

Klamath River Basin

NOAA

2011 Report to Congress



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Front cover image of salmon in Blue Creek courtesy of Thomas Dunklin.

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Table of Contents

Executive Summary	1
Introduction	3
Purpose of the Report	3
Status of Species	3
Chinook Salmon	3
Coho Salmon	5
Steelhead	5
Restoration and Recovery	6
Lower Klamath Tributaries Riparian Restoration Projects and Yurok Tribal Native Plant Nursery	6
Shasta River/Big Springs Creek Restoration Project for Coho Salmon Recovery	8
Shasta River Fish Passage Project—Grenada Irrigation District Dam Removal and Fish Screen Installation	9
Seiad Creek Off-Channel Habitat and Floodplain Restoration Project	9
Funding Updates	11
Fisheries Management	11
Total Maximum Daily Loads (TMDLs)	12
Historic Klamath Hydroelectric Settlement Agreement (KHSa) and Klamath Basin Restoration Agreement (KBRA)	13
Compilation of Information Regarding Potential Effects of the Proposed Klamath Basin Restoration Agreement (Draft 11) on Fish and Fish Habitat Conditions in the Klamath Basin, with Emphasis on Fall Chinook Salmon	13
Research and Monitoring	14
NMFS Southwest Fisheries Science Center Research and Monitoring Activities	14
Economic Analysis Support for the Klamath Secretarial Determination	14
Production Modeling Support for the Klamath Secretarial Determination	14
Water and Sediment Quality Analysis Support for the Klamath Secretarial Determination	14
Impacts of Fish Disease on Klamath River Fall-Run Chinook Salmon Population Dynamics	14
Klamath River Fall-Run Chinook Salmon Stock and Fishery Assessment	15
Genetic Population Structure and Stock Identification-Based Estimation of Klamath River Basin Salmonid Contribution in Ocean Fisheries	15
Klamath River Stream Temperature Modeling and Use of Thermal Refugia by Salmonids	15
Application of Intergenerational Genetic Tagging for Chinook Salmon at the Trinity River Hatchery	16
Genetic Broodstock Management of Coho Salmon at Iron Gate Hatchery	16
Other Research and Monitoring Activities	16
U.S. Fish and Wildlife Service Fisheries Program Activities	16
Shasta River Juvenile Coho Salmon Habitat and Migration Study	17
Compilation of Information Relating to Myxozoan Disease Effects to Inform the Klamath Basin Restoration Agreement	17
Juvenile Coho Salmon Behavioral Characteristics in Summer Thermal Refugia	18
Klamath River Basin Juvenile Salmonid Production Monitoring	18
Summary	18
References	18

Executive Summary

The Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 required NOAA's National Marine Fisheries Service (NMFS) to develop a recovery plan for Klamath River coho salmon in 2007 and submit annual reports to Congress beginning in 2009. This document is the third annual Klamath River Basin Report to Congress. The report updates information presented in the 2010 annual report and includes: 1) the actions taken under the recovery plan and other laws relating to recovery of Klamath River coho salmon, and how those actions are specifically contributing to its recovery; 2) the progress made on the restoration of salmon spawning habitat, including water conditions as they relate to salmon health and recovery, with emphasis on the Klamath River and its tributaries below Iron Gate Dam; 3) the status of other Klamath River anadromous fish populations, particularly Chinook salmon; and 4) the actions taken by the Secretary of Commerce to address the calendar year 2003 National Research Council recommendations regarding monitoring and research on Klamath River Basin salmon stocks.

The Klamath River Basin supports Chinook salmon, coho salmon, and steelhead populations, among other anadromous species. Historically, anadromous fish populations supported important commercial, recreational, and tribal fisheries. However, many anadromous fish populations have declined substantially in abundance and the restoration of these populations will require strong partnerships and collaboration between agencies and stakeholders throughout the basin. One of the target stocks of the ocean mixed-stock recreational and commercial salmon fisheries is the Klamath River fall-run Chinook salmon stock. Since the early 1990s, this stock has restricted the ocean mixed-stock salmon fisheries off California and Oregon due to low returns. However, based on recent increases in naturally spawning adults, the Secretary declared Klamath River fall Chinook salmon rebuilt in 2011.

Of anadromous fish occurring within the Klamath River Basin, only coho salmon are protected under the federal and California Endangered Species Act (ESA). Updated abundance data for Klamath River coho salmon stocks suggest that populations are not viable and some populations are at a high risk of extinction. Although limited data are available on steelhead and spring Chinook salmon abundance in the Klamath River Basin, abundance data for these species suggest wild populations continue to be at low levels.

Several noteworthy restoration and recovery actions were implemented in 2010. Two projects included construction and monitoring of off-channel ponds to address limited winter rearing habitat for ESA-listed coho salmon. The Lower Klamath tributary restoration project was completed by the Yurok Tribe using 2009 American Recovery and Reinvestment Act funding and included tree planting in McGarvey and Terwer Creeks; expansion of the Yurok Tribe's native plant nursery; and instream structure installation, bank stabilization, and off-channel pond construction in Terwer Creek. Off-channel ponds were also constructed by the Mid-Klamath Watershed Council and Karuk Tribe with funding received in 2010 from the U.S. Fish and Wildlife Service (USFWS) and PacifiCorp. Monitoring efforts following construction showed more than 250 juvenile coho salmon moving into the new ponds in Terwer Creek, illustrating the importance of this habitat for overwintering coho salmon. In 2010, NOAA's Open Rivers Initiative provided funding to the Shasta River Fish Passage Project for removal of the Grenada Irrigation District diversion dam. This project will be implemented in summer/fall of 2011, and will provide year-round access for salmon and steelhead to over 23 miles of the Shasta River, Big Springs complex,

and Parks Creek. Restoration efforts by The Nature Conservancy continue on the Shasta River Big Springs Creek to restore more than 11 miles of salmon and steelhead spawning and rearing habitat, and the USFWS funded 2.8 miles of riparian fencing on the adjacent Shasta Springs Ranch.

Also, in early 2010 a major milestone was reached toward the potential removal of four PacifiCorp dams on the upper Klamath River, and comprehensive restoration of the Klamath River Basin with signature of the Klamath Basin Restoration Agreement and Klamath Hydroelectric Settlement Agreement. Teams are currently working on studies and environmental review in support of a Secretarial Determination to occur by March 2012 regarding whether dam removal will advance restoration of the salmonid fisheries of the Klamath River Basin and is in the public interest. NMFS has been making substantial progress in response to the 2003 National Research Council's recommendations to increase research and monitoring of Klamath River Basin salmon stocks, particularly with regard to the Klamath Basin Restoration Agreement and the Klamath Hydroelectric Settlement Agreement. These recommendations will be addressed in more detail in subsequent reports, as progress continues in these efforts. Scientists from NMFS are engaged in a wide range of research projects, including providing technical support for the Secretarial Determination on Klamath River dam removal, ocean mixed-stock salmon fisheries management, and the recovery of Klamath River Basin salmon and steelhead stocks.

