of inadequate data for the specific stocks of concern. Instead, conclusions and data will have to be drawn from a thorough review of available literature. Data from outside the Columbia Basin should be obtained from published sources only (<2 years).

An alternative approach to direct comparisons between wild and hatchery R/S would be to compare the observed survival rate (ln(R/S)) for hatchery fish to that predicted from the stock-recruitment relationship for the stock in question using both wild and hatchery spawners (<2 years).

Question 6a

*What do the retrospective analyses indicate about the contribution of **harvest** to the observed spatial/temporal differences in stock indicators?*

Overall Conclusion

Chapter 13 (which is incomplete) contains the retrospective analyses of harvest effects and has not yet been subjected to internal and external review. The authors of that chapter have an interim conclusion with a reasonable degree of confidence that harvest has not significantly contributed to declines in index upstream (Snake and Upper Columbia Rivers) stream-type chinook stocks between the pre-1970 and post-1974 periods.

Evidence (all from Chapter 13, which was incomplete at the time of editing the Conclusions Document)

Freshwater harvest rates (mainstem and tributary) were reduced from annual averages of approximately 54% between 1950 and 1970 to less than 8% for 1975-1995 for spring chinook. For summer chinook, freshwater harvest rates were reduced from annual averages of approximately 32% between 1950 and 1970 to 3% between 1975 and 1995 (Ch. 13). (***)

Ocean harvest rates for upstream stream-type spring and summer chinook salmon are estimated to be less than 5% and possibly less than 1% for the post-1974 period (Ch. 13). (**)

The decline in ln(Recruit/Spawner) and ln(Spawner/Spawner) and in survival rate indices are coincident with a substantial decline in harvest rates. Coincident trends are contrary to the hypothesis that harvest is a major contributing factor to the decline in productivity and survival rate indices for upstream stream-type chinook between the pre-1970 and post-1974 periods (Ch. 13). (***)

Information Needs

Review spawner-recruit estimates (see Note on Spawner and Recruit Data under Question 1; <1 year).

The Harvest workgroup will supply information needs once their retrospective analyses are completed.

Question 7a

What do the retrospective analyses indicate about the contribution of ocean conditions and terrestrial climate to observed spatial/temporal differences in stock indicators?

Overall Conclusions

7a.1 We conclude with reasonable confidence that stocks differ in their degree of statistical association with selected indicators of ocean conditions and terrestrial climate, but there are no consistent differences in response between upstream/downstream stocks.

Certain environmental stressors are associated with spawner to recruit survival (ln (Recruits/Spawner)) for some stocks and not for others. In particular upstream/downstream stocks show systematic differences in their associations with drought and ocean indicators. Although this suggests that the effects of both ocean and local climatic conditions differ between sub-basins, the relative contribution of these effects to observed upstream/downstream differences in stock indicators is unclear.

7a.2 We conclude with reasonable confidence that climatic conditions have contributed to observed differences in stock indicators between the pre-1970 and post-1974 periods.

There is evidence from published literature that an abrupt shift in ocean conditions in the North Pacific ocean in 1976 has affected salmon populations throughout the North Pacific. In general, southern populations have been negatively affected by this change, while northern populations have been positively affected. This implies that ocean conditions have contributed to temporal patterns in stock indicators of Snake River and lower Columbia spring/summer chinook stocks. Ocean conditions may amplify the effects of other stressors on these stocks, and continued poor ocean conditions may reduce any positive results of measures that reduce the impacts of these stressors.

