71st Annual Northwest Fish Culture Concepts

Annual Meeting and Workshop

December 6 – 8, 2022

Cultivating Success – The Future of Aquaculture in the Northwest Region

Schedule at-a-Glance

Day 1	**9 AM** Registration Desk Open **1 PM** Opening Remarks **1:40 PM** Session 1 **4:50 PM** NWFCC Hall of Fame Inductees **5:30 PM – 10 PM** Poster Session and Vendor Social
Day 2	**8 AM** Session 2 **11:40 PM** Lunch **1:30 PM – 2:50 PM** Session 3 **3:20 – 4:30 PM** Session 4 **5:30 – 7:30 PM** Executive Committee Meeting
Day 3	**8 AM** Session 5 **12 PM** Closing Remarks

Organized by:

U.S. Fish and Wildlife Service

in Cooperation with the

AFS Fish Culture Section

DoubleTree Hotel

Portland, Oregon

WiFi: **Hilton Honors Meeting Network** *Access Code:* **NWFCC22**

Thanks to the 2022 NWFCC Working Group

Jesse Rivera

and

Margaret Anderson
Mike Clark
Matt Cooper
Debbie Eddy
JJ Mora Flores
David Hines
Ryan Koch

Ian MacDonald
Hayley Muir
Dan Nehler
Derek Pugh
Brook Silver
Bob Turik
Jeremy Voeltz

Special thanks to **The American Fisheries Society, Fish Culture Section, particularly Jeff Heindel for his assistance**

Keynote Profile: CHRIS TATARA

Chris Tatara's career with NOAA Fisheries began in 1999 at the Santa Rosa, California office of what was then the Southwest Region. There, he provided scientific support on toxicology and water quality issues in support of NOAA Fisheries regulatory activities under the Endangered Species Act. In 2002, he joined the Fisheries Ecology and Conservation program at the NOAA Northwest Fisheries Science Center and is stationed at the Manchester Research Station located in Port Orchard Washington. In 2021 Chris became a supervisory research fisheries biologist and oversees the NOAA captive broodstock program for the ESA-listed Snake River sockeye salmon. Chris earned a B.S. in fisheries biology from the University of California, Davis and a Ph.D. in ecology from the University of Georgia, Athens.

Chris is a member of a research team that investigates the effects of artificial propagation (hatcheries) on natural anadromous salmonid populations. The team designs and conducts experiments to evaluate the ecological and behavioral effects of hatchery rearing strategies for anadromous salmonids and recommends solutions for the enhancement, conservation and protection of salmonid fisheries. The team specifically investigates the effects of hatchery-rearing practices on the development of juvenile and adult salmonids, investigates mechanisms underlying domestication, and how rearing practices can be altered to minimize domestication selection and fitness loss.

Day 1: Tuesday, December 6

9:00 AM	Registration Desk Open		
1:00 PM	Opening Remarks	Nate Wilke	USFWS
	Native American Invocation	Ron Suppah	Confederated Tribes of the Warm Springs Reservation of Oregon
	Keynote Address	Chris Tatara	NOAA
	Session 1: Fish Health and Nutrition, Part I		
	Session Chair:	Bill Gale	USFWS
1:40 PM	The USFWS AADAP Program – Supporting Fish Drug Approvals	Bonnie Johnson	USFWS
2:00 PM	Aquatic Animal Drug Approval Partnership Program: Introduction to INADS	Paige Maskill	USFWS
2:20 PM	Predicting pathogen prevalence in salmon populations using pooled tissue samples	Julie Harris	USFWS
2:40 PM	Thiamine supplementation improves survival and body condition of hatchery-reared steelhead (*Onchorhynchus mykiss*) in Oregon	Dr. Aimee Reed	ODFW
3:00 PM	**Afternoon Break**		
3:20 PM	1st Raffle		
	Session #1 Fish Health and Nutrition, Part II		
	Session Chair:	Bill Gale	USFWS
3:30 PM	*Lactococcus* in California Hatcheries	Dr. Karly Hatcher	CDFW
3:50 PM	Strategies to Improve Fish Vaccination	Dr. Katherine Onofryton	AquaTactics Bimeda
4:10 PM	Inside Out: Using External Morphological Features to Diagnose Internal Spinal Deformities	Ian McDonald	USFWS
4:30 PM	Treating for Thiamine Deficiency Complex in Chinook Salmon at California Hatcheries	Dr. Kevin Kwak	CDFW
4:50 PM	2nd Raffle Drawing and NWFCC Hall of Fame Inductees		
5:10 PM	**End of Day**		
5:30 PM	Trade Show, Poster Session, and Social		

AFS AMERICAN FISHERIES SOCIETY

DAY 2: WEDNESDAY, DECEMBER 7

8:00 AM	3rd Raffle Drawing and Announcements		
	Session #2: Hatchery Innovations and Technology, Part I		
	Session Chair:	Todd Gilmore	USFWS
8:10 AM	Yakama Nation Coho Facility Part 1: Design	Kevin Jensen	McMillen, LLC
8:30 AM	Yakama Nation Coho Facility Part 2: Facility Context and Operations	D.J. Brownlee	Yakama Nation YKFP
8:50 AM	Onalaska High School Steelhead Production	Kevin Hoffman	Onalaska School District
9:10 AM	Onalaska High School Rainbow Trout and Coho Salmon Production		
9:30 AM	Onalaska High School Partial Recirculating Aquaculture System		
9:50 AM	**Morning Break**		
10:10 AM	4th Raffle		
	Session #2: Hatchery Innovations and Technology, Part II		
	Session Chair:	Todd Gilmore	USFWS
10:20 AM	Construction of the Native Salmonid Conservation Facility	Mark Hassebrock	HDR
10:40 AM	Effects of rearing system on growth responses and saltwater tolerance of Spring Chinook Salmon (*Oncorhynchus tshawytscha*)	Ronald Twibell	USFWS
11:00 AM	Fall Creek Fish Hatchery: One Solution for Species Reintroduction after Barrier Removal	Jodi Burns	McMillen, LLC
11:20 AM	Piper Redux: Status update regarding revision of Fish Hatchery Management	Dr. Jesse Trushenski	Riverence Holdings, LLC
11:40 AM	**Lunch**		

AQUATACTICS
FISH HEALTH

DAY 2: WEDNESDAY DECEMBER 7 (CONTINUED)

1:20 PM	5th Raffle		
	Session #3: Advances in Conservation Science		
	Session Chair:	Jeremy Voeltz	USFWS
1:30 PM	Partial-year continuous light treatment reduces precocious maturation in age 1+ hatchery reared male Spring Chinook Salmon (*Oncorhynchus tshawytscha*)	Andrew Pierce	CRITFC
1:50 PM	Niagara Springs White Sturgeon Hatchery: A Repatriation Approach to Snake River White Sturgeon Culture	Steve Stowell	IDFG
2:10 PM	Retention of passive integrated transponder tags in hatchery YY male brook trout: effect of tag size, implantation site, and double tagging	Matt Piteo	USFWS
2:30 PM	Aligning Development of Summer Steelhead from a Series of Spawning Events Using Water Temperature Manipulation	Hayden Fitte	IDFG
2:50 PM	**Afternoon Break**		
3:10 PM	6th Raffle		
	Session #4: Mixed Bag		
	Session Chair:	Jeremy Voeltz	USFWS
3:20 PM	A Review of Methods to Reduce Warming Water in Hatcheries	BayLee Moser	Oregon Hatchery Research Center
3:40 PM	Using real-time data monitoring and collection to access fish health and conduct site surveys, an introduction to the Beacon®	Chandler Smith	Aquasend
4:00 PM	The National Pollutant Discharge Elimination System, Regional Water Quality Control Boards and the California Department of Fish and Wildlife's Fish Hatcheries - Challenges, Confusion, Years of Data (are we actually polluters?)	Terry Jackson	CDFW
4:20 PM	7th Raffle		
4:30 PM	**End of Day**		
5:30 PM	**Executive Committee Meeting**		

DAY 3: THURSDAY, DECEMBER 8

8:00 AM	8th Raffle Drawing and Announcements		
	Session #5: Rearing and Release Strategies, Part I		
	Session Chair:	Jeremy Voeltz	USFWS
8:10 AM	Improving return numbers by adopting breeding strategies observed more fit among wild fish: Initial evidence from a three-year experiment at Sandy Hatchery, Oregon.	Dr. Michael Banks	OSU
8:30 AM	The Surrogate Wild Fishes Rearing Method Mitigates the Stress Response in Juvenile Chinook Salmon and Steelhead Trout	Crystal Herron	OSU
8:50 AM	Can Hatchery Rearing Practices Influence the Onset of Fin Erosion in Steelhead Trout?	Jennifer Krajcik	Oregon Hatchery Research Center
9:10 AM	Volitional Release and Circulars	Eric Hammonds	ODFW
9:30 AM	Big Fish, Small Fish, Less Fish, More Fish; Tradeoffs Between Size and Abundance In Rearing Deschutes Spring Chinook Salmon	Dina Spangenberg	NOAA
9:50 AM	**Morning Break**		

Day 3: Thursday, December 8 (Continued)

10:10 AM	9th Raffle		
	Session #5: Rearing and Release Strategies, Part II		
	Session Chair:	Jeremy Voeltz	USFWS
10:20 AM	The effect of reducing dietary lipid and food availability on smolt quality, age structure and adult returns in yearling fall Chinook salmon: a production scale hatchery experiment	Deborah Harstad	NOAA
10:40 AM	Rearing strategies for steelhead in a partial reuse aquaculture system	Kelsey Lear	IDFG
11:00 AM	Increasing Juvenile Survival of Upriver Bright Fall Chinook at Willard National Fish Hatchery Through Alternative Release Strategies	Justin Baker	USFWS
11:20 AM	Performance of diploid and triploid Fall Chinook Salmon in Idaho lakes and reservoirs	Will Lubenau	IDFG
11:40 AM	Kelt Reconditioning – Safety Net for Snake River Steelhead	Scott Everett	NPT
12:00 PM	**Closing Remarks**		
12:10 PM	Grand Prize Raffle Drawings		