Purpose of the Report

Introduction

The Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (Magnuson-Stevens Reauthorization Act or MSRA)¹ of 2006 was signed into law on January 12, 2007, amending the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act or MSA).² The MSRA required NOAA's National Marine Fisheries Service (NMFS) to prepare an MSA Klamath River Coho

Salmon recovery plan in 2007 and submit annual reports to Congress starting in 2009.³ The recovery plan was completed in July 2007⁴ and the first annual report to Congress was submitted in 2009⁵ and the second report was submitted in 2010.⁶ This document is the third annual Report to Congress and provides updated information on: 1) the actions taken under the recovery plan and other law relating to recovery of Klamath River coho salmon, and how those actions are specifically contributing to its recovery; 2) the progress made on the restoration of salmon spawning habitat, including water conditions as they relate to salmon health and recovery, with emphasis on the Klamath River and its tributaries below Iron Gate Dam; 3) the status of other Klamath River anadromous fish populations, particularly Chinook salmon; and 4) the actions taken by the Secretary of Commerce to address the calendar year 2003 National Research Council recommendations regarding monitoring and research on Klamath River Basin salmon stocks.

Status of Species

Chinook Salmon

Populations of Klamath River Basin Chinook salmon upstream of the Klamath-Trinity Rivers confluence are composed of the Upper Klamath and Trinity Rivers Chinook Salmon Evolutionary Significant Unit (ESU). Populations downstream of the confluence are a component of the Southern Oregon and Northern California Coastal Chinook Salmon ESU. Neither of these ESUs is listed under the ESA, although a petition to consider listing the Upper Klamath and Trinity Rivers Chinook Salmon ESU, including both spring-run and fall-run, was received and is undergoing review. Chinook salmon (Exhibit 1) continues to be the most abundant salmonid species present in the Klamath River Basin and supports important commercial, recreational, and tribal fisheries.

The abundance of fall-run Chinook salmon adult escapement to the Klamath River Basin has been highly variable across years. Exhibit 2 illustrates the estimated abundance of fall-run Chinook salmon adult returns to the Klamath River Basin during 1978–2010, the abundance of Chinook salmon returns that spawned in natural areas and hatcheries, and the abundance of Chinook salmon harvests in tribal and in-river recreational fisheries. In 2010, the ocean salmon fisheries south of Cape Falcon, Oregon, were very restricted; it is estimated that the stock barely met its conservation objective floor (35,000 natural area adult spawners) with 37,200 natural area adult spawners returning to the Klamath River, less than the average return during 1978–2010.

The limited data for Klamath River Basin spring-run Chinook salmon suggest that adult spawner abundance has been highly variable since 1980. Recent adult spawner abundance estimates

Exhibit 1: Chinook Salmon Spawning in Shasta River.
Photo courtesy of Bob Pagliuco.



¹ Public Law No. 109-479.

² Public Law No. 94-265.

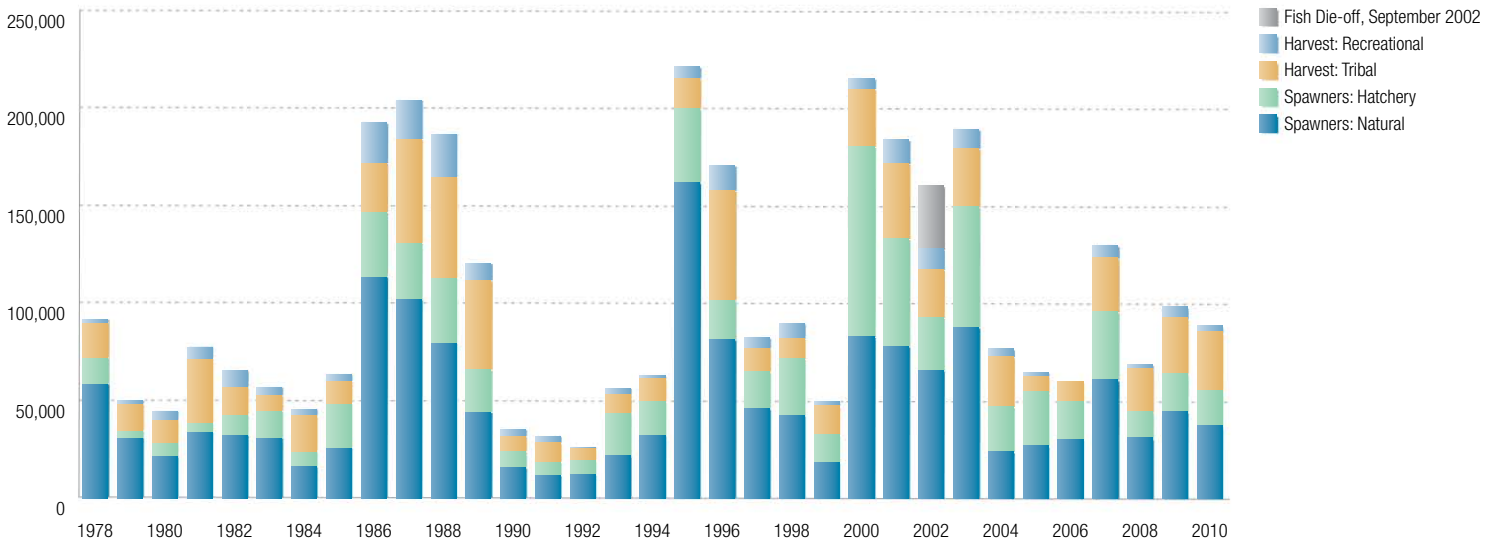
³ See MSRA Section 113(b).

⁴ NMFS Southwest Region. The Magnuson-Stevens Reauthorization Act Klamath River Coho Salmon Recovery Plan. July 10, 2007.

⁵ NMFS Southwest Region. NOAA Klamath River Basin 2009 Report to Congress. Available at <http://www.nmfs.noaa.gov/pr/pdfs/klamath2009.pdf>.

⁶ NMFS Southwest Region. NOAA Klamath River Basin 2010 Report to Congress. Available at http://swr.nmfs.noaa.gov/Klamath/Klamath_2010.pdf.

Exhibit 2: Estimated Abundance of Fall-Run Chinook Salmon Adult Returns to the Klamath River Basin, Abundance of Chinook Salmon Returns Spawning in Natural Areas and Hatcheries, and Fall-Run Chinook Salmon Harvest in River Recreational and Tribal Fisheries, 1978–2010^{A,B,C}

