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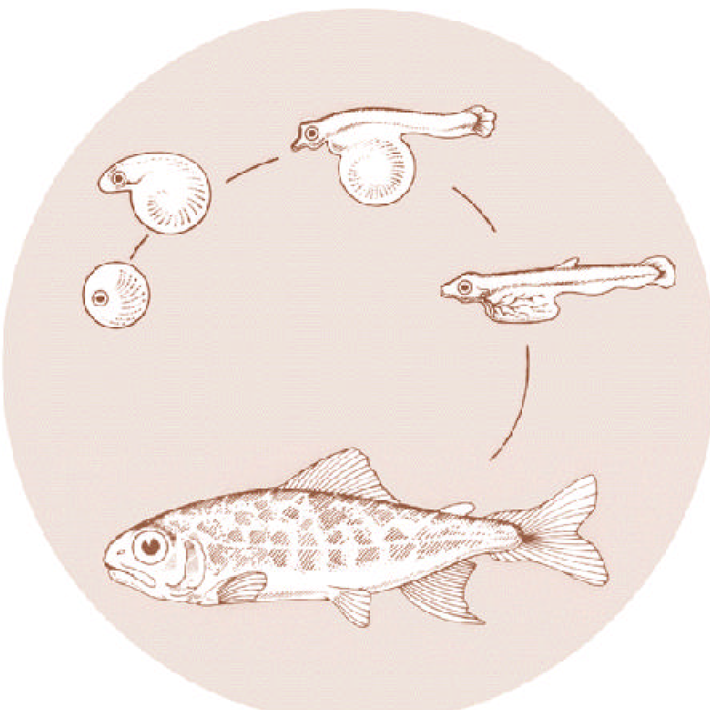
UMATILLA HATCHERY MONITORING AND EVALUATION

(September 1, 1992 - October 30, 1993)

Annual Report 1993



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Bonneville Power Administration
Environment, Fish and Wildlife Division
P.O. Box 3621
905 N.E. 11th Avenue
Portland, OR 97208-3621

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UMATILLA HATCHERY MONITORING AND EVALUATION

ANNUAL REPORT 1993
(September 1, 1992- October 30, 1993)

Prepared by:

MaryLouise Keefe
Richard W. Carmichael
Shannon M. Focher
Warren J. Groberg
Michael C. Hayes

Oregon Department of Fish and Wildlife
Portland, Oregon

Prepared for:

U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
P.O. Box 3621
Portland. OR 97283-362 1

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EXECUTIVE SUMMARY

This report covers the second year of comprehensive monitoring and evaluation of the Umatilla Hatchery. As both the hatchery and the evaluation study are in the early stages of implementation, much of the information contained in this report is preliminary. The majority of the data that is crucial for evaluating the success of the hatchery program, the data on post-release performance and survival, is yet unavailable. In addition, several years of data are necessary to make conclusions about rearing performance at Umatilla Hatchery. The conclusions drawn in this report should be viewed as preliminary and should be used in conjunction with additional information as it becomes available. A comprehensive fish health monitoring program was incorporated into the monitoring and evaluation study for Umatilla Hatchery. This is a unique feature of the Umatilla Hatchery evaluation project.

Objectives for FY 1993

1. Document egg-take, and egg-to-fry and egg-to-smolt survival rates for fall chinook, spring chinook, and summer steelhead reared at Umatilla Hatchery and released into the Umatilla River.

2. Document rearing densities and loading factors for fall chinook, spring chinook, and summer steelhead reared at Umatilla Hatchery and released into the Umatilla River.

3. Document number, size, time, and release location for fall chinook, spring chinook, and summer steelhead reared at Umatilla and Bonneville hatcheries and released into the Umatilla River.

4. Monitor water quality parameters in an index series of Michigan and Oregon raceways in which fall chinook were reared, and in a series of Michigan raceways in which spring chinook and summer steelhead were reared.

5. Collect and compare monthly measurements of length, weight, and condition factors for fall chinook reared in the Michigan and Oregon systems, and for spring chinook and summer steelhead reared in the Michigan system at Umatilla Hatchery.

6. Calculate and compare growth rates for fall chinook reared in the Michigan and Oregon systems, and for spring chinook and summer steelhead reared in the Michigan system at Umatilla Hatchery.

7. Determine and compare fin condition, degree of descaling, degree of smolting, length, weight, and condition factor at release for fall chinook reared in the Michigan and Oregon systems, spring chinook and summer steelhead reared in the Michigan system, and for spring chinook reared at Bonneville Hatchery.

8. Compare the physiological stress response of fall chinook salmon reared in Michigan and Oregon systems at Umatilla Hatchery.

9. Compare the $Na^+K^+ATPase$ activity of gill tissue from subyearling and yearling spring chinook salmon reared at Umatilla Hatchery.

10. Cold brand and release representative groups of fish reared at Umatilla Hatchery, including fall chinook from all Michigan and Oregon raceways, subyearling spring chinook salmon reared in Michigan raceways, yearling spring chinook reared in Oregon raceways, summer steelhead reared in Michigan raceways, and spring chinook yearlings reared in standard raceways at Bonneville Hatchery to evaluate smolt migration performance.

11. Acquire recovery information for branded fall chinook, spring chinook, and summer steelhead reared in raceways at Umatilla or Bonneville Hatcheries and compare relative survival and characteristics of the migration to John Day Dam.

12. Fin mark, coded-wire tag, and release replicate groups of fall chinook salmon subyearlings from all Michigan and Oregon raceways to evaluate smolt-to-adult survival.

13. Fin mark, coded-wire tag, and release replicate groups of spring chinook salmon from Michigan and Oregon raceways to evaluate smolt-to-adult survival for the fall release program.

14. Fin mark, coded-wire tag, and release representative groups of summer steelhead to evaluate smolt-to-adult survival.

15. Fin mark, coded-wire tag, and release replicate groups of subyearling and yearling spring chinook at Umatilla Hatchery and yearling spring chinook at Bonneville Hatchery to determine smolt-to-adult survival for the yearling and subyearling production evaluations.

16. Fin mark, fin mark and body tag, body tag only, coded-wire tag plus fin mark, and release replicate groups of fall chinook salmon to evaluate the effects of marking and tagging on smolt-to-adult survival.

17. Fin mark, fin mark and coded-wire tag, and release replicate groups of fall chinook salmon yearling smolts and fall release spring chinook reared at Bonneville Hatchery to determine smolt-to-adult survival.

18. Develop and implement statistical creel methods and report results of 1992-1993 creel survey to estimate sport harvest of summer steelhead, spring chinook, and fall chinook.

19. Participate in the development of a water quality sampling and monitoring program in the Umatilla Basin.

20. Participate in planning the production and management activities of anadromous fish in the Umatilla River Basin.

21. Conduct monthly fish health examinations on fresh dead or moribund, and healthy juvenile fish from index raceways of each species of fish reared at Umatilla Hatchery.

22. Conduct preliberation fish health examinations on 30 juvenile fish per index raceway of each species and stock of fish reared at Umatilla and Bonneville hatcheries.

23. Collect gills at preliberation from 10 juvenile fish from a cross-section of upper, middle and lower Michigan raceways, and upper and lower Oregon raceways, for histological examination.

24. Using data obtained from monthly and preliberation fish health examinations, assess the effects of differing rearing strategies and environments on fish health.

25. Examine fish by appropriate diagnostic methods when unusual loss or behavior occurs. Implement therapeutic or prophylactic measures to control, moderate, or prevent disease outbreaks.

26. Monitor brood stocks used for Umatilla Hatchery production for *Renibacterium salmoninarum* and culturable viruses, and for erythrocytic inclusion body syndrome in chinook. Use weekly subsamples for large spawning populations.

27. Develop methods to use the enzyme-linked immunosorbent assay for *R. salmoninarum* on small fish.

28. Implement Federal Drug Administration Investigational New Animal Drug erythromycin experimental feeding protocols for the three rearing strategies of juvenile spring chinook at Umatilla Hatchery.

Accomplishments and Findings for FY 1993

We achieved all of our objectives except a portion of one in FY 1993. We did not complete objective ten. We were unable to brand spring chinook yearlings from Bonneville Hatchery due to logistic and personnel limitations.

Water shortages continued to be a problem at Umatilla Hatchery and prevented us from reaching some hatchery production goals. Although spring chinook and summer steelhead goals were achieved, fall chinook subyearling production was only 50% of the desired level. Smolt sizes at release were at or near goals except for the spring chinook yearlings from Umatilla Hatchery which were released at 89.0 fish/lb, a size comparable to yearlings reared at Bonneville Hatchery.

Water quality parameters measured at Umatilla Hatchery were similar between systems and between passes within a system and were within standard limits established for fish culture systems. Any differences that were observed were not consistent, nor large enough to affect fish performance.

We found few differences between lengths and weights of fish reared in Michigan and Oregon systems and between fish reared in different passes within both systems in 1993. Monthly differences tended to be small and were probably not meaningful, and there was no difference at time of release.

Food conversion ratios for fall chinook subyearlings were higher in Michigan than in Oregon raceways. In addition, summer steelhead reared in Michigan raceways continued to be poorer at converting feed compared to steelhead reared at the Irrigon Hatchery in standard raceways. Although steelhead densities were reduced in 1993, steelhead densities may still be too high to achieve good food conversion. The density reduction did appear to reduce fin erosion and improve general condition of the smolts.

Gill ATPase levels were used as a physiological index of smoltification for spring chinook yearlings and subyearlings. Although the ATPase levels increased significantly at release for subyearling spring chinook, there was no difference measured at the hatchery or at the release site. A review of other studies suggests that these yearlings were released too early in the smoltification process to exhibit increased gill ATPase levels.

Plasma cortisol and glucose were measured as routine indices of the physiological stress response in fall chinook salmon. Michigan reared fall chinook had significantly greater basal cortisol levels than Oregon reared controls, suggesting that these fish may be experiencing chronic-stress while in the hatchery.

Branding studies of fall chinook, spring chinook, and summer steelhead indicated that most fish moved relatively quickly from the upper Umatilla River to John Day Dam on the Columbia River. The migration pattern for fall chinook was very similar in 1992 and 1993 despite different weather and water conditions. Spring chinook yearling migration appeared to be delayed compared to the migration timing of subyearling spring chinook and fall chinook. However, the migration of spring chinook was complicated by high mortality associated with releasing fish during extreme flooding in the Umatilla River.

Our assessment of body-tagging indicates that it is too costly and time consuming to be useful as a mass mark. Thus, we have recommended that this aspect be eliminated from the current tagging and marking program.

No disease outbreaks occurred in the juveniles of any species or stock reared at Umatilla Hatchery during this report period. The causative agent of bacterial cold water disease, *Flexibacter* psychrophilus was detected at a greater prevalence from the gills of fall chinook juveniles in Michigan raceways during monthly monitoring than from gills of this stock in Oregon raceways. However, fish with gills colonized by this bacterium did not show evidence of systemic infection.

The prevalences and levels of *Renibacterium salmoninarum,* the causative agent of bacterial kidney disease, in juvenile chinook salmon, determined during monthly and preliberation monitoring indicated that this pathogen should not be a major factor in survival of most chinook stocks reared at Umatilla Hatchery during 1992-1993. Both the direct fluorescent antibody test and the enzyme-linked immunosorbent assay indicated that the 92 brood of spring chinook adults from Carson NFH had a high prevalence of *R. salmoninarum.* In ovarian fluid cell pellets from individual females, the prevalence was ten-fold greater in the 92 brood over that of the 91 brood.

Adult stocks of steelhead and fall chinook returning to the Umatilla River have had low prevalences and levels of *R. salmoninarum* over the past two years. They have also been negative for infectious hematopoietic necrosis virus.

.Methods to assay kidney samples from small fish, at a relatively high dilution, were developed to allow use of the enzyme-linked immunosorbent assay for *R. salmoninarum*. This was important for disease evaluations at Umatilla Hatchery because a large portion of fish sampled during monthly and preliberation monitoring are below a size at which standard assays by this technology are done.

Comparisons of the direct fluorescent antibody test and the enzyme-linked immunosorbent assay for *R. salmoninarum* on kidney samples from the same fish indicate that the correlation between the two assays is greater as the infection level reaches the clinical stage.

. Management Implications and Recommendations

1. The poor food conversion of summer steelhead and fall chinook reared in Michigan raceways in 1993 suggests that it will require more feed and cost more to produce the same pounds of fish in the Michigan system. However, water shortages at Umatilla Hatchery have resulted in substantial decrease in chinook salmon production. Rearing fish in Michigan ponds, at higher densities with less water, has allowed us to come closer to our goals than would have been possible with rearing fish only in Oregon raceways. In addition, the initiation of the fall release program for spring chinook has allowed us to achieve our spring chinook production goals.

2. Overall water quality and fish rearing performance data suggest that Michigan raceways provide a rearing environment that is comparable in quality to standard Oregon systems.

3. The branded fish recovery rate at John Day Dam was poor for spring chinook yearlings and migration timing indicated a delayed migration. These fish were liberated during flood conditions on the Umatilla River and subsequently suffered considerable mortality. Future releases should not occur until flood conditions in the Umatilla River have subsided.

4. We recommend eliminating the body tagging program. Two years of data has revealed that body tagging is not cost effective or efficient enough to be considered for a mass marking program, especially when compared to ventral fin clips. Although the fin clip quality of fall chinook was low in 1993, improvements should be possible.

5. Segregation of progeny from high level carrier *R. salmoninarum* positive females in years when prevalences are high should be a future consideration at Carson National Fish Hatchery.

6. At subclinical infection levels, the fluorescent antibody test was an unreliable indicator of infection.

UMATILLA HATCHERY MONITORING AND EVALUATION

INTRODUCTION

The Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program authorized construction of the Umatilla Hatchery in 1986. Measure 703 of the program amended the original authorization for the hatchery and specified evaluation of the Michigan type of rearing using oxygen supplementation to achieve production goals of 290,000 lb of steelhead *(Oncorhynchus* mykiss) and chinook salmon (Oncorhynchus tshawytscha). The hatchery was completed in the fall of 1991. Justification for the hatchery, in part, was that it provided opportunity to develop considerable knowledge and understanding of new production and supplementation techniques. The use of the Michigan type of rearing at Umatilla Hatchery was selected because it could increase smolt production given the limited hatchery well water supply, and would provide an opportunity to compare the Michigan type of rearing with the standard Oregon method. Results of testing the Michigan method of rearing will have systemwide application in the Columbia Basin.

The Umatilla Hatchery is the foundation for rehabilitating chinook salmon and enhancing summer steelhead in the Umatilla River (CTUIR and ODFW 1990) and is expected to contribute significantly to the Northwest Power Planning Council's goal of doubling salmonid production in the Columbia Basin. Hatchery production goals and a comprehensive plan for monitoring and evaluation are presented in the Umatilla Hatchery Master Plan (CTUIR and ODFW 1990). The Comprehensive Plan for Monitoring and Evaluation of Umatilla Hatchery (Carmichael 1990) was approved by the Northwest Power Planning Council as a critical part of the adaptive management process that guides the fisheries rehabilitation program in the Umatilla River. The adaptive management process uses monitoring and evaluation to increase knowledge about the uncertainties inherent in the fisheries rehabilitation program and will complement the developing systemwide monitoring and evaluation program.

The monitoring and evaluation goals are to:

1. Provide information and recommendations for culture and release of hatchery fish, harvest regulations, and natural escapement that will lead to the accomplishment of long-term natural and hatchery production goals in the Umatilla River Basin in a manner consistent with provisions of the Council's Columbia River Basin Fish and Wildlife Program.

2. Assess the success of achieving the management objectives in the Umatilla River Basin that are presented in the Master Plan and the Comprehensive Rehabilitation Plan.

A substantial proportion of the production at Umatilla Hatchery will be produced in the "Michigan Type" oxygen supplementation rearing system. This rearing system has not been thoroughly evaluated to determine the effects on smolt-to-adult survival. In addition, the rearing strategies proposed for spring chinook salmon are somewhat different than normal. The constant water temperature will provide growth conditions that should allow production of subyearling smolts at 15-20 fish/lb. Production of yearling smolts will require an unusually extensive period of incubation in chilled well water.

The monitoring and evaluation program objectives for this report period were to:

1. Document fish cultural and hatchery operational practices.

2. Monitor water quality parameters in a series of Michigan and Oregon raceways for each species reared.

3. Determine to what extent the efficiency of producing adult fall chinook, spring chinook, and summer steelhead can be increased through the Michigan rearing method.

4. Determine and compare smolt migration performance and smolt-to-adult survival of subyearling and yearling spring chinook.

5. Identify and compare the effects of tagging and marking on smolt-to-adult survival of subyearling fall chinook smolts.

6. Coordinate the development of a water quality sampling and monitoring program in the Umatilla River Basin.

7. Participate in planning and coordination activities associated with anadromous fish production, passage, monitoring, and evaluation in the Umatilla River Basin.

8. Monitor and evaluate the health of fish at Umatilla Hatchery.

Extensive background and justification for Umatilla Hatchery monitoring and evaluation is presented in Carmichael (1990). In this report, we present a review of our activities and findings for the Umatilla Hatchery Monitoring and Evaluation Project from 1 November 1992 to 31 October 1993. We have designed our program to include evaluation studies in the following categories: fish cultural practices, water quality monitoring, rearing performance and survival studies, spring chinook yearling and subyearling production evaluation, spring chinook fall release program evaluation, fall chinook marking and tagging evaluation, creel surveys, and planning and coordination.

STUDY SITE

The Umatilla fish hatchery is located approximately seven miles from the town of Irrigon, Oregon (Figure 1). The hatchery is operated under a cooperative agreement among the Oregon Department of Fish and Wildlife, the Confederated Tribes of the Umatilla Indian Reservation, the Bonneville Power Administration, the U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers. A schematic diagram illustrating the raceway configuration for the Umatilla Hatchery is displayed in Figure 2.

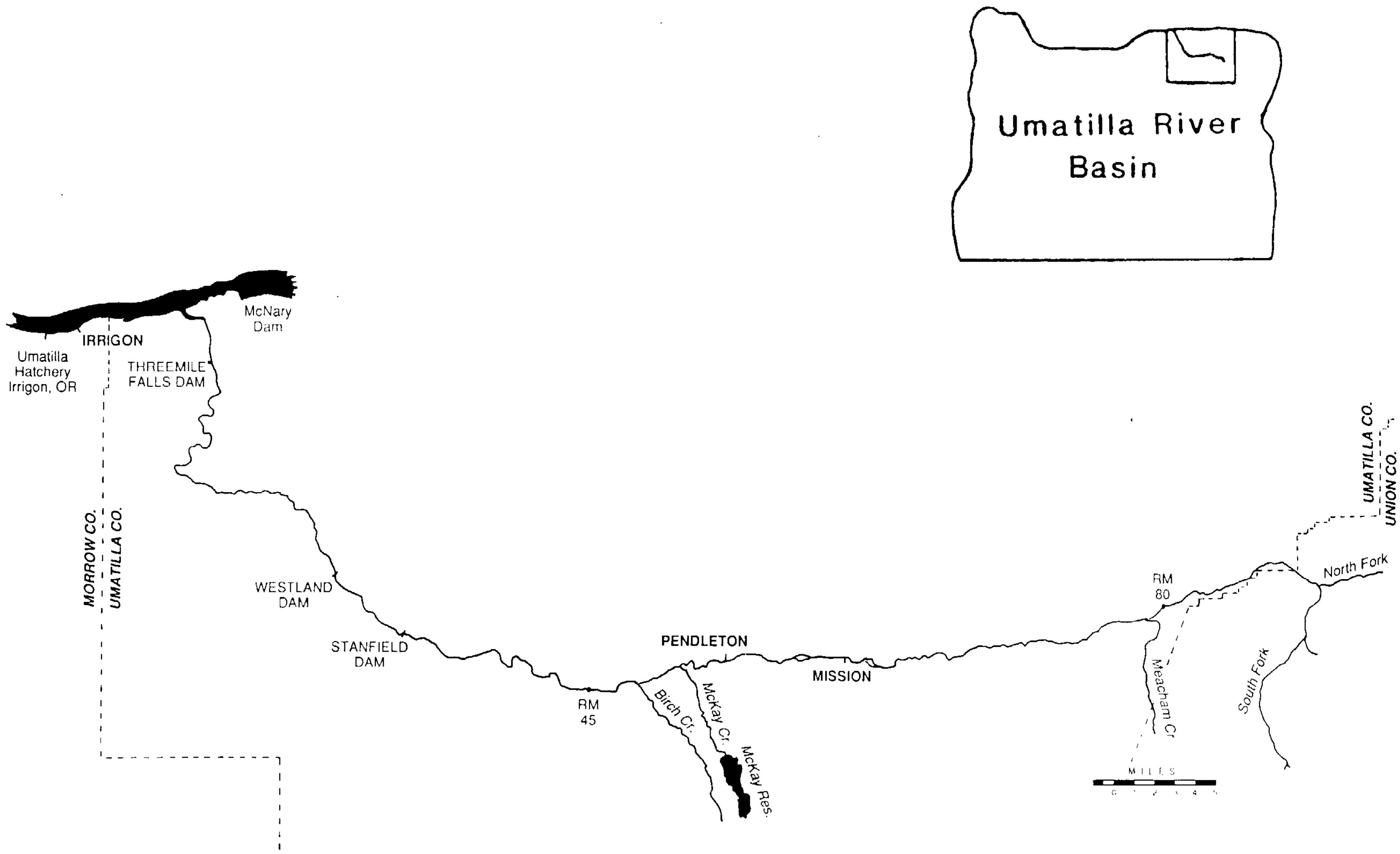


Figure 1. Location map, Umatilla Basin.

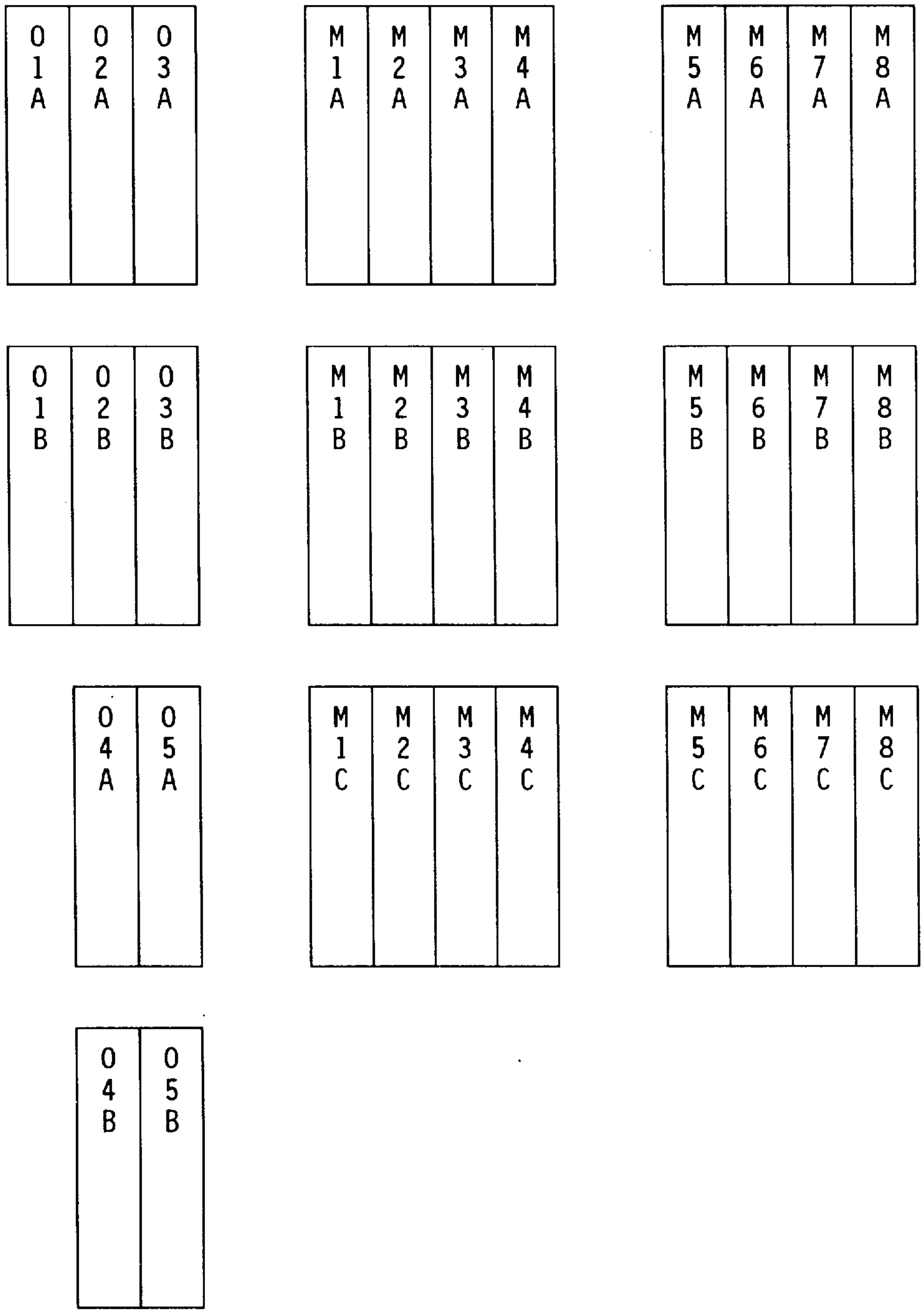


Figure 2. Raceway schematic for Umatilla Hatchery (O = Oregon raceway, M = Michigan raceway, number = raceway, A = first pass, B = second pass, C = third pass).

The Umatilla Hatchery was designed for production of salmonids in oxygen supplemented "Michigan" type raceways and in non-oxygen supplemented standard "Oregon" type raceways. Specific information about the hatchery is available in the Umatilla Hatchery Master Plan (CTUIR and ODFW 1990) and in the Environmental Assessment Report (Bonneville Power Administration 1987). The Michigan system consists of eight series of raceways with three raceways per series for a total of 24 raceways. Water flows from the upper raceway (A) to the middle raceway (B) and then to the lower raceway (C) within each series. Before the water enters each raceway, pure oxygen is supplemented through a pipe injection system. Each Michigan raceway is 27.7 m long and 2.7 m wide with a water flow of approximately 2,839-3,520 Lpm. Water depth was kept at 76 cm during rearing. In each raceway there are nine baffles placed 10-11 ft apart to promote water movement across the bottom and aid in raceway cleaning. In addition, Michigan raceways were cleaned by vacuuming at the outflow screen three times per week and brush cleaned once per week. Due to water availability problems, not all Michigan raceways were operated in 1992.

The Oregon system at Umatilla Hatchery consists of five series of raceways with two raceways per series for a total of 10 Oregon raceways. Water flows from the upper raceway (A) to the lower raceway (B). Each Oregon raceway is 27.7 m long and 6.1 m wide and no cleaning baffles are present. Oregon raceways were vacuumed once per week at the outflow screen and broom cleaned once per week. Water depth was kept at 107 cm during rearing. All 10 Oregon raceways were used in 1992.

For the summer steelhead, we compared Umatilla River strain to Wallowa stock reared in the Irrigon Hatchery. All raceways at the Irrigon site were Oregon style, but were slightly larger at 30.5 m long and 6.1 m wide. Water height was kept at 117 cm. Physical characteristics of each style raceway are presented in Table 1.

Table 1. Physical characteristics of the Oregon and Michigan system raceways located at Umatilla and Irrigon hatcheries, Irrigon, Oregon.

System	Location	Length (m)	Width (m)	Water Depth (cm)	Volume (m^3)	Flow (Lpm)
Michigan	Umatilla	27.7	2.7	76	58	2,839[a]
Oregon	Umatilla	27.7	6.1	107	176	4,731
Oregon	Irrigon	30.5	6.1	117	215	5,791

[a] *Summer steelhead* were reared *in Michigan raceways with a flow of 3,520 Lpm.*

The Umatilla River and tributaries are located in Umatilla, Morrow, and Union counties, Oregon (Figure 1). Tests or evaluations of fall and spring chinook salmon subyearlings were conducted at the Umatilla Hatchery or at the Thornhollow release site (Umatilla River mile 74). Summer steelhead and spring chinook yearling evaluations were conducted at the respective hatchery in which they were reared, and at the Fred Grey release site (spring chinook - Umatilla River mile 80) or at the Bonifer or Minthorn springs acclimation sites.

METHODS

Fish Cultural Practices

We monitored fish cultural and hatchery operational practices at Umatilla Hatchery. Hatchery records were used to determine the number of eggs taken, egg mortality, fry mortality, and smolts released. Egg-to-smolt survival rates were calculated for fall chinook, spring chinook, and summer steelhead. The number of fish released, the size of fish released for major production groups, and the location of release were determined from hatchery records.

Water Quality Monitoring

We monitored water quality in an index series of Michigan and Oregon raceways in which fall chinook and fall release spring chinook salmon were reared and in a series of Michigan or Oregon raceways in which spring chinook and summer steelhead were reared. Index series were selected so that all systems and passes where fish were being held were represented during weekly sampling. Measurements were taken between 1100-1800 h on each sampling day and samples were collected weekly from mid-February through October 1993. Parameters measured at the head and tail of each raceway included water temperature ("C), total gas pressure (mm Hg), partial pressure of oxygen (mm Hg), partial pressure of nitrogen (mm Hg), and pH. Parts per million of O_2 were calculated from the partial pressure of O_2, pH, and temperature data. We used a Model TBO-F, Common Sensing meter to monitor gas pressure and a portable meter to determine pH. Both meters were calibrated immediately prior to each sampling period.

We determined total alkalinity and unionized ammonia from water samples collected biweekly at the tail of each raceway. Samples were collected between 0700 and 0800 h to minimize impact from daily feeding activities and were sent immediately for analysis. We used the titration method (Standard Methods 1980) to determine the alkalinity (mg/l CaC03). Total ammonia concentrations were determined by an independent testing laboratory using the phenate method. The proportion of unionized ammonia was calculated from total ammonia, temperature, and pH.