POSTER SESSION ABSTRACTS

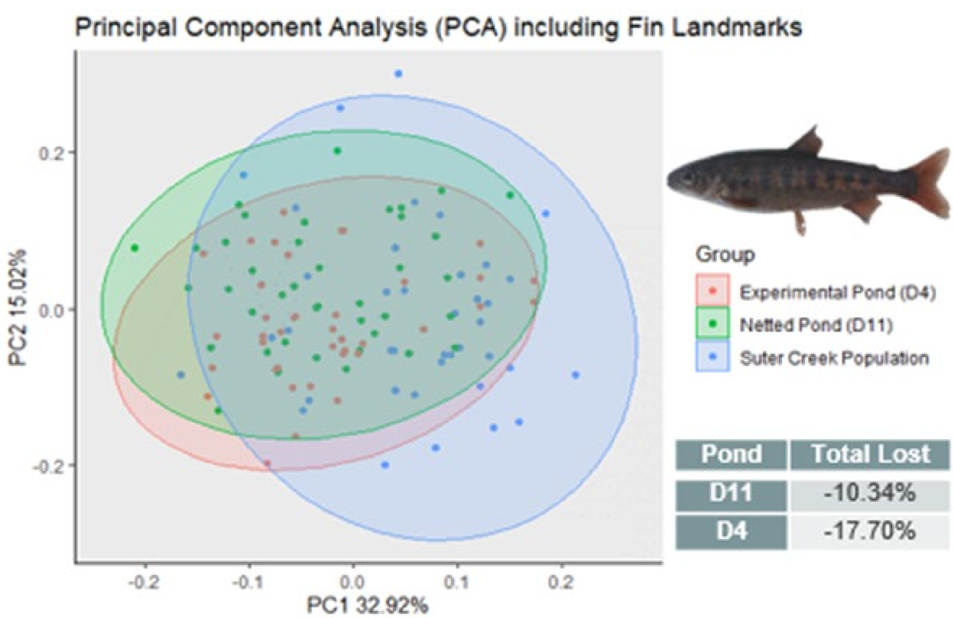
Determination of Morphological Variation Between Eagle Creek National Fish Hatchery Coho and Suter Creek Coho

Chanice Davies[1]

[1]Columbia River Fish and Wildlife Conservation Office, USFWS, 1211 SE Cardinal Court Suite 100, Vancouver, Washington 98683, chanice_davies@fws.gov

This study examined morphological variation within populations exposed to different levels of avian predator burden within Eagle Creek National Fish Hatchery's juvenile Coho (Oncorhynchus kisutch) population. This experiment compared one population with no exposure to avian predators (concealed by bird netting), one pond exposed to avian predators (dippers, kingfishers, heron, etc.), and a population of wild fish from the local Eagle Creek watershed. 30 fish were collected from each treatment and were photographed to compare morphological variation using geometric morphometric analysis (D11 netted group, D4 exposed group, and Suter Creek wild Coho). A comparison of percentage difference between the two hatchery ponds indicated that there was disproportionately higher loss in the exposed pond when compared to the total loss in the netted pond when comparing the initial inventory to the marking totals (17.70% loss for the exposed pond versus 10.71% average loss with netted ponds). A principal component analysis of morphological landmarks found significant difference between the two hatchery populations but did indicate morphological differences between hatchery and wild populations. These results suggest that avian predator avoidance did not trigger morphological variation within populations of hatchery fish. Future studies will compare survival rates for returning adults for each subgroup to determine whether exposure to predators in early development increases survival in returning adults.

TABLES



Pond	Total Lost
D11	-10.34%
D4	-17.70%

Development of rearing methods for juvenile Pacific lamprey (*Entosphenus tridentatus*) to be used in research

Ann Gannam[1], John Chan[2], Cody Slaugh[3], James Barron[4]

[1]Abernathy Fish Technology Center, Longview, WA. [2]USGS Ukiah Field Station, Ukiah, CA. [3]USFWS Idaho Fish & Wildlife Office, Chubbuck, ID. [4]BPA, Portland, OR

The goals of lamprey research at the Abernathy Fish Technology Center are to develop rearing protocols for fish held in captivity, for research and for captive rearing. Conservation aquaculture is a potential technique to help restore Pacific lamprey populations. Lamprey are new to culture and have a unique life history. Research has been done to increase our understanding of lamprey biology which will improve our ability to raise lamprey through their larval stage. Recent work at Abernathy has indicated the importance of clean sand, water source/temperature as well as larval density in raising these fish. Results from these studies will be presented.

10-Years of Chinook Salmon Contribution to the Pacific Ocean and Columbia River from Columbia River Gorge National Fish Hatcheries

Todd Gilmore, Doug Olson, Brook Silver, Steve Lazzini, Justin Baker, David Hand, Jesse Rivera

US Fish and Wildlife Service, Columbia River Fish and Wildlife Conservation Office, 1211 SE Cardinal Court, Suite 100, Vancouver, WA

The Columbia River Gorge National Fish Hatcheries (NFH; Carson NFH, Little White Salmon NFH, Spring Creek NFH, Willard NFH, and Warm Springs NFH) release approximately 20 million juvenile Chinook salmon each year with about nine percent being released with a coded-wire tag. For juvenile Chinook salmon released between 2008 and 2017 (brood years 2006 to 2015) from the Columbia River Gorge NFHs, adults recovered with a coded-wire tag were analyzed to determine the contribution to freshwater and ocean fisheries. Over this 10-year period, the Columbia River Gorge NFHs contributed more than one million adult Chinook salmon to the Pacific Ocean and Columbia River, including harvest (sport, commercial and tribal fisheries), hatchery returns, and spawning ground coded-wire tag recoveries. Tule fall Chinook contributed to ocean fisheries in Washington (53.8%), British Columbia (25.5%), Oregon (19.8%), Alaska (0.6%) and California (0.2%), with a 10-year total contribution of more than 245,000 adults. For the Columbia River, tule fall Chinook contributed more than 615,000 adults over 10-years, where 61.3% were harvested in freshwater, 38.3% returned to hatcheries, and 0.4% were recovered on spawning grounds. Upriver bright fall Chinook contributed to ocean fisheries in Alaska (44.7%), British Columbia (41.4%), Washington (9.7%), Oregon (3.7%), and California (0.5%), with a 10-year total contribution of more than 45,000 adults. Within the Columbia River, upriver bright fall Chinook contributed more than 165,000 adults over 10-years, with 31% harvested in freshwater, 46% returned to hatcheries, and 23% were recovered on spawning grounds. Spring Chinook contributed more than 170,000 adults over 10-years to the Columbia River, where 42% were harvested in freshwater, 55% returned to hatcheries and 3% were recovered on spawning grounds. Less than 1% (246 adults over 10-years) of spring Chinook recoveries contributed to ocean fisheries.

Pettit Lake Creek Weir

Jason Hill

HDR, Gig Harbor, WA

After propagating the Snake River for centuries, the Snake River sockeye salmon were blocked from their historic breeding grounds in Pettit Lake. As their populations dwindled over the next 30 years and the Shoshone-Bannock Tribe petitioned for listing on the Endangered Species List, the species teetered on extinction. Despite removing the blockage, habitat improvements and a captive breeding program, the previous Pettit Lake Creek Weir remained an obstacle.

The new weir fixes a design flaw — one that miscalculated the creek's peak flow, while its innovative design is friendlier for fish and the operators. It traps both juveniles and adults. It will help biologists gather data and tag the fish, which will have far-reaching impacts on restoring the population. After two years of growing in the lake, the fish begin a two-year, 1,800-mile round trip to the Pacific Ocean and back–the longest and highest distance to travel for any fish.

At one time, more than 150,000 sockeye salmon returned to central Idaho. When the Shoshone-Bannock tribe petitioned for protected status, there were just four. Since then, populations have stabilized, but the new weir begins a process of restoring the sockeye populations that once swam through the creek. Less intrusive than the previous structure, it is in the same location, but can handle increased flows, does not collect debris, and blends into the area. The precast concrete and weathered steel structure simplified construction, reduced impacts and maintains the Sawtooth National Recreation Area's visual requirements.

The project team worked alongside the Shoshone-Bannock Tribe, Bonneville Power Administration, U.S. Army Corps of Engineers, Idaho Department of Fish and Game and the U.S. Forest Service to deliver the project. Constructed through the summer, while the creek levels were low, the project team completed the project prior to the annual migration.

Transfer Management: Nez Perce Tribe (NPT) and Fish and Wildlife Service (FWS) Signing Agreement

Ahla Johnson, Brent Broncheau, Kayla Warden, Nez Perce Tribe Production, Dworshak Hatchery, 276 Dworshak Complex Dr. Orofino Id. 83544, kaylaw@nezperce.org

Transfer of management was finalized with the signing of the agreement between the NPT and USFWS on June 16th, 2022. Dworshak National Fish Hatchery (DNFH) has become a model in co-management, where two dedicated fisheries departments work side by side.

The Nez Perce Tribe (NPT) and the United States (US) agreed upon a settlement of the NPT's water claims filed in the Snake River Basin Adjudication (SRBA); This Memorandum of Agreement is entered into between the US Fish and Wildlife Service (USFWS) and the NPT and directs the US to "enter into an agreement for the joint management of hatchery programs and the DNFH". Agreement was ratified by Congress in the SRBA Settlement Act of 2004 (PL 108-447).

Now that the tribe has been involved with the production and rearing of the Salmon and Steelhead, giving the overall picture of anadromous fish incentive for their importance not only to the environment and public but to a way of life the nimiipuu people has followed since time immemorial.

