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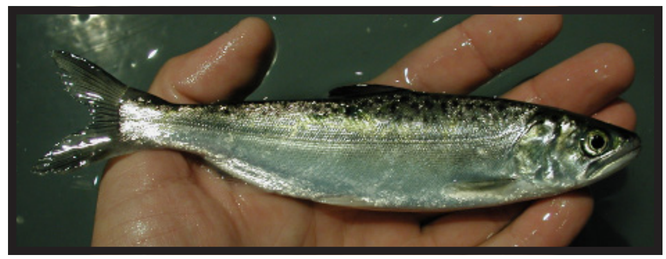
2010 Willamette Basin Fisheries Science Review



Kalapuya A & B Rooms
Spirit Mountain Casino
27100 S.W. Salmon River Highway
Grand Ronde, Oregon 97347

Jan 24 – 26, 2011

2010 Willamette Fisheries Science Review

January 24th -26th, 2011
Grand Ronde, OR

MONDAY	Title	Presenter
8:15	Sign-in, Coffee & Research Coordination	
9:00	Welcome and Introduction	Chairwoman Kennedy
9:10	Opening Remarks	Col Miles
	JUVENILE SALMONID PASSAGE STUDIES	
9:20	Evaluation of the New Flow Control Structure on Passage Route Selection and Survival for Out-Migrating Smolts at the Willamette Falls Hydroelectric Project	Chris Karchesky
9:40	Hydroacoustic Evaluation of Juvenile Salmonid Passage at Cougar Dam, 2010	Fenton Khan
10:00	Hydroacoustic Evaluation of Juvenile Salmonid Passage at Lookout Point Dam, 2010	Fenton Khan
10:20	**BREAK (30 min)**	
10:50	Development of PIT tag detection System for Leaburg and Walterville Dams	Sandy Downing
11:10	Multi -Method Assessment of Direct Mortality and Passage Conditions at Cougar Dam, South Fork Mckenzie, OR	Paul Heisey, Fred Monzyk & Joanne Duncan
11:50	Downstream Fish Passage Above and Below Dams in The Middle Fork Willamette River: A Multi-Year Summary	Matt Keefer
12:10	**LUNCH (1 hour)**	
	SALMONID LIFE HISTORY STUDIES	
13:20	Feasibility of using otolith and scale analyses to characterize life history variation in spring Chinook salmon in three Willamette Valley Project reservoirs and tributaries	Chris Caudill
13:40	Genetic pedigree analyses of spring Chinook outplanted above Cougar Dam, South Fork McKenzie River	Michael Banks
14:00	Incorporating Uncertainty into a Life-cycle Model for Spring Chinook in the McKenzie River	Noble Hendrix

MONDAY	Title	Presenter
14:20	Juvenile Salmon Usage of North Fork Reservoir on the Clackamas River – Synthesis of 50 years of Research	Nik Ackerman
14:40	**BREAK (30 min)**	
15:10	Life History Characteristics of Spring Chinook Salmon in Willamette Reservoirs: What We've Learned So Far	Fred Monzyk
15:50	Willamette Spring Chinook: Life Histories, Habitat Use, and Restoration	Kirk Schroeder
16:30	Slices, An information framework for a biologically-effective network of conservation and restoration in the Willamette River floodplain	David Hulse
16:50	The contribution of tidal fluvial habitats in the Columbia River Estuary to the Recovery of Diverse Salmon ESUs	Dan Bottom

TUESDAY	Title	Presenter
8:00	**Coffee & Research Coordination**	
	LAMPREY	
9:00	Migration Characteristics and Habitat Use of Adult Pacific Lamprey in the Willamette Basin May Vary with Annual Flow Regimes	Ben Clemens & Tiia Workman
9:20	Migration behavior and distribution of Pacific lamprey in the Willamette Basin	Rebecca McCoun & Shadia Duery
9:40	Larval Pacific Lamprey (*Entrosphenus tridentata*) Exposed to Port of Portland Sediment: Method Development for Monitoring Behavior, Individual Growth, and Survival and Preliminary Results	Julia Unrein
	RESIDENT FISH	
10:00	Evaluation of Impacts to Bull Trout and Chinook Salmon in the South Fork McKenzie River from the Cougar Dam Water Temperature Control Project, 2001-2010	Nik Zymonas, Michael Hogansen and Vince Tranquilli
10:40	**BREAK (20 min)**	
11:00	Effects of U.S. Army Corps of Engineers Willamette Project Operations on Oregon Chub and Other Floodplain Fishes	Brian Bangs
	ADULT SALMON AND HATCHERY MANAGEMENT	
11:30	Introduction to adult studies and thoughts on pre-spawn mortality	David Griffith
11:40	Review of Fish return data collected at Fall Creek and Cougar Fish Faculties in the Willamette Valley, Oregon.	Greg Taylor
12:00	Distribution and Behavior of Wild and Hatchery Spring Chinook Salmon Outplanted above Detroit Dam	Ryan Emig
12:20	**LUNCH (1 hour)**	
13:30	Migration behavior and spawning success in spring Chinook salmon in Fall Creek and the North Fork Middle Fork Willamette River: relationships among fate, fish condition, and environmental factors: 2008-2010	Chris Caudill
13:50	Pathological Changes Associated With Prespawning Mortality in Chinook Salmon in The Willamette River and Management Options	Carl Schreck

TUESDAY	Title	Presenter
14:10	Trends in pre-spawning mortality of spring Chinook salmon in tributaries of the Willamette River	Luke Whitman
14:30	The Proportional Natural Influence (PNI) Concept in Hatchery Management: Foundation, Application, and Issues.	Craig Busack
14:50	**BREAK (20Min)**	
15:10	Effects of release strategies and broad-scale environmental conditions on upper Willamette River hatchery Spring Chinook	Marc Johnson
15:30	Monitoring and Evaluation Using Genetic Information	Denise Hawkins
15:50	Willamette Hatchery Mitigation Program Research, Monitoring and Evaluation Plan	Chuck Peven
16:10	Historical and Current Status of Coho Salmon(*Oncorhynchus Kisutch*) in the Willamette Basin above Willamette Falls	Tom Murtagh
16:25	**BREAK (15 Min)**	
16:35	Panel Discussion - Hatchery Broodstock Integration Integrated vs. Segregated, or Integrated AND Segregated: opportunities to make hatchery programs really complicated. Panelists: Craig Busack (NOAA); Mark Chilcorte (NOAA); Michael Blouin (OSU); Marc Johnson (ODFW) Moderators: Cameron Sharpe (ODFW)	

WEDNESDAY	Title	Presenter
8:00	**Coffee & Research Coordination**	
	WATER QUALITY	
9:00	Thermal Effects of Dams in the Willamette River Basin, Oregon	Stewart Rounds
9:20	Evaluation of interim water temperature operations at Detroit and Big Cliff Dams, Water year 2010	Kathryn Tackley & Ian Chane
9:40	Modeling Operational Strategies at Detroit Dam to meet downstream water temperature goals in the North Samtiam River, 2010	Norman Buccola
10:00	Temperature Management of the Lower Deschutes River (RKm 161) using the New Selective water withdrawal facility at Round Butte Dam	Don Ratliff & Lori Campbell
10:20	**BREAK (30 min)**	
	INSTREAM FLOW & HABITAT	
11:10	Preliminary results of watershed scale macroinvertebrate drift composition and abundance during summer baseflow within salmon rearing habitat	Bob Danehy
11:30	WILLAMETTE RIVER TRIBUTARY INSTREAM FLOW STUDY: Determining Chinook and Steelhead Habitat-Flow Relationships in the North Fork Santiam River below Detroit Dam and the South Fork Santiam River below Foster Dam	Dudley Reiser & Michael Gagner
11:50	Closing Remarks	
12:00	**MEETING ADJOURNED**	

JUVENILE SALMONID PASSAGE STUDIES

EVALUATION OF THE NEW FLOW CONTROL STRUCTURE ON PASSAGE ROUTE SELECTION AND SURVIVAL FOR OUT-MIGRATING SMOLTS AT THE WILLAMETTE FALLS HYDROELECTRIC PROJECT

Chris Karchesky[1]*, Tim Shibahara[2], Brian Pyper[3], Paul Heisey[1], Mike Hanks[1], Joanna Fulmer[1] and Dan Cramer[1]

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The Willamette Falls Hydroelectric Project is owned and operated by Portland General Electric, and is located at river km 42.6 on the Willamette River. As a part of the FERC Settlement Agreement issued in 2005 for the Project, a Flow Control Structure (FCS) was constructed at the apex of the Willamette Falls (Falls), a naturally occurring basalt rock formation located within the project area. The purpose of this structure is to focus flow and downstream migrants in a location that provides a safe and efficient passage route during out-migration periods. The FCS was constructed in 2007, and consists of a series of three spill bays, each 15.2 m wide, located across a 45.7 m wide area at the apex of the Falls. Flow through each spill bay is controlled by an inflatable rubber bladder dam, which can be operated independently.

HI-Z Turb`N Tag technology was used to evaluate condition of juvenile Chinook salmon (*Oncorhynchus tshawytscha)* following passage through the FCS in fall 2008. Testing occurred over a 9 day period using 762 juvenile Chinook ranging in size from 108 mm to 206 mm. Smolts were released through each of the three spill bays as well as at a control release site downstream. While each bay appeared to have slightly different hydraulic and passage characteristics, we did not find a significant difference in survival or malady rates among individual spill bays. The combined survival estimate for juvenile Chinook following passage through the FCS was 96.8% (0.968, 95% CI = 0.954 to 1.000), and the combined malady estimate was 3.1% (0.031, 95% CI = 0.017 to 0.045). The maladies observed during this evaluation were largely consistent with mechanical forces. In addition to juvenile Chinook, 49 adult steelhead were also tagged and released through the FCS. All adult steelhead were recaptured alive and remained alive throughout the 48 hour holding period resulting in an overall survival estimate of 100%. In addition, none of the adult steelhead had passage related maladies upon recapture, therefore, the overall malady rate for adult steelhead was 0%.

A radio telemetry study was conducted in spring 2010 to provide information concerning the FCS and how its operations affect passage route selection and movement of out-migrating Chinook salmon smolts under normal facility operations. Run-of-the-river hatchery smolts were collected at the Project and implanted with radio transmitters. A total of 267 smolts ranging in size from 112 to 218 mm were released approximately 5 km upstream on 19 separate occasions from 3 March through 23 April. Of these

fish, 233 passed the Project, with 209 passing over the Falls and 23 passing via the T.W. Sullivan Powerhouse (the passage location of one fish was undetermined). The calculated passage rate for fish passing over the Falls was 90.1% (0.901, 95% CI = 0.862 to 0.940). Of the smolts that passed over the Fall, the majority (92.8%) passed through the FCS. Logistic regression was used to examine relationships between passage rates and river flow, FCS operation, fish length, and release day. Results of this analysis indicated that flow was the primary factor influencing route selection; the estimated probability of passing over the FCS increased from 76% to 95% as flow increased from 16 kcfs to 35 kcfs.

