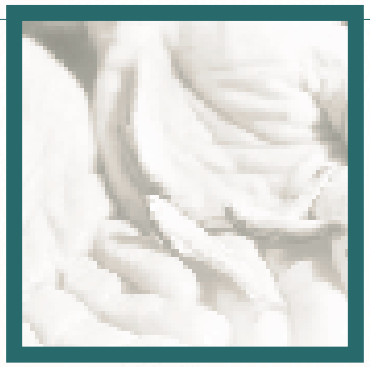
Partnerships in Science:

A New Era in Salmon Recovery



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A new era in Salmon Recovery

New partnerships and scientific tools set the course for recovery of wild salmon stocks

INTRODUCTION

The Pierce Conservation District clearly did its homework before seeking state funding to restore an off-channel lake as a rearing area for young coho and chinook salmon on the Puyallup River system.

Using a new map-based data system known as "SSHIAP," the district was able to demonstrate both the shortage of rearing areas on the Puyallup and the advantages of restoring the lake to address that problem. The state Salmon Recovery Funding Board, convinced by the evidence, funded the project and the conservation district hopes to begin work in the summer of 2001.

SSHIAP – the Salmon and Steelhead Habitat Inventory and Assessment Project – is just one example of a new generation of scientific tools developed by the Washington Department of Fish and Wildlife (WDFW) and tribal co-managers to support Washington's statewide salmon recovery effort.

Some of those tools, such as mass marking hatchery salmon and using hatcheries as rescue stations for depleted stocks, were designed specifically to support our work as fisheries managers. Others, including SSHIAP, have much broader application to habitat-restoration groups and other partners in the salmon recovery effort throughout the state.

This report describes how WDFW, in concert with treaty tribes and other resource managers, is using science to shape a new era of salmon conservation through advances in harvest practices, hatchery operations and habitat restoration. Hydro operations – the fourth "h" of salmon recovery – are discussed in the habitat section along with efforts to correct impassible culverts and other obstructions to fish passage.

These developments come at a critical time for our state. With 15 salmon and trout stocks in Washington listed as threatened or endangered under the federal Endangered Species Act (ESA), a major statewide recovery effort is now underway involving everyone from fisheries managers and local salmon recovery groups to public utility managers and private landowners.

WDFW scientists track salmon from their first trip downstream as smolts (pictured) to their return to spawn.

WDFW is pleased to be a major partner in this effort, although it would be a mistake to view the initiatives discussed in this publication as simply a response to ESA listings. Many of these changes were underway long before the first listing was announced in 1992, while others have been developed to address specific management goals in the field. For example:

- Coded wire tag technology was pioneered by WDFW scientists back in the early 1970s to help track the migration of hatchery-produced salmon in the open ocean and monitor the survival rates of various stocks. This 30-year-old technology is now more useful than ever, providing historical trends and helping fisheries managers set fishing seasons that protect wild salmon.

With 15 salmon and trout stocks in Washington now listed as threatened or endangered under the federal Endangered Species Act (ESA), a major statewide recovery effort is now underway.

Washington salmonid populations listed under the federal Endangered Species Act

(As of June 2000)

Endangered

Snake River sockeye
Listed November 1991

Upper Columbia steelhead
Listed August 1997

Upper Columbia spring chinook
Listed March 1999

Threatened

Snake River spring/summer chinook
Listed April 1992

Snake River fall chinook
Listed April 1992

Snake River steelhead
Listed August 1997

Lower Columbia steelhead
Listed March 1998

Columbia/Snake River bull trout
Listed June 1998

Hood Canal summer chum
Listed March 1999

Lower Columbia chum
Listed March 1999

Lake Ozette sockeye
Listed March 1999

Puget Sound chinook
Listed March 1999

Lower Columbia chinook
Listed March 1999

Middle Columbia steelhead
Listed March 1999

Coastal/Puget Sound bull trout
Listed November 1999

- Mass marking of hatchery salmon, which began with coho in 1996 and is now being expanded to some chinook stocks, allows fishers to tell on sight whether a fish originated in a hatchery or in the wild. This was a major step forward in establishing selective fisheries that protect wild salmon while allowing fishers to harvest abundant hatchery stocks.
- In 1977, long before the stock was listed under the ESA, WDFW captured about 50 returning White River spring chinook salmon and moved them to a state hatchery to guard against immediate extinction. This year, 800 adults returned, more than the previous 20 years combined, an indication of how much time it can take to recover a depleted stock. More than a third of all WDFW hatcheries are now involved one way or another in helping to protect and recover wild salmon stocks.

A New Era in Salmon Recovery provides an overview of these and other initiatives to help develop a broader public understanding of WDFW's role in the salmon-recovery process.

While this publication makes frequent reference to partnerships between state and tribal co-managers and other resource managers, it does not attempt to catalogue all of their many individual efforts to protect and restore wild salmon runs. Rather, it focuses on the scientific tools and recovery strategies this agency is employing in the statewide recovery effort.

One theme that emerges from these pages – perhaps above all others – is that recovering our native salmon populations is a shared responsibility. Harvest management requires cooperation between the states, the tribes and all affected citizens. Hatchery reform can only progress so far without the funding needed to make the necessary improvements at the 143 state, tribal and federal facilities in this state. And restoring critical habitat area to a functional condition that can support healthy runs of wild salmon will require the participation of governments, businesses and individuals throughout the state.

Jeffrey Koenings, Ph.D
Director
Washington Department of Fish and Wildlife

The goal of this agency is not just to restore native salmon stocks to the point where the federal government will remove them from the list of ESA-protected species. Our goal, consistent with both our legislative mandate and the Governor's Salmon Recovery Strategy, is to help revitalize those stocks to the point where they, and sustainable fisheries, can once again thrive.

Salmon are not just a symbol of the Northwest. They are also an indicator of our environmental health, an important sector of our economy and a cornerstone of our culture. Through science and public support, WDFW is working to sustain all these values and preserve our native salmon runs for generations to come.

Jeffrey Koenings, Ph.D, Director
Washington Department
of Fish and Wildlife

A new era in Harvest Management

Innovative methods, scientific data shape fisheries

A new era of fisheries management is unfolding in Washington in which science and innovative fishing methods are being used to protect troubled salmon stocks while still providing for sustainable fisheries.

These developments are dramatically changing harvest practices by focusing salmon fisheries on plentiful stocks while safeguarding depressed wild populations, as required by the federal Endangered Species Act (ESA).

For sport and commercial fishers, these changes have meant fewer fishing days, more restrictions on fishing areas and a move toward new types of fishing gear designed to avoid impacts on protected species. For the Washington Department of Fish and Wildlife (WDFW) and tribal co-managers, crafting sustainable fisheries that protect weak stocks has brought a greater need for collaboration and scientific certainty than ever before.

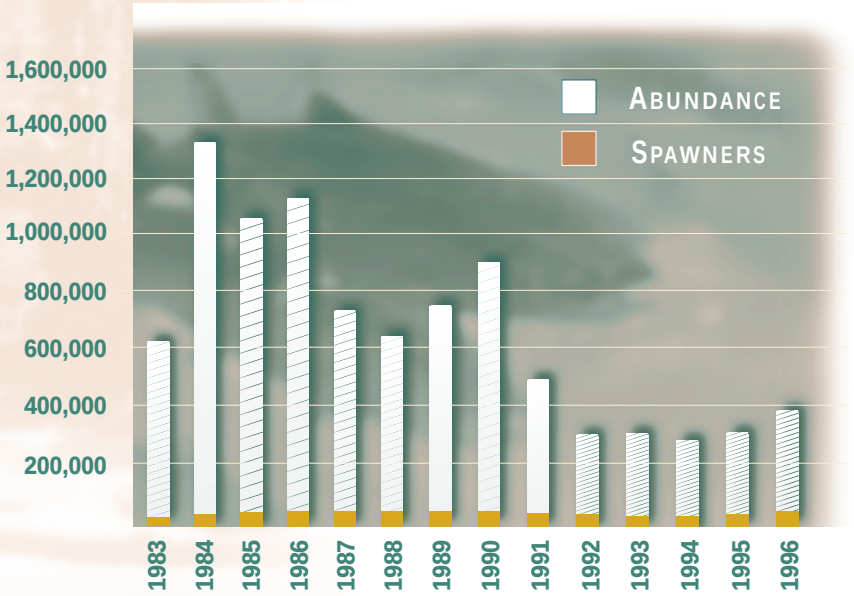
With more than a dozen stocks of Washington salmon and steelhead now listed by the federal government as threatened or endangered, the need for careful, conservation-oriented salmon management is all too apparent. But the fact is that WDFW and the tribes were making major strides to protect wild salmon long before listings for Puget Sound chinook and other stocks were ever announced.

Harvest rates sharply trimmed

The state has played a dominant role in managing fisheries since the appointment of Washington's first fish commissioner in 1890. For decades, sport fishing for salmon was open 365 days a year and the commercial fleet thrived. Yet, despite drastic reductions in fishing days and harvest rates, salmon runs began to decline sharply in the last decades of the 20th century due largely to changing ocean conditions and the loss of freshwater and estuarine habitat. Today, salmon fishing is confined to times and areas in which protected wild fish are not present in large numbers.

A strong run of sockeye salmon passes through the Ballard Locks in July 2000. The fish provided one of the nation's largest urban recreational fisheries.