Skeletal anatomy of common deformities of hatchery Chinook salmon (Oncorhynchus tshawytscha)

Ian MacDonald, Jesse Rivera

Columbia River FWCO, U.S. Fish and Wildlife Service, Vancouver, Washington

Skeletal deformities are present in all hatcheries across the northwest, but few hatchery professionals have ever seen what these common skeletal deformities look like internally. We collected normal and deformed chinook salmon from 4 hatcheries within the federal hatchery system. These fish were then "diaphonized" using a series of chemical baths and histological stains to clear their muscle tissue and dye their skeletons allowing us to analyze their skeletal features without the excision of tissues. We identified 11 common deformities within the fish collected. Common deformities observed included stunted growth, conjoined twins, single deviations of the spinal column, multiple deviations of the spinal column, severe deviations of the spinal column, abdominal vertebral fusions, caudal vertebral fusions, deformities of the tail, multiple vertebral fusions, multiple fusions with poor vertebral ossification, and compression of the vertebral bodies. We hope that this study can be used by hatchery professionals to visually diagnose deformities within their own production fish.

Optimization of triploid induction parameters and analysis of triploid sterility in burbot *Lota lota*

Luke P. Oliver, Joseph T. Evavold, and Kenneth D. Cain

Department of Fisheries and Wildlife Sciences and the Aquaculture Research Institute,

University of Idaho, Moscow, ID, 83844, USA, loliver@uidaho.edu

Optimization of triploid induction parameters was investigated for burbot using thermal and hydrostatic shock. Additionally, the sterility of sexually mature male and female triploid burbot was assessed. Hydrostatic shock experiments investigated duration of shock using 7,500 or 8,500psi at 180°C minutes post-fertilization. Thermal shocks investigated duration of shock and post-fertilization shock timing using a shock of 16°C. Assessment of triploid sterility was conducted by fertilizing triploid eggs with diploid sperm, fertilizing diploid eggs with triploid sperm, and comparing fertilization, and survival to diploid males crossed with diploid females. A hydrostatic shock of 7,500psi at 180°C minutes post-fertilization for 10 or 20°C minutes can induce triploidy at or over 90%, and exhibits survival that it statistically similar, $p = \leq 0.05$, to controls. A hydrostatic shock of 8,500psi for 5 or 10°C minutes at 180°C minutes post-fertilization yields triploid induction of 93 and 100%, respectively, with survival that is statistically similar to controls, $p = \leq 0.05$. Thermal induction experiments indicated that shocks at 16°C, 120°C minutes post-fertilization, for durations between 350 and 450°C minutes has potential to induce triploidy at or over 90% while facilitating survival statistically similar to controls, $p = \leq 0.05$. Tetraploid larvae were detected in three of the optimization experiments. No surviving larvae were produced from the crosses utilizing triploid fish. Assessment of sterility of 4-year-old triploid burbot confirmed they are functionally sterile and would present reduced risk of uncontrolled reproduction within or outside of an aquaculture operation.

Recirculating Aquaculture System (RAS) Approaches

Eric Orton Mechanical Engineer

HDR, Gig Harbor, WA

Incorporation of Recirculating Aquaculture Systems (RAS) or Partial Recirculation Aquaculture Systems (PRAS) into today's fish hatcheries as a way to reduce water consumption, conserve energy, increase sustainability, and more. The poster will address the differences between RAS & PRAS along the benefits and drawbacks of each system. Additionally, the poster will provide examples of where the different systems have been installed and are in use and give the reader an idea of where RAS and/or PRAS can be utilized within their facility.

Assessing the effect of hatchery noise on the development of Chinook salmon mechanosensory systems

Rikeem Sholes[1], Susannah Schloss[2], Olivia Molano[2], Loranzie Rogers[3], Dr. Joseph Sisneros[3], Dr. Andrew Brown[3], Dr. Georgina Cox[2], Ken Lujan[1], Dr. Allison Coffin[2]

[1]US Fish and Wildlife Service, Vancouver, WA. [2]Washington State University, Vancouver, WA. [3]University of Washington, Seattle, WA

Modern fish hatcheries present unique rearing conditions for commercial fish. Excessive noise from common hatchery operations can lead to the improper development of important mechanosensory systems and, potentially, reduced fitness. We sought to determine if noise exposure influenced the lateral line or inner ear development of Chinook salmon (Oncorhynchus tshawytscha) fry. Experiments were conducted at Spring Creek National Fish Hatchery located along the Columbia River. In addition to producing industrial noise typical of hatcheries, this facility is also situated less than 30 m from a highway and active train track. We exposed developing fry to white noise @ 150 dB (re 1 µPa), ambient hatchery noise, or a sound dampening treatment. Samples were taken regularly until smoltification, after which all remaining fish were released. Otolith development was assessed visually after inner ear dissections to quantify the relative proportion of otoliths containing vaterite; an aberrant calcium carbonate polymorph that negatively impacts hearing thresholds in salmon. We also performed hair cell density measures along the saccular epithelium to assess potential hearing damage caused by prolonged sound exposure. We assessed changes to lateral line morphology using DASPEI, a vital dye that specifically labels lateral line neuromasts. To evaluate the effects of abnormal lateral line development we quantified neuromasts on the head and body of the fish and conducted rheotaxis assays to assess lateral line function. Developing fish were placed in a Loligo swim tunnel to determine their ability to maintain position in a current. Collectively, this research will inform hatchery practices that may ultimately increase fitness of important commercial fish populations.

Gamete Borrowing: Cooperative strategies to mitigate impacts to natural-origin steelhead in the Methow Subbasin alongside conservation hatchery programs

Clifford Smith[1], Brandi Parsley[2], Leaf Seaburg[2], Matt Abrahamse[2], Matt Cooper[3]

[1]Mid-Columbia Fish and Wildlife Conservation Office, Winthrop Sub-Office, USFWS, 453D Twin Lakes Road Winthrop, WA 98862, Winthrop, WA. [2]Upper Columbia Steelhead Kelt Reconditioning Project, Yakama Nation Fisheries, 2 Johnson Lane Winthrop, WA 98862, Winthrop, WA. [3]Mid-Columbia Fish and Wildlife Conservation Office, 7501 Icicle Road Leavenworth, WA 98826, Leavenworth, WA

In the Methow Subbasin, Winthrop National Fish Hatchery's (WNFH) Upper Columbia River summer steelhead trout (Oncorhynchus mykiss) program has dual objectives of mitigating for loss of habitat upstream of Grand Coulee Dam and assisting recovery of this threatened population. WNFH's steelhead program is genetically integrated as part of a stepping-stone model management agreement with Douglas County PUD's Wells Hatchery. Natural- and hatchery-origin steelhead are collected for WNFH's conservation and Wells' safety-net broodstock programs each spring. Fisheries managers are concerned with potential impacts of reducing the natural spawning population when adults are utilized for hatchery conservation broodstock, especially in low return years. To address this concern, the Yakama Nation and U.S. Fish and Wildlife Service (USFWS) cooperatively have adopted different strategies to mitigate the potential for overextraction of the natural-origin population and to increase the spawning population. The Yakama Nation's Upper Columbia Steelhead Kelt Reconditioning Project rears live-spawned, natural-origin female kelts in circular tanks at WNFH for one or two years then releases them to spawn in the river. USFWS releases live-spawned males back into the subbasin so they have the chance to spawn in the river the same year. These methods have allowed the WNFH's Steelhead Conservation program to essentially function as a "gamete borrowing" program aimed at meeting WNFH's conservation summer steelhead brood goal, while potentially reducing impacts on the natural-origin spawning population. Live spawned adults that are successfully released back to the river are tracked providing insight into potential respawning movements. We continue to monitor the effects of these gamete borrowing strategies, which could be considered for implementation in other steelhead conservation hatchery programs.

Efficacy of Extended Protection Against *Salmincola californiensis* for Juvenile Hatchery Spring Chinook for a Reintroduction Program in Oregon

Stacy Strickland

Oregon Department of Fish and Wildlife Fish Health, 726 SW Lower Bend Rd., Madras, OR

A reintroduction program began in the upper Deschutes Basin in 2008 for spring Chinook salmon (*Oncorhynchus tshawytscha*) and summer steelhead (*O. mykiss*). Initial fish passage data was fairly good for outmigrating Chinook and not as successful for steelhead. As adults started returning however, the steelhead had higher smolt to adult return ratios (SARs) than the Chinook. Research into why the Chinook weren't returning focused on possible pathogens causing low juvenile survival. We began monitoring the freshwater copepod (*Salmincola californiensis*) load on juvenile spring Chinook reaching the Selective Water Withdrawal tower in Lake Billy Chinook in 2015. Initial data showed that nearly half of the mortalities examined had lesions from copepods on gills and fins and up to 30% of the live fish examined also had these lesions. It was theorized that fish with lesions would have lower chance of surviving to the ocean due to increased disease susceptibility and poor smolting capability. In 2021, a medicated treatment was initiated to reduce this copepod load post-release from the hatchery and acclimation sites. We present the first two years of treatment results.

