Proceedings of the
52nd Annual Pacific Northwest Fish Culture Conference

New Millennium – New Horizons

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Conference Hosted By
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Preface

The Oregon Department of Fish and Wildlife is honored and privileged to host the 52nd annual Pacific Northwest Fish Culture Conference. Fish culturists and scientists from private, State, Tribal and Federal facilities in the Northwest have used this unique and informal conference for the exchange of information and ideas about all aspects of fish culture for the past 52 years. These conferences are hosted on a rotating basis by the various fisheries agencies in the Pacific Northwest. The subject matter generally focuses on topics directly applicable to fish culture, although many times the subjects spill over into management and research themes which are intimately entwined with the science of fish culture. This conference is also used to renew old friendships, begin new ones, and develop personal contacts between those of common interest. All persons interested in fish husbandry are invited to attend and to actively participate.

To this year's participants, we welcome you to: New Millennium – New Horizons!

These Proceedings contain abstracts and talks presented at the conference. They are unedited, contain progress reports of uncompleted programs, and, as such, should not be considered a formal peer-reviewed publication. Mention in these Proceedings does not indicate approval, recommendation, or endorsement of any proprietary product or material.

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Session I -

Investigative Fish Culture Techniques

Session Chair:
Matt Frank
ODFW – Asst. Manager Cole Rivers Hatchery

Early Sexual Maturation in 1+ age Male Spring Chinook Salmon - Examination of the Roles of Size and Fatness.

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Abstract

The incidence of early sexual maturation (before the first females have reached sexual maturity) of male chinook salmon appears to be higher in hatchery-reared males than in their wild counterparts. This reduces the effectiveness of both enhancement and conservation hatcheries. I will present the results of four experiments, conducted from 1993 to 2001, that examine he relationships among growth rate (size), fatness and the incidence of male sexual maturation at 1+ years of age. In brief, our results indicate that the decision to mature sexually is made in the late fall or early winter prior to spring maturation. Growth rate, or size, appears to be the most important factor determining whether a fish will begin to mature. Our results suggest that, in fish larger than 8 g, the larger the fish is by the previous late fall or early winter, the greater the chance that it will sexually mature by the following spring. An apparent exception is that low body fatness tends to reduce the incidence of maturation in small fish. Our results indicate that it may be necessary to alter current rearing practices to reduce the incidence of early male sexual maturation in spring chinook salmon.

Heating and Chilling Water to Meet Program Goals

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In 1974 I was privileged to open the Reiter Skykomish Rearing Ponds. This facility is located East of Goldbar, WA on the Skykomish River. At that time the facility was comprised of two 5-acre earthen rearing ponds. The main water source is Austin Creek. Austin Creek supplies 3.5 CFS to over 10 CFS of well aerated surface water. This water source usually is clean, but during bad weather quickly turn to mud. The water temps run from a late summer high of 50-54 degrees (F) and a winter low of 38 - 42 degrees (F).

After a few years of great winter and summer steelhead returns, it was decided to start collecting adults. About this time it was also decided that each river system should try to maintain its own strain of steelhead. At that time the practice within the Washington State Dept of Game was that all steelhead eggs had to be screened for virus before they could be transferred out of the river system. Once the eggs were cleared by our lab we shipped our egged eggs to our South Tacoma Fish Hatchery. Where the 56 - 58 degree (F) water could speed the development of these eggs into fingerlings that were fin clipped and shipped back to their "home" facility by late June to mid July. These fish were usually received at about 100 FPP.

In 1988, the Washington State Dept of Wildlife (formerly the Dept. of Game) built an adult trap and holding tank as well as a small egg incubation building at the Reiter Skykomish site. Some of the problems we had with the Summer Steelhead were due to the 38 - 42 degree water temps that delayed the spawning time from January to February and March. Another problem was the small egg takes that could be as few as 14,000 eggs to the "big" takes of 180,00 eggs. The 38 - 42 degree incubation water also slowed egg development so that in meant shipping the eyed eggs from late March well into April. These created problems, at the South Tacoma Fish Hatchery, having five to seven small lots of fish of varying ages (sizes).

After the first year or so I decided to try to do something to solve the problem of egg delivery timing. I settled on building a re-circulating, heated water system. Using the bottom of a "blue" barrel as a water reservoir. I used 250-watt aquarium heater as a heat source controlled by a Honeywell heat control unit. The Honeywell heat control unit is the type that you can adjust to within 1 degree of your desired water temperature. This heated water was then pumped up to the top of an eight tray vertical incubator stack. This heated water drained back into the reservoir to be re-circulated. Fresh water was introduced at the rate of 2.5 GPH. For an emergency backup I used an electric solenoid controlled flood valve that would deliver raw water in case of a power failure. It was decided to heat the incubation water to 54 degrees (F). The Fig A drawing (Figure 1), should help explain what I build.

Once the eggs reached the eyed stage and were cleared of virus, I used this equipment as follows. I would leave egg take #1 on raw water, egg take # 2 was put on heated water until the TU's matched that of egg take # 1, then combined both groups on raw water. Egg take # 3 was also heated until its TU's matched those of egg takes 1 & 2. Them all three egg takes were delivered to the South Tacoma Fish Hatchery. Following egg takes were handled in much the same way.

I used this system through 1995 with few problems. In 1996 I transferred to the Arlington Fish Hatchery where I encountered much the same problem in reverse.

Part of the planting program at the Arlington hatchery is the Alpine Lake Program that plants Rainbow and Cutthroat fingerlings into mountain lakes, usually over 3,500 feet in elevation. The problems we encountered are that we have to use January and February spawned rainbow and cutthroat trout that are planted in August and September. The fish have to be around 400 to 500 FPP because these fish are planted from an airplane or are backpacked. In the past these fish were "slowed" by crowding and withholding feed. Yes these fish were the right size in August and September but they weren't in very good condition. We were able to solve this problem with the use of the heated water system only using chillers instead of heaters.

A good example of this is that in October of this year, we had two groups of Tokul Creek Cutthroat in our hatchery. Both of these groups were spawned during the winter of 2001. Lot 1 was used for planting into beaver dams during the late spring and early summer. Lot 2 was used for the Alpine Lakes program and were planted in the late summer and early fall. In October when we finished the programs and were closing down the hatchery we compared the two groups of Cutthroat. Lot 1 was 27.5 FPP and lot 2 was 300 to 365 FPP. Both of these groups of fish were planted in great condition, because of the tools we were able to use.

Since 1998 we have been improving both of these systems. We now have one-pass water systems, using gravity instead of pumps. The two drawings Fig B & C below (Figure 1) will help to explain how these systems work.

The heated water system (Fig B, Figure 1) uses two 1,200 watt, 120 volt hot water tank heaters. A Honeywell temperature control unit controls water temperature. We are able to get 3 - 4 gpm of 54 degree (F) water. This heated water is used primarily to speed groups of winter steelhead. We end up with two hatches of fish that were spawned over a six-week period.

The chilled unit (Fig C, Figure 1) is primarily used for the fish in our Alpine lake program. We start with green eggs and have kept them in the chiller until they are ready to swim-up. Using a Frigid Chiller Unit we are able to get 3 to 4 gpm of 40 degrees (F) water. The only problem that we have is a 50% eyed egg loss. We are planning to try 42 degrees (F) this next hatching period to see if we can reduce this egg loss.

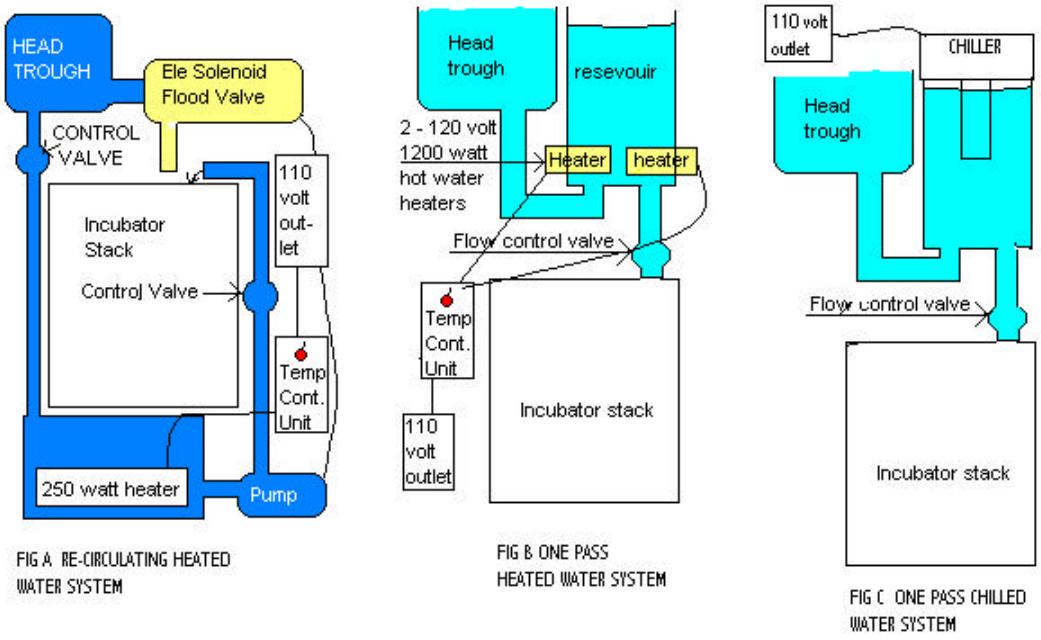

Figure 1. Schematic drawings of incubation water temperature control equipment: Re-circulating heated (Fig A); One pass heated (Fig B); and One pass chilled (Fig C).

Partial Spawning of Adult Winter Steelhead

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Abstract

The purpose of this project was to find any significant changes in the viability of eggs if portions of the eggs were removed from individual females over varying periods. One practical use for this technology would be to partially spawn wild fish and then return them to the stream where they could spawn naturally while keeping some of their offspring to be reared in the hatchery. This could give us the potential to use the genetic input from a population of wild fish and still allow them to spawn in the wild. It could also allow us to utilize a larger number of wild fish without creating egg surpluses in wild broodstock programs. After initial removal of approximately 1,000 eggs from each female, the fish were held in numbered holding tubes. These fish were then spawned again at intervals ranging from 2 to 13 days. At eye up, all eggs were counted. This study was conducted with returning hatchery stock winter steelhead and was concluded at eye up of the eggs. Eggs were incubated in standard vertical incubators using 5 GPM. Loss percentages were not consistent one way or the other, probably due to the variables common in fish culture. Average losses for initial egg takes were 5.5%, while the other groups averaged a slightly higher loss of 7.3%. The results show that, in most cases, after removing the initial portion of eggs from a female, the remaining eggs continued to be viable up to and including 13 days.

History

After lengthy discussions on developing a new wild brood stock of winter steelhead, which included decisions on how many adult spawning pairs we would use, we stumbled on a theory that we thought might be of value. Could females be only partially spawned and then returned to the river? Would those females absorb water back into the body resulting in the retained eggs becoming water hardened? Would the already mature eggs continue to "ripen" beyond viability?

Methods and Equipment

Adult holding tubes, which several of us had seen or used at different facilities, had been built to be used in developing a new wild broodstock in the Alsea basin. We wanted to test the holding abilities of these 6" PVC tubes along with a system of racks designed to suspend the tubes in one of our raceways. We felt that testing this operation using hatchery stock winter steelhead would help us work out any problems without endangering any of the wild stock adults. This study allowed us to test the system under our particular conditions and at the same time answer a few questions.

Hatchery stock winter steelhead adults, captured at the Alsea Hatchery, were randomly selected and partially stripped of approximately 1,000 eggs. Not all of the females were initially spawned on the same day. Fish condition and any other observations were recorded and the fish were placed in numbered holding tubes. After a period ranging from 2 to 13 days, the females

were spawned again and returned to the stream the same as the production spawned females in this river system. No adult mortality was experienced and no adverse reactions were noted due to holding these fish in tubes.

The eggs from each female were kept separate in individual trays so they could be tracked. All eggs were handled in the same manner as production eggs with the exception of lower densities. Eyed eggs were shocked after accumulating between 400 and 425 temperature units. The groups were allowed to sit for a 24-hr. period, then picked and counted. Dead eggs as well as blanks (unfertilized eggs) were counted separately to establish if there had been any deterioration of fertility rates. Blank eggs accounted for only a small percentage of overall loss and it was determined that fertility was not effected in this study.

Mortality rates ranged from 1.1% to 15.3% in the initial groups and 0.4% to 20.8% in the groups taken later. Average loss for initial groups was 5.46% while the second egg take groups averaged a slightly higher 7.32% (Figure 1). There was no correlation between the longer intervals and higher mortality. Fluctuation in loss was probably due to variables common in aquaculture. Green to eyed egg losses with this particular stock of winter steelhead averages +/- 6.0% when incubated at a normal production rate of 6,000 eggs per tray.

Results

Partial or "split" spawning was not found to adversely effect egg quality or egg fertility rates among winter steelhead in this study. It could open the door to increasing the number of parent groups without generating surplus eggs. With the additional parent groups, a larger genetic cross section of the stock could be obtained. It could allow fish from wild stocks to be partially spawned and then returned to the stream to spawn naturally. It would be interesting to test these methods on other steelhead stocks and salmon species as well.

Acknowledgments

I would like to thank the crew at Alsea hatchery. They are always willing to put extra effort into studies such as this to improve fish culture techniques.

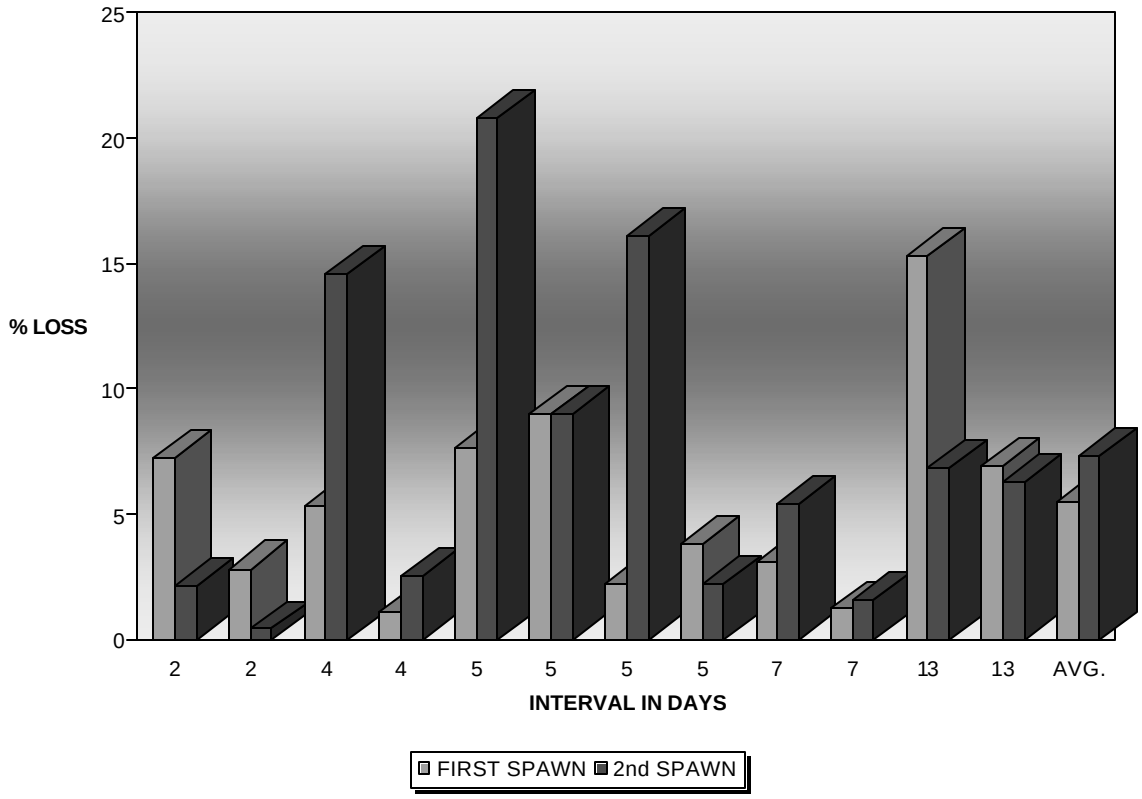

Figure 1. Alsea winter steelhead second spawning eyed egg mortality rates. Interval in days is the number of days from first to second spawning for an individual female.

The Effect of Automated Sub-Surface Feeders on the Behavior and Predator Vulnerability of Fall Chinook Salmon

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Abstract

The study compares how automated-subsurface and hand-surface feeding techniques effect the growth, in-culture survival, behavior, and predator vulnerability of fall chinook salmon. Three 6,000 liter fiberglass raceways were fitted with a feeder system that automatically delivered food below the water surface. The three control raceways were fed by hand scattering pellets across the surface. Each raceway was stocked with 4,800 fall chinook salmon with the fish in both treatments being reared and handled in a similar manner except for feeding method.

Within a month, fish in the hand fed raceways became conditioned to swim over to the person feeding them and would swarm at the surface competing for food. Fish in the automated subsurface feeder raceways would never swim over to people working near the surface of their raceway. Underwater video taping indicated no significant difference in the vertical distribution of fish in the two treatments. Fish removed from both treatments that were individually observed in 200 liter tanks also displayed identical depth preferences. Fish from the two treatments were equally vulnerable to merganser predation as quantified in test arenas. Fish from both automated and hand fed treatments exhibited a fright response to inanimate objects and bird models displayed beside the rearing raceway. Fish from the automated feed delivery group also exhibited strong fright responses to the image of a human standing beside the raceway, while the hand fed group approached the image; suggesting specific image conditioning. In-culture mortality in the automated subsurface feeder raceways was nearly double that in the conventional hand fed raceways (7.2 vs 4.4%). We conclude that while broadcast hand feeding at the surface conditions fall chinook salmon to approach the image of humans, it may not increase susceptibility to predation.

Salmon Culture Methods in the Russian Far East

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and Tatiana Shmigirilova, Amurrybvod.

Abstract

The Russian Far East relies extensively on salmon for food and commerce. There is a long history of using salmon culture to augment and enhance natural populations of pink, chum, coho, chinook, sockeye, and cherry salmon. There are also recent efforts to use fish culture methods to attempt restoration of reduced or extirpated salmon runs. This presentation will briefly describe and illustrate fish culture methods in use now at facilities in the Sakhalin, Amur, and Kamchatka areas of the Russian Far East and summarize some current issues.

Logistics of Collecting and Holding Angler Caught Alsea Basin Winter Steelhead Brood Stock

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Abstract

A new hatchery reared Winter Steelhead program was created in the Alsea Basin. Alsea hatchery was utilized for the spawning, incubation, and rearing of progeny taken from wild steelhead. The criteria for random collection and spawning dictated a need to be able to capture, transport, hold, and monitor individually all fish collected. To accomplish this project a group of anglers were organized to collect adults by angling. The logistics of holding fish during angling operations, transportation, and pre-spawn holding and monitoring was accomplished using a 6" x 36" PVC tube. The tubes have one fixed barred end and one removable barred end to allow water flow through the tube. The tubes allowed anglers to transport fish along side drift boats. Tubes could be tied off at anyone of eight designated fish pickup points for hatchery pickup or fish could be transported by anglers using aerated fish boxes. Upon arrival at the hatchery, each tube was assigned a number and placed on a holding rack that had been erected in a raceway pond. Fish were successfully held in tubes until post spawn released. This method of holding allowed the program to successfully collect, monitor, treat, spawn, and maintain a record of all actions taken from collection through release of each individual fish.

Introduction

The Alsea basin has had substantial fisheries for hatchery winter steelhead since the late 1930's. Due to spawning and collection practices the hatchery winter steelhead adults have, over time, been compressed into an earlier returning program. In an effort to expand and possibly improve the winter steelhead fishery in the Alsea basin, a program was developed to collect wild winter steelhead adults from the Alsea basin with return and spawning times that were similar to historic returns. To meet the needs of the program the following criteria was developed.

- **Adults would be collected randomly throughout the Alsea basin:** Although some trapping abilities exist on four tributaries, it was decided that the best approach would be to organize a group of anglers willing to collect wild broodstock by angling. This would require a means for anglers to hold and transport live adults.
- **Spawn only enough broodstock to meet egg needs required for the 60,000 smolt program. Brood stock actually spawned should have proportionate return and spawn times representing the existing natural production:** Since only the number of adults needed to meet program would be spawned (35 pair) we needed the ability to determine capture time and estimated spawning time of individual fish. Since collected fish could spawn anywhere between immediately after capture or up to two months post capture, there was a need to track each fish individually. By tracking each fish individually we would be able to determine prior to spawning if the adult was needed for the program. If a proportionate representation for the estimated time of spawning was

already on hand, adults that were collected but not needed could be released prior to spawning.

- **Develop a means for maintaining records for each individual fish:** The ability to record all actions for an individual fish would allow us to ensure that a particular fish fit the program need prior to spawning. All actions could be recorded such as, who collected, date of collection, place of collection, physical appearance of fish when received at hatchery, pre-spawning checks, treatments, dates of spawning, and dates of release.

Based on the above criteria it was evident that we would need a means for individual transportation and holding of collected fish. After reviewing other programs that have used PVC holding tubes with varying degrees of success, we decided on utilizing this method for not only holding but also collection/transportation.

Methods

Holding Tube

The primary tool used in the adult capture, transporting, and holding phase of this project would be a fish tube. The design (Figure 1) consist of a 36" section of 6" diameter PVC pipe. Each end has been drilled to except three ½" diameter PVC bars. On one end the bars are permanently secured with ½" caps. The other end of the holding tube is drilled to receive a barred gate. The gate is constructed of three lengths of ½" diameter pipe connected to a 1 ¼" PVC pipe which serves as the handle. The gate is secured by a pin that is inserted through a hole in the middle gate bar.

Aerated Holding Container

Containers utilized ranged from large ice chest coolers, aluminum fish boxes, and fifty-gallon Rubber Maid containers. All containers were large enough to hold at least one fish tube and all containers utilized a "Super Saver livewell Areator (Figure 2).

Angling Volunteers

Anglers who volunteered for the program were registered and given instruction on proper handling of collected fish. Volunteers were given fish holding tubes. Anglers who were planning to dedicate substantial effort to the program were also given aerated holding containers.

Upon capturing an unmarked winter steelhead, anglers placed the fish headfirst into the holding tube. This fish holding tube could be placed inside an aerated holding container and transported in the boat or tied over the side of the boat as it drifted down river. Fish could be transported in the aerated holding container directly to the hatchery or tied off to the bank as the boat passed one of eight designated pickup points along the Alsea River. Anglers could then notify hatchery personnel that a fish required pickup at a given location. Anglers could notify the hatchery by phone, or a message was sometimes relayed by state and county police. Upon notification, hatchery personnel would utilize a portable tank to transport fish to the hatchery holding area.

After arrival fish were checked for sex, condition, fin clips, etc. The tube was then assigned a number and placed on a holding rack. A record was initiated for each fish brought in. Whenever individual fish were handled the record was updated with new information. Information would include date of capture, where capture took place, who collected the fish,

when fish should next be checked for ripeness, fish condition, treatments required, date spawned, and, when and where released.

Figure 1. Fish Holding and Transport Tubes.

Figure 2. Fish Transport Box.

Results

This method of collection and holding allowed us to collect enough adults and take only eggs needed to meet the requirements of the program. It allowed for a day to day collection of adult broodstock by individual anglers without having to organize "main event" collection days. The holding of broodstock in individual holding tubes proved very successful. Overall results can be seen in Table 1. The other benefits realized by utilizing fish tubes for holding wild broodstock were:

- There was only the need to check fish which had been recorded as near ripe the previous week and not and entire holding pond.
- The ability to treat only fish requiring treatment.
- The ability to track and monitor individual fish to ensure they fit the needs of the program prior to spawning

One of the most important benefits and positive experiences achieved in this program has been the inclusion of local citizens in resolving the logistical details in the collection portion of this project. This program has given us an opportunity to work with local anglers on a project that not only assist the hatchery in achieving its production goals but hopefully will reward efforts of all those involved by increased and improved angling opportunities in the future.

Table 1. Alsea Basin Wild Winter Steelhead Broodstock Collection Summary.

Collect			
Date	Female	Male	Jack
2/2 JAN	4	0	0
1/2 FEB	11	10	1
2/2 FEB	4	3	0
1/2 MAR	5	5	1
2/2 MAR	6	4	0
1/2 APR	3	1	1
2/2 APR	0	1	0
1/2 MAY	0	2	0
Total	33	26	3
Spawn			
Date	Female	Male	Jack
2/2 JAN	0	0	0
1/2 FEB	5	3	0
2/2 FEB	4	5	0
1/2 MAR	7	5	0
2/2 MAR	5	5	0
1/2 APR	3	3	1
2/2 APR	2	2	0
1/2 MAY	2	3	0
Total	28	26	1
Mortality	5	0	0

NATURES Semi-natural Raceway Habitat: The Forks Creek Experience

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Abstract

Natural Rearing Enhancement (NATURES) studies conducted from 1992-1994 have shown that the in-stream survival of chinook salmon reared in raceways with semi-natural habitat composed of gravel substrates, in-stream structure, and overhead cover may be 25 to 50% higher than that of salmon reared in conventional raceways. A new experiment was initiated at the Washington Department of Fish and Wildlife Forks Creek Hatchery to determine if semi-natural raceway habitat also increases smolt to adult survival. Since 1997, fall chinook salmon have been reared from swim-up fry to zero-age smolt in 9.75 m long raceways. Each year, half of the raceways have been fitted with semi-natural habitat composed of gravel paver substrate, conifer in-stream structure, and camouflage net overhead cover, while the other half are maintained as conventional controls. The raceways fitted with semi-natural raceway habitat can be cleaned with conventional vacuum technology and require only a minor increase in maintenance effort. The in-stream survival of smolts reared in semi-natural raceway habitat averaged 3.8, 10.0, 24.0, and 1.0% higher than their conventional counterparts in 1997, 1998, 1999, and 2000 respectively. The relative in-stream survival advantage for semi-naturally reared fish was greatest (10.0 and 24.0%) in years when baseline (control) survival was less than 61% (60.6 in 1998, 59.3 in 1999). In years, when baseline survival increased above 73% (73.3 in 1997, 80.2 in 2000) the relative survival difference was reduced (3.8 and 1.0%). Theoretically, survival advantages of NATURES may be highest when survival difficulties (e.g., predation) are most severe. The recovery of coded wire tagged salmon released to the sea will be followed over the next five years to determine if semi-natural raceway habitat rearing produces similar increases in smolt to adult survival.

Session II -
Fish Propagation and Conservation – Program Updates

Session Chair:
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Successful Natural Production of Hatchery Spring Chinook Salmon: A Lesson From Lookingglass Creek in Eastern Oregon

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Abstract

Hatchery-produced adult Rapid River stock (RR) spring chinook salmon that returned to Lookingglass Hatchery were used to evaluate the restoration of natural production in Lookingglass Creek. We compared life history characteristics and production indices of the adult RR and their naturally-produced progeny with those of the extinct Lookingglass Creek natural population (LCE), and other naturally-produced fish from Grande Ronde River (GRR) or other Columbia and Snake River basin tributaries (CSR). We released from 50 to 133 adult RR above Lookingglass Hatchery in 1992, 1993, 1994, 1996, and 1997. We estimated that in some years 9 to 198 additional fish passed the weir without capture. There was no significant difference in mean adults-per-redd among the RR, LCE, or CSR.

The mean juveniles-per-redd for the RR (1993 to 1997) cohorts was higher than the mean for LCE (1965 to 1969) and GRR (1993 to 1997) cohorts. Monthly median fork lengths of juvenile salmon from the RR cohorts were similar or greater than the range for the LCE cohorts. Downstream movement of juveniles for the RR cohorts peaked 1 to 2 months later in the fall than the LCE cohorts. Juveniles from both the RR and LCE moved downstream predominantly as sub-yearlings. RR fish that were PIT-tagged exhibited arrival timing at, and survival indices to, Lower Granite Dam within the range observed for GRR fish. Progeny-per-parent ratios for RR fish were similar to those estimated for GRR.

Status of the Grande Ronde Basin Spring Chinook Salmon Captive Broodstock Program

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Abstract

Extremely low returns of adult spring chinook salmon (*Oncorhynchus tshawytscha)* compelled the initiation of a captive broodstock gene conservation program for the Grande Ronde Basin. The program began in 1995 with collection of wild parr from each of Catherine Creek, Lostine River and upper Grande Ronde River with the objective of restoring population numbers to 150 returning adults while maintaining genetic diversity and integrity of each stock and nearby wild stocks. Up to 500 wild parr are collected from each stream and cohort and reared to smoltification at Lookingglass Fish Hatchery. From smoltification to adulthood they are reared in freshwater at Bonneville Fish Hatchery or in saltwater at Manchester Marine Laboratory. Performance indices, such as growth, survival, fecundity and fertility rates, sex ratios, age of maturity and causes of mortality, were measured, recorded and evaluated for each stock, cohort and treatment and F_1 generation fish were monitored for survival, growth, migration and return indices. Indices were compared among stocks, cohorts and treatments and with expected rates from the literature that were used to develop this program. The Captive Broodstock Program has met or exceeded most, but not all, expected rates. Unresolved problems remain, including: inability to collect parr each year in Grande Ronde River; BKD-caused mortality and culling; low growth rate; synchronizing maturation timing with wild fish; low fecundity, egg-to-smolt survival, smolt production and migration survival of; and disposition of excess F_1 fish in years of overproduction. This program will provide information that will be useful to other, similar efforts.

Saltwater vs. Freshwater Rearing in the Grande Ronde River Basin Spring Chinook Salmon (*Oncorhynchus tshawytscha*) Captive Broodstock Program

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Abstract

A captive broodstock gene conservation program was developed in 1995 for Grande Ronde Basin spring chinook salmon (*Oncorhynchus tshawytscha*) due to extremely low adult returns. Up to 500 wild parr were collected in each of Catherine Creek, upper Grande Ronde River and Lostine River. These fish are reared to smoltification at Lookingglass Fish Hatchery and from smolt to adult in either freshwater (Bonneville Fish Hatchery) or saltwater (National Marine Fisheries Service, Manchester Marine Laboratory) after smoltification. At maturity the saltwater-reared fish are transported to Bonneville Fish Hatchery for spawning. We compared survival, growth and spawning characteristics between fish reared in either freshwater or saltwater and spawned in 1998-2001. A greater percentage of fish reared in freshwater survived to spawn and freshwater produced larger fish of both sexes at each age. Four-, five- and six-year old freshwater females were longer, heavier and/or with higher condition factor (K). Three-year old freshwater males had greater length, weight and K and four and five-year-old males had higher K. Mean age of spawners was lower (2.9 years vs. 3.0 years) in freshwater males, but not different for females. Mean fecundity was higher but number of eggs / kg was lower in freshwater females. Mean number of eggs / kg decreased with age of freshwater females but increased with age for saltwater females. Mean fertility, hatching success and time of spawning within the spawning season were similar between the two treatments. These results will be used to improve rearing methods in this and other captive broodstock programs.

Reconditioning of Wild Steelhead Kelts

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Abstract

Results of three years of reconditioning steelhead kelts in freshwater tanks will be discussed. Condition of the spawned out adults at time of capture is strongly related to survival and redevelopment of gametes. Another important factor in reconditioning kelts is successfully transitioning to commercial feed. Different diets were tested to determine relative time to first feeding, and percentage of fish that eventually feed. Reconditioned adults are released in mainstem Yakima River and allowed to return to natal streams and spawn naturally. Reconditioned adults are radio tagged at release to determine when and where spawning occurs.

