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Abstracts

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Homing patterns and spawning site selection of Yakima River spring Chinook salmon

ANDREW DITTMAN; *Northwest Fisheries Science Center, NOAA Fisheries*

A number of conservation and supplementation hatchery programs, including the YKFP hatchery, are utilizing satellite acclimation facilities to "seed" or repopulate underutilized rivers or streams. The effectiveness of offsite releases from satellite facilities for ensuring successful imprinting, minimizing straying and contributing to salmon recovery has not been demonstrated. The overall goal of our project is to describe the spatial and temporal patterns of homing and spawning by wild and hatchery-reared spring chinook salmon released from acclimation facilities as part of the YKFP supplementation program. In collaboration with Yakama Nation biologists, we have conducted a comprehensive carcass and redd survey for spring Chinook salmon in the entire upper Yakima sub-basin from 2002-2008. In general, we have observed that hatchery-reared and wild fish had similar distributions within the watershed but the site of rearing and release significantly affects the distribution of adult spawning within the sub-basin. In 2008, we recovered 308 natural origin and 1012 hatchery carcasses. Analysis of the spatial distribution of hatchery and wild spawners in 2008 is incomplete but will be described during this presentation.

Abundance and Distribution of Spring Chinook Salmon Redds in the Yakima River Basin Before and After Supplementation.

DARRAN MAY, MARK JOHNSTON, MARY MOSER, DON LARSEN, DAVID FAST, AND ANDREW DITTMAN

Redd site selection by spawning salmon involves a complex trade off between natal site fidelity and a hierarchy of physical and environmental controls. To understand the effects of hatchery supplementation on redd distributions, we analyzed nearly three decades of spatially and temporally continuous spring Chinook salmon *Oncorhynchus tshawytshcha* redd data in the Yakima River basin. Redd numbers increased for both the supplemented (Upper Yakima R.) and unsupplemented (Naches R.) populations during the post-supplementation period, but increases were greater for the Upper Yakima R. compared to the Naches R. population. Redd distributions of both populations were spatially heterogeneous and as expected with increased total numbers, redd densities increased in 10 of 11 reaches in the Upper Yakima population and 9 of 10 reaches in the Naches population during the post supplementation period. Data showed an increase in density and proportion of Upper Yakima redds within proximity of the central hatchery in the period after the initiation of the hatchery program. Concurrent carcass survey data further indicated that the proportions of wild fish spawning in the vicinity of the central hatchery facility increased post supplementation. The proportion of wild spawners also increased in the upper Teanaway River in proximity to the acclimation facility and decreased in the Cle Elum River after supplementation.

Linking physical habitat characteristics to Chinook spawning distribution in the Yakima River

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Hatchery supplementation of spring Chinook salmon in the upper Yakima River basin has raised questions about the interbreeding of wild- and hatchery-origin fish. Acclimation facilities are intended to disperse hatchery-origin adults throughout the upper watershed, but if suitable spawning habitat is limited then undesirable competition and interbreeding may occur. The objectives of this study are to (1) evaluate spatial patterns of spawning by hatchery and wild Chinook salmon, and (2) identify physical habitat variables that characterize redd sites used by wild- and hatchery-origin spring Chinook. Extensive surveys

of channel morphology and physical habitat (e.g., substrate, depth, wetted width, cover) were conducted in over 180 kilometers of mainstem, floodplain, and tributary river habitat in 2007. Longitudinally linked habitat units were identified based on broad-scale changes in gradient, substrate, or depth. To explain the fine-scale distribution (<250m) of wild-and hatchery-origin Chinook redds and the physical characteristics that affect their distribution, over 70 sites were intensively surveyed in 2008. Preliminary results suggest that redd densities of wild- and hatchery-origin Chinook peak upstream of the Cle Elum River confluence. Within that section, island braided reaches with multiple channels attract the most spawners. Desirable habitat factors include gravel substrate, proximity to deep water and cover, and downwelling zones above riffle crests.

Response of a spawning population of spring Chinook salmon to flow alteration in a highly regulated system.

STEVE CORBETT, MARY MOSER, ANDY DITTMAN, DON LARSEN, DARRAN MAY; *NOAA Fisheries, Northwest Fisheries Science Center, Seattle WA*

The Yakima River is a hydrologically regulated system managed to balance the needs of irrigation while sustaining populations of spring Chinook salmon (*Oncorhynchus tshawytscha*). Each Autumn, coincident with spawning, flow is significantly and abruptly reduced in the upper Yakima River, while during the summer the hydrograph is artificially high. We used radio telemetry to document movements of adult spring Chinook salmon in the upper Yakima River during flow alteration. Adult salmon (total length 60-93 cm) were collected in June as they migrated into the upper Yakima River, implanted intragastrically with radio transmitters and released 7 km upstream of the collection site. Radio-tagged fish were relocated using a combination of fixed site receivers and mobile tracking surveys. Several fish migrated from the release site to points upstream (mean distance 85 km; range, 46-110 km) and moved at a mean rate of 3 km/day (range 0.5-6.2). Of these fish, most were last relocated in areas of historically high spawning density and a proportion of radio tags were recovered in the carcasses of post-spawned fish. Decreased flows appear to have prompted some fish to move upstream and preliminary results have management implications related to flow reduction timing, ramp-down rates, and maintenance of minimum flows.

Upper Yakima River Spring Chinook Pedigree Study

TODD W. KASSLER, SCOTT M. BLANKENSHIP, CRAIG A. BUSACK, KENNETH I. WARHEIT; *Washington Department of Fish and Wildlife*

Several studies have shown that the relative reproductive success (RRS) of hatchery-origin fish in the natural environment is less than that of natural-origin fish. Yet, these studies do not evaluate RRS by determining the relative fitness in the natural environment of natural-origin fish with different percentages of hatchery ancestry (i.e., 0, 1, and 2 hatchery-origin parents). We have begun a study to examine these differences using a genetic-based parentage analysis. The concept is to genotype hatchery-origin parents that have the opportunity to reproduce in the wild, and then determine the number of adult offspring that return from hatchery x hatchery or hatchery x natural crosses. As part of a more comprehensive sampling program, in 2003 tissues were collected from all hatchery-origin spring Chinook passing Roza Dam (defined here as the parental generation), and in 2007 tissues were collected from all natural-origin four-year old returning adult Chinook (here defined as the offspring generation - F_1). To date, we have genetically analyzed all 2003 parents (1,409 males, including adults, jacks, and precocial parr; and 793 females) and a subset of the F_1 offspring (583 four-year olds from 2007).

Based on the number of hatchery- and natural-origin fish returning to Roza Dam in 2003 (minus the natural-origin fish spawning in the hatchery), the expected proportion of hatchery-origin, mixed hatchery and natural-origin, and natural-origin Chinook produced in 2003 and returning to Roza Dam in 2007 was 45%, 44%, and 11%, respectively. Based on our preliminary parentage analysis of the 583 F_1 offspring collected in 2007 (and assuming unassigned parents are of natural-origin), 28% were assigned to hatchery-origin, 51% mixed hatchery and natural-origin, and 20% natural-origin. Overall, the natural-origin Chinook produced more returning F_1 offspring than expected given a hypothesis of equal production between hatchery- and natural-origin Chinook. Furthermore, we also identified a higher proportion of hatchery-origin mothers were successful than hatchery-origin fathers.

DNA-based stock-of-origin assignment of Chinook salmon (*Oncorhynchus tshawytscha*) smolts outmigrating past Chandler trap (Yakima River) for years 2004-2008: computational error, methodological concerns, and outmigration trends

KENNETH I. WARHEIT AND TODD W. KASSLER; *Washington Department of Fish and Wildlife, Molecular Genetics Laboratory*

Since 2001, the WDFW Molecular Genetics Laboratory has been genetically assigning to stock Chinook salmon smolts that pass the Chandler Trap. Beginning 2004, the lab has used a standardized set of genetic markers (GAPS markers) for both the baseline and smolt genetic fingerprints, enabling year-to-year comparisons of results. In addition, since 2004 a host of analytical tools have been developed to evaluate the efficacy of the baseline data sets and to enhance statistical confidence of both mixture analyses and individual assignments. In this talk we will introduce some of these tools, evaluate the baseline data used for assigning Chandler smolts to stock, provide new estimates of stock proportions based on five years of data (2004-2008), and compare the stock composition of the outmigrating Chinook smolts in the Yakima River system from 2004-2008.