HYDROACOUSTIC EVALUATION OF JUVENILE SALMONID PASSAGE AT COUGAR DAM, 2010

Fenton Khan*, Gary Johnson, and Gene Ploskey

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We evaluated juvenile salmonid behavior at Cougar Dam on the McKenzie River during 2010. The study was conducted by the Pacific Northwest National Laboratory for the U.S. Army Corps of Engineers, Portland District (USACOE). The goal of this study was to provide information on fish behavior at the dam to support decisions on long-term measures and operations to enhance dam passage conditions. An understanding of juvenile salmonid behavior as they pass through the dams and the size distribution of fish that are passing will be important components for developing operations and structures that pass fish safely and efficiently. The study period was from February 1, 2010 to January 31, 2011. The objective was to examine fish behavior and movement patterns in the nearfield (<20 m) forebay of the Water Temperature Control Tower. We used a Dual Frequency Identification Sonar (DIDSON) acoustic camera to obtain fish behavior data. The DIDSON was deployed on a barge at the tower and aimed across the tower intakes. Data were collected 24hr/d, 7d/wk for the course of the study period. This study is currently in the data collection and analysis phase. However, we submitted two in-season progress reports with preliminary data to the USACOE, one in August and one in November.

For the August report, we processed data for nine days, one day a week, between mid March and May for fish behavior. During the course of these nine days, a total of 1,093 events were found in this data set (an event is when a fish or group of fish enter and exit the sample volume). East-to-west movement in front of the tower intakes and milling were the most common behaviors observed in the preliminary data set. These two patterns comprised about 73% of the total events. The next most common movement patter was west-to-east (13%). Fewer than 9% of the events involved movement into the tower from the forebay. Approximately 5% of the events were fish moving from the tower toward the forebay. Fish activity in the immediate forebay of the intake tower was much higher in May than March or April.

For the November report, we processed data from five dates (bi-weekly) in July, August, and September. During these five days, a total of 73 fish events were found in the data set. Milling was the most common behavior observed. This pattern comprised over half (53%) of the total events. The next most common movement patterns were west-to-east (15%) and east-to-west (12%). Movement toward the forebay from the tower comprised 11% of the total events, with another 8% involving movement into the tower from the forebay. Fish activity was highest in September. Schooling behavior was observed in 11% of the observed events, mostly in July and August. Predator activity was observed in 4% of all events in the five-day data set. The proportion of predator events was highest when fish abundance was highest.

Data for the study period March – December will be analyzed and presented at the Willamette Basin Fisheries Science Review Meeting. Expected results include behavior and distribution of juvenile salmonids at the dam.

HYDROACOUSTIC EVALUATION OF JUVENILE SALMONID PASSAGE AT LOOKOUT POINT DAM, 2010

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We evaluated downstream passage of juvenile salmonids at Lookout Point Dam on the Willamette River during 2010. The study was conducted by the Pacific Northwest National Laboratory for the U.S. Army Corps of Engineers, Portland District (USACOE). The study goal was to provide information on fish passage rates and distribution at the dam to support decisions on long-term measures and operations to enhance dam passage conditions for downstream-migrating juvenile salmonids. The study period was from February 1, 2010 to January 31, 2011. An understanding of when juvenile salmonids pass through the dam, the relative efficiency of existing routes at passing fish, the vertical and horizontal distribution of fish in the near forebay of dam, and the size distribution of fish that are passing will be important components for developing operations and structures that pass fish safely and efficiently. The objective was to estimate total number, and seasonal, daily, and diel distribution of juvenile salmonid passage through the dam. We obtained passage data using fixed-location hydroacoustics, where transducers were deployed at each of the three penstock intakes and the four regulating outlets of the dam. Data was collected 24hr/d, 7d/wk for the course of the study period. This study is still in the data collection and analysis phase. However, we submitted two in-season progress reports with preliminary fish passage data to the USACOE, one in August and one in November.

For the August report, we presented raw data of fish passage at the penstock, regulating outlets (RO), and vertical distribution at the dam face for the course of three days in June when the regulating outlets were in operation and 4 days in July when juvenile Chinook salmon were captured in the screw trap below the dam. From June 8 – 10, two juvenile targets passed the penstock (turbine unit 2) and two passed at RO 1 (RO 2 and 3 were off and now fish passed at RO 4). Vertical distribution data of fish at the forebay face of the dam show a large number of candidate fish targets were found in the first 5 meters of the pool and few candidate targets were found between 5 and 10 meters and at deeper depths between 15 and 25 meters. From July 15 – 18, two juvenile targets passed the penstock (turbine unit 3). The ROs were off during this period. Vertical distribution data indicated large numbers of candidate targets were found in the upper layer of the water column between the surface and 15 meters deep and fewer candidate targets were found between 15 and 25 meters deep.

For the November report, fish passage data were processed for August and September for the penstock intake for turbine unit 3 and forebay vertical distribution. These months were chosen because they include a portion of the late summer outmigration of juvenile salmon. During this period, turbine unit 3 was the only operating unit because units 1 and 2 were out of service for maintenance and the ROs were not operated. Therefore, all fish passing the dam during this period passed at unit 3. The individual fish tracks were extrapolated spatially and temporally to produce relative passage rates. Preliminary estimates of candidate targets show a total of 2,693 juvenile salmon sized fish passed the penstock of Turbine unit 3. Fish passage began on August 5 and continued throughout August and September, except for a few days when it appeared fish did not pass the penstock. A daily average of 44 juvenile targets passed the dam during these two months. Run timing peaked on August 20 when an estimated 424 juvenile fish passed the penstock. Vertical distribution data of fish at the forebay face of the dam for this period show a large number of fish were found in the upper 10 meters of the pool, especially between 5 and 10 meters below the water surface. A smaller number of fish were found between 10 and 15 meters and very few at deeper depths between 15 and 35 meters.

Data for the study period (March – December) will be analyzed and presented at the Willamette Basin Fisheries Science Review Meeting. Expected results include run timing and passage rates and distribution of juvenile salmonids at the dam.

DEVELOPMENT OF PIT-TAG DETECTION SYSTEMS FOR LEABURG AND WALTERVILLE DAMS

Sandra Downing[1]*, Gabriel Brooks[1], Bruce Jonasson[1], Fred Monzyk[2], and Don Warf[3]

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Over the past 15 years, millions of salmonids in the Columbia River Basin have been tagged with PIT tags. Results from the Research, Monitoring and Evaluation (RME) projects have been used to aid in making management decisions for helping listed stocks. When the Willamette Biological Opinion was released, it made sense to try to apply PIT-tag technology to increase our knowledge of this basin's stocks. A tour of potential dams combined with other proposed research led to the decision to develop PIT-tag detection systems first for Leaburg and Walterville Dams. Temporary systems were installed in 2009. The Corps, NOAA Fisheries Service, and ODFW are working with the owner of the dams, Eugene Water and Electric Board (EWEB), to find acceptable permanent designs. The presentation will cover both the current and future plans.

MULTI -METHOD ASSESSMENT OF DIRECT MORTALITY AND PASSAGE CONDITIONS AT COUGAR DAM, SOUTH FORK MCKENZIE, OR

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One of the highest priority actions in the two Willamette Valley Project BiOps is the development of downstream passage solutions for ESA listed fish at Cougar Dam, a U.S. Army Corps of Engineers Dam on the South Fork McKenzie River, Oregon.

In December, 2009 and January, 2010, passage conditions through turbines and regulating outlets (RO's) at Cougar Dam were evaluated using three separate research methodologies. Downstream passage research efforts included a direct mortality study using the HI-Z method by Normandeau and Associates, a Sensor Fish study by Battelle, and a study of PIT tagged fish by Oregon Department of Fish and Wildlife (ODFW).

Treatment fish and Sensor Fish treatments for the RO releases were conducted with 2 different gate openings; 1.5 ft (440 CFS) and 3.7 ft (1040 CFS). Turbine Unit 2 was tested under 3 operating conditions; minimum load (340 CFS), maximum load (550 CFS), and maximum efficiency (455 CFS). All treatment fish and Sensor Fish used in the study were released through the same fish release pipe system.

HI-Z Direct Mortality

Treatment and control fish for this study were tagged with radio tags and HI-Z tags, balloon tags that allow researchers to recapture fish in the tailrace of the dam. Fish are assessed for condition at recapture, 1hr, 24hrs, and 48 hrs after release, and type and mechanism of injury are determined. Injury and mortality rates are then calculated and compared to control fish rates.

Sensor Fish Study

Sensor Fish are 24.5mm by 90mm cylindrical polycarbonate vessels containing angular rate-of-change sensors, accelerometers, and a pressure sensor. The onboard sensors give a detailed picture of passage conditions using pressure and acceleration magnitudes, recording passage travel conditions from release to the tailrace. Sensor Fish are tagged with radio and HI-Z tags and following recovery data are downloaded. Specific locations that cause injury and mortality and the magnitude of trauma causing events within the passage route are identified.

PIT Tag study
The PIT tag study was a mark/recapture study to develop Cormack-Jolly-Seber (CJS) survival estimates using fish tagged with SST PIT tags. Treatment fish were released 0.8 km downstream and recaptured at three locations downstream that use antennas placed in juvenile power project outfalls; Leaburg (RKM 337.2), Walterville (RKM 319.9), and Willamette Falls (RKM 42). Dam passage survival was determined comparing CJS survival probabilities for treatment and control fish.

RESULTS
When one compares the 48 hr survival estimate for HiZ tagged fish to the relative detection rates of PIT tagged fish it is evident that though they follow the same trend there are large differences between the methods for some treatments. The trends observed in the two live fish studies were further confirmed by the data on hydraulic conditions and strike from the Sensor Fish releases.
Results from all test methodologies indicate the best passage conditions were through the RO with a 3.7' gate opening; the worst conditions were through the turbine at max-load.

Table 1. Treatment data and sample sizes.