This represents a fundamental change from the way fisheries managers determined fishing seasons just 20 years ago. Where catch limits were once based on overall abundance of salmon in an area, they are now generally based on the weakest stocks within the run. In practical terms, this means that limits on the incidental take of wild, listed stocks often determine catch levels for the entire fishery. While this has required fishers to forgo some opportunities to catch abundant returns of hatchery salmon, it has also afforded weak wild stocks an extra measure of protection.



Changes in freshwater habitat and ocean conditions have dramatically reduced salmon productivity in recent years, as returning spawners produce fewer surviving offspring.

WDFW and the tribes did not impose new fishing restrictions – which became increasingly stringent throughout the 1990s – simply because there were fewer fish to catch. Rather, the sharp fishing reductions of recent years were triggered by biologists' recognition that productivity rates – which reflect the number of surviving fish produced by a spawning population – had dropped dramatically as a result of changes in ocean conditions and freshwater habitat loss and degradation. As streams became warmer, clogged with silt or channeled by development, salmon lost the cold, clean water, the natural side channels and bank vegetation they need to survive to adulthood. As spawning fish produced fewer survivors, it meant a corresponding drop in the numbers of fish available for sustainable harvest.

The new conservation ethic has extended beyond Washington waters, as exemplified in harvest agreements reached through the 1999 re-negotiation of the Pacific Salmon Treaty by the United States and Canada – a major step toward stemming the loss of critical state fish populations to outside fisheries. Among other measures, the treaty reduces Canadian catch of Washington's chinook and coho salmon for a decade and is expected to increase the number of Puget Sound chinook which survive to spawn.

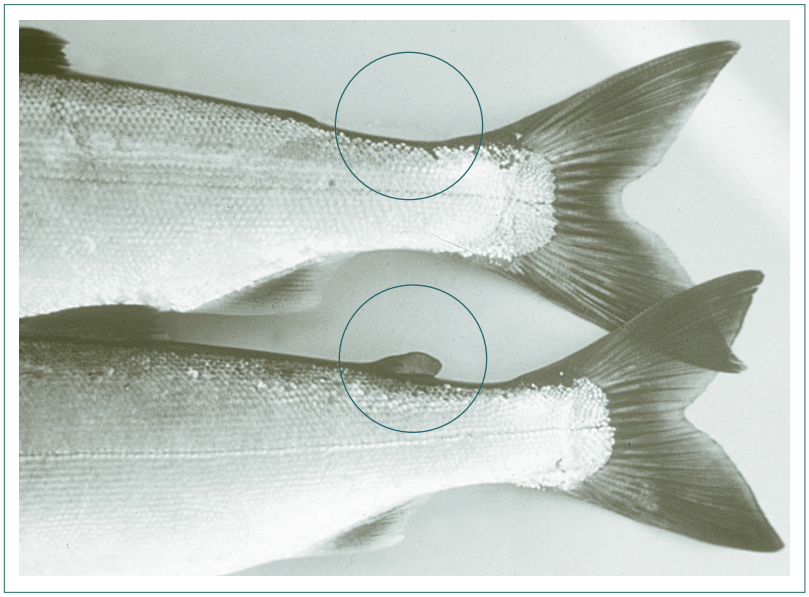
Closer to home, annual days of Puget Sound sport chinook fishing have dropped by an average of two-thirds in the last decade, and when fishing does occur managers attempt to target healthy wild or hatchery-produced salmon stocks. Puget Sound sport chinook catches have been cut by 70 percent, and ocean chinook harvest has dropped 96 percent over the past 25 years. In 1994, ocean salmon fishing was closed entirely when a weak coho run required protection.

As wild stocks have declined, there also has been a concerted effort to trim the size of the commercial fishing fleet. Non-tribal commercial fishing licenses have been reduced by nearly 60 percent in the last decade, in part through federally funded license buyback programs. In 1974, Puget Sound commercial salmon license holders numbered 2,512. Today, a quarter-century later, there are 965 license holders remaining. On the coast, salmon troll licenses have dropped from 3,488 to 220 during the same time period.

As streams became warmer, clogged with silt or channeled by development, salmon lost the cold, clean water, the natural side channels and bank vegetation they need to survive to adulthood.

Selective fishing spares protected salmon

Those who are still fishing are using new gear and new methods to specifically target plentiful fish, while avoiding protected wild stocks. By doing so, they are helping ensure that fishing can continue in the era of the ESA.



Hatchery-produced salmon are marked by removing the adipose fin near the tail, (top), allowing fishers to distinguish them from protected wild fish (bottom).

To make it possible for salmon fishers to target their efforts on abundant hatchery stocks, WDFW initiated a mass-marking program, removing the adipose fin on the lower back of millions of hatchery-produced coho and chinook to distinguish them from wild fish. Mass marking, coupled with efforts to educate anglers in proper de-hooking and release methods, is critical to WDFW's selective fishing strategy, particularly with regard to the recreational fishery.

In similar fashion, non-tribal commercial seiners have been required since 1998 to release all chinook and chum taken as incidental catch. Beginning in 1999, they were also required to use brailing nets to sort their catch to help reduce mortality of released chinook. In addition, purse seiners are required to release coho in many areas.

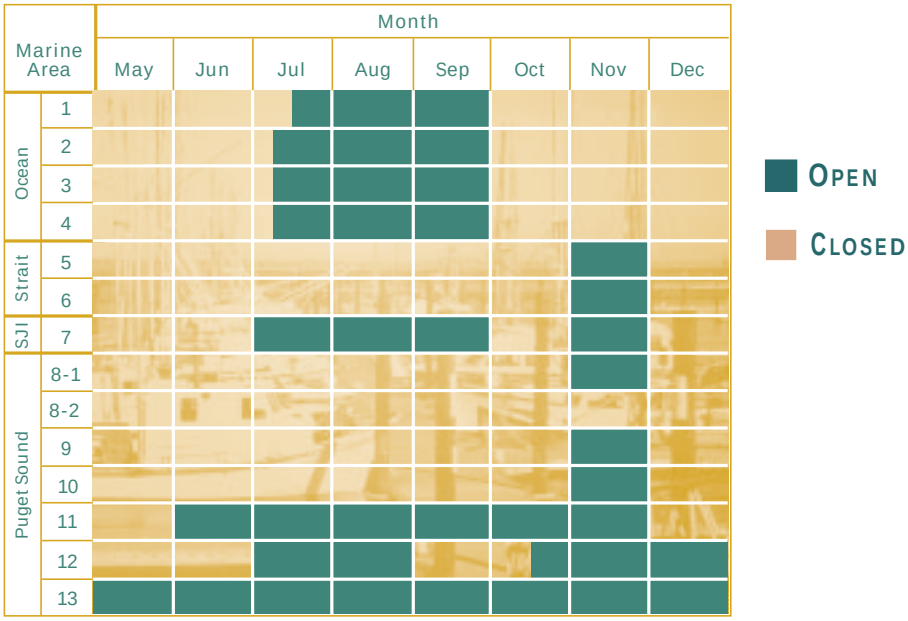
In a continuing effort to offer commercial fishers alternatives to traditional gillnets – which smother salmon by compressing their gills – WDFW fisheries managers are testing two alternative gear types in Puget Sound. The experimental gear, tangle nets and floating trap nets, allow fishers to release unharmed a larger number of fish caught unintentionally. The tests, supported by $226,000 in state and federal funding, are part of an overall effort by WDFW to develop and evaluate an array of selective fishing methods.

Collaborative season setting

Management of Washington's salmon fishery was a collaborative effort even before the first salmon stock was listed as "threatened" under the ESA in 1992. WDFW and Indian treaty tribes co-manage the near-shore fishery in a government-to-government relationship, based on 19th century treaty rights that were affirmed by federal court rulings in the 1970s and 1980s. Fisheries in the Columbia River and its tributaries are co-managed by the states of Washington and Oregon through the Columbia River Compact, a process which also provides for direct involvement by the Columbia River treaty tribes and the state of Idaho.

Since Washington salmon migrate north over thousands of miles of ocean waters, harvest management also is a national and

Fishing opportunities are carefully managed by time and location to avoid weak wild stocks.



Chinook sport seasons – 2000

WDFW scientists collect data on salmon from returning runs to guide future fish management decisions.

international affair. Both the Pacific Salmon Treaty between the United States and Canada and the coastwide Pacific Fishery Management Council demonstrate the wide-ranging cooperative efforts required for effective salmon management.

In all, the state and tribal co-managers participate in four separate harvest management processes including:

- The Pacific Salmon Commission, which was established by treaty in 1985 and includes management panels and technical committees, consisting of representatives from Alaska, Washington, Oregon and Canada, the treaty Indian tribes of Washington and the Columbia River and the federal government.
- The Pacific Fishery Management Council (PFMC) which includes principal fisheries officials from the states of California, Oregon, Idaho, Washington and Alaska, the tribes, the regional director of the National Marine Fisheries Service and eight private citizens, and manages coastal fisheries from three to 200 miles off shore.
- The North-of-Falcon forum in which federal, state and tribal fish managers meet with interested constituents in a series of public meetings in the late winter and early spring, in tandem with PFMC deliberations on ocean seasons, to set recreational and commercial salmon fisheries for waters within three miles of the coast of Washington and northern Oregon, as well as in Puget Sound.
- The Columbia River Compact, established by federal law and comprised of one voting member each from Washington and Oregon, which establishes commercial fishing seasons in the mainstem Columbia River in consultation with treaty tribes, the state of Idaho, the National Marine Fisheries Service (NMFS) and the U. S. Fish and Wildlife Service.

