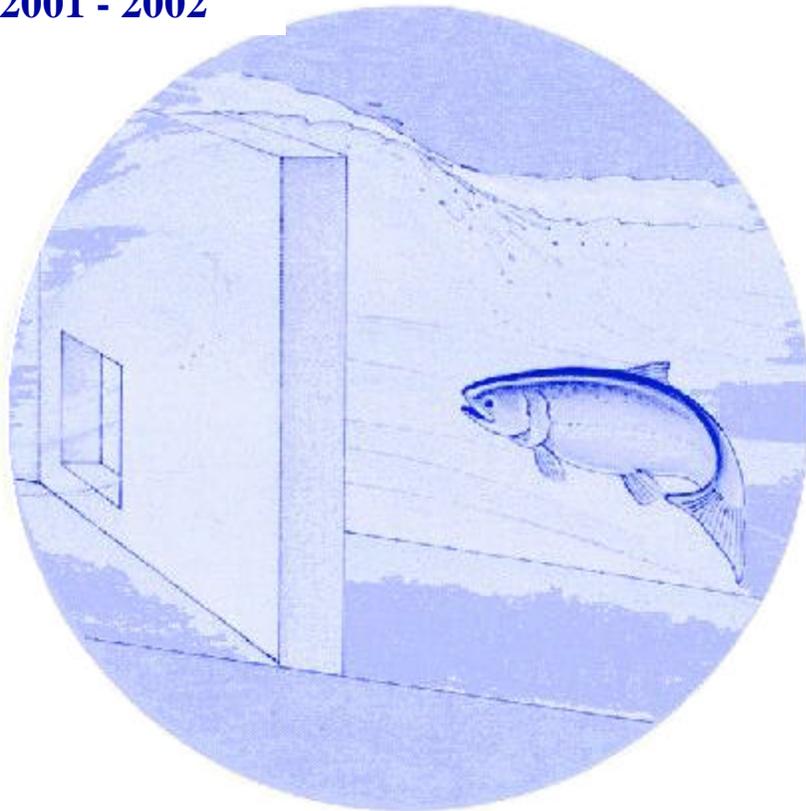


# Yakima/Klickitat Fisheries Project

Washington Department of Fish and Wildlife Policy/Technical  
Involvement and Planning

Annual Report  
2001 - 2002



DOE/BP-00006215-1

March 2003

This Document should be cited as follows:

*Pearsons, Todd, John Easterbrooks, "Yakima/Klickitat Fisheries Project", Project No. 1995-06425, 16 electronic pages, (BPA Report DOE/BP-00006215-1)*

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This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA.

**WDFW POLICY/TECHNICAL INVOLVEMENT AND  
PLANNING IN THE YAKIMA/KLICKITAT FISHERIES  
PROJECT**

**Annual Report 2001-2002**

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**Project Number 1995-064-25**

**March 2003**

## **Introduction**

The Yakima/Klickitat Fisheries Project (YKFP) is a supplementation project sponsored by the Northwest Power Planning Council (Columbia River Basin Fish and Wildlife Program 1994, Measure 7.4K). The objectives of the YKFP are: 1 - to test the hypothesis that new supplementation techniques can be used in the Yakima River Basin to increase natural production and to improve harvest opportunities while maintaining the long-term genetic fitness of the wild and native salmonid populations and keeping adverse ecological interactions within acceptable limits (Yakima Fisheries Project Final Environment Impact Statement, 1996); 2 - provide knowledge about the use of supplementation, so that it may be used to mitigate effects on anadromous fisheries throughout the Columbia River Basin; 3 - to maintain and improve the quantity and productivity of salmon and steelhead habitat, including those areas made accessible by habitat improvements; 4 - to ensure that Project implementation remains consistent with the Council's Fish and Wildlife Program; and 5 - to implement the Project in a prudent and environmentally sound manner. Current YKFP operations have been designed to test the principles of supplementation (Busack et al. 1997). The Project's experimental design has focused on the following critical uncertainties affecting supplementation:

1. The survival and reproductive success of hatchery fish after release from the hatchery;
2. The impacts of hatchery fish as they interact with non-target species and stocks; and,
3. The effects of supplementation on the long-term genetic fitness of fish stocks.

The YKFP endorses an adaptive management policy applied through a project management framework as described in the Yakima/Klickitat Fisheries Project Planning Status Report (1995), Fast and Craig (1997), Clune and Dauble 1991. The project is managed by a Policy Group consisting of a representative of the Yakama Nation (YN, lead agency) and a representative of the Washington Department of Fish and Wildlife (WDFW). The functions of the parties are described in an MOU between the YN and the WDFW. A Scientific and Technical Advisory Committee (STAC) consisting of one representative from each management entity reports to the Policy Group and provides technical input on policy and other issues. Additional committee's, such as the Monitoring Implementation and Planning Team (MIPT), serve as the discretion of STAC. The Policy Group and STAC meet periodically (usually monthly) to conduct the business of the YKFP.

Although the YKFP is an all stocks initiative (BPA 1996), most effort to date has been directed at spring chinook salmon and coho salmon. This report is a compilation of the year's activities between August 1, 2001 and July 31, 2002. All findings should be considered preliminary until data collection is completed or the information is published in a peer-reviewed journal.