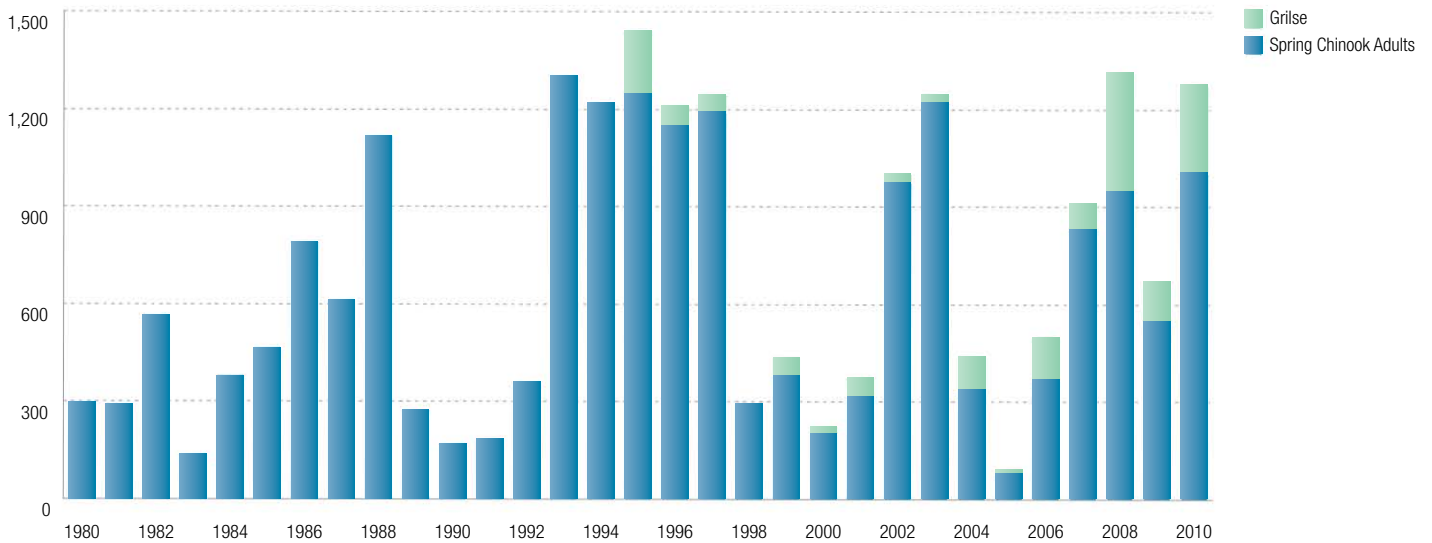


^A Source: California Department of Fish and Game. 2011. Klamath River Basin fall-run Chinook salmon spawner escapement, in-river harvest and run-size estimates, 1978-2010. Available from W. Sinnen, CDFG, 5341 Ericson Way, Arcata, CA 95521.

^B Harvest includes non-catch fishery mortality. Because these estimates are based on return spawners, estimates of Chinook salmon harvest in commercial and recreational ocean fisheries are not included.

^C Upper-most category in 2002 represents fish die-off. U.S. Fish and Wildlife Service. 2003. Klamath River Fish Die-Off September 2002: Report on Estimate of Mortality. Report number AFWO-01-03. Arcata Fish and Wildlife Office, Arcata, California. 29 p.

Exhibit 3: Estimated Abundance of Spring-Run Chinook Salmon Adult Spawners in the Salmon River, 1980–2010^{A,B,C}

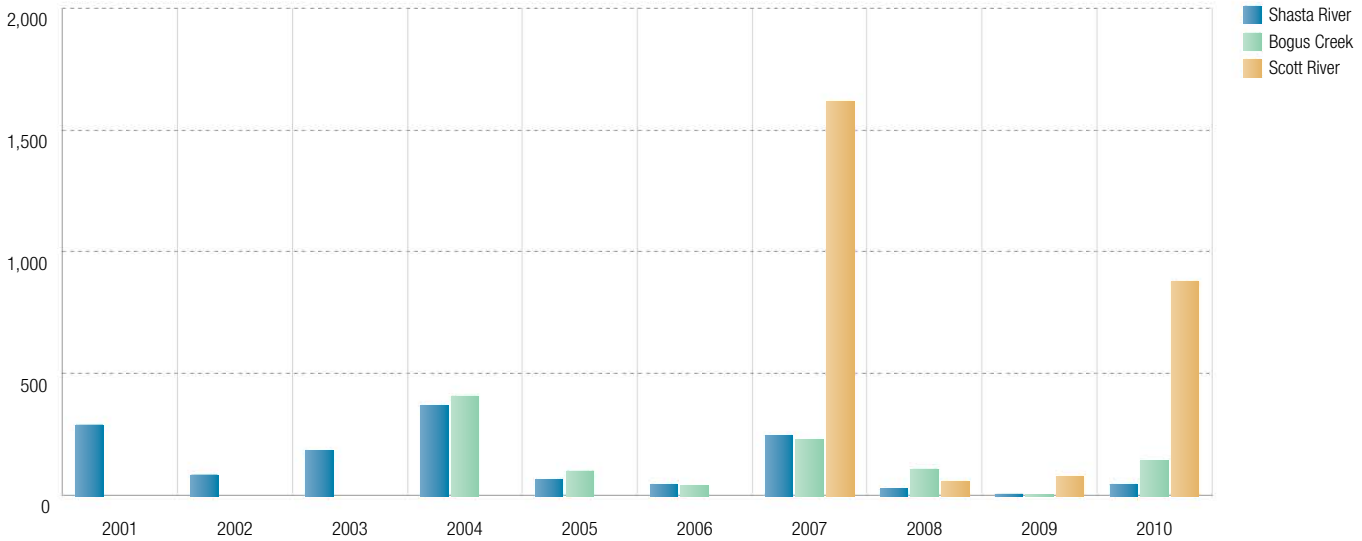


^A Source: Data collected by the Salmon River Restoration Council (<http://www.srrc.org>).

^B Grilse data are not available prior to 1995. Surveys prior to 1995 contain information on abundance of all spawning spring Chinook salmon, including grilse. A grilse is a salmon that returns to freshwater after a single winter at sea.

^C 2006 count is an estimate (wildfires prevented survey access to 35% of the Salmon River).

Exhibit 4: Estimated Abundance of Coho Adult Salmon Derived from Weir Counts in the Shasta River, Bogus Creek, and Scott River, 2001–2010^{A,B}



^A Source: California Department of Fish and Game, Northern Region, Yreka. Data obtained as part of the Klamath River Project (KRP), which funds video fish-counting facilities and cooperative spawning ground surveys.

^B Bogus Creek and Scott River weir data are not available prior to 2004 and 2007, respectively.

have been lower than levels observed in the late 1980s and early 2000s. Dam construction eliminated a substantial amount of the historical spawning and rearing habitat for spring-run Chinook salmon. In addition, dam construction was partially responsible for the extirpation of at least seven spring-run Chinook salmon populations. Two spring-run Chinook salmon natural populations remain: the Salmon River population and the South Fork Trinity River population. Exhibit 3 shows the estimated abundance of spring-run Chinook salmon adults in the Salmon River during 1980–2010. Similar to Klamath River Basin fall-run Chinook salmon, the abundance of Salmon River spring-run Chinook salmon spawners varies substantially from year to year.

Coho Salmon

Coho salmon in the Klamath River Basin are a component of the Southern Oregon and Northern California Coast (SONCC) coho salmon ESU, which was listed as threatened in 1997 under the ESA. All nine coho salmon populations within the Klamath River Basin have declined dramatically in abundance relative to historical levels, and dam construction beginning in the early 20th century has substantially reduced the historic habitat of the two uppermost populations. All