ESA protection of listed salmon affects all of these management bodies, since any fishery that would have even a small impact on a listed stock must first receive federal authorization from NMFS. Fishing seasons approved during the North-of-Falcon forum, for example, must be approved by NMFS for compliance with the ESA, since Puget Sound and coastal salmon fisheries may encounter listed stocks. The same is true for Columbia River fisheries approved by the Columbia River Compact.

Since Washington salmon migrate north over thousands of miles of ocean waters, harvest management also is a national and international affair.

Under the law, NMFS can grant petitioners an exemption to the general prohibition against the "take" of a listed species, or provide authorization for certain levels of "take," so long as they can demonstrate that a proposed fishery or other action will not jeopardize the continued existence of a listed species. In 2000, NMFS approved harvest

management plans submitted by WDFW and the tribes for Puget Sound chinook salmon, Hood Canal summer chum salmon and several stocks on the Columbia River. For 2001, the co-managers are preparing new Fisheries Management and Evaluation Plans, which include maximum allowable catch levels for listed stocks and other information required by NMFS. Similarly, the co-managers are developing Hatchery Genetic Management Plans to address impacts to listed stocks from hatchery operations.

Conservative fishing seasons, combined with scientific innovations such as mass-marking and selective fishing gear, are making it increasingly possible to develop fisheries that have a minimal impact on weak stocks. Moreover, in this new era of fisheries management, WDFW and the tribes are involved in an unprecedented number of partnerships to monitor the harvest, enforce fishing rules and work cooperatively on research projects that support the shared goals of providing sustainable fisheries and protecting weak stocks.

Salmon science starts in the streambed

Like the salmon life cycle itself, the science of salmon management begins in hundreds of freshwater streams and rivers across the state.

WDFW scientists monitor young salmon (smolts) as they head downstream on their way to sea and each fall conduct exhaustive surveys of spawning adult salmon and the numbers of new egg nests (redds) they have created.

Smolt monitoring, which WDFW scientists began pursuing extensively in the 1970s, screens streams to collect and equip young, out-migrating salmon with coded-wire tags. The smolts swim into a waterborne trap where they are counted, sometimes tagged with tiny coded wires and released back to the water to continue their journey to sea. As those same salmon later are harvested or return to spawn as adults, the coded wire tags are recovered. Besides offering direct estimates of a stream's salmon populations, smolt monitoring also offers a valuable indication of the habitat potential a given stream offers for the production and support of subsequent generations of salmon.

Commercial fishers are pursuing new selective fishing practices. Here, a fisher removes a salmon from a commercial net in a test of selective beach seine gear.

Each fall, state and tribal biologists and technicians walk, float and fly over thousands of miles of Washington streams counting and collecting information on spawning salmon and tallying the number of redds in streambed gravel. These spawner surveys, along with smolt data, provide valuable information that helps fish managers reconstruct information about the

Selective fishing techniques, such as careful de-hooking and release of unmarked, wild fish, allows fishing to continue while wild stocks are protected.

strength of the current year's run and make estimates about the likely strength of the next generation of salmon. By extension, the survey data helps fish scientists gauge the effectiveness of on-going harvest management and fish recovery efforts and guides future fish management activities.

Scientific data used to set seasons

Information collected in the spawner surveys is a starting point in the process of setting scientifically sound fishing seasons for the coming year. The data, along with counts of fish returning to hatcheries and harvest information from various fisheries, are used to create forecasts of the likely strength of an upcoming season's salmon runs.

These pre-season forecasts are added to a base of information on historic run-size strength and fishery impacts for the various salmon populations. Coded-wire tags, the primary tool used to develop this base of information for chinook salmon fishery impacts, are inserted into the snouts of young fish and bear marks identifying the hatchery or freshwater where the fish originated. Later, electronic detection equipment is used to check coho and chinook caught in fisheries or recovered from spawning grounds, allowing scientists to tell which fish bear the coded wire tags, so the tags can be extracted and read. In some locations, otoliths (fish ear bones) are given a distinct marking by varying hatchery water temperatures as fish eggs are incubated, and later recovered and analyzed in a similar way to coded wire tags, revealing information about where the fish originated.

Biological information and data gleaned from coded wire tags and other methods is assembled into a computer model that offers a snapshot of an upcoming season's fishery under various regulation options. Results from these computer simulations are then compared to conservation goals, obligations under the Pacific Salmon Treaty, the Pacific Fishery Management Council, allocation requirements for treaty tribes and protection requirements for salmon populations listed as threatened or endangered under the ESA.

The conservation goals are designed to ensure that enough fish survive harvest in order to spawn and sustain the long-term health of the run. These goals are set jointly by state and tribal fish managers, based on the best available scientific information on the number of fish a given stream is capable of supporting and the number of "recruits," or new fish that can be produced by each pair of spawning adults.

Salmon fisheries that may have "incidental impacts" on fish populations protected under the ESA – whether those fisheries are established as part of the annual season-setting process or later set when changes in abundance are detected as runs return – must be approved by the National Marine Fisheries Service. This cooperation between federal and state salmon managers ensures that, overall, wild salmon recovery efforts are not hampered when fishing occurs on other plentiful stocks.

To ensure compliance with fishing regulations and selective fishing methods, WDFW has stepped up its enforcement and sampling activities on the water.

Fishing monitored throughout the season

Fisheries management does not end when seasons are set. Tribal and state biologists cooperate in analyzing the size of actual returning fish runs as salmon and steelhead migrate back to their native rivers and hatcheries.

In some areas these test fisheries can provide updated run-size information that helps ensure sport, tribal and non-Indian commercial fisheries are appropriate for the size of actual salmon returns while allowing optimum numbers of fish to spawn. As a result of in-season test fisheries and other monitoring activities, a fishery may be closed because a quota has been reached, or fishing rules may be modified if information indicates the number of fish actually returning is substantially different from pre-season forecasts.

A number of non-Indian commercial fisheries in Puget Sound are monitored through a by-catch observer program which checks and counts non-target species captured in net fisheries. These efforts, primarily focused on Puget Sound sockeye, pink and chum salmon purse seine fisheries in recent years, evaluate the rate of encounters with chinook and other species that fishers are required to release. In an attempt to supplement this observer information, non-Indian gillnet, purse seine and reef net fishers targeting sockeye and pink salmon also have been required since 1999 to keep catch logbooks.

Marine enforcement emphasized

To ensure compliance with fishing regulations and selective fishing methods, WDFW has stepped up its enforcement and sampling activities on the water. Enforcement ranks have been re-deployed to create a special marine detachment that patrols salmon fishing activity along the Washington coast.

The increased presence of enforcement officers on the state's coastal waters appears to be increasing fishers' compliance with fish protection rules. In contacts with more than 2,830 fishers during the 1999 coastal salmon season, officers found a 95 percent or greater compliance rate with selective salmon fishing regulations. Biological sampling confirmed that anglers were correctly identifying wild, unmarked coho salmon 99 percent of the time.

The goal of harvest restrictions is to allow sufficient numbers of naturally spawning adult fish to lay eggs in freshwater streams. The resulting young fish would then rear in habitats that provide proper conditions for rapid growth and good survival. Unfortunately, many freshwater habitats are not providing what young fish need to survive. Such degraded habitats need to be restored to achieve the recovery of salmon.

A new era in

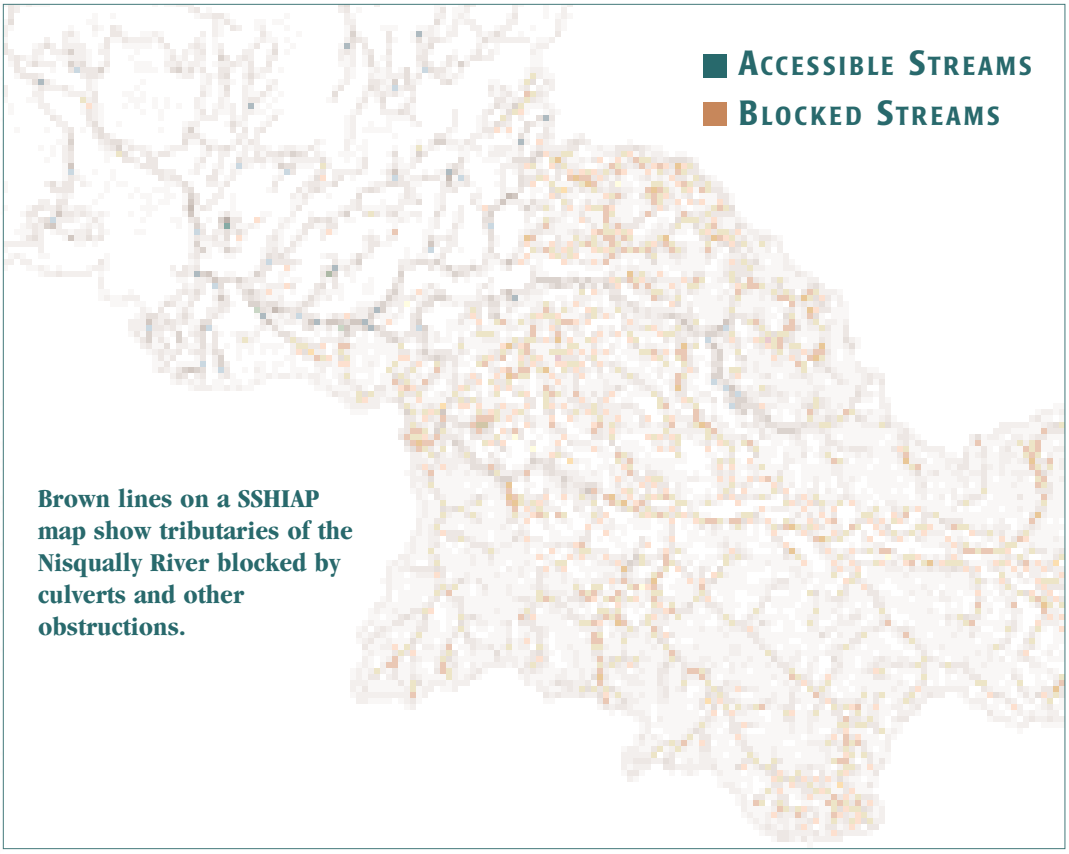
Habitat Restoration

Science points the way to recovery

Salmon need adequate flows of clean, cold water to survive and flourish. Unfortunately, the amount of freshwater and estuarine habitat available to salmon for spawning and rearing has been greatly diminished over the past century by the state's growing human population.