ORAL PRESENTATION ABSTRACTS

Increasing Juvenile Survival of Upriver Bright Fall Chinook at Willard National Fish Hatchery Through Alternative Release Strategies

Justin Baker[1], David Hand[1], Travis Collier[2], and Bob Turik[3]

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[2]Willard National Fish Hatchery, USFWS, 5501B Cook-Underwood Road, Cook, Washington 98605

[3]Little White Salmon National Fish Hatchery, USFWS, 56961 SR14 Cook, Washington, 98605

Willard National Fish Hatchery (NFH) began rearing Upriver Bright (URB) fall Chinook salmon in 2013 with support from Mitchell Act funds. Monitoring of juvenile migration following release for 2015 to 2017 release years raised concerns over low juvenile survival. Beginning in 2018, an alternate release strategy of transporting half of juvenile URBs reared at Willard NFH downstream to Little White Salmon NFH for release was initiated to address this concern. From 2018-2022, approximately 4.8 million juvenile URBs reared at Willard NFH have been released at Little White Salmon NFH or Drano Lake depending on water conditions. During low water years (e.g., 2018) juveniles were released at the Drano Lake boat ramp, otherwise releases occurred at the Little White Salmon NFH. The live recapture Cormack-Jolly-Seber model in the program MARK was used to estimate apparent juvenile survival for release locations and compare with estimates from the Little White Salmon NFH URB program. Estimates of juvenile survival were lower for URBs released at Willard NFH, though estimates were similar among release locations in 2020 (brood year 2019) and credible intervals overlapped for release years 2019-2020. An evaluation of juvenile survival and migration timing, fish condition and mean size at release, along with adult returns will be discussed and the overall effectiveness of release strategies to improve survival and ensure Willard NFH's broodstock and harvest goals are met.

Improving return numbers by adopting breeding strategies observed more fit among wild fish: Initial evidence from a three-year experiment at Sandy Hatchery, Oregon.

Dr. Michael Banks[1], Dr. Heather Auld[1], Mr. David Jacobson[1], Mr. Charles Baker[2], Mr. Ryan Queen[2]

[1]HMSC, Oregon State University, Newport, OR. [2]ODFW, Sandy, OR

That offspring have greater fitness if their parents had free choice of mating partner is a key mystery of life that has long been favored among biologists. We present here initial findings from our attempt to determine if we might use this understanding to improve the fitness of hatchery salmon. Eggs from each of ~120 coho broodstock were divided into two equal portions during spawning conducted at Sandy Hatchery in 2019, 2020, and 2021. Half were bred to a random male as per common hatchery practice. The other half were bred to a specific male chosen so that genotypes of female and male best emulate combinatorial patterns observed most successful in a long-term pedigree in the wild. That pedigree evaluated fitness among wild and hatchery coho families by counting the number of returns arising from free-choice breeding in a natural context (Calapooya Creek, Umpqua River, Southern Oregon). Pedigree of jack returns (n=1,293) to Sandy Hatchery in 2021 provides our first evidence from the 2019 spawn. Offspring from eggs bred with 'wild-like-chosen' males had more returns (52%) than

those from an equal number of eggs combined with randomly chosen males (48%). Ranking families by which father had the greatest number of returns provided more striking evidence that evoking 'wild-like' mating strategies may hold promise to improve hatchery return numbers. Eight of the top dozen alpha families were fathered by 'wild-like-chosen' males with only four random chosen males ranking among these top 12 alpha male families. Further, 'wild-like-chosen' males fathered 102 more returning jacks than the number returning from randomly chosen males, yet both started with an equal number of eggs. These preliminary results raise keen interest in forthcoming findings for the full three cohorts of jacks and adults that will return to Sandy Hatchery over the next three years.

Yakama Nation Coho Facility Part 2: Facility Context and Operations

D.J. Brownlee[1], Kevin Jensen[2]

[1]Yakima/Klickitat Fisheries Project, Ellensburg, WA. [2]McMillen, LLC, Boise, ID

Melvin R. Sampson was a historical leader of the Yakama Nation who held numerous leadership roles during his 30+ year career, including Yakama Nation Tribal Chairman and Yakima/Klickitat Fisheries Project (YKFP) Program Manager. After extirpation of Coho Salmon from the Yakima River in the mid-1980's, Mel Sampson championed an "All Stocks Initiative" to restore all indigenous anadromous fish runs in the Yakima River. The Melvin R. Sampson Coho Facility is an extension of that vision. Current annual release goals include 500,000 parr and 200,000 smolts annually. Parr are reared at the facility until late summer, then released into various tributaries in the upper Yakima Basin where they over-winter and migrate to the ocean the following spring. Smolts are reared on Yakima River water inside the facility until spring of the following year, then directly released into the Yakima River during high water events. As Part 2 of a two-part talk, this presentation will provide a high-level overview of the aquaculture program, discuss some of the historical and cultural significance of the program to the Yakama Nation, and provide insights on facility operations since commissioning in late 2021.

Fall Creek Fish Hatchery: One Solution for Species Reintroduction after Barrier Removal

Jodi Burns

McMillen, Boise, Idaho

River restoration and improved connectivity for native resident and anadromous fish species in the United States continues to be a major focus of conservation efforts for some aquatic systems altered by decades of anthropogenic impacts. Barrier removal is one of many engineering options currently available to address impediments to river systems with physical migration barriers. Currently the largest barrier removal project in North America, the Klamath River Renewal Project includes the removal of four dams along the Klamath River in California. As part of the overall Project, California Department of Fish and Wildlife's (CDFW) existing Iron Gate Fish Hatchery (IGFH) production will be moved to the Fall Creek Hatchery site. Used historically to produce anadromous stocks of Pacific salmon, the current hatchery site will be modified to upgrade existing facilities and construct new facilities for Coho and Fall Run Chinook Salmon production. Working collaboratively with signatories to the Klamath Hydroelectric Settlement Agreement, McMillen led the design efforts for the Fall Creek Hatchery which will include new incubation system facilities; first and early rearing, grow-out, and juvenile rearing raceways; and the design of new waste collection systems, fish handling traps, adult holding, and spawning ponds. This presentation will provide a high-level overview of the proposed Fall Creek Fish Hatchery and the benefits it will provide for species reintroduction post barrier removal.

Kelt Reconditioning – Safety Net for Snake River Steelhead

Scott Everett[1]

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Snake River steelhead are listed as threatened under the Endangered Species Act and recent trends pose a serious concern for the Nez Perce Tribe and other Snake Basin co-managers. The 2022 Biological Viability Assessment done by NOAA Fisheries indicates Snake River steelhead populations all showing a significant decline (50%) in abundance over the past five years, 2016-2021 and the return of steelhead passing Bonneville Dam in 2021 was the lowest recorded since Bonneville Dam was constructed in 1938. In an effort to increase abundance of natural origin spawners, the Nez Perce Tribe, in conjunction with the Columbia Inter-Tribal Fish Commission, have implemented a kelt (or post spawned steelhead) reconditioning effort. The reconditioning process entails collecting natural-origin outmigrating kelts in the spring at Snake River dams or tributaries weirs, holding and feeding them until they began to remature either in October of the year they were collected or the following fall. Reconditioned or rematuring kelts are released into the mainstem Snake River as the steelhead run is coming upriver. In recent years, the release of reconditioned Snake River kelts has increased the abundance of natural-origin steelhead females available to spawn by 10% to 20%. As a result of the success of this relatively new aquaculture technique, Bonneville Power Administration is funding the construction of a facility dedicated to kelt reconditioning at Nez Perce Tribal Hatchery on the Clearwater River in 2022.

Aligning Development of Summer Steelhead from a Series of Spawning Events Using Water Temperature Manipulation

Hayden Fitte

Idaho Department of Fish and Game, Ahsahka, Idaho

Water temperature plays a fundamental role in the development of fish eggs and fry, which subsequently impacts the timing of ponding and initiation of exogenous feeding. Because summer steelhead (*Oncorhynchus mykiss*) eggs at Clearwater Fish Hatchery are received across a range of dates due to a protracted spawning period, staff sought to better align egg and fry development using water temperature manipulation. Utilizing a Tytan 48 kW inline water heater, incubation water temperatures were manipulated to steadily consolidate the daily temperature units from multiple lots of eggs received throughout March 2022. Using various mixtures of ambient (5.56-6.67°C) and heated (21.11°C) water, hatchery staff effectively aligned daily temperature units, allowing them to pond all of the resulting fry on the same date.

Volitional Release and Circulars

Eric Hammonds and Jen Krajcik

Alsea Fish Hatchery, ODFW, 29050 Fish Hatchery Rd Alsea Or, 97324

Round Butte Hatchery (RBH) rears Spring Chinook in converted ladder cells for volitional release each spring. Due to an aging system, they are considering converting the ladder cells to circular tanks. There are many benefits to the overall fitness of rearing salmon in circular tanks. However, before committing to this type of tank, it is important to know that salmon can be volitionally released out of circulars, and how the circulars may affect the number of fish that residualize in the rearing unit. As part of the program management, any residual fish are culled, so an artificial increase or decrease in residuals would affect production numbers. Literature about volitional release in general pointed to attraction flow being most important for fish movement, in that if flow is sufficient, fish will find and use the exit. Volitional release studies we found all utilized raceways as the rearing vessel, and there were no studies out of circular tanks. In this study we tested the fish's ability to volitionally release out of circulars. We found that fish will release out of a circular, through an opening as small as 2 inches, given enough flow. Future research should focus on the percentage of fish that residualize, if they are truly residualized fish, and how to maximize outmigration from circular tanks.