Treatment	CFS	Pool Elevation in ft MSL (head)	# of fish released (control)	
RO gate opening 1.5ft	440	1530-1533 (280)	PIT	1010 (507)
			HI-Z	156(79)
			Sensor fish	19*(2)
RO gate opening 3.7ft	1040	1533-1534 (281)	PIT	1001 (502)
			HI-Z	163(79)
			Sensor fish	16*(2)
Turbine Minimum Load	340	1541(289)	PIT	989 (511)
			HI-Z	169 (89)
			Sensor fish	12*(2)
Turbine Maximum Load	550	1541(289)	PIT	999 (501)
			HI-Z	170 (89)
			Sensor fish	8*(2)
Turbine Maximum Efficiency	455	1540(287)	HI-Z	40 (89)
			Sensor fish	4*(2)

*Number of usable data sets, number sensors released greater.

The trends observed in the two live fish studies were further confirmed by the data on hydraulic conditions and strike from the sensor fish releases. Detailed results are given in appendices C & D, however in summary, the best passage conditions were through the RO with a 3.7' gate opening, with the worst conditions experienced through the turbine at max-load. It is also important to note the anomaly where Sensor Fish were getting “hung-up” behind the runner of the unit. It could be further evidence of an issue with pre-inflation of the HI-Z tag.

DOWNSTREAM FISH PASSAGE ABOVE AND BELOW DAMS IN THE MIDDLE FORK WILLAMETTE RIVER: A MULTI-YEAR SUMMARY

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Rotary screw traps were used to evaluate downstream fish passage at five sites in the Middle Fork Willamette River from 2003-2010. Three sites were downstream from dams (Lookout Point, Hills Creek, and Fall Creek dams) and two were upstream from reservoirs (North Fork Middle Fork and Fall Creek). The target population was ESA-listed juvenile spring Chinook salmon, but samples included ~11 native and ~6 non-native species. More than 195,000 individuals were collected (note: sites were not sampled in all years).

Downstream from dams, fish trapping rates were strongly seasonal, with the highest passage in November-January for most species, including Chinook salmon. High dam passage rates coincided with relatively high river discharge (and some spill) as well as low reservoir elevations. Fish passage increased as elevation dropped because fish had easier access to regulating outlet and turbine passage routes. Above reservoirs, collection rates were highest in late winter through mid-summer, coincident with juvenile Chinook salmon emigration from spawning reaches (mostly February-May). Few fish of any species were trapped at above-reservoir sites from September-January.

A total of 13,365 juvenile Chinook salmon were trapped and measured across all sites and years, including 10,864 above reservoirs and 2,501 below dams (Table 1). Salmon trapped above reservoirs were predominantly subyearlings plus small numbers of yearlings. Those trapped below dams included a variety of size and age classes. Fork length and migration timing data provided evidence for at least two – and perhaps as many as four – Chinook salmon age classes in the aggregate sample. Likely life history types included subyearling emigration, stream resident rearing followed by yearling emigration, reservoir rearing with yearling emigration, and reservoir residualization with delayed emigration. Many of the largest salmon (> 25 cm) were collected below Lookout Point Dam and we hypothesize that some of these fish spent a year each in Hills Creek and Lookout Point reservoirs. To what degree the observed life history variation represents adaptive life history "decisions" or is a by-product of impeded downstream passage is currently unknown.

Annual Chinook salmon mortality estimates downstream from dams ranged from 8-59% and differed substantially among sites and years (Table 1). All estimates were likely minimums because dead salmon capture efficiency was very low in several tests. At all sites, mortality was significantly higher for larger

salmon, perhaps because they used different passage routes than smaller salmon or because large salmon were more susceptible to injuries from shear stress, turbine blade strikes, or blunt force trauma. After correcting for salmon size effects, mortality was significantly associated with environmental (i.e., discharge) and operational (i.e., spill, reservoir elevation) conditions at dams. Total salmon mortality estimates (14% below Fall Creek, 25% below Lookout Point, and 53% below Hills Creek) suggest that there were important differences in passage hazards among projects. These almost certainly included route-specific effects that could not be resolved from the screw trap data.

With all years and fish species combined, dead fish made up ≤ 2% of the Fall Creek and North Fork samples upstream from reservoirs. By comparison, minimum total mortality was 36% below Fall Creek Dam, 39% below Hills Creek Dam, and 69% below Lookout Point Dam. Mortality estimates were strongly affected by relative species abundance at each site. In general, mortality was higher for non-native species, especially centrarchids. Among-species differences were likely a function of morphology or physiology, passage timing, and behavior. The combined Chinook salmon and multi-species mortality results suggest that site-specific features at each project affect mortality risk during dam passage. Operational modifications, including seasonal reductions in reservoir elevation, may facilitate Chinook salmon emigration and reduce mortality across species.

Table 1. Annual and total numbers of juvenile Chinook salmon collected in screw traps, the numbers trapped per day of operation, and percentages of salmon that were dead, 2003-2010.

				Year					
Trap	2003	2004	2005	2006	2007	2008	2009	2010	**Total**
				Salmon collected					
Fall Creek	-	-	6831	273	2126	43	-	-	**9273**
Fall Creek Dam	-	-	-	396	293	162	174	-	**1025**
North Fork	-	-	-	-	1192	399	-	-	**1591**
Hills Creek Dam	771	177	-	-	-	-	-	-	**948**
Lookout Point Dam	-	-	-	-	20	190	110	208	**528**
				Salmon collected per day					
Fall Creek	-	-	48.1	1.3	18.2	0.8	-	-	**17.9**
Fall Creek Dam	-	-	-	1.9	1.1	0.7	0.9	-	**1.2**
North Fork	-	-	-	-	4.9	3.4	-	-	**4.5**
Hills Creek Dam	6.9	0.5	-	-	-	-	-	-	**2.0**
Lookout Point Dam	-	-	-	-	0.2	0.6	0.4	2.2	**0.7**
				Percent dead					
Fall Creek	-	-	0.2	1.5	0.1	0.0	-	-	**0.2**
Fall Creek Dam	-	-	-	7.8	15.4	22.8	16.1	-	**13.8**
North Fork	-	-	-	-	1.9	0.5	-	-	**1.5**
Hills Creek Dam	51.9	58.8	-	-	-	-	-	-	**53.2**
Lookout Point Dam	-	-	-	-	15.0	30.0	20.0	24.5	**25.2**

SALMONID LIFE HISTORY STUDIES

FEASIBILITY OF USING OTOLITH AND SCALE ANALYSES TO CHARACTERIZE LIFE HISTORY VARIATION IN SPRING CHINOOK SALMON IN THREE WILLAMETTE VALLEY PROJECT RESERVOIRS AND TRIBUTARIES

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Available data suggest that juvenile Chinook salmon life history traits are variable within and among WVP populations, including traits that resemble both an ocean-type life history with subyearling emigration in summer or fall and a stream-type life history with yearling emigration in spring. Moreover, recent analyses of screw trap data suggests the potential for simultaneous emigration of three or even four year classes emigrating from the Middle Fork Willamette River that may include a mix of stream- and reservoir-reared juveniles. Notably, smolt-to-adult returns (SARs) may differ considerably between life history types. For example, approximately 70% of the unmarked adults returning to the North Santiam River in 2007-2008 exhibited evidence of reservoir rearing and a yearling life history. Differences in performance are likely to be related to juvenile condition or size at out-migration, differences in outmigration timing, or other factors linked to life history traits. Consequently, determining the juvenile rearing habitat and emigration ecology of these populations will assist in developing appropriate management strategies, e.g., major management option under consideration is whether juveniles should be passed through reservoirs and dams or collected and transported around them during emigration.

We are using Chinook salmon scales and otolith microchemistry to resolve life history types and test the ability of scale analysis to accurately classify life history types with three primary goals: 1) determine the degree of life history variability in three Willamette River sub-basins (McKenzie, Santiam, and Middle Fork Willamette basins) by surveying juvenile growth patterns and otolith isotopic ratios from individuals collected from stream and reservoir rearing habitats; 2) evaluate the variation in growth patterns and potential life histories in unmarked juvenile salmon passing Willamette Falls; and 3) evaluate the ability of scale and otolith analyses to resolve the natal stream, juvenile rearing habitat, and ocean entry timing for adult salmon of unknown source.

We are currently analyzing scales and otoliths collected in 2009 and 2010 from juveniles collected in three WVP drainages (Middle Fork Willamette, McKenzie, and Santiam) and adults collected during spawning ground surveys. Water samples collected in 2010 will provide a survey of seasonal and geographic geochemical variation within and among drainages that will determine the resolution with which juveniles and adults may be assigned to natal reaches based on stable isotope composition in otolith nuclei. Scale analyses to date have identified patterns indicating multiple life histories consistent with screw trap observations, including a pattern not previously observed by the ODFW Scale Project: a juvenile from Lookout Point Reservoir with two annuli. Representative juvenile life histories (based on scale interpretations) are currently under preparation from juveniles and adults for otolith microchemical analyses and we anticipate presenting results at the January meeting.

GENETIC PEDIGREE ANALYSES OF SPRING CHINOOK OUTPLANTED ABOVE COUGAR DAM, SOUTH FORK MCKENZIE RIVER

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Adult spring Chinook salmon (*Oncorhynchus tshawytscha*) are outplanted above Willamette Project dams to provide forage for native bull trout (*Salvelinus confluentus*) and establish sustainable breeding populations in high quality habitat above reservoirs. Newly constructed trap and haul facilities at the base of Cougar Dam, South Fork McKenzie River may be used to collect and transport the progeny of outplants to their natal spawning grounds above the dam. However, this practice carries the risk of "mining" the most productive wild population of spring Chinook remaining in the Willamette Basin. In my lab, we have begun to use microsatellite genotypes to construct a genetic pedigree of Chinook outplanted and produced above Cougar Reservoir. Our efforts aim to inform management of best outplanting practices and quantify the risks of the trap and haul operation to the wild Chinook population of the South Fork McKenzie. Pedigree analysis of data for adult Chinook planted above the reservoir in 2008 (N=875) and 2007 (N=882) revealed evidence that all but one of 184 juvenile out-migrant samples (taken by screw trap during 2009) likely originated from 2008 adult plants. Sixty-six of these juveniles assigned to two parents perfectly, 75 to two parents but with one allele mismatch, 28 to two parents but with two allele mismatches, 7 assigned to a mother only and 7 assigned to a father only. Two jacks sampled at the Cougar trap and haul facilities in 2010, however, did not match any likely parental combination from among adult samples we analyzed from above reservoir plantings in 2007 & 2008.

INCORPORATING UNCERTAINTY INTO A LIFE-CYCLE MODEL FOR SPRING CHINOOK IN THE MCKENZIE RIVER

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The U.S. Army Corps of Engineers, Portland District (CENWP) has initiated a multi-year study to evaluate a range of alternative actions to improve survival and productivity of spring Chinook salmon, winter steelhead, and secondarily bull trout and Oregon chub. Beginning in 2010, alternatives to improve the survival and productivity of these target species will be evaluated and prioritized for their biological benefit, technical feasibility, and cost effectiveness. To meet this need, CENWP wishes to develop population models that can be used to assist in evaluating different alternatives.