The Paradox of Faster Growing Wild Fish Maturing at Older Ages Than Slower Growing Hatchery Fish: Probability-of-Maturation Reaction Norms to the Rescue

CURTIS M. KNUDSEN; *Oncorh Consulting*

Life history theory predicts that faster growing fish will mature at a younger age and larger size-at-maturity than from slower growing population. However, in the upper Yakima spring chinook we have observed just the opposite: slower growing hatchery fish return at a smaller size-at-maturity and mature at a younger mean age, producing about twice as many age 3 jacks within a cohort as natural origin fish. Why is this so, and what processes are in play that result in predictions contrary to those one would make via life history theory?

In the hatchery environment natural selection is relaxed. Beginning with the trapping and transport of adults to CESRF, continuing during their holding in the protected environment until spawning, adults no longer have to find thermal refugia, migrate up-river past barriers and predators, find and defend mates and spawning sites, successfully deposit fertilized gametes, and finally protect their redds from superimposition from other females. Within the hatchery, eggs and juveniles are protected during incubation through emergence from thermal and hydrologic shocks, predation, and disease again relaxing the effects of natural selection. Thus, there is no longer a fitness penalty to be paid if an individual fish has not allocated sufficient energy reserves for mate competition or has allocated insufficient yolk reserves to eggs to guard against starvation during post-emergence fry rearing. In the hatchery environment, fish do not experience mate competition nor have to experience periods of starvation post-emergence. Relaxation of natural selection and imposition of new hatchery selection forces results in the development of new genotypic norms of reaction for hatchery fish.

Data from the Spring Chinook Domestication Study will be used to illustrate how Hatchery Control, and to a lesser degree, the Supplementation Production fish have demonstrated adaptation to the hatchery environment and a descriptive model of Probability of Maturation Reaction Norms will be presented that resolves the paradox of faster growing natural origin fish maturing at older ages than slower growing hatchery origin fish.

Evaluation of yearly and geographic variation in early male maturation in hatchery and wild spring Chinook salmon from the Yakima River, Washington

DON LARSEN, BRIAN BECKMAN, DEB HARSTAD, PAUL PARKINS, KATHY COOPER, DINA SPANGENBERG; *NOAA Fisheries,* don.larsen@noaa.gov

Over the past decade our research has revealed that approximately 10-50% (depending population and brood year) of the male fish from several Columbia River hatchery programs mature precociously at age-2 (commonly referred to as minijacks) rather than the more typical age 3-5 for this species. Instead of migrating to the ocean for long-term rearing and growth, minijacks remain in headwater streams or undertake a short-term migration downstream, turn around, and attempt to migrate back upstream to complete the maturation process within the same year. Age of maturation in salmon is influenced by genetic, biotic, and abiotic factors including energy stores, size and/or growth rate at specific times of year. In the Yakima River basin we have conducted a six year monitoring effort to enumerate minijack rates of hatchery spring Chinook salmon released from acclimation sites in upper Yakima basin and corresponding minijack rates of wild and hatchery fish migrating through the Chandler smolt by-pass facility in the lower Yakima River during the spring smolt migration. Minijack rates of hatchery fish at release have ranged from approximately 30-60% under the programs conventional rearing regime and over all years combined there have been no significant differences in rates between the acclimation sites (avg. 40%). Minijack rates are highly correlated with both release length ($R2 = 0.74$) and weight ($R2 = 0.71$). At Chandler, minijack rates ranged from 15-25% among hatchery males and 0-4% among wild males. Hatchery fish were significantly heavier than wild fish, but fork lengths

were comparable. Finally, the proportion of minijacks at release from the acclimation sites was positively correlated with the proportion of hatchery minijacks collected at Chandler (R2 = 0.71).
(In cooperation with YN, WDFW, BPA contract #'s 2002-031-00).

Precociously mature salmon on the spawning grounds

CHRISTOPHER L. JOHNSON; *Washington Department of Fish & Wildlife*

Artificial propagation of Chinook salmon (*Oncorhynchus tshawytscha*) has the potential to alter the abundance and distribution of males that precociously mature in freshwater and thereby influence ecological and genetic interactions in the natural environment. Previous research indicates that the Cle Elum Supplementation and Research Facility (CESRF) has produced and released an average of 129,249 precocious males per year into the upper Yakima Basin between 1999 and 2008. We investigated the abundance and distribution of precociously mature hatchery and natural origin male spring Chinook salmon during the spawning season in the Yakima River. We counted the number of precocious males on the spawning grounds while snorkeling during the peak of spawning, and electrofished to determine abundance and distribution of precocious males away from redds. Numbers of hatchery precocious males present per active redd in 2008 (0.30) were the greatest observed since the first year of supplementation. However, these levels are below those thought to suggest genetic risk to the population. Hatchery and natural origin precocious males were both found throughout the spawning range during the spawning season, although differences in distribution between origins were detected ($P<0.05$). Hatchery origin precocious males on and away from redds were more often in areas of low spawning density.

Micro-Jacks and mini-Jacks: a tail of early male maturation

BRIAN BECKMAN, DON LARSEN, PAUL PARKINS, DEB HARSTAD, DINA SPANGENBERG AND KATHY COOPER; *Northwest Fisheries Science Center, NOAA Fisheries, Seattle Wa*

Variability in age at maturation is a common theme in Chinook salmon life histories, including spring Chinook salmon from the Yakima Basin. Larsen and colleagues have described the magnitude and variation in the production of mini-Jacks (mature at age 2) at the Cle Elum Supplementation and Research Facility (CESRF) and mini-Jacks are commonly produced (20 – 40% of all males released). Micro-jacks (mature at age-1) are not commonly found at CESRF but are often found near spawning areas in the Yakima River. We will describe an experiment in which the proportions of male Yakima River spring Chinook salmon maturing at age-1 and age-2 were varied due to alterations in emergence timing and differing growth rates. In particular, we will examine whether the total number of males maturing precociously (age 1 + age 2) vary between treatments; thus, addressing the hypothesis that suggests that the total proportion of males maturing precociously is a fixed proportion of the population.

Vulnerabilities of water availability and agriculture from climate change in the Yakima River Basin, Washington

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Projections of a warming world due to global climate change are well documented and were summarized in 2007 in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. For the Yakima River Basin, global climate models project a warming over the next 90 years, as much as 3° Celsius, that can have large effects on water availability and agriculture. The hydrologic system in the basin is very sensitive to such temperature increases. Indeed, snowpack is vulnerable to temperature increases ranging from 1° to 2° Celsius, with a 59 percent decrease in snowpack calculated with a 2° Celsius increase. Potential future changes in the hydrologic system will be additive to existing historical trends and will make management of water in the basin for both instream (fish habitat) and out of stream uses increasingly more complex. Observed data suggest that groundwater in some areas may no longer be a reliable supplemental source for water under a warming climate. Climate change scenarios also indicate that groundwater recharge to the aquifer system is sensitive to increasing temperatures. Furthermore, increasing temperatures will increase crop-water demand and likely result in less water leaving the root zone in agricultural areas, thereby decreasing recharge to the groundwater system. Together, historical trends and potential future effects of climate change indicate significant vulnerabilities in water availability, agriculture, and fish habitat in the Yakima River Basin.

Effects of domestication on predation mortality and competitive dominance

ANTHONY FRITTS, *Washington Department of Fish and Wildlife*

Propagation of fish in hatcheries has the potential to unintentionally change the genetic composition of donor populations and to subsequently contribute to reduced survival in natural environments. This is a particular concern for supplementation or conservation hatcheries because the objective of these hatcheries is to increase natural production. The mechanism of genetic change most likely to occur in conservation hatcheries is domestication, or natural selection in an artificial environment. We present the results of the sixth year of monitoring to detect changes to predation mortality and competitive dominance of the supplemented population of spring Chinook salmon in the upper Yakima River relative to two control populations; one with no prior hatchery influence and a segregated hatchery population in it's third generation of hatchery culture.