Predicting pathogen prevalence in salmon populations using pooled tissue samples

Julianne Harris[1], Corie Samson[2], Christine Parker-Graham[3]

[1]Columbia River Fish and Wildlife Conservation Office, USFWS, Vancouver, WA. [2]Pacific Region Fish Health Program, USFWS, Orofino, ID. [3]Pacific Region Fish Health Program, USFWS, Lacey, WA

Pooling tissue samples for virology and bacteriology is a common practice for routine fish health screening. Per American Fisheries Society (AFS) Blue Book methods, up to five fish may be represented in one pooled sample. Pooling reduces testing costs (by 80% for pools of five) but estimating pathogen prevalence from pooled samples is not intuitive. Our objectives were to estimate pathogen prevalence from pooled samples and to evaluate those estimates for accuracy and precision using simulation. We examined estimates of pathogen prevalence for a standard sampling scenario at some National Fish Hatcheries (NFH): 150 fish sampled in 30 randomly selected pools of five individuals each. We used a binomial model to estimate pathogen prevalence for this pooling scenario (for all potential numbers of positive pools), and to estimate pathogen prevalence of infectious hematopoietic necrosis virus (IHNV) in some NFH populations of Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss*). When 150 fish were sampled in 30 pools of five individuals, estimates of pathogen prevalence were very similar (± 5%) to 95% of simulated true values when seven or fewer pools were positive and adequately similar (± 10%) when 21 or fewer pools were positive. Seven positive pools had an estimated pathogen prevalence of 5.5% (95% interval: 2.0% – 9.6%) and 21 positive pools had an estimated pathogen prevalence of 21.4% (95% interval: 14.0% – 31.3%). True pathogen prevalence over 50% could not be estimated adequately using this pooling scenario. Precision of pathogen prevalence estimates increased with the number of pools sampled and with the addition of smaller-sized pools or individual samples. Estimates of IHNV ranged among NFH populations and years and were often slightly higher for samples from the ovarian fluid than the kidney/spleen for both Chinook salmon and steelhead.

The effect of reducing dietary lipid and food availability on smolt quality, age structure and adult returns in yearling fall Chinook salmon: a production scale hatchery experiment

Deborah Harstad[1], Don Larsen[1], Lance Clarke[2], Dina Spangenberg[1], Will Cameron[3], Robert Hogg[4], Brett Requa[5], Brian Beckman[1]

[1]NOAA NMFS, Seattle, WA. [2]ODFW, LaGrande, OR. [3]ODFW, Hermiston, OR. [4]CTUIR, Walla Walla, WA. [5]ODFW, Cascade Locks, OR

Age of maturation in Chinook salmon *Oncorhynchus tshawytscha* is phenotypically plastic, influenced by both genotype and environmental factors including the availability and composition of diet. Growth and energetic status of fish during hatchery rearing can impact age of maturation not only as minijacks, but can have impacts on the return of older age classes of fish as well. A production scale experiment was carried out on Umatilla fall Chinook salmon reared at Bonneville Hatchery, Oregon for brood years 2010-2013 to compare the standard rearing regime with modified lipid levels and feeding schedules in attempt to reduce minijack rates while maintaining acceptable adult returns on yearling fall Chinook salmon. Dietary treatments included two feeding frequencies (standard [fed 7 d/week] and reduced [fed 4 d/week]) and two dietary lipid levels (standard [18%] and reduced [12%]) in a two-by-two factorial design; treatments were applied for approximately 9 months, beginning in March (a month after fry emergence) and lasting until December of their first year, after which all fish were reared on the standard feed regime (7d-18%) until the time of release the following spring as yearlings. Growth and energetic indices were monitored throughout hatchery rearing and confirmed findings from previous laboratory-based studies that physiological status 10 to 12 months prior to spawn timing is important for the 'decision' to mature. To evaluate post-release performance, fish from each rearing group were coded-wire-tagged and a subset also received PIT tags. Overall, diet manipulation reduced the numbers of minijacks returning in the first year and increased the proportion of fish returning at older age classes.

Construction of the Native Salmonid Conservation Facility

Mark Hassebrock[1], Lloyd Dixon[2]

[1]HDR, Gig Harbor, WA. [2]Seattle City Light, Seattle, WA

The Federal Energy Regulatory Commission (FERC) issued a new 42-year license for the Seattle City Light (SCL) Boundary Dam on March 12, 2013. In October of 2013, SCL contracted with HDR for design of a conservation hatchery to fulfill obligations cited in the settlement agreement for the license. On August 27, 2021, SCL issued Notice to Proceed to Lydig, authorizing field activities to commence on September 13,2021 and construction of the facility finally began. This presentation briefly describes the program associated with restoration of native Westslope Cutthroat populations in the tributaries draining into the Pend Oreille River above Boundary Dam, and the facility that is currently under construction to support that program. The bulk of the presentation will focus on photographs of construction progress with commentary regarding challenges encountered and associated solutions.

Lactococcus in California Hatcheries

Dr Karly Hatcher[1], Dr Mark Adkison[1], Dr Esteban Soto[2], Tresa Veek[1], Dr Christine Richey[1], Kavery Mukkatira[1], Dr Kevin Kwak[1], Dr Patricia Miller[1], Taylor Abraham[2], Zeinab Yazdi[2], Khalid Shahin[2], Taylor Heckman[2], Eric Littman[2], Tryssa de Ruyter[2]

[1]CDFW Fish Health Lab, Rancho Cordova, CA. [2]UC Davis School of Veterinary Medicine Aquatic Animal Health Lab, Davis, CA

Several trout hatcheries in California experienced a bacterial outbreak of *Lactococcus* in 2020 leading to the loss of over 3 million trout. This led to significant research efforts in attempt to determine the cause, the source of infection, potential treatments, the method of spread, effective hatchery decontamination protocols, as well as vaccine development and vaccination of the fish. The goal of this presentation is to discuss the efforts of the California Department of Fish and Wildlife Fish Health Laboratory and the Aquatic Animal Health Laboratory at the UC Davis School of Veterinary Medicine, to control the outbreaks and advise future hatchery and fisheries resource management, in the presence of *Lactococcus*.

The Surrogate Wild Fishes Rearing Method Mitigates the Stress Response in Juvenile Chinook Salmon and Steelhead Trout

Mrs. Crystal Herron[1], Ms. Olivia Hakanson[1], Ms. Michelle Scanlan[1], Mrs. Jennifer Krajcik[2], Mr. Ryan Couture[3], Dr. Karen Cogliati[4], Dr. James Peterson[1,5], Dr. Carl Schreck[1]

[1]FWCS, Oregon State University, Corvallis, OR. [2]Oregon Hatchery Research Center, ODFW, Alsea, OR..
[3]Oregon Department of Fisheries and Wildlife, Corvallis, OR. [4]Fisheries and Oceans, Canada, Ottawa, ON.
[5]Oregon Cooperative Fisheries Research Unit, USGS, Corvallis, OR

Hatchery reared salmonids differ from their wild counterparts morphologically, genetically, behaviorally, and physiologically. The objective of the Wild Fish Surrogate Project is to develop hatchery rearing methods that result in fish more akin to wild fish as opposed to conventionally reared hatchery fish. Rearing density, in-tank structure, feed, and feeding method are manipulated to provide fish with a more wild-like rearing environment. Fish reared by the Surrogate Project for the US Army Corps of Engineers and their contractors are used to study juvenile downstream passage efficiency through high head dams. We provide evidence that Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead trout (*O. mykiss*) reared using the surrogate methods are more resilient when presented with stressors. Fish were subjected to a three hour simulated transport stressor and monitored over the next 23 or 24 hours. Plasma was collected for cortisol analysis. In Chinook salmon, head kidneys were incubated in order to determine baseline cortisol secretion when reared at high and low density, with and without in-tank structure. In-tank structure mitigates the stress response in both Chinook salmon and steelhead trout. The lowered stress response is further reduced when combined with low tank density in Chinook salmon, but has not been tested in steelhead trout.

Onalaska High School Steelhead Production

Kevin Hoffman

Onalaska School District, Onalaska, Wa

The Onalaska High School has a very rare and unique Aquaculture program. The High School students rear and release 35,000 Steelhead, 100,000 Coho Salmon, and 9,000 Rainbow Trout into the Newaukum River System, including 600 five-pound Jumbo Rainbow Trout for fishermen which are released in Carlisle Lake. We work in partnership with the Washington State Department of Fish and Wildlife, The Chehalis Basin Fisheries Task Force, The Onalaska Alliance, and the Chehalis Tribe. The program has been in existence for 32 years and the goals are to provide an unmatched educational experience in the Aquaculture field and to provide the entire Newaukum River Basin and Carlisle Lake with sport fishing opportunities.

Onalaska High School Rainbow Trout and Coho Salmon Production

Kevin Hoffman

Onalaska School District, Onalaska, Wa

The Onalaska High School has a very rare and unique Aquaculture program. The High School students rear and release 35,000 Steelhead, 100,000 Coho Salmon, and 9,000 Rainbow Trout into the Newaukum River System, including 600 five-pound Jumbo Rainbow Trout for fishermen which are released in Carlisle Lake. We work in partnership with the Washington State Department of Fish and Wildlife, The Chehalis Basin Fisheries Task Force, The Onalaska Alliance, and the Chehalis Tribe. The program has been in existence for 32 years and the goals are to provide an unmatched educational experience in the Aquaculture field and to provide the entire Newaukum River Basin and Carlisle Lake with sport fishing opportunities.

Onalaska High School Partial Recirculating Aquaculture System (PRAS)

Kevin Hoffman

Onalaska School District, Onalaska, Wa

Technology in Aquaculture is the future. Be ready for High School students to give you an overview of how different hatchery designs including flow through, partial reuse, and serial reuse work. Receive an in-depth look at how partial reuse systems are constructed and how well they work. Can you imagine growing 1,000lbs of Rainbow Trout on 13 gallons per minute of fresh water with the addition of a 100 GPM pump, and fan? Join our session to learn how.