## **Progress**

The policy level activities that John Easterbrooks (WDFW, Policy Representative) attended to during the past year included:

- 1) Attended and participated in monthly YKFP Policy Group meetings and 2002 Project Annual Review.
- 2) Resumed work on Cle Elum Hatchery interpretive display (I.D.) committee in August 2001 with Bonneville Power Administration (BPA, David Byrnes, Dave Thomas) and Dan Barrett (Cle Elum Supplementation and Research Facility manager). Worked on designing and siting I.D. infrastructure (signage kiosks) and began development of display content. Attended follow-up meeting in January 2002 to continue work on content “story line”.
- 3) Worked with STAC and MIPT members and Yakama Nation Policy lead from Fall, 2001 to Spring, 2002 to develop a coordinated response to the Independent Scientific Review Panel’s (ISRP) review of the YKFP Monitoring & Evaluation Project during the FY2002 Columbia Plateau Provincial Review. Together, with YN policy rep., approved the preferred experimental design to investigate “hatchery domestication selection” utilizing a wild x wild “control” line and an experimental hatchery x hatchery (H x H) line of spring chinook at the Cle Elum Hatchery.

One policy decision critical to the YKFP’s affirmative response to the ISRP review included acknowledgement by the co-managers that surplus H x H adults returning to Roza Dam must be removed (killed, if necessary) to prevent them from spawning in the upper Yakima Basin with natural-origin and YKFP supplementation adults.

Another policy decision I (John Easterbrooks) made as YKFP policy representative and WDFW Regional Fish Program Manager, was to commit WDFW to target the non-tribal spring chinook sport fishery on YKFP hatchery fish unless the natural-origin run were to be exceptionally large. Selectively harvesting marked hatchery fish will address three major concerns of the ISRP:

- a) The selective fishery will be used to help manage the proportion of hatchery-origin fish on the upper Yakima Basin spawning grounds to prevent “genetic overwhelming” of natural-origin fish,
  - b) It will reduce fishing mortality impacts to the unsupplemented Naches Basin stocks (Naches R. and American R.) by eliminating direct harvest and reducing incidental hooking mortality through protective gear restrictions, and
  - c) A selective fishery will reduce the potential for negative genetic impacts of hatchery supplementation fish or H x H control-line fish straying into the Naches Basin and spawning with wild fish.
- 4) Compiled and edited comments from WDFW STAC and MIPT members and drafted the final response letter (10 pages) to the YN on the 2001 Coho Planning Status Report (PSR) in November 2001.

- 5) Developed a detailed response in December, 2001 for distribution to the general public defending the YKFP from unwarranted criticism concerning salmon supplementation in the upper Yakima Basin. There is considerable concern from trout anglers that the “blue ribbon” fishery in the upper Yakima R. above Roza Dam is being harmed by the YKFP. During the 2001 drought year, the high incidence of precocialism by YKFP smolts was a particular concern of trout anglers. This generated considerable correspondence to WDFW that had to be responded to by the YKFP Policy Rep./Regional Fish Program Manager. With data and input from WDFW’s Ecological Interactions Team, we were able to develop a strong, science-based response that was widely circulated among the angling public. This has helped to build support for the YKFP and maintain lines of communication with WDFW’s trout fishing constituency.
- 6) Tasked to independently develop justification supporting the Cle Elum Hatchery’s three surface water right applications pending with the Washington Department of Ecology (DOE). Analyzed the data and wrote a “white paper” in February, 2002 which was submitted to DOE. In April, 2002, DOE issued five-year, temporary permits authorizing continued diversion of 11,220 gpm (25.0 cfs) instantaneous flow for fish propagation. Based on the technical analysis provided to DOE, the surface water permits are “non-interruptible” with no requirement to curtail pumping for the hatchery because of low river flow. The continued operation of the CESRF hinged on successfully securing an extension of the temporary water rights.
- 7) Documented (written) policy decisions approved in 2002:
  - Approved use of Easton Ponds for coho smolt acclimation for 6-8 weeks and closed the affected ponds to trout fishing for the duration of YKFP use (2002-01).
  - Approved use of 100 YKFP adult spring chinook for research of migration energy expenditures of fish migrating in the Columbia R. past hydroelectric dams (2002-02).
  - Approved the preferred “domestication selection” experimental design developed by STAC and MIPT. Authorized staff to begin implementation of the plan with collection of hatchery fish brood stock at Roza Dam to initiate the H x H line (2002-03).
  - Approved a CWU research proposal to study the effects of genetics and diet on age 0+ precocialism at the Cle Elum Hatchery (2002-04).
  - Approved a policy proposed by STAC to address disease risks associated with rearing spring chinook at CESRF from parents that are confirmed to have high concentrations of Bacterial Kidney Disease (BKD) pathogens. The policy includes measures to minimize the potential for spawning high BKD fish in the future. It also directs fish culture staff to destroy fertilized eggs or fry from high BKD parents at the earliest time after confirmation of their status (2002-05).

