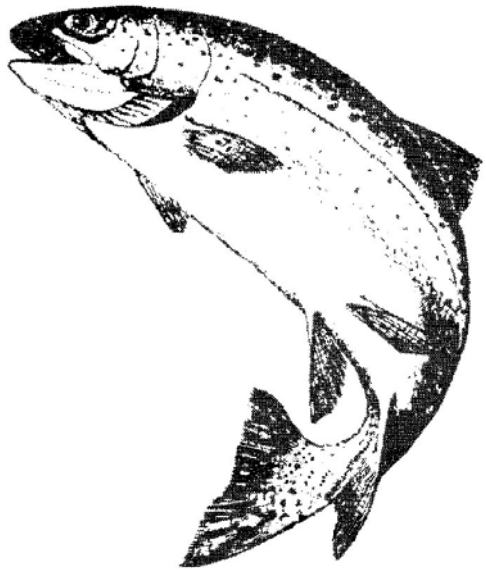
SUMMARY OF
THE TENTH

PACIFIC COAST STEELHEAD MANAGEMENT MEETING



March 7-9, 2006
Fort Worden State Park and Conference Center
Port Townsend, Washington

Sponsored by:

Pacific States Marine Fisheries Commission

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U.S. Fish and Wildlife Service

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[1] Abstract not submitted.

Pacific Coast Steelhead Management Workshop
March 7-9, 2006
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I. Introduction

The Pacific States Marine Fisheries Commission, with partial support from the U.S. Fish and Wildlife Service Sport Fish Restoration Program, sponsored the tenth workshop on steelhead (*Oncorhynchus mykiss*) management. The session, held in Port Townsend, Washington, was attended by some 80 Pacific Coast fisheries managers, researchers and other interested parties from the states of Alaska, Washington, Idaho, Oregon, and the province of British Columbia.

Topics for the workshop included:

- the status of stocks and the Endangered Species Act
- steelhead age structure and repeat spawners
- the Pacific Ocean Shelf Tracking Project
- hatchery reform and implications for steelhead management
- environmental variability in stock recruit models
- resident and anadromous life history forms

The workshop was structured as a series of individual presentations by topic area, followed by a panel discussion and/or questions from the audience. The meeting allowed steelhead managers and researchers on a coastwide basis to discuss common problems and to share insights into possible solutions. The following abstracts were prepared by the speakers and are a short summary of their presentations.

In addition, a series of contributed papers covered winter steelhead life history; hatchery steelhead accounting above Lower Granite; California catch data; effects of hatchery strays; and conservation of divergent populations in Hood River, Oregon. Abstracts of those contributed papers are also included in this summary.

Members of the Workshop Steering Committee were:

Katie Perry, State of California
Roger Harding, State of Alaska
Bill Horton, State of Idaho
Stephen Phillips, Pacific States Marine Fisheries Commission
Rhine Messmer, State of Oregon
Nick Gayeski, Washington Trout
Bob Leland, State of Washington
David Welch, POST
Bob Hooten, Province of British Columbia, Canada

II. Steelhead Stock Status Review by Jurisdiction

Session Chair: Roger Harding, Alaska Department of Fish and Game

A. California

Katie Perry, California Department of Fish and Game

California has six Distinct Population Segments (DPS) of steelhead as determined by the National Marine Fisheries Service (NMFS). Four of the six are listed as threatened (Northern California, Central Valley California, Central California Coast, and South-Central California Coast), one as endangered (Southern California) and one was determined to not warrant listing (Klamath Mountains Province). The two northern DPSs include summer, winter, and half-pounder runs of steelhead, while the remaining DPSs include only winter steelhead.

Monitoring efforts in California are inadequate to properly assess population abundance and trends and conclusions about stock status are tenuous. Only a few streams are monitored for adult returns, and where we have juvenile abundance or density data we do not know how these data relate to the status of the adult populations. Based on the limited data available it appears that California's steelhead populations range from stable to declining.

The Department of Fish and Game is currently developing a Coastal Salmonid Monitoring Plan with assistance from NMFS. In addition, two separate but coordinated monitoring planning efforts will be initiated this spring that will focus on steelhead monitoring and adult Chinook salmon escapement monitoring in California's Central Valley.

B. Oregon

Rhine Messmer, Oregon Department of Fish and Wildlife

The Oregon Department of Fish and Wildlife has recently completed a stock status assessment of Oregon's 79 steelhead populations as part of the development of the Oregon Native Fish Status Report (2005) and continued implementation of Oregon's Native Fish Conservation Policy. These steelhead populations are comprised of 49 winter steelhead populations grouped into four Species Management Units (SMUs) and 30 populations of summer steelhead which are grouped into seven SMUs. The report describes the current conservation status of Oregon's steelhead SMUs based on interim criteria defined in Oregon's Native Fish Conservation Policy. These criteria include:

1. Existing Populations. Criteria: At least 80% of historical populations are still in existence (i.e. not extinct) *and* not at risk of extinction in the near future.
2. Habitat Use Distribution. Criteria: Naturally produced members of a population occupy at least 50% of the historically-used habitat in at least 3 of the last 5 years for at least 80% of the existing population.

3. Abundance. Criteria: Number of naturally-produced fish is greater than 25% of average levels in at least 3 of the last 5 years for at least 80% of existing populations.

4. Productivity. Criteria: Population replacement rate for at least 80% of existing populations is at least 1.2 naturally-produced adult offspring per parent in 3 of the last 5 years when total abundance was less than average returns of naturally produced fish.

5. Reproductive Independence. Criteria: 90% or more of spawners are naturally produced in at lest 3 of the last 5 years for at least 80% of existing populations.

6. Hybridization. Criteria: Hybridization with non-native species is rare or nonexistent in 3 of the last 5 years for at least 80% of the existing populations.

The purpose of the Native Fish Conservation Policy (NFCP) is to ensure the conservation and recovery of native fish in Oregon. The NFCP provides a basis for managing hatcheries, fisheries, habitat, predators, competitors, and pathogens in balance with sustainable natural fish production. NFCP implementation priorities and actions will, in part, be based on assessments of current conservation risks identified in this report. The Oregon Native Fish Status Report summarizes risk assessments completed for native salmon, steelhead, trout, and selected sensitive species using the NFCP interim criteria. Risk, as used in the stock status report, refers to the threat to the sustainability of a unique group of populations in the near-term (5-10 years).

The interim criteria are designed to provide temporary guidance to ensure the conservation of native fish prior to completion of more detailed conservation plans for each species or group of populations. Risks evaluated based on interim criteria refer to the immediate possibility that a unique group of populations may become extinct or fall to low levels where future prospects for recovery are damaged in the interim until an effective conservation plan can be developed and implemented. Interim criteria do not describe long-term conservation risks of continuing downward trends, increasing threats or extended intervals of unfavorable environmental conditions. Long-term risks will be considered in conservation plans.

Winter Steelhead Status

Oregon's winter steelhead are found in a wide number of small to moderate-sized coastal, lower Willamette, and lower Columbia streams. SMUs include the Rogue, Coastal, Willamette and Lower Columbia River SMUs.

The coastal SMU consists of 23 populations and is classified as "Potentially At Risk" due to hatchery fish influence in some basins. The basins that fail the Reproductive Independence criteria include the Necanicum, Lower Nehalem, Wilson, Siletz, Yaquina, Alsea, Coos, Coquille and South Coquille. No coastal steelhead populations are listed under the Endangered Species Act (ESA) although Oregon's coastal winter steelhead were listed Candidate in 1998.

