Klamath River Basin

2017 Report to Congress

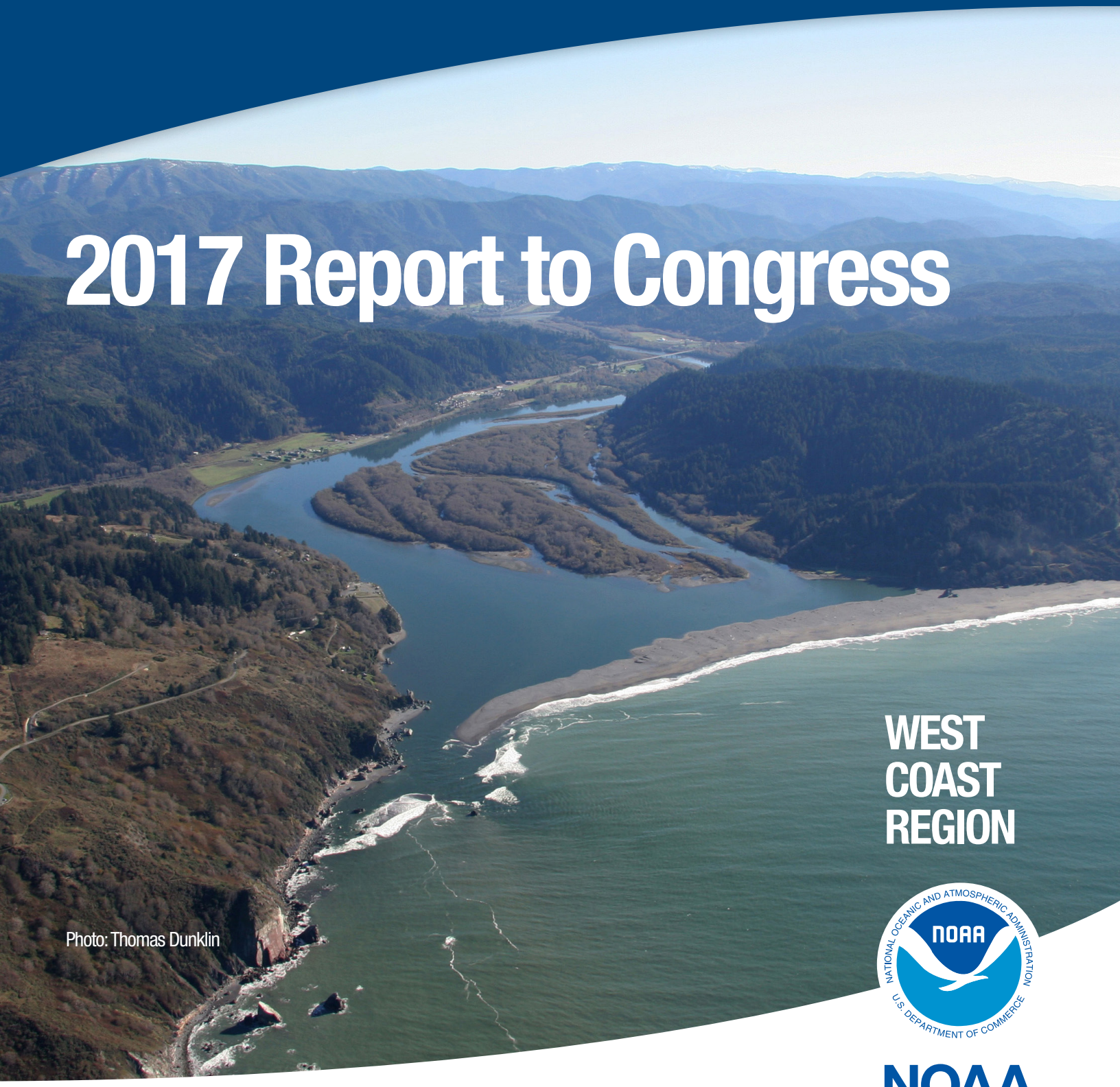

Photo: Thomas Dunklin

WEST COAST REGION

NOAA FISHERIES

U.S. Department of Commerce | National Oceanic and Atmospheric Administration | National Marine Fisheries Service

REPORT TO CONGRESS

NOAA'S KLAMATH RIVER BASIN RECOVERY AND RESTORATION PROGRESS

Developed pursuant to: Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 (P.L. 94-265)

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Klamath River Basin

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Adult spring-run Chinook salmon hold in the river during summer months before spawning in the fall

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Executive Summary

The Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 (MSA) required NOAA's National Marine Fisheries Service (NMFS) to develop a recovery plan for Klamath River coho salmon (Recovery Plan), which was completed in 2007 (NMFS 2007), and to submit annual reports to Congress beginning in 2009. This document is the sixth annual Klamath River Basin Report to Congress. This report updates information presented in the 2014 annual report for the calendar years 2014 through 2016 and includes: (1) the actions taken under the Recovery Plan, and other law relating to recovery of the Southern Oregon/Northern California Coast (SONCC) coho salmon (*Oncorhynchus kisutch*) in the Klamath River, 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 (*O. tshawytscha*); and (4) the actions taken by the Secretary of Commerce (Secretary) to address the calendar year 2003 National Research Council (NRC) recommendations regarding monitoring and research on Klamath River Basin salmon stocks (NRC 2004). The report also includes updates on the status of issues related to the Bureau of Reclamation's (Reclamation) Klamath Project and highlights impacts to anadromous fish resources of the drought that affected the region during the reporting period.

The Klamath Basin supports Chinook salmon, coho salmon, and steelhead (*O. mykiss*) populations, as well as other Endangered Species Act (ESA) protected anadromous species (e.g., the Southern Distinct Population Segments of North American green sturgeon (*Acipenser medirostris*) and eulachon (*Thaleichthys pacificus*)). Historically, anadromous fish populations supported important commercial, recreational, and culturally significant tribal fisheries. However, many anadromous fish populations have declined precipitously in abundance. The restoration of these populations will require strong and lasting partnerships among government 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. Since the early 1990s, this stock has restricted the ocean mixed-stock salmon fisheries off California and Oregon due to low returns.

Of the anadromous salmonid fish occurring within the Klamath Basin, only coho salmon are protected under both the federal and California ESAs. Updated abundance data for Klamath River coho salmon stocks, which are collected by the California Department of Fish and Wildlife (CDFW), suggest coho salmon populations are not viable, and that some of these populations are at high risk of extinction. Although limited data are available on steelhead and spring-run Chinook salmon abundance in the Klamath Basin, abundance data for these species suggest wild populations continue to persist at low levels.

Several noteworthy restoration and recovery actions have been implemented in the Klamath River system since the last report to Congress in 2014 (NMFS 2014a). In years 2014–2016, projects included the installation of several large-scale constructed wood jams, gravel augmentation, advancements in flow management, off-channel pond construction, streambank stabilization projects, advancement on developing safe harbor agreements, development of a Hatchery and Genetic Management Plan (HGMP) for Iron Gate Hatchery (IGH) coho salmon (CDFW 2014), and other modifications intended to enhance essential fish habitat complexity and improve water quality. Noteworthy information in this report also includes updates on the protracted drought of 2014, 2015, and early 2016 that impacted the Klamath Basin and the fisheries.

Introduction

The MSA[1] was signed into law on January 12, 2007, amending and appending the Magnuson-Stevens Fishery Conservation and Management Act[2] of 1976. The MSA required NMFS to prepare a Klamath River Coho Salmon Recovery Plan and submit annual reports to Congress starting in 2009.[3] The MSA Klamath River Coho Salmon Recovery Plan was completed in July

[1] Public Law No. 109-479.
[2] Public Law No. 94-265.
[3] See MSA Section 113(b).

2007 (NMFS 2007) and the submission of annual reports began in 2009.[4] This report to Congress provides updated information on: (1) the actions taken under the Recovery Plan, and other law relating to recovery of the SONCC coho salmon in the Klamath River, 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 to address the calendar year 2003 NRC recommendations regarding monitoring and research on Klamath Basin salmon stocks. The report also includes updates on the status of issues related to Reclamation's Klamath Project and highlights impacts of the drought that affected the region during the reporting period.

Status of Klamath Basin Anadromous Salmonid Species

Chinook Salmon

Populations of Chinook salmon in the Klamath Basin upstream of the confluence of the Klamath and Trinity rivers are composed of the Upper Klamath-Trinity Rivers (UKTR) Chinook salmon Evolutionarily Significant Unit (ESU[5]). Populations downstream of the confluence are a component of the SONCC Chinook salmon ESU. Neither of the ESUs are listed under the ESA. Chinook salmon continue to be the most abundant salmonid species present in the Klamath Basin, and support important commercial, recreational, and tribal fisheries.

Chinook salmon in the Klamath basin are comprised of distinct fall-run and spring-run populations, but both the UKTR Chinook salmon ESU and the SONCC Chinook salmon ESU are inclusive of fall-run and spring-run Chinook salmon life-histories. The abundance of fall-run Chinook salmon adult escapement to the Klamath Basin has been highly variable over time. Exhibit 1 shows the estimated abundance of fall-run Chinook salmon adult returns to the Klamath Basin between 1981 and 2016, the number of Chinook salmon that spawned in natural

[4] Available at: http://www.westcoast.fisheries.noaa.gov/klamath/salmon_management.html
[5]Policy on Applying the Definition of Species Under the ESA to Pacific Salmon (ESU policy) (56 FR 58612; November 20, 1991).

areas and hatcheries, and the abundance of Chinook salmon harvests in tribal fisheries and in-river recreational fisheries.

