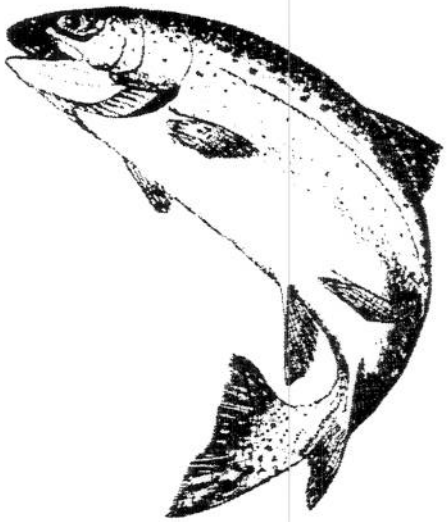
Summary of
the Sixth

Pacific Coast Steelhead Management Meeting



March 3 - 5, 1998
Fort Worden State Park Conference Center
Port Townsend, Washington

Sponsored by:
Pacific States Marine Fisheries Commission
and
U.S. Fish and Wildlife Service

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Pacific Coast Steelhead Management Workshop
March 3-5, 1998
Fort Worden State Park Conference Center
Port Townsend, Washington

Introduction

During March 3-5, 1998, the Pacific States Marine Fisheries Commission in conjunction with the U.S. Fish and Wildlife Service sponsored the sixth in a series of workshops on steelhead (*Oncorhynchus mykiss*) management. The workshop was attended by approximately 61 Pacific Coast fisheries managers and researchers representing the states of Alaska, Washington, Idaho, Oregon, and California, the province of British Columbia, and the Russian Republic. Topics for this workshop included:

- an update on the status of steelhead in each management jurisdiction;
- NMFS perspectives of pending Endangered Species Act (ESA) listings;
- management agency responses to declining steelhead population abundance and ESA listings;
- a discussion of selective harvest techniques and their associated problems; and
- contributed reports on current steelhead research projects.

The workshop was structured as a series of panel presentations, followed by discussion and/or questions from the audience. It was intended as a forum to allow steelhead managers and researchers on a coastwide basis to discuss common problems and to share insights into possible solutions. The following abstracts prepared by the speakers summarize their presentations.

Workshop Steering Committee:

Doug Jones, Alaska Department of Fish and Game
Bob Leland, Washington Department of Fish and Wildlife
Bruce Sanford, Washington Department of Fish and Wildlife
Art Tautz, Ministry of Environment, British Columbia
Sharon Kiefer, Idaho Department of Fish and Game
Bob Hooton, Oregon Department of Fish and Wildlife
Dennis McEwan, California Department of Fish and Game
Mick Jennings, Confederated Tribes of the Warm Springs
Al Didier, Pacific States Marine Fisheries Commission

Steelhead Stock Status Review By Jurisdiction
Session Chair: Mick Jennings

Alaska
Glen Freeman - Alaska Department of Fish and Game

Limited available data suggest the current overall status of steelhead in Alaska is below historical levels. Recent steelhead data collected by the Alaska Department of Fish and Game consist of weirs, commercial and sport fishery catches, and index stream surveys.

Data collected at weirs operated by the Alaska Department of Fish and Game on the Karluk River (Southcentral) and the Situk River (Southeast), two of Alaska's largest steelhead producers, show variable but increased adult escapements since depressed returns in the early 1990's. The reported commercial and sport fishery harvests of steelhead declined sharply following an Emergency Order in 1993 and more restrictive regulations to the commercial and sport fisheries adopted by the Board of Fisheries in 1994 and 1997. Since 1991, Statewide Harvest Survey information on the Alaska sport fishery indicated peak steelhead catches in 1993, with declines from 1994 through 1996. Recent steelhead research in Southcentral Alaska has been limited primarily to an annual weir project operated on the Karluk River. Snorkel surveys were standardized in 1997 to improve the reliability of index counts in 13 streams of small to medium size throughout Southeast Alaska. Continued refinement of research and management actions taken by the department, along with public support and barring natural disaster, should ensure the viability of wild steelhead throughout its range in Alaska.

British Columbia
Bob Hooton and Rob Bison - BC Ministry of Environment

The "northern" regions of British Columbia include, for purposes of the present discussion, the upper Fraser stocks (primarily Thompson and Chilcotin), the central coast Dean R stock and the Skeena, Nass, Stikine and Taku stocks. The focus in these areas is on the interior tributaries which support only summer steelhead. Coastal stocks are almost exclusively winter steelhead for which little conclusive stock status information is available. The common and dominant feature of the interior summer steelhead stocks is interception in mixed stock commercial net fisheries targeting salmon. Most of the stocks for which data are available continue to absorb commercial fishery exploitation rates of about 50%, although some reductions in domestic harvest rates have been realized. Allocation debates continue to be unresolved. Commercial fisheries operate in advance of run status evaluations generally leaving allocations to the legislated priority uses (conservation first, natives second and other fishers last) unfulfilled or uncertain. Spawning escapement targets have seldom been met in recent years. The deficit appears to be increasing in the more southern systems while central and more northerly stocks exhibit more average abundance. The most northerly systems in the province remain virtually unstudied with only anecdotal information available. Sport fisheries have been managed on a non-consumptive basis to facilitate use at minimal cost to spawner abundance. North coast winter steelhead stocks are unaffected by commercial fisheries and seldom targeted by natives.

Whereas these stocks are not monitored on any consistent or comprehensive basis there is nothing to suggest they are anywhere near as impoverished as south coast winter steelhead have become.

Washington
Bruce Sanford - Washington Department of Fish and Wildlife

Representative steelhead populations were assessed throughout Washington, including rivers of Puget Sound, north and south coast, and tributaries of the Columbia and Snake rivers. In general, wild steelhead abundance shows long-term downward trend in most areas. Areas of the most concern include south Puget Sound (e.g. Nisqually, Puyallup), south coastal rivers (e.g. Humptulips, Chehalis, Willapa Bay tributaries), lower and mid-Columbia (e.g. S.F. Toutle, Wind, Yakima), upper Columbia (Wenatchee, Methow) and Snake River (e.g. Tucannon, Touchet). In comparing abundance levels, present day populations of these areas range from 60% to 20% of 1980's run size estimates. Healthy and stable wild populations occur primarily within north Puget Sound (e.g. Skagit, Snohomish) and the north coast (Quillayute). Within these areas escapement goals are consistently achieved. However, some rivers are also beginning to show a declining trend (Hoh).

Hatchery return rates in many areas exhibit declining smolt-to-adult survival rates. Past survival rates of two to three percent have fallen to less than one percent.

Causes of this downward trend is not specifically known, but it is believed that ocean survival rates for the last several years have contributed significantly to the decrease. Degraded freshwater habitat, especially in relation to flood and drought periods is also believed to be a factor.

Oregon
Mark Chilcote - Oregon Department of Fish and Wildlife

The object of this review was to provide an examination of the status of steelhead in Oregon with respect to likelihood of persistence. This review was conducted using repeatable methodology commonly employed in the field of conservation biology. Although more than 130 steelhead populations exist in Oregon, the status conclusions were based at the evolutionarily significant unit (ESU) level. Three indicators of species health were used to assess the risk of extinction of steelhead in Oregon: 1) the likelihood of long-term population persistence, 2) the capacity of populations to resist and survive short-term periods of extreme environmental stress, and 3) the identification of populations at immediate risk of reproductive failure and extirpation. The overall conservation ratings for each ESU in Oregon were as follows: Klamath Mountains Province = Secure, Oregon Coast = Sensitive, Lower Columbia = Threatened, Willamette = Threatened, Middle Columbia = Sensitive, and Snake = Threatened. Specific problems were discussed for individual populations including the water withdrawal impact on Mid-Rouge summer steelhead, the removal of a natural barrier on the health of Siletz summer steelhead, the adverse impact of non-native summer steelhead on wild winter steelhead in the Clackamas, and the apparent reproductive failure of the Deschutes summer steelhead because of interbreeding with out-of-basin, genetically maladapted stray steelhead.