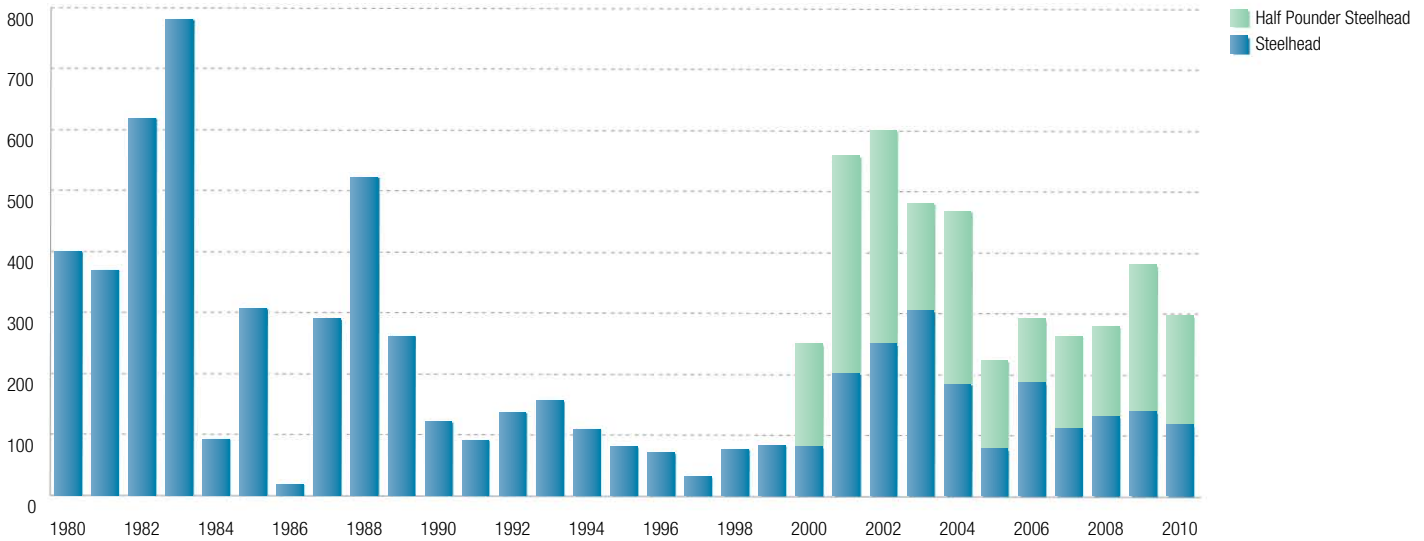
of the Klamath River Basin’s coho salmon populations are considered to be at a moderate or high risk of extinction, based on the most recent available estimates of adult spawning abundance derived from numerous sources (Exhibit 4).

Steelhead

Steelhead populations in the Klamath River Basin are part of the Klamath Mountains Province steelhead ESU. This ESU is not listed under the ESA. Steelhead in the Klamath River Basin are widely distributed and include both winter and summer steelhead populations. However, dam construction has substantially reduced the overall habitat for steelhead in the Klamath River Basin. Winter steelhead abundance is not well known, but it is thought to be stable. Summer steelhead are generally considered to be less viable than winter steelhead.⁷ Salmon River summer steelhead estimated abundance has been relatively consistent since 2000 (Exhibit 5).

⁷ NMFS 2001 Reevaluation of the Status of Klamath Mountains Province Steelhead. Prepared by the West Coast Steelhead Biological Review Team, March 14.

Exhibit 5: Estimated Abundance of Summer Steelhead in the Salmon River, 1980–2010^{A,B,C}



^A Source: Data collected by the Salmon River Restoration Council (<http://www.srrc.org>).

^B 2006 count is an estimate (wildfires prevented survey access to 35% of the Salmon River).

^C Half pounder data not available prior to 2000. A half pounder is a steelhead that returns from their first ocean season to fresh water from July through September, after only two to four months of saltwater residence.

Restoration and Recovery

Here we highlight key restoration actions in the Klamath River Basin during 2010 that have advanced the recovery of SONCC coho salmon.

Lower Klamath Tributaries Riparian Restoration Projects and Yurok Tribal Native Plant Nursery

The Yurok Tribe was awarded \$527,951 of American Recovery and Reinvestment Act (ARRA) funds in 2009 to improve in-stream and streamside river habitat of the Lower Klamath River tributaries to benefit threatened coho salmon as well as Chinook salmon and steelhead trout. Project activities included planting 25,000 trees in Terwer and McGarvey creeks, installing complex in-stream structures, stabilizing over 1,000 feet of eroding stream bank, and expanding the Tribal native plant nursery (Exhibits 6–11). This project also included the construction of over an acre of off-channel ponds to provide

overwintering habitat for threatened coho salmon. Preliminary monitoring results have shown that over 250 juvenile coho and over 1,500 juvenile Chinook salmon have moved into the newly created pond habitat and are growing very quickly relative to other nearby habitats within Terwer Creek.

During 2010, the U.S. Fish and Wildlife Service's Partners for Fish and Wildlife (PFW) Program provided funding and technical expertise to the Yurok Tribe to implement stream, floodplain, and riparian restoration activities in Lower McGarvey Creek, a top-priority tributary to the Lower Klamath River. Project objectives include decommissioning floodplain roads and stream crossings, creating 550 feet of complex off-channel rearing habitat for juvenile salmonids, and installing 15 complex wood jams to increase geomorphic function. The Yurok Tribe is conducting extensive monitoring before, during, and after implementation of this project to document project effectiveness and to aid in refining designs for similar projects planned throughout the Lower Klamath River Sub-Basin.

The Yreka Fish and Wildlife Office PFW Program funded nine habitat restoration projects on private lands in the middle Klamath River in 2010, including projects in the Shasta River and Scott River watersheds. These include several miles of

Exhibit 6: Pond A Panoramic with PIT Tag Antennas on Terwer Creek. *Photos courtesy of Bob Pagliuco.*



Exhibit 7: Pond B Panoramic on Terwer Creek. *Photo courtesy of Bob Pagliuco.*



Exhibit 8: Yurok Restorationists Planting Willow Baffles on Terwer Creek. *Photo courtesy of Dave Weskamp.*



Exhibit 9: Building Wood Structures on Terwer Creek. *Photo courtesy of Dave Weskamp.*



Exhibit 10: Tribal Native Plant Nursery. *Photo courtesy of Dave Weskamp.*



riparian fencing and planting, off-channel rearing habitat improvement for coho salmon, and forest fuels reduction projects. Previously funded restoration projects completed in 2010 enhanced or restored more than 13 miles of riparian habitat, and over 250 acres of wetland habitat in the middle Klamath River.

Shasta River/Big Springs Creek Restoration Project for Coho Salmon Recovery

The Nature Conservancy (TNC) has been awarded \$1,645,741 through ARRA funding to improve more than 11 miles of important salmon spawning and rearing habitat along the Shasta River and Big Springs Creek by excluding cattle from 11 miles of creek, supporting natural re-vegetation of 70 acres of the riparian zone, and actively planting 20 riparian acres (Exhibits 12–13). Additional project elements include

Exhibit 11: Terwer Creek Pond Site with ARRA Banner. *Photo courtesy of Dave Weskamp.*



Exhibit 12: Chinook Salmon Spawning in Big Springs Creek, 2009. *Photo courtesy of Bob Pagliuco.*



Exhibit 13: Cattle Exclusion Fencing and Vegetative Regrowth on Big Springs Creek. *Photo courtesy of Bob Pagliuco.*



reducing warm tailwater inputs, constructing an interpretative viewing deck, and monitoring different elements of the project. Preliminary monitoring results have shown that TNC achieved their 5-year monitoring goal of reducing stream temperatures in Big Springs Creek, with an average decrease of daily maximum water temperatures by 2.5 degrees Celsius during August 2009 compared to August 2008. In addition, the USFWS PFW program funded 2.8 miles of new riparian fencing on the adjacent Shasta Springs Ranch in 2010.