Technical recommendations were provided to the policy group concerning a variety of issues such as: disease risk and management, domestication experimental design, mixed stock fisheries issues, genetic risks, quantitative objectives, and study recommendations (e.g., precocialism, physiology). Technical information about the Klickitat Basin was also provided to the YN as part of the Master Planning Process. Much technical planning and policy focus has been on responding to Independent Scientific Review Panel (ISRP) comments, particularly the development of an experimental design that would adequately test domestication. Monitoring and evaluation results for 2001 were presented at a Project Annual Review (PAR) in March 2002.

Current information indicates that natural production and harvest goals are on track, ecological impacts are within acceptable limits, and useful information is being disseminated. Adults that have been taken to the hatchery have had higher return rates than fish that were left to spawn in the river. Most of the demographic variables that have been measured on hatchery and wild fish have been similar. However, the size-at-age of hatchery returnees has been smaller than fish produced in the river. The status of most non-target taxa (NTT) are within acceptable limits, and those that are not, were caused by factors other than supplementation. There appears to be significant constraints to natural production including, but not limited to, predation by fish and birds, and intra- and interspecific competition for food and space.

Summaries of each WDFW topical 2001 annual report, that has been produced under the Yakima/Klickitat Fisheries Project Monitoring and Evaluation Contract (Project 1995-064-24), have been reproduced below.

## Demographics

*Knudsen, C. 2002. Reproductive Ecology of Yakima River Hatchery and Wild Spring Chinook and Juvenile-to-Adult PIT Tag Retention. Project Number 1995-064-24. Annual Report 2001. DOE/BP-00004666-3.*

This is the first of a series of annual and progress reports that address reproductive ecological research and comparisons of hatchery and wild origin spring chinook in the Yakima River basin. In addition, research on retention and loss of PIT tags from the juvenile to adult stage are also included. Baseline data have been collected prior to supplementation to characterize the baseline reproductive ecology, demographics and phenotypic traits of the unsupplemented upper Yakima population, however this report focuses on data collected on hatchery and wild spring chinook returning in 2001; the first year of hatchery adult returns. This report is organized into three chapters. Summaries of each chapter are included below.

**Adult traits:** Size-at-Age - Naturally spawning age-3 and age-4 hatchery fish were significantly smaller than wild fish of the same age: 2.9 cm smaller in 3-year olds and 2.1 cm smaller in 4-year olds. Both 3- and 4-year old hatchery origin fish weighed approximately 0.3 kg less than wild fish of the same age. There was no significant Treatment effect (OCT vs SNT) in body size. Age-4 fish from the American River (male 67.6 cm; female 64.3 cm) were larger than Naches fish (male 63.3 cm; female 63.3 cm). American River fish (male 83.3 cm; female 76.4 cm) were also larger at age-5 than Naches fish (male 71.9 cm; female 74.2 cm) of the same age. These

populational differences in size-at-age are likely local adaptations developed in response to selection pressures such as migration difficulty, spawn timing, and intra-sexual competition. Sex Ratio - The female:male (F:M) ratios of upper Yakima River wild and hatchery origin fish collected at either Roza Adult Monitoring Facility (RAMF) or on the spawning grounds as carcass samples were not significantly different. The F:M ratios of American (1.1) and Naches (2.0) spawning ground carcass samples were significantly different from the upper Yakima population (3.2) and may partially reflect between population differences in rates of nonanadromous precocial male development. Age Composition - As in previous years, the overwhelming majority of upper Yakima River wild fish returned as 4-year olds (85%) with 5% returning at age-5. Age-4 fish made up 86% of the total hatchery origin returns. Age-3 jacks made up 10 and 14% of the total wild and hatchery populations, respectively. Using linear discriminant function analysis, we classified wild fish into 3-, 4- and 5-year-old ages with 100, 89, and 94% classification accuracy, respectively. Based on scale sampled carcass recoveries, age composition of the American River was 0, 67 and 33% age-3, -4 and -5, respectively. Naches system fish were 1, 65 and 35% age-3, -4 and -5, respectively. Historically, American River fish return at older mean age than Naches fish, but in 2001 age compositions were essentially equivalent due in large part to the very strong 1997 (age-4) broodyear return across all three populations. Sexual Dimorphism - There were no significant Sex (Male vs. Female) effects detected in body size of wild and hatchery age-4 carcass recoveries in the Naches and upper Yakima River populations. Upper Yakima River wild age-5 fish did demonstrate significant sexual dimorphism in body size, as did the American River population age-4 and -5 year olds. In paired length and weight samples collected from the same fish, first at RAMF and later at CESRF, fork length increased 4.4% in males and 2.6% in females on average, while male and female body weights decreased by 16.3% and 13.4%, respectively. Run/Spawn Timing - Mean and median passage timing at RAMF and mean spawn timing (Sept. 26) of both upper Yakima River hatchery and wild fish was not significantly different. Mean and median spawn timing was August 19 and 21, respectively, for the American River and September 14 and 17, respectively, for the Naches population based on carcass recoveries. The earlier American River and Naches, to a lesser degree, spawn timing is a local adaptation to cooler incubation water temperatures experienced by the higher elevation populations that require more time to accumulate sufficient temperature units to fry emergence, which is generally synchronized across all Yakima basin spring chinook populations. Carcass Recovery Bias - The F:M ratio at RAMF was significantly different from the F:M ratio of spawning ground carcass recoveries, indicating that sex ratios estimated from carcass recoveries are biased. This is because female carcasses are recovered at higher rates than male carcasses. In addition, a comparison of the proportion of age-3, -4 and -5 old fish in the RAMF sample and the carcasses recovery sample indicated that older, larger fish were recovered as carcasses at significantly higher rates than younger, smaller fish. Within age classes, the mean POHP of wild origin age-4 and age-5 carcass recoveries did not differ significantly from fish sampled at RAMF. Thus, carcass recovery length distributions do appear to accurately represent size-at-age.