In the Puget Sound area, nearly 70 percent of the original tidal wetlands have been lost to development. On the Columbia River, dams have left only 52 of 550 miles of free-flowing water available for spawning and migration. Statewide, road culverts block an estimated 30,000 stream miles to salmon passage. These and other changes in the natural habitat pose a major threat to Washington's native salmon populations.

Although local governments have jurisdiction over most land-use decisions, the Washington Department of Fish and Wildlife (WDFW) is working to protect fish and wildlife habitat in a variety of ways. As administrator for the state's hydraulics code, WDFW actively enforces regulations on activities that may affect the state's marine and freshwater resources. It also provides technical support for the newly created Lead Entity groups, responsible for coordinating local salmon-recovery efforts, and is working with local governments, dam owners, foresters, farmers and others to adopt



Brown lines on a SSHIAP map show tributaries of the Nisqually River blocked by culverts and other obstructions.

policies and procedures consistent with salmon recovery.

But WDFW's greatest contribution to habitat restoration in recent years may be the scientific tools and technical know-how the agency has made available to others involved in Washington's salmon-recovery effort. Since 1999, when seven additional salmon species were listed as "threatened" or "endangered" under the federal Endangered Species Act (ESA), resource managers and property owners alike have turned increasingly to WDFW for the science necessary to make sound judgments about properly functioning habitat.

Now more than ever, WDFW and the tribes are key partners in a statewide recovery effort that involves state and federal agencies, local governments, volunteer groups and individual citizens.

The science of habitat restoration

Reversing decades of habitat losses for salmon requires more than just dedication and hard work on the part of biologists and volunteers. With hundreds of watershed groups around the state competing for limited resources, decisions about which projects to fund and how to design them need to be based on science, not hunches. Local governments and individual land-owners, too, are looking for scientific certainty about how their decisions will ultimately affect the resource.

Working together, WDFW and the tribes have pioneered several important scientific tools in recent years that provide a scientific framework for Washington's habitat-restoration efforts.

The Salmonid Stock Inventory (SaSI), completed in 1993, gave resource managers the first comprehensive index of Washington's wild salmon stocks, including their condition and distribution.

Developed by the department in partnership with treaty tribes and the Northwest Indian Fisheries Commission (NWIFC), SaSI categorizes stock condition four ways: healthy, depressed, unknown, or critical.

For fisheries managers, SaSI provides a framework to help guide the state's harvest and hatchery strategies. For habitat managers at the state, federal and local level, it also answers fundamental questions in habitat restoration: Where do the state's various salmon stocks spawn and what is their condition? WDFW is currently updating SaSI stock information to guide future management efforts.

While SaSI characterizes the status of salmonid stocks, the Salmon and Steelhead Habitat Inventory and Assessment Project (SSHIAP) details the riparian, freshwater, and estuarine habitat conditions for these species. Developed by WDFW and the treaty tribes, SSHIAP uses a map-based GIS data system to track the condition of more than 60,000 miles of streams – segment by segment – throughout western Washington.

Since 1995 when the system was first deployed, SSHIAP has given resource managers a common base of information on a wide variety of habitat conditions, ranging from stream gradients to the locations of fish passage barriers. WDFW and the NWIFC are currently working to add estuarine habitat data, improve the system's analytical abilities, and provide access to SSHIAP's key functions to local governments and

watershed-restoration groups via the Internet.

Most recently, WDFW has been working with an analytical system called Ecosystem Diagnosis & Treatment (EDT), which not only catalogs existing habitat conditions but also models how changes in those conditions will affect salmon stocks. EDT is a valuable tool for determining which improvements to freshwater habitat will have the greatest benefit to native salmon stocks.

EDT has already been used to develop watershed plans in Oregon, Montana and for the Cowlitz, Yakima and Nisqually rivers in Washington. Now, WDFW is using it to help assess salmon-recovery strategies for Puget Sound and the lower Columbia River, thereby providing a scientific framework for salmon-recovery options ranging from specific habitat improvements to further reductions in fishing pressure.

WDFW established the Watershed Stewardship Team, a group of professional biologists assigned to support salmon restoration efforts by local organizations throughout the state.

But WDFW's involvement in the science of habitat restoration extends well beyond computer models and data systems. Just as important is the technical expertise the agency provides to everyone from local governments to individual landowners seeking guidance in developing policies and projects consistent with the ESA and other laws.

One WDFW publication, hailed by *Seattle University Law Review* as a prime example of "best available science," has become a virtual handbook for local officials in developing ordinances for riparian areas. Generally known as "the riparian book," WDFW's *Management Recommendations for Washington's Priority Habitats (riparian)* contains the same kind of scientific recommendations that agency biologists make in the field.

WDFW is also working with other agencies to produce a new series of publications that provide practical advice on issues ranging from fish screens and streambank protection to dredging and gravel removal. Drafts and other information on the *Guidelines for Salmonid Habitat Protection and Restoration* project – a joint effort by WDFW, the Washington Department of Ecology and the Washington Department of Transportation – can be viewed on the agency's website at www.wa.gov/wdfw/hab/salguide/salguide.htm

Supporting local watershed restoration

Watershed restoration efforts, conducted by local volunteers, are at the heart of the Salmon Recovery Act approved by the Legislature in 1998. Since then, millions of dollars have been allocated by the state's Salmon Recovery Funding Board (SRFB) to support locally developed habitat restoration projects throughout the state.

But the Legislature recognized that volunteer organizations would also need technical support to be successful. To provide that assistance, WDFW established the Watershed Stewardship Team, a group of professional biologists assigned to support salmon restoration efforts by local organizations throughout the state.

A major focus of the WDFW team is to maximize the effectiveness of the local Lead Entities, charged with identifying and

The Nooksack Salmon Enhancement Association began restoring Double Ditch Creek in 1995 (top). Restoration was completed in 1999 (bottom).

prioritizing potential restoration projects in their areas. With administrative help from WDFW, 23 Lead Entities – representing local and tribal governments in 30 counties – were established by September 2000, and several others are pending.

Watershed Stewardship Team members provide a link between the Lead Entities and the technical resources of WDFW, including the scientific tools they need to compete effectively for project funding from the state SRFB and other sources. In that role, team members participate on the Lead Entities' individual technical advisory groups and work with local watershed councils and planning units to integrate salmon recovery objectives with broader watershed stewardship activities.

While most of the projects proposed to the Lead Entities come from city, county and tribal governments, many also originate with the 12 Regional Fisheries Enhancement Groups (RFEGs), created by the 1990 Legislature to coordinate volunteer-based habitat recovery and fish enhancement work in their regions. The Watershed Stewardship Team also provides technical support to these groups and to two new RFEGs authorized in August 2000 to serve areas of eastern Washington.

Together, these 14 non-profit organizations stand with local and tribal governments on the front lines of the state's salmon-recovery effort. In fiscal year 1999 alone, the RFEGs collectively improved 148 miles of stream habitat, deposited 27,000 salmon carcasses in streams to provide key nutrients, replaced or repaired 41 culverts and released three million salmon eggs and fry. In all, the RFEGs worked on 205 projects around the state with a total budget of more than $4.6 million. To support these efforts, members of WDFW's Watershed Stewardship Team provided assistance in an array of disciplines, including biology, permitting procedures, grant writing and volunteer management.

WDFW also administers a separate program, the Volunteer Cooperative Fish and Wildlife Enhancement Project, which provided $1.6 million in grants during the 1999-01 budget period to support a variety of volunteer projects ranging from tree planting on Union Flat Creek in Whitman County to operation of salmon rearing pens on Hood Canal.

Targeted agency restoration work

While many important restoration projects can be done by volunteers, certain high-risk projects require involvement by agency specialists. The WDFW Environmental Restoration Division has a staff of approximately 80 biologists, engineers, welders, heavy equipment operators and other specialists who not only advise local restoration groups but also take on projects that require their expertise.

Part of the division is devoted to engineering, including fabrication of fish screens and weirs used in projects throughout the state. Other division personnel work directly with local governments and state agencies on

projects that may be beyond the scope of local volunteers.

For example, the Salmonid Screening, Habitat Enhancement and Restoration (SSHEAR) group has been working with the Washington Department of Transportation and local governments since the mid-1980s to identify and correct highway culverts that present a barrier to fish passage. As of April 2000, the SSHEAR group had corrected 244 culverts, opening up 310 square miles of salmon habitat. SSHEAR has also served as an advisor to local governments on hundreds of other culvert repairs.