Rearing Performance and Survival Studies

Fall Chinook Salmon

Rearing Performance: To evaluate rearing performance, mean length and weight were determined, and condition factor, growth rates, and food conversion ratios were calculated once per month from mid-March 1993 to pre-release in June 1993. During monthly sampling we measured 100 fork lengths and 50 weights from a sample of fish out of each raceway. Length and weight data were used to calculate the condition factor (weight/length^3*100,000); (Nielsen et al. 1983). Growth rates were determined by plotting mean monthly weight over time.

We calculated the mean food conversion ratio for fall chinook in the Oregon and Michigan systems from food conversion ratios for each raceway. Ratios were determined only after fish were split into their final raceway. The total weight gained by a group of fish in each raceway was calculated by subtracting the total weight at the start of the time period from the final weight at release. To estimate the food conversion ratio, we divided the total pounds of feed fed by the pounds of weight gained.

Smolt Condition: We examined smolts at pre-release to determine their general condition. Measurements included fork length (mm), weight (g), condition factor, smolt stage, and the amount of descaling. The pre-release sample was taken 7-10 days prior to liberation from the hatchery. At pre-release we measured fork lengths of 300 fish and weight of 100 fish from each raceway. The length and weight data were used to calculate condition factors as described above.

We documented the smolt stage from a sample of 200 fish in each raceway. To evaluate smoltification, we examined both sides of the fish and classified them as smolts if they were silvery and no parr marks were present. Fish with discernible, yet not a complete set of parr marks, were classified as intermediate smolts while fish with full parr marks were noted as parr.

To determine the extent of descaling, we examined 200 fish in each raceway and recorded the scale condition on each side of the body. We recorded scales as undamaged if the cumulative scale loss was less than 3% either side of the body. If cumulative scale loss exceeded 3% on one side of the body, but was less than 16%, we listed the side as partially descaled. Descaled sides were those that had a cumulative scale loss equal to or exceeding 20%.

We evaluated and compared the physiological stress response of fall chinook reared in Michigan and Oregon systems to both a primary and secondary stressor. The physiological stress response was evaluated for the response to a primary stressor at the hatchery prior to release and for the response to a secondary stressor at the release site after transport from the hatchery. Plasma levels of cortisol and glucose were assayed for 36 salmon from each raceway. Control fish were removed from the raceway or stocking truck and immediately euthanized with tri-methylcaine sulfate (MS-222). The eighteen treatment fish were subjected to a standardized stress by removing them from a raceway (primary stressor) at the hatchery or from the stocking truck (secondary stressor) at the release site and holding them out of water in a 0.1 m^2 net pen for 30 seconds. The net pen containing fish was returned to the raceway or placed in the Umatilla River for one hour. After one hour the fish were euthanized with tri-methylcaine sulfate (MS-222). After euthanization we severed the caudal peduncle of each fish and collected blood samples in heparinized capillary tubes. The tubes were sealed, placed on ice, and transported to the laboratory. The tubes were spun with a microcentrifuge for two minutes to separate the plasma from the red blood cells. When necessary, due to small fish size, we pooled plasma samples from two fish to obtain a sufficient volume for analysis. The plasma was transferred into storage tubes, transported on dry ice, and stored in a supercool freezer (-80°C). These samples were analyzed by an independent laboratory for plasma concentrations of cortisol and glucose.

Smolt Migration Performance: We compared the smolt migration success, migration rate, and the duration of migration for fall chinook salmon reared in the Oregon and Michigan systems. To identify fish, we freeze-branded approximately 10,000 fall chinook salmon from each of the Oregon and Michigan raceways. The brands were approved by and coordinated with the National Marine Fisheries Service and the Fish Passage Center. Each raceway was assigned a unique brand. The branding rods were supercooled with liquid nitrogen and were applied to a fish for one second to leave a brand. To determine brand quality, we subsampled approximately 100 fish from each raceway during pre-release sampling and evaluated each brand for readability based on the following criteria. Readable brands were those that were clearly readable and could not be mistaken for other brands. Light or faint brands were considered good. Obscure brands were light and possibly distorted or placed a little high or low, but were still legible. Non-readable brands were those which could not be recognized. This information, along with total numbers branded, was sent to personnel at the Fish Passage Center in Portland, Oregon, who monitored downstream fish passage and recorded the numbers of branded fish observed at mainstem Columbia River dams. Brand recovery data was received from the Fish Passage Center. We compared the brand recovery rates and travel timing to John Day Dam for fish reared in Michigan and Oregon raceways. Recovery rates were calculated by dividing the total estimated passage daily count by the total number of readable brands released. Run timing was examined by comparing median dates required for fish to reach John Day Dam. We also plotted the daily passage counts and the average cumulative index against days since release for all releases combined.

Smolt-to-Adult Survival: In the future we will compare the percentage of fall chinook surviving from the smolt to the adult stage between Michigan and Oregon raceways. To identify fish from each raceway in 1993, we attempted to mark approximately 30,000 fall chinook from all 10 raceways with coded-wire tags and adipose fin clip (AD+CWT). A subsample of 300-400 fish from each raceway was checked for tag retention a minimum of 14 days after tagging.

Spring Chinook Salmon

Fall Release:

Rearing Performance: The 106,000 spring chinook released in the fall of 1992 were reared in Oregon raceways 03A and 03B. The rearing performance evaluation for these fish was the same as the 1991 brood fall chinook except there was no Michigan versus Oregon system evaluation. The 492,000 spring chinook released in the fall of 1993 were reared in the same manner as the fall chinook, including evaluation and comparison of both rearing systems.

Smolt Condition: We monitored the smolt condition of 1991 brood fall release spring chinook salmon in the same manner as for fall chinook salmon except that no physiological stress tests were conducted and there was no system evaluation. For the 1992 brood fall release spring chinook, the smolt condition evaluation was conducted in the same manner as fall chinook. In addition, gill ATPase levels for 1993 fall release spring chinook were measured as a physiological index of smoltification. Gill samples were obtained at approximately 45, 30, and 15 days prior to release, and at the time of release. Gill filaments were removed by cutting them from the four left gill arches. Occasionally, it was necessary to remove filaments from right arches. Once cut, the gill filaments were placed in a fixative (SEI buffer), transported on dry ice, and stored in a supercool freezer (-80°C). These samples were analyzed by an independent laboratory for $Na^{+}K^{+}$ATPase (μmoles P/h/mg of protein).

smolt Migration Performance: The .1991 and 1992 brood fall release spring chinook were not freeze-branded. Therefore, we did not evaluate the migration performance for these groups.

Smolt-to-Adult Survival: In the future, we will monitor the percentage of fall release spring chinook surviving from the smolt to the adult stage for the 1991 brood and compare survival between fish reared in Michigan and Oregon systems for the 1992 brood. To identify fish from each raceway, we ADtCWT marked two groups of approximately 26,000 fish each for the 1991 brood and 10 groups of approximately 37,000 fish each for the 1992 brood.

Spring Release: A Michigan versus Oregon rearing system evaluation was initiated with the 1991 brood subyearling chinook salmon released in the spring of 1992. The methods associated with this evaluation can be found in Keefe et al. (1993). Due to water limitations, I992 was the only year that this evaluation was conducted. Data from this year of evaluation will be included in this and future reports.

Summer Steelhead

Rearing Performance: Summer steelhead rearing performance was monitored in the same manner as for fall chinook salmon excepting the system evaluation. In addition, we compared food conversion ratios between Michigan reared steelhead from Umatilla Hatchery and Wallowa stock steelhead reared in standard raceways at Irrigon Hatchery. The food conversion ratio for Wallowa stock steelhead was generated from overall data on 30 raceways and was not calculated to generate a mean and standard error. Additionally, food sources were different for Umatilla and Irrigon reared steelhead, further complicating the comparison of food conversion ratios.

Smolt Condition: Smolt condition for summer steelhead was evaluated in the same manner as described for fall chinook salmon with the following modifications. We compared pre-release data between Michigan reared, Umatilla steelhead and standard reared Wallowa steelhead. We compared only raceways containing fish in similar graded size groups. In addition, we evaluated fin erosion on summer steelhead by examining all fins on approximately 200 fish per raceway as described in the 1992 annual report (Keefe et al. 1992). No tests between passes were conducted because summer steelhead were graded prior to ponding in Michigan raceways. Pre-release data was obtained at the Minthorn and Bonifer Springs acclimation sites for Umatilla steelhead and at the Wallowa and Big Canyon acclimation sites for Wallowa steelhead.

Smolt Migration Performance: In 1993, we initiated a study of summer steelhead smolt migration performance by branding approximately 10,000 fish in each Michigan raceway. Branding methods were the same as described for fall chinook. Smolt migration success, migration rate, and the duration of migration was compared between raceways of steelhead reared in the Michigan system.

Smolt-to-Adult Survival: In the future we will compare the percentage of summer steelhead surviving from the smolt to the adult stage between Michigan raceways. To identify fish from each raceway, we coded-wire tagged plus LV marked three replicates of approximately 10,000 fish from each raceway. A subsample of 300-400 fish from each raceway was evaluated a minimum of 14 days after tagging.

Spring Chinook Subyearling and Yearling Production Evaluation

Rearing Performance:

The methods used to monitor spring chinook salmon subyearling and yearling rearing performance are as described for fall chinook salmon with the exception of the system comparisons. Spring chinook salmon yearlings from Bonneville hatchery were not monitored on a monthly basis,

Smolt Condition:

We monitored the smolt condition of Umatilla reared spring chinook salmon in the same manner as for fall chinook salmon, except there were no physiological stress tests conducted and no system comparisons made. In addition, gill ATPase levels were analyzed as per the methods described for 1992 brood fall release spring chinook.

Smolt Migration Performance:

Smolt migration success, migration rate, and the duration of migration was compared for spring chinook salmon subyearlings and yearlings reared at Umatilla Hatchery in the same manner as for fall chinook salmon. In 1993, four groups of approximately 5,000 yearlings and six groups of approximately 10,000 subyearlings were freeze-branded at Umatilla Hatchery to identify fish reared in each raceway. No freeze-branding was conducted at Bonneville Hatchery.

Smolt-to-Adult Survival:

In the future we will compare the percentage of spring chinook smolts surviving to the adult stage between groups of yearlings reared at Umatilla and Bonneville hatcheries and subyearlings reared at Umatilla Hatchery. In addition, we will compare subyearling survival with expected values. We marked approximately 50,000 subyearlings from each of six raceways with AD-CWT. We AD-CWT marked approximately 20,000 yearlings from each of two raceways at Bonneville Hatchery and from each of six raceways at Umatilla Hatchery. To assure accuracy of tagging, a subsample of 300-400 fish from each raceway was checked for tag retention a minimum of 14 days after tagging.

Bonneville Hatchery Production Evaluation

In the future we will determine smolt-to-adult survival for fall chinook yearling smolts and fall release spring chinook reared at Bonneville Hatchery in the same manner as described for fall chinook salmon, with the exception of no Michigan versus Oregon evaluation. To identify fish in each raceway, we Ad-CWT marked approximately two groups of 20,000 fall chinook yearlings and two groups of 25,000 fall release spring chinook from each of two raceways for each race.

Effects of Tagging and Harking on Subyearl ing Fall Chinook Salmon

To evaluate the effects of marking on survival of fall chinook salmon, all Umatilla fall chinook were marked with fin marks, blank-wire body tags, or coded-wire tags. Two replicate groups of 70,000 salmon each were marked as follows: left ventral clip (LV), left ventral clip plus body tag (LV-BT), body tag only (BT), and adipose (AD)-right ventral clip (RV) plus coded-wire tag (CWT). We will compare smolt-to-adult return rates based on future recoveries at Three Mile Dam and other collection sites in the Columbia River Basin (Figure 1). Effects of different marks will be based on the following comparisons:

1. BT versus LV.
2. BT-LV versus BT to evaluate the effect of a ventral clip.
3. BT-LV versus LV to evaluate the effect of the body tag.
4. AD-LV+CWT versus LV to evaluate the effect of the adipose clip and coded-wire tag.

Tag retention checks were conducted on both coded-wire tagged and body tagged fish a minimum of 14 days after tagging.

We also evaluated the quality of the ventral fin clips on fall chinook. Fin clips were categorized as "good" if no fin or a small stub remained or "fair" if a fin stub of approximately 25% remained. Fin clips with approximately 50% of the fin remaining were considered "poor" and fins with more than 75% remaining were classified as "unclipped".

Creel Survey

The primary goals of the Umatilla creel survey were 1) to identify recreational fishing areas that are used for fall chinook, spring chinook, and summer steelhead; 2) to develop and implement statistical methods to estimate total effort, total catch, total harvest, and number harvested by tag code for fall chinook, spring chinook, and summer steelhead recreational fisheries; and 3) to coordinate with the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) in their development of a monitoring program for tribal fisheries.

The coded-wire-tagged returns presented are from fish reared in hatcheries other than the Umatilla Hatchery and stocked into the Umatilla River. The 1993-94 season will be the first year of returns of fish reared in the Umatilla Hatchery.

Because of the split fishing seasons, the 1992-1993 creel surveys on the Umatilla River were divided into three separate surveys:

1) Fishery: coho salmon and fall chinook salmon jacks (16-24 inches)
Date: 1 October to 30 November 1992
Boundary: Stanfield Dam downstream to Highway 730.
2) Fishery: summer steelhead
Date: 1 December 1992 to 31 March 1993
Boundary: The lower boundary of the CTUIR reservation downstream to Highway 730.
3) Fishery: spring chinook salmon
Date: 29 May to 13 June 1993
Boundary: Umatilla Forks downstream to the upper boundary of the CTUIR reservation; and the lower boundary of the CTUIR reservation downstream to the Yoakum bridge.

The survey methods used in 1992-1993 were the same as described in the 1992 annual report (Keefe et al. 1993) except for the following modifications. The fall chinook and coho fishery was open from Stanfield Dam to Highway 730. The 1992 methods stated that we would conduct a full creel survey for this entire area, but due to limited personnel and access to the river we only conducted periodic spot checks for anglers above Three Mile Falls Dam. No anglers were observed from Three Mile Falls Dam to Stanfield Dam for the 1992 survey. Another modification to the 1992 methods concerned non-sampling during some scheduled sample days in January because the river was iced over and anglers could not fish.

Our statistical analysis was also modified from that described in the 1992 annual report. Fishing pressure was estimated for strata within each month instead of daily pressure for the summer steelhead and spring chinook fishery. To estimate monthly pressure, we calculated the average pressure count for each count interval and strata and determined the area under the curve. Total catch was estimated for each strata by multiplying the mean monthly catch rate by the estimated pressure. We are currently evaluating methods to estimate the variance of the catch for each stratum within each month.

Statistical Analyses

The majority of tests comparing parameters between Michigan and Oregon systems and between passes within each system were analyzed using T-tests and analysis of variance (ANOVA). When applicable, we used a nested ANOVA to separate sources of variation within the Michigan and Oregon systems. A maximum of three nesting levels were used and were as follows:

First level - SYSTEM (e.g. Michigan, Oregon)
Second level- RACEWAY (e.g. M2, 03)
Third level - PASS (e.g. A, B, C)

For tests designed to analyze baseline physiological stress responses the data were tested for differences within a system and were pooled if no differences existed. We also tested the ability of fish to respond to stress by subtracting mean control values for cortisol or glucose for each raceway from mean treatment values. The analysis of gill ATPase in spring chinook included a date effect. Growth rates were tested by comparing the slopes of regression lines computed from monthly growth information (Sokal and Rohlf 1981). The proportion of descaled and partially descaled fish and food conversion ratios were tested using the Kruskall-Wallis and Wilcoxon non-parametric analyses. Differences between pairs of means were tested by the Wilcoxon method. For tests comparing the Oregon and Michigan systems, we included only A and B raceways. Tests designed to examine differences within the Michigan system included A, B, and C raceways. To compare survival indices we used paired binomial tests or Chi-square when appropriate. When Chi-square demonstrated significance among passes, paired binomial tests were run on all possible combinations using an alpha level adjusted to 0.02 to clarify where significant differences existed (Sokal and Rohlf 1981). The results of all tests, including planned comparisons of differences between means using the Sidak technique (Sokal and Rohlf 1981), were evaluated at an alpha level = 0.05.

RESULTS

Fish Cultural Practices

Fall Chinook Salmon

The egg sources for 1992 brood fall chinook salmon were Upriver Bright stock from Bonneville and Little White Salmon hatcheries and from the Umatilla River. Eggs were incubated at all hatcheries at 50-52°F. Approximately 195,000 green eggs from the Umatilla River source were taken in early November 1992 and were immediately transferred to Umatilla Hatchery. Approximately 1.63 million eyed eggs were transferred from Bonneville to Umatilla Hatchery in early December 1992 and approximately 1,000,000 eyed eggs were transferred from Little White Salmon to Umatilla Hatchery in early December 1992.

Fall chinook were ponded on 10 February 1993 into four Oregon raceways. Fish were subsequently split into six Michigan and two Oregon raceways when they reached 181 fish/lb in late March 1993. In April, fish were moved once more for tagging, marking, and branding from two Oregon raceways to four Oregon raceways for a final ponding total of six Michigan and four Oregon raceways. Rearing conditions for the fall chinook are described in Table 2. To standardize donor parentage for each treatment and control group, fish were split so that each Michigan and Oregon raceway received equal proportions of fry from all egg-takes. All Upriver Bright stock fall chinook salmon were released on 24 and 25 May 1993 at 61 fish/lb. Additional release information can be found in Table 3. Egg-to-smolt survival estimates can be found in Table 4.

Table 2. Rearing conditions for 1992 brood fall and spring chinook salmon subyearlings and summer steelhead and 1991 brood spring chinook yearlings and fall release spring chinook salmon reared in Oregon or Michigan system raceways at Umatilla, Irrigon, and Bonneville hatcheries during 1992-1993.

Race-species, release strategies	System	Density (lb/ft^3)	Loading Factor (lb/gal/min)
		Umatilla Hatchery	
Fall Chinook:			
Subyearlings	Michigan	2.0-2.4	5.4-6.6
	Oregon	0.5-0.7	2.6-3.5
Spring Chinook:			
Fall release	Oregon	0.3-0.4	1.6-2.1
Subyearlings	Michigan	1.9-2.0	5.2-5.5
Yearlings[a]	Oregon	1.0	5.0
Summer Steelhead:	Michigan	4.0-4.5	8.9-9.9
		Irrigon Hatchery	
Summer Steelhead:	Oregon	1.3	6.6
		Bonneville Hatchery	
Fall Chinook[a]:			
Yearlings	Oregon	0.49-1.10	3.8.-8.2
Spring Chinook[a]:			
Fall release	Oregon	0.55-0.66	4.3-5.2
Yearlings	Oregon	5.0-5.3	0.64.-0.70

[a] 1991 brood yearlings

Table 3. Release information for salmon and steelhead reared at Umatilla and Bonneville hatcheries and released into the Umatilla River in 1993.

Race-species, release strategies, rearing system	Date released	Number released	Mean weight (9)	Release location	Mean fork (mm)
		Umatilla Hatchery			
Fall Chinook:					
Subyearlings					
Michigan	24 May	1,678,124	7.4	UmR. RM 74	85.9
Oregon	25 May	951,793	7.4	UmR. RM 74	85.8
Spring Chinook:					
Fall release[a]					
Oregon	11 *Nov*	101,416	24.4	UmR. RM 80	120.5
Subyearlings					
Michigan	02 Jun	667,367	16.3	UmR. RM 74	109.3
Yearlings					
Oregon	24 Mar	208,782	50.5	UmR. RM 80	158.8
Summer Steelhead:					
Michigan	13 May	65,465	74.8	Bonifer	199.6
Michigan	16 Apr	47,979	80.9	Minthorn	198.2
Michigan	18 Apr	44,824	102.4	Bonifer	220.1
		Bonneville Hatchery			
Fall Chinook:					
Yearlings					
Oregon	31 Mar	134,837	9.1[b]	UmR. RM 74	NA
Spring Chinook:					
Fall Release					
Oregon	03 Nov	132,154	38.8[b]	UmR. RM 80	NA
Yearlings					
Oregon	22 Mar	186,948	38.3	UmR. RM 80	142.2

[a] *Fall release data for 1991 brood spring chinook.*
[b] *Data based on hatchery liberation slips.*

Table 4. Egg-take and survival of salmon and steelhead reared at Umatilla Hatchery during 1992-1993. Fall chinook are 1992 brood, spring chinook yearlings and fall release are 1991 brood, subyearlings are 1992 brood, and summer steelhead are 1992 brood.

Race-species, release strategy, source	Number of eggs taken or received	Egg loss (%)	Egg-to-fry survival (%)	Egg-to-smolt survival (%)
Fall Chinook:				
Bonneville	1,615,003	0.9	99.0	
Little White Salmon	992,668	0.9	99.0	
Umatilla	181,419	7.5	92.0	
Total	2,189,090	1.4	98.6	94.3[a]
Spring Chinook:				
Yearling Spring and Fall Release[b]:				
Carson	332,000	2.8	97.2	93.4[c]
Subyearling Spring Release:				
Carson	957,000	19.0	81.0	69.7
Summer Steelhead:				
Umatilla	423,810	52.8	47.2	43.3[d]

a *Surviva7 estimates for a77 three hatcheries. Estimates do not inc7ude 31,600 smolts removed for passage evaluation*

b *yearlings are from 1991 brood year. Spring chinook yearling program was modified for the fa77* release *program* after *initia7 ponding.*

c *Surviva7 estimate is based on eyed egg-to-smo7t stage; other estimates are based on green egg-to-smo7t stage. Eggs were incubated at Oxbow and Carson hatcheries. 1991 brood spring chinook yearlings wi77 be included in FY93 Annua7 Report.*

d *Surviva7 estimate does not include 25,090 sac fry that were destroyed due to a reduction in program goals*

Spring Chinook Salmon

Fall Release: The source for 1991 and 1992 brood of spring chinook released in the fall were Carson stock. Fish cultural practices for the 1991 brood were detailed in the 1992 annual report (Keefe et al. 1992). Information on 1991 brood released in the fall can be found in Table 3. Egg-to-smolt survival estimates can be found in Table 4.

For the 1992 brood, apprgximately 632,000 1992 brood green eggs were received and incubated at 42.5 F for the first seven days. The incubation temperature was then lowered to 38 F for 244-300 days. Approximately 533,000 fall release fry were ponded into one Oregon raceway in April 1993. In early June the fish were split into two Oregon raceways when they reached 125 fish/lb. Fish were split into six Michigan and four Oregon ponds after marking and tagging in August of 1993. Approximately 492,000 of these fish will be released in November 1993.

Spring release: The brood source for spring chinook salmon was Carson stock from the Carson National Fish Hatchery in Washington. Approximately 957,000 green eggs were transferred in August 1993 to Umatilla Hatchery. Fish were ponded into one Oregon raceway at the end of November 1992 at 1,375 fish/lb and split into two Oregon raceways at 427 fish/lb in late December. In mid-February 1993 all of the fish were removed from the Oregon raceways and split into three Michigan raceways at an average weight of 96 fish/lb. The final splits were completed in early March when fish were transferred to six Michigan raceways. Fish were ponded and split so that each Michigan raceway received equal proportions of fry from all egg-takes at the Carson Hatchery. This ensured that the donor parentage for each treatment and control group was equal. Rearing conditions for spring chinook are described in Table 2. Spring chinook subyearlings were liberated on 2 June 1993 at approximately 28 fish/lb (Table 3). Egg-to-smolt survival estimates can be found in Table 4.

Approximately 332,000 spring chinook green eggs programmed for production for spring release were received and incubated as described for 1992 fall release spring chinook. Approximately 232,000 fry were placed into indoor Canadian troughs in late May 1993. These fish were transferred into one Oregon raceway in June 1993 at 294 fish/lb. In late August, these fish were split into four Oregon raceways. Spring chinook yearlings (Carson stock) will also be reared at Bonneville Hatchery and fish from both hatcheries will be released in spring 1994. Information on fall releases that occurred in 1992 can be found in Table 3. Egg-to-smolt survival estimates can be found in Table 4.

Summer Steelhead

The 1992 broodstock for summer steelhead were Umatilla River stock, Approximately 285,000 green eggs were taken to Umatilla Hatchery for incubation at 52 F. Approximately 224,000 fry were ponded into indoor tanks at swim-up. Fish were moved outside into one Oregon raceway in August 1992 at 199 fish/lb and split into two Oregon raceways in September at 89 fish/lb. In late October the fish were split into three Michigan raceways (M5A, M5B, and M5C) at 92.6 fish/lb, 55.9 fish/lb, and 40.8 fish/lb, respectively. Rearing conditions for summer steelhead are described in Table 2. Fish from raceways M5B and M5C were moved to the Bonifer Springs and Minthorn Springs acclimation sites on 1 April 1993. Fish from raceway M5A were transferred to Bonifer Springs on 20 April 1993 and were released 13 May 1993 at 6.1 fish/lb (Table 3). Egg-to-smolt survival estimates can be found in Table 4.

Water Quality Monitoring

Comparisons of Oregon and Michigan Systems

Comparisons of water quality data from Michigan and Oregon raceways are presented in Table 5. Water quality data for other Oregon and Michigan raceways not included in the standard comparisons are presented in Table 6.

Table 5. Comparisons of water quality parameters in Oregon and Michigan system raceways during 1992-1993 sampling. Means are combined values for first and second pass raceways (* = significant difference P>0.05).

Race-species, parameter measured	Mean parameter value (N) Oregon	Michigan	t-test
Fall Chinook:			
Temperature Head ("C)	11.1 (16)	11.1 (16)	ns
Temperature Tail ("C)	11.3 (16)	11.2 (16)	ns
pH Head	8.0 (12)	7.9 (12)	ns
pH Tail	7.9 (12)	8.3 (12)	ns
Oxygen Head (ppm)	9.4 (14)	11.1 (14)	*
Oxygen Tail (ppm)	7.9 (14)	8.7 (14)	*
Nitrogen Head (mmHg)	613 (14)	594 (16)	*
Nitrogen Tail (mmHg)	621 (14)	595 (16)	*
Total Pressure-Head (mmHg)	748 (14)	753 (16)	ns
Total Pressure-Tail (mmHg)	735 (14)	721 (16)	*
Unionized ammonia (µg/l)	2.01 (8)	1.68 (8)	ns
Alkalinity (mg/l CaC03)	130 (8)	144 (8)	ns
Fall Release Spring Chinook (Fall Release - 1993)			
Temperature Head ("C)	14.3 (24)	14.2 (24)	ns
Temperature Tail ("C)	14.5 (24)	14.3 (24)	*
pH Head	7.9 (20)	7.9 (20)	ns
pH Tail	7.9 (20)	7.8 (20)	ns
Oxygen Head (ppm)	9.6 (24)	10.3 (24)	*
Oxygen Tail (ppm)	8.8 (24)	9.5 (24)	*
Nitrogen Head (mmHg)	610 (24)	599 (24)	*
Nitrogen Tail (mmHg)	624 (24)	606 (24)	*
Total Pressure-Head (mmHg)	757 (24)	757 (24)	ns
Total Pressure-Tail (mmHg)	760 (14)	753 (24)'	ns
Unionized ammonia (µg/l)	1.86 (8)	1.47 (8)	ns
Alkalinity (mg/l CaC03)	146 (8)	145 (8)	ns

Table 6. Water quality parameters in Michigan or Oregon system raceways during 1992-1993 sampling.

Race-species, parameter measured	Mean oarameter value (N) Oregon	Michigan
Fall Release Spring Chinook Yearlings (Fall Release - 1992)[a]:		
Temperature Head (°C)	~15.3 (26)	-
Temperature Tail ("C)	15.3 (26)	
pH Head	7.8 (26)	
pH Tail	7.8 (26)	
Oxygen Head (ppm)	9.5 (26)	
Oxygen Tail (ppm)	8.8 (26)	-
Nitrogen Head (mmHg)	610 (26)	
Nitrogen Tail (mmHg)	612 (26)	
Total Pressure-Head (mmHg)	759 (26)	-
Total Pressure-Tail (mmHg)	753 (26)	
Unionized ammonia (µg/l)	1.63 (11)	
Alkalinity (mg/l CaC03)	113 (11)	
Spring Chinook Subyearlings:		
Temperature Head ("C)	-	11.0 (42)
Temperature Tail ("C)	-	11.0 (42)
pH Head	-	8.0 (36)
pH Tail	-	8.0 (36)
Oxygen Head (ppm)	-	11.0 (39)
Oxygen Tail (ppm)	-	9.6 (39)
Nitrogen Head (mmHg)	-	593 (39)
Nitrogen Tail (mmHg)	-	596 (39)
Total Pressure-Head (mmHg)	-	752 (39)
Total Pressure-Tail (mmHg)	-	734 (39)
Unionized ammonia (µg/l)	-	2.74 (18)
Alkalinity (mg/l CaC03)	-	139 (18)
Spring Chinook Yearlings (Spring Release - 1993):		
Temperature Head ("C)	13.1 (68)	-
Temperature Tail ("C)	13.1 (68)	-
pH Head	7.9 (64)	-
pH Tail	7.9 (64)	-
Oxygen Head (ppm)	9.9 (68)	-
Oxygen Tail (ppm)	9.0 (68)	-
Nitrogen Head (mmHg)	608 (68)	-
Nitrogen Tail (mmHg)	612 (68)	-
Total Pressure-Head (mmHg)	756 (68)	-
Total Pressure-Tail (mmHg)	747 (68)	-
Unionized ammonia (µg/l)	1.99 (30)	-
Alkalinity (mg/l, CaC03)	123 (30)	

Table 6, continued

Race-species, parameter measured	Mean parameter value (N) Oregon	Michigan
Summer Steelhead:		
Temperature Head ("C)		11.7 (47)
Temperature Tail ("C)		11.7 (47)
pH Head		7.8 (47)
pH Tail		7.7 (47)
Oxygen Head (ppm)		11.6 (47)
Oxygen Tail (ppm)		9.0 (47)
Nitrogen Head (mmHg)		591 (47)
Nitrogen Tail (mmHg)		593 (47)
Total Pressure-Head (mmHg)		759 (47)
Total Pressure-Tail (mmHg)		726 (47)
Unionized ammonia (µg/l)	-	1.12 (20)
Alkalinity (mg/l CaC03)		131 (20)

a Water quality data for spring chinook yearlings released in fa77 1992 was not reported in the 1992 annua7 report.