Partial-year continuous light treatment reduces precocious maturation in age 1+ hatchery reared male Spring Chinook Salmon (*Oncorhynchus tshawytscha*)

Nick Hoffman[1], Lea Medeiros[2], Neil Graham[3], Hayley Nuetzel[3], Andrew Pierce[3,2], James Nagler[2]

[1]University of Idaho, Moscow, Idaho. [2]University of Idaho, Moscow, ID. [3]CRITFC, Portland, OR

Hatchery programs designed to conserve and increase the abundance of natural populations of spring Chinook Salmon Oncorhynchus tshawytscha have reported high proportions of males precociously maturing at age 2, called minijacks. High proportions of minijacks detract from hatchery supplementation, conservation, and production goals. This study tested the effects of rearing juvenile Chinook Salmon under continuous light (LL) on minijack maturation in two trials. Controls were maintained on a simulated natural photoperiod for both trials. For trial 1, LL treatment began on the summer solstice 2019 or the autumn equinox 2019 and ended in late March 2020 (LL-Jun-Apr and LL-Sep-Apr, respectively). A significant reduction in the percent of minijacks (%MJ) was observed versus controls (28.8 %MJ) in both LL-Jun-Apr (5.4 %MJ) and LL-Sep-Apr (9.3 %MJ). Trial 2 was designed to evaluate whether stopping LL treatment sooner was still effective at reducing maturation proportions relative to controls. LL treatments began on the summer solstice 2020 and continued until the winter solstice (LL-Jun-Dec) or the final sampling in April 2021 (LL-June-Apr). LL-Jun-Dec tanks were returned to a simulated natural photoperiod after the winter solstice. Both photoperiod treatments showed a significant reduction in %MJ from the controls (66 %MJ): LL-Jun-Dec (11.7 %MJ), LL-Jun-Apr (10.3 %MJ). In both trials, minijacks had higher body weights, were longer, and had increased condition factor when compared to females and immature males in all treatment groups at the final sampling. In both trials, there was little or no effect of LL treatment on fork length or body weight in immature males and females versus controls, but an increase in condition factor versus controls was observed. This study shows that continuous light treatment reduces minijack maturation in juvenile male Spring Chinook Salmon, and could provide an effective method for Spring Chinook Salmon hatcheries interested in reducing minijack production.

The National Pollutant Discharge Elimination System, Regional Water Quality Control Boards and the California Department of Fish and Wildlife's Fish Hatcheries - Challenges, Confusion, Years of Data (are we actually polluters?)

Terry Jackson, Senior Environmental Scientist (Specialist)/Fisheries Biologist

California Department of Fish and Wildlife Statewide Hatchery National Pollutant Discharge Elimination System (NPDES) & Homeland Security Coordinator. Fisheries Branch, 1010 Riverside Parkway, Suite 100, West Sacramento, CA 95605, terry.jackson@wildlife.ca.gov

Coordinating the National Pollution Discharge Elimination System (NPDES) permitting, and water quality requirements and compliance for 26 California Department of Fish and Wildlife (DFW)-operated fish hatcheries statewide with 5 Regional Water Quality Control Boards (RWQCB) and numerous Basin Plans is challenging at best. Operations range from a matrix of native/rescued and introduced trout, terminal mitigation anadromous flow-through, enhancement, research, spring or well groundwater, high elevation, valley, coastal, desert and forested. Each DFW Concentrated Aquatic Animal Production (CAAP) facility operates under a General Order or Individual NPDES permit, sometimes a Time Schedule Order (TSO), and one hatchery has a California Water Code Section 13267 Investigative Order.

When hatchery managers just want to raise fish, how does a NPDES Coordinator navigate changing rules and inconsistencies between and within RWQCBs, evaluate impacts of hatchery discharges on water quality, fish and the aquatic environment/beneficial uses of the receiving water, and moderate operational and financial burdens placed on hatcheries to help them raise fish without committing effluent violations? How does a NPDES Coordinator evaluate the data, compare it to the science, deal with the Anti-Backsliding Requirements, provide a solid tool-box of drugs and chemicals for disease treatment, and traverse the National Toxics Rule (NTR), California Toxics Rule (CTR), and Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (State Implementation Policy or SIP)? Do we have a reasonable opportunity to contest unreasonable requirements and penalties? With over a decade of NPDES Coordination for DFW, I aspire to provide an intriguing presentation of hope.

Yakama Nation Coho Facility Part 1: Design

Kevin Jensen, Noah Hornsby

McMillen, LLC, Boise, Idaho

The Melvin R. Sampson (MRS) Coho Facility near Ellensburg, Washington is part of the Northwest Power and Conservation Council's (NPCC's) Fish & Wildlife Program (Program) and is a component of the Columbia River Fish Accords between Action Agencies and the Lower River Tribes. Under the Program, the Yakama Nation (YN) and Yakima/Klickitat Fisheries Project (YKFP) are managing Coho reintroduction efforts in the Yakima River Basin by using artificial propagation to re-establish, supplement, and/or increase natural production and harvest opportunities of anadromous salmonids. The MRS Coho Facility is an extension of these efforts. The MRS Coho Facility includes Coho spawning, incubation, and rearing facilities, as well as operations that integrate with the overall YKFP. Due to a number of site constraints and production goals, as well as overall tribal objectives related to project sustainability, the MRS Coho Facility includes a partial recirculating aquaculture system (PRAS), multiple points of energy recovery, renewable energy generation, and a fully integrated chiller system to meet the needs of today while addressing the climate uncertainties of tomorrow. As Part 1 of a two-part talk, this presentation will provide a high-level overview of this design-build project, with a focus on some of the engineering and construction challenges encountered, and insights gained throughout development of the project.

The USFWS AADAP Program – Supporting Fish Drug Approvals

Bonnie Johnson, Marilyn "Guppy" Blair, Niccole Wandelear, Julie Schroeter, Shane Ramee, Paige Maskill

USFWS - AADAP Office, Bozeman, MT

The U.S. Fish and Wildlife Service's (USFWS) Aquatic Animal Drug Approval Partnership Program (AADAP) is the only program in the United States that is exclusively dedicated to acquiring U.S. Food and Drug Administration (FDA) approval of new medications for use in fish culture and fisheries management. To gain FDA approval of a drug, sufficient data must be generated and accepted by the FDA's Center for Veterinary Medicine (CVM) to demonstrate the drug is safe for humans, target animals, and the environment, and can be manufactured consistently and is effective for its proposed use(s). To fulfill this mission, the AADAP team collaborates with federal, state, tribal, academic, and private sector partners to implement the National Investigational New Animal Drug (INAD) Program, conduct research to support New Animal Drug Approvals (NADAs), and disseminate aquatic animal drug use information via a professional outreach program. This presentation will give an overview of the AADAP Program; drug approval process; and updates on work that the AADAP Research Team has conducted. This will also include informing the audience of the current national needs for studies and how they can become involved.

Can Hatchery Rearing Practices Influence the Onset of Fin Erosion in Steelhead Trout?

Jennifer Krajcik[1], David Lawson[1], Olivia Hakanson[2], Crystal Herron[2], Michelle Scanlan[2], Carl Schreck[2]

[1]Oregon Hatchery Research Center, Corvallis, OR. [2]Department of Fisheries Wildlife and Conservation Sciences, Oregon State University, Corvallis, OR

Steelhead trout (*Oncorhynchus mykiss*) are commonly raised in hatcheries in the Northwest. They often exhibit interspecific aggression, nipping their tank mates during rearing. The Oregon Hatchery Research Center (OHRC) raises steelhead for the Wild Fish Surrogate Project (WFSP) to provide to the Army Corps of Engineers for testing juvenile fish passage methods. The goal of the project is to produce fish that are wild-like, both in behavior and appearance. Wild fish tend to have fully formed fins, while hatchery fish sometimes have damaged fins. To better fulfill the goals of the WFSP, we asked when this damage first occurs (2021, 2022), whether the damage was caused by bacteria or skeletal deformities (2021), if damaged fins could regrow (2021), and if we could shift the timing of damage through manipulation of density (2022). We manipulated incubation temperature to create two groups that were spawned on the same day but ponded 10 days apart both years. In 2021 we raised fish at the OHRC and the Fish Performance and Genetics Laboratory (FPGL) and found that damage occurred by 887 and 954 accumulated temperature units (ATUs) in the early and late groups, respectively. We found that the damage was not caused by bacteria or skeletal deformities. When fish with damaged fins were isolated, they were able to regrow their fins. In 2022 we repeated the experiment, again manipulating incubation temperatures to separate two groups by 10 days. We also reared the fish in two densities, with the high-density treatment being 2 times higher than the low-density treatment. We found that minor damage occurred at all densities at the same ATUs and size. Heavy damage occurred in the high-density treatments before the low-density treatments. Future work will continue to manipulate hatchery rearing practices to delay the onset of fin erosion in steelhead trout.

Treating for Thiamine Deficiency Complex in Chinook Salmon at California Hatcheries

Dr. Kevin Kwak[1], Dr. Taylor Lipscomb[2], Dr. Jacques Rinchard[3], Dr. Mark Adkison[1], Jason Kindopp[4], Dr. Rachel Johnson[5], Dr. Dale Honeyfield[6], Dr. Donald Tillett[7]

[1]California Department of Fish and Wildlife, Rancho Cordova, CA. [2]USFWS, Shasta Lake, CA. [3]State University of New York, Brockport, Brockport, NY. [4]California Department of Water Resources, Oroville, CA. [5]NOAA: Southwest Fisheries Science Center, Santa Cruz, CA. [6]USGS (retired), Kearneysville, WV. [7]USGS (retired), Colombia, MO

Thiamine deficiency complex (TDC) has been recognized as a nutritional deficiency disease of Vitamin B1 (Thiamine). Several Chinook Salmon (*Oncorhynchus tshawytscha*) hatcheries in the Central Valley of California have reported cases of TDC since 2019. Current thiamine supplementation methods require eggs incubated in a thiamine bath during water-hardening or placing fry in a thiamine immersion bath. These treatments either cause gaps in biosecurity or require abundant amounts of resources to perform. The need for an early, effective, and economical treatments for thiamine deficiency in returning Chinook Salmon led to the development of novel thiamine treatments. We evaluated the efficacy of a one-time thiamine mononitrate bath administered during fertilization at concentrations of 1,500 and 4,500 mg/L for an average of 45 seconds for single pairings. Egg thiamine concentrations were evaluated and compared to a control group. Eggs receiving the 1,500 mg/L and 4,500 bath treatments exhibited a higher average thiamine concentration of 13.0 nmol/g and 24.1 nmol/g respectively when compared to the average control group (9.3 nmol/g). For returning Spring-Run Chinook Salmon broodstock, adults (n=30) were injected with a standard 1 ml (500mg) dose of Thiamine HCl or for the control group a standard 1 ml dose of saline (n=38). At spawning, the average egg thiamine levels were measured from the injected and non-injected females as 24.0 nmol/g and 9.9 nmol/g respectively. Eggs from thiamine-injected females had a higher average thiamine concentration than non-injected females.