Shasta River Fish Passage Project— Grenada Irrigation District Dam Removal and Fish Screen Installation

The Grenada Irrigation District (GID) diversion dam is the last remaining diversion dam on the Shasta River that is known to be a partial to complete barrier to salmonid migration, depending on the time of the year in relation to the irrigation season. The dam blocks the majority of prime spawning and rearing habitat in the Shasta River. In 2010, NOAA's Open Rivers Initiative provided \$800,000 to the Shasta River Fish Passage Project to remove the dam and provide year-round access to over 23 miles of the Shasta River, the Big Springs complex, and Parks Creek (Exhibits 14–15). In addition, this project will lower water temperatures in the Shasta River by an estimated 1.5 to 3.0 degrees Celsius by eliminating the impoundment at the current diversion facility. This project is expected to be implemented in the summer/fall of 2011.

Exhibit 14: Grenada Irrigation District Dam, 2009. *Photo courtesy of Gary Black.*



Exhibit 15: Grenada Irrigation District Dam, 2009. *Photo courtesy of Bob Pagliuco.*



Seiad Creek Off-Channel Habitat and Floodplain Restoration Project

The Mid Klamath Watershed Council (MKWC) and the Karuk Tribe received funding from PacifiCorp and USFWS's PFW Program to address limited winter rearing habitat for threatened coho salmon on Seiad Creek, a priority tributary of the middle Klamath River. Seiad Creek's side-channel habitat has been destroyed by flood-control structures and mining. The Seiad Creek Off-Channel Ponds Project has created three off-channel habitat ponds to provide winter-rearing habitat for juvenile salmonids throughout a 1.6-mile stream reach of Seiad Creek (Exhibits 16–18). The Karuk Tribe has documented the presence of juvenile salmonids, including coho salmon, from other watersheds in these sites. These habitats are groundwater-fed pools in the floodplain, connected to Seiad Creek at their downstream end, and are designed to provide low-velocity winter-rearing habitat. Preliminary monitoring results show more than 650 juvenile coho salmon moved into the newly created pond habitat, illustrating the value of this habitat type to the life history of coho salmon during the winter months. Two more off-channel habitat ponds funded by the PFW Program will be constructed in the area in 2011. Another ongoing effort funded by PacifiCorp—the Seiad Creek Channel Reconfiguration and Floodplain Connectivity Project—will restore a three-quarter-mile reach of Seiad Creek impaired by dredge mining and diking. A 70 percent engineered design has been completed. Final design and implementation are planned for 2012.

Exhibit 16: Alexander Pond, 2010. *Left photo courtesy of Will Harling, MKWC. Right photo courtesy of Jennifer Silveira, USFWS.*



Exhibit 17: Stender Pond, 2010. *Photo courtesy of Will Harling, MKWC.*



Exhibit 18: Buma-Ludwig Pond, 2010. *Left photo courtesy of Jennifer Silveira, USFWS. Right photo courtesy of Will Harling, MKWC.*



Funding Updates

Federal and state agencies in the Klamath River Basin are continuing to commit funding and personnel resources toward restoration activities largely recommended in the Klamath River coho salmon recovery plan (Exhibit 19).

The U.S. Forest Service (USFS), often in partnership with other entities, focuses on active restoration of National Forest System Lands within the Klamath Basin. Restoration activities include fish passage improvements, road decommissioning, road storm-proofing, forest thinning, fuels reduction projects, and small dam removal. In addition, the USFS conducts extensive ongoing monitoring, including effectiveness of Best Management Practices, water quality requirements for Total Maximum Daily Load plans (e.g., in-channel sediment, temperature, shade), other water quality (e.g., bacteria, nutrient sampling), and fisheries (otolith microchemistry for successful rearing identification, population surveys, etc.). Specific actions improving fish passage include upgrades to multiple sites that were blocking or restricting anadromous fish

passage. Road storm-proofing activities include outcropping, road surfacing, culvert upgrades, culvert inlet treatments, reductions in diversion potential at stream crossings, reductions in risk for road-related landslides, etc. Partners involved in these efforts have included Tribes, universities, local watershed councils, local contractors, and other state and federal agencies.

Fisheries Management

The federal ocean salmon fishery off the coasts of California, Oregon, and Washington is managed under the Pacific Coast Salmon Fishery Management Plan (FMP), in accordance with the MSA and ESA consultation standards. Pursuant to the MSA, the Pacific Fishery Management Council (PFMC) provides fishery management recommendations to the Secretary of Commerce through NMFS. The Secretary will implement the management measures into regulation if the PFMC recommendations are consistent with the MSA, ESA consultation standards, and other applicable laws.

Exhibit 19: Annual Funding in the Klamath River Basin by NOAA and Other Federal and State Agencies, 2000–2010

Fiscal Year	NOAA		State of California			Other Federal Agencies			
	NMFS PCSRF ^A	NMFS ^B	NOAA Restoration Center	Department of Fish and Game	Coastal Conservancy	US Fish and Wildlife Service	US Forest Service ^C	Bureau of Reclamation	Natural Resources Conservation Service
2000	\$2,477,000	\$500,000	\$36,000	\$3,208,300	\$100,000	\$347,600	\$1,629,000	\$342,300	NA
2001	\$5,948,000	\$500,000	\$100,000	\$491,800	\$100,000	\$311,800	\$1,352,000	\$339,700	NA
2002	\$4,453,000	\$600,000	\$20,000	\$3,202,800	NA	\$464,100	\$1,273,000	\$883,500	\$189,200
2003	\$2,398,300	\$600,000	\$32,000	\$1,931,000	\$600,000	\$339,000	\$2,559,000	\$3,493,600	\$1,130,800
2004	\$3,154,400	\$750,000	\$100,000	\$978,900	\$140,000	\$297,700	\$5,048,000	\$1,812,200	\$1,539,800
2005	\$2,391,800	\$675,000	\$125,000	\$1,930,300	\$300,000	\$349,300	\$3,091,000	\$8,234,300	\$1,662,900
2006	\$951,000	\$1,000,000	\$117,000	\$11,565,100	\$375,800	\$525,900	\$2,264,000	\$5,426,100	\$1,079,100
2007	\$1,380,000	\$1,050,000	\$370,000	\$784,600	\$580,000	\$1,016,800	\$1,847,000	\$8,290,700	\$926,800
2008	\$1,363,000	\$3,000,000	\$345,000	\$467,700	\$128,000	\$880,200	\$2,300,000	\$5,284,600	\$1,397,600
2009	\$1,551,800 ^D	\$3,000,000	\$2,173,691	\$434,900	\$50,000	\$2,451,071	\$7,339,000	\$398,876 ^E	\$419,199
2010	\$2,843,000	\$2,750,000	\$860,000	\$943,000	NA	\$2,056,246	\$7,112,000	NA	NA
TOTAL	\$27,359,500	\$14,425,000	\$4,278,691	\$25,938,400	\$2,373,800	\$6,983,471	\$35,814,000	\$34,107,000	\$8,345,399

^A Pacific Coastal Salmon Recovery Fund.

^B 2006 funding does not include an additional \$60,340,000 for Klamath River Basin disaster relief.

^C U.S. Forest Service updates have been modified since the 2010 Report to Congress, and include work conducted with other partners and on at least two forests.

^D This amount was allocated in 2008 and distributed in 2009.

^E This amount does not include the Trinity River Restoration Program.