Temperature: For fall chinook salmon, water temperatures measured at the head and tail of the index raceways were similar between systems, averaging 11.1°C. The highest yearly mean temperatures we observed were 15.3°C in Oregon raceways that contained fall release spring chinook which are reared during the summer months.

pH: pH measurements at the head and tail of Michigan and Oregon raceways generally fell within the range of 7.0-8.0. In the fall chinook raceways, there was no significant difference in mean pH between rearing systems. Mean pH for all other raceways ranged from 7.7 to 8.3.

Oxygen, Nitrogen, and Total Gas Pressure: In the fall chinook raceways, mean oxygen (02) levels (ppm), and the means for partial pressure of nitrogen (N2) and total pressure at the tails of the raceways were significantly different between the Michigan and Oregon systems. Mean 02 (head and tail) was greater in the Michigan than the Oregon system. The partial pressure of N2 (head and tail) and total pressure (tail) were significantly greater in Oregon raceways. Mean 02 levels typically declined 1 to 2.5 ppm from the head to the tail of the raceways in both rearing systems. We did not observe any daily oxygen levels below the recommended level of 6.5 ppm in 1993.

Alkalinity: No significant differences in alkalinity values were found between Michigan and Oregon systems for fall chinook or fall release spring chinook during 1993 (Table 5). In all raceways, mean alkalinity ranged from a low of 113 mg $CaCO_3$/L to a high of 146 mg $CaCO_3$/L (Tables 5 and 6). Weekly measurements of alkalinity in individual raceways ranged from 80 mg $CaCO_3$/L to 173mg $CaCO_3$/L.

Unionized Ammonia: Comparisons of mean unionized ammonia between Michigan and Oregon systems for fall chinook were not significantly different. For all raceways mean NH_3 levels ranged from 1.1 to 2.7 µg/L.

Within Michigan System Comparisons

Temperature: Water quality data for first, second, and third pass Michigan raceways can be found in Table 7. There were no significant differences between passes for temperature measurements at the head or tail of fall chinook, spring chinook, or summer steelhead raceways.

pH: Within the Michigan system, mean pH values of individual raceways ranged from a low of 7.56 in a 3rd pass summer steelhead raceway to a maximum of 8.40 in a 1st pass fall chinook raceway. There was a significant difference between passes for pH values at the heads and tails of both fall chinook and summer steelhead raceways. For both species, pH showed a gradual decline from 1st pass to 3rd pass raceways. No significant difference was found between passes in the raceways containing spring chinook subyearlings.

Oxygen, Nitrogen, and Total Gas Pressure: No significant differences were observed between passes for mean O_2 (ppm) in any raceways. Relatively large O_2 drops (>2.0 ppm) occurred from the head to the tail of fall chinook and summer steelhead raceways. Mean total pressures and mean N_2 partial pressures were significantly different between passes. In each raceway, total pressure and N_2 partial pressure declined as water was recycled from 1st to 2nd to 3rd pass raceways.

Alkalinity: No significant differences for alkalinity were found between passes for any Michigan raceway. Mean values ranged from 131 to 145 $CaCO_3$/L.

Unionized Ammonia: No significant differences were found between passes. Mean NH_3 levels ranged from 0.93 to 2.92 µg/L.

Table 7. Comparison of water quality parameters between first, second, and third pass Michigan system raceways during 1992-1993. Parameter means with similar letters or without letters are not significantly different (Sidak test; P>0.05). (Letters in parentheses indicate sample size for first (A), second (B), or third (C) pass raceways.)

Race-species, parameter measured	N	Mean parameter value 1st pass	2nd pass	3rd pass
Fall Chinook:				
Temperature Head ("C)	8(7C)	11.0	11.1	11.4
Temperature Tail ("C)	8	12.1	11.3	11.5
pH Head	6	8.40 a	7.88 ab	7.70 b
pH Tail	6	8.10 a	7.77 ab	7.68 b
Oxygen Head (ppm)	7(6C)	11.0	11.2	11.3
Oxygen Tail (ppm)	7	8.6	8.8	8.8
Nitrogen Head (mmHg)	8	602 a	585 ab	565 b
Nitrogen Tail (mmHg)	8	603 a	587 ab	570 b
Total pressure-Head (mmHg)	8	759 a	747 a	731 b
Total pressure-Tail (mmHg)	8	727 a	715 ab	699 b
Unionized ammonia (µg/l)	4	2.00	1.38	1.21
Alkalinity (mg/l CaC03)	4	143	145	144
Spring Chinook (subyearlings):				
Temperature Head ("C)	14	10.9	10.9	11.1
Temperature Tail ("C)	14	10.9	11.0	11.1
pH Head	12	8.07	7.97	7.91
pH Tail	12	8.02	7.95	7.86
Oxygen Head (ppm)	13	10.9	10.8	11.3
Oxygen Tail (ppm)	13	9.4	9.6	9.9
Nitrogen Head (mmHg)	13	604 a	597 ab	579 b
Nitrogen Tail (mmHg)	13	607 a	597 ab	585 b
Total pressure-Head (mmHg)	11	760 a	752 ab	745 b
Total pressure-Tail (mmHg)	11	741	734	727
Unionized ammonia (µg/l)	6	2.92	2.89	2.40
Alkalinity (mg/l CaC03)	6	139	139	140
Summer Steelhead:				
Temperature Head ("C)	25(22BC)	11.7	11.8	11.8
Temperature Tail ("C)	25(22BC)	11.6	11.7	11.7
pH Head	20	7.89 a	7.78 ab	7.67 b
pH Tail	20	7.79 a	7.69 ab	7.56 b
Oxygen Head (ppm)	25(22BC)	11.4	11.8	12.4
Oxygen Tail (ppm)	25(22BC)	8.8	9.4	9.8
Nitrogen Head (mmHg)	25(22BC)	599 a	583 b	564 c
Nitrogen Tail (mmHg)	25(22BC)	602 a	583 b	563 c
Total pressure-Head (mmHg)	25(22BC)	764 a	753 b	742 c
Total pressure-Head (mmHg)	25(22BC)	730 a	721 b	705 a
Unionized ammonia (µg/l)	10	1.05	1.18	0.93
Alkalinity (mg/l CaC03)	10	131	131	132

Fall Chinook Salmon

Rearing Performance: Fall chinook salmon were not ponded until March 1993. Consequently, comparisons between Michigan and Oregon systems could only be made for the monthly sample in April and pre-release sample in May. No significant differences were observed for length, weight, or condition factor between systems (Table 8). However, there were significant differences between passes within each system. Within the Oregon system length, weight, and condition factor were similar between passes in March (Table 9). However, by April fish raised in second pass Oregon raceways were significantly longer (5%), and heavier (9%) and had a higher condition factor than fish raised in first pass raceways. At pre-release, fish in second pass were only 3% longer and were similar in both weight and condition factor. The April sample among Michigan raceways showed that fish in third pass raceways were significantly longer (3% to 6%) than fish in first and second pass raceways and significantly heavier (11%) than fish in second pass raceways (Table 9). No data was available for April weights or condition factor in first pass raceways. By pre-release, fish in third pass raceways were only 1% longer and were similar to fish in first and second pass raceways in both weight and condition factor.

Table 8. Monthly and pre-release comparisons of mean length, weight, and condition factor for fall chinook salmon reared in Oregon and Michigan system raceways during 1993. Letters indicate statistical grouping for tests between systems for each time period. Means with the same letter or without letters are not significantly different (Sidak's multiple comparison test, P>0.05).

Date,	Length(mm)		Weight(g)		Condition Factor[a]	
system	N	Mean(SE)	N	Mean(SE)	N	Mean(SE)
March:						
Oregon	449	52.6(0.19)	262	1.8(0.03)	262	1.20(0.008)
April:						
Oregon	208	64.0(0.37)	140	3.1(0.08)	140	1.16(0.023)
Michigan	823	63.3(0.17)	135	3.2(0.08)	135	1.16(0.012)
Pre-release:						
Oregon	1263	85.8(0.21)	440	7.4(0.09)	1	1.18 -
Michigan	1245	85.6(0.20)	434	7.3(0.09)	1	1.17 -

[a] *At pre-release, individua7 fish condition factors were not available. Condition was calculated using the mean weight and mean 7ength of the total number of fish measured and weighed. No statistica test was conducted.*

Table 9. Monthly and pre-release comparisons of mean length, weight, and condition factor for fall chinook salmon reared in Oregon and Michigan system raceways during 1993. Letters indicate statistical grouping for tests between passes within systems for each time period. Means with the same letter or without letters are not significantly different (Sidak's multiple comparison test, P>0.05).

Date, raceway position	Length(mm)			Weight(g)			Condition Factor[a]		
	N	Mean(SE)	Group	N	Mean(SE)	Group	N	Mean(SE)	Group
Oregon Raceways									
March:									
1st Pass	235	52.6(0.28)		144	1.8(0.04)		144	1.19(0.011)	
2nd Pass	214	52.7(0.25)		118	1.8(0.04)		118	1.21(0.011)	
April:									
1st Pass	101	62.3(0.48)	b	63	2.6(0.08)	b	63	1.04(0.014)	b
2nd Pass	107	65.6(0.51)	a	77	3.5(0.10)	a	77	1.26(0.037)	a
Pre-release:									
1st Pass	639	84.6(0.28)	b	216	7.3(0.11)			1.20	---
2nd Pass	624	87.0(0.31)	a	224	7.6(0.14)			1.16	---
Michigan Raceways									
April:									
1st Pass	596	62.9(0.19)	b		---			---	
2nd Pass	227	64.4(0.08)	b	135	3.2(0.08)		135	1.16(0.012)	
3rd Pass	210	66.8(0.41)	a	109	3.6(0.09)		109	1.17(0.012)	
Pre-release:									
1st Pass	604	85.6(0.28)	b	206	7.5(0.12)		_	1.20	---
2nd Pass	641	85.7(0.30)	ab	228	7.2(0.13)		-	1.15	---
3rd Pass	641	86.5(0.27)	a	214	7.5(0.13)			1.16	---

[a] *At pre-release individua7 fish condition factors were not available. Condition was calculated using the mean weight and mean 7ength of the total number of fish measured and weighed. No statistica test was conducted.*

Growth rates after final splitting were tracked for 70 days. The slopes of regression lines for weight gain between Michigan and Oregon system fish were significantly greater than zero, but were not significantly different from each other. Mean food conversion ratios were significantly poorer in the Michigan system than in the Oregon system (Table 10). However, within the Michigan system, mean ratios were not significantly different in 1993.

Table 10. Comparison of mean food conversion ratios for fall chinook salmon reared in Oregon and Michigan system raceways and within Michigan system raceways during 1993. Letters indicate statistical grouping for tests between systems or between passes within a systems. Means with the same letter or without letters are not significantly different (Wilcoxon test or Kruskall-Wallis tests, P>0.05).

Rearing system, raceway position	N	Mean food conversion ratio (SE)[a] (lb feed/lb fish)
Oregon	4	1.16(0.09)a
Michigan	4[b]	1.43(0.05)b
1st Pass	2	1.38(0.08)c
2nd Pass	2	1.48(0.20)c
3rd Pass	2	1.39(0.21)c

[a] *Food conversion is calculated as pounds of feed divided by pounds of fish.*
[b] *Combined first and second pass raceways.*

Smolt Condition: The mean lengths and weights of fall chinook salmon measured in Oregon and Michigan system raceways at pre-release were not significantly different in 1993 (Table 8). Although condition factor could not be statistically tested, it appeared to be similar between systems. Within the Oregon system fall chinook from second pass raceways were significantly longer (3%) than fish from first pass Oregon raceways, but there was no difference between weights. In the Michigan system there was a significant difference between passes for fork length with fish in third pass raceways being significantly longer than fish in first pass raceways. Mean weight was similar between passes and condition factor could not be tested, but was higher in first than second pass raceways.

Approximately 7% of all fall chinook in Michigan and Oregon raceways were classified as smolts at pre-release and there was no significant difference in the percentage of smolts between systems or for passes within systems. We examined the proportions of fall chinook that were descaled and partially descaled in the Michigan and Oregon raceways and found no significant difference between systems (Table 11). In addition, there were no differences in descaling proportions between passes within Michigan or Oregon systems.

Analysis of the stress response of fall chinook salmon tested at the hatchery demonstrated that salmon in Michigan raceways had significantly higher baseline cortisol and glucose levels than fish raised in Oregon raceways (Figure 3). However, when we compared the magnitude of the cortisol and glucose responses to a standardized stress, we found no significant differences between Michigan or Oregon reared fish (Figure 4). This response was consistent for fish exposed to the primary stressor (at the hatchery) and to the secondary stressor (after transportation to the release site).

Table 11. Comparison of the mean proportion of descaled, partially descaled, and undamaged (not-descaled) fall chinook reared in Oregon and Michigan system raceways and within system raceways during 1993 (SE in parentheses). Means with the same letter or without letters are not significantly different (Wilcoxon or Kruskall-Wallis test, P>0.05).

System, raceway position	N	Descaled	Partially descaled	Undamaged
Oregon	4	0.01 (0.00)	0.74 (0.11)	0.26 (0.11)
First Pass	2	0.00 (0.00)	0.57 (0.10)	0.43 (0.10)
Second Pass	2	0.01 (0.01)	0.91 (0.03)	0.09 (0.03)
Michigan	4[a]	0.04 (0.01)	0.62 (0.14)	0.35 (0.13)
First Pass	2	0.06 (0.01)	0.41 (0.16)	0.53 (0.15)
Second Pass	2	0.01 (0.01)	0.82 (0.08)	0.17 (0.08)
Third Pass	2	0.02 (0.01)	0.62 (0.12)	0.36 (0.11)

[a] *Combined first and second pass raceways.*

Within the Michigan raceways there was no significant difference between passes in the baseline cortisol or glucose levels of fall chinook (Figure 5). When Michigan reared fish subjected to primary or secondary stressors were tested for the magnitude of the cortisol or glucose response to a standard stress, we found no significant difference between fish reared in first, second, or third pass raceways (Figure 6).

Smolt Migration Performance: During 1993 more than 10,000 fish were branded in each raceway (Table 12). The number of readable brands ranged from 9,522 to 10,583 among raceways. Brand return information from 1992 was received after the 1992 annual report was published and is presented with 1993 data here. In 1992 fewer than 23 brands were collected from any raceway; but in 1993, brand recoveries were higher and ranged from 31 to 61 per raceway. Binomial analyses indicated significantly higher survival for Michigan fish than Oregon fish in both 1992 and in 1993 (Table 13). However, because of brand identification concerns with fall and spring chinook, comparisons between Michigan and Oregon systems for 1992 are equivocal.

Within system comparisons demonstrated significant differences in survival between passes (Table 13). In 1992 and 1993, Michigan system survival indices were significantly lower for fish from first pass than for second or third pass raceways. For Oregon system releases, survival indices for second pass raceways were significantly greater than for first pass raceways in 1992, but no differences were observed in 1993.

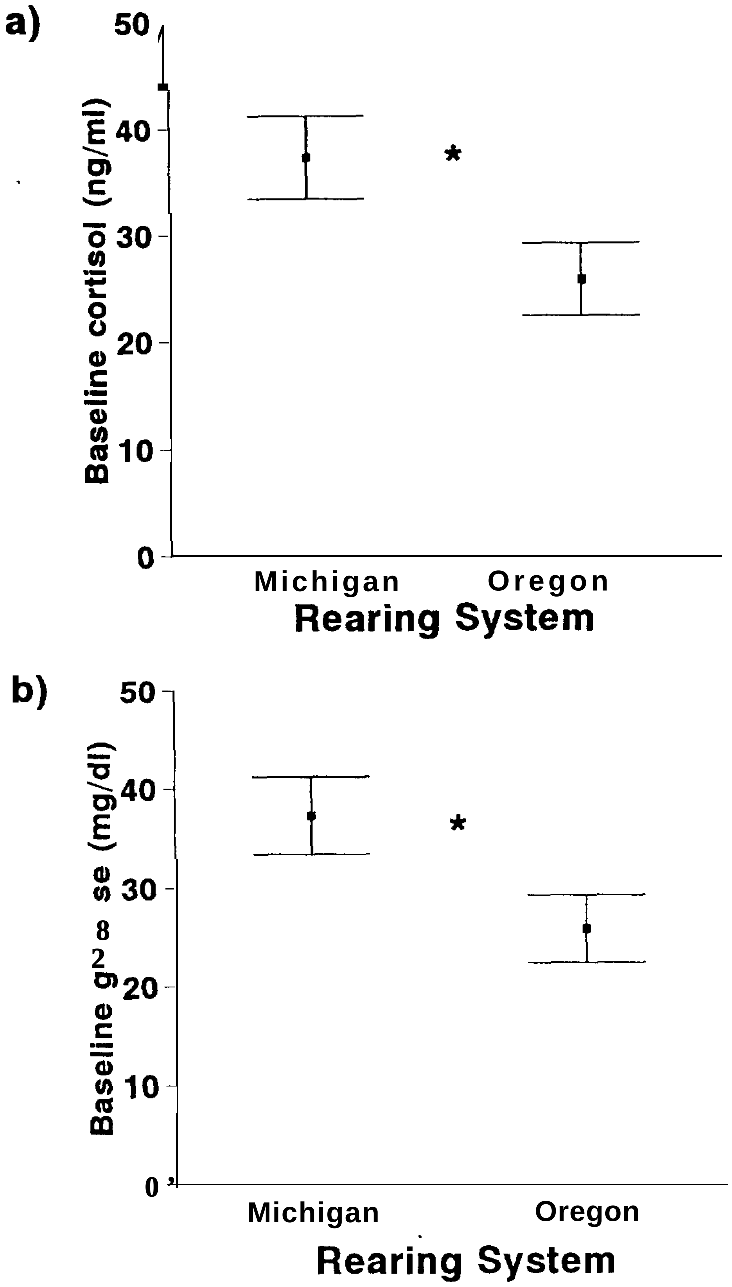


Figure 3. Baseline a) mean plasma cortisol and b) mean plasma glucose levels (+/- 1SE) for fall chinook salmon reared in Michigan and Oregon systems and subjected to a standardized stress. Asterisk indicates a significant difference between systems (t-test, $P \leq 0.05$).

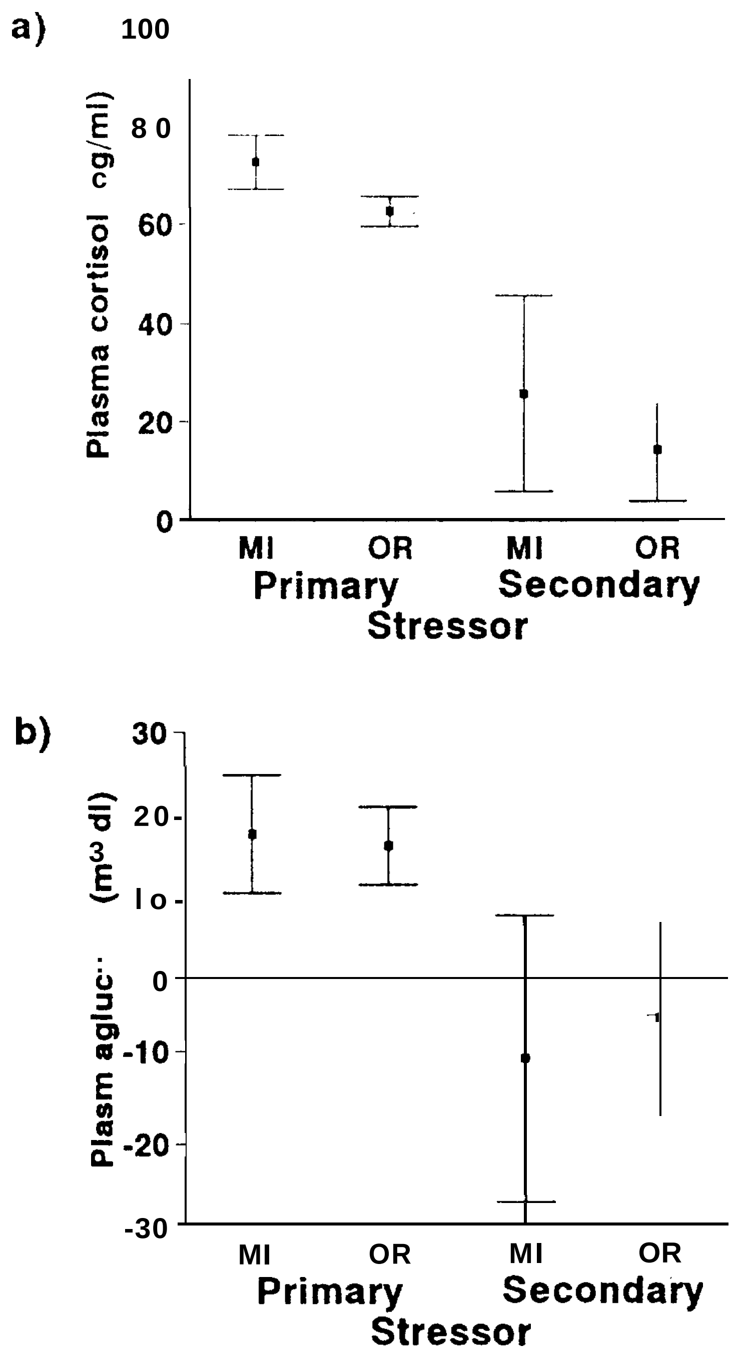


Figure 4. Magnitude of a) mean plasma cortisol and b) mean plasma glucose response (+/- 1SE) for fall chinook salmon reared in Michigan and Oregon system raceways and subjected to a standardized stress in 1993. Primary stressor represents the standardized stressor at the hatchery, while secondary stressor represents the standardized stressor after transport to the river release site. Asterisk indicates a significant difference between systems (t-test, $P \leq 0.05$).

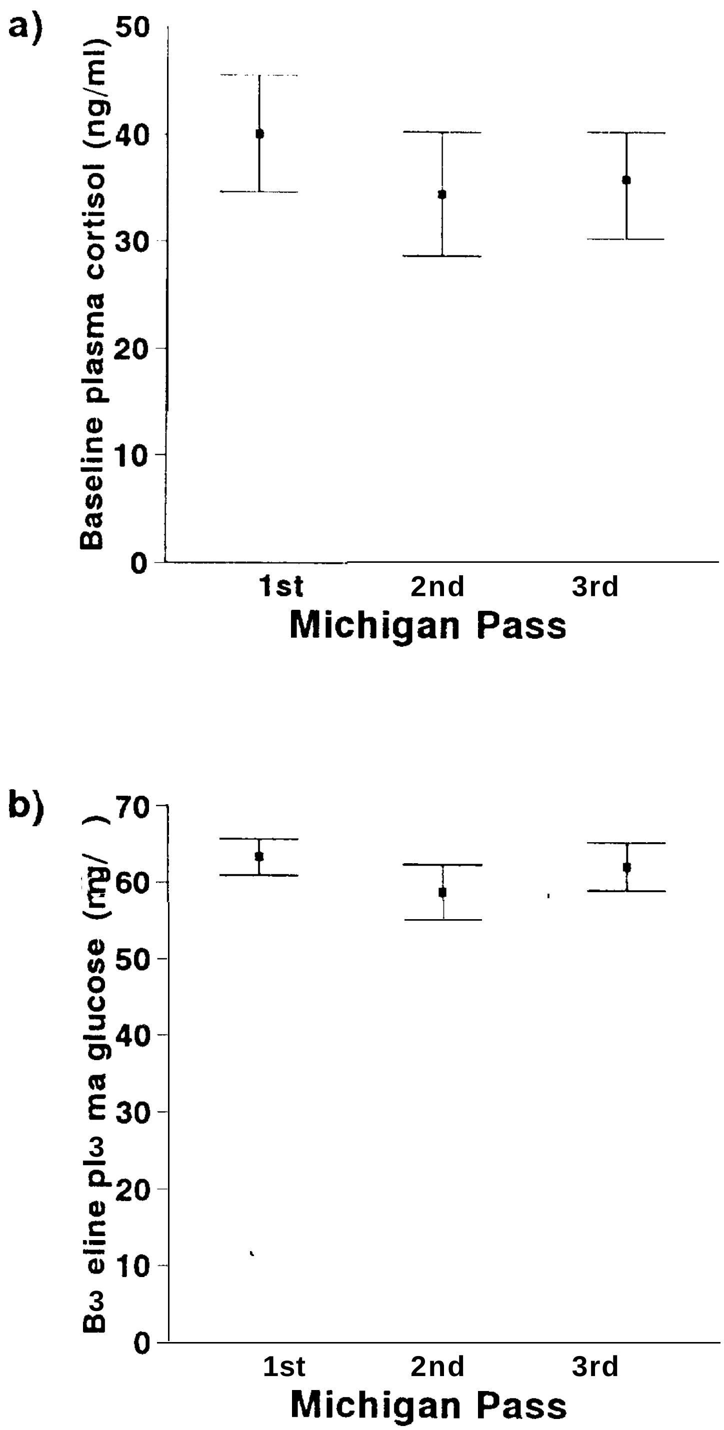
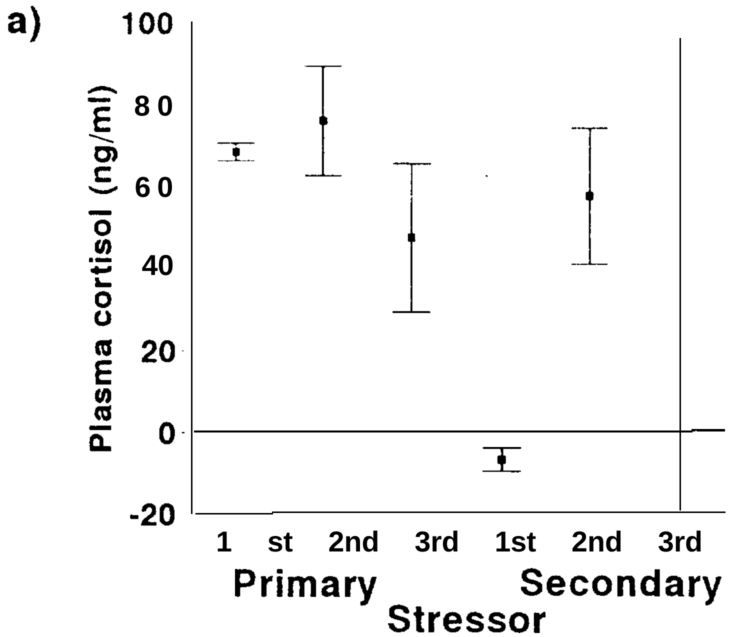


Figure 5. Baseline a) mean plasma cortisol and b) mean plasma glucose levels (+/- 1SE) for fall chinook salmon reared in Michigan 1st, 2nd, and 3rd pass raceways and subjected to a standardized stress, 1993. Different letters indicate a significant difference between passes, while the same letter or absence of letters indicates statistically similar hormone levels (Sidak multiple comparison test, Pt0.05).



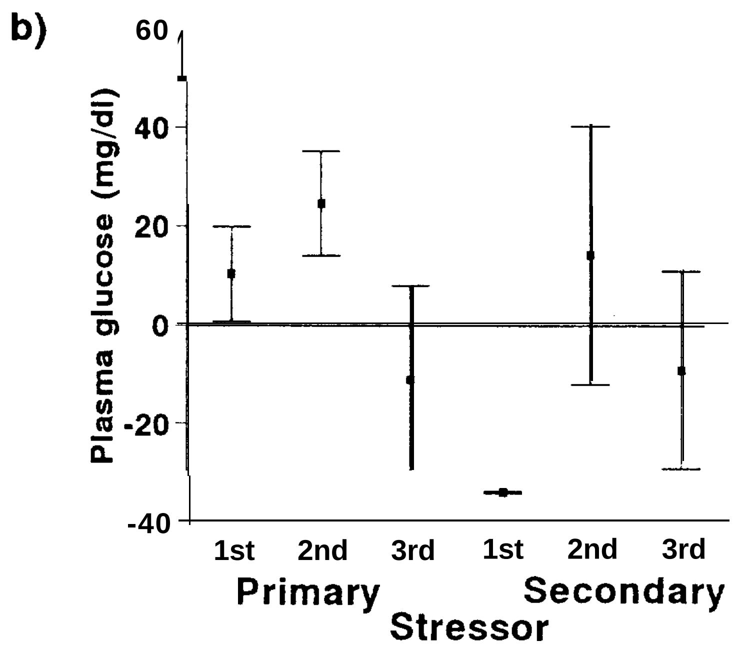


Figure 6. Magnitude of a) mean plasma cortisol and b) mean plasma glucose response (+/- 1SE) for fall chinook salmon reared in Michigan system lst, 2nd, and 3rd pass raceways and subjected to a standard stress, 1993. Primary stressor represents the standardized stressor at the hatchery, while secondary stressor represents the standardized stressor after transport to the river release site. Different letters indicate a significant difference between passes, while the same letter or absence of letters indicates statistically similar hormone levels (Sidak multiple comparison test, $P<0.05$).

Table 12. Brand and coded-wire-tag information for fall chinook salmon marked at Umatilla Hatchery during 1993 (LOC = location of brand, POS = position of brand, RA = right anterior, LA = left anterior, RV = right ventral clip, CWT = coded-wire tag).

System, raceway	Number branded	Brand Size	LOC	Brand	POS	Fin clip	Readable brands	CWT code	Number CWT[a]
Michigan:									
2A	10,631	3/16"	LA	L	3	RV	9,855	076330	28,964
2B	10,605	3/16"	RA	E	4	RV	10,393	070127	27,063
2c	10,023	3/16"	LA		2	RV	9,522	076334	29,958
3A	10,672	3/16"	RA	L	3	RV	10,352	076331	29,537
3B	10,117	3/16"	LA	L	4	RV	10,117	076333	29,718
3C	10,331	3/16"	RA	E	2	RV	9,949	076332	29,451
Oregon:									
2B	10,571	3/16"	LA	L	1	RV	10,465	070126	29,594
3A	10,288	3/16"	LA	L	2	RV	10,288	076329	30,706
	10,555	3/16"					9,837	070125	30,149
3B	10,583	3/16"	RA	L	1	RV	10,583	076335	30,371

Table 13. Survival indices for Umatilla Hatchery fall chinook salmon subyearlings based on brand recoveries at John Day Dam during spring 1992 and 1993. Letters indicate statistical grouping for tests between systems or between passes within systems for each year. Means with the same letter or without letters are not significantly different (Paired binomial test with alpha adjusted to 0.02).