The Rogue winter steelhead SMU consists of eight populations. The SMU passed all interim criteria and therefore, is classified as "Not At Risk". Rogue SMU winter steelhead are not listed under the ESA (determined to be not warranted in 2001).

The Lower Columbia winter steelhead SMU consists of nine populations. Although data is limited for several populations in this SMU (Youngs, Big, Clatskanie, and Gorge populations), precautionary application of the interim criteria treats inconclusive or insufficient data as failure in the assessment of risks to the SMU. Therefore, the SMU failed the Abundance, Productivity and Reproductive Independence criteria and is classified as "At Risk". The Lower Columbia winter steelhead SMU is listed as Threatened under the ESA (1998 listing).

The Willamette winter steelhead SMU consists of nine populations in tributaries to the Willamette River above Willamette Falls. The SMU is listed as "Potentially At Risk" due to several of the steelhead populations not meeting the Distribution criteria. These populations include Rickreall and the North and South Santiam which all have passage blocked by dams, and therefore reduced available habitat and reduced habitat quality. Steelhead in the Willamette SMU are listed as Threatened (1999) under the ESA.

Summer Steelhead Status

Oregon's summer steelhead naturally occur in some coastal basins and in many of the larger Columbia River tributaries from Hood River upstream to the Snake River.

The Coastal summer steelhead SMU consists of populations in the Siletz and the North Umpqua basins. The SMU is listed as "Potentially At Risk" due to low Productivity for the Siletz River population and failure of Reproductive Independence for the North Umpqua population. Coastal summer steelhead are not listed under the ESA, but were listed as Candidate species in 1998.

The Rogue summer steelhead SMU passed all interim criteria and is therefore classified as "Not At Risk". The Rogue SMU includes the Middle and Upper Rogue summer steelhead populations. Abundance of these populations is annually monitored by counts at Gold Ray Dam. Rogue summer steelhead were found to be Not Warranted for ESA listing in 2001.

The Lower Columbia summer steelhead SMU consists of only the Hood River population. This SMU is listed as "At Risk" due to failure to pass the Abundance, Productivity and Reproductive Independence criteria.

The Mid Columbia summer steelhead SMU consists of 11 historic populations between The Dalles Dam and the Snake River. The SMU only met three of the six interim criteria and is listed as "At Risk". The Deschutes River summer steelhead population failed Abundance, Productivity and Independence criteria. Many of the Mid Columbia summer steelhead populations, including the Deschutes, are impacted by stray hatchery summer steelhead, many of which originate from hatchery programs in the

Snake River Basin. The Mid Columbia summer steelhead SMU was listed as Threatened under the ESA in 1999. A draft recovery plan for Oregon Middle Columbia River summer steelhead was completed in January of 2006.

The Snake summer steelhead SMU is made up of five populations from streams flowing into the Snake River below Hells Canyon Dam. This SMU is classified as "Not At Risk". The Upper Grand Ronde population did not meet the productivity criterion due to low resiliency in this population. The Snake River SMU was listed as Threatened under the ESA in 1997.

Klamath Steelhead SMU consists of two populations in the Klamath basin upstream of the Oregon/California border. This SMU is listed as "At Risk" due to failure to meet five of the six interim criteria (only met the Hybridization criteria). Construction of dams on the Klamath River without passage have extirpated the Klamath Lake steelhead population(s).

Summary

The Oregon Native Fish Stock Status Report (Public Review Draft) and Volume II – Methods and Population Results, completed in August of 2004 provides the most current assessment of Oregon's steelhead populations. These reports can be viewed at http://www.dfw.state.or.us/fish/ONFSR/. ODFW is currently working on the final draft of this report which should be available later this year. Conservation Plans will be developed following the completion of the Stock Status Report and will illustrate a range of options for recovery strategies, fisheries and the responsible use of hatchery produced fish.

The purpose of the NFCP is to ensure the conservation and recovery of native fish in Oregon. This recovery is not only focused on ESA recovery requirements but also includes meeting broader ecological, social and cultural benefits.

C. Washington

Ann Blakley, Washington Department of Fish and Wildlife

Steelhead stock identification and status assessment was conducted in 1992 and revised in 2002-2006 by WDFW and many Washington State treaty tribes as part of the Salmonid Stock Inventory (SaSI). Numbers of populations have changed as new information, particularly from genetic analyses, has led to refinements in the stock list. Status is based on trends in estimates of abundance for a stock, including measures of spawner abundance, juvenile abundance and, decreasingly, harvest. Status is rated as healthy, depressed, critical, unknown or extinct. Healthy status means that there is no consistent negative trend in abundance, that stock goals are generally being met and that numbers of fish are consistent with potentially available habitat quantity and quality and are within the range of inter-annual variation observed for the stock. Depressed or critical status means that there is a negative trend in abundance, or that numbers of fish are below levels expected from the potentially available habitat and that goals are

generally not being met. The biological significance of a depressed rating is that natural production has been reduced but probably not to the level where permanent genetic damage to the population has occurred. A critical rating reflects more a severe decline in natural production and means that permanent genetic damage is likely to occur or has already occurred. Unknown status means that there are no data for a stock or that data exist but are inadequate to rate stock status (e.g. too few years of data or poor quality data). Extinct status is reserved for populations whose presence was well documented but which is no longer present in its historic range.

In 1992, 141 steelhead stocks were identified. Thirty-six were rated healthy, 44 were rated depressed, one was rated critical, 60 were rated unknown, and none were rated extinct. In 2002-2006 137 stocks were identified. Twenty-eight were rated healthy, 38 depressed, one critical, 66 unknown and none were rated extinct. Stocks were examined by region within Washington. Steelhead populations are faring far better on the Washington Coast than in Puget Sound or the Columbia and Snake River Basins. The reasons for this difference are not clear.

Of seven steelhead ESUs in Washington, four [or five if Puget Sound steelhead are listed] have been listed as threatened under the federal Endangered Species Act: (Puget Sound?), Lower Columbia River, Mid-Columbia River, Snake River Basin and Upper Columbia River. Steelhead in the Puget Sound, Olympic Peninsula and Southwest Washington ESUs are not listed.

D. Idaho

Bill Horton, Idaho Department of Fish and Game

Snake River steelhead status fluctuates with migration corridor habitat and flow conditions annually. Idaho historically produced about 55% of the total summer steelhead in the Columbia River basin. An average of 70,000 wild adult summer steelhead entered the Snake River during the 1960s, based on Ice Harbor Dam counts. During this period, steelhead were the most numerous anadromous fish returning to the Snake River Basin. The documented 30 year decline of Snake River steelhead led to their listing as threatened in October 1997, pursuant to the federal Endangered Species Act. Development of the Federal Columbia River Power System (FCRPS), particularly the four dams and reservoirs on the Lower Snake River, is considered to be the primary factor in Snake River steelhead decline.

The majority of steelhead entering the Snake River return to Idaho. About 60 % of the historical steelhead habitat in Idaho is still available, primarily in the Salmon and Clearwater River drainages. About 30 % of Idaho's existing steelhead habitat is included within designated wilderness or wild and scenic river corridors. Because approximately 69 % of the lower Snake River basin is comprised of lands within the jurisdiction of the federal government, most of the steelhead spawning and rearing habitat in Idaho is federally managed.

During the 1990s, the naturally-produced steelhead run, as counted at Lower Granite Dam (uppermost Snake River dam), averaged only 11,900. This was an 83 % decline from the 1962-70 period. The 1995-99 average was even worse at 8,200 naturally-produced adult steelhead counted at Lower Granite Dam. However, some positive change has occurred in the status of Idaho steelhead since the start of the new century. From 2001-2005, the counts have improved sharply to an average of 31,000, likely because of improved migration and ocean conditions.