To meet this objective, R2 Resource Consultants, Inc. (R2) has been facilitating the development of a spring Chinook model capable of providing annual forecasts of stage specific abundances while incorporating uncertainty in model coefficients. The life-cycle models will be used to evaluate CENWP management alternatives for the North Santiam, South Santiam, Middle Fork Willamette, and McKenzie rivers. The Species Life Cycle Analysis Modules (SLAM) was used as the modeling framework (http://www.nwfsc.noaa.gov/trt/slam/slam.cfm), and the existing Willamette SLAM applications for spring Chinook (developed by Oregon Department of Fish and Wildlife for Recovery Planning) were used as the starting point for model development. A benefit of quantitative life cycle models is the necessary review of hypotheses regarding population vital rates (e.g., life-history stage specific survival rates) and synthesis of data sources required to parameterize such a model. Further, a model that incorporates uncertainty requires uncertainty in the parameters, thus providing an opportunity to quantify the confidence that one has in a specific model parameter values (i.e., based on most likely, minimum, and maximum values).

The McKenzie River was chosen as the first tributary of the Willamette to initiate SLAM model development due to the relatively simple dam configuration and availability of site-specific data sources. The McKenzie ODFW model used for Recovery Planning was altered to incorporate fish passage at Cougar Dam. Further, the model parameters were updated to reflect more current data sources (e.g., habitat surveys, redd count surveys, and Cougar Dam survival studies) and to adequately represent uncertainty in previously derived parameter values. Finally, a variance partitioning analysis was completed to determine what parameter values were most responsible for uncertainty in two key life history stages, adult returns and juveniles below Leaburg Dam. Uncertainty in the abundance of both stages can be attributed to uncertainty in juvenile production for the McKenzie River above Leaburg Dam (excluding south Fork McKenzie upstream of Cougar Dam). The model is currently being modified to include the role of CENWP operations on temperature, flow, and other water quality variables that may affect the survival and productivity of spring Chinook. In addition, the McKenzie SLAM model will be used to help define research, management, and evaluation priorities over the near term. Models of North

Santiam, South Santiam, and Middle Fork spring Chinook will be developed in 2011 using the McKenzie River Spring Chinook SLAM model as a template.

JUVENILE SALMONID USAGE OF NORTH FORK RESERVOIR ON THE CLACKAMAS RIVER – SYNTHESIS OF 50 YEARS OF RESEARCH

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Construction of North Fork Dam was completed in 1959 at river mile 29 of the Clackamas River. The dam impounded North Fork reservoir (NFR), a 350 acre reservoir measuring roughly 4 miles long with a maximum depth of 135 feet. The reservoir is at the upstream end of a three dam, run-of-the-river project. Facilities at the dam have provided for upstream and downstream passage of native anadromous salmonids (spring Chinook, winter steelhead, and coho) since its construction.

In 1962 evaluations were initiated to understand juvenile salmonid usage of NFR. Since that time, various studies have been completed that either directly or indirectly provided information relative to the use of NFR by juvenile salmonids. This presentation will provide a summary of findings from and techniques employed over nearly 50 years of research. In conclusion, I will cover changes that will occur to the project and planned monitoring and evaluation activities associated with the recently issued License for the Clackamas hydro Project.

LIFE-HISTORY CHARACTERISTICS OF SPRING CHINOOK SALMON IN WILLAMETTE RESERVOIRS: WHAT WE'VE LEARNED SO FAR

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Several Reasonable and Prudent Alternatives (RPAs) were identified in the 2008 Willamette BiOp to address downstream passage concerns for juvenile spring Chinook salmon (*Oncorhynchus tshawytscha*) through Willamette Valley Project (WVP) dams and reservoirs. The feasibility of any of these proposed measures is contingent upon a better understanding of juvenile Chinook salmon use of the reservoirs. In 2010, ODFW initiated investigations into the life-history characteristics of juvenile Chinook salmon rearing in selected WVP reservoirs to provide basic information to guide Action Agencies' decisions in carrying out RPA measures in the Willamette BiOp. These investigations included the operation of fish traps in streams above Detroit (North Santiam River), Foster (South Santiam River), Cougar (South Fork McKenzie River), and Lookout Point (Middle Fork Willamette River) reservoirs to assess migration timing, abundance, and size of Chinook entering the reservoirs. We also conducted sampling within Cougar and Lookout Point reservoirs to assess distribution, growth, and potential predation for juvenile Chinook salmon rearing in these areas.

The fish trap above Cougar Reservoir was the only one installed early enough to sample the entire juvenile migration period. Juvenile Chinook salmon emigrated from the South Fork McKenzie River into Cougar Reservoir primarily as fry (95% of the total catch; estimated abundance 728,000) with peak reservoir entrance occurring in late April (range February-June). The mean size of fry entering Cougar Reservoir was 34 mm FL. In both Cougar and Lookout Point reservoirs, fry were found in shallow nearshore (<1 m) habitat with the highest snorkel observations occurring in the upper third of the reservoir. In late summer and fall, parr appeared more dispersed throughout the reservoirs with highest catch rates still in the upper reservoir. Reservoir-rearing juvenile Chinook salmon grew rapidly immediately after entrance compared to their stream-rearing counterparts and continued to grow in late fall. As reservoir surface temperatures increased, parr appeared to descend into deeper water by July and fed primarily on *Daphnia* spp. Yearling Chinook salmon were also present throughout the year in the reservoirs, indicating that not all fish emigrate out of the reservoirs in their first year.

Predator fish species we observed in Cougar Reservoir included bull trout (*Salvelinus confluentus*), cutthroat trout (*O. clarkii*), rainbow trout (*O. mykiss*), and spotted bass (*Micropterus punctulatus*). Lookout Point Reservoir contained more predator species including northern pikeminnow (*Ptychocheilus oregonensis*), spotted bass, walleye (*Sander vitreus*), white crappie (*Pomoxis annularis*), cutthroat trout, and rainbow trout. Diet samples were collected from predator species but have not yet been analyzed.

WILLAMETTE SPRING CHINOOK: LIFE HISTORIES, HABITAT USE, AND RESTORATION

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Spring Chinook salmon in the Willamette River basin have been listed as a threatened species under the federal Endangered Species Act. Habitat throughout the Willamette Basin has been altered because of dam construction, urban and agricultural development, and simplification of rivers. For example, dams constructed in the basin for flood control have directly affected spring Chinook by blocking access to historical spawning and rearing areas, and they have also altered patterns of water temperature and flow, which in turn can affect expression of life histories. Knowledge about life history and how life histories may be affected by environmental changes are important for designing effective recovery strategies and restoration activities. Recovery of spring Chinook salmon depends on understanding life history patterns, how juvenile fish use habitats, and what restoration approaches may best protect life history diversity.

Perspectives about restoration of the Willamette River can be shaped by knowledge about the life history of native fish. Investigations using PIT tag studies, field observations, and historical information have begun to change the perspective of how juvenile spring Chinook are using the river. Juvenile Chinook exhibit a broad diversity of rearing and migratory life histories, each using the river in different ways and at different times of year. Juvenile Chinook migrate to the Willamette River as newly-emergent fry, subyearlings, and yearlings. Fish may rear in the river for as little as one month up to eighteen months or longer before emigrating. Two year classes of juvenile Chinook (fry and yearlings) simultaneously rear in the river from January through mid June and use different types of habitats. Fry use the edges of the river in shallow water, whereas the older and larger fish rear closer to the current in deeper water. Seasonal changes in flow and temperature also influence which habitats are used by juvenile Chinook. For example, juvenile Chinook have been captured in the winter in intermittent streams and seasonally flooded areas, up to 30 km from the Willamette River.

Insights about life history of juvenile spring Chinook can inform decisions about restoration actions and priorities. Areas of the Willamette River with active channel changes provide diverse habitats for multiple size classes of juvenile fish. A variety of seasonal habitats including cold water refuges, side channels, and floodplains are also found in these active areas. Restoration actions that conserve or restore habitat diversity in the Willamette River will be important, but fish must be able to access these habitats. Because flow in the Willamette River is directly affected by operation of dams in the basin, spatial and temporal connectivity will be influenced by flow management decisions. Conservation and restoration of diverse riverine habitats should be important components of a recovery strategy. Dams in the basin should be managed to help return the river to more normative conditions as measured by indicators such as sufficient flows to allow channel formation processes to occur and to provide access to seasonally important habitats. Life history diversity provides resilience for the Willamette Chinook populations. Maintaining this diversity by protecting and restoring diverse habitats will help to insure the continued persistence of Willamette spring Chinook.

SLICES, AN INFORMATION FRAMEWORK FOR A BIOLOGICALLY-EFFECTIVE NETWORK OF CONSERVATION AND RESTORATION IN THE WILLAMETTE RIVER FLOODPLAIN

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This presentation documents an effort to demonstrate and make accessible a geographic framework for tracking change over space and time in the floodplain of the Willamette River as a means of furthering natural resource conservation and restoration. The information framework seeks to pragmatically integrate the geomorphic and hydrologic processes shaping rivers, the biological communities and processes comprising river ecosystems and the human systems guiding their land and water use trajectories. It is intended to help in making decisions about what natural characteristics to conserve or restore, where best to conserve or restore them, and how proposed conservation or restoration actions may fit into a larger guiding vision of a restored Willamette River floodplain. In short, this framework, oriented on the floodplain axis, provides a consistent basis for comparing changes in geomorphic structure, aquatic ecosystems and human settlement. We employ this framework for floodplain assessment by first mapping one-km "slices" of the floodplain at right angles to the floodplain's center axis, and then further elaborating each 1 Km slice by delimiting ten 100-m slices within it. Within these 100-m slices we measure and report characteristics that represent the dynamic processes that structure and are structured by the river and its floodplain, and that together capture key relations of ecological dynamism and resilience. The science that clarifies the importance of these characteristics to native river processes is well established. In its final form, the slices framework will include data on channel complexity, floodplain forests, number and location of cold water refuges, native and non-native fish species richness and the capacity for non-structural flood storage. The current version includes data on channel complexity

THE CONTRIBUTION OF TIDAL FLUVIAL HABITATS IN THE COLUMBIA RIVER ESTUARY TO THE RECOVERY OF DIVERSE SALMON ESUs

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From 2002 – 2008 NOAA Fisheries led a team of researchers studying the distribution, habitat use, life histories, and genetic sources of subyearling Chinook salmon in the lower 100 kilometers of the Columbia River estuary. The research results largely confirmed hypotheses that (1) salmon rearing opportunities in the lower estuary have decreased in the last century; (2) the estuarine life histories of juvenile salmon have become less diverse, and (3) salmon food webs remain closely linked to wetland plant sources. Habitat use and estuary residency of juvenile Chinook salmon were size related: shallow nearshore habitats and wetlands were used primarily by the smallest size classes, and residence times decreased with fish size at estuary entry. Subyearling Chinook salmon occupied all available wetland types surveyed—emergent, scrub/shrub, and forested—and many subyearling salmon resided in the estuary for considerably longer periods (i.e., weeks or months) than most tagging studies have estimated (i.e., a few days). Our genetic analyses showed that most Columbia River ESUs can express estuary-resident life histories. However, genetic results from this and other (i.e. upper-estuary) studies suggested that temporal and spatial patterns of estuary use may vary among genetic stock groups. If this is true, then estuary restoration sites may need to be strategically located to satisfy the particular rearing requirements of different evolutionarily significant units (ESUs).