Precocial Maturation and Migration in Yearling Hatchery Chinook Salmon, Umatilla River, Oregon

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Abstract

Hatchery-produced fall and spring chinook salmon, *Oncorhynchus tshawytscha,* return to the Umatilla River, Oregon as mini-jack, precocial yearling males. In some years mini-jacks comprise up to one half the Umatilla River return. Our goal was to determine if mini-jacks migrated to saltwater, or stayed in the Columbia River prior to returning. In 1999-2000 we collected otoliths from adult male fall chinook salmon, fall and spring chinook salmon mini-jacks and from a reference group of fall chinook salmon juveniles held in the Columbia River 14 days. All mini-jacks and adults were of hatchery origin confirmed by coded wire tag recovery and had been released after one month of acclimation in the Umatilla River. We tested Sr/Ca ratios across the otoliths with microchemistry to determine whether they spent time in saltwater. Analysis of water chemistry data confirmed that mini-jacks migrated at least 350 km to the estuary or further into saltwater prior to returning. They all had gonadotropic indices over 5% similar to adults and jacks. Factors that may contribute to mini-jack development include size and date at release, acclimation (one month versus over-winter), and heritability within certain stocks at different hatcheries. Management implications include fewer returning adults, overestimated of escapement since mini-jacks are included in some determinations, potential fishery and interference with other chinook salmon stocks.

Spring Chinook Salmon on the Warm Springs Indian Reservation of Oregon

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Abstract

Spring chinook salmon (*Oncorhynchus tshawytscha)* have been a vital component of the culture, nutrition and economy of the Indian tribes of the Columbia Basin for thousands of years. A variety of human and natural impacts have eliminated or reduced naturally spawning stocks. In the 10,000 square mile Deschutes River drainage, the only remaining wild populations of spring chinook exist in the Warm Springs River and Shitike Creek, both of which are entirely within the boundaries of the Warm Springs Indian Reservation of Oregon. Life history parameters, including spawning escapement, redd production, juvenile outmigration, harvest, and adult returns have been monitored through cooperative efforts for more than 25 brood years. The population has fluctuated dramatically over the study period. During droughts of the late 1960's, late 1970's and early 1990's the population declined. Strong year classes have been associated with good water years. The population has been very resilient, and the 1996 and 1997 brood years have produced record numbers of returning adults. Furthermore, operation of Warm Springs National Fish Hatchery is an integral component of production of spring chinook salmon on the Warm Springs Indian Reservation. Hatchery fish provide a harvestable surplus for tribal and sport fisheries and also provide a source of live adults and carcasses for use as outplants and for nutrient enrichment in streams underseeded by natural production.

Hatcheries, Harvest and Wild Fish: An Integrated Program at Warm Springs National Fish Hatchery, Oregon

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Abstract

Warm Springs National Fish Hatchery is operated by the U.S. Fish and Wildlife Service and is located on the Warm Springs River within the Warm Springs Indian Reservation of Oregon. The Warm Springs River is a major tributary of the Deschutes River in north central Oregon, which enters the Columbia River 205 miles from the Pacific Ocean. The purpose of the hatchery program is to cooperatively manage the hatchery with the Confederated Tribes of the Warm Springs Reservation of Oregon to provide harvest opportunities and protect wild fish populations. The management objectives established for the hatchery are: 1) produce fish for harvest, 2) maintain wild fish traits in the hatchery and stream environment, 3) minimize impact on wild fish to very low, acceptable levels, and 4) develop and implement a hatchery operations plan to achieve our harvest and conservation goals for Warm Springs River fish populations. The management of Warm Springs National Fish Hatchery demonstrates a sustainable program which integrates hatcheries, harvest and wild fish production.

Introduction

In this report, we present information on the Warm Springs National Fish Hatchery Program. We present information about the history of hatchery production along with providing comparisons of hatchery and wild life history traits and comparative performance measures. This paper describes a sustainable program that integrates hatcheries, harvest and wild fish production.

Information on the management of Deschutes River fish populations can be found in Oregon Department of Fish and Wildlife (1997). Spateholts and Olson (2001) presented information on the cultural significance and natural production of spring chinook salmon on the Warm Springs Indian Reservation. This paper describes an integrated program at Warm Springs National Fish Hatchery, which considers both harvest and wild fish production objectives.

The U.S. Fish and Wildlife Service (Service) operates Warm Springs National Fish Hatchery. The purpose or goal of the hatchery program is to cooperatively manage the hatchery with the Confederated Tribes of the Warm Springs Reservation of Oregon (Tribe) to provide harvest opportunities and protect/conserve wild fish populations (Olson et al. 1995; USFWS 1999). The Tribe and Oregon Department of Fish and Wildlife (ODFW) co-manage the Deschutes River fisheries.

As with most hatchery programs, a primary objective is to produce fish for harvest. We also wish to maintain wild fish traits in the hatchery and stream environment, and minimize

impact on wild fish to very low, acceptable levels. To achieve our harvest objective and conserve Warm Springs River fish populations, we develop every five years, and implement annually, our Hatchery Operations Plan. This plan is policy guidance and is signed by representatives of both the Service and Tribe.

Production plans for the hatchery have changed over time. In the 1971 Master Plan, a substantial program was planned for stocking Reservation waters with trout. In 1977, with facility design changes and shifting Service and Tribal priorities, the trout program was reduced. And in 1981, the trout program was reduced further and hatchery production of summer steelhead (*Oncorhynchus mykiss*) was terminated because of disease and rearing problems. Hatchery production is now 100% spring chinook salmon (*Oncorhynchus tshawytscha*) with a production goal between 500,000 and 750,000 juvenile fish at 15 fish per pound.

Methods

Warm Springs National Fish Hatchery is located at River Mile 8 on the Warm Springs River, within the Warm Springs Indian Reservation, in north central Oregon (Figure 1). The Warm Springs River enters the Deschutes River at River Mile 84, which enters the Columbia River 205 miles from the Pacific Ocean, upstream of only two main-stem dams on the Columbia River, Bonneville and The Dalles dams.

The data was collected and analyzed through cooperative efforts by all three agencies, the Service, ODFW, and Tribe. A number of comparisons between hatchery and wild fish were examined. We reviewed juvenile and adult life history and production from the Warm Springs and Deschutes Rivers.

The run reconstruction data was developed using the mouth of the Deschutes River as our reference point. Adult recruitment was estimated by adding escapement plus harvest. Escapement was determined by enumerating adult fish returning to the Warm Springs River at the hatchery trap site by Service personnel. Harvest in the Deschutes River was estimated by ODFW and the Tribe as described in Lindsay et al. (1989).

Returning fish were sorted by species, examined for marks and sampled at the hatchery to determine age, length and sex composition. To determine age, coded-wire tags were recovered from hatchery fish (Johnson 1990) and scales were collected from 50 to 200 wild fish. Age was noted using the standard Gilbert and Rich (1927) format for pacific salmon. Length was measured to the nearest cm fork length. Hatchery fish were also sampled in the fishery and at the hatchery to recover coded-wire tags (Vreeland 1990).

The number of spawners was estimated by spawning ground surveys conducted by Tribal staff. Knowing how many fish were passed upstream of the hatchery and how many redds were deposited, we obtained an estimate of adult fish per redd production. By incorporating an estimate of the number of females upstream, we estimated pre-spawning mortality, where female mortality = 1-(# redds / # females). The total number of eggs taken and eggs per female were estimated by hatchery staff. The egg per female estimate for hatchery fish was also used to estimate egg deposition for wild fish, where each redd represented one female. Recruit per spawner ratios were used to estimate productivity of wild and hatchery fish.

Juvenile fish at the hatchery were externally marked prior to release to identify them as hatchery fish in the fishery and upon return to the hatchery. For external marks, we have applied a ventral fin clip and/or an adipose fin clip. For over 10 years now, hatchery production of

spring chinook has been 100% adipose fin clipped and coded-wire tagged. This marking has also allowed us to conduct rearing and release group studies at the hatchery (Olson 1997).

Hatchery methods used standard Service techniques as described in Piper et al. (1982). Sampling was conducted at the hatchery for tag retention, mark quality, length and weight. We crowded fish to obtain our sample size of a minimum 100 fish per pond and between 300 to 500 fish per tag code. Juvenile fish were measured to the nearest mm fork length and/or total length. Fish were weighed using the "wet" method to determine number of fish per pound in each pond sampled. The number released from the hatchery into the Warm Springs River was quantified by subtracting the total pond mortality from the total number ponded at time of marking. Hatchery records were maintained by the Service's Columbia River information System or CRiS (Pastor 1992).

The Tribe estimated wild and hatchery juvenile production from the Warm Springs River by operating an out-migrant trap near the mouth of the Warm Springs River. Fish collected in the trap were also measured and weighed. For more detail see Lindsay et al. (1989) and Spateholts and Olson (2001).

Pearson's chi-square statistic (alpha @ 0.05) was used to compare age and length frequency distributions between hatchery and wild fish. Student's t-test and analysis of variance models (alpha @ 0.05) were used to test for differences in length at downstream migration, length at spawning, and differences in survival rates between hatchery and wild fish at various life stages, as appropriate. Additional details are provided in the subsequent results & discussion section. Statistical procedures are described in Zar (1974). SYSTAT, Microsoft PowerPoint and Excel, dBASE, and Lotus copyrighted software were used to analyze and present the data (reference to trade names does not imply endorsement by the U.S. Fish and Wildlife Service).

Results & Discussion

Spring Chinook Hatchery Broodstock - Production at the hatchery began in 1978. During the first 4 years of production (1978-81), 100% of the broodstock were wild origin. Initial guidelines were to not exceed one-third of the wild return or about 450 fish for hatchery broodstock, taken throughout the run.

During the first 10 years of operation, wild fish contributed a significant portion to the hatchery broodstock (Figure 2). We have recently developed a sliding scale for wild fish inclusion based on their projected return. For example, at wild runs < 800 no wild fish are retained for broodstock, and at wild runs >1,300 up to 10% of the broodstock can be wild brood (or about 60 wild fish for a hatchery broodstock of 600). Using this sliding scale method, we are considering increasing the number of wild fish in the hatchery broodstock during years of high wild fish abundance. For example when 1,800 or more wild fish are projected back to the Warm Springs River, up to 15% of the broodstock may be wild fish. Our goal, over a 10-year period of variable recruitment, is to have an average10% wild fish in our hatchery broodstock.

Juvenile Production - Juvenile releases of spring chinook salmon from the hatchery have ranged from 200,000 to over 1 million fish (Figure 3). Release goals now range between 500,000 and 750,000, depending in part from adult returns available for broodstock and on-going rearing density studies. The number of juveniles released from the hatchery exceeded wild juvenile production from the Warm Springs River each year since 1978. Wild production of

spring chinook salmon from the Warm Springs River has ranged from 30,000 to over 100,000 juvenile fish (Spateholts and Olson 2001).

Wild fish have shown a fall and spring out-migration pattern from the Warm Springs River with up to two-thirds exiting during the fall out-migration period (Lindsay et al. 1989; Spateholts and Olson 2001). Releases from the hatchery were typically split into fall and spring releases as well (Figure 3). The fall sub-yearling release from the hatchery has ranged from 10% to 50% of production. Since 1991, about 10 % of hatchery production was volitionally released in the fall as described in Olson (1997).

Examining their size at out-migration (mean (+/- SD) fork length), juvenile hatchery fish at release were larger than their wild counterparts, especially the fall out-migrants. For example, hatchery fish averaged 167mm (+/- 26mm) in fall of 1996 (n=448) and 149mm (+/- 26mm) in spring of 1997 (n=851), whereas wild fish averaged 98mm (+/- 11mm) in fall of 1996 (n=305) and 112mm (+/- 15mm) in spring of 1997 (n=64) as shown in Figure 4. For each out-migration period we used a two-sample t-test on length grouped by stock, assuming unequal variances. There was a significant difference in fork length between hatchery and wild fish for both the fall ($P<<0.001$, t =-50.0) and spring out-migration periods ($P<<0.001$, t=-17.5). A significant difference was also observed eight years prior for the fall of 1988 and spring of 1989 time periods (Olson et al. 1995).

Previous studies have shown that spring yearling fish, both wild and hatchery, migrate quickly downstream and can exit the Deschutes River within days (Cates 1992). The wild fall migrants typically over-winter in the Deschutes River (Lindsay et al. 1989). Hatchery fish released in the fall appear to exhibit both a fall and spring migration from the Deschutes River. There is evidence that smaller hatchery fish are over-wintering in the Deschutes River whereas some of the larger fish exit the Deschutes River that fall (USFWS 1999). To shed more light on the fate of fish released in the fall, the U.S. Geological Survey-Biological Resources Division, Columbia River Lab have initiated studies using radio telemetry techniques.

Average age at return - We updated Olson et al. (1995) with seven additional years of data to determine average (+/- SD) age composition of the Warm Springs stock at return to the Deschutes River, brood years 1978-95 (Figure 5). For both wild and hatchery stocks, most fish returned at age four (80% (+/-8%) for wild and 82% (+/-9%) for hatchery fish). However, the wild stock had more fish returning at age five (16% (+/-7%) for wild and 7% (+/-5%) for hatchery fish), whereas the hatchery stock returned more age three fish (5% (+/-1%) for wild and 11% (+/-7%) for hatchery fish). We pooled all brood years (n=18) and found a significant difference in age distribution between wild and hatchery fish ($P<<0.001$, Chi-square=1,816).

Length at spawning - Olson et al. (1995) previously reported a significant difference in length frequency distributions for age four and age five wild and hatchery fish. Age five fish were found to be significantly larger than age four fish; and wild fish were significantly larger than hatchery fish. Upon further investigation, Olson et al. (1995) used 1991-93 data where wild fish were sampled as they were passed upstream from May through early September while hatchery fish were sampled at time of spawning in late August and early September. All data from 1991-93 were pooled for both spring and fall periods. To further explore this issue, we eliminated the spring sample period and examined fork length of age four and age five hatchery and wild fish only at time of spawning. We pooled years 1990, 1992 and 1996, when approximately 10% of the broodstock were wild fish, and looked for differences in length. Sex

and fork length were recorded from each fish spawned. We found that age five fish were larger than age four fish, males were bigger than females, and wild fish were bigger than hatchery fish (Figure 6). For each age we used a 2 x 2 Analysis of Variance model to look for significant differences between each stock and sex. For age four fish, there was a significant difference (P=0.009) in length between wild (n=129) and hatchery (n=1,293) fish but no significant difference (P=0.135) between sexes was found. For age five fish, the largest difference was between sexes (P=0.057) with no significant difference (P=0.433) found between wild (n=31) and hatchery (n=64) stocks. Furthermore there was no significant interaction of stock and sex on the length of age four (P=0.96) or age five (P=0.99) fish.

We also specifically looked for differences in lengths between hatchery and wild females. For each age we used a two-sample (pooled variance) t-test on length grouped by stock. For each age group, wild females were larger than hatchery females (Figure 6). We were able to detect a significant difference between hatchery (n=763) and wild (n=73) females at age four (P=0.02, t =-2.4). The difference between age five hatchery (n=37) and wild (n=17) females was not statistically significant (P=0.5, t =-0.6), in-part because of small sample size. The difference in means between hatchery and wild females in both age groups was 1.1 cm. The biological significance of 1.1 cm is not great but it may have an influence in the number of eggs produced per female. After examining 24 egg takes at Warm Springs NFH, egg production was positively correlated to the length of each mature female spawned (r = 0.655) and was a significant linear relationship, P < 0.001 (Columbia River information System, 10/16/01; see also Pastor and Sheldrake 1995). Based on this relationship, hatchery fish would produce fewer eggs per female than wild fish of the same age.

Differences in age and length at return may be affected by size at release from the hatchery. Our target has been to release fish at 15 fish per lb., however we have recently observed good survival of fish released at a smaller size at 22 fish per lb. We need to continue looking at size at release from the hatchery to not only maximize survival but also determine if we can achieve similar size at release, as well as achieve similar age and length composition at return for hatchery and wild fish.

Cumulative run timing - We examined 13 years (1987-1999) of return timing data collected at the hatchery. Wild and hatchery fish returned to the Warm Springs River from late April through September, spawning from late August through September. Most wild and hatchery fish returned to the Warm Springs River by late June. However, in the early part of the run, hatchery fish typically had a one to two week lag in their return when compared to wild fish (Figure 7). For example, by May 31 of each year, an average 64% (+/-15% SD) of the wild and 49% (+/-14% SD) of the hatchery fish had returned to the Warm Springs River. By June 30 of each year, an average 89% (+/-5% SD) of the wild and 85% (+/-5% SD) of the hatchery fish had returned. We pooled all brood years, separated by one-month intervals from May 31 through September 30 and found a significant difference in cumulative run timing between wild and hatchery fish (P<<0.001, Chi-square=396). Recognizing this difference, we have developed a broodstock collection strategy based on wild stock returns. Size at release may be affecting age at return, which may affect run timing as well. We will continue monitoring our management actions to see if a similar run timing between wild and hatchery fish can be achieved.

Survival - We have compared survival of hatchery and wild fish at different life stages and tested for significant difference using a paired sample t-test (Wilcoxon non-parametric analysis) for brood years 1978-96 (n=19). As expected, we observed an inverse relationship in

egg-to-juvenile and juvenile-to-adult survival between hatchery and wild fish (Table 1). Hatchery fish had a consistent survival advantage from egg-to-juvenile (75% +/- 18% SD vs. 9% +/- 4% SD) and wild fish had a consistent survival advantage from juvenile-to-adult (2.8% +/- 2.7% SD vs. 0.3% +/- 0.3% SD). These differences between stocks were highly significant for both egg-to-juvenile ($P<<0.001$) and juvenile-to-adult survival ($P<< 0.001$).

Mixed results were observed when comparing the adult recruit per spawner (R/S) ratio (Table 1). Wild fish had higher R/S ratios 13 out of 19 years while hatchery fish had higher R/S ratios 6 out of 19 years, however this difference was not significant ($P=0.243$). The average R/S ratio was similar for both stocks, with an average R/S ratio of 3.2 (+/- 1.9 SD) for wild and 2.8 (+/- 3.3 SD) for hatchery fish. A R/S ratio of one or greater indicates a population that is replacing itself over time and a population with a R/S ratio of about 3.0, as seen here for both wild and hatchery fish, has the potential to sustain a fishery, which leads into our next discussion, harvest in the Deschutes River.

Harvest - The primary fishing area for spring chinook salmon in the Deschutes River occurred at Sherars Falls (ODFW 1997). Both wild and hatchery fish have contributed to harvest (S. Pribyl, ODFW, personal communication). As shown in Figure 8, more wild than hatchery fish from the Warm Springs River were often harvested, until recently. Improved survival of Warm Springs hatchery fish and restrictive regulations on sport fisheries has led to increased harvest on hatchery fish, which is one of our objectives. For example, in return year 2000, almost 2,800 Warm Springs hatchery fish were harvested in tribal and sport fisheries, while only 339 wild fish were harvested (Gauvin and Olson 2001). A substantial number of wild fish were also caught (1,340) but were required to be released back to the river because of selective sport fishery regulations set by ODFW. Sport fishers were able to identify marked (adipose fin clipped) hatchery spring chinook. The objective of this ODFW regulation is to reduce sport fishing mortality on wild fish, catch & keep hatchery fish, and have more wild fish returning to the Warm Springs River to spawn.

Escapement goal - Based on analyses by Lindsay et al (1989), an escapement goal of 1,300 or more wild spring chinook salmon upstream of the hatchery has been established by the Tribe, ODFW and the Service. A wild spring chinook return projected to be less than 1,300 fish triggers more restrictive fishing regulations by ODFW and the Tribe. In early years of hatchery operation our intent was to supplement natural production; not all fish were marked; and up to 30% hatchery fish were passed upstream (Figure 9). Under our current operation plan guidelines, we manage for an exchange of 10% hatchery fish upstream for 10% wild fish incorporated into the hatchery broodstock. For example, in the 2000 return year over 2,600 wild and approximately 285 hatchery fish were passed upstream of the hatchery. We were also able to incorporate 55 wild fish with 452 hatchery fish for broodstock.

Pre-spawning mortality - From 1977 to 2000, the pre-spawn mortality of spring chinook salmon passed upstream of the hatchery to spawn naturally (both wild and hatchery fish) averaged 47% (+/- 12% SD). Spring chinook salmon kept for broodstock at the hatchery typically had less than 20% pre-spawn mortality, except for the first four years of hatchery operation (41% +/- 9%). Bacterial kidney disease was suspected as one of the primary causes of high pre-spawn mortality, especially in 1980 and 1981 for both the naturally spawning population (74% mortality) and hatchery broodstock (48% mortality). Because of this, erythromycin injections were administered since 1982 to all hatchery and wild adult spring

chinook salmon either passed upstream or kept for broodstock. After using erythromycin, the pre-spawn mortality of fish passed upstream of the hatchery has averaged 46% (+/- 10%).

The amount of handling on fish as they returned to the hatchery may have contributed to fish health problems and pre-spawn mortality. Operation of a volitional passage system is being investigated to reduce handling and pre-spawn mortality of fish passed upstream of the hatchery, as discussed in the following section. Fish passed upstream by the volitional passage system will not be handled and subsequently not given erythromycin as well.

Passage system - A new passage system was installed at the hatchery in 1996. Our objectives were to reduce pre-spawning mortality of fish passed upstream to < 40% (< 3 fish per redd), curtail erythromycin injections on volitionally passed spring chinook, achieve 95% passage efficiency for wild spring chinook, and achieve 90% passage efficiency for hatchery spring chinook (95% tag retention X 95% tag detection). Implementing the 100% coded wire tagging program along with installation of the new passage system at the hatchery will allow us to reduce the handling of wild fish and will hopefully reduce pre-spawning mortality.

Service engineers designed the passage system to fit in existing catch ponds at the hatchery (Figure 10). The passage system includes a modified 15-foot long Denil steeppass fishway (Bell 1986), along with a coded-wire tag tube detector and gate manufactured by Smith-Root, Inc. (Figure 11). A video system is in place to monitor fish passing upstream of the hatchery, similar to that described by Hatch et al. (1994).

The hatchery staff conducted tests of the system during 1996-98 (Figure 12). During these tests, the fish entered the ladder and swam up the steeppass. The effectiveness of detecting and guiding coded-wire tagged hatchery fish to a holding pond was monitored. Non-tagged hatchery and wild fish were also monitored as they were guided to another catch pond and recorded by a video system as they continued their migration through the ladder then on upstream of the hatchery.

The passage system met our objective of 95% passage efficiency for wild fish, with fewer than 5% wild fish passed to the wrong catch pond (95.4% (+/- 0.7% SD) average passage efficiency). However, separating out hatchery fish was not as effective and a number of limitations became evident. Efficiency improved each year but on average 10.7% (6.8% SD) of the hatchery fish were passed to the incorrect catch pond because of poor tag retention. In addition, 11.3% (7.5% SD) of the coded-wire tagged hatchery fish were not detected and were also passed to the wrong catch pond. Our objective was to achieve 90% passage efficiency for hatchery fish but overall we averaged 77.8% (11.5% SD) for the three years tested.

The sheer number of hatchery and wild fish returning also effects operation of the passage system. When a large number of hatchery fish returned relative to wild fish, even if the passage system separated out 90% of the hatchery fish, more than 10% of the fish upstream would have been hatchery origin. For example in 1999, 2,770 hatchery and 493 wild fish returned to the Warm Springs River. Even with 90% passage efficiency, 277 hatchery fish would have been passed upstream. This would not meet our operation plan guidelines, so the passage system was not operable in 1999. Also during peak passage times, the system did not respond quickly enough to separate out each individual fish. The upstream channel needed improvement as well. Fish milled around in the upstream catch pond and swam back and forth past the viewing chamber. This appeared to not only impede passage but also required hatchery staff to spend a considerable amount of time monitoring videotapes.

With improvements in tag retention, detection and passage past the viewing chamber, volitional passage can potentially benefit wild fish passing the hatchery site, including Endangered Species Act (ESA) listed bull trout (*Salvelinus confluentus*). However, another ESA listed fish, summer steelhead, may continue to limit full implementation of the passage system, as described in the next section.

Summer steelhead - Adult summer steelhead enter the Deschutes River beginning in June. They over-winter in the Deschutes River until entering the Warm Springs River in February just prior to spawning. The peak of the spawning run at the hatchery is in mid-April and the run is complete by mid to late May (Cates 1992).

As stated earlier, steelhead hatchery production in the Warm Springs River was terminated in 1981; since 1986 all hatchery steelhead coming back to the Warm Springs River are strays. To eliminate hatchery steelhead strays from the upstream spawning population, all steelhead were sorted at the hatchery. To maintain the genetic characteristics of wild steelhead in the Warm Springs River, we sacrificed all steelhead with missing or deformed fins and passed only unmarked "wild" fish upstream.

Starting in 1987 we observed a large increase in the estimated number of steelhead strays in the Warm Springs River (Figure 13). The percentage that were estimated as strays from 1987 to 2001 averaged 50.1% (+/- 11.8% SD), while the percentage of strays estimated from 1979 to 1986 averaged 11.8% (+/- 5.6% SD). If we were to pass all steelhead upstream, regardless of origin, a large proportion of the fish would have been strays since 1987. Because of these hatchery strays, the volitional passage system was not operated until the steelhead run was over in late May. In effect, we have maintained a wild fish refuge for steelhead upstream of the hatchery.

So where are these hatchery strays coming from? Each year we have observed a handful of steelhead strays with coded-wire tags. For example in 1998, 26 coded-wire tags were recovered. Based on simple mark release expansion we were able to account for the origin of 119 fish (Figure 14, from Olson and Pastor 1998). Note that 380 fish was the total stray count in 1998. Assuming the tagged-to-nontagged release expansion is accurate, 161 hatchery steelhead were recovered with an unknown origin. Almost all steelhead were marked to externally identify them as hatchery fish but not all were marked with representative coded-wire tags. We do not know the origin of all hatchery strays, but based on recoveries, the Snake River hatchery programs contributed a large portion of strays to the Warm Springs River, especially the Irrigon hatchery program which released steelhead into the Grande Ronde watershed of the Snake River.

The situation at Warm Springs is an indicator of a larger problem of hatchery steelhead straying into the Deschutes River. As estimated by ODFW, hatchery strays have accounted for over one-half of the estimated number upstream of Sherars Falls in recent years (Figure 15). For example, of the total 21,203 steelhead estimated past Sherars Falls in the 1999-2000 run year, 4,790 were wild, 2,628 were from Round Butte hatchery, and 13,785 were considered out of basin hatchery strays (S. Pribyl, ODFW, personal communication). The Draft NMFS Biological Opinion on hatcheries recognized this issue and has recommended some hatchery program changes in the Snake River to hopefully reduce the stray problem. Furthermore, all steelhead hatchery programs should have representative groups coded-wire tagged in order to assess straying. Fisherman should also be encouraged to keep all hatchery steelhead caught. The

Warm Springs program can continue to serve as an indicator for monitoring the effects of these management actions.

Conclusion

In this paper we have demonstrated that hatchery operations and production from Warm Springs National Fish Hatchery considered not only harvest, but wild fish production objectives as well. Future operations and research for evaluating this program include continuation of cooperatively collecting and sharing data between all three management agencies, the Tribe, ODFW and Service. For example, we will determine the annual run reconstruction of wild and hatchery spring chinook salmon, we will collect data for population monitoring of ESA listed summer steelhead and bull trout as well as monitor other fish passing the hatchery site, and we will continue with rearing and release studies at the hatchery to improve performance, including diet, growth, reduced rearing densities, and fish health evaluations. We will explore funding available to continue developing collaborative projects with our partners, including development of alternative rearing environments at the hatchery to simulate natural rearing behavior and growth, evaluating performance and ecological interactions of hatchery and wild fish, and evaluate & implement facilities to improve water quality at the hatchery. Using the information we have collected and analyzed to date, we have begun updating our operation plan for 2002-2006. We strive to cooperatively manage the hatchery in order to provide harvest opportunities and protect/conserve wild fish populations.

In *Fisheries* magazine, Pajak (2000) illustrated that institutions, society and the environment all need to be integrated to achieve a sustainable program. We are hopeful that our management of Warm Springs National Fish Hatchery demonstrates a sustainable program which integrates…hatcheries, harvest and wild fish production.

Acknowledgements

We wish to acknowledge contributions from the staff at the Warm Springs Tribe Department of Natural Resources, Warm Springs National Fish Hatchery, Lower Columbia River Fish Health Center, and staff from the Columbia River Fisheries Program Office, particularly Paul Wilson for advice on statistics, Donna Allard for desk top publishing and web page management, and Steve Pastor for data management. Howard Schaller and Tim Roth reviewed and provided helpful comments for this paper. Skip Walch, Pat Kemper, Tyson Lankford, Chuck Fuller, Travis Collier and Steve Olhausen were responsible for tagging and bio-sampling. Mike Paiya, Mavis Shaw, Dan Magneson, Randy Boise, Kevin Blueback and Cheryl Patterson-Courtney provide invaluable expertise at the hatchery. We also wish to acknowledge cooperative management from the Oregon Department of Fish and Wildlife, The Dalles District Office, especially Steve Pribyl and Erik Olsen for providing steelhead run data and spring chinook salmon harvest statistics.

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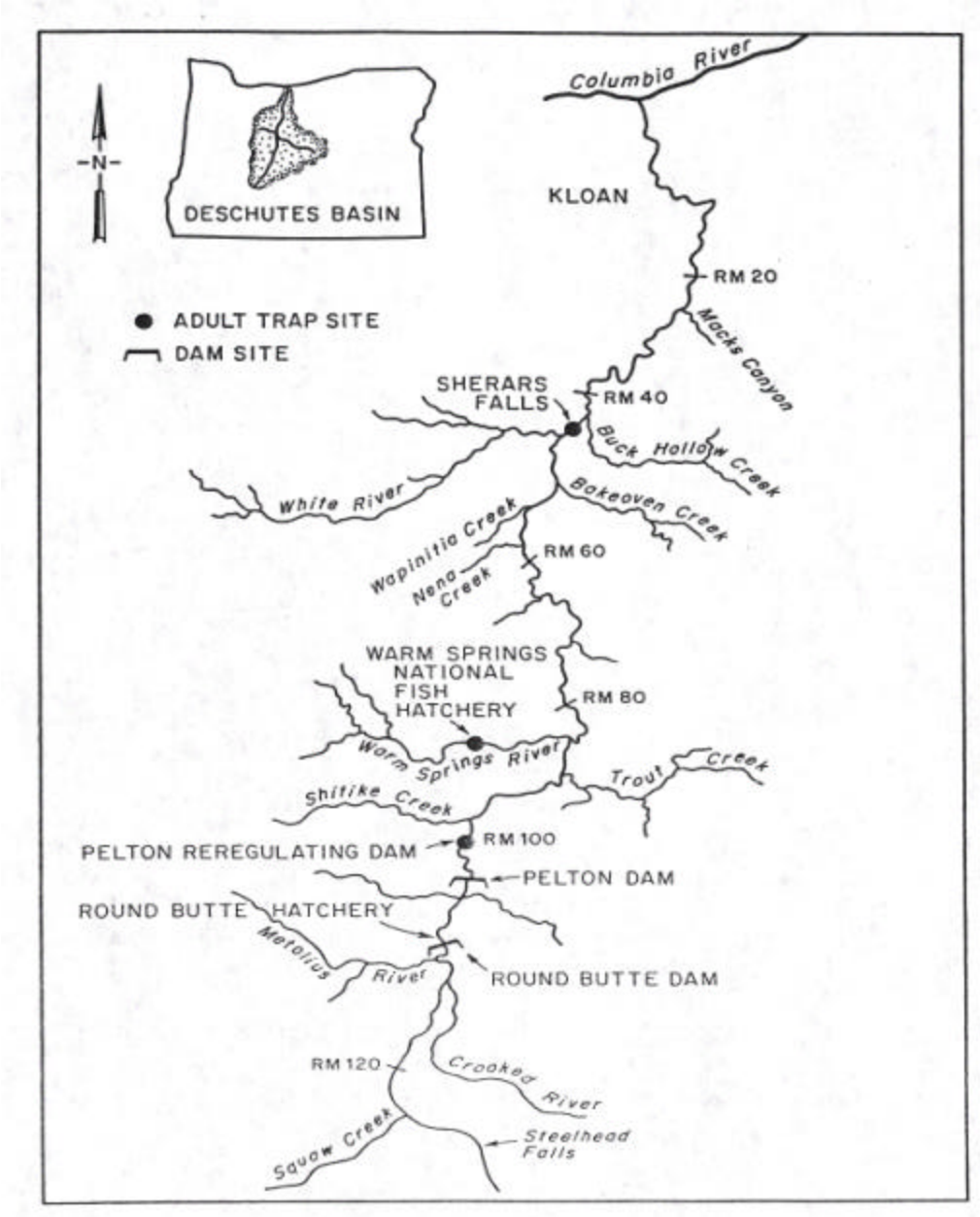

Figure 1. The lower 100 miles of the Deschutes River and location of Warm Springs National Fish Hatchery, Oregon (Lindsay et al. 1989).