**Gametic traits:** Naturally spawning age-4 hatchery females (3,820 eggs) were 9% less fecund (340 eggs) than wild origin females (4,160 eggs) based on the observation in Chapter 1 that age-4 hatchery females were on average 2.1 cm smaller in POHP length than age-4 wild females and common length/fecundity slopes (see below). Age-5 wild origin females (5,101 eggs) were

significantly more fecund on average than age-4 wild females. Fecundity and female body size were positively correlated in both hatchery and wild origin age-4 females. The fecundity/length and fecundity/weight slopes of age-4 hatchery and wild origin females were not significantly different (common slopes =  $863 \text{ eggs} \cdot [\text{kg body weight}]^{-1}$  and  $165 \text{ eggs} \cdot [\text{cm POHP}]^{-1}$ ). Wild age-5 females also had significant, but weaker, positive correlations between female body size and fecundity and had significantly shallower linear relationships, producing less than half as many eggs per kg increase in body weight ( $389 \text{ eggs} \cdot [\text{kg body weight}]^{-1}$ ) and almost 1/3 fewer eggs per cm increase in POHP length ( $113 \text{ eggs} \cdot [\text{cm POHP}]^{-1}$ ). Including body weight, mean egg weight and POHP in a multi-variate fecundity regression equation significantly increased the amount of variation explained and improved the precision of fecundity estimates. There was no significant difference between age-4 hatchery (0.195 g) and wild (0.192 g) origin mean egg weights. Age-5 wild origin females had significantly heavier eggs (0.216 g). There were weak positive correlations between egg weight and female POHP and body weight. The relationship between egg size and fecundity was negative, weak and significant only in wild age-4's. Female Reproductive Effort (RE), the ratio of the weight of gametes to total body weight, of hatchery females (mean=0.207) was greater than age-4 (mean=0.201) and age-5 (mean=0.193) wild females. The difference between hatchery and age-5 wild females was statistically significant. There was no significant difference in viability of eggs of hatchery (mean viability =0.87) and wild (mean viability =0.89) origin females. Both hatchery (mean=0.009) and wild (mean=0.004) origin females had very low proportions of abnormally developing fry, but the hatchery proportion was significantly greater than the wild proportion. There was no significant difference between wild and hatchery origin fry fork lengths or body weights at the "button up" stage. There were strong positive relationships between fry size and egg weight for both wild and hatchery origin females. The fry fork length/egg weight relationship explained 73 and 62% of the total variation and the fry body weight/egg weight relationship explained 93 to 82% of the total variation in wild and hatchery fish, respectively. There were weak positive correlations between fry size and adult female size, although the total variation explained ranged from only 5 to 10%.

**PIT Tag Loss:** We estimated tag loss in spring chinook returns 1-3 years after release. Annually from 1998 to 2001, approximately 40,000 0-age juveniles were tagged with a PIT tag, Coded-wire tag (CWT) injected into the snout, and an adipose fin clip to estimate downstream juvenile survival through the Yakima and Columbia rivers. Upon return, fish fell into one of four categories based on tag retention: 1) PIT tagged/CWT/Ad clipped (all tags and marks retained), 2) CWT/Ad clipped (lost PIT tag), 3) PIT tagged/Ad clipped (lost CWT), or 4) Ad clipped only (lost both PIT and CWT). Returning age-2, -3 and -4 hatchery origin fish were monitored at RAMF in 2001 for the presence of each tag and mark, and tag loss estimates were calculated. We found that PIT tags were lost in increasing proportions as return age increased. Age-2, -3 and -4 fish were estimated to have total losses of 3, 10 and 16% of their PIT tags, respectively. PIT tag loss also increased over time within a year. Adult female PIT tag loss estimates were 15, 17 and 23% in May, June and July-September, respectively. Adult males PIT tag loss estimates were 11, 10 and 24% in May, June and July-September, respectively. Spring chinook pass RAMF 1-5 months prior to spawning, while still not fully mature and our data likely underestimate actual loss at the time of spawning. This study utilized 400-kHz PIT tags and some of our tag "loss" may actually be due to missed, undetected PIT tags. While this might result in overestimated loss, it would not explain the increase in PIT tag loss over time. Juvenile-to-adult survival studies

using PIT tags will underestimate actual survival rates when tag loss occurs. However, comparisons between similar groups of PIT tagged fish that lose tags at comparable rates are valid relative survival comparisons. Care should be taken before extrapolating adult survival estimates from PIT tagged fish to untagged populations.