To improve understanding of stock distributions, in 2010 we initiated a series of new surveys in the tidal-fluvial reaches of the estuary (i.e., Rkm 100 to Bonneville Dam) where relatively few genetic samples have been collected. We genotyped a total of 1,500 juvenile Chinook salmon collected every other month (beginning in March) from six of eight estuary hydrogeomorphic reaches (C – H). Stock compositions were highly variable spatially and seasonally. West Cascade Fall stock was relatively abundant in all months and was among the major contributors to all reaches except H. In contrast, “Upriver” stocks (e.g., upper Columbia River summer/falls, Snake River Falls, Deschutes River falls) appeared later during the July survey, were most prevalent above reach E, and accounted for 85% of the total catch in reach H. Yearling Willamette River Spring Chinook were abundant in reaches C – F during March but subyearlings appeared in subsequent bimonthly surveys in reaches D – G. Samples during this and other fish surveys revealed that a diversity of Columbia River stocks benefit from floodplain wetland and main-stem habitats in and near the lower Willamette River, including upper Willamette River, lower Columbia River, and upper Columbia River summer-fall ESUs. In 2011 we will repeat the bimonthly genetic surveys and begin supplemental sampling in a greater variety of habitats at the Willamette and Columbia River confluence (reach F). From the combined 2010-2011 stock-survey results, we will identify key habitat complexes to begin finer-scale studies of stock-specific habitat use, life histories, and performance of juvenile Chinook salmon.

LAMPREY

MIGRATION CHARACTERISTICS AND HABITAT USE OF ADULT PACIFIC LAMPREY IN THE WILLAMETTE BASIN MAY VARY WITH ANNUAL FLOW REGIMES

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Pacific lamprey (*Entosphenus tridentatus)* are declining precipitously in abundance in the Pacific Northwest. Data on their migratory biology is quite sparse. We report on preliminary results of the second year of our research on the migration characteristics and habitat use of radio-tagged adult Pacific lamprey in the Willamette Basin, with a focus above Willamette Falls. Fish were tracked by boat throughout the mainstem above Willamette Falls. Tracking by airplane was also done on the mainstem Willamette and its major tributaries. During 2009, 43% (125 of 294 radio-tagged fish) were detected in the mainstem Willamette River. Most of the detected fish were found in the lower river, many in the deep, slow-moving Newberg pool, although fish were also distributed throughout the basin. Of the detected fish, 61% held in the same location over a period of several weeks to months, the majority of which held in equal proportions in either rock revetments or in the main channel. By contrast, during the comparatively higher flow year of 2010, more fish were detected in the mainstem Willamette River at 57% (125 of 219 radio-tagged fish), and they were relatively evenly distributed throughout the basin. Of the detected fish, 90% held in the same location over a period of several weeks to months, the majority of which held in the main channel, followed by rock revetments. Plane surveys during the spring and summer of 2010 suggest that the Santiam River system and the mainstem Willamette River are popular destinations, either for continued holding or for spawning. These data suggest that lamprey migration characteristics may vary with river flow.

MIGRATION BEHAVIOR AND DISTRIBUTION OF PACIFIC LAMPREY IN THE WILLAMETTE BASIN

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Background: Significant declines in Pacific lamprey (*Entosphenus tridentatus)* dam counts throughout the Columbia Basin have produced a mounting interest in lamprey population biology. Pacific lamprey possess the same charismatic, anadromous life-history strategy that is well documented in salmon and steelhead populations. These cold water fish start their upstream migration as adults in early spring and spawn approximately one year later. They appear to prefer tributary habitats for spawning, but patterns in their pre-spawning migratory movements and holding habitat preferences are not well documented.

Methods: The Willamette Basin was chosen to conduct a two year study on lamprey migration behavior and homing distribution. From May till August a spread out sample of, 148 in 2009 and 219 in 2010, Pacific lamprey were radio-tagged over Willamette Falls. To track the radio-tagged lamprey twenty-one radio telemetry sites were installed on the main stem and major tributaries of the Willamette River.

Results: From May to mid August adult Pacific lamprey were observed in active migration over Willamette falls. Water temperature may have been an important limiting factor for lamprey movement. Thus, active migration started at 11°C and ended at 22°C, and detections at our fixed sites ceased until water temperatures dropped back to 11°C around November. During active migration, tagged lamprey distributed in three clusters throughout the upper basin on the main stem (lower RM 35-45 , mid RM 108 and upper RM 160-180) traveling 5-20 miles a day, typically during night and early-morning hours. A range of migration behavior has been observed. During spawning time lamprey were observed on the main stem as well as in the tributaries. As we look closely at the movement behavior of each tagged lamprey new questions arise. Further identification and characterization of freshwater habitat utilized by migrating adult Pacific lamprey could be critical to sustaining populations throughout the Pacific Northwest.

LARVAL PACIFIC LAMPREY (*ENTROSPHENUS TRIDENTATA*) EXPOSED TO PORT OF PORTLAND SEDIMENT: METHOD DEVELOPMENT FOR MONITORING BEHAVIOR, INDIVIDUAL GROWTH, AND SURVIVAL AND PRELIMINARY RESULTS

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Nothing is known about the effects contaminated sediment from Portland Harbor may have on larval Pacific Lamprey (*Entrosphenus tridentata*). This pilot project is aimed at developing experimental methodologies that could assess effects of contaminated sediment on behavior, growth and development of ammocoetes held individually in the laboratory. In addition, we are providing some initial results from trials utilizing sediments collected from the Portland Harbor Superfund site. The initial research focused on a) potential effects of chronic exposure to contaminated sediment on survival and growth and b) whether or not ammocoete behavior demonstrates a preference of uncontaminated over contaminated sediments. Ammocoetes collected from the Siletz River were transferred to the Fish Performance and Genetics Laboratory in Corvallis, Oregon, and acclimated in large holding tanks. Weight change was comparable in ammocoetes held individually in 3”, 4” or 6” diameter mesh bags and those tested as a sympatric group in larger tanks. As part of tests aimed at optimizing feeding opportunities for the animals, we found that a Baker’s yeast slurry supplemented with a larval fish diet injected down into the sediment yielded excellent growth when compared to providing the same feed formulation just on the surface of the sediment or introducing biologically conditioned well water to the tanks. Initial results from sediment exposure trials demonstrated that growth was predominately observed in Siletz River sediment, but there was no statistical difference between contaminated and control hatchery pond sediment. Preliminary behavioral trials indicated a preference for Siletz River sediment over both contaminated and control hatchery pond sediments. Rearing and experimental methods developed from these trials are being used to conduct bioassays on ammocoetes exposed to sediment collected from a number of areas within the Portland Harbor Superfund site, including “clean” reference sites to establish effects on survival, growth, and sediment preferences.

RESIDENT FISH

EVALUATION OF IMPACTS TO BULL TROUT AND CHINOOK SALMON IN THE SOUTH FORK MCKENZIE RIVER FROM THE COUGAR DAM WATER TEMPERATURE CONTROL PROJECT, 2001–2010

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Construction of water temperature control and upstream fish passage facilities at Cougar Dam presented the opportunity to study bull trout and Chinook salmon populations in the South Fork McKenzie River and to monitor the effects of construction and operation of these facilities. In this presentation, we highlight selected findings from this decade-long effort to assess distribution, abundance, and movements of bull trout and Chinook salmon in the project area.

Extreme drawdown of the reservoir for construction activities in 2002–2004 created environmental conditions having potentially adverse effects on the bull trout population. Drawdown resulted in some stranding mortality and a substantial rate of downstream passage, but we manually recovered and transported most of the bull trout we detected in the tailrace. Annual bull trout redd counts increased from ≤13 prior to 1999 to 25–35 during 2000–2006. After completion of temperature control facilities, we detected few bull trout below the dam, and the new upstream passage facility yielded only one bull trout in 2010. Redd counts increased to ≥70 in 2009 and 2010. Recently improved population status is likely a response to the combined effects of previous fisheries management changes and resumption of normal reservoir operations after 2004.

Chinook salmon redd counts downstream of Cougar Dam varied from 51 to 142 redds during the project period, and carcass surveys indicated that about 85% of adult Chinook salmon spawning downstream of the dam were of wild origin. In 2010, the new upstream passage facilities collected >100 adults, and relatively few fish spawned in the tailrace. Water temperatures downstream of Cougar Dam followed a more natural pattern after 2004, although factors such as water quality, substrate characteristics, and fluctuations in discharge may have limited survival of eggs in some redds downstream of the dam. Upstream of the dam, telemetry results for 2007 and 2009 indicated that out-planted adult hatchery Chinook salmon tended to drop downstream from release locations and 44–50% survived to spawning. In 2010, wild and hatchery adults exhibited high rates of survival and less downstream movement, although these fish were released considerably later in the season than anticipated (beginning July 28). Screw-trapping efforts indicated that most juvenile Chinook salmon upstream of Cougar Dam entered the reservoir as fry, but few fry were captured in the tailrace or regulating outlet channel. Most juvenile Chinook salmon (91%) captured below the dam were 100–150 mm FL, and mortality was positively associated with fish length. Abundance of juvenile Chinook salmon in screw traps downstream of the dam tended to be highest from late autumn through spring, although at finer temporal scales, factors including dam operations and reservoir conditions appeared to affect catch rates.