California

Dennis McEwan - California Department of Fish and Game

Steelhead rainbow trout were formerly distributed in California coastal drainages from the Mexican to the Oregon border and throughout the Sacramento and San Joaquin river drainages of the Central Valley. At present, they have been mostly extirpated from drainages south of Malibu Creek in Los Angeles County and from most of their former habitat in the Sacramento and San Joaquin river systems. Summer steelhead populations, which are severely depressed in California, exist only in coastal drainages from the Mattole River north and the entire run consists of only about 2,000 adults (90% of which is found in only four populations). The most secure populations of winter steelhead occur in north coast drainages, however, these populations have declined as well. On the Trinity River, the number of naturally produced winter steelhead has declined from roughly 10,000 adult fish in the early 1980's to about 2,000 fish at present. The upper Eel River natural winter steelhead stock has declined from an average of about 500 spawning adults in the late 1980's to less than 100 today. In the upper Sacramento River system, the natural run size has declined from an average of about 13,000 adult steelhead in the late 1960's to an average of about 1,000 in the early 1990's. Populations have been reduced to remnant status in the San Joaquin river system, however there appears to be a self-sustaining population in the Stanislaus River, based on observations of a small number of emigrating smolts (< 100) at a trapping facility every year for the past three years. Anecdotal information indicates that a few adult steelhead continue to return to the Tuolumne and Merced rivers also. On the Carmel River on the south-central coast, the steelhead population has shown a slight increase over the past three years (approximately 700 adults) and was reopened this year to catch-and-release angling. On the southern California coast, we continue to trap several hundred smolts per year at the Vern Freeman Fish Facility on the Santa Clara river, despite the extremely low numbers of adult steelhead observed (less than five per year) passing the fishway. This may indicate that anadromous progeny are being produced from non-anadromous forms existing in headwater tributaries such as Sespe Creek. As of this writing, adult steelhead returns to all State and federal hatcheries are well below the number returning last year at this time, indicating that adverse ocean conditions (possibly an El Nino effect) may have severely reduced populations.

In 1996, the California Department of Fish and Game published the *Steelhead Restoration and Management Plan for California*. This document will serve as the blueprint for the Department's restoration efforts. The key reason for the decline as identified in the Steelhead Plan is freshwater habitat loss and degradation resulting chiefly from three factors: inadequate streamflows resulting from water development, loss of habitat due to dam construction, and watershed disturbances from land-use activities. The north coast streams (north of San Francisco Bay) suffer mainly from watershed impacts from timber harvest operations and other land use activities, although water development for agriculture is a major impact on some streams. The south coast streams (south of San Francisco Bay) suffer from all three impacts, but some have good restoration potential because barriers are relatively small and can be made passable, the upper reaches of these streams are in good condition, and there are extant native coastal rainbow trout populations in headwater reaches. The Central Valley drainages have been impacted greatly

by water development and placement of impassable dams at low elevations on all major tributaries. It is estimated that 82% to 95% of historical spawning and rearing habitat in the Central Valley is above the dams. The Steelhead Plan makes both programmatic and stream-specific recommendations for restoration and the Department has begun implementation of some of the recommended measures.

Idaho
Alan Byrne - Idaho Department of Fish and Game

The Snake River basin within Idaho historically produced 55% of the total summer steelhead in the entire Columbia River basin. The peak historic escapement of steelhead into the Columbia River was estimated to be over 500,000 adults. An average of 70,000 adult summer steelhead entered the Snake River from 1962 – 1970, based on Ice Harbor Dam counts. The Snake River wild escapement declined to an average of 12,500 fish, based on Lower Granite Dam counts, in the 1990's. Idaho Department of Fish and Game (IDFG) predicts about 8,600 wild steelhead will pass Lower Granite Dam during the 1997-1998 fish run. Idaho's steelhead must pass a total of eight dams on the Snake and Columbia rivers during their migration to and from the ocean. These dams are the primary cause for the steelhead decline. Today 59% of the historic habitat in Idaho is accessible to steelhead. Thirty-one percent of Idaho's steelhead habitat lies in federally protected Wilderness Areas or Wild and Scenic River corridors. This habitat is capable of producing 4 million smolts. If smolt-to-adult survival rates were in the range that were estimated in the late 1960's (3% – 6%) then Idaho could produce 120,000 to 240,000 wild steelhead adults.

The State of Idaho recognizes eight distinct management units of naturally spawning, native summer steelhead. These steelhead units are separated into two races, A-run and B-run, consisting of many populations. Maintaining this population structure and race differentiation is crucial to avoiding extinction and for rebuilding steelhead populations in Idaho. IDFG monitors steelhead parr densities yearly throughout the state. Parr densities are declining in all steelhead production areas, but the decline has been more severe in B-run streams. In 1996, IDFG estimated that parr densities were less than 20% of carrying capacity.

Columbia River
Steve Parker - Yakama Nation Fisheries

Approximately 257,000 summer steelhead destined for spawning areas above Bonneville Dam entered the Columbia River in 1997. This run size is about 120% of the 1985-96 average. About 35,700 (13.9%) were of wild origin and 209,500 were of hatchery origin. The total return of Group A steelhead was estimated by the standard run timing method to be 175,100, of which 29,000 (16,6%) were classified as wild fish. Of the hatchery component, about 54% were 1-salt fish and 45% were 2-salts. The wild component was comprised of 63% 1-salt and 34% 2-salt as wild fish. The Group B steelhead return was estimated to be 81,900 of which 6,700 were classified as wild fish. The ocean age composition in the hatchery component was estimated as

36.0% 1-salt and 57.3% 2-salt fish. The wild component was comprised of 22.1% 1-salt and 68.1% 2-salt fish.

Columbia River mainstem fisheries harvested a minimum of about 25,000 summer steelhead. Incomplete recreational harvest estimates for the mainstem Columbia and Snake rivers may add something like 10,000 to 15,000 hatchery steelhead to the total. Available records show that non-Indian commercial fisheries incidentally harvested about 300 summer steelhead, none of which were wild Group A fish and 31 of which were estimated to be of wild Group B origin. Although total recreational catch estimates are not available, catch sampling suggested that 85 wild Group A and 46 wild Group B steelhead were incidentally harvested in mainstem recreational fisheries below McNary Dam. Treaty Indian commercial and subsistence fisheries harvested about 9.0% of the total upriver run of summer steelhead, or about 23,200 fish. Hatchery steelhead comprised about 82.8% of the catch, of which 12,500 were estimated to be Group A and 6,700 were estimated to be Group B fish. An estimated 2,450 wild Group A steelhead and 1,510 wild Group B steelhead also were harvested in treaty Indian fisheries. These catches represent harvest rates of 8.7% and 23.7% for wild Group A and wild Group B steelhead, respectively.

Steelhead escapements from mainstem fisheries are measured at mainstem hydroelectric dams. Escapement counts at McNary Dam totaled about 128,300, but accurate stock separation is not currently possible at this location. The escapement of Group A steelhead to the upper Columbia was counted at Priest Rapids Dam and totaled about 9,000 including about 900 wild fish. Nearly half that number were subsequently counted at the uppermost counting station at Wells Dam. Escapements of Group A and Group B steelhead into the Snake River totaled about 94,500 at Ice Harbor Dam. Escapement counts at the uppermost Snake River counting station at Lower Granite Dam will not be complete until spring, but counts through the present time project a total around 85,000 fish. Separation into stock components and wild hatchery proportions were not available at the time of this writing.