Exhibit 20: Chinook Salmon Spawning in Big Springs Creek, 2009. *Photo courtesy of Bob Pagliuco.*



Since 2008, Klamath stocks have experienced reduced impacts from the mixed-stock ocean salmon fishery, as a result of management measures designed to protect continued low returns of Sacramento River fall-run Chinook salmon. Despite widespread salmon fishery closures in 2008 and 2009, the 2010 abundance forecast of Sacramento River fall-run Chinook salmon was the third lowest on record, with only 2008 and 2009 values being lower. As a result, the PFMC recommended very restrictive salmon fisheries south of Cape Falcon, Oregon, again in 2010. Only two 4-day openings in early July were available for commercial fishing south of Point Arena in California, and 54 days in July and August in the Fort Bragg area. Commercial fisheries were also restricted in Oregon in 2010, and no fall commercial fisheries were established south of Cape Falcon due to concerns over the status of Sacramento River fall-run Chinook salmon. Retention of coho salmon in the ocean salmon fishery off California was prohibited again in 2010, in accordance with ESA consultation standards designed to reduce fishery impacts on Klamath River Basin coho salmon.

The PFMC established a conservation objective for Klamath River fall-run Chinook (KRFC) salmon in the FMP, which requires a long-term average escapement of 33 to 34 percent potential naturally spawning adults, but no fewer than 35,000 naturally spawning adults. In 2007, an Overfishing Concern was triggered under the terms of the FMP after failing to achieve at least 35,000 natural-area spawners for three consecutive years. Upon triggering of the Overfishing

Concern, NMFS considered KRFC salmon to be overfished. As part of a rebuilding plan, the PFMC has been designing the ocean salmon fisheries to achieve a forecast escapement of at least 40,700 naturally spawning adults (MSY spawning escapement) each year since 2008. Although the stock failed to achieve 35,000 naturally spawning adults in 2008, escapement exceeded 40,700 naturally spawning adults in 2009. In 2010, the stock successfully exceeded the FMP conservation objective of 35,000 naturally spawning adults. Based on recent increases in naturally spawning adults, the rebuilding criteria adopted by the PFMC were met in 2010, and the Secretary declared KRFC salmon rebuilt in 2011.

Total Maximum Daily Loads (TMDLs)

In accordance with the Federal Clean Water Act and the California Porter-Cologne Water Quality Control Act, acceptable pollutant loading levels were determined for water bodies in California that have been identified as impaired, which includes the Klamath River and its major tributaries. The TMDL development team for the Klamath River (mainstem) and Lost River included the California North Coast Regional Water Quality Control Board (Regional Water Board), Oregon Department of Environmental Quality (ODEQ), U.S. Environmental Protection Agency (EPA) Regions 9 and 10, and technical contractor Tetra Tech, Inc. NMFS personnel provided technical assistance to the TMDL development team throughout 2010 by reviewing and commenting on draft TMDL and ESA consultation products. TMDLs for the Klamath River's major tributaries (Lost, Scott, Shasta, and Trinity Rivers) were previously established. The TMDLs for the mainstem Klamath River (including an implementation plan for the already approved Lost River TMDL) was approved by the California State Water Resources Control Board and U.S. EPA Region 9 in December 2010. NMFS completed its ESA consultation on the Klamath River TMDLs in December 2010.

The Oregon Department of Environmental Quality issued a departmental order adopting TMDLs for the listed parameters for the Upper Klamath (Link Dam to California state line) and the Upper Lost Rivers. The Oregon TMDLs have been submitted to EPA Region 10 for final approval. Impairments addressed by the TMDLs that will apply to the Klamath River

mainstem are listed in Exhibit 21. Once implemented, the TMDLs and the associated Implementation Plans are expected to improve water quality, reduce stress on salmonids from pollution, and contribute to their recovery.

Exhibit 21: Proposed TMDLs in the Klamath River Mainstem in Oregon and California

Water Quantity Parameters Covered under Oregon TMDLs (ODEQ)	Water Quality Parameters Covered under California TMDLs (Regional Water Board)
Dissolved Oxygen	Dissolved Oxygen
pH	Organic Enrichment
Ammonia	Nutrients
Temperature	Temperature
Chlorophyll-a	Microcystin

Historic Klamath Hydroelectric Settlement Agreement (KHSa) and Klamath Basin Restoration Agreement (KBRA)

On February 18, 2010, over 30 parties came together to sign the KHSa and KBRA. The KBRA is intended to: 1) restore and sustain natural fish production and provide for full participation in ocean and river harvest opportunities of fish species throughout the Klamath River Basin; 2) establish reliable water and power supplies which sustain agricultural uses, communities, and National Wildlife Refuges; and 3) contribute to the public welfare and the sustainability of all Klamath River Basin communities. The KHSa lays out a process for additional studies, environmental review, and a determination by the Secretary of the Interior by March 31, 2012, regarding whether removal of four dams owned by PacifiCorp: 1) will advance restoration of the salmonid fisheries of the Klamath River Basin and 2) is in the public interest. If this determination is affirmative, removal of the dams is targeted for 2020 in order to provide for planning, permitting, and ratepayer funding. The KHSa and KBRA together represent the largest dam removal project and river restoration effort in U.S. history. While federal agencies cannot execute all the programs of the KBRA until Congress has provided appropriate authorization, federal agencies have

committed to implementing certain programs agreed to by the parties and identified in the KBRA for which authorization, funding, and capacity currently exist.

Compilation of Information Regarding Potential Effects of the Proposed Klamath Basin Restoration Agreement (Draft 11) on Fish and Fish Habitat Conditions in the Klamath Basin, with Emphasis on Fall Chinook Salmon

Hetrick et al. (USFWS Pacific Southwest Region, Arcata Fisheries Program) prepared a compilation and summary of modeling exercises, analyses, and available information on effects of the KBRA on anadromous salmonids and their habitat in December 2009. The document includes sections on water quantity, water quality, geomorphology and channel maintenance, fish health, fish production, and real-time water management. Analyses indicate that implementing the KBRA would benefit the restoration of anadromous salmonids prior to the removal of PacifiCorp Project dams. However, gains in fish habitat and fish production potential that would result from dam removal, including the reestablishment of anadromous salmonid populations upstream of Iron Gate Dam (IGD), exceed gains that could be achieved below IGD through manipulation of flows alone.

Hetrick et al. concluded that removal of PacifiCorp dams and subsequent reestablishment of basin connectivity and variable stream flows in the Klamath River would be expected to contribute significantly toward restoration of physical, chemical, and biological processes and interactions that are essential to a functional aquatic ecosystem. The authors concluded that the KBRA water and fish programs would, over time, achieve the KBRA's goal of restoring the "natural sustainability of fisheries and full participation in harvest opportunities, as well as the overall ecosystem health of the Klamath River Basin" when viewed in combination with the implementation of an effective drought plan, dam removal, and other restoration actions. The timing and magnitude of improvements will largely depend on the implementation schedule for the full suite of restoration and management actions identified in the KBRA.

Research and Monitoring

Here we highlight key research and monitoring actions in the Klamath River Basin in 2010.

NMFS Southwest Fisheries Science Center Research and Monitoring Activities

Research activities by the NMFS Southwest Fisheries Science Center (SWFSC) have recently expanded in the Klamath River Basin. Specific projects were initiated in direct response to ESA-listed coho salmon recovery needs and in support of the March 2012 Department of the Interior (DOI) Secretarial Determination concerning dam removal under the KHSA. In addition, the SWFSC is continuing its long history of providing ocean harvest management support for Klamath River fall-run Chinook salmon.

