SOS II: FISH IN HOT WATER

Status, threats and solutions for California salmon, steelhead, and trout.

Based on a report by Dr. Peter B. Moyle, Dr. Rob Lusardi and Patrick Samuel commissioned by California Trout.

CALIFORNIA TROUT

FISH · WATER · PEOPLE

UC DAVIS
CENTER FOR
WATERSHED SCIENCES

The foundation of *State of the Salmonids II: Fish in Hot Water* is based on 32 rigorously researched, peer-reviewed biological and ecological species accounts prepared by Dr. Peter B. Moyle, Patrick J. Samuel, and Dr. Robert A. Lusardi. Each account has been externally reviewed and will be published as *Salmon, Steelhead, and Trout in California: Status of Emblematic Fishes, Second Edition,* which can be viewed and downloaded from California Trout's website, www.caltrout.org, and the University of California, Davis Center for Watershed Sciences website, www.watershed.ucdavis.edu.

© 2017 California Trout, Inc., San Francisco. All rights reserved. Reproduction in whole, or in part, without permission, is prohibited.

STATE OF THE SALMONIDS II: FISH IN HOT WATER

Status, threats and solutions for California salmon, steelhead, and trout.

Based on a report by Dr. Peter B. Moyle, Dr. Rob Lusardi and Patrick Samuel
commissioned by California Trout.

The mission of California Trout is to ensure resilient, wild fish thriving in healthy waters for a better California.

TABLE 1. SPECIES ENDANGERMENT SUMMARY

Common and scientific names, species status (state and federal listings), and Level of Concern for all 32 of California's native salmon, steelhead, and trout.

"If knowledge is power, then this information should be critical in reversing the trend toward a continued decline of our special fishes, with California Trout at the forefront of aquatic conservation."

Dr. Peter Moyle

	SPECIES COMMON NAME	SPECIES SCIENTIFIC NAME	SPECIES STATE AND FEDERAL LISTING STATUS	STATUS SCORE	LEVEL OF CONCERN	
SALMON	California Coast Chinook Salmon	*Oncorhynchus tshawytscha*	Federally threatened	2.9	HIGH	
	Central Valley Fall-run Chinook Salmon	*Oncorhynchus tshawytscha*	Federal Species of Special Concern	2.7	HIGH	
	Central Valley Late Fall-run Chinook Salmon	*Oncorhynchus tshawytscha*	State and Federal Species of Special Concern	2.1	HIGH	
	Central Valley Spring-run Chinook Salmon	*Oncorhynchus tshawytscha*	State and Federally threatened	1.7	CRITICAL	
	Sacramento River Winter-run Chinook Salmon	*Oncorhynchus tshawytscha*	State and Federally endangered	1.3	CRITICAL	
	Southern Oregon/Northern California Coast Chinook Salmon	*Oncorhynchus tshawytscha*	Federal Sensitive Species	3.1	MODERATE	
	Upper Klamath–Trinity Rivers Fall-run Chinook Salmon	*Oncorhynchus tshawytscha*	Federal Sensitive Species	3.1	MODERATE	
	Upper Klamath–Trinity Rivers Spring-run Chinook Salmon	*Oncorhynchus tshawytscha*	State Species of Special Concern, Federal Sensitive Species	1.6	CRITICAL	
	Central California Coast Coho Salmon	*Oncorhynchus kisutch*	State and Federally endangered	1.3	CRITICAL	
	Southern Oregon/Northern California Coast Coho Salmon	*Oncorhynchus kisutch*	State and Federally threatened	1.7	CRITICAL	
	Chum Salmon	*Oncorhynchus keta*		1.6	CRITICAL	
	Pink Salmon	*Oncorhynchus gorbuscha*		1.6	CRITICAL	
STEELHEAD	Central California Coast Steelhead	*Oncorhynchus mykiss irideus*	Federally threatened	2.0	HIGH	
	Central Valley Steelhead	*Oncorhynchus mykiss irideus*	Federally threatened	3.1	MODERATE	
	Klamath Mountains Province Summer Steelhead	*Oncorhynchus mykiss irideus*	State Species of Special Concern	1.9	CRITICAL	
	Klamath Mountains Province Winter Steelhead	*Oncorhynchus mykiss irideus*	Federal Sensitive Species	3.3	MODERATE	
	Northern California Summer Steelhead	*Oncorhynchus mykiss irideus*	Federally threatened	1.9	CRITICAL	
	Northern California Winter Steelhead	*Oncorhynchus mykiss irideus*	Federally threatened	3.3	MODERATE	
	South-Central California Coast Steelhead	*Oncorhynchus mykiss irideus*	Federally threatened	1.9	CRITICAL	
	Southern Steelhead	*Oncorhynchus mykiss irideus*	Federally endangered	1.9	CRITICAL	
TROUT	Bull Trout*	*Salvelinus confluentus*	Extinct	0.0	EXTINCT	
	California Golden Trout	*Oncorhynchus mykiss aguabonita*	State Species of Special Concern	1.9	CRITICAL	
	Coastal Cutthroat Trout	*Oncorhynchus clarkii clarkii*	State Species of Special Concern	2.7	HIGH	
	Coastal Rainbow Trout	*Oncorhynchus mykiss*		4.7	LOW	
	Eagle Lake Rainbow Trout	*Oncorhynchus mykiss aquilarum*	State Species of Special Concern, Federal Sensitive Species	2.3	HIGH	
	Goose Lake Redband Trout	*Oncorhynchus mykiss newberrii*	State Species of Special Concern	3.1	MODERATE	
	Kern River Rainbow Trout	*Oncorhynchus mykiss gilbertii*	State and Federal Species of Special Concern	1.4	CRITICAL	
	Lahontan Cutthroat Trout	*Oncorhynchus clarkii henshawi*	State and Federally threatened	2.0	HIGH	
	Little Kern Golden Trout	*Oncorhynchus mykiss whitei*	Federally threatened	2.0	HIGH	
	McCloud River Redband Trout	*Oncorhynchus mykiss stonei*	State Species of Special Concern	1.4	CRITICAL	
	Paiute Cutthroat Trout	*Oncorhynchus clarkii selenirus*	Federally threatened	2.1	HIGH	
WHITEFISH	Mountain Whitefish	*Prosopium williamsoni*	State Species of Special Concern	3.4	MODERATE	

*Bull trout are not trout, but actually a member of the char family.

FOREWORD

ABOUT THE AUTHORS

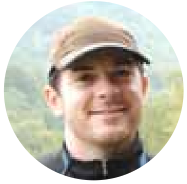
Peter Moyle is the Distinguished Professor Emeritus in the Department of Wildlife, Fish and Conservation Biology and Associate Director of the Center for Watershed Sciences, at UC Davis. He is author or co-author of more than 240 publications, including the definitive Inland Fishes of California (2002). He is co-author of the 2017 book, *Floodplains: Processes and Management for Ecosystem Services.* His research interests include conservation of aquatic species, habitats, and ecosystems, including salmon; ecology of fishes of the San Francisco Estuary; ecology of California stream fishes; impact of introduced aquatic organisms; and use of floodplains by fish.

DR. PETER B. MOYLE
Center for Watershed Sciences, UC Davis

Patrick Samuel is the Conservation Program Coordinator for California Trout, a position he has held for almost two years, where he coordinates special research projects for California Trout, including the State of the Salmonids report. Prior to joining CalTrout, he worked with the Fisheries Leadership & Sustainability Forum, a non-profit that supports the eight federal regional fishery management councils around the country. Patrick got his start in fisheries as an undergraduate intern with NOAA Fisheries Protected Resources Division in Sacramento, and in his first field job as a crew member of the California Department of Fish & Wildlife's Wild and Heritage Trout Program.

PATRICK J. SAMUEL
California Trout

Robert Lusardi is the California Trout/UC Davis Wild and Coldwater Fish Researcher focused on establishing the basis for long-term science specific to California Trout's wild and coldwater fish initiatives. His work bridges the widening gap between academic science and applied conservation policy, ensuring that rapidly developing science informs conservation projects throughout California. Dr. Lusardi resides at the UC Davis Center for Watershed Sciences and works closely with Dr. Peter Moyle on numerous projects to help inform California Trout conservation policy. His recent research interests include Coho salmon on the Shasta River, the ecology of volcanic spring-fed rivers, inland trout conservation and management, and policy implications of trap and haul programs for anadromous fishes in California.



DR. ROBERT LUSARDI
Center for Watershed Sciences, UC Davis

A WORD FROM DR. PETER MOYLE

I have a long history working with salmon and trout. My first publication on California's amazing fish fauna was a short note on juvenile Chinook salmon in the Kings River in 1970, where I captured them on a field trip with a fish biology class. Only later did I discover salmon had spawned in the river after an absence of 28 years! The resilience of salmon, steelhead, and other native fishes has continued to impress me ever since.

Unfortunately, my career has been spent documenting their decline in California, starting with the extirpation of Bull trout. But I have also long realized that California's unique fishes, especially its salmonids, are worth fighting for. Not only are they resilient, but they are beautiful, with astonishingly diverse life histories and habitats. Saving these fishes means saving special waters: the cold streams that flow through redwoods, rivers in urban southern California, unique lakes such as Eagle Lake, and complex estuaries. But saving these fishes also means living with change. Even as human-induced changes on the landscape have continued to intensify, it is the resilience of salmon and trout that keeps them with us.

But this adaptability only takes them so far; their existence now depends on what we do. I am proud to say that I have been a member of California Trout almost since its beginning, when it was pretty much Dick May, the organization's founder. From its inception, California Trout has been as much about keeping streams and lakes wild, as it has about fishing. That attitude still makes me happy to work with California Trout, even if it is to document the continued decline of our special fishes, as in this report. If knowledge is power, then this information should be critical in reversing the trend, with California Trout at the forefront of aquatic conservation.

> *"What we Californians do to enhance the resilience of our native fishes is likely to set examples for the rest of the world."*
>
> Dr. Peter Moyle

This brings us to the present State of the Salmonids report. This second edition is a much improved version of the report that Josh Israel, Sabra Purdy, and I put together in 2008 for California Trout.

This report had its genesis in the 1976 and 2002 versions of my *Inland Fishes of California*[1] and in the *Fish Species of Special Concern in California*[2] reports, which teams from my laboratory generated for the California Department of Fish and Wildlife.

The authors of this present report undertook the task of re-evaluating the status of California salmonids because:

- We really like these fishes (!);
- We wanted to provide more comprehensive information than was present in other sources, under one cover;
- We wanted to further develop and us a method for assessing the status of each species in quantitative manner that is repeatable and allows comparisons among species; and
- We wanted to discuss the many controversial ideas about how to improve management of California salmonids to reverse their downhill slide, and add some ideas of our own.

Frankly, I also thought that only California Trout was likely to be bold enough to sponsor the task of comprehensive evaluation.

The gap between the 2008 and 2017 reports is 10 years,[3] a very short period to detect change. But we felt that the time was ripe for it because the 2012-16 drought stressed virtually all salmonid populations in the state, a major test of their resilience.

We regarded the drought as harbinger of the effects of global warming/climate change. The 10-year period was also one in which much new information appeared on the salmonids, especially on species listed under the state and federal endangered species acts. As we began drafting the 2017 report, we realized that the new information and increasingly obvious impacts of climate change required us to rethink the metrics used in the 2008 report to evaluate status. In 2017, we added a new metric and improved the calculation of three others. Unfortunately, these improvements meant we could not directly compare the status scores of each species from 2008 with those from 2017, as had been planned.

We were able, however, to compare the verbal judgments of status, based on the score ranges. The verbal 'scores' still revealed that California salmonids were markedly worse off than they were 10 years ago. While drought was certainly a major contributing factor, each species has its own story to tell of unique factors causing continued decline.

It is raining outside as I write this and as we finish a record wet-water year. We can only hope that our salmonid fishes will respond positively to this dramatic turn-around in flows in our rivers. But we do have to recognize that record drought followed by record precipitation is likely to characterize the future in California; global climate change is causing increased variability in the place that already has the most variable climate in the United States.

At the same time, I consider myself fortunate to live and work in a state that often exercises leadership in conservation. Therefore, what we Californians do to enhance the resilience of our native fishes is likely to set examples for the rest of the world.

This is a big responsibility, but I am happy to be part of making it happen with California Trout.

Dr. Peter B. Moyle

[1] Moyle, P. B. 2002. *Inland Fishes of California*. Revised and expanded. Berkeley: University of California Press. 502 pp.

[2] Moyle, P., R. Quiñones, J. Katz, and J. Weaver. 2015. *Fish Species of Special Concern in California.* 3rd edition. Sacramento: California Department of Fish and Wildlife.

[3] The information in the first report only goes through 2007, while in the second report it goes through 2016, mostly.

CURTIS KNIGHT
Executive Director
California Trout

"One cannot be pessimistic about the West. This is the native home of hope. When it fully learns that cooperation, not rugged individualism, is the quality that most characterizes and preserves it, then it will have achieved itself and outlived its origins. Then it has a chance to create a society to match its scenery."

Wallace Stegner

LETTER FROM CALIFORNIA TROUT'S EXECUTIVE DIRECTOR

The story the fish tells us is clear. If we don't act, we face losing our native salmon, steelhead and trout species. This would be tragic, not just because we would lose these iconic species, their beauty, their mystery, but as importantly, we would lose what they signify – cold, clean water, healthy rivers, a better California. As a proud Californian, I take this personally. I care about the legacy I leave to my daughters, and to their children.

California is a great state. We're the innovators, the pioneers, one of the most important food producing regions in the world, and the leaders in technology. We have unmatched geographic diversity, from an epic coastline to the magnificent Sierra, majestic redwoods to the open beauty of the desert. What would the loss of our native fish mean for who we are?

I am reminded of one of my favorite quotes by Wallace Stegner, an orator of California who referred to the West as the 'geography of hope' and emphasized that we have an opportunity to create 'a society to match its scenery.'

Are we up to the challenge?

This report tells the story of the fish. Its findings lay out a clear set of actions and a path forward. The science, findings and actions can be a guide not just for CalTrout but for all organizations, agencies, regulators and funders who care about California's fish and their waters. We encourage this report being used as the blueprint to work together to reverse the trend toward extinction and return California's native salmonids to resilience.

The time to act is now. We have lost one species already – the Bull trout – in 1975. Since that time, California's human population has almost doubled. The fact that we still have 31 different kinds of salmon, steelhead and trout underscores their inherent resilience. But the recent drought has reminded us how close we are to losing more of these species. For example, the Sacramento River winter-run Chinook was likely only one dry year away from disappearing.

Forever.

In 50 years, what will California be? What legacy will we leave? Will we still be the leaders, the innovators, the food producers? Will we still have 31 kinds of trout, steelhead and salmon, or will we lose others on our watch? At CalTrout, we believe the health of these fish is an indicator of the health of our water and of our beautiful state.

We can reverse the trend. Together, we can ensure California has thriving populations of wild trout, steelhead and salmon. We can ensure our legacy for future generations by passing on a California whose society matches its scenery.

Curtis Knight, CalTrout Executive Director

TABLE OF CONTENTS

INTRODUCTION

A LIFE HISTORY INTERTWINED WITH OURS

Salmon, trout, and their relatives are the iconic fishes of the Northern Hemisphere. These salmonid fishes are characteristic of the region's cold, productive oceans, rushing streams and rivers, and deep cold lakes. They are adapted for life in dynamic landscapes created by glaciers, volcanoes, earthquakes, and climatic extremes. Salmonids thrive through their mobility, moving freely between ocean and river systems; they show an extraordinary ability to adapt in isolation to extreme local conditions from deserts to rain forests. This has resulted in a handful of species producing hundreds of genetically distinct runs, races, and subspecies, all with life histories superbly tuned to local habitats.[4] [5]

Not surprisingly, salmonids have a long history intertwined with that of diverse peoples. Salmon appear as images in Cro-Magnon cave art of 10,000 or more years ago and have been important food for indigenous peoples wherever they occur. The importance of salmonids to humans stems from their accessibility and high nutritional content; salmon bring nutrients and calories from the rich northern oceans into streams, while trout and other inland forms concentrate scarce resources present in cold water streams and lakes. In both situations they become available for human harvest. In the 17th century, at the beginning of the Industrial Revolution, angling for trout developed in Europe as a source of recreation (Walton 1653). This peculiar aesthetic led to trout, mainly Brown trout and Rainbow trout, being introduced into streams and lakes all over the world. The importance of salmon for food and sport also led to the introduction of Chinook salmon, Atlantic salmon, and Rainbow trout into the Southern Hemisphere to support fisheries and canneries. Today, Atlantic salmon and Rainbow trout are cultured worldwide.

The natural ability of salmon and trout to rapidly adapt to changing conditions is the characteristic that has made them relatively easy to culture. Their behaviors, life histories and other characteristics have been modified in response to hatchery environments and to match the desires of hatchery managers. This has resulted in some varieties of trout and salmon that are true domestic animals, wonderful for meat production but poor at surviving in the wild. For anadromous salmon and steelhead, hatchery operations were established to enhance wild populations, mainly for fisheries, and to replace lost production due to the construction of dams. As a result, such operations have sought to satisfy two rather contradictory goals: production of large numbers of fish, which requires producing fish adapted to artificial environments, and production of fish that will survive and grow in the wild. Their mixed success at satisfying the second goal is best indicated by the gradual decline in most fisheries that depend on hatcheries, rapid decline of many wild salmonid populations that interact with hatchery fish,[6] and the listing of many salmonids as species threatened with extinction under the statutes of multiple countries.

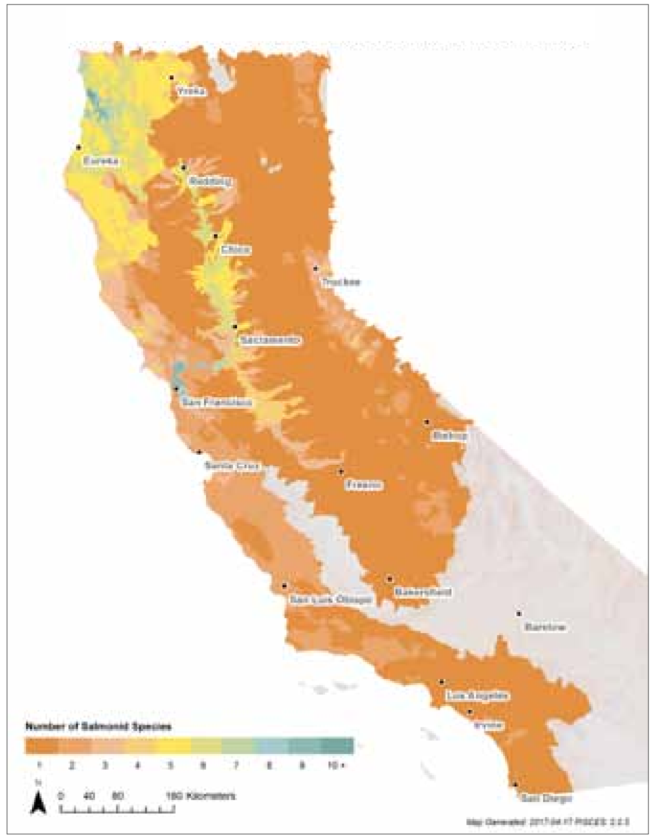
Despite their adaptability, ease of culture, and economic importance, salmonid fishes are in severe decline in many of their native habitats; many populations have been extirpated.[7] The reasons for this are complex and multiple, but boil down to a combination of human competition for use of high quality water, alteration of the landscapes through which rivers and streams flow, overfishing, use of production hatcheries to maintain fisheries, and introductions of alien species as predators or competitors. Concern for the loss of salmonid fisheries led to some of the earliest fish conservation efforts in Europe, but during the 20th century, the principal responses were to culture them in hatcheries and to limit take by fisheries. Habitat restoration, especially restoration of flows to degraded rivers, has generally been a low priority.

[4] Behnke, R. J. 2002. *Trout and salmon of North America.* The Free Press, New York.

[5] Moyle, P. B. 2002.

Nowhere in the world is the diversity of salmonids and their problems more evident than in California (Figure 1). The state not only marks the southern end of the range of all anadromous species on the Pacific Coast, but its dynamic geology and climate has resulted in the evolution of many distinctive inland forms, such as three kinds of Golden trout in the southern Sierra Nevada. The diversity of salmonids is also the result of California's large size (411,000 km2), length (spanning 10° of latitude), and adjacent location to the California Current of the Pacific Ocean, one of the most productive ocean regions of the world.[8] All this has resulted in the evolution of hundreds of genetically distinct populations, although there are just eight recognized native species.

Redwood Highway, Salmon Fishing on the Klamath River, Requa, California.
Photo: Humboldt County Historical Society.



Left: Figure 1. Current native salmonid species richness in California.

Areas in orange and brown indicate low salmonid richness, or a low total number of salmonid species in a watershed, while blue to green areas indicate watersheds with relatively higher numbers of salmonid species. The areas with the highest salmonid diversity are near the mouth of the Klamath River in far northern California and the San Francisco Estuary.

The mouth of the Klamath River. Photo: Thomas Dunklin.

[6] Levin, P. S., Zabel, R. W. and Williams, J. G. (2001). "The road to extinction is paved with good intentions: Negative association of fish hatcheries with threatened salmon." *Proceedings of the Royal Society,* London. Series B Biological Sciences 268, 1153–1158.

[7] Montgomery, D. 2003. *King of Fish: The Thousand-year Run of Salmon.* Westview Press, Boston, MA.

[8] Moyle 2002.

CALIFORNIA'S SALMONIDS

We recognize 32 distinct salmonids in California, 21 of them anadromous, 11 of them non-anadromous (Table 1, page II). Of these salmonids, 22 are endemic to California and only five are shared with neighboring states. These salmonids can all be recognized as species for management purposes under definitions in the federal Endangered Species Act (ESA) of 1973.

However, they are a combination of species, subspecies, Evolutionary Significant Units (ESUs), and Distinct Population Segments (DPSs, Box 1), as defined by National Marine Fisheries Service (NMFS) and the U.S. Fish & Wildlife Service (USFWS), the federal management agencies with oversight for ESA endangered or threatened salmon, steelhead, and trout species.

Many (15, 47%) of California's salmonids are already recognized as threatened, endangered, or extinct by state and federal governments (Table 1, page II), but the only focused overviews of all salmonids in the state have been those sponsored by California Trout.[9,10]

We undertook these overviews to compile information for all ESA-listed and non-listed California salmonids because they:

- are characteristic of most of California's inland and coastal waters, so they serve as umbrella species for much broader aquatic conservation efforts
- are exceptionally vulnerable to climate change, through rising temperatures and changing streamflow patterns
- are in a general state of decline
- are the state's most valuable and charismatic groups of fishes in its inland waters
- are not being monitored as closely as they should be, especially forms not listed under state and federal Endangered Species acts (ESAs).

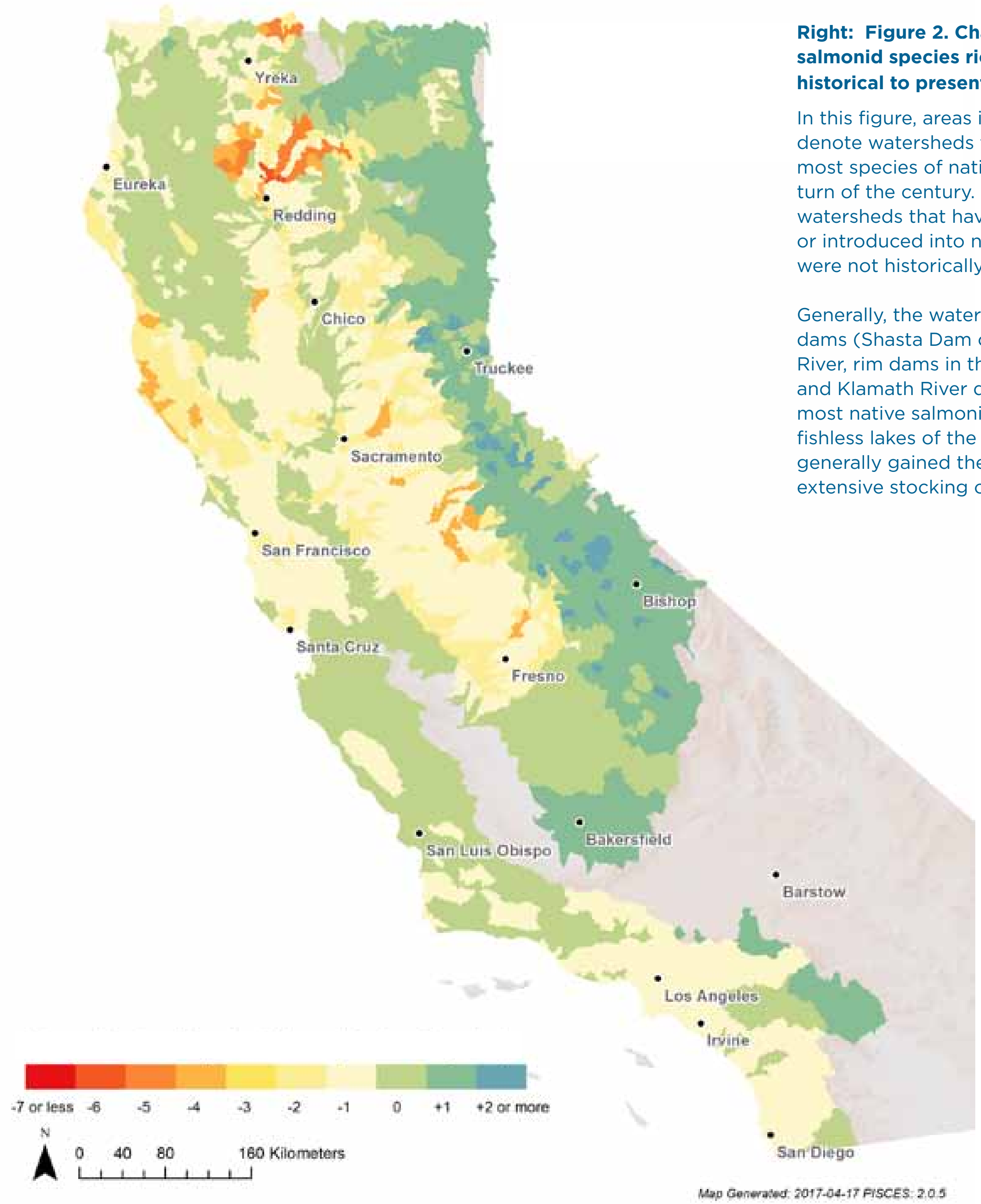
Most importantly, our goal has been establishing baseline evaluations of status that will enable repeatable, systematic comparisons of species status over the years, in response to environmental changes, climate change and other anthropogenic factors affecting populations.

It has also been our perception (and still is) that current lists of threatened and endangered species do not reflect the true condition of all salmonids in California, which have seen considerable changes on the landscape due in large part to myriad human-caused threats, considerable habitat restoration, and efforts to reintroduce species to their historical habitats (Figure 2).

Iron Gate Dam. Photo: Mike Wier.

[9] Moyle, P. et al. (2008). *Salmon, Steelhead, and Trout in California. Status of an Emblematic Fauna.* 316pp.

[10] Katz, J. et al. (2012). "Impending Extinction of Salmon, Steelhead, and Trout *(Salmonidae)* in California." *Environmental Biology of Fishes* 96:1169-1186.



Right: Figure 2. Change in native salmonid species richness in California, historical to present.

In this figure, areas in red and orange denote watersheds that have lost the most species of native salmonids since the turn of the century. Areas in blue denote watersheds that have had species stocked or introduced into new habitats where they were not historically found.

Generally, the watersheds behind major dams (Shasta Dam on the Sacramento River, rim dams in the Sierra Nevada foothills, and Klamath River dams) have lost the most native salmonids, while the historically fishless lakes of the Sierra Nevada have generally gained the most species through extensive stocking over decades.

BOX 1

Evolutionary Significant Units

An ESU is a cluster of populations that had a common evolutionary history and trajectory. While this worked to protect purely anadromous fishes, such as salmon, it did not work for anadromous rainbow trout, which often were one genetic population that included resident trout populations. This necessitated a different management unit, the Distinct Population Segment.

Distinct Population Segment

NMFS and USFWS created the Distinct Population Segment (DPS) management concept for steelhead, in order to list anadromous forms of Rainbow trout under the Endangered Species Act due to the sharp declines in abundance, while not listing resident forms, which were relatively more abundant in most watersheds.

SUMMARY AND FINDINGS

A GLOBAL LOSS OF DIVERSITY?

In this State of the Salmonids II report we explore the following questions:

What is the status of all California salmonids, both individually and collectively?

What are major factors responsible for their present status, especially of declining species?

How can California's salmonids be saved from extinction?

This second edition is timely. During the writing of the first edition of the State of the Salmonids report in 2008, the commercial salmon fishery was closed due to low adult returns. Each year since then, the fishery has been restricted or constrained in some way.

At the writing of this report, the commercial salmon fishery is again closed for the 2017 season. The northern part of the state is emerging from historic drought (2012-2016), which saw significant negative impacts on salmonid populations and juvenile survival.

Further, new information, especially in the form of federal and state agency reports, and genetic and life history research that was not available before have been published, helping to paint a clearer picture of the true plight of California's salmonid populations. While California's climate, precipitation patterns, and trends in salmonids has changed, monitoring efforts, especially for species not listed under the Endangered Species Act, remain insufficient.

In 2015, our partners at Trout Unlimited released the *State of the Trout* report,[11] which provided a broad overview of the status, trends, and threats facing the trout species across the United States. While that report provided a general overview, this report dives more deeply into the status and trends facing all of California's salmonids at the southern edge of their range.

Status reviews are needed more frequently to alert managers and others on changes in the trends of the salmonids across California. While considerable efforts were made to compare the results of this second edition with the first edition of the *State of the Salmonids* report (2008), the level of information available for most species has greatly improved, as has our understanding of the threats they face and their impacts on salmonid populations. As a result, our current effort uses vastly improved metrics to portray what we feel is a considerable improvement in the quality of the status assessments for each species.

This report will alert agencies, stakeholders, and the public to the potential extent of the problem with declining salmon, steelhead, trout and their waters in order to encourage strategic conservation, especially in the face of climate change. In fact, the decline of California salmonids is a problem of national significance. Because of its complexity, California produces conditions similar to conditions throughout the range of salmonids, but its southern location and extreme development of water resources means the state's problems presage those of other areas. Loss of California's salmonids means a global loss of diversity.