Non-target Taxa Monitoring

GABRIEL M. TEMPLE; *Washington Department of Fish and Wildlife,*templgmt@dfw.wa.gov

Salmon supplementation and reintroduction programs have the potential to negatively impact other valued fish taxa, which are not the target of enhancement (non-target taxa). We evaluated the impacts of spring Chinook salmon supplementation and coho salmon reintroduction (hereafter supplementation) to non-target fish taxa after stocking approximately one million yearling smolts annually in the upper Yakima Basin between 1999 and 2008. Field methods included backpack electrofishing and snorkeling in tributaries, and drift-boat electrofishing in the main stem. We used three sequential steps in our evaluation: First, we determined if spatial overlap occurred between supplementation fish and non-target taxa. Second, if overlap occurred, we determined if a decline in abundance, size, or biomass occurred during supplementation. Lastly, if a decline occurred, we determined if the change could be reasonably attributed to supplementation. Spatial overlap and changes in abundance, size, or biomass were determined to be significant if they exceeded containment objectives. Salmon rarely overlapped cutthroat and bull trout in tributaries, but some overlap of cutthroat occurred in relatively high elevations of the main stem, and considerable overlap with rainbow trout occurred in tributaries and the main stem. Salmon overlapped mountain whitefish and sucker species in the main stem, and dace and sculpin species in tributaries. With the exception of steelhead, the lower 90% confidence limit of abundance, size, and biomass was above the containment objective for non-target taxa that overlapped significantly with salmon. We used rainbow trout as an analog for steelhead. The lower 90% confidence limit of rainbow trout size in tributaries and in the main stem, were below our containment objectives. Comparisons of rainbow trout size in tributaries, and size in main stem sections with relatively high and low salmon abundance revealed that these changes were unlikely to be the result of supplementation (BACIP $P>0.05$). Our data indicate that early stages of salmon supplementation have not impacted valued species in the upper Yakima Basin beyond predetermined containment objectives.

Monitoring and Evaluation of Northern Pike Minnow on Juvenile Salmonids on the Yakima River, Washington

MICHAEL PORTER**,** *Yakama Nation Fisheries*

During smolt migration timing on the Yakima River, juvenile salmonids are consumed in large numbers by the Northern Pike Minnow. The objectives of YKFP's continuing Northern Pike Minnow predation study are to estimate the abundance of the Northern Pike Minnow and their consumption of juvenile salmonids. Timing of the study is during primary smolt migration, in spring and early summer. The study area on the Yakima River consists of 39 river miles, stretching from the confluence of the Naches River to the town of Granger. In order to determine abundance of this species, and get a measure of juvenile salmonid consumption, Northern Pike Minnow are captured via electro-shocking. Capture allows for a mark, count, and collection of stomach contents. A population size is determined by the mark/recapture effort. Juvenile salmonid consumption estimates are determined by analyzing stomach contents by bone diagnostics and factoring in a consumption rate.

Monitoring and Evaluation of Avian Predation on Juvenile Salmonids on the Yakima River, Washington: Great Blue Heron Predation of Juvenile Salmonids

MICHAEL PORTER**,** *Yakama Nation Fisheries*

Avian Predation of Juvenile Salmonids within the Yakima River Basin is a significant source of smolt mortality. Previous studies of avian predation have focused on the obvious avian predators which congregate in large numbers at areas deemed hotspots. Hotspots on the Yakima River usually occur near dams and typical avian predators are; Double Crested Cormorants, American White Pelicans, and California/Ring billed Gulls. In 2008 it was discovered that considerable amounts of juvenile salmonid mortality was associated with the Great Blue Heron which lives and feeds along river reaches. PIT tags implanted within juvenile salmonids were found in significant numbers within Great Blue Heron Rookeries located along river reaches. Within the Selah Rookery, below Roza Dam, PIT tags discovered

represented hatchery and wild fish from 2000 to 2008 smolt migration years. Yearly numbers of PIT tags fluctuated at Selah and an initial study was conducted to assess the predation by Great Blue Heron as a function of Yakima River flow below Roza Dam. For 2009 studies of Great Blue Heron predation will focus on determining Heron population numbers within the Yakima Basin (16 known rookeries), and developing PIT tag detection efficiencies for various rookeries.

YAKIMA RIVER COHO RE-INTRODUCTION FEASIBILITY STUDY

TODD NEWSOME; *Yakama Nation Fisheries*

Smolts were released volitionally on April 21, 2008. Approximately 904,714 coho smolts were released from the four acclimation sites Easton and Holmes in the Upper Yakima River and Lost Creek and Stiles in the Naches River. Approximately, 20,000 coho were pit tagged to monitor survival. Summer Parr released in Big Creek, Reecer Creek, Wilson Creek, South Fork Cowiche Creek, Nile Creek, and North Fork Little Naches also migrated out in 2008.

The 2008 migration showed average success. The Yakima Coho (In-Basin Brood) showed higher survival rates to McNary Dam than the Eagle Creek Coho (Out-of Basin), but had higher pre release mortality. This is presumably due to the pit tagging time difference. Eagle Creek coho are generally pit tagged in the late winter and Yakima Coho are tagged as early summer parr, therefore they have a whole year to carry the tag before release. Survival Comparison among sites ranged from 17% at Easton to only 12% at Holmes. In the Naches system, Stiles and Lost Creek showed nearly 38% survivals for both in basin and out of basin coho. Summer Parr survival was significant with South Fork Cowiche and Reecer Creeks posting the highest survival at nearly 30%

Approximately, 300 adult coho were placed in Taneum Creek to spawn. Nile, Wilson and South Fork Cowiche Creeks had 40 adults placed into each tributary. There were 75 redds found in Taneum Creek, and only a handful in each of the other 3 tributaries. Low water condition during planting hindered coho movement and subjected the fish to high predation. Because of the high success rate in Taneum Creek, WDFW and YN personnel were able to pit tag approximately 1300, wild rearing coho. These fish will be leaving the system in 2009.

In 2008, the Yakima River Coho escapement was increased remained relatively constant with 4,590 adults being observed into Prosser Hatchery and over Prosser Dam. The smolt to adult (SAR) rates for the Hatchery Origin Returns (HOR) was 1% and the Natural Origin Returns (NOR) was 7.4%. Hatchery SAR's were reduced from the previous year, however, the difference in survival between wild and hatchery remains constant.
The Naches River was again a significant producer of coho redds (60) and the Upper Yakima River maintsem continued to climb from 0 in 2003, 33 in 2004 to 57 in 2005 to 49 in 2008. In addition, the tributary coho redd counts were high the highest ever recorded and for the first time more coho redds were located in tributaries than the maintsem.

Coho salmon reintroduction and interactions with rainbow trout in Taneum Creek, Washington

GABRIEL M. TEMPLE; *Washington Department of Fish and Wildlife,*templgmt@dfw.wa.gov

Artificial propagation programs designed to re-establish salmon in areas they have become extirpated is one tool used by fishery managers to expand the currently depressed range of salmon throughout the Columbia Basin. However, reintroducing species to their historic range can be problematic for many reasons (e.g. loss of local adaptation; failure to address causal mechanisms), including introduced risks to species that are not the target of enhancement (NTT). It is possible that restoring a natural sympatric species balance can increase ecological efficiency in areas that one or more species have been extirpated. We present preliminary results from the first year of a stream scale coho salmon *Oncorhynchus kisutch* reintroduction program in Taneum Creek, Washington. Our objectives were to determine if we could jumpstart coho salmon natural production using adult coho salmon out-planting in a creek they have been extirpated from for over a century. In addition, we evaluated if the benefit gained from salmon reintroductions outweighed any negative effects to rainbow trout density and growth that may have resulted from our reintroduction effort.