WDFW also has been working to improve salmon habitat on its own lands. In the fall of 2000, WDFW in concert with the U.S. Army Corps of Engineers and the Skagit System Cooperative completed a major renovation of the Skagit Wildlife Area, opening up 350 acres of prime estuarine habitat to juvenile salmon on the south fork of the Skagit River. The Deepwater Slough project, which involved breaching or removing some 14,000 feet of dikes and shoring up others, is expected to substantially improve survival rates for young Skagit River chinook and coho salmon while also protecting a popular hunting area against flooding. Several other projects are now under way on WDFW lands to maximize riparian or estuarine habitat for wild salmon.

Also this year, WDFW biologists worked with the U.S. Army Corps of Engineers, the National Marine Fisheries Service, the Muckleshoot Tribe and local officials to address a unique salmon-passage problem at the Ballard Locks. For years, salmon smolts suffered high mortality rates when they were drawn into the facility's barnacle-encrusted piping system as the locks filled with water. This year, four "smolt slides" were installed that allow young salmon to bypass the lock chambers, which are also now filled at a slower rate to prevent the smolts from being drawn into the deadly pipes. Initial indications are that fish fatalities have dropped substantially with the new system and WDFW is continuing to monitor the situation to gauge the long-term success of the project.

Hydraulic permit process

WDFW administers the oldest and most direct regulatory activity designed to protect salmon and other fish – the Hydraulic Permit Approval (HPA) program. Created by the Legislature in 1949, the hydraulic law requires WDFW approval for any project that will "use, divert, obstruct or change the natural flow or bed of any of the salt or fresh waters of the state."

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In fiscal year 1999, approximately 50 WDFW habitat biologists throughout the state reviewed more than 6,000 individual hydraulic applications on projects ranging from private docks to stream restoration activities proposed by local volunteer groups. The goal of the program is "no net loss" of fish life or habitat.

WDFW is currently working with the National

Marine Fisheries Service and the U.S. Fish and Wildlife Service to bring the HPA program into compliance with the ESA by 2003. As part of that process WDFW is conducting an extensive review of the Hydraulic Code rules for ESA compliance and developing an Environmental Impact Statement and compliance agreement. Once the program receives federal approval, anyone who abides by the terms of a hydraulics permit will automatically be covered by WDFW's federal approval under the ESA.

Forests, fish and agriculture

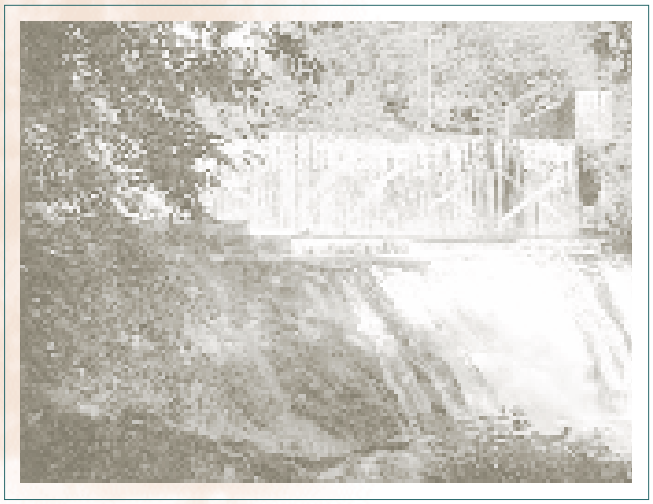
The forestry and agriculture industries have long been mainstays of Washington's economy, but they can also have a major impact on salmon and their habitat. In recent years, WDFW has worked with both industries, at the negotiating table and in the field, to find alternatives to practices that cause erosion, stream siltation, increased water temperatures and other forms of habitat degradation.

The Forest and Fish Agreement, adopted into law by the 1999 Legislature and now being implemented by the Forest Practices Board, significantly improves logging practices on private lands for the next 50 years to protect salmon habitat. As a party to that agreement, WDFW successfully pressed for measures that expand buffer zones around streams, require timber companies to repair logging roads that leach sediment and provide additional protection for 60,000 miles of forested riparian habitat. Now, WDFW scientists are working to assess the effectiveness of the new emergency rules and determine whether changes need to be made to further safeguard the future of Washington salmon.

This ongoing monitoring program includes an "adaptive management" provision that allows the Forest Practices Board to either tighten or loosen the new rules, based on their effectiveness in protecting the resource. A team of 10 staff members is currently working to collect baseline data, monitor compliance, help small-scale forest landowners identify sensitive sites, consult with other agencies and implement various provisions of the agreement. As a member of the scientific group that will advise the Forest Practices Board on any necessary changes to the agreement, WDFW will provide much of the scientific data and analysis needed to make adaptive management work for the mutual benefit of salmon and the forestry industry.

The SHEAR group has corrected 244 impassable culverts like this one, but hundreds more still need attention.

Meanwhile, WDFW has been working since 1999 to improve agricultural practices that endanger salmon. That's when the "Agriculture, Fish and Water" process started with discussions among the agricultural community, the tribes, and representatives from all levels of government. This broad effort is designed to help all parties reach agreement on new guidelines for agriculture and irrigation that are consistent with the ESA and the Clean Water Act. Specific work is under way to update the federal Field Office Technical Guides (FOTGs) that outline acceptable farm practices, including development of guidelines for irrigation districts that address water use, conservation and water quality requirements of the ESA. If agreement can be reached on the new



Removal of Goldsborough Dam in Mason County is expected to open up habitat for an additional 2,000 coho salmon and 10,000 chum salmon.

standards, farmers who abide by them will have protection against any challenge to their ESA compliance.

WDFW also piloted a targeted effort in the spring of 2000 to help southeast Washington farmers comply with existing laws on passage and screening and may help them comply with ESA requirements. The initiative began in the Walla Walla River Basin where a WDFW enforcement officer and biologist have contacted hundreds of landowners to identify fish-passage problems such as inadequate fish-protective screening on irrigation intake structures. The point of this Cooperative Compliance Review Program (CCRP) isn't to issue citations, but to inform water users of state standards, educate them through workshops, and encourage voluntary compliance by working together to find ways to share the costs of needed improvements. Through this approach, WDFW seeks to protect both local economic and environmental concerns and to establish community support for more "fish friendly" farming practices.

Hydro operations

At last count, there were nearly 1,000 dams of one kind or another in Washington state, ranging in size from the massive hydroelectric dams on the Columbia River to small irrigation dams no more than a few feet high. While most of these structures have a useful purpose, many also present a significant barrier to the migration of native salmon.

WDFW has little direct control over most dams, whether they are owned by the federal government, state agencies, local governments, public utilities or private interests. It does, however, provide scientific recommendations to federal agencies that operate dams on the Columbia River and to the Federal Energy Regulatory Commission (FERC) whenever a new dam is proposed or an existing dam comes up for license renewal.

In its advisory role, WDFW has successfully advocated for improving salmon passage and habitat conditions at dozens of facilities, including dams on the Cowlitz, Columbia, Nisqually, Skagit, Wynoochee and other rivers. In 1999, the owners of Condit Dam decided it would be more cost-effective to remove their structure from the White Salmon River than to make the fish-friendly modifications recommended by WDFW and other groups.

Occasionally, WDFW has an opportunity to play a more direct role in improving fish passage at a dam site. At Duncan Creek in Skamania County, WDFW is working with area landowners to replace an ineffective culvert at Duncan Creek Dam, which presents a barrier to migrating native chum salmon. The agency helped the landowners, who own the dam, obtain grants to meet part of the project costs and is designing the new gate, which will be operated by the landowners with oversight by WDFW.

On Goldsborough Creek in Mason County, the goal is not to rehabilitate a dam but to remove one. Built in 1921 as the City of Shelton's original source of power, Goldsborough Dam currently has no useful purpose but continues to block salmon from 14 miles of ideal spawning ground upstream. At the request of the Simpson Timber Company, the dam's owner, WDFW and the U.S. Army Corps of Engineers have joined in a partnership to remove the aging wooden

structure and recontour the streambed to facilitate salmon passage during the summer of 2001. Once completed, the project will open up vital freshwater habitat for an estimated 2,000 adult coho salmon, 10,000 chum salmon and hundreds of steelhead and sea-run cutthroat trout every year.

At these and other sites around the state, WDFW is working to mitigate and, when possible, eliminate barriers posed by dams to natural migration of Washington's native salmon populations. While each dam presents different challenges, WDFW's overriding goal is to make each one as "fish friendly" as possible.

Public outreach and education

For all of the science-based initiatives by resource managers to protect native salmon and their habitat, WDFW recognizes that public involvement and support are critical for the restoration effort to be successful. For that reason, public education and outreach programs are an essential part of the agency's approach to salmon recovery.

For a start, WDFW is committed to providing the best available scientific information to anyone who needs it, whether that person is a lawmaker drafting legislation or a land-owner trying to determine an appropriate stream setback. Thousands of people every year get the answers they need through the agency's Priority Habitats and Species (PHS) program, which identifies the location of sensitive species and habitats, along with the steps necessary to protect them. Others go right to WDFW's salmon recovery website (www.wa.gov/wdfw/recovery.htm), which receives more than 10,000 "hits" per year by people researching topics from volunteer opportunities to assessments of individual salmon stocks.

Visitors to the website can also assess their own impact on salmon habitat through an on-line evaluation that focuses on such issues as personal water consumption and commuting habits.

The *NatureMapping* program is designed for those who want to learn while taking an active part in salmon recovery. Through this program, developed by WDFW, the University of Washington and the U.S. Geological Service, the public can learn about habitat restoration while helping to collect habitat and stream data that contribute to fish-management decisions. Volunteers can also qualify for grants through a separate program designed to encourage public involvement in habitat restoration and other projects.