System, Raceway position	Percent Survival Index	
	1992	1993
Michigan[a]	2.8a	6.5a
First Pass	2.3x	6.0x
Second Pass	3.3y	7.0y
Third Pass	3.2y	7.0y
Oregon[a]	1.6b	5.0b
First Pass	0.8t	4.6
Second Pass	2.3u	5.4

[a] *First and second pass raceways combined.*

Branded fall chinook were released on 18 and 19 May in 1992 and 24 and 25 May in 1993. In 1992, the first branded fish were recovered at John Day Dam 25 days after release while in 1993 the first brands were recovered only 10 days after release (Figure 7). Branded fish continued to be captured from some raceways for more than 60 days after release in each year. In 1992, the percent cumulative index reached 50% at 30 days after release for Michigan system fish while Oregon recoveries required approximately 38 days. In 1993, 30 days were required to reach the 50% cumulative index for each system. When we compared the mean number of days required to reach the 50% cumulative index for Oregon and Michigan systems, we found no significant differences in either year.

Smolt-to-Adult Survival: The goal of 30,000 recognizable coded-wire-tagged fall chinook salmon was reached in three of ten raceways and was nearly attained in all other raceways (Table 12). Tag retention ranged from 96.0 to 99.7% for all ten fall chinook raceways.

Spring Chinook Salmon

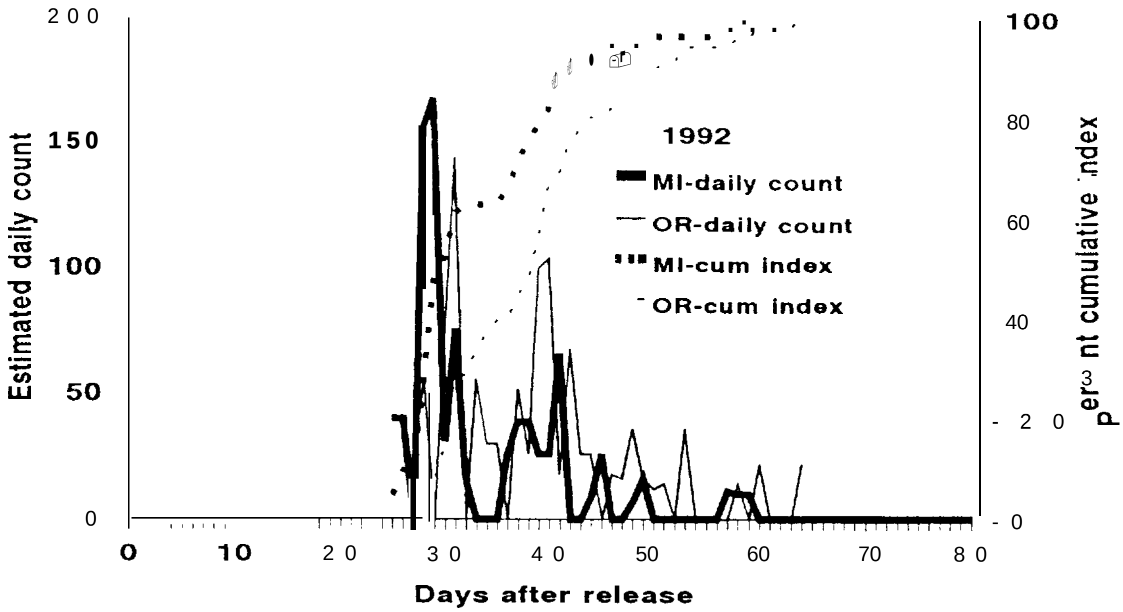
Fall Release:

Rearing Performance: Spring chinook from the 1991 brood raised for fall release were ponded into Oregon raceways in July 1992. Food conversions ranged from 2.61 to 2.64 and averaged 2.62 for the 1991 brood.

Spring chinook from the 1992 brood averaged 84.7 mm (FL) in July. In September salmon from Michigan raceways were significantly longer, heavier, and had higher condition factor than fish from Oregon raceways (Table 14). However, in October, Oregon system fish were significantly longer and heavier but there was no difference between condition factors. From September through October 1993, food conversions averaged 2.09 in the Oregon raceways and 2.51 in Michigan raceways. Final food conversions for 1992 brood will be reported in the 1994 annual report.

smolt Condition: Pre-release data for 1991 brood spring chinook salmon raised in Oregon raceways were obtained in November 1992 (Table 15). There was no significant difference between passes for spring chinook mean lengths, weights, or condition factors. Descaling was examined on approximately 200 fish in each raceway. More than 80% of all fish were identified as having less than 3% descaling and we found no descaled fish. Data for the 1992 brood will be included in the 1994 annual report.

smolt-to-Adult Servival: Approximately 26,000 of the 1991 brood spring chinook were marked Ad+CWT in each raceway in 1992 (Table 16). Tag retention ranged from 98.5% to 98.7%. Of the 1992 brood spring chinook, more than 37,000 fish from each raceway were marked Ad+CWT in August 1993 (Table 15). Tag retention ranged from 93.2% to 99.0%. Final coded-wire tag data will be available in the 1994 annual report.



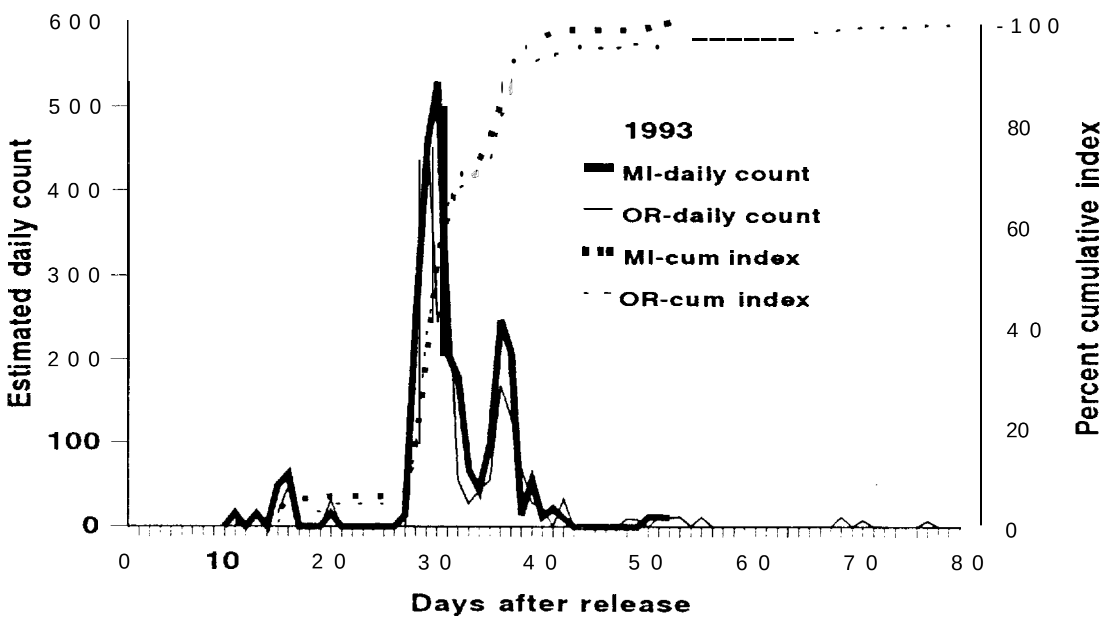


Figure 7. Estimated daily counts and percent cumulative index of branded fall chinook subyearlings recovered at John Day Dam. Salmon were reared in Michigan and Oregon systems at Umatilla Hatchery and were released in the Umatilla River on 18-19 May 1992 at RM 42 and on 24-25 May 1993 at RM 74.

Table 14. Monthly comparisons of mean length, weight, and condition factor for 1992 brood spring chinook salmon reared in Oregon system raceways and released in the fall, 1993. Letters indicate statistical grouping for tests between systems for each time period. Means with the same letter or without letters are not significantly different (Sidak's multiple comparison test, P>0.05).

Date, system	Length(mm) N	Length(mm) Mean(SE)	Length(mm) Group	Weight(g) N	Weight(g) Mean(SE)	Weight(g) Group	Condition Factor N	Condition Factor Mean(SE)	Condition Factor Group
July:									
Oregon	422	84.7(0.21)		251	7.6(0.08)		510	1.26(0.007)	
August:									
Oregon	900	96.0(0.18)		489	11.4(0.09)		489	1.28(0.004)	
September:									
Oregon	454	105.6(0.27)	a	233	15.8(0.18)		233	1.33(0.008)	b
Michigan	420	103.7(0.31)	b	323	15.7(0.18)		323	1.38(0.011)	a
October:									
Oregon	447	117.1(0.36)	a	248	21.4(0.27)	a	248	1.32(0.005)	
Michigan	467	114.0(0.35)	b	218	20.0(0.30)	b	218	1.33(0.005)	

Table 15. Pre-release comparisons of mean length, weight, and condition factor for 1991 brood spring chinook salmon reared in Oregon raceways and released in the fall, 1992. Means without letters are not significantly different (t-test, P>0.05).

System, raceway position	Length(mm) N	Length(mm) Mean(SE)	Weight(g) N	Weight(g) Mean(SE)	Condition Factor N	Condition Factor Mean(SE)
Oregon	610	120.5(0.45)	200	4.4(0.50)	200	1.36(0.008)
1st pass	302	120.2(0.43)	100	24.2(0.52)	100	1.35(0.008)
2nd pass	308	120.8(0.46)	100	24.6(0.49)	100	1.36(0.008)

Table 16. Numbers of recognizably coded-wire-tagged and adipose clipped 1991 and 1992 brood spring chinook that were released in the fall from Umatilla Hatchery.

Brood Year	Raceway	Tag code	Number
1991	03A	071542	25,633
	03B	071543	26,135
1992[a]	02A	070155	37,471
	02B	070157	37,488
	03A	070156	37,495
	03B	070158	37,473
	M2A	070159	37,619
	M2B	070161	37,630
	M2C	070216	37,695
	M3A	070160	37,418
	M3B	070162	37,717
	M3C	070163	37,667

[a] *Numbers actually released wi77 be determined in November 1993.*

Spring Release:

Smolt Migration Performance: Information from 1992 subyearling brand releases was unavailable for the 1992 annual report and is presented here. Survival indices based on brand returns were significantly higher for fish reared in the Michigan system than for Oregon system fish (Table 17). However, brand identification concerns between fall and spring chinook make these results equivocal. Survival indices within Michigan raceways were also significantly different (Table 17). Within the Oregon raceways, the survival index for fish from second pass raceways was significantly greater than for first pass raceways.

Spring chinook were liberated from 11-13 May 1992 and the first recovery date at John Day Dam for the ten raceways ranged from 28 May to 2 June 1992. Passage through the dam was completed for all raceways by 27 June and brand recoveries showed two peaks at 22 days and 33 days from release (Figure 8). Approximately 27 days were required to obtain 50% of the recoveries and nearly 40 days were needed for 90% recovery. Our data showed that the time required for 50% of the total run to reach the John Day Dam was 22.5 days for Oregon system fish and 27.5 days for Michigan fish. These values were significantly different, but, once again, brand identification concerns make these results equivocal.

Smo7t-to-adu7t Adu7t Surviva7: Numbers of spring chinook subyearlings that were branded in 1992 were included in the 1992 annual report.

Table 17. Survival indices for Umatilla Hatchery spring chinook salmon subyearlings based on brand recoveries at John Day Dam during spring 1992. Letters indicate statistical grouping for tests between systems or between passes within systems for each year. Means with the same letter or without letters are not significantly different (Paired binomial test with alpha adjusted to 0.02).

System, Raceway position	Percent Survival Index[a]
Michigan[b]	7.5a
First Pass	9.8x
Second Pass	5.2y
Third Pass	0.4y
Oregon	4.0b
First Pass	2.8b
Second Pass	5.2a

[a] *Recovery rates are based on an adjusted number of readable brands at large because of fish kill that occurred at the Westland Dam trap and haul site.*
[b] *Combined first and second pass raceways.*

Summer Steelhead

Rearing Performance: We monitored, but did not test, means of length, weight, and condition factor for summer steelhead because these fish were graded before ponding (Table 18). The amount of feed needed to raise one pound of summer steelhead at the Umatilla Hatchery was similar between passes (Table 19). The mean food conversions for Michigan raceways were higher than the food conversion ratio for standard raceways at the Irrigon Hatchery. Statistical tests between Oregon and Michigan raceways could not be conducted because replicate data points were not available.

Smolt Condition: Pre-release length, weight, and condition factor data for Umatilla stock summer steelhead at the Umatilla Hatchery and Wallowa stock summer steelhead from the Irrigon Hatchery are presented in Table 18. The mean fork length for fish in all Michigan raceways was greater than 198 mm at pre-release.

When we compared pre-release data for the graded, large steelhead, we found that Umatilla steelhead had significantly greater means for length and weight, while Wallowa stock steelhead had a significantly greater mean condition factor.

Umatilla River summer steelhead descaling evaluations are presented in Table 20. Statistical tests could not be conducted without replicates, but the majority of damage was partial descaling and was higher in second and third pass raceways than in the first pass raceway. The proportion of fish without scale damage ranged from 0.40 to 0.62'in the three raceways.

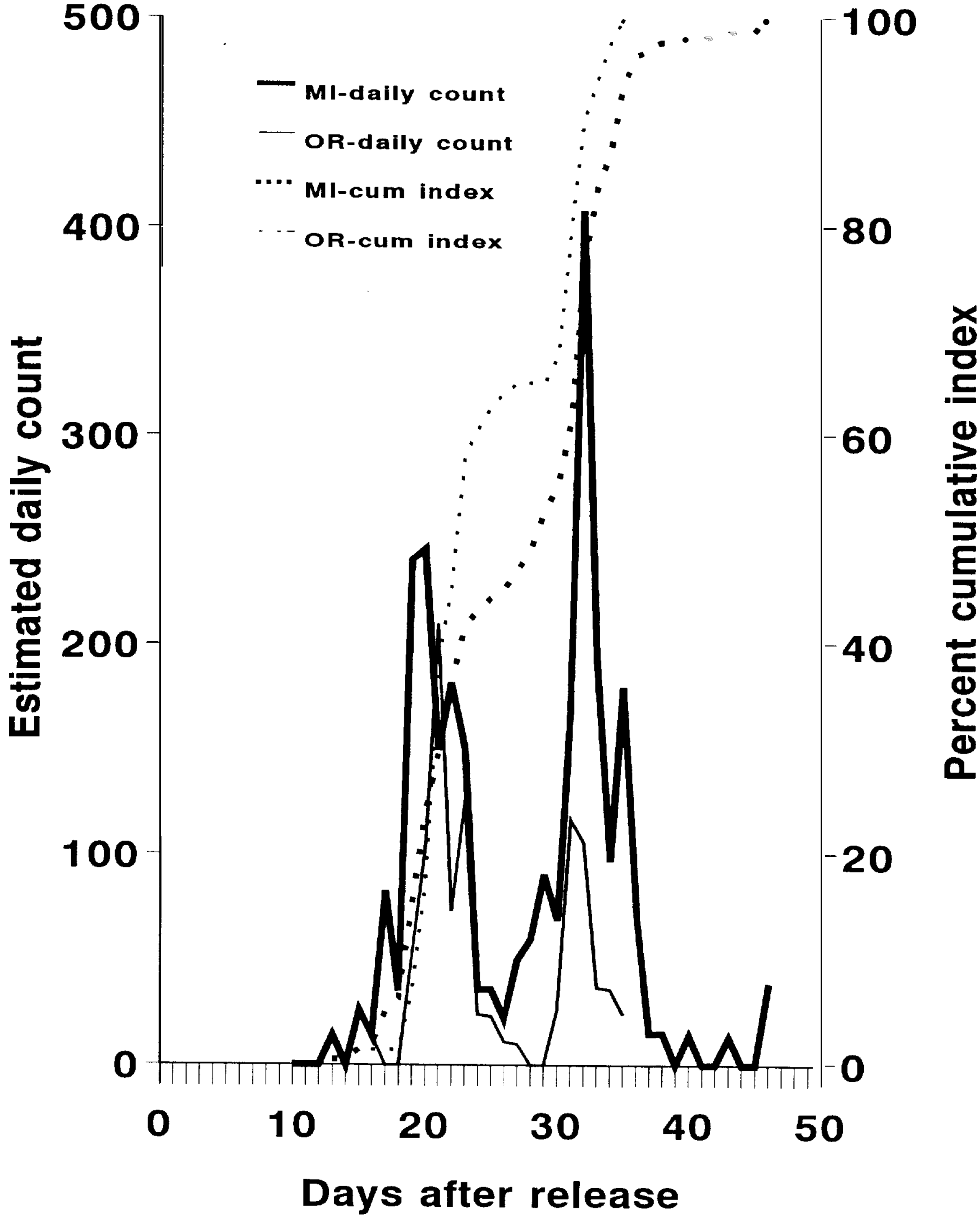


Figure 8. Estimated daily counts and percent cumulative index of branded spring chinook subyearlings recovered at John Day Dam. Salmon were reared in Michigan and Oregon systems at Umatilla Hatchery and were released in the Umatilla River on 11-13 May 1992 at RM 80.

Table 18. Monthly and pre-release comparisons of length, weight, and condition.factor for summer steelhead reared in Michigan system raceways at Umatilla Hatchery and for Wallowa stock summer steelhead reared in standard raceways at Irrigon Hatchery during 1993.

Hatchery, sample, raceway position	Length(mm)		Weight(g)		Condition factor	
	N	Mean(SE)	N	Mean(SE)	N	Mean(SE)
Umatilla:						
January:						
1st Pass	136	112.5(1.61)	50	19.6(1.41)	50	1.13(0.01)
2nd Pass	112	145.8(1.69)	57	35.9(1.55)	57	1.12(0.01)
3rd Pass	113	158.0(1.59)	50	48.4(1.63)	50	1.16(0.01)
February:						
1st Pass	109	135.4(2.13)	52	30.2(1.76)	52	1.13(0.01)
2nd pass	102	167.4(1.96)	75	56.6(2.39)	49	1.12(0.01)
3rd pass	128	173.3(1.52)	50	62.1(2.42)	50	1.14(0.01)
March:						
1st pass	103	135.4(2.65)	103	31.5(1.64)	103	1.14(0.01)
2nd pass	113	177.2(2.26)	56	66.7(3.34)	56	1.13(0.01)
3rd pass	105	194.1(2.08)	50	87.3(4.16)	50	1.11(0.02)
Pre-Release:						
1st pass	298	199.6(1.14)	110	74.8(2.13)	110	0.93(0.006)
2nd pass	308	198.2(1.16)	98	80.9(2.65)	98	1.01(0.007)
3rd pass	324	220.1(0.99)	108	102.4(2.50)	108	0.93(0.013)
Irrigon:						
Pre-Release[a]:						
Acclimation	208	203.8(1.34)	100	91.0(2.17)	100	1.06(0.006)

[a] *Because fish were graded, data presented for Irrigon steelhead are comparable to the data from the third pass raceway at Umatilla Hatchery.*

Table 19. Comparison of food conversion ratios for summer steelhead reared in Michigan (Umatilla Hatchery) and standard (Irrigon Hatchery) system raceways during 1993.

Rearing system, raceway position	N	Mean food conversion ratio (SE) (lb feed/lb fish)
Michigan:	2[a]	1.49 (0.06)
1st Pass	1	1.55
2nd Pass	1	1.43
3rd Pass	1	1.53
Oregon:	1	1.18

[a] *Combined 1st and 2nd pass raceways*

Table 20. Comparison of the proportion of descaled, partially descaled and undamaged (not descaled) summer steelhead reared in first and second and third pass Michigan raceways at Umatilla Hatchery during 1993.

System, raceway position	N	Descaled	Partially descaled	Undamaged
Michigan: 1993				
1st pass	204	0.08	0.30	0.62
2nd pass	200	0.03	0.56	0.41
3rd pass	204	0.02	0.58	0.40

Smolt Migration Performance: Of approximately 10,000 (Table 22) branded summer steelhead released from raceways M5B and M5C into the Umatilla River in April 1993, 191 and 119 were recovered at John Day Dam. This resulted in an expanded daily passage count of 2,764 and 1,723 for ponds M5B and M5C, respectively. Brand recovery rates were estimated at 28.7 and 19.5% for raceways M5B and M5C, respectively. No brand recovery data was available for raceway M5A.

In 1993 only Umatilla stock hatchery steelhead were examined for fin erosion. All fish possessed fins that were at least lightly eroded. However, the amount of severe dorsal and pectoral fin erosion was greatly reduced in the third pass raceway, declining from more than 90% in 1992 to less than 11% in 1993 (Table 21). In the three Michigan raceways, 91.0% to 98.5% of the fish were classified as having caudal fins in good condition.

Table 21. Comparison of the severity of fin erosion among summer steelhead (Umatilla River stock) reared in first and second and third pass Michigan system raceways at Umatilla Hatchery during 1993.

	Percent severity of fin erosion								
	Light			Moderate			Severe		
Fin	1st pass	2nd pass	3rd pass	1st pass	2nd pass	3rd pass	1st pass	2nd pass	3rd pass
1993:									
Dorsal	30.8	41.4	51.2	55.2	51.0	37.9	13.9	7.6	10.8
Caudal	91.0	98.5	94.1	8.5	1.5	5.4	0.5	0.0	0.5
Pectoral	96.0	76.0	93.6	2.1	7.0	4.4	1.5	17.0	2.0

[a] *Light erosion = more than 90% of fin remaining, little or no damage.*
Moderate erosion = fin approximately 50% eroded.
Severe *erosion = less than 25% of fin remaining, almost no fin* rays *visible.*

Table 22. Brand and coded-wire tag information for summer steelhead marked at Umatilla Hatchery during 1993. (POS = position of brand, LOC = location of brand, RA = right anterior, LA = left anterior, LV = left ventral clip, CWT = coded-wire tag.)

System, raceway	Number branded	Size	LOC	Brand	POS	Fin clip	Readable brands	CWT code	Number CWT*
Michigan:									
M5A	10,174	1/4"	LA	B	1	LV	9,055	076052	13,117
								076053	11,410
								076054	9,907
M5B	10,479	1/4"	RA	B	1	LV	9,641	076055	10,031
								076056	9,418
								076057	9,643
M5C	10,427	1/4"	RA	B	3	LV	8,863	076058	10,194
								076059	9,792
								076060	9,440

*Number recognizably coded-wire tagged

Summer steelhead reared in second and third pass raceways were released on 16 and 18 April and first recovered from third pass raceways at John Day Dam on 24 April, six days after release (Figure 9). Fifty percent of the brand recoveries were made by the 20th and 22nd day after release; and after approximately 30 days, 90% of the total brands had been recovered from both ponds. A small number of branded summer steelhead were also collected at Bonneville Dam from 7 May to 15 May.

Smolt-to-Adult Survival: The goal to mark 9 groups of 10,000 summer steelhead in each Michigan raceway was achieved for only four groups (Table 22). We tagged within 94% of the goal for the other five replicate tag codes. Percent tag retention ranged from 94.0% to 99.3%.

Spring Chinook Yearling and Subyearling Production Evaluation

Rearing Performance

Umatilla Subyearlings:

Spring chinook subyearlings from the 1992 brood year were ponded into Oregon raceways in November 1992, and were transferred to Michigan raceways in mid-February 1993 and remained there until release. Mean fork lengths for spring chinook were not significantly different between Michigan passes in February or April, but fish from first pass raceways were longer than fish from second and third pass raceways in March (Table 23). Significant differences were found between passes for mean weight and mean condition factor in each month. Generally, fish in second pass raceways weighed less and were in poorer condition than fish from first and third pass raceways. The mean food conversion ratios of subyearlings were not significantly different between passes of Michigan raceways (Table 24). Food conversion ratios for individual raceways ranged from 1.46 to 1.59.

Umatilla Yearlings:

Yearlings from the 1991 brood raised in Oregon raceways at Umatilla Hatchery showed steady growth from January until pre-release in March 1993 (Table 25). In January, mean weights and mean condition factors between passes were similar, but fish from second pass raceways were significantly longer than fish from first pass raceways. No differences were observed in February. Food conversion ratios ranged from 1.61 to 1.77 and averaged 1.70.

Bonneville Yearlings:

The rearing performance of Bonneville yearlings was not monitored except for food conversion ratios. The overall ratio for yearlings raised at Bonneville Hatchery was 2.04.

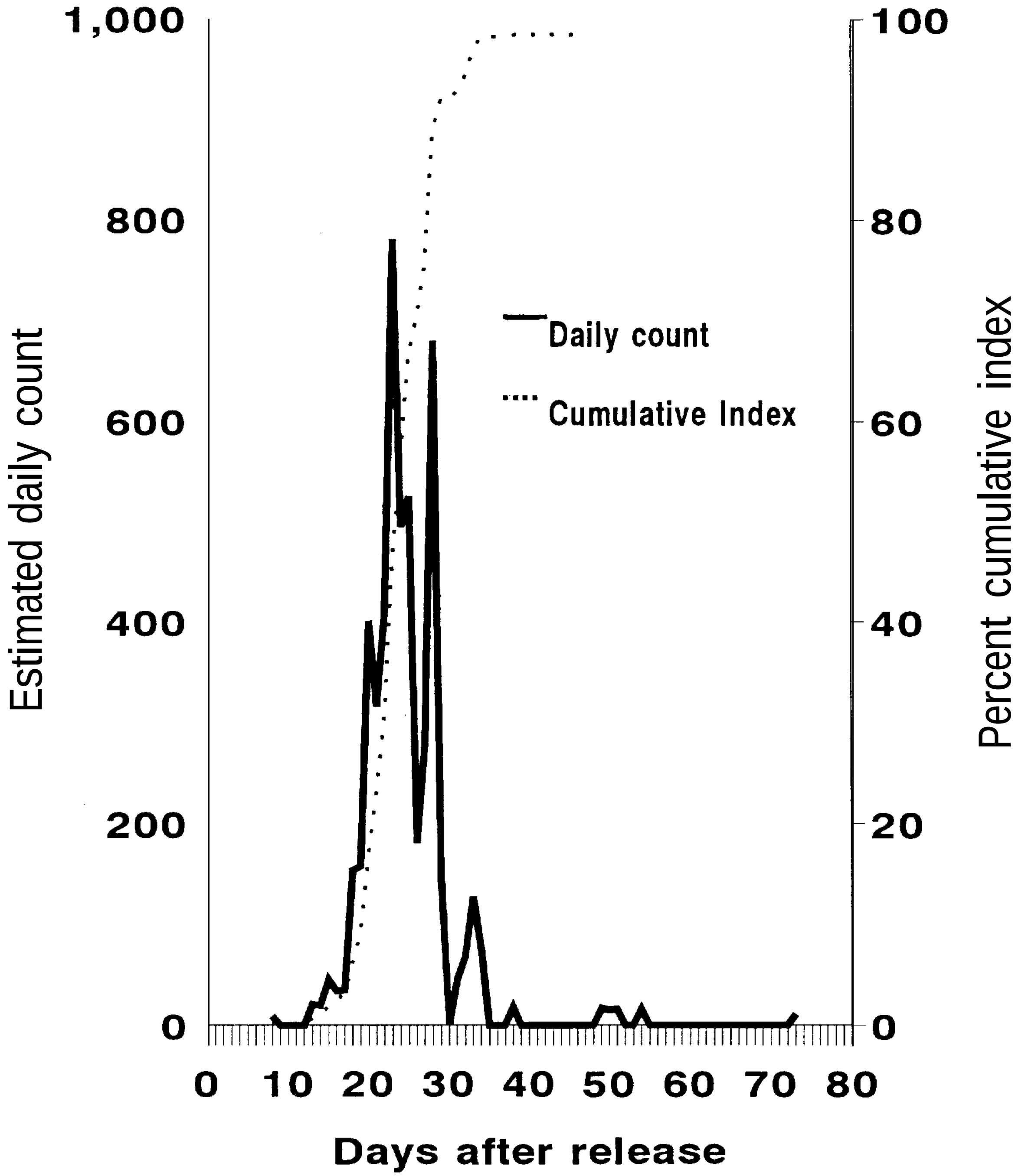


Figure 9. Estimated daily counts and percent cumulative index of branded summer steelhead reared in Michigan raceways, released in the Umatilla River, and recovered at John Day dam during 1993 .

Table 23. Monthly and pre-release comparisons of mean length, weight, and condition factor for spring chinook salmon subyearlings reared in first, second, and third pass Michigan system raceways during 1993. Letters indicate statistical grouping for tests between passes for each time' period. Means with the same letter or without letters are not significantly different (Sidak's multiple comparison test, P>0.05).