EFFECTS OF US ARMY CORPS OF ENGINEERS WILLAMETTE PROJECTS OPERATIONS ON OREGON CHUB AND OTHER FLOODPLAIN FISHES

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Oregon chub (*Oregonichthys crameri*), small minnows endemic to the Willamette Valley, were federally listed as endangered under the Endangered Species Act in 1993. In 2010, the species status was upgraded to threatened, with the primary remaining threat being nonnative fishes, which were found to be widespread in off-channel habitats preferred by Oregon chub. In 2009, we initiated a floodplain monitoring study, as part of the U. S. Army Corps of Engineers' Willamette Valley Biological Opinion, with the objective of identifying those conditions (flow levels, temperature regimes, habitat modifications) that may allow Oregon chub to thrive, and co-exist with non-native fishes, in connected habitats. Our approach includes mapping the bathymetry and hydrologic points of connection, monitoring water levels and temperatures, and sampling fish assemblages at each location. We calculate water volume, area, and vegetated areas at these habitats, and describe the relationship between water levels, temperatures, and hydrologic connection with mainstem river flows (regulated and unregulated). We will compare these physical data with the changes in Oregon chub and other species abundance and community structure over time. In this multi-year study, we will assess the impacts of altered flow and temperature regimes, floodplain restoration, and reconnection of off-channel habitats on habitat availability and fish assemblages downstream of Dexter Dam on the Middle Fork Willamette River. We will discuss details of our study plan, results from our first full year of monitoring, and provide examples of the application of our methods. We will also discuss the results of two feasibility studies, initiated in 2010, that were designed to test methods for monitoring movement patterns of adult and larval Oregon chub.

ADULT SALMON AND HATCHERY MANAGEMENT

REVIEW OF FISH RETURN DATA COLLECTED AT FALL CREEK AND COUGAR FISH FACILTIES IN THE WILLAMETTE VALLEY, OREGON

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Biologist from the U.S. Army Corps of Engineers (USACE) operated two fish collection facilities in 2010 at Cougar and Fall Creek Dams. The Cougar fish facility was operated for the first time in 2010. The Fall Creek Fish Facility operated from April 16th-October 25th. A total of 747 Chinook (538 unmarked, 209 marked) returned to Fall Creek and we transported all of the unmarked fish upstream of the dam. Cougar fish facility operated from July 27th-October 26th. A total of 251 Chinook returned to Cougar (224 unmarked, 27 marked) and we transported all the Chinook with the exception of two on October 19th. In addition, we also transported a single bull trout measuring 475mm, 90 unmarked rainbow, and 124 unmarked cutthroat trout above the dam. A summer steelhead captured and tagged at Fall Creek on July 26th was subsequently captured at Cougar on October 12th. We will present a summary of the data collected to date at both fish facilities.

DISTRIBUTION AND BEHAVIOR OF WILD AND HATCHERY SPRING CHINOOK OUTPLANTED ABOVE DETROIT DAM

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Adult hatchery spring Chinook have been outplanted above Detroit Reservoir since 1996. Prior to this study, information on spawning distribution and success has been available only for these marked (adipose fin-clipped) fish, which may behave differently than naturally-produced (unmarked) fish. Spawning ground surveys by ODFW indicated the outplanted fish spawn mainly in Horn and Marion Creeks near Marion Forks Hatchery. The spawning has been characterized by superimposition of redds and intense competition for spawning habitat, especially in Horn Creek, while very little spawning has occurred in the North Santiam River upstream of Horn Creek despite the presence of quality habitat.

We investigated the spawning distribution and success of marked and unmarked Chinook salmon above Detroit Dam to inform future outplanting efforts, which may eventually include unmarked fish. The objectives of this study were to (1) determine spawning distribution differences between marked and unmarked fish outplanted in the North Santiam and Breitenbush rivers above Detroit Dam; (2) evaluate pre-spawning mortality between marked and unmarked adults, and (3) evaluate the relationship of release date on distribution and spawning success of adults.

We used radio telemetry to monitor movement and distribution of outplanted spring Chinook in July-October 2010. Using gastrically-implanted radio tags, we released paired groups of marked and unmarked fish in the North Santiam and Breitenbush rivers in July and August (100 total fish released). We tracked fish daily with mobile receivers and employed fixed detection sites on the Breitenbush River at RM 4.0 and on the North Santiam River above Horn Creek at RM 86.5.

Six fish were tracked to spawning (four marked; two unmarked). Distribution patterns were difficult to assess due to the low spawning success. Of the 12 pre-spawn mortalities we recovered, five were unmarked fish and 10 were from the Breitenbush river. We also recovered 41 shed tags in the Breitenbush and North Santiam rivers, and 40 tags were never detected, went missing during the season, or were unrecoverable. Movement among fish presumed alive followed several patterns: (1) upstream only; (2) upstream movement followed by downstream movement; (3) fallback into the reservoir, and 4) migration from the Breitenbush River into the North Santiam River. Five fish migrated to the vicinity of Marion Forks Hatchery, but surprisingly, none spawned in Horn Creek. One marked fish migrated above Horn Creek. Seven fish fell back into Detroit Reservoir. Two fish migrated from the Breitenbush River through Detroit Reservoir and into the North Santiam River.

MIGRATION BEHAVIOR AND SPAWNING SUCCESS IN SPRING CHINOOK SALMON IN FALL CREEK AND THE NORTH FORK MIDDLE FORK WILLAMETTE RIVER: RELATIONSHIPS AMONG FATE, FISH CONDITION, AND ENVIRONMENTAL FACTORS: 2008-2010

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In recent years, high percentages (80-90%) of adult Chinook salmon transported above dams in some Willamette River tributaries have died prior to spawning. In 2010 we surveyed the energetic status and prespawn survival rates of two populations of Willamette River spring Chinook salmon, monitored river environmental conditions, and investigated the relationships among prespawn mortality and a suite of potential causative factors.

A total of 200 Chinook salmon were sampled at Fall Creek. Fish were collected, assessed for energetic condition, PIT-tagged and/or radio-tagged, and then transported above the dam and allowed to spawn naturally. A total of 62 PIT-tagged salmon were recovered from spawning ground surveys on Fall Creek, a recapture rate of 31%. Prespawn mortality estimates were 41.9% for PIT-tagged fish and 62.9% for radio-tagged fish. Previous years' prespawn mortality estimates were 9.4% in 2008 and 84.8% in 2009 for PIT-tagged carcasses, with associated recovery rates of 16.4% and 16.5%, respectively. A total of 68 redds were counted on Fall Creek in 2010 representing a fish:redd ratio of 7.9. River temperatures in 2010 remained below 22°C and the peak temperatures occurred in mid-August, relatively late compared to previous study years.

One hundred ninety two Chinook salmon collected at the Dexter trap were outplanted into the North Fork Middle Fork (NFMF) Willamette River in 2010. To assess the effects of holding fish on prespawn mortality an additional 100 Chinook salmon were sampled, held at Willamette Hatchery in Oakridge, Oregon, and then outplanted to the NFMF prior to spawning. Fifty four (19.9%) PIT-tagged fish were recovered in the NFMF in carcass surveys. A total of 121 redds were counted in the NFMF. Prespawn mortality of immediate NFMF outplants was estimated to be 57.9%. In contrast, prespawn mortality after outplanting hatchery-held fish was 13.3% (note: an additional 7 mortalities occurred at the hatchery). Even accounting for mortality during holding, fish held at the hatchery exhibited an increase in survival during the 2010 season compared to immediate outplanted adults. The higher survival may have been related to the use of antibiotics for hatchery held fish and/or cooler holding temperatures. The results

suggest holding fish prior to outplanting may reduce prespawn mortality. Prespawn mortality for NFMF outplants in 2009 was 36.4% based on a PIT tag recovery rate of 5.3%. Fish were not assessed in 2008.

Results of this study in combination with previous Willamette River Chinook salmon studies suggest that: 1) there is an association between prespawn mortality rate and temperature conditions encountered during holding, and 2) the underlying causal mechanism of prespawn mortality is probably an interaction of fish condition and disease status, energetic status, and environment (e.g., temperature). Monitoring migration behavior, disease status and fate in the lower river in conjunction with multi-year sampling of adult energetic status, other fish condition metrics, and environmental variables in tributaries will: 1) provide insights into the factors causing prespawn morality; 2) determine how mean salmon condition varies from year to year in response to environmental factors such as main stem conditions and ocean conditions; and 3) will assist in the development of effective management strategies to reduce prespawn mortality in Willamette River spawning tributaries.

PATHOLOGICAL CHANGES ASSOCIATED WITH PRESPAWNING MORTALITY IN CHINOOK SALMON IN THE WILLAMETTE RIVER AND MANAGEMENT OPTIONS

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This project is aimed at determining the cause of prespawning mortality of spring Chinook salmon employed in outplanting programs in the upper Willamette River system and developing management approaches to alleviate this problem. We used standard necropsy methodologies, similar to those being employed for adult salmonids in other large river systems such as the Fraser and Yukon, consisting of gross and histological examinations of outplanted fish from the upper North Fork of the Middle Fork of the Willamette River and Fall Creek. We compared fish that (1) died prespawning, (2) fish from Willamette Falls that had not experienced the system above Oregon City, (3) fish taken alive at about the same time as prespawned mortalities and those that (4) spawned in the wild, (5) those that spawned at Willamette Hatchery, and (6) fish from Dexter and Fall Creek allowed to mature in a cool, pathogen free facility (Fish Performance and Genetics Laboratory, FPGL). We included fish representing different temporal parts of the run in the above comparisons.

As in the prior year, we identified massive infections and severe lesions in fish that died prior to spawning. It appears that the fish are becoming infected with some of the parasites in the river above Willamette Falls, as judged by lack of presence of parasites in fish from below that area. Examination of fish from the falls and held in pathogen free water would confirm this. In addition, conditions in the upper river, perhaps elevated temperature, appear responsible for some heavy parasite burdens in fish maturing in the upper river system; this contention is based on the fact that fish that matured in cool, pathogen free water at the FPGL did not have such infections, and there is a time effect. A new finding this year is that, in addition to parasites seen previously, some fish in the river had extreme infections of the hind brain by a myxozoan (*Myxobolus* sp.). Although not as lethal as *M. cerebralis* (the causative agent of whirling disease), similar pathogens have been shown to disrupt swimming ability and likely affect other critical functions. Also, prespawning mortality fish exhibit a significantly greater infection by *Nanophyetus* metacercariae than survivors. We contend that it is now clear that fish of the upper Willamette system are dying of infections associated with multiple parasites. Bacterial infections were also observed in the fish, and it would be insightful to establish the interactive effects of parasites, bacteria and fungi on morbidity. It is important to understand how collection and outplanting protocols affect disease prevalence and severity, and to establish how the modification of flow and temperature regimes affect the fish, pathogens and other hosts of the pathogens.