The forecast for the 1998 upriver summer steelhead return is 262,000 which includes about 179,000 Group A fish and 83,000 Group B fish. Based on the 5-yr average proportion of wild fish in these groups, the 1998 return is projected to include 34,500 wild Group A and 9,000 wild Group B steelhead.

Interior Columbia River Basin and Portions of the Klamath River Basin

Russell F. Thurow, Danny C. Lee, and Bruce E. Rieman - U.S. Forest Service

We summarized presence, absence, current status, and probable historical distribution of steelhead *Oncorhynchus mykiss* in all U.S. waters entering the Columbia River basin east of the Cascade Mountains and those portions of the Klamath River basin in Oregon. The complete study area included 7,498 subwatersheds covering 58.3X10.6ha. Data were compiled from existing sources an via surveys completed by more than 150 biologists working in the region. We developed models to quantitatively explore relationships among fish status and distribution, the biophysical environment, and land management. Biophysical setting was an important determinant of species distributions and habitat suitability. We applied model results to predict fish presence in unsampled areas and mapped expected distributions in more than 3,700 subwatersheds. Steelhead are extinct in 54% of their potential historical range. Despite being

widely distributed in their remaining range, most population are severely depressed. Less than 2% of the subwatersheds in the current range were classified as supporting strong populations. Wild, indigenous fish are rare; 22% of remaining steelhead stocks were judged to be genetically unaltered by hatchery-reared fish. Much of the historical production has been eliminated. However, a core for rebuilding and maintaining functional areas remains. Protection of core areas critical to stock persistence and restoration of a broader matrix of productive habitats will be necessary. This effort will require conservation restoration of sufficient habitats to ensure the full expression of phenotypic and genotypic diversity in steelhead.

ESA – The NMFS Perspective

Session Chair – Bob Hooton

Overview of Endangered Species Act: Listing and Regulatory Processes

Jim Lynch - NMFS Protected Resources Division

The Endangered Species Act of 1973 (ESA) is a powerful federal law that provides numerous protections for species that are found by the federal government to be at risk of extinction. The National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) share responsibility for implementing this law. NMFS is responsible for species that spend a majority of their lives in marine areas, while FWS is responsible for most terrestrial species and species that spend a majority of their lives in freshwater environments.

When determining if a species of salmon warrants protection under the ESA, NMFS convenes a Biological Review Team (BRT) which analyzes the best available scientific and commercial information, making biological recommendations to the Regions. The Regions consider this information, along with factors of decline and existing conservation efforts, in making its listing recommendations to the Assistant Administrator for Fisheries. Prior to listing species, NMFS seeks input from comangers, peer reviewers, and other interested parties. These comments and recommendations are taken into consideration prior to making final listing decisions. Several salmon species have already been listed under the ESA, and several more are currently in various stages of the notice and comment rule making process.

Once species are listed, section 4(d) of the ESA requires NMFS to promulgate regulations under section 9 that will conserve threatened species. In appropriate cases, 4(d) rules may except certain actions from take when they are conducted in accordance with approved state or tribal plans (e.g., forestry, agriculture, road building). In some cases, there may be a healthy population of salmon or steelhead within an overall ESU that is listed. In such a case, it may not be necessary to apply the full range of prohibitions available in section 9. NMFS intends to use the flexibility of the ESA to respond appropriately to the biological condition of each ESU and the populations within it, and to the strength of state and tribal plans in place to protect them.

Update of West Coast Steelhead under the U.S. Endangered Species Act

Peggy Busby - NMFS Protected Resources Division

In August 1996, the National Marine Fisheries Service (NMFS) announced the results of a status review of steelhead (*Oncorhynchus mykiss*) from the states of Washington, Idaho, Oregon, and California. This status review, conducted by a Biological Review Team (BRT) of federal scientists, identified 15 evolutionarily significant units (ESUs) to be considered under the U.S. Endangered Species Act (ESA). In the August 1996 notice, 10 of these ESUs were proposed for listing under the ESA, 5 as endangered and 5 as threatened. An additional ESU was designated a candidate species, and four ESUs were determined not to be warranted for listing at that time. Following the proposed listing, the agency considered the comments of peer reviewers, comanaging governments and agencies, and the public in forming the final listing determinations. In August 1997, NMFS announced a final rule for five steelhead ESUs. Listed as endangered were the Southern California and Upper Columbia River ESUs, and listed as

threatened were the Central California Coast, South-Central California Coast, and Snake River Basin ESUs. The final listing determinations for five other steelhead ESUs were deferred due to substantial scientific disagreement on issues and data analysis. "Species" issues to resolve for the deferred ESUs were the relationship between summer and winter steelhead and the configuration of the Central Valley ESU. "Risk" issues focused on data interpretation and analysis of data not previously available.

During the six-month extension for the deferred ESUs, the BRT was able to consider new information and data on west coast steelhead. New genetic data from co-occurring populations of summer and winter steelhead in Oregon as well as new information from the Washington Department of Fish and Wildlife supported the BRT's previous conclusion that these run-types are not monophyletic evolutionary lineages; rather, they represent diversity within the ESUs in which they occur. Evidence of the historic and continued presence of steelhead within the San Joaquin River Basin of the Central Valley of California and newly available genetic information affirmed the BRT's previous decision to include San Joaquin River steelhead in the Central Valley ESU; however, the BRT was unable to determine whether historically there may have been more than one ESU in this region. The BRT considered new data and data analysis methods that were submitted to the administrative record. Key among this information was the ODFW draft document "Conservation Status of Steelhead in Oregon" (see Chilcote elsewhere in this volume). Based on new information, the BRT concluded that the Oregon Coast ESU was at lower risk than previously determined. Beyond the deferred ESUs, the BRT also reevaluated the risk to the Middle Columbia River ESU (previously a candidate species) and the Upper Willamette River ESU (previously not warranted for listing). The BRT concluded that these ESUs were both at risk of endangerment.

In February 1998, NMFS announced a proposal to list the Middle Columbia River and Upper Willamette River ESUs as threatened. Final listing determinations for the five deferred ESUs was announced by NMFS in March 1998; the Lower Columbia River and Central Valley ESUs were listed as threatened; the Oregon Coast, Klamath Mountains Province, and Northern California ESUs were designated as Candidate species, to be reassessed within 4 years. See table 1 for a summary of the current listing status of steelhead under the ESA.

Table 1. Listing status of West Coast Steelhead under the U.S. Endangered Species Act, as of March 1998.

Listed as Endangered	**Listed as Threatened**	**Proposed as Threatened**	**Candidate Species**	**Not warranted for listing**
Southern California	South-Central California Coast	Upper Willamette River	Oregon Coast	Puget Sound
Upper Columbia River	Central California Coast	Middle Columbia River	Klamath Mountains Province	Olympic Peninsula
	Central Valley		Northern California	Southwest Washington
	Lower Columbia River			
	Snake River Basin			

Recreational Fishery Management and Evaluation Plans-Snake River Basin ESU

Herb Pollard - NMFS Sustainable Fisheries Division, Hatcheries and Inland Fisheries Branch

The National Marine Fisheries Service believes that selective recreational fisheries may be conducted in a manner that does not impair recovery of listed steelhead. However, in order to continue recreational fisheries in waters which support listed fish, protective measures must be in place. NMFS strategy has been to develop a series of standards for protecting listed juvenile and adult steelhead in recreational fisheries. The draft Section 4(d) rule adopts the standards and defers management to the appropriate state or tribe, pending adoption of appropriate management and evaluation plans. The States of Oregon, Washington and Idaho have produced recreational fishery management and evaluation plans to NMFS draft standards.