Economic Analysis Support for the Klamath Secretarial Determination

The Economics Team of the SWFSC is co-chairing an economics subteam that is preparing an analysis of costs, benefits, and regional economic impacts to inform the DOI's Secretarial Determination regarding the removal of four dams on the Klamath River. The subteam includes economists from several DOI agencies, as well as three SWFSC economists. The economics subteam is working closely with other multi-agency subteams (e.g., biology, engineering, water-quality, tribal, real estate, recreational), as well as SWFSC biologists and ecologists, to ensure that the wide-ranging effects of dam removal are reflected accurately in the economic analysis. The analysis will address issues such as costs associated with dam removal, mitigation, and implementation of the Klamath Basin Restoration Agreement; benefits to fish populations and tribal and non-tribal fisheries; foregone hydropower; foregone reservoir and whitewater recreation; effects on refuge recreation, agriculture, and tribal/cultural values; non-use value to the public; and effects on regional income, employment, and tax

revenue. All economic studies will be completed in 2011 for the 2012 Secretarial Determination.

Production Modeling Support for the Klamath Secretarial Determination

The Landscape Ecology Team of the SWFSC and NMFS Southwest Region Protected Resource Division are collaborating with the biology subteam in preparing work to support a cost-benefit analysis for the Secretarial Determination regarding the removal of four dam on the Klamath River. These teams are developing population dynamics models that will predict future abundance of Klamath River fall-run Chinook salmon during 2010–2060 under dams-out and status-quo scenarios. The models incorporate observed population dynamics of fall-run Chinook salmon populations in the Klamath River Basin, past and predicted future hydrologic and water-quality information, and estimates of spawning and rearing habitat quantity and quality throughout the basin.

Water and Sediment Quality Analysis Support for the Klamath Secretarial Determination

NMFS Southwest Region Habitat Conservation Division personnel are providing technical support to the Klamath Secretarial Determination process on the Water Quality Subteam. In 2010, this included sampling plan review for gathering additional water and sediment samples, review of water quality and sediment contamination data generated through this process, and review of the appropriate reports as they were being developed. This work will inform the NEPA process now underway for the Secretarial Determination regarding the removal of four dams on the Klamath River.

Impacts of Fish Disease on Klamath River Fall-Run Chinook Salmon Population Dynamics

The Salmon Assessment Team of the SWFSC is engaged in the construction and analysis of space- and stage-structured models to evaluate the effects of the parasite *Ceratomyxa shasta* on the short- and long-term population dynamics of Klamath River fall-run Chinook salmon. The nature and spatial extent of the disease transmission between intermediate pathogen hosts and fall-run Chinook salmon

are relatively well understood, as is the disease lethality when a fish is infected. However, research conducted to date has not evaluated the significance of these factors on overall stock dynamics. We analyzed spatially structured abundance data for naturally spawning salmon and survival data on hatchery-released salmon for associations with the exposure to *C. shasta* and stream discharge, an important factor for ceratomyxosis in juvenile salmon. The results suggest that ceratomyxosis reduces the survival of fish that migrate through the location where parasite densities are highest, and that this effect is also detectable in spawning-abundance estimates. A scientific article reporting these findings has been accepted for publication in *Transactions of the American Fisheries Society*. Future work on this subject will examine the extent to which increased juvenile mortality rates translate into reductions in adult abundance.

Klamath River Fall-Run Chinook Salmon Stock and Fishery Assessment

The SWFSC Salmon Assessment Team leads efforts in conducting the annual stock assessment of Klamath River fall-run Chinook salmon. The data collected are used by NMFS in reporting the stock's status to Congress; and by the PFMC and the CDFG to develop ocean commercial and recreational salmon fishery regulations off the coasts of California and Oregon, and river tribal and recreational fishery regulations in the Klamath River Basin. The assessments are used to determine the current status of Klamath River fall-run Chinook salmon and forecast stock abundance, fishery impacts, and spawning escapements in the coming year as a function of prospective fishery management measures. Surveys of spawning fish are conducted cooperatively by a variety of agencies (including CDFG, USFWS, Tribes, and USFS) and local watershed groups, with funding provided by USFWS, CDFG, and others.

Genetic Population Structure and Stock Identification-Based Estimation of Klamath River Basin Salmonid Contribution in Ocean Fisheries

The Molecular Ecology and Genetic Analysis Team of the SWFSC has several projects intended to provide a better understanding of Klamath/Trinity River Basin salmon and

steelhead population structure. The Team is engaged in extensive evaluations of population structure for Chinook and coho salmon in the entire basin below Iron Gate and Lewiston dams, as well as above and below both dams for steelhead/rainbow trout. The Chinook salmon data are also used to enhance the coastwide baseline dataset for Genetic Stock Identification (GSI). These projects are conducted in collaboration with Humboldt State University, CDFG, Oregon Department of Fish and Wildlife, and the Hoopa Valley Tribe. In addition, the Team is evaluating the contribution of Klamath and Trinity River Chinook salmon stocks to ocean fisheries through GSI analysis of port samples. Port samples are collected from commercial and recreational fisheries by CDFG. The contribution of Klamath/Trinity River Basin salmon stocks in commercial fisheries is also being estimated and associated with exact catch location data, in a unique collaboration with the commercial salmon fleet.

Klamath River Stream Temperature Modeling and Use of Thermal Refugia by Salmonids

Late summer and early fall water temperature regimes are critical to the persistence of salmon and steelhead populations in the Klamath River. Water temperatures critically influence fish physiology in numerous ways, and understanding water temperature dynamics is a prerequisite to assessing acute and chronic thermal impacts on salmonids. Currently, the temperature dynamics of the Klamath River mainstem are not well understood at the appropriate scales necessary for fisheries management decisions. The presence and duration of cold water refugia may be a key factor for salmonid survival, yet little is known about the spatiotemporal dynamics of these refugia. The SWFSC is addressing these issues through a combination of a high-resolution stream temperature and fish mortality models of the Klamath River mainstem, and fish tracking studies to evaluate the associated spatial response of salmonids in and around selected thermal refugia. This model is driven by recently developed NASA satellite-derived climate data. The model will provide hindcasts and forecasts (including various climate change scenarios) of the Klamath River mainstem at sub-hourly intervals for every one kilometer of stream reach. These data will be used as inputs to spatially explicit fish energetic models in order to evaluate the temperature

impacts on salmonids at sub-adult life stages. Finally, the SWFSC will measure fine-scale spatiotemporal use of the thermal refugia and mainstem by salmonids through radio tracking of individual fish.

Application of Intergenerational Genetic Tagging for Chinook Salmon at the Trinity River Hatchery

In collaboration with the Hoopa Valley Tribe and Humboldt State University, the SWFSC Molecular Ecology and Genetic Analysis Team has initiated an intergenerational genetic tagging project at the Trinity River Hatchery for both Fall and Spring Chinook salmon. This project involves taking tissue samples from all broodstock used in Chinook salmon production and then genotyping them with 96 single nucleotide polymorphism genetic markers developed by the SWFSC. These genotypes provide individual-specific tags for 100 percent of the hatchery production that can be recovered at any life stage from fish produced at the hatchery. Future applications of this tagging program include evaluation of contribution of Trinity River Hatchery fish to ocean fisheries, estimation of the heritability of age at reproduction, and detailed analysis of the effects of hatchery practices on marine/post-release survival.