Month, raceway position	Length(mm)			Weight(g)			Condition factor		
	N	Mean(SE)	Group	N	Mean(SE)	Group	N	Mean(SE)	Group
February:	321	72.1(0.30)		197	4.4(0.07)		197	1.14(0.006)	
1st Pass	103	73.0(0.53)		74	4.8(0.10)	a	74	1.17(0.011)	a
2nd Pass	115	71.6(0.54)		69	4.2(0.13)	b	74	1.11(0.009)	b
3rd Pass	103	71.7(0.46)		54	4.2(0.11)	b	54	1.14(0.011)	a
March:	699	76.3(0.19)		366	5.6(0.06)		366	1.24(0.006)	
1st Pass	247	77.3(0.30)	a	128	5.7(0.11)	a	128	1.23(0.008)	b
2nd Pass	216	75.9(0.34)	b	123	5.3(0.09)	b	123	1.18(0.008)	c
3rd Pass	236	75.6(0.33)	b	115	5.8(0.11)	a	115	1.31(0.011)	a
April:	655	86.7(0.21)		455	8.1(0.08)		455	1.22(0.005)	
1st Pass	205	86.9(0.39)		117	8.3(0.15)	a	117	1.22(0.009)	ab
2nd Pass	219	86.0(0.36)		159	7.8(0.12)	b	159	1.21(0.009)	b
3rd Pass	231	87.0(0.36)		179	8.3(0.12)	a	179	1.24(0.007)	a
Pre-release:	1865	109.3(0.18)		666	16.3(0.14)		666	1.21(0.003)	
1st Pass	623	109.6(0.32)		202	16.3(0.29)		202	1.20(0.006)	b
2nd Pass	516	109.3(0.31)		219	16.3(0.24)		219	1.22(0.006)	a
3rd Pass	523	109.0(0.29)		245	16.2(0.20)		245	1.22(0.005)	a

Table 24. Comparison of mean food conversion ratios for spring chinook salmon subyearlings reared in Michigan system raceways and spring chinook salmon yearlings reared in Oregon system raceways during 1993. Means with the same letter or without letters are not significantly different (Wilcoxon test or Kruskall-Wallis tests, P>0.05).

Release strategy, rearing system, raceway position	N	Mean food conversion ratio (SE)
Subyearlings		
Michigan	6	1.53 (0.020)
1st Pass	2	1.52 (0.005)
2nd Pass	2	1.48 (0.020)
3rd Pass	2	1.59 (0.010)
Yearlings		
Oregon	4	1.70 (0.030)
1st Pass	2	1.75 (0.010)
2nd Pass	2	1.65 (0.040)

Table 25. Monthly and pre-release comparisons of mean length, weight, and condition factor for 1991 brood spring chinook salmon yearlings reared in Oregon system raceways at Umatilla Hatchery and Bonneville Hatchery during 1993. Letters indicate statistical grouping for tests between passes for each time period. Means of passes without letters or means with the same letter are not significantly different (Sidak multiple comparisons test, P>0.05).

Month, raceway position	Length (mm)			Weight (g)			Condition Factor		
	N	Mean(SE)	Group	N	Mean(SE)	Group	N	Mean(SE)	Group
Umatilla Hatchery									
January:	443	137.9(0.56)		230	36.7(0.62)		230	1.35(0.006)	
1st Pass	233	136.6(0.78)	b	104	35.4(0.90)		104	1.35(0.008)	
2nd Pass	210	139.3(0.78)	a	126	37.7(0.85)		126	1.36(0.008)	
February:	439	154.6(0.78)		215	48.4(1.08)		215	1.25(0.006)	
1st Pass	213	154.2(1.12)		106	49.2(1.42)		106	1.26(0.008)	
2nd Pass	226	154.0(1.08)		109	47.7(1.62)		109	1.25(0.008)	
Pre-release:	1245	158.8(0.00)		407	50.5(0.00)		407	1.20(0.000)	
1st Pass	640	157.6(0.66)	b	200	49.9(1.19)		200	1.20(0.006)	
2nd Pass	606	160.1(0.69)	a	208	51.1(1.13)		208	1.20(0.006)	
Bonneville Hatchery									
Pre-release:	1583	142.2(0.00)		485	38.3(0.00)		485	1.13(0.000)	

Smolt Condition

Subyearlings:

At pre-release, there was no significant difference between passes for mean fork length or mean weight of Umatilla-reared subyearling spring chinook (Table 23). Mean condition factor was significantly greater in third and second pass raceways than in the first pass raceway. Approximately 27% of the spring chinook subyearlings were identified as smolts. The proportion of smolts for all raceways ranged from 0.15 to 0.36 and there was no significant difference in proportions between passes. Most subyearlings were either partially descaled or descaled in 1993 (Table 26). The proportion of partially descaled fish ranged from 0.66 to 0.86 and the proportion of descaled fish ranged from 0.09 to 0.25. Mean proportions of partially descaled or descaled fish were not significantly different between passes.

Table 26. Comparison of the mean proportion of descaled, partially descaled, and undamaged (not-descaled) spring chinook yearlings and subyearlings reared at Umatilla and Bonneville hatcheries (SE in parentheses) during 1993. Means within the Michigan system for subyearlings with the same letter or without letters are not significantly different (Wilcoxon or Kruskall-Wallis test, P>0.05).

Release strategy rearing system, raceway position	N	Descaled	Partially descaled	Undamaged
Umatilla Subyearlings:				
Michigan	4a	0.21 (0.04)	0.74 (0.05)	0.06 (0.02)
1st / 2nd pass	2	0.25 / 0.16 (0.01)	0.69 (0.05)	0.05 (0.05)
3rd pass	2	0.18 (0.06)	0.79 (0.08)	0.06 (0.02)
pass		(0.05)	0.76 (0.07)	0.07 (0.03)
Umatilla Yearlings:				
	4	0.01 (0.08)	0.18 (0.04)	0.81 (0.03)
Bonneville Yearlings:				
	4	0.01 (0.00)	0.65 (0.00)	0.34 (0.00)

[a] *Combined first and second pass raceways.*

Spring chinook salmon subyearlings showed significant increases in ATPase specific activity levels as they approached release (Figure 10). Mean activity levels were lowest on 25 March at 2.9 p-moles P/h/mg protein and highest on 18 May (15 days prior to release) at 8.1 p-moles P/h/mg protein. However, ATPase on 18 May was not significantly different from the ATPase level measured at release. In the ANOVA model, sampling date explained the majority of the variation. Although the model indicated a significant difference among passes within one raceway, there was no overall difference between passes.

Yearlings reared at Umatilla Hatchery weighed 51 g at release and fish from second pass Oregon raceways were significantly longer than fish from first pass raceways (Table 24). No significant differences were found between passes for weight or condition factor. A visual examination of smolt condition showed that 41% of the yearlings were smolts. Nearly all other fish were intermediate smolts, with just a few Parr. Few yearlings were descaled and most fish were undamaged (Table 26).

The ATPase specific activity levels of yearlings were relatively consistent between sampling dates (Figure 11) and although date was a significant factor affecting measurements, no clear pattern emerged. Mean activity levels ranged from a low of 7.3 p-moles P/h/mg on 23 February to a high of 9.5 p-moles P/h/mg on 11 February.

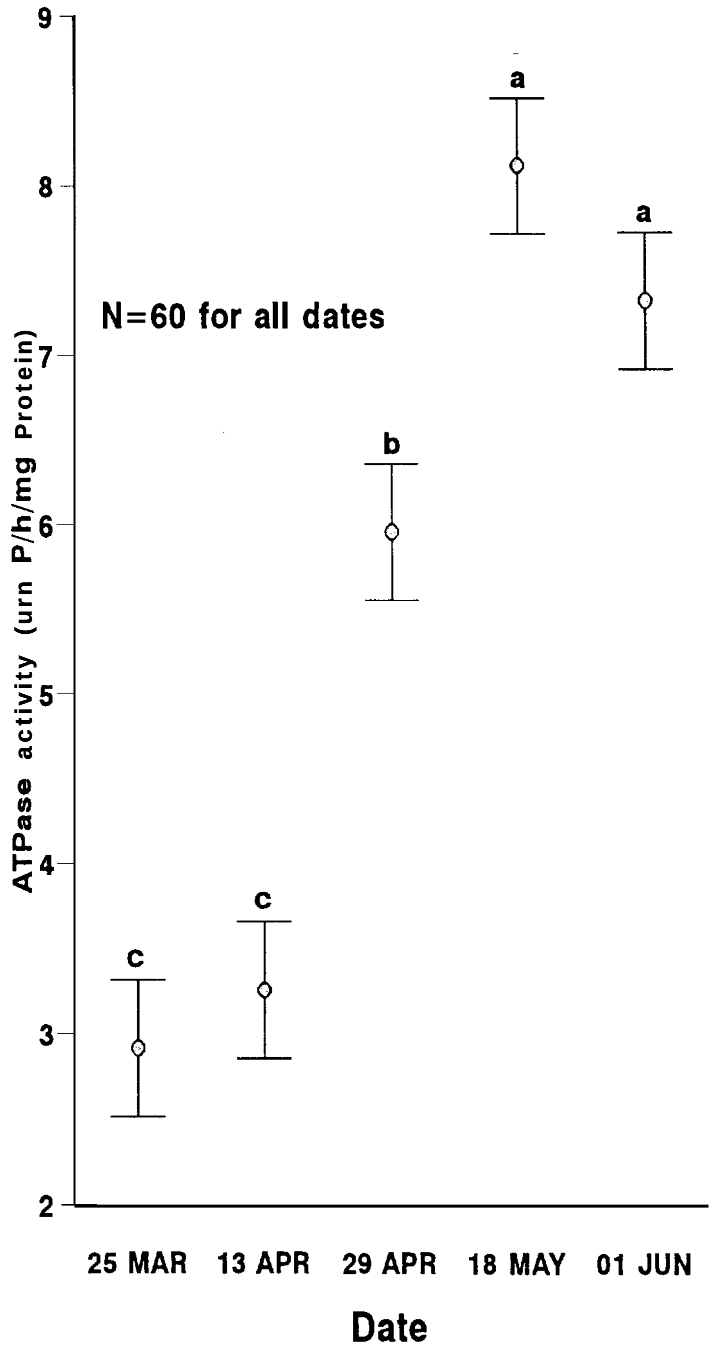


Figure 10. Mean gill ATPase specific activity (μm P/h/mg protein) in spring chinook salmon subyearlings tested Prior to release (April-May) and at release (June) in 1993. Bars = 95% C.I. Means with similar letters are not significantly different (Sidak multiple comparison test P>0.05).

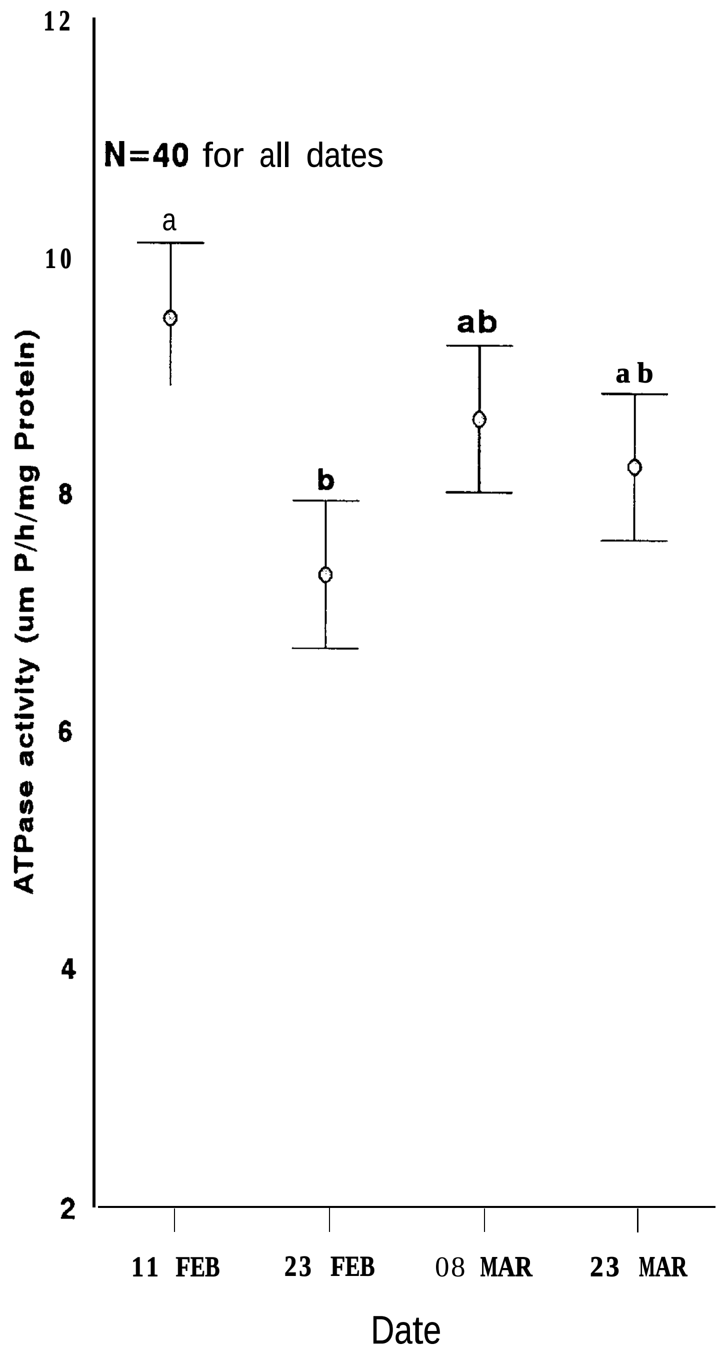


Figure 11. **Mean gill** ATPase **specific activity** (μm P/h/mg **protein) in spring chinook salmon yearlings tested prior to release (Feb-Mar) and at release** (June) **in** 1993. **(Bars = 95%** C.I. **Means with similar letters are not significantly different, Sidak multiple comparison test** P>0.05).

Yearlings produced at Bonneville hatchery were released at 38 g (Table 25). A visual examination of smolt condition showed that 10% of Bonneville yearlings were smolts. Nearly all other fish were intermediate smolts. Most yearlings from Bonneville were partially descaled, but few fish were descaled (Table 26).

Smolt Migration Performance

Approximately 10,000 spring chinook subyearlings were branded from each Michigan raceway in 1993 (Table 27). The numbers of readable brands ranged from 9,160 to 10,408. The overall survival index averaged 2.5% and there was no significant difference between first, second, or third pass Michigan raceways in 1993 (Table 28). Subyearlings were released on l-2 June 1993 and the first branded fish were recorded at John Day Dam on 7 June. Returns peaked 19 days after release (Figure 12). Fifty percent of the brands were recovered after 19 days and 90% of the brands were recovered after 27 days. A few branded fish were also recovered at Bonneville Dam, with the first captured 15 days after release.

We branded approximately 5,000 yearlings from each Oregon raceway at Umatilla Hatchery in 1993 to monitor migration success and rate to John Day Dam (Table 29). A total of 70 branded spring chinook yearlings from four raceways were recovered at John Day Dam and 77 brands from three raceways were recovered at Bonneville Dam. These numbers were expanded to a total daily passage count of 829 at John Day Dam and 234 at Bonneville Dam. Based on a total of 21,085 readable brands, the estimated survival index was 3.9% to John Day Dam and 1.1% to Bonneville dam (Table 28). Testing suggested that the survival index for yearlings from first pass raceways to John Day Dam was significantly greater than for fish from second pass raceways.

Umatilla Hatchery yearlings were released on 24 March 1993 and branded fish were recovered at John Day Dam from 15 to 59 days after release (Figure 13). Fifty percent of the branded fish passed the dam after 39 days and 90% of the run was recovered after 46 days. At Bonneville Dam, smolts were first collected on 9 April and last observed on 11 May. Smolt migration performance of Bonneville yearlings was not monitored.

Table 27. Brand and coded-wire tag information for spring chinook salmon subyearlings marked at Umatilla Hatchery during 1993. (POS = position of brand, LOC = location of brand, RA = right anterior, LA = left anterior, RV = right ventral clip, CWT = coded-wire tag.)

System, raceway	Number branded	Size	LOC	Brand	POS	Fin clip	Readable brands	CWT code	Number[a] CWT
Michigan			LA						
6A	10,247	3/16"	RA	5	1	RV	9,161	076136	53,289
6B	10,344	3/16"		5	4	RV	9,982	076135	53,101
6C	10,362	3/16"	RA	5	2	RV	10,051	076132	53,266
7A	10,099	3/16"	RA	5	1	RV	9,160	076137	53,405
7B / 7C	10,2[illegible] / 10,408	3/16"	LA	5	4	RV	10,167	076134	52,613
					2	RV	10,408	076133	53,032

[a] *Number recognizably tagged and released.*

Table 28. Survival indices for Umatilla Hatchery spring chinook salmon subyearlings and yearlings reared in Michigan and Oregon system raceways based on brand recoveries at John Day Dam during spring 1993. Letters indicate statistical grouping for tests between passes within systems. Means with the same letter or without letters are not significantly different (Paired binomial test with alpha adjusted to 0.02).

Age Class, system, raceway position	Survival Index
Subyearlings	
Michigan	2.5
First Pass	2.2b
Second Pass	1.8b
Third Pass	3.6a
Yearlings	
Oregon	3.9
First Pass	4.0a
Second Pass	3.8b

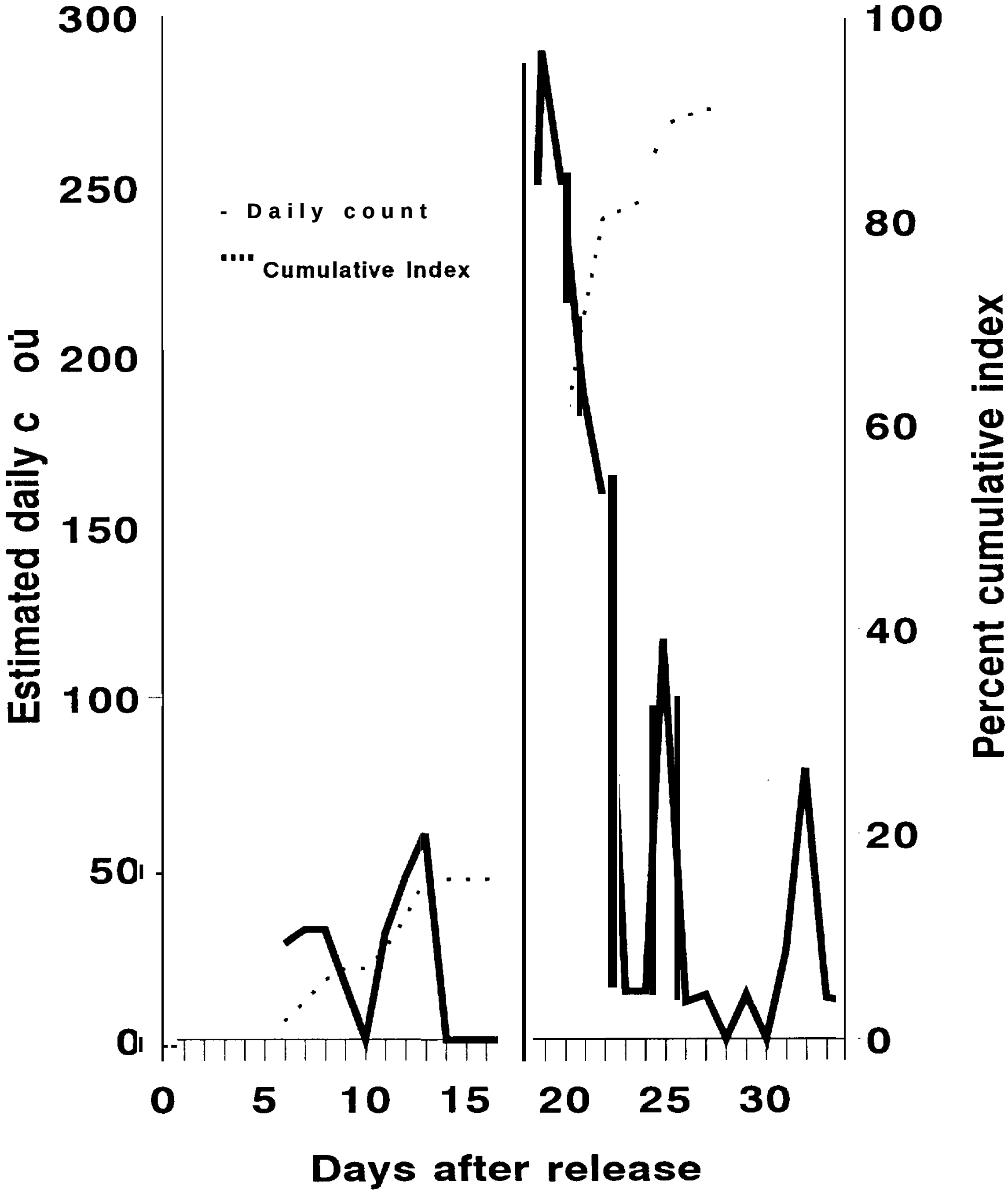


Figure 12. Estimated daily counts and percent cumulative index of branded spring chinook subyearlings reared in Michigan system raceways, released in the Umatilla River (2 June, RM 74) and recovered at John Day Dam during 1993.

Table 29. Brand information for 1991 brood spring chinook salmon yearlings (spring release) marked at Umatilla Hatchery during 1993. (POS = position of brand, LOC = location of brand, RA = right anterior, LA = left anterior, RV = right ventral clip.)

System, raceway	Number branded	Size	LOC	Brand	POS	Fin clip	Readable brands
Oregon							
4A 4B	5,630 5,232	1/4"	RA	B	3	RV	5,574
5A	5,320	1/4"	LA	B	1	RV	4,871
		1/4"	LA	B	3	RV	5,272
5B	5,417	1/4"	RA	B	1	RV	5,368

Smolt-to-Adult Survival

Replicate groups of more than 50,000 subyearlings were marked Ad t CWT from each of six Michigan raceways in 1993 (Table 27). Tag retention for the six raceways ranged from 97.3% to 99.3%. Replicate groups of approximately 20,000 yearlings were coded-wire tagged from four raceways at Umatilla Hatchery (Table 30). Tag retention ranged from 96.9% to 99.7%. Approximately 20,000 fall release yearlings were tagged in each of two raceways at Bonneville Hatchery (Table 30). Tag retention ranged from 92.5% to 94.9%.

Table 30. Numbers of recognizably coded-wire-tagged and adipose clipped 1991 brood year spring chinook yearlings marked at Umatilla and Bonneville hatcheries and released in the Umatilla River during 1993.

Hatchery	Raceway	Tag code	Number[a]
Umatilla			
	04A	075741	21,157
	04B	075740	20,880
	05A	075742	20,307
	05B	075739	21,499
Bonneville			
	B1	071455	20,035
	B2	071456	20,107

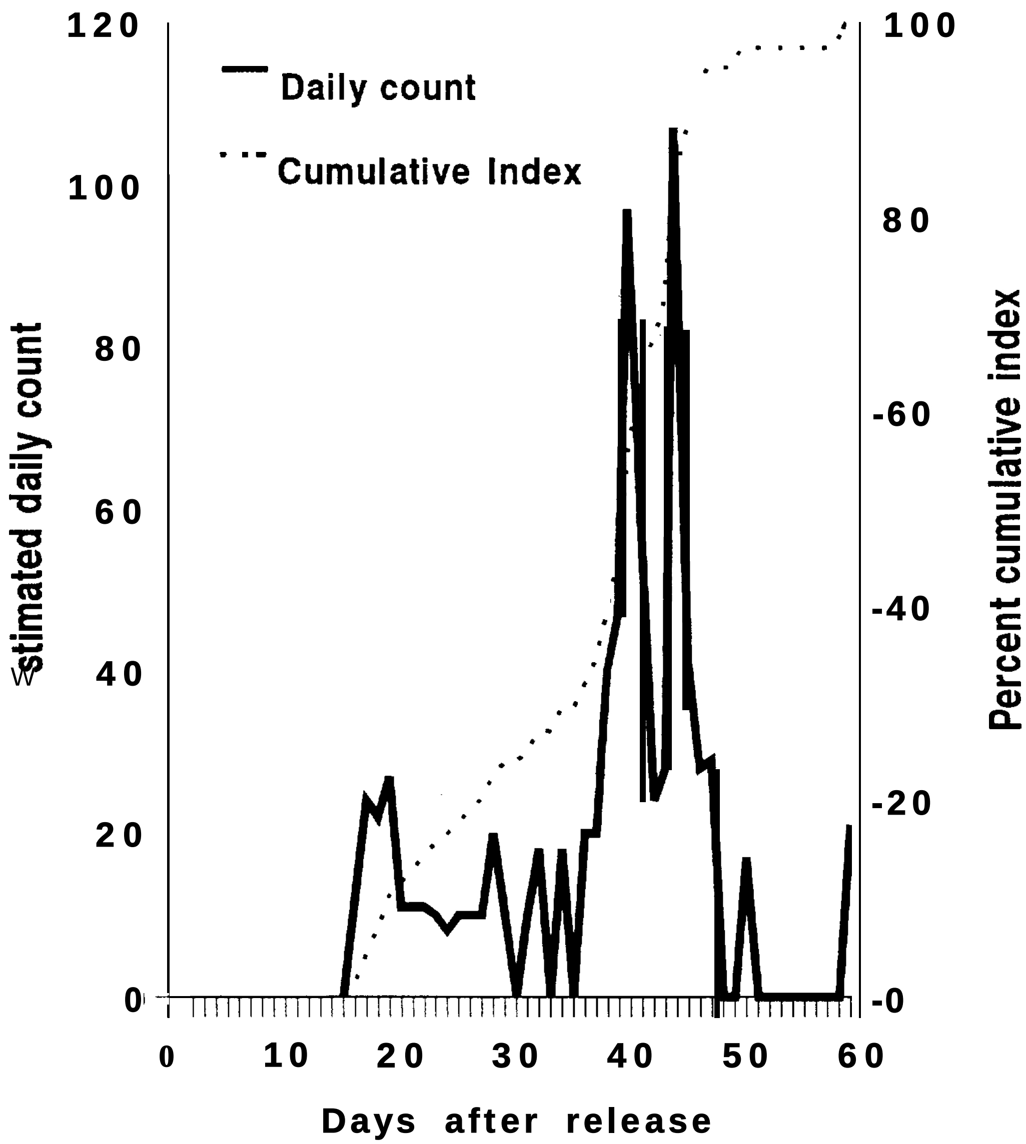


Figure 13. Estimated daily counts and percent cumulative index of branded spring chinook yearlings reared in Oregon raceways, released in the Umatilla River (24 Mar, RM 80) and recovered at John Day Dam during 1993.

Bonneville Hatchery Salmon Evaluation

Numbers of fall chinook yearling smolts and fall release spring chinook marked Ad t CWT is presented in Table 31. Tag retention ranged from 93.4 to 96.3% for fall chinook and 97.7% to 100.0% for fall release spring chinook.

Effects of Marking on Subyearling Fall Chinook Salmon

A summary of completed body tagging and fin marking to evaluate the effects of tagging and marking is presented in Table 32. Tag retention for body-tagged groups ranged from 93.5% to 100.0% and averaged 96.3%. Tag retention for groups marked ADtCWT were 97.5% and 99.3%. An evaluation of fin clip quality to ensure clipped fish would be recognizable when they returned as adults showed varying results. Clipping quality improved during the year; the number of poor fin clips averaged 15% in Michigan raceways and 4% in Oregon raceways. Future adult fall chinook returns will be analyzed to determine the influence of different tag and marking techniques on survival to adulthood.

Creel Survey

Catch statistics for 1992-93 creel surveys are reported in Tables 33 to 35. We estimated that anglers fished 2,210 hours and caught 148 chinook and 132 coho, and harvested 41 and 105 fish, respectively for the 1992 fall chinook/coho salmon creel season on the Umatilla River from Highway 730 to Stanfield Dam (Table 33). We conducted a creel survey throughout the entire summer steelhead season from 1 October 1992 to 31 March 1993. We estimated that anglers fished 5,293 hours and harvested 37 of the 177 steelhead that were caught (Table 34). In 1993 the Umatilla River was reopened for spring chinook fishing for the first time since 1991. We estimated that anglers fished a total of 1,529 hours on the Umatilla and harvested 18 fish (Table 35). The majority of anglers on the Umatilla River were residents of Umatilla and Morrow counties (Table 36). Coded-wire tag recovery information can be found in Table 37.

Planning and Coordination

The research monitoring and evaluation team has participated in planning and coordination activities for the Umatilla Basin. We have assisted the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) in determining sacrifice rates of AdtCWT fish for research needs and in determining data and methods needed to make adult predictions. We have participated extensively in hatchery production planning. We provided personnel to work cooperatively with hatchery personnel and CTUIR teams to collect data from returning adults at Three Mile Falls Dam and during spawning. We assisted CTUIR in conducting spring chinook spawning ground surveys.

Table 31. Numbers of recognizably coded-wire-tagged and adipose clipped fall chinook yearlings and fall release spring chinook marked at Bonneville Hatchery and released in the Umatilla River during 1992 and 1993.

Race	Raceway(s)	Tag code	Number
Fall Chinook	A5	071461	22,239
	A6	071460	23,863
Fall Release Spring Chinook	A8	076047	17,269
	A8 & A9	076046	24,221
	A9	076045	24,638
	A10	076044	15,433
	A10 & All	076043	24,992
	All	076042	25,104

Table 32. Numbers of fall chinook salmon fin clipped and recognizably marked with coded-wire-tags or body-tags at Irrigon and Umatilla hatcheries to study the effects of tagging and marking from 1991 to 1993.

Mark	Irrigon Hatchery 1991	Umatilla Hatchery 1992	Umatilla Hatchery 1993
Left ventral		69,816	61,801[a] 66,204[a]
Body tag & left ventral		65,749 67,144	68,644 70,442
Body tag	147,586	70,435 65,184	69,225 69,518
Adipose & coded-wire tag	104,258		
Adipose & coded-wire tag & right ventral	103,980	31,982 32,287	29,594 29,360
Adipose & coded-wire tag & body tag	145,048		

[a] *Adjusted for fin clip quality*

Table 33. Estimated catch for fall chinook salmon and coho salmon in the lower Umatilla River from Hwy 730 to Three Mile Falls Dam for the 1992 fall chinook/coho season. Total catch and number harvested includes f95% confidence intervals. Steelhead could not be harvested during this fishery.