## Reproductive Success

*Schroder, S. L., C.M. Knudsen, B. D. Watson, T. N. Pearsons, S. F. Young, and J. A. Rau. January 2003. Comparing The Reproductive Success Of Yakima River Hatchery- And Wild-Origin Spring Chinook. Annual Report 2001. DOE/BP-00004666-7.*

In the Yakima Spring Chinook supplementation program, wild fish are brought into the Cle Elum Hatchery, artificially crossed, reared, transferred to acclimation sites, and released into the upper Yakima River as smolts. When these fish mature and return to the Yakima River most of them will be allowed to spawn naturally; a few, however, will be brought back to the hatchery and used for research purposes. In order for this supplementation approach to be successful, hatchery-origin fish must be able to spawn and produce offspring under natural conditions. Recent investigations on salmonid fishes have indicated that exposure to hatchery environments during juvenile life may cause significant behavioral, physiological, and morphological changes in adult fish. These changes appear to reduce the reproductive competence of hatchery fish. In general, males are more affected than females; species with prolonged freshwater rearing periods are more strongly impacted than those with shorter rearing periods; and stocks that have been exposed to artificial culture for multiple generations are more impaired than those with a relatively short exposure history to hatchery conditions.

A key question that the Yakima Fish Supplementation Project is designed to address is whether the spring chinook produced by the Cle Elum Hatchery have had their reproductive competence affected by the fish cultural regimes they experienced. In 2000, an observation stream (spawning channel) was built adjacent to the Cle Elum Hatchery. The stream is being used to compare the reproductive success of hatchery- and wild-origin spring chinook reproducing in a quasi-natural setting. The channel is 127 m long by 7.9 m wide and is laid out in the shape of a “U.” It is subdivided into seven sections by concrete cross weirs. Spawning gravel from a local quarry was imported into the stream and water from the hatchery’s raceways is pumped into the stream when adult salmon, their eggs, and newly emerged fry are present.

Direct reproductive comparisons between hatchery- and wild-origin fish were not possible until 2001 when the first hatchery adults produced by the project returned to the Yakima River. During the period covered by this report, only wild spring chinook were available. However, these fish provided us with an important opportunity to refine how the observation stream should be operated. Consequently, in 2000 we filled two 15 m long by 7.9 m wide channel sections with wild spring chinook to: 1) refine fish handling and tagging procedures, 2) evaluate how physical conditions in the stream affected adult distribution patterns, 3) ascertain whether the methods developed to monitor and record environmental conditions in the observation stream provided an adequate overview of the physical conditions the adults and their offspring experienced in

stream, 4) develop and test behavioral observation techniques 5) examine the effects of different instantaneous spawner densities on the ability of the fish to reproduce, and 6) determine what the egg-to-fry survival rate might be in the stream.

The techniques used to select which fish were placed into the stream, how they were weighed, measured, tagged, and DNA sampled all proved to be relatively non-stressful. For example, many of the fish spawned within hours after being placed into the stream and their reproductive behavior was very similar to what has been observed in wild fish spawning in the upper Yakima River. Previous work done on naturally spawning spring chinook indicated that they prefer to spawn in 30 to 90 cm/sec flows and 24 cm or deeper water. Water flows in the stream were systematically recorded before adults were placed into the stream and after spawning had taken place. About 50% of the area in each section contained flow and depth characteristics preferred by spring chinook. Other portions had slower flows that could be used for resting areas and also some zones of very rapid flow. We found that the females established their redd locations in areas where flows equaled 38 to 61 cm/sec. The last females to establish redds in the high-density section did so in higher velocity areas than the fish that had already acquired territories. In general, water velocities decreased from the head end of a section to its end. The first locations of each section that were selected as redd sites occurred at the very end of each section. These sites had optimal flows and were reminiscent of the pool riffle interface areas that occur in natural streams.

The gravel placed in the stream had a Fredle index value of around 7 and was easily moved by the females. A gravel mixture having a Fredle index of 22 was requested, however, the material used had more fines than specified. In retrospect, the spawning bed materials imported into the stream turned out to be more appropriate for our experimental purposes because females will have to thoroughly clean the gravel in their nest sites to obtain high egg-to-fry survival rates. Hence, if differences exist between the ability of hatchery and wild females to clean the gravel in their nests then disparities in egg-to-fry survival rates should occur. This may not have happened if our original gravel recipe had been employed. Since the water used to run the observation stream originates from the hatchery's raceways, sand and organic sediments are continually being imported into the stream. Gravel samples were taken before any fish were placed into the observation stream and also collected after fry emergence had been completed. When the gravel was first placed into the stream it had a Fredle index of around 11. After emergence was complete this index was reduced to approximately 7, indicating that more fines had been introduced. Consequently, the gravel was cleaned prior to placing adults into the structure in 2001. The cleaning process reduced the quantity of fines but did not appreciably raise the Fredle value. However, for the reasons given above the gravel mixture currently in the stream is fulfilling our experimental objectives.