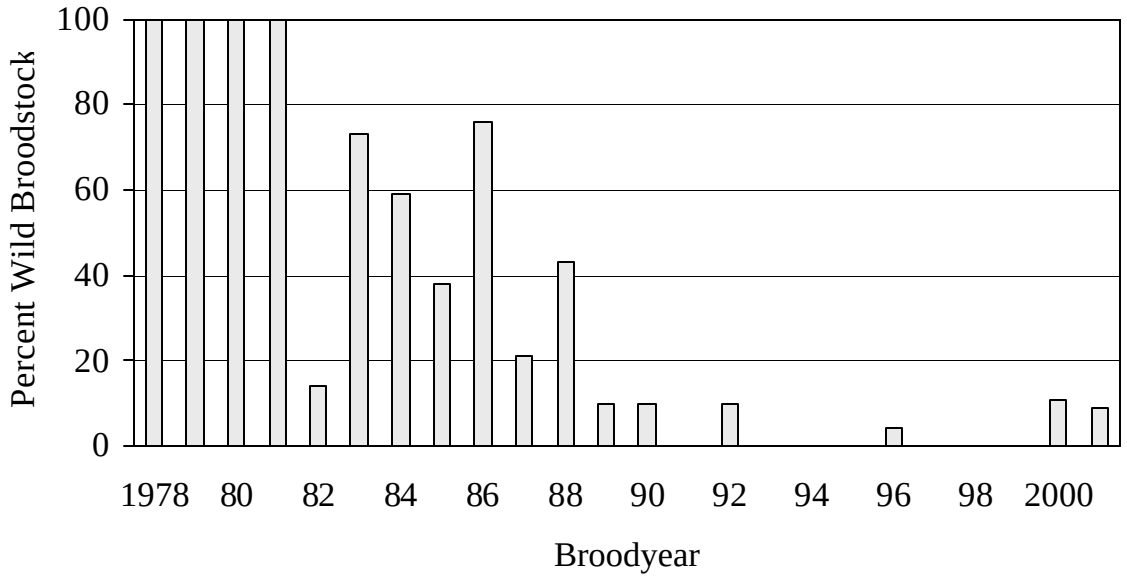

Figure 2. Percentage of wild spring chinook salmon used for broodstock at Warm Springs National Fish Hatchery, 1978-2001.

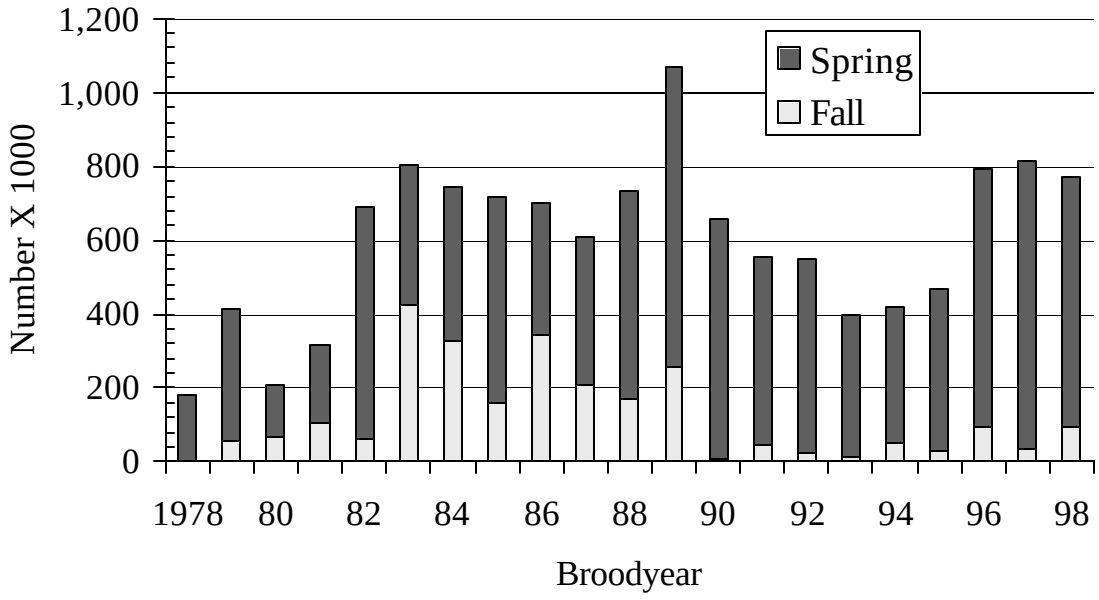

Figure 3. Releases of juvenile spring chinook salmon from Warm Springs National Fish Hatchery during fall and spring periods, broodyears 1978-98.

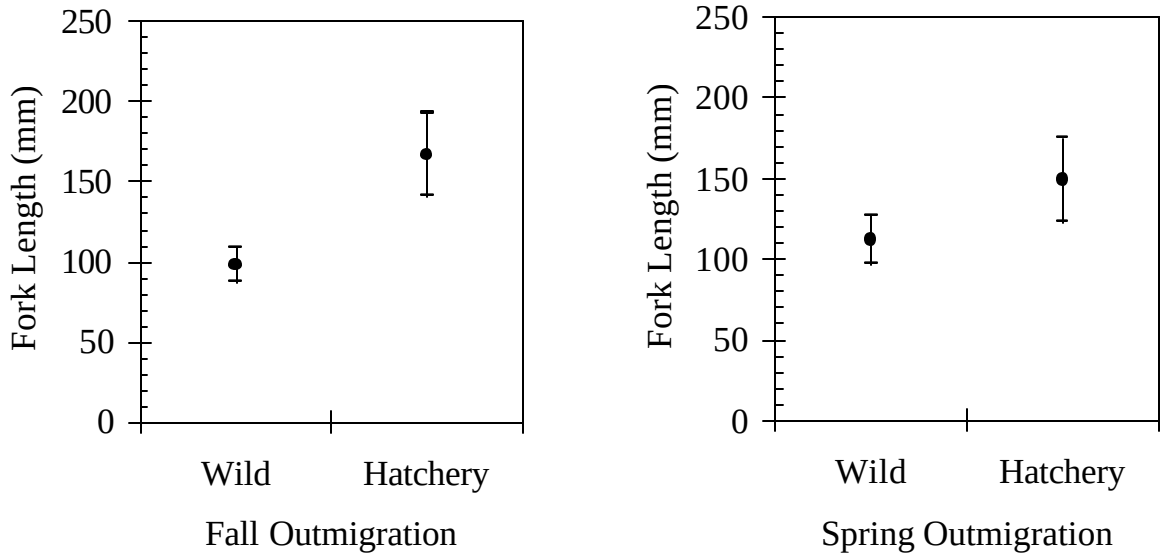

Figure 4. Fork length comparisons (mean and SD) between wild and hatchery juvenile spring chinook salmon during the fall 1996 and spring 1997 out-migration periods from the Warm Springs River.

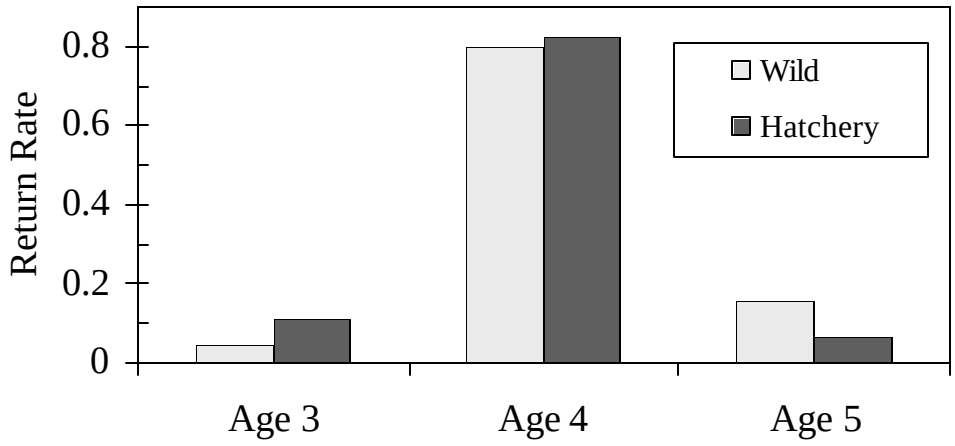

Figure 5. Comparison of age-class strength for wild and hatchery spring chinook salmon returning to the Deschutes River, brood years 1978-95.

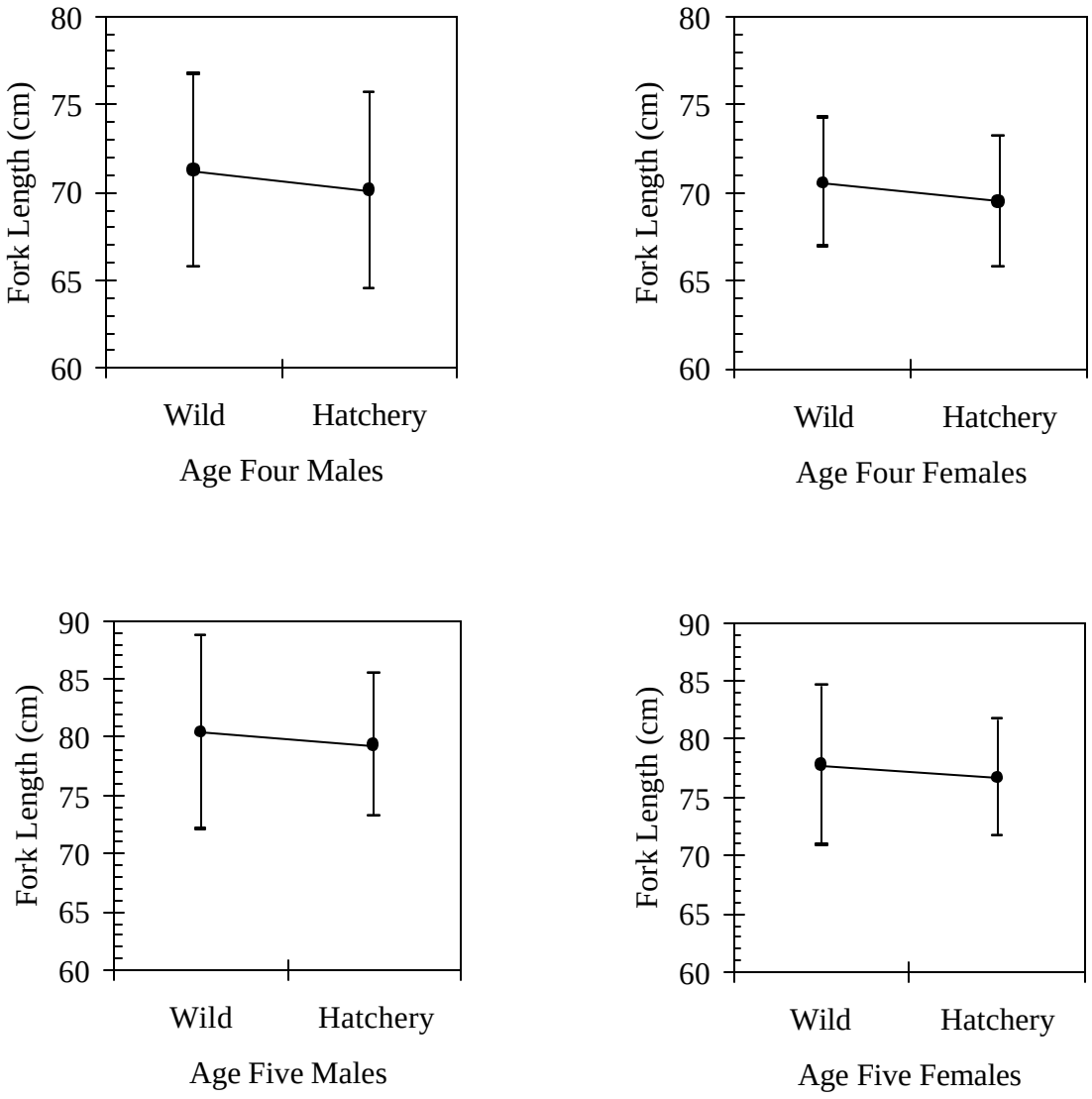

Figure 6. Fork length comparisons (mean and SD) between wild and hatchery adult spring chinook salmon in the Warm Springs River, sampled at spawning in 1990, 1992 and 1996.

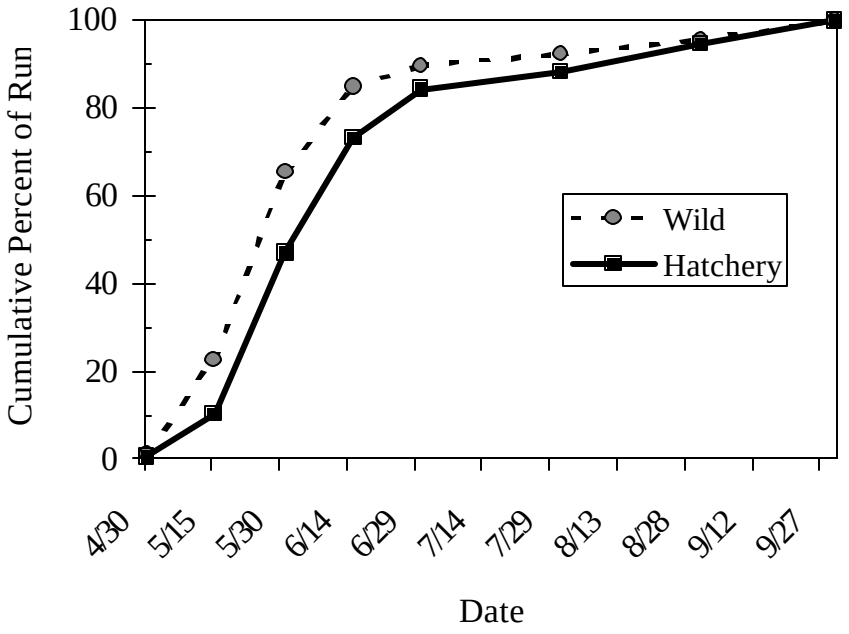

Figure 7. Cumulative run timing (%) of wild and hatchery spring chinook salmon returning to the Warm Springs River, 1987-1999.

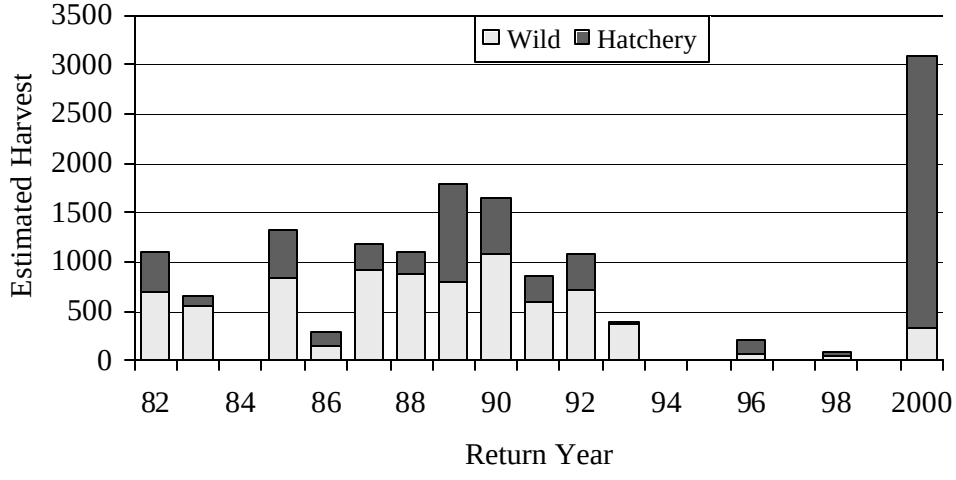

Figure 8. Estimated harvest of Warm Springs stock spring chinook salmon in the Deschutes River, 1982-2000. Data derived from S. Pribyl, ODFW, personal communications.

Table 1. Comparison of survival at different life stages for wild and hatchery spring chinook salmon from the Warm Springs River, 1978-1996 broodyears.

	Wild Stock			Hatchery Stock		
Brood Year	Egg to Juvenile (%)	Juvenile to Adult (%)	Recruit per Spawner	Egg to Juvenile (%)	Juvenile to Adult (%)	Recruit per Spawner
1978	6.38	1.52	1.59	25.89	0.84	2.65
1979	5.42	4.11	3.59	60.53	0.09	0.89
1980	11.58	3.30	6.46	53.99	0.42	2.76
1981	10.75	4.12	6.67	57.20	0.56	3.49
1982	8.73	2.82	4.16	71.71	0.03	0.30
1983	10.72	2.25	3.70	86.73	0.13	1.71
1984	8.74	2.41	3.33	70.46	0.12	1.38
1985	7.31	3.01	3.49	55.33	0.54	4.53
1986	8.27	3.19	3.57	87.14	0.28	3.20
1987	7.47	1.46	1.47	84.10	0.13	1.20
1988	9.88	1.78	2.65	86.94	0.18	1.79
1989	7.59	0.69	0.82	92.93	0.02	0.21
1990	7.29	0.44	0.52	68.94	0.005	0.04
1991	5.40	0.37	0.28	81.54	0.02	0.22
1992	13.66	2.57	4.11	88.95	0.16	1.58
1993	8.76	2.68	3.55	98.46	0.29	4.10
1994	13.79	0.46	0.99	85.71	0.15	1.94
1995	2.24	12.95	4.54	83.51	0.43	7.30
1996	18.48	2.27	6.09	93.45	1.27	14.35
Mean	9.08	2.76	3.24	75.45	0.30	2.82
SD	3.63	2.72	1.94	18.22	0.32	3.32

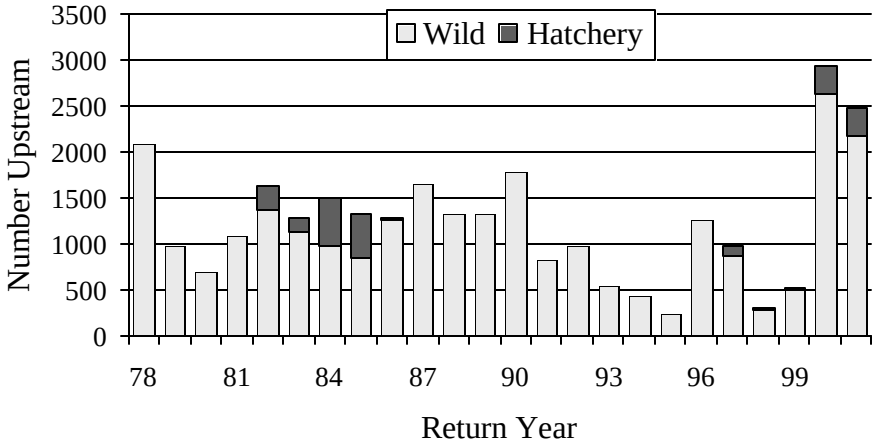

Figure 9. Number of wild (unmarked) and hatchery spring chinook salmon passed upstream of Warm Springs National Fish Hatchery, 1978-2001. A small percentage (< 5%) of unmarked fish each year may in fact be hatchery fish.

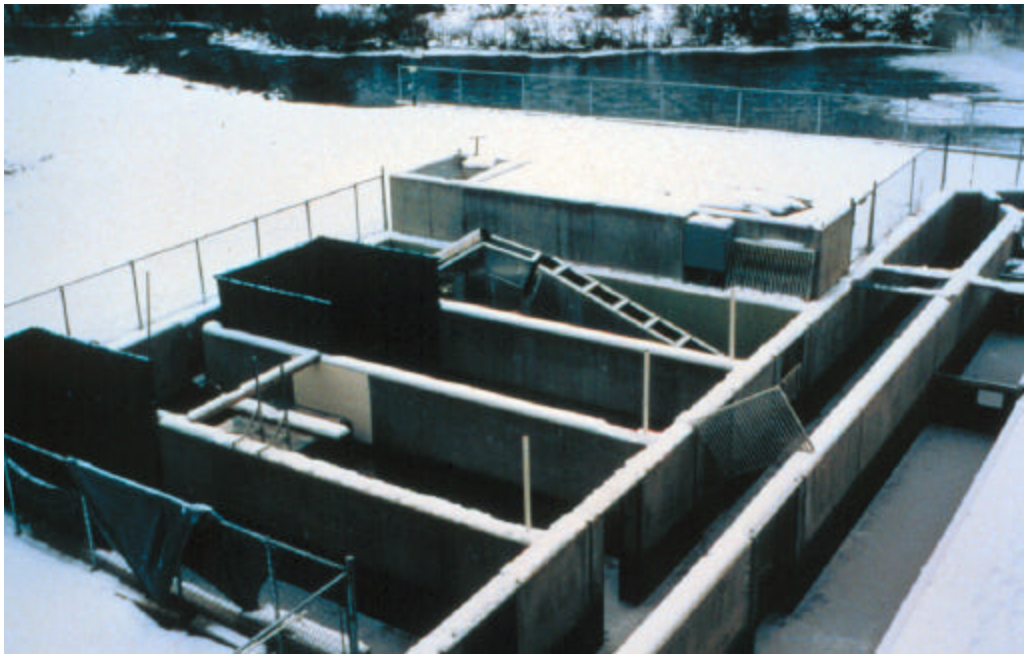

Figure 10. Volitional passage system installed in existing catch ponds at Warm Springs National Fish Hatchery, Oregon.

Denil Steeppass Fishway

Coded-Wire Tag Tube Detector

Video Camera Housing

Tag Detector Gate

Figure 11. Photographs of components of the volitional passage system installed in existing catch ponds at Warm Springs NFH.

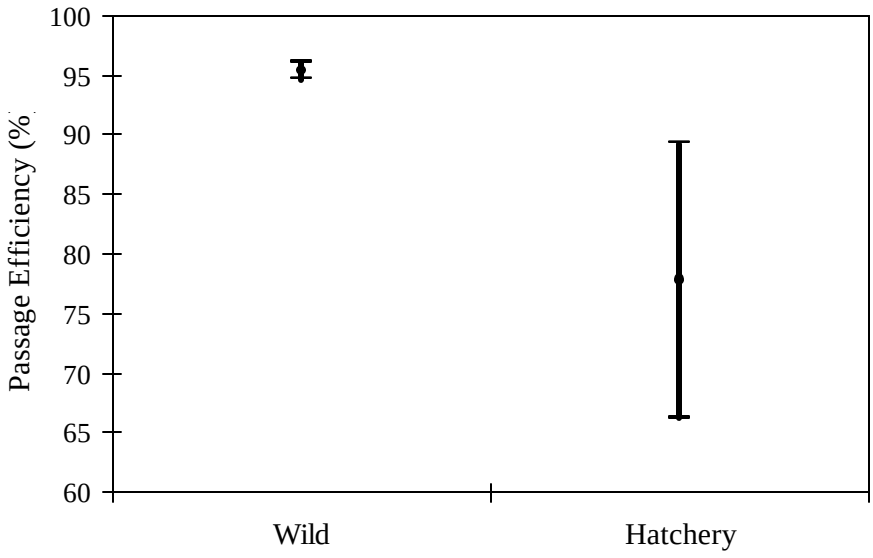

Figure 12. Percentage of wild (n=855) and hatchery (n=823) spring chinook salmon diverted to the correct pond during tests of the volitional passage system, 1996-98 (mean and SD).

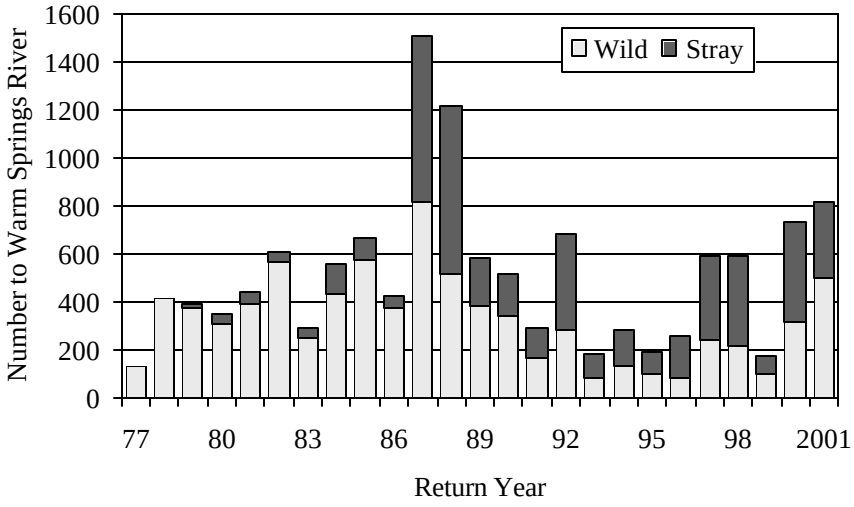

Figure 13. Total number of wild (unmarked) and stray hatchery summer steelhead returning to the Warm Springs River, 1977-2001.

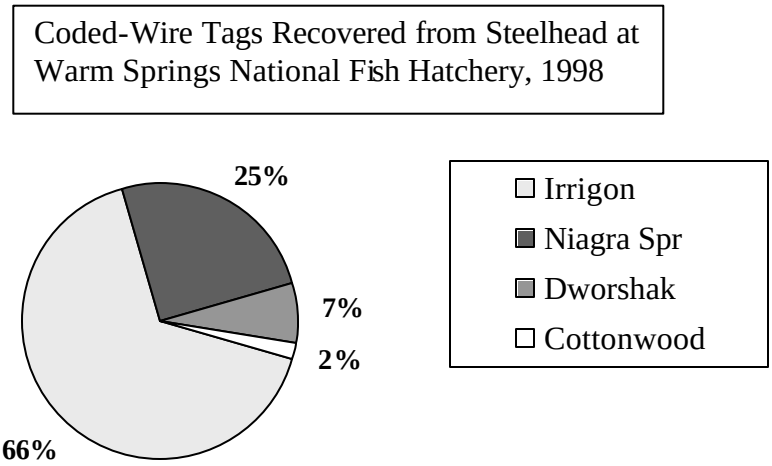

Figure 14. Hatchery origin of coded-wire tagged summer steelhead (n=26) recovered at Warm Springs National Fish Hatchery in 1998. The percent distribution represents an expanded estimate (n=119) of non-tagged and tagged release groups from the hatchery of origin (Olson and Pastor 1998). All adult recoveries in 1998 originated from Snake River juvenile release sites.

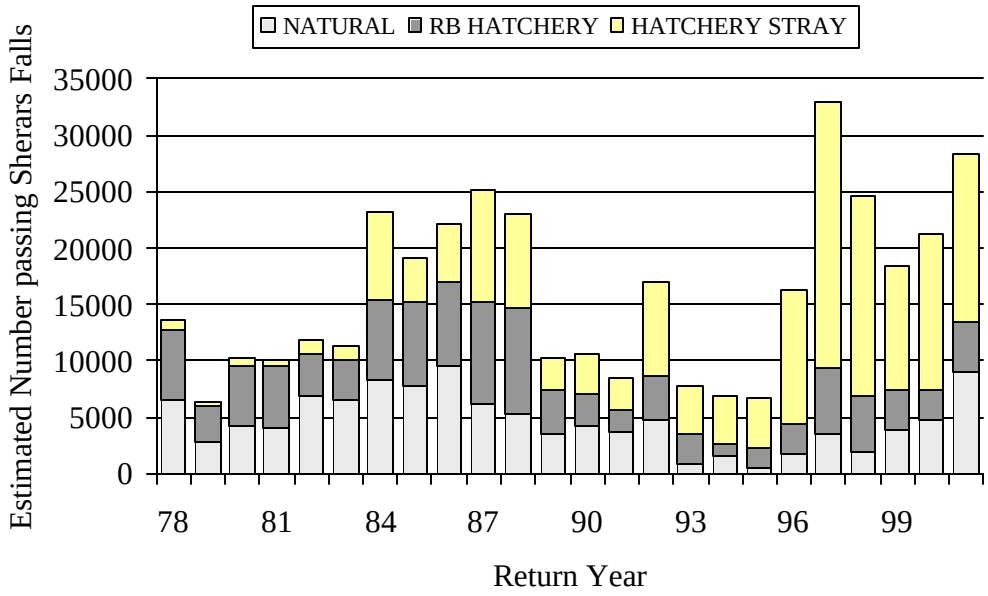

Figure 15. Estimated number of summer steelhead that migrated past Sherars Falls, Deschutes River, Oregon by run year 1977-78 to 2000-01 (S. Pribyl, ODFW, personal communication).

Cle Elum Supplementation and Research Facility First Adult Returns

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Introduction

The Cle Elum Supplementation & Research Facility (CESRF) utilizes traditional and experimental fish culture management practices in a production scale rearing and acclimation project. The emphasis for production is on the quality rather than quantity of fish propagated and reared at this facility. Supplementation describes the hypothesis of how natural runs could be strengthened as a result of this project: native adult salmon are artificially propagated, and natural production from the resulting adult returns will bolster naturally produced fish. The supplementation goal is to increase the number of naturally spawning fish, while maintaining long-term genetic fitness of the species under enhancement, and keeping adverse interactions with wild fish at a minimum (Maynard 1996, Pearsons et al, 1994). The CERSF releases juvenile chinook salmon from three acclimation sites near potential spawning habitat. The aim is to produce enough natural spawners to phase out artificial production of the target species altogether.

The proposed practices and operating philosophies of the CERSF differ from that of most Columbia River Basin hatcheries. Traditionally, conventional hatchery goals have been to increase fish numbers, mitigate for fish losses and increase harvest opportunities. The CERSF plan includes that and alternatively, strives to preserve the genetic diversity of supplemented fish stocks, compiles information on supplementation techniques, develops and carries out research activities and utilizes an adaptive management policy to risk-taking. Strategies to minimize negative genetic impacts are (but not limited to): creating a genetic/geographical index of naturally spawning salmon (Busack et al. 1991), not taking first generation supplemented progeny into the facility as broodstock but allowing them to spawn naturally, collecting broodstock over the migration period so as to be representative of a natural fish run, taking no more than 50% of the wild salmon for broodstock, applying factorial mating crosses to ensure genetic diversity, and using rearing vessels that resemble natural conditions more closely (Hager 1999).

Work Description/Methodologies

Wild adult brood fish randomly selected and trapped at Roza Dam throughout the spring chinook run, are transported to the facility where they are held for propagation in early fall. Historically, since 1997, adult collection and transportation starts in late-April to mid-May and continues through the month of August. At spawning time, individual female egg lots are sampled, divided into parts or thirds and cross-mated with milt from several male fish. An incubation isolation bucket houses individual egg lots until the eyed egg stage, and water temperature is thermally manipulated to take advantage of chiller-cooled well water and egg

development. At the eyed egg stage, egg lots are sorted, counted and divided into experimental and control lots and bedded down in vertical stack incubators. These fish are ponded outside in early spring; experimental fish put into Semi-Natural Treatment (SNT) and Optimal Conventional Treatment (OCT) raceways, and reared in these vessels until transfer to acclimation sites the following winter. SNT raceways receive painted pond walls and bases, suspended woody debris, floating covers and underwater feeders, whereas OCT raceways are traditional concrete ponds (no frills) and fish are hand fed (surface broadcast feeding).