Month, day type	Number samoled days	Number samoled anglers	Hours fished	Fall Chinook Salmon Number caught	Fall Chinook Salmon Number harvested	Fall Chinook Salmon Catch rate fish/h	Coho Salmon Number caught	Coho Salmon Number harvested	Coho Salmon Catch rate fish/h
October									
Weekday	9	85	567	5+ 6	5± 6	0.03	34±25	21±16	0.02
Weekend	9	182	455	5±10	4±10	0.10	33± 5	29± 4	0.07
Total	18	267	1022	10±12	9±12	0.08	67±26	50±16	0.06
November									
Weekday	6	88	663	79±65	24±25	0.07	45±31	38±24	0.02
Weekend	11	207	525	59±19	8± 6	0.17	21± 1	17±10	0.04
Total	17	295	1188	138±68	32±26	0.14	65±33	55±26	0.03
Grand Total	35	562	2210	148±68	41±28	0.12	132±41	105±31	0.04

Table 34. Estimated catch for summer steelhead on the lower and upper Umatilla River for the period October 1 1992 to March 31 1993. Lower River = Highway 730 to Three Mile Falls Dam. Upper River = Stanfield Dam to the lower CTUIR boundary.

Month, day type	Number sampled days	Number sampled anglers	Hours fished	Number caught	Number harvested	Catch rate fish/h
			Lower River			
December						
Weekday	9	64	569	19	8	0.03
Weekend	8	66	346	0	0	0.00
Total	17	130	915	19	8	0.02
January						
Weekday	8	5	127	0	0	0.00
Weekend	13	40	171	9	2	0.05
Total	21	45	298	9	2	0.03
February						
Weekday	7	31	625	96	0	0.15
Weekend	9	58	411	25	6	0.06
Total	16	89	1036	122	6	0.11
March						
Weekday	9	0	49	0	0	0.00
Weekend	7	16	79	0	0	0.00
Total	16	16	128	0	0	0.00
Grand Total	70	280	2376	150	15	0.05
			Upper River			
December						
Weekday	9	37	408	22	22	0.05
Weekend	8	44	253	3	0	0.01
Total	17	81	662	25	22	0.03
January						
Weekday	5	1	62	0	0	0.00
Weekend	8	21	197	0	0	0.00
Total	13	22	259	0	0	0.00
February						
Weekday	7	28	611	0	0	0.00
Weekend	9	115	1173	2	0	0.001
Total	16	143	1784	2	0	0.00
March						
Weekday	9	4	110	0	0	0.00
Weekend	7	13	102	0	0	0.00
Total	16	17	213	0	0	0.00
Grand Total	62	263	2917	27	22	0.01

Table 35. Estimated catch for spring chinook salmon in the Umatilla River from Yoakum Bridge to the lower CTUIR boundary (Section 1) and from the upper CTUIR boundary at Ryan Creek to the Umatilla Forks (Section 2) from May 29 to June 13 1993.

Section day type	Number sampled days	Number sampled anglers	Hours fished	Number caught	Number harvested	Catch rate fish/h
Section 1						
Weekday	5	6	98	0	0	0.00
Weekend	7	33	220	0	0	0.00
Total	12	39	317	0	0	0.00
Section 2						
Weekday	7	52	608	4	4	0.01
Weekend	12	93	603	14	14	0.02
Total		145	1211	18	18	0.02
Grand Total	12	184	1528	18	18	0.02

Table 36. Summary of angler's residence for the 1992 fall chinook and coho salmon season, 1992-93 summer steelhead season and 1993 spring chinook salmon season on the Umatilla River.

Species	River section	Anglers interviewed	Angler residence (%) Umatilla and Morrow Counties	Other Oregon counties	out of state
coho/ fall chinook	Umatilla	566	94.9	3.0	2.1
summer steelhead	Lower Umatilla	280	93.6	5.7	0.7
summer steelhead	Upper Umatilla	263	87.1	12.2	0.8
spring chinook	Lower Umatilla	43	91.0	9.0	0.0
spring chinook	Upper Umatilla	148	98.6	0.7	0.7

Table 37. Summary of recoveries of coded-wire-tagged fall chinook salmon, summer steelhead, and spring chinook salmon from creel surveys on the Umatilla River for the 1992-93 creel survey season.

Fishery	Tag code	Number recovered Observed	Expanded
fall chinook	075325	1	2
	075621	1	2
summer steelhead	075217	1	1
	075342	2	5
	075345	1	3
spring chinook	075114	2	5
	075107	1	3
	635661	1	3

DISCUSSION

Fish Cultural Practices

Water shortages continued to be a problem during 1992-1993 at Umatilla Hatchery and prevented hatchery production from reaching some production plan goals for fall chinook salmon. Only 2.7 million fall chinook salmon subyearlings were released compared to a goal of 5.9 million. The production goal for spring chinook subyearlings was 720K in 1993; however, we released only 667K smolts. The release of 209K spring chinook yearlings was very near the goal of 210K and fall released spring chinook exceeded the goal of 492K. Incorporation of a fall release, spring chinook program has increased total spring chinook production to 1.5M, a level that exceeds original production goals by approximately 400,000 smolts. The summer steelhead goal was reduced in 1993 to 150K and this goal was met with approximately 158K smolts released into the Umatilla River.

Overall, egg-to-smolt survival rates at Umatilla Hatchery were better than expected and 1992 values. Fall chinook egg-to-smolt subyearling survival rates exceeded 94%, well above the predicted survival rate of 64%. Spring chinook yearling egg-to-smolt survival rates also exceeded 93% and subyearling rates were 69% compared to a predicted survival rate of 56%. Survival rates for subyearlings might have been higher except for an outbreak of bacterial kidney disease. The egg-to-smolt survival rate for summer steelhead was 10% lower than the predicted rate of 53%.

Although hatchery survival was high, growth of fish raised at Umatilla Hatchery was poorer than originally anticipated. Fall chinook released in 1993 at 61 fish/lb were near the target size of 60 fish/lb, and were larger than fish released in 1992. The larger release size was related to flow conditions in the Umatilla River, which enabled us to delay release until late May. However, flows in the Umatilla Basin are variable and this option may not be available in the future. As stated in the 1992 report, stress created by tagging and handling may limit our ability to meet size goals. Some handling problems were reduced in 1993 by altering the branding schedule so that all branding was completed in one week. In addition, the body tagging program will be eliminated in 1994, further reducing handling in the Oregon raceways.

Overall, spring chinook growth was less than expected at Umatilla Hatchery. Fall release spring chinook salmon from the 1991 brood were liberated at approximately 18 fish/lb in November 1992, below the release goal of 12 fish/lb. Spring chinook subyearlings and yearlings from Umatilla Hatchery and yearlings from Bonneville Hatchery were released in spring 1993 as part of the yearling and subyearling production evaluation. Subyearlings from Umatilla Hatchery were liberated at 28 fish/lb and although they were larger than smolts released in 1992, they were still under the size-at-release target of 20 fish/lb. It is likely that the presence of BKD in the raceways slowed fish growth. The decrease in size-at-release of spring chinook may result in decreased smolt-to-adult survival and adult returns as compared with the original targets used in the Umatilla Hatchery Master Plan (CTUIR and ODFW 1990).

The size-at-release of spring chinook yearlings from Umatilla Hatchery was 8-9 fish/lb compared to a goal of 5 fish/lb while fish from Bonneville .were released at 11.6 fish/lb, below the goal of 10 fish/lb. However, the size-at-release goal at Umatilla Hatchery was only a theoretical goal based on expected growth given Umatilla Hatchery water temperatures. The actual size at release this year was comparable to other yearling spring chinook salmon programs, including the Bonneville program, and is preferable for the evaluation.

Because summer steelhead were graded, size-at-release was variable among raceways in 1993. Only fish in the third pass raceway met the size-at-release goal of 5 fish/lb. In comparison, even though releases were earlier in 1992, fish from first and second pass raceways reached the 5 fish/lb goal. Several factors may have affected fish growth in 1993. First, the steelhead in the first pass raceway included gradeouts and were initially ponded at a smaller size than comparable first pass fish in 1992. In addition, weather conditions in 1993 were much cooler than in 1992 and may have reduced growth while fish inhabited the acclimation raceways at Minthorn and Bonifer Springs. Poor food conversion may also prevent summer steelhead from reaching release weight goals. Fish reared in Michigan raceways were less efficient than fish reared in standard systems.

Water Quality Monitoring

The water quality at the Umatilla Hatchery was similar for salmon and steelhead raised in Oregon or Michigan raceways. During the report period, oxygen levels never dropped below 6.5 ppm as occurred during 1992. Maximum levels of dissolved oxygen in oxygen supplemented raceways were below levels that cause damage.because of chronic exposure (Colt et al. 1991). We observed some differences in oxygen levels and nitrogen gas pressure and total gas pressure between systems for fall chinook salmon, but these differences were either expected due to oxygen supplementation in Michigan raceways or not great enough to affect fish performance measures. Alkalinity remained high in all raceways in 1992-1993, and the buffering capacity kept pH levels within the recommended ranges (6.0-9-0; Colt 1991). We did not monitor water quality at the Irrigon or Bonneville hatcheries; therefore, we could not make comparisons between fish raised at Umatilla Hatchery and fish raised at other hatcheries.

Rearing Performance and Survival Studies

Overall, data from 1993 suggests that Michigan raceways provide a similar rearing environment and result in similar hatchery smolt production as rearing in standard Oregon raceways. Although some system differences were evident from the monthly monitoring of size and condition factor, these differences were usually not evident by pre-release. Results of the growth estimates and the smolt condition evaluation were also similar between systems. Results of the fall chinook stress challenge tests and smolt migration pattern evaluation also failed to demonstrate any significant differences between systems. Furthermore, the results of size, condition factor, growth, and smolt migration of fish in different rearing systems were consistent with those for fall and spring chinook salmon in 1992.

There were some clear differences evident between systems. However, the direction of these differences varied with the parameter measured. Food conversion was worse for Michigan reared fall chinook salmon, fall release spring chinook salmon, and summer steelhead when compared with control groups reared in Oregon ponds. When 1992 data are included, four out of five rearing groups evaluated showed Michigan reared fish to be less efficient at converting food to growth than Oregon reared fish. In addition, basal levels of cortisol were elevated in Michigan reared fall chinook salmon in both 1992 and 1993 suggesting that these fish may be experiencing increased stress compared to Oregon reared controls. On the other hand, migration data from both 1992 and 1993 releases indicate that survival to John Day Dam was greater for Michigan reared fish. These different measures of smolt performance give conflicting messages about the comparative quality of smolts reared in Michigan and Oregon systems. Given current data, we think that this variability among performance parameters indicates that the differences seen are not demonstrative of different rearing systems, but more likely reflect random variability. This idea is further supported by interannual variation evident when examining individual parameters and species. As data from future release years becomes available, consistent differences between rearing systems, if they exist, should be elucidated.

Within System Evaluation

Overall, fish rearing and performance parameters were uniform between passes of both Michigan and Oregon rearing systems. However, there were differences among passes with respect to fish size and survival to John Day Dam. There was a clear tendency for fish to be larger and heavier in lower pass raceways. We are uncertain whether the size differences seen are sufficient to affect post-release survival. Within the Oregon system, densities are lower in second pass raceways. Thus, we might anticipate that these larger, less dense fish reared in second pass raceways would survive better than fish in first pass raceways. Both in 1992 and 1993 there were significant differences in survival to John Day Dam for fish reared among different passes. However, whether fish in lower or upper passes had greater survival varied between years and among species. We will look to data from future releases to determine if these differences among passes are consistent and biologically significant.

Effects of Harking on Subyearling Fall Chinook Salmon

The evaluation of marking on subyearling fall chinook salmon was implemented to evaluate the potential of body tags and ventral fin clips as a mass mark for production purposes. Adult return and smolt-to-adult survival data is still unavailable to assess the impacts of various marks on survival. However, an evaluation of marking efficiency clearly demonstrates that the time and cost required is prohibitive for using body tags as a production mark. Based on current data, the additional handling time required and costs associated with body tagging are six to nine times greater than the time and cost of fin clipping alone. In addition, the inaccuracy of detecting body tags in returning adult chinook salmon is substantially greater than we expected. We estimate that only 70 - 90% of body tagged fish returning will be properly identified due to differential tag placement within the musculature of the fish, low sensitivity of the wand detector, and difficulty in passing an adult chinook through the field detector.

Although body tags may provide a more reliable means of identification than fin clips, information from other fin clipping operations indicates that clip quality can be improved by delaying fin clipping until the average fish size is greater than 55 mm. We recommend eliminating the body tag program until cost or time reductions can be made. Future returns from the current marking program will provide information on the feasibility of using body tags or coded-wire tags should the costs be reduced.

Creel Survey

This was the first year of creel census for the jack fall chinook and coho salmon season. The number of fall chinook salmon jacks passed above Three Mile Falls Dam in 1992 was 64 fish and the estimated number harvested below the dam was 36 fish. This harvest represents 36% of the jack run. As an overall contribution to the sport fishery on the Umatilla River, the fall chinook-coho fishery provided 1,105 hours fished per month, in comparison to the summer steelhead season which provided 1,323 hours fished per month.

The 1992-93 steelhead fishing season may not have been representative of normal fishing seasons due to river conditions such as flooding and freezing. The number of steelhead returns during the 1992-93 fishery were so few that we changed to a catch and release of wild fish on March 1 1993. However, summer steelhead counts at Three Mile Falls Dam were similar to previous years with the majority of the run passing in April after the season had been closed. Historically, the counts of steelhead at Three Mile Dam, for the past 27 years, averaged 2,083 and the sport harvest from punch card estimates averaged 485 fish. Data from the 1993 punch card estimates for the steelhead season 'are not yet available. However, the 1992 December catch estimate of 67 fish is lower than the 27 year average catch of 90 fish. Comparing the 1992-93 catch rates between the lower Umatilla River and the lower Grande Ronde River (Flesher 1991), summer steelhead fisheries show similar rates at 29.5 and 18.7 hours per fish, respectively. However, the catch rate on the upper Umatilla

River was much lower at 158.8 hours per fish.

The spring chinook salmon fishing season was reopened in 1993 for the first time since 1991. In 1993, the spring chinook harvest decreased 30% from the average in previous years and the hours fished dropped 25% from the average for 1991 and 1990. The spring chinook runs at Three Mile Falls Dam for the years 1989-1992 ranged from 163 to 2,190. The 1993 counts fell within that range at 1,214 fish.

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FISH HEALTH MONITORING AND EVALUATION

INTRODUCTION

Fish health operations proceeded as scheduled in the project work statement. In the second year this included preliberation examinations at Bonneville Hatchery and the increased use of enzyme-linked immunosorbent assay (ELISA) technology for evaluating ***Renibacterium salmoninarum*** **(Rs) levels in fish.**

Feeding of erythromycin to juvenile salmonids must now be done under a Federal Drug Administration (FDA) Investigational New Animal Drug (INAD) permit held by Christine M. Moffitt of the University of Idaho, principal investigator for registering the drug (Moffitt et al. 1993). For the three release strategies of spring chinook at Umatilla and one at Bonneville that receive prophylactic erythromycin, this requires implementing, monitoring and evaluating four separate INAD experimental protocols. These were integrated into the Umatilla program without compromising the monitoring and evaluation goals. While INAD activities are not defined in the project work statement, they became an essential and significant component of the fish health program.

METHODS

Juvenile Monthly Monitoring

A Vibra-Cell Model VC50T (Sonics and Materials Inc., Danbury, CT) high intensity ultrasonic processor with a 2 mm microtip was purchased under the project. This device provides a mechanism to disaggregate kidney samples from small fish for the enzyme-linked immunosorbent assay (ELISA) that previously had to be assayed by the less sensitive direct fluorescent antibody test (DFAT). Dilutions of kidney as high as 1:16 (weight:volume) in Tween-20 buffer are now a routine procedure. Otherwise, all methods described in the 1992 Annual Report (Keefe et al. 1993) were used in the second year.

Juvenile Disease Outbreak Monitoring

A severe outbreak of bacterial kidney disease (BKD) in the Bonneville yearling fall chinook (95.91) at Bonneville Hatchery provided an opportunity to compare the ELISA and the DFAT on samples from the same fish. This was also necessary to evaluate the severity of the disease in these populations prior to their transfer to the Umatilla River in March. The fish in raceway Al-3 had not received a erythromycin feeding in the fall of 1992. Those in A4-6 had received a 21 day erythromycin regimen with antibiotic fed every other day for 42 days at 69 mg of antibiotic per kg of body weight per day during September and October of 1992. Twenty grab-sampled fish from each of the six raceways (Al-6) were collected on 25 February 1993. Kidney smears for the DFAT and whole kidneys processed at a 1:8 dilution for the ELISA were assayed as described in the 1992 Annual Report (Keefe et al. 1993).

Investigational New Animal Drug Monitoring

Erythromycin feeding protocols and evaluations of either efficacy or toxicity were developed for the three release groups of Carson spring chinook (75.91 fall subyearlings and yearlings, and the 75.92 spring subyearlings) juveniles reared at Umatilla Hatchery. This was done to meet FDA INAD 4333 permit requirements for the prophylactic use of erythromycin on salmonid fish for BKD caused by Rs (Moffitt et al. 1993).

The subyearling spring release 75.92 juveniles received their first treatment of the antibiotic at a dosage of 102 mg per kg body weight per day for 21 consecutive days in January of 1993 while in Oregon raceway OlA. An equal number were fed the same dosage for 35 consecutive days during January and February while in raceway OlB. Standardized toxicity tests under the INAD 4333 were conducted on days 1, 3, 7 and 14 following the last antibiotic feeding day. After being randomly and equally distributed from the two Oregon raceways into six Michigan raceways, they received a second 21 day erythromycin feeding at a rate of 138 mg per kg body weight per day during April 1993. Toxicity tests as described above were done and juvenile preliberation ELISA assays for Rs were performed on 30 fish per raceway sampled on 04 May 1993. The erythromycin levels were about half those used for the 91 brood Carson subyearling spring chinook to meet requirements of the FDA INAD permit.

The Carson fall release subyearling and spring release yearling spring chinook juveniles (75.91) received a 21 consecutive day first feeding of erythromycin at 136 mg per kg body weight per day in June of 1992 while in Canadian troughs. The fall release subyearlings received a second 21 day antibiotic feeding regimen in October of 1992 while in two Oregon raceways (03A and 038). The dosage for this treatment was at 115 mg per kg body weight per day. Juvenile preliberation ELISA assays were done on 30 fish per raceway sampled on 27 October 1992. One-half of the spring release yearlings of this brood (75.91) received their second 21 day erythromycin prophylaxis at a rate of 115 mg per kg body weight per day in August of 1992 while in one Oregon raceway (04A). The other half of this release group in 05A did not receive a second antibiotic feeding at this time. The fish from each raceway were equally and randomly distributed between four Oregon raceways (04 and 05 series) for completion of rearing. Thus, an equal proportion of fish in each raceway would have received either one or two treatments of erythromycin. In February of 1993, fish in all four raceways received either their second or third antibiotic treatment for 21 consecutive days at 113 mg per kg body weight per day. On 23 July 1992 a pre-second treatment evaluation was done by assaying 30 fish from 04A by the ELISA. Then on 23 September 1992 a post-second treatment evaluation was made by assaying 30 fish each from 04A (second treatment group) and 05A (non-second treatment group) using the ELISA. Preliberation ELISA evaluations were also done on 30 fish from each of the four Oregon raceways on 17 March 1993.

RESULTS

Juvenile Monthly Monitoring

External parasites were not detected in wet mounts of gill or body scrapings from a total of 267 moribund/fresh dead fish and 180 grab-sampled healthy fish examined by microscopy. Gill condition of healthy fish was normal by gross examination and none of the moribund/fresh dead fish showed evidence of clinical bacterial gill disease. Yellow pigmented gill bacteria were isolated from 62.5% (20/32) of the moribund/fresh dead steelhead (Appendix Table A-6). *Flexibacter psychrophilus* specific antiserum was used to test 6/20 of these in the rapid slide agglutination test and all six were positive for the cold water disease (CWD) bacterium. Similar bacteria were isolated from 47.6% (50/105) of moribund/fresh dead fall chinook juveniles and 100% of seven isolates tested with *F. psychrophilus* antiserum were positive (Appendix Table A-7). This bacterium was detected systemically in 25.0% (8/32) of these same steelhead (Appendix Table A-6) and in 2.9% (3/105) of the same fall chinook (Appendix Table A-7) examined. In steelhead, this agent was detected most consistently in the graded-small fish in the M5A upper Michigan raceway (Appendix Table A-6). In the fall chinook there is evidence for a higher prevalence of *F. psychrophilus* on the gills of fish in Michigan raceways (Appendix Table A-7). Forty percent (12/30) of fish examined in Oregon raceways carried these bacteria while 76% (38/50) from Michigan raceways appeared to harbor *F. psychrophilus*. Yellow pigmented bacteria were isolated from the gills of 47.4% (18/38) of the 75.92 brood spring chinook juveniles (Appendix Table A-8), 50.0% (7/14) of the fall release 75.91 brood spring chinook (Appendix Table A-9) and from 10.6% (5/47) of the 75.91 yearling spring chinook (Appendix Table A-10). The CWD bacterium was not detected systemically in any of the 183 moribund/fresh dead spring chinook tested from these populations (Appendix Tables A-8-10). Opportunistic aeromonad-pseudomonad bacteria were isolated only from decomposing dead fish. Atypical erythrocytic inclusion body syndrome (EIBS) inclusions were found at a low level in one of 160 moribund chinook examined and in none of 37 healthy chinook. There were no indications of EIBS associated anemia.

Assays for *Renibacterium salmoninarum* by the ELISA and DFAT

Forty-two moribund/fresh dead and 30 grab-sampled normal-appearing Umatilla summer steelhead (91.92) were tested by the ELISA for Rs during the six months of monthly monitoring while the fish were in three Michigan raceways (M5A, M5B and M5C) (Appendix Table A-11). Kidney tissue from these was homogenized at a 1:8 or 1:16 dilution; the mean OD reading for moribund/fresh dead fish was 0.014 and the range was 0.000-0.110. Two of these were very low level Rs positive at readings of 0.101 and 0.110. One of the 25 normal fish from raceway M5C had an OD reading of 0.129, indicating that a very low level of Rs antigen was possibly present. This sample was contaminated with material from the digestive tract which can produce an artificially high reading. The other 29 normal fish from M5A and M5C had a mean OD reading of 0.017 and a range of 0.000-0.089 indicating no infection. Based on these data, 4.2% (3/72) of the steelhead tested were Rs positive (OD reading >0.089) at a very low level.

Fifty moribund/fresh dead fall chinook (95.92) juveniles from six Oregon raceways (O1A-B,O2A-B and O3A-B) and 60 from six Michigan raceways (M2A-C and M3A-C) were examined in February, March and April of 1993 for Rs by the DFAT (Appendix Table A-12). Two percent (1/50) from Oregon raceways were positive by DFAT and 8.3% (5/60) from Michigan raceways were Rs positive. None of twenty-five grab sampled fish from Oregon raceways were positive by the DFAT while 20.0% (4/20) from Michigan raceways were Rs positive (Appendix Table A-12).

Ten moribund/fresh dead 75.92 brood spring chinook subyearlings from two Oregon raceways (O1A-B) were examined in January 1993 for Rs by the DFAT (Appendix Table A-13). Twenty percent (2/10) were high level positives (3+). None of five grab-sampled fish were positive. A total of 75 moribund/fresh dead of this stock from nine Michigan raceways (M6A-C, M7A-C and M8A-C) were examined during monthly monitoring in February, March and April of 1993 for Rs by the ELISA (Appendix Table A-13). Of these, 42.7% (32/75) were Rs positive and more significantly, 17.3% (13/75) were positive at very high levels indicating clinical infection. Twenty-five fish from lower raceways between the three Michigan series were also grab-sampled and examined by the ELISA and six of these were Rs positive (24.0%); two (8.0%) were infected at moderate levels.

During monthly monitoring 76 moribund/fresh dead yearling spring chinook of the 75.91 brood from four Oregon raceways (O4A-B and O5A-B) were examined from September 1992 through February 1993 for Rs by the ELISA (Appendix Table A-15). Fifteen of 75 (20.0%) were positive; 4.0% (3/76) at moderate levels. Sixty-five were also grab-sampled for the ELISA and 15.4% (10/65) were positive; 4.6% (3/65) at moderate levels.

Juvenile Preliberation Monitoring

External parasites were not detected in wet mounts of gill or body scrapings examined by microscopy from a total of 25 fish. Gill condition was normal by gross examination except that one juvenile steelhead from raceway M5A had a few gill aneurysms. No culturable viral agents were detected by cell culture assays. Six-hundred sixty blood smears from the combined chinook stocks at Umatilla Hatchery were negative for EIBS inclusions. At Bonneville Hatchery, 5.8% (7/120) of the 75.91 yearling spring chinook examined had typical EIBS inclusions; three at high levels (> 20 inclusions per blood smear).

Assays for *Renibacterium salmoninarum* by the ELISA

All 90 Umatilla summer steelhead (91.92) juveniles tested for Rs by the ELISA were negative (Appendix Table A-16). Mean ELISA OD readings for the 30 fish from each raceway were 0.014, 0.013 and 0.008 for M5A, M5B and M5C, respectively.

One of 120 (0.8%) Bonneville fall chinook (95.92) juveniles from four Oregon raceways had an OD reading greater than 0.200 (0.247) while 3/180 (1.7%) in six Michigan raceways had readings greater than 0.200 (0.282, 0.331 and 0.919) (Appendix Table A-17). None of the fish in Oregon raceways had readings in the range of 0.100-0.199 and one in Michigan raceways was in this range. Mean OD readings for the 30 fish from each Oregon raceway were 0.038, 0.020, 0.020 and 0.017 for 02A, 02B, 03A and 03B, respectively. For the six Michigan raceways, means were 0.022, 0.021, 0.024, 0.041, 0.026 and 0.048 for M2A, M2B, M2C, M3A, M3B and M3C, respectively. Because of their small size, kidneys from these fish for the ELISA were processed at twice the dilution (1:16) as those from steelhead.

In Carson spring chinook (75.92) subyearling juveniles, 3.9% (7/180) from six Michigan raceways had OD readings of 0.100-0.199 indicating a very low level of infection, 1.7% (3/180) had low readings between 0.200 and 0.399, 2.8% (5/180) were moderately positive between OD 0.400 and 0.699, 0.6% (1/180) were high level positive at 0.964 and 1.1% (2/180) showed clinical infection levels at greater than OD 1.000 (Appendix Table A-19). The M7 series of raceways had more Rs positive fish (12/90) and at higher antigen levels than the M6 series (6/90 positive). Mean OD by raceway was 0.047, 0.066, 0.067, 0.095, 0.068 and 0.105 for M6A, M6B, M6C, M7A, M7B and M7C, respectively.

Sixty fall release 75.91 subyearling spring chinook in two Oregon raceways (03A and 03B) were all negative for Rs by the ELISA (Appendix Table A-20). As a result, they were quite homogeneous in their ELISA distribution pattern. Means were 0.016 and 0.020, and ranges were 0.005-0.060 and 0.005-0.053 for raceway 03A and 03B, respectively.

Similar results were obtained with samples from the yearling of this 75.91 spring chinook stock in four Oregon raceways the following spring (Appendix Table A-21). None of 120 fish tested were positive by ELISA. Means were 0.025, 0.030, 0.030 and 0.030, and ranges were 0.007-0.088, 0.008-0.058, 0.004-0.090 and 0.009-0.074 for raceway 04A, 04B, 05A and 05B, respectively.

At Bonneville Hatchery, however, the ELISA results of the yearling 75.91 spring chinook from four raceways sampled two days later than those at Umatilla Hatchery were significantly different. Of 120 fish tested, 12.5% (15/120) were Rs positive (Appendix Table A-22). Twelve of these (10.0% of the 120) were positive at very low levels, one was a low level positive, one was positive at a moderate level and one was a high level positive. Means were 0.098, 0.028, 0.026 and 0.041, and ranges were 0.011-0.787, 0.006-0.133, 0.000-0.223 and 0.000-0.0479 for raceway B1, B2, B3 and B4, respectively.

Juvenile Disease Outbreak Monitoring

There were no disease episodes in fish at Umatilla Hatchery during the period of this report. Although the bacteria responsible for CWD and BKD were frequently detected, no increased loss to either pathogen was observed.

At Bonneville Hatchery, however, yearling 95.91 brood fall chinook programmed for transfer to the Umatilla River had a BKD epizootic in February 1993. Fish'in three of six raceways (Al-6) suffered high loss with clinical signs of BKD. The severity of the epizootic by raceway was assessed using both the DFAT and ELISA on 20 grab-sampled fish from each raceway (Appendix Table A-18). In raceways Al-3 where the loss was highest, the DFAT showed 45.4% (11/20), 0% (0/20) and 65.0% (13/20) of the fish tested to be Rs positive in raceway Al, A2 and A3, respectively. ELISA results of kidneys from these same fish revealed that 95.5% (19/20), 79.0% (15/19) and 100% (20/20) were positive for each raceway, respectively. The DFAT showed only

1.7% (1/60) of the fish from raceways A4-6 to be Rs positive, whereas by the ELISA 20.0% (12/60) were positive. Infection levels by both assays were determined to be far higher in raceways Al-3 than in A4-6. Because of the severity of BKD in fish in raceways Al-3, they were not transferred to the Umatilla River.

Broodstock Monitoring

The Umatilla summer steelhead (93.00) broodstock was negative for replicating agents, including IHN virus, by cell culture assays. Individual sex fluid samples from 100% of the females (49) and males (49) spawned were tested for IHN virus. Two or three-fish tissue pools from all 98 females and males spawned were also screened and negative for replicating agents. All 98 spawned adults and six adult mortality were sampled for Rs by the ELISA and all were negative (Appendix Table A-23).

Eggs to Umatilla Hatchery from the Bonneville fall chinook (92.00) broodstock were spawned on 10 November 1992. Virus sampling on this date showed that 5.0% (1/20) of individual ovarian fluid samples from females were positive (Appendix Table A-24). All 516 adults spawned on this date were sampled for Rs and assayed by the ELISA. Four-hundred seventy-three (91.7%) of these were negative, 6.2% (32/516) were low level positive, 0.8% (4/516) were at moderate levels, 0.6% (3/516) were high level positive and 0.8% (4/516) were in the clinical range (Appendix Table A-25). All 15 female and male adults assayed for EIBS from that spawning were negative (Appendix Table A-26).