Genetic Broodstock Management of Coho Salmon at Iron Gate Hatchery

Historically low returns of coho salmon to the upper Klamath River Basin, including to Iron Gate Hatchery, over the past few years raises concerns about genetic variability and inbreeding in this ESA-listed salmon stock. The SWFSC is conducting a genetic analysis of coho salmon hatchery broodstock from 2004–2009 to evaluate inbreeding and family structure in the hatchery fish, as well as genetic differentiation from naturally spawned stocks. Preliminary results indicated a substantial amount of inbreeding in the Iron Gate Hatchery coho salmon production. This resulted in an in-season active broodstock management program in 2010, in which coho salmon returning to Iron Gate Hatchery that are potential broodstock are genetically characterized prior to spawning to identify and avoid potential inbred matings. This technique significantly reduced inbreeding in Iron Gate Hatchery coho salmon production.

Other Research and Monitoring Activities

U.S. Fish and Wildlife Service Fisheries Program Activities

In 2010, the USFWS, working in close collaboration with tribal and agency partners, contributed more than \$2 million to support research and monitoring studies supporting management and restoration of anadromous fish populations and associated aquatic habitats in the Klamath River Basin, including participation in the Trinity River Restoration Program (Exhibit 22). Studies ranged from the collection of adult escapement and stock assessment data used by Klamath River Technical Team and the Pacific Fishery Management Council to develop harvest management recommendations, and co-hosting the 2010 Klamath Fish Health Conference with NMFS and university partners. Other examples of

Exhibit 22: Rotary Screw Trap Used to Monitor the Abundance of Outmigrant Juvenile Salmonids on the Klamath River Near Bogus Creek.
Photo courtesy of USFWS.



USFWS work conducted in the Klamath River Basin in 2010 included monitoring of juvenile fish abundance, size, growth, and health; assessing the prevalence and distribution of fish diseases and their intermediate hosts; monitoring and modeling water temperature conditions; and refining a fall Chinook salmon production model to further the Secretarial Determination process (Exhibit 23). The USFWS led collaborative studies to develop fish habitat/flow relationship models on both the Klamath and Trinity rivers to inform water management, assess effectiveness of mechanical and flow-derived restoration actions, and guide the methods and design

Feature Project: Mainstem Klamath and Trinity Rivers Fall Chinook Salmon Spawning Escapement

This collaborative project involving the USFWS, Native American tribes, U.S. Forest Service, and California Department of Fish and Game monitors the spawning distribution and estimates age composition and spawning escapement of natural Fall Chinook salmon within an 80-mile reach of the Klamath and 105-mile reach of the Trinity River (Exhibit 24). Data are used by the Pacific Fisheries Management Council to develop run size forecasts and harvest strategies for tribal, commercial, and sport fisheries. Annual and a multiyear trend analysis reports are available from the Arcata Fish and Wildlife Office website at <http://www.fws.gov/arcata/>.

Exhibit 23: Diseased Chinook Salmon Captured on the Klamath River.
Photo courtesy of USFWS.



of future restoration projects. USFWS also provided \$90,000 in ARRA fund grants through the National Fish Passage Program (NFPP) to the Karuk Tribe, Mid-Klamath Watershed Council, and Salmon River Restoration Council to survey the lower reaches of tributary streams throughout the middle Klamath River and to remove more than eight fish passage barriers.

Shasta River Juvenile Coho Salmon Habitat and Migration Study

California Department of Fish and Game (CDFG) biologists in Yreka reported that 49 adult coho salmon returned to the

Shasta River in the fall of 2010, and they observed spawning in the upper basin. Field surveys were limited in 2010 due to restricted access by a landowner to principal rearing habitat used by juvenile coho salmon in 2008 and 2009, but

biologists are hoping to resolve access issues. Additional work on this project in 2010 included: installation of a rotary trap in the upper Shasta, development and maintenance of remote detection systems, and Klamath River Basin Passive Integrated Transponder (PIT) tag database management.

Exhibit 24: Fall Chinook Salmon Carcass on the Klamath River.
Photo courtesy of USFWS.



Compilation of Information Relating to Myxozoan Disease Effects to Inform the Klamath Basin Restoration Agreement

J.L. Bartholomew (Oregon State University, Department of Microbiology) and J.S. Foott (USFWS, CA-Nevada Fish Health Center) prepared a technical report comparing predicted differences in disease effects on juvenile Chinook and coho salmon between two scenarios: current conditions, and with removal of the four Klamath project dams (Bartholomew and Foott 2010). Their research focused on two myxozoan parasites, *Ceratomyxa shasta* and *Parvicapsula minibicornis*, both associated with disease and mortality of Klamath River salmon, and their intermediate host, the polychaete worm, *Manayunkia speciosa*. In order to develop an infectious zone, an area must include physical habitat with stable, low-velocity flows, close proximity to spawning habitats, and temperatures above 15 degrees Celsius. These factors were used to describe infectious zones under current conditions, and where high rates of infection are anticipated to occur in the future. The authors determined that it is likely that dam removal will result in reduced polychaete densities due to a reduction in nutrients and fine benthic organic matter; however, it is not clear if these lower densities would be significant enough to reduce disease.

Juvenile Coho Salmon Behavioral Characteristics in Summer Thermal Refugia

R. Sutton (Bureau of Reclamation, Denver, CO) and T. Soto (Karuk Tribe, Orleans, CA) summarized results from studies conducted since 2006, showing juvenile coho salmon in the mainstem Klamath congregating in large schools at the mouths of cooler tributaries, referred to as thermal refugia (Sutton and Soto 2010). Objectives included investigating temperature tolerances and habitat requirements, determining the timing of thermal refugia use by juveniles, and assessing juvenile coho salmon movement in the late summer and fall. Juvenile coho salmon started using thermal refugia habitat when mainstem temperatures reached 19 degrees Celsius, but use decreased when temperatures reached 22–23 degrees Celsius, indicating their upper thermal tolerance level. The authors also documented juveniles moving into and rearing in thermal refugia habitats in the lower reaches of non-natal tributaries, most likely due to suitable habitat conditions such as cool temperatures and presence of escape cover.

Klamath River Basin Juvenile Salmonid Production Monitoring

The USFWS and tribal, state, and federal partners are conducting a multiyear study to assess annual estimates of juvenile abundance of Chinook and coho salmon, steelhead,

and lamprey in the Klamath and Trinity rivers. Fish trapping sites are also used to collect information on incidence of infectious fish diseases and their relation to environmental effects such as water temperature and flow. Information from this study has proved valuable in assessing potential effects of water management alternatives, habitat restoration efforts, and disease management.

Summary

NMFS is committed to further strengthening conservation program partnerships for the recovery of salmonid populations within the Klamath River Basin. Habitat restoration and conservation, along with improved scientific knowledge of the threats to population viability, are furthering efforts to recover and restore anadromous salmonids in the Klamath River Basin. Continued commitment to these activities is imperative to restoring the river ecosystem and the communities that depend on it for their livelihood and cultural heritage. Future progress on these efforts will continue to be reported annually to Congress.

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