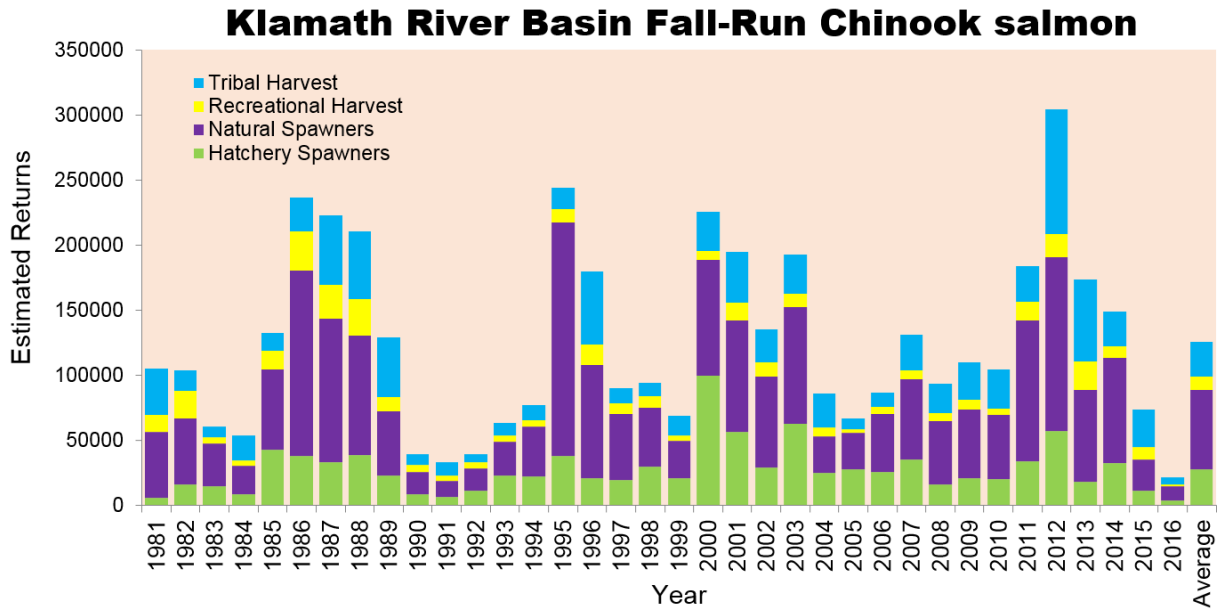

Exhibit 1. Klamath Basin adult fall-run Chinook salmon abundance estimates (CDFW 2017a).

The limited data available for Klamath Basin spring-run Chinook salmon suggest that adult spawner abundance has also been highly variable since 1980 (Exhibit 2). Recent adult spawner abundance estimates have been considerably lower than levels observed in the late 1980s and early 2000s. Dam construction eliminated hundreds of miles of historical spawning and rearing habitat for spring-run Chinook salmon. Dam construction was at least partially responsible for the extirpation of at least seven spring-run Chinook salmon populations (Hamilton et al. 2005). The further declines in abundance of spring-run Chinook salmon observed in 2015 and 2016 are likely related to the historic drought that occurred during much of the reporting period. The observed climatic conditions and some potential effects of drought are discussed in the Historic Drought Conditions Section below.

Only two natural populations (i.e., not of hatchery origin) of spring-run Chinook salmon remain: the Salmon River population and the South Fork Trinity River population. The sole hatchery in the Klamath River system that produces spring-run Chinook salmon is the Trinity River Hatchery (TRH). The majority of the spring-run Chinook salmon in the Klamath Basin return to

the Trinity River. The estimated abundance of spring-run Chinook salmon adults in the Klamath Basin from 1981 to 2016 is shown in Exhibit 2.

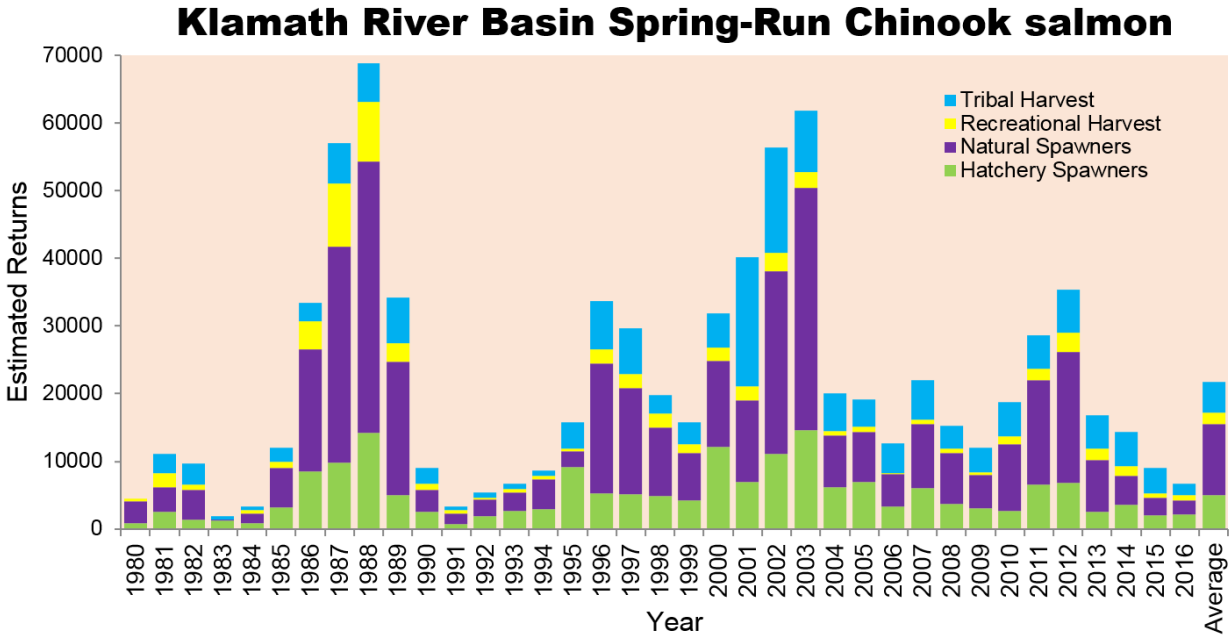

Exhibit 2. Klamath Basin adult spring-run Chinook salmon abundance estimates (CDFW 2017b).

Coho Salmon

Coho salmon in the Klamath Basin are a component of the SONCC coho salmon ESU. The SONCC coho salmon ESU was listed under the ESA as threatened in 1997. All of the nine remaining coho salmon populations within the Klamath Basin (i.e., Upper Klamath, Middle Klamath, Lower Klamath, Shasta River, Scott River, Salmon River, Upper Trinity, Lower Trinity, and South Fork Trinity populations) have declined significantly relative to historical levels. Dam construction on the main stem Klamath River, beginning with the Copco I Dam in 1918, and the Trinity Dam on the Trinity River in 1956, has substantially reduced the available habitat of the two uppermost populations. Many of the Klamath Basin coho salmon populations are considered to be at high risk of extinction because they are below, or likely below, their critical depensation threshold (NMFS 2014b, NMFS 2016a). The critical depensation threshold, as defined in the SONCC Coho Recovery Plan (NMFS 2014b), refers to the population size under which recovery becomes unlikely because, for a variety of biological and ecological reasons, the population is too small to replace itself in subsequent generations.

Estimates of returns for four of the nine populations are provided in Exhibit 3.

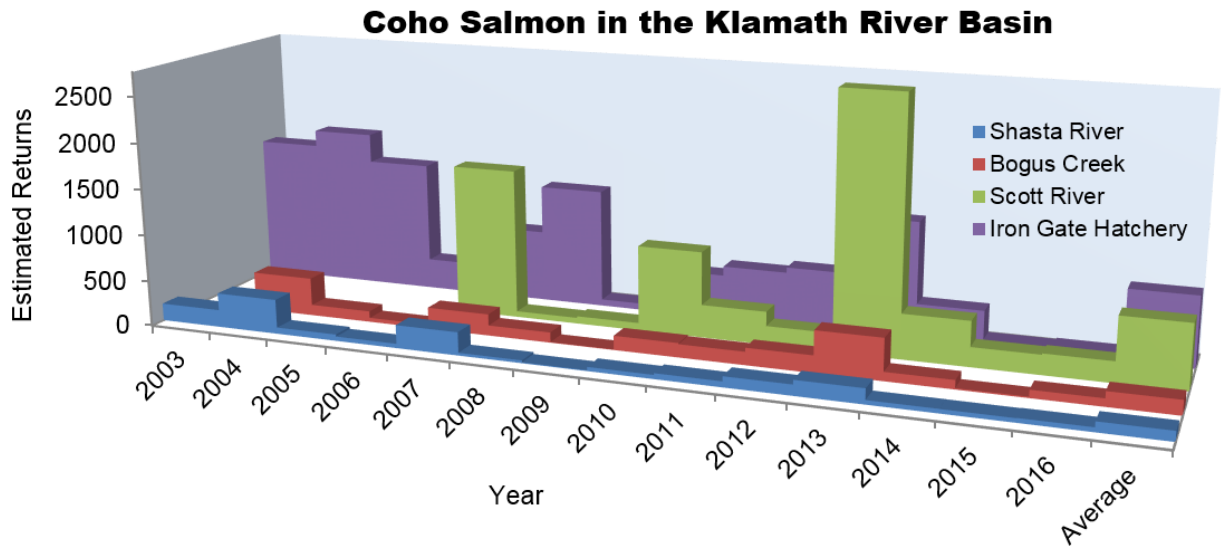

Exhibit 3. Estimated adult abundance of four of the nine Klamath Basin coho salmon populations.

Coho salmon generally exhibit a 3- year life cycle. In the Scott River, adult coho salmon abundance data collected over the past decade have indicated the population has one strong brood year-class, which is visible in Exhibit 3 in the years 2007, 2010, and 2013. However, low returns in 2016 suggest the strong brood year may have been diminished to levels consistent with lesser strength brood years. The relatively low 2016 adult returns in the Scott River were derived from a 2013 juvenile year class that was subjected to drought conditions (i.e., lows flows, warm temperatures, and disconnected tributaries), and exhibited low juvenile in-river survival, despite rescue and relocation efforts (CDFW 2016). Both Shasta River and Bogus Creek spawner abundance levels remain low even with contributions from IGH. Coho salmon populations in the Trinity Basin have been variable, but have been trending negatively since 2013.