Prior to acclimation site transfer, all fish are marked or tagged. Ten percent of each raceway receive a Passive Integrated Transponder-tag (PIT) and coded wire micro-tag (cwt) in the snout. The remaining population receive a body cwt in one of six body sites, and a Visually Implanted Elastomer (VIE) mark in the adipose eye tissue, right or left side to denote SNT or OCT designation. All fish are adipose-fin clipped. Three colors correspond to three acclimation sites: red, green and orange for Jack Creek, Easton and Clark Flats Acclimation Sites. The fish undergo a quality control check after marking/tagging operations, and are transferred to the acclimation sites. The fish are held a minimum of sixty days before pond screens are pulled and fish allowed to volitionally leave on their own. Emigration is passively monitored from each site as PIT-tagged fish pass through a tag detection pipe in the outfall channel. Tag information (both CWT and PIT) are transmitted to a basin-wide databases (PSMFC RMIS and PTAGIS) that track stocks throughout the Columbia River Basin.

Upper Yakima River Spring Chinook Returns

Brood year 1997 spring chinook juveniles released from Easton and Clark Flats Acclimation sites in 1999, returned to the Yakima River as largely four-year-old fish (89%) with the wild upper Yakima chinook cohort. Returns from 1997 adult progeny are listed in the "Total Returns" column in Table 1. Adult spring chinook collected for hatchery propagation for the 1997 brood year are listed under the "Adult Spawners" column in Table 1. Hatchery origin information, OCT and SNT designates, was collected for every hatchery adult that crossed Roza Dam in 2000 and 2001. Final results from this data are pending further analysis, and are not ready for presentation at this time.

Wild Yakima River spring chinook adult returns, from brood year 1997, are listed under the "Total Returns" column in Table 2. The majority of wild returning adults (90%) were four-year-old fish. The total number of naturally spawning wild spring chinook in 1997 is listed under Adult Spawners, Table 2.

Table 1. Cle Elum Supplementation and Research Facility Adult Returns.

Brood[1] Year	Adult[2] Spawners	Age-3 Returns	Age-4 Returns	Age-5 Returns	Total[3] Returns
1997	255	688	6,180		6,868
1998	371	990			990
1999	381				
2000	526				

Table 2. Upper Yakima River Wild Spring Chinook Returns.

Brood Year	Adult Spawners	Age-3 Returns	Age-4 Returns	Age-5 Returns	Total Returns
1997	1,141	530	5,010		5,540
1998	369	336			336
1999					
2000					

Estimated Benefits of Supplementation for Upper Yakima Stock

This year an estimated 13,988 adult Upper Yakima spring chinook entered the mouth of the Yakima River, with an 11,190 chinook passing over Roza Dam. Fishing seasons occurred in late April through early June on the Yakima River in 2001 for non-tribal recreational fishermen, as well as for tribal fishers. Approximately 2,000 spring chinook were harvested in the Yakima River sport fishery, and 2,500 fish were harvested in the Yakima River tribal fishery. Data management estimates that, with the returns from the Cle Elum facility, the overall Upper Yakima spring chinook return and the number of harvestable fish were increased by 83% from what they otherwise would have been had all Upper Yakima spring chinook returning to Roza Dam in 1997 been allowed to spawn in the wild.

Figure 1 illustrates the 2001 adult returns with supplementation, and contrasts this information to a hypothetical estimate of the 2001 adult return without supplementation. Without the supplementation effort undertaken in 1997, an estimated 6,130 adults would have passed over Roza Dam (assuming all upper Yakima spring chinook returning to Roza Dam in 1997 had been allowed to spawn in the wild and returned at the rate observed in 2001 for wild fish) and returns per spawner (fish returning to Roza divided by brood fish collected at Roza) would average around 4.86 (Figure 2). The 255 adult spring chinook taken into hatchery production in 1997 produced a combined (age-3 and age-4) total return of 6,868 fish to Roza Dam (Table 1), and a returns per spawner ratio of 26.93.

Estimated Benefits of Supplementation for Upper Yakima Stock		
	To Roza	to river mouth
2001 adult returns with supplementation	11,190	13,988
Est. 2001 adult returns w/o supplementation	6,130	7,662
Supplementation benefit (number of fish)	5,060	6,325
Percent supplementation benefit	82.6%	

Figure 1. Estimated Benefits of Supplementation, 2001.

Cle Elum Supplementation	Wild Escapement
Returns/Spawner	Returns/Spawner
26.93	4.86

Figure 2. Returns Per Spawner, 1997 Brood Year.

It is important to highlight that increasing the number of fish returning to fisheries and to the natural spawning grounds are only two of the objectives of this project. The overriding objective of the project is to increase the long-term natural productivity of Yakima River salmon populations. Therefore, it is critical for the project to demonstrate that these hatchery-influenced fish which have been added to the natural spawning population in 2001 (and will be added in the future) do not decrease the survivability or long-term fitness of the population over time. Monitoring and evaluation to measure these parameters is a long-term aspect of the project. Digital photographs, DNA samples, and biological data (lengths, weights, scales, etc.) are all being collected from many of these fish at varying stages in their life cycle. These data will be analyzed over time to derive conclusions about these parameters of the project.

Cle Elum Spawning Channel

Research with a focus on reproductive ecological fitness has been implemented this year in the Cle Elum Spawning Channel. The spawning channel was constructed in summer of 2000, and the first comparative behavioral/reproductive fitness studies of hatchery and wild spring chinook took place fall 2001. The 300 foot, horseshoe-shaped channel was divided into two large observation areas to collect data on proportional female and male, hatchery and wild, adult spring chinook spawning activity. The goal of this effort is to assess how well supplemented chinook progeny spawn and reproduce as compared to their wild counterparts. Researchers can observe physiological, morphological and behavioral characteristics of hatchery and wild fish, to determine if differences due to relaxed sexual selection or the hatchery-rearing artifact are evident in supplemented fish.

The 2001 spawning channel activities placed forty-four adult spring chinook in the two observational areas (upper channel and lower channel), for two experimental sets on two separate occasions roughly one week apart. Upper and lower channel spring chinook densities are shown in Figure 3. Spawning channel adult fish were anesthetized, weighed, tagged with a Petersen disc tag (yellow, white) to differentiate males and females, and scanned for PIT-tag numbers before transfer to the spawning channel. Once fish were placed in the channel, observers would watch and record individual courtship and spawning behavior behind a tall camouflage fence. When spawning activities concluded, adult fish were removed from the channel and sampled for BKD, weighed, cut open for egg retentions and later placed back into the river to decompose. Data results for all observations are not available at the time of this writing. Progeny emergence and survival will be monitored in spring 2002.

Cle Elum Supplementation Spawning Channel		
	Upper Channel	Lower Channel
Wild males	11	11
Wild females	11	11
Hatchery females	11	11
Hatchery males	11	11

Figure 3. Spring chinook Distributions, Wild and Hatchery, in the 2001 Spawning Channel Experiment.

Conclusion

This experimental supplementation project is still very new and the results cannot be fully evaluated until several generations of fish have returned and all project parameters have been more completely analyzed. We are encouraged by the returns we have seen in 2001, but recognize that we still have much work to do both in terms of scientific monitoring and evaluation and in restoring habitat in the Yakima River Basin to facilitate the increases in natural productivity that this project is striving to produce.

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Session III - Fish Health

Session Chair:

Rich Holt

ODFW – Senior Fish Pathologist

Case Studies from the National Wild Fish Health Survey

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Fish have been sampled from sites in Washington, Oregon, Idaho and beyond to help understand the health profile of wild, naturalized, and native fish. Through 1997 to 2001, over 4,000 fish and 20 species have been examined by the Lower Columbia River Fish Health Center for the National Wild Fish Health Survey. Generally, the fish have been healthy and rarely has overt disease been noted. However, the pathogen causing bacterial kidney disease, *Renibacterium salmoninarum* is commonly found in the salmonids and other bacterial pathogens including *Aeromonas salmonicida* (furunculosis) and *Flavobacterium psychrophilum* (cold water disease) have also been noted in species as diverse as Pacific lamprey and steelhead. Two isolations of infectious hematopoietic necrosis virus in chum salmon and steelhead have also been made. Several case histories from the Lower Columbia River Fish Health Center will be presented.

Information from the National Wild Fish Health Survey, conducted by the nine USFWS Fish Health Centers, is available through the web site http://wildfishsurvey.fws.gov/ . This database can be queried by disease, fish species, and watershed through an user-friendly data retrieval system to obtain geographically-linked fish health information.

Botulism at Winthrop National Fish Hatchery

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Abstract

During the summer of 2001, coho that were being reared at Winthrop NFH started dying in a fashion typical of an infectious agent. Normal diagnostic procedures commonly used produced no likely causes. The authors explore the case history of this episode, present mortality curves, diagnostic photos and ultimate diagnosis. This case illustrates and documents potential hazards and situations that fish culturists may encounter in the current pursuit of "natural rearing methods", and suggests options to avoid such situations in the future.

A Preliminary Report on: The Adaptation of Wound Repair Trial Techniques at Round Butte Hatchery, to Evaluate the Ability of Dietary Enhancement, to Improve the Stress Response of Spring Chinook and Steelhead

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Abstract

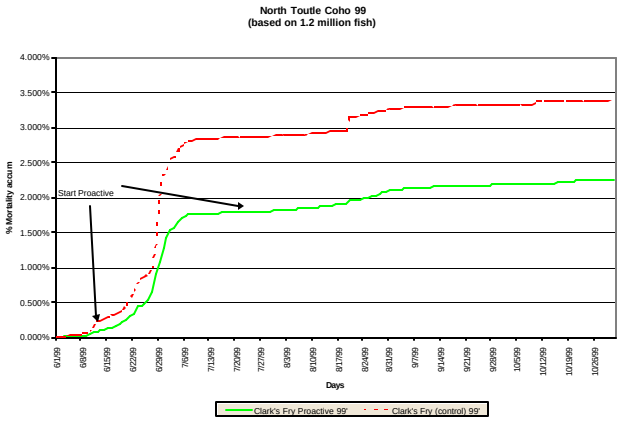
Production enhancement hatchery managers are often faced with needing to evaluate and adapt new fish feed technology to improve their production programs, which are often constrained by environmental and stock specific variables that can be unique to that hatchery. New fish feed products on the market, designed to impart improved health and better ability to respond to stress, have made conventional hatchery trial methods of marginal use in evaluating and understanding these product benefits, due to the variability associated with acute stress and how it effects program performance. This study examined using previously reported wound repair methodology to more specifically and equivocally evaluate whether current immuno-stimulant technology made available by the PROACTIVE feed produced by Moore-Clark, and recommended feeding programs, are useful for producing fish better able to survive and tolerate acute stress. The goal was to find a better tool for enhancement hatcheries to use for evaluating the effectiveness, and learning to adapt PROACTIVE feed, or other dietary enhancements to improve stress response, in this production enhancement environment. Unique aspects of the method included: 1. Combining experimental groups in hatchery tanks to provide homogeneous access to feed, and exposure to stress. 2. Individually weighing and measuring fish to allow assessment of individual treatment populations. 3. Adopting yes/no parameters for assessing wound healing and the occurrence of inflammation (Picture 1). 4. A 3 x 4 factorial design to provide a range of stress and feeding options that allow evaluation of both benefit and potential implementation strategy, in a format to allow technical staff to better collaborate on interpretation of results. Improved rate of wound closure and occurrence of wound inflammation were documented ($P<.05$) in several dietary treatments. Suggestions for further refinement of this method are discussed.

Picture 1. Shows a Spring Chinook from the wound repair trial with a wound classified as wide = Yes, and with inflammation = NO.

Introduction

As discussed by Jobling (1998) success in acclimating to environmental stress depends on ability of individuals to carry out and maintain successful compensatory responses when exposed to stressors. Compensatory responses in fish are thought to be analogous to the 'general adaptation syndrome' model seen in mammals. Here the stress responses are divided into Primary, Secondary, and Tertiary categories.

Picture 2. Shows example of data from a successful hatchery level trial at the North Toutle WDFW Salmon hatchery on Coho salmon. Here PROACTIVE was fed to prepare the fish for coldwater and columnaris outbreaks in June and July.



The Primary response, also called the 'alarm stage' of stress response, is characterized by rapid changes which involve sensing the stress, triggering a release of catacholamines that initiate secondary effects in organ systems like the cardiovascular, and the release of ACTH (adrenocorticotropic hormone) that leads to the production and release of cortisol. Within minutes cortisol levels in salmonids exposed to stress rises. High circulating levels of cortisol have been associated with immune suppression.

The Secondary response directs a range of metabolic effects, that include decreased protein synthesis, increased protein catabolism of muscle, lipolysis, and depletion of glycogen and Vitamin C stores. These responses are thought to have evolved as adaptive mechanisms in response to increased energy demands associated with responding to an acute stress. Priming the non-specific secondary immune system, via cues from alarm substances mentioned above, is another aspect of the secondary stress response. These secondary response changes, typically last days or hours following an acute stress exposure. Longer termed chronic stress, is characterized by reduced growth, health status, and fertility, and makes up the Tertiary stress response.

It is preferred and most common, to try to reduce the impact of stress on hatchery fish by taking action to remove the source of the stress. While this is preferred, it is not always an option. However, by understanding the mechanisms of how stress affects fish, as described by Jobling above, we can find ways to reduce the impact of stress on fish by working with these mechanisms to improve the fishes ability to respond to stress.

The peer reviewed literature on immuno-stimulant technology for improving the ability of fish to respond to stress associated with pathogen attack, has been recently reviewed by Sakai (1999). It is clear that the scientific community has moved our knowledge of immuno-stimulant use in fish forward to a significant degree, warranting production level experimentation to document the ability of this knowledge to be useful in production situations. Production level efforts are required, as stresses and stress impact on production goals, vary from site to site at the practical production level.

Moore-Clark made a step in this direction a few years ago by making available an immuno-stimulant product called PROACTIVE, and partnering with northwest enhancement hatcheries in a series of production level field trials, to determine the potential for immuno-stimulant technology to have a practical benefit (Picture 2). The approach has been to target well defined acute stress (Jobling, 1998) situations for trials. Its important that these situations be well defined, to give us an understandable basis for assessing the value of improvement. Its also important that they be acute stress situations, as the mechanism of effect for beta-glucan type immuno-stimulants, is to act as part of the primary response system for stress, as an alarm substance, for the secondary immune system. Here impurities carried by wounds are able to be detected at initial stages of infection, to allow the secondary immune system to elevate activity in anticipation of increased pathogen activity. This mechanism of effect for Proactive, lends itself to preparing fish to deal with such definable acute stress (DAS). Picture 3 shows a DAS imparted by the wound repair trial methodology in this study. Other examples of DAS situations in the enhancement industry include, mass marking, fish transportation, general fish handling, and saltwater transfer.

Field trial results to date have been difficult to base industry level conclusions on, though positive results have been seen to warrant further study. We have found these trials to vary in their usefulness, because mortalities may or may not occur following a DAS. This is due to the variable nature of overall culture and environmental conditions at frontline production facilities that are subject to many external forces. This variability can affect both the exposure to pathogens and ability of fish to respond to them on a pond to pond basis. These studies point to the need for a way to assess these diets at frontline hatcheries regardless of the impact of external variability on the stress to the fish. The trial results at North Toutle WDFW salmon hatchery, shown in Picture 2 are an example of positive results obtained using conventional trial methods. Conventional trials like this would have much more practical application if used to follow-up, or if run in parallel, with smaller scale trials as discussed here, to work out which feeding strategy imparted the best stress response performance.

Picture 3. Shows a wound made in this trial to provide a definable acute stress (DAS) by which stress response capability could be assessed.

This study examined using wound repair methodology to more specifically and equivocally, evaluate whether current immuno-stimulant technology made available by the PROACTIVE feed and feeding programs is useful for producing fish, better able to survive and successfully respond to acute stress. The goal was to find a better tool for Round Butte and other enhancement hatcheries to use for evaluating the effectiveness of PROACTIVE for improving stress response, and for determining how best to feed PROACTIVE at a given site, to maximize the benefit.

Materials and Methods

Fish Production

Spring Chinook from production lots at the ODFW Round Butte fish hatchery were used for the first study. Following normal program procedures, fish were first fed and initially reared in 6 foot diameter circular tanks (15gpm) shown in Picture 4. During this period they are on 51 degree F water from Lake Billy Chinook reservoir and are fed commercial starter feed from Moore-Clark for maximum growth. At approximately 1 gram, all fish are moved to large concrete Burrows raceways (600 gpm, 1.5 lb/ft^3 rearing density) for the next phase of grow-out. At this time they are placed on approximately 50% rations (fed to satiation) to control growth. During this time fish in this program are normally mass marked (coded wire tagged and adipose fin clipped) causing a DAS. Randomly sampled fish from this program entered the first wound repair trial at this time, for experimentally controlled DAS, instead of the production mass marking process.

Picture 4. Shows the tanks used to hold the experimental groups.

Steelhead from production lots at the ODFW Round Butte fish hatchery were used for the second study. Following normal program procedures, fish were first fed and initially reared in 6 foot diameter circular tanks (15gpm). During this period they were on 51 degree F water from Lake Billy Chinook reservoir, and were fed commercial starter feed from Moore-Clark for maximum growth. At approximately 1 gram, all fish were moved to large concrete Burrows raceways (600 gpm, 1.5 lb/ft^3 rearing density) for the next phase of grow-out. At this time they were placed on full rations fed to satiation. During this time fish in this program are normally mass marked (multiple fin clips) which constitutes a DAS. Randomly sampled fish from this program entered the second wound repair trial at this time, for experimentally controlled DAS, instead of the production mass marking process.

Treatment Groups

Dietary Treatments

To provide a range of PROACTIVE feeding periods before and after wounding, primary and secondary dietary treatment periods were utilized. Figure 1a and 1b show a schematic of how

FIRST TRIAL: Spring Chinook

Week

Feeding	1	2	S1	3	4	5	S2	6	7	S3	8	9	S4
PaPa Treatment Group	PA	PA		PA	PA	PA		C	C		C	C	
PaC Treatment Group	PA	PA		C	C	C		C	C		C	C	
CPa Treatment Group	C	C		PA	PA	PA		C	C		C	C	
CC Control Group	C	C		C	C	C		C	C		C	C	

PA= Fed Clark's Fry PROACTIVE C= Fed Clark's Fry

Figure 1a. Shows the primary and secondary treatment groups for the first trial on Spring Chinook. S1, S2, S3, and S4 denote the 4 sampling periods for the study.

dietary treatments were administered over the coarse of the experiment. During the primary dietary treatment period fish were fed either Clark's Fry PROACTIVE (Pa) or regular Clark's Fry (C) for 2 weeks prior to the first sample period S1. At the S1 sampling, half of each primary dietary treatment group would be assigned to one of 2 secondary treatment groups. During the secondary dietary treatment period, fish were fed either Clark's Fry PROACTIVE (Pa) or regular Clark's Fry (C) prior to the second sample period S2. Figure 2a and 2b show how the original primary dietary groups were split into the secondary dietary groups. This allowed the configuration of 4 dietary treatments for the experimental design, as follows: PaPa, PaC, CPa, and CC.

FIRST TRIAL: Steelhead

	Week											
Feeding	**1**	**2**	**S1**	**3**	**4**	**S2**	**5**	**6**	**S3**	**7**	**8**	**S4**
PaPa Treatment Group	PA	PA		PA	PA		C	C		C	C	
PaC Treatment Group	PA	PA		C	C		C	C		C	C	
CPa Treatment Group	C	C		PA	PA		C	C		C	C	
CC Control Group	C	C		C	C		C	C		C	C	
	PA= Fed Clark's Fry PROACTIVE							C= Fed Clark's Fry				

Figure 1b. Shows the primary and secondary treatment groups for the first trial on Spring Chinook. S1, S2, S3, and S4 denote the 4 sampling periods for the study. Two weeks instead of 3 were allowed between the S2 and S3 sampling periods due to scheduling constraints effecting sampling options.

This trial was done on discretionary basis around regular hatchery operations. Sampling periods were initially planned to be scheduled on 2 week intervals. It was necessary to go 3 weeks between the S2 and S3 sampling in the first trial.

PROACTIVE is a proprietary feed additive, produced by the Moore-Clark company. It is marketed as additive to any of the other Moore-Clark feeds, to be used to better prepare fish to respond to stresses encountered during culture. Key ingredients of PROACTIVE are beta glucans, elevated vitamin C levels and organic selenium. General feeding recommendations are for feeding PROACTIVE for 2 week prior and 2 weeks after a stressful event. A four week interval between treatments is recommended.

Picture 5. Shows how the wound treatment was administered.

Wound Treatments

To provide a range of DAS timing with respect to the dietary treatments, 3 wounding treatments were utilized. Figures 3a and 3b show schematics of how wound treatments were administered over the coarse of the experiment. In the first trial the initial wound treatment (W1) was administered at S1 sampling, to provide a DAS following the primary dietary treatments but before the secondary treatments. The second wound treatment (W2) was administered at the S2 sampling to provide a DAS following all dietary treatments. The third wound treatment (N) was to not wound the fish, to provide a control for the other wound treatments.

Week

Wounding	1	2	S1	3	4	5	S2	6	7	S3	6	7	S4
W1			Rs										
W2							Ls						
N													

Rs= Right side wound.

Ls= Left side wound

Figure 3a. Shows when the wound treatments were administered over the coarse of the trial. S1, S2, S3, and S4 denote the 4 sampling periods for the study. Fish from the W1 groups were wounded on the right side at the S1 sampling. Fish from the W2 group were wounded on the left side at the S2 sampling.

The W2 treatment was modified to include wounding at both the S1 and S2 samplings from the first trial to the second trial. In the first trial it was felt that there was not enough difference between the W1 and W2 wound treatments. Also, wounding the W2 fish at S1 eliminated the need to vent fin clip to distinguish groups. W1 and W2 groups could be distinguished by the presence of a left side wound through all subsequent samplings.

Week

Wounding	1	2	S1	3	4	S2	5	6	7	S3	6	7	S4
W1			Rs										
W2			Ls			Rs							
N													

Rs= Right side wound.

Ls= Left side wound

Figure 3b. Shows when the wound treatments were administered over the coarse of the trial. S1, S2, S3, and S4 denote the 4 sampling periods for the study. At the S1 sampling, W1 fish were wounded on the right side while W2 fish were wounded on the left side. Fish from the W2 group were wounded a second time on the right side at the S2 sampling.

This along with adipose fin clips, allowed the wounds, along with adipose fin clips, to act as marks to distinguish all 6 experimental groups, in a given tank. The W2 group was wounded a second time on the right side at the S2 sampling.

At S2, S3, and S4 samplings, wounds were visually inspected by hatchery staff. Wounds that had any gap were classified as 'wide' (Picture1). Wounds with no gap were classified as 'narrow' (Picture 7). Wounds showing any pink coloration were classified as inflamed (Picture 3). Wounds showing no pink coloration were scored as non-inflamed (Picture 1).

Experimental Groups

The Four dietary groups and three wound treatment groups combined to make a 4 x 3 factorial design as follows:

PaPa W1	PaPa W2	PaPa N
PaC W1	PaC W2	PaC N
CPa W1	CPa W2	CPa N
CC W1	CC W2	CC N

The same design was used in both trials. The sampling table set-up is shown in Picture 6. In the first trial, a number of fish in excess of the 600 needed to fill control and treatment groups, were set aside in 2 circular tanks and fed either Control diet or PROACTIVE diet during this time.

Figure 4a. This schematic shows how the 12 experimental groups were formed for the Spring Chinook trial. PRG= Production Raceway Group. Pa= Proactive Feeding. C= Control Feeding. W1= Right side wound. W2= Left side wound. N=No Wound.

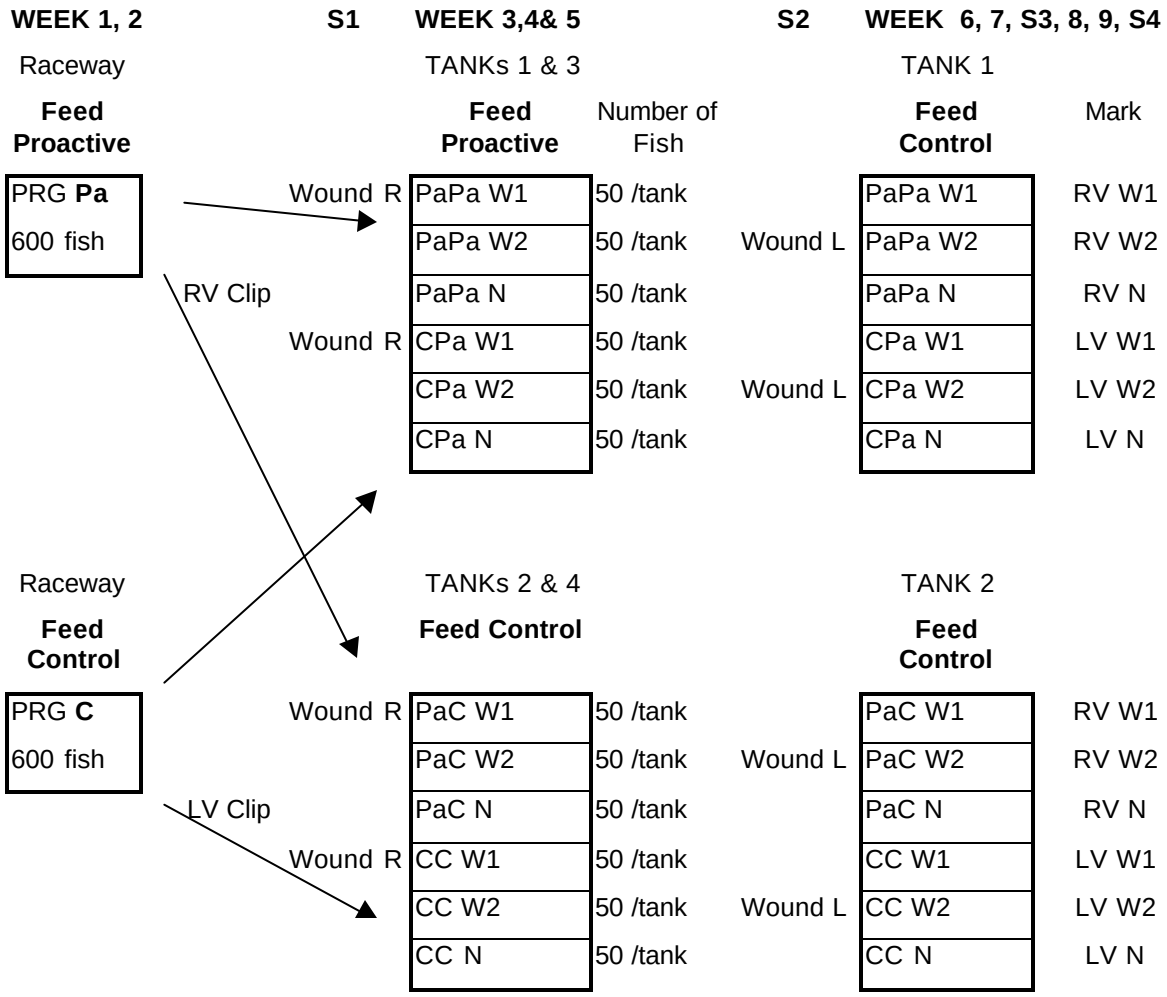


Figure 4a shows the overall schematic for how the experimental groups were assembled and handled. The goal was to synchronize the PROACTIVE feeding and the S1 wounding of the experimental groups, with the actual mass marking of the production groups. In the first trial, two control diets were used; control A (Clark's Fry) and control B (Vextra Pacific). Clark's Fry PROACTIVE was used as the treatment diet.

At sampling period S1, following the two week feeding, 600 fish were randomly selected from each of the PROACTIVE and Control groups and distinguished from each other by ventral fin clip. Figure 5a shows the timeline for how the sampling was carried out. A right ventral clip was given to fish from the PROACTIVE group. A left ventral clip was given to fish from the two control groups. Control group A or B fish were distinguished by adipose fin clip. Control A fish

	Week												
Sampling	**1**	**2**	**S1**	**3**	**4**	**5**	**S2**	**6**	**7**	**S3**	**6**	**7**	**S4**
Weight (g/fish)			*				*			X			X
Length (fork length, mm)			X				X			X			X
K factor										X			X
SGR (% bw/day)										X			X
Delta L (mm/day)			X				X			X			X
CV Length (mean/stdev)			X				X			X			X
Wound Close (Wide/Narrow)							X			X			X
Visible Inflammation (Yes/No)							X			X			X
Mortality			X	X	X	X	X	X	X	X	X	X	X

* equipment failure prevented individual weights from being taken.

Figure 5a. Shows how the Spring Chinook trial was implemented over the 8 weeks of the trial.

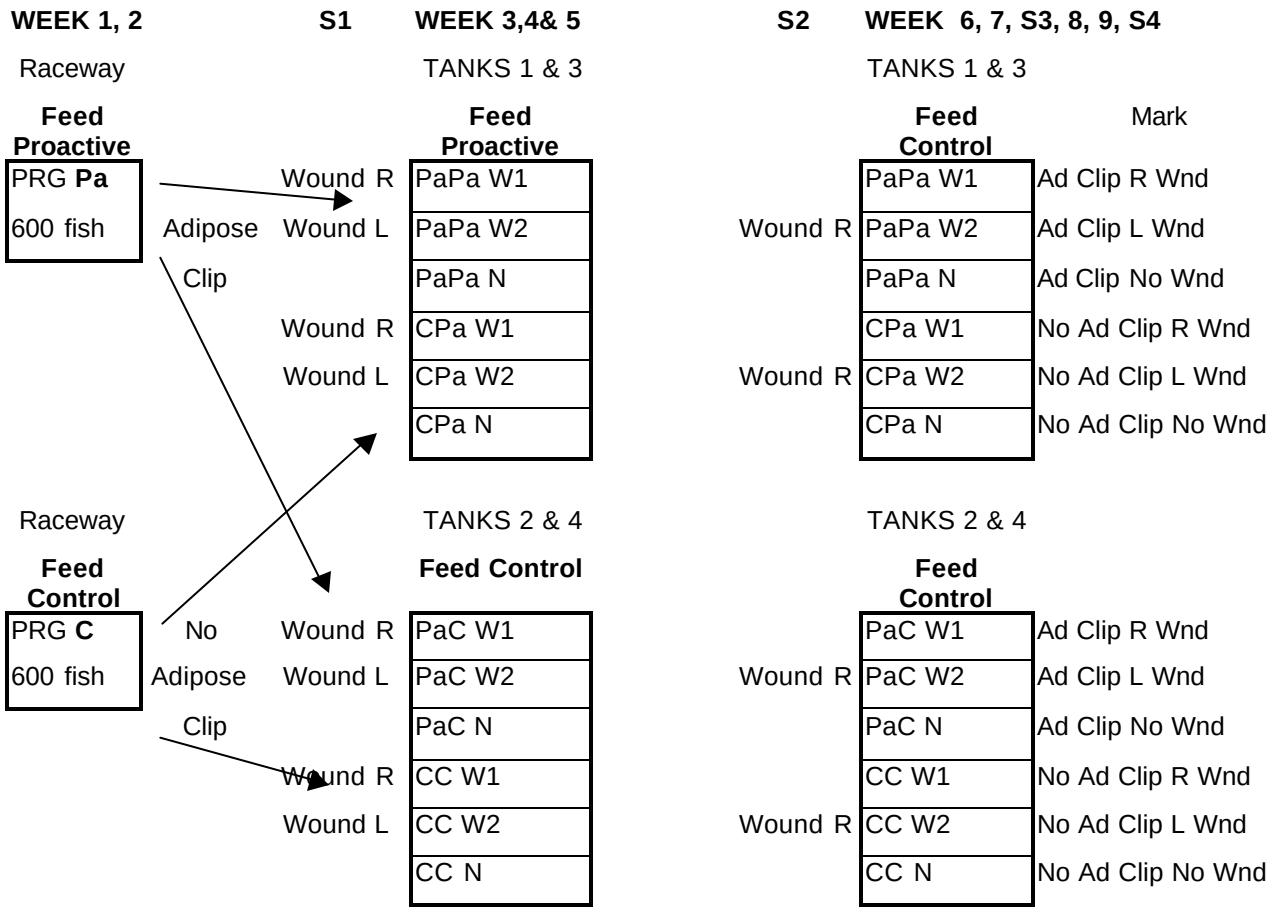
were adipose fin clipped, Control B fish were not. Fish were then randomly assigned to one of two duplicate groups (tanks 1 and 3 or tanks 2 and 4) for the duration of the trial. Also at this time, 1/3 of the fish from each treatment and control group, were randomly selected to be wounded on the right side, as described below for the W1 wound group. During weeks 3 through 5, ponds 1 and 3 were fed PROACTIVE diet , and ponds 2 and 4 were fed Control A diet.