Lance Kruzic - NMFS Sustainable Fisheries Division, Hatcheries and Inland Fisheries Branch

The Oregon Department of Fish and Wildlife and the National Marine Fisheries Service have been working cooperatively to develop a fisheries management plan for Oregon coastal steelhead that will reduce hatchery and harvest impacts to wild steelhead while providing recreational fishery opportunities. Available information suggests previous harvest of juvenile and adult steelhead may have severely impacted wild steelhead populations. Recent changes to trout and adult steelhead fisheries, including no retention of wild steelhead, shortening the general trout season, and establishing sanctuary areas that are closed to fishing, will substantially reduce harvest impacts to wild steelhead. Steelhead hatchery program changes, such as the development of more locally-adapted broodstocks, reducing the number of hatchery fish released, and changing the locations of hatchery smolt releases, will help reduce the risks associated with hatchery fish.

Management Responses to Steelhead Listings and Declining Steelhead Stocks
Session Chair: Sharon Kiefer

Vancouver Island Steelhead Crisis: Can We Manage Our Way Out of the Ocean Survival Bottleneck?

Craig Wightman - BC Ministry of Environment

Since 1990, there have been dramatic declines in wild and hatchery steelhead abundance in many east coast Vancouver Island streams. Escapements of winter steelhead, which support much of the region's sport fishing effort, have declined from a peak abundance of 40-60 fish per kilometer in the mid 1980s, to less than 10 fish per kilometer in 1996-1997.

The "disappearance" of hatchery steelhead from these rivers strongly suggests a marine "bottleneck" has occurred, given the non-dependence of hatchery smolts on two to three years of freshwater rearing that wild steelhead require before smolting.

Low marine survival of Vancouver Island steelhead is not unprecedented, as was witnessed in the early 1980s, coincident with a strong *El Niño* event off the British Columbia coast. At that time, wild smolt ocean survival was estimated at 8%, compared to an average of about 15% which characterized the mid to late 1980s period.

For the Keogh River near Port Hardy (on the northeast end of Vancouver Island), the province's Fisheries Research Section has operated a counting fence since 1976. The primary objective of this unique facility (i.e., the only long-term monitoring station for steelhead ocean survival in British Columbia) is to enumerate steelhead smolts migrating out of the river in the spring, and adults returning two-to-three years later. By annually monitoring this population in a standard way, biologists are able to calculate annual marine survival for each group of seaward-migrating smolts.

Over the last five years, Keogh winter steelhead returns have been at record lows. Not unexpectedly, very poor adult returns have contributed to poor fry recruitment, and subsequently to low smolt production. For example, while "normal" smolt yields from the system averaged 6,500, yields for each of the last four years have been less than 1,500.

At Keogh, differences in adult returns can be explained almost entirely by variation in smolt-to-adult survival (i.e., in ocean). Based on growing scientific evidence that a sudden large-scale change in Pacific Ocean climate occurred around 1990, much lower than expected survival of Keogh steelhead is most likely attributable to unfavourable ocean conditions.

In 1997, calculated smolt survival for Keogh steelhead was less than 3%, which is below the "population replacement" level required to sustain this stock. Furthermore, the average size of returning adult steelhead is smaller for the 1992-1996 period, again pointing to changes in ocean productivity. A similar decrease in mean size has been observed for Fraser River sockeye salmon.

Given accumulating evidence for a North Pacific Ocean regime shift, which may last a decade or more based on past experience, what critical conservation measures need to be taken by Vancouver Island steelhead managers, and what is an appropriate timeframe for such actions? Based on an on-going consultation process with key stakeholders (i.e., First Nations, sport fishing organizations, licenced angling guides and sport fishing retailers), the following ten priority areas requiring government's immediate attention were identified:

1. Increase funding for all steelhead management functions and activities. Improved stock abundance monitoring is to be the primary objective.

2. Impose more conservative sport fishing regulations, where necessary, to protect critically low steelhead stocks. Restrictions should include gear types (i.e., no bait), mandatory release of wild and hatchery fish, and area closures (i.e., spawning sanctuaries). "Blanket" bans on all sport fishing were not supported by some prominent sport fishing groups.

3. Undertake aggressive habitat restoration programs to increase wild steelhead smolt yields from each watershed where adult returns have declined in recent years.

4. Work closely with federal biologists and oceanographers to monitor marine conditions relative to expected steelhead survival trends.

5. Assess all steelhead hatchery programs relative to production targets (i.e., smolts and fry), genetic concerns and sport fishery enhancement goals. This should include the necessity for captive brood programs where some stocks are clearly "at risk".

6. Where practical and clearly beneficial, undertake predator control programs to increase juvenile as well as adult steelhead survival.

7. Increase the public profile of the steelhead conservation issue through media interviews, press releases, and public meetings in smaller communities along the Island's east coast.

8. Monitor the effects of sport fishing regulation changes on some east coast streams in terms of relocated angling pressure on west coast steelhead stocks. Be prepared to take in-season regulation measures to protect those other stocks, where necessary.

9. Increase enforcement of sport fishing regulations by hiring additional Conservation Officers or changing workload priorities for existing enforcement personnel. In addition, habitat protection activities should be accelerated in all watersheds where steelhead stock declines have occurred.

10. Monitor the economic impacts of reduced steelhead angling opportunities on licence sales, guide effort/catch and fishing tackle retailers, and use this information to increase government support for steelhead management programs.

Many of the above priorities will be considered "cornerstones" in development of a Vancouver Island Steelhead Recovery Plan. The drafting of this plan is now well underway but will continue to evolve through public input, provincial policy decisions, management actions and stock abundance trends for Vancouver Island steelhead.

Washington Perspective of ESA and Recovery Considerations
Bruce Sanford - Washington Department of Fish and Wildlife

Presently two regions are listed under the Endangered Species Act: the Upper Columbia ESU (endangered) and the Snake River ESU (threatened). It is expected that the Lower Columbia ESU will be listed as threatened within the next few weeks. In addition, the mid-Columbia ESU has just been proposed for a threatened listing. Thus, with regard to steelhead, ESA concerns focus on the Columbia River.

Although WDFW will be taking a lead role in developing recovery plans, the scope of agency control is limited to harvest and hatchery issues. Habitat issues, including land practices, water use and hydropower, are issues that WDFW act in an advisory role. With the various listings, the governor of Washington has formed the Joint Natural Resources Cabinet to expand involvement among state agencies and to take leadership in developing coordinated statewide strategies. In addition WDFW has developed a Wild Salmonid Policy that is intended to focus management on natural stocks.

Rebuilding plans will integrate a number of components; among the most important are: (1) sharing of the conservation burden, (2) maintaining local control, (3) working with adaptive approaches, and (4) developing multi-species strategies. It is also important to develop the criteria for delisting early in the process, from which goals and objectives can be identified and alternative measures be considered if the criteria is not met.

For the Upper Columbia ESU, hatchery fish were also listed as endangered and identified as "essential for recovery". The spawn/recruit relationship of the natural spawning steelhead is estimated at 0.33. With fish passage over eight and nine dams, harvest and hatchery measures will play merely supportive roles for rebuilding plans. Without major improvements in juvenile passage survival, it is not expected that rebuilding will occur and that we will only continue to mitigate losses.