[11] Trout Unlimited. (2015). *State of the Trout: A Report on the Status and Trends of Native Trout in the United States.* Trout Unlimited, Arlington, VA.

[12] Moyle, P. et al. (2013). *Climate Change Vulnerability of Native and Alien Freshwater Fishes of California: A Systematic Assessment Approach*. PLoS ONE 8(5): e63883.

SOS! STATE OF THE SALMONIDS

At the current rate, California stands to lose 45% of its remaining native salmonids, including 11 of 21 anadromous species and 3 of 10 of its inland species, in the next 50 years unless significant actions are taken to stem the decline. (Figure 3). **Under present conditions, 23 of the remaining 31 species (74%) are likely to be extinct in the next 100 years.**

There are three main reasons for changes in the Level of Concern across nearly all salmonids since 2008 (Figure 4):

1. the 2012-16 historic drought in California,
2. improved information, and
3. increased understanding of climate change impacts on salmonids.

The Level of Concern is increasing for California's salmonids, but especially for its anadromous species. In general, anadromous species in California face a higher risk of extirpation from their range than inland native trout because they depend on access to diverse, high quality habitat during various parts of their life cycle, and are therefore exposed to numerous anthropogenic and environmental threats throughout their lives.

For most species, abundance generally declined due to reductions in suitable habitat stemming from drought impacts. An improved understanding of genetics, abundance, and species range information has also positively or negatively impacted species status. For example, the Level of Concern for Central Valley steelhead remained the same (Moderate) since 2008 due to a better understanding of the nature of steelhead/resident Rainbow trout interactions and genetics, despite recent low adult returns. Conversely, the Central Valley fall-run Chinook salmon Level of Concern increased significantly (from Low to High) since 2008 due to a better understanding of the limited abundance of wild individuals without signs of hybridization with hatchery fish.

Finally, the climate change scoring in this report has built upon recent work[12] and a better understanding of the specific impact climate change is likely to have on each species, which led to a score reduction of the climate change factor in nearly all cases.

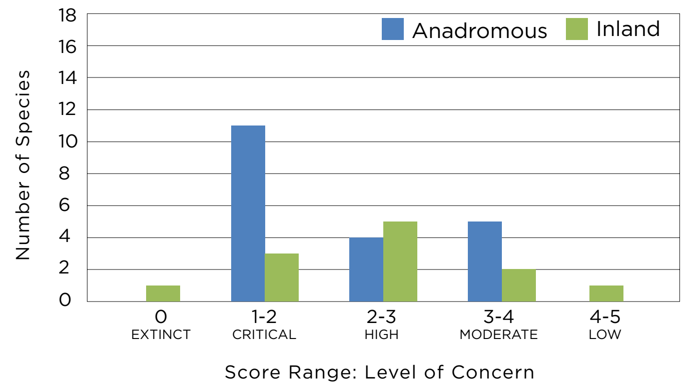


Figure 3. Status of California salmonids; 21 anadromous species and 11 inland species.

Anadromous species include all salmon, steelhead and Coastal Cutthroat trout. Inland species include all trout (with the exception of Coastal Cutthroat and Bull trout) as well as Mountain Whitefish.

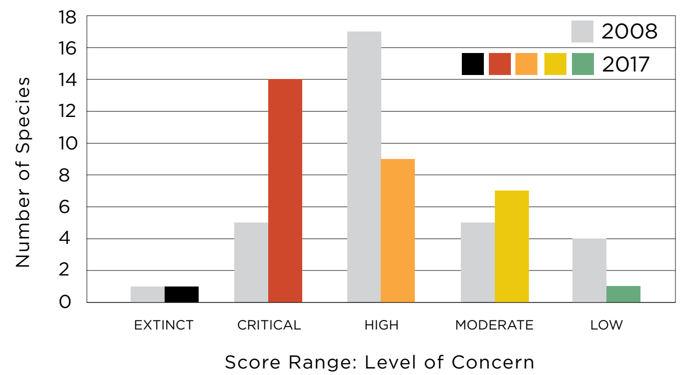
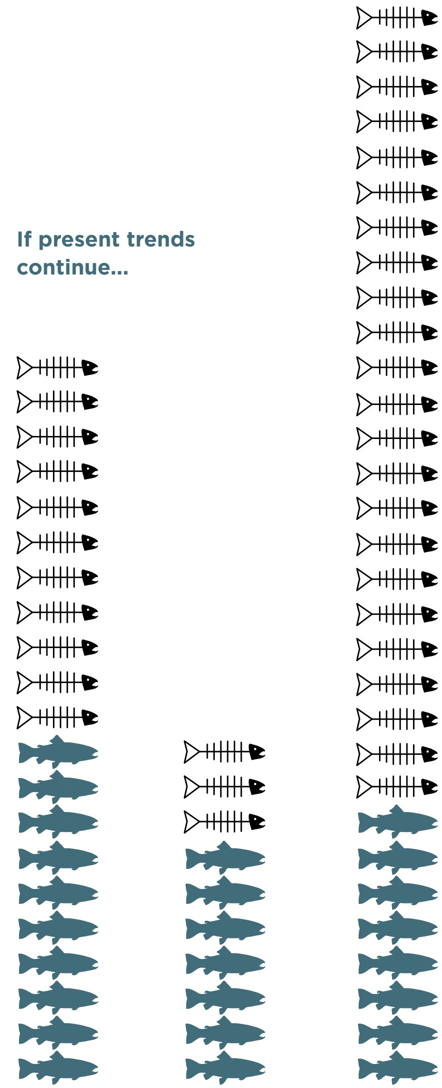


Figure 4. Change in Level of Concern 2008 to 2017

If present trends continue...



Within 50 years 11 of 21 (52%) of California's anadromous species are likely to be extinct.

Within 50 years 3 of 10 (30%) of California's inland species are likely to be extinct.

Within 100 years 23 of 31 (74%) of California's remaining species are likely to be extinct.

OPEN HERE TO SEE ANTHROPOGENIC THREATS

THE EFFECTS OF CLIMATE CHANGE ON CALIFORNIA SALMONIDS

Climate change was scored as a critical or high threat for 26 of 31 species (87%).

It is the major, overarching anthropogenic threat affecting salmonids in California. Due to its high impact and importance to the long term survival of all salmonids in California, it is highlighted below.

Climate change was scored a critical or high threat for a majority of species, and was considered a low threat to only one species.

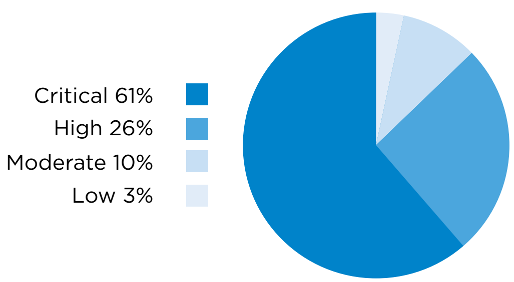


Figure 5. Climate change threat score (%) for California's 31 remaining salmonids.

1. LACK OF COLD WATER

Salmon, steelhead, and trout in California rely on cold, clean water to survive. Climate change is likely to reduce availability and access to cold water for salmonids in California through increasing average air temperatures and decreasing precipitation. In general, dry areas are likely to become drier, while wet areas are likely to get wetter. Particularly at higher elevations in California, precipitation is likely to fall as rain rather than snow, reducing overall snowpack and the critical snowmelt that provides cold water year-round to California's salmonid species.

2. LOW AND VARIABLE STREAMFLOWS

Earlier runoff during the spring is anticipated, causing prolonged periods of low streamflows during summer and early fall. Variability in weather will also increase, causing more frequent, prolonged drought and high intensity storm events. Higher magnitude winter floods, reductions in annual streamflow, and broad declines in cold water habitat for fishes are already occurring, with increasing rates of these changes anticipated.

3. CONSTRICTED HABITAT

All salmonids require thermal refuge areas, diverse habitats, and broad ranges to persist in the face of climate change. Species with very limited ranges, such as Eagle Lake Rainbow trout, and those that over summer in freshwater waiting to spawn, such as spring-run Chinook salmon and summer steelhead, are most susceptible to climate change because they are least able to access these refuge areas, which are largely inaccessible behind dams, diversions, and waterfalls.

4. REDUCED HABITAT SUITABILITY AND SURVIVAL

As temperatures increase and streamflow regimes change, habitats become less suitable for native salmonids and invasive species tend to thrive. Alterations in the amount and timing of streamflows reduces the survival of all juvenile salmonids. In the Pacific Ocean, sea surface temperatures are likely to increase, making ocean habitats less suitable for growth and survival of salmon and steelhead in the future.

5. FOOD WEB ALTERATION

In the Pacific Ocean, climate change is likely to reduce the powerful upwelling of the California Current, which drives primary productivity and supports the entire food web for all marine life, including anadromous fishes. Increased ocean acidification is also likely to impact ocean productivity.

6. RISING SEA LEVELS

Rising sea levels are likely to inundate and degrade important estuarine and lagoon habitats, historically critical components of the juvenile salmon and steelhead life cycle.

The majority of salmonid species in California is currently facing, or is likely to face, extinction from climate change if present trends continue. Salmon, steelhead, and trout have adapted to a wide variety of climatic conditions in the past, and could likely survive substantial changes to climate in the absence of other anthropogenic stressors. By taking actions to reduce anthropogenic threats identified in this report, allowing salmonid species access to a variety of high-quality habitats at appropriate times, and increasing population abundance, species resilience to climate change can be improved.

ANTHROPOGENIC (HUMAN-CAUSED) THREATS

The population of California is approaching 40 million people. We live in a highly altered natural environment. As such, the human impact on the state's salmonids were important to include in the SOS II report because:

1. California's salmonids can adapt to natural environmental change, but that ability is limited when faced with these human-induced threats.
2. Human-caused threats limit the long-term viability of salmonid populations by decreasing their resilience to change.
3. Determining which threats have the greatest impact on species can help to target conservation and restoration efforts, providing a roadmap for a return to resilience.

For each species, an analysis was conducted of 15 anthropogenic factors (illustrated at left) which limit, or potentially limit, a species' viability. The threats were rated for each species by critical, high, medium, low, or not applicable (n/a).

The top three anthropogenic threats, after climate change, vary by anadromous and inland species as would be expected given their different life histories. The top threats to anadromous species are overwhelmingly estuary alteration, major dams, and agriculture, while inland species face threats from alien species, fire, and hatcheries.

For more information on the impact of each anthropogenic threat to California's salmonids, see the illustration fold-out at left.

For more details on how the anthropogenic threats were ranked visit Methods at the back of this report.

TOP 3 ANTHROPOGENIC THREATS TO ANADROMOUS SPECIES

ESTUARY ALTERATION

Estuary and lagoon habitat has been significantly reduced through conversion to support the state's growing population and myriad land uses. Loss of these productive rearing habitats statewide, but especially in the highly altered Sacramento-San Joaquin Delta, reduces survival for all salmonids.

CRITICAL/HIGH THREAT:
13 of 21 (62%)
anadromous species

MAJOR DAMS

Dozens of major and thousands of smaller dams block access to historical salmon and steelhead habitat. Dams also alter flow regimes by changing the timing, magnitude, duration, rate of change and frequency of historical streamflows.

CRITICAL/HIGH THREAT:
13 of 21 (62%)
anadromous species

AGRICULTURE

California's booming agricultural industry reduce the survival and productivity of all salmon runs in the state. Agricultural demands on water reduces and alter the timing of streamflows that degrade water quality and habitat.

CRITICAL/HIGH THREAT:
8 of 21 (38%)
anadromous species

TOP 3 ANTHROPOGENIC THREATS TO INLAND SPECIES

ALIEN SPECIES

Brown and Brook trout have been introduced extensively across California, and are sources of competition and predation for native trout. These non-native species are generally better able to survive in degraded habitats historically occupied by native species.

CRITICAL/HIGH THREAT:
7 of 10 (70%)
inland species

FIRE

Fires may potentially wipe out entire populations through direct mortality, sedimentation and siltation of habitat, and destruction of riparian habitat, especially for species with very limited ranges. Climate change is likely to increase the risk of more frequent and intense fires in California in the future.

CRITICAL/HIGH THREAT:
2 of 10 (20%)
inland species

HATCHERIES

Hatchery-origin Rainbow trout strains have been widely stocked across California for over a century. These fish hybridize with native Redband, Rainbow, Golden, and Cutthroat trout, and their offspring replace genetically pure populations in the limited habitats they still occupy.

CRITICAL/HIGH THREAT:
2 of 10 (20%)
inland species

ANTHROPOGENIC THREATS

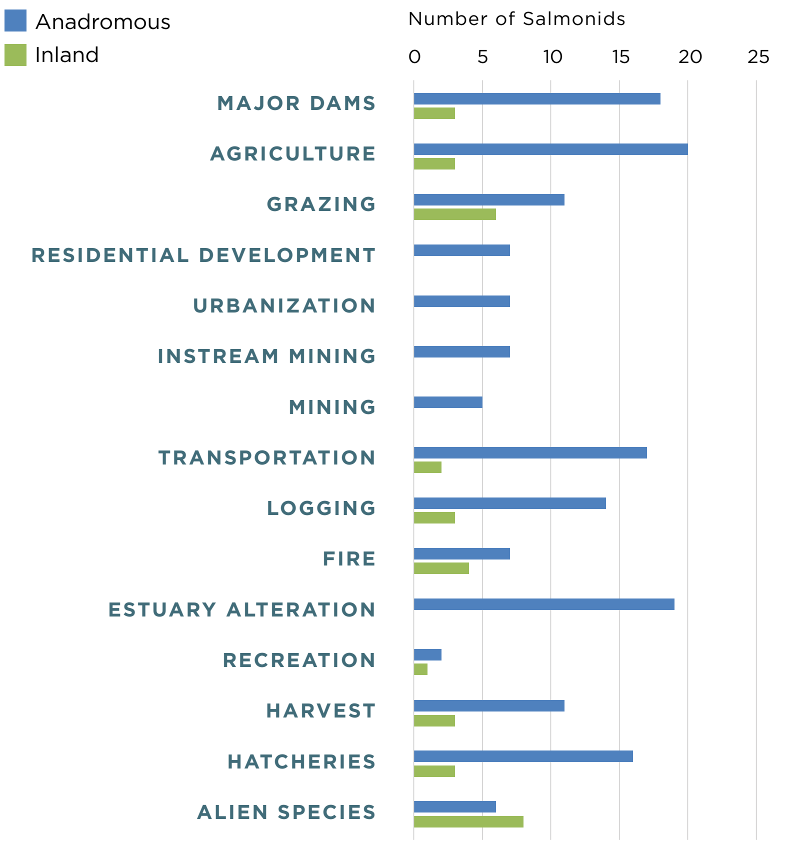


Figure 6. Number of anadromous and inland salmonids with critical, high and medium threat levels by anthropogenic threat.

FIRE

Wildfires are a natural component of California's landscape. However, fire suppression, coupled with climate change, has made modern fires more frequent, severe and catastrophic. The transition from relatively frequent understory fires to less frequent, but catastrophic, crown fires can have a severe impact on fish habitat and wipe out populations with narrow habitat ranges.

LOGGING

Many heavily logged watersheds once supported the highest species diversity and abundance of fishes, including anadromous salmon and steelhead. Improperly managed logging increases sediment in streams, increases solar input which increases stream temperatures, and degrades riparian cover. Stream habitat is also degraded by the extensive network of unpaved roads that supports timber extraction.

RECREATION

Human use of streams, lakes, and surrounding watersheds for recreation has greatly increased with population expansion. Boating, swimming, angling, off-road vehicles, ski resorts, golf courses and other activities or land uses can negatively impact salmonid populations and their habitats. The impacts are generally minor; however, concentration of multiple activities in one region or time of year may have cumulative impacts.

INSTREAM MINING

Widespread and often severe instream mining impacts occurred mid-19th to early 20th century due largely to hydraulic mining. Many rivers were excavated, dredged, and hydraulically mined for gold, causing dramatic stream degradation. Instream gravel mining also removed riparian vegetation and spawning gravels and degraded riparian habitats. Such mining is now largely banned, but lasting impacts remain in many areas.

HATCHERIES

Hatcheries and releases of hatchery reared salmonids into the wild can negatively impact wild populations through competition, predation, disease, and loss of fitness and genetic diversity. Hatchery influences are especially apparent to for anadromous species where dams blocked access to spawning habitat and hatcheries were established as mitigation. Inland trout can also be impacted with stocking of hatchery fish for recreation.

MAJOR DAMS

Dams block access to historical spawning and rearing habitats. Downstream, dams alter the timing, frequency, duration, magnitude, and rate of change of flows decreasing habitat quality and survival.

AGRICULTURE

Impacts from agriculture include streams polluted by agricultural return water or farm effluent; reduced flow due to diversions which can affect migratory patterns; and increased silt and pesticides in streams. Marijuana grow operations, legal and illegal, were considered in this metric.

GRAZI

Improperly
livestock g
damage str
limit riparia
and increas
This can res
habitat com
stream tem
decreased s
conditions.
meadow str
down cuttir
meadows d
reductions

NG

managed
razing can
reambanks,
n vegetation
e sedimentation.
sult in a loss of
nplexity, increased
peratures, and
spawning habitat
Severe grazing in
reams can cause
ng resulting in
rying out and
in streamflow.

MINING

This factor refers to hard rock mining, from which contaminated tailings, mine effluents, and toxic pollutants may have been dumped or leached into streams, mostly from abandoned mines. Mercury mining, used for processing gold in placer and dredge mining, left a lasting negative impact on wildlife.

ESTUARY ALTERATION

All anadromous salmonids depend on estuaries for rearing during a portion of their lives. Most estuaries in the state are highly altered from human activities, especially diking, draining, and sandbar removal between the estuary and ocean. Land-uses surrounding estuaries often involve extensive wetland reclamation, greatly reducing ecological function and habitat complexity.

RESIDENTIAL DEVELOPMENT

As California's population grows, rural development increasingly encroaches along or near streams. Resulting impacts include water diversions, groundwater pumping, streambed alteration (to protect houses from flooding, construct road crossings, etc.), and pollution (especially from septic tanks and illegal waste dumping).

URBANIZATION

Development of towns and cities often negatively affects nearby streams through alteration for flood prevention, channelization, and water diversion, and increased pollution. The timing and magnitude of flows are altered by the increase in impervious surfaces such as pavement. Pollution from surface runoff, sewage discharges, and storm drains can degrade water quality and aquatic habitats.

HARVEST

Harvest relates to legally regulated commercial, tribal, and recreational fisheries, as well as illegal harvest (poaching). Over-harvest can have substantial impacts on fish populations, particularly for those with already limited abundance or distributions, those which are isolated or reside in discrete habitats making them easy to catch (e.g. summer steelhead), or those that attain large adult size (e.g., Chinook salmon).

ALIEN SPECIES

Non-native species (including fishes and other aquatic organisms) are ubiquitous across many of California's watersheds; their impacts on native species through hybridization, predation, competition, increased disease transmission, and habitat alteration can be severe.

TRANSPORTATION

Transportation corridors such as highways confine stream channels and increase sedimentation, pollution, and habitat degradation from storm runoff and altered streamflows. Culverts and other passage or drainage modifications associated with roads often block migration and restrict fish movements, which can fragment populations.

RETURN TO RESILIENCE

SAVING CALIFORNIA'S SALMONIDS FROM EXTINCTION

The science behind this report has made it clear: many of salmon, steelhead, and trout are in poor condition with the last several years of severe drought pushing several species to the edge of extinction. To reverse the extinction trend, more Californians need to care.

We must do a better job of making the case that diverse and resilient wild populations of trout, steelhead and salmon matter not just to fish lovers, but to all Californians. Resilient fish populations indicate healthy waters, important for drinking water, agriculture, commerce, and the health of people and the environments in which we live. Declining fish populations indicate degraded waters, which threaten the health and economic well-being of all Californians.

The good news is that 31 of our 32 salmonid taxa still persist. We have an opportunity to reverse this trajectory toward extinction, but the findings of this report underscore that we must act now. We must take bold, scientifically informed, and innovative actions to improve resilience of our native salmon, steelhead, and trout and the waters upon which we all depend.

Improving resilience requires an improvement in salmonid life history diversity. Salmonids have responded and adapted to environmental change for more than 50 million years due to variation in their life histories and behavior. Much of this variability is tied to differences in the timing of fresh water and ocean migrations. These timing differences contribute to life history diversity which, in turn, promotes species resilience to change. Over the last century, life history and behavioral diversity has been greatly diminished due to changes in habitat, discontinuity between habitats, genetic homogenization, and interactions with non-native species. The relatively recent reduction in salmonid life history and behavioral diversity means that salmonids are less able to adapt to a rapidly changing California. Access to diverse and productive habitats, and reductions in interactions between hatchery and wild salmonids, are fundamental to restoring salmonid resilience throughout California. Many of the historically productive and diverse habitats used by salmonids are either blocked behind dams and levees or are significantly altered and no longer function properly. Restoring such habitats and access to them is of paramount importance.

Improving salmonid status throughout California requires investing in productive and diverse habitats that promote salmonid diversity and resilience. Here is California Trout's action plan to return our rivers and salmon, steelhead, and trout to resilience. If fully implemented, many of the species in this report will thrive.

PROTECTING AND RESTORING PLACES THAT MATTER MOST

STRONGHOLDS: PROTECT THE BEST

We must protect the best of what habitats are left. Few fully functioning river ecosystems, with relatively intact watersheds and high-quality habitat, exist today in California, such as the Smith River, Blue Creek, the Eel River and Butte Creek, among others. This is reason enough to make managing systems like these in perpetuity the highest priority, to protect salmonid diversity and production.

PROTECT AND RESTORE SOURCE WATERS

Protecting and restoring source waters including meadows, springs, and groundwater will allow them to continue to provide refuges for salmonids during stressful times and buffer the effects of climate change. Source headwaters are key to hydrologic connectivity and are vital during periods of low streamflows and drought.

RESTORE PRODUCTIVE AND DIVERSE HABITATS

Restoring function to once-productive but now highly altered habitats can greatly improve rearing conditions for juvenile salmonids, especially floodplains, coastal lagoons, estuaries, and spring-fed rivers, can greatly improve rearing conditions for juvenile salmonids. These types of habitats are relatively scarce, yet are vital nurseries for juvenile fishes and support robust growth rates when compared with typical in-river conditions. Improved growth prior to ocean migration and high life history diversity increases the likelihood of marine survival and adult returns to natal tributaries.

STRATEGIES TO PROMOTE

ADOPT RECONCILIATION ECOLOGY AS THE BASIS FOR MANAGEMENT: WILD FISH IN WORKING LANDSCAPES

Reconciliation Ecology recognizes that most ecosystems are altered by human actions, with people as a key part of the ecosystem. Therefore, highly managed ecosystems in working landscapes must play a major role in contributing to salmon diversity and abundance. If the mechanisms supporting salmonid growth and life history diversity can be restored or recreated in human-dominated ecosystems, these "working landscapes" can be put to work to recover salmonids throughout California. Current work on the Yolo Bypass in the Central Valley, for example, shows that managing rice fields to mimic natural floodplains creates substantial growth benefits for juvenile salmon.

IMPROVE HABITAT CONNECTIVITY AND PASSAGE TO HISTORICAL SPAWNING AND REARING HABITAT

Removing dams and fish passage barriers or providing volitional passage to historically important spawning and rearing habitats is key for persistence of many anadromous salmonids. Access to lost habitats will help boost population abundance, improve life history diversity, and population resilience to environmental changes. For populations downstream of dams, there is a need to institute scientifically based environmental streamflow regimes throughout California that favor native species.

IMPROVE GENETIC MANAGEMENT

Broad changes to the way salmonid hatcheries are operated throughout California need to be instituted. Changes should include reducing gene flow between hatchery and wild salmonids, minimizing hatchery straying into non-natal watersheds, and marking all hatchery fish with an adipose fin clip so that they can be readily distinguished from wild fish, and using strict mating protocols to discourage inbreeding and fitness reduction.

We call this plan a "Return to Resilience" because both salmonids and their managers must be resilient in response to change wrought by the ever-increasing human demands on the planet.

Without this kind of plan, and commitments to implement it, the main option is to accept the loss of most salmonid diversity in California, with a few populations maintained as low-diversity "boutique" populations, to remind us of our lost past and bleak future.[13]

[13] Lackey, R., Lach, D., and S. Duncan. 2006. Salmon 2100: *The Future of Wild Pacific Salmon.* American Fisheries Society, Bethesda, MD, i-vii, (2006).

CALTROUT: PROTECTING CALIFORNIA'S FISH AND WATERS SINCE 1971

California Trout's mission is to ensure resilient wild fish thriving in healthy waters for a better California. Our unique business model provides science-based solutions to complex resource issues while balancing the needs of wild fish and people. The *SOS II: Fish in Hot Water* Report informs our blueprint and ensures our work is focused on the right priorities. These are:

PROTECT STRONGHOLDS

There are still rivers in California that produce abundant wild steelhead and salmon – and we intend to keep them that way.

RESTORE SOURCE WATERS

Source water areas are the life blood of the state – in particular the Sierra headwaters and the volcanic spring aquifers of the Mt. Shasta area.

WILD FISH, WORKING LANDSCAPES

California's rivers and landscapes have been highly altered and, as a result, wild fish populations have suffered. CalTrout is finding innovative ways to put nature back into the mix, bringing wild fish back into California's working landscapes.

CalTrout's "Nigiri Project" at Knaggs Ranch; working with agricultural floodplains to regenerate salmon populations. Photo: Mike Wier.

We are California-focused. Our expert staff are rooted in local communities, hard at work implementing over 30 large-scale, on-the-ground conservation projects in key geographical areas where wild fish influence the community: North Coast, Mount Shasta/Klamath, Sierra Headwaters, Central California, and Southern California.

We lead innovative, science-based solutions that work for the diverse interests of fish, farms, commerce, and community. Our successful proof-of-concept projects establish precedent, empowering partners and influencing statewide policy.

This work would not happen without the support of our partners and donors. Thank you for trusting CalTrout to protect our state's fish and waterways.

SPECIES ACCOUNTS

The following 74 pages describe 32 species accounts: one for each kind of native salmon, steelhead, and trout.

Each account has been distilled from comprehensive, peer-reviewed life history accounts and scoring rubrics prepared by Dr. Peter B. Moyle, Dr. Robert Lusardi, Patrick Samuel, and will be published as *Salmon, Steelhead, and Trout in California: Status of Emblematic Fishes, Second Edition.* Readers interested in learning more about the diverse salmonid species in California, report methods, science underlying the scoring in the accounts, and obtaining references for further reading can find the full report on California Trout's website (www.caltrout.org) and UC Davis' Center for Watershed Sciences website (www.watershed.ucdavis.edu). A glossary is provided at the end of the report for reference.

APPROACH

The general approach taken in the analysis was to:

- Compile literature, administrative reports, survey data, interviews with species experts, and other information for all 32 kinds of salmon, steelhead, and trout.
- Produce detailed accounts on the biology, threats, and status for all species.
- Evaluate the status of each species using a set of standard criteria.
- Conduct an overall analysis of the status of California's salmonids and of the factors affecting their status based on information summarized in the species accounts.

The status of each extant species was determined using seven criteria (area occupied, estimated adult abundance, environmental tolerance, genetic risk, dependence on human intervention, anthropogenic threats, and climate change (Table 2). Each criteria was then scored on a scale of 1.0 to 5.0, where 1.0 was the lowest possible score for an extant species and 5.0 was the highest score. The seven criteria were equally weighted and averaged to produce an overall score for each species.

Species scoring an average of 1.0 to 2.9 were regarded as being in serious danger of extinction within the next century, while species scoring higher were regarded as reasonably secure for the immediate future. The research team recognized that information for determining the status for some species was incomplete and uneven, and developed a "reliability index" to give a sense of the certainty associated with the status scoring determination. A reliability score of "one" indicated the status rating selected had low reliability because little peer-reviewed information was available, whereas a reliability score of "four" indicated the status rating selected was highly reliable, based on numerous accounts in the published literature and agency reports.

METRIC	SCORE	JUSTIFICATION
Area occupied	1	Unhybridized California Golden trout are confined to a few small tributaries in one watershed.
Estimated adult abundance	3	Volcano Creek populations may be <1,000 but, if other populations with conservation value within native range are counted, the numbers would be much higher, perhaps 50,000.
Intervention dependence	2	Annual monitoring of barrier performance required; continued implementation of Conservation Strategy is critical. Rescued individuals from Volcano Creek will need to be re-introduced based on genetic management strategy.
Environmental tolerance	3	Generally tolerant of a wide range of conditions and habitats within their native range.
Genetic risk	1	Hybridization with rainbow trout is a constant high risk.
Climate change	1	Rated critically vulnerable in Moyle et al. (2013).
Anthropogenic threats	2	1 High, 1 Medium threat.
Average	1.9	LEVEL OF CONCERN: CRITICAL
Certainty (1-4)	4	Well-documented.

Right: Table 2. Example of California Golden trout status scoring assessment.

For the complete Methods used to assess the status of salmonids, readers should consult the methods section at the end of this report.

SCORES EXPLAINED

To graphically represent the Level of Concern for each salmonid in California, a scoring bar is used to represent categorizies from 0.0 to 5.0:

4.5

4.0 - 5.0
LEVEL OF CONCERN: LOW

Regarded as being healthy, with large populations that spawn in California, a wide distribution inside the state, and were stable and/or expanding outside their native range.

3.5

3.0 - 3.9
LEVEL OF CONCERN: MODERATE

Considered to be under no immediate threat of extinction but were in long-term decline or had naturally small, isolated populations.

2.5

2.0 - 2.9
LEVEL OF CONCERN: HIGH

Considered to be under severe threat of extinction in 50-100 years. These species could easily slip into the first category if current trends continue.

1.5

1.0- 1.9
LEVEL OF CONCERN: CRITICAL

Regarded as being in serious danger of extinction in their native range within the next 50 years.

0

0
LEVEL OF CONCERN: EXTINCT

MAPS EXPLAINED

Each species account includes a range map generated from PISCES (Figure 7), which is a software and data clearinghouse for the best-known ranges for native fishes of California, housed at the University of California, Davis Center for Watershed Sciences. The data used to generate maps are compiled from multiple sources and experts and is stored and exported as range and summary maps.