Evidence for conclusion 7a.1

Analyses of stock-recruitment data do not show differences between Snake River and downstream stocks that are significant:

Models in which ocean survival was assumed to differ systematically between Snake River and downstream stocks do not provide a significantly better fit to stock-recruitment patterns than models in which ocean survival was assumed to be constant for all stocks (Ch. 5, p. 18). (***)

Correlation analyses of year effects estimated from stock-recruitment data indicate that:

Year effects (effects that were assumed to reflect common factors affecting survival of all stocks, including ocean conditions) were not associated with either the North Pacific Index (NPI; an index of ocean conditions in the North Pacific) or the May upwelling index (Ch. 5, p. 17). (***)

Regression analyses of survival rates (measured as ln(recruits/spawner)) indicate that:

The patterns of statistical association between the NPI and survival rates of upstream and downstream stocks are complex. Upper-Columbia and John Day stocks generally showed more association with NPI than other lower Columbia or Snake River stocks (Ch. 4, p. 16, Tab. 4.6). The John Day consistently shows either a positive relationship or no relationship to the NPI in the 2nd and 3rd ocean winter (Ch. 4, Tab. 4.6). However, with some regression models, none of the stocks showed any relationship to the NPI in the 1st ocean winter or to the upwelling index (Ch. 4, Tabs. 4.2a, 4.2b, and 4.4b). (**)

The patterns of statistical association between survival rates and upwelling indicators are also complex. Survival rates of lower Columbia stocks showed a stronger degree of association with the May upwelling index than upstream stocks (Ch. 4, p. 16, Tab. 4.6). However, adding the upwelling index as a covariate for all downstream stocks (as a single group) in the MLE analysis did not affect the MLE. Furthermore, there was no correlation between upwelling indices from different months (e.g. between May upwelling and June upwelling), suggesting that these indices did not reflect the strong temporal signal in upwelling conditions that would indicate a possible mechanism for observed associations between survival rates and upwelling indicators (Deriso, unpubl. analysis). Work by Hinrichsen et al. (cited in Ch. 12) suggests that the timing of the spring transition in winds (associated with a change from downwelling to upwelling conditions), rather than its strength in any

one month, may have more effect on smolt to adult survival. (**)

Survival rates for most upstream spring-summer stocks decreased under May-September drought conditions, while downstream stocks and Snake River summer chinook stocks showed no significant association with this factor (Ch. 4, p. 16, Tab. 4.6). (**)

Evidence for conclusion 7a.2

Analyses of stock-recruitment data indicate that:

Year effects on recruitment (effects that were assumed to reflect common factors affecting survival of all stocks, including ocean conditions) were generally positive for the 1952-1968 brood years and negative for 1970-1989 brood years (Ch. 5, p. 13). (***)

Correlation analyses of year effects estimated from stock-recruitment data indicate that:

Sockeye salmon from Bristol Bay, Alaska, had higher survival rates in years when there were positive year effects than in years when there were negative year effects (Deriso and Peterman, unpubl. analysis, cited in Ch. 5, p. 17). (***)

Reviews of previous studies (Chapter 12) suggest that:

Many populations of marine fish, including Pacific salmon, have experienced major and persistent changes since the mid-1970's. Salmon catches in the northern portion of the Pacific Ocean (off northern B.C. and Alaska) have increased, while catches of southern populations (off Washington, Oregon, and California) have decreased (Ch. 12, p. 2-3). (***)

There was a major shift in oceanographic conditions in the North Pacific ocean between 1976 and 1977 (Ch. 12, p. 1). (***)

The shift in ocean conditions in 1976 was characterized by a change in current patterns along the west coast of North America. The effect of this change was to lower productivity of coastal waters in the southern portion of the west coast (off Washington and Oregon), and increase productivity off northern B.C. and Alaska (Ch. 12, p. 3-4). (**)

Catches of Columbia River spring chinook (which depend on fishing effort, catchability, etc. as well as on recruitment) were inversely correlated with the Pacific Northwest Index (PNI), a composite index of freshwater and marine climate patterns in the Pacific Northwest (Ch. 12, p. 6). (**)

Information Needs

See Information Needs under question 3a.

Test for correlations between Chapter 5 year-effects and PNI, flow, water of origin, timing of spring transition relative to arrival times, and other environmental variables (<1 year).

Test for statistical associations between survival rate indices and other environmental variables (extension of Chapter 4, with a priori hypotheses) (<1 year).

Preamble to Questions 3b-7b

A reasonable objective for management of hydro, habitat, harvest, and hatcheries in the Snake and Columbia River basin is that these activities should result in survival rates that allow persistence and