The same is true for the Snake River. Natural steelhead are low in abundance and obtaining adequate brood stocks for rebuilding remains questionable. With the major hatchery releases via the Lower Snake River Compensation Plan, the issue is "rebuilding versus mitigation". The only direct actions we have presently initated are stricter harvest measures to protect wild steelhead.

For Lower Columbia ESU, the State of Washington has developed an active role that involves agencies and tasks beyond WDFW. This includes the Joint Natural Resources Cabinet and involvement with local government, similar to the Oregon process. WDFW is also undergoing a major review of hatchery practices, not only in light of ESA but also in response to our Wild Salmonid Policy.

The Impact of the Listing of Steelhead Trout under the Endangered Species Act on Steelhead Management in Idaho
David A. Cannamela - Idaho Department of Fish and Game

The crash of Idaho's wild steelhead populations mirrors that of our chinook and sockeye populations. The Columbia River hydrosystem is the primary cause of the decline, and in its

current configuration precludes recovery of Idaho's anadromous stocks. Specifically, the eight dams on the lower Snake and Columbia rivers, which are not in Idaho, have greatly altered the migration route of Snake River Basin anadromous fish to and from the ocean. Although we have taken substantial actions in the areas we control, specifically in-state harvest and hatchery management, these actions alone cannot reverse the current population trends. The most substantial and probably most beneficial management decisions were made in response to the crash of wild steelhead in the 1970s, well in advance of the ESA-listings (sockeye in 1991, chinook in 1992, and steelhead in 1997). At that point, Idaho Department of Fish and Game personnel decided to manage specific areas as wild (native, naturally produced) or hatchery-influenced.

Wild stocks have been protected from over-harvest and from hatchery impacts. Efforts to restrict the harvest of wild adult steelhead began in the 1970's. Since 1986, the only harvest of adipose-fin-clipped steelhead adults has been allowed in non-treaty fisheries. Fishing seasons and fishery locations have been structured to limit impacts to wild fish.

Hatchery-influenced areas have been and continue to be managed primarily for fishery mitigation purposes. All of our hatchery steelhead programs were established as mitigation for federal or private dam construction. Hatchery-influenced areas, primarily the upper Salmon River, the Little Salmon River, and the South Fork Clearwater River, were heavily stocked with non-endemic hatchery fish, mostly fry and smolts, during the late 1970s through the mid-1980s. Therefore, present day stocks in hatchery-influenced areas are comprised of remnant endemic stocks, if they still remain, and non-endemic stocks.

Recent management efforts have focused on reducing fishing impacts to juvenile rainbow/steelhead, improving the migration success of hatchery smolts, and participation in regional processes related to management of the hydrosystem. Fishing regulations continue to evolve to provide protection of juvenile steelhead, especially in wild areas. Some type of restrictive regulation now governs all areas managed for native steelhead, except the lower Clearwater River tributaries.

We have investigated methods for reducing residualization and improving the success of migrating hatchery smolts. Research has focused on smolt size-at-release and acclimation.

Although we have been involved in hydrosystem issues for about 30 years, recently our involvement has escalated. We now participate in a myriad of regional forums that address short-term and long-term strategies mostly for improving the survival of smolts through the Columbia/Snake river migration corridor outside of Idaho.

ESA-related tasks now require a substantial administrative effort. We are responsible for "maintaining" ten Section 10 permits, one Section 4d management plan, and at least two Section 7 consultations with NMFS as the issuing agency.

Steelhead Conservation Strategies Under The Oregon Plan for Salmon and Watersheds
Barry McPherson - Oregon Department of Fish and Wildlife

The Oregon Plan for Salmon and Watersheds evolved from Governor John Kitzhaber's Coastal Salmon Restoration Initiative (*CSRI*) that was initially intended to restore the health of watersheds and the salmon populations they supported in all Oregon rivers south of the Columbia River. The initial *Oregon Plan* was completed in March 1997 as a combined, state-

funded, *CSRI* and *Healthy Streams Partnership* with a focus on coho salmon of watersheds south of the Columbia River. The plan was expanded to address steelhead in coastal rivers and the Columbia River Basin in a December 1997 draft titled *The Oregon Plan for Salmon and Watersheds, Supplement I – Steelhead.* Although Supplement I expands the scope of the plan statewide and begins to address the other anadromous salmonid species and a few resident and non-salmonid species, the overwhelming emphasis is on steelhead and on western Oregon watersheds, with the exception of the Willamette Basin above Willamette Falls. The ultimate goal of the plan is to become a statewide, coordinated effort by local citizens to prepare and implement actions that maintain and improve the health of their watersheds with the assistance of government and private partnerships, and with monitoring and scientific review that leads to improvement of the plan over time.

The plan is largely a compilation of the responsibilities and action plans of all state agencies that have any authority over aquatic resources, wildlife habitat, or land use. It also includes measures that certain watershed councils intend to take, and to varying degrees, the Steelhead Supplement includes measures committed to by federal agencies, local governments, SWCDs, Oregon State University, and industries (forest products, electric utilities, and agriculture). Increased enforcement of existing habitat protection and environmental quality laws is an objective, but the cornerstone of the effort is a reliance on voluntary increases in protection/restoration, public/private partnerships, and the use of local watershed councils to assess problems and set for habitat improvement with technical assistance from agencies. Many changes in steelhead hatchery programs had already been implemented to meet ODFW's Wild Fish Management Policy (WFMP), and the Steelhead Supplement commits ODFW to complete and then monitor compliance with WFMP. Beyond the WFMP, several changes in stocking programs and angling regulations for steelhead and resident trout have been made to increase survival of wild steelhead, more changes are being proposed, and monitoring of juvenile and adult steelhead is being increased. Inventories of habitat and juvenile steelhead distribution are also being increased. The Oregon Legislature has approved new funding for some of these activities, and funding from other sources, particularly the federal government, is being sought.

The Oregon Plan for Salmon and Watersheds can be accessed at: www.oregon-plan.org.

ESA Listing of Steelhead in California and the Department of Fish and Game's Response.
Dennis McEwan, California Department of Fish and Game

Of the 15 steelhead Evolutionarily Significant Units (ESU's) identified by the National Marine Fisheries Service (NMFS), six are in California and all of these were proposed for listing under the Endangered Species Act (ESA). Of the six California ESU's, three were listed by NMFS in August 1997: the Southern California ESU as endangered, and the Central California Coast and South-Central California Coast ESU's as threatened. The NMFS listing decision for the Southern California ESU did not include historical steelhead streams south of Malibu Creek in Los Angeles County and specifically excluded non-anadromous forms of coastal rainbow trout. This could prove to be a fatal flaw in the restoration and protection of the anadromous forms given the potentially essential role that the non-anadromous forms play in population persistence in the highly variable, marginal environment of southern California. The listing decision for the other three ESU's (Central Valley, Northern California, and Klamath Mountains

Province) was deferred for six months, and the statutory deadline for decisions was February 9, 1998. NMFS failed to make a decision on this date and, at this writing they have not made a decision for these three ESU's.

The Department of Fish and Game has been actively involved in steelhead conservation and restoration activities since the creation of the Steelhead Management and Restoration Project in 1991. On the south coast (south of San Francisco Bay), there are many streams that still have intact habitat and are well-protected on National Forest lands. The major problem is that much of the stream reaches are inaccessible because of small, impassable dams in the lower reaches. The restoration objective for this area is to provide connectivity of these presently inaccessible stream reaches to anadromous fish. The Department is involved in implementing restoration projects (installation of fishways and fish screens) on several southern California streams to accomplish this. Because of severely restrictive angling regulations placed on anadromous reaches of southern California streams in 1996, there will probably be few additional impacts to angling opportunities resulting from the recent listing of the Southern California ESU. For the two ESU's that were listed as threatened, NMFS has yet to issue a section 4(d) ruling, so there has been no change to state angling regulations. The Department is currently discussing needed regulation changes with NMFS to allow some angling opportunities in these ESU's.