The species range maps presented here show the watersheds in which each species was historically found and where they can be found today as a result of dam building, stocking, reintroduction efforts, and other factors. Some species have been translocated, or captured, transported, and released into habitats where they were not historically found to help increase their range or establish refuge populations for future reintroduction efforts.

HISTORICAL RANGE

Historical range indicates a species range before human settlement of California. Current range indicates where a fish can be found today and is shaded to differentiate direct observations, such as surveys or other confirmed sightings, and the expert opinion of professional biologists familiar with the species.

TRANSLOCATED RANGE

Translocated range indicates a species range that has been expanded beyond its historical range through purposeful capture, transport, and release and is shaded to differentiate between direct observations and expert opinion.

Note

These scores (left) are for species status in California only. A species like Chum salmon that is on the verge of extinction in California, for example, has a low score even though it is abundant in much of its range north of Oregon.

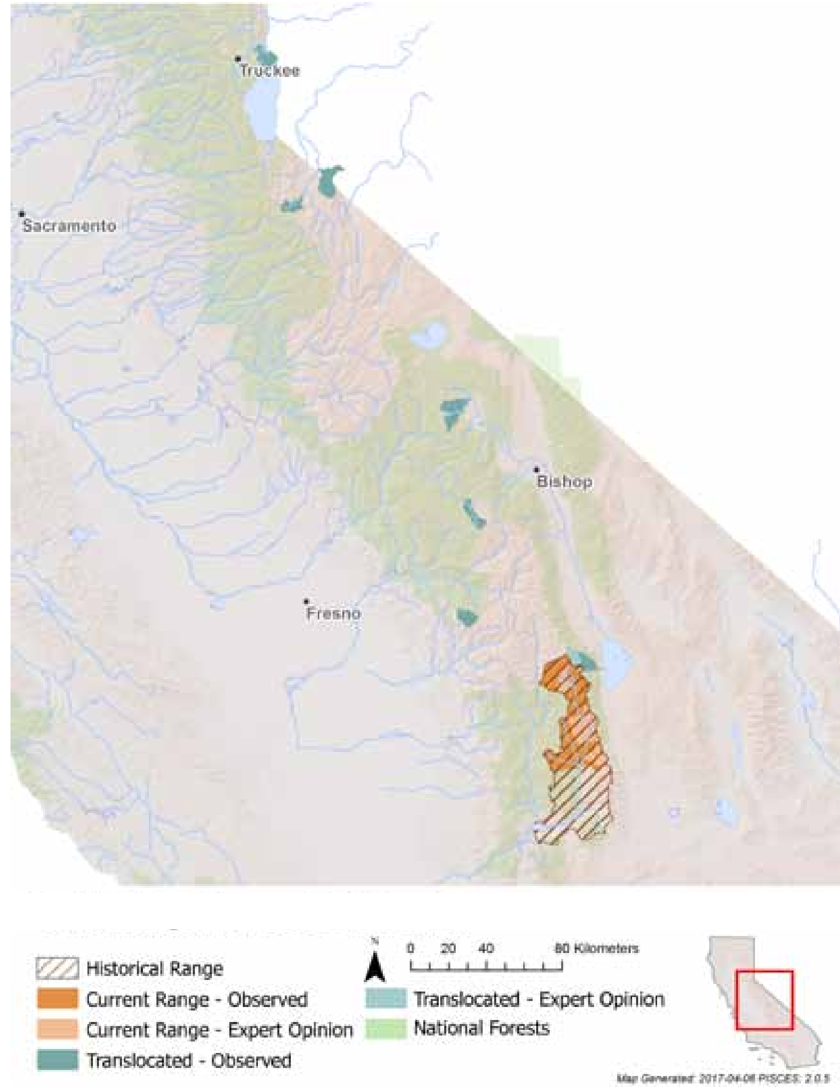


Figure 7. Example of a PISCES distribution map for California Golden trout.

Every effort has been made to provide accurate species distribution maps, but interested readers should consult the full report for detailed range descriptions.

SALMON

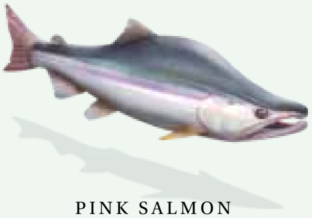
Oncorhynchus

California's diverse geography and habitats have allowed four species of salmon to live at the southern end of their ranges: Chinook, Coho, Pink, and Chum. California Chinook occur as eight genetically distinct populations (Evolutionary Significant Units or ESUs), seven of which are found only in California. Likewise, there are two ESUs of Coho salmon, one endemic to the state. California's small runs of Pink and Chum salmon may actually be maintained from strays from northern populations in Oregon or Washington, but more research is needed on the origins of these fish. Perhaps the most distinctive of these salmon is Sacramento River winter-run Chinook salmon, having evolved to exploit the cold, spring-fed waters found year-round in tributaries of the upper Sacramento River.

CHINOOK SALMON
Oncorhynchus tshawytscha

COHO SALMON
Oncorhynchus kisutch

CHUM SALMON
Oncorhynchus keta



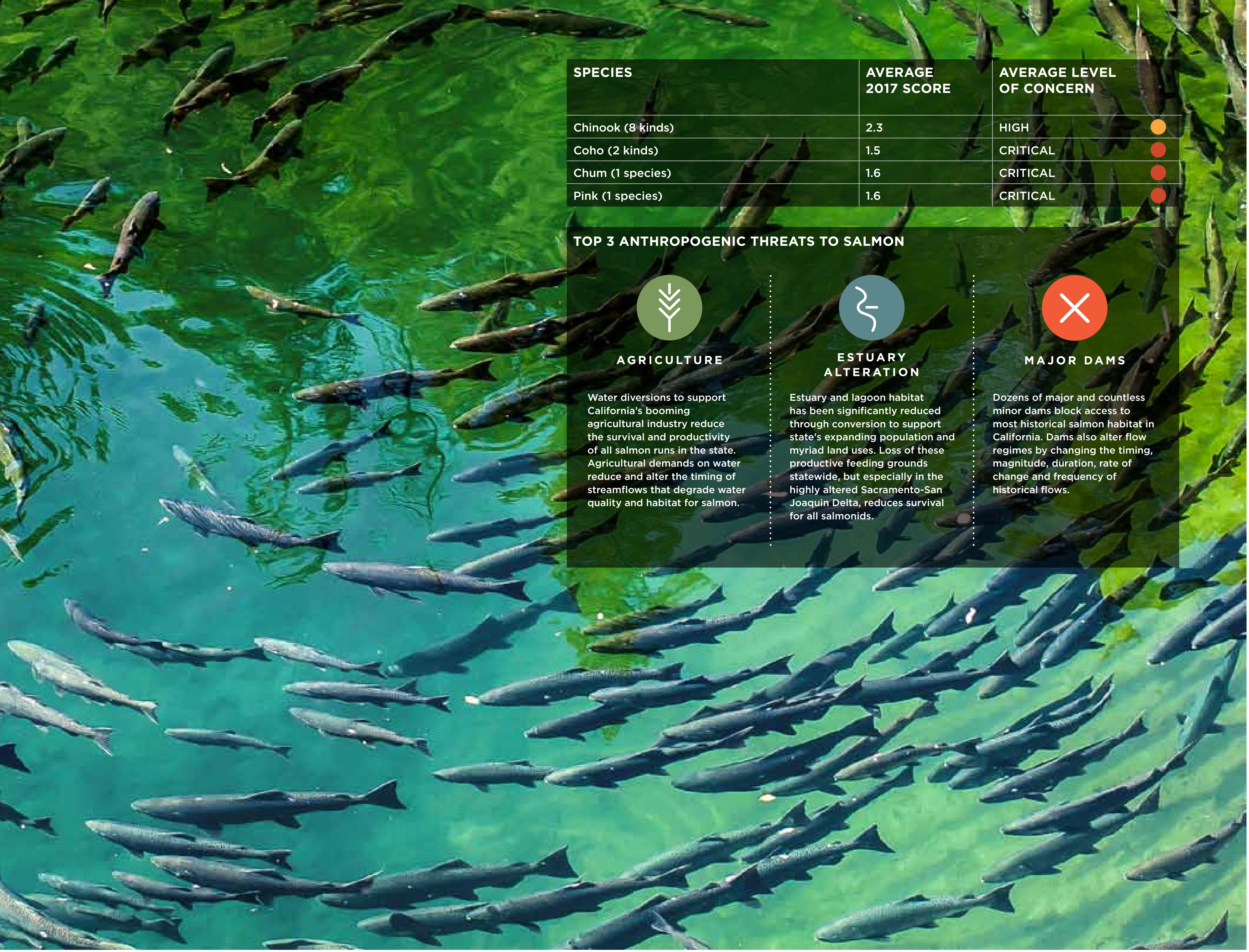
PINK SALMON
Oncorhynchus gorbuscha

HABITAT AND BEHAVIOR

All salmon species are adapted to cold, clean, fresh water habitats but spend the majority of their lives at sea. They seek out natal streams using an acute sense of smell to spawn and complete their life cycles. Female salmon select a site to dig a redd in loose gravel and cobbles, with appropriate streamflow, depth, and temperature, and then deposit up to several thousand pea-sized pink to orange eggs. Males defend females and fertilize the eggs. Once in fresh water, adult salmon do not eat, and die shortly after spawning. Alevins emerge after several weeks to months in gravel, and as they absorb their yolk sacs they become known as fry. These young salmon slowly gain strength until they are able to seek out prey in faster waters. As they grow, the young salmon become known as parr, and feed aggressively in a variety of freshwater habitats, increasing their size before migrating to the Pacific Ocean. Depending upon the species and available habitat, juvenile salmon can spend from just a few weeks to multiple years growing in fresh water before migrating to the sea. As they migrate downstream, juveniles take on a silvery coloration and undergo changes to allow them tolerate salt water, and become known as smolts. Once at sea, most of California's salmon spend two to five years feeding on small fishes, squid, crustaceans, and other invertebrates in the rich upwelling currents over the Continental Shelf. Some of these fish school with salmon from Oregon and Washington and migrate to feeding grounds in the North Pacific before returning to fresh water to spawn and complete their life cycles.

Depending on their geographic origin, genetics, and prevailing environmental conditions, salmon species migrate back into the streams in which they were born. In general, Chinook salmon return to spawn in the main channels of rivers and tributaries, while the smaller Coho, Pink, and Chum salmon tend to prefer to spawn in small, low gradient tributaries with slower streamflows closer to sea. After death, the marine-derived nutrients in salmon bodies helps to fuel the food web that supports juvenile salmon as well as providing sustenance for the entire watershed.

Salmon Circle. Photo: Mike Hupp.



SPECIES	AVERAGE 2017 SCORE	AVERAGE LEVEL OF CONCERN
Chinook (8 kinds)	2.3	HIGH
Coho (2 kinds)	1.5	CRITICAL
Chum (1 species)	1.6	CRITICAL
Pink (1 species)	1.6	CRITICAL

TOP 3 ANTHROPOGENIC THREATS TO SALMON

AGRICULTURE

Water diversions to support California's booming agricultural industry reduce the survival and productivity of all salmon runs in the state. Agricultural demands on water reduce and alter the timing of streamflows that degrade water quality and habitat for salmon.

ESTUARY ALTERATION

Estuary and lagoon habitat has been significantly reduced through conversion to support state's expanding population and myriad land uses. Loss of these productive feeding grounds statewide, but especially in the highly altered Sacramento-San Joaquin Delta, reduces survival for all salmonids.

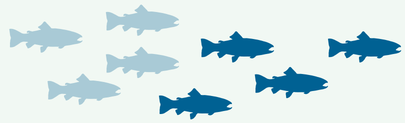
MAJOR DAMS

Dozens of major and countless minor dams block access to most historical salmon habitat in California. Dams also alter flow regimes by changing the timing, magnitude, duration, rate of change and frequency of historical flows.

CHINOOK SALMON

Oncorhynchus tshawytscha

CHINOOK SALMON



Of the eight kinds of Chinook salmon in California, four saw an increase in Level of Concern since 2008.

Chinook, or "King" salmon, are the largest of the Pacific salmon, reaching 36 kg (about 84 lbs.). Most Chinook in California average around 9 kg (20 lbs.). California Chinook once ranged from the Smith River near the Oregon border south to the Kings River (Tulare County). They historically supported vast commercial, recreational, and tribal fisheries; there were once canneries along San Francisco Bay, at the mouth of the Eel and Klamath rivers, and on the Sacramento River. In 2008, the commercial Chinook salmon fishing season was closed due to low numbers of returning adults, and has been curtailed every season since, including complete closure for the 2017 season.

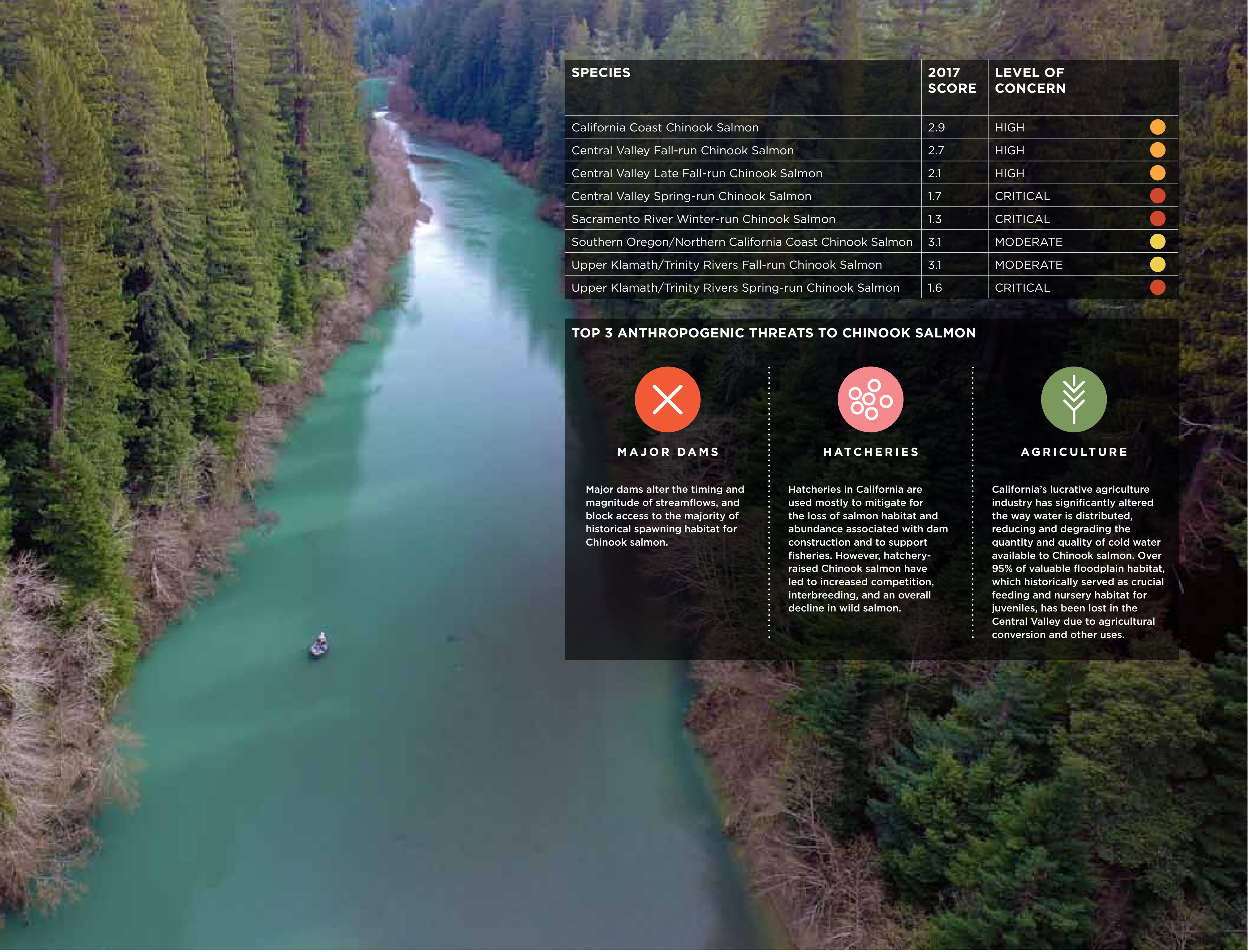
HABITAT AND BEHAVIOR

There are eight genetically distinct populations, or Evolutionary Significant Units (ESUs) of Chinook salmon in California. While salmon hatch in fresh water, they spend the majority of their lives (one to five years) at sea feeding on shrimp, krill, squid, anchovies, rockfish, and other fishes. They feed in the rich, nearshore upwelling currents from Monterey Bay to Southern Oregon, and some join other salmon further offshore in the North Pacific. Across California, adult Chinook return to fresh water during most months of the year, and seek out natal streams using their acute sense of smell. They generally spawn at two to six years of age, with three to four year-old adults accounting for the majority of the population.

They prefer cold water temperatures of approximately 5°-13°C (41-55°F) for migrations. After arriving at spawning grounds, each female selects a suitable spot with gravel of the right size, oxygenated water, adequate streamflows, and velocity. The males develop blotchy dark colored patches on their bodies, slightly humped backs, and a hooked jaw called a kype, for fighting off other males and defending a female. The females excavate a large redd with their tails and then lay their eggs directly in the gravel and cobbles. Males then fertilize the eggs, which hatch in about two to three months. Both adult males and females do not eat after they enter fresh water, and so they die shortly after spawning. The ocean nutrients in their bodies help replenish streams and the cycle starts anew.

California's varied habitats have allowed Chinook salmon to develop a spectrum of life histories, enabling them to adapt to diverse conditions and watersheds. Different traits between runs, such as run-timing, maturation timing, and juvenile migration patterns allow maximum use of available habitat, because the runs are segregated in the spawning habitats they use and when they use them. Juvenile Chinook spend varying amounts of time in fresh water feeding before migrating to sea as smolts. Floodplains, estuaries, lagoons, and tidal marsh habitats historically provided rearing habitat for juveniles, enabling them to put on weight before migrating to the Pacific Ocean, which greatly increases their chances of survival.

Drift Boat on South Fork Eel. Photo: Mike Wier.



SPECIES	2017 SCORE	LEVEL OF CONCERN
California Coast Chinook Salmon	2.9	HIGH
Central Valley Fall-run Chinook Salmon	2.7	HIGH
Central Valley Late Fall-run Chinook Salmon	2.1	HIGH
Central Valley Spring-run Chinook Salmon	1.7	CRITICAL
Sacramento River Winter-run Chinook Salmon	1.3	CRITICAL
Southern Oregon/Northern California Coast Chinook Salmon	3.1	MODERATE
Upper Klamath/Trinity Rivers Fall-run Chinook Salmon	3.1	MODERATE
Upper Klamath/Trinity Rivers Spring-run Chinook Salmon	1.6	CRITICAL

TOP 3 ANTHROPOGENIC THREATS TO CHINOOK SALMON

MAJOR DAMS

Major dams alter the timing and magnitude of streamflows, and block access to the majority of historical spawning habitat for Chinook salmon.

HATCHERIES

Hatcheries in California are used mostly to mitigate for the loss of salmon habitat and abundance associated with dam construction and to support fisheries. However, hatchery-raised Chinook salmon have led to increased competition, interbreeding, and an overall decline in wild salmon.

AGRICULTURE

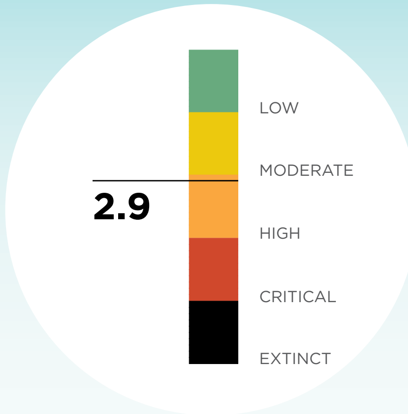
California's lucrative agriculture industry has significantly altered the way water is distributed, reducing and degrading the quantity and quality of cold water available to Chinook salmon. Over 95% of valuable floodplain habitat, which historically served as crucial feeding and nursery habitat for juveniles, has been lost in the Central Valley due to agricultural conversion and other uses.

CALIFORNIA COAST CHINOOK SALMON

Oncorhynchus tshawytscha

LEVEL OF CONCERN: HIGH

California Coastal Chinook salmon are vulnerable to extinction in the next 50-100 years if coastal stream conditions continue to deteriorate.



Spawning Chinook. Photo: Jim Inman.

CLIMATE CHANGE IMPACT

Climate change is likely to lead to increased temperatures and reduced snowpack in the headwaters of the Eel River, which will make managing the release of cold water from dams and reservoirs to support salmonids even more difficult in the future.

TOP 3 ANTHROPOGENIC THREATS

MAJOR DAMS

Scott Dam, Coyote Valley Dam, and Warm Springs Dam reduce water quality and quantity across the CC Chinook salmon range. The timing of water transfers from the upper Eel River into the Russian River watershed at Pacific Gas & Electric's Potter Valley Project reduces habitat suitability for Eel River salmonids.

LOGGING

Historical and current land use practices related to logging and its associated road construction, such as erosion and removal of large woody debris habitat, continue to increase the vulnerability of CC Chinook salmon. This is especially true in smaller watersheds.

AGRICULTURE

Many tributaries are facing increasing frequency of water withdrawals and overdraft due to increasing demands of irrigationto support expansion of vineyards and marijuana cultivation.

SUMMARY

From 2012-2016, poor ocean conditions, historic drought, record high temperatures, and exploding marijuana cultivation have had significant negative impacts on CC Chinook salmon, so much so that NMFS concluded that endangered status was likely in the future for the DPS.

CONSERVATION ACTIONS

- Work with stakeholders to find a water sharing balance, which has been disrupted by Scott and Van Arsdale dams on the Eel River and Coyote Valley Dam on the Russian River, to recover CC Chinook.
- Mark all hatchery Chinook salmon in the ESU range and implement a Genetic Stock Identification program to determine the origins of harvested salmon.
- Implement an extensive monitoring program for the Eel River to evaluate restoration activities and adaptively assess salmonid recovery.
- Leverage partnerships with public and private landowners, law enforcement, legal precedent, and voluntary efforts to reduce illegal water diversions and secure streamflows for all salmonids.

METRIC	SCORE	JUSTIFICATION
Area occupied	3	CC Chinook salmon occupy 5 major watersheds.
Estimated adult abundance	3	All populations have less than 1,000 spawners in most years, but there is some mixing among populations; there have been recent increases in the Eel River population, but reliable data are lacking.
Intervention dependence	3	Long-term declines indicate intervention needed, especially in improved flows and habitat in the Russian and Eel rivers.
Environmental tolerance	3	Fall-run life history allows for moderate tolerance of environmental conditions encountered.
Genetic risk	2	Major watersheds may have distinct populations, all threatened by small size and similar genetic issues. The loss of spring-run life history was a major loss of diversity within the ESU.
Climate change	2	Likely to accelerate declines, especially in reservoir-dominated systems with reduced flows and altered channels.
Anthropogenic threats	1	8 Medium threats.
Average	2.9	LEVEL OF CONCERN: HIGH
Certainty (1-4)	3	Fairly well studied.

CHARACTERISTICS

CC Chinook salmon can be distinguished from other salmon species by heavy spotting on their tails and black coloration inside their lower jaw and at the base of their teeth. CC Chinook salmon are nearly identical in appearance to other Chinook salmon, and are separated from other Chinook based on their geographic distribution and genetic differences. CC Chinook salmon in the Eel River average around 56 cm (22 in.) in length.

ABUNDANCE

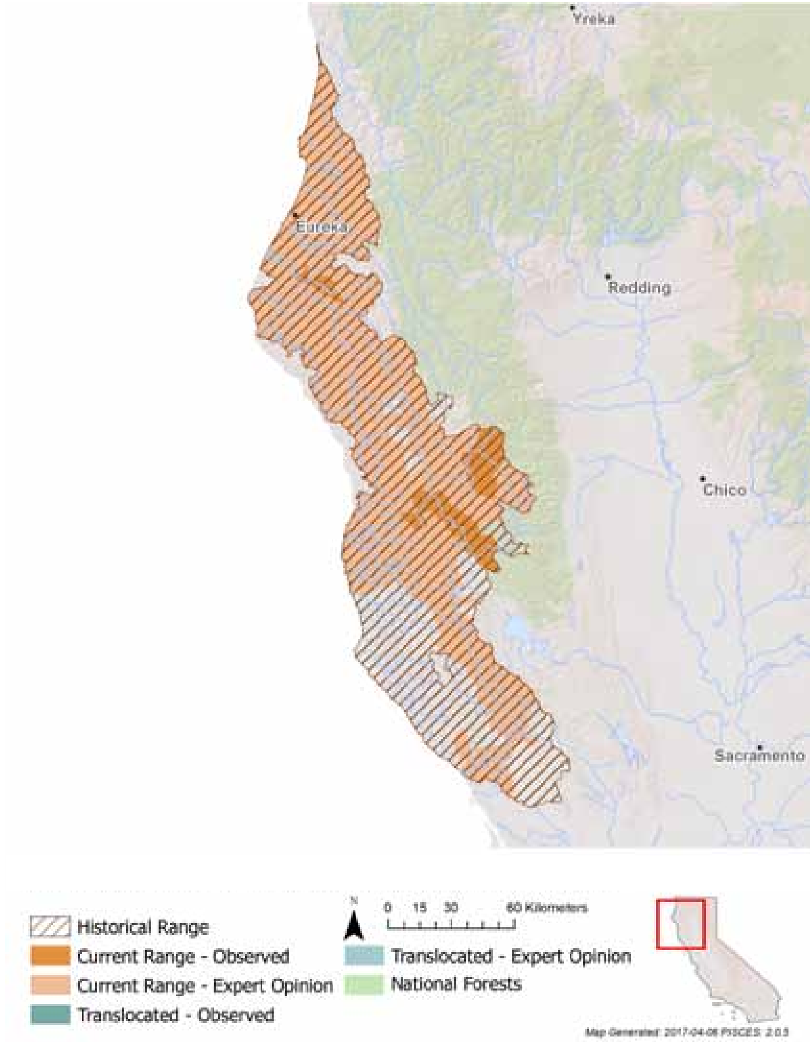
Abundance of CC Chinook salmon has likely decreased by more than 90% from historical numbers, though reliable estimates are lacking, especially for the Eel River watershed. The Eel River once supported a cannery with catches over 500,000 Chinook and Coho combined per year in the late 19th century. In 'good' years, historic runs were on the order of 600,000 fish combined in the ESU, perhaps dropping to 30,000-50,000 in 'bad' years. Present numbers total approximately 5,000-20,000 fish each year.

HABITAT AND BEHAVIOR

CC Chinook are all fall–run salmon; the spring-run life history has been lost throughout the ESU. CC Chinook typically return to their natal rivers after spending two or three years at sea between September and early November, often following large early winter storms. Spawning in the larger basins peaks between late October and December, and eggs hatch after 40-60 days. The majority of CC Chinook salmon juveniles emerge from the gravel in the late winter or spring and migrate downstream within a few months. Smolts use food-rich tidal or flooded habitats with overhanging cover or undercut banks to forage before migrating to sea.

GENETICS

CC Chinook salmon in the Eel River are more closely related to populations in northern watersheds than those on found along the Mendocino Coast. Chinook salmon of unknown origin occasionally migrate to coastal basins south of the Russian River (e.g., Lagunitas Creek, Marin County), and are under consideration to be in included in the CC Chinook salmon ESU in the future based on their reported genetic similarities.



CALIFORNIA COAST CHINOOK SALMON DISTRIBUTION

The CC Chinook ESU includes salmon that spawn in coastal watersheds from Redwood Creek (Humboldt County) to the Russian River (Sonoma County). In general, small coastal streams within this range can support CC Chinook salmon as long as they have open estuaries during peak migration times (fall through spring). In the Eel River watershed, CC Chinook salmon could historically access habitat up to natural boulder roughs on the upper mainstem Eel River, but they are currently blocked from accessing this habitat by Scott Dam and Lake Pillsbury (Lake County).

CENTRAL VALLEY FALL-RUN CHINOOK SALMON

Oncorhynchus tshawytscha

LEVEL OF CONCERN: HIGH

Central Valley (CV) fall-run Chinook salmon abundance has fluctuated widely in recent years, but the number of spawners typically exceeds 100,000 fish per year. However, this run is supported by significant production from several major federal and state hatcheries, which has troubling impacts on the productivity and survival of remaining wild Chinook.

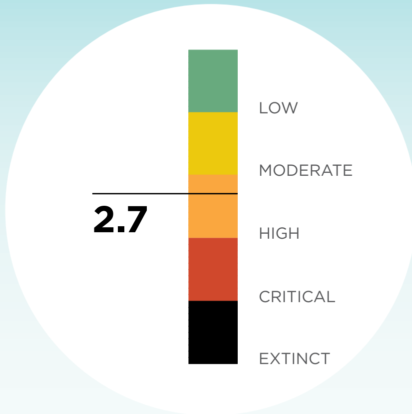


Photo: Patrick Jarrett.

CLIMATE CHANGE IMPACT

Central Valley fall-run Chinook salmon are highly vulnerable to climate change impacts. As precipitation patterns change and warmer stream temperatures become more common, managers will struggle to maintain cold water releases from dams during summer and fall months to sustain all Central Valley Chinook salmon. Similarly, as temperatures in the Pacific Ocean increase over time, growth and survival of all salmonids at sea is likely to be reduced.

TOP 3 ANTHROPOGENIC THREATS

HATCHERIES

Hatchery production of fall-run Chinook salmon meant to augment wild stocks has instead replaced populations with a homogenous, hatchery-dominated population. High straying rates from trucking juvenile salmon to the San Francisco Estuary reduce genetic diversity. In addition, hatchery-produced Chinook salmon increase competition, predation, and risk of disease for wild fish.

ESTUARY ALTERATION

Millions of juvenile fall-run Chinook migrate into the San Francisco Estuary every year, but very few of them survive to return as adults due in large part to the extensive drainage and levee system constructed on historical floodplain and salt marsh habitats that once provided rich feeding grounds for all anadromous Central Valley salmonids.

AGRICULTURE

State Water Project and Central Valley Project pumps divert about 40% of flows from the Sacramento-San Joaquin Delta for agriculture, which causes poor water quality, high predation rates, and traps juvenile salmonids in dead-end canals. Levees limit access to off-channel habitats that provide food and protection from predators.