WDFW's *Salmon in the Classroom* program helps young people connect with the natural world through a course of study that combines classroom instruction with hands-on learning in local communities. Every year, more than 30,000 participating students raise salmon eggs at their schools and release them in local rivers. Separate programs, called Project WILD and Aquatic WILD, provide training for teachers who are helping to shape the next generation of watershed stewards in Washington state.

Thirty thousand students each year participate in WDFW's Salmon in the Classroom program; here, students release fry they reared as part of the program.

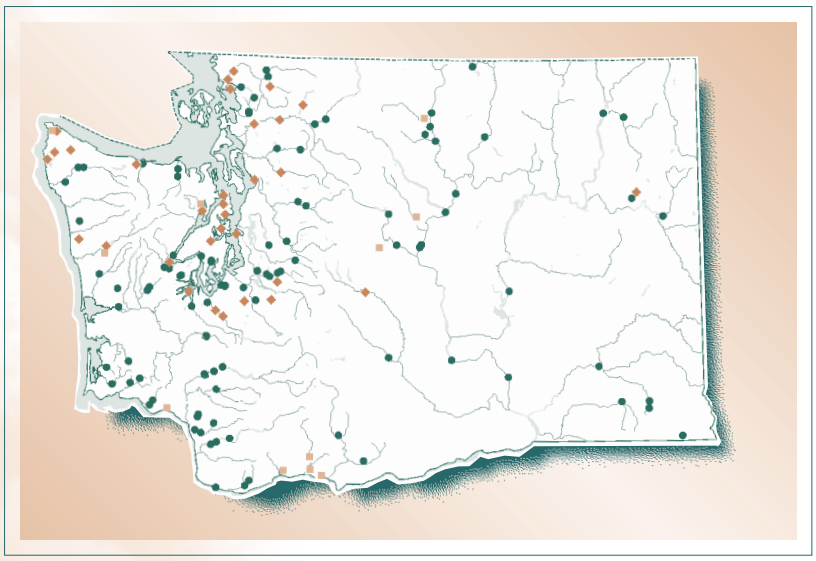
A new era in

Hatchery Operations

Facilities provide sustainable fisheries while supporting recovery of wild stocks

For more than a century Washington Department of Fish and Wildlife (WDFW) hatcheries have produced fish for harvest. Today, hatcheries still provide the foundation for the state's vastly popular recreational salmon fishery and thousands of jobs that depend on it.

But they also do much more than that. Once seen as mere "fish factories," hatcheries are now becoming a key management tool for the conservation of native salmon stocks. A third of WDFW's hatcheries are now being used in some capacity to help restore indigenous wild salmon populations and more are getting involved in that effort every year.



Washington's system of 143 state, tribal and federal hatcheries produces fish for sustainable harvest and aids in wild stock recovery efforts.

To achieve this dual role of wild stock conservation and sustainable fisheries, hatchery operators are relying on science. Beginning in the 1970s, WDFW scientists and technicians began developing new scientific tools that have since become an integral part of hatchery operations.

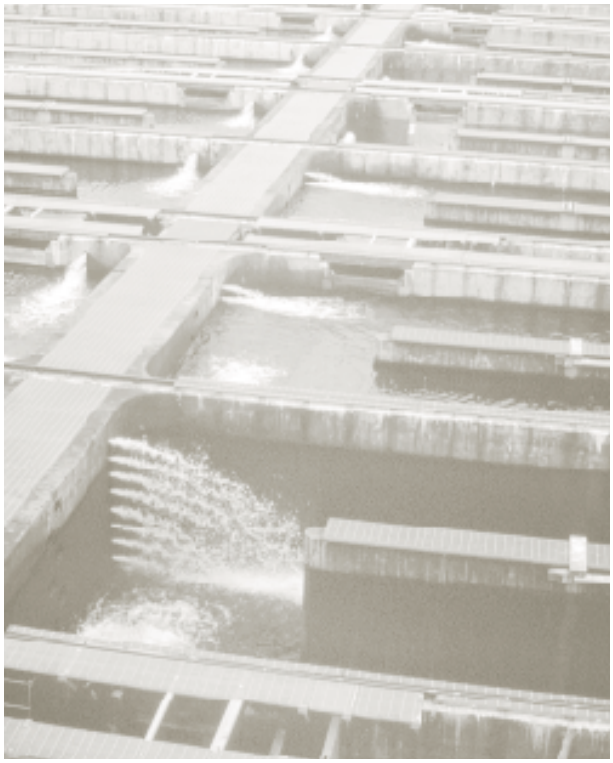
Every year, coded wire tags are inserted into the snouts of 15 million hatchery fish, providing critical information on fish migrations, hatchery survival rates and which fish are caught where. In 1996, hatchery workers began marking hatchery salmon by clipping their adipose fins so they can be readily distinguished from wild ones, laying the groundwork for today's selective fisheries.

Hatchery workers also take DNA samples from fish to determine how many hatchery versus wild fish were in a river at a given time. And, most recently, work has begun on comprehensive Genetic Management Plans for hatchery operations statewide. As part of these plans, WDFW technicians are determining the scientific risks and benefits that hatchery programs pose for both wild and hatchery fish within specific watersheds. These assessments will provide the scientific foundation for the Genetic Management Plans, which are designed to ensure hatchery operations do not conflict with or impede wild fish recovery efforts under the federal Endangered Species Act (ESA).

WDFW technicians are currently determining the scientific risks and benefits that hatchery programs pose for both wild and hatchery fish within specific watersheds.

Also, in an unprecedented collaborative effort, a group of scientists representing state and tribal co-managers, the federal government and independent organizations has recently been established by Congress to

make sure the best available science is developed and applied in coming years as Puget Sound and western Washington hatcheries are refocused to meet their dual role of supporting sustainable fisheries and wild stock conservation. WDFW will use the guidelines developed by this independent Hatchery Scientific Review Group as it works to update the aging infrastructure of many hatcheries, some of which actually pose physical and other obstacles to the recovery of wild salmon stocks.



Most salmon caught by sport and commercial fishers are reared in hatchery raceways like these.

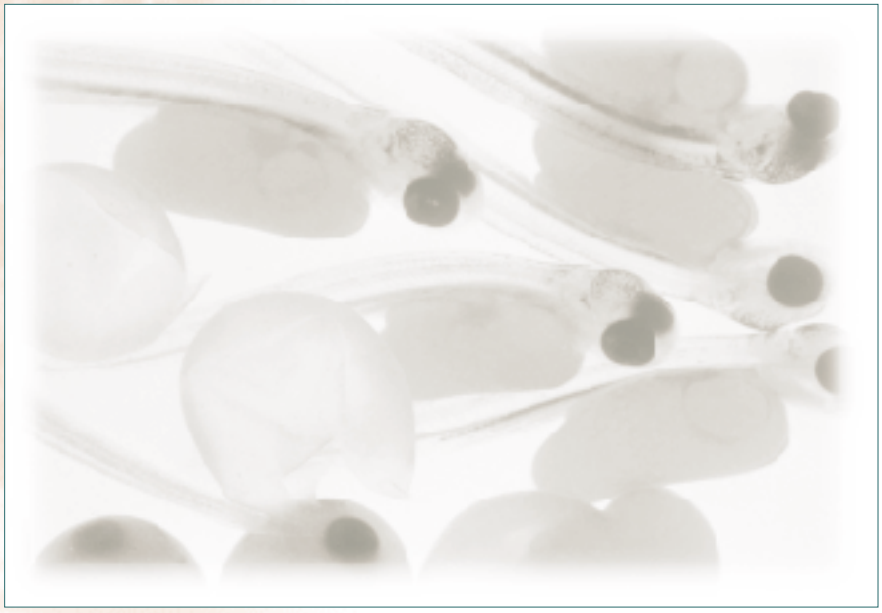
Sustainable fisheries

The first hatchery in Washington state was built in 1895 on the Kalama River at a cost of $5,000. Soon thereafter, the development of a statewide hatchery system proceeded at a rapid pace, and by 1900 there were facilities on the Chehalis, Wenatchee, Nooksack, Skokomish, Willapa, Wind, Samish, Little Spokane, Methow, Colville, Klickitat, Snohomish, White and Nisqually rivers. Just five years after the first hatchery went into operation, the state was producing an estimated 58 million fry annually at 15 different locations.

Today, WDFW operates 96 hatchery facilities, which produce a majority of the fish caught in Washington sports and commercial salmon fisheries. Also contributing to the catch are the 35 tribal hatcheries and 12 federal hatcheries in Washington state. All of these facilities have helped to replace fisheries production lost through habitat degradation and other factors. Of the 96 facilities operated by WDFW:

- Sixty rear salmon at some life-stage. The remainder rear game fish (trout, steelhead and warm water species) exclusively.
- More than 200 million fish were produced by those facilities in 1999.
- In Hood Canal and Puget Sound areas, more than 99 million chinook, chum, coho, sockeye, pink and steelhead were released from state hatcheries.
- About 14.5 million chinook, coho and steelhead were released into Washington's coastal waters.
- In recent years, approximately 75 percent of all coho and chinook caught in all state waters came from hatcheries, while 90 percent of those species caught in Puget Sound and freshwater tributaries were of hatchery origin.

In 1995, a WDFW study found that commercial fishing contributed an estimated $531 million to the state's economy and supported 16,400 jobs. In 1996, the U.S. Census Bureau, in conjunction with other federal agencies, estimated that sport fishers spent more than $704 million in Washington that year. While these totals have no doubt declined as the harvest has been curtailed in recent years, salmon produced at state hatcheries still make a significant contribution to the state's economy.



A new generation of hatchery salmon begins life.