NMFS recently completed a status review of the SONCC coho salmon ESU (NMFS 2016a) and determined that there has been no improvement to the status of SONCC coho salmon in the past 5 years. The SONCC coho salmon ESU is considered threatened under the ESA (i.e., likely to become endangered within the foreseeable future throughout all or a significant portion of its range). The status review noted the low number of adult coho salmon entering the Shasta River

in the 2014–2015 season as particularly concerning. Although the population trend is declining in abundance and there is a heightened risk (e.g., drought) to the SONCC coho salmon ESU since the previous status review in 2011, NMFS (2016a) recommends the ESU remain classified as a threatened species. No changes are recommended with regard to hatchery production levels or fishery management quotas (NMFS 2016a). Exhibit 4 below, taken from the NMFS (2016a) 5-year status review, shows that all nine extant populations of SONCC coho salmon in the Klamath Basin are at moderate or high estimated extinction risk.

Stratum	Population	Estimated Extinction Risk
Interior Klamath	Middle Klamath River	Moderate
	Upper Klamath River	High
	Shasta River	High
	Scott River	Moderate
	Salmon River	High
Interior Trinity	Lower Trinity River	High
	South Fork Trinity River	High
	Upper Trinity River	Moderate
Central Coastal Basin	Lower Klamath River	High

Exhibit 4. SONCC coho salmon ESU populations and their predicted risk of extinction baaed on spawner density (taken from table 9 of NMFS (2016a) 5-Year Status Review).

Steelhead

Steelhead populations in the Klamath Basin are part of the Klamath Mountains Province (KMP) steelhead Distinct Population Segment (DPS). The KMP steelhead DPS is not listed under the

ESA. Steelhead in the Klamath Basin are widely distributed and include winter-, summer-, and fall-run populations. Dam construction has substantially reduced the quantity of accessible habitat for steelhead in the Klamath Basin (Hamilton et al. 2005). Winter steelhead abundance is not well known because of the difficulty of surveying during periods of high flow, but it is thought to be stable. Summer steelhead are generally considered to be less abundant than winter steelhead. The estimated abundance of Salmon River summer steelhead has been relatively consistent since 2000 (Exhibit 5). Returns of natural-origin fall steelhead adults to the Trinity Basin have decreased considerably since the last report to Congress (Exhibit 6). Historically, hatchery fall-run KMP steelhead were produced at both the TRH and IGH, but adult returns of steelhead to IGH diminished to such an extent that the hatchery has not been able to produce steelhead since 2012 (IGH and TRH, unpublished data).

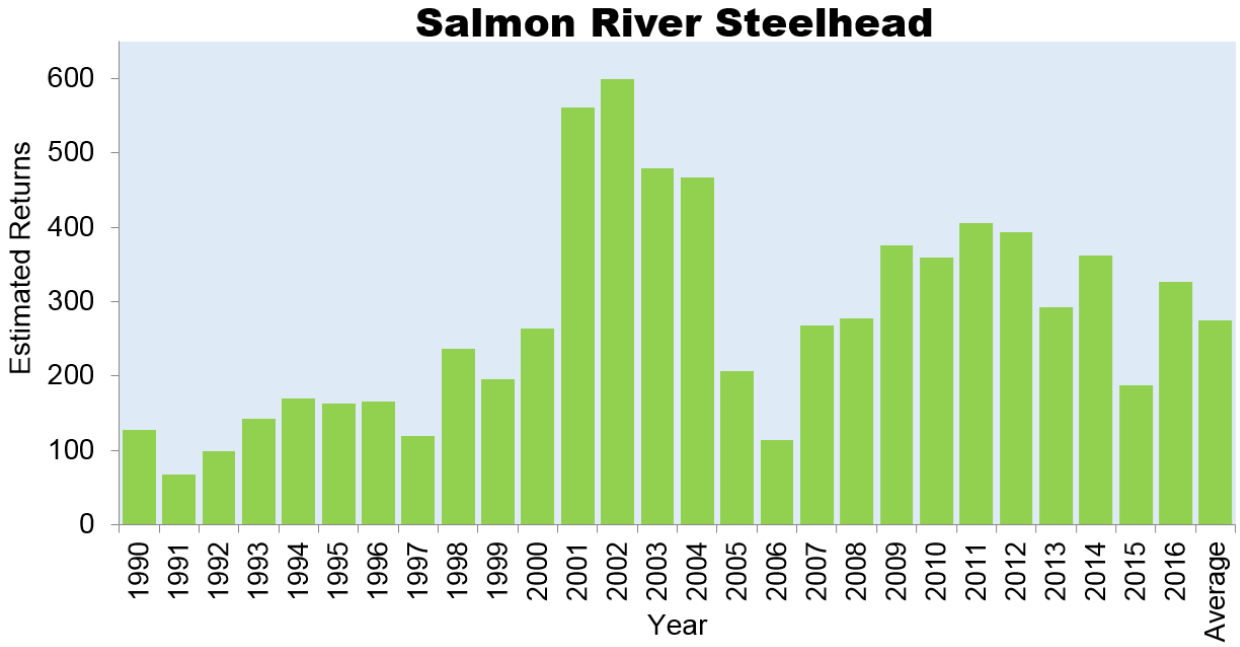

Exhibit 5. Salmon River summer steelhead abundance estimates[6].

[6] Data courtesy of Lyra Cressey of the Salmon River Restoration Council in 2017. The 2006 count is an estimate (wildfires prevented survey access to 35 percent of the Salmon River). "Half-pounder" data not available prior to 2000. A "half-pounder" is a steelhead that returns to freshwater after only 2 to 4 months of saltwater residence.

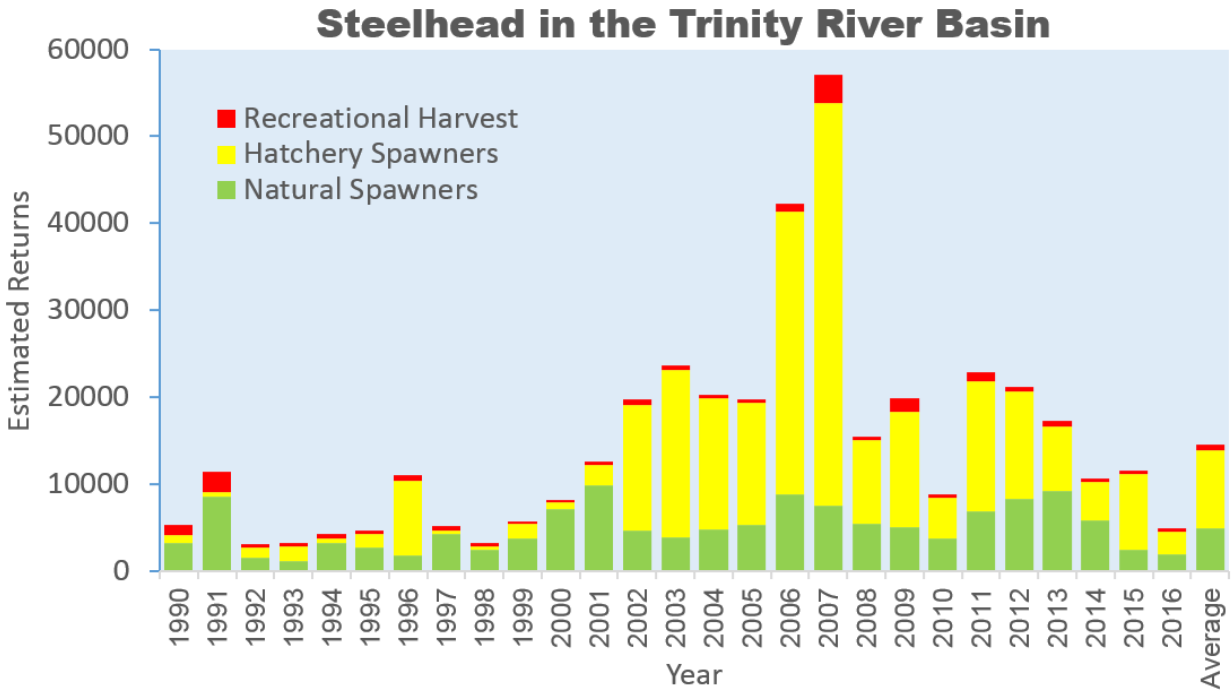

Exhibit 6. Trinity Basin fall steelhead abundance estimates (CDFW 2017c).

Historic Drought Conditions

A drought cycle in California began in December 2012 and continued into 2016. The severity and duration of the drought prompted California Governor Edmund G. Brown to issue Executive Order B-29-15 on April 1, 2015, mandating the State Water Resources Control Board to implement state-wide water conservation and irrigation efficiency standards. The measure was intended to enhance regulatory efforts to conserve water, promote innovative technologies, and simplify response procedures.

The regional hydrology of the Klamath Basin is influenced by several factors: snowpack abundance and quality, amount and location of rain, temperature, soil moisture content, consumptive use by humans and livestock, and commercial irrigation. The hydrology of the upper Klamath Basin is primarily snowmelt-driven, whereas the middle and lower basin are predominately rain-driven. The statewide snowpacks in 2014 and 2015 were at or near their lowest levels in centuries (Exhibit 7). On May 28, 2015, automated sensors indicated that California's snowpack had been completely depleted. Measurements of snow levels taken on

April 1 each year are used when predicting water availability and streamflows the following summer (Littell et al. 2009). Typically, the snowpack accounts for as much as 30 percent of California's water supply. Many reservoirs in the state, including those that support the Klamath system, were well below capacity for the duration of the drought, including during the typically wet winter months (Exhibit 8).