Water temperatures were recorded once every two hours throughout the spawning and incubation period. Seasonal changes in temperature occurred but no differences were observed between temperatures taken in the water column and those that were obtained from temperature probes that had been buried 30 cm below the gravel surface. In summary, the physical conditions in the stream, water velocity, depth, gravel composition, and temperature, were all similar to those that have been observed in natural spawning sites used by spring chinook. The procedures developed

in 2000 to create these conditions were repeated in 2001 and again in 2002 when fish were placed into the stream and allowed to spawn.

Both scan and focused behavioral observations were made on the fish while they spawned in the observation stream. These observations revealed that the social status of the fish could be discerned by examining their nuptial color patterns. Three general patterns, one referred to as “stripe”, another as “gold”, and the last as “black” were observed. Gradations between these patterns clearly exist and the fish are capable of quickly changing from one pattern to the next. Territorial females and sub-dominant males usually had the stripe pattern, dominant males generally possessed the black pattern, while non social or wandering fish of both sexes typically had the gold pattern. Our observations also indicated that large differences in the reproductive behavior of the males placed in the sections existed. Some individuals participated in many spawnings while others apparently never spawned. Precocial males invaded the stream sections and one was observed spawning with a female and a larger male. A DNA pedigree analysis made on fry sampled from each section indicated that our behavioral observations coincided with male reproductive success. That is, those individuals that appeared behaviorally dominant fathered most of the fry produced from a section. This same analysis showed that the precocial males had fathered some of the fry collected from both sections. Moreover, the behavioral observations and the DNA pedigree work indicated that variation in female reproductive success was much lower than that seen in males. All the females placed in the sections were observed to produce offspring while that was clearly not the case for the males.

In addition, we discovered that placing 8 females ( $8 \text{ m}^2/\text{female}$ ) produced enough intra-sexual competition among the fish to reduce redd sizes and induce some egg retention. In the section with a lower instantaneous density ( $17 \text{ m}^2/\text{female}$ ) redd sizes were two to three times as large and egg retention was relatively low. One of our experimental goals is to induce competition among females when wild and hatchery fish spawn together. This is being done to expose any differences that may exist in the capacity of wild and hatchery females to secure territory locations and spawn. The results of the fieldwork performed in 2000 indicated that such competition would occur when  $\leq 8 \text{ m}^2$  is allotted per female. Consequently, 2001 and 2002 when both hatchery and wild females were allowed to spawn together in the observation stream the instantaneous female density equaled about  $8 \text{ m}^2$  per female.

Modified fyke nets were placed at the end of each section of the observation stream to obtain a systematic sample of fry that could be used to perform the DNA pedigree analysis. This trapping effort also allowed us to measure the egg-to-fry survival rate in the channel. Altogether about 24,000 fry were produced and egg-to-fry survival was estimated to be slightly higher than 66 percent.

In conclusion, the observation stream provided an excellent quasi-natural environment where reproductive success could be objectively appraised. Observations on spawning spring chinook that would be logistically difficult if not impossible to conduct in the Yakima River can be performed in the stream. Because of this we have the infrastructure and techniques to assess whether differences exist between hatchery and wild origin adult spring chinook during their reproductive period.

## Genetics

*Busack, C., S. L. Schroder, J. B. Shaklee, and S. F. Young. 2002. Genetic studies in the Yakima Basin. Annual Report 2001. DOE/BP-00004666-2.*

Genetic work for 2001 consisted of two major phases, both reported on here. The first is a DNA microsatellite analysis of several hundred juveniles from the experimental spawning channel at the Cle Elum Supplementation Research Facility, using the genetic markers to assign the juveniles to parents, and thus judge reproductive success of individual fish. The second is a reevaluation and revision of plans for studying domestication in the spring chinook supplementation effort.

The pedigree analysis was significant in three respects. First, it showed that this approach can be successfully applied to the spawning channel research. Secondly it showed that this approach does indeed yield very useful information about the relative reproductive success of fish in the channel. Finally, it showed that this information can yield additional information about the experimental design.

- Of the 961 juveniles on which analysis was attempted, 774 yielded enough genetic information to be used in the pedigree analysis. Of these, 754 were assigned to males and females known to have been placed into the channel. Of the other 20, all were assignable to females, but sires were unknown. The genotypes of 17 of these were consistent with a single theoretical male genotype, suggesting a single precocial male sired them.
- The inferred parentage of the fish demonstrated that there had been substantial leakage of juveniles from one section of the channel into another.
- Reproductive success of females was fairly even, but success of males varied considerably. In a group of seven males (including the hypothetical one), one contributed 79% of the progeny analyzed, and three contributed none.

The domestication experimental design evaluation was prompted by a critical review of the project by the Independent Scientific Review Panel (ISRP). The ISRP review set into motion a design revision process which extended beyond the contract period; the report presented here is intended to be an account of our work through the end of the contract period, so does not include developments beyond that point. As such, combined with the upcoming 2002 report, it will provide a complete record of our process through the experimental design revision process. The current report contains the following:

- An explanation of the general concept of domestication, and why domestication is a concern in the YKFP spring chinook program.
- A discussion of the basics of experimental design for domestication.
- A history of domestication experimental design for domestication in the YKFP.
- A review of potential designs that would answer the ISRP's criticisms.
- A revised design containing the following elements:
- A control line under continuous hatchery culture (i.e.; no spawning in the wild)

- Use of the Naches population, where appropriate, as a wild control line.
- Cryopreservation of sperm for later evaluation of long-term genetic trend,
- Continuous monitoring of phenotypic trend in the supplemented line.