The 91 brood year Umatilla fall chinook (91.00) were sampled and assayed for EIBS (86 fish), culturable viruses (318 fish) and Rs (113 fish) (Appendix Table A-27 and A-28). All were negative for these pathogens. Progeny from these were not part of Umatilla Hatchery production, however they were raised at Irrigon and liberated into the Umatilla River. They are also future brood for Umatilla Hatchery.

Eggs from the 92 brood year Umatilla fall chinook (91.00) adults were combined with those from Bonneville for Umatilla Hatchery production. These adults were monitored similar to the 91 brood (EIBS - 112 fish, viruses - 116 fish and Rs - 230 fish) and negative except for one low level Rs positive male (Appendix Table A-29 and A-30).

Appendix Table A-31 and A-32 are for the 91 brood year Carson spring chinook (75.00) adults providing eggs for Umatilla Hatchery. These tables and results from them were submitted for the 1992 Annual Report, however the tables did not appear in the published document. A summary of these tables is thus provided. Adults were spawned and sampled for IHN virus as four-female and two-to four-male family groups. An 83.3% (300/360) prevalence of the virus was detected in ovarian fluids from females and 27.6% (59/214) of the male milt samples were IHN virus positive (Appendix Table A-31). All family groups had at least one parent that was IHN virus positive; Two of 75 (2.7%) blood smears had inclusions diagnostic for EIBS virus. Of 360 smears made from ovarian fluid cell pellets assayed for Rs by the DFAT, 3.9% (14/360) were positive (Appendix Table A-32). Four of the 14 positives were rated at the highest positive level (4+) for the bacterium, two at the next level (3+), two at the next level (2t) and six were rated at the lowest positive level (1+).

Similar sampling was conducted on the 92 brood year Carson spring chinook (75.00) adults and the ELISA for Rs from kidney samples collected on 24 July 1992 and 17 August 1992 was added. Eggs for Umatilla Hatchery production were from spawnings from 3 August 1992 through 25 August 1992. Viral sampling during this period showed that 81.9% (298/364) of individual ovarian fluid samples were IHN virus positive and 33.3% (14/42) of milt samples tested were positive for the virus (Appendix Table A-33). Fifty-three fish assayed for EIBS were negative. Of 84 smears made from ovarian fluid cell pellets assayed for Rs by the DFAT, 39.9% (33/84) were positive (Appendix Table A-34). Four of the 33 positives were rated at the highest positive level (4t) for the bacterium, four were at the next level (3+), nine at the next level (2t) and sixteen were rated at the lowest positive level (1+). Twenty-three kidney samples from females and 18 from males were also assayed by the ELISA for Rs. Thirteen of 23 females (56.2%) were positive and 83.3% (15/18) of males tested were Rs positive (Appendix Table A-35). Clinical levels of the bacterial antigen were detected in 22.0% (9/41) of these fish.

Investigational New Animal Drug Monitoring

No signs of erythromycin toxicity were observed in the 75.92 Carson spring chinook subyearling juveniles following their first Gallimycin 50 (erythromycin) feeding regimen for 21 or 35 days. Following their second 21 consecutive day Gallimycin 50 feeding in April, however, signs of severe toxicity, including some mortality, was observed on day 1 and 3 toxicity tests in fish from all six treated Michigan raceways (M6A-C and M7A-C).

The 75.91 Carson spring chinook yearlings were tested by the ELISA before and after their second erythromycin (Gallimycin 50) feeding in August 1992 (Appendix Table A-37). The OD mean, range and standard deviation for the pre-second feeding raceway (04A) and the post-second feeding control raceway (05A) are very similar. For 04A these values are 0.100, 0.086-0.232 and 0.026 for the mean, range and standard deviation, respectively. These same values for 05A are 0.112, 0.088-0.246 and 0.029. The mean for the post-second feeding raceway (04A) is also similar (0.105), however the range (0.094-0.128), and thus the standard deviation (0.007), is much smaller for this group.

DISCUSSION

There were no outbreaks of infectious disease in any species or stock of juvenile fish reared at Umatilla Hatchery during this report period. To date, external parasites have not been observed on any fish examined at Umatilla. Monthly monitoring did reveal the presence of the bacterial fish pathogens *F. psychrophilus* and Rs, the causative agents of cold water disease and bacterial kidney disease, respectively. *F. psychrophilus* was isolated most frequently from gill smears made on culture medium and was only occasionally detected from kidney smears that would indicate systemic infection (Appendix Tables A-6-10). In fall chinook there was a tendency indicated for a higher prevalence of these bacteria on the gills of fish in Michigan raceways (Appendix Table A-7). Rs infection of steelhead was essentially nonexistent (Appendix Table A-

11), and minimal in the 91 brood spring chinook (Appendix Table A-14 and A-15). Levels and prevalences of antigens of this bacterium in the 92 brood fall and spring chinook, however, indicate significant infection (Appendix Table A-12 and A-13).

Preliberation monitoring confirmed the observations from monthly monitoring relative to Rs. Results from these assays revealed that BKD was more severe in the subyearling 92 brood spring chinook (Appendix Table A-19) than in the subyearling 92 brood fall chinook (Appendix Table A-17). Some reduction in survival to adulthood of the spring chinook might be anticipated from the ELISA results and observations made during monthly and preliberation monitoring.

There were significant differences between the preliberation monitoring results of the 75.91 yearling Carson spring chinook at Umatilla and Bonneville Hatcheries. One-hundred twenty fish from a total of four raceways at each hatchery were assayed for Rs by the ELISA (Appendix Table A-22 and A-23). None were positive at Umatilla while 12.5% tested positive at Bonneville. Three of the 120 (2.5%) at Bonneville were in the OD range (>.0.200 OD units) that could be an indicator of impaired survival to adulthood. Also, inclusions typical of EIBS were detected in 5.8% of the Bonneville fish and in none at Umatilla. Three (2.5%) at Bonneville had very high numbers of inclusions (>20 per microscope field) indicating the clinical phase of infection. These kinds of results provide strong evidence for the need to factor the disease status of juveniles at release into the total equation for their survival to the adult lifestage. This is especially required when comparing different populations.

Broodstock monitoring results from the 91 and 92 brood year Carson spring chinook adults may explain the BKD severity in the 92 brood juveniles. Ovarian fluid cell pellets from subsamples of the spawning females in 1991 were 3.9% Rs positive (Appendix Table A-32), whereas in 1992 they had a 39.9% prevalence (Appendix Table A-34). This ten-fold increase in the 92 brood year adults may well account for the incidence of the vertically transmitted Rs bacterium in their progeny. Such year-to-year variation in the prevalence of Rs in spring chinook brood fish supports the concept for segregation of progeny from high titer Rs females in years when prevalences are high. A very high prevalence of IHN virus was again detected in the 92 brood year Carson spring chinook adults (Appendix Table A-33). And, as in progeny of the 91 brood, no evidence for vertical transmission was seen, either as loss to the virus or its isolation from subyearling fish prior to liberation.

Inclusions typical of EIBS have only been sporadically observed in blood smears of both adults and juveniles. No indications of EIBS associated anemia or secondary infections have been observed.

IHN virus has not been detected in adult steelhead or fall chinook returning to the Umatilla River in the past two brood years. Nor, have the levels and prevalences of Rs been other than incidental in these brood fish (Appendix Table A-23, A-28 and A-30). These observations are consistent with monitoring of the same stocks in prior years under other programs. The lack of occurrence of these salmonid pathogens in adults returning to the Umatilla River is in sharp contrast to their typically high prevalence in lower Columbia River adult chinook stocks used as brood for Umatilla Hatchery

(Appendix Tables A-24, A-25 and A-31-34). Hopefully, prudent disease control measures will ensure that the current and future brood from the Umatilla River remain relatively free of serious pathogens.

Part of the multi-faceted approach to maintain Umatilla River salmonid stocks as disease-free as possible is to prevent the direct introduction of heavily infected juvenile populations. This was part of the rationale for recommending that three raceways of yearling fall chinook from Bonneville Hatchery not be liberated into the Umatilla River in the spring of 1993. Extensive sampling for BKD in six raceways of these fish indicated that three raceways of fish (A4-6) posed minimal risk for significant introduction of Rs (Appendix Table A-18). Raceways Al-3, however, contained yearling fall chinook which posed a high risk for horizontal transmission of Rs to other populations, were judged to have a low probability for significant survival to adulthood, and if survivors did return as adults, they would likely be heavily infected with the bacterium.

Evaluations for Rs in these fish at Bonneville also provided an opportunity to compare the DFAT and ELISA in samples from the same fish. Results from this study indicated that the DFAT correlates to the ELISA only when infection levels are very high (>l.000 OD units). At subclinical levels determined by the ELISA, the DFAT was not a reliable indicator of presumed infection. The DFAT sample is obtained by passing a cotton swab through a portion of the kidney and areas harboring Rs bacteria can be missed. Further, detection of bacteria by microscopy requires on the order of 10 bacteria per gram of tissue to be present. For the ELISA, the entire kidney is excised and homogenized for the assay which detects antigenic components of the bacterium. Only microgram amounts of bacterial material are required to be detectable using the ELISA.

The low sensitivity of the DFAT was the impetus for attempts to expand the use of the ELISA to populations of small fish for the Umatilla production program. By using a sonicator and dilutions of kidney as high as 1:16, ELISA can now be an effective Rs evaluation method for most of the juvenile fish at Umatilla. Work is continuing to determine optical density relationships between samples processed at selected dilutions.

The INAD process for the prophylactic use of erythromycin on juvenile spring chinook salmon became a significant component of the fish health program at Umatilla. Prophylactic erythromycin was integral to the spring chinook rearing program in the first year but the INAD requirements became far more stringent in the second year. The alternative to the INAD process, not feeding erythromycin, was not even considered because it was feared that losses to BKD could be devastating. For the most part, only toxicity tests following erythromycin treatment were implemented to meet INAD requirements. For unexplained reasons, the 92 brood Carson spring release subyearlings showed typical signs of erythromycin toxicity on day 1 and 3 toxicity tests following their second feeding at 138 mg of erythromycin per kg body weight per day. This was observed in fish from all six Michigan raceways and was so severe as to cause some mortality. No toxicity was observed in these same fish following their first feeding at 102 mg per kg per day approximately two months earlier. Conceivably, more aggressively feeding fish assimilated more antibiotic and these were the fish that displayed toxic responses. The yearling release group of this same stock, however, received an initial erythromycin feeding at 223 mg per kg per day and showed no signs of toxicity. Pre and post-erythromycin feeding comparisons of ELISA readings were made in a raceway of the 91 brood Carson juveniles (Appendix Table A-37) and a group that did not receive this second feeding. The Rs levels in all groups were mostly negative to marginal positive and valid comparisons on the efficacy of the erythromycin in reducing Rs are not possible to assess. This kind of evaluation would be very informative in fish that have significant subclinical levels of infection such as the 92 brood Carson spring chinook juveniles currently at Umatilla.

Some differences in the incidence and prevalence of infectious agents and their effect on fish health have been documented in the first two years of evaluation. The significance and consistency of these differences will require additional epidemiological and statistical analyses, as well as the continued collection of data. Minor adjustments are being made as the project proceeds to fulfill these needs. The scope of the fish health monitoring project is also providing a means for quantitative risk assessment not normally available. In some cases there is even the potential to validate or invalidate these attempts at risk assessment.

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APPENDIX A

Appendix Table A-1. Number of Umatilla summer steelhead (91.92) juveniles sampled per raceway in Michigan series 5 (M5A, M5B, and M5C) during monthly monitoring.

Date sampled	01 Al	O1A[2]	M5A[1]	M5A[2]	M5B[1]	M5C[1]	M5C[2]
9-92	5	5					
10-92			0		0	0	5
11-92			5		5	5	5
12-92			3		0	2	5
1-93			4		5	5	5
2-93			4		0	1	5
3-93			3	5			

[1] *Moribund or fresh dead fish.*
[2] *Normal healthy appearing fish.*

Appendix Table A-2. Number of Bonneville fall chinook salmon (95.92) juveniles sampled per raceway in Oregon series 1, 2, and 3 (O1A, O1B, O2A, O2B, O3A, and O3B), and in Michigan series 2 and 3 (M2A, M2B, M2C, M3A, M3B, and M3C) during monthly monitoring.

Date sampled	O1A[1]	O1B[1]	O1B[2]	O2A[1]	O2B[1]	O2B[2]	O3A[1]	O3B[1]	O3B[2]	M2A[1]	M2B[1]	M2C[1]	M2C[2]	M3A[1]	M3B[1]	M3C[1]	M3C[2]
2-93				5	5	5	5	5	5								
3-93	5	5	5							5	5	5	5	5	5	5	5
4-93				5	5	5	5	5	5	5	5	5	5	5	5	5	5

[1] *Moribund or fresh dead fish.*
[2] *Normal healthy appearing fish.*

Appendix Table A-3. Number of Carson spring chinook salmon (75.92) juveniles sampled per raceway in Oregon series 1 (O1A and O1B), and in Michigan series 6, 7, and 8 (M6A, M6B, M6C, M7A, M7B, M7C, M8A, M8B, and M8C) during monthly monitoring.

Date sampled	O1A[1]	O1B[1]	O1B[2]	M6A[1]	M6B[1]	M6C[1]	M6C[2]	M7A[1]	M7B[1]	M7C[1]	M7C[2]	M8A[1]	M8B[1]	M8C[1]	M8C[2]
1-93	5	5	5												
2-93												5	5	5	5
3-93				5	5	5	5	5	5	5	5				
4-93				5	5	5	5	5	5	5	5				

[1] *Moribund or fresh dead fish.*
[2] *Normal healthy appearing fish.*

Appendix Table A-4. Number of Carson spring chinook salmon (75.91) fall release juveniles sampled per raceway in Oregon series 3 and 4 (O3A, O3B, O4A, and 04B) during monthly monitoring.

Date sampled	O3A[1]	O3B[1]	O3B[2]	O4A[1]	O4A[2]
6-92				53	53
7-92				23	53
9-92	3	5	5		

[1] *Moribund or fresh dead fish.*
[2] *Normal healthy appearing fish.*
[3] *These were combined with the* yearling *production then split in 8-92 to* separate *raceways.*

Appendix Table A-5. Number of Carson spring chinook salmon (75.91) yearling juveniles sampled per raceway in Oregon series 4 and 5 (O4A, 048, O5A, and 05B) during monthly monitoring.

Date sampled	O4A[1]	O4A[2]	O4B[1]	O4B[2]	O5A[1]	O5B[1]	O5B[2]
6-92	5[3]	5[3]					
7-92	2[3]	5[3]					
9-92	1		0	5	5	3	5
10-92	8		2	5	3	5	5
11-92	3		0	5	5	2	5
12-92	1			5	1	2	5
1-93	4		5	5	1	1	5
2-93	5	5	5	5	5	5	5

[1] *Moribund or fresh dead fish.*
[2] *Normal healthy appearing fish.*
[3] *These* were *combined with the fall release production then split in 8-92 to separate raceways.*

Appendix Table A-6. Proportions and prevalences (%) of bacterial agents isolated from moribund or fresh dead Umatilla summer steelhead (91.92) during monthly juvenile fish health monitoring.

Date samoled	Raceway	Systemic bacteria' F. psychrophilus	Systemic bacteria' APS	Gill bacteria[2]
9-92	O1A	0/5 (0)	3/5 (60)	0/5 (0)[3]
10-92	M5C	ND[4]	ND[4]	ND[4]
11-92	M5A	1/5 (20)	0/5 (0)	5/5 (100)[3]
	M5B	1/5 (20)	0/5 (0)	5/5 (100)[3]
	M5C	1/5 (20)	0/5 (0)	5/5 (100)[3]
12-92	M5A	2/3 (67)	0/3 (0)	1/3 (33)[3]
	M5B	ND[4]	ND[4]	ND[4]
	M5C	1/2 (50)	0/2 (0)	0/2 (0)[3]
1-93	M5A	1/4 (25)	1/4 (25)	ND[4]
	M5B	0/5 (0)	3/5 (60)	0/1 (0)[3]
	M5C	0/5 (0)	0/5 (0)	ND[4]
2-93	M5A	1/4 (25)	0/4 (0)	3/3 (100)[3]
	M5B	ND[4]	ND[4]	ND[4]
	M5C	0/1 (0)	0/1 (0)	ND[4]
3-93	M5A	0/3 (0)	0/3 (0)	1/3 (33)[3]

1 *The only systemic bacteria isolated from kidney smear inocula were* Flexibacter psychrophilus *and aeromonad-psuedomonad (APS) types.*

2 *These were determined to be significant only if yellow pigmented colonies were the prevalent type on smears made from gill inocula.*

3 *The rapid slide agglutination test on 6/32 of these isolates using* F. psychrophilus *polyclonal rabbit antiserum was positive.*

4 *Indicates not done (ND) because no moribund or fresh dead fish were available.*

Appendix Table A-7. Proportions and prevalences (%) of bacterial agents isolated from moribund or fresh dead Bonneville fall chinook salmon (95.92) during monthly juvenile fish health monitoring.

Date sampled	Raceway	Systemic bacterial: *F. psychrophilus*	Systemic bacterial: APS	Gill bacteria[2]
2-93	02A	0/5 (0)	0/5 (0)	0/5 (0)[3]
	02B	0/5 (0)	5/5 (100)	0/5 (0)[3]
	03A	0/5 (0)	4/5 (80)	0/5 (0)[3]
3-93	M3A	0/5 (0)	2/5 (40)	0/5 (0)[3]
	M3B	0/5 (0)	0/5 (0)	5/5 (100)[3]
	M3C	0/5 (0)	D/5 (0)	3/5 (60)[3]
	M2A	0/5 (0)	0/5 (0)	0/5 (0)[3]
	M2B	0/5 (0)	0/5 (0)	3/5 (60)[3]
	M2C	0/5 (0)	0/5 (0)	2/5 (40)[3]
	O1A	0/5 (0)	0/5 (0)	0/5 (0)[3]
	O1B	0/5 (0)	0/5 (0)	0/5 (0)[3]
4-93	02A	2/5 (40)	0/5 (0)	2/5 (40)[3]
	02B	0/5 (0)	0/5 (0)	4/5 (80)[3]
	03A	1/5 (20)	0/5 (0)	3/5 (60)[3]
	03B	0/5 (0)	1/5 (20)	3/5 (60)[3]
	M2A	0/5 (0)	0/5 (0)	4/5 (80)[3]
	M2B	0/5 (0)	1/5 (20)	2/5 (40)[3]
	M2C	0/5 (0)	0/5 (0)	5/5 (100)[3]
	M3A	0/5 (0)	0/5 (0)	5/5 (100)[3]
	M3B	0/5 (0)	0/5 (0)	5/5 (100)[3]
	M3C	0/5 (0)	0/5 (0)	4/5 (80)[3]

1 *The only systemic bacteria isolated from kidney smear inocula were* Flexibacter psychrophilus *and aeromonad-psuedomonad (APS) types.*

2 *These were determined to be significant only if yellow pigmented colonies were the prevalent type on smears made from gill inocula.*

3 *The rapid slide agglutination test on 6/32 of these isolates using* F. psychrophilus *polyclonal rabbit antiserum was positive.*

Appendix Table A-8. Proportions and prevalences (%) of bacterial agents isolated from moribund or fresh dead Carson spring chinook subyearling salmon (75.92) during monthly juvenile fish health monitoring.

Date sampled	Raceway	Systemic bacteria[1] F. psychrophilus	Systemic bacteria[1] APS	Gill bacteria[2]
1-93	O1A	0/5 (0)	4/5 (80)	0/5 (0)
	O1B	0/5 (0)	2/5 (40)	0/5 (0)
2-93	M8A	0/5 (0)	0/5 (0)	0/2 (0)
	M8B	0/5 (0)	3/5 (60)	ND[3]
	M8C	0/5 (0)	1/5 (20)	3/3 (100)
3-93	M6A	0/5 (0)	0/5 (0)	1/2 (50)
	M6B	0/5 (0)	3/5 (60)	3/3 (100)
	M6C	0/5 (0)	0/5 (0)	1/1 (100)
	M7A	0/5 (0)	1/5 (20)	2/2 (100)
	M7B	0/5 (0)	2/5 (40)	3/3 (100)
	M7C	0/5 (0)	1/5 (20)	2/2 (100)
4-93	M6A	0/5 (0)	1/5 (20)	2/5 (40)
	M6B	0/5 (0)	0/5 (0)	ND[3]
	M6C	0/5 (0)	1/5 (20)	ND[3]
	M7A	0/5 (0)	0/5 (0)	1/5 (20)
	M7B	0/5 (0)	0/5 (0)	ND[3]
	M7C	0/5 (0)	0/5 (0)	ND[3]

1 *The only systemic* bacteria *isolated from kidney* smear *inocula* were *aeromonad-psuedomonad (APS) types.*

2 *These were determined to be significant only if yellow pigmented colonies* were *the prevalent type on smears made from gill inocula.*

3 *Indicates not done (ND) because no moribund or fresh dead fish* were *available.*

Appendix Table A-9. Proportions and prevalences (%) of bacterial agents isolated from moribund or fresh dead Carson spring chinook fall release juvenile salmon (75.91) during monthly juvenile fish health monitoring.

Date sampled	Raceway	Systemic bacteria *F. psychrphilus*	Systemic bacteria APS	Gill bacterial[1]
6-92	04A	0/5 (0)	0/5 (0)	4/5 (80)
7-92	04A	0/2 (0)	0/2 (0)	0/2 (0)
9-92	03A	0/3 (0)	0/3 (0)	1/3 (33)
	03B	0/5 (0)	0/5 (0)	2/4 (50)

1 *These were determined to be significant only if yellow pigmented colonies* were *the prevalent type on smears made from gill inocula.*

Appendix Table A-10. Proportions and prevalences (%) of bacterial agents isolated from moribund or fresh dead Carson spring chinook yearling salmon (75.91) during monthly juvenile fish health monitoring.

Date sampled	Raceway	Systemic bacterial: *F. psvchrophilus*	Systemic bacterial: APS	Gill bacteria[2]
6-92	04A	0/5 (0)	0/5 (0)	4/5 (80)
7-92	04A	0/2 (0)	0/2 (0)	0/2 (0)
9-92	04A	0/1 (0)	0/1 (0)	ND[3]
	04B	ND[3]	ND[3]	ND;
	05A	0/5 (0)	0/5 (0)	ND[3]
	05B	0/3 (0)	1/3 (33)	0/3 (0)
10-92	04A	0/8 (0)	3/8 (38)	0/5 (0)
	04B	0/4 (0)	2/4 (50)	0/2 (0)
	05A	D/3 (0)	1/3 (33)	0/2 (0)
	05B	0/5 (0)	1/5 (20)	0/2 (0)
11-92	04A	0/3 (0)	1/3 (33)	0/3 (0)
	04B	0/2 (0)	0/2 (0)	0/2 (0)
	05A	0/5 (0)	4/5 (80)	0/2 (0)
	05B	0/2 (0)	0/2 (0)	0/2 (0)
.2-92	04A	0/1 (0)	0/1 (0)	0/1 (0)
	04B	ND[3]	ND[3]	ND[3]
	05A	0/1 (0)	0/1 (0)	0/1 (0)
	05B	0/2 (0)	0/2 (0)	0/2 (0)
1-93	04A	0/4 (0)	2/4 (50)	1/1 (100)
	04B	0/5 (0)	4/5 (80)	ND[3]
	05A	0/1 (0)	1/1 (100)	ND[3]
	05B	0/1 (0)	1/1 (100)	ND[3]
2-93	04A	0/5 (0)	4/5 (80)	0/1 (0)
	04B	0/5 (0)	0/5 (0)	0/1 (0)
	05A	0/5 (0)	3/3 (100)	0/5 (0)
	05B	0/5 (0)	0/5 (0)	0/5 (0)

1 *The only systemic bacteria isolated from kidney* smear *inocula* were *aeromonad-psuedomonad (APS) types.*

2 *These were determined to be significant only if yellow pigmented colonies* were *the prevalent type on smears made from gill inocula.*

3 *Indicates not done (ND) because no moribund or fresh dead fish were available.*

Appendix Table A-11. **DFAT results and ELISA readings (OD_{405}) of kidney samples from Umatilla summer steelhead** (91.92) **juveniles sampled during monthly monitoring from one Oregon raceway (O1A), and three Michigan raceways (M5A, M5B and M5C).**

	DFAT		ELISA OD_{405}				
Date sampled	O1A[2]	O1A[3]	M5A[2]	M5A[3]	M5B[2]	M5C[2]	M5C[3]
9-92	0/5[4]	0/5[4]					
10-92							.007
							.017
							.017
							.022
							.067
11-92			.000		.000	.000	.012
			,000		.000	.002	.024
			.000		.000	.003	.035[5]
			.000		.002	.004	.051[5]
			.003		.003	.004	.129[5]
12-92			.000			.004	. 000
			.000			,018	.002
			.004				.005
							.014
							.089
1-93			.013		.010	.015	.003
			.029		.013	.025	.003
			.031		.014	.027	.006
			.101		.035	.027	.014
					,110	.050	.015
2-93			.000			.001	.004
			,002				.005
			.007				,006
			.008				.007
							.011
3-93			.003	.004			
			.003	.004			
			.011	.004			
				,005			
				,040			

1 *Individual kidney samples* were *homogenized in PBS-Tween 20 buffer* at a *1:8 or 1:16 weight/volume dilution* for *the ELISA.*

2 *Moribund or fresh dead fish.*

3 *Normal healthy appearing fish.*

4 *Examined by the DFAT because of the small fish size.*

5 *Possible digestive tract contents in the sample.*

Appendix Table A-12. DFAT results of kidney samples from Bonneville fall chinook salmon (95.92) juveniles sampled during monthly monitoring from six Oregon raceways (O1A, O1B, O2A, O2B, O3A, and O3B), and six Michigan raceways (M2A, M2B M2C, M3A, M3B, and M3C).

	Proportion positive for *Renibacterium salmoninarum*																
Date sampled	O1A[1]	O1B[1]	O1B[2]	O2A[1]	O2B[1]	O2B[2]	O3A[1]	O3B[1]	O3B[2]	M2A[1]	M2B[1]	M2C[1]	M2C[2]	M3A[1]	M3B[1]	M3C[1]	M3C[2]
2-93				0/5	0/5	0/5	0/5	0/5	0/5								
3-93	0/5	1/5	0/5							0/5	0/5	0/5	3/5	2/5	1/5	2/5	1/5
4-93				0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5	0/5

[1] *Moribund or fresh dead fish.*
[2] *Normal healthy appearing fish.*

Appendix Table A-13. DFAT results and ELISA readings (OD_{405}) of kidney samples[1] from Carson spring chinook subyearling salmon (75.92) juveniles sampled during monthly monitoring from two Oregon raceways (O1A, and O1B), and nine Michigan raceways (M6A, M6B M6C, M7A, M7B, M7C, M8A, M8B and M8C).

Date sampled	DFAT			ELISA OD_{405}											
	O1A[2]	O1B[2]	O1B[3]	M6A[2]	M6B[2]	M6C[2]	M6C[3]	M7A[2]	M7B[2]	M7C[2]	M7C[3]	M8A[2]	M8B[2]	M8C[2]	M8C[3]
1-93	2/5	0/5	0/5												
2-93												.002	.009	.004	.003
												.005	.011	.093	.007
												.005	.014	2.333	.007
												.042	.034	2.740	.012
												.077	.037	2.779	.015
3-93				.013	.015	.105	.017	.034	.021	.008	.012				
				.019	.082	.108	.018	.035	.028	.141	.104				
				.164	.084	.154	.030	.065	.035	.226	.116				
				,184	.264	.225	.059	2.737	.089	.349	.490				
				.314	3.066	2.950	.074	3.223	1.652	3.030	.502				
4-93				.012	.013	.016	.023	.001	.019	.004	,007				
				.053	.024	.016	.061	.016	.020	.004	.039				
				.061	.110	.018	.070	.024	.067	.026	.040				
				.243	.152	.040	.090	.024	.139	.129	.063				
				3.049	3.115	.051	.095	.084	3.033	2.564	.079				

[1] *Individual kidney samples were homogenized in PBS-Tween 20 buffer at a 1:16 weight/volume dilution for the ELISA.*
[2] *Moribund or fresh dead fish.*
[3] *Normal healthy appearing fish.*

Appendix Table A-14. ELISA readings (OD_{405}) of kidney samples' from Carson spring chinook fall release salmon (75.91) juveniles sampled during monthly monitoring from two Oregon raceways (03A and 038).

	ELISA OD_{405}		
Date sampled	03A[2]	03B[2]	03B[3]
9-92	.010	.004	.006
	.011	.016	.006
	.014	.019	.010
		.047	.027
		.602	.044

[1] *Individual kidney samples were homogenized in PBS-Tween 20 buffer at a 1:16 weight/volume dilution for the ELISA.*
[2] *Moribund or fresh dead fish.*
[3] Normal *healthy appearing fish.*

Appendix Table A-15. ELISA readings (OD_{405}) of kidney samples[1] from Carson spring chinook yearling salmon (75.91) juveniles sampled during monthly monitoring from four Oregon raceways (04A, 04B, 05A, and 05B).