Picture 6. Shows the sample table set-up.

At S2 sampling, 1/3 of the fish were randomly selected from the non wounded fish in each tank to be wounded on the left side. During weeks 6, 7, and 8, all fish received Control A diet.

In the second trial a number of fish in excess of the number needed to fill all control and treatment groups, were set aside in 2 circular tanks and fed either Control diet or Proactive diet during through this 2 week period. Figure 4b shows the overall schematic for how the experimental groups were assembled and handled. As in the first trial, the goal was to synchronize the S1 wounding and PROACTIVE feeding of the experimental groups with the actual mass marking and PROACTIVE feeding of the production groups. In the second trial, Clark's Fry served as the control diet, Clark's Fry Proactive served as the treatment diet.

Figure 4b. This schematic shows how the 12 experimental groups were formed for the Steelhead trial. PRG= Production Raceway Group. Pa= Proactive Feeding. C= Control Feeding. W1= Right side wound. W2= Left side wound. N=No Wound.



At sampling period S1, 612 fish were randomly selected from each of the PROACTIVE and Control groups and distinguished from each other by an adipose fin clip. Figure 5b shows the timeline for how the sampling was carried out. An adipose fin clip was given to fish from the Proactive group. No adipose fin clip was given to fish from the Control group. Fish were then

	Week												
Sampling	**1**	**2**	**S1**	**3**	**4**	**S2**	**5**	**6**	**7**	**S3**	**6**	**7**	**S4**
Weight (g/fish)			X			X				X			X
Length (fork length, mm)			X			X				X			X
K factor			X			X				X			X
SGR (% bw/day)			X			X				X			X
Delta L (mm/day)			X			X				X			X
CV Length (mean/stdev)			X			X				X			X
Wound Close						X				X			X
Visible Inflammation (Yes/No)						X				X			X
Mortality			X	X	X	X	X	X	X	X	X	X	X

Figure 5b. Shows how the Steelhead trial was be implemented over the 8 weeks of the trial.

randomly assigned to one of two secondary dietary treatment groups for the duration of the trial, in one of three triplicate tanks. During weeks 3 and 4, tanks 1,3, and 7 were fed PROACTIVE diet, and tanks 2, 4, and 8 were fed Control diet. Also at this time, 136 fish from each tank were randomly selected to be wounded on either the right side or left side, as described below for the W1 and W2 wound groups.

At S2 sampling, all fish that received a left wound at S1 sampling were given an additional wound on the right side. During weeks 6, 7, and 8, all fish received Control diet. This modification to the W2 wound treatment group for the second trial was made to provide a greater amount of acute stress, and over a different time frame with respect to the dietary treatments, compared to the W1 group.

Wound Technique

The administration of the wound was adapted from wound repair studies done by Ashley et al.(1975) and Verlhac et al.,(2000). These studies both made 1 cm long incisions that were 0.5cm deep on fish that were 30 to 50g (~15 to 9 fish/lb). These dimensions assured that the incisions penetrated the epidermis, dermis, and underlying musculature. Wound location was standardized, by orienting them with respect to the lateral line and dorsal fin. The wound technique for this study was adapted from those studies as follows.

As some length variation is natural in pacific salmonids, the length of the incision was related to the body length, by making the wound length, the length of the base of the dorsal fin. Incision depth was set at half the length of the incision, not to exceed the depth to the centerline of the fish. The incision was oriented halfway between the dorsal fin base and the lateral line, parallel to the lateral line. There turned out to be some variability in the wound lengths and depths between fish in this experiment. This variability appeared to have little practical effect on the recovery of the wound.

Ashley et al,(1975), sutured their wounds while Verlhac et al, (2000) disinfected theirs with penicillin-streptomycin. For purposes of this study, no additional suturing or disinfecting was done, as one of the treatment attributes we were interested in observing was the response of the secondary immune system to infection. The wound technique was carried out while fish were under anesthesia for measurement of length and weight.

Picture 7. Shows a wound observed to be narrow with no inflammation.

In the first trial, at sampling S2, W1 fish were at 3 weeks post wounding. Their wounds were observed and categorized as to being wide or narrow in opening, and as to whether inflammation was or was not visible. These determinations were made visually. All wounds appeared to have grown a thin cell layer to close the wound. Wide wounds had definite openings as show in Picture 1. Narrow wound openings appeared to be mostly closed as shown in Picture 7. Wounds where visible inflammation could be seen, clearly

had pink coloration present, as shown in Picture 3. Wounds in the second trial were classified in the same manner.

Unique aspects of our method include:

1. The 12 treatment groups combined into 2 common tanks according to their secondary dietary treatment group (Figures 4a and 4b). This allowed easier feeding, fewer tanks to set-up and maintain. More importantly, combining groups also provided homogeneous exposure to pathogens and homogeneous access to feed for multiple experimental groups. This made observed pathogenic and growth effects, effects due to treatment more verifiable.
2. Individually weighing and measuring fish allowed K factors to be computed for individual fish to allow comparisons within a given treatment group. As the impact of stress for smaller fish in a population of salmonids can be greater than that for larger fish who become dominant over the smaller fish, we wanted to find a method for observing this, using growth and k factor parameters.
3. We adopted yes/no parameters for assessing wound healing and the occurrence of inflammation. We wanted to determine if subjective visual evaluation could be used at the hatchery staff level to assess wound repair and inflammation.
4. A 3 x 4 factorial design to provide a range of stress and feeding options to allow evaluation of both benefit, and potential implementation strategy, in a format to better allow technical staff to better collaborate on interpretation of results. Improved rate of wound closure and occurrence of wound inflammation were documented ($P<.05$) in several dietary treatments.

The experimental design also provided wounding, applied at a range of times with respect to the dietary treatments, to provide insight on what would be an optimal implementation strategy for PROACTIVE at this hatchery. The need to look at a range of feed timing strategies was important because the key ingredients of PROACTIVE feeds have more than one mode for enhancing a fishes stress response. For example, the beta glucans function as an alarm substance to activate the secondary immune system, as part of the primary stress response, while Vitamin C functions to aid collagen formation and also has an ongoing role as an antioxidant.

Also, as the experimental design utilizes fish from production hatchery groups, trials can be run in parallel with actual production programs to give the experimental groups a production context. This could be useful for finding the best implementation strategy in new hatcheries versus their individual stress concerns. In these trials we matched the feeding rates to those of the respective production groups, but did not carryout the initial 2 week dietary treatment feeding of PROACTIVE and control diet in the actual production raceways. Fish were taken from the production groups and placed in circular tanks for the initial feeding, as all actual production groups were fed PROACTIVE.

Experimental Analysis

The experimental design for the first trial is shown in Figure 6a. Two factor Analysis of Variance was used to test for significant differences in parametric data parameters. If differences were found, T-tests were then utilized to test for statistical differences between individual experimental groups. Chi Square goodness of fit (Zar 1974) was used to test for significant differences in non-parametric data.

It was determined that 1,200 fish per day was the approximate limit to the number of fish that could be sampled per day. As the non-parametric wound repair and inflammation data, was considered the most important, treatment groups of 50 fish each were selected for use though this would only allow for duplicate treatment replication. The largest individual group possible from which to draw observed frequencies was considered a priority. Control groups were used to compute the expected frequencies.

Figure 6a. Shows experimental design of Spring Chinook trial.

Production feeding	**Trial tank feeding**	**W1**: Wound below right dorsal at S1 Sampling.	**W2**: Wound below left dorsal at S2 Sampling.	**N**: No Wound
Pa:PROACTIVE R vent clip (fed Proactive weeks 1 & 2)	**Pa**:PROACTIVE TANKs 1 & 3 (fed Proactive weeks 3,4, & 5)	**PaPa W1** >Fed PA for 2 weeks before and 3 weeks after wounding at S1 (right side). > 50 fish x 2 reps	**PaPa W2** >Fed 5 weeks before wounding at S2 (left side). > 50 fish x 2 reps	**PaPa N** >Fed Pa week 1 through 5. No Wounding. > 50 fish x 2 reps
Pa:PROACTIVE R vent clip (fed Proactive weeks 1 & 2)	**C**:CONTROL TANKs 2 & 4 (fed control diet weeks 3,4, & 5)	**PaC W1** >Fed PA for 2 weeks before wounding at S1(right side). > 50 fish x 2 reps	**PaC W2** >Fed PA for 2 weeks on then 3 weeks off before wounding at S2 (left side). > 50 fish x 2 reps	**PaC N** >Fed Pa week 1 and 2. No Wounding. > 50 fish x 2 reps
C: CONTROL L vent clip (fed Control diet weeks 1 & 2)	**Pa**:PROACTIVE TANKs 1 & 3 (fed Proactive weeks 3,4, & 5)	**CPa W1** >Fed for 3 weeks after wounding at S1 (right side). > 50 fish x 2 reps	**CPa W2** >Fed PA for 3 weeks before wounding at S2 (left side). > 50 fish x 2 reps	**CPa N** >Fed Pa week 3 through 5. No Wounding. > 50 fish x 2 reps
C:CONTROL L vent clip (fed Control diet weeks 1 & 2)	**C**:CONTROL TANKs 2 & 4 (fed control diet weeks 3,4, & 5)	**CC W1** >No Proactive, wounding at S1 (right side). > 50 fish x 2 reps	**CC W2** >No Proactive, wounding at S2 (left side). > 50 fish x 2 reps	**CC N** >No PA fed. No Wounding. > 50 fish x 2 reps

The experimental design for the second trial is shown in Figure 6b. Statistical analysis are done as described for trial one. The 1,200 fish per day estimate of the approximate limit to the

number of fish that could be sampled per day was found to be correct. As Heterogeneity Chi Square analysis in the first trial indicated it to be appropriate to pool the non-parametric wound repair and inflammation data, individual treatment groups were reduced to 34 fish per treatment group to provide triplicate treatment replication. This provided triplicate parametric means to compare for the derived date including, Delta L and SGR.

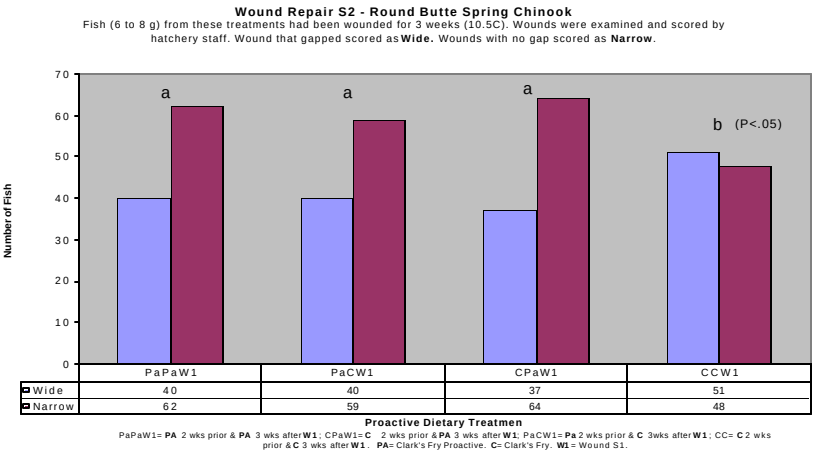
Figure 6b. Shows experimental design of Steelhead trial.

Production feeding	**Trial tank feeding**	**W1**: Wound below right dorsal at S1 Sampling.	**W2**: Wound below left dorsal at S1 sampling, then below right dorsal at S2 Sampling.	**N**: No Wound
Pa:PROACTIVE Adipose clip (fed Proactive weeks 1 & 2)	**Pa**:PROACTIVE TANKs 1, 3, & 7 (fed Proactive weeks 3 & 4)	**PaPa W1** >Fed PA for 2 weeks before and 2 weeks after wound (right side). > 34 fish x 3 reps	**PaPa W2** >Fed PA 2 weeks before wounding at S1 (left side), then fed PA 2 weeks before 2nd wounding at S2 (right side). > 34 fish x 3 reps	**PaPa N** >Fed Pa week 1 through 4. No Wounding. > 34 fish x 3 reps
Pa:PROACTIVE Adipose clip (fed Proactive weeks 1 & 2)	**C**:CONTROL TANKs 2, 4, & 8 (fed control diet weeks 3 & 4)	**PaC W1** >Fed PA for 2 weeks before wound (right side). > 34 fish x 3 reps	**PaC W2** >Fed PA 2 weeks before wounding at S1 (left side), then fed control diet 2 weeks before 2nd wounding at S2 (right side). > 34 fish x 3 reps	**PaC N** >Fed Pa week 1 and 2. No Wounding. > 34 fish x 3 reps
C: CONTROL No Adipose clip (fed Control diet weeks 1 & 2)	**Pa**:PROACTIVE TANKs 1, 3, & 7 (fed Proactive weeks 3 & 4)	**CPa W1** >Fed for 3 weeks after wound (right side). > 34 fish x 3 reps	**CPa W2** >Fed control diet 2 weeks before wounding at S1 (left side), then fed PA 2 weeks before 2nd wounding at S2 (right side). > 50 fish	**CPa N** >Fed Pa week 3 and 4. No Wounding. > 34 fish x 3 reps
C:CONTROL No Adipose clip (fed Control diet weeks 1 & 2)	**C**:CONTROL TANKs 2, 4, & 8 (fed control diet weeks 3 & 4)	**CC W1** >No PA fed. Wounded at S1 (right side). > 34 fish x 3 reps	**CC W2** >No PA fed. Wounded at S1 (left side) and at S2 (right side). > 34 fish x 3 reps	**CC N** >No PA fed. No Wounding. > 34 fish x 3 reps

Preliminary Results

The sampling was completed in mid fall so we have not yet had the time needed, to fully analyze the data and prepare a final report as of the report due date. We have prepared some preliminary results to provide an idea of the nature of effects seen in this trial.

Figure 7. Compares the occurrence of wide wounds versus narrow wounds, two weeks following the wounding of the W1 group, observed in Spring Chinook in the first trial.

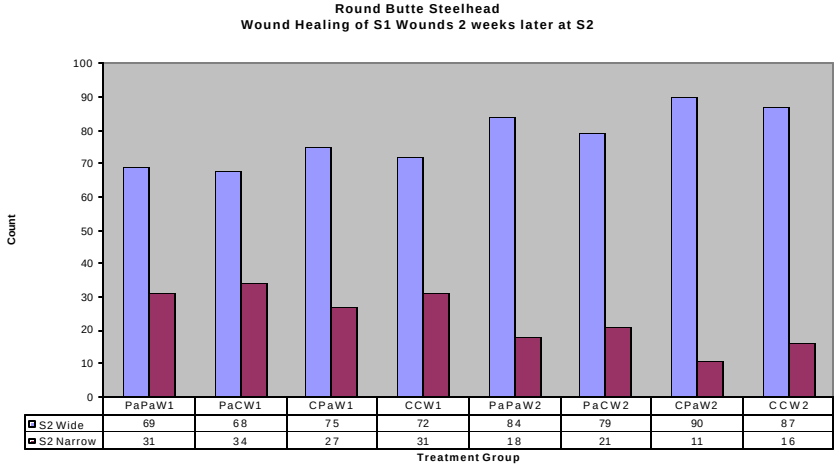


Wound Healing Effects:

Elevated rate of wound repair was seen in the spring chinook fed PROACTIVE as either a primary or secondary dietary treatment compared to the control groups which did not receive any PROACTIVE (Figure 7). Wound repair rates in the steelhead in the second trial appeared to be little affected by the dietary treatments (Figure 8).

It did appear that the right side of the fish healed faster than the left side. It was noted that right wounds were made in a head to tail direction, while the left wounds were made in a tail to head direction, going against the grain of the scales. Cutting against the grain of the scales, likely made a more damaging wound than cutting with the grain of the scales.

Figure 8. Compares the occurrence of wide wounds versus narrow wounds, two weeks following the wounding of the W1 and W2 groups, observed in Steelhead in the second trial.



In the first trial on spring chinook, less inflammation was seen, as determined by the occurrence of pink coloration of the wounds, in W1 groups that received PROACTIVE for the 3 week feeding period (secondary dietary treatment) prior to the S2 sampling (Figure 9). In the steelhead in the second trial, wound repair rates appeared to be little affected by the dietary treatments (Figure 10). Also with the inflammation data, there appeared to be a difference between right and left wounded fish, as described above.

We thank you for your patience with these preliminary results. As this effort was as much about developing a another way to listen to what the fish are telling us about their stress capability, as it was about testing PROACTIVE, we decided it was appropriate to move forward with this preliminary report format. Further examination of the data from these trials will allow more interpretation and discussion of results.

Figure 9. Compares the occurrence of inflamed wounds and non-inflamed wounds, two weeks following the wounding of the W1 group, observed in Spring Chinook in the first trial.

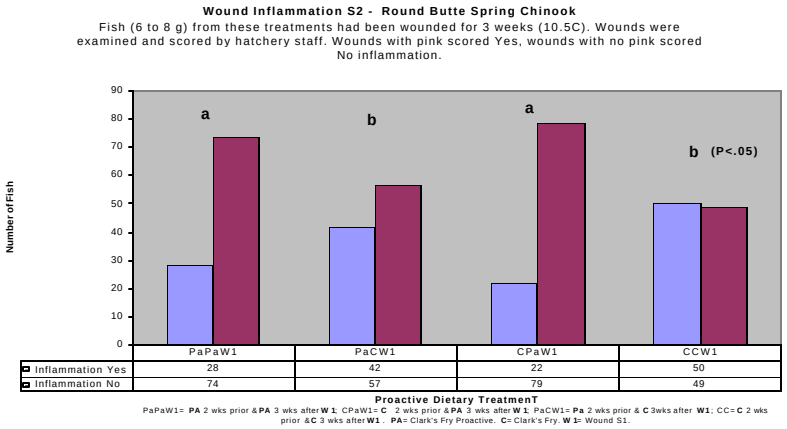
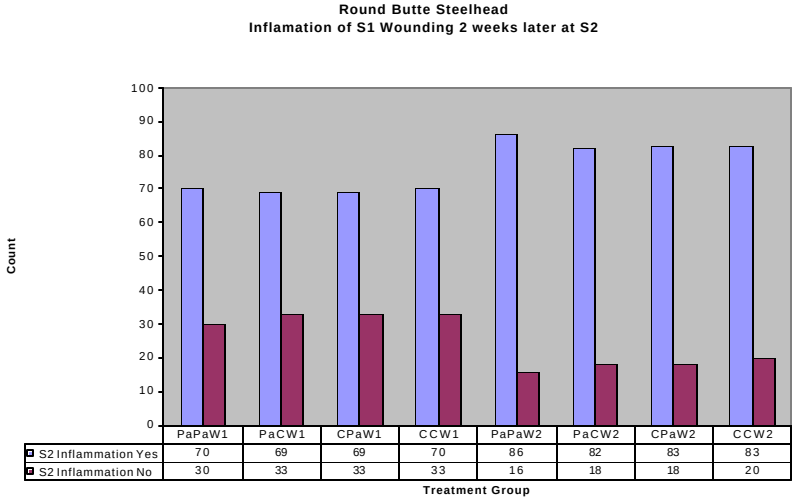


Figure 10. Compares the occurrence of inflamed wounds none inflamed wounds, two weeks following the wounding of the W1 and W2 groups, observed in Steelhead in the second trial.



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Spawning Techniques to Reduce the Levels of Bacterial Kidney Disease in North Santiam River Spring Chinook

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Abstract

North Santiam spring chinook salmon (*Oncorhynchus tshawytscha*) carry Bacterial Kidney Disease (BKD), which is vertically transmitted from adult to offspring. In 1991, OSU Microbiologists, in cooperation with the ODFW pathologists and Marion Forks Fish Hatchery began a study to determine the levels of BKD in chinook salmon. This involved taking kidney samples from both adults and smolts and testing them by ELISA to determine if the kidneys contained either low, medium, high positives or negative levels.

Before 1992 there had been limited action taken in controlling this disease. In 1992 - 1995 adult fish were tested but their offspring were not destroyed. In the 1994-1997 action was taken to prevent the smolts from dying by feeding 2 treatments of medicated feed for 21 days. This treatment seemed to have a positive effect on the smolts but adults continued to return with positive BKD results.

In 1996 several new spawning techniques were implemented to begin rearing BKD negative smolts. During spawning, eggs were collected and kept in separate numbered mesh bags, disinfected and placed in BKD free water until the water hardening process was completed. Eggs were then placed in incubators with numbers corresponding to the female that was ELISA tested. Once the lab identified BKD positive females, the eggs from that female were destroyed. In 1996 there were not enough BKD negative eggs and eggs containing low levels of BKD were used to meet production goals.

Link to PowerPoint Presentation: Originals\Proceedings_Jones_BKD.ppt

Culling of Eggs from BKD Positive Spring Chinook Females Can Lead to Reductions of the Disease in Smolts and the Use of Medicated Feed.

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Abstract

Spring chinook salmon are highly susceptible to Bacterial Kidney Disease (BKD) caused by the Gram positive rod *Renibacterium salmoninarum*. Over the years, outbreaks of this disease have occurred at all Oregon Department of Fish and Wildlife hatcheries which raise spring chinook salmon (*Oncorhynchus tshawytscha*). For many years we have been relying on feeding erythromycin as Gallimycin or Aquamycin to juveniles and injecting pre-spawning adult fish with erythromycin to treat for the disease. Treatments have been administered either prophylactically as an attempt to prevent clinical disease, or therapeutically where outbreaks of BKD have occurred.

In some cases, outbreaks of BKD have occurred in the fall and winter in spite of two prophylactic erythromycin feedings given to spring chinook. A culling program to remove eggs from BKD positive parents began in 1993 with Willamette River stock spring chinook salmon and was expanded over the next four years to encompass all the Willamette River system stocks. Except for the Willamette stock 1993 brood where both males and females were sampled, only females have been tested for *R. salmoninarum*. The culling was initiated as an attempt to decrease the BKD outbreaks during rearing and reduce the level of BKD in out-migrating smolts. In conjunction with the elimination of eggs from BKD positive fish, a reduction in the amount of erythromycin (approximately 1,351 pounds per year) being fed prophylactically at four of the five facilities has resulted in substantial cost savings (approximately $46,200 per year).

Fish were designated positive for BKD either by clinical (visual) signs of disease such as pustules, swollen kidneys or gray kidneys or by examination of kidney tissue using the enzyme linked immunosorbent assay (ELISA) technique. Numbers of fish which were positive for *R. salmoninarum* have ranged from a low of 0.4% in the Clackamas River stock in 2001 to a high of 47.8% in the North Santiam River stock in 1997. Eggs from positive fish were culled at all facilities to varying degrees. Where possible, 100% of eggs from females which had kidney pustules or from which *R. salmoninarum* antigen was detected by ELISA were discarded. In four instances, due to production constraints, the number of culled eggs ranged from 30-93%. In these cases the fish were segregated and in one instance the number of prophylactic erythromycin feedings were increased.

Besides the reduced erythromycin, we have noted over time the absence of BKD outbreaks in populations where progeny originated from females where no *R. salmoninarum* antigen was detected. Outbreaks of BKD in culled negative fish have occurred only at McKenzie Hatchery where *R. salmoninarum* is highly prevalent in the water supply. In these cases the outbreaks were delayed by two to four months and the incidence and mortality was less severe. No outbreaks have occurred in the last three years at this facility. The numbers of infected smolts prior to release has been reduced dramatically at all the facilities since the culling

program started and just as important, the number of fish with moderate or high levels of BKD have decreased to few or none in all the stocks.

Introduction

Bacterial kidney disease (BKD) caused by the Gram positive bacterium *Renibacterium salmoninarum* affects many species of salmonids. Spring chinook salmon (*Oncorhynchus tshawytscha*) are particularly susceptible to the organism. The Oregon Department of Fish and Wildlife (ODFW) has attempted to control this disease with the use of erythromycin. Returning adults are injected with erythromycin at a target of 22 mg/Kg of body weight once or twice during the summer holding period depending on the time of entrance to a hatchery's trap. Historically, juvenile fish have been prophylactically or therapeutically fed erythromycin medicated feed (Gallymicin and more recently Aquamycin) at a target dose of 100 mg/Kg of body weight from one to three times during the rearing period.

In spite of attempts to reduce the impact of *R. salmoninarum* on spring chinook salmon stocks in Oregon's Willamette River system by using erythromycin, outbreaks of the disease continued to occur with regularity at several ODFW facilities. To further reduce the effect of *R. salmoninarum* on these stocks, a culling program began in 1993 with Willamette River stock spring chinook and was expanded over next four years to include all the Willamette River system stocks. The culling program was initiated as an attempt to reduce the BKD outbreaks during rearing and decrease the level of *R. salmoninarum* in migrating smolts. As part of the culling program it was also proposed to reduce the reliance on erythromycin, thus reducing medication costs.

Materials and Methods

The culling program has occurred at the following Willamette River system facilities: Willamette Hatchery (Willamette River stock, 1993-2001); McKenzie Hatchery (Willamette River stock, 1994-1999 and McKenzie River stock, 1995-2001); Minto Pond (North Santiam River stock, 1996-2001); South Santiam Hatchery (South Santiam River stock, 1996-2001) and Clackamas Hatchery (Clackamas River stock, 1997-2001).

The enzyme linked immunosorbent assay (ELISA) method is used for detection of *R. salmoninarum* antigen. Except for the 1993 brood Willamette River stock where both males and females were sampled, only females have been sampled for the presence of *R. salmoninarum* antigen. Kidney samples (approximately 2 g) are collected from fish with individual razor blades and placed in whirl pack bags. Eggs are placed in incubator trays labeled with the same number as the whirl pack bags. The samples are weighed and diluted 1:4 with phosphate buffered saline and homogenized by running a rolling pin over the bags several times. Aliquots are poured into tubes, boiled and centrifuged. The supernatant is then used to load 96 well plates pre-coated with goat anti *R. salmoninarum* antigen. The plates are incubated, washed, reacted with a secondary antibody conjugated to horse radish peroxidase and followed by ABTS (a chromagen) and peroxidase as a color substrate. Positive samples change color. Plates are read and the results downloaded to a computer. We have assigned the following ELISA optical density (OD) readings to *R. salmoninarum* antigen levels: <0.1 = negative; 0.1 - 0.199 = low; 0.2 - 0.499 = moderate and ≥ 0.5 = high.

Where possible, eggs from fish with OD readings of ≥ 0.1 were destroyed. Early in the program in situations where not enough negative eggs were available for production targets, eggs

from low level positive adults were segregated and fish were reared separately from those which came from negative adults. In some of these cases the fish were fed erythromycin as Aquamycin medicated feed two or three times during the rearing period. Where all positive eggs were culled, the use of erythromycin was initially reduced by giving fish a single feeding in the spring and eliminating the summer treatment. Over a period of a few years all Aquamycin medicated feedings were eliminated for the Willamette, Marion Forks, South Santiam and Clackamas stocks as well as the McKenzie stock reared at Willamette Hatchery. Most fish at McKenzie Hatchery continue to receive two erythromycin feedings because of horizontal transmission from natural spawning fish in its water supply. This year, we have eliminated the second feeding for the fall release fish and plan to expand this to a spring release group next year.

Results and Discussion

Antigen of *R. salmoninarum* in kidney tissue from the five stocks has been detected at a 7.7% level since the inception of the program. Percent of fish with detectable antigen has ranged from a low of 0.4% (Clackamas River stock, 2001) to high levels of 30 and 47.8% in the first two years of sampling in the North Santiam River stock (Table 1).

Of all the fish which tested positive for *R. salmoninarum* antigen between 30 and 100% of their eggs were destroyed. The remaining eggs from positive adults and resulting fry were segregated from those testing negative. All eggs from females which tested positive at moderate and high levels were destroyed and only eggs from those testing at low levels were kept as needed to reach production targets in the Willamette River stock in 1993, the McKenzie River stock in 1995 and in the North Santiam River stock in 1996 and 1997 (Table 2). Of these, the 1995 McKenzie River stock was fed Aquamycin three times before being released in the fall of 1996 for migration to the ocean. No clinical BKD was detected in these fish. The other groups were segregated and fed Aquamycin two times with no clinical BKD detected during rearing until release in the spring of 1997.

Overall, 58.5% of the fish which tested positive for *R. salmoninarum* antigen had low level OD readings while 10% had moderate and 31.6% had high readings (Table 3). One third of the fish in the high OD level group had clinical signs of BKD at spawning time. These fish had typical kidney pustules, gray kidneys or swollen kidneys. The eggs were discarded, no kidney samples were collected and the fish were assumed to have high OD readings.

The percent of eggs culled by stock and year are presented in Table 4. Eggs culled from positive adults came from all parts of the spawning cycle. In 1997, in the Willamette and McKenzie stocks there was no correlation between the presence of *R. salmoninarum* antigen and erythromycin injections. Positive fish were as likely to come from non injected as well as injected females. During the program, 8.3% or 6,323,200 eggs have been culled due to the presence of *R. salmoninarum* antigen in kidney tissue of the adults or because eggs from fish whose kidneys tested negative were mixed together in a tray with those of a female testing positive. Egg mixing accounted for 1,834,650 eggs being destroyed which would have been considered negative for the presence of the antigen (Table 4). Starting in 1997, eggs were either placed one female per tray or if the eggs of two females were placed in one tray, they are separated by a plastic divider. This step has eliminated the need to remove eggs from fish considered to be negative for *R. salmoninarum* antigen.

Outbreaks of BKD have not occurred in the Willamette, North Santiam, South Santiam and Clackamas stocks since the culling program began. Low if any signs of clinical BKD have

been detected in these stocks during this period. An outbreak of BKD did occur on McKenzie River stock at McKenzie Hatchery in fingerlings from the negative 1995 and 1996 brood fish. These outbreaks were delayed by two months in 1995 and three months in 1996 from the typical timing of annual outbreaks at this facility. The outbreaks resulted in much lower numbers of fish affected compared to previous years before the culling program was instituted. Overall, the level of BKD and numbers of infected smolts prior to release has been reduced dramatically at all the facilities since the culling program started. More importantly, the number of fish with moderate or high levels of *R. salmoninarum* have decreased to few or none in the five stocks (Table 5).

Erythromycin feedings have been eliminated for the Willamette, North Santiam, South Santiam and Clackamas stocks. These reductions have decreased the use of the drug by approximately 1,351 pounds per year with a savings of approximately $46,200 per year. All groups of the McKenzie stock have continued to receive two feedings of medicated feed until this brood year where the fall release group received only one feeding. Next year we will give only one feeding to a spring release group and evaluate the results before we put the entire production on a single medicated feeding as we further reduce the use of erythromycin to control BKD.

Acknowledgments

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Thanks to the crews of the following hatcheries for their patience and invaluable help: Clackamas, Marion Forks, McKenzie, South Santiam and Willamette.

The following people have participated in this program over the years: Craig Banner, Blane Bellerud, John Drennan, Mary Edwards, Judy Engelking, Mark Engelking, April Erickson, Rich Holt, Jennifer Hulett, Nadine Hurtado, John Kaufman, Terry Kreps, Jeff McNight, Harriet Lorz, Tim Plawman, Mark Redhead, Greg Rutherford, Todd Sandell, Stephanie Sims, Bryant Spellman, Sharon Vendshus and Robin Whitmore.