## Ecological Interactions

### Non-target Taxa of Concern

*Pearsons, T. N., A. L. Fritts, G. M. Temple, M. R. Schmuck, and C. L. Johnson. 2002. Yakima River Species Interactions Studies. Annual Report 2001. DOE/BP-00004666.*

Species interactions research and monitoring was initiated in 1989 to investigate ecological interactions among fish in response to proposed supplementation of salmon and steelhead in the upper Yakima River basin. This is the tenth of a series of progress reports that address species interactions research and supplementation monitoring of fishes in the Yakima River basin. Data have been collected before and during supplementation to characterize the ecology and demographics of non-target taxa (NTT) and target taxon, and to monitor interactions and supplementation success. Major topics of this report are associated with implementing NTT monitoring prescriptions for detecting potential impacts of hatchery supplementation, and monitoring fish predation indices. This report is organized into two chapters, with a general introduction preceding the first chapter. This annual report summarizes data collected primarily by the Washington Department of Fish and Wildlife (WDFW) between January 1, 2001 and December 31, 2001 in the Yakima basin, however these data were compared to data from previous years to identify preliminary trends and patterns. Summaries of each of the chapters included in this report are described below.

- Release of large numbers of hatchery origin salmon has the potential to negatively impact other taxa (non-target taxa, NTT). To determine changes in NTT status that could be related to hatchery smolt releases, we compared the abundance, size structure, and distribution of 16 non-target taxa before and 3 years after annual spring releases of about 1 million yearling salmon smolts (coho and chinook) in the Yakima River. Approximately 20% of the chinook salmon released were precocial males which did not migrate to the ocean and reared in the freshwater environment along with many NTT. Relative to presupplementation conditions, most of the parameters that we measured increased slightly or did not change, and all, except steelhead size (-1%) and leopard dace abundance (-13%), were within the predetermined containment objectives. Neither of the two status indicators that were outside of the containment objectives were significantly different from pre-supplementation conditions ( $P > 0.05$ ). The lack of statistically significant tests for steelhead and leopard dace could be the marginal power of the statistical tests (Power=56% for steelhead and Power=16% for leopard dace with an alpha of 0.10). However, comparisons of the steelhead size in index areas that were stocked and those that were not stocked indicated that supplementation was not the cause of the decline in size. The decrease in the leopard dace abundance index was

also unlikely to have been caused by supplementation activities because the mechanisms of predation that could be influenced by yearling salmon releases were not observed. These results suggest that risk containment actions are not necessary at this time. However, future risks could be reduced by minimizing the production and release of precocially mature salmon.

- We estimated the number of salmonids that smallmouth bass ate during the spring of 2001 in the Yakima River. Predator surveys were conducted during the weeks of March 15 and March 29 and weekly from April 12 through June 15 in two sections of the lower Yakima River and spot sampling in an area of hypothetically high predation, termed a “hotspot”. Abundance was estimated using the relationship between catch per unit effort and population estimates that were calculated using maximum likelihood estimators of mark and recapture data from 1998 to 2000. We were unable to obtain valid mark-recapture estimates in 2001. Diet was determined by lavaging smallmouth bass and identifying consumed fish in the lab by examining diagnostic bones. Daily consumption was calculated by estimating the average number of salmonids that a bass ate per day and extrapolating that number to the number of bass in the lower 68 kilometers of the Yakima River. Daily estimates were then summed to yield total consumption during the spring. Abundance of bass >150 mm increased during the spring from a low of 1,685 on March 16 to a high of 13,104 on May 17. The increase in abundance was primarily due to immigration of fish from the Columbia River and partially from recruitment of smaller fish into the 150 mm and larger size range. Daily consumption of salmonids was relatively low until late April and sharply increased in early May. Consumption of salmonids sharply decreased in early June despite the fact that bass numbers remained high and temperature increased. This decrease is likely to be due to bass shifting their behaviors from feeding to spawning. Smallmouth bass ate an estimated 230,265 salmonids during the spring. Only 6,906 of these were estimated to be spring chinook. The remainder was mostly fall chinook salmon. Salmonid consumption estimates for 2001 were similar to estimates for 2000 (202,722 total salmonids and 3,083 spring chinook) despite the lower abundance of bass in 2001. Horn Rapids Dam (Wanawish) again had only a fraction of the smallmouth congregated below it as it had in 1999 and may not be a hotspot during all years.