SUMMARY

Central Valley fall-run Chinook salmon are largely supported by hatcheries, which results in significant ecological and genetic impacts to the sustainability of the run.

CONSERVATION ACTIONS

- Reconnect rivers with oxbows, side channels, and floodplains (e.g., Sutter and Yolo bypasses), and set back levees to increase valuable feeding habitat.
- Clip the adipose fin on all hatchery Chinook salmon and implant coded wire tags in a fraction of fish to improve research and management.
- End trucking of hatchery Chinook to the San Francisco Estuary to limit straying to non-natal watersheds and reduce hybridization.
- Relocate hatcheries in estuaries to minimize competition and gene flow between hatchery and wild stocks, and allowing hatchery fish to be harvested while freeing wild populations to recover and adapt to local conditions.
- Close hatcheries where adverse impacts outweigh benefits.

CHARACTERISTICS

Central Valley fall-run Chinook are generally smaller than late fall-run Chinook, typically measuring 45-60 cm (18-24 in.) in length, and weighing 9-10 kg (20-22 lbs.). Fall-run Chinook salmon make up the largest run in the Central Valley today, and once supported robust commercial and recreational fisheries in the Pacific Ocean and fresh water. Due to low adult returns, the fishery has either been closed or restricted every year since 2008.

METRIC	SCORE	JUSTIFICATION
Area occupied	2	Some indication of natural self-sustaining populations in the upper Sacramento River watershed, Clear and Butte creeks.
Estimated adult abundance	4	Annual spawning returns generally exceed 100,000 fish.
Intervention dependence	2	The majority of remaining spawning and rearing habitat is dependent on instream flow releases from major dams, gravel augmentation and other ongoing efforts; population appears largely dependent on hatchery augmentation.
Environmental tolerance	3	Moderate physiological tolerance, multiple age classes.
Genetic risk	2	High hatchery production has resulted in genetic homogenization of the run, reducing overall fitness.
Climate change	3	The 'ocean' life strategy makes them the least vulnerable of all CV Chinook runs to extirpation; however, models suggest dramatic changes to lower elevation CV rivers and streams.
Anthropogenic threats	2	1 High and 8 Medium threat
Average	2.7	LEVEL OF CONCERN: HIGH
Certainty (1-4)	4	Well studied although still much uncertainty about ocean stage.

ABUNDANCE

The historical abundance of fall-run Chinook salmon is difficult to estimate because populations declined significantly before good records were kept. Best estimates suggest that as many as one million fall-run Chinook salmon once returned to spawn in the Central Valley each year. Gold mining, dam construction, and commercial fishery impacts caused stocks to plummet by the 1940s. Annual runs have averaged around 150,000 fish per year over the past decade. Most returning adult fall-run Chinook salmon are from hatcheries today, with only a few streams in the northern portion of Sacramento Valley sustaining wild runs.

HABITAT AND BEHAVIOR

Adult CV fall-run Chinook salmon return to fresh water in late summer and early fall, and spawn relatively quickly after reaching spawning grounds in mainstem rivers. Spawning peaks from October-November, but can continue through December and into January if stream conditions allow. Juveniles emerge from December through March, and spend up to seven months feeding before migrating downstream in spring. Fall-run juveniles are younger and smaller than other Chinook juveniles during their downstream migrations. Most juveniles enter salt water in late spring and early summer, when upwelling currents provide abundant food. Immature fall-run Chinook typically spend between two to five years in the Pacific Ocean from Point Sur (Monterey County) to Point Arena (Mendocino County) before returning to fresh water as adults to spawn.

GENETICS

Hatchery operations that increase straying of fish to various rivers have produced a genetically homogenous population of fall-run Chinook salmon, and wild and hatchery fish are now indistinguishable from each other. This hatchery-mediated loss of genetic diversity is a major threat to the continued existence of Chinook salmon in California, which rely on genetic and life history differentiation to adapt to changing environmental conditions over time. Decades of interbreeding between fall and spring-run Chinook salmon has produced hybrid fish that return to the Feather River in spring, but are nearly genetically identical to fall-run Chinook. Despite differences in genetics, life histories, and run-timing, NMFS groups fall-run and late fall-run Chinook salmon into a single "special concern" ESU.

CENTRAL VALLEY FALL-RUN CHINOOK SALMON DISTRIBUTION

Central Valley fall-run Chinook salmon historically spawned in all major Central Valley rivers from the upper Sacramento, McCloud, and Pit rivers (Siskiyou County) in the north to the Kings River (King County) in the south. Today, they are restricted to a small fraction of their historical habitat by dams in every major river in the Central Valley. Passage into the mainstem San Joaquin River, above the confluence with the Merced River, is intentionally blocked at Hills Ferry by a CDFW-operated weir. On the Sacramento River, Keswick Dam near the town of Redding blocks upstream migration.

CENTRAL VALLEY LATE FALL-RUN CHINOOK SALMON

Oncorhynchus tshawytscha

LEVEL OF CONCERN: HIGH

Central Valley (CV) late fall-run Chinook salmon are vulnerable to extinction in the next 50-100 years. They have been eliminated from the majority of their native spawning habitat and for the most part are now dependent upon cold water releases from reservoirs and gravel augmentation to maintain suitable habitat.

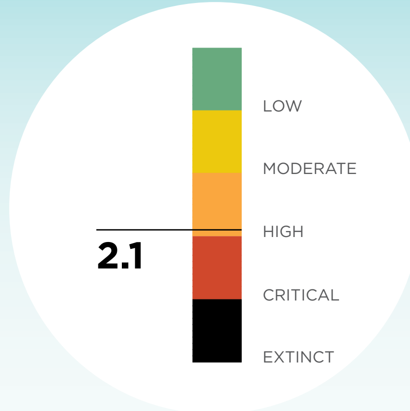


Photo: Patrick Jarrett.

CLIMATE CHANGE IMPACT

Late fall-run Chinook salmon are critically vulnerable to extinction from the effects of climate change because of the run's dependence on cold water released from dams, their low abundance, and their limited range due to dam construction.

TOP 3 ANTHROPOGENIC THREATS

MAJOR DAMS

Keswick and Shasta dams on the Sacramento River, and numerous hydropower and diversion dams on Battle Creek block access to the majority of historical spawning habitat for late fall-run Chinook salmon.

AGRICULTURE

Diversions and pumps to supply water for agriculture negatively impact all Central Valley Chinook salmon by reducing streamflows, entraining juveniles, and increasing predation risk.

ESTUARY ALTERATION

Loss of once-diverse, productive feeding and nursery habitats in the San Francisco Estuary and Sacramento-San Joaquin rivers Delta has changed the way juvenile Chinook salmon migrate to the ocean and eliminated aspects of life strategy diversity.

SUMMARY

In the past 10 years, numbers of Central Valley late fall-run Chinook salmon have remained low but appear stable. Evidence of hybridization with, and misidentification as, fall-run Chinook salmon have complicated efforts to accurately assess the status of this unique run.

CONSERVATION ACTIONS

- Include late fall-run Chinook salmon in a comprehensive research and monitoring plan for the Central Valley, to fill data gaps in abundance, distribution, and spawning studies.
- Recognize late fall-run Chinook as an independent ESU for management purposes based on their unique run timing, genetics, and life histories.
- Enhance late fall-run Chinook populations in Battle Creek and the San Joaquin Basin to increase the geographic range, genetic diversity, and climate change resilience of the run.

CHARACTERISTICS

Central Valley late fall-run Chinook salmon were not recognized as a unique run until 1966, so little is known about their historical habitats or habits. They appear similar to other Central Valley Chinook salmon, but tend to be larger, reaching 75-100 cm (30-39 in.) and weighing 9-10 kg (20-22 lbs.) or more.

ABUNDANCE

Historical abundance estimates are not available for Central Valley late fall-run Chinook salmon. While numbers have varied over time, the population in the Sacramento River and Battle Creek appears small but stable. Each year since

METRIC	SCORE	JUSTIFICATION
Area occupied	2	Only one primary population concentrated in the upper Sacramento River; some tributary spawning and rearing.
Estimated adult abundance	3	Total escapement has averaged approximately 10,000 spawners in recent years, while contribution from Coleman National Fish Hatchery is low (~10%).
Intervention dependence	2	Primary population is dependent on Shasta Dam operation for flows and gravel injection for spawning habitat improvement.
Environmental tolerance	3	Moderate physiological tolerance, multiple age classes.
Genetic risk	2	Hybridization with other runs may occur as evidenced by significant mixing of in-river spawners of natural and hatchery-origin on Battle Creek and potential hybridization with fall-run Chinook.
Climate change	1	Extremely vulnerable due to dependence on cold water releases from Shasta Reservoir, snowpack, and spring-fed flows.
Anthropogenic threats	2	2 High and 4 Medium threats.
Average	2.1	LEVEL OF CONCERN: HIGH
Certainty (1-4)	2	Least studied of Central Valley Chinook runs

2002, less than 20,000 adults have returned to the Sacramento River, while about a thousand adults have returned to Battle Creek.

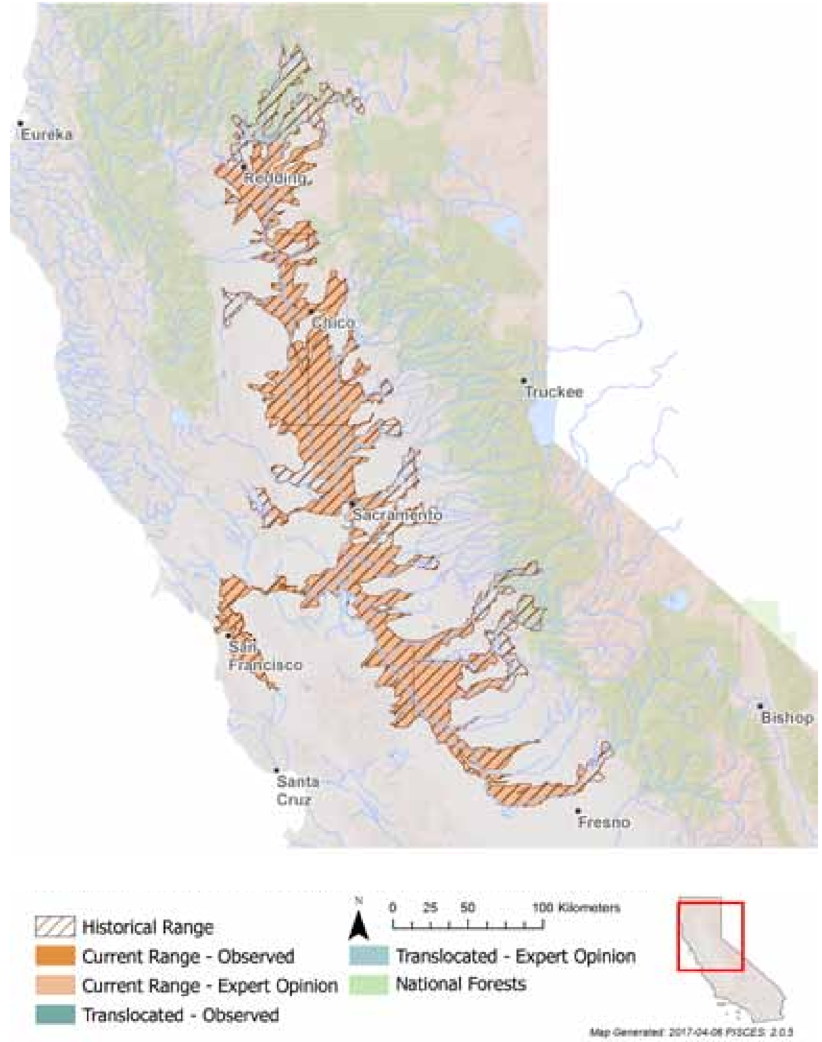
HABITAT AND BEHAVIOR

The late fall-run life strategy is much less well-known than those of other CV Chinook runs because of its recent recognition as a discrete run, its tendency to migrate and spawn when the Sacramento River is high, cold, and turbid, and limited historic capacity for genetic differentiation. Late fall-run Chinook adults begin their spawning migrations in mid-October to November, and spawn quickly after reaching spawning grounds in December to January. Unlike other Central Valley Chinook salmon, most late fall-run fish are four years old when they return to spawn. Fry emerge from the spawning gravel from April to June, and over-summer in the Sacramento River for 7-13 months before migrating out to sea. Juvenile migration to the ocean peaks in October; tagged juvenile late fall-run Chinook salmon moved downstream to the San Francisco Estuary from 14 to 23 km (about 9 to 14 mi.) per day.

GENETICS

Currently, late fall-run and fall-run are considered by NMFS to be two separate "races" under a single ESU.

Sacramento-San Joaquin River Delta. Photo: Unknown.



CENTRAL VALLEY LATE FALL-RUN CHINOOK SALMON DISTRIBUTION

Central Valley late fall-run Chinook salmon most likely historically spawned in the upper Sacramento and McCloud rivers, which are now blocked by Shasta Dam, as well as in portions of major Sacramento and San Joaquin River tributaries with adequate cold water in summer. Today, most late fall-run Chinook spawn in the mainstem Sacramento River between Red Bluff Diversion Dam and Keswick Dam, and in Battle Creek (Tehama County).

CENTRAL VALLEY SPRING-RUN CHINOOK SALMON

Oncorhynchus tshawytscha

LEVEL OF CONCERN: CRITICAL

Central Valley (CV) spring-run Chinook are vulnerable to extinction in the next 50 years or less if present trends continue. Small, self-sustaining populations remain in only a few watersheds.

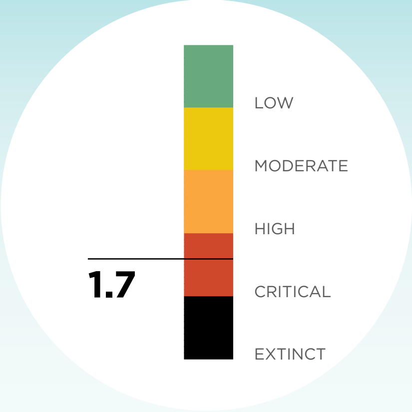


Photo: Dana Lee.

CLIMATE CHANGE IMPACT

Central Valley spring-run Chinook salmon are critically vulnerable to climate change due to their reliance on cold spring water and snowmelt to sustain them through warm summer months in holding pools.

TOP 3 ANTHROPOGENIC THREATS

MAJOR DAMS

Only spawning areas in Mill and Deer creeks are not impacted by major dams, but small dams divert water for agricultural and urban usage. The Butte Creek population is dependent on continued human intervention and relies on water transferred from the Feather River via a series of canals and hydroelectric powerhouses.

HATCHERIES

Past interbreeding of spring and fall-run Chinook salmon has reduced the genetic integrity of the Feather River spring-run Chinook population. Feather River Fish Hatchery strays hybridize with populations in other watersheds, reducing their fitness and increasing the extinction risk of the last wild populations.

AGRICULTURE

Water diversions from the Sacramento River to support agriculture reduce the quantity and quality of water for spring-run Chinook. Dams and diversions with obsolete fish screens, dams, poor fish ladders, and levees that are part of the State Water Project and Central Valley Project reduce juvenile and adult survival.

SUMMARY

Populations of Central Valley spring-run Chinook plummeted during the drought (2012-2016), primarily as a result of high pre-spawn mortality of over-summering adults and eggs associated with reduced streamflows and high water temperatures. Straying of salmon from the Feather River Fish Hatchery to other watersheds, and hybridization with other populations, reducing the resilience of remaining natural-origin populations.

CONSERVATION ACTIONS

- Restore spring-run to the San Joaquin River watershed, where they can exploit the snowpack predicted to persist in the high southern Sierra.
- Protect and enhance cold water habitat in Deer, Mill, and Butte creeks through water acquisition or forbearance, conjunctive use of groundwater wells, water use efficiency improvements, and shifting land use practices and management.
- Remove passage barriers to spring-run Chinook salmon throughout their range, especially in Battle Creek and the Yuba River.
- Restore floodplains that serve as important nursery and feeding habitat for all juvenile Central Valley salmonids.
- Amend hatchery practices to eliminate interactions between Feather River Fish Hatchery Chinook and wild populations.

METRIC	SCORE	JUSTIFICATION
Area occupied	2	Self-sustaining populations are in Deer, Mill, and Butte creeks, with potential for populations in Battle and Clear creeks, as the result of restoration.
Estimated adult abundance	2	Total numbers have periodically dropped below 5,000 fish even when Feather River Hatchery (FRH) fish are counted. When FRH fish are not counted, most of the remaining fish are in Butte Creek.
Intervention dependence	2	If not for significant restoration, especially in Butte Creek, spring-run Chinook would likely already be extinct in the Central Valley.
Environmental tolerance	2	Narrow physiological tolerances in summer for both adults and juveniles.
Genetic risk	2	Butte Creek and Deer-Mill creeks populations appear to be distinct, but effect of hybridization with FRH fish unknown.
Climate change	1	Extremely vulnerable given small population sizes and range, and the already high summer temperatures in streams they inhabit.
Anthropogenic threats	2	Four High threats.
Average	1.7	LEVEL OF CONCERN: CRITICAL
Certainty (1-4)	4	Well-studied.

- Explore removal of diversion dams or other passage obstructions throughout the DPS range, but especially in Battle Creek or the Yuba River.

CHARACTERISTICS

All California Chinook salmon are similar in appearance, with some slight differences in size, shape, and coloration. Central Valley spring-run Chinook salmon are separated by their run timing, spawning areas, and late maturation in fresh water.

ABUNDANCE

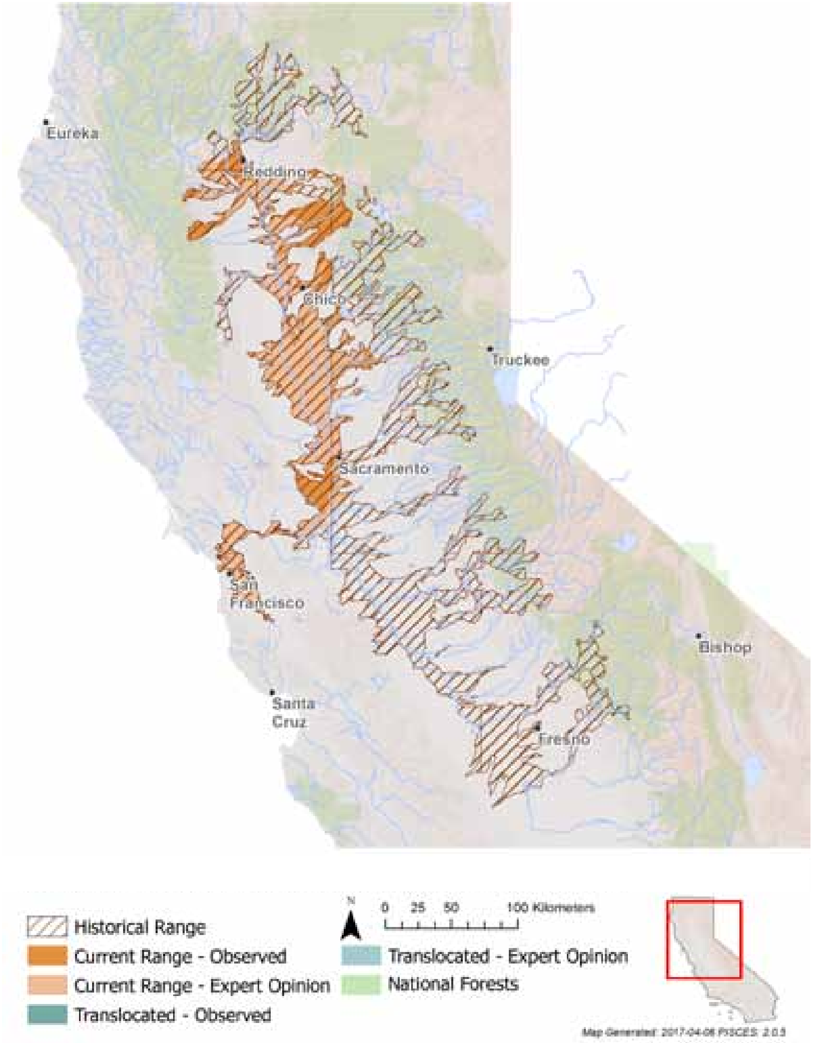
19th century spring-run Chinook salmon were once as abundant as fall-run Chinook in the Central Valley, numbering approximately one million returning adults per year. Over the past forty years, annual abundance has varied considerably, from highs around 30,000 fish to lows of about 3,000 fish. Since 2012, population estimates have plummeted.

HABITAT AND BEHAVIOR

Spring-run Chinook salmon migrate upstream during high runoff events starting in January or February. High flows, especially from snowmelt, allow adults to access higher elevation, smaller tributaries in April through June that are generally inaccessible to salmon at other times of the year. Adults seek out deep, cool pools in tributary streams less than 21°C (70°F) where these big fish hold over the summer before spawning in the fall. They prefer pools with plenty of cover, such as rock ledges, bubble curtains, and woody debris. Most spring-run Chinook adults in the Central Valley are four years old and average 78.5cm (31 in.). Juvenile spring-run Chinook spend varying amounts of time in freshwater before migrating to sea: 1) a matter of weeks after hatching, 2) a few months after hatching, or 3) an entire year or more in fresh water.

GENETICS

The delayed maturation strategy in spring-run salmon arose as a single evolutionary event in a Chinook population and spread throughout the species' range, primarily through straying of fish to other watersheds. There are only two distinct self-sustaining populations of Central Valley spring-run Chinook salmon: one in Deer and Mill creeks and one in Butte Creek.



CENTRAL VALLEY SPRING-RUN CHINOOK SALMON DISTRIBUTION

Central Valley spring-run Chinook salmon historically ranged throughout all major snowmelt tributaries of both the Sacramento and San Joaquin rivers, including the Pit River (Modoc County) and the headwaters of the San Joaquin River in the south (Fresno County). Today, only the mainstem Sacramento River and Butte (Butte County), Mill, and Deer creeks (Tehama County) maintain wild spring-run Chinook. In most years, some adults return to Antelope, Big Chico, Little Chico, Beegum, Battle, and Clear creeks, but these populations are not considered self-sustaining. Recent surveys have documented very few spring-run Chinook in the Stanislaus, Tuolumne, and Merced rivers.

SACRAMENTO RIVER WINTER-RUN CHINOOK SALMON

Oncorhynchus tshawytscha

LEVEL OF CONCERN: CRITICAL

Sacramento River winter-run Chinook salmon (winter-run) face immediate risk of extinction. The ESU has been extirpated from its native spawning range by dams and has been reduced to a single small spawning population, which is wholly dependent on artificially-created spawning habitat and cold water releases from Shasta Reservoir.

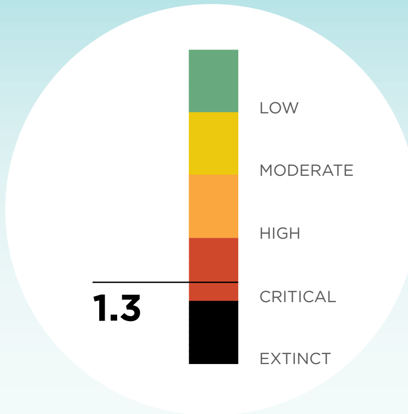


Photo: Ed Homich.

SUMMARY

Multiple critically dry years (2012-2016) in a row during the drought reduced the amount of cold water available for release from Shasta Reservoir. Warm water releases drastically reduced winter-run egg and juvenile survival and have likely devastated the population.

CONSERVATION ACTIONS

- Create volitional passage to spawning habitat in Battle Creek.
- Increase juvenile survival by restoring floodplain habitats along lower Battle Creek, the mainstem Sacramento River, and the Yolo and Sutter bypasses.
- The proposed trap and haul programs to truck both adult and juvenile winter run Chinook around Keswick, Shasta, and McCloud dams should be viewed as a last resort extinction prevention effort which should only be implemented after all other restoration measures have been exhausted.

CLIMATE CHANGE IMPACT

Sacramento River winter-run Chinook salmon are critically vulnerable to climate change due to their highly restricted range, dependence on cold water releases from Shasta Dam, and low tolerance for high stream temperatures. Their migration and egg hatching timing during the warmest months of the year make them particularly vulnerable to increasing stream temperatures. Climate change is also likely to make maintaining a cold water pool in Shasta Reservoir more difficult.

TOP 3 ANTHROPOGENIC THREATS

MAJOR DAMS

Shasta and Keswick dams prevent access to all historical spawning and most juvenile nursery areas for Sacramento River winter-run Chinook. Ironically, this run is entirely reliant on water releases from Shasta and Keswick dams.

HATCHERIES

Hatchery-raised winter-run Chinook salmon account for nearly a third of the spawning population and are likely accelerating the decline of wild Chinook salmon. NMFS considers the winter-run Chinook salmon population at a moderate risk of extinction from “excessive hatchery influence.”

AGRICULTURE

Agricultural diversions along the Sacramento River can trap or delay fish in canals and irrigation ditches. Federal and state pumps in the southern Delta alter flows and reduce survival of juveniles. Levees have cut off rivers from over 95% of critical floodplain habitats in the Central Valley.

CHARACTERISTICS

While there are no obvious physical differences between Sacramento River winter-run Chinook salmon and other Chinook in the Central Valley, they tend to be smaller than fish of other runs.

ABUNDANCE

Historically, winter-run Chinook salmon runs likely numbered around 200,000 spawning adults per year. They have been in serious decline over the last decade, with an estimated 827 adults returning to spawn in 2011. Accurate abundance data has been difficult to collect, because fish assumed to be winter-run Chinook were later discovered to be either spring- or late fall-run fish using better genetic techniques.

METRIC	SCORE	JUSTIFICATION
Area occupied	1	A single population in a reach below dams; extirpated from their historical range.
Estimated adult abundance	2	The recent (2007-16) assessments indicate an average of <3,000 returning spawners annually. In recent years, the number of adults dipped below 2,000 on several occasions.
Intervention dependence	1	A captive broodstock program has been initiated to augment the conservation hatchery program at Livingston Stone Fish Hatchery. The naturally spawning population depends entirely on cold water releases from Shasta Dam.
Environmental tolerance	1	Winter-run Chinook spawn in the most thermally challenging times of the year and are particularly at risk to high temperatures and low dissolved oxygen levels.
Genetic risk	2	Considerable genetic drift resulting from consolidation of winter-run populations into a single population is likely exacerbated by the large influence of hatchery broodstock.
Climate change	1	Extremely vulnerable because of reliance on cold water habitat and releases from Shasta Reservoir.
Anthropogenic threats	1	1 Critical, 2 High, 5 Medium factors.
Average	1.3	LEVEL OF CONCERN: CRITICAL
Certainty (1-4)	4	Well-studied population.

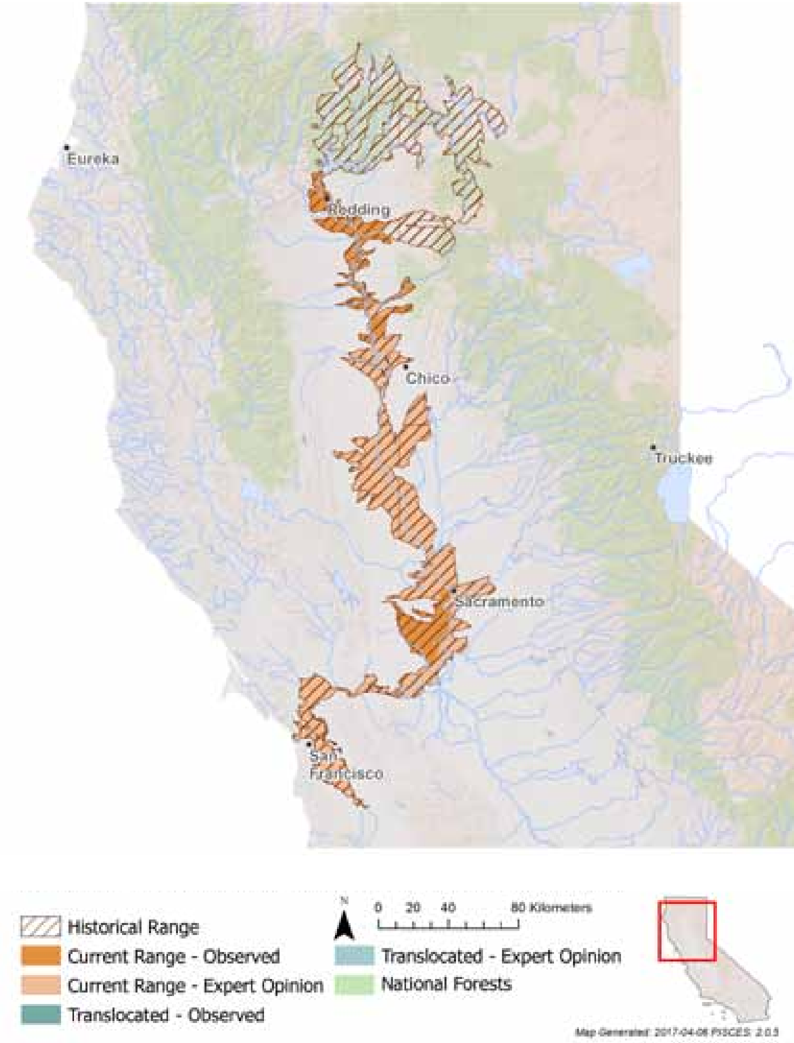
In 2015, about 3,500 winter-run Chinook adults returned to spawn, but warm water releases from Shasta Reservoir significantly reduced egg and juvenile survival and will likely lead to low adult returns for the next two to three years.

HABITAT AND BEHAVIOR

Sacramento River winter-run Chinook salmon evolved in stable, cold, spring-fed streams in high elevation headwaters that are now blocked by large dams on the upper Sacramento River, McCloud River, and Battle Creek. Adults enter fresh water as sexually immature fish from January to May, with a peak in mid-March. Historically, they would hold in spring-fed streams to mature before spawning from April through August, with eggs incubating during the hot summer months. Winter-run juveniles appear to occupy fresh water year-round, and generally prefer temperatures between 10-16°C (50-61°F). Fry emerge from redds from July to mid-October and juveniles feed for five to 10 months before migrating downstream in January through April during the first high flows of the rainy season, moving mostly at night to avoid predators. Historically, juveniles would spend up to several months feeding and growing in off-channel habitats in the lower river and Delta. Juvenile winter-run Chinook feed for longer periods in fresh water compared to other Chinook, growing to relatively large sizes without having to over-summer in fresh water when conditions are most stressful.