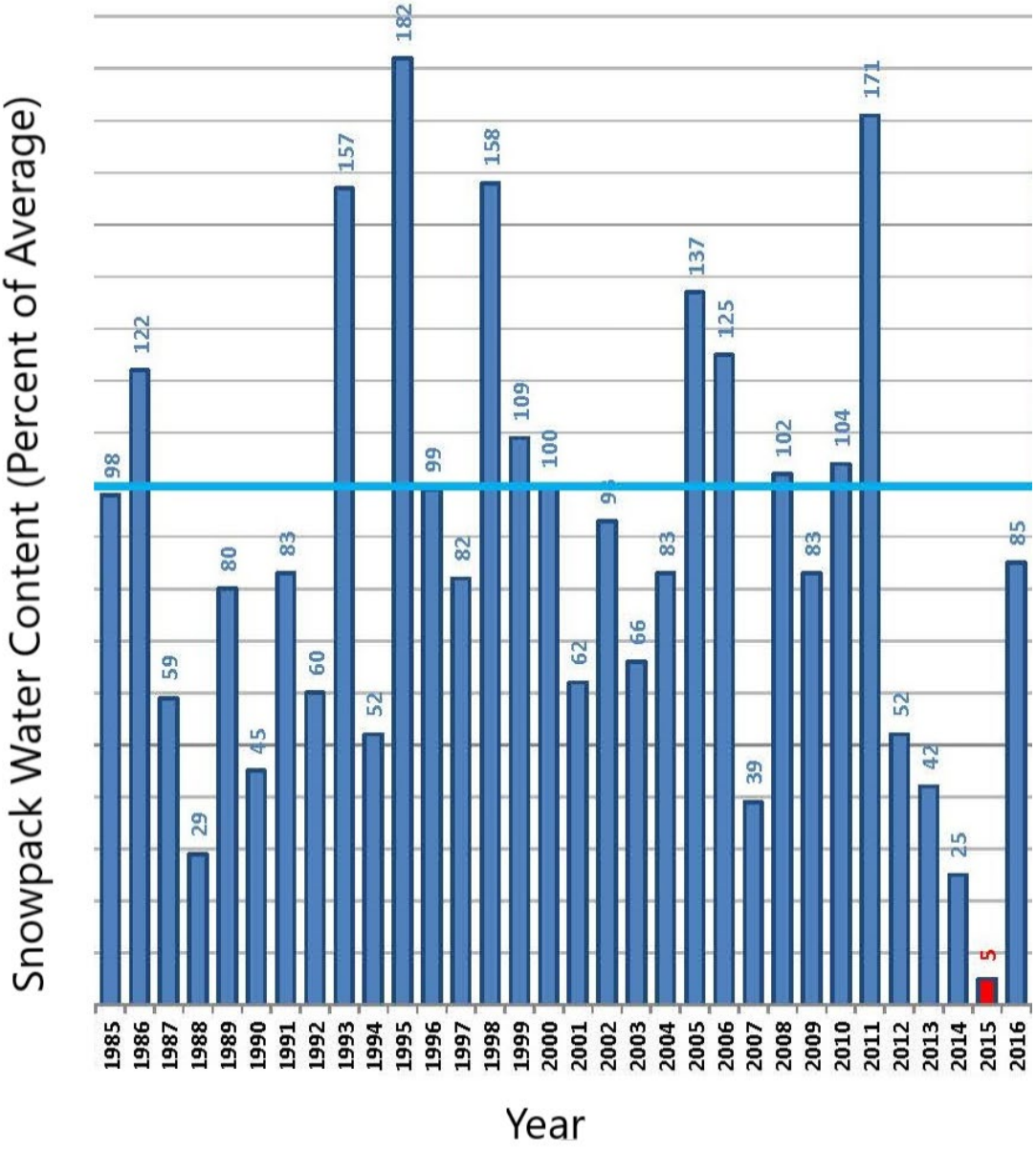

Exhibit 7. Snowpack water content as statewide percent of average. Water year 2015, highlighted in red, is the lowest snowpack year on record. Blue horizontal line indicates 100 percent of average (DWR 2017).

Exhibit 8. North Trinity Lake in February 2014 (Photo Credit: Tim Reed/USGS)

In addition to record low snowpack and precipitation totals in 2014 and 2015, the Upper Klamath Basin maintained record high temperatures during the summers of 2014 and 2015. The combined result of these climatic factors was severe drought in the Klamath Basin during much of the reporting period (Exhibit 9).

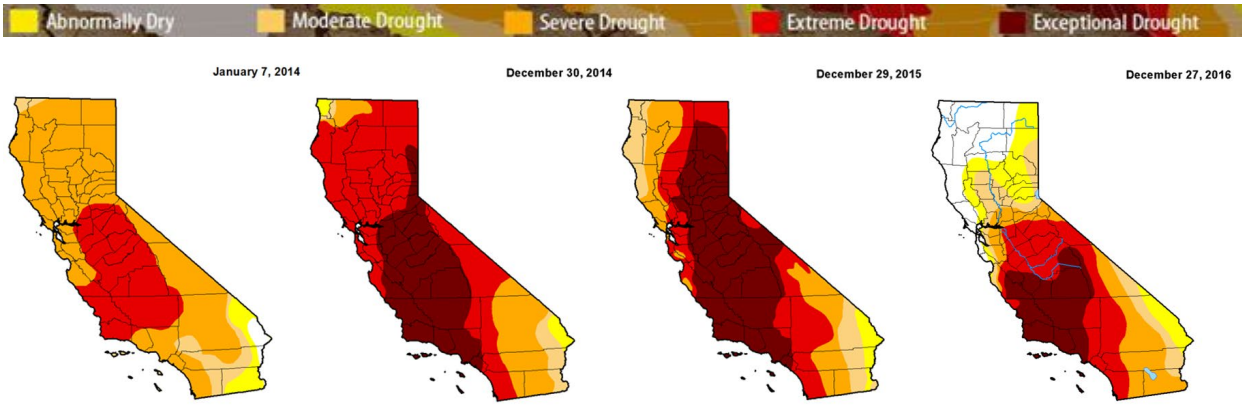

Exhibit 9. The Klamath Basin endured severe drought conditions beginning in 2013 and lasting until rain in 2016 improved drought conditions. (NDMC 2016)

When river temperatures reach predetermined "trigger" levels at specific U.S. Geological Survey gauges in the Klamath River, as described in the joint biological opinion for Reclamation's Klamath Project operations (NMFS & USFWS 2013), stream managers may be required to increase flows. Management decisions regarding flow releases for fish require close coordination among Reclamation, PacifiCorp, NMFS, the U.S. Fish and Wildlife Service (USFWS), tribes, and stakeholders. When Reclamation follows drought condition protocols, dam releases are minimal.

Drought effects in freshwater systems include impacts to anadromous fish. Water temperatures above 21°C can have deleterious impacts to salmonids, depending on life stage, and can be lethal (EPA 2001). High in-stream temperatures can affect migration timing, force adult fish to seek temperature refugia instead of suitable spawning habitat, negatively affect incubation success, and reduce availability of cold water refugia that are critical for juvenile rearing (NMFS FED 2016). Low stream flows combined with warm air temperatures can have synergistic effects with other water quality indicators (e.g., dissolved oxygen, pH) (NMFS FED 2016), which can result in high rates of disease for Chinook salmon. Juvenile Klamath River Chinook salmon have a history of incidence of myxosporean parasite infections, including *Ceratonova shasta* and *Parvicapsul minicornis*, which can be significant causes of mortality in these populations. Infection rates are temperature- and flow-dependent, and *C. shasta* prevalence of infection in sampled juvenile Chinook salmon was the highest on record during peak emigration in 2015 (True et al. 2016), which was the fourth and most intense year of the drought. *C. shasta* infection rates are further discussed in the Research and Monitoring section below.

Another drought-related phenomenon that can have impacts to anadromous fish is the increased incidence of wildfire. The average number of acres in California that burned annually in forest fires during 2014 to 2016 was 232,968, with a maximum of 291,282 acres in 2015, compared to an average of 98,439 acres burned annually during 2011 to 2013 (CALFIRE 2016). A number of significant fires were seen in the Klamath Basin during the drought (e.g., 2014 Beaver Fire, 2014 Whites Fire, 2014 Happy Camp Complex, 2015 River Complex, 2015 Route Complex, 2015 Fork complex, 2016 Tully Fire (CALFIRE 2016)). Negative impacts to anadromous fish from forest fires can result from altered hyrdologic function, increased sediment loading and turbidity,

decreased habitat resulting from water drafting (i.e., water being removed from streams for fire-fighting and dust abatement), and other factors.

In addition to poor in-river conditions for salmonids during the reporting period, the drought coincided with generally poor ocean conditions for salmon. The California current did not produce the usual supply of nutritious lipid-rich northern zooplankton types during the period of record, but rather an abnormal abundance of less nutritious lipid-poor southern zooplankton types. Additionally, a suite of other indices of ocean conditions provided poor conditions for salmon growth and surivival during the reporting period, especially during 2015 and 2016 (Exhibit 10).

	Year																		
Ecosystem Indicators	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
PDO (Sum Dec-March)	16	6	3	12	7	18	11	15	13	9	5	1	14	4	2	8	10	19	17
PDO (Sum May-Sept)	10	4	6	5	11	15	14	16	12	13	2	9	7	3	1	8	17	19	18
ONI (Average Jan-June)	18	1	1	6	12	14	13	15	8	11	3	10	16	4	5	7	9	17	19
46050 SST (°C; May-Sept)	15	8	3	4	1	7	19	14	5	16	2	9	6	10	11	12	13	18	17
Upper 20 m T (°C; Nov-Mar)	18	11	8	10	6	14	15	12	13	5	1	9	16	4	3	7	2	19	17
Upper 20 m T (°C; May-Sept)	15	11	13	4	1	3	19	17	7	8	2	5	12	10	6	16	18	9	14
Deep temperature (°C; May-Sept)	19	6	8	4	1	10	12	16	11	5	2	7	14	9	3	15	18	17	13
Deep salinity (May-Sept)	18	3	8	4	5	15	16	9	6	1	2	13	17	12	11	10	19	14	7
Copepod richness anom. (no. species; May-Sept)	17	2	1	7	6	13	12	16	14	10	8	9	15	4	5	3	11	18	19
N. copepod biomass anom. (mg C m^{-3}; May-Sept)	17	13	9	10	3	15	12	18	14	11	6	8	7	1	2	4	5	16	19
S. copepod biomass anom. (mg C m^{-3}; May-Sept)	19	2	5	4	3	13	14	18	12	10	1	7	15	9	8	6	11	16	17
Biological transition (day of year)	17	11	6	7	8	12	10	16	15	3	1	2	14	4	9	5	13	19	19
Ichthyoplankton biomass (log (mg C 1000 m^{-3}); Jan-Mar)	19	10	2	6	8	17	16	12	15	14	1	11	3	13	9	7	18	4	5
Ichthyoplankton community index (PCO axis 1 scores; Jan-Mar)	9	13	1	6	4	10	18	16	3	12	2	14	15	11	5	7	8	17	19
Chinook salmon juvenile catches (no. km^{-1}; June)	18	4	5	16	10	13	17	19	12	8	1	6	7	15	3	2	9	14	11
Coho salmon juvenile catches (no. km^{-1}; June)	18	7	12	5	6	2	15	19	16	3	4	9	10	14	17	1	11	8	13
Mean of ranks	16.4	7.0	5.7	6.9	5.8	11.9	14.6	15.5	11.0	8.7	2.7	8.1	11.8	7.9	6.3	7.4	12.0	15.3	15.3
Rank of the mean rank	19	6	2	5	3	13	15	18	11	10	1	9	12	8	4	7	14	16	16

Exhibit 10. Poor ocean conditions for salmonids occurred during the 2014–2016 period (NMFS NWFSC 2016). Rank scores were derived from ocean ecosystem indicators and color-coded to reflect ocean conditions for salmon growth and survival (green = good, yellow = intermediate, red = poor). Lower numbers indicate better ocean ecosystem conditions, or "green lights" for salmon growth and survival.