Wild stock conservation

State hatcheries, historically designed to augment or replace wild fish for harvest, are now also playing an increasingly important role in restoring wild runs depleted by habitat degradation and other factors. During the past two decades, the number of hatchery facilities involved in some aspect of wild salmon recovery has increased from two to 36 as hatcheries have become an integral part of Washington's salmon recovery strategy. In fact, some hatchery stocks have been listed by the federal government for protection under the ESA.

Some restoration projects are designed to rear a limited number of wild fish in a hatchery for a specific period. Others hold an entire stock in a hatchery for an extended period to ensure its survival. White River spring chinook salmon, listed under the ESA as a threatened species in 1999, have moved between several hatchery facilities on the road to recovery.

Long before the proposed listing, state and tribal fisheries managers began working to rescue the White River stock. In 1977, biologists estimated that fewer than 50 wild spring chinook remained and moved all that could be captured from the river to the state's Minter Creek Hatchery to guard against immediate extinction. Some smolts reared at Minter Creek were released as juveniles and returned to spawn; others were transferred to salt water net pens in south Puget Sound to be reared to maturity in the state's first successful captive broodstock program.

In 1990, with the completion of the White River Hatchery, operated by the Muckleshoot Tribe, eggs from Minter Creek were returned to their native river and later released as smolts. Since then, the number of returning adults has grown through the joint efforts of WDFW, the Muckleshoots and the Puyallup Tribe. This year over 800 adults returned, more than the previous 20 years combined.

Similar efforts are under way at WDFW facilities on the Nooksack, White, Dungeness, Snake and Tucannon rivers as well as several rivers that flow into Hood Canal. Without them, there is a high likelihood that more native salmon species would now be extinct.

New scientific and technical improvements

Hatchery management has become increasingly more sophisticated in recent decades as WDFW has worked to maximize the health of both hatchery and wild stocks. In the late 1970s, the agency adopted restrictive stock transfer guidelines to maintain the genetic integrity of local broodstock at hatcheries by minimizing the intermingling of stocks. In 1991, WDFW and the tribes adopted a statewide salmonid disease policy to prevent the importation or dissemination of pathogens known to affect salmon and steelhead. Under that policy, rigorous measures are taken to ensure the health of hatchery fish.

Beyond simply preventing the spread of disease, WDFW has also adopted a number of hatchery procedures designed to preserve

the unique characteristics of Washington's various wild salmon populations – a major goal of the ESA. Although wild salmon and those reared for generations in a hatchery can look pretty much alike, scientists know that the behavior of these fish, as well as their genetic makeup, can be markedly different. In the past few decades, WDFW has developed a number of scientific tools that allow hatchery workers and fishers to distinguish between hatchery salmon and wild salmon at the hatchery weir and in open water.

Hatchery management has become increasingly more sophisticated in recent decades as WDFW has worked to maximize the health of both hatchery and wild stocks.

Coded wire tags

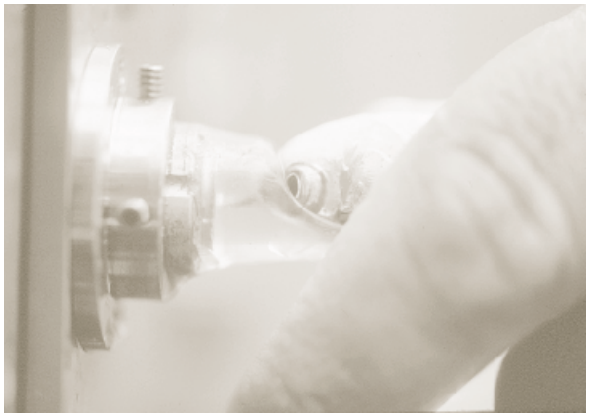
Beginning in the early 1970s, WDFW scientists pioneered a technique to help them determine specific information about chinook and coho reared and released from hatcheries. They began inserting miniature (1/25th of an inch) metal tags into the snouts of the juvenile hatchery fish when they are two to three inches long. The tags are imprinted with a specific number identifying a specific group within the hatchery where the fish was reared.

The tags, retrieved after a fish spawns or is harvested, can offer several types of information. Scientists can determine the migratory patterns of the fish, for example, or identify those that fared best on various diets. Because fisheries managers from Alaska to California also mark fish with coded wire tags, and then share the data with WDFW scientists, the data gleaned from the coded wire tag technique can be especially useful in helping fisheries managers structure sustainable fisheries.

Otolith marking and genetic analysis

In 1988, WDFW pioneered another technique to mark hatchery fish called otolith marking. Unlike coded wire tags, otolith marking doesn't provide an unlimited number of unique codes to collect various types of data. But it is superior to coded wire tags in that an entire hatchery run of fish can be marked relatively inexpensively.

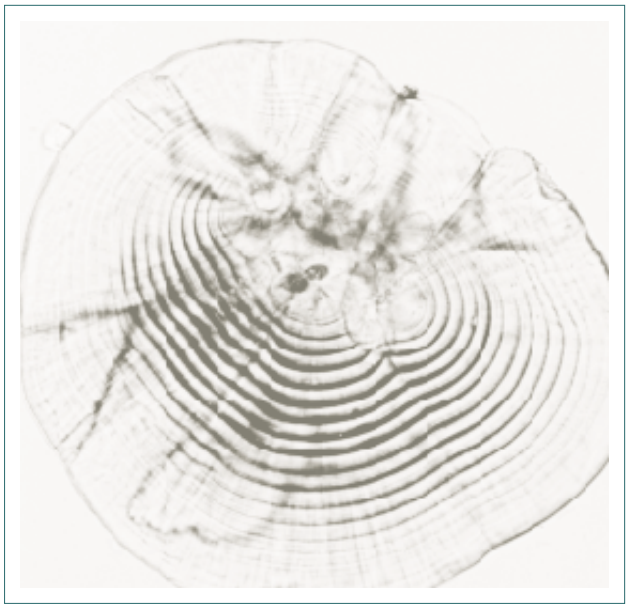
Otolith marking involves a portion of a fish's ear bone, the otolith, which is among the first to calcify as a fish develops. When an otolith from a mature fish is cross-sectioned and examined under a microscope, it displays a pattern of



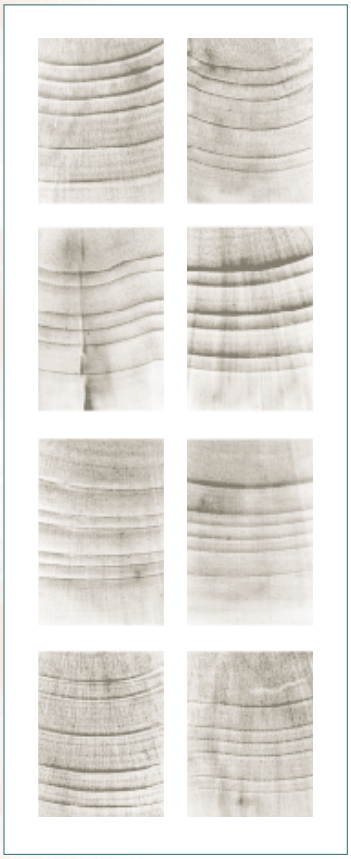
Millions of young salmon (smolts) are marked each year with tiny coded wire tags which identify their river or hatchery of origin.

Returning adult salmon are electronically scanned to detect coded wire tags bearing information about the fish's origin and age; by recovering and examining the tags from fish harvested or surveyed on the spawning grounds, fish managers can reconstruct run profiles.

An otolith, the calcified tissue from a fish's inner ear, displays a distinctive pattern similar to a tree ring.



By deliberately altering the water temperature of hatchery egg trays, the otoliths of entire batches of young salmon can be marked in unique, identifying patterns. Later, when those fish are recovered as adults, the otoliths can be recovered, sectioned and examined under a microscope to give valuable information about the composition of fish runs.



light and dark rings similar to a tree trunk. Scientists have learned that otoliths can be marked with identifiable patterns by raising and lowering water temperatures at certain intervals as eggs are incubated in hatcheries.

When the thermally-marked fish are later recovered as adults – either in fisheries or after they have spawned – the otoliths are removed and sent to WDFW's lab where they are read under a microscope. Similar to a bar code, the unique band patterns of an otolith allow scientists to determine whether the salmon originated in a hatchery or a natural stream – and if from a hatchery, *which* hatchery.

In the mid-1980s, WDFW scientists began to employ genetic analysis to determine which individual fish stocks are present in a fishing area and the composition of hatchery and wild fish in a river's annual salmon run. Genetic analysis is also used to gauge the success of wild salmon recovery efforts by measuring the number of wild fish returning to a particular spawning stream. Both cell protein analysis and, more recently, DNA studies are used to identify fish by individual stocks.

Mass marking

Perhaps the most far-reaching technique for distinguishing hatchery salmon from wild fish involves removing the adipose fin from hatchery fish before they are released from the facility. The missing adipose fin – normally a small fin on the fish's back near its tail – gives both fishers and hatchery personnel an obvious way to tell if returning fish originated in the hatchery or in the wild.

Mass marking hatchery salmon has become an essential tool in WDFW's selective fishing strategy, which allows for fishing on healthy hatchery stocks while protecting weak wild stocks in the waters where the two stocks intermingle. If fishers catch an unclipped wild fish, they may be required to return it to the water under current fishing regulations.

WDFW began mass marking hatchery coho in 1996 and chinook in 1999. Last year, 62 million hatchery salmon were mass marked, including nearly 100 percent of the coho salmon in the Puget Sound and on the Washington coast. WDFW also marked nearly 95 percent of coho and 100 percent of the spring chinook in the lower Columbia River.