GENETICS

While the four Central Valley Chinook salmon runs are each genetically distinct, they are more closely related to each other than they are to Chinook salmon in other regions.Historically, there were four separate populations of winter-run Chinook salmon that spawned in headwater reaches of the upper Sacramento, McCloud, and Pit rivers and Battle Creek.



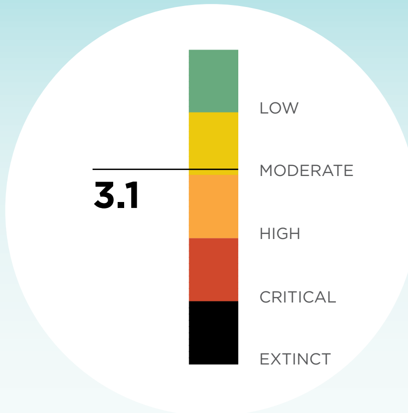
SACRAMENTO RIVER WINTER-RUN CHINOOK SALMON DISTRIBUTION

Historically, Sacramento River winter-run Chinook salmon migrated to the headwaters of the Sacramento, Pit, and McCloud rivers, as well as Battle Creek (Tehama County). All historical spawning habitat is now upstream of major dams. Today, the one remaining population spawns in the mainstem Sacramento River immediately downstream of Keswick Dam near Redding.

SOUTHERN OREGON/ NORTHERN CALIFORNIA COAST CHINOOK SALMON

Oncorhynchus tshawytscha

LEVEL OF CONCERN: MODERATE



Southern Oregon/Northern California Coastal (SONCC) Chinook salmon in California are limited to only a few watersheds, but populations remain stable. They may be vulnerable to natural events such as fires, earthquakes, or floods due to their small population size and limited range.

Left: Juvenile Chinook, Mill Creek. Photo: Glenn Kubacki. Right: Spawning Chinook salmon. Photo: Patrick Jarrett.

CLIMATE CHANGE IMPACT

SONCC Chinook are vulnerable to increasing stream temperatures, changes in streamflows in tributaries, and variable ocean conditions associated with climate change.

TOP 3 ANTHROPOGENIC THREATS

LOGGING

Historical logging throughout the Smith and Klamath basins fueled the expansion of improperly built stream crossings (culverts, bridges, cattle crossings, and other structures) that create fish passage barriers and represent a major source of habitat loss in SONCC Chinook streams.

ESTUARY ALTERATION

Levees, dikes, tide gates, and rip-rap have been used extensively in estuaries to control flooding, improve bank stability, and promote agriculture but have disconnected the estuary from important nursery habitats such as sloughs and tidal wetlands.

AGRICULTURE

In the Smith River Estuary, construction of dikes and reclamation of lands for agriculture and grazing have reduced the amount of juvenile rearing habitat by more than 40%, and diversions for flower bulb cultivation, alfalfa production, pasture irrigation, and other purposes may affect salmon outmigration and reduce water quality.

SUMMARY

Southern Oregon/Northern California Coastal Chinook salmon populations in California remain relatively small but stable.

CONSERVATION ACTIONS

- Re-evaluate operation of the Rowdy Creek Fish Hatchery program to minimize competition and hybridization with wild Chinook.
- Increase salmonid monitoring in the lower Smith and Klamath rivers to determine trends in abundance, harvest rates, and genetic relationships between spring- and fall-run Chinook salmon.
- Preserve and promote the Smith River as a Wild and Scenic salmon "stronghold" that produces wild fish abundance.

CHARACTERISTICS

SONCC Chinook are similar in appearance to Chinook from other basins in California, but are generally more rounded in shape and heavier. The Smith River regularly produces the largest Chinook salmon in the state, up to 36 kg (about 84 lbs.), though most average 10 kg (22 lbs.).

ABUNDANCE

SONCC Chinook abundance has varied widely over time. The lower Klamath river tributaries likely supported a few thousand spawning adults each year. On the Smith River, historical run sizes are not known, but current numbers likely represent only a fraction of what they once were. Recent abundance estimates for SONCC Chinook in the Smith River are between 15,000 and 20,000 returning adults per year and the population is assumed to be stable.

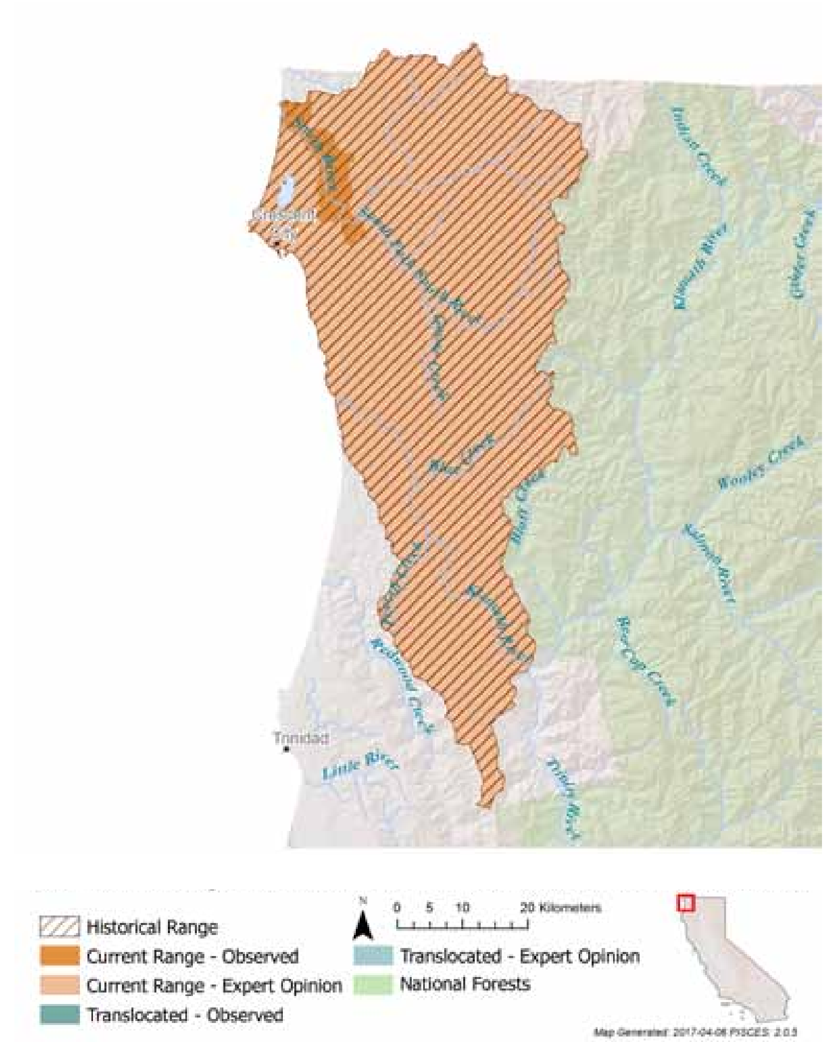
METRIC	SCORE	JUSTIFICATION
Area occupied	4	Blue Creek and Smith River are the principal populations, along with smaller populations in tributaries.
Estimated adult abundance	3	Between 5,000 and 50,000 spawners in the Smith in most years; in 2011-2012, adult spawners were estimated at 20,000. <1,500 spawners in Klamath tributaries in most years.
Intervention dependence	4	California populations are largely self-sustaining but some supplementation by hatcheries is likely.
Environmental tolerance	3	Multiple juvenile life histories and spawner age diversity demonstrate physiological tolerances.
Genetic risk	3	Limited hatchery operations in California, but some concern for hybridization with hatchery ‘strays’ from Rowdy Creek Fish Hatchery and other ESUs.
Climate change	2	Fall-run is least vulnerable to climate change as they spawn later and scouring of redds is less likely to influence juveniles; sea level rise may negatively affect rearing in estuaries; Smith River likely to retain runs under worst-case scenarios through end of the century. Vulnerable to increasing temperatures, changes in flow regimes in tributaries, and variable ocean conditions.
Anthropogenic threats	3	Multiple threats rated as “Medium.”
Average	3.1	LEVEL OF CONCERN: MODERATE
Certainty (1-4)	2	Least studied of Klamath River Chinook runs.

HABITAT AND BEHAVIOR

SONCC Chinook generally migrate upstream to natal rivers in fall months (September-December) in the Klamath River and late-fall (November-December) in the Smith River to spawn. Depending on season and location, the majority of Chinook returning to spawn are three years old, though in some years four year old fish are the most abundant. Spawning typically peaks in December. Chinook use larger cobbles to build their redds than other salmon species. After 40-60 days, eggs hatch and fry emerge about a month later. Juvenile SONCC Chinook often spend at least a few months in fresh water feeding and growing before undertaking taxing ocean migrations. They emerge from the lower Klamath tributaries starting in February and migrate downstream through July on their journey to the sea.

GENETICS

SONCC Chinook salmon from the Smith River and lower Klamath River tributaries share genetic similarities. Lower Klamath River Chinook are genetically distinct from those in Klamath River tributaries upstream of the Trinity River confluence. In Blue Creek, there is a discrete late fall-run of Chinook, which seems to be segregated from other fish but requires more study. Very small numbers of spring-run Chinook salmon return to the Smith River in most years, but the relationship between these fish and the fall-run SONCC Chinook is not well understood at this time.



SOUTHERN OREGON/NORTHERN CALIFORNIA COAST CHINOOK SALMON DISTRIBUTION

Southern Oregon/Northern California Coastal Chinook range from the Elk River, Oregon to the Klamath River’s confluence with the Trinity River. The majority of SONCC Chinook are found in Oregon streams. In California, they are found in the Smith River, Wilson Creek, and a few tributaries of the lower Klamath River such as Blue Creek. Unlike other Chinook salmon in California, SONCC Chinook tend to migrate and feed at sea north of Cape Blanco, Oregon.

UPPER KLAMATH-TRINITY RIVERS FALL-RUN CHINOOK SALMON

Oncorhynchus tshawytscha

LEVEL OF CONCERN: MODERATE

Upper Klamath-Trinity Rivers (UKTR) fall-run Chinook are not in immediate danger of extinction, although their numbers have declined in recent decades. There appears to be an increasing reliance on hatcheries to maintain fisheries, and returns of hatchery-origin fish may be masking a decline of wild production in the Klamath-Trinity Basin.

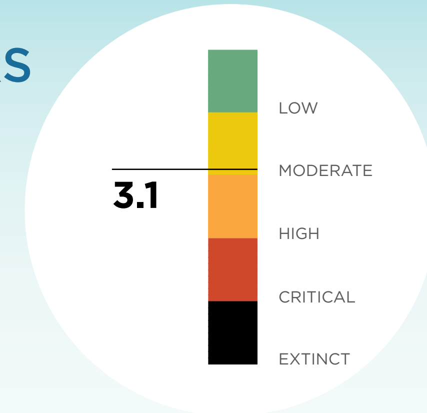


Photo: Patrick Jarrett.

CLIMATE CHANGE IMPACT

Warm water temperatures in fall months are already a substantial threat to salmon in the lower Klamath River, and are likely to continue to rise and exacerbate problems with disease outbreaks and die-offs. Climate change will reduce reliability of cold water pool behind the Klamath dams, which must be removed to promote migration of salmon, steelhead, and trout and allow them to access cold water habitat upstream.

TOP 3 ANTHROPOGENIC THREATS

MAJOR DAMS

Lewiston and Iron Gate dams negatively affect UKTR fall-run Chinook populations by prohibiting access to historical upstream spawning, rearing, and migration habitats and altering seasonal flows and temperatures in remaining downstream habitat.

MINING

Mining was a principal cause of decline of UKTR Chinook in the Scott, Salmon, and Trinity rivers, and historical mining impacts still limit the fall-run Chinook population. Legacy mining has disconnected and constricted juvenile salmon habitat, filled in adult holding habitat, degraded spawning grounds, and altered streamflows.

HATCHERIES

Hatchery salmon are likely replacing natural escapement of at least some wild populations of UKTR fall-run Chinook. Large numbers of hatchery fish in the Klamath-Trinity system may negatively impact natural-origin Chinook salmon and reduce fitness through competition, hybridization, predation, and/or disease transmission.

SUMMARY

Upper Klamath-Trinity Rivers fall-run Chinook salmon abundance has varied widely throughout the Klamath Basin over the last decade, though the proportion of wild adults in the Trinity River has increased over that time.

CONSERVATION ACTIONS

- Remove the four lowermost Klamath dams to allow fall-run Chinook salmon to access historical spawning habitat upstream.
- Adaptively manage streamflows and habitat restoration as part of the Trinity River Restoration Program to increase abundance of UKTR fall-run Chinook salmon and their habitat.
- Update hatchery practices at Trinity River Hatchery to reduce competition, predation, loss of genetic diversity, and life history diversity in wild salmonids.
- Limit harvest to only adipose fin clipped hatchery Chinook to determine hatchery impacts on wild fish and inform Chinook re-colonization efforts in the upper Klamath River Basin after dams are removed.
- Improve habitat and flow conditions in the Shasta and Scott rivers, which provide reliable cold water habitat.

METRIC	SCORE	JUSTIFICATION
Area occupied	5	Widely distributed in Klamath and Trinity basins.
Estimated adult abundance	4	Abundant, with several large populations, but hatchery-origin fish are a problem for wild runs.
Intervention dependence	3	Major intervention is required to maintain fisheries, primarily through hatchery propagation and flow regulations.
Environmental tolerance	3	Moderate physiological tolerance.
Genetic risk	3	Genetically diverse population but heavily influenced by hatcheries.
Climate change	2	Vulnerable to increasing temperatures in mainstem rivers, changes in flow regimes in tributaries, and variable ocean conditions.
Anthropogenic threats	1	1 "High" and 8 "Medium." A highly managed population.
Average	3.1	LEVEL OF CONCERN: MODERATE
Certainty (1-4)	4	Most studied of Klamath River Chinook runs.

CHARACTERISTICS

UKTR fall-run Chinook are sexually mature fish that enter the Klamath Estuary during late summer to early fall and spawn shortly after reaching their natal spawning grounds. In general, UKTR Chinook spawning adults are smaller, more rounded, and heavier in proportion to their length compared to Central Valley Chinook due to their shorter migrations. Today, UKTR fall-run Chinook salmon are part a component of commercial, recreational, and tribal subsistence fisheries.

ABUNDANCE

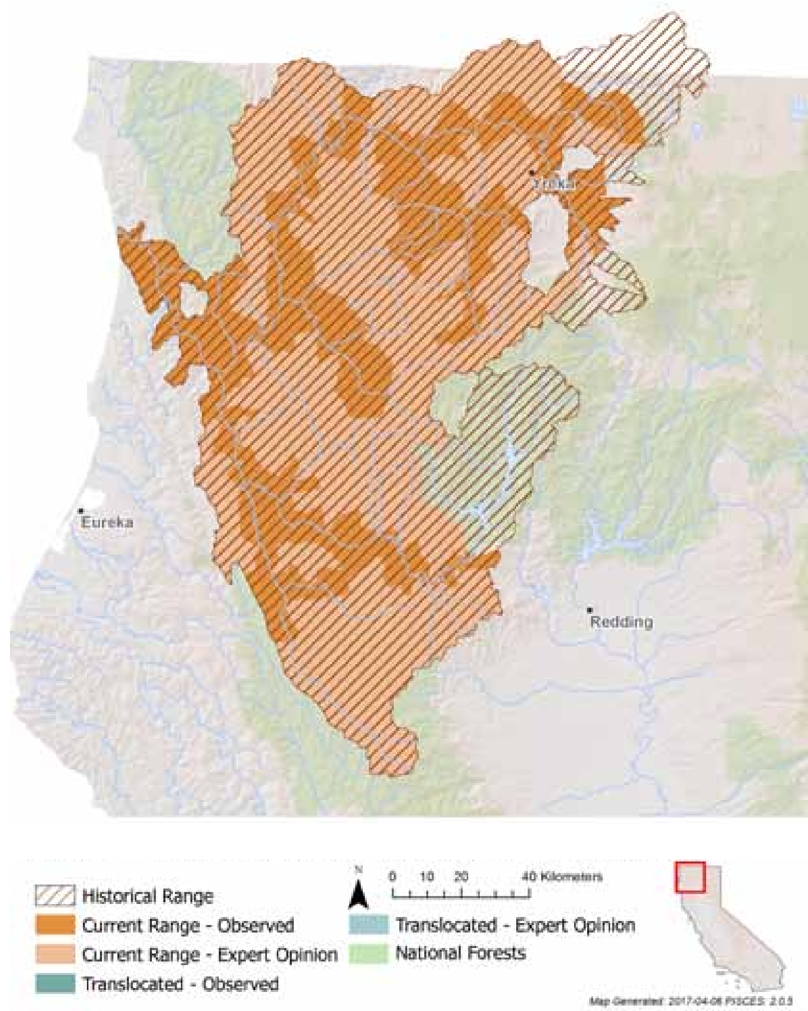
UKTR fall-run Chinook are sexually mature when they enter the Klamath Estuary during late summer to early fall and spawn shortly after reaching their natal spawning grounds. In general, UKTR Chinook spawning adults are smaller, more rounded, and heavier in proportion to their length compared to Central Valley Chinook. Today, UKTR fall-run Chinook salmon are a component of commercial, recreational, and tribal subsistence fisheries.

HABITAT AND BEHAVIOR

Adult UKTR fall-run Chinook salmon enter the Klamath Estuary from early July through September, and slowly migrate upstream from mid-July to October as temperatures decrease. In the Trinity River, fall-run Chinook salmon migration occurs between September and December. Spawning can occur over several months depending on the tributary, but generally peak between November and December, which is one to four weeks later than occurred historically. UKTR Chinook salmon have larger and fewer eggs than those from the Central Valley. While most UKTR fall-run Chinook are three years old when they spawn, in some years, two year-old small male salmon, called grilse, can make up a large proportion of the run. Juvenile UKTR Chinook salmon exhibit one of three life strategies: (1) rapidly migrating to the ocean; (2) spending summer months in cool tributaries until migrating out to sea in the fall; and (3) spending over a year in fresh water feeding before migrating to sea. A very rare fourth strategy has been documented in the spring-fed Shasta River, where male parr salmon mature entirely in fresh water and may spawn multiple times throughout their lives.
Life history strategies depend on food availability, streamflows, water temperature, and other factors.

GENETICS

UKTR fall-run Chinook are more similar to UKTR spring-run Chinook than they are to other fall-run Chinook in lower Klamath River tributaries.



UPPER KLAMATH-TRINITY RIVERS FALL-RUN CHINOOK SALMON DISTRIBUTION

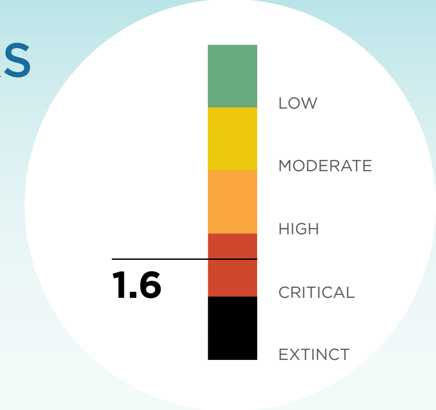
UKTR Chinook salmon are found in all major tributaries of the Klamath River upstream of the Klamath-Trinity rivers confluence.

UPPER KLAMATH-TRINITY RIVERS SPRING-RUN CHINOOK SALMON

Oncorhynchus tshawytscha

LEVEL OF CONCERN: CRITICAL

Chinook salmon exhibiting spring run timing in the Klamath Basin are likely to disappear in the next 50 years. Small, self-sustaining populations remain primarily in the Salmon and South Fork Trinity rivers, where they are highly vulnerable to climate change, hybridization with hatchery-origin fish, and other stressors.



Chinook in Bubbles. Photo: USFWS. Right: Leaping Chinook. Photo: Unknown.

CLIMATE CHANGE IMPACT

Climate change is likely the greatest threat to the long-term persistence of UKTR spring-run Chinook salmon due to anticipated increases in summer water temperatures and decreases in availability of cold water refuges for holding adults in summer. Removal of Iron Gate, Copco 1, Copco 2 and J.C. Boyle dams on the Klamath River is critical to allow spring-run fish back into cold headwaters of the Klamath basin.

TOP 3 ANTHROPOGENIC THREATS

MAJOR DAMS

Iron Gate (Klamath), Dwinnell, (Shasta), and Lewiston (Trinity) dams block access to a majority (970 km or about 600 mi) of historical spawning habitat for spring-run Chinook.

HATCHERIES

Hybridization of wild and hatchery-origin Chinook from Trinity River Hatchery, as well as interbreeding with spring- and fall-run fish in the Trinity River, may reduce fitness of wild spring-run Chinook salmon.

LOGGING

Legacy and ongoing impacts from timber operations in the Klamath-Trinity region degrade spawning areas, fill essential holding pools, increase summer stream temperatures due to reduced riparian vegetation, and remove trees and large wood that serve as important habitat for all salmonids.

SUMMARY

Recent returns of Upper Klamath-Trinity rivers (UKTR) spring-run Chinook salmon to the South Fork Trinity and Salmon rivers represent a small fraction (< 3%) of historical numbers. Drought from 2012-2016 significantly reduced cold water during critical over-summering periods for spring-run Chinook, contributing to their decline.

CONSERVATION ACTIONS

- Remove the four lowermost Klamath dams to restore access to historical cold water habitat, and undertake long-term restoration and monitoring in newly accessible habitat.
- Prioritize restoration activities in the Salmon, New, and South Fork Trinity rivers that still hold wild UKTR spring run Chinook.
- Reduce the impacts of sedimentation from roads, logging, and other activities into UKTR watersheds.
- Reduce water diversions and groundwater pumping for agricultural and other uses, especially in summer, to keep cold water in streams during stressful summer and fall months.
- Improve habitat and flow conditions in the Shasta and Scott rivers.

METRIC	SCORE	JUSTIFICATION
Area occupied	2	Only Salmon River and South Fork Trinity River support wild, self-sustaining populations.
Estimated adult abundance	2	A few hundred natural spawners support the population, with attendant impacts of small populations and hatchery influence.
Intervention dependence	2	Hatchery stocks maintain the mainstem Trinity run; Klamath dam removal in Klamath is needed to restore access to historical range.
Environmental tolerance	2	Narrow temperature tolerance (< 20ºC) during migrations; temperatures and other factors limiting in summer holding areas.
Genetic risk	1	Hybridization with fall-run and/or hatchery spring-run is occurring in Trinity River; fitness reduction may result from hybridization.
Climate change	1	Increased temperatures, density of adults and juveniles and disease outbreaks, and reduction in suitable habitats will limit populations.
Anthropogenic threats	1	3 High, 7 Medium factors.
Average	1.6	LEVEL OF CONCERN: CRITICAL
Certainty (1-4)	3	Fairly well-studied.

CHARACTERISTICS

UKTR spring-run Chinook salmon enter fresh water as silvery, immature fish. They lack the breeding colors or kype of fall-run males. Spring-run Chinook salmon once made up the most abundant run in the Klamath Basin. These fish are an indicator of ecosystem health due to their reliance on cold water during the warmest months of the year when streamflows are reduced and temperatures approach their upper tolerance.

ABUNDANCE

Historical runs of UKTR spring-run Chinook likely totaled more than 100,000 fish annually. Over the last decade, average annual estimates have averaged less than 2,000 adults.

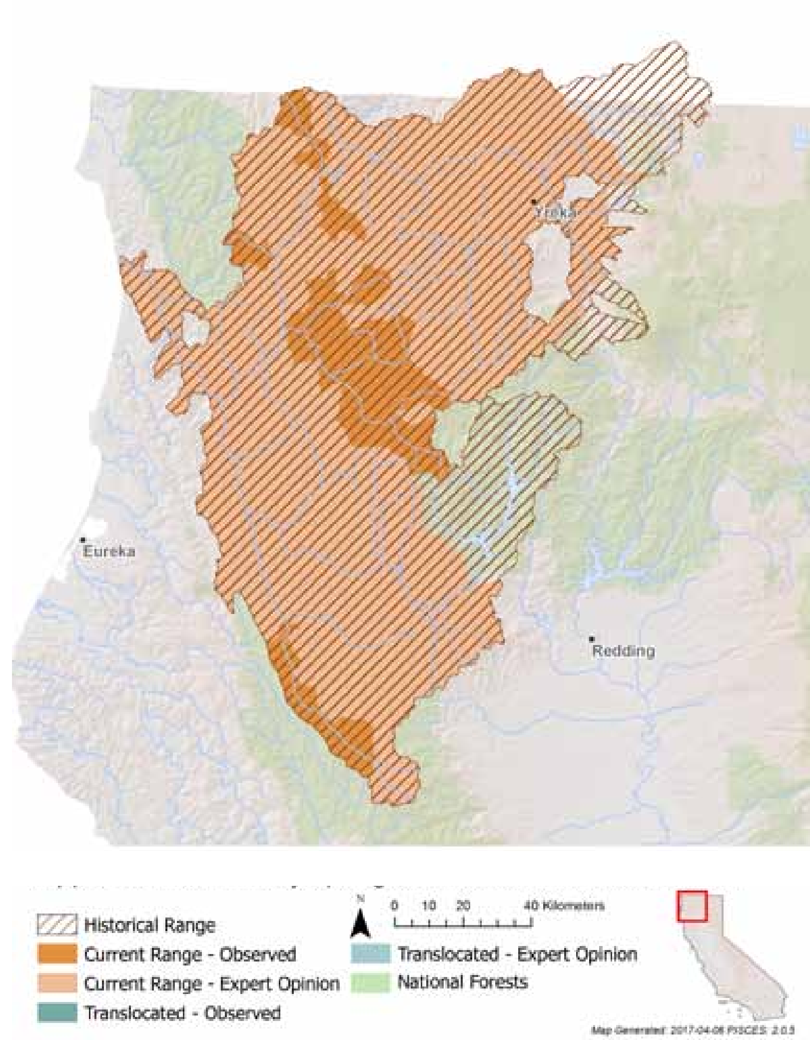
HABITAT AND BEHAVIOR

Adult UKTR spring-run Chinook salmon enter the Klamath Estuary from March through July, with a peak in late May or early June. Spring-run Chinook salmon can migrate up to 3.7 km (about 2.2 mi.) a day, and reach the Trinity River from May through August. They hold in cold water streams from 10-16°C (50-61°F) for 2-4 months before beginning to spawn in early September, about 4-6 weeks earlier than their fall-run counterparts.

Historically, there was minimal spawning overlap between fall- and spring-run Chinook due to differences in run-timing and access to a wide variety of spawning habitat throughout the Klamath Basin. Adults require deep, cool holding pools to over-summer, such as the mouths of tributaries and areas with subsurface flow from springs or groundwater seeps. Eggs hatch in 40-60 days, usually in January to late May, and absorb their yolk sacs for another 4-6 weeks. The vast majority of juvenile spring-run Chinook begin migrating downstream from February through mid-June to feed and grow in the ocean before returning to spawn at age three or four.

GENETICS

The latest genetic studies indicate that fall- and spring-run Chinook salmon in the Upper Klamath-Trinity rivers are more closely related to one another than each is to fall- or spring-run Chinook from adjacent basins. It is hypothesized that the spring-run life history first evolved in Chinook salmon populations in California, and then spread more recently into northern populations.

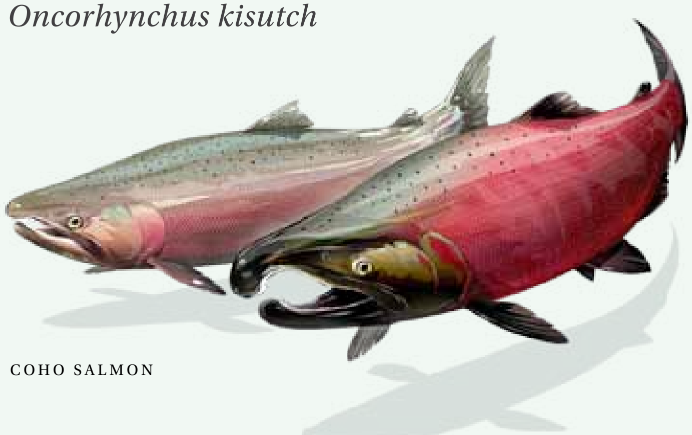


UPPER KLAMATH-TRINITY RIVERS SPRING-RUN CHINOOK SALMON DISTRIBUTION

UKTR spring-run Chinook salmon were once widely disbursed throughout tributaries of the Klamath River upstream of the Trinity River confluence, including the Sprague, Wood, and Williamson rivers (Oregon), and the Shasta, Salmon, and Trinity rivers in California. The construction of dams on the Klamath (Iron Gate), Shasta (Dwinnell), and Trinity (Lewiston) rivers block access to their historical spawning grounds. While small numbers of adults return to a handful of streams each year, only the South Fork Trinity and Salmon rivers support self-sustaining populations with little hatchery influence.

COHO SALMON

Oncorhynchus kisutch



COHO SALMON

Of the two kinds of Coho salmon in California, both saw an increase in Level of Concern since 2008.