The overriding factor in the decline of natural steelhead populations in the Central Valley is the fact that the aquatic environment has been rendered mostly unsuitable for steelhead due to the loss of 82% to 95% of historical spawning and rearing habitat because of construction of impassable dams at low elevations on all major tributaries. This factor is not addressed in two ongoing, large-scale Central Valley anadromous fish restoration initiatives: the Central Valley Project Improvement Act (CVPIA) and the CALFED program. Over the past two decades, efforts to restore Central Valley anadromous species have focused almost exclusively on chinook salmon, and the dominant management philosophy has been that measures to restore chinook salmon populations will benefit steelhead as well. This philosophy fails to recognize the life-history differences and differing habitat requirements between salmon and steelhead, particularly juvenile rearing habitat requirements. The CVPIA and CALFED programs continue to promote this management philosophy and do not address steelhead restoration specifically, consequently, will most likely not achieve adequate restoration for Central Valley steelhead populations unless changes to the programs are made. Actions to adequately restore Central Valley steelhead must include reestablishing access to former upstream habitat or providing adequate year-round habitat conditions in tail-water habitats below the major reservoirs.

The Department is actively involved in discussions with NMFS regarding the efficacy of listing steelhead populations in the Klamath Mountains Province and Northern California ESU's. In response to the proposed listings, the Department has developed conservation plans for these two ESU's that we believe are adequate to address the declines so that listing will not be necessary. These plans contain four major objectives: 1) reduce recreational harvest and angling-related mortality by implementing more restrictive regulations and closures; 2) operate hatcheries to minimize adverse interactions with natural populations; 3) initiate a monitoring program to assess population status and success of restoration programs; and 4) continue to implement programs and projects to protect and restore degraded habitat. Actions the State has taken so far to implement the conservation plans include:

- Promulgated of angling regulation changes and closures to protect natural stocks in these ESU's (there is no commercial harvest of steelhead in California waters and there is little interception in the commercial salmon fishery).

- Initiation of a program to fin-clip all hatchery steelhead.

- Establishment of new steelhead monitoring and assessment program for the north coast. This program will include 14 new positions, including nine fishery biologists, and will cost an estimated $1.6 million. We are attempting to have this program included in the proposed Governor's budget for the upcoming fiscal year, which begins July 1, 1998.

- The Department will continue with its habitat and watershed restoration programs. However, most habitat protection measures are not within the regulatory authority of the Department, hence will need to be addressed by other state agencies such as the Department of Forestry and Fire Protection (who establish Timber Harvest Practice rules) and the State Water Resources Control Board (who control water rights).

Selective Harvest Techniques and Problems

Session Chair – Bruce Sanford

Hatchery and Wild Fish: Can they coexist? A genetics perspective.
Steve Phelps - Washington Department of Fish and Wildlife

The Washington Department of Fish and Wildlife has been studying the genetic population structure of steelhead since the late 1980's. These genetic data indicate that most of the wild steelhead collections examined were genetically distinct from the primary hatchery strains used for fish management and that substantial genetic structuring exists among the steelhead collections. Our interpretation of the steelhead genetic data is that the bulk of populations still contain native gene pools and that the historical patterns of genetic diversity are still intact. For these results to occur, the reproductive success of hatchery-origin steelhead in the wild has to be poor. These results are consistent with other research such as the Kalama River studies. An unknown is the amount of hatchery-wild interbreeding and the potential depression of stock productivity. Even though there are no direct reproductive success studies in the upper Columbia River, the poor spawning success and diminished survival of the progeny of hatchery spawners could be a substantial factor in the current inability of wild upper Columbia River steelhead to replace themselves.

Hooking Mortality of Juvenile Steelhead
Dan Schill - Idaho Department of Fish and Game

We (with R.L Scarpella) summarize results of past studies that directly compared hooking mortality of resident (nonanadromous) salmonids caught and released with barbed or barbless hooks. Barbed hooks produced lower hooking mortality in two of four comparisons with flies and in three of five comparisons with lures. Only one of 11 comparisons resulted in statistically significant differences in hooking mortality. In that instance, barbless baited hooks caused significantly less mortality than barbed hooks, but experimental design concerns limited the utility of this finding. Mean hooking mortality rates from past lure studies were slightly higher for barbed hooks than barbless ones, but the opposite was true for flies. For flies and lures combined, mean hooking mortality was 4.5% for barbed hooks and 4.2% for barbless hooks. Combination of test statistics from individual studies by gear type via meta-analysis yielded nonsignificant results for barbed versus barbless flies, lures, or flies and lures combined. We conclude that the use of barbed or barbless flies or lures plays no role in subsequent mortality of trout caught and released by anglers. Because natural mortality rates for wild trout in streams commonly range from 30% to 65% annually, a 0.3% mean difference in hooking mortality for the two hook types is irrelevant at the population level, even when fish are subjected to repeated capture. Based on existing mortality studies, there is no biological basis for barbed hook restrictions in artificial fly and lure fisheries for resident trout. Restricting barbed hooks appears to be a social issue. Managers proposing new special regulations to the angling public should consider the social costs of implementing barbed hook restrictions that produce no demonstrable biological gain.

Mortality of rainbow trout Oncorhynchus mykiss caught and released by anglers using number 8 worm-baited hooks was investigated during 1990-1991 at the Hagerman (Idaho) State Fish Hatchery and within a 2-km segment of Badger Creek, Idaho. Cutting the line on deep-hooked rainbow trout reduced postrelease mortality by 36% in the hatchery and 58% in the wild trout, and 60% of the wild rainbow trout that had been hooked deeply and released by cutting the line shed hooks during the same periods. There were no significant differences ($P>0.05$) in condition factors among surviving control, light-hooked, and deep-hooked hatchery rainbow trout. Seventeen percent of 281 wild rainbow trout on Badger Creek were hooked in the gills or esophagus. Overall, hooking mortality was estimated to be 16% for wild rainbow trout. No significant differences in the incidence of deep hooking were observed between small (<200 mm total length) and large (≥200 mm) wild rainbow trout ($P>0.05$). The frequency of deep hooking was associated with the type of stream habitat where hooking occurred ($P<0.02$) and was higher for catches on a "slack like" than a "tight line" ($P<0.001$). These data suggest that stream locations where bait anglers actually catch fish and the general habitat characteristics of a stream could influence bait-related hooking mortality. Other factors that could influence the compatibility of bait fishing and special-regulation fisheries for salmonids include natural mortality rates, the degree of participation in such fisheries by bait anglers, and the proportion of bait anglers that cut the leader on deep-hooked fish prior to release. Depending on management goals, bait fishing may be compatible with special-regulation fisheries for salmonids in more situations than is commonly believed.

Hooking Mortality of Adult Steelhead

Dan Rawding - Washington Department of Fish and Wildlife

In the 1980's fishery managers in Washington, Oregon, Idaho, and British Columbia introduced wild steelhead release (WSR) regulations to protect at risk wild steelhead stocks from overharvest. Since that time wild steelhead populations continued to decline and presently the majority of wild steelhead stocks in the Pacific Northwest are managed under WSR. There is an indirect mortality associated with the catch and release of wild steelhead. It has become increasingly important for fishery managers to quantify losses for depressed wild stocks in catch and release fisheries. A method will be presented to determine the total sport fishing mortality to wild steelhead under WSR fisheries. Wild winter steelhead sport fish mortality rates in Lower Columbia River tributaries are estimated to be 1% to 3% of run size. Although not directly estimated it is likely that wild summer steelhead sport fish mortality rates are higher due to risk factors such as warmer water temperature and higher interception rate.