These protocols can be implemented quickly and easily during the tagging or fertilization processes. Broodstock injections can also bolster thiamine levels in returning adult CS. Both treatments have the potential to prevent TDC in developing CS embryos and yolk-sac fry while providing significant logistic and/or economic improvements over current thiamine deficiency treatments.

Rearing strategies for steelhead in a partial reuse aquaculture system

Kelsey Lear[1]

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Hagerman National Fish Hatchery is a part of the Lower Snake River Compensation Plan and releases approximately 1.56 million steelhead (*Oncorhynchus mykiss*) annually. Eyed eggs are received from the Sawtooth Fish Hatchery (located in Stanley, Idaho) and are reared to smolt size. These smolts are then transported back to Stanley, Idaho for release into the Salmon River. In 2014, Hagerman National Fish Hatchery constructed a Partial Reuse Aquaculture System (PRAS) in response to the declining East Snake River Plain Aquifer. A five year evaluation was conducted, in which it was determined that steelhead can be raised in circular tanks in a PRAS. However, outmigration of these PRAS reared steelhead in comparison to steelhead reared in outdoor linear raceways has been poor. In 2021, staff looked at body-lengths per second (BL/s) during rearing to see if this could have an effect on steelhead outmigration.

Staff used three different groups: 1) exercised at 2 BL/s for 6 months, 2) exercised at 2 BL/s for 4 months, and 3) exercised at 2 BL/s for 2 months. Growth was monitored biweekly to achieve target velocities. This study will be repeated for brood year 2022.

Performance of diploid and triploid Fall Chinook Salmon in Idaho lakes and reservoirs

Will Lubenau, Phil Branigan, Kevin Meyer

Idaho Department of Fish and Game, Nampa, Idaho

Fall Chinook Salmon are stocked into select Idaho lakes and reservoirs as both a predatory means to control population size of other species, and to provide an additional and unique trophy angling opportunity for Idaho anglers. Sterility in Chinook Salmon may provide increased angling success in fisheries, eliminate spawning-related reductions in population size, and eliminate natural reproduction concerns. However, field evaluations to determine growth, survival, and longevity of triploid Fall Chinook Salmon relative to diploid fish are lacking. This research evaluated sterile Fall Chinook Salmon by stocking uniquely marked triploid and diploid fish into select lakes and reservoirs throughout Idaho. Longevity and survival of stocked diploid and triploid fish were compared over time using angler-collected tissue samples to see if there were any significant differences between the ploidy levels. The goal of this work was to quantify whether triploid Fall Chinook Salmon survive well enough to sustain sport fishing while limiting potential self-reproducing populations.

AQUATIC ANIMAL DRUG APPROVAL PARTNERSHIP (AADAP) PROGRAM: INTRODUCTION TO INADS

Paige Maskill, Bonnie Johnson, Dr. Marilyn "Guppy" Blair

Aquatic Animal Drug Approval Partnership Program, Bozeman, Montana

Within aquaculture and fisheries management, it is not uncommon for reared fish to need aquatic drugs for treatment of disease, sedation, spawning, or marking. The number of available approved aquaculture medications is limited, thus leaving the medicine cabinet lacking for many treatment options. One way to legally use unapproved medications is to work with the U.S. Fish & Wildlife Service's (USFWS) Aquatic Animal Drug Approval Partnership (AADAP) Program to participate under the National INAD Program (NIP). The NIP has over 15 different Investigational New Animal Drug (INAD)s that are available for fishery managers to use if they follow the established study protocols and report the study data. The NIP was created over 20 years ago, and each year more than 200 facilities/offices located throughout the United States have participated and benefited from the program. The field data collected from INAD studies has created a wealth of useful information. This data has contributed to demonstrating efficacy and safety of individual INADs in the field to the Food and Drug Administration (FDA), as well as to assist pharmaceutical drug sponsors in assembling complete data packages for FDA submission. In addition, the NIP has functioned to help maintain the health and fitness of fish stocks across the country, and assisted fisheries managers in meeting restoration, recovery, and recreational program objectives. This presentation will provide an in-depth explanation of the INAD Program including what an INAD is, how one can participate in the INAD Program, and how the data is used. For more information on the NIP and the AADAP program, please visit the AADAP website (https://www.fws.gov/fws.gov/program/aquatic-animal-health/aquatic-animal-drug-approval-partnership) and the NIP website (https://fws.gov/service/investigational-new-animal-drugs-inads).

Inside Out: Using External Morphological Features to Diagnose Internal Spinal Deformities

Ian MacDonald, Jesse Rivera

Columbia River FWCO, U.S. Fish and Wildlife Service, Vancouver, Washington

Fish with skeletal deformities are a normal part of hatchery chinook production at hatcheries throughout the Pacific Northwest. Although many deformities are easy to detect visually (scoliosis, conjoined twins, etc.), others may be more difficult to detect due to variance in body shape, the degree of deformity, and the prevalence of deformed fish within the hatchery population. This study focused on deformities of the spinal column in Chinook salmon (*Oncorhynchus tshawytscha*). We collected samples of normal and deformed fish from 5 strains of Chinook (spring chinook, tule fall chinook, and upriver bright chinook) from 4 federal hatcheries (Little White Salmon, Carson, Spring Creek, Willard). We created morphological “standards” using morphometric data and diaphonized spinal columns from morphologically normal and deformed fish from each hatchery. We provide some simple morphological metrics that can be used to easily diagnose deformities from external morphological features to aid in the identification of these less obvious deformities. Additionally, we provide insights into the sub-lethality of some of these deformities that may allow deformed juveniles to return as adults.

A Review of Methods to Reduce Warming Water in Hatcheries

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As hatcheries and regulatory agencies work to reduce the effects of climate change on natural salmon populations, water temperature has become an important issue. Hatcheries inherently tend to warm the water as it moves through them because of how slowly the water moves through the tanks and ponds, and how much water is held in settling and abatement ponds. We tested five different technologies to cool the water in 6’ fiberglass circular tanks: shade cloth, misters, sprinklers, modulated floating cover, and an insulated tarp. Here we discuss the various merits of each method, their limitations, and their possible applications.

Strategies to Improve Fish Vaccination

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AquaTactics Bimeda, Kirkland, WA

Vaccination is an often underutilized tool as part of a preventive disease management plan in fish culture. Some of the barriers to vaccine usage are an unfamiliarity with the process of vaccination, cost, effort, difficulty in assessing efficacy, assumed low efficacy due to fish stress and mortality, and non-adaptive strategies for vaccination for each fish culture premises. There are several methods to improve vaccine efficacy and ease of usage. These methods include familiarizing producers with different vaccine strategies, reducing stress in fish, communicating as a fish health team, reassessing the vaccination strategy, and using vaccination as one tool in a comprehensive fish health plan. In particular, proper fish health assessment with some potential husbandry changes may improve vaccine efficacy and reduce the risk of adverse events. Producers and fish health personnel will learn about ideal vaccine candidates, the goals of vaccines, the difficulty of choosing a pathogen strain, and an introductory understanding of what goes into vaccine production and utilization. Producers may be concerned with the cost of vaccination and potential low efficacy, which may deter them from seeking and using this preventive strategy, but it is always a "value proposition". The cost of the vaccine and application must prove cost-effective and the ideal target ranges from 1:$3 to 1:$10 payback. Fish health managers and veterinarians can help producers achieve greater vaccination success with clear communication, involvement in the vaccine process, and improvements in vaccination set-up to allow for efficient, safe vaccination of fish without exorbitant costs. Producers and culturists should feel confident in vaccinations as a means to prevent disease, decrease pathogen load, and reduce the need and frequency of expensive therapeutic treatments. Strategies for disease prevention, fish stress reduction, vaccination, and overall fish health improvement can be adapted to many different species and fish culture practices.

Retention of passive integrated transponder tags in hatchery YY male brook trout: effect of tag size, implantation site, and double tagging

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Tag retention is a fundamental consideration in mark-recapture studies. We conducted a laboratory study to evaluate retention of 8-mm full-duplex and 12-mm half-duplex passive integrated transponder (PIT) tags implanted in the abdomen, cheek musculature, and dorsal sinus of age-0+ YY male brook trout (*Salvelinus fontinalis*). Treatments included both single- and double-tagged fish. We monitored survival, growth, and tag retention for 181–187 days for 640 tagged fish and 80 untagged controls (range 83–195 mm FL). Survival averaged 98.3% and was unrelated to tagging treatments. A transient effect of tagging on growth in mass was noted for some tagged fish during the first recapture interval (13–17 d). Tag retention was 100% for the dorsal implantation site, 83% with 8-mm tags for the cheek, 97.5% with 8-mm tags for the abdomen, and 99.6% with 12-mm tags for the abdomen. Retention of 8-mm tags at the cheek site was higher for larger fish. Across treatments, 78% of the tag loss occurred within 30 d of tagging, and no tags were lost after 90 d. Tag loss was independent of whether fish were single or double tagged. Double tagging with one full- and one half-duplex tag may be useful for field applications. Double tagging may also be useful in hatchery applications where tag shedding is a concern and individual fish identification is integral to a program's success (e.g., genetic management of broodstock).