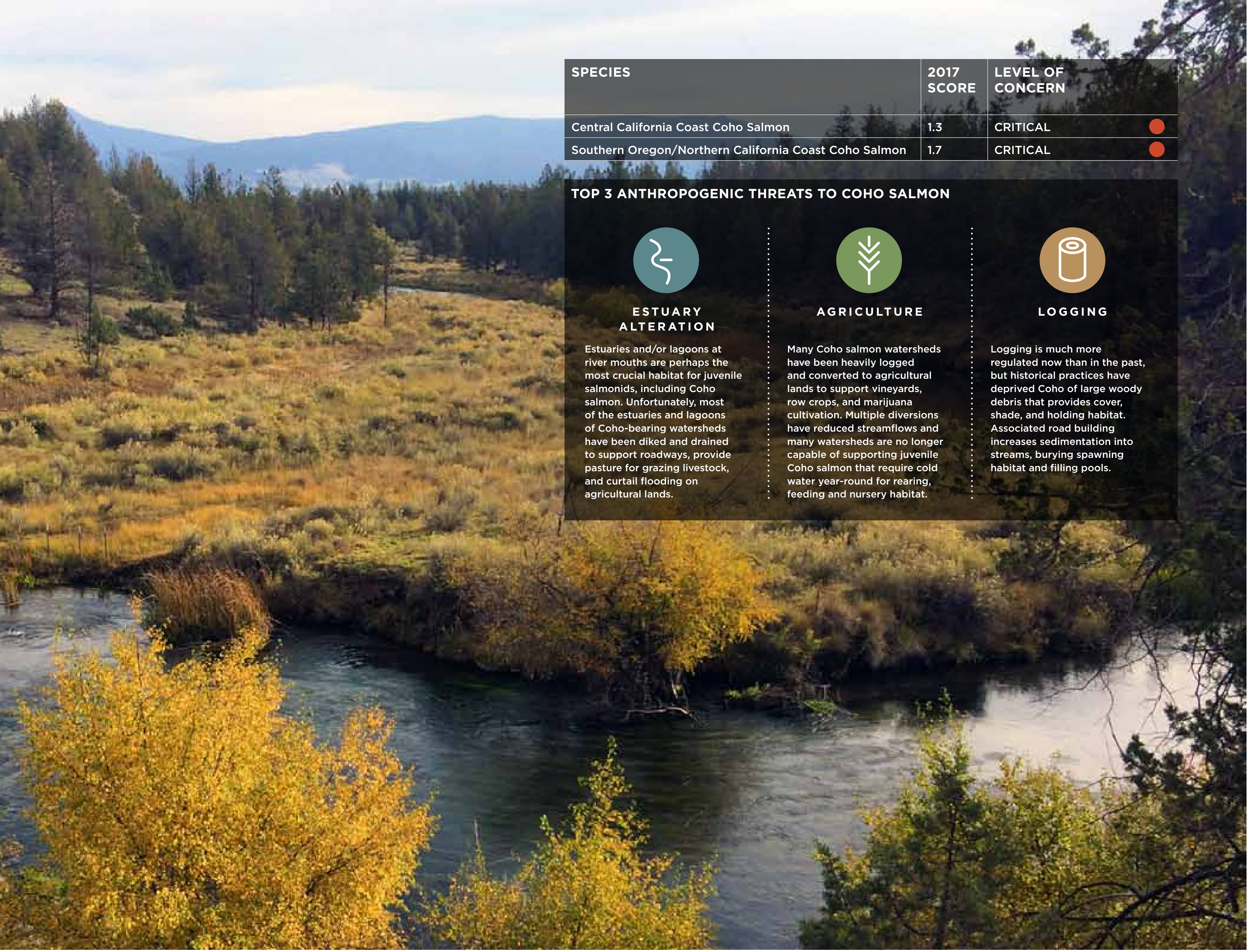
Coho salmon range widely across the northeast Pacific Ocean, but the southern extent of their range lies near Santa Cruz. Today, Coho salmon in California have been reduced to less than 5% of their historical numbers. Spawning adult Coho salmon are 55-80 cm (approximately 22-31 in.) long and weigh 3-6 kg (approximately 7-13 lbs.). While at sea, Coho are silvery with white to cream bellies, giving them their nickname "silver salmon." In fresh water, they are dark green on the head and back, maroon on the sides, and grey to black on the belly. Spawning males have a kype, bright red stripe on their sides, and slightly humped back. Anglers can differentiate Coho and their grey to white gums with the black mouths and black gums of Chinook salmon.

HABITAT AND BEHAVIOR

Coho salmon in California are separated into two ESUs for management. Southern Oregon/Northern California Coast Coho salmon (SONCC Coho) range from the Oregon border south to the Mattole River (Mendocino County), inclusive, while California Central Coastal Coho salmon (CCC Coho) range from the Mattole River south to Santa Cruz County. They can only be distinguished from one another through genetic analysis. Despite decades of stocking Coho along California's coast to help boost populations, wild fish rarely spawn with hatchery-raised Coho. Coho salmon use some part of their spawning streams on a year-round basis for migration, nursery areas, and foraging. In California, Coho spend 6-18 months feeding in the Pacific Ocean before returning to their natal streams between September and mid-January to spawn. Some fraction of returning male Coho salmon spend only one year at sea and are called "jacks," while virtually all females return after two years at sea. Adult Coho salmon use low-gradient streams that flow directly into the ocean or in tributaries of large rivers to spawn, usually by March of each year. Females are capable of laying up to 7,000 eggs each and, while both the males and females die after spawning, females may survive to guard their redds for up to two weeks.

Eggs hatch after 8-12 weeks in the gravel, and the alevins absorb their yolk sacs for another 4-10 weeks until they can search for food on their own. Most juvenile Coho salmon utilize slow, off-channel habitats, such as floodplains, sloughs, ponds, and backwater eddies for at least one, but up to two years as refuge from high floods and as feeding and nursery habitats. In general, juvenile Coho salmon prefer to feed and grow in streams with abundant shade, large woody debris, and slow currents before emigrating to sea. Estuaries and lagoons with plentiful food provide critical habitat for juvenile Coho salmon, helping them acclimate to saltwater and improving their chances of marine survival.

Shasta Meadow. Photo: Val Atkinson.



SPECIES	2017 SCORE	LEVEL OF CONCERN
Central California Coast Coho Salmon	1.3	CRITICAL
Southern Oregon/Northern California Coast Coho Salmon	1.7	CRITICAL

TOP 3 ANTHROPOGENIC THREATS TO COHO SALMON

ESTUARY ALTERATION

Estuaries and/or lagoons at river mouths are perhaps the most crucial habitat for juvenile salmonids, including Coho salmon. Unfortunately, most of the estuaries and lagoons of Coho-bearing watersheds have been diked and drained to support roadways, provide pasture for grazing livestock, and curtail flooding on agricultural lands.

AGRICULTURE

Many Coho salmon watersheds have been heavily logged and converted to agricultural lands to support vineyards, row crops, and marijuana cultivation. Multiple diversions have reduced streamflows and many watersheds are no longer capable of supporting juvenile Coho salmon that require cold water year-round for rearing, feeding and nursery habitat.

LOGGING

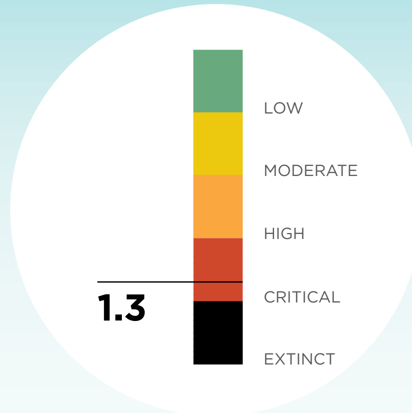
Logging is much more regulated now than in the past, but historical practices have deprived Coho of large woody debris that provides cover, shade, and holding habitat. Associated road building increases sedimentation into streams, burying spawning habitat and filling pools.

CENTRAL CALIFORNIA COAST COHO SALMON

Oncorhynchus kisutch

LEVEL OF CONCERN: CRITICAL

Most or all Central California Coast Coho salmon populations in small coastal streams will become extinct in the next 50 years without significantly increased intervention and protection of watersheds.



Left: Juvenile Coho, Mill Creek. Photo: Glenn Kubacki. Right: Adult male Coho salmon. Photo: Mike Sparkman.

CLIMATE CHANGE IMPACT

Climate change could push CCC Coho to extinction in California. Climate change is predicted to increase stream temperatures, create variability in streamflow (including greatly reduced summer flows), and change ocean conditions that dictate CCC Coho salmon growth and survival.

TOP 3 ANTHROPOGENIC THREATS

AGRICULTURE

Irrigation diversions for agriculture, especially vineyards, in many CCC Coho streams reduce streamflows, while illegal and unregulated marijuana cultivation further reduces suitable habitat for growing juveniles in tributaries, especially during summers coinciding with drought.

URBANIZATION

Urbanization has eliminated all Coho populations in the San Francisco Bay region, and is increasingly contributing to the loss of CCC Coho habitat in streams in Marin and Sonoma counties through encroachment of homes and development.

ESTUARY ALTERATION

Agricultural and other land uses pollute lagoons with suburban waste, runoff, and pollution. Lagoons are often opened artificially to prevent flooding of agricultural fields or houses, which may carry juvenile Coho out to sea before they are ready, reducing their survival to adulthood.

SUMMARY

Central California Coast (CCC) Coho salmon populations continue to deteriorate at the southern end of their range.

CONSERVATION ACTIONS

- Protect source waters in remaining CCC Coho salmon watersheds including the Garcia, Noyo, and Gualala rivers and Lagunitas, Scott, and Waddell creeks.
- Develop and maintain restoration hatcheries to be used in conjunction with habitat improvement and evaluation measures to boost populations and increase genetic diversity of CCC Coho.
- Increase inter-agency cooperation, private landowner partnerships, mobilization of public opinion, and development of an extensive monitoring program to maintain CCC Coho salmon.

CHARACTERISTICS

CCC Coho salmon are identical in appearance and habits to Southern Oregon Northern California Coast (SONCC) Coho to the north. They can only be distinguished by differences in geographic range and genetics.

ABUNDANCE

Almost all of the remaining streams containing CCC Coho salmon have populations less than 100 spawning adults per year, unless enhanced through hatcheries. Most CCC Coho populations are threatened with extinction in the near future, with the exception of populations in Lagunitas Creek (Marin County), the Russian River (Sonoma County), and Santa Cruz County

METRIC	SCORE	JUSTIFICATION
Area occupied	2	Most populations not self-sustaining in long run.
Estimated adult abundance	2	All populations are small, isolated, and may function independently. Most are < 100 adults in most years.
Intervention dependence	1	All populations require intervention to persist and most have intensive management in place or proposed.
Environmental tolerance	1	Coho are generally among the most sensitive salmonids to environmental conditions.
Genetic risk	1	Populations small and isolated.
Climate change	1	At southern end of range so exceptionally vulnerable.
Anthropogenic threats	1	8 Medium threats.
Average	1.3	LEVEL OF CONCERN: CRITICAL
Certainty (1-4)	4	Well documented.

watersheds due largely to the heroic efforts of managers, concerned citizens, and conservation hatcheries.

HABITAT AND BEHAVIOR

Habitat requirements of CCC Coho salmon are similar to SONCC Coho salmon. Timing of streamflows is critically important to CCC Coho salmon, which need cold water at specific times to support successful spawning and juvenile survival. Severe high flow events that occur early in winter (December, January) can scour holding pools, move large wood cover, open lagoon mouths for migration, and generally improve Coho habitat, while similar flood events later in the season (February, March) can wash away redds and eggs or flush juvenile CCC Coho out of over-wintering habitat such as pools, side channels, or estuaries.

GENETICS

CCC Coho salmon are most similar to Coho in neighboring watersheds than they are to Coho in Northern California or Southern Oregon.

Coho salmon preparing to spawn. Photo: Mike Wier.

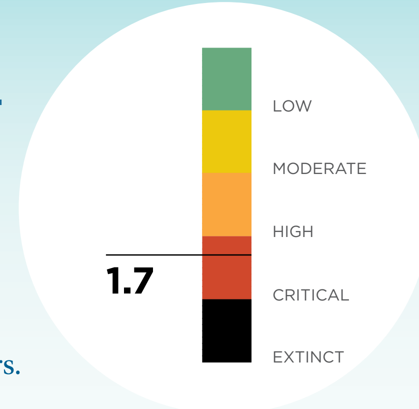
CENTRAL CALIFORNIA COAST COHO SALMON DISTRIBUTION

CCC Coho salmon historically ranged in coastal streams from Punta Gorda (Humboldt County) to the San Lorenzo River and (likely) Soquel and Aptos creeks (Santa Cruz County). While some populations of CCC Coho have been lost from streams ranging from Santa Cruz to Marin counties over the past several decades, there has also been some dispersal through stocking, such as the movement of Coho from Scott Creek to Waddell and Gazos creeks (Santa Cruz County).

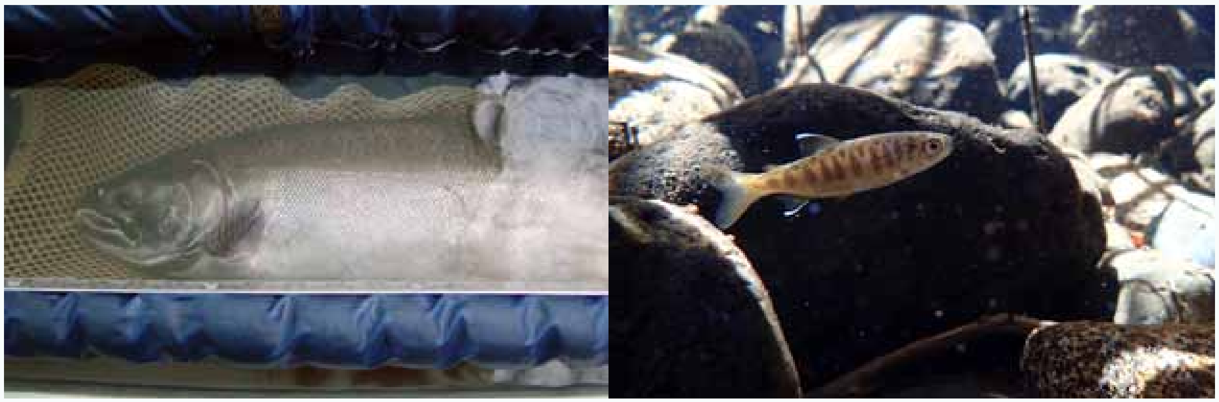
SOUTHERN OREGON/ NORTHERN CALIFORNIA COAST COHO SALMON

Oncorhynchus kisutch

LEVEL OF CONCERN: CRITICAL



Southern Oregon/Northern California Coast Coho are critically vulnerable to extinction as wild fish within the next 50-100 years. There has likely been 95% or more decline in numbers since the 1960s in California due to dam construction and habitat degradation from various land use practices.



Left: Adult female Coho salmon. Photo: Mike Sparkman. Right: Juvenile Coho salmon, Smith River. Photo: Justin Garwood.

CLIMATE CHANGE IMPACT

Climate change will lead to increased stream temperatures, more frequent and prolonged drought, and reduced streamflows that will negatively impact survival of SONCC Coho in the future.

TOP 3 ANTHROPOGENIC THREATS

HATCHERIES

Hatchery-origin Coho salmon are having a negative effect on wild Coho salmon by competing with them for resources during all life stages and through hybridization. In the Trinity River, it appears that wild SONCC Coho salmon have been completely replaced by hatchery fish from the Trinity River Hatchery.

ESTUARY ALTERATION

Most estuaries throughout the SONCC Coho range are highly altered, which reduces important nursery areas and connectivity among habitats used by all Coho life stages.

AGRICULTURE

Irrigation diversions in many streams reduce flows during critical juvenile growth and feeding periods in the summer months, especially from illegal marijuana cultivation.

SUMMARY

Southern Oregon/Northern California Coast (SONCC) Coho salmon populations have likely declined 95% from their historical abundance. There are general indications of continued long-term decline and/or high variability in numbers from larger streams.

CONSERVATION ACTIONS

- Remove the four lowermost Klamath dams to restore access to historical cold water habitat.
- Halt all production hatchery programs for Coho salmon to allow wild stocks to recover.
- Use emergency rearing facilities that mimic natural conditions to increase juvenile SONCC Coho survival during drought or significant watershed restoration.
- Protect spawning, rearing, and feeding habitats, and connectivity between them, to allow Coho salmon to express their diverse life histories on a broad scale.
- Use voluntary water forbearance programs, reduce illegal water diversions, and expand use of water storage tanks to maintain cold streamflows during all seasons.
- Enhance habitat and improve flow conditions in the Shasta and Scott rivers to support Coho salmon.

CHARACTERISTICS

SONCC Coho salmon are identical in appearance to Central California Coast Coho, and are distinguishable only by genetic differences.

METRIC	SCORE	JUSTIFICATION
Area occupied	4	Populations in Eel, Klamath, Mattole, and other watersheds.
Estimated adult abundance	2	Most populations are isolated and function independently and are < 100 fish. Less than 5,000 wild adults return to spawn each year.
Intervention dependence	2	All populations require continuous intervention to persist.
Environmental tolerance	1	Coho are among the most sensitive of salmonids to changing environmental conditions.
Genetic risk	1	See Bucklin et al. (2007).
Climate change	1	Rated critically vulnerable in Moyle et al. (2013).
Anthropogenic threats	1	1 Critical, 3 High factors.
Average	1.7	LEVEL OF CONCERN: CRITICAL
Certainty (1-4)	4	Well-studied populations.

ABUNDANCE

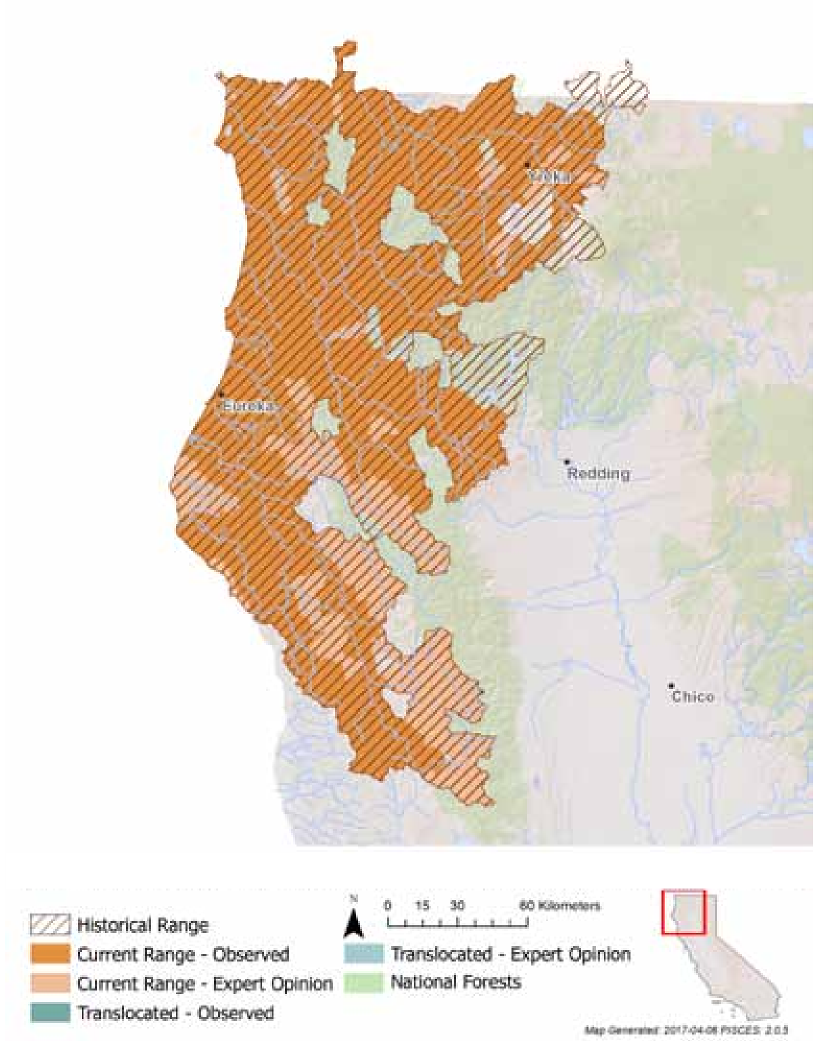
About 75 years ago, between 100,000 to 300,000 SONCC Coho returned to spawn in freshwater each year. Currently, populations are less than 5% of historical abundance, or less than a generous estimate of 5,000 wild individuals. The number of streams capable of supporting Coho salmon runs have declined 40-50%. Accurate abundance estimates covering a large timespan are uncommon, which makes population trend analysis difficult.

HABITAT AND BEHAVIOR

Virtually all female and most male SONCC Coho salmon in California are three years old when they spawn, with some males returning as two year-old “jacks.” Spawning migrations begin in September through late-December in Northern California, with a peak in October-November, while spawning occurs mostly in November and December. In some years, spawning can occur as late as March in some watersheds, especially if stream flows are low or access is limited because of drought. Females deposit 1,400-7,000 eggs. Eggs hatch in early spring, and alevins slowly absorb their yolk sac before seeking out prey. Unlike most other salmonids, juvenile SONCC Coho salmon use parts of their spawning streams and estuary habitats throughout the year. These young salmon require very cold, clean water between 10-15.5°C (50-60°F) to grow. In the spring-fed Shasta River in Northern California, juvenile SONCC Coho salmon can flourish in warmer waters of 18°-20°C (66°-68°F) because food is abundant and habitat conditions are favorable. Juveniles generally feed and grow in slow-moving, off-channel habitats, small, clear tributaries, and estuaries before undertaking ocean migrations in the spring. They generally express three life history strategies: 1) juveniles up to one year of age feed and grow in their natal streams and migrate to sea in the spring; 2) juveniles up to two years old feed and grow in estuaries and off-channel habitat during winter and spring before migrating to sea during the first major fall rainstorm; and 3) yearling juveniles move downstream to other streams or estuaries in spring and grow in the main channels during summer and fall before migrating in the winter. Once at sea, Coho from different regions school together as they migrate to the North Pacific to feed on small fish, shrimp, crabs, and invertebrates before returning to spawn after 6-18 months.

GENETICS

In California, Punta Gorda (Humboldt County) separates California’s two Evolutionary Significant Units (ESUs) of Coho salmon: SONCC Coho and Central California Coast (CCC) Coho salmon. Coho have strong homing instincts to their natal rivers, and so populations from neighboring streams are closely related to one another. Historical widespread stocking of non-CCC Coho salmon has not appeared to reduce the genetic integrity of remaining wild fish.



SOUTHERN OREGON/NORTHERN CALIFORNIA COAST COHO SALMON DISTRIBUTION

SONCC Coho salmon are distributed widely across the North Pacific, from northern Japan to California. SONCC Coho are found in the Rogue River (Oregon) to the Mattole River (Mendocino County). Historically, SONCC Coho occupied numerous coastal basins with high quality habitat in the lower portions of watersheds.

CHUM SALMON

Oncorhynchus keta

LEVEL OF CONCERN: CRITICAL

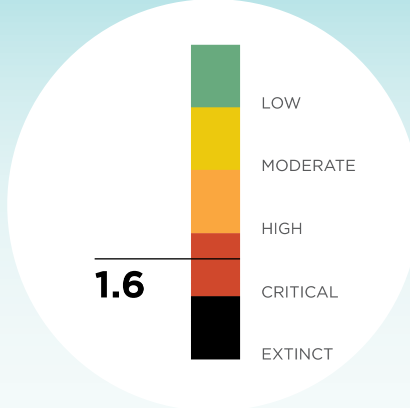


Photo: USFWS.

The status of Chum salmon in California is poorly understood. It appears as if they have already ceased to exist as a self-sustaining species in California, or their populations are too small to be detected.

CLIMATE CHANGE IMPACT

Poor ocean conditions such as increased sea surface temperatures, reduced upwelling currents, and low food availability is likely to reduce survival of Chums in the ocean and limit connections to more northern populations over time.

TOP 3 ANTHROPOGENIC THREATS

ESTUARY ALTERATION

The significant alteration of estuaries in California streams, where young Chums spawn and rear, likely has the greatest negative impact on Chum salmon populations.

AGRICULTURE

Low gradient sections of rivers and surrounding habitat have generally been highly altered to provide pasture for livestock. Agricultural diversions have degraded watersheds throughout the Chum salmon historical range.

LOGGING

Land uses, such as logging, have increased sedimentation and siltation in known Chum salmon spawning streams, and reduced large woody debris, which provides cover for juveniles.

SUMMARY

Recent observations of small, but reliable returns of Chum salmon in Mill Creek (Smith River, Del Norte County) and the South Fork Trinity River (Trinity County) have drawn attention to the few remaining watersheds where they spawn, and highlighted the need for targeted surveys to document their occurrence. While the Level of Concern has increased slightly since 2008, Chum salmon are vulnerable to anthropogenic threats.

CONSERVATION ACTIONS

- Restore the Eel and other large coastal estuaries along the North Coast to benefit all salmonids.
- Conduct genetic and spawning studies on Chums in California to determine if they represent a distinct, self sustaining population or are strays from northern populations.
- Maintain suitable streamflows, water quality, and habitat in lower watersheds through partnerships, regulations, and other mechanisms that benefit all salmonids.

METRIC	SCORE	JUSTIFICATION
Area occupied	2	If Chum salmon are still maintaining populations in California, there are only 2-3 in the Smith, Klamath, and Trinity rivers.
Estimated adult abundance	1	There is little evidence that any population is more than a handful of spawners, perhaps in the range of 6-20 adults in most years.
Intervention dependence	2	No effort is currently being made to specifically protect Chum salmon runs; it is unlikely for the species to persist in California without intervention.
Environmental tolerance	2	Southern populations have fairly narrow spawning habitat requirements; juvenile Chums require functioning estuarine habitats for feeding and growth.
Genetic risk	1	California populations, if not already extirpated, are extremely small and vulnerable to inbreeding depression and other genetic problems. Genetic studies are needed on California populations.
Climate change	1	Small changes in flows or temperatures and/or small changes in ocean conditions could eliminate the populations.
Anthropogenic threats	1	2 High threats; severity of most threats unknown.
Average	1.6	LEVEL OF CONCERN: CRITICAL
Certainty (1-4)	1	Information is very limited.

CHARACTERISTICS

Chum salmon are one of the smaller species of salmon; they may grow to over 1 m in length, but most in California are less than 65 cm (26 in.). They are best known for their slight hump, hooked snout, and protruding canine-like teeth during spawning. They are dark olive on the back and dark maroon on the sides, with irregular greenish vertical bars on the sides and no spots on the back or tail.

ABUNDANCE

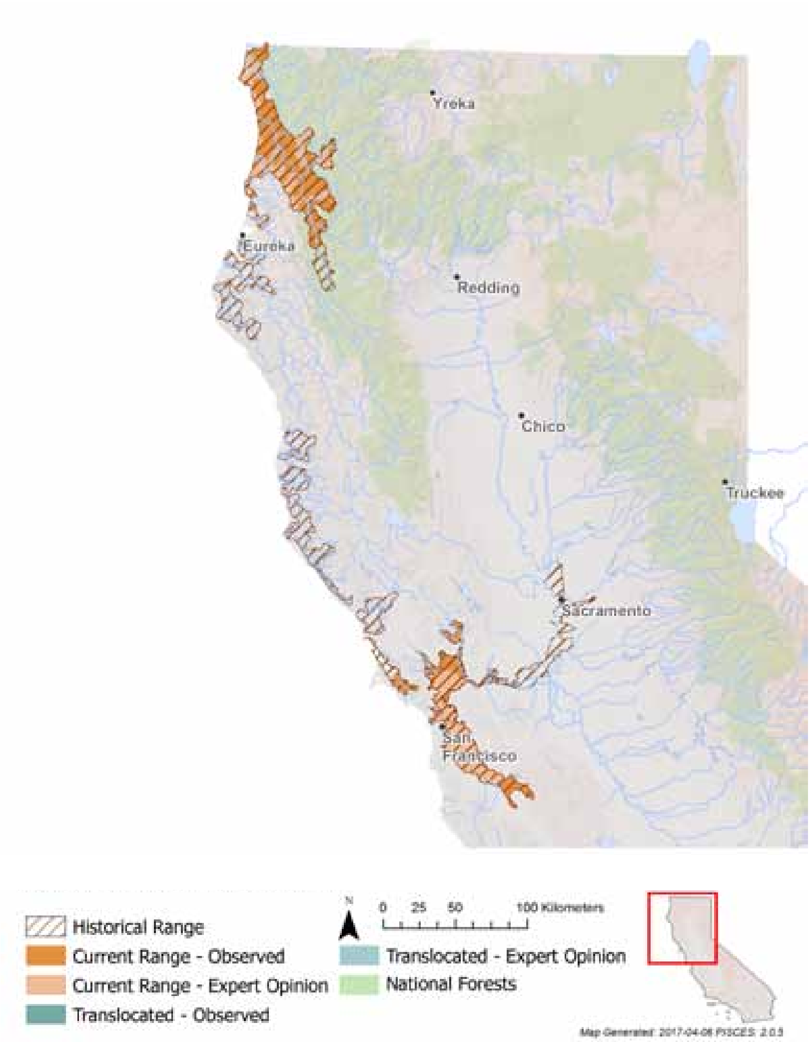
Chum salmon have likely always been uncommon in California, and more common in Oregon and Washington. Chum salmon may spawn sporadically in California streams from San Francisco Bay north to the Oregon border, but the rivers with the most reliable spawning populations are the Smith, Klamath, and South Fork Trinity rivers. Most occurrences of spawning Chum in California today are likely strays from the Pacific Northwest from both natural and hatchery production.

HABITAT AND BEHAVIOR

Chum salmon live to two to seven years of age, though most spawn between the ages of three and five. Most Chums spawn within 200 km (approximately 124 mi.) of the Pacific Ocean due to their poor swimming ability, and some populations even spawn in the intertidal reaches of streams. In California, they enter streams from August through January on their spawning run. Unlike Chinook or Coho salmon, juvenile Chum salmon quickly migrate downstream to spend several months feeding on abundant copepods and amphipods in estuaries rather than rearing in freshwater. As a result, their survival is more closely tied to ocean productivity than freshwater conditions.

GENETICS

Chum salmon are closely related to sockeye and pink salmon. No genetic studies on California populations are available, but the fish are considered to be part of the loose Pacific Coast ESU.



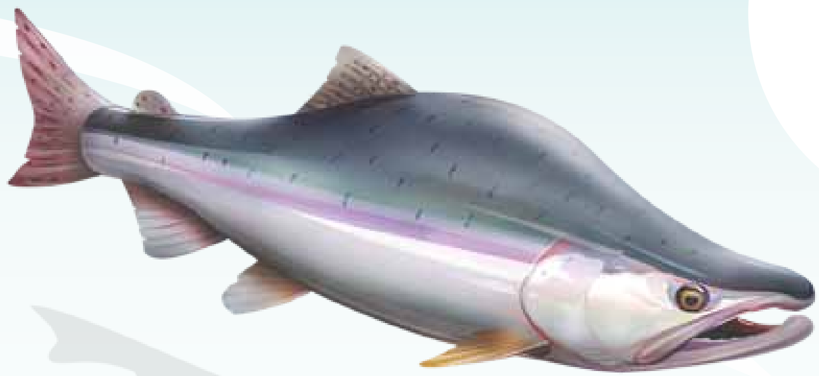
CHUM SALMON DISTRIBUTION

Chum salmon have the widest natural distribution of any Pacific salmon, spanning Japan to California. In California, Chum salmon range from the Smith River to the San Lorenzo River (Santa Cruz County), though they are somewhat regularly observed only in the Smith and Trinity rivers in far northern California.