For Idaho management purposes, natural and hatchery-produced steelhead are classified as A-run and B-run groups. Naturally-produced steelhead are further defined by production lineage as "wild" (endemic) or "natural" (non-endemic or hatchery-influenced). B-run steelhead in the Columbia River return exclusively to Idaho. They are characterized by later freshwater entry and larger adult size at age with a predominantly two-ocean return.

Wild or naturally-produced A and B index groups at Lower Granite Dam averaged 6,400 and 1,800 adult steelhead during the 1995-99 period, demonstrating the especially critical status of B-run steelhead. Parr density information generally reflects the poor adult returns counted at Lower Granite Dam. From 2001-05, the A-run index rebounded to nearly 21,000 per year, and the B-run index rose to about 6,500 for those years, which is more than three times the late 1990's values for both groups.

There is a mix of natural and hatchery steelhead production strategies in Idaho, ranging from wilderness genetic refugia to large-scale hatchery smolt programs. Idaho Department of Fish and Game estimates the statewide accessible habitat could produce at least 4 million steelhead smolts. Areas managed as wild steelhead include expansive contiguous habitat: the Lochsa and the Selway river drainages of the Clearwater River, and the Middle Fork and South Fork drainages of the Salmon River. A few smaller tributaries are also included. Much of the wild steelhead refugia habitat is in areas designated as wilderness or wild and scenic river status.

Since the 1960s, the composition of the steelhead run entering Idaho has changed. The proportion of hatchery origin steelhead has steadily increased due to declining returns of natural fish and development of hatcheries. During 1965-69, the Snake River steelhead run was essentially 100% wild. From 1975-79, the steelhead run at Lower Granite Dam averaged 59 % naturally-produced fish and from 1985-89, the run averaged 24 % naturally-produced fish. From 1995-99, the run slipped further to an average of 11 % naturally-produced steelhead. In the last five years, the natural steelhead have rebounded slightly to comprise about 16 % of the total steelhead production above Lower Granite Dam.

All steelhead hatcheries in Idaho were developed during the last 35 years as mitigation for federal and private hydropower production. IDFG has utilized steelhead smolt production almost exclusively to support sport harvest opportunity for hatchery steelhead in selective fisheries. Steelhead harvest declined from about 20,000 wild steelhead annually in the 1950s and 1960s to near 10,000 as wild fish numbers

plummeted in the 1970s, and we closed sport fishing some years. Selective fisheries were implemented in the late 1970s. Legal wild fish sport harvest was terminated with the advent of mass marking (adipose fin-clip) in the mid-1980s. Harvest increased to an average of 48,900 hatchery steelhead during the last 10-year period. Use of hatchery smolts for steelhead supplementation had been limited to small-scale research, but has increased in the last few years to about 15 % of the hatchery smolts being released to return hatchery adults to production habitat.

The future of steelhead in Idaho and the Snake River Basin will be defined by improvement in smolt-to-adult return rates (SAR). Egg-to-smolt survival, particularly in wild fish areas, has probably not declined significantly from the 1960s. Currently, SARs are not sufficient for consistent replacement. National Oceanic and Atmospheric Administration Fisheries personnel have indicated that naturally-produced Snake River steelhead are at significant risk of extinction. For migratory years 1990-2001, SARs ranged from 0.1% to 3.1% for naturally-produced juvenile steelhead tagged with Passive Integrated Transponder tags and detected as adults at Lower Granite Dam. The estimated number of naturally-produced steelhead smolts for the Snake River Basin has been less than a million since 1989. So the carrying capacity of Idaho's habitat hasn't been reached in many years and the 2% to 6% SARs necessary for consistent replacement are not being attained, at least on a regular basis, either.

E. British Columbia

Bob Hooten, BC Ministry of Environment

Steelhead are distributed along the entire 1200 km coast of British Columbia, the coastal islands and all the major Pacific drainages arising in the interior of the province. Depending on the definition of a stock there are between 400 and 630 that fall into one of three categories – winter steelhead, coastal summer steelhead and interior summer steelhead. Winter steelhead dominate at approximately 85 % of all stocks while interior summer steelhead and coastal summer steelhead comprise 12% and 3% respectively of the aggregate stock picture. The estimated abundance of the province's wild steelhead resource is also dominated by winter steelhead at 66% with interior summer fish at about 26% and coastal summers at 8%. A review in 2002 indicated that among all stocks in the province only 33 were estimated to exceed 500 fish and only 18 more than 1000. Hatchery steelhead production is confined to the southwest corner of the province with one exception. The contribution of hatchery steelhead is significant in terms of total provincial angling effort and catch but not in terms of the number and location of streams stocked. Stock status is monitored through a variety of methods ranging from gillnet test fisheries and fishwheel operations in the lower reaches of three major Pacific drainages, resistivity counters in five significant index streams, snorkel counts in more than two dozen smaller south coast streams and annual fry abundance monitoring in another 5-10 streams. A 30 year program on the Keogh River on northern Vancouver Island provides the province's only complete data set on smolts out and adults back. The generalized picture for British Columbia indicates a south north gradient in abundance and stock health. Southern stocks continue to be depressed with some on the brink of extirpation. The central coast of the province remains as a

transition zone between the extreme conservation concern zone (<10% of carrying capacity) to the south and the routine management zone (>33% of carrying capacity) to the north. A northward creep of depressed abundance is evident. Reduced freshwater capacity linked directly to ongoing "development" pressures combined with a depressed ocean productivity regime continues to limit steelhead abundance, with or without angling. Despite the bleak pattern evident over most of the past decade, in-season observations for the current winter steelhead season may herald a mild reversal of the trend in southern BC. Managers of the day are increasingly challenged by competing uses of habitat, by steadily increasing angler efficiency that creates an illusion of abundance, by the inescapable fact steelhead are low on the political priority list, and by the mythology surrounding the capacity of fish culture to replace nature. It is suggested the future of angling rests with quality, not quantity.

F. Alaska

Anthony Crupi, Alaska Department of Fish and Game, Division of Sport Fish, Douglas, Alaska.

Steelhead *Oncorhynchus mykiss* are found in coastal streams of Alaska from Dixon Entrance in Southeast Alaska, north through the Gulf of Alaska, to the Alaska Peninsula in Southwest Alaska. The number of documented streams containing steelhead decreases through the north and westward distribution of this species. The length of steelhead streams documented in Alaska's Anadromous Waters Catalog totals 4,202 km with over 63% (2,662km) located in Southeast Alaska. Only about 4% of the total km of catalogued anadromous waters in Alaska are known to contain steelhead. The harvest of steelhead by sport anglers in Alaska has declined to an average of 495/year while the incidental harvest by commercial fishermen is largely unknown. The Alaska Department of Fish and Game was recently given new Emergency Order (EO) authority by the Board of Fisheries to require commercial fishermen to report incidentally caught steelhead; however, reporting may only be required in commercial fishing districts where there is a conservation concern. The Federal Subsistence Board continues to expand subsistence harvest opportunities for steelhead by federally qualified subsistence users (rural Alaskans) in Southeast Alaska. Legal subsistence gear types include gaffs, dip nets, handlines, spears, and rod–and-reel, and the use of bait in freshwater was approved in early 2006. Hatchery production of steelhead in Alaska is limited to one facility that annually releases approximately 6,000 smolts in the Ketchikan area and one research hatchery that releases approximately 5,000 to 20,000 smolt per year. Detrimental impacts to critical habitat continue to pose a long-term threat to steelhead stocks in Alaska as our resource-extraction based economy continues to expand.