Identification of hatchery salmon also allows fisheries managers to monitor the number of hatchery adult fish present in natural spawning areas, and to observe the

The research is expected to yield findings on the interactions between hatchery and wild fish.

interactions between hatchery and wild juvenile fish after the hatchery fish are released. If high stray rates or negative interactions occur, adjustments in hatchery production levels can be made.

Until recently, all marking was done by hand and it was a slow process. In order to mark a larger number of fish in a shorter period of time, WDFW in 1999 began using an automated machine capable of marking 5,000 fingerling coho or chinook an hour. The machine uses a flow of cold water to attract fish to a chute where mechanized gates separate them and hold them for individual fin clipping. A tiny camera and special software helps position the clipper and verifies that the adipose fin is removed.

Because mass marking has been successful in helping hatchery workers and fishers alike to distinguish between hatchery salmon and wild fish, the National Marine Fisheries Service has encouraged fisheries managers to mark all hatchery-produced salmon. One problem, however, is that fish managers coastwide also clip the adipose fin of salmon outfitted with coded-wire tags, creating potential confusion. Scientists are currently working on a solution, however, and it is clear that mass marking will continue to play an integral role in the state's selective fishing strategy for years to come.

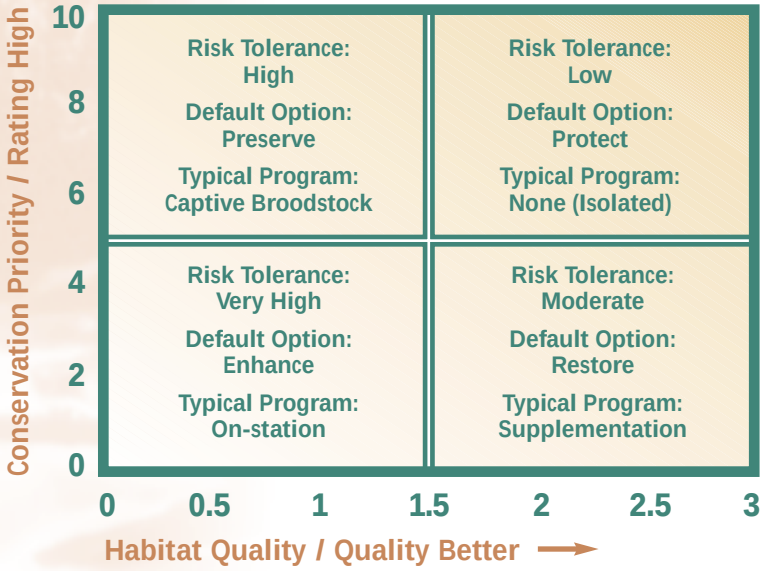
The NATURES project

In an effort to find ways to raise fish with more natural attributes in artificial settings, WDFW technicians, in concert with tribal, federal and private partners, have initiated Natural Rearing Enhancement Systems (NATURES) at several hatchery locations. Unlike the barren concrete ponds that typify the average hatchery facility, these systems attempt to simulate natural rearing conditions at hatcheries by equipping hatchery tanks with sand or rock bottoms, small trees or large snags or other modifications.

Scientists hope to determine if fish reared under such conditions take on the coloration and behaviors of their natural cousins and, hence, stand a better chance of survival in the wild. The research also is expected to yield findings on the interactions between hatchery and wild fish. Moreover, fish reared under such "natural" hatchery conditions could be used to re-establish wild runs in streams where wild fish have disappeared.

Changing hatchery practices include experimental efforts to produce fish with more natural coloration. The fish in the upper photo, reared in an unshaded hatchery pond, shows paler coloration than the fish in the lower photo, reared under a vegetation cover.

Hatchery Benefits / Risk Analysis Framework



The quality of available habitat is a major factor in selecting hatcheries for wild stock conservation programs.

Reviewing and Improving Hatchery Infrastructure

Despite WDFW's successes in using hatcheries for wild salmon recovery, many challenges remain. Some hatcheries pose physical obstacles for young fish attempting to get past the hatchery and downstream; others, built decades ago, prevent spawning adults from getting upstream to spawn. Water intakes at some WDFW hatcheries were not designed to meet current standards, while others have permanent racks across the stream that divert all returning adult salmon, hatchery and wild, into the hatchery.

Besides the structural problems at hatcheries themselves, physical and genetic interactions between wild and hatchery fish also can weaken wild stocks. Interbreeding can result in deleterious genetic effects, while competition for food and other resources between hatchery and wild fish may reduce the number of wild fish the habitat can sustain. Predation on wild fish by hatchery fish may also affect wild fish populations. WDFW is currently conducting a Benefits/Risk Analysis Procedure on all hatcheries and fish-production facilities to determine their compatibility with the goal of recovering wild stocks.

The department has begun to redesign some hatchery facilities to provide safe passage for wild fish to and from natural rearing areas located upstream of hatcheries. WDFW also regularly monitors the discharge from all hatcheries to comply with federal water quality standards. However, compliance with these standards has not been met at all facilities due to insufficient funding. The department presently is prioritizing the structural deficiencies and seeking federal, state and private funds to fix them.

WDFW is presently working on Hatchery Genetic Management Plans for those hatchery operations that can potentially affect a listed species. Scheduled to be completed in 2001, these plans will be reviewed by the National Marine Fisheries Service to ensure hatcheries are being operated in a manner that will not impede the recovery of wild salmon. Working with the tribes, the state also is constructing a new database that will more efficiently supply resource managers with key hatchery data.

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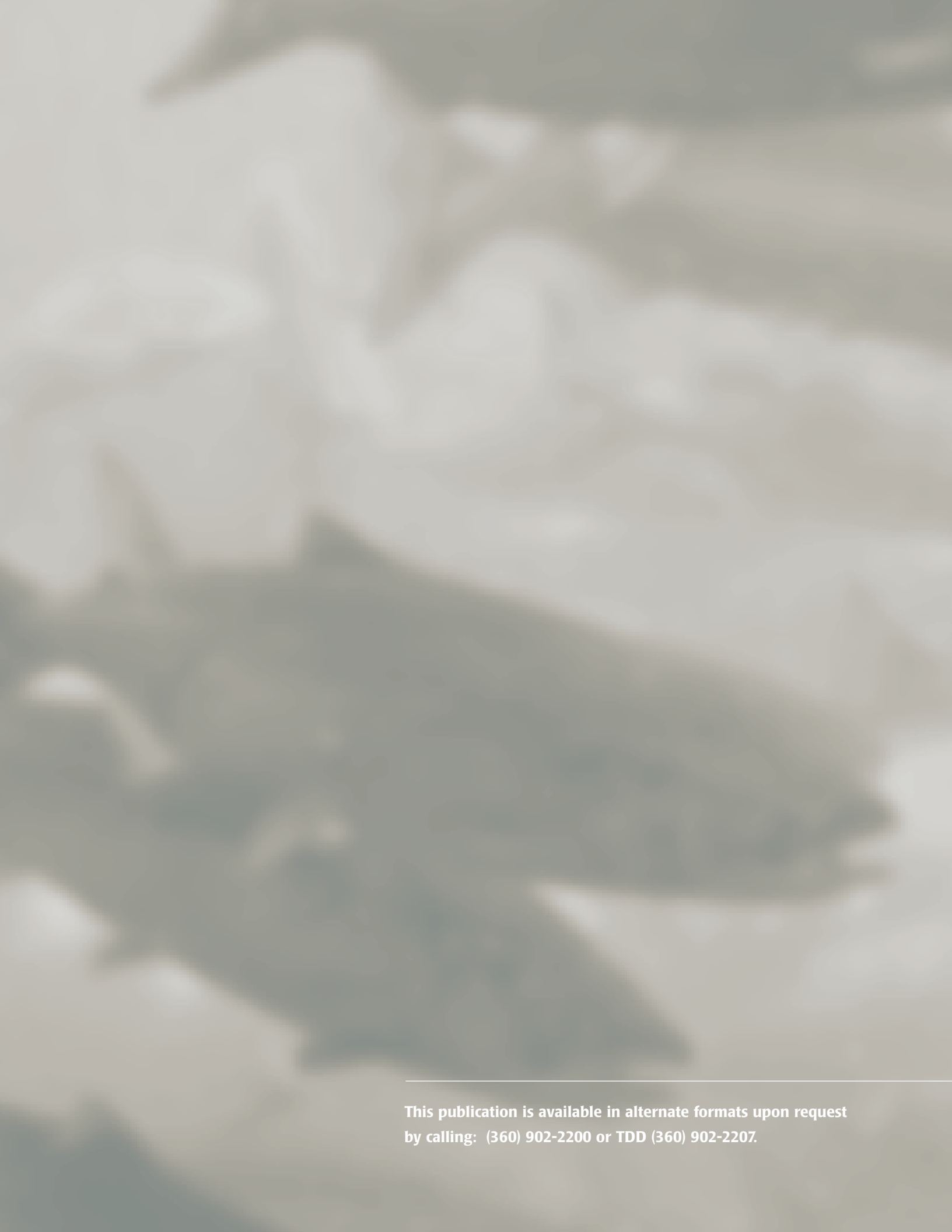
Against this background, an independent Hatchery Scientific Review Group is expected to complete a scientific framework and guidelines for hatchery operations by spring, 2001. The framework and guidelines are expected to provide the basis for hatchery operations in the years ahead as the facilities meet their dual role of sustainable fisheries and wild fish conservation.



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