Harvest Rates and Sustainable Wild Populations

Mark Chilcote - Oregon Department of Fish and Wildlife

The long-term influence of a variety of different harvest rates on wild fish abundance was predicted for 26 populations of steelhead in Oregon. Using recruitment relationships for each of these populations (developed from historical spawner and recruit data) it was shown that

for a relatively healthy stock (winter steelhead in the North Umpqua River), harvest rates up to 45% were sustainable. In contrast, for a very unhealthy population (upper South Santiam winter steelhead) even light harvest rates in the range of 15% were forecast to be unsustainable. A second analysis consisted of a sequence of PVA model runs performed for 8 potential harvest rates from 0% to 70%, for 26 wild steelhead populations. The probability of persistence after 100 years for most populations (19 out of 26) was 100% when model run harvest rates were set to less than 30%. It was not until harvest rates exceeded 60% that a majority of the populations were forecast to have less than a 50% probability of persistence. From this analysis it was concluded that most wild steelhead populations can be safely exposed to harvest rates of up to 30% without risk to sustainability or persistence. The exceptions are populations that for reasons unrelated to harvest set, are at risk. These exceptions, of which wild steelhead in the upper South Santiam is one, are at a high risk of extinction even when harvest rates are scaled back to zero (no fishing).

Steelhead Harvest in California

Terry Jackson - California Department of Fish and Game

The Steelhead Trout Catch Report-Restoration Card (Report Card) program began collecting angling effort and harvest data in 1993 for California steelhead. California had not provided steelhead harvest estimates prior to 1993. Revenue from sales of the Report Card provides the only funding source in California specifically for steelhead projects to monitor, restore and enhance California's steelhead resources. With the recent ESA events, analyses of steelhead sport harvest has become critical for evaluating steelhead populations while attempting to provide some steelhead harvest opportunity. Evaluation of angler success and harvest alternatives, such as daily and annual bag limits, were conducted for sport harvest regulation changes for the ESA. Comparisons with other streams utilizing data collected by other programs, such as creel census, angler box surveys and run counts, provides useful information when evaluating the potential effects of angling on steelhead populations in regard to regulations.

Contributed Papers on Current Steelhead Research

Session Chair: Doug Jones

Karluk River Steelhead: Summary of Six Years of Research on Spawning Population Size and Fishery Mortality

Len Schwarz - Alaska Department of Fish and Game

Spawning population size was estimated for Karluk River steelhead from 1992 throught 1997. Steelhead were captured in the river using hook and line and marked with Floy tbar tags during April prior to spawning. All emigrating fish were examined for the presence of a tag at the Karluk River salmon weir, which operates mid-May through September. This situation allowed for abundance to be estimated with a closed population estimator (Chapman's modification of the Peterson Estimator) using April tagging as the marking event and the weir operation as the recapture event. Population sizes ranged from 4,100 to 10,800.

Sport fishing mortality was documented during the autumns of 1994 and 1995 through the use of creel census. Results were almost identical with harvests of approximately 30 steelhead and a release of 3,000 fish. Angler effort was approximately 600 angler days from October 1 through November 10.

Subsistence harvests were documented from the villages of Karluk and Larsen Bay through household surveys conducted from 1991 through 1994. Harvests averaged 50 steelhead from Karluk Village and 340 fish from Larsen Bay Village.

The incidental harvest of steelhead in the commercial salmon fishery was examined from 1991 through 1994. Harvests averaged 360 steelhead, ranging from 41 to 705 fish.

In addition to the information on spawning population size and fishing mortality, the following information on life history was collected: (1) the Karluk River steelhead spawning population is dominated by initial spawners, averaging 84%; (2) spawning mortality averaged only 44%; (3) the dominant age classes were 2.2 and 2.3, accounting for 95% of the population; (4) some spawning was documented in January, which is unique; and (5) the sex ratio for initial spawners alternated each year.

Relationship between kelt and spawner abundance in steelhead trout (*Oncorhynchus mykiss*) of the Karluk River, Alaska.

Robert N. Begich - Alaska Department of Fish and Game
Dr. George LaBar, Department of Fish and Wildlife Resources, University of Idaho

From 1992 through 1997 a mark-recapture experiment conducted at the Karluk River, Alaska utilizing a pre-spawn marking event in conjunction with a post-spawn weir census of emigrating steelhead kelts as the recapture event was used to estimate spawning population size and spawning survival. The estimated abundance of spawning steelhead ranged from 4,107 (SE = 134) fish to 10,803 (SE = 347) fish. The number of emigrating kelts counted through the weir ranged from 2,613 to 6,826 fish. Spawning survival was estimated from pre-spawn capture to post-spawn weir emigration. From recaptures of marked fish the estimated six year mean of spawning survival was 56% for all steelhead, 55% for females, and 52% for males.

Logistic regression modeling of mark-recapture data was used to identify biotic factors significantly related to steelhead spawning survival and to estimate the probability of surviving spawning. Model probabilities of spawning survival were applied to kelt data collected at the weir during each emigration to estimate spawning population size for each year. Comparison between spawning population estimates derived from mark-recapture methods and logistic modeling methods revealed that annual spawning survival and kelt emigrations are population processes which can be used to assess spawning stock status.

Biennial survival of adult repeat spawning steelhead was estimated from tagged/marked recaptures at the Karluk River weir. For the 1992 through 1995 populations of emigrating steelhead kelts the mean biennial survival from time of emigration (marking at the weir) to a second successful emigration (recapture at the weir) was 23.8% for all steelhead, 27.8% for females, and 18% for males.

Migration Behavior and Distribution of Steelhead with Radio Transmitters in the Columbia and Snake Rivers

Ted Bjorn, Lowell Stuehrenberg, Rudy Ringe, Ken Tolotti - Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho and Fish Ecology Division, NW Fisheries Science Center

Adult steelhead were outfitted with radio transmitters at John Day Dam in 1993 and at Bonneville Dam in 1996 and 1997 to study their migrations and passage success at dams in the Columbia and Snake Rivers. More than 800 steelhead were released with transmitters in each of the three years. Fixed-site antennas and radio receivers were set up at most dams and major tributaries to monitor fish passage. Fish were also located by mobile trackers, and were recaptured in fisheries, at hatcheries, and at weirs in tributary streams.

In 1997, 82% of the 531 steelhead tagged during the June through August period (mostly 'A' group) had fin clips (hatchery fish). Through mid-February, 123 (23%) of the A group fish had been recorded passing Lower Granite Dam, and 197 had been recaptured and reported to us. Of the 197 recaptured fish, 28 had been recaptured at hatcheries or weirs, and 159 (30%) had been recaptured in fisheries, 52% tribal and 48% sport, with 69% of the sport catch downstream from Lower Granite Dam and 31% upstream.

Of the 444 steelhead tagged during September and October 1997 (mostly 'B' group), 90% were hatchery fish, 34% were recorded at Lower Granite Dam through mid-February, and 33% had been recaptured. Of the 146 recaptured fish, 18 were recaptured at hatcheries and weirs and 125 in fisheries, 30% tribal and 70% sport, with 44% of the sport catch downstream from Lower Granite Dam and 56% upstream.