Yakima River Fall Chinook Supplementation 2008-09

MELINDA DAVIS; *Yakama Nation Fisheries*

The goal for the YKFP Fall Chinook program is to supplement and enhance the Yakima River Fall Chinook populations. Since 1998, rearing strategy for our in-basin hatchery fish has been the focal point for our supplementation program. From BY1998-BY2004, two treatment methods (accelerated vs. conventional) were compared to determine which treatment would yield the best smolt survival to McNary Dam. The accelerated treatment dominated in all release years except one. In BY2005, the in-basin program was shifted to an accelerated rearing program.

In BY2006 to further investigate optimal rearing strategies, two new experiments were implemented: 1) Using our in-basin stock, we compared a group of the accelerated sub-yearlings (BY2007) versus a group held to a yearling release (BY2006) and 2) Using our out-basin Little White Salmon (LWS) stock, we compared a group of 500,000 brought in as eyed eggs and reared under accelerated conditions versus the remainder of the group, 1.2 million, that comes in as pre-smolts reared conventionally with final acclimation at Prosser Hatchery. Both experimental groups were monitored using PIT tags. The 2008 release of yearlings out-performed the accelerated sub-yearling releases. The LWS accelerated fish also out-performed their conventionally reared cohorts in the 2008 release. The 2009 results of both experiments are pending releases.

Redd surveys of fall Chinook adults returning to the Yakima River were conducted above Prosser Dam between mid-September and early November. A total of 201 redds were found in the Yakima River mainstem and 46 redds were also located in the Marion Drain.

In the fall of 2008, the Yakama Nation obtained early-run (summer) Chinook green eggs/milt from Wells Hatchery (Washington State Department of Fish and Wildlife). The objective for this project is to initiate investigation of the feasibility of establishing an early-run fall Chinook population in the Yakima River, with the goals being to:

1) Develop a naturally spawning adult population in the Yakima River between Sunnyside Dam and Roza Dam, and in the lower Naches River from the mouth to the Tieton River, and,
2) Increase the number of natural-origin returning summer-run adults in the lower Columbia, Zone 6, and the lower Yakima River contributing to harvest augmentation for both the tribal and sports fishery.

Approximately 200,000 eggs were fertilized, incubated and reared at the Yakama Nation Prosser Hatchery. Final acclimation is at the Stiles acclimation pond, located in the lower Naches River. Upon release, these fish will be monitored using a combination of either a PIT tag or coded wire tag only.

Modeling summer Chinook reintroduction

CHRIS FREDERIKSEN; *Yakama Nation Fisheries*

The most current summer Chinook reintroduction EDT diagnosis (current and historic) was completed in the spring of 2008 for the Yakima Subbasin. This diagnosis was fairly simplistic and included too few potential life history patterns (both juvenile and adult). In order to characterize the life history patterns most suitable to environmental conditions in the Yakima Subbasin, the existing Yakima summer Chinook database was expanded to include all summer Chinook freshwater adult and juvenile life history patterns documented in the donor stock populations residing in the Upper Columbia. All biologically plausible combinations of life history patterns were combined to evaluate critical uncertainties concerning the biological responses to anticipated temporal and spatial characteristics of the environment. The results of the analysis hypothesize the suitable characteristics of a summer Chinook population adapted to the Yakima Basin, the feasibility of summer Chinook reintroduction, and estimate the natural production potential of the Yakima Subbasin. This information will assist future planning efforts with artificial production strategies through multiple phases of the reintroduction process.

Update on the Status of Bull Trout in the Yakima Basin

YUKI REISS; *Recovery Program Coordinator, Yakima Basin Fish and Wildlife Recovery Board*

Bull trout (*Salvelinus confluentus*) is one of two ESA listed fish species in the Yakima basin. Yakima populations were listed as "threatened" in 1998 as part of the Columbia River DPS (Distinct Population Segment), and comprise the entire Mid-Columbia core population. The status of local populations in the Yakima basin has fluctuated. Redd count monitoring began in the early 1990s on a subset of local populations, and index areas for other populations have been established in subsequent years, including new discoveries such as a North Fork Tieton spawning population in 2007. Current proposed bull trout projects in the basin include a pit tagging study in the North Fork Tieton, a Bull Trout Task Force, and continued improvement of a genetics baseline.

Genetic Analysis of Yakima Basin Bull Trout (*Salvelinus confluentus*)

MAUREEN P. SMALL, DENISE HAWKINS AND JENNIFER VON BARGEN; *Washington Department of Fish and Wildlife, Conservation Division, Genetics Lab*

A total of 462 bull trout samples from the Yakima River Basin were analyzed at 16 standardized microsatellite loci. Genetic analysis identified at least 11 distinct bull trout populations in the Yakima River Basin. Pairwise F_{ST} tests and tests of genotypic differentiation indicated highly significant differences among population collections with the exception of those from the American River and Union Creek. Although these were not significantly different from each other, a combined collection generated signals indicating a mixture of differentiated groups. Eight bull trout collected from NF Tieton and within Tieton basin also appeared to form a genetically distinct group, suggesting another

possible spawning population in the Tieton basin. Genetic data were used to confirm population of origin for juvenile samples and to identify adult samples collected by the Bureau of Reclamation in the Tieton pool below Rimrock Dam. Genetic data were also used to infer population of origin for adults with unknown population membership collected as part of a WDFW telemetry study of bull trout movement and adults collected by WDFW throughout the Yakima River basin.

Steelhead Monitoring on Satus, Toppenish, and Ahtanum Creeks

TIM RESSEGUIE, *Yakama Nation Fisheries*

The Yakama Nation Fisheries Resource Management Program monitors the steelhead populations on the Ahtanum, Toppenish, and Satus watersheds. Our three pass redd count surveys of all known steelhead spawning habitat in the Satus Creek watershed conducted annually between the months of March and May provides a good index to track spawning escapement of that DPS. Redd count surveys in Toppenish and Ahtanum Creeks are usually less complete because of poor access and high flows; however, still provide information on timing and distribution. We also operate rotary screw traps on each tributary to monitor the steelhead out-migration between the months of November and June each year.

Steelhead Reconditioning

DAVID FAST, *Yakama Nation Fisheries*

The steelhead kelt reconditioning project continued over the past year with survival results from different recovery and release strategies. To evaluate the potential benefits of reconditioning we released one test group of outmigrating kelts directly into the Yakima River at the collection station at Prosser dam to determine the in-river survival (Direct Release). A second group of fish was collected and transported below Bonneville dam (Direct Release). A third group was held for a brief period and then transported and released below Bonneville dam (Short Term Rearing). And a forth group was held in circular tanks at the Prosser Facility and released in the fall after being reconditioned (Long Term Rearing). The long-term group was fed for about six months and examined with ultrasound to determine the status of the gametes before release. All fish in the study were given PIT tags so that they could be tracked through the Columbia and back to the Yakima for evaluation of survival.

Genetic Comparisons Between *Oncorhynchus mykiss* Juvenile Migrants and Mature Residents From the Upper Yakima River

[1]SCOTT M. BLANKENSHIP, [1]CHERRIL BOWMAN, AND [2]GABRIEL M. TEMPLE, *Washington Department of Fish and Wildlife*

Previous genetic studies in the Yakima Basin have documented genetic differences among the anadromous *Oncorhynchus mykiss* (i.e., steelhead) populations; however, limited information is available regarding the genetic affinities between anadromous and resident forms of *O. mykiss* in the Yakima River. In 2008, an initial study was conducted evaluating genetic affinities among known adult steelhead spawners, juvenile migrants, and mature residents. Genetic relationships among mature resident collections were ambiguous due to insufficient sampling, cutthroat trout admixture, and relatedness. The present study extends last year's work by analyzing additional mature resident (N=269) *O. mykiss* from tributaries to the upper Yakima River, along with newly identified juvenile migrants (N=71). Mature residents were collected from middle fork Teanaway River, north fork Teanaway River, Swauk Creek, Taneum Creek, and Umtanum Creek. Juvenile migrant *O. mykiss* were analyzed from middle fork Teanaway River, north fork Teanaway River, and Taneum Creek. We evaluated the genetic similarities between collections with the same life history type, and between collections differing in life history.