Klamath Hydroelectric Settlement Agreement (KHSA), Klamath Basin Restoration Agreement for the Sustainability of Public and Trust Resources and Affected Communities (KBRA) and the Upper Klamath Basin Comprehensive Agreement

On April 18, 2014, the Klamath Basin Irrigators, the Klamath Tribes, and officials from the Department of Commerce, Department of the Interior, and various state and local entities signed the Upper Klamath Basin Comprehensive Agreement (UKBCA) (Exhibit 11). The goal of the comprehensive agreement group, led by Richard Whitman of Oregon, was to build upon the Klamath Basin Restoration Agreement (KBRA) and the Klamath Hydroelectric Settlement Agreement (KHSA), which were both originally signed in 2010. A purpose of the UKBCA and the KBRA was to resolve water rights in the Upper Klamath Basin through negotiated settlement. The UKBCA included three key elements:

- A Water Use Program that increases stream flows in the tributaries above Upper Klamath Lake—adding at least 30,000 acre feet annually to inflows to the lake, while creating a stable, predictable setting for agriculture to continue in the Upper Klamath Basin;
- A Riparian Program that improves and protects riparian conditions to help restore fisheries; and
- An Economic Development Program for the Klamath Tribes.

Exhibit 11. Upper Klamath Basin Comprehensive Agreement Signing Ceremony on April 18, 2014, on the banks of Spring Creek at the headwaters of the Klamath Basin. Seated, left to right, Rancher Garrett Roseberry, Rancher Roger Nicholson, former Oregon Governor John Kitzhaber, Chairman Don Gentry (Klamath Tribes), Rancher Becky Hyde. Standing, left to right, former Secretary of the Interior Sally Jewell, Oregon Senator Ron Wyden, California Resources Secretary John Laird, Oregon Senator Jeff Merkley, and former Under Secretary of Commerce for Oceans and Atmosphere Kathryn Sullivan.

Funding for restoration projects in the UKBCA would have come largely through mechanisms outlined in the KBRA, signed in 2010. The overall cost of the UKBCA and the Klamath agreements of 2010 was estimated to be $545 million, a significant reduction from the original projected cost of $1 billion in earlier Klamath agreements. The UKBCA also resolved water right disputes that were not addressed in the KBRA.

On September 15, 2015, the Yurok Tribe issued a statement to the press formally withdrawing from the KBRA. In its press release, the Yurok Tribe noted that the agreement continued to change over time, and the negotiated benefits they had worked for had become “unachievable” (Times Standard 2015).

Complete implementation of the 2010 Klamath agreements would have required enactment of federal authorizing legislation, which was introduced but not enacted. According to its terms, the KBRA expired at midnight on December 31, 2015, because federal authorizing legislation was not enacted by that time. However, the KHSA and the UKBCA would not, and did not, expire at that time. Although U.S. Representative Greg Walden (R-OR) presented draft legislation on December 4, 2015, this proposal did not provide for dam removal, which was a critical component of the KHSA/KBRA. The parties involved in the agreements resolved to find another way to move the process forward.

On April 6, 2016, the parties signed an amended KHSA. An integral component of the amended KHSA stipulated that PacifiCorp and the Klamath River Renewal Corporation (KRRC) would jointly file an application with the Federal Energy Regulatory Commission (FERC) for transfer of the license for four Klamath River dams (J.C. Boyle, Copco I, Copco II, and Iron Gate) from PacifiCorp to the KRRC, and the KRRC would file an application to surrender and remove the four dams. These applications were filed with FERC on September 23, 2016. Consistent with the KHSA, the KRRC application proposed to commence deconstruction activities on or about January 1, 2020.

Another agreement, the Klamath Power and Facilities Agreement (KPFA), was also signed on April 6, 2016. The KPFA provides commitments to Reclamation's Klamath Project water users in the Upper Klamath Basin. The KPFA anticipates that Reclamation will take control of operation of the Keno and Link River dams from PacifiCorp. The KPFA also includes commitments to help protect the farmers and ranchers who receive water deliveries from the Klamath Project from potential regulatory burdens that may arise after protected anadromous fishes are reintroduced into the Upper Klamath Basin.

Restoration and Recovery

The following sections highlight recent key restoration actions in the Klamath Basin that are intended to advance the recovery of the SONCC coho salmon ESU.

Klamath Project Operations - Klamath River Restoration Conservation Measure

Reclamation proposed the Klamath River Restoration Conservation Measure (KRRCM) as part of the ongoing Klamath Project operations for the 2013–2023 period, stipulated in the formal joint ESA consultation with the USFWS and NMFS (NMFS & USFWS 2013). Proposed KRRCM activities are intended to offset adverse effects of Klamath Project operations, promote the survival and recovery of SONCC coho salmon, and improve their designated critical habitat. These activities include, but are not limited to: installing or improving instream habitat structures, improving fish passage by modifying existing barriers, restoring or improving riparian habitats, removing small dams where beneficial (i.e., flashboards, and permanent structures), creating off-channel/side-channel habitats, and creating/installing tail-water collection ponds, water storage tanks, piping ditches, fish screens, head gates, and water gauges.

Reclamation partnered with the National Fish and Wildlife Foundation (NFWF), which administers the KRRCM grant program and provides various degrees of matching funds. Successful project proposals were selected through a competitive process coordinated closely with Reclamation, NMFS, CDFW, and NFWF program managers in the Klamath Basin.

Several noteworthy restoration projects have been implemented since the last report to Congress. These projects include the installation of several large-scale wood jams to increase habitat complexity and improve floodplain connection, gravel augmentation to mitigate for lost spawning habitat downstream of Iron Gate Dam and increase floodplain connectivity, construction of beaver dam analogues to improve juvenile rearing habitat and increase the water table, fish passage improvement projects for all life stages of salmonids, enhancement of riparian cover and aquatic vegetation with native flora, and installation of in-stream fish screens to reduce mortalities at diversions. Specific examples include:

- The Middle-Klamath Coho Refuge Habitat Enhancement Project

    - planning and design efforts directed at the enhancement of coho refuges and off-channel refuge habitats along the middle Klamath River corridor.
- The Horse Creek Wood Loading Project
    - to address a lack of instream wood in Horse creek, a Mid-Klamath tributary.
- Increasing Year-Round Rearing Capacity and Habitat Quality for Natal and Non-natal Populations of Coho Salmon in a Priority Lower Klamath Tributary Project
    - to evaluate the restoration effectiveness of beaver dam analogues to increase the amount of slow-velocity rearing habitat available to juvenile coho throughout the Klamath Basin.
- The Parks Creek Fish Passage Project
    - to re-establish fish passage for all life stages of salmonids in Parks Creek, the last significant spawning and refugia area in the Shasta River watershed for coho salmon, by re-designing the current fish passage barrier.
- Cold Water Habitat for Coho Salmon Project
    - to develop a dependable cold-water rearing habitat and wetland feature for coho salmon located at the confluence of the cross canal and the Shasta River below Dwinnell Dam.
- The Bogus Creek Fish Passage Project
    - to remove three flashboard irrigation dams and fish screens in Bogus Creek, reprofile the streams in the location of the diversions by installing roughened channels, and construct three on-stream fish screens, which will provide year-round fish passage opportunities and eliminate juvenile coho entrainment.
- The Cold Creek Fish Passage Project
    - to improve passage and habitat for adult and juvenile coho salmon in Cold Creek in the Klamath River Watershed. Project will install a roughened channel at the diversion site on Cold Creek, which will allow for irrigation deliveries while providing volitional streamwide passage for oversummering juveniles, outmigrating smolts, and adults moving into the spawning grounds.
- The Lower French Creek Off-Channel Habitat Development Project
    - to restore the natural channel form and function and increase the carrying capacity and condition of juvenile coho salmon by constructing an off-channel pond with coarse woody debris structures and associated riparian vegetation in the floodplain of lower French Creek, a Trinity River tributary.

- The Klamath National Forest Coho Habitat Enhancement Project in Horse Creek, China Creek, and Little Horse Creek
    - designed five sites on three Middle Klamath tributaries for creation of both off-channel and instream rearing and spawning habitat for coho salmon and other salmonid species.
- The Parks Creek Fish Passage Project at Cardoza Ranch
    - designed a new means of diverting water that will provide continuous fish passage and reduce summer water temperatures in Parks Creek, by replacing the existing diversion at Cardoza Ranch with a pumping facility in the Shasta River, 1 mile downstream from the Parks-Shasta confluence, to eliminate the need for the Parks Creek impoundment.
- The Lower Yreka Creek Restoration Project
    - to increase spawning and rearing habitat for coho salmon and other salmonids and expand the existing beaver population by lowering the floodplain, removing concrete and levees from streamside areas, and installing a self-sustaining side channel.
- The Lower Beaver Creek Coho Salmon Off-Channel Habitat Restoration Project
    - to further the restoration of off-channel habitat along the Klamath River by locating optimum sites for creation of off-channel ponds along lower Beaver Creek, a Klamath River tributary.