Thiamine supplementation improves survival and body condition of hatchery-reared steelhead (*Onchorhynchus mykiss*) in Oregon

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Early rearing of steelhead (*Onchorhynchus mykiss*) in Oregon hatcheries is often problematic; fry can become emaciated and die during the period between hatch and first feed. Thiamine (vitamin B1) deficiency has caused early mortality in salmonids; however thiamine status of Oregon's anadromous steelhead populations is currently unknown. Of 26 egg samples from three Oregon hatcheries in 2019, 20 (77%) had thiamine levels < 10 nmol/g, and 13 of those samples (50%) had levels <6.50 nmol/g, suggesting thiamine deficiency of adult female steelhead. To investigate if thiamine deficiency was causally related to fry survival, females were injected with buffered thiamine HCl 50 mg/kg prior to spawning; additionally, a subset of eggs were supplemented via bath treatment with thiamine mononitrate (1000 ppm) spawning. Cumulative fry mortality at 6-weeks post hatch from thiamine-injected females was 2.90% compared to 13.89% mortality of fry without thiamine supplementation. Fry treated only with the thiamine via bath as eggs had a mortality rate of 6.91%. There were no additional improvements in mortality in fry from injected females that also received a thiamine bath. Furthermore, condition factors were higher in thiamine-supplemented fry than in those that received no thiamine. These data identify thiamine deficiency in Oregon steelhead and suggest supplementation with thiamine can mitigate early rearing mortality of fry.

Using real-time data monitoring and collection to access fish health and conduct site surveys, an introduction to the Beacon®

Chandler Smith

Aquasend, Vista, California

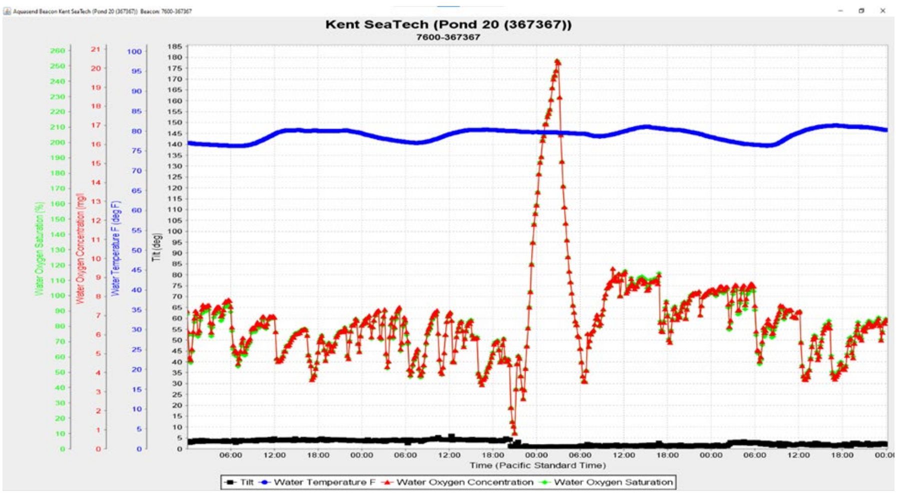
Aquafarm and hatchery managers continually make decisions regarding fish health, how to increase yields and lower overall production costs. Water quality management is an essential tool to aquaculture operations and is affected by variables that can drastically affect fish health and production procedures. Aquasend®, an enterprise of Precision Measurement Engineering, recently conducted product pilot programs at three aquaculture farms with varying goals to help farmers monitor their water quality and collect data in real-time.

Two farms were in California with a third farm on the island of Oahu, Hawaii. The goals of the deployments varied from measuring dissolved oxygen and temperature to establishing optimal feeding windows, to collecting data to determine if water quality was reaching levels to sustain the reintroduction of aqua farming.

One deployment successfully alerted farmers of a pond's dissolved oxygen crash resulting from a failed aerator. Dissolved oxygen levels hit a life-threatening number of .08mg/L followed by an excessive amount of liquid oxygen pumped into the water causing a sharp increase to 20mg/L. Farmers quickly responded to both drastic changes alerted by the Aquasend Beacon® bringing the water to safe levels preventing fish kills and saving money.

Monitoring the oxygen and temperature levels of tanks, raceways and ponds in real-time can provide essential data to enhance fish health, increase yields and alert managers before losing product, as well as decrease labor costs. Other benefits include determining optimum biomass capacity, decreasing energy costs and conducting site evaluations. I will discuss site pilot deployment goals, testing parameters and data collection results. I will also discuss how the Beacon® connects to an online portal that can be accessed from any device and will send alerts instantly if the temperature or dissolved oxygen levels drop. Finally, I will review data points throughout the pilot programs via the online interface.

TABLES



Big Fish, Small Fish, Less Fish, More Fish; Tradeoffs Between Size and Abundance In Rearing Deschutes Spring Chinook Salmon

Dina Spangenberg[1], Dr. Don Larsen[1], Ryan Gerstenberger[2], Shaun Montgomery[3], Deb Harstad[1], Dr. Brian Beckman[1]

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From previous work we determined that the Deschutes stock of spring Chinook salmon reared at Round Butte/Pelton Ladder were relatively large throughout the rearing process, had relatively high rates of precocial male maturation (minijacks), and skewed adult returns towards fish returning as 3-year olds (jacks). Along with hatchery managers, we designed an experiment to assess if rearing fish at half the size but at twice the abundance would affect smolt quality, increase SARs, and diversify age structure of returning adults. Using this Deschutes stock of fish, two treatment groups were produced, bigs at approximately 8 fish per pound (fpp) and 80 thousand fish per raceway (low abundance) and smalls at approximately 15 fpp and 150 thousand fish per raceway (high abundance). In addition, we monitored a third group, a Hood River stock of fish, that was reared at 15 fpp (small) and 75 thousand fish per raceway (low abundance). Juvenile fish from 6 brood years (2015 to 2020) were sampled four times from Oct to April, prior to release, and monitored for size, growth rate, whole body lipid, Na+/K+ ATPase, and early male maturation. Data from this study suggests that rearing fish at a smaller size and increased abundance does not appear to adversely affect smolt quality. We are currently awaiting adult returns from all brood years to assess SARs and age class.

Niagara Springs White Sturgeon Hatchery: A Repatriation Approach to Snake River White Sturgeon Culture

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In 2021, construction was completed on the Niagara Springs White Sturgeon Hatchery in Wendell, Idaho. The facility is cooperatively operated by the Idaho Department of Fish and Game and Idaho Power Company. The hatchery is designed to annually culture 2,500 juvenile White Sturgeon (*Acipenser transmontanus*) for the purpose of achieving a conservation goal to increase White Sturgeon abundance in the Snake River, Idaho between Shoshone Falls and Brownlee Dam. Fertilized eggs are sourced from spawning adults in the Snake River and then transferred to the hatchery where a water heating system allows fish culturists to mimic natural incubation and rearing temperatures within the hatchery setting. Fish are reared to a target release size of approximately 200 grams each. They are then stocked accordingly in designated river segments to meet conservation objectives.

Piper Redux: Status update regarding revision of Fish Hatchery Management

Dr. Jesse Trushenski

Riverence Holdings LLC, Bozeman, MT

The 1st edition of Fish Hatchery Management—also known as the 'Piper Manual', 'Black Book', or simply the fish culturist's bible—is an invaluable resource that provides practical, 'how-to' guidance related to fish culture and hatchery operation. Fish Hatchery Management captured what was known about the art and science of fish culture and—using look-up tables, real-world examples, and an approachable style—distilled it into actionable information for the practicing fish culturist. A 2nd edition was published in 2002, but lost some of the practicality that made the 1st edition so valued and widely used among fish culturists. Piper Redux is the working title for a 3rd edition that will modernize Fish Hatchery Management for new generations of fish culturists. "Redux" means to revive, bring back, and present in a new way. This is precisely what Piper Redux intends to do—to recapture the practical tone and everyday insight of the 1st edition of Fish Hatchery Management, infuse it with contemporary knowledge, and make this fundamental information readily accessible to all fish culturists. This presentation will provide a status update regarding the revision process, summarize the results of a recent end-user survey, and illustrate how the 3rd edition is being tailored to meet the needs of contemporary fish culture and working fish culturists.

Effects of rearing system on growth responses and saltwater tolerance of Spring Chinook Salmon (*Oncorhynchus tshawytscha*)

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Pacific salmon (Oncorhynchus spp.) produced in conservation hatcheries are commonly reared in tanks and raceways supplied with flow-through water. Due to various factors, particularly limited water supplies, recirculating systems are being evaluated for rearing of a variety of aquatic species, including Pacific salmon. As controlled studies evaluating different rearing systems for most aquaculture species are limited, we conducted a 20-week growth trial followed by a one-week saltwater challenge to assess growth, survival and saltwater preparedness of juvenile spring Chinook Salmon (O. tshawytscha) reared in single-pass rectangular tanks (rectangular tanks), single-pass circular tanks (circular tanks), recirculating aquaculture systems (RAS) or partial recirculating aquaculture systems (PRAS). At the conclusion of the growth trial, fish reared in rectangular tanks exhibited significantly lower weight gain and feed efficiency (FE) compared with fish reared in the other systems. Additionally, survival of fish reared in rectangular tanks was significantly reduced compared with that of fish reared in circular tanks or PRAS. At the conclusion of the saltwater challenge, survival was significantly reduced in fish that were reared in rectangular tanks (70%) compared with fish that were reared in the other systems (92-96%). Also following saltwater challenge, plasma calcium and potassium levels were significantly elevated in fish that were reared in rectangular tanks compared with those that were reared in RAS, suggesting impaired osmoregulation in the former. Water physicochemistry varied among the rearing systems throughout the study. Dissolved oxygen levels declined throughout the study in all rearing systems and were significantly lower in RAS than in the single-pass systems. By week 16, ammonia levels were significantly reduced while nitrite and nitrate levels were significantly elevated in the RAS compared with single-pass systems. Results of this study suggest RAS and PRAS may be appropriate for rearing spring Chinook Salmon for conservation purposes.

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