Steelhead stock status assessment projects include snorkel surveys of selected index streams in Southeast Alaska and several weir enumeration projects. During 2006, four weirs will be operated to count steelhead in Southeast Alaska; annual steelhead weir counts in Southcentral Alaska come primarily from weirs operated to count salmon. Steelhead research projects in Southeast include a combined smolt/adult weir to investigate spawner-recruit relationships, and a project to compare the number of

steelhead observed by snorkel surveyors to a weir count, i.e., snorkel count calibration. Personnel at two of these weirs will continue to recover steelhead previously tagged with passive integrated transponder (PIT) tags in an effort to document changes in scale patterns over time; collectively these projects should improve our scale ageing techniques and interpretation of the observed scale pattern to a steelhead's life history.

Conservative angling regulations were adopted for steelhead in 1994 and since then the response of steelhead stocks has been mixed. Snorkel index counts between 2003 and 2005, were on average, similar or higher than the counts recorded between 2000 and 2002; and six of the 12 index streams had record high snorkel counts between 2003 and 2005. The survey counts suggest that the steelhead stocks in index streams are stable and while some streams are experiencing good escapements, others have not rebounded from the depressed levels of the late 1980's and early 1990s. Collectively the snorkel counts, stream-side observations from anglers and biologists, and our weir counts, provide the only information on which to base management decisions for steelhead in Southeast Alaska. It is impossible to draw "range-wide" inferences about the stock status of steelhead from our limited information, our "best guess" is that steelhead stocks throughout Southeast Alaska are stable. The limited statewide stock status information for Alaska's steelhead populations further reinforce the importance of protecting critical habitat and the need for continued conservative regulations to limit harvest.

G. National Oceanic and Atmospheric Administration

James Myers, Conservation Biology Division, Northwest Fisheries Science Center, and Donna Darm, Protected Resources Division, National Atmospheric and Oceanic Administration (NOAA), Northwest Region

In June 2005, NOAA Fisheries convened a Biological Review Team (BRT) to assess the risk of extinction facing steelhead in Puget Sound. The BRT evaluation focused on the four Viable Salmon Population (VSP) parameters: abundance, productivity, spatial structure, and diversity. The BRT also considered the current condition of freshwater and nearshore habitat, ocean conditions, the contribution of existing hatchery programs, and the potential benefits of ongoing recovery actions in Puget Sound for Chinook and chum salmon. Overall, Puget Sound steelhead have exhibited a general decline in abundance. Population specific information indicated that half of all populations exhibited significantly negative trends. Of particular concern was the status of summer-run steelhead populations throughout Puget Sound, most of which are at critically low abundances. The release of non-native summer Skamania steelhead and Chambers Creek winter steelhead were viewed as potential risks to diversity through interbreeding and abundance through competition. Additionally, the presence of large numbers of hatchery fish in many basins was a source of further uncertainty in abundance estimates. The degradation of freshwater and nearshore habitat conditions was considered a major risk factor. It was unclear if recovery actions currently underway would provide a substantial benefit to steelhead, especially given differences in freshwater habitat utilization by steelhead relative to chum or Chinook salmon. Lastly, the contribution of resident *O. mykiss* to steelhead persistence was considered, but

information was limited and the BRT concluded that the role of resident fish was not a substantial factor.

NOAA Fisheries will consider the BRT's report in deciding whether to propose Puget Sound steelhead for listing as threatened or endangered under the ESA. If listing is proposed, NOAA Fisheries will likely apply the Distinct Population Segment (DPS) Policy, and propose to list only anadromous *O. mykiss* (steelhead). If listing is proposed, the proposal would be open to public comment and review for 12 months prior to any final listing determination.

III. Steelhead Age Structure and Repeat Spawners

Session Chair: Nick Gayeski, Washington Trout

A. Genetic and Phenetic Dynamics of Steelhead Recolonization Above Dams: Green River Study

Gary Winans, National Oceanic and Atmospheric Association

I report on preliminary genetic and phenetic data we have collected for resident trout above the Howard Hanson Dam, Green River in comparison to steelhead populations below the dam. Our goal is to describe the levels and patterns of differentiation prior to 2008 when steelhead will be passed over the dam and juvenile O. mykiss smolts transported downstream. This diverse set of markers will help us understand who is producing smolts in this "recolonization" program, and more interestingly, who is producing adult recruits back to the dam.

B. Covariation in Recruitment and Productivity Between Mid Columbia Steelhead Populations

Steven P. Cramer. S.P. Cramer & Associates, Inc

There is widespread evidence of density-dependence and moderate intrinsic growth rates across the eight spawner-recruit data sets for Middle Columbia steelhead populations. Middle Columbia steelhead populations share similar habitats, and appear as a consequence to have very similar productivities. Among the data sets analyzed, there is no evidence that one or more of the populations have exhibited relatively poor productivity over the past two decades. Available evidence on Mid Columbia Steelhead strongly substantiates compensatory survival; survival increases as abundance decreases. Survival at extreme low densities is estimated to be 3.5 times higher than at the un-fished equilibrium level (near recent escapement levels). Given that survival changes as abundance changes, lambda (cohort replacement rate) is only useful as a red-flag indicator of population trend, not as an indicator or predictor of extinction risk. Present abundance levels appear healthy and in the range of the estimated carrying capacity for each subbasin. The intrinsic productivity of 3.5 recruits per spawner under existing conditions, including passage mortality at main-stem Columbia dams, indicates Mid Columbia Steelhead could withstand substantial increases in mortality, particularly from short-term events, without driving the population to extinction.

C. Using simulation techniques to estimate management parameters on Snake River steelhead: Declines in productivity make rebuilding difficult.

Rishi Sharma, Columbia River Inter-Tribal Fish Commission, and Henry Yuen, U.S. Fish and Wildlife Service

We collected adult and juvenile spawner recruit data on wild summer steelhead (*Oncorhynchus mykiss*) for the Snake River and estimated parameters for fisheries management by partitioning the data into predam and postdam periods and fitting the Ricker and Beverton–Holt models to those time series. The results showed a decline in productivity irrespective of the model chosen and the way in which the pre- and

postdam periods were defined. However, the data were noisy and the confidence bounds on parameter estimates were fairly large. To reconcile the different management goals derived from the different data sources (adult or juvenile data) or model choice (Ricker or Beverton–Holt), we used simulation techniques and Bayesian algorithms. The combined approach suggests a recovery management goal (i.e., spawning stock associated with the maximum sustainable yield) of 60,000 steelhead above Lower Granite Dam. At current smolt-to-adult survival rates, the data indicate optimal escapement of between 20,000 and 27,000 adults. We note that Snake River steelhead stocks cannot be managed for recovery escapement levels given current estimates of smolt-to-adult survival rates, and we discuss alternatives for present-day management and rebuilding over time.