A viable management option is suggested by our findings. It appears that holding fish in cool, pathogen free water for much of their maturation prior to outplanting could enhance survival to spawning. However, to optimize these effects we suggest that fish from earlier parts of the run could be used, as their survival to spawning (90%) was considerably higher than those collected later (70%). As judged from our small sample size, earlier and later transported fish still spawned at the same time, therefore genetic consequences of such a tactic could be minimal.

TRENDS IN PRE-SPAWNING MORTALITY OF SPRING CHINOOK SALMON IN TRIBUTARIES OF THE WILLAMETTE RIVER

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Spring Chinook salmon in the Willamette drainage migrate into the river in spring and must survive until fall, when they spawn. Because these fish must hold in the river and spawning tributaries through summer and early fall, they are vulnerable to stressors that may lead to mortality prior to spawning. Pre-spawning mortality is highly variable within the upper Willamette Basin, although surveys conducted by Oregon Department of Fish and Wildlife have revealed trends among tributaries and years. Within years, Chinook salmon consistently have lower pre-spawning mortality in the more normative rivers than in rivers that have been highly altered. The overall pattern of mortality among the different sub-basins has remained consistent, although pre-spawning mortality among years can be variable. For example, pre-spawning mortality in some years was especially low across all sub-basins. We continue to investigate potential factors that affect these trends and our data suggest that pre-spawning mortality is affected by factors both within and outside of the Willamette Basin. Pre-spawning mortality was generally higher downstream of passable dams than upstream of them and hatchery fish typically had higher pre-spawning mortality than wild fish. Causative factors affecting pre-spawning mortality are likely to be complex and cumulative. However, environmental conditions in the Willamette River and spawning tributaries, especially water temperature, are likely to be important. High pre-spawning mortality in Willamette spring Chinook is a critical limiting factor that affects the viability of these populations, therefore understanding the causes will be an important component for successful recovery.

THE PROPORTIONAL NATURAL INFLUENCE (PNI) CONCEPT IN HATCHERY MANAGEMENT: FOUNDATIONS, APPLICATION, AND ISSUES

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The proportionate natural influence (PNI) statistic has become a key though controversial concept in the management of integrated hatchery programs. According to the model on which the concept is based, a population influenced by an integrated hatchery program lives in two environments, and is affected both by the natural selective forces of the natural environment and the domesticating selective forces of the hatchery environment. This makes the population a generalist in the two environments, with its characteristics intermediate between what they would be in the pure hatchery or pure natural environment. The mean value of traits exhibited by the population will be determined by a number of factors, most of which are not well known. But the equilibrium value relative to the two optima that would be achieved in either environment, which is called proportionate natural influence (PNI) is determined almost entirely by the rate of gene flow between the natural and hatchery environments. Assuming that these gene flow rates are well estimated by the proportion of broodstock consisting of natural-origin fish (pNOB) and the proportion of fish on the spawning grounds consisting of hatchery-origin fish (pHOS), PNI can be approximated by:

Although this is just an approximation, it is a very good one. It provides hatchery managers with much better advice on how to integrate natural and hatchery production than has been previously available. It also provides a framework for comparing all hatchery programs for their potential for domestication, regardless of the program intent. The HSRG has adopted the PNI concept in its guidance for integrated hatchery programs, recommending that for populations of high conservation/recovery importance PNI should be 0.67, and with pHOS limited to 0.3.

A PNI level implies a fitness level, but is not a measure of fitness, and we can't say anything about absolute fitness at a given PNI level. However, assuming the model is a reasonable approximation to reality, we can make statements about the relative fitness less expected under different PNI levels.

Implementation of PNI guidelines has proven to be both logistically challenging and scientifically and philosophically controversial. In terms of logistics, it requires identification and typically removal of surplus hatchery fish through weirs, selective harvest, or program reductions. In terms of science and philosophy, this widely publicized approach has met with much skepticism and controversy for a number of reasons. Perhaps the most important is the belief that "surplus" hatchery-origin fish should be used to increase seeding levels and that rare natural-origin fish should spawn in the wild and not be used for broodstock.

EFFECTS OF RELEASE STRATEGIES AND BROAD-SCALE ENVIRONMENTAL CONDITIONS ON UPPER WILLAMETTE RIVER HATCHERY SPRING CHINOOK

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Coded wire tags (CWTs) are a useful tool for examining the effects of environment and management on Pacific salmon stocks. Using multivariate approaches, I have explored CWT data for spring Chinook salmon (*Oncorhynchus tshawytscha*) released by Marion Forks, South Santiam, McKenzie and Willamette hatcheries over a twenty year period. We report evidence for a precipitous decline in the proportion of age-5 individuals in both Columbia River fisheries and on spawning grounds. Also, in contrast to most Columbia River spring Chinook stocks, highest CWT recovery rates for Willamette River stocks coincide with “warm ocean” conditions in the year of juvenile outmigration. Larger size at time of release appears to favor survivorship for smolts released in the fall, but not those released in the spring. Our findings aim to assist with improved understanding and management of Willamette spring Chinook.

MONITORING AND EVALUATION USING GENETIC INFORMATION

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The USFWS Abernathy Fish Technology Center Applied Program in Conservation Genetics conducts applied research to: 1) Support the management needs of the USFWS Pacific Region's 18 National Fish Hatcheries; 2) Use genetic methods to meet real-time fishery needs to conserve and manage throughout the Pacific Region; 3) Assist with Endangered Species Act status reviews and recovery planning, via genetic monitoring and evaluation of listed populations and species; and 4) Establish and maintain genetic tissue/DNA repositories for the USFWS. The Program has been, and is currently, involved in several collaborative projects in the Willamette Basin including an evaluation of the genetic origin of *Oncorhynchus mykiss* from the Middle Fork Willamette Basin, a study of genetic variation and development of a genetic monitoring plan for upper Willamette bull trout, an assessment of genetic variation in natural and re-introduced populations of Oregon chub, a description of genetic population structure of coho in the Clackamas River with a comparison to coho from Eagle Creek National Fish Hatchery, and projects to characterize coho, lamprey, and steelhead in Agency Creek. In this presentation, I will provide a brief description of these projects and an overview of the AFTC Applied Program in Conservation Genetics.

WILLAMETTE HATCHERY MITIGATION PROGRAM RESEARCH, MONITORING AND EVALUATION PLAN

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The Willamette Hatchery Mitigation Program (WHMP) is an extensive program that encompasses most of the Willamette Basin, nine facilities, two species listed under the ESA, and numerous resource management challenges. Therefore, the WHMP research monitoring and evaluation (RM&E) plan is also extensive.

The purpose of the Plan is first to develop research, monitoring and evaluation goals and objectives that are consistent with those outlined in the 2008 BiOp and current Hatchery and Genetic Management Plans (HGMPs). The Plan also serves to coordinate strategies used for implementation and establishes a process for monitoring effectiveness of hatchery-related BiOp actions. One of the key aspects of the Hatchery RM&E Plan is that it will readily be incorporated into the larger Willamette Comprehensive RM&E Plan that addresses all components of the BiOp (e.g., fish passage, habitat improvement). The Hatchery RM&E Plan relies on format, findings, and ideas from previous work done within the Upper Columbia Basin (e.g., Murdoch and Peven 2005, Hays et al. 2006), and NE Oregon (Hesse et al. 2006).

A second key aspect of the Plan is that it is consistent with the concept of adaptive management and, as such, is intended to be a living document. Potential changes to the document may arise out the finalization of the Willamette River Recovery Plan, annual adjustments made to the Willamette FPMP, or based on the results of studies undertaken to address specific goals and objectives identified within the Plan. It is anticipated that this Plan will be updated to incorporate necessary changes on an as needed basis.

HISTORICAL AND CURRENT STATUS OF COHO SALMON (*ONCORHYNCHUS KISUTCH*) IN THE WILLAMETTE BASIN ABOVE WILLAMETTE FALLS

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Non-native coho salmon are now naturalized in many tributary streams above Willamette Falls, a once impassable barrier to their migration located at RM 26 in Oregon City. Genetic testing on some fish show origins from Lower Columbia River early-run hatchery stocks which were released in large numbers in most subbasins above Willamette Falls from the 1950s through 1997. Data collected from spawning ground surveys and a radio telemetry project in 2009 show most coho currently use the Tualatin and Yamhill rivers for spawning and rearing. However, significant numbers are also observed in the Molalla, Santiam and Luckiamute subbasins.

The population is showing surprising survival success and has increased at a marked rate in recent years. Over 25,000 adults were counted at the Willamette Falls fish counting station in 2009, almost exclusively from natural production. Extensive miles of good spawning and rearing habitat, reduced commercial and sport harvest impacts on wild coho, improved flow management in the mainstem Willamette River, and overall good ocean conditions are contributing factors. More work is needed to better understand the dynamics of this unique coho population and the potential competition effects on federally listed ESA winter steelhead and spring Chinook salmon.

WATER QUALITY

THE THERMAL EFFECTS OF DAMS IN THE WILLAMETTE RIVER BASIN, OREGON

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Methods were developed to assess the effects of dams on streamflow and water temperature in the Willamette River and its major tributaries. These methods were used to estimate the flows and temperatures that would occur at 14 dam sites in the absence of upstream dams, and river models were applied to simulate downstream flows and temperatures under a no-dams scenario. The dams selected for this study include 13 dams built and operated by the U.S. Army Corps of Engineers as part of the Willamette Project, and 1 dam on the Clackamas River owned and operated by Portland General Electric. The no-dam conditions were estimated for the entire 2001-02 period, but methods and equations were developed and documented so that conditions during other years also could be estimated.

Streamflows in the absence of upstream dams were estimated from previous river models or on the basis of measured dam releases, changes in reservoir storage, a correction for evaporative losses, and an accounting of flow effects from upstream dams. Without-dam streamflows were characterized by higher peak flows in winter and spring and much lower flows in late summer, as compared to with-dam measured flows.

Without-dam water temperatures were estimated from measured temperatures upstream of the reservoirs in combination with a typical downstream warming rate based on historical data and downstream river models. Regressions with measured temperatures from nearby or similar sites were used to extend the without-dam temperature estimates to the entire 2001–02 time period. Without-dam temperature estimates were characterized by a more natural seasonal pattern, with a maximum in July or August, in contrast to measured patterns at many of the tall dam sites where the annual maximum temperature typically occurred in September or October. Without-dam temperatures also tended to have more daily variation than with-dam temperatures.

Streamflow and temperature estimates downstream of the dam sites were generated using existing CE-QUAL-W2 flow and temperature models. Model results showed that late-summer Willamette River streamflow without upstream dams was reduced to levels much closer to historical pre-dam conditions, with annual minimum streamflows approximately one-half or less of dam-augmented levels. The thermal effects of the dams varied according to the time of year, from cooling in mid-summer to warming in early autumn. Thermal effects diminished with increasing distance downstream, from 6°C or more at most of the taller dam sites to less than 1°C downstream of the Santiam River confluence and less than 0.5°C downstream of the Clackamas River confluence. For more information, see the full report at http://pubs.usgs.gov/sir/2010/5153/.