PINK SALMON

Oncorhynchus keta

LEVEL OF CONCERN: CRITICAL



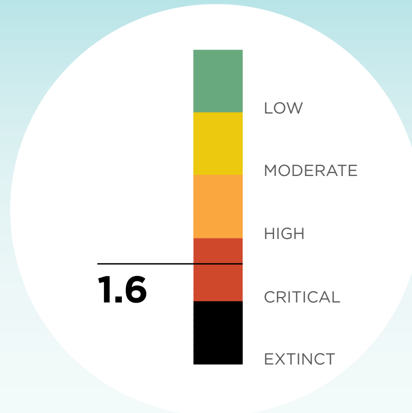


Photo: WDFW.

There are probably only one or two self-sustaining populations in California. It is highly likely that Pink salmon will disappear from California streams (except as strays from northern populations) within the next 25-50 years, if they have not already.

CLIMATE CHANGE IMPACT

Climate change will increase stream temperatures and eventually shift the southern boundary of Pink salmon northward outside of California, and contribute to sea level rise that will make habitat less suitable over time.

TOP 3 ANTHROPOGENIC THREATS

ESTUARY ALTERATION

Pink salmon are extremely vulnerable to estuary degradation, which they rely on for spawning and nursery habitat.

AGRICULTURE

Diversions, dikes, levees, and drained marsh/estuary habitat to support agriculture in lower river stretches make habitat less suitable for Pink salmon spawning.

LOGGING

Historical and current logging practices and associated road building causes increased stream sedimentation, which reduces egg survival in watersheds where Pink salmon spawning still occurs.

SUMMARY

Pink salmon in California are considered by many to be strays from more northern populations. However, the existence of very small but consistent spawning runs in Redwood Creek and the Garcia River watershed over the last fifteen years call this determination into question. These recent observations suggest that small and very fragile populations still exist in the state, and have been overlooked or ignored. Despite the slight increase in Level of Concern since 2008, Pink salmon are vulnerable to anthropogenic threats.

CONSERVATION ACTIONS

- Increase monitoring of coastal rivers with confirmed spawning of Pink salmon, such as the Garcia River and Redwood Creek, and potential habitat (e.g., Ten Mile River, Humboldt County and Russian River, Sonoma County) to determine population status.
- Conduct genetic studies to determine the origins of Pinks in California.
- Protect potential spawning areas in lower reaches of coastal streams and restore estuaries that serve as nursery habitat for salmonids.

METRIC	SCORE	JUSTIFICATION
Area occupied	1	Only confirmed from Garcia River and Redwood Creek.
Estimated adult abundance	2	Numbers very uncertain, so this is a best guess.
Intervention dependence	3	Largely unstudied, but some intervention needed if this species is to persist.
Environmental tolerance	1	Short life cycle, dependent on 1-2 streams.
Genetic risk	1	If a local population, then risk is high.
Climate change	1	Critically vulnerable to increased stream temperatures and sea level rise impacts on estuaries.
Anthropogenic threats	1	2 High and 3 Medium threats; loss of important spawning and crucial estuarine habitat.
Average	1.6	LEVEL OF CONCERN: CRITICAL
Certainty (1-4)	2	Very limited documentation

CHARACTERISTICS

Pink salmon have large black oval marks and spots on their backs, tails, and fins making them easy to tell apart from other salmon species. In the ocean, their backs are silvery blue to olive in color, with silver sides and white bellies. In freshwater, males take on a humped back, while their snouts, full of sharp teeth, become exaggerated and hooked. Pink salmon are the smallest members of the salmon family, usually reaching 60 cm long (about 24 in.) and weighing 2.5 kg (5.5 lbs.). The largest recorded Pink salmon measured 76 cm (30 in.) and weighed 6.3 kg (nearly 14 lbs.). Unlike other juvenile salmon, Pink salmon do not have parr marks.

ABUNDANCE

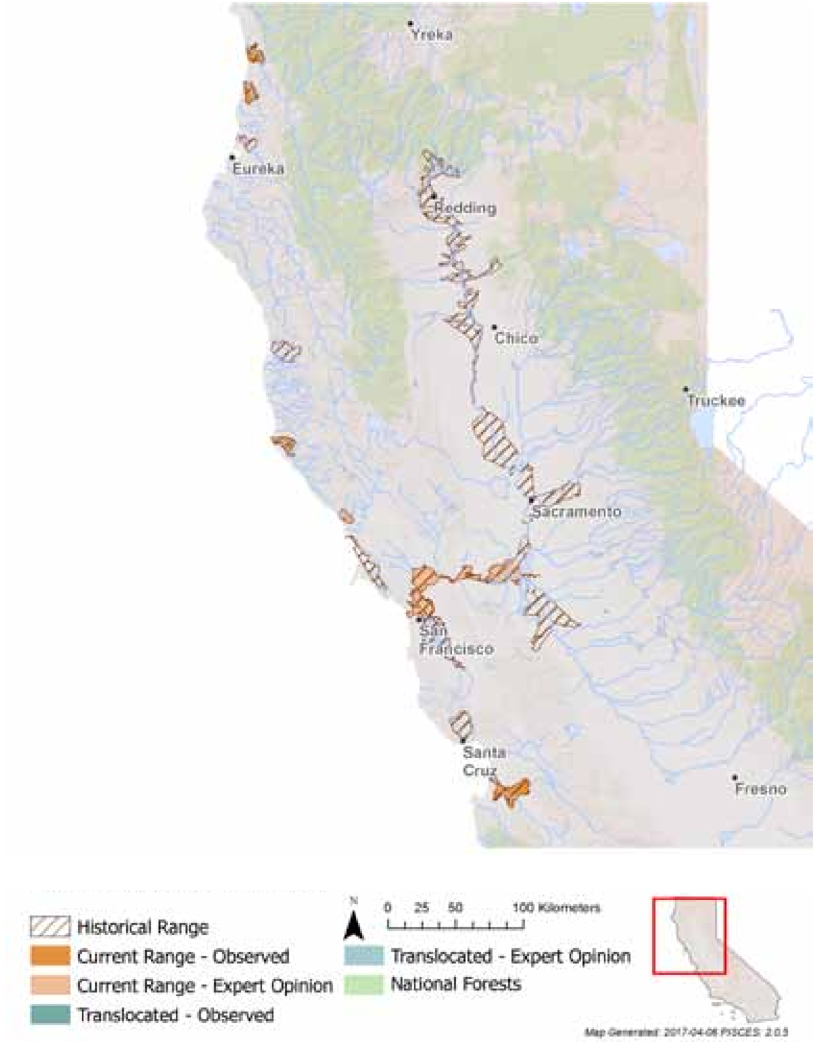
California represents the southern edge of the Pink salmon range, and they have never been common in the state. It is highly likely that Pink salmon were once common enough in California to support small runs in several rivers, but they are much less common today than they were historically. Due to their use of lower stream reaches and rapid migration to the ocean, they are difficult to accurately document. Present day populations likely depend on straying from more northern populations.

HABITAT AND BEHAVIOR

Pink salmon typically live for two years, and return to freshwater from June to September. Their two-year life cycle has given rise to discrete odd- and even-year runs in the same river systems. Pink salmon spawning in California typically takes place in odd years, though Redwood Creek supports a small even-year run. Spawning occurs in October in intertidal or lower reaches of streams, and young hatch in February or March. Young Pink salmon do not feed in freshwater, but migrate quickly in large schools at night to reach river estuaries. At sea, Pink salmon grow quickly, feeding on abundant small crustaceans and invertebrates and eventually shift to eating small fish, squid, and shrimp.

GENETICS

Scientists do not know much about the relationship of California fish to more northern populations from Puget Sound, Washington, where they are thought to originate. Most, but not all, Pink salmon return to California streams in odd years, suggesting there is a complex relationship between these fish and the consistent runs in Oregon and Washington.

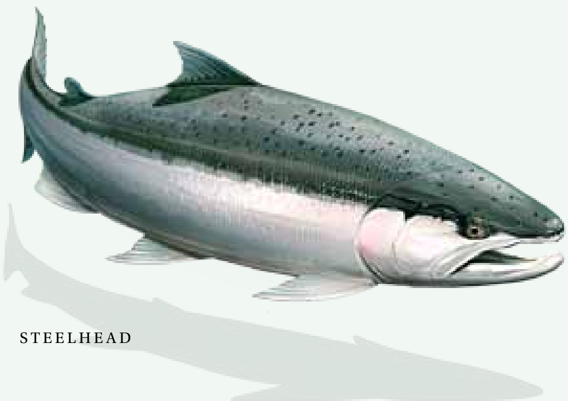


PINK SALMON DISTRIBUTION

In the ocean, Pink salmon range from the Korean coast around the rim of the North Pacific to La Jolla (San Diego County). In California, they have been documented in streams from Monterey County in the south to Del Norte County in the north, though most of the few fish that return to spawn do so reliably in only a handful of streams, including Prairie and Redwood creeks (Humboldt County) and Garcia and Ten Mile rivers (Mendocino County).

STEELHEAD

Oncorhynchus mykiss irideus



STEELHEAD

Of the eight kinds of steelhead in California, six saw an increase in Level of Concern since 2008.

Steelhead are Rainbow trout that migrate to sea before returning to fresh water to spawn, a behavior known as anadromy. All steelhead in California are nearly identical in appearance. When they enter fresh water from the ocean they are a bright, silver-blue “steel” color which gives them their name. As adults remain in fresh water they darken, taking on a greenish hue on the back and iridescent pink and red sides characteristic of resident Rainbow trout. Steelhead have many small black, spots radiating outward in lines on their back and tail. Spawning males have a kype used for fending off other males to secure mates. Juveniles have dark vertical ovals along their sides, called parr marks, and unlike juvenile salmon, have spots on their fins and a short anal fin. There are eight Distinct Population Segments (DPSs) of steelhead in California, based on their geographic ranges, genetics, and life histories.

BEHAVIORS AND HABITAT

Steelhead in California range from the Oregon border south to the Mexico border. These southern populations have a spectrum of adaptations and express a broad range of life histories that allow them to thrive in California’s diverse large rivers, small tributaries, estuaries, lagoons, and the Pacific Ocean.

Steelhead can live seven years and, unlike salmon species, may return to fresh water to spawn up to four times throughout their lives. There are two distinct run timing histories of steelhead recognized in Northern California: winter and summer. These two runs are distinct in their genetics, sexual maturation, and behavior. Where there is suitable habitat and open estuary mouths to the sea, adult and juvenile steelhead can be found migrating from fresh to salt water and vice versa during every month of the year, especially in large northern California rivers.

Despite different run timings, most steelhead spawn from December through April. Post spawn adults, known as “kelts,” slowly make their way from spawning tributaries to the ocean by summer. Eggs incubate in gravel redds dug by females for one to two months, depending on water temperature. Juveniles prefer habitats with cool water close to 17°C (about 63°F), but there can be significant variability in their tolerances if food is plentiful. During winter and spring, juvenile steelhead prepare for ocean migrations by undergoing physical changes that allow them to tolerate saltwater; these small, silvery fish are known as “smolts.” Smolts migrate downstream to the Pacific Ocean during the spring, where they remain for at least a year. After spending a few months in the food-rich upwelling California Current, juvenile steelhead migrate to the open waters of the North Pacific Ocean to feed on crustaceans, squid, shrimp, and fish. Unlike salmon, steelhead do not seem to school at sea, and are rarely caught in salt water. Their distribution and behavior at sea is poorly understood.

WHAT’S THE DIFFERENCE BETWEEN STEELHEAD AND RAINBOW TROUT?

Rainbow trout have two basic life histories with different names: steelhead and resident trout. The relationship between steelhead and residents is beautifully flexible and complex, making the species one of most successful salmonids in the world, but creating headaches for managers. Anadromous steelhead regularly produce to resident trout offspring. Resident trout populations regularly produce anadromous smolts. In populations where both forms occur, they regularly interbreed. This varied life history has a strong adaptive genetic basis.

This diversity of life histories appears to be particularly important in California, where both fresh water and ocean environments can undergo dramatic multi-year fluctuations in habitat quality. For example, if survival is low during down-stream migration or in the ocean for an extended period, then resident trout will have an adaptive advantage. If ocean conditions are good and promote high survival and growth, then offspring of migratory steelhead females will predominate in fresh water. Resident trout also thrive above natural barriers to anadromy (e.g., waterfalls) while steelhead can re-colonize streams where resident fish have been eliminated by natural causes (e.g. volcanic eruptions, catastrophic wildfire). In watersheds with both steelhead and wild resident Rainbow trout, the fish are part of a single, complex gene pool, which allows them to adapt to river systems that are highly variable.

Recognizing their diverse domestic and wild origins, the ‘Coastal Rainbow trout’ is not really a discrete genetic entity. Coastal Rainbow trout in this report are defined as resident Rainbows that mostly inhabit watersheds upstream of natural and man-made barriers without access to the ocean, although robust populations of resident trout are now found in tailwater habitats below dams throughout the state.

SPECIES	2017 SCORE	LEVEL OF CONCERN
Central California Coast Steelhead	2.0	HIGH
Central Valley Steelhead	3.1	MODERATE
Klamath Mountains Province Summer Steelhead	1.9	CRITICAL
Klamath Mountains Province Winter Steelhead	3.3	MODERATE
Northern California Summer Steelhead	1.9	CRITICAL
Northern California Winter Steelhead	3.3	MODERATE
South-Central California Coast Steelhead	1.9	CRITICAL
Southern Steelhead	1.9	CRITICAL

TOP 3 ANTHROPOGENIC THREATS TO STEELHEAD

MAJOR DAMS

Dams in watersheds across California have significantly limited the ability of steelhead to access historical spawning, migration, feeding, and nursery habitat. Altered streamflows caused by dams may also affect stream temperature and reduce gravel quantity and quality necessary for successful spawning and egg incubation.

ESTUARY ALTERATION

There is little suitable estuarine habitat left in California, and what remains is subject to high turbidity and poor water quality, caused by a variety of land uses such as road construction, agriculture, logging and rural development.

AGRICULTURE

Agriculture negatively impacts steelhead through stream diversions and warm return flows which can degrade water quality. In the last two decades, illegal water diversions to support marijuana cultivation has significantly limited survival of juvenile steelhead in small tributaries throughout the North Coast.

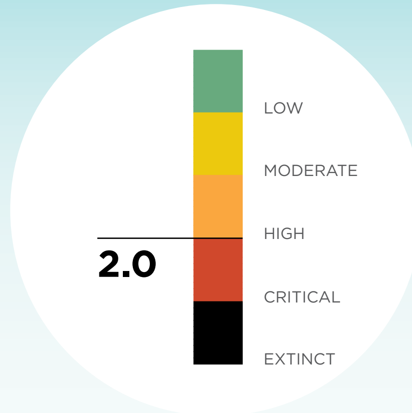
East Fork San Gabriel River. Photo: Richard Wong.

CENTRAL CALIFORNIA COAST STEELHEAD

Oncorhynchus mykiss irideus

LEVEL OF CONCERN: HIGH

Central California Coast (CCC) steelhead populations are in long-term decline, and face extinction in the next 100 years without significant investments in monitoring, habitat restoration, and increased efficiency in water use and management.



Left: Adult steelhead. Photo: Mark Capelli. Right: Steelie tail. Photo: Mike Wier.

CLIMATE CHANGE IMPACT

Currently, there are few accessible headwater habitats at higher elevations to provide cold water to support CCC steelhead without the removal of dams. With reduced precipitation expected in a changing climate, inflows to estuaries become too warm and oxygen-poor to support juvenile steelhead growth and survival. More common prolonged drought will deplete reservoir storage, possibly leading to the release of highly turbid, warm water downstream, further degrading spawning and rearing habitat.

TOP 3 ANTHROPOGENIC THREATS

MAJOR DAMS

Across the CCC steelhead range, dams and other manmade barriers block greater than a fifth of historical spawning, migration, nursery, and feeding habitat and have significantly limited populations.

URBANIZATION

Most CCC steelhead streams are in urban or suburban areas that reduce steelhead habitat suitability through water diversions, groundwater pumping, riparian habitat intrusion and degradation, and pollution. The associated expansion of roadways, vineyards and other agriculture, logging, mining, sewage discharge, and other actions reduce suitable habitat for steelhead.

ESTUARY ALTERATION

Estuaries and lagoons serve as critical nurseries for juvenile steelhead, yet continue to fill with sediment from upstream land uses such as urbanization and agriculture. For example, over 90% of critical wetland and estuarine habitat in the San Francisco Bay has been drained and/or filled.

SUMMARY

Most Central California Coast steelhead populations are extremely low in abundance (e.g., San Francisco Bay tributaries) and far below recovery thresholds, particularly after drought (2012-2016) significantly reduced spawning and rearing habitat across their range. While steelhead will continue to exist in the far reaches of larger watersheds, it is likely that populations in many watersheds will disappear over the next 25-50 years unless large-scale conservation and restoration actions are coordinated and implemented.

CONSERVATION ACTIONS

- Use legal tools such as Assembly Bill 2121 minimum flow requirements, Fish and Game Code 5937, and the Sustainable Groundwater Management Act to secure water in streams, especially during critical summer and fall months.
- Restore estuary habitat and function for juvenile steelhead and other salmonids.
- Implement CDFW's statewide coastal salmonid monitoring program to collect abundance, life history, and population data to inform recovery efforts.

CHARACTERISTICS

Central California Coast steelhead are anadromous coastal Rainbow trout that live downstream of manmade barriers throughout their range. They are very similar to Northern California winter steelhead in appearance.

METRIC	SCORE	JUSTIFICATION
Area occupied	2	Multiple watersheds occupied in California but very few viable populations still exist.
Estimated adult abundance	2	The Russian River contains > 1,000 spawners annually, with smaller contributions from other populations, but numbers are declining and supported by hatcheries.
Intervention dependence	2	Habitat restoration and barrier removal are critical to increasing habitat availability.
Environmental tolerance	4	Able to adapt to live in freshwater and estuarine environments.
Genetic risk	3	Widespread but populations increasingly fragmented and isolated, with potential for interbreeding with hatchery fish.
Climate change	1	Extremely vulnerable due to limited access to habitat and cumulative effects of other factors (e.g. urbanization) dams, etc.).
Anthropogenic threats	2	3 High, 3 Medium factors.
Average	2.0	LEVEL OF CONCERN: HIGH
Certainty (1-4)	3	Hard numbers are few but status is fairly certain.

ABUNDANCE

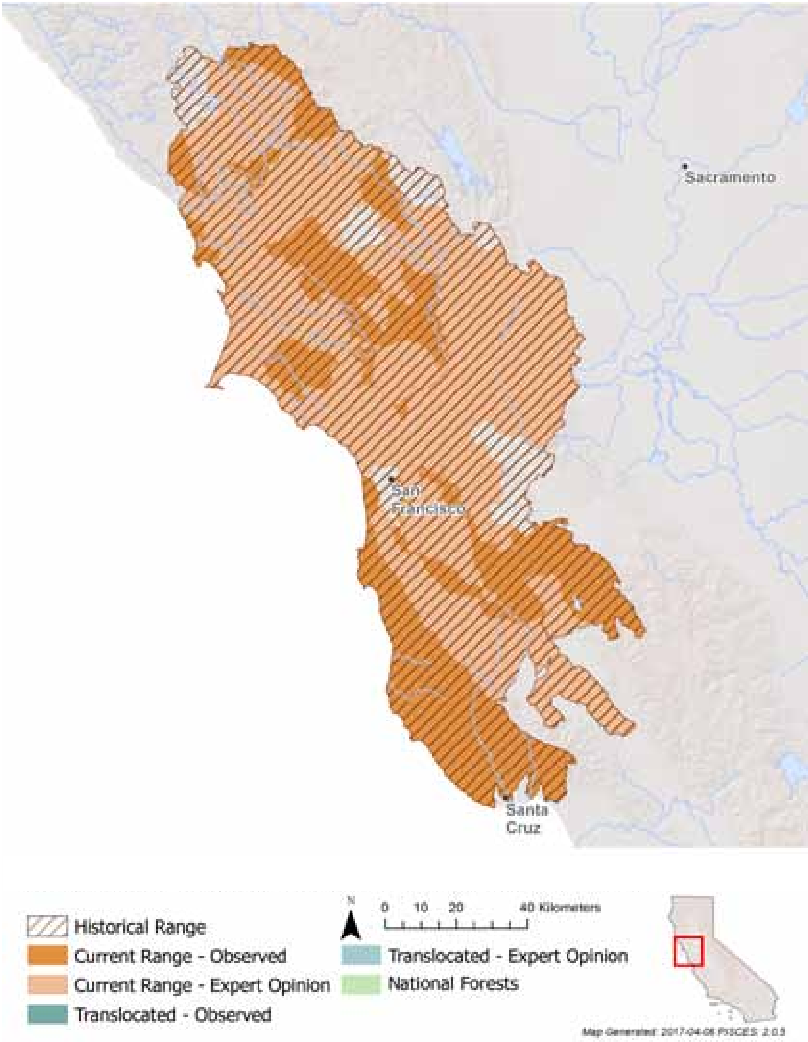
Historical abundance estimates of Central California Coast steelhead are limited. During the early 1960s, the California Department of Fish and Wildlife estimated about 94,000 CCC steelhead spawned throughout their range, with most spawning occurring in the Russian (50,000) and San Lorenzo rivers (19,000). With the exception of hatchery-raised steelhead from the Warm Springs Hatchery on the Russian River, most watersheds support less than a few hundred adult steelhead per year. Current populations are likely less than 10% of these historical estimates. For example, CDFW has not documented spawning steelhead in San Francisco Bay tributaries since the drought started in 2012.

HABITAT AND BEHAVIOR

All CCC steelhead are winter-run fish, entering freshwater as mature adults during the highest flows of the year, typically between late December and February. Adults returning to freshwater are mostly three and four years old, and typically spawn during late spring (February to April). With favorable flow and temperature conditions, female steelhead may spawn and return to saltwater in only a few weeks, while male fish may linger and spawn multiple times before returning to the ocean. Eggs hatch after about a month in the gravel, with fry emerging and beginning to feed about three weeks later. When juvenile steelhead reach about 10 cm (about 4 in.) in length, they begin to smolt and migrate downstream during spring and summer months to seek out foraging opportunities in larger mainstem rivers or critical estuaries and lagoons. Smolts spend up to two years or more in larger rivers and estuaries putting on weight and roughly doubling in length before their arduous journey to the Pacific Ocean. Once at sea, CCC steelhead migrate to cool waters offshore of the Klamath-Trinidad coastline before moving to feeding grounds in the North Pacific with steelhead from other regions.

GENETICS

CCC steelhead are more closely related to more southerly steelhead populations south of Monterey Bay than they are to populations north of the Russian River. Steelhead from the Russian River (Sonoma County) south to the Golden Gate Bridge form a distinct genetic group, while steelhead from the Golden Gate Bridge south to Big Sur form another.



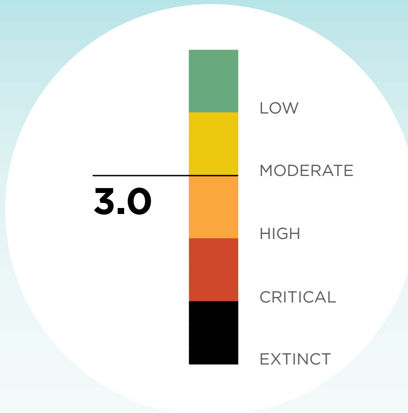
CENTRAL CALIFORNIA COAST STEELHEAD DISTRIBUTION

Central California Coast steelhead range from the Russian River (Sonoma County) south to Aptos Creek (Santa Cruz County). Within the San Francisco Bay Estuary, CCC steelhead are found in the Guadalupe and Napa rivers, and San Leandro, San Lorenzo, Coyote, San Francisquito, San Mateo, and Alameda creeks. Populations of CCC steelhead still reside in the upper reaches of streams that feed reservoirs, such as Upper San Leandro Reservoir upstream of Chabot Dam. Some small coastal streams south of the Golden Gate Bridge also contain CCC steelhead, such as Pilarcitos and Pescadero creeks in San Mateo County and Scott and Waddell creeks in Santa Cruz County.

CENTRAL VALLEY STEELHEAD

Oncorhynchus mykiss irideus

LEVEL OF CONCERN: MODERATE



Central Valley steelhead are not in danger of extinction but their numbers will remain low until river conditions that support their migratory life history improve. The highly-altered tail-water habitats downstream of dams select against anadromous life histories and instead favor resident life histories by supplying cool water year-round.

Left: American steelie. Photo: Mike Wier. Right: A steelhead parr holding under a rock. Photo: Jen Edgar.

CLIMATE CHANGE IMPACT

Climate change is likely to threaten Central Valley steelhead mainly through temperature increases and changes in flow regimes. Warmer temperatures will increase the difficulty of managing large dams to maintain sufficiently large pools of cool water to support juvenile steelhead through the Central Valley's increasingly hot, dry summers.

TOP 3 ANTHROPOGENIC THREATS

MAJOR DAMS

An estimated 80-95% of steelhead spawning, rearing, and migration habitat is blocked by dams throughout the Central Valley. Where anadromous fish once thrived, most are now replaced by Rainbow trout with resident life histories in cold tailwaters downstream of dams.

ESTUARY ALTERATION

The Sacramento-San Joaquin Delta and San Francisco Estuary are highly altered environments that select against the anadromous steelhead life history due to its low flows, elevated water temperatures, lack of cover, unnatural flows due to the operations of a series of pumps, invasive species, and predation threats.

HATCHERIES

Interbreeding between hatchery and natural-origin steelhead reduces the reproductive capacity and inhibits the recovery of natural steelhead populations in the Central Valley.

SUMMARY

Central Valley steelhead were listed as "threatened" in 1998 following a severe decline in naturally produced steelhead returning from the ocean, the result of dams blocking access to much of their former spawning and rearing habitats. Recent adult returns have been low, presumably due to drought-related impacts.

CONSERVATION ACTIONS

- Amend dam operations to mimic natural streamflow patterns and improve conditions that favor the anadromous life history of steelhead.
- Invest in restoration actions in the few Central Valley streams that produce wild steelhead, such as Deer and Battle creeks.
- Exclude hatchery steelhead from the DPS for management purposes, and revise hatchery practices to reduce interactions between hatchery fish and naturally spawning steelhead while producing fish to support the fishery.
- Focus fisheries management in the Central Valley on sustaining diverse, wild trout populations in tailwaters downstream of dams, and restore river and off-channel habitats.
- Investigate the causes of poor juvenile hatchery steelhead survival.
- Increase access to historic floodplain rearing habitat in the Central Valley.

METRIC	SCORE	JUSTIFICATION
Area occupied	4	Steelhead are present in small numbers in at least 5 rivers, plus 3 hatcheries.
Estimated adult abundance	3	Steelhead include hatchery fish; based on NMFS estimate.
Intervention dependence	2	Steelhead life history increasingly dependent on hatcheries; valley floor Rainbow trout depend on tailwaters below dams.
Environmental tolerance	4	Rainbow trout are one of most tolerant salmonids but conditions in lower rivers/Delta may exceed tolerances of migrating steelhead.
Genetic risk	4	Appears to be one population with little genetic structure.
Climate change	2	Appears to be one population with little genetic structure.
Anthropogenic threats	2	Score of “2” for only steelhead. Would be a “5” if resident trout were also considered.
Average	3.0	LEVEL OF CONCERN: MODERATE
Certainty (1-4)	3	Steelhead are well studied, but steelhead/Rainbow trout interactions need more study.

CHARACTERISTICS

Historically, adult Central Valley steelhead were relatively small compared to coastal steelhead, rarely exceeding 60 cm (about 24 in.) and a few kg (about 6 lbs.). Their slender body type allows them to undertake long and difficult migrations far inland to Central Valley rivers.

ABUNDANCE

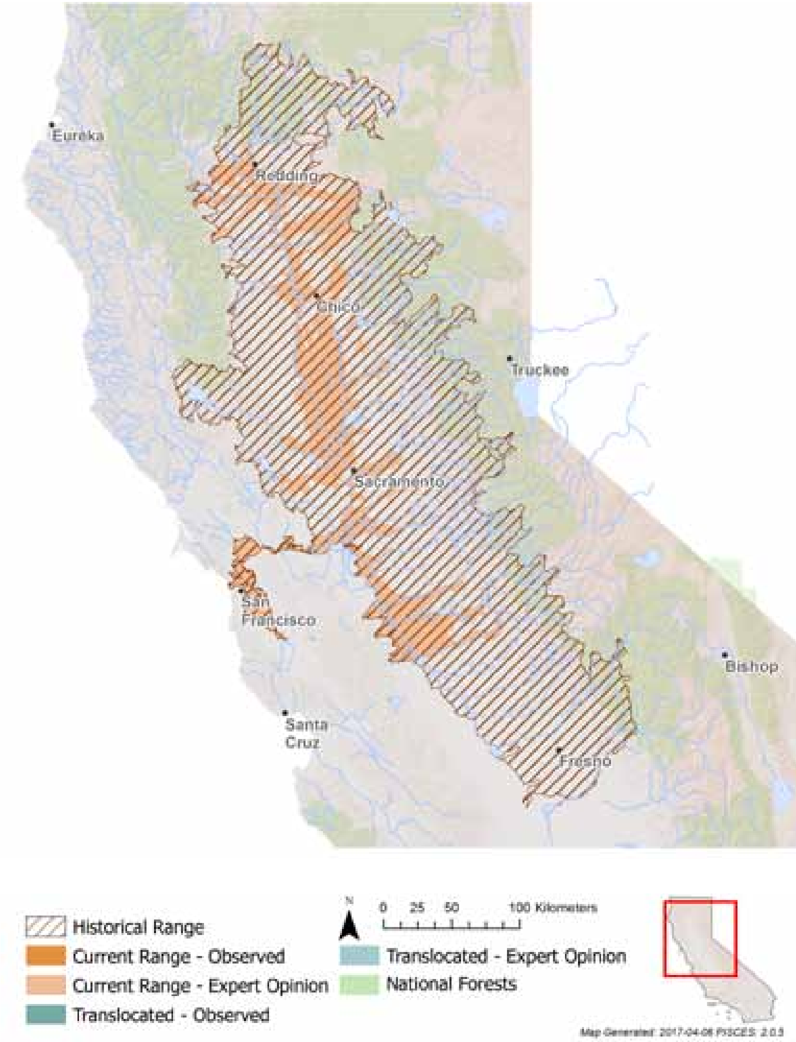
Abundance estimates for Central Valley steelhead are lacking due to the timing of winter spawning migrations during periods of high flows. Historically, it is likely that 50,000-100,000 adult steelhead returned per year based on estimates of available habitat and food resources. In 2016, NMFS estimated that an average of 4,600 adult steelhead returned to spawn per year, including to hatcheries. In contrast, resident trout both above and below dams are abundant.