Table 1. Number of fish positive for *Renibacterium salmoninarum* antigen in five Willamette River, Oregon adult spring chinook salmon stocks from 1993-2001.

Fish Stock	Brood Year	Total Fish Sampled	BKD Positive Fish	Percent BKD Positive
All	1993-2001	16,901	1,295	7.7
Willamette R.	1993	1,454	172	11.8
Willamette R.	1994	852	12	1.4
Willamette R.	1995	1,097	80	7.3
Willamette R.	1996	1,351	93	6.9
Willamette R.	1997	1,452	170	11.7
Willamette R.	1998	938	10	1.1
Willamette R.	1999	954	17	1.8
Willamette R.	2000	714	17	2.4
Willamette R.	2001	551	24	4.4
McKenzie R.	1995	472	44	9.3
McKenzie R.	1996	544	27	5.0
McKenzie R.	1997	622	64	10.3
McKenzie R.	1998	479	16	3.3
McKenzie R.	1999	672	25	3.7
McKenzie R.	2000	450	5	1.1
McKenzie R.	2001	548	35	6.4
North Santiam R.	1996	193	58	30.0
North Santiam R.	1997	224	107	47.8
North Santiam R.	1998	291	18	6.2
North Santiam R.	1999	235	15	6.4
North Santiam R.	2000	255	10	3.9
North Santiam R.	2001	257	32	12.5
South Santiam R.	1996	642	74	11.5
South Santiam R.	1997	524	28	5.3
South Santiam R.	1998	465	3	0.7
South Santiam R.	1999	521	26	5.0
South Santiam R.	2000	544	33	6.0
South Santiam R.	2001	575	28	4.9
Clackamas R.	1997	440	9	2.0
Clackamas R.	1998	444	10	2.3
Clackamas R.	1999	500	15	3.0
Clackamas R.	2000	461	6	1.3
Clackamas R.	2001	472	2	0.4

Table 2. Eggs culled due to the presence of *Renibacterium salmoninarum* in Oregon's Willamette River adult spring chinook salmon stocks from 1993 to 2001.

Fish Stock	Year	Total BKD fish	Low BKD # — % culled	Mod. BKD # — % culled	High BKD # — % culled	Total % culled	Number of eggs culled
Willamette R.	1993	172	88 — 35	24 — 100	60 — 100	80	625,500
Willamette R.	1994	12	5 — 100	0	7 — 100	100	18,800
Willamette R.	1995	80	42 — 100	7 — 100	31 — 100	100	616,500
Willamette R.	1996	93	58 — 100	7 — 100	28 — 100	100	738,000
Willamette R.	1997	170	130 — 100	7 — 100	33 — 100	100	1,152,000
Willamette R.	1998	10	7 — 100	0	3 — 100	100	45,000
Willamette R.	1999	17	17 — 100	0	0	100	76,500
Willamette R.	2000	17	12 — 100	2 — 100	3 — 100	100	76,500
Willamette R.	2001	24	9 — 100	1 — 100	14 — 100	100	108,000
McKenzie R.	1995	44	21 — 0	2 — 100	21 — 100	30	96,800
McKenzie R.	1996	27	13 — 100	5 — 100	9 — 100	100	214,200
McKenzie R.	1997	64	48 — 100	5 — 100	11 — 100	100	267,200
McKenzie R.	1998	16	7 — 100	0	9 — 100	100	72,000
McKenzie R.	1999	25	22 — 100	1 — 100	2 — 100	100	112,500
McKenzie R.	2000	5	1 — 100	0	4 — 100	100	22,500
McKenzie R.	2001	35	16 —100	1— 100	18 — 100	100	157,500
North Santiam R.	1996	58	18 — 22	2 — 100	38 — 100	93	200,600
North Santiam R.	1997	107	75 — 65	19 — 100	13 — 100	46	251,000
North Santiam R.	1998	18	7 — 100	6 — 100	5 — 100	100	81,000
North Santiam R.	1999	15	7 — 100	5 — 100	3 — 100	100	67,500
North Santiam R.	2000	10	3 — 100	3 — 100	4 — 100	100	45,000
North Santiam R.	2001	32	13 —100	4 — 100	15 —100	100	144,000
South Santiam R.	1996	74	23 — 100	14 — 100	37 — 100	100	379,900
South Santiam R.	1997	28	23 — 100	2 — 100	3 — 100	100	126,000
South Santiam R.	1998	3	3 — 100	0	0	100	13,500
South Santiam R.	1999	26	21 — 100	2 — 100	3 — 100	100	117.000
South Santiam R.	2000	33	23 — 100	6 — 100	4 — 100	100	148,500
South Santiam R.	2001	28	15 —100	2— 100	11—100	100	126,000
Clackamas R.	1997	9	4 — 100	0	5 — 100	100	40,500
Clackamas R.	1998	10	5 — 100	0	5 — 100	100	45,000
Clackamas R.	1999	15	14 — 100	1 — 100	0	100	67,500
Clackamas R.	2000	6	6 — 100	0	0	100	27,000
Clackamas R.	2001	2	1 — 100	1 — 100	0	100	9,000

Table 3. Levels of *Renibacterium salmoninarum* in five Willamette River, Oregon adult spring chinook stocks from 1993 to 2001.

Fish Stock	Year	Total fish[a]	Low BKD # - % positive	Mod. BKD # - /%positive	High BKD # - %positive	Clinical BKD[b]
Willamette R.	1993	1,454	88 — 6.1	24 — 1.7	60 — 4.1	20
Willamette R.	1994	852	5 — 0.6	0	7 — 0.8	2
Willamette R.	1995	1,097	42 — 3.8	7 — 0.6	31 — 2.8	7
Willamette R.	1996	1,351	58 — 4.3	7 — 0.5	28 — 2.1	8
Willamette R.	1997	1,452	130 — 9.0	7 — 0.5	33 — 2.3	19
Willamette R.	1998	938	7 — 0.7	0	3 — 0.2	1
Willamette R.	1999	954	17 — 1.8	0	0	0
Willamette R.	2000	714	12 — 1.7	2 — 0.3	3 — 0.4	0
Willamette R.	2001	551	9 —1.6	1 — 0.2	14 — 2.5	8
McKenzie R.	1995	472	21 — 4.5	2 — 0.4	21 — 4.5	11
McKenzie R.	1996	544	13 — 2.4	5 — 0.9	9 — 1.7	1
McKenzie R.	1997	622	48 — 7.7	5 — 0.8	11 — 1.8	5
McKenzie R	1998	479	7 — 1.5	0	9 — 1.9	3
McKenzie R	1999	672	22 — 3.3	1 — 0.2	2 — 0.3	0
McKenzie R	2000	450	1 — 0.2	0	4 — 0.9	0
McKenzie R	2001	548	16 —2.9	1— 0.2	18 — 3.2	6
North Santiam R.	1996	193	18 — 9.3	2 — 1.0	38 — 19.7	22
North Santiam R.	1997	224	75 — 33.5	19 — 8.5	13 — 5.8	2
North Santiam R.	1998	291	7 — 2.4	6 — 2.1	5 — 1.7	4
North Santiam R.	1999	235	7 — 3.0	5 — 2.1	3 — 1.3	0
North Santiam R.	2000	255	3 — 1.2	3 — 1.2	4 — 1.5	0
North Santiam R.	2001	257	13 —5.1	4 — 1.6	15 —5.8	5
South Santiam R.	1996	642	23 — 3.6	14 — 2.2	37 — 5.8	8
South Santiam R.	1997	524	23 — 4.4	2 — 0.4	3 — 0.6	1
South Santiam R.	1998	465	3 — 0.7	0	0	0
South Santiam R.	1999	521	21 — 4.0	2 — 0.4	3 — 0.6	0
South Santiam R.	2000	544	23 — 4.2	6 — 1.1	4 — 0.7	0
South Santiam R.	2001	575	15 —2.6	2— 0.3	11—1.9	3
Clackamas R.	1997	440	4 — 0.9	0	5 — 1.1	4
Clackamas R.	1998	444	5 — 1.1	0	5 — 1.1	3
Clackamas R.	1999	500	14 — 2.8	1 — 0.2	0	0
Clackamas R.	2000	461	6 — 1.3	0	0	0
Clackamas R.	2001	472	1 — 0.2	1 — 0.2	0	0

a = Includes fish culled at spawning time due to presence of clinical BKD signs.

b = Fish with typical BKD kidney pustules, no samples collected. These fish were counted as high level positives.

Table 4. Percentage of BKD positive eggs culled from five Willamette River, Oregon stocks of spring chinook salmon from 1993 to 2001.

Fish Stock	Brood Year	Number of Eggs Culled	Percent of Eggs Culled
All	1993 - 2001	6,323,200	8.3
Willamette R.	1993	625,000*	15.0
Willamette R.	1994	54,000*	0.7
Willamette R.	1995	616,500*	11.5
Willamette R.	1996	738,000*	12.5
Willamette R.	1997	1,152,000*	19.0
Willamette R.	1998	45,000	1.1
Willamette R.	1999	76,500	1.8
Willamette R.	2000	76,500	2.4
Willamette R.	2001	108,000	4.4
McKenzie R.	1995	96,800*	5.1
McKenzie R.	1996	214,200*	10.4
McKenzie R.	1997	267,200	9.5
McKenzie R.	1998	72,000	3.3
McKenzie R.	1999	112,500	3.7
McKenzie R.	2000	22,500	1.1
McKenzie R.	2001	157,500	6.4
North Santiam R.	1996	200,600*	24.9
North Santiam R.	1997	251,000	22.6
North Santiam R.	1998	81,000	6.2
North Santiam R.	1999	67,500	6.4
North Santiam R.	2000	45,000	3.9
North Santiam R.	2001	144,000	12.5
South Santiam R.	1996	379,900*	13.0
South Santiam R.	1997	126,000	4.8
South Santiam R.	1998	13,500	0.6
South Santiam R.	1999	117,000	5.0
South Santiam R.	2000	148,500	6.1
South Santiam R.	2001	126,000	4.9
Clackamas R.	1997	40,500	2.0
Clackamas R.	1998	45,000	2.3
Clackamas R.	1999	67,500	3.0
Clackamas R.	2000	27,000	1.3
Clackamas R.	2001	9,000	0.4

* = Approximately 45% of these eggs were from negative females but were destroyed because they were sharing a tray with those of a positive female.

Table 5. Levels of Renibacterium salmoninarum in five Willamette River, Oregon spring chinook smolt stocks from 1993 to 2001.

Fish Hatchery	Lot #[a]	Exam date mo/yr	Total fish	Low BKD # - % positive	Mod. BKD # - /% positive	High BKD # - % positive	Percent BKD positive
Willamette	22.95	10/96	58	11 — 39.3	0	0	19.0
Willamette	22.95	1/97	53	38 — 71.7	8 — 15.1	2 — 3.8	90.6
Willamette	24.95	1/97	68	60 — 88.2	1 — 1.5	0	89.7
Willamette	23.96	10/97	50	40 — 80.0	0	0	80.0
Willamette	24.96	10/97	62	18 — 29.0	0	0	29.0
Willamette	24.96	2/98	39	0	0	0	0
Willamette	23.97	10/98	71	6 — 8.5	0	0	8.5
Willamette	24.97	10/98	62	1 — 1.6	0	0	1.6
Willamette	24.97	2/99	65	0	0	0	0
Willamette	22.97	2/99	72	23 — 31.9	0	0	31.9
Willamette	22.98	1/00	60	0	0	0	0
Willamette	24.98	2/00	60	4 — 6.7	0	0	6.7
Willamette	23.99	10/00	60	2 — 3.3	0	0	3.3
Willamette	24.99	10/00	60	0	0	0	0
Willamette	22.99	2/01	75	3 — 4.0	0	0	4.0
Willamette	24.99	2/01	71	14 — 19.7	0	0	19.7
Dexter Ponds	24.95	10/96	59	10 — 16.9	2 — 3.4	0	20.3
Dexter Ponds	22.96	10/97	58	1 — 1.7	0	0	1.7
Dexter Ponds	22.96	1/98	58	1 — 1.7	0	0	1.7
Dexter Ponds	22.96	2/98	60	12 — 20.0	1 — 1.7	0	21.7
Dexter Ponds	22.97	10/98	59	1 — 1.7	0	0	1.7
Dexter Ponds	22.97	1/99	60	1 — 1.7	0	0	1.7
Dexter Ponds	22.97	2/99	60	5 — 8.3	0	0	8.3
Dexter Ponds	22.98	10/99	60	2 — 3.3	0	0	3.3
Dexter Ponds	22.98	1/00	60	0	0	0	0
Dexter Ponds	22.98	2/00	61	0	0	0	0
Dexter Ponds	22.99	10/00	60	0	0	0	0
Dexter Ponds	22.99	1/01	20	0	0	0	0
Dexter Ponds	22.99	2/01	40	2 — 5.0	0	0	5.0
McKenzie	23.95	10/96	57	14 — 24.6	0	0	24.6
McKenzie	22.95	10/96	59	25 — 42.4	0	0	42.4
McKenzie	24.95	10/96	56	11 — 19.6	0	0	19.6
McKenzie	23.95	1/97	116	102 — 87.9	4 — 3.4	2 — 1.7	93.1
McKenzie	24.95	1/97	64	19 — 30.2	19 — 30.2	25 — 39.1	98.4
McKenzie	23.96	10/97	66	1 — 1.5	0	0	1.5
McKenzie	23.96	1/98	63	12 — 17.5	0	0	17.5
McKenzie	23.96	2/98	69	29 — 42.0	1 — 1.4	2 — 2.9	46.4
McKenzie	23.97	10/98	74	23 — 31.1	0	0	31.1
McKenzie	23.97	1/99	126	25 — 19.8	1 — 0.8	0	20.6
McKenzie	23.97	2/99	121	24 — 19.8	1 — 0.8	1 — 0.8	21.5
McKenzie	23.98	10/99	65	2 — 3.1	1 — 1.5	0	4.6
McKenzie	23.98	1/00	126	14 — 11.1	0	0	11.1
McKenzie	23.98	2/00	183	17 — 9.3	0	0	9.3

Table 5. Continued.

Fish Hatchery	Lot #[a]	Exam date mo/yr	Total fish	Low BKD # - % positive	Mod. BKD # - /% positive	High BKD # - % positive	Percent BKD positive
McKenzie	23.99	10/00	60	0	0	0	0
McKenzie	23.99	1/01	65	1 — 1.5	0	0	1.5
McKenzie	23.99	2/01	198	19 — 9.6	0	0	9.6
McKenzie	23.00	10/01	Inc.	—	—	—	
Marion Forks	21.95	2/97	67	67 — 100	0	0	100
Marion Forks	21.95	3/97	50	48 — 96.0	2 — 4.0	0	100
Marion Forks	21.97	1/99	60	25 — 41.7	1 — 1.7	0	43.3
Marion Forks	21.97	2/99	132	47 — 35.6	1 — 0.8	0	36.4
Marion Forks	21.98	2/00	60	2 — 3.3	0	0	3.3
Marion Forks	21.99	2/01	67	5 — 7.5	0	0	7.5
South Santiam	24.95	1/97	64	46 — 71.9	0	0	71.9
South Santiam	24.96	10/97	63	1 — 1.6	0	0	1.6
South Santiam	24.96	2/98	64	56 — 87.5	0	0	87.5
South Santiam	24.97	10/98	62	2 — 3.2	0	0	3.2
South Santiam	24.97	1/99	63	1 — 1.6	0	0	1.6
South Santiam	24.98	10/99	63	6 — 9.5	0	0	9.5
South Santiam	24.98	1/00	60	1 — 1.7	0	0	1.7
South Santiam	24.99	10/00	60	4 — 6.7	0	0	6.7
South Santiam	24.99	1/01	70	18 — 25.7	1 — 1.4	0	27.1
South Santiam	24.00	10/01	Inc.	—	—	—	
Clackamas	19.95	8/96	119	28 — 23.5	0	2 — 1.7	25.2
Clackamas	19.96	8/97	60	6 — 10.0	0	0	10.0
Clackamas	19.96	1/98	60	27 — 45.0	6 — 10.0	3 — 5.0	60.0
Clackamas	19.96	2/98	60	23 — 38.3	1 — 1.7	0	40.0
Clackamas	19.97	3/99	60	14 — 23.3	0	0	23.3
Clackamas	19.98	8/99	32	1 — 3.1	0	0	3.1
Clackamas	19.98	10/99	30	4 — 13.3	0	0	13.3
Clackamas	19.98	2/00	59	20 — 33.9	2 — 3.4	1 — 1.7	38.3
Clackamas	19.98	3/00	59	16 — 27.1	0	0	27.1
Clackamas	19.99	8/00	30	1 — 3.3	0	0	3.3
Clackamas	19.99	3/01	120	4 — 3.3	0	0	3.3
Clackamas	19.00	7/01		7	1	0	

[a] = In the case of these stocks, lot numbers are composed of a two digit number indicating the originating stream followed by a period and the last two digits of the year the eggs were collected. The stocks are as follows: 19 – Clackamas River, 21 – North Santiam River, 22- Middle Fork of the Willamette River, 23 – McKenzie River and 24 – South Santiam River. Some hatcheries rear multiple stocks.

In Hatchery Survival, First-Time Dam Detections and Incidence of Bacterial Kidney Disease in Oregon Captive Brood Spring Chinook Progeny Reared at Lookingglass Hatchery Under Varying Levels of BKD Segregation: Is There Value in BKD Segregation/Culling?

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Part of the Lookingglass Hatchery program located in Northeast Oregon is to rear Lostine River, Catherine Creek and Upper Grande Ronde River progeny from the Oregon spring chinook captive broodstock program. Brood year 1999 progeny from these three captive brood stocks were ponded and reared based on the *Renibacterium salmoninarum* (Rs) antigen levels of the female parents within facility constraints at Lookingglass Hatchery and program evaluation requirements (Tables 1-3). Increased loss due to BKD occurred in two of six Lostine River raceways and two of six Catherine Creek raceways containing progeny primarily from moderate/clinical BKD females. Peak losses occurred in July 2000 when losses were as high as 0.5-1.7%/day for the Catherine Creek stock and 0.6-0.8%/day for the Lostine River stock. The cumulative percent mortality for the two high BKD segregation Catherine Creek raceways was 11.60% and 29.86% from final ponding to transfer from Lookingglass Hatchery (Figure 1). Cumulative percent mortality for the two high BKD segregation Lostine River raceways was 12.71% and 13.56% (Figure 2). The low BKD segregation raceways experienced a mean cumulative percent loss of 0.38% for Catherine Creek and 0.45% for Lostine River for the same time period. The incidence (%) and proportion of fish with BKD in mortality by raceway generally showed a positive relationship to maternal BKD levels or BKD segregation status. The combined proportion of mortality with BKD from the two high BKD Catherine Creek raceways was 88/93 (94.6%) and 66/67 (98.5%) for the Lostine River stock (Figures 3 & 4). In contrast, the low BKD segregation raceways for the Catherine Creek had only 2/87 (2.3%) and 1/54 (1.8%) mortality with clinical BKD. Pre-liberation Rs ELISA values from 160 grab-sampled Catherine Creek fish showed that 3/160 (1.9%) were clinical values (≥ 1.000 OD units) and 4/160 (2.5%) were high level values in the 0.600-0.999 value range. All seven of these values were from high BKD segregation raceways. Pre-liberation Rs ELISA values from 100 grab-sampled Lostine River fish showed that 2/100 (2%) were low to moderate values in the 0.200-0.599 value range and both of these were from higher risk BKD segregation raceways. Preliminary out-migration data showed first-time dam detection differences between the higher risk BKD segregation raceways that experienced increased loss and detections from other raceways (Table 4). PIT-tag detections for the higher risk BKD Catherine Creek (raceway 10) and Lostine River (raceway 7) fish were 4% and 27% respectively. Mean PIT-tag detections for the all the other raceways were 51% for Catherine Creek and 48.7% for Lostine River. These data show the real potential risk of BKD loss associated with rearing progeny from captive populations with elevated maternal BKD levels and support what is known regarding Rs and vertical transmission within the egg (Fryer et al. 1993).

Table 1. Lostine River BY99 Captive Brood progeny ponding plan at Lookingglass Hatchery.

R2	**R3**	**R4**	**R5**	**R6***	**R7***
34.4k	20.2k	34.0k	14.5k	18.7k	17.7k
Low 100%		Low 100%	Low 21.7%		
	Mod 53.7%		Mod 37.9%	Mod 58.8%	Mod 58.8%
	Clin 38.6%		Clin 23.4%	Clin 31.6%	Clin 31.6%
	Gross 7.7%		Gross 16.9%	Gross 6.9%	Gross 6.9%
L	**M/C/G**	**L**	**L/M/C/G**	**M/C/G**	**M/C/G**

Table 2. Grande Ronde River BY99 Captive Brood progeny ponding plan at Lookingglass Hatchery.

R8
2.5k
Low 88.1%
Mod 11.9%
L/M

Table 3. Catherine Creek BY99 captive Brood progeny ponding plan at Lookingglass Hatchery.

R9	R10*	R11*	R12	R13	R14
23.9k	23.9k	23.8k	25.7k	25.7k	24.7k
Low 79.4%		Low 22.3%	Low 99.9%	Low 99.9%	Low 99.9%
Mod 18.7%	Mod 68.7%	Mod 40.9%	Mod 0.1%	Mod 0.1%	Mod 0.1%
	Clin 18.2%	Clin 24.4%			
Gross 1.9%	Gross 13.1%	Gross 12.4%			
L/M/G	M/C/G	L/M/C/G	L/m	L/m	L/m

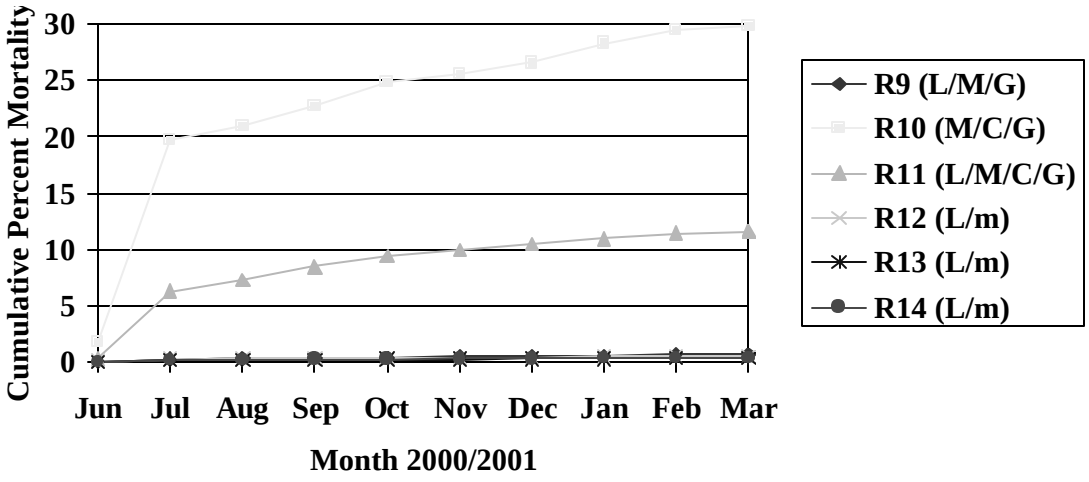

Figure 1. Cumulative Percent Mortality for Catherine Creek BY99 Captive Brood progeny at Lookingglass Hatchery.

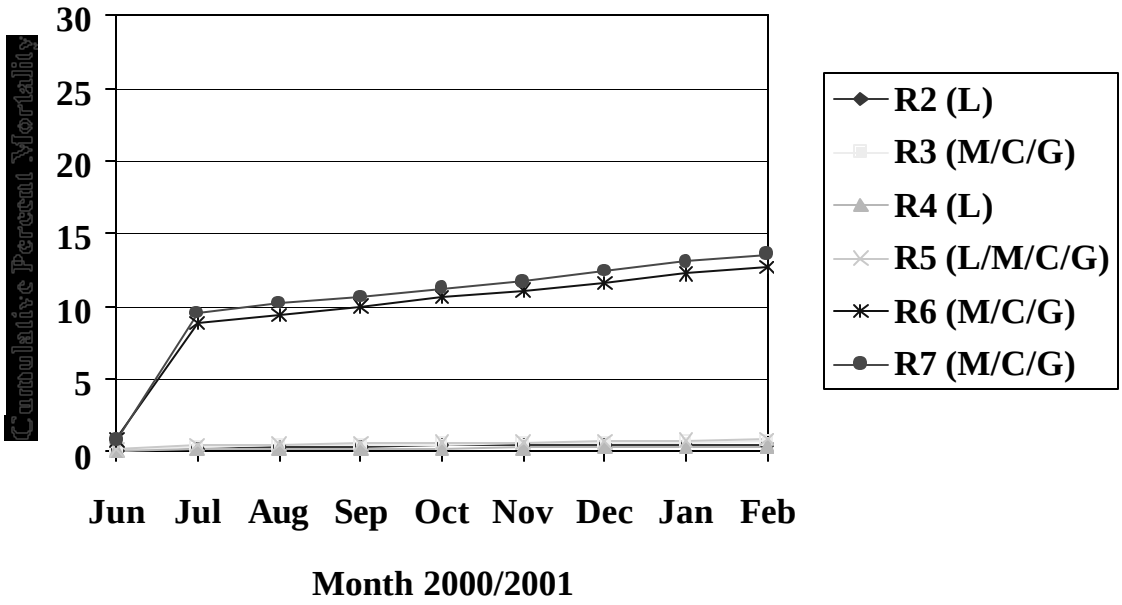

Figure 2. Cumulative Percent Mortality for Lostine River BY99 Captive Brood progeny at Lookingglass Hatchery.

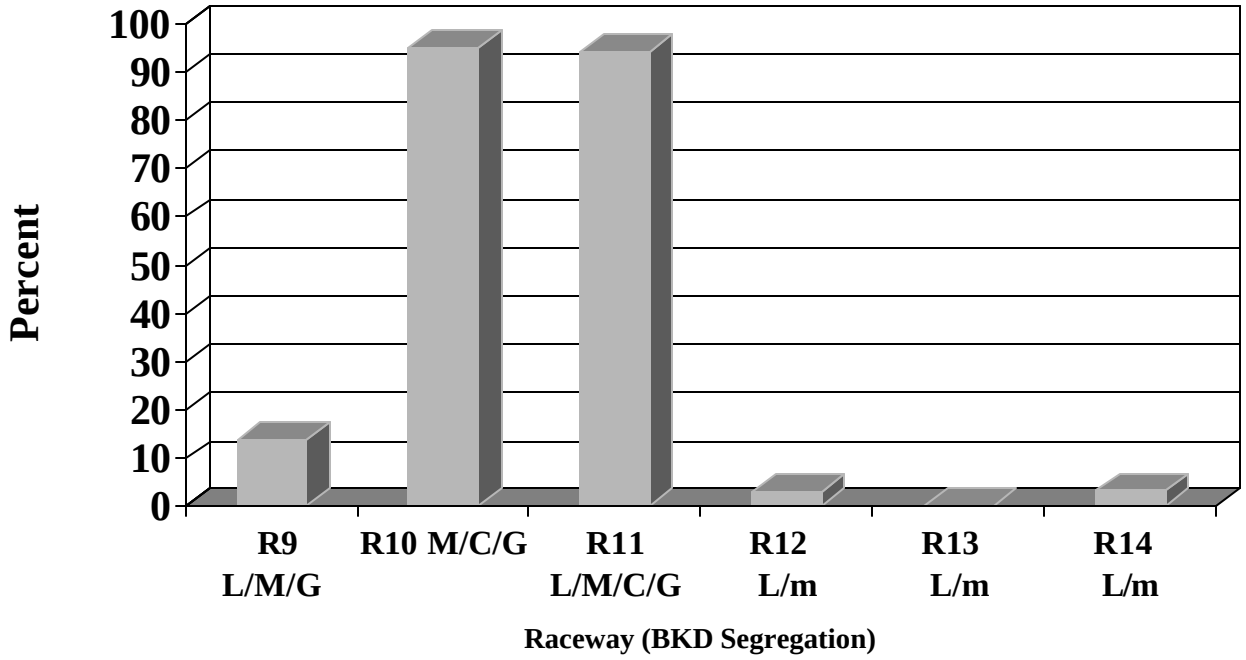

Figure 3. Proportion (%) of BY 99 Catherine Creek mortality with clinical BKD at Lookingglass Hatchery.

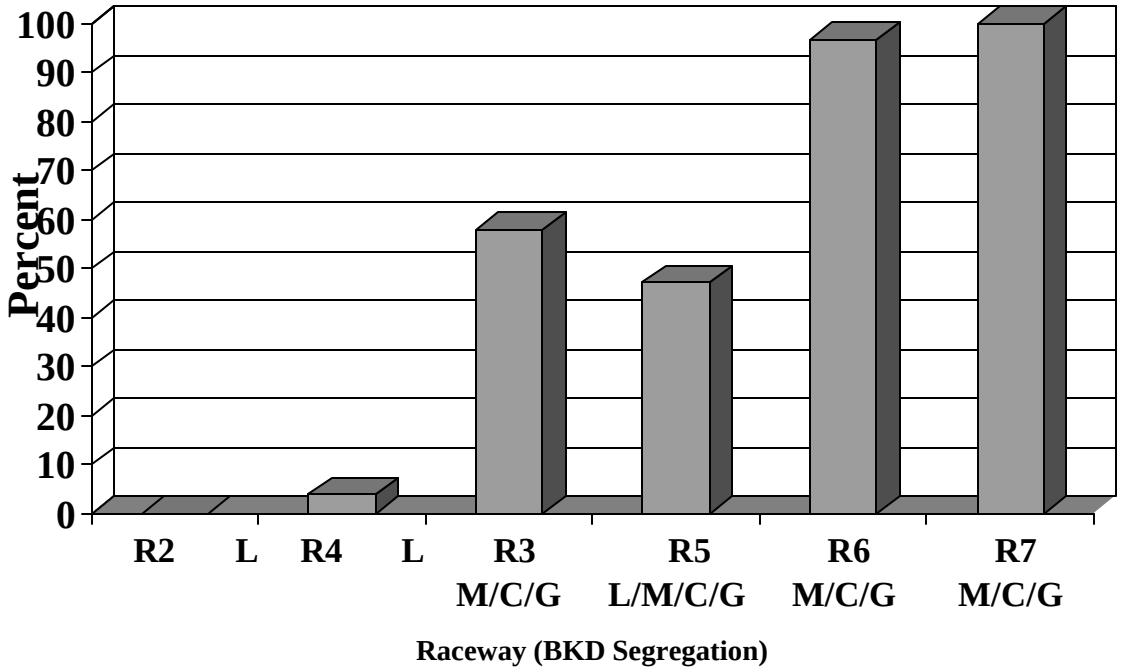

Figure 4. Proportion (%) of BY99 Lostine River Mortality with clinical BKD at Lookingglass Hatchery.

Table 4. First-time dam detections of BY99 Captive Brood progeny PIT-tagged at Lookingglass Hatchery (migration year 2001)[a].

Stock	Raceway	BKD Segregation	# Released	% Detected
Lostine River	2	L	3,501	45%
	4	L	3,494	48%
	5	L/M/C/G	476	53%
	7	M/C/G	436	27%
Grande Ronde	8	L/M	495	50%
Catherine Creek	10	M/C/G	469	4%
	12	L/m	6,801	49%
	13	L/m	6,823	51%
	14	L/m	6,822	53%

[a] Data provided by Erick Van Dyke (ODFW Research, La Grande, Oregon)

Conclusions

- Generally there was a positive relationship to maternal BKD levels (BKD segregation) with respect to all four parameters measured during fish health monitoring.
    1. Daily percent mortality
    2. Cumulative percent mortality
    3. Proportion (%) of mortality with clinical BKD (ELISA 1.000 or above)
    4. Grab-sampled Rs ELISA profiles (Monthly + pre-liberation)
- Real potential risk exists from BKD loss associated with rearing progeny from captive populations with elevated maternal BKD levels.
- There were PIT-tag dam detection differences between the higher risk BKD segregation raceways and other raceways indicating poorer out-migration survival.
- The significant levels of Rs antigen detected in grab-sampled fish at pre-liberation indicates the real potential for continued loss during out-migration and beyond, impacts to other out-migrant stocks, amplification of Rs in stocks?
- ANSWER to question in title: YES! The message and value of BKD segregation rearing and/or culling (PREVENTION CONTOL) needs to continue to be stressed to fisheries program decision makers.