D. Kelt Steelhead Reconditioning Research

Douglas Hatch, Ryan Branstetter, John Whiteaker, Shawn Narum, Jeff Stephenson, Dave Fast, Joe Blodgett, Bill Bosch, and Todd Newsome; Columbia River Inter-Tribal Fish Commission, Yakama Nation

All wild steelhead populations originating above Bonneville Dam on the Columbia River are listed under the U.S. Endangered Species Act. A promising approach to effectively increase natural production of wild steelhead is to capitalize on their iteroparous life history strategy by capturing fish during the early stages of their outmigration and applying steelhead kelt reconditioning. Reconditioning is the process of culturing post-spawned fish so that they survive, grow, and undergo gonad recrudescence for a repeated spawning event. We developed and tested fish husbandry techniques to successfully recondition post spawn steelhead. Survival rates have reached 62% in one year and averaged nearly 40% over 4 years. Rematuration rates have ranged from 85-97%. We are in the process of evaluating several potential management scenarios that range from low cost / minor handling to higher cost / intense handling. These management scenarios will be discussed. In particular, we evaluated two steelhead management strategies by using hydroacoustic telemetry to track individuals and evaluate survival, travel time, and behavior in the lower 233km of the Columbia River. The experiment consisted of two treatment groups; one group that was collected, and immediately transported and released at rkm 233, and the second group that was collected, placed in a reconditioning facility for 6 weeks and then transported and released at rkm 233. Treatment group survival to the ocean ranged from 0 to 53% with an important temporal component. Travel time from release to the estuary ranged from 3 to 25 days. At least two distinct migration patterns were observed in the estuary. The first was a linear movement to the ocean and the second oscillated with the tide in the upper reaches of the estuary. Future work will attempt to link estuary migration pattern with plasma ion concentrations and gill ATPase activity. This projected was funded by the Bonneville Power Administration.

E. Individual lifetime reproductive success of repeat spawning vs. one-time spawning steelhead

Todd R. Seamons and Thomas P. Quinn – School of Aquatic and Fishery Sciences, University of Washington

Simply because they spawn twice (or more), all else equal, repeat spawning steelhead (*Oncorhynchus mykiss*) are expected to have higher lifetime reproductive success than those that only spawn once. In addition, the larger size of repeat spawners is hypothesized to confer advantages during and after spawning in terms of reproductive success. Larger females may produce more or larger eggs; larger males may have a size advantage during competition for ripe females. Furthermore, one may also hypothesize that repeat spawning individuals may also gain an advantage from their prior knowledge of the spawning stream. Thus, we hypothesized that repeat-spawning steelhead should, on average, have more offspring on average than one-time spawners; that they would produce more than twice the number of offspring as one-time spawning steelhead due to hypothesized advantages; and finally, repeat-spawning fish would, on average, have more offspring their second time spawning than their first time. We tested these hypotheses by calculating the lifetime reproductive success of one-time and repeat spawning steelhead for 19 brood years from Snow Creek, Washington. Lifetime reproductive success was determined by enumerating returning adult offspring that were genetically matched to one-time and repeat spawning parents.

F. Potential for hatchery-wild reproductive interaction at a segregated steelhead hatchery in Washington State

Michael Dauer, Todd Seamons, Lorenz Hauser, Tom Quinn, Kerry Naish

Steelhead (*Oncorhynchus mykiss*) hatcheries provide a logical platform to study the effectiveness of the 'Segregated Hatchery Model' (Mobrand et al. 2005), because they have historically been managed with return timing as the method of segregating hatchery and wild stocks. This segregation model predicts that if the proportion of hatchery fish spawning in the wild does not exceed 5%, the hatchery stock will not pose a risk of introgression to the wild population. To demonstrate whether there is the potential for interaction *in situ*, we examined an out-of-basin steelhead hatchery at Forks Creek, WA from its inception in 1994. Adult scales were collected from both hatchery and wild stocks and analyzed to determine variation in life histories, including incidence of iteroparity. Additionally, genetic assignment methods using microsatellites were performed to verify population of origin. Results from scale readings indicate that hatchery and wild stocks have similar life histories with the exception that hatchery fish spend one year exclusively in freshwater, whereas wild fish remain two to three years before smolting. Because hatchery fish are sacrificed once they return to the hatchery as adults, any evidence of spawn checks in hatchery-origin individuals indicates out-of-hatchery spawning behavior and represent a possible means for genetic hybridization with wild stocks. Despite an expectation of zero hatchery repeat spawners, we found an incidence of iteroparity of 8% for hatchery returning adults. This was in comparison to the 16% found in the wild populations. Future work will include the continuation of the survey of mating success to determine if iteroparous individuals of hatchery origin

have attained reproductive success outside the hatchery. These findings will aid in determining the efficacy of maintaining segregated hatchery stocks, and quantify the ecological risk these hatcheries present to wild populations.

IV. The Pacific Ocean Shelf Tracking Project (POST)

Session Chair: David Welch

A. Overview of the POST Project and what it can do for steelhead biology and management.

Abstract not submitted.

B. Migratory behavior and early marine survival of hatchery-reared steelhead from Hood Canal, Washington.

Barry Berejikian and Skip Tezak, NOAA Fisheries, Northwest Fisheries Science Center, Manchester Research Station, Manchester, Washington

A preliminary study steelhead migration patterns, timing, and inferred survival was conducted using age-2 hatchery-reared steelhead smolts released into the Hamma Hamma River in 2005. Fifty steelhead smolts were implanted with Vemco V8-6L acoustic transmitters on 13 May 2005 and were held for 10 days to assess tagging mortality. All 50 fish survived and were released on 23 May 2005. Fixed VR-2 receivers were placed in the Hamma Hamma estuary and along the east and west shore of Hood Canal just north of the Hood Canal Bridge. The tags were configured to be detected by the POST project in the Straits of Juan De Fuca and Strait of Georgia.

We recovered the five Hood Canal receivers on 28 July 2005. Based on a preliminary data analysis, smolt survival through the Hamma Hamma estuary was at least 82%. Survival to the northern end of Hood Canal was at least 44%, and at least 24% of the released smolts migrated through the Strait of Juan de Fuca. None of the released smolts were detected in the Strait of Georgia. Seventy-eight % of the steelhead detected in the Hamma Hamma estuary spent less than 12 hours within range of the estuary receivers. Steelhead detected at N. Hood Canal spent an average of 12.4 days (± 9.9) residing in Hood Canal. Travel time from N. Hood Canal to the Strait of Juan de Fuca listening line (near Pillar Point) ranged between 3.5 and 6.6 days, suggesting accelerated migration speeds in the Straits.

In 2006, we propose to conduct a study to estimate early marine survival, migration timing, and nearshore habitat use of natural-origin steelhead smolts in Hood Canal. The study would provide the first estimates of nearshore habitat use for steelhead in Hood Canal and provide the initial links between spatial-temporal characteristics of steelhead populations and early marine survival. Four hypotheses relating to population-specific and individual survival and habitat use will be tested by establishing an array of fixed acoustic receivers in Hood Canal to track the movements of individual juvenile steelhead during their seaward migration. We will estimate survival by installing Vemco VR2 acoustic telemetry receivers at each of three river mouths and the Hood Canal Bridge. We will again collaborate with POST to detect migration through the Straits of Juan de Fuca and Georgia. Nearshore habitat use, and more specifically, the use of eelgrass in nearshore migrating steelhead, will be evaluated by placing VR2 receivers in paired (eelgrass vs. non-eelgrass) nearshore habitats.

C. Steelhead smolt survival during the downstream and early ocean migration: effects of body size and migration distance

Mike Melnychuk, University of British Columbia

Using the Pacific Ocean Shelf Tracking (POST) array, we estimated downstream and early ocean survival of steelhead during the smolt migration. Survival rates were highly variable between five British Columbia populations, ranging from 19-91% for the downstream portion and 4-58% by the end of the early ocean migration. Much of the variation in survival rates was attributed to body size, with larger fish having a greater survival advantage both within and between populations. Between populations, longer migration distances were associated with higher mortality rates. One population, from the Cheakamus River, was studied in more detail on a smaller spatial scale using an additional mobile tracking component. Fish swam rapidly and few died during the migration through Howe Sound. Travel speeds averaged 0.7-0.9 body lengths per second downstream and 1.0-2.6 BL/s 1 in ocean waters. Smolts showed nocturnal migration patterns in freshwater, but no patterns with respect to time of day were observed during the ocean migration. Aggregated detection probabilities of 92-96% on lines of ocean receivers suggest that migration routes of small fishes can be quantified over several hundred kilometres, and survival rates can be estimated for even a modest number of tagged fish.