Many steelhead destined for upriver tributaries enter lower Columbia River tributaries on their way upstream. Of 300 steelhead recorded at Lower Granite Dam in 1996, more than half entered one or more tributaries before continuing upstream. In 1997, 56% of the 269 steelhead recorded at Lower Granite Dam entered the Little White Salmon, White Salmon, and/or Deschutes rivers during their migration through the lower Columbia River. Mean times to migrate from release downstream from Bonneville Dam to Lower Granite Dam were 48 d for all 269 fish, 42.8 d for the 118 steelhead that did not enter the three lower tributaries, and 53.4 d for the 115 fish that entered one of the tributaries.

Genetic Differentiation of Steelhead (*Oncorhynchus mykiss*) on Kodiak Island, Alaska

T. Chatto, S.J. Miller, and W.J. Spearman - USFWS Kodiak-NWR and Fish Genetics Laboratory

Steelhead populations on the Kodiak Archipelago in the Gulf of Alaska may represent geographically isolated and genetically unique resources. A total of 16 rivers within the Archipelago support populations of steelhead, 8 of which lie within the boundaries of the Kodiak National Wildlife Refuge. One of these, the Karluk River, is the largest steelhead producer in South-central and Western Alaska. In 1997 a study was initiated to begin building a genetic baseline for Kodiak Island, evaluate population substructuring, and recommend measures to conserve the genetic diversity of steelhead populations on the Refuge. Pectoral fin samples were collected from a total of 167 adult steelhead representing the Karluk, Ayakulik and Sturgeon Rivers using nonlethal sampling methods. Samples from each drainage were pooled and genetic variation was assessed based on restriction-site analysis of the cytochrome-b segment of the mitochondrial DNA. Seven composite genotypes were identified and used to characterize stock relationships. Tests of homogeneity using the G-test were significantly ($p \leq 0.05$) different for all pairwise comparisons between the steelhead populations of the Karluk, Ayakulik and Sturgeon rivers. Currently, genetic markers for the nuclear genome are being evaluated for their utility in defining stock relationships. Work will be initiated in 1998 to classify other steelhead populations on the Refuge. These preliminary results suggest that: 1) a management plan to identify long term conservation goals for these populations is needed, and 2) strategies to reverse any population declines will need to focus on conserving baseline levels of genetic diversity.

Questions About Overwinter Mortality Among Skeena Summer Steelhead

Bob Hooton, Craig Wightman, and Rob Bison - BC Ministry of Environment

The traditional approach to estimating the abundance of spawning summer steelhead in Skeena River tributaries has been to use the estimated number of steelhead entering the system from tidewater and subtracting mortalities from various upstream fisheries. There has been little, if any, attention paid to non-fishing mortality which may occur anytime after freshwater entry. Fishing mortality is generally confined to the pre-winter period although some first nations harvest occurrs in a few isolated areas in early spring. The normal assumption is that all fish which are not caught by someone in the fall spawn the following spring. Radio telemety data from 13 different studies on Skeena summer steelhead over a period of 18 years suggest there is a substantial loss of fish between fall and the peak spawning period in the following May. However, it is impossible to detect how much of the observed losses or aberrant behaviour may have been due to capture and/or tagging and/or harboring an orally inserted radio tag within the body cavity for up to ten months. Observed losses to spawning populations varied between times, locations and tagging methods and ranged from only about 2% to as high as 56%. Such reductions in spawning stocks are highly significant relative to achieving management goals heretofore dictated by focusing only on fishing mortality. Further studies of this emerging issue are proposed.

Radio Telemetry Studies of Steelhead on the Kamchatka Peninsula

Mark Chilcote and Randy Reeve - Oregon Department of Fish and Wildlife

In 1996 a radio telemetry study was initiated to study the general migration patterns and potential overwintering location of steelhead in the Utkholok River, Kamchatka. In 1997, this study was continued in the Utkholok and expanded into a previously unexplored steelhead river the Saichik. In both years a portion of the fish did not migrate upstream more than 2 Rkm from their initial tagging location in the lower Utkholok River (Rkm 16) during the fall observation period. However, in 1997 at least one-half of the tagged fish continued slowly on an upstream migration over the six-week monitoring period. Observations in the Saichik River suggested a different pattern, with only one of the eight radio tagged steelhead failing to migrate a considerable distance upstream. The apparent difference in migration behavior between the Utkholok and the Saichik steelhead may be due to innate differences in hydrology and channel morphology between to basins.

The Structure of Steelhead Populations in Kamchatkan and North American Water Bodies

Ksenia A Savvaitova, Kirill V. Kuzischin, and Dimitri S. Pavlov - Department of Ichthyology, Moscow State University

The structure of steelhead populations throughout the range of *Oncorhynchus mykiss* in Asia and North America are various. Steelhead populations of "ocean maturing type" predominate in North America. In the rivers of Western Kamchatka "stream maturing type" prevails. Spawning migration and spawning time of American steelhead are longitudinal. In some rivers steelhead migrate throughout the year. In Kamchatka water bodies steelhead migrate during a 2.5-3 month period and spawn no more than 2-3 weeks.

In America and Kamchatka the intrapopulational structure of local steelhead stocks are also not identical. In North America as a rule local populations are presented by anadromous steelhead. Sometimes residual fishes exist in the frame of one population. In some rivers "half-pounders" are known. In rivers of Western Kamchatka local populations consist of typically-anadromous, coastal-anadromous, and riverine groupings. Recently "half-pounders" were discovered, but few in number.

The differences between Kamchatkan and North American steelhead probably depend upon the different environmental conditions in Kamchatkan and North American rivers. Kamchatkan rivers cover with ice in late October to early November, whereas steelhead rivers in North America are situated in a zone of moderate climate and are free of ice throughout the year. The features that characterize the structure of local populations (age structure, age at smoltification, duration of ocean period, age at maturation, repetition of spawning, growth rate, etc.) varies in the same manner in both North America and Kamchatka and depends on environmental conditions, sometimes connected with the geographical position on the river.

The Diversity of Pacific Trouts in Kamchatkan Water Bodies

Ksenia A Savvaitova, Kirill V. Kuzischin, and Dimitri S. Pavlov - Department of Ichthyology, Moscow State University

Until very recently the only trout known in Kamchatkan water bodies was *Oncorhynchus mykiss*. In 1994 and 1996 in the Sedanka River (Tigil River basin, Kamchatka) specimens with features of American cutthroat trout, *O. clarki*, and redband trout of was *O. mykiss* were discovered. The phenetic diversity of Kamchatkan trouts is higher than was supposed earlier. It can be pictured as a series of forms: trout , similar to the coastal cutthroat trout *O. clarki clarki*; trout, similar to the westslope cutthroat *O. clarki lewisi*; trout, similar to the subspecies of redband trout of *O. mykiss*; coastal rainbow *O. mykiss irideus* or Kamchatkan *O. mykiss mykiss*. Between all these forms there are transitional types - individuals with various combinations of unclearly expressed features which are difficult to assign with full confidence to this or that form.

At the present time it is not possible to explain the reasons for the existence of the "series of trout forms" in the Sedanka River. It is possible that here there is a zone of second intergradation between *clarki* and *mykiss*. In the zone of their contact the hybrid population with a high level of individual variation exists. It is also probable that the Kamchatkan trout forms belong to populations of one species. In this case their diversity is the result of local population variability.

New Kamchatkan trouts have primitive features: e.g., cutthroat mark and basibranchial teeth. It is not excluded that these forms belong to relict populations of the species, which have diverged less from one another than American ones, and that North-East Asia was the place where evolution of the whole group began.

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