Implementation of hydraulic redd sampling and two-year smolt rearing programs to reduce domestication in steelhead supplementation programs

B.A. BEREJIKIAN, *NOAA Fisheries, Northwest Fisheries Science Center, Resource Enhancement and Utilization Technologies Division*, barry.berejikian@noaa.gov

In 2006, NOAA Fisheries, Northwest Fisheries Science Center and collaborators initiated a large-scale, long-term test of supplementation for ESA-listed steelhead in Hood Canal. The study involves supplementing three populations with locally derived fish collected as embryos from natural redds. Supplemented populations and three additional (control) populations are monitored for abundance, productivity, and genetic and life history diversity. In attempts to reduce inadvertent domestication selection the supplementation programs do not involve any artificial spawning. All fish spawn naturally and embryos are collected at the eyed stage of development. Furthermore, juveniles are reared to the modal age at smoltification (age-2) by manipulating ration. This presentation 1) provides a basis for the hypothesis that

yearling smolt programs select for rapid growth rates and associated behavioral traits, 2) describes the methods used to initiate and carry out two-year smolt programs, and 3) provides preliminary data on growth rates for each of the three populations.

A review of the relative fitness of hatchery- and natural-origin salmon and steelhead

B. A. BEREJIKIAN; *NOAA Fisheries, Northwest Fisheries Science Center, Resource Enhancement and Utilization Technologies Division,* barry.berejikian@noaa.gov

Estimates of the relative fitness of hatchery- and natural-origin salmon can help determine the benefits and risks of artificial propagation in supplementing natural stocks. Data on relative fitness can be used to parameterize productivity models, improve the assessments of natural population productivity, and assist in predicting the effectiveness of stocking as part of an overall recovery effort. Published information on relative fitness of hatchery and natural-origin salmon (i.e., ratio of hatchery recruits per spawner to natural recruits per spawner) is biased towards one iteroparous species (steelhead, *O. mykiss*), and includes studies of several non-locally adapted hatchery populations that have been highly domesticated. Recently, an important study (Araki et al. 2007) estimated that hatchery-origin fish with two hatchery-origin parents had only 55% the relative lifetime fitness of hatchery-origin fish with one hatchery and one natural-origin parent, suggesting rapid fitness loss and a genetic basis for it. Recent models such as the All H Analyzer (AHA) have been used for several different species and life history types (e.g., ocean and stream-type Chinook salmon) and require relative fitness estimates to guide best management practices. Therefore, an up-to-date, broad-scale assessment and understanding of relative fitness data is essential. In this presentation, I summarize information on published and non-published studies that have attempted to quantify relative fitness. I discuss evidence for fitness loss in the context of species differences, local adaptation, life history, spawner density, gender, and hatchery objectives.

Environmental drivers of steelhead abundance in partially anadromous *Oncorhynchus mykiss* populations

IAN COURTER, CASEY JUSTICE AND STEVE CRAMER; *Cramer Fish Sciences*

Oncorhynchus mykiss populations with ocean access display considerable life history plasticity. Resident (rainbow trout) and anadromous (steelhead) adults commonly produce offspring of the alternate ecotype, but environmental drivers of this life-history response are not well understood. Patterns in *O. mykiss* ecotypic distribution, suggest that flow and temperature conditions play an important role in determining the predominance of either resident or anadromous life history forms. As a supplement to traditional hypotheses about declining steelhead abundance, we propose a theory supported by evidence from pristine rivers. We hypothesize that flow regimes providing cool temperatures and maintaining depth and velocities necessary to sustain adult *O. mykiss* throughout the summer and fall seasons result in increased resident rainbow trout abundance and decreased steelhead abundance. This theory is consistent with a commonly referenced ecological principle that "when the animal's needs are being met, it stays where it is; when they are not, it moves until it finds appropriate conditions for its current demands." Furthermore, our hypothesis may explain why mainstem habitats in regulated river systems often support renowned resident rainbow trout populations, while tributaries tend to produce predominantly steelhead.

Flow and temperature effects on life history diversity of *Oncorhynchus mykiss* in the Yakima River basin

CASEY JUSTICE, IAN COURTER, AND STEVE CRAMER; *Cramer Fish Sciences*

To explore the effect of environmental conditions on the distribution of resident and anadromous *Oncorhynchus mykiss* in the Yakima River basin, we used a life-cycle modeling approach to simulate flow and temperature effects on relative reproductive success of each ecotype. Model results indicated that flow regimes providing cool temperatures and maintaining depths and velocities necessary to sustain adult *O. mykiss* throughout the summer produced habitats that favored a resident life history strategy, explaining in part why the upper Yakima Basin supports predominantly resident rainbow trout, while tributaries in the lower basin continue to produce predominantly steelhead. Channel type and location within the basin were also important factors determining the life history composition of *O. mykiss*. Mainstem habitats and upper basin sites favored a resident life history while tributary habitats and lower basin sites promoted a migratory life history strategy. Alteration of flow conditions in mainstem habitats had little effect on the relative reproductive success of anadromous *O. mykiss*. Our modeling demonstrated that tributary habitats were most likely to support an anadromous ecotype, and management actions that improve tributary habitats have the greatest potential to increase abundance of steelhead in the Yakima Basin.

Cle Elum Fish Passage Update: Reintroduction Moving Forward

BRIAN SALUSKIN; *Yakama Nation Fisheries*

In 2008 the Yakama Nation (YN) participated in the completion of feasibility study of fish passage at Cle Elum and Bumping Lake dams. YN worked with the Washington Department of Fish and Wildlife (WDFW) in developing the Master Plan for reintroduction of anadromous fish above the reservoirs. The effort is part of a Bureau of Reclamation (BOR) led cooperative investigation with the YN, state, other federal agencies that studied the feasibility of providing fish passage at Cle Elum Lake dam, one of the five large storage dams of the Yakima Project. The dams: Bumping, Kachess, Keechelus, Cle Elum, and Tieton, were never equipped with fish passage facilities. Four of the five reservoirs were originally natural lakes and historically supported Native American fisheries for sockeye salmon and other anadromous and resident fish. Of these Cle Elum has the best habitat above the reservoir for this fish passage project. The EIS process that has been launched is part of the agreed-upon planning process for Cle Elum Dam. An EIS for Bumping Lake fish passage will be prepared separately at a future time. The BOR estimated that approximately 263,000 to 1.2 million smolts will be needed to fully seed the Cle Elum River basin above Cle Elum Dam (USBOR 2007a and 2007b). This data was used to establish a near-term (2009-2017) project goal of collecting 500 pairs of adult sockeye salmon from Priest Rapids Dam depending on availability after escapement goals have been reached and the broodstock needs of the Skaha Lake project have been met (Wright and Smith 2004). Wright and Smith (2004) estimated a minimum escapement of between 10,000-40,000 fish above Wells Dam to meet the Skaha project needs of 250-1000 pairs of adults, before surplus brood can be obtained in late June/early July 2009. Successful implementation of fish passage at Cle Elum and Bumping dams could eventually lead to future detailed study of fish passage at the other three dams. The 2008 activities included 250,000 fry (April) and 250,000 summer/parr plants (June) above the lake, and 12,000 pit tagged coho released directly into the Cle Elum Lake. The interim passage protocols use Passive Integrated Transponder (PIT) tags implanted in the test fish to monitor their movement through the system. PIT tag detectors located at Cle Elum, Roza, Prosser, McNary, and Bonneville dams will record the passage of these juveniles as they migrate downstream, and when they return as adults. The 2008 activities are a continuation of the work done in the previous four fiscal years.

Habitat, Wildlife and Watershed Management, Room 101

I-90 Snoqualmie Pass East Project Overview

JASON SMITH; *Washington State Department of Transportation, Environmental Program*

Interstate 90 is the main east-west transportation corridor across Washington State. I-90 connects the deep-water ports, large population centers, and retail and service businesses of the Puget Sound with the farmlands, industries, and extensive outdoor recreational areas of Eastern Washington. The uninterrupted movement of cars, trucks, freight, and recreational vehicles across the Cascade Mountains and Snoqualmie Pass is essential to our quality of life and the economic vitality of our state. Through the I-90 Snoqualmie Pass East Project, WSDOT will improve I-90 by providing a safer, more efficient six-lane freeway from Hyak to Easton. The project will straighten roadway curves, replace old pavement, reduce rock fall hazards, and build a new snowshed to reduce closures due to avalanche control. WSDOT will also construct wildlife crossings over and under I-90 for the safe movement of wildlife and enhance wetlands and habitats throughout the corridor. Construction is scheduled to begin in 2009 on the first five miles of the I-90 corridor between Hyak and Keechelus Dam.