National Fish and Wildlife Foundation

In addition to disbursing funds provided by Reclamation for the KRRCM as required by the 2013 joint biological opinion (NMFS & USFWS 2013), NFWF also worked with other partners within the Klamath Basin over the course of the reporting period to restore stream, riparian, and wetland habitats throughout the region. For example, the Western Rivers Conservancy contributed to NFWF's award to create a cold-water refuge in the Blue Creek watershed through the acquisition of the last 8,582 acres of the 47,097-acre complex. Similarly, the California Conservation Corps partnered with NFWF to implement a program to engage youth as watershed stewards. Other Klamath Basin partnership projects implemented during the reporting period included purchasing and restoring wetlands, eradicating invasive plants, restoring sections of the Little Shasta and Salmon rivers, and rehabilitating mine-tailing sites.

NOAA's Restoration Center - Lower Klamath River Fisheries and Riparian Habitats

In 2014 to 2016, NOAA's Restoration Center provided ongoing funding for restoration projects in the Lower Klamath River. Examples of such projects include the construction of large, engineered wood structures and improving riparian habitats. These projects increased the formation and maintenance of deep pools with complex cover, improved salmonid spawning habitat, and increased slow-velocity habitats to benefit adult and juvenile salmonids. These projects also promote healthy and resilient riparian forests and facilitate long-term wood recruitment into stream habitats.

In Hunter Creek, a tributary to the Lower Klamath River, a large wood project included the construction of 48 engineered wood jams (Exhibit 12) along a 1-mile reach. The project was completed in 2014. The engineered structures increased habitat complexity, and will continue to provide excellent refugia for anadromous fish for years to come. Additionally, native trees were planted along the banks of Hunter Creek and willow baffles were installed to provide additional immediate and long-term benefits to native fish species. Fish surveys conducted after project completion have shown increased use of the area by native salmonids.

Exhibit 12. NOAA Restoration Center Biologist Bob Pagliuco provides scale for an engineered wood jam on Hunter Creek in the Lower Klamath basin.

The NOAA Restoration Center also partnered with Yurok Tribal Fisheries to install wood jams in the upper portion of the Terwer Creek project reach. These activities were funded by the USFWS. NOAA's Restoration Center installed 18 engineered wood jams of various sizes within Terwer Creek prior to project completion in 2015.

Pacific Coastal Salmon Recovery Fund

NMFS is the government agency responsible for administering the Pacific Coastal Salmon Recovery Fund (PCSRF). During the reporting period 2014–2016, PCSRF awarded $4,523,786 to projects within the Klamath Basin, including habitat improvement projects, salmonid census surveys, fish disease research projects, and management of invasive species such as the brown trout (*Salmo trutta*). These grants were awarded competitively and have leveraged over $1,810,916 in matching funds from several non-governmental organizations over the past 3 years. Salmon restoration activities have the added benefit of stimulating local economies where those projects occur.

SONCC Coho Salmon Recovery Plan

In 1997, NMFS determined that declining coho abundance and productivity, range reductions, and diminished life history diversity in the SONCC area warranted listing coho salmon populations (i.e., from the Mattole River in California to the Elk River in Oregon, inclusive) as a threatened species under the ESA. In October 2014, NMFS released the Final Recovery Plan for SONCC Coho Salmon. The goal of the plan is to recover the species to the point that it becomes naturally self-sustaining and no longer requires the protections afforded by the ESA, at which point it may be delisted under the ESA.

The SONCC Coho Salmon Recovery Plan describes actions that are necessary for recovery such as: removal of, or improved fish passage at, both large and small dams; ensuring the availability of sufficient water quantity and quality; restoring in-channel habitat and upslope ecological function; and the creation, maintenance, and safeguarding of suitable estuarine habitat necessary to support both juveniles and adults. Other actions include managing fisheries, reducing detrimental effects of land use activities, decreasing the incidence of salmonid disease, and operating hatcheries in a manner that is consistent with recovery goals.

The cost of achieving recovery and delisting of SONCC coho salmon through implementation of the SONCC Coho Salmon Recovery Plan's actions is estimated at approximately $5 billion over a 100-year period. Many of the actions identified in the plan are designed to improve watershed-wide processes by restoring ecosystem function to benefit many co-occurring indigenous flora and fauna. By setting goals and using objective, measurable criteria, progress toward achieving the biological and threat abatement recovery objectives of the SONCC Coho Salmon Recovery Plan can be tracked objectively.

Ocean Fisheries Management

Chinook Salmon

The 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 enacts the management measures into regulation if the PFMC recommendations are consistent with the MSA, ESA Section 7 consultation standards, and other applicable laws.

In December 2011, the Pacific Coast Salmon FMP was amended (Amendment 16) to provide a new framework compliant with the MSA and National Standard Guidelines. Overfishing occurs when the exploitation rate exceeds the maximum fishing mortality threshold of 71 percent. Annual exploitation rate levels for Klamath River fall Chinook are set using an abundance-based harvest control rule that was adopted in 2011 with Amendment 16 of the Pacific Coast Salmon FMP. Under the harvest control rule, annual allowable exploitation rates for Klamath River fall Chinook salmon for the years 2013 through 2016 ranged from a high of 68 percent (2013) to a low of 25 percent (2016). The observed annual post-season exploitation rates were below the maximum fishing mortality threshold; therefore, the Klamath River fall Chinook salmon stock was not subject to overfishing during the reporting period.

In September 2015, the PFMC approved Comprehensive Ecosystem Based Amendment 1 (CEBA 1), including Amendment 15 to the Coastal Pelagic Species FMP and Amendment 19 to the Pacific Coast Salmon FMP, which provide new protections for some forage fish species. The final rule to implement CEBA 1 was published on April 4, 2016 (81 FR 19054). The action is intended to prohibit commercial fishing of unmanaged forage fish species in federal waters until adequate scientific study can inform the PFMC of potential impacts to existing fisheries, fishing communities, and food webs within the marine ecosystem. The PFMC has also made recent changes to actively managed forage species. For example, sardines are an important food source for salmonids; in 2006, the stock assessment estimated a biomass for West Coast populations of 1.32 million metric tons, which supported a substantial sardine directed fishery (NMFS 2006). Since then, the population of sardines has dropped precipitously to an estimated 106,000 metric tons in 2016 (NMFS 2016b).

Coho Salmon

The Klamath coho salmon stock is managed as part of the SONCC coho salmon ESU. The incidental take limit for the commercial Chinook salmon fishery for this ESU is an ocean exploitation rate of no more than 13.0 percent on SONCC coho salmon, using the

Rogue/Klamath hatchery stocks as an indicator (NMFS 2016a). Post-season exploitation rates from the ocean fishery have been consistently below this limit (Exhibit 13) since exploitation rates were first assessed in 2007, in part because fisheries targeting coho salmon, and retention of coho salmon caught incidentally in Chinook-directed fisheries south of the Oregon/California border, are prohibited.

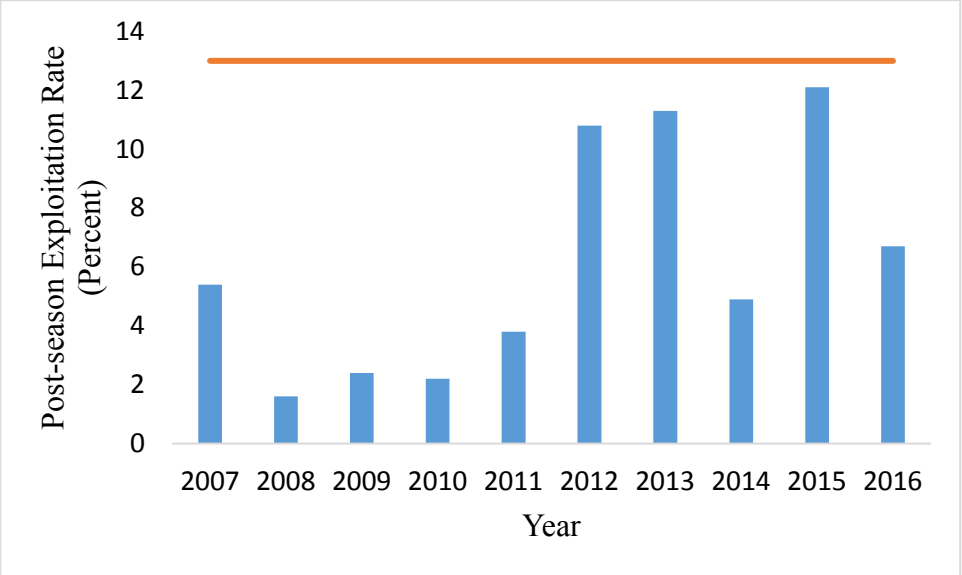

Exhibit 13. Ocean fishery post-season exploitation rates of the Rogue River/Klamath River coho salmon. Orange line indicates the incidental take maximum limit ocean exploitation rate of 13 percent (PFMC 2008–2017).

Research and Monitoring

The following sections highlight key research and monitoring actions in the Klamath Basin during this reporting period that were intended to inform management to benefit salmonids in the basin.

NMFS SWFSC Research and Monitoring Activities

Research activities by the NMFS Southwest Fisheries Science Center (SWFSC) have continued in the Klamath Basin, with projects focused on gaining an understanding of environmental variation, and fish response at spatial scales ranging from local to regional to inform

management. This work is intended to promote the conservation of coho salmon (ESA-listed), steelhead, and Chinook salmon populations. The SWFSC is also continuing its long history of providing ocean harvest management support for Klamath River fall-run Chinook salmon.

Fall-Run Chinook Salmon Stock Assessment

The SWFSC Salmon Assessment Team leads efforts in conducting the annual stock assessment of Klamath River fall-run Chinook salmon. Surveys of spawning fish are conducted cooperatively by multiple agencies (including CDFW, USFWS, U.S. Forest Service, and tribal fisheries departments) and local watershed groups, with funding provided by USFWS, CDFW, and others. The data collected are used for multiple purposes, including: by NMFS in reporting the stock's status to Congress; by the PFMC, CDFW, and tribes to develop ocean commercial and recreational salmon fishery regulations off the coasts of California and Oregon, and tribal and recreational fishery regulations in the Klamath Basin upstream of the mouth of the river; and to forecast stock abundance.