V. Special Presentation – Hatchery Reform and Implications for Steelhead Management

Heather Bartlett, Washington Department of Fish and Wildlife

Steelhead differ from Pacific salmon in many ways, but are similar to Atlantic salmon. They are considered by fisheries biologists in the Pacific Northwest to be the most difficult to protect and manage because of the diversity in life history patterns that exist both within and between populations (Shapovalov and Taft 1954). *Oncorhynchus mykiss* is a highly polymorphic species, possessing a variety of physical and life-history phenotypes. It is difficult to summarize one life history strategy (anadromy - steelhead) without due recognition of the other (resident – rainbow trout). The two strategies co-mingle on some continuum with certain residency at one end, and certain anadromy on the other. Anadromy is not obligatory in *O. mykiss* (Rounsefell 1958; Mullan et al. 1992b). Progeny of anadromous steelhead can spend their entire life in freshwater, while progeny of rainbow trout can migrate seaward. West coast steelhead have two major ancestral lineages; coastal steelhead and inland steelhead, with the boundary between the two lineages coinciding around the crest of the Cascade Mountains. Steelhead evolutionarily significant units (ESU) have been created within each of these two lineages to distinguish among populations with similar genetic, ecological, geographical and geologically similar habitat.

Although the overall abundance and productivity of the anadromous form of *O. mykiss* within Washington State's ESUs varies considerably, the productive potential that existed prior to European settlement has been reduced substantially. The abundance, productivity and genetic diversity of salmon populations in the northwest have been influenced by four major factors; habitat, hydropower, harvest, and hatcheries. Although the specific H-factor contributing to the declines at the watershed level vary, the consequences are evident – fishing opportunities for naturally produced steelhead are limited and populations in many regions of Washington are at a significant risk of extinction. Subsequent to the federal endangered species act (ESA) listing of Washington's salmon populations, each H-factor has undergone a level of scrutiny and review to identify strategies or actions that each can take respectively to improve the overall health and vitality of our salmon.

Washington's hatchery system represents a tremendous investment by our citizens, and hatchery origin steelhead provide a substantial recreational and economic benefit to Washington State residents. Hatchery fish comprise the vast majority of the recreational fishery harvest of steelhead (96% of recreational fishery harvest in 2003-2004). There has been a fundamental paradigm shift in how we view hatcheries. They are no longer a replacement of habitat, but rather an integral part of the watershed in which they operate. The National Research Council concluded in their influential report "Upstream: Salmon and Society in the Pacific Northwest", that hatcheries had generally failed to compensate for habitat degradation and recommended a broader, ecosystem perspective for hatchery management. In its review, the NRC (1996) concluded that, quote "Hatcheries can be useful as part of an integrated comprehensible approach to

restoring sustainable runs of salmon, but by themselves they are not an effective technological solution to the salmon problem."

The failure of hatcheries to offset habitat degradation and concomitantly meet harvest objectives has been influenced by many factors including ESA constraints, cyclic ocean conditions, and the complexity of the steelhead life cycle. The Hatchery Reform Project is a systematic science-driven redesign of our hatchery system to achieve two new goals:

- Conserve naturally spawning populations
- Support sustainable fisheries

Rather than focus on an unproductive debate over whether hatcheries are inherently good or bad, we began with the premise that hatcheries are tools that should be used when they represent the best strategies for meeting clear and measurable goals for salmonid stocks.

The tools developed during the Hatchery Reform Project, coupled with the completion of a DRAFT Steelhead Science paper – Assessment of Washington Populations and Programs (Scott and Gill – in draft 2006) will lay the foundation for how we manage steelhead in the future to ensure healthy natural populations and healthy fisheries.

VI. Environmental Variability in Stock Recruit Models (re: Harvest and Escapement Goals)

Session Chair: Nick Gayeski, Washington Trout

A. An exploratory analysis of climate impacts on Washington steelhead productivity

Nick Mantua, University of Washington

Run-reconstruction time series for six wild steelhead populations (Skagit WSH, Quileute WSH, Chehalis WSH, Kalama WSH, Wenatchee SSH, and Yakima SSH) in Washington State are used to develop recruits-per-spawner (R/S) time series. Additionally, smolt-to-adult return rates (SAR's) for three hatchery steelhead programs (Chehalis WSH, Green WSH, and Kalama WSH) are also used to identify year-to-year changes in marine productivity. Comparisons between aspects of freshwater and marine steelhead habitat are made for the best and worst productivity periods for each steelhead population examined.

Environmental data examined include daily streamflow records, monthly sea surface temperatures, and monthly upwelling wind indices, all matched to key stages of the steelhead lifecycle. Preliminary results of this exploratory analysis find weak tendencies for high wild steelhead productivity and low hatchery steelhead SAR's with warm spring-summer SST during the smolt migration year. However, no prominent patterns of environmental links with productivity are identified, possibly because the R/S time series are confounded with density dependent effects.

B. The influence of variable marine survival on fishery management goals for wild steelhead populations: an examination of the population dynamic of Wind River steelhead

Dan Rawding, Washington Department of Fish and Wildlife

An assumption made by many scientists is that juvenile salmon and steelhead abundance in freshwater is density dependent and marine survival is density independent. If these assumptions are tenable a freshwater production curve, based on the relationship of spawners and smolts, may be used to explore a range of fisheries management or escapement goals that may be appropriate for steelhead populations under a range of observed marine survivals. Data collected on steelhead in the Wind River, a tributary to the Columbia River, is used to explore a range of fisheries management options for this population.

VII. Relationships and Implications of Resident and Anadromous Life History Forms in *Onchrynchus mykiss*

Session Chair: Pat Hulett, Washington Department of Fish and Wildlife

A. Effects of 70 years of freshwater residency on early male maturity and smoltification in a Southeast Alaskan steelhead stock

Frank Thrower, NOAA Fisheries, Auke Bay Laboratory, Alaska Fisheries Science Center

In 1926, juvenile *Oncorhynchus mykiss* were transported from lower Sashin Creek, Southeast Alaska, above two barrier waterfalls and stocked into Sashin Lake which had been fishless to that time. In 1996 and 1997, we took gametes and tissue samples from the rainbow trout population in Sashin Lake and the anadromous steelhead population in the lower creek to compare genetic differentiation, and survival, growth, early maturity and smolting in a hatchery environment. An analysis of mtDNA, microsatellite and allozyme alleles revealed a large reduction in variation between the populations, particularly with respect to rare alleles. In the hatchery environment, survival, growth and early maturity were similar between populations and years, however, age two progeny of resident fish smolted at a significantly lower rate than progeny of anadromous adults (55.6% and 39.4% for resident progeny in ’98 and ’99 vs 67.8% and 64.6% for anadromous progeny). Although lower, this significant smolting rate for resident fish is remarkable, given the complete selection against the phenotype in the upper watershed. Smolts from both groups were similar in size, ATPase production and timing, and saltwater tolerance. These results indicate that significant genetic resources of anadromous *O. mykiss* may still exist in many stocked lakes or impoundments throughout the western U.S.