EVALUATION OF INTERIM WATER TEMPERATURE OPERATIONS AT DETROIT AND BIG CLIFF DAMS, WATER YEAR 2010

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Detroit and Big Cliff are two of the 13 multi-purpose projects operated by the Corps of Engineers in the Willamette Valley, Oregon. Located in Marion County in the rugged mountain forests below Mt. Jefferson, the two dams store the waters of the North Santiam River, Breitenbush River and Blowout Creek. The authorized purposes for Detroit project are flood risk management, irrigation, hydroelectric power, recreation, navigation, fish and wildlife and water quality. The authorized purposes for Big Cliff project include hydroelectric power and re-regulation.

Construction and operation of Detroit and Big Cliff Dams has altered the pre-dam seasonal thermal regimes in the North Santiam River. The altered temperature regime has negatively affected the productivity of ESA-listed spring Chinook salmon and winter steelhead in the lower North Santiam River, and has been identified as one of the most critical limiting factors for species recovery.

Reasonable and Prudent Alternative (RPA) 5.1.1 in the National Marine Fisheries Service's Biological Opinion (NMFS 2008) required an evaluation and implementation of modified operations at the Detroit and Big Cliff projects on the North Santiam River to improve downstream water temperature and TDG conditions for anadromous fish species listed under the Endangered Species Act (ESA). The objective of interim operations was to achieve water temperature benefits below the Detroit/Big Cliff complex without jeopardizing the authorized purposes of the dams.

In 2010, interim temperature control operations were conducted from June 01 through October 31, 2010. The Corps of Engineers monitored the effectiveness of interim temperature control operations by conducting water quality and biological assessments throughout the 2010 season. In general, interim temperatures operations met temperature targets throughout the season, but slightly exceeded these targets in late fall during incubation.

Although the benefits may not be quantifiable at the population level, interim temperature control has mitigated some of the potential thermal impacts to the ESA-listed species in the North Santiam River and provided overall benefits to the aquatic ecosystem below the dams.

MODELING OPERATIONAL STRATEGIES AT DETROIT DAM TO MEET DOWNSTREAM WATER-TEMPERATURE GOALS IN THE NORTH SANTIAM RIVER, 2010

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Water temperatures within a certain range are of vital importance in providing beneficial habitat for threatened Willamette basin salmonids such as upper Willamette River Chinook salmon (*Ocorhynchus tshawytscha*) and winter steelhead (*O. mykiss*). Following the National Marine Fisheries Service's Biological Opinion of 2008, the U.S. Army Corp of Engineers Willamette Basin dam operations have been evolving to improve water quality for fish species listed under the Endangered Species Act. One of the largest of these dams in the Willamette River basin, Detroit Dam, is located on the North Santiam River and impounds 455,100 acre-feet of water at full pool. From the time of its construction in 1953 until 2006, the operation of Detroit Dam resulted in an altered seasonal pattern of downstream water temperatures in the North Santiam River when compared to pre-dam conditions. Under an operational plan that emphasized power generation, the dam provided a net cooling effect to the North Santiam River in the early summer, but a net warming effect during the late summer and autumn. However, the structure of Detroit Dam allows releases at various depths, which allows water from multiple depths to be released and blended to meet a downstream temperature target. In particular, the release of cool water from deep in the lake in late summer and early autumn can help mitigate problems with the release of water that otherwise would be too warm for fish.

To explore the cooling potential that can be achieved by using multiple release structures at Detroit Dam during autumn of 2010, the USGS conducted simulations using a previously developed model of Detroit Lake that was based on the two-dimensional (laterally averaged) hydrodynamic model CE-QUAL-W2. Using a combination of measured and forecasted inputs (flow, water temperature, and meteorologic conditions), numerous scenarios involving the use of the existing outlets (each at different depths) at Detroit Dam were explored. A "blending" algorithm within CE-QUAL-W2 previously developed by the USGS was used to predict the necessary flow from each outlet needed to meet a user-defined time-series of downstream temperature targets. Initial model runs using CE-QUAL-W2 in "blending" mode were used to quickly assess the extent to which temperature targets could be met using available dam outlets. This information then was combined with feasible dam operations to simulate downstream temperatures resulting from various operational scenarios.

TEMPERATURE MANAGEMENT OF THE LOWER DESCHUTES RIVER (RKM 161) USING THE NEW SELECTIVE WATER WITHDRAWAL FACILITY AT ROUND BUTTE DAM

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Lake Billy Chinook (LBC) was formed in 1964 by construction of Round Butte Dam on the Deschutes River at km 177. Located in the canyons of the Crooked and Metolius rivers in addition to the Deschutes, LBC has a surface area of 1619 ha, and a maximum depth of 122 m. Until December 2009, all water exited from a depth of ~ 73 m. Because all three tributary rivers are dominated by groundwater inputs of different temperatures, thermal stratification by tributary input normally occurred. Denser, cold Metolius water filled the reservoir bottom up to 73 m while the warmer inputs from the Crooked and Deschutes would fill the major volume of the reservoir down from the surface. Surface currents ebbed up the Metolius Arm and not to fish collection facilities resulting in the failure of downstream fish passage in the late 1960s. During warm months water in the epilimnion and top 35 m was trapped. Biological activity progressed with blue-green algae booms often occurring during late summer. The presence of LBC also had the effect of delaying the cycle of discharge temperatures down the lower Deschutes River about 6 weeks resulting in cooler water discharged during spring - and warmer water discharged during fall than would have occurred naturally. With the completion of the new Selective Water Withdrawal Facility, nearly all water is withdrawn from the top 14 m from November through June and at least 50% the remainder of the year. This has resulted in a significantly cooler reservoir as the volume is being filled from the bottom with cold, denser Metolius river water. From July through October, deep cold water is mixed with warmer surface water in increasing amounts to manage lower Deschutes River temperatures below the hydro Project (Rkm 161) to or below natural thermal potential (NTP). NTP is the approximate temperature the river would be at Rkm 161 without the dams and is a calculated value using input flow volumes and temperatures of the three tributaries and the average air temperature at the Redmond Airport in a regression equation. The year 2010 was a transition year with stratified temperatures cooling to modeled temperatures in November. Water quality at LBC appeared to have improved during 2010 with no major blooms of filamentous blue-green algae species observed. Nutrient and chlorophyll monitoring will begin in 2011.

INSTREAM FLOW & HABITAT

PRELIMINARY RESULTS OF WATERSHED SCALE MACROINVERTEBRATE DRIFT COMPOSITION AND ABUNDANCE DURING SUMMER BASEFLOW WITHIN SALMON REARING HABITAT

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Anadromous fish require a suite of habitats during their life cycle and the quality of each can impact overall health of populations. For some species the primary spawning and rearing habitats are in the upper reaches of forested watersheds. In the Willamette Valley, most of those watersheds were logged in the 20th century and the logging caused lasting impacts to habitat which are impediments to recovery. The early loggers harvested the riparian forest and transported the logs using the river. The lack of large wood, elevated water temperature, and impaired hyporheic exchange, common in many Willamette watersheds today, is, in part, a legacy of these practices.

Our research is attempting to examine the effects of elevated water temperatures on fish energetics. Stream temperature underlies all facets of fish metabolism, therefore is a major factor in conservation and recovery of salmon. There are well established species specific relationships of fish growth relative to stream temperature and food ration, therefore food availability influences the impacts of elevated temperatures.

In this presentation we will offer preliminary results of watershed scale macroinvertebrate drift composition, abundance, and stream temperature during summer baseflow. The Calapooia River is the focal watershed for our fish energetics research. The Calapooia watershed is potentially habitat for two species listed as threatened under ESA: Winter Steelhead trout and Spring Chinook salmon. In the summer of 2010 we conducted a detailed study of both stream temperature and available food during baseflow in the upper Calapooia River. We deployed a network of 60 temperature recorders in the upper watershed. Invertebrate drift was sampled one 24-hour period per week for four weeks at eight randomly selected reaches within areas potentially accessible to anadromous fishes. During the four weeks stream temperatures rose and discharge declined at the eight sites. We calculated both total drift (number per day) and drift density (number per m^3). We collected drift for 24 hrs and a three hour twilight period. Total drift abundance ranged from more than 300,000 to less than 13,000 per day. Drift density ranged from more than 200 to less than 20 individuals per m^3 of flow. Both total drift and drift density declined during the experiment. Taxonomic resolution was largely to species for immature insects, genus for adult insects, and order for terrestrial taxa. With the exception of Baetid mayflies, Ephemeropterans, Plecopterans, and Trichopterns were a minor component of drift. Chironomidae (larvae and adults), Baetids, and Simulids dominated drift. The twilight samples (3 hrs) comprised 34% of the total daily drift, with a strong Chironomidae component, particularly adults.

These data along with results from mainstem physical habitat surveys and tributary drift will be used to evaluate current conditions from a fish energetics perspective. Although the Calapooia watershed has some features that differentiate it from some Willamette Valley basins (e.g. elevation); the work should have some inferential potential for other salmon producing watersheds in the valley.

WILLAMETTE RIVER TRIBUTARY INSTREAM FLOW STUDY: DETERMINING CHINOOK AND STEELHEAD HABITAT-FLOW RELATIONSHIPS IN THE NORTH FORK SANTIAM RIVER BELOW DETROIT DAM AND THE SOUTH FORK SANTIAM RIVER BELOW FOSTER DAM

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The 2008 Biological Opinion (BO) prepared by the National Marine Fisheries Service (NMFS) on continued operation of the Corp of Engineers' (COE) Willamette Valley Project (WVP) describes minimum stream flows to be released into the Willamette River tributaries below WVP dams. Development of these prescribed minimum stream flow targets was determined based on limited local information. Therefore, the 2008 BO included a reasonable and prudent alternative to further investigate how flow volumes related to fish habitat for the target ESA-listed species (natural origin spring Chinook and winter steelhead) by life stage. As specified in this alternative, the CEO commissioned instream flow studies to identify the relationship between river flow rate and habitat conditions for adult passage, holding, and spawning/incubation, and juvenile rearing in the North Fork Santiam River below Detroit Dam and the South Fork Santiam River below Foster Dam. System specific technical studies included instream flow data collection utilizing 1-D hydraulic modeling as described in the PHABSIM method, development of Habitat Suitability Criteria curves, review of previous adult upstream passage surveys, and monitoring changes in water temperature and adult holding area in large pools.