HABITAT AND BEHAVIOR

Today, all adult Central Valley steelhead are winter-run fish, beginning their upstream migrations to fresh water during peak flows between December and February. Returning adults are mostly three to four years old, and typically spawn from February to April. After hatching in spring and absorbing their yolk sac, steelhead fry move into deeper, mid-channel habitats in the late summer and fall. They grow quickly as opportunistic, voracious predators by feeding on aquatic and terrestrial insects, small fish, frogs and other prey. Most juvenile Central Valley steelhead feed and grow in their natal streams for one or two years before migration in late December through the beginning of May, peaking in mid-March. In general, both juveniles and resident adults prefer complex habitat boulders, submerged clay and undercut banks, and large woody debris that provide feeding opportunities, segregation of territories, refuge from high velocities, and cover from predators.

GENETICS

Below dams in the Central Valley, resident trout and steelhead, including hatchery steelhead, form one genetic population that bears the signature of genetic input from introduced North Coast hatchery steelhead. The highly altered Central Valley rivers today favor fish that exhibit the resident life history, which has a genetic basis and can evolve rapidly from ancestral steelhead. Both natural and hatchery steelhead are in decline, suggesting that the anadromous life history itself is not sustainable in the highly altered Central Valley.



CENTRAL VALLEY STEELHEAD DISTRIBUTION

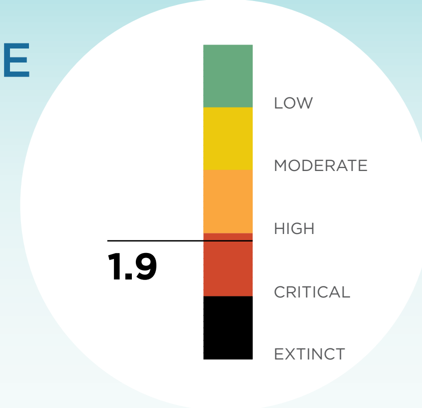
Historically, Central Valley steelhead inhabited the Sacramento and San Joaquin Rivers and most of their tributaries as part of a single population with resident Rainbows. There were possibly 81 discrete populations from the San Joaquin Valley north to the Pit River drainage in the past. Due to the construction of dams and water diversions, nearly 95% of previously accessible habitat to CV steelhead has been blocked or lost. Above dam Rainbow trout populations appear to retain much of this native genetic population structure. A long history of translocations of hatchery Rainbow trout and steelhead, and pervasive habitat alteration, have created a single heavily hatchery-influenced population.

KLAMATH MOUNTAINS PROVINCE SUMMER STEELHEAD

Oncorhynchus mykiss irideus

LEVEL OF CONCERN: CRITICAL

Klamath Mountain Province (KMP) summer steelhead are in a state of long-term decline in the Klamath Basin. These stream-maturing fish face a high likelihood of extinction in California in the next 50 years due to their reliance on cold water sources during the warmest summer months, which are becoming increasingly rare.



Left: Trinity steelhead. Photo: Brian Vais. Right: Steelhead natal home, North Fork Trinity. Photo: Glen Kubacki.

CLIMATE CHANGE IMPACT

Climate change is likely the single largest contributing factor to the long-term decline of summer steelhead in the KMP. Climate change is already reducing summer streamflows, increasing stream temperatures, and altering seasonal flow patterns in KMP summer steelhead watersheds, which will lead to further reduction in suitable headwater streams that summer steelhead rely upon.

TOP 3 ANTHROPOGENIC THREATS

MAJOR DAMS

Iron Gate (Klamath), Dwinnell (Shasta), and Lewiston (Trinity) dams block access to large portions of former KMP summer steelhead habitats; the unreachable middle and upper portions of the Klamath and Trinity rivers were historically important spawning and rearing grounds.

AGRICULTURE

Agricultural water diversions in the KMP, especially for alfalfa irrigation, have reduced streamflows and degraded water quality, particularly in the Scott and Shasta rivers. Large-scale marijuana cultivation also degrades habitats through water diversions, increased sedimentation, and pollution with fertilizers, herbicides, and/or pesticides.

LOGGING

The Klamath and Trinity basins have been heavily logged in the past century. Along with construction of road networks, logging activities increase erosion, increase sediment discharge into waterways, and reduce habitat quantity and quality by causing the deep pools summer steelhead rely on to fill with sediment.

SUMMARY

Only two or three Klamath Mountain Province summer steelhead populations are large enough to sustain this unique life history throughout the next 50 years under present conditions. Most of the smaller populations are likely to disappear due to reduced streamflows, shrinking availability of suitable habitat, and higher temperatures throughout the summer months in headwater tributaries.

CONSERVATION ACTIONS

- Recognize KMP summer steelhead as a DPS and manage them separately from winter steelhead based on different conservation needs.
- Draft and implement a summer steelhead management plan to manage land use activities and improve habitat.
- Initiate a monitoring program to determine abundance and life history information and document habitat usage.
- Amend fishing regulations to protect vulnerable spring-run Chinook salmon and summer steelhead while in fresh water.
- Remove the four lowermost Klamath dams to restore access to historical habitat and prioritize habitat restoration to support re-colonization by wild steelhead.

METRIC	SCORE	JUSTIFICATION
Area occupied	2	Much diminished from historical distribution.
Estimated adult abundance	2	Populations are very small and isolated.
Intervention dependence	3	No intervention is being undertaken but is badly needed.
Environmental tolerance	2	Adults require cold water refuges and pool habitat with cover that is free from human disturbance.
Genetic risk	2	Due to the spatial and temporal separation between summer and winter fish, the summer steelhead life history is in jeopardy of extinction in the KMP.
Climate change	1	Highly vulnerable; temperatures and flows already marginal in many areas and summer steelhead require cold water in the warmest months to survive to spawn.
Anthropogenic threats	1	2 High, 6 Medium factors.
Average	1.9	LEVEL OF CONCERN: CRITICAL
Certainty (1-4)	3	Steelhead are well studied, but steelhead/Rainbow trout interactions need more study.

CHARACTERISTICS

KMP summer steelhead are nearly identical to the more common KMP winter steelhead in their appearance. They can be differentiated by their timing of freshwater migration from April through June, timing of sexual maturation in freshwater, location of spawning in higher-gradient habitats than other steelhead, and genetic variation. KMP summer steelhead may live up to seven years, and may return to spawn to their natal streams several times throughout their lives, especially in the Scott River.

ABUNDANCE

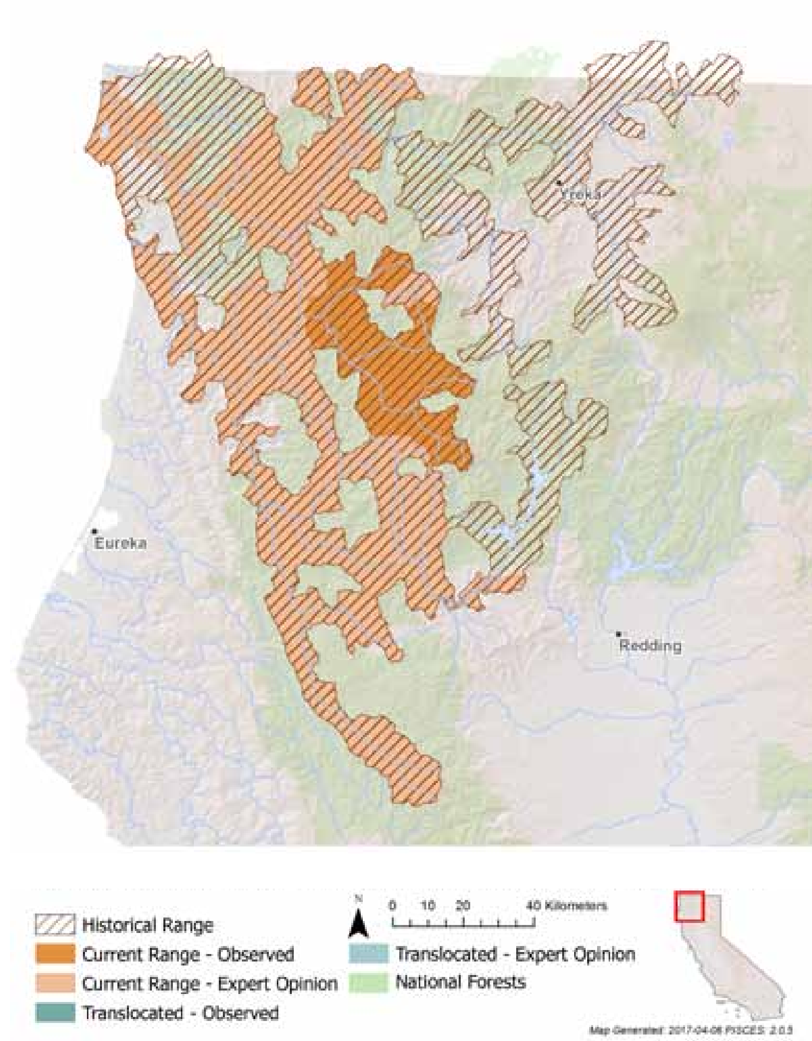
Little is known about the historical abundance of summer steelhead in the KMP. In recent decades, estimates of returning adults annually ranged from 1,400 to 4,000 fish. They have since dwindled to less than approximately 2,000 adults for the past decade. However, increases have been documented in some tributaries, such as the South Fork Trinity River, in recent years.

HABITAT AND BEHAVIOR

The open Klamath Estuary provides steelhead access to diverse habitats — from spring-fed systems such as the Shasta River, to snowmelt-driven Trinity River tributaries — at different times of year. Summer steelhead enter Klamath and Trinity river tributaries by June and ascend into summer holding areas with deep, bedrock pools with some overhead cover and cool seeps, often sharing these pools during the summer with spring-run Chinook salmon. They spawn from January to March, about a month earlier than winter steelhead. Generally, summer steelhead spawn in small or intermittent headwater tributaries, and juveniles migrate into perennial streams soon after hatching. Juvenile summer steelhead typically spend two years in fresh water before migrating to the ocean, and returning to spawn at three or four years of age.

GENETICS

Klamath Mountains Province summer and winter steelhead are distinct from one another in their life histories, behaviors, and genetics, but are currently lumped together for management. The cues for early migration in summer steelhead has a genetic basis that can be passed on to offspring. More genetic research is needed on the existence of a possible fall-run steelhead in the Klamath and Trinity rivers, which enter fresh water a month earlier than winter steelhead and appear to have an intermediate life history between summer and winter fish.



KLAMATH MOUNTAINS PROVINCE SUMMER STEELHEAD DISTRIBUTION

The KMP summer steelhead range historically included all coastal streams and their tributaries from the Klamath River, including Upper Klamath Lake, to the Elk River in southern Oregon. Their current distribution has been significantly reduced by dam construction, and now includes merely the Klamath River and its main tributaries, the Trinity, Salmon, Scott, and Shasta rivers, and other streams north to the Oregon border. It is likely that summer steelhead once migrated far upstream of the present site of Copco Dam on the Klamath River.

KLAMATH MOUNTAINS PROVINCE WINTER STEELHEAD

Oncorhynchus mykiss irideus

LEVEL OF CONCERN: MODERATE

Klamath Mountain Province (KMP) winter steelhead are in a state of decline from historical numbers in the Klamath Basin. These ocean-maturing fish are relatively more widespread than the stream-maturing summer-run fish, yet still face an uncertain future due to reductions in suitable habitat.

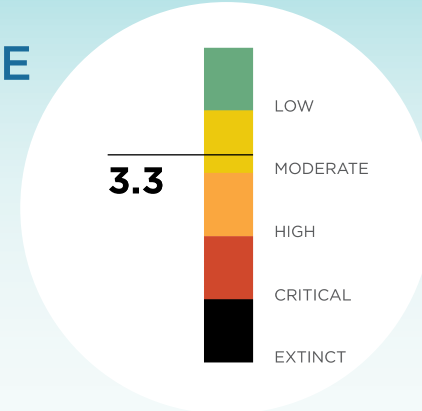


Photo: Jonathan Matthews.

CLIMATE CHANGE IMPACT

KMP winter steelhead are not as vulnerable as KMP summer steelhead due to their migration timing. As a result of climate change, all KMP watersheds are expected to see increases in stream temperatures, which will reduce available habitat. Snowmelt-fed rivers (e.g., Salmon and Scott rivers) may see sharp decreases in streamflows during the spring and summer months. The timing of peak flows has already shifted in the Klamath River — nearly a month earlier than existed historically.

TOP 3 ANTHROPOGENIC THREATS

MAJOR DAMS

The Klamath Dams (Klamath River), Dwinnell Dam (Shasta River), and Lewiston Dam (Trinity River) block access to hundreds of miles of potential migration, spawning, and nursery habitat for KMP winter steelhead, and reduce streamflows during important migration periods.

HATCHERIES

The Trinity River Hatchery releases hundreds of thousands of juvenile steelhead each year, which negatively impact wild steelhead in the KMP through increased competition, predation, hybridization and reduced fitness over time.

MINING

Historical hydraulic mining in KMP watersheds removed spawning gravels, simplified stream reaches, and reduced suitable habitat. The Scott, Salmon, and South Fork Trinity rivers still bear the scars of past mining that limit steelhead production through excessive sedimentation.

SUMMARY

Lack of strong, coordinated protection for wild stocks, combined with reductions in habitat associated with climate change, will continue to negatively impact KMP winter steelhead. Due to dam operations selecting for resident life histories, low adult returns, and negative impacts on wild fish, Iron Gate Hatchery on the Klamath River stopped rearing steelhead in 2013.

CONSERVATION ACTIONS

- Manage KMP winter and summer steelhead separately based on their different habitat and conservation needs.
- Remove the four lower Klamath dams to restore access to nearly 480 km (300 mi.) of historical habitat and undertake large-scale restoration.
- Use a hatchery and genetics management plan to reduce negative impacts of hatchery steelhead on remaining wild fish and protect life history and genetic diversity.
- Preserve relatively unaltered habitats, such as Blue Creek in the Klamath River Basin.
- Implement the California Coastal Salmonid Monitoring Plan to fill critical data gaps.
- Work with private and public partners to increase streamflows and reduce diversions in the Klamath Basin, especially in the Shasta and Scott rivers.

METRIC	SCORE	JUSTIFICATION
Area occupied	4	Winter steelhead found throughout KMP watersheds; dams block access to large portion of upstream spawning and rearing habitat.
Estimated adult abundance	3	KMP winter steelhead abundance is relatively unknown, but is probably less than 50,000 fish/year including Smith River run.
Intervention dependence	3	Frequent management actions needed for habitat restoration and protection to prevent continuation of long-term decline. Klamath dam removal and restoration is likely to improve this score.
Environmental tolerance	4	Steelhead are very adaptable and winter fish return during a time when flows are highest and temperatures lowest.
Genetic risk	3	Presumably genetically diverse; however, hybridization risk with hatchery steelhead is a considerable threat.
Climate change	3	All KMP watersheds are projected to see seasonal water temperatures and flows change.
Anthropogenic threats	1	9 Medium factors.
Average	3.3	LEVEL OF CONCERN: MODERATE
Certainty (1-4)	3	Steelhead are well studied, but steelhead/Rainbow trout interactions need more study.

CHARACTERISTICS

KMP winter steelhead are nearly identical in appearance to their more rare summer counterparts, but are more likely to have spawning colors in the lower reaches of rivers. Winter steelhead can be distinguished from summer steelhead in their run timing, genetics, sexual maturation, and spawning locations in mainstem rivers and tributaries.

ABUNDANCE

KMP winter steelhead returns have declined from historical estimates of approximately 220,000 fish per year to less than 50,000 fish per year, including steelhead from the Trinity River Hatchery. The presence of presumed fall-run steelhead makes accurately predicting abundance of winter steelhead difficult. The life histories, behaviors, and genetics of these fish remain the subject of ongoing research.

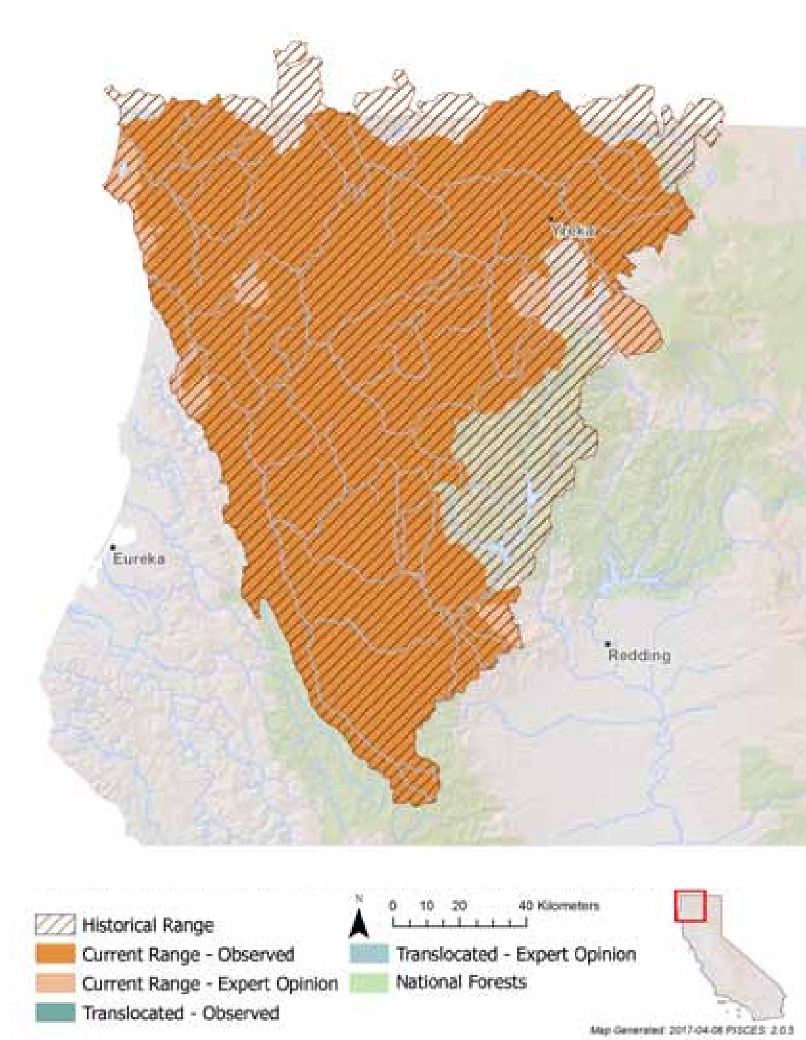
HABITAT AND BEHAVIOR

The Klamath River Basin supports the greatest diversity of steelhead life histories anywhere. KMP winter steelhead enter fresh water between November and April as mature adults. They spawn soon after arriving on spawning grounds, and migrate back to sea by March or April.

One-half to two-thirds of KMP winter steelhead spawn more than once during their lives. Fry emerge from redds beginning in April, and juveniles defend territories in or below riffles where food is most abundant. Juvenile KMP steelhead can adopt one of three life histories, though the first is the most common by far: 1) spend up to two years in fresh water before migrating to sea; 2) a fresh water resident strategy (about 10% of the population); and 3) spend two to three years in fresh water before migrating to sea. Some juvenile steelhead spend two to four months in the Klamath Estuary or Pacific Ocean before returning to fresh water between August and October to over-winter. These immature fish, called “half-pounders,” are likely to survive and spawn multiple times during their life.

GENETICS

KMP winter steelhead are more closely related to KMP summer steelhead than to other winter steelhead. Steelhead from lower Klamath River tributaries are most similar to those from other nearby coastal rivers (e.g. Smith River, Del Norte County), while steelhead from the Shasta and Scott rivers are closely related to Iron Gate Hatchery steelhead.



KLAMATH MOUNTAINS PROVINCE WINTER STEELHEAD DISTRIBUTION

The KMP winter steelhead range includes all coastal rivers and creeks throughout the Klamath-Trinity rivers basin north to the Elk River near Port Orford, Oregon. In the Klamath River, they historically ascended all major rivers and tributaries, and likely spawned in tributaries to Upper Klamath Lake before passage was blocked by a chain of dams. In the Trinity River, steelhead historically utilized each of the North, South, East, and Stuart forks of the river until Lewiston Dam blocked upstream access to much of this historical habitat.

NORTHERN CALIFORNIA SUMMER STEELHEAD

Oncorhynchus mykiss irideus

LEVEL OF CONCERN: CRITICAL

Northern California (NC) summer steelhead are in long-term decline and this trend will continue without substantial human intervention on a broad scale. They are vulnerable to extinction by 2050 due to their reliance on cold water during the warmest months and are critically susceptible to climate change.

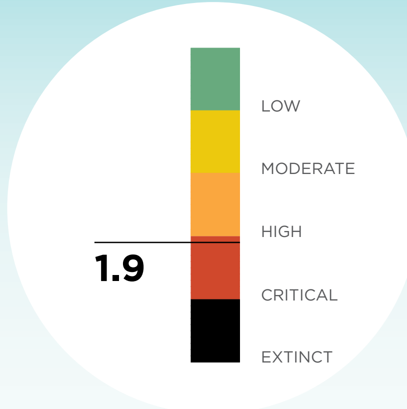


Photo: Conrad Calimpong.

CLIMATE CHANGE IMPACT

Climate change is likely to alter precipitation and streamflows and lead to warmer temperatures, which reduces suitable habitat and places further stress on small populations of NC summer steelhead. Any reductions in streamflows or increases in water temperature are likely to disproportionately affect NC summer steelhead due to their run timing.

TOP 3 ANTHROPOGENIC THREATS

MAJOR DAMS

Scott Dam on the upper mainstem Eel River blocks access to an estimated 463 km (285 mi.) of potential spawning, migration, and nursery habitat, while Matthews Dam blocks over a third of potential steelhead habitat in the Mad River.

AGRICULTURE

Grazing and diversions to support agriculture have altered floodplains, decreased bank stability, and increased sedimentation and pollutants. Illegal water diversions and subsequent habitat degradation of remote headwater streams for marijuana cultivation has become the limiting factor for NC summer steelhead survival in many streams in the DPS.

ESTUARY ALTERATION

Estuaries of the Eel and Mad rivers and Redwood Creek have been leveed, armored with hard structures, drained, constrained by tide gates, and converted to support agricultural and rural development, which degrades critical steelhead nursery habitats.

SUMMARY

Sufficient flows and cool temperatures are rapidly disappearing across the Northern California (NC) summer steelhead DPS range during critical over summering months. This is largely due to drought-related flow reductions and illegal and unregulated diversions to support exploding marijuana cultivation.

CONSERVATION ACTIONS

- Implement the 2016 Eel River Action Plan with the Eel River Forum partners, which remains the best option for increasing NC summer steelhead runs.
- Integrate statewide coastal salmonid monitoring programs and Habitat Conservation Plans of large private landowners with other restoration activities.
- Work with stakeholders to expand best management practices for land uses that allow water to remain in streams, especially during critical summer months.
- Evaluate the potential for changes to operations of the Eel River dams as part of the Potter Valley Project on the upper mainstem Eel River.

METRIC	SCORE	JUSTIFICATION
Area occupied	2	Much diminished from historical distribution.
Estimated adult abundance	2	Likely fewer than 1,000 adults across the DPS in a given year.
Intervention dependence	3	Require continuous monitoring and significant improvement of habitat and accessibility for recovery.
Environmental tolerance	2	Adults require coldwater refuges and pool habitat with cover that is free from human intervention.
Genetic risk	2	Spatial and temporal segregation between summer and winter fish make this life history susceptible to extinction.
Climate change	1	Highly vulnerable; temperatures and flows already marginal in many areas and summer steelhead require cold water in the warmest months to survive to spawn.
Anthropogenic threats	1	3 High and 5 Medium threats. Sufficient flows and temperatures are rapidly disappearing in the DPS.
Average	1.9	LEVEL OF CONCERN: CRITICAL
Certainty (1-4)	2-3	Actual numbers of fish poorly known.

CHARACTERISTICS

NC summer steelhead can be distinguished from other steelhead by their run timing, life histories, genetic variation, maturation while in fresh water, and their preferred spawning habitat in higher-gradient habitats and small tributaries.

ABUNDANCE

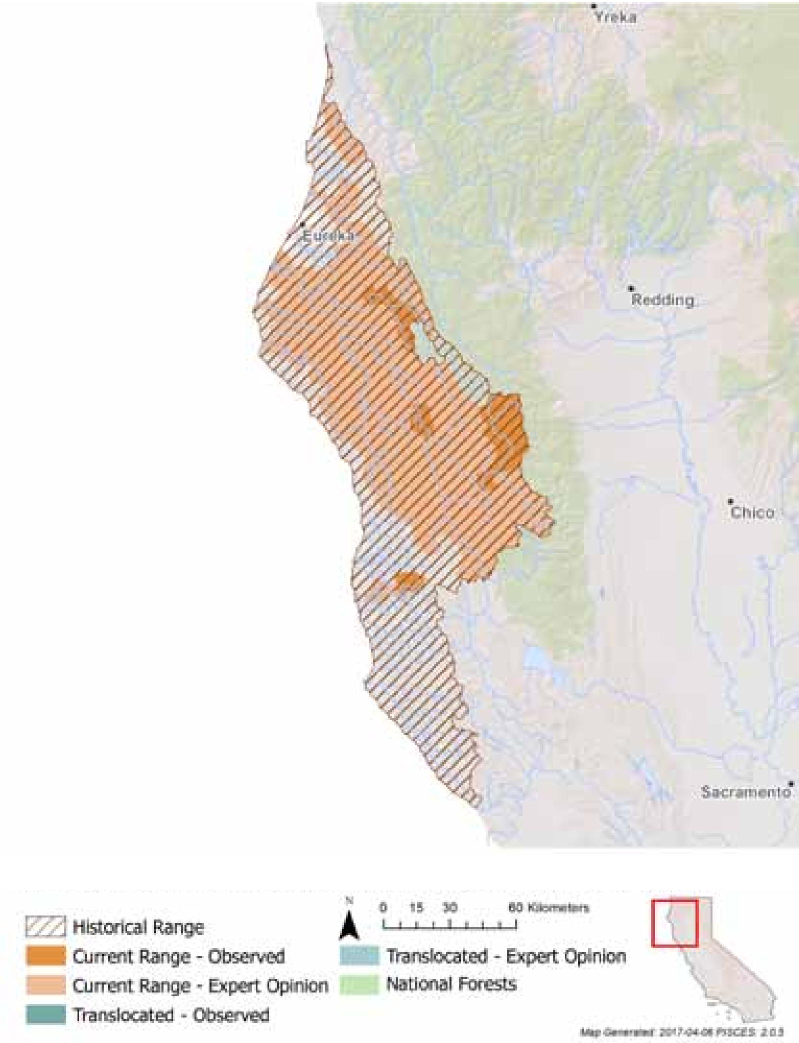
Little historical abundance information exists for NC summer steelhead. Abundance estimates today come mostly from volunteer snorkel surveys in headwater tributaries and mainstem rivers during summer months. The Eel River, which once supported the largest run of NC summer steelhead, has had decreasing adult returns over the last fifty years.

HABITAT AND BEHAVIOR

Summer steelhead migrate further inland into smaller tributaries than winter fish. They spend summer months resting in pools with consistent cool temperatures as they mature, waiting for winter rains to spawn in December-February. NC summer steelhead can tolerate water temperatures up to approximately 23°C (about 73°F) for short periods of time, but seek refuge in deep pools with cool seeps and springs. They prefer pools with boulders, large woody debris, and undercut banks that provide cover from predators and visual separation from other fishes. After spawning, adult fish migrate back to the Pacific Ocean around March. Juveniles leave their natal tributaries from April to June to feed and grow in mainstem rivers and estuary habitats before migrating to sea. Once at sea, most juveniles spend their first months near the coast before moving to the North Pacific Ocean to feed on krill, squid, fish, crustaceans, and amphipods in surface waters.

GENETICS

Recent studies found that NC winter and summer steelhead are distinct from one another. NC summer steelhead are more closely related to NC winter steelhead than they are to summer steelhead from other regions in California. NC summer steelhead have a genetic variation similar to spring-run Chinook salmon that influences run-timing to fresh water, which allows them to access higher elevation and smaller tributaries for spawning.



NORTHERN CALIFORNIA SUMMER STEELHEAD DISTRIBUTION

Historically, NC summer steelhead ranged from Redwood Creek (Humboldt County) in the north to the Mattole River (Mendocino County) in the south. Today, only a few select watersheds still support summer steelhead, including Redwood Creek and the Mad, Eel, and Mattole rivers. They can be found in the mainstem, upper mainstem, North, Middle, and South forks of the Eel River.

NORTHERN CALIFORNIA WINTER STEELHEAD

Oncorhynchus mykiss irideus

LEVEL OF CONCERN: MODERATE

Northern California winter steelhead are in a state of long-term decline over much of their range due to land use practices that reduce habitat for juveniles, such as diversions that desiccate nursery tributaries during summer months.

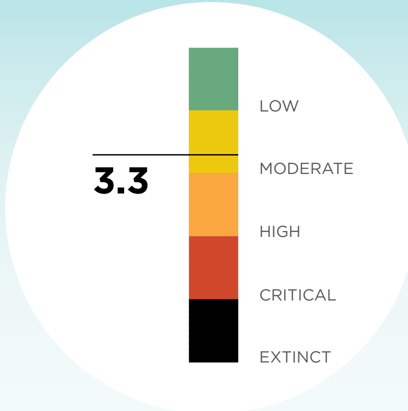


Photo: Mike Wier.

CLIMATE CHANGE IMPACT

NC winter steelhead are highly vulnerable to climate change due to juvenile reliance on small, headwater tributaries for nursery habitat. Reductions in suitable cold water are also expected to result in local extirpations and range contractions for NC steelhead, as higher gradient headwater streams that could provide refuge are inaccessible behind waterfalls, boulder fields, or