B. Variation in growth, precocious maturation, smoltification, and marine survival in anadromous and derived freshwater forms of southeast Alaskan *Oncorhynchus mykiss*: implications for conservation of steelhead

Jeffrey Hard, Conservation Biology Division, Northwest Fisheries Science Center; Frank Thrower, Auke Bay Laboratory, Alaska Fisheries Science Center; John Joyce, Auke Bay Laboratory, Alaska Fisheries Science Center

We evaluated genetic variation within and between anadromous steelhead and resident rainbow trout originally derived from the same wild anadromous Alaskan stock in the 1920s. We measured phenotypes for growth, smoltification, and maturation in over 6,500 age-2 fish in 75 purebred and crossbred families. Smolting and precocious male maturity were highly variable among families within populations and significantly different between populations. Each of the four lines produced among the two lines yielded significant numbers of smolts at age two. Heritabilities of precocious male maturity, smolting and growth were moderate to high, and the genetic correlation between growth and smolting was low. Smolting and maturation were negatively genetically correlated. Genetic divergence of these populations was modest at both neutral loci and quantitative traits and appears to reflect primarily additive genetic

effects and interactions among alleles within loci. Estimates of Qst for smolting and growth were not significantly different from those of Fst, based on DNA microsatellite allele frequencies. However, marine survival to adulthood of progeny of resident parents released to the ocean was significantly lower than that of progeny of anadromous parents. These results indicate that even low levels of adaptive differentiation may yield appreciable outbreeding depression for survival. Disruption of "modest" local adaptations may therefore impart significant fitness consequences for wild fish that undertake marine migrations.

C. Genetic relationships among resident and anadromous *Oncorhynchus mykiss* in Cedar River, Washington: implications for steelhead recovery planning

Anne R. Marshall, Maureen Small, and Steve Foley, Washington Department of Fish and Wildlife

The goal of this research project was to understand genetic population structure of Cedar River resident and anadromous *O. mykiss* to assist with conservation and recovery strategies. Cedar River drains into Lake Washington, which is artificially connected to Puget Sound by a shipping channel and lockage system. Landsburg Dam at Cedar River mile 21 had blocked anadromous adults from 17.5 mainstem miles and associated tributary habitat from 1900 until September 2003 when a fish ladder became operational. Restoration of steelhead to the upper watershed was intended but steelhead abundance had been critically low during the last 14 years. In contrast, resident or non-anadromous *O. mykiss* were present throughout the river, and appeared abundant in below-dam areas. To evaluate genetic relationships between anadromous and resident populations, we sampled 180 resident phenotypic *O. mykiss* in below- and above-dam Cedar River areas, 24 phenotypic *O. mykiss* smolts from a lower Cedar River trap, and 57 putative Cedar River steelhead that had been captured at the shipping locks. We also sampled wild and hatchery steelhead in the adjacent and historically-connected Green River, lake-resident *O. mykiss*, and non-native hatchery rainbow trout stocks. We sampled adult and smolt *O*. *clarki* in Cedar and nearby rivers in order to identify *O. mykiss*/*O*. *clarki* genetic hybrids in samples. We collected data for 22 microsatellite DNA loci in all samples and used six nuclear DNA loci for additional species identification. We found that nearly all sampled resident adult *O*. *mykiss* in Cedar River zones were native-origin and not introduced hatchery trout. Below- and above-Landsburg Dam resident *O*. *mykiss* were divergent, but above-dam fish were genetically more similar to below-dam residents than to wild steelhead. This suggested that above-dam *O*. *mykiss*, which had a long isolation from steelhead, could get downstream successfully prior to the fish ladder. Below-dam resident *O*. *mykiss* as a group were divergent from steelhead, but individual genotypic analyses showed many resident fish were most likely derived from native steelhead. Based on genetic assignment tests, approximately 25% of smolts had higher likelihoods of originating from resident instead of anadromous *O*. *mykiss*. Among all Cedar River phenotypically identified fish we found about 14.5% *O*. *mykiss*/*O*. *clarki* genetic hybrids. We speculate that the resident life-history exhibited by Cedar River *O*. *mykiss* may have become recently more common due to modified fish communities and freshwater habitats, coincidental to poor steelhead returns. Similar to other studies, our results suggest that

non-anadromous *O*. *mykiss* may contribute to reducing extinction risk for steelhead. However, to improve the status of steelhead, resident phenotypes must produce smolts that have successful marine migrations.

D. Residualism and Residency: The Same Side of Different Coins

Cameron Sharpe, Washington Dept. of Fish and Wildlife, Conservation Biology Unit, Kalama Research Team

Residual steelhead are defined as hatchery fish of smolt age that fail to emigrate with the remainder of their cohort. Resident trout are fish that do not adopt anadromy even with the opportunity to do so. The two terms are not synonymous but some overlap is apparent: some residual steelhead remain in freshwater and attain a size and age in excess of most naturally produced smolts. We present data on size distributions of residual and resident trout and discuss the implications of the presence of these two forms of the species on research programs ongoing in the Kalama River, Washington.

E. Alternative Life History Strategies of *Oncorhynchus mykiss* in Northeast Oregon: Evidence from Otolith Elements and Controlled Breeding Experiments

Jim Ruzycki, Michael Flesher, Debra Eddy, Gary Vonderohe, Oregon Department of Fish and Wildlife; and Timothy Whitesel, US Fish and Wildlife Service

In 1997, the anadromous form of *Oncorhynchus mykiss* in the Snake River basin was protected under the federal ESA. However, *O. mykiss* exhibit a variety of life-history strategies and in Northeast Oregon, both resident and anadromous forms coexist. We evaluated the relationship between these life history forms in Northeast Oregon. Using elemental analysis (WD-EM) of otoliths collected from various life stages, we demonstrate that both resident and anadromous females produced progeny that expressed both life history strategies. Most (79-87%), of the sampled age 0 fish had anadromous mothers. Resident mothers produced 7-33% of the smolts and 9-33% of the anadromous adults sampled. Fifty-four to seventy-seven percent of resident adults had anadromous mothers. The range in the results represents the various basins we sampled. We also conducted various crosses in the hatchery between anadromous and resident forms to determine morphological variation and migratory propensity of progeny from differing parental stock. Offspring were reared in a hatchery, PIT tagged, released, and then monitored for detection at downstream dams. Generally, progeny from resident matings had greater condition factors than those from anadromous matings. Offspring from anadromous parents had the highest propensity to migrate (45.8%) and resident progeny had the lowest (3.8%). Resident parents produced the most precocious progeny (17.6%) and a disproportionately small proportion of precocious progeny (2 of 1,236) migrated. Larger progeny (>170 mm) were detected migrating at significantly higher rates compared to smaller progeny ($P < 0.001$), however, there was no significant difference ($P \geq 0.1$) in condition factors between progeny that were detected at downstream dams and those that went undetected. Using both approaches, we demonstrate a plasticity of phenotypes with each life-history form producing both resident and anadromous adults. Our evidence suggests that

resident *O. mykiss* significantly contribute to steelhead ‘populations’ in the basins we studied.

IX. Contributed Papers

Session Chair: Bill Horton, Idaho Department of Fish and Game

A. Life History of Winter Steelhead, a 30 Year Perspective

Hal Michael, Washington Department of Fish and Wildlife

Winter steelhead in at least Puget Sound and the Gulf of Georgia are struggling to survive. The life history of these fish is substantially more complex than is appreciated by managers. The interplay of return timing, spawn timing, spawning location, age composition, presence of repeat spawners, stream hydrograph, contribution of non-anadromous spawners, and contribution by spawning salmon needs to be considered in management. Data collected over 30 years and results of studies in other areas are combined to present a picture of what winter steelhead require to maintain strong naturally reproducing populations.