Pre-construction wildlife monitoring for Washington's I-90 Snoqualmie Pass East project.

ROBERT A. LONG, PAULA MACKAY, AND JAMES BEGLEY; *Western Transportation Institute, Montana State University*

Interest in wildlife crossing structures and other tools (e.g., fencing and jump-outs) for mitigating the effects of roads on wildlife is growing rapidly, with state departments of transportation increasingly including such measures in highway projects. Often, wildlife monitoring efforts associated with such projects are under-funded and conducted only after construction or for only short time periods of time. As part of an ambitious project to improve a 15-mile stretch of Interstate 90 (I-90) east of Snoqualmie Pass, the Washington State Department of Transportation (WSDOT) is planning to install a large number of wildlife underpasses, multiple overpasses, wildlife fencing, and jump-outs. The crossing structures have been designed and located with a broad range of species in mind (e.g., amphibians, fish, mammals). A key component of the I-90 project is its commitment to extensive wildlife monitoring—both prior to and following the construction of structures. The long-term and multi-phased nature of this project will make it possible to collect valuable baseline data prior to construction, with sufficient power to detect effects. Working with WSDOT and other project partners, the Western Transportation Institute has developed a comprehensive monitoring plan and begun pre-construction monitoring of this project. Pre-construction monitoring objectives include quantifying existing rates of highway crossing by various species and species groups, assessing the rate of roadkill and wildlife-vehicle collisions, and surveying throughout the project area to evaluate species occupancy and distribution. In addition, the I-90 project emphasizes a unique, multi-tiered approach that will permit large-scale questions of wildlife connectivity to be explored. Here we review the important components of the monitoring program, and present some results from the first full year of monitoring.

Pre-construction baseline monitoring of pikas for Washington's I-90 Snoqualmie Pass East project: Habitat and Distribution

KRISTINA ERNEST[1], PATRICIA GARVEY-DARDA[2], PAUL HOUGHTALING[1], PATRICK EMBLIDGE[1], AND CRYSTAL DAVIDSON[1]; [1]*Department of Biological Sciences, Central Washington University,* [2]*US Forest Service, Cle Elum Ranger District*

Pikas (*Ochotona princeps*) are a low-mobility, talus-obligate species. During 2008, we began baseline monitoring of this species adjacent to the Interstate 90 (I-90) Snoqualmie Pass East project to determine the distribution of talus, talus patch occupancy by pikas, and pika relative abundance. We mapped 46 talus patches onto a project area map, and conducted surveys for pika abundance at 40 patches. Pikas occurred at 38 of the talus patches we visited, including 3 sites directly adjacent to I-90 (i.e., abutting highway shoulders or bridge supports). Occupied patches included both natural talus and human-made rock piles. Pikas were directly observed (seen or heard calling) at the majority of these sites; only indirect evidence (pika haypiles or latrines) was found at some sites. We conducted live-trapping at nine different talus sites, 3 north of I-90, 5 south of I-90, and one directly under or adjacent to I-90. These talus patches ranged in size from < 1 to ~20 acres. We marked trapped pikas with ear tags, collected ear tissue samples for genetic analyses, and then released pikas at the site of capture. A total of 29 individual pikas was captured, at six of the nine trapping sites. We also characterized talus patch habitat by measuring isolation (distance to nearest talus patch), slope angle, slope aspect, percent canopy cover, and rock size. Overall, pikas occupied most talus patches surveyed in the I-90 project area. Relative abundances varied considerable, as did habitat characteristics. A monitoring plan for pre- and post-construction was developed.

Pre-construction baseline monitoring of amphibians for Washington's I-90 Snoqualmie Pass East project: Distribution, detection and tracking.

MICHELLE LESTER, SUSAN BRADY, APRIL BARECCA, BRENNA HILL, JASON IRWIN, AND STEVE WAGNER; *Department of Biological Sciences, Central Washington University*

Amphibians are often overlooked species with respect to mitigation efforts for development projects. However, the Washington State Department of Transportation (WSDOT) has designed crossing structures to facilitate connectivity of multiple taxa along a 15-mile stretch of Interstate 90 (I-90) Snoqualmie Pass corridor. In order to assist with this effort, we are developing a baseline monitoring plan for amphibians as indicators of low mobility species. During 2008, we conducted distribution surveys and pilot studies to identify focal species and techniques useful in the project area. Intensive visual encounter surveys were conducted throughout the project area to map species occurrence with respect to connectivity enhancement areas (CEAs) and existing potential crossing structures (i.e., culverts, overpasses etc). Pilot studies included the assessment of funnel traps, drift fences, pit fall traps, and visual encounter transect surveys for amphibian detection. In addition, we evaluated toe clipping, visual implant elastomers and radio telemetry as methods for tracking individuals. Based upon our results, we have developed a baseline monitoring plan consisting of focal species and a combination of techniques to quantify the existing connectivity of amphibian populations.

History of elk-agriculture conflicts in the Yakima Basin

ANTHONY NOVACK, *Washington Department of Fish and Wildlife*

Elk management at the landscape level has impacts to localized agricultural interests. The Yakima Basin has three general areas, Kittitas Valley, Yakima-Wenas Valley, and Hanford reach, where differences in management of the surrounding landscapes and the public/private ownership matrix results in a distinct set of conflicts with elk and agriculture. Crop depredations typically occur at the interface of private lands bordering large public landholdings. Small individual landowners can suffer tens of thousands of dollars worth of damage in the form of direct crop losses, broken fences, irrigation repairs and other property losses. A broad array of tools have been employed to minimize elk-agricultural conflicts which include: 1) compensation for crop losses, 2) construction of elk proof fence to protect crops, 3) issuance of special elk hunting permits and a modified elk seasons to remove problem elk.

Status of the Spotted owl population on the Cle Elum Study Area, Washington, USA, 1989-2008

STAN SOVERN; *Pacific Northwest Research Station, United States Forest Service*

We marked 801 spotted owls in 1989-2008, and used yearly re-observations of the marked owls to estimate reproduction, survival, and population growth rate. Reproduction followed an odd-even year pattern with reproduction higher in even-numbered years in 1989-2000, after which time this pattern became less evident. Yearly empirical counts show a decline in number of owls of approximately 70% in 1992-2008. Annual apparent survival estimates from program MARK for 1989-2003 were generally high (0.86, SE = 0.017) for non-juvenile owls. The spotted owl population on the Cle Elum Study Area has declined by about 6.2%/year during (95% CI = 2.4 – 10%), based on the most recent population growth rate estimate calculated for 1992-2003. A meta-analysis of spotted owl mark-recapture data from 11 spotted owl demography study areas was completed in January, 2009. The results of this analysis will be made public in summer, 2009, and will include updated population growth rate estimates for all study areas.