Genetic Broodstock Management of Coho Salmon at Iron Gate Hatchery

Historically low returns of coho salmon to the upper Klamath Basin over the past decade, including to IGH, raised concerns about genetic variability and inbreeding in this ESA-listed salmon ESU. Hatchery management has been improved by the completion of an HGMP in 2014 (CDFW 2014). The SWFSC has been conducting a continual genetic analysis of coho salmon broodstock at IGH since 2006 to evaluate inbreeding and family structure in the hatchery-produced fish, and to differentiate hatchery-origin fish from naturally spawned stocks. Since 2010, the SWFSC has provided in-season genetic broodstock management. Coho salmon returning to IGH that are potential broodstock are rapidly characterized for genetic relatedness prior to spawning in order to identify and avoid potential inbred matings. This technique has significantly reduced inbreeding in IGH coho salmon. These data are also being used to inform a planned collaboration to supplement coho salmon populations in the Shasta River in habitat restored by supportive private landowners, and will be valuable if additional supplementation programs (e.g., upstream of migratory barriers) are necessary in the future.

Contributions of Coho Salmon at Iron Gate Hatchery to Juvenile Production and Habitat Utilization in the Shasta River

Large-scale habitat protection and restoration in the Shasta River, along with dwindling natural production by coho salmon in this sub-basin of the Klamath River, have led to efforts to supplement natural populations of coho salmon in the Shasta River. Concurrently, monitoring efforts have determined that a significant proportion of adult coho salmon entering the Shasta River during spawning season originated at IGH, approximately 30 km upriver from the confluence of the Klamath River with the Shasta River. SWFSC staff are using genotype data collected from all adult coho salmon returning to IGH for genetic broodstock management purposes. This allows biologists to identify the origin of juvenile coho salmon encountered in the Shasta River. Pedigree reconstruction techniques help determine the extent to which juvenile salmon are descended from IGH parents that spawned naturally, and the extent to which salmon produced in the hatchery are using the Shasta River as rearing habitat following release.

Genetic Tagging of Chinook Salmon at Trinity River Hatchery

SWFSC staff are collaborating with the Hoopa Valley Tribal Fisheries Department and Humboldt State University to conduct an evaluation of intergenerational genetic tagging at the TRH for both fall- and spring-run Chinook salmon. This project involves taking tissue samples from all broodstock used in Chinook salmon production and then genotyping them with genetic markers developed by the SWFSC. These genotypes provide individual-specific tags for all TRH produced fish that can be recovered, regardless of life stage. These tags are being recovered in ocean fisheries and associated with exact catch location data in a unique collaboration with the commercial salmon fleet. These genetic tag recoveries will provide information about the differences in ocean migration patterns of the fall- and spring-run Chinook salmon from the Trinity River and will be used to evaluate the contribution of TRH fish to ocean fisheries. Future applications of this tagging program include estimation of the heritability of age at reproduction and detailed analyses of the effects of hatchery practices on marine/post-release survival.

U.S. Fish and Wildlife Service Contributions in the Klamath Basin

The USFWS Fish and Aquatic Conservation (FAC) Program is described in its *Strategic Plan for the U.S. Fish and Wildlife Service Fish and Aquatic Conservation Program: FY 2016-2020*. In summary, the FAC Program is responsible for:

- facilitating the restoration of nationally significant fishery resources;
- seeking and providing mitigation of fishery resources adversely impacted by federal water development projects;
- assisting with management of interjurisdictional fisheries and fish resources and aquatic habitats;
- providing technical assistance to Native American tribes; and
- maintaining a federal leadership role in scientifically based management of national fishery resources.

The Arcata, California, Fish and Wildlife Office (AFWO) implements the FAC Program for the Klamath Basin. The AFWO FAC Program includes several components intended to restore conditions in the Klamath Basin, including: the Trinity River Restoration Program, the Klamath River Fish Habitat Assessments Program, generation of several relevant long-term datasets, generation of important decision support tools, and the Partners for Fish and Wildlife Program.

Trinity River Restoration Program

A primary focus of the AFWO FAC Program continues to be implementation of the Trinity River Restoration Program (TRRP). The goal of the TRRP is to restore anadromous fish populations in the Trinity River to pre-dam levels through a suite of flow management and in-stream restoration actions guided by an adaptive management program. The USFWS is charged with implementing the TRRP for the Secretary of the Interior as a co-lead with the Bureau of Reclamation.

To enhance the production of naturally spawned salmonids, the TRRP outlines a suite of restoration actions, including streamflow management, gravel augmentation, and mechanical channel rehabilitation. In 2015, the TRRP analyzed longer-term performance of channel rehabilitation sites to inform the adaptive management process. Rearing habitat increased at 12

of 18 sites directly after construction. A trend analysis indicated that the level of initial benefit from construction was not sustained over longer time periods at many sites. Trends in rearing habitat that resulted from channel rehabilitation were, in many instances, directly related to the creation and sustainability of off-channel features. Current and ongoing analyses of the physical context of these rehabilitation sites will provide the opportunity for improving the restoration program.

Klamath River Fish Habitat Assessment Program

The Klamath River Fish Habitat Assessment Program, also known as the Klamath River Flow Study, continues to provide the data, analytical tools, and models needed to help restore the Klamath Basin. Established by Congress in 2001, the program was initiated to provide a scientific road map to guide the restoration of Klamath River salmon, steelhead, sturgeon, and lamprey and associated fisheries. The AFWO's Klamath Program has contributed in furthering the understanding of the complex life cycle of *C. shasta* and its relation with environmental parameters and possible control measures. In addition, the AFWO has been involved with implementing status and trend monitoring for mainstem Chinook salmon production; a water quality monitoring network; a fish die-off quick response program; habitat inventories and fish habitat use assessments; juvenile fish health monitoring; modeling and validation of in-river fish production; and hydrologic monitoring (USFWS 2015).

Long-Term Datasets

The AFWO FAC Program has monitored adult Chinook salmon spawner abundance on the Klamath and Trinity rivers for more than 20 years, establishing an expansive mainstem spawning dataset for the Basin. These data are used to develop and support flow management alternatives and are a driving parameter in modeling work that is used to define the extent of fish diseases and to guide harvest regulations and restoration actions. The FAC Program has also monitored the abundance and health of outmigrant juvenile salmon and steelhead on the Klamath and Trinity rivers for more than 20 years. The AFWO FAC Program has established the single most extensive water quality dataset for the Klamath Basin, which proved critical in the FERC re-licensing process for PacifiCorp's Klamath River dams, and in establishing the baseline that will

be used to define methods and sites to incorporate into the Klamath Basin Integrated Fisheries Restoration and Monitoring Plan (IFRMP), which is described in more detail below.

Decision Support Tools

The FAC Program continues to lead collaborative efforts in the Klamath Basin to guide and assess the effectiveness of large river restoration activities. Through a collaboration between the USFWS, U.S. Geological Survey, and Texas State University, the FAC Program continues to play a lead role in developing decision support system tools such as SIAM (Klamath River System Impact Assessment Model), SALMOD (salmon production model), and, most recently, the Stream Salmonid Simulator (or S3 Model). The S3 Model is an integrated set of sub-models that will be used to quantifiably predict and compare the effects of various management alternatives (such as pre- and post-dam removal, restored passage, pre- and post- physical habitat restoration, etc.) on the production of juvenile Chinook salmon. The S3 Model is currently being extended into the Trinity Basin and, as requested by NMFS and Reclamation through newly established reimbursable agreements, is also being expanded to incorporate coho salmon.

Partners for Fish and Wildlife Program

The USFWS Partners for Fish and Wildlife Program (PFW) works to efficiently achieve voluntary habitat restoration on private lands, working under a mission "to restore, protect, and enhance fish and wildlife habitat cooperatively through voluntary partnership with private landowners, tribes, and other entities." Through this program, the USFWS strives to implement science-based, sustainable, and economically viable habitat restoration projects. These are natural, process-based solutions to conservation challenges, and provide direct, timely, measurable, and lasting benefits to USFWS trust resources while concurrently improving ecological conditions.

In the Klamath Basin, PFW project managers focus on terrestrial and aquatic habitat restoration with private landowners, including tribes, and collaborate with non-governmental organizations and local government entities to implement dozens of habitat restoration projects each year. Between its inception in 2007 and 2016, the USFWS, through the PFW, has invested more than $40 million in the Klamath Basin on habitat restoration planning, project implementation, and monitoring. This investment has resulted in a long list of successes, ranging from acres and

miles of habitat restored to social changes, resulting in collaborations with historically unwilling landowners and stakeholders.

The PFW Program includes several projects in the Klamath Basin, as detailed below:

- Restoring Off-Estuary Habitat in Hoppaw Creek
    - This project aimed to increase the quality and quantity of juvenile salmonid rearing habitat and improve migratory conditions for adult salmonids returning to Hoppaw Creek to spawn by installing constructed wood jams, creating an off-channel habitat feature, and planting native trees within the riparian area. Through this project, PFW helped create 1.5 acres of off-channel wetland habitat and improve 0.275 miles of instream habitat on Yurok Reservation lands.
- Miners Creek Beaver Dam Analogues
    - The primary purpose of this project was to install two beaver dam analogues to improve the quantity and quality of coho salmon rearing habitat in Miners Creek, a tributary to the Scott River. The installation of these beaver dam analogues resulted in the formation of nearly 10 acres of rearing habitat for coho salmon, steelhead, and other aquatic species. The newly installed beaver dams have impounded water and improved the quantity and quality of coho salmon rearing habitat in the watershed (Exhibit 14).
- Mill Creek Streambank Stabilization
    - This project reduced the lateral migration of the creek into a pasture while increasing in-stream complexity to providing habitat for coho salmon and other anadromous fish species. The bank erosion was reduced by installing six engineered logjams along the streambank. The logjams divert water away from the eroding streambank and increase the frequency, depth, and complexity of pool habitat as well as promote sediment deposition.
- Sugar Creek Off-Channel Project
    - This off-channel pond project provides habitat for juvenile coho and Chinook salmon on Sugar Creek, a tributary to the Scott River. The project involved the connection of an existing groundwater-fed off-channel pond with lower Sugar Creek. Once connected with Sugar Creek, the off-channel pond added approximately 0.48 acres of habitat to the

tributary. Juvenile salmonids were observed feeding off the surface of the connected pond almost immediately after construction of the channels (Exhibit 15).