B. Accounting for Hatchery-Origin Steelhead Returns to the Snake River Basin, 1995-2002

Herb Pollard, NMFS/NWR Hatcheries and Inland Fisheries Branch and Chris Starr, USFWS, Lower Snake River Compensation Plan Office

Artificial propagation facilities funded as mitigation for hydroelectric development release approximately 10 million steelhead smolts in the Snake River basin each year and annual adult returns of hatchery origin steelhead range from 60,000 to over 200,000. Concern for the potential negative impacts from interaction of artificially propagated steelhead stocks with natural, indigenous steelhead stocks is one reason that the Snake River Basin steelhead Evolutionarily Significant Unit (ESU) was listed as threatened, under the Endangered Species Act (ESA). Similar concerns about ecological or genetic interactions between hatchery-origin and natural-origin steelhead have been expressed in a number of scientific reviews of the affects of artificial propagation, and in the status reviews leading to the listing of the ESU. NMFS found that the impacts of ecological and genetic interactions between hatchery-origin and natural-origin steelhead, and the uncertainty regarding the distribution of the hatchery-origin fish, were risks sufficient to conclude that operation of steelhead hatcheries could jeopardize the survival and recovery of the ESU. Although adjustments were made in management programs after the listing of the native fish to reduce the potential risks, the large number of hatchery-origin steelhead that migrate into the Snake River and potentially interact with listed natural-origin steelhead remains a concern.

To evaluate the extent of potential interaction between natural and hatchery-origin steelhead stocks, NMFS requested that the USFWS, Lower Snake River Compensation Plan office, and their cooperators in the Snake River Basin steelhead hatchery programs provide an accounting for hatchery-origin steelhead at upstream hatcheries, weirs and traps, in harvest, and in natural spawning areas.

Managers accounted for an average of 95.9% of the adult steelhead returns in harvest, hatchery rack returns, natural mortality, and returns to direct-stream releases. Homing

fidelity within the Snake River subbasins is high. Numbers of hatchery strays detected at weirs and in spawning surveys in areas managed for natural production generally total less than 1% of the spawning escapement. Genetic surveys have not detected hatchery influence in natural populations. While excessive straying into areas identified as important to natural spawning has not been found, there are still large numbers of unaccounted hatchery-origin steelhead. Straying into some out-of-basin areas does occur, and some release strategies may tend to increase straying.

C. Comparison of Catch Data from the California Steelhead Fishing Report-Restoration Card and the Recreational Angler Survey for the Smith River (Del Norte County)

Terry Jackson, Associate Fishery Biologist, California Department of Fish & Game

Fishery managers have depended on creel and angler surveys for decades to provide estimates of the catch and angler success rate, particularly for a few specific streams. Salmon and steelhead tags/harvest cards/report cards have also been utilized for decades, but provide state-wide data. In an era of budget restrictions in California, costly recreational angler survey programs are being decommissioned. With declining steelhead stocks coast-wide, the loss of these programs and these data make the fishery manager's job to monitor, manage and restore steelhead resources more difficult. More importance is thus placed on data provided by steelhead tags/harvest cards/report cards. In addition to harvest, the California Steelhead Fishing Report-Restoration Card (Report Card) collects angler effort and numbers released.

We compared the catch data acquired from the statewide Report Card for the Smith River (Del Norte County) with catch data obtained through a standard recreational angler survey (roving and access point) specific to the Smith River that has been ongoing since 1997/98. The Smith River supports a popular fishery for steelhead and is recognized by anglers as one of the highest quality steelhead fisheries in the state. It is the only stream in California where wild steelhead can be kept. Wild and hatchery steelhead catch data from the Report Card and the Angler Survey Access Point data (both completed trips) were compared for the same time periods of four seasons (1998/99-2001/02). The two methods produced significantly different results for virtually all catch and effort parameters compared, where Report Card estimates were nearly always higher. Though the angler survey provides "real time" data collection and more likely to gather data regarding unsuccessful fishing trips, it is difficult to effectively sample the numerous access points and sample all angler types proportional to their level and type of effort (e.g., bank vs boat anglers). With the Report Card, some anglers may not record their unsuccessful trips as required and successful anglers are more inclined to return their Report Card; however, with increased angler education regarding the necessity of accurate data, increased Report Card returns and minor adjustments to account for unrecorded unsuccessful trips, the Report Card data is a cost effective tool for reliable estimates of the steelhead catch and angler success rates state-wide.

D. Effects of Hatchery Strays on Recruitment of Natural Steelhead in Mid Columbia Basins

Steven P. Cramer. S.P. Cramer & Associates, Inc.

Comparisons of natural recruitment between several streams in the Mid Columbia Basin with high and low proportions of hatchery steelhead did not demonstrate adverse impacts in streams with hatchery fish present. The rise and fall of natural fish recruitment per natural spawner has been parallel in the Yakima, Deschutes, John Day, Umatilla, and Warm Springs rivers, even though estimates of the hatchery proportion of the steelhead run to these streams ranges from 0% to greater than 50%. Productivity values estimated from stock-recruitment analyses of steelhead populations in streams with "all wild" steelhead was not significantly different from the productivity of steelhead populations in streams with mixed "hatchery-wild" stocks. Interbreeding of hatchery strays with wild fish was reduced by differences in spawning distribution. Counts of steelhead past dams in both the Umatilla and Deschutes rivers showed substantially higher proportions of hatchery fish present in the main stem than were observed in tributaries where spawning of wild fish was concentrated. The lack of a homing imprint that guides steelhead to optimal areas for reproduction probably contributes to poor reproductive performance of stray hatchery fish. The assumption that hatchery steelhead negatively impact productivity of wild steelhead in the Middle Columbia region was not supported by data available from streams in the region.

E. Conserving divergent populations of threatened summer run and winter run steelhead trout (*Oncorhynchus mykiss*) ecotypes in the Hood River, Oregon: Implementing genetic based broodstock assignments

Andrew Matala, Abernathy Fish Technology Center, US Fish and Wildlife Service

Two distinctive steelhead (*Oncorhynchus mykiss*) stocks are native to the Hood River, Oregon basin. Summer-run (SR) steelhead migrate upstream during the summer and fall, mature in-stream, and spawn the following spring in the west fork. Winter-run (WR) steelhead migrate upstream during the winter and early spring immediately before spawning in the east or middle forks. The Oregon Dept. of Fish & Wildlife has developed a hatchery supplementation program to implement recovery of these ESA-listed stocks. Steelhead are trapped for broodstocks from among returning wild fish, and ecotype identity is determined based on run timing and physical traits. When the temporal return of the two stocks overlaps, the hatchery programs pose significant genetic risk of inadvertently crossbreeding adults of both ecotypes

Using a suite of 22 microsatellite nuclear DNA loci, we investigated the genetic structure among adult steelhead, and steelhead juveniles from the east, middle, and west forks of Hood River. The topology of a neighbor-joining dendrogram demonstrated similarity among known SR adults and west fork juveniles, and a distinct grouping of known WR adults with both east and middle fork juveniles. The feasibility of using a genetic assignment test for identifying ecotype of origin was evaluated, using a baseline of juvenile steelhead allele frequencies to differentiate SR (west fork) from WR (east, middle forks). Correct assignments were determined by calculating the log of the odds

ratio (LOD) of likelihood probabilities. Among known WR adults, 91.5% assigned to the east or middle fork, while 77.7% of known SR adults assigned to the west fork. A real time rapid-response (RTRR) protocol was developed, which provided hatchery personnel with genetic ecotype assignment results within 24-hours. Of 112 mature fish being held in 2005, 39 WR and 32 SR individuals were identified and retained for brood stock based on ecotype assignments (CL $\geq$ 95%).

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