	ELISA OD_{405}						
Date sampled	04A[2]	04A[3]	04B[2]	04B[3]	05A[2]	05B[2]	05B[3]
9-92	.006			.004	.007	.009	.012
				.008	.008	.014	.015
				.011	.010	.057	.017
				.015	.012		.066
				.035	.013		.081
10-92	,009		.011	.008	.007	.006	.008
	.036		.012	.013	.015	.007	.014
	.041		.048[4]	.014	.368[5]	.009	.015
	.047		.083[4]	.017		.044	.024
	.060			.110		.102[4]	.030
	.108[4]						
	.190						
	,432						
11-92	.002		.025	.035	.014	.013	.029
	.032		.027	.044	,064	.024	.036
	.150			.045	,067		.048
				.172	.134		.094
				.210	.195		.114
12-92	,044			.009	.006	.035	.022
				.015		.054[5]	.023
				.022			.037
				.025			.037
				,028			.110
1-93	.030		.068	.010	.086	.518	.019
	.066		.083	.015			.024
	.089		.098	.020			.024
	.148		.099	.021			.031
			.100	.027			.036
2-93	.028	.016	.015	.035	.013	.015	.018
	,042	.029	.019	.042	.022	.020	.019
	,044	.098	.036	.042	.023	.023	.020
	.063	.299	.045	.097	.035	.029	.024
	.126	.448	.121	.136	.052	.042	.064

1 *Individual kidney samples were homogenized in PBS-Tween 20 buffer at a 1:8 or 1:16 weight/volume dilution for the ELISA.*
2 *Moribund or fresh dead fish.*
3 *Normal healthy appearing fish.*
4 *Possible digestive tract contents in the sample.*
5 *Low sample volume inoculated.*

Appendix Table A-16. Preliberation ELISA readings (OD_{405}) of kidney samples[1] from 30 Umatilla summer steelhead (91.92) juveniles from each of three Michigan raceways (M5A, M5B and M5C). Means and ranges for each raceway are shown below the 30 individual sample readings. Fish in M5B and M5C were sampled on 3-17-93 at a mean body weight of 67 and 87 gms/fish, M5A was sampled on 4-14-93 at 58 gms/fish.

	ELISA OD_{405}		
Sample number	M5A	M5B	M5C
1	.005	.003	.002
2			
3	.008	.004	.003
4	.008	.004	.003
5	.009	.005	.003
6	.009	.005	.004
7	.009	.006	.005
8	.009	.006	.005
9	.010	.006	.005
10	.011	.006	.005
11	.011	.007	.006
12	.011	.007	.006
13	.012	.007	.007
14	.012	.008	.007
15	.012	.008	.007
16	.013	.009	.007
17	.013	.009	.007
18	.013	.010	.007
19	.014	,010	.007
20	.014	.010	.008
21	.014	.011	.008
22	.015	.014	.009
23	.016	.015	.010
24	.018	.015	.010
25	.019	.015	.010
26	.019	.018	.011
27	.020	.022	.012
28	.022	.022	.013
29	.032	.038	.013
30	.033	.084	.030
Mean	.014	.013	.008
Range	.005-.033	.003-.084	.002-.030

[1] *Individual kidney samples* were *homogenized in PBS-Tween 20 buffer at a 1:8 weight/volume dilution.*

Appendix Table A-17. Preliberation ELISA readings (OD_{405}) of kidney samples[1] from 30 Bonneville fall chinook salmon (95.92) juveniles from each of four Oregon raceways (O2A, O2B, O3A, and O3B), and six Michigan raceways (M2A, M2B, M2C, M3A, M3B, and M3C). Means and ranges for each raceway are shown below the 30 individual sample readings. Fish in Oregon raceways were sampled on 5-19-93 at a mean body weight of 6.5 gms/fish, and Michigan raceways on 5-19-93 were 7.6 gms/fish.

	ELISA OD_{405}									
Sample number	02A	02B	03A	O3B	M2A	M2B	M2C	M3A	M3B	M3C
1	.010	.006	.007	.003	.005	,007	.006	.005	.000	.007
2	.011	.007	.009	.005	.007	.008	.008	.012	.003	.008
3	.015	.008	.011	.007	.008	.009	.008	.013	.005	.009
4	.019	.008	.011	.008	.009	.010	.010	.015	.005	,011
5	.019	.010	.011	.008	.009	.010	.012	.016	.006	.011
6	.020	.010	.012	.009	.012	.011	.015	.017	.007	.012
7	.021	.011	.012	.009	.012	.012	.016	.017	.008	.013
8	.021	.013	.012	.009	.013	.013	.016	.019	.009	.013
9	.023	.013	.012	.010	.013	.013	.016	.019	.009	.013
10	.023	.014	.013	.011	.014	.014	.016	.019	.009	.014
11	,024	.015	.014	.011	.015	.015	.017	.022	.009	.015
12	,025	.016	.014	.012	.015	.015	.018	.024	.010	.015
13	.025	.016	.014	.012	.015	.015	.018	.025	.011	.015
14	.025	.016	.015	.013	.016	.015	.019	.025	.012	.015
15	.027	.017	.016	.014	.017	.016	.020	.025	.012	.016
16	.027	.019	.017	.014	.023	.017	.020	.028	.014	.016
17	.028	.021	.017	.015	.025	.017	.022	.030	.015	.016
18	,029	.022	.018	.015	.025	.018	.024	.030	.015	.016
19	.030	.023	.021	.018	.025	.019	.025	.031	.015	.017
20	.030	.024	.023	.018	.026	.022	.026	.033	.016	.017
21	.034	.025	.024	.018	.026	.023	.026	.034	.017	.017
22	.035	.025	.024	.020	.026	.025	.029	.037	.018	.022
23	.035	.025	.025	.021	.026	.028	.032	.040	.019	.024
24	.042	.029	.028	.025	.027	.030	.032	.043	.020	.025
25	.044	.031	.028	.026	.028	.035	.033	.043	.021	.026
26	.044	.031	.029	.028	.030	.035	.040	.048	.026	.030
27	.056	.032	,029	.031	.031	,046	.040	.061	.036	.030
28	.059	.033	.033	.033	.037	.051	.045	.079	.042	.040
29	.095	.033	.036	.035	.037	.064	.048	.131	.045	.041
30	.247	.046	.057	.039	.085	.050	.282	.331	.053	.919
Mean	.038	.020	.020	.017	.022	.021	.024	.041	.026	.048
Range	.010-.247	.006-,046	.007-.057	.003-.039	.005-,085	.007-.064	.006-.050	.005-.282	.000-.331	.007-.919

[1] *Individual kidney samples* were *homogenized* in *PBS-Tween 20 buffer* at *a 1:16 weight/volume dilution.*

Appendix Table A-18. Comparative ELISA and DFAT results for *Renibacterium salmoninarum* in kidney samples from 120 Bonneville fall chinook yearling salmon (95.91) from each of six raceways (A-l through A-6) at Bonneville on 2-25-93. Twenty fish per raceway were grab-sampled and assayed by both the ELISA and DFAT.

	RACEWAY ELISA OD_{405} & DFAT DENSITY[2]					
Sample	A-l		A-2		A-3	
number	ELISA	DFAT	ELISA	DFAT	ELISA	DFAT
1	0.260	-	0.240		**2.933**	4t
2	2.327	3t	0.240		1.186	-
3	0.067		1.166		2.572	2t
4	2.280	2t	0.112		2.255	3t
5	0.109	-	1.271		0.389	
6	0.216		0.189		0.108	
7	2.565	4t	0.376		0.214	
8	1.925	t	1.095		0.847	-
9	0.973		0.089		2.824	3t
10	0.458		0.072		2.970	4+
11	0.342	+	0.17		**2.739**	4t
12	1.424	1+	NS[3]		0.110	
13	2.063	2t	0.196		2.799	4t
14	1.714	1+	0.647		0.327	
15	1.729	2t	0.039		2.694	4t
16	0.638		0.251		**2.946**	4t
17	0.926		0.662		2.063	2t
18	2.616	3t	0.235		1.101	3t
19	1.454		1.264		1.357	3t
20	1.999	1+	0.090		3.016	4t
Proportion positive	19/20	11/20	15/19	0/20	20/20	13/20

1 *Individual kidney samples were homogenized in PBS-Tween 20 buffer at a 1:8 weight/volume dilution.*

2 *The DFAT density results indicate the number of fluorescing cells observed per field as follows: - indicates no cells, 1+ indicates 1-9 cells, 2t indicates 10-99 cells, 3t indicates 100-999 cells, 4t indicates more than 1,000 cells.*

3 *NS indicates that no sample was available*

Appendix Table A-18. Continued.

Sample number	RACEWAY ELISA OD_{405} & DFAT DENSITY[2]					
	A-4		**A-5**		**A-6**	
	ELISA	DFAT	ELISA	DFAT	ELISA	DFAT
1	0.100	-	0.091		0.049	-
2	0.199	-	0.335		0.057	-
3	0.076	-	0.070		0.054	-
4	0.386	-	0.079	-	0.096	-
5	0.103	-	0.099	-	0.088	-
6	0.042		0.168		0.111	-
7	0.063		0.059		0.119	-
8	0.082		0.181		0.060	-
9	0.106	-	0.044	-	0.356	t
10	0.051		0.060		0.048	-
11	*0.092*		0.067	-	0.091	-
12	0.088		0.063		0.068	-
13	0.098		0.060		0.279	-
14	0.095	-	0.075	-	0.028	-
15	0.059		0.208		0.048	-
16	0.136	-	0.031	-	0.127[4]	-
17	0.062	-	0.024		0.042	-
18	0.075	-	0.130		0.031	-
19	0.081	-	0.049		0.047	-
20	0.040	-	0.021		0.048	-
Proportion positive	6/20	0/20	5/20	0/20	5/20	1/20

2 ***The DFAT density results indicate the number of fluorescing cells observed per field as follows: - indicates no cells,*** 1t ***indicates l-9 cells,*** 2t ***indicates 10-99 cells,*** 3t ***indicates 100-999 cells,*** 4t ***indicates more than 1,000 cells.***

4 ***This sample had a low inoculum volume of 100 ul.***

Appendix Table A-19. Preliberation ELISA readings (OD405) of kidney samples[1] from 30 Carson spring chinook subyearling salmon (75.92) juveniles from each of six Michigan raceways (M6A, M6B, M6C, M7A, M7B, and M7C). Means and ranges for each raceway are shown below the 30 individual sample readings. Fish in Michigan raceways were sampled on 5-04-93 at. a mean body weight of 10.2 gms/fish.

Sample number	ELISA OD_{405} M6A	M6B	M6C	M7A	M7B	M7C
1	.008	.009	.004	.014	.012	.003
2	.008	.016	.010	.015	.016	.007
3	.009	.017	.011	.016	.019	.008
4	.009	.018	.012	.018	.021	.009
5	.010	.019	.014	.018	.024	.011
6	,014	.020	.015	.019	.024	.011
7	.017	.023	.016	.019	.025	.012
8	.017	.023	.017	.024	.025	.014
9	.019	.024	.017	.024	.026	.014
10	.020	.025	.017	.024	.026	.015
11	.023	.026	.018	.024	.027	.015
12	.029	.028	.019	.027	.027	.016
13	.032	.030	.024	.028	.029	.016
14	.032	.031	.026	.029	.036	.021
15	.034	.032	.028	.029	.037	.023
16	.038	.034	.029	.030	.043	.025
17	.039	.034	,030	.032	.043	.028
18	.046	.037	.030	.033	.046	.030
19	.046	.037	.035	.034	.048	.036
20	.048	.041	.037	.035	.057	.043
21	.054	.041	.039	.035	.071	.044
22	.056	,043	.040	.036	.083	.046
23	.056	.043	.044	.037	.084	.047
24	.056	.047	.051	.040	.094	. 049
25	.063	.050	.053	.040	.107	.050
26	.070	.051	.056	.041	.144	.052
27	.090	.058	.076	.057	.161	.066
28	.098	.059	.256	.515	.161	.161
29	.120	.085	.409	.518	.191	.623
30	.260	.964	.573	1.050	.333	1.664
Mean	,047	.066	.067	.095	.068	.105
Range	.008-.260	.009-.964	.004-.573	.014-1.050	.012-.333	.003-1.664

[1] *Individual kidney samples were homogenized in PBS-Tween 20 buffer at a 1:8 weight/volume dilution.*

Appendix Table A-20. Preliberation ELISA readings (OD_{405}) of kidney samples[1] from 30 Carson spring chinook fall release salmon (75.91) juveniles from each of two Oregon raceways (03A and 038). Means and ranges for each raceway are shown below the 30 individual sample readings. Fish in two Oregon raceways were sampled on 10-27-92 at a mean body weight of 22.7 gms/fish.

Sample number	ELISA OD_{405} 03A	03B
1	.005	.005
2	.007	,006
3		
4	.008	.012
5	.010	.012
6	.010	.014
7	.011	.014
8	.011	.015
9	.011	.016
10	.011	.016
11	.012	.016
12	.012	.016
13	.012	.016
14	.012	.017
15	.013	.017
16	.013	.019
17	.014	.019
18	.014	.020
19	.014	.020
20	,015	.021
21	.015	.021
22	.017	.021
23	.020	.022
24	.020	.022
25	.021	.024
26	.021	.025[2]
27	.025	.031
28	.035	.034
29	.037	.034
30	.060	.053
Mean	.016	.020
Range	.005-.060	.005-.053

[1] *Individual kidney samples* were *homogenized in PBS-Tween 20 buffer at a 1:16* weight/volume *dilution.*

[2] *Possible* digestive tract contents in sample.

Appendix Table A-21. Preliberation ELISA readings (OD_{405}) of kidney samples[1] from 30 Carson spring chinook yearling salmon (75.91) juveniles from each of four Oregon raceways (04A, 04B, 05A, and 05B). Means and ranges for each raceway are shown below the 30 individual sample readings. Fish in four Oregon raceways were sampled on 3-17-93 at. a mean body weight of 52.2 gms/fish.

Sample number	ELISA OD_{405} 04A	04B	05A	05B
1	.007	.008	.004	.009
2	.007	.014	.007	.012
3	.007	.015	.008	.013
4	.008	.016	.009	.015
5	.009	.016	.010	.015
6	.009	.017	.012	.015
7	.010	.017	.013	.015
8	.011	.018	.014	.019
9	.013	.019	.015	.020
10	.013	.021	.015	.021
11	.013	.022	.015	.022
12	.014	.024	.018	.022
13	.014[2]	.026	.019	.022
14	.016	.026	.021	.022
15	.016	.027	.023	.026
16	.018	.028	.023	.027
17	.018	.028	.024	.028
18	.019	.028	.024	.028
19	.020	.030	.026	.029
20	.020[2]	.030	.028	.029
21	.021	.032	.035	.031
22	.032	.039	.036	.035
23	.032	.041	.037	.039
24	.034	.044	.046	.039
25	.037	.048	.057[2]	.041
26	.040	.050	.066	.043
27	.064	.051	.070	.046
28	.064	.054	.072	.063
29	.073	.056	.075	.069
30	.088	.058	.090	.074
Mean	.025	.030	.030	.030
Range	.007-.088	.008-.058	.004-.090	.009-.074

1 *Individual kidney samples* were *homogenized in PBS-Tween 20 buffer at a 1:8 weight/volume dilution.*

2 Possible digestive tract contents in sample.

Appendix Table A-22. Preliberation ELISA readings (OD_{405}) of kidney samples[1] from 120 Carson spring chinook yearling salmon (75.91) juveniles from each of four raceways (B1, B2, B3, and B4) at Bonneville Hatchery. Means and ranges for each raceway are shown below the 30 individual sample readings. Fish in four raceways were sampled on 3-19-93 at a mean body weight. of 38.3 gms/fish.

	ELISA OD_{405}			
Sample number	B1	B2	B3	B4
1	.011	.006	.000	.000
2	.016	.009	.005	.006
3	.019	.009	.006	.007
4	.022	.009	.006	.007
5	.023	.012	.010	.009
6	.025	.012	.011	.011
7	.034	.012	.013	.013
8	.038	.013	.013	.013
9	.039	.014	.014	.014
10	.039	.014	.016	.015
11	.040	,016	.016	.018
12	.043	.017	.016	.019
13	.046	.017	.016	.021
14	.046	.018	.017	.022
15	.047	.021	.017	.022
16	.059	.021	.018	.023
17	.061	.022	.019	.023
18	.062	.024	.019	.027
19	.094	.024	.021	.027
20	.103	.030	.022	.027
21	.108	.031	.023	.028
22	.119	.031	.024	.030
23	.128	.031	.025	.030
24	.136	.034	.027	.033
25	.138	.034	,028	.035
26	.143	.038	.030	.047
27	.156	.054	.031	.048
28	.171	.055	.036	.052
29	.184	.079	.065	.125
30	.787	.133	.223	.479
Mean	.098	.028	.026	.041
Range	.011-.787	.006-.133	.000-.223	.000-,479

[1] *Individual kidney samples were homogenized in PBS-Tween 20 buffer at a 1:8 weight/volume dilution.*

Appendix Table A-23. ELISA readings (OD_{405}) of kidney samples[1] from 104 Umatilla summer steelhead spawned in 1993.

Sample number	ELISA OD_{405}	Sample number	ELISA OD_{405}	Sample number	ELISA OD_{405}
1	.003	36	,009	71	.018
2	.003	37	,009	72	.018
3	.004	38	.009	73	.019
4	.004	39	.010	74	.019
5	.004	40	.010	75	.019
6	.004	41	.010	76	.019
7	.004	42	.010	77	.020
8	.005	43	.010	78	.020
9	.005	44	.010	79	.020
10	.005	45	.010	80	,021
11	.005	46	,010	81	.021
12	.005	47	.011	82	.021
13	.005	48	.011	83	.022
14	.005	49	.011	84	.022
15	.006	50	.011	85	.022
16	.006	51	.011	86	.023
17	.006	52	.011	87	.023
18	,006	53	.012	88	.024
19	.006	54	.012	89	.025
20	.006	55	.012	90	.027
21	.007	56	.012	91	.028
22	.007	57	.013	92	.030
23	.007	58	.013	93	.031
24	.007	59	.014	94	.032
25	.007	60	.014	95	.032
26	.008	61	.014	96	.032
27	.008	62	.014	97	.036
28	.008	63	.015	98[2]	.047
29	.008	64	.015	99[2]	.020
30	.008	65	.015	100[2]	.028
31	.009	66	.015	101[2]	.029
32	.009	67	.015	102[2]	.031
33	.009	68	.016	103[2]	.033
34	.009	69	.017	104[2]	.088
35	.009	70	.018		

[1] *Individual kidney samples were homogenized in PBS-Tween 20 buffer at a 1:4 weight/volume dilution.*

[2] *These samples were from adult mortalities.*

Appendix Table A-24. Proportions and prevalencfs of infectious hematopoietic necrosis virus (IHNV) detected in ovarian fluid and pyloric caeca/kidney/spleen (PKS) samples collected from Bonneville fall chinook salmon (95.00) spawned for Umatilla Hatchery production in 1992.

Date sampled	Proportion and prevalence (%) of IHNV	
	Ovarian fluid	PKS
1 l-02-92	0/20 (0)	0/12 (0)
11-10-92	1/20 (5)	
11-13-92	0/2 (0)	
11-16-92	6/20 (30)	
1 l-23-92	0/23 (0)	
1 l-25-92	4/20 (20)	
11-30-92	4/20 (20)	
12-10-93	19/30 (63)	

[1] *Ovarian fluids were three-female pooled samples.*
[2] *PKS samples were from five-female pooled samples.*

Appendix Table A-25. Distribution by ELISA (OD_{405}) of 2550 kidney samples[1] from Bonneville fall chinook salmon spawned in 1992.

	Number of fish per Range of ELISA OD_{405}						
Spawning date	.000-.099	.100-.199	.200-.399	.400-.599	.600-.799	.800-.999	>1.000
1 l-02-92	102	6		1	4		1
1 l-06-92	269	5	1		1	2	5
1 l-10-92	473	32	3	1	1	2	4
11-13-92	229	1		1			
11-16-92	364	11	1	4	2	1	7
11-19-92	126	7		2	3	2	5
ii-23-92	79	4					6
1 l-30-92	192	16	6	1	2	2	20
12-4-92	120	20	10	4			12
12-18-92	4	1	1				1

[1] *Individual kidney samples were homogenized in PBS-Tween 20 buffer at a 1:4 weight/volume dilution.*

* *These analyses were done and data provided by the ODFW Corvallis Fish Pathology Laboratory funded under a Bonneville Power Administration Bacterial Kidney Disease contract.*

Appendix Table A-26. Proportions and prevalences of erythrocytic inclusion body syndrome (EIBS) detected in blood smears collected from Bonneville fall chinook salmon (95.00) spawned for Umatilla Hatchery production in 1992.

Date sampled	Proportion and prevalence (%) of EIBS	
	Male	Female
11-06-92	1/10 (10)	1/20 (5)
11-10-92	0/15 (0)	0/15 (0)
11-16-92	1/10 (10)	0/10 (0)
11-23-92	7/20 (35)	0/11 (0)
11-30-92	2/15 (13)	0/63 (0)
12-04-93	3/20 (15)	0/85 (0)
Total	14/90 (16)	1/204 (1)

Appendix Table A-27. Date and number of spawned adults sampled for erythrocytic inclusion body syndrome (EIBS) and culturable viruses from Umatilla fall chinook salmon (91.00) at Minthorn Ponds in 1991. Culturable viruses were sampled for as individual ovarian fluids (OF) from females or individual milts (M) from males, and two-fish pyloric caeca/kidney/spleen (PKS) pools from two females.

Date sampled	Number Sampled for EIBS	Number and type of sample for culturable viruses		
		OF	M	PKS
11-06-91	32	31	31	15
11-12-91	28	46	46	15
11-14-91	0	30	30	
11-18-91	20	29	29	
11-21-91	0	17	17	
11-26-91	6	6	6	

Appendix Table A-28. ELISA readings (OD_{405}) of 112 kidney samples[1] from the Umatilla fall chinook salmon (91.00) **adults in** 1991.

Date sampled	ELISA OD_{405} Female	Male
1 l-06-91	.009	.004
	.009	.004
	,013	,004
	,014	.004
	.015	.006
	.017	.006
	.018	.008
	.019	.012
	.021	,015
	.092	.045
	.038[2]	
11-12-91	.009	.005
	.012	,006
	.014	.006
	.016	.008
	,020	.008
	.021	.011
	.023	.013
	.023	.013
	,030	.013
	.039	.017
11-14-91	.008	.001
	.009	.004
	.011	,007
	.011	.008
	.012	.009
	.013	.011
	.016	.011
	.021	.011
	.021	.011
	.028	.011
11.-18-91	.005	.005
	.008	.005
	.010	,008
	.012	.012
	.013	.013
	.013	.014

1 *Individual kidney samples were homogenized in PBS-Tween 20 buffer at a 1:4 weight/volume dilution.*

2 *This sample was from an adult mortality.*

Appendix Table A-28. Continued.

Date sampled	ELISA OD_{405} Female	Male
11-18-91	.014	.016
	.015	.018
	.016	,020
	.023	
11-21-91	.005	.005
	.008	.005
	.010	.008
	.012	,012
	.013	.013
	.013	.014
	.014	.016
	.015	,018
	.016	.020
	.023	
11-26-91	.005	.005
	.006	.007
	.007	.008
	.008	.011
	.011	.014
	.022	,040

Appendix Table A-29. Date and number of spawned adults sampled for erythrocytic inclusion body syndrome (EIBS) and culturable viruses from Umatilla fall chinook salmon (91.00) at Minthorn Ponds in 1992. Culturable viruses were sampled for as individual ovarian fluids (OF) from females or individual milts (M) from males, and two-fish pyloric caeca/kidney/spleen (PKS) pools from two males or two females.

Date sampled	Number Sampled for EIBS	Number and type of sample for culturable viruses: OF	M	PKS
1 l-09-92	26	13	13	14
11-13-92	30	15	15	16
11-16-92	14	7	7	7
11-19-92	28	16	16	16
11-24-92	14	7	7	7

Appendix Table A-30. ELISA **readings** (OD_{405}) **of 115 kidney samples**[1] **from Umatilla fall chinook salmon** (91.00) **adults in 1992.**

Date sampled	ELISA OD_{405} Female	Male
1 l-09-92	.001	.001
	.006	.001
	.007	.003
	.008	.003
	.009	.003
	.009	.003
	.009	.004
	.011	.006
	.011	.007
	.011	.007
	.013	.008
	.014	.011
	.016	.023
11-13-92	.001	,002
	,004	.004
	.004	.005
	.004	.006
	.004	.006
	.005	.007
	.006	.008
	.007	.008
	.009	.009
	.009	.009
	.010	.010
	.010	.010
	.012	.011
	.012	.013
	.022	.014
11-16-92	.007	.009
	.008	.011
	.010	.011
	.010	.014
	.011	.015
	.015	.016
		.023
11-19-92	.002	,006
	.005	.007
	.008	.009

[1] *Individual kidney samples* were *homogenized in PBS-Tween 20 buffer* at *a 1:4 weight/volume dilution.*

Appendix Table A-30. Continued.

Date sampled	ELISA OD_{405} Female	Male
11-19-92	-009	.010
	.009	.011
	.010	.013
	.011	.013
	.013	.013
	.013	.013
	.024	.014
	.025	.023
	.028	.027
	.045	.033
	.063	.040
	.067	.043
	,069	.061
1 l-24-92	.002	.003
	.003	.005
	.004	.019
	.004	.019
	.008	.030
	.010	.063
	.011	.199

Appendix Table A-31. Proportions and prevalences of infectious hematopoietic necrosis virus (IHNV)[1] detected in individual ovarian fluid and milt samples collected from Carson spring chinook salmon (75.00) spawned for Umatilla Hatchery production in 1991.

Date sampled	Proportion and prevalence (%) of IHNV	
	Ovarian fluid	Milt
8-05-91	37/48 (77.1)	4/46 (8.7)
8-12-91	89/124 (71.8)	21/68 (30.9)
8-19-91	134/148 (90.5)	30/74 (40.5)
8-26-91	40/40 (100)	4/26 (15.4)

[1] *An isolate was characterized by reaction with monoclona7 antibody 2NH105B using an indirect fluorescent antibody assay as a Type 2 strain of IHNV. IHNV titers ranged from 1 X 10 to 3 X 10 plaque forming units/ml.*

Appendix Table A-32. Proportions and prevalences of *Renibacterium salmoninarum* detected by the direct fluorescent antibody test in smears made from ovarian fluid cell pellets in samples collected from Carson spring chinook salmon (75.00) females spawned in 1991.

Date sampled	*Renibacterium salmoninarum* positives'	
	Proportion	Percent
8-05-91	13/172	7.6
8-19-91	1/120	0.8
8-20-91	0/68	0

[1] *Six of the 14 positives rated at the 1+ 7evel* for Renibacterium salmoninarum, *two at the* 2t *level*, *two at the* 3t *level and four at the* 4t *level.*

Appendix Table A-33. Proportions and prevalences of infectious hematopoietic necrosis virus (IHNV)[1] detected in individual ovarian fluid and milt samples, and five-fish pooled pyloric caeca/kidney/spleen (PKS) samples collected from Carson spring chinook salmon (75.00) spawned for Umatilla Hatchery production in 1992.

Date sampled	Proportion and prevalence (%) of IHNV		
	Ovarian fluid	Milt	PKS
8-03-92	30/40 (75.0)	9/20 (45.0)	5/8 (62.5)
8-10-92	33/44 (75.0)	5/22 (22.7)	l/4 (25.0)
8-18-92	67/80 (83.8)		
8-19-92	50/60 (83.3)		
8-26-92	118/140 (84.3)		

1 *An isolate was characterized by reaction with monoclonal antibody 2NH105B using an indirect fluorescent antibody assay as a Type 2 strain of IHNV. IHNV titers ranged from 1 X 10 to 3 X 10 plaque forming units/ml.*

Appendix Table A-34. Proportions and prevalences of *Renibacterium salmoninarum* detected by the direct fluorescent antibody test in smears made from ovarian fluid cell pellets in samples collected from Carson spring chinook salmon (75.00) females spawned in 1992.

Date sampled	*Renibacterium salmoninarum* positives[1]	
	Proportion	Percent
8-03-92	14/40	35.0
8-10-92	19/44	43.2

1 *Sixteen of the 33 positives rated at the* ***1+*** *level for* Renibacterium salmoninarum, *nine at the 2+ level, four at the* 3t *level, four at the* ***4+*** *level.*

Appendix Table A-35. ELISA readings (OD 405) of 41 kidney samples[1] from Carson spring chinook salmon (75.00) adults in 1992.

Date sampled	ELISA OD_{405} Female	ELISA OD_{405} Male
7-24-92	.112	.259
	,152	.281
	.315	.292
	.364	.314
	.393	.350
	.435	.410
	.445	.557
	,808	.563
	1.544	1.098
	2.482	1.949
8-17-92	.029	.020
	.034	.026
	,036	.028
	.039	.160
	.044	.297
	.049	1.089
	.053	2.198
	.055	2.588
	.062	
	.074	
	.825	
	2.111	
	2.527	

[1] *Individual kidney samples were homogenized in PBS-Tween 20 buffer at a 1:4 weight/volume dilution.*

Appendix Table A-36. Date and number of fish sampled for erythrocytic inclusion body syndrome (EIBS) in blood smears collected from Carson spring chinook salmon (75.00) spawned for Umatilla Hatchery production in 1992.

Date samoled	Number of fish sampled
8-10-92	33
8-18-92	20

Appendix Table A-37. ELISA readings (OD_{405}) of kidney samples from Carson spring chinook (75.91) juveniles before and after their second 21 consecutive day feeding regimen with erythromycin. Thirty fish from raceway 04A were sampled on 23 July 1992 (pre-feeding) and 30 were sampled on 23 September 1992 (post-feeding). Thirty fish from 05A were also sampled on 23 September 1992 and served as non-treated post-second feeding controls.

	ELISA OD_{405}		
	Pre-Second Feeding	Post-Second Feeding	
		Erythromycin	Control
Sample Number	Raceway 04A	Raceway 04A	Raceway 05A
1	,086	.094	.088
2	.087	.095	.092
3	,088	.097	.095
4	,089	.098	,096
5	,089	.099	.096
6	.089	,099	.096
7	.089	.100	.096
8	.090	.100	.097
9	.091	.101	.097
10	.091	.102	.098
11	,091	.103	.098
12	.091	.103	.100
13	.091	.104	.101
14	.092	.105	.103
15	.092	.106	.104
16	.092	.106	.107
17	,093	.106	.107
18	.093	.107	.107
19	.094	.107	.110
20	.095	.107	.111
21	.095	.107	.111
22	.098	.107	.115
23	.099	.108	.115
24	.105	.108	.117
25	.109	.109	.119
26	.109	.109	.123
27	.110	.110	,123
28	.111	.111	.139
29	.121	.123	.159
30	.232	.128	.246
Mean	.100	,105	.112
Range	.086-.232	.094-.128	.088-.246
Standard Deviation	.026	.007	.029