Exhibit 14: Miners Creek beaver dam analogue before/after precipitation event.

Exhibit 15. Cluster of coho salmon under woody debris placed in Sugar Creek off-channel pond.

Cooperative Research Projects with Humboldt State University

The NMFS SWFSC, along with the NMFS West Coast Region (WCR), supports Professor Darren Ward, a faculty member at Humboldt State University, to conduct original research on regional fisheries issues. Some of Dr. Ward's NMFS-sponsored research projects within the Klamath Basin during the reporting period include:

- Partnering with the CDFW to study the juvenile residency time, growth, and outmigration size of juvenile Chinook salmon at multiple locations in the Shasta River.
- Partnering with the CDFW to monitor the freshwater life history stages of coho salmon, specifically the survival of out-migrating juveniles and adult escapement.
- Partnering with the Karuk Tribal Fisheries Department to monitor and analyze the seasonal growth, retention, and movement of juvenile coho salmon between natural and constructed habitats of the mid-Klamath portion of the river.
- Partnering with the Hoopa Tribal Fisheries Department to study predation on juvenile salmon by brown trout in the Trinity River.
- Studying the marine survival rates of coho salmon from small coastal watersheds throughout Northern California, aided by the CDFW.
- Modeling the effects of life history variation and population dynamics as they relate to alternative restoration treatments in Freshwater Creek, assisted by the CDFW.

The NMFS SWFSC and WCR also provide support for Dr. Andrew Kinziger, who is also a faculty member at Humboldt State University. Dr. Kinziger and graduate student Keith Parker engaged in studies during the reporting period that were designed to:

- Evaluate genetic mark-recapture techniques as an approach to estimate coho salmon escapement without requiring exogenous tagging.
- Study the effects of the Klamath River dams and salmon hatchery operations on current inputs of marine-derived nutrients in food webs within the Klamath River watershed.

This project also includes sampling above the existing dams to provide a baseline to assess changes associated with potential dam removal.

Myxozoan Disease Effects on Klamath Basin Salmonids

Researchers from the USFWS Fish Health Center and Oregon State University annually monitor for two myxozoan parasites, *Ceratonova (syn. Ceratomyxa) shasta* and *Parvicapsula minibicornis,* and their intermediate host, *Manyunkia speciosa*, the polychaete worm associated with disease and mortality of Klamath River salmon. Monitoring is complicated by the fact that Chinook salmon from different areas of the basin experience different water quality conditions (e.g., temperature, flow rates) and have varying parasite loads, with fewer parasites detected in fall-run Chinook from the Klamath than those in the Shasta or Trinity rivers (Foott et al. 2013). Monitoring demonstrated that parasite infections and disease rose sharply in 2014 and 2015, with 81 and 91 percent infection rates, respectively, in sampled juvenile Chinook salmon, when water temperatures were optimal for pathogens, and nearly lethal to Klamath River salmonids (Exhibit 16)(True et al. 2016). These spikes in disease resulted in emergency water releases from Iron Gate and Trinity dams to lower water temperatures in the river.

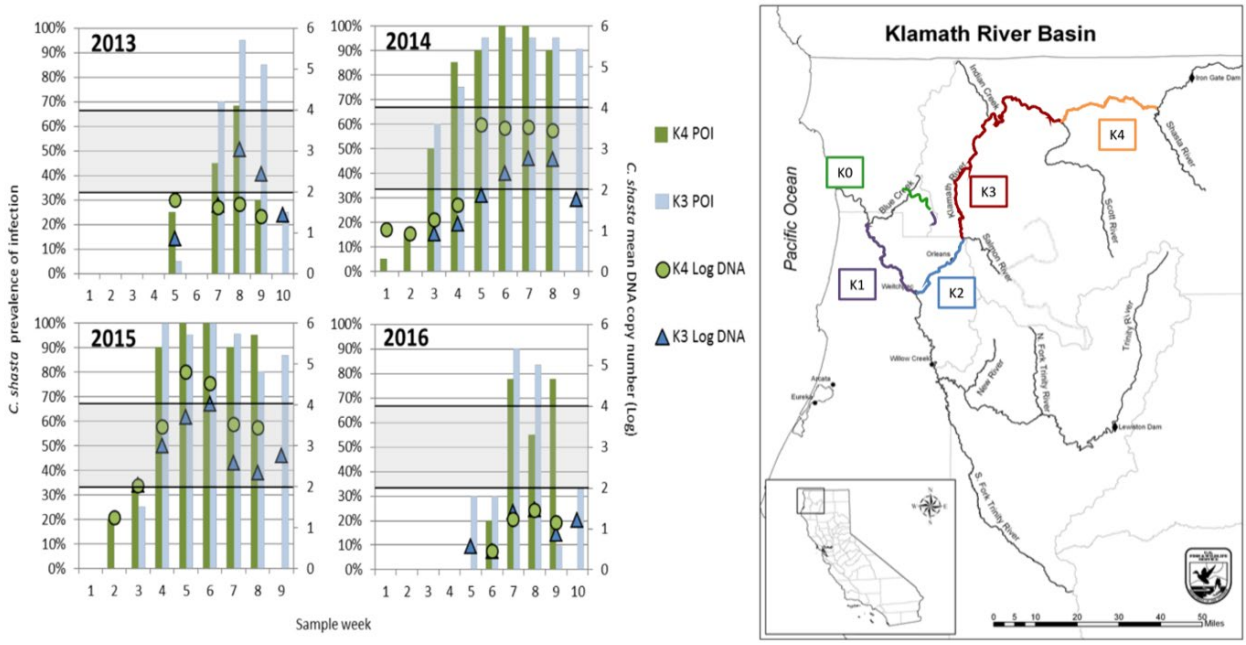

Exhibit 16. *C. shasta* probability of infection for the upper reaches (i.e., K3, K4) of the Klamath River (True et al. 2016).

These researchers have also developed a suite of models to better understand the complex interactions involved in the life cycle of *C. shasta* with the goal of managing disease in Klamath River salmonids. Global climate models (developed by other researchers) provide projected temperature and water flow data. These data are then used to predict polychaete host density. The predictions of polychaete host density, along with other variables, are then used to identify points in the life cycle that may be sensitive to management actions. For example, increasing winter flows could decrease polychaete populations through scouring, resulting in fewer parasites and less disease in the fish host (Exhibit 17).

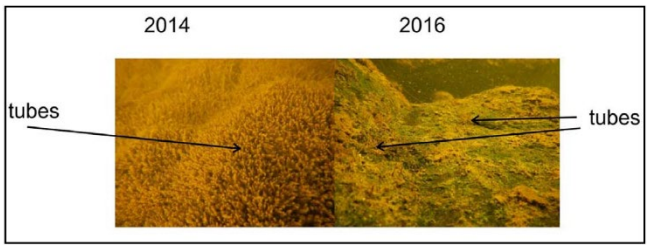

Exhibit 17. Split screen picture of an identical rock in the mainstem Klamath River taken in 2014 (left) and in 2016 (right) following the high flow pulse of 11,200 cfs from Iron Gate Dam in March 2016. The image shows that the scouring flow dramatically reduced the concentration of *M. speciosa*.

Klamath Basin Integrated Fisheries Restoration and Monitoring Plan (IFRMP)

There has been a widely recognized need for a transparent, basin-wide, science-driven approach to fisheries management and fish habitat restoration in the Klamath Basin that integrates needs of ESA-listed suckers, bull trout, and coho salmon with those of other tribal and public trust species such as spring and fall Chinook salmon, steelhead, Pacific lamprey, and green sturgeon (NRC 2004).

The USFWS and NMFS, with assistance of the Pacific States Marine Fisheries Commission (PSMFC), are working closely with local partners in helping to guide the various components of the IFRMP, including the design, prioritization, effectiveness monitoring, and adaptive management aspects of the overarching plan. The goal of this effort is to facilitate restoring and sustaining natural fish production that provides for full participation in ocean and river harvest opportunities of various fish species throughout the Klamath Basin. The IFRMP is intended to help agencies and tribes with fisheries management jurisdiction to wisely allocate funds to

support restoration and monitoring work in the Klamath Basin. This includes providing decision-making processes and tools that allow agencies to determine how to logically sequence and prioritize the implementation of actions for restoring fisheries and fish habitat, how to design monitoring and evaluation activities to assess the effectiveness of restoration actions, and how to adjust restoration actions based on what is learned. The monitoring component of the plan will also provide data necessary to inform harvest management, design fish habitat restoration actions, and support water management decisions in the basin. The plan will also incorporate monitoring and restoration being developed in an Anadromous Fish Reintroduction Plan—a separate effort being completed by the states of Oregon and California and the Klamath Tribes.

To date, the PSMFC has contracted ESSA, an environmental consultant group, to coordinate the development of the IFRMP and an associated synthesis report with fisheries agencies, tribes, and interested parties. This synthesis report is the first of several steps toward development of the overall IFRMP. An initial IFRMP workshop was held in November 2016 to identify critical building blocks for the synthesis report. Progress on the IFRMP can be tracked on the PSMFC website here: http://kbifrm.psmfc.org/.

Summary

Habitat restoration and conservation, along with improved scientific knowledge of the threats to population viability, are furthering efforts to increase survival and recovery of anadromous salmonids in the Klamath Basin. Continued commitment to these activities is imperative to restoring the Klamath River ecosystem and the communities that depend on it for their livelihood and cultural heritage. NMFS is committed to further strengthening conservation program partnerships for the preservation of salmonid populations for future generations. We will continue to report progress on these efforts to Congress.

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