Prey use by male and female cougars in an elk and mule deer community

KEVIN WHITE; *Washington State University*

Male and female predators may select for different species, sexes, and ages of prey because of sexually dimorphic body size where larger males select for larger prey. I tested for sexually dimorphic prey use by cougars (*Puma concolor*) from 2003 – 2008 in central Washington State. I predicted that males would kill a greater proportion of larger prey (elk) (*Cervus elaphus*), while females and females with offspring would kill smaller prey (mule deer) (*Odocoileus hemionus*) more frequently. I investigated 436 potential cougar predation sites identified by Global Positioning System (GPS) clusters (≥ 2 locations within 50 m on the same or consecutive day) and successfully located prey remains at 345 sites from 18 cougars (9M, 9F) (1-261 days post predation). I found 127 prey remains at female GPS clusters, 111 at females with offspring clusters and 107 at male clusters. I detected 184 mule deer, 142 elk and 17 other remains from 4 other species. I used log-linear modeling to detect differences in prey use and age of prey killed among cougar reproductive classes. Females and females with offspring killed more mule deer than elk (62% vs. 38%), while males killed more elk than mule deer (55% vs. 45%) ($P < 0.01$). Males killed 4 times as many adult elk than females (24% vs. 6%) and females killed about twice as many adult mule deer than males (26% vs. 15%). There

were no differences in cougar kill intervals among reproductive classes ($P > 0.05$). Mean kill interval for all cougars was 6.9 days/kill, (SD = 3.94 days, range = 0.6 – 19.8 days, n = 136 inter-kill intervals). Cougars stayed at elk kills 4.81 days and 3.10 days for mule deer. The duration spent on kills differed among cougar reproductive classes ($P < 0.01$) and seasons ($P < 0.01$), with females remaining on kills longer than males (4.72 days vs. 3.43 days). Males had greater effects on elk and females had greater effects on mule deer. Managers should take sexually dimorphic prey use into account when prescribing hunting of predators as a method for prey conservation.

Assessment of Small Storage Opportunities and Constraints: Potential Aquatic and Riparian Ecosystem Enhancements in the Swauk Creek Watershed

DAVID GERTH; *Kittitas Conservation Trust,* DR. ALLEN E. SULLIVAN; *Central WA University*

Swauk Creek is utilized by 15 native fish species, including bull trout (ESA threatened) and steelhead (ESA endangered). Spring Chinook continue to utilize the lower mile of the stream for rearing. Steelhead currently spawn upstream of the Lauderdale junction. Low late season flows through the lower 7 miles of the creek have been identified as a primary limiting factor to salmonid production in the watershed.

Maintenance of flows in Swauk Creek at 2.5 cfs at Lauderdale Junction during annual low flow periods (July – October) would maintain surficial flow in the stream and prevent the formation of fish passage barriers to the confluence with the Yakima River.

Storage of 300-500 acre feet of water during peak early season flows would enable late season augmentation to agricultural consumptive uses, thus reducing the need to divert creek water during late season low flow periods.

Nutrient Limitation in Swauk Creek River Basin

TANYA LAMB; *Central Washington University, Mentor:* CLAY ARANGO*, Biology*

Historically, salmon subsidized Pacific Northwest streams with marine-derived nitrogen and phosphorus, important nutrients that control stream food web productivity. With regional salmon decline, many streams have become nutrient limited. Swauk Creek, in the upper Yakima River basin, holds promise for salmon restoration because it currently supports a small run of steelhead, and coho salmon will be reintroduced within the decade. However, decades of curtailed nutrient subsidies may have decreased food web productivity, which could impede salmon restoration. I studied three headwater streams in Swauk basin in summer and autumn using nutrient diffusing substrata to measure nutrient limitation. In this method, nitrogen, phosphorus, or both diffuse from agar through a glass disk or a cellulose sponge that select for autotrophic or heterotrophic biofilms respectively. Although Iron and Hovey creeks responded significantly to nutrient treatments, Swauk Creek did not, although a larger sample size may have detected a significant response. Autotrophic and heterotrophic biofilms were co-limited by nitrogen and phosphorus in the summer and the fall in Iron Creek, but only heterotrophic biofilms were co-limited in the summer and fall in Hovey Creek. Importantly, nitrogen or phosphorous alone did not induce a significant response in any creek. Co-limitation by nitrogen and phosphorus in Iron and Hovey Creek is consistent with patterns in other streams with long-term salmon decline. Despite having no baseline to compare historic and current nutrient limitation patterns in Swauk basin, food web productivity would likely increase if salmon runs are successfully recovered.

Cottonwood Sex Ratios on the Wapato Reach: New Conclusions

TOM ELLIOTT; *Yakama Nation Wildlife Program*

Black cottonwoods are the only native riparian tree in the semi-arid portion of Yakima River riparian zones. As such, they provide critical functions to riparian and aquatic ecosystems, including linkages between hydrology, channel dynamics, and other organisms. Previous studies have suggested that the sex ratios of black cottonwoods may be severely skewed towards males on the middle reaches of the Yakima, potentially creating a reproductive bottleneck with long term population implications.

As part of my thesis research, I sampled for cottonwood sex ratios on the Wapato Reach between Parker Dam and Satus Creek. My results show that there is probably not an imbalance between males and females and that in this respect at least Wapato Reach cottonwood forests may be relatively unimpaired. Additional spatial analyses of sex ratios found no association between hydrological factors and sex ratios.

Although sex ratios may be balanced, more work is needed to understand the long term trajectory of cottonwood forests in the Wapato Reach and whether current flow and sediment regimes are sufficient to maintain sufficient rates of forest regeneration.

Vulnerabilities of water availability and agriculture from climate change in the Yakima River Basin, Washington

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Projections of a warming world due to global climate change are well documented and were summarized in 2007 in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. For the Yakima River Basin, global climate models project a warming over the next 90 years, as much as 3° Celsius, that can have large effects on water availability and agriculture. The hydrologic system in the basin is very sensitive to such temperature increases. Indeed, snowpack is vulnerable to temperature increases ranging from 1° to 2° Celsius, with a 59 percent decrease in snowpack calculated with a 2° Celsius increase. Potential future changes in the hydrologic system will be additive to existing historical trends and will make management of water in the basin for both instream (fish habitat) and out of stream uses increasingly more complex. Observed data suggest that groundwater in some areas may no longer be a reliable supplemental source for water under a warming climate. Climate change scenarios also indicate that groundwater recharge to the aquifer system is sensitive to increasing temperatures. Furthermore, increasing temperatures will increase crop-water demand and likely result in less water leaving the root zone in agricultural areas, thereby decreasing recharge to the groundwater system. Together, historical trends and potential future effects of climate change indicate significant vulnerabilities in water availability, agriculture, and fish habitat in the Yakima River Basin.

Aspects of Groundwater in the Yakima River Basin

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Surface water in the Yakima River Basin is fully appropriated and there are increasing demands for water for municipal, fisheries, agricultural, industrial, and recreational uses. These demands must be met by groundwater withdrawals and/or by changes in the way water resources are allocated and used. An integrated understanding of the groundwater flow system and its relation to the surface-water resources is needed in order to implement most water-resources management strategies in the basin.

The U.S. Geological Survey began a cooperative effort with Bureau of Reclamation, the Yakama Nation, and Washington State Department of Ecology to obtain an understanding of the Yakima River Basin aquifer system. Under this program, a variety of approaches and analytic tools have been developed to address the issues of water management under existing conditions, future growth scenarios, and potential regional climate change, including a comprehensive assessment of groundwater.

The comprehensive assessment of groundwater included a generalized, mean annual water budget to provide an overview of the magnitude of the various budget components and information important for understanding the framework of the groundwater system in the basin. Process-based models that compute distributed water budgets on a watershed scale were employed to estimate recharge, and groundwater pumpage from the aquifer system was estimated for 8 categories of use. Hydrogeologic units were defined and mapped. Hydraulic characteristics were estimated to provide a range of values for the hydrogeologic units. The hydrogeologic framework was then integrated into a regional groundwater model.

Trends in groundwater levels were analyzed and mapped; in some areas, groundwater pumping has caused water-level declines of more than 300 ft. The depth to and elevation of the water table was mapped for the structural basins and areas outside the basins where there were sufficient data. The assessment of river-aquifer exchanges was accomplished using isotope data, seepage investigations, mini-piezometer data, groundwater levels and temperature data, and thermal profiles.

In combination, these approaches identify groundwater movement in the aquifer system and may lead to a way to accommodate municipal, agricultural and ecological needs of the basin within the physical limitations of the hydrologic system.

A Giant Sucking Sound: Marion Drain and Mid-Toppenish Creek Groundwater Interactions

TOM ELLIOTT; *Yakama Nation Wildlife Program*

Toppenish Creek drains 1500 square kilometers of the East Cascades and flows in its entirety through the Yakama Reservation. Historically this watershed supported extensive salmon runs and cultural use of its floodplains. Drastic land-use changes in the last two centuries, however, have led to creek incision, floodplain de-watering, and impaired function for the creek and associated wetlands and riparian ecosystems. The loss of ecological function has in turn led to declines in cultural use of the system.