References

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Chemical Contaminants in Fish Food and Juvenile Chinook Salmon

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Abstract

Populations of wild Pacific salmon are declining, and it is accepted that various natural and anthropogenic factors have contributed to the decline of these salmon populations. Exposure to toxic contaminants may indirectly affect populations of salmon, for example, by increasing susceptibility to opportunistic pathogens at lower exposure levels than are necessary to observe direct toxicity, especially fish that migrate through contaminated estuaries and waterways. We have an ongoing program that measures contaminant levels and associated biological effects in juvenile Pacific salmon. As part of this effort, tissues of juvenile chinook salmon (*Oncorhynchus tshawytscha*) from various estuaries in Washington and Oregon were analyzed for polychlorinated biphenyls (PCBs), DDTs and aromatic hydrocarbons. As expected, whole bodies and stomach contents of chinook salmon from urban estuaries contained higher levels of bioaccumulative PCBs and DDTs than did the tissues of fish from non-urban estuaries. Surprisingly, however, juvenile chinook salmon from some hatcheries in Washington and Oregon contained levels of PCBs and DDTs that were comparable to those measured in juveniles from urban estuaries. As a result of these findings, we analyzed several samples of fish food to determine if hatchery food was a potential source of contaminants in hatchery fish. Hatchery food contained a wide range of contaminant concentrations and juvenile chinook salmon from the hatcheries are bioaccumulating chemical contaminants from certain fish foods as well as from other sources in estuaries.

Efficacy of AQUI-S™ as an Anesthetic on Various Life-Stages of Rainbow Trout *Oncorhynchus mykiss*

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Abstract

The use of anesthetics is an important tool with broad application to fisheries management programs. Most often, anesthetics are used to reduce stress associated with the handling or transportation of fish. Anesthetics are widely used both in the culture of captive populations, and in field situations that involve the management of wild stock fish populations. Although a number of compounds have been used in the past, currently, the only approved anesthetic for use on fish is tricaine methanesulfonate (i.e., FINQUEL and Tricaine-S). While FINQUEL and Tricaine-S have been found to be effective anesthetics for use in aquaculture, both products require a 21 day withdrawal period after treatment before harvestable fish can be released. This requirement greatly restricts approved use in many cultured populations and wild stock populations. AQUI-S is a new anesthetic that is approved for use in New Zealand and several other countries as a zero-withdrawal time product. Efforts are currently underway in the United States to gain U.S. Food and Drug Administration approval for the use of AQUI-S as an anesthetic with no withdrawal period. The active ingredient in AQUI-S is approved for human consumption in the U.S. when used as a food flavoring (21-CFR 172.515). A recent study conducted at the Bozeman National INAD Office evaluated various life-stages of rainbow trout treated with AQUI-S at concentrations ranging from 5 - 80 mg/L to induce handleable and anesthetized fish. Preliminary results indicate that if approved by FDA, AQUI-S may be a useful tool for aquaculturists and field biologist.

History of Liberations in the State of Oregon

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Fish transportation has came a long ways since the day of the horse and buggy. Nearly 100 years of development has brought fish transportation to a new level. Life support systems that are more dependable has taken a lot of the stress off of drivers; better and easier to get to liberation sites has added to less stress on fish as well as drivers; diesel powered trucks, comfortable seats, brakes that actually work, and sweet music radios have definitely been an improvement. One would wonder what some of the earlier liberation wagon or truck drivers would think about today's liberation units.

With the beginning of trout production in fish hatcheries, transportation of fish immediately became a problem. Fish were usually hauled from the hatcheries by horse and wagon and later by other means of transportation. One of the other methods was an old railroad pullman car called 'The Rainbow". "The Rainbow" fish distribution car was purchased in 1913 for $6,700 from O.W.R. & N. Railroad. The car was equipped with milk cans for holding the fish and an aeration system to bubble oxygen to each milk can. The distribution car could be attached to any train traveling through out the state. The train would be met at various stations along a route, which still left the fish far from their destination. Either pack string horses, horse and wagon, or early vintage automobiles would be waiting at the stations to immediately pick up the fish and move them on to their liberation destination. "The Rainbow" was used to haul fish by rail until 1922. At this time it was retired.

The horse and wagon as the main means of fish transportation was replaced by truck in the late teens or early twenties. Early fish liberation flat bed trucks were loaded with milk cans in which the fish were carried. Around 1927-1928, early fish tank trucks came into use. They gradually replaced the flat bed truck and milk can method. Nothing much in the way of liberation truck development was done until the early 1940's. Because of gains in fish production, there was a need then for more liberation equipment. Three wooden tankers were built out of 2-inch tongue and groove Port Orford cedar. These were 425-gallon units with no insulation. Life support system for the fish consisted of 1 ½ inch circulation pumps driven by the power take off from the truck engine. Ice was used to chill the water when it was thought to be necessary. In 1947, the old Game Commission had four 425 gallon liberation units statewide. These smaller units were used to haul fish to the head of pack trails where the fish were held in a live box until a pack train could haul them into their liberation destinations.

It was at around the late 1940's that the airplane made its appearance and began to be a proven and a feasible and economical method to liberate fish. The fish were carried in a specially constructed belly tank that was suspended between the wheels of the plane. Releasing the fish at an altitude of approximately four hundred feet above the lake had proven successful. The tank on the plane was equipped with an aerating device and a flap-type hinged door that was sealed on a watertight gasket. In the actual liberation the pilot would pass over the edge of the lake, trip the door and pull the plane up sharply. This resulted in less forward progress of the fish as well as helping to empty the tank.

The planting boat also made its debut about this time. The early planting boats were towed behind another boat and when the liberation site was reached, the fish were either dipped out with a long handled dip net, or the boat was over turned and the fish released. Actually the planting boat was merely a floating live box. By 1950 horse packing liberation operations were curtailed partly because of excessive cost and partly because airplane stocking had been able to accomplish comparable results. Two aircraft were used for high lake stocking at this time.

In the early 1950's, as older units began to wear out, larger liberation units were put into service. They were 725-gallon units mounted on two-ton trucks. The tanks were made from plywood and fiberglass and were insulated to maintain low water temperatures. They were also equipped with an aeration system, which included a 2-inch pump with one venturi on the discharge side of the pump. The pump was driven by a power take off from the truck.

By the mid 1950's, it had been discovered that if fish were hauled in water temperatures ranging in the low to mid 40's, the delayed mortality went way down. Fish culturists began to explore and evaluate mechanical refrigeration as a practical means of controlling water temperatures in liberation tanks. During this period of time, improvements were being made on the venturie system and overhead spray units. The development of mechanical refrigeration was frustrating and costly. Finally by 1959 some new refrigerated tankers were put into service. After the first mechanical difficulties that were encountered had been overcome, these units were able to haul up to 50% more than the conventional units of that day. By 1960, another large refrigerated 1,000-gallon tanker had been put in service making it three refrigerated tankers and a total fleet of 23 units. Also in 1960, a new technique of transporting small amounts of fish successfully in plastic bags using water and oxygen came into use.

As hatchery fish production increased through out the 1960's, liberation equipment had to meet the demand. More equipment was added to the fleet. Portable slip tanks were built that were 150-gallon units with Briggs & Stratton engine powered pumps and that could be fitted in the back of a ¾ ton pickup. Also in the late 1960's, two 1,600-gallon units were put into service. These units had diesel powered refrigeration units. Up until that point, refrigeration units had been powered by gasoline engines that seemed to create continual problems. The new diesel units proved to be a much better unit. In addition, these new units also had a single cylinder diesel pump for a back up circulation system that also proved to be an effective back up system. Prior to this, most back up systems were powered by a power take off from the truck engine. By the early 1970's the Game Commission and the Fish Commission merged into the Oregon Department of Fish & Wildlife. Diesel powered refrigeration units were replacing gasoline powered units and power take off back up systems were being totally replaced by diesel powered units. Also in the late 1960's a new way of loading fish rapidly and with no stress or injuries to the fish was developed. This was called the fish pump. Over the years the fish pump had quite a few improvements made to it.

With the merger of the two Commissions, additional liberation equipment from the old Fish Commission was added to the inventory. In the early 1970's, two units commonly referred to as the "Ruptured Duck" which was stationed at Willamette Hatchery and the "Blue Goose" which was stationed at Sandy and Clackamas Hatcheries came into use. They were both 3,500-gallon units with a 4-inch recirculation pump driven by V-4 Wisconsin gasoline engines. Oxygen was bubbled through carbon stones. These units did not have refrigeration units and did not have back up pumps installed. In the late 1980's, a diesel engine was installed to power the main pump and a small diesel powered pump was installed as a back-up pump. In the early

1980's the unit referred to as the "Ruptured Duck" which was pulled by a gasoline powered tractor was retired. The other unit known as the "Blue Goose" was pulled in the early days by a gasoline-powered tractor but in 1974, a diesel-powered tractor was purchased. This unit was used up through the 1990's and was just recently retired. The "Blue Goose" was the unit that I personally drove for many years.

In the 1970's, changes were taking place in the aerial stocking of the high lakes. Airplanes were being equipped with larger tanks that were divided into compartments thus allowing them to stock several lakes in a single trip. Some of the problems with the aerial stocking by fixed wing aircraft were the accuracy of the pilot to get the fish into the water if he was in fact able to locate the lake. In the 1980's, a new method of fish liberation into the high lakes came on the scene thanks to an arrangement made with the U.S. Forest Service. This was using their heli-tack crew to experiment with the possibilities of stocking by helicopter. This method of aerial fish liberation proved to be very successful in the terms of many more lakes could be planted in a single trip by using what is know as "Coke cans" in a rack in the helicopter. An allocation for each lake was put into a separate can. Accuracy was pinpoint and it was also much more economical. The one problem with this was the fact that in the early years of helicopter stocking, the department could possibly loose the use of the helicopter in the event of forest fires.

Fiberglass tanks, well insulated and with newer type ceramic diffusers to disperse oxygen and with 12 volt aerators were put into use. These type tanks proved to be very economical with very few problems and hauled fish quite well when ambient temperatures were lower. Central Oregon, because of its warmer summer weather continued using refrigerated trucks more than Willamette Valley located units.

In the early 1990's, two 2,800-gallon units were put together using milk tank trailers, which were refurbished, with all the necessary equipment to make distribution tankers. Two used diesel tractors were purchased to pull these trailers. The life support system was aerators and oxygen. Other "milk" type tankers were built and are still in use today. The original milk tankers were just recently retired.

Over the years, new and unique fish transportation ideas have came up. Some have proven to be quite successful. Two different programs involved barging fish tankers down the Columbia River and the Willamette River. Both of these programs were successful in the terms of using barges to haul tankers.

Fish transportation has came a long ways since the day of the horse and buggy. Nearly 100 years of development has brought fish transportation to a new level. Life support systems that are more dependable has taken a lot of the stress off of drivers; better and easier to get to liberation sites has added to less stress on fish as well as drivers; diesel powered trucks, comfortable seats, brakes that actually work, and sweet music radios have definitely been an improvement. One would wonder what some of the earlier liberation wagon or truck drivers would think about todays liberation units.

All of this development of equipment over the years has been for an end result; providing fishing opportunities for everyone, young and old.

I would like to acknowledge Terry Dufour, Randy Winters and others who have originally given the first presentation on Fish Transportation. This presentation has maintained

most of the original slides and documentation. I have added some slides and have up-dated the last 20 plus years to this presentation.

If you have any questions please contact Dennis Dahrens @ (503)630-3403, Or email Dpdahrens@aol.com

Session IV -
Fish Propagation and Beyond

Session Chair:
Jack Hurst
ODFW – Manager Umatilla Hatchery

A Historical Perspective of the Columbia River Indian Fishery

Steven K. Olhausen

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As we enter the early 21st century and with over 100 years of salmon and steelhead fish culture in the Columbia River basin behind us, we face many challenges in the future, providing fish for production and harvest. One group of people involved in both the production and harvest of salmon and steelhead on the Columbia River are the four treaty tribes. These being the Yakama, Warm Springs, Umatilla and Nez Perce tribes. The reliance on hatchery fish has become ever more important in maintaining the tribal cultural ties to the River and the opportunity to fish for subsistence, ceremonial and commercial purposes. My purpose here will be to give an historical perspective of the Indian fishery from early times to present day.

They figure that Celilo was formed some 13 to 16 thousand years ago by a series of scouring, eroding glacial floods caused by the periodic melting of an enormous ice dam which blocked prehistoric Lake Missoula. These glacial floods rushed across eastern Washington and down the gorge of the Columbia creating many falls and cataracts over time.

The fishery in the Columbia River Basin has been estimated, archaeologically speaking, going on for some 10 thousand years and maybe a tad bit more. Although some fishing was going on at numerous locations along the Columbia and its tributaries, the central and most popular fishing site was located some 200 miles from the mouth of the river. This was Wyam or better known as Celilo Falls. This place and the surrounding area was one of greatest trading sites in North America. Salmon made it so!

It was the pivotal trade spot for the Sahaptin-speaking people (Yakama, Umatilla, Walla Walla, Warm Springs, Wanapums, Wyampums and others) and the Wasco/Chinookan-speaking people could barter for beads, buckets , blankets, berries, and buffalo robes for Nusook (the salmon). It was the great "meeting place" for the region where many tribes gathered to trade, arrange for marriages, form alliances, gamble and gossip.

The fishery was mainly a dipnet and hoopnet (a big dipnet) affair. These were long, wooden handled (10 to18 ft.) with attached wire hoops with a net mesh attached. Some of the nets set in place, in an eddy or drift while the smaller dipnets were used to sweep an area of holding water. It depended on the fishing site. Some spears were used, but to a very limited area and only at certain flows.

Some seines were used below Celilo and some fishwheels were built near Celilo, but with limited success. These were used by non-Indians and were only in existence for a comparatively short time in the mid 19th and 20th century.

At 10:00am on Sunday March 10, 1957 the gates of the newly completed Dalles Dam closed and 6 hours later Wyam (Celilo Falls) was no more! Within a few years a new fishery was established within the area known as the Zone 6 Indian Fishery. This area encompasses that portion of the river between Bonneville and McNary Dams with short sanctuary areas above and below each dam. A set gillnet fishery is the main method used today, with some dipnetting

being used along the main stem Columbia River and some tributaries. Prior to the final Judge Belloni decisions of the 1960's and 70's that finally set down those rules, in what we now call U.S. vs. Oregon, the fair share concept (50% of the harvestable surplus of fish destined for their usual and accustomed fishing areas and gave the tribes co-management responsibilities for their fisheries) that area was a hot bed of controversy which ranged from not recognizing and ignoring the fishery to mid-night raids on fishing camps at Cook and Underwood, and other "in-lieu sites" taking people out of there beds and beating, arresting, and jailing them.

Fishing to these people is not just for monetary gain, although we all know how important that is in modern times. It is also a means of subsistence and used for ceremonial purposes and they take great care, in most cases, to use every part of the fish.

No matter what your personal opinion is on the subject of the pros and cons of the Indian fishery, the fact remains that legally they have the right to their share of the harvestable surplus. One must realize they were here first! The runs of salmon, steelhead and other fish are not what they once were (conservative estimates put the annual runs of fish into the Columbia at 11 to 16 million prior to 1800). Until things change, in terms habitat and natural production, the importance of artificial production of salmon and steelhead in the Columbia River will insure that the heritage, customs and traditions of the Indian people and the salmon will prevail for the old and the young!

Oregon's Volunteer-Based Salmon and Trout Enhancement Program (STEP): Propagation Activity Overview and Examples

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Abstract

The Salmon and Trout Enhancement Program (STEP) is a volunteer-based program within the Oregon Department of Fish and Wildlife (ODFW) that seeks to enhance salmon, trout, and other fish resources of the state, and the fisheries dependent on these species. STEP activities are varied, as are the individuals or groups participating in STEP. Activities can be grouped into four main categories: monitoring (fish and habitat surveys), habitat restoration (riparian and in-stream), education (classes and materials), and propagation. Propagation activities which STEP volunteers undertake include broodstock collection and holding, spawning, egg incubation, rearing, acclimation, and release. Most of the facilities which STEP groups utilize are built and run by the volunteers with ODFW assistance and oversight. The purpose of these programs is to rehabilitate or supplement populations of naturally produced salmon and trout and augment fisheries with hatchery fish. STEP propagation programs will release approximately four million salmon or trout in the next year. One of the most successful propagation programs is conducted in Coos County. A history of this varied program will be presented in order to give an idea of STEP propagation program's origins, scope, and management.

For more information about the STEP program, visit:

www.dfw.state.or.us/ODFWhtml/VolunteerProg/STEP.html

Fish Propagation and Beyond: A Harvest Perspective

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Statewide Salmon Fishery Manager

Abstract

Hatchery production of salmon and steelhead is the mainstay for Oregon's fisheries. In recent years, nearly all of Oregon's spring chinook, coho, and steelhead sport fisheries have been restricted to fin-clipped hatchery fish with wild fish released unharmed. Fall chinook fisheries still occur on healthy coastal and Columbia upriver bright wild fall chinook. The Columbia River commercial gill-net fishery will use the tangle net in 2002 for live capture of spring chinook and only hatchery fish can be retained. The ocean commercial troll fishery off the Columbia River mouth is restricted to adipose fin-marked coho only. Other summer and fall commercial salmon fisheries (ocean and Columbia) are focused on hatchery fish with wild fish impact limits driving their harvest levels. It is paramount that fish culturists and fishery managers work together to produce the best hatchery product possible to ensure Oregon's fisheries. Fishery managers are responsible for implementing fisheries to harvest hatchery returns at the highest level possible (within wild fish and other constraints) to reduce surpluses at hatcheries. Managers should also periodically review mitigation agreements for lost wild fish production to ensure society is receiving full compensation.

New Life for Old Ponds

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Background

The Oregon Department of Fish and Wildlife owns and operates 34 hatcheries throughout the State of Oregon. Many of these facilities were first built almost 100 years ago, and some of the original structures are still in operation. Pond technology varies at each facility, ranging from Burrows re-circulating ponds to raceway and older circular ponds. As the individual facility's mission is revised, the manner in which a pond is used may also change and the structure subsequently modified. Environmental pressures also affect the facility's operation and further modifications are needed. Coupled with a small capital improvement budget, more is being asked of these old structures.

Locations

With 34 hatcheries scattered over a broad range of environmental conditions, ODFW is challenged in finding a similarly broad range of solutions in repairing and restoring the older ponds (See Figure 1).

Table 1. Sample of Hatchery Location, Elevation and Age.

Hatchery	Location	Elevation	Year First Built (Rmld.)
Bonneville	Cascade Locks	46 feet	1909 (1957, 1974)
Marion Forks	Detroit	2,580 feet	1951
Oak Springs	Maupin	850 feet	1922 (1992)
Wallowa	Enterprise	3,700 feet	1920 (1985)
Wizard Falls	Sisters	2,760	1947

Table 1 [1] gives a sampling of the diversity of locations and age of five ODFW-operated hatcheries. The oldest facility is Bonneville Hatchery at 92 years, though it has been through several remodels. Marion Forks is perhaps most representative of many of the State-funded facilities. Originally built in 1952, there have not been any significant remodels. It still operates 48 circular ponds and 8 raceways. The condition of the circular ponds are still relatively good, as evidenced by minimal spalling and cracking of the concrete.

Wizard Falls Hatchery was also built in the same era as Marion Forks, and is close to the same elevation. Wizard Falls uses circular ponds, and also has several oval ponds. The similarity differs in the concrete condition, however. Several ponds here have exhibited serious to severe deterioration.

Why would two similarly aged facilities, separated by only 20 air miles exhibit such differing conditions? There are likely several reasons, some of which are:

- Construction Quality
- Concrete Quality
- Climate Differences
- Use of Protective Coatings
- Maintenance Practices

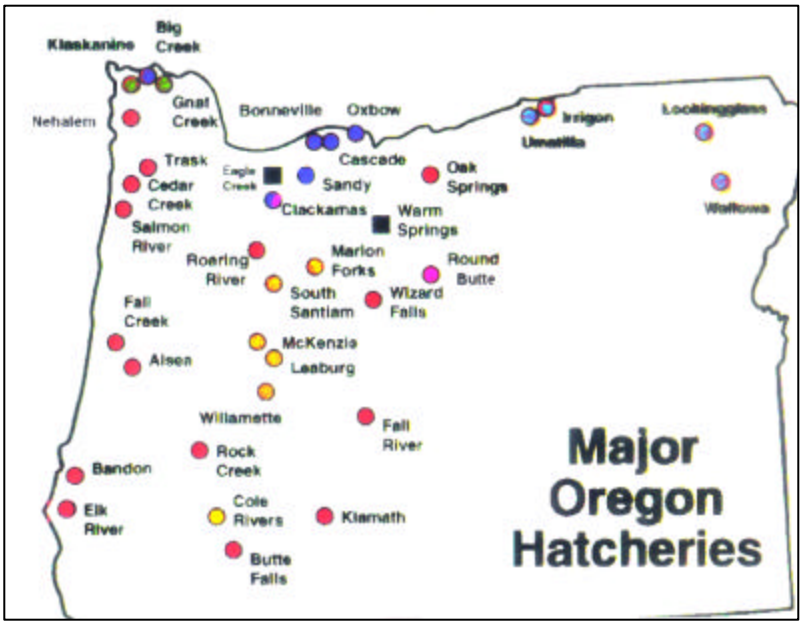

Figure 1.

Map of Oregon, showing relative locations of ODFW-operated hatcheries

Types and Causes of Concrete Pond Deterioration

Most of us take for granted the multitude of concrete structures around us – as long as it is in good condition. Yet we will readily notice when the concrete deteriorates. Usually we will see it in the form of cracks and spalls. Cracks of course are self-evident. Spalls are the corners of walls and slabs that break off of structures, leaving a "ragged" edge or corner. Other forms of deterioration are surface erosion and "crumbling" concrete.

Concrete Cracks

Cracking is a given, considering the nature of concrete. It is mixed and placed when it is wet, and gains strength as it dries, or "cures". The drying or "hydration" process, when the moisture evaporates out, causes a molecular shrinkage that in turn causes tension within the concrete section. This tension accumulates along the structure's length until it reaches a point where the tension exceeds the strength of the concrete and breaks the concrete section, hence the crack. We can somewhat control the cracking by the amount of water used in the initial mix, and we can add additives that slow the shrinkage or add air pockets. We can control where the crack occurs by placing a joint at predetermined intervals, but we can never completely eliminate the occurrence of cracks.

In some cases, the crack is merely a cosmetic nuisance. In a pond containing smolts, the crack can allow leakage of water, which needlessly increases water consumption and in some cases allows the escape of small fish. More serious conditions can result in the structural failure of major components, such as corrosion of internal steel reinforcing; undermining pond bottom

slabs, and wall collapse. Continued exposure to moisture and the possibility of alternate freezing can widen the crack, causing further damage. In any case the crack should be repaired.

Recently, our Oak Springs Hatchery Adult Brood Stock pond developed cracks and leakage that undermined a significant portion of the bottom slab. The severity was not known until sinkholes developed adjacent to the pond, indicating sub-grade erosion and collapse of the supporting soil. Subsequent repairs consisted of grout injection in the sub-grade below the slab, to replace the eroded soils and to provide foundation support.

"Spalling"

Spalls are pieces of concrete that break off or otherwise separate from the main structure. The causes can be from single or repeated impacts such as vehicle or equipment wheels, or the effects of weathering and exposure. Small cracks can allow moisture to penetrate, which can subsequently freeze, expand and break off the piece of concrete.

Surface Erosion

A common form of deterioration found in hatchery ponds is the erosion of the concrete surface, or removal of the smooth finish of the concrete. This can occur by a number of ways, but perhaps the most common is the misuse of high-pressure power washer hatchery personnel use to periodically clean the ponds.

During pond construction, when the concrete is first placed, the finishing process uses floats to form a surface "cream". This "cream" consists of cement and fine sand, and forms a protective coating over the concrete matrix. The coating helps prevent the intrusion of foreign and potentially harmful materials into the concrete.

While the goal is to adequately (and quickly) clean the pond, the temptation is often to use a higher pressure spray than necessary. The result is the eventual removal of the surface finish, exposing the more porous material and the aggregate of the concrete. Potential problems that may occur at this stage are accelerated deterioration due to weathering/exposure and to the buildup of bacteria in inaccessible "nooks and crannies". The bacteria can be detrimental to small fish as well as promoting further concrete deterioration. Small concrete cracks are less detectable at this stage, which can delay needed repairs.

General Deterioration of Concrete

In more advanced stages of deterioration we can see the concrete begin to "crumble" when the cement binder either loses its ability to hold the matrix together, or in some cases there just was not enough cement to begin with. Construction quality was found to be quite variable during the 1940's and 1950's, which could explain the differing pond conditions between the Marion Forks and Wizard Falls hatcheries. A common method of "cost-savings" included using less cement in the concrete mix.

Another occurrence that is receiving more recent attention is a phenomenon called "alkali-silica reactivity" or "ASR". Although the use of reinforced concrete dates back hundreds of years, ASR was first identified in the 1940's in California and dam builders have recognized its affects for some time. It was in the 1980's that ASR was found to be more prevalent, primarily in the western and central U.S. ASR is a chemical reaction between the alkalis found in cement and the silica from certain types of aggregate. The alkali and silica react to form a gel within the concrete matrix. The gel itself is harmless, except it allows moisture to penetrate and

then expands. The expansion causes stresses in the concrete resulting in pattern cracking of the structural element. The cracking then provides access for further moisture intrusion, leading to freeze/thaw damage, sulfate attack or corrosion of the steel reinforcing [2].

Figure 2.

This photograph shows the surface of a concrete pond aggressively cleaned with a power washer. Note the aggregate.

Methods of Repair

Crack and Joint Repair

The two most common means of crack repair are injection and surface coatings. Smaller cracks (less than 1/8-inch in width) are best repaired by an **epoxy-injection method**, using a two-component mixture injected under high pressure with special equipment. The two components, an epoxy resin and a catalyst, form an adhesive bond with material on both sides of the crack, both sealing the crack and restoring the structural integrity of the repaired element. Disadvantages are it's relatively high cost, and potential toxicity of the catalyst. There are a number of products available. Read the instructions.

Epoxy-injection can be used on larger cracks, but it may become cost prohibitive due to the amount of material needed. Other methods that have been used fairly successfully include filling the crack with **silicon-based caulks**. Older methods that were used include filling the crack with a hot asphalt mixture poured into the crack. While it successfully stopped leakage, it is not a desirable means to repair concrete cracks. It was found to contaminate the concrete substrate on both sides of the crack, causing long-term deterioration and making other more desirable methods ineffective. The contaminated concrete will not allow the bonding of other repairs such as epoxy-injection and caulking. The use of asphaltic crack and joint fillers should be discouraged.

Repairing cracks (and concrete joints) requires proper preparation in order for the caulk or epoxy to work effectively. It cannot be emphasized enough how important it is to properly clean the crack prior to filling it. Again, follow the instructions of the manufacturer, particularly if warranties are to remain in effect. The following photograph (Figure 3) shows a pond ready for application of a new coating system.

Joints are similar to cracks (except that they are "supposed" to be there). The use of a silicon-based adhesive caulk works best, as it adheres to the sides of the joint and maintains a

seal. The joint is located to accommodate movements between the slab elements or at the slab and wall interface. You will recall earlier discussions about concrete shrinkage, where cracks develop as concrete hydrates and shrinks. The placement of joints enables the designer to control where these cracks occur. The flexibility of the joint repair allows the joint to function as needed.

Figure 3.

Ponds at Bonneville Hatchery, prepared for application of new coating. Note repaired cracks joints.

Deteriorated Concrete Repair

Concrete that has deteriorated to the point of crumbling is difficult to repair, and the deteriorated portion should be replaced. Any loose or soft material must be removed, either by water-blasting or careful jackhammer to expose solid concrete matrix. Often this will involve a significant portion of the structure, and consideration may be made to complete replacement of the structure. This may be true for structures suffering from ASR, since the deterioration process will continue in any portion of the remaining structure after repairs are made.

Again, proper preparation of the remaining strata of concrete is essential to proper repairs. Any new concrete must be placed against clean, solid existing concrete, or the adhesion will not occur and the new portion will break off. The use of a "brush-on" epoxy adhesive product on the existing surface prior to placement of new concrete is recommended.

New Surface Coatings

ODFW has used a number of different products for recoating or resurfacing existing ponds, with a variety of success. Until recently, there were limited products available, with limited options for color. While some resurfaced ponds appeared to pass the durability test, there were some operational limits such as too slippery for personnel to walk on, or the color was too bright.

Several newer products have become available, and ODFW has begun research on some of the use of various types of coating products. In 2000, repairs were needed for ponds at the Trask Hatchery near Tillamook, OR. It was an opportunity to try a new coating system. The criteria ODFW's Engineering section required were as follows:

1. Flexibility to accommodate joint movements
2. Ease of application
3. Non-toxicity to juvenile fish
4. Durability under temperature variations and sunlight/UV exposure
5. Ability to bridge small cracks
6. Reduced slippage for hatchery personnel
7. Color selection
8. Cost

The product, "Durashield 310" is a two-component polyurethane coating system that contains no volatile organic compounds or solvents [3]. Application is by spray, brush or applied with a roller. The system was installed at the Trask Hatchery in August 2000. A variety of colors were used to simulate a more natural setting instead of a plain concrete surface. According to manufacturer's literature, the product meets items all of the criteria items noted above, at the time of the application. Over a year has passed, and the product continues to perform effectively.

ODFW intends to use the Durashield 310 in several ponds at the Bonneville Hatchery, to compare and substantiate the product's performance. Several other products will also be reviewed during the 2002 construction season. The following photographs show the new coating application at Trask Hatchery.

Figure 4.

The prime coat has been applied, in preparation of placing the Durashield 310. The prime coat was applied by a spray system.

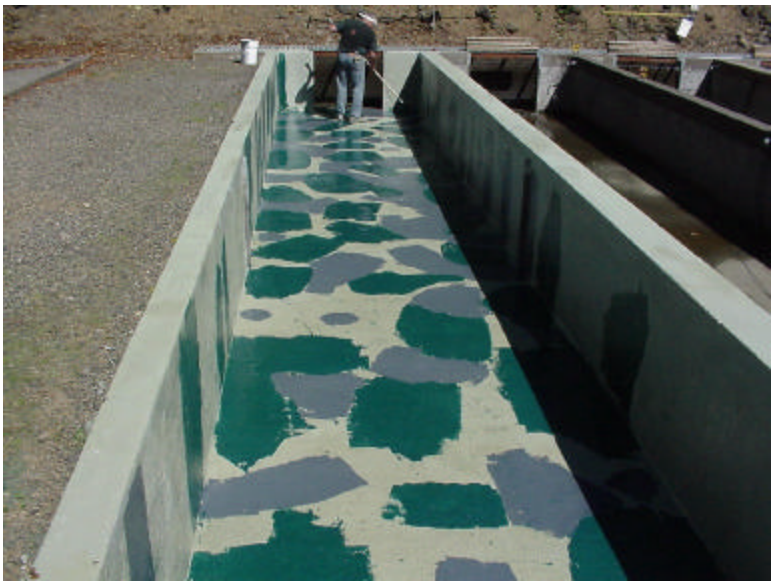

Figure 5.