## **Bird Predation**

*Major, W. III, J. M. Grassley, K. Ryding, and C. E. Grue. August 2002. Development of an Index to Bird Predation of Juvenile Salmonids within the Yakima River. Annual Report 2001. DOE/BP-00004666-6.*

Avian predation of fish is suspected to contribute to the loss of out-migrating juvenile salmonids in the Yakima Basin, potentially constraining natural and artificial production. In 1997 and 1998, the Yakima/Klickitat Fisheries Project (YKFP)—whose goal is increasing natural production within the Yakima River—initiated investigations to assess the feasibility of developing an index to avian predation of juvenile salmon within the river. This research—conducted by Dr. Steve Mathews and David Phinney of the University of Washington and the Washington Department of Fish and Wildlife (WDFW)—confirmed that Ring-billed Gulls and

Common Mergansers were the primary avian predators of juvenile salmon (Phinney et al. 1998), and that under certain conditions could significantly impact migrating smolt populations.

Beginning in 1999, the Washington Cooperative Fish and Wildlife Research Unit (WACFWRU) was asked by the YKFP to continue development of avian consumption indices. Monitoring methods developed by Phinney et al. (1998) were adopted (with modifications) and monitoring of impacts to juvenile salmon along river reaches and at areas of high predator/prey concentrations (colloquially referred to as “hotspots”) has continued each year through 2001.

In 2001, piscivorous birds were counted from river banks at hotspots and from a raft or drift boat along river reaches. Consumption by gulls at hotspots was based on direct observations of foraging success and modeled abundance; consumption by all other piscivorous birds was estimated using published dietary requirements and modeled abundance. Seasonal patterns of avian piscivore abundance were identified, diurnal patterns of gull abundance at hotspots were identified, and predation indices were calculated for hotspots and river reaches (for both spring and summer). Changes in survey methods in 2001 included the addition of surveys in the 'Canyon' reach during spring and altering the method of directly measuring gull feeding rates at hotspots.

Primary avian predators in 2001 were ‘gulls’ (California and Ring-billed) at hotspots and Common Mergansers within upper river reaches. Consumption on the lower reaches was distributed among a number of species, with slightly more than half of all fish consumption being attributed to American White Pelicans. Estimated consumption by gulls at both hotspots combined (8 Apr - 30 Jun) was 169,883 fish. Assuming a worst case scenario (all fish taken were smolts) this represented approximately 4.9% of all smolts estimated passing or being released from the Prosser Dam area during the 2001 smolt migration season. Total gull abundances and estimates of consumption between the two hotspot sites were opposite that seen in 2000. Foraging gulls at Horn Rapids Dam were regressed against flow for the 3 years and found to be significant ( $\alpha=0.1$ ,  $P=0.081$ ,  $r^2=0.2589$ ). A similar 3-year regression vs. fish passage through the Chandler Juvenile Fish Facility, however, did not show a significant relationship ( $\alpha=0.1$ ,  $P=0.396$ ,  $r^2=0.3708$ ).

Total estimated take by Common Mergansers across all strata surveyed was 14,777 kg between 8 Apr and 31 Aug, 2001. Approximately 66 percent of that consumption was within the upper river reaches (Stratum 1) where there is a known breeding population of mergansers. Graphical comparisons of merganser abundances over the three years (1999-2001) in the upper reaches of the Yakima River suggest an increase in 2001 from the previous 2 years in both the spring and summer survey periods, but overlapping confidence intervals prevent assumptions regarding upward or downward trends in abundance.

## Pathogens

*Thomas, J.B., and T.N. Pearsons. 2003. Pathogen screening of naturally produced Yakima River spring Chinook smolts. Annual Report 2001. DOE/BP-00004666-8.*

The change in pathogens prevalence to wild fish is probably the least studied ecological interaction associated with hatchery operations. In 1999, the Cle Elum Hatchery began releasing spring chinook smolts into the upper Yakima River to increase natural production. Part of the evaluation of this program is to evaluate whether introduction of hatchery produced smolts would impact the prevalence of specific pathogens in the naturally produced spring chinook smolts. Increases in prevalence of any of these pathogens could negatively impact the survival of these fish. Approximately 200 smolts were collected at the Chandler smolt collection facility on the lower Yakima River during 1998, 2000 and 2001 and monitored for specific pathogens. The pathogens monitored were infectious hematopoietic necrosis virus, infectious pancreatic necrosis virus, viral hemorrhagic septicemia, *Flavobacterium psychrophilum*, *Flavobacterium columnare*, *Aeromonas salmonicida*, *Yersinia ruckeri*, *Edwardsiella ictaluri*, *Renibacterium salmoninarum* and *Myxobolus cerebralis*. In addition, the fish were tested for *Ceratomyxa shasta* spores in 2001. Not all testing has been completed for every year, but to date, there have only been minimal changes in levels of the bacterial pathogens in the naturally produced smolts. At this point, due to the limited testing so far, these changes are attributed to normal fluctuation of prevalence.

## **Acknowledgments**

We would like to thank Bonneville Power Administration for financially supporting this work. In addition, we could not have completed this work without the help and support of many individuals from the Bonneville Power Administration (especially David Byrnes and Patti Smith), Yakama Nation (especially Melvin Sampson and David Fast), and Washington Department of Fish and Wildlife (especially Craig Busack, Curt Knudsen, Bill Hopley, Steve Schroder, Anthony Fritts, Gabriel Temple, and Christopher Johnson).

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