Marion Drain is a large agricultural drain located on the northern edge of the Toppenish Creek floodplain. It intercepts agricultural drain water flowing south from the Wapato Irrigation District and but also potentially drains water from Toppenish Creek because of the drain's low surface water elevation. In order to better understand the interaction between Toppenish Creek and Marion Drain, the Yakama Nation installed a network of ground-water monitoring wells in the floodplain between the creek and the drain. Data collected from 2005 to the present reveals that Marion Drain surface water elevation is indeed lower than that of Toppenish Creek for most of the year, and that the water table slopes away from the creek to the drain in parts of the floodplain.

This condition could have implications for floodplain recharge and wetland function in the Toppenish Creek floodplain. Strategies for mitigating the influence of Marion Drain on Toppenish Creek are considered and several scenarios are presented. Future study should include more wells south of Toppenish Creek, soils analysis, and temperature data in order to develop restoration strategies.

Low-Cost Wood Replenishment in Taneum Creek: Results from the January 2009 Flood

SCOTT R. NICOLAI; *Yakama Nation Habitat Program*

Instream restoration involving large woody material has been utilized in many habitat projects in the Pacific Northwest. Because of restrictions on material availability and heavy equipment requirements for transportation and placement, large wood projects are expensive, resulting in lost opportunities for additional restoration. This presentation describes a wood replenishment project on Taneum Creek along state-owned land that began in April, 2008. The approach involves thinning overstocked stands adjacent to the stream channel, and dragging the full-length trees into the stream channel with manual tools. Trees placed in the channel are not anchored, thus movement via stream hydraulics is anticipated. Following the January 2009 flood, over 70% of placed trees remained within the ordinary high water mark. This approach is extremely low cost and meets multiple objectives, including improved instream complexity, improved forest stand conditions and carbon sequestration.

Winter Water: A hot topic for cold fish

JASON MCCORMICK***;*** *Washington Water Trust*

In the past five years Washington Water Trust has conducted two permanent purchases of water rights in the winter for the express purpose of enhancing steam flow in Yakima Basin tributaries. Winter stream flow is legally diverted in Washington State for the purpose of providing drinking water for livestock, known as "stockwater." Stockwater is typically diverted from streams during a period of November 1 to April 30 in the Yakima Basin. Anadromous fisheries compete with stockwater for winter stream flows in tributaries to the Yakima River. Enhancing winter stream flows provide for increased habitat and potentially increased water temperatures.

Water Quality in Lower Yakima River Tributary Streams and Irrigation Return Drains

SCOTT LADD; *Yakama Nation Water Resources*

Water quality in streams and irrigation return drains within the irrigated portion of the Yakama Reservation was evaluated from 2006-2008. The investigation quantified the bacteria, total suspended solids (TSS), and nutrient loads discharging to the Yakima River from the Yakama Reservation. Year-round biweekly sampling was conducted on 13 streams and drains that discharge to the Yakima River, plus several drains internal to the irrigation system and reference locations. A total of 13 laboratory and field parameters were measured. Stream gaging was conducted to calculate loading and to evaluate the relationship between hydrology and water quality. This study identified potential sources of contamination that contribute to Lower Yakima River water quality impairment and provided data regarding the magnitude, location and timing of constituent discharge into the Yakima River. The information is being used to identify target areas for improvement, and to improve water quality through outreach, education, and regulatory enforcement.

Habitat and Floodplain Activities of the Yakima Countywide Flood Control Zone District

JOEL FREUDENTHAL; *Yakima County Public Services, Surface Water Management Division*

I will discuss several floodplain restoration activities that are occurring on Ahtanum Creek, the Naches River, and the Yakima River (Gap to Gap and Wapato Reaches). I will also discuss the January flood, and the changes in flood damage response by the Corps of Engineers, and the future for further changes in Corps Management of levees in the Yakima Basin as a whole.

Panel on Tributary Access

DAVE MYRA ET AL.; *Yakima Tributary Access and Habitat Program*

Presenters for the Yakima Tributary Access and Habitat Program (YTAHP) will present information about the beginning of the program, partners involved at the beginning and current partnerships. Funding sources will be discussed and the importance of and amount of cost-share dollars obtained for the various projects will be given. The initial work elements of the Strategic Plan and the current evolution of the plan will be discussed. Also presented will be the accomplishments to date and the need for ongoing efforts in the work being done by YTAHP. Some of the completed projects will be illustrated as well as the variety and number of projects in the current scope of work. Also discussed will be the issues and challenges of obtaining permits and the mechanism of how YTAHP has been able to move projects through permitting. Some information will be presented about additional goals YTAHP is pursuing and how they may be added in the future.

Market-based water acquisition and restoration tools

LISA PELLY; *Washington Rivers Conservancy*

Washington Rivers Conservancy facilitated a reverse water right auction for Manastash Creek water right holders as a method to acquire water for instream flow. All water right holders in Manastash Creek with surface water rights confirmed by the Yakima Adjudication Court were invited to submit bids to sell all or a portion of their water rights to the state in an effort to increase flows in the creek by at least 3 cubic feet per second.

Wilson Creek Restoration and Grazing Innovation Project

JILL ARANGO; *Cascade Land Conservancy*

The Cascade Land Conservancy, Kittitas County Conservation District and the Mid-Columbia Fisheries Enhancement Group have teamed up on a project to test and refine an innovative technique for managing lands along rivers and creeks. The Pioneers in Conservation Program has funded the project on the lower half mile of Wilson Creek near Ellensburg using flash grazing of livestock to control noxious weed establishment. Flash grazing involves stocking a pasture with a large number of grazing animals for a very brief period.

Schools of Salmon

RACHEL LITTLE; *Benton Conservation District* and DENISE BUCK; *North Yakima Conservation District*

What do schools of salmon have to do with schools of students? Today's students are tomorrow's landowners, voters, regulators and fish biologists. What skills, knowledge and attitudes do we hope they will have towards aquatic resources, our region and economy? Conservation Districts are working together to help schools educate tomorrow's leaders. *Salmon in the Classroom* connects students to salmon and local rivers. *Water on Wheels* contains lessons on water, soil and energy conservation, with the message that "every little bit counts." *Wheat Week* examines the wheat plant as a system and builds bridges between the wheat industry, dams and salmon recovery. Teacher workshops provide professional development with science-based information on ecosystems, wildlife, natural resource conservation, risk assessment and alternative energy.

Yakima/Klickitat Fisheries Project - Habitat Projects Update

JOHN MARVIN; *Yakama Nation Habitat Program*

The Yakama Nation's Yakima-Klickitat Fisheries Project (YKFP) continues to promote strategic habitat protection and restoration in priority reaches of the mainstem Yakima River and in the most productive tributary streams. Projects undertaken include habitat acquisitions, restoration and protection. Current acquisition projects include protection of important habitat areas in strategic locations as funding and opportunities arise, including properties in the Ellensburg urban area and along the Naches River. Acquired habitat properties are restored based on specific plans, such as for the Harris (Naches River side channel), Fortune (Naches River), and Holmes (Yakima River side channel) properties. YKFP is currently conducting reach assessments for the Swauk and Taneum creeks to design appropriate restoration of degraded habitat. In addition, YKFP is developing a project with the US Forest Service to relocate a significant portion of roadway away from the Little Naches River. YKFP is in the process of acquiring LIDAR (Light Detection and Ranging) data to aid in restoration efforts and environmental planning. YKFP is active in local environmental planning and education. Participation in environmental planning includes the development of the Yakima County and City of Ellensburg Critical Areas Ordinances, coordinating discussion of flood issues in west Ellensburg and participation in local project permitting with potential to impacts sensitive habitat. Every year around Earth Day, YKFP sponsors two days of environmental education with elementary students from Ellensburg at the Holmes habitat property. The Earth Day education includes a series of stations for students to get hands on education about macroinvertebrates, water quality, wildlife, riparian zone & tree planting, a salmon life cycle game, and release of student incubated salmon fry.