The Durashield 310 base coat is installed and the color "overcoats" are being applied. At the time of the application, the product was only available in limited colors. A standard gray was used as a base coat, and darker gray, green and reddish brown were used to simulate natural color variations.

Figure 6.

Completed paint scheme.

New Construction

Many of the issues facing hatchery facilities can only be addressed by replacing the deteriorated ponds with new ones. If this becomes the preferred action, paying attention to the specifications for concrete materials is an opportunity to mitigate future problems. Recent technological advances include admixtures that will improve a concrete structure's ability to resist the aging process and withstand weather attack. The use of "air entrainment" additive introduces microscopic air pockets into the concrete that resist freeze/thaw damage. Other additives such as "fly ash" (a by-product of coal combustion) help reduce the amount of water needed in mixing and placing concrete, thereby reducing the shrinkage and resultant cracks.

Contractor Selection

Selecting a specific product is always a challenge, and can be particularly so when the agency making the selection must follow state laws and procedures. ODFW is no different in that regard. Oregon rules limit product specification but latitude is given by specifying product performance criteria. Clear and attainable performance standards must be outlined in the contract document's specifications to enable the use of the desired genre of products. Fortunately, with some research and the assistance of technical representatives, proper specifications were included in the bid documents that will enable ODFW to experiment with several products.

Selecting a qualified contractor can be equally challenging. Attention should be made to proper qualifications, particularly when using a specialty contractor for application of a coating system or epoxy injection. It is appropriate to specify a number of items to insure desired or needed construction quality, such as:

- Years of experience with a system
- Number of previous installations
- Certification with a national or regional technical organization
- References

ODFW has engaged in both "pre-bid" and "pre-construction" conferences, with prospective and selected contractors. This has served to clarify specific needs on a project, as well as establish a strong communication base with the construction professional.

Footnotes:

[1] Sources are "Operations Plans….", IHOT Report by ODFW, 1995 and ODFW Engineering files.

[2] Article entitled "ASR Mitigation" by Tom Kuennen, Structural Engineer Magazine, August, 2000.

[3] Technical Data Sheet for "Durashield 310", provided by Lifelast, Inc., Vancouver, WA.

Session V - Public Outreach

Session Chair:
Deb Eddy
ODFW – Northeast Oregon Research

Rising from the Ashes: 2000 vs. 2001 Free Fishing Day Event at Leaburg Hatchery

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Abstract

Free Fishing Weekend is a statewide event that occurs in early June. The intent is to allow individuals who may not be familiar with fishing an opportunity to try it out with out having to purchase a license or tags. Many hatcheries host events that include educational displays and a chance to catch fish in a setting with a high degree of success.

In 2000, Leaburg Hatchery hosted the first Free Fishing Day event at the hatcheries display pond. Even with 6 months planning, numerous problems occurred that resulted in a less then perfect event. After tremendous brainstorming and work from a diverse group of individuals and companies the 2001 event went off virtually with out a hitch. This presentation will detail the problems that occurred during 2000 and how they were solved resulting in a vastly improved 2001 event.

Tools to Reach Out to Your Local Community - and Get Your Story Heard

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Abstract

In light of the recent decision by Judge Hogan which effectively de-listed Oregon coast coho, the need has risen to provide good information about the roles of hatcheries. Fish managers, hatchery staff and researchers have always had good reason to tell the stories of hatcheries. The story is more complicated and speakers need to consider the message before giving it. This talk will focus on:

- Audience
- Message
- Tools to reach your audience with your message (media, open houses, educational forums, drop in tours)

Use of Volunteers for Backpack Stocking

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Abstract

Located in the beautiful Cascade Mountains, Marion Forks Fish Hatchery has resurrected the once dubious task of getting fingerling rainbow, cutthroat and brook trout into many of the high lakes of the Mt. Jefferson Wilderness. With the rising cost of helicopter use for the stocking program, Marion Forks took on the treacherous task of hiking these fragile creatures into the pristine mountain lakes. The hatchery has taken on the job of stocking 15 to 25 lakes each spring with nothing more than a backpack and a bag of cheese-its. The equipment needed is an overnight size backpack that will hold a four galloon square bucket, plastic bag, water, ice and a hard working loyal Marion Forks employee. The bucket will hold up to 300 young trout, depending on size, for about 3 hours without aeration. When we plan longer hikes the use of a battery powered pocket aerator will give you some extra time.

One of the many public outreach projects that Marion Forks performs is to organize about 60 volunteers to pack fish into Marion Lake. Ten thousand rainbow trout are stocked each year. The hike is about 2 miles and takes around 1 hour and 15 minutes to get to the lake. We have been doing this project for 7 years and have always had great turnouts. People have come from as far away as Russia to enjoy the event. The first few years we had to advertise to get people to volunteer. Since then, it has gained so much popularity that return customers and word of mouth fill the 60 spots quickly. People young and old alike volunteer. Our volunteers include individuals, family groups, boy scouts, church organizations, hiking clubs, school groups, and ODFW personnel. After the long hike we set up a hatchery open house and provide a barbeque lunch.

Link to PowerPoint Presentation: Originals\Proceedings_Grenbemer_Backpack Stocking.ppt

Elk River Fish Hatchery: An Operations Overview

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Abstract

Elk River Fish Hatchery has been in operation since 1968 producing fall chinook salmon, winter steelhead and rainbow trout. Chinook salmon reared at Elk River contribute to economically important sport and commercial fisheries from southeast Alaska to northern California. A full factorial matrix spawning method is perhaps unique among Oregon's coastal hatcheries, and uses all of the trapped adults to perpetuate genetic diversity and historic age-at-return composition. The Elk River fall chinook salmon is one of the indicator stocks evaluated for ocean exploitation under the Pacific Salmon Treaty.

Introduction

Elk River Fish Hatchery near Port Orford, Oregon is owned and operated by the Oregon Department of Fish and Wildlife. Since 1968 Elk River Hatchery has been producing salmon and steelhead smolts for the Rogue Watershed District of the Southwest Region.

Budget

Hatchery funding is 50% State General Fund and 50% State Wildlife Fund. With a biennial budget of approximately $610,000 the hatchery supports four permanent employees.

Physical Plant

Located at River Mile (RM) 14 on Elk River, the hatchery was constructed in the mid to late 1960's on 11 acres of donated land. Originally, river water was drawn through submerged filter beds, but since the late 1980's the hatchery water supply is drafted through a screened intake by four 40 hp line-shaft turbine pumps with a total capability of 12,000 gpm. The 24 modified Burrows rearing ponds are supplied with 300-600 gpm each. The hatch house contains 35 full stacks of Heath type incubators. Hatch house water is supplied by a sub-surface well driven with a 7.5 hp line-shaft turbine pump, which delivers 400 gpm. Remaining structures include the office and shop buildings, a 40,000 lb capacity feed freezer, and the adult collection and spawning area.

Broodstock Collection

Biologically and genetically acceptable broodstocks of fall chinook salmon and winter steelhead are collected annually from Elk River and Chetco River. Elk River fall chinook adults are trapped and held on site from early November to late January, and typically spawn within two weeks after collection. Chetco River fall chinook are seined and trucked to Elk River in October and November. Held in epoxy-coated ponds, they spawn from mid November through December. Chetco River winter steelhead are seined and trucked from late December through March, are held in concrete holding ponds coated with polyurethane, and typically spawn from mid January through April. Some adult steelhead are on hand for as long as 60-80 days prior to the spawn.

Spawning

Full factorial matrix spawning is standard for all stocks. Green eggs from all ripe females are mixed and separated into containers. The number of containers is equal to the number of ripe males. For fall chinook, egg fertilization is based on 5-10% jacks, 30% 3-year-old males, and 55-60% 4-5 year old males. Sperm from one male is used to fertilize one container of eggs. In this manner, sperm from each male fertilizes some eggs from all females in the spawn group. Eggs are water hardened and disinfected with 100 ppm iodophore for one hour, then supplied with 5 gpm of well water at 48-50 degrees F. Incubation continues for about 100 days prior to ponding.

Fish Production

Elk River ChF: 325,000 smolts @ 12 F/lb for Sept-Oct release. Chetco River ChF: 150,000 smolts @ 12 F/lb for September release. Chetco River StW: 50,000 smolts @ 6 F/lb for mid April release; 20,000 grade-outs to Garrison Lake. Cape Cod Rb: 1,600 @ .1-3.0 F/lb for Free Fishing Weekend and release to area ponds.

Outreach

Volunteer Hatchery Hosts; school tours on spawn days; donation of spawned carcasses to commercial crabbers in Port Orford; informational kiosks; slide shows to schools and campgrounds; trophy trout to area lakes; Free Fishing Weekend (200 kids and lunker trout to 10 lbs); maintenance of Ironhead Boat Ramp; sponsors of community service and summer youth workers; booths at Curry County Fair, Watershed Symposium and job fairs.

Alternate Presentations

Fish Health: A perspective on changes and advancements for the new century.

Dr. Pete Taylor

Pathologist/Microbiologist
Abernathy Fish Technology Center, USFWS
Longview, WA 98632

Abstract

This talk presents a broad overview of fish health over the past 50 years. Discussion on standardization, new methodologies and new areas of research opportunities are presented.

Taking Triploid Experimentation to Production Mode

Bob Esselman

Idaho Deptartment of Fish and Game, Hayspur Fish Hatchery
071 US Hwy 20, Bellevue, Id. 83313
(208) 788-2847. email: besselman@sunvalley.net

Abstract

This presentation will discuss how a fishery management request was investigated by research and implemented by hatcheries. A need to impact the genetic intergression by hatchery rainbow on indigenous cutthroat drove this project. Researchers worked with hatcheries to develop methodology to induce triploidy. Hatcheries worked to develop tools to take the methodologies to the production mode. Monitoring of induction rates demonstrated a 96.2% average for 10 million eyed eggs produced production year '00/'01.

Abstracts for Posters

Poster Coordinator:
Cindy Studebaker
ODFW – Fish Propagation Staff

Advances In Salmonid Restoration Using Moist Incubation, Otolith Marking, and Eyed-Egg Out-planting

Tod Jones

Clatsop Economic Development Council

Abstract

Poster will show methods of incubation utilizing minimal water without prophylactic treatment, stress marking otoliths for evaluation, and out-planting stress-marked eyed eggs with the Salmon Egg Planting Device and Method.

Mobile PIT-tag Detection of Juvenile Salmonids in the Columbia River Estuary

Richard D. Ledgerwood, Brad A. Ryan, and Edmund P. Nunnallee

National Marine Fisheries Service, Fish Ecology Division
2725 Montlake Boulevard East, Seattle, Washington 98112-2097
dick.ledgerwood@noaa.gov

Abstract

We developed mobile detection equipment to interrogate migrating juvenile salmonids (*Oncorhynchus* spp.) implanted with passive integrated transponder (PIT) tags. Mobile detection equipment was deployed using a pair-trawl in the freshwater portion of the Columbia River estuary near Jones Beach, river kilometer (RKm) 75. Since 1995, nearly 30,000 PIT-tagged juvenile salmon have been detected using the pair trawl. In addition, we adapted this equipment for use on land to interrogate PIT-tags deposited by piscivorous water birds on Rice Island (RKm 35) and East Sand Island (RKm 8). Since 1998, over 155,000 PIT tags have been detected on bird colonies using the land-based equipment. In 2001, we also developed and tested a prototype saltwater detection system using a small trawl, and we anticipate sampling for PIT-tagged salmonids in the lower estuary using this equipment in 2002. Interrogations recorded using the trawls have been used to compare diel behavior, migration speeds, and survival among species and groups of PIT-tagged fish. Interrogations recorded on bird colonies have been used to evaluate relative vulnerability to predation among salmonid species, between hatchery and wild fish, and between transported and in-river migrating fish. Until these mobile interrogation systems were developed, PIT-tag interrogation was limited to stationary detectors at hydroelectric facilities, and no detection capability was available downstream from Bonneville Dam. These new detection methods provide an opportunity for researchers to utilize PIT-tag technology in the lower watershed and to better monitor predation on juvenile salmonids.

National Fish Hatchery Assessment in the Columbia River Basin

Doug Olson

Columbia River Fisheries Program Office, U.S. Fish and Wildlife Service
9317 NE Highway 99, Suite I, Vancouver, Washington 98665
(360) 696-7605. email: doug_olson@fws.gov

How many U.S. Fish and Wildlife Service National Fish Hatcheries are there?

Nationwide there are 66 National Fish Hatcheries, 7 Fish Culture Technology Centers, and 9 Fish Health Centers, totaling 82 facilities in 39 states. In the Columbia River basin, there are 12 National Fish Hatcheries, 1 Technology Center and 2 Fish Health Centers, totaling 15 facilities in 3 states (Idaho, Oregon and Washington) with support from 3 fishery resource management offices and one regional office.

Why are we producing fish at National Fish Hatcheries in the Columbia River?

National Fish Hatcheries are authorized by laws and agreements to mitigate for salmon and steelhead losses at Federal dams. These National Fish Hatcheries conserve fishery resources, meet tribal trust responsibilities, and provide sport and commercial fishing opportunities. Specific laws and agreements include Tribal Treaties of 1855, U.S. v Oregon (1969), U.S. v. Washington (1974), Mitchell Act (1938), Columbia Basin Project Act (Grand Coulee Mitigation 1940), John Day Mitigation Act, Lower Snake River Compensation Plan / Dworshak Mitigation Act, and Federal Statute 184 (1966).

What is the Columbia River Fisheries Resource Office - Hatchery Assessment Team doing?

Our office conducts production planning, marking, monitoring, and post-stocking evaluations. For example, in 2001, over 15 million fish were marked at our National Fish Hatcheries in the Columbia River. Marking can include fin clips, coded-wire tags, PIT tags, and branding. To keep track of hatchery programs, our office maintains the Columbia River Information System and participates on Streamnet and U.S. v Oregon Production Advisory Committees. We also develop Hatchery and Genetic Management Plans and Section 7 Biological Assessments for Endangered Species Act compliance. We develop collaborative projects to investigate diet, release, and rearing density to improve hatchery performance, as well as develop in-stream studies using traps, radio telemetry, and snorkeling to investigate behavior, wild and hatchery interactions and habitat use. Our vision for hatchery assessment is: 1) use National Fish Hatcheries to conserve populations, 2) produce fish for sport, commercial and tribal fisheries, 3) use National Fish Hatcheries to complement fish and wildlife production in their natural habitat, 4) develop partnerships for watershed-based projects in streams where we operate our National Fish Hatcheries, 5) work with engineers, landscape architects, biologists and fish culturists to design and operate hatcheries which simulate natural features, 6) advance education, research and management of our National Fish Hatcheries, and 7) build relationships and establish trust.

Assessment of florfenicol and oxytetracycline treatments to control an epizootic of coldwater disease.

Mary Peters Swihart[1], Steve Turner[2], Doug Dysart[2], and Susan Gutenberger[1]

U.S. Fish and Wildlife Service

[1] Lower Columbia River Fish Health Center
61552 SR 14, Underwood, WA 98651
(509) 493-3156. email: Mary_PetersSwihart@fws.gov

[2] Eagle Creek National Fish Hatchery
34288 SE Rainbow Rd, Estacada, OR 97023
(503) 630-6270

Abstract

The efficacy and safety of florfenicol was compared to that of oxytetracycline to control a naturally-occurring epizootic of bacterial coldwater disease in juvenile coho salmon *(Oncorhynchus kisutch*) at Eagle Creek National Fish Hatchery. The onset of the epizootic was related to the age of the fish and time of first feeding. Therefore, raceways were assigned to the two treatment groups and the control group based on their pre-treatment mortality and time of first feeding. The treatment groups received either 15 mg florfenicol/kg fish/day top-coated onto non-nutritive fish pellets for 10 days or 7 g oxytetracycline/100 lbs. fish/day for 14 days as treated feed. Efficacy of each drug and the safety of florfenicol were determined by comparing daily morality counts during drug administration and 14-days post-treatment. Sensitivity to each antibiotic was assessed through bacterial cultures of kidney and brain tissues. Residues of florfenicol in whole fish were also analyzed. The florfenicol treatment was more effective in controlling the epizootic than oxytetracycline. Cumulative mortalities in the florfenicol group were also lower than the control group indicating that the florfenicol did not contribute to mortality and therefore was safe to use in this population of fish. Cultures of *Flavobacterium psychrophilum* (the causative agent of coldwater disease) were sensitive to both antibiotics before and after treatment. Residues of florfenicol were detected on the last day of treatment, but none found at days 6 and 14 post-treatment. These results suggest that florfenicol can be an effective treatment to control a naturally-occurring coldwater disease epizootic.

The Survival of Unfed Hatchery Coho Fry Used to Supplement a Population

Laura S. Jackson and David W. Loomis

Oregon Department of Fish and Wildlife
4192 N. Umpqua Highway, Roseburg, OR 97470
Laura.S.Jackson@state.or.us

Abstract

For years ODFW volunteers have raised unfed fry for release in under seeded streams to help rebuild salmon populations. However, there has been little scientific evaluation of the effectiveness of these releases. Thus, the purpose of this study is to measure the survival of unfed, hatchery coho fry used to help supplement under seeded habitat.

Brush Creek and Big Tom Folley Creek in the Umpqua watershed were selected as the treatment and control streams. These streams are similar in size, land use and had at least 3 years of pre-treatment coho smolt out-migration data.

Coho were thermally marked at Rock Creek Hatchery by warming and chilling incubation water. This causes a recognizable pattern in the growth rings of the fish's otolith (eardrum bone). Voucher specimens were collected and sent to the Washington Department of Fish and Wildlife Otolith Laboratory as a template for the mark pattern. In 1999, 2000, and 2001 approximately 200,000 otolith-marked fry were released annually in Brush Creek. Survival was estimated by collecting every 12th coho smolt the following year and determining its mark status.

Preliminary analysis of the 2000 and 2001 smolt data indicates that approximately 0.7 to 1.3% of the unfed fry survived to the smolt stage. They composed 52 and 57% of the smolt out-migration in 2000 and 2001. There was no significant difference between the lengths of marked and unmarked smolts or out-migration time.

Smolts will be collected in 2002 to conclude the study. Then additional analysis will be conducted to look at survival estimates and if the unfed fry contributed to the coho smolt population in Brush Creek.

Smolt Tissue Selenium Loss as a Measure of Accumulated Stress

John E. Halver[1], S.R. Felton, and R. Zbanyszek

[1] Professor Emeritus in Nutrition
School of Aquatic and Fishery Sciences, University of Washington
Box 355100, Seattle, WA 98195-5100
(206) 543-9619. e-mail: halver@u.washington.edu

Door Prizes and Donors

Door Prize Coordinator:
Terry Jones
ODFW – Marion Forks Hatchery

List of Door Prizes and Donors

Vendor	Door Prize
Bi-Mart	*$20.00 Gift Certificate,* Camo Folding Arm Chair
G.I. Joes	$20.00 Gift Certificate
Kershaw	Multi-Tool
Berkley	5500 Casting Reel, 6' Spinning rod
Oregon Chain	(2) 25' pieces of chainsaw chain
Big 5	Pair of Binoculars
Eagle Claw	8'6" IM7 Fishing Pole
Wrangler	(2) Gift Certificate for 1 pair of Wrangler Jeans
Benchmade Knives	Knife
Jim Teeny	Hat & T-Shirt
Fishing and Hunting News	1 Year Subscription
G-Loomis	*1/2 off cat. item, $ from Moore-Clark*, GL2 Fishing Rod
Buck Knives	*30% off cat. item, $ from Moore-Clark*, Bucklite Buck Knife
The Local Fisherman's New	(4) 1 Year Subscriptions
The Local Fisherman's New	2 tickets to the Sportsman's Show
Pro-Cure	12 Bottles of Pro-Cure Egg Cure
Mar-Don Resort (WA)	2 nights tent site or Hook-up, &boat mor. or paddle boat
Englund Marine	Sparhawk Rain Jacket
Lamiglass	Graphite Fly Rod and Case
Moore-Clark	$100, *purchased Loomis Rod and Buck Knife*
Duck Commander	(2) T-Shirts
Duck Commander	(2) License Plate Covers
Duck Commander	(2) Duckcalls
Delorm mapping	(2) Oregon Atlas's
Leatherman Tool	(2) Leatherman Tools
Reel Tackle Shop	Kershaw Fillet Knife
Luhr Jensen	Salmon Fishing Pack
Cabela's	Duck Print
Cabela's	Binoculars
Cabela's	Cabela's Tackle Box
Stash Tea	Stash Tea Gift Box
Stern's	Stern's Camp Mat
Colleen Weis	Digital Camera Case
I-5 Campers	12V Deep Cycle Battery
G.I. Joes (Medford)	Fillet Knife and Sharpener
Bi-Mart (Roseburg)	$25.00 Gift Certificate
The Edgewater Inn	Room for 2
Seven Feathers	Dinner for 2 ($30.00)
Jot's Resort (Gold Beach)	Room for 2
Blackbird	Mitchell 300 X Fishing Reel
Hellgate Jetboat Excursions	Hellgate Jetboat Trip
Eager Inc.	pH Tester
Nestucca Valley Sporting Goods	Guided Fishing Trip for 2
SW Region Office	Framed Salmon Poster

Exhibitors

Exhibitor Coordinator:
Ken Bourne
ODFW – Sandy Hatchery

Vendor Name, Address, and Phone List

Name	Address, Contact	Phone Number
American Fisheries Society	Oregon Chapter Tony Faast	503-231-6233
Aquaneering, Inc.	8280 Clairemont Mesa Blvd #117, San Diego, CA, 92111 Kathryn Waters	858-541-2028
Bio-Oregon, Inc.	P.O. Box 429, Warrenton, OR 97146 Russ Farmer, Bruce Buckmaster, Walter Kost, Dennis Roley, Ron Anderson	800-962-2001
Christensen Net Works	5510-A Nelson Ave., Ferndale, WA 98248 Catherine Holmes, Britt Holmes	360-384-1446
Common Sensing, Inc.	P.O. Box 130, Clark Fork, ID 83811 Brian D'Aoust	208-266-1541
EMA Engineering Products	P.O. Box 10, Philomath, OR 97370 Stephanie Smith	541-929-3225
EWOS Canada, Ltd.	1720 14th Ave. #212, Campbell River, B.C. V9W 8B9 Canada Russell Strang, Jean Legault	888-673-9993
Familian Industrial Plastics	740 South 28th St., Washougal, WA 98671 Cynthia Galbraith	360-835-2129
Harper Brush Distributing, Inc.	P.O. Box 2185, Renton, WA 98056 Ken Taylor	800-344-2074
Hatchery International	5001 Forbidden Plateau Rd., Courtenay, B.C. V9J 1R3 Canada Ben Thompson	800-661-0368
Innovative Coating Solutions, Inc.	3315 NE 112th Ave. Suite 66, Vancouver, WA 98682 Jay Glover	360-885-2446
IRAS A/S	Gammelby Mollevej 3 DK 6700 Esjerg, Denmark Niels Olgaard	(+45) 76 11 49 49
Jensorter, Inc.	20225 Harvest Lane, Bend, OR 97701 Greg Jensen	541-389-3591
Magic Valley Heli-Arc & MFG., Inc.	P.O. Box 511, Twin Falls, ID 83303 Linda Owens	208-733-0503
Mari-Source	P.O. Box 580, Milton, WA 98354 Mark Vermilion	253-922-2700
Mt. Hood Community College, Fisheries	26000 SE Stark St., Gresham, OR 97030 Todd Hanna	503-667-6422

Name	Address, Contact	Phone Number
Moore-Clark, USA, Inc.	P.O. Box 209, Edmonds, WA 98020 Ron Malnor	800-561-8881
Nelson & Sons, Inc.	P.O. Box 57428, Murray, UT, 54157 Chris Nelson	208-882-2617
Oregon Angler	2311 Jolie Point Rd., West Linn, OR 97068 Dennis Richey	503-655-4022
Point Four Systems	2704 Clarke St., Port Moody, B.C. V3H 1Z1, Canada Kai Roos	604-939-9936
PRaqua Supplies, Ltd.	P.O. Box 774 Station A, Nanaimo, B.C. V9R 5M2, Canada Rocky Boschman	250-754-4844
Rain County Refrigerate, Inc.	1610-6th St., Bellingham, WA 98225 Mark Vondrachek	360-671-9165
Rangen, Inc.	P.O. Box 706, Buhl, ID 83316 Jerry Fullerton	800-657-6446
Specialty Products, Inc.	2410 104th St. Ct. S. Suite D, Lakewood, WA 98499 Kelly Brown	253-588-7101
The Lynch Company, Inc.	4706 SE 18th St., Portland, OR 97202 Martin Ralston	503-236-3825
The Reel Tackle Shop	39261 Proctor Blvd., Sandy, OR 97055 Debbie Schneider	503-668-5791
VMG Industries, Inc.	2175 Meadows Ct., Grand Junction, CO 81503 Bruce Marshall	970-242-8623
Warren Water Broom, Inc.	42111 Blossom Lane, Astoria, OR 97103 Del Warren	503-458-6694
Water Management Tech, Inc.	P.O. Box 66125, Baton Rouge, LA 70896 Maureem	225-755-0025
Western Chemical	1269 Lattimore Rd., Ferndale, WA 98248 Ron Secor	800-283-5292

Pacific Northwest Fish Culture Conference Historical Record

Pacific Northwest Fish Culture Conference Historical Record

Year	Location	Host Agency	Chairperson
1950	Portland, OR	U.S. Fish and Wildlife Service	Ted Perry
1951	Wenatchee, WA	U.S. Fish and Wildlife Service	Roger Burrows
1952	Seattle, WA	Washington Department of Fisheries	Bud Ellis
1953	Portland, OR	Fish Commission of Oregon	Fred Cleaver
1954	Seattle, WA,	U.S. Fish and Wildlife Service	Bob Rucker
1955	Portland, OR	Oregon Game Commission	John Rayner
1956	Seattle, WA	Washington Department of Game	Cliff Millenbach
1957	Portland, OR	U.S. Fish and Wildlife Service	Harlan Johnson
1958	Seattle, WA	Washington Department of Fisheries	Bud Ellis
1959	Portland, OR	Fish Commission of Oregon	Ernie Jeffries
1960	Olympia, WA	Washington Department of Game	John Johansen
1961	Portland, OR	Oregon Game Commission	Chris Jensen
1962	Longview, WA	U.S. Fish and Wildlife Service	Roger Burrows
1963	Olympia, WA	Washington Department of Fisheries	Bud Ellis
1964	Corvallis, OR	Oregon State University	John Fryer
1965	Portland, OR	U.S. Fish and Wildlife Service	John Halver
1966	Portland, OR	Fish Commission of Oregon	Wally Hublou
1967	Seattle, WA	University of Washington	Loren Donaldson
1968	Boise, ID	Idaho Department of Fish and Game	Paul Cuplin
1969	Olympia, WA	Washington Department of Game	John Johansen
1970	Portland, OR	Oregon Game Commission	Chris Jensen
1971	Portland, OR	U.S. Fish and Wildlife Service	Marv Smith
1972	Seattle, WA	Washington Department of Fisheries	Dick Noble
1973	Wemme, OR	Oregon Fish Commission	Ernie Jeffries
1974	Seattle, WA	University of Washington	Ernie Salo
1975	Otter Crest, OR	Oregon State University	Jack Donaldson
1976	Twin Falls, ID	University of Idaho	Bill Klontz
1977	Olympia, WA	Washington Department of Game	Jim Morrow
1978	Vancouver, WA	U.S. Fish and Wildlife Service	Dave Leith
1979	Portland, OR	Oregon Department of Fish and Wildlife	Ernie Jeffries
1980	Courtenay, BC	Fisheries & Oceans Canada	Keith Sandercock

Year	Location	Host Agency	Chairperson
1981	Olympia, WA	Washington Department of Fisheries	Will Ashcraft
1982	Gleneden Beach, OR	National Marine Fisheries Service	Einar Wold
1983	Moscow, ID	University of Idaho & Idaho Department of Fish and Game	Bill Klontz & Evan Parrish
1984	Kennewick, WA	Washington Department of Game	Jim Gearheard,
1985	Tacoma, WA	U.S. Fish and Wildlife Service	Ed Forner
1986	Eugene, OR	Oregon Department of Fish and Wildlife	Chris Christensen
1987	Tacoma, WA	Washington Department of Fisheries	Will Ashcraft
1988	Richmond, BC	B.C. Ministry of Environment	Don Peterson & Peter Brown
1989	Gleneden Beach, OR	National Marine Fisheries Service	R.Z. Smith
1990	Boise, ID	Idaho Department of Fish and Game	Bill Hutchinson
1991	Redding, CA	California Department of Fish and Game	Ken Hashagen
1992	Wenatchee, WA	Washington Department of Wildlife & Alaska Department of Fish and Game	John Kerwin & Irv Brock
1993	Spokane, WA	U.S. Fish and Wildlife Service	Ed Forner
1994	Sunriver, OR	Oregon Department of Fish and Wildlife	Rich Berry
1995	Fife, WA	Washington Department of Fish & Wildlife	Larry Peck
1996	Victoria, BC	B.C. Ministry of Environment, Lands & Parks Department of Fisheries & Oceans, Canada	Don Peterson & Greg Bonnell
1997	Gleneden Beach, OR	National Marine Fisheries Service	R Z. Smith
1998	Boise, ID	Idaho Department of Fish and Game	Tom Rogers & Tom Frew
1999	Seattle, WA	U.S. Fish and Wildlife Service	Ray Brunson
2000	Sacramento, CA	California Department of Fish and Game	Judy Urrutia
2001	Portland, OR	Oregon Department of Fish and Wildlife	Trent Stickell & George Nandor

Fish Culture Hall of Fame

2000 Inductees

At the 51st Annual Pacific Northwest Fish Culture Conference there were two inductees to the NWFCC Hall of Fame, Dr. George W. Klontz and Earl Leitritz. The proceedings of the 51st NWFCC includes a dedication to Dr. George W. Klontz.

Earl Leitritz began his career as a technician in the 1940's and worked his way through California's fish hatchery system eventually becoming Supervisor of Fish Hatcheries. Earl's grinding of beef liver, fish feeding, and cleaning raceways greatly influenced his interest in developing newer and more efficient fish culture practices. This background and scientific approach led him to the publication of Fish Bulletin 107 in 1953 by the California Department of Fish and Game for which he is known. He states in the foreword, "This volume has been prepared at the request of many of the department's fish hatchery personnel. A hatchery treatise has long been needed to acquaint the beginning employee with the rudiments of fish culture, and also to act as a handy reference for those already experienced in the work." Fish Bulletin 107 was revised and updated by Robert C. Lewis in 1976 and republished as Fish Bulletin 164.

Earl had a hobby of restoring old cars. This hobby cost him an eye when a laminated wooden steering wheel literally exploded while he was turning it on a lathe. He then wore an eye patch like you see in pictures of pirates. Earl retired on a ranch located near Cedarville in Modoc County in the northeast corner of California. Earl joked that when he retired he would raise potatoes instead of fish.

Earl Leitritz suffered a fatal stroke while visiting Australia and died on March 2, 1968.

Bill Schaefer (Retired)
California Department of Fish & Game

NORTHWEST FISH CULTURE HALL OF FAME

HONORARY INDUCTEES

Year Inducted	Name	Affiliation	Sponsor
1999	Dr. Lorin Edward Perry	U.S. Fish & Wildlife Service	John Halver
1999	Mr. Roger E Burrows	U.S. Fish & Wildlife Service	Laurie Fowler
1999	Mr. James W. Wood	Washington Dept. of Fish & Wildlife	Bill Klontz
1999	Dr. Loren Donaldson	University of Washington (Dept. of Fisheries)	Jack Donaldson
1999	Mr. Robert Piper	U.S. Fish & Wildlife Service	Charlie Smith
2000	Dr. George W. Klontz	University of Idaho	Irv Brock
2000	Earl Leitritz	California Dept. of Fish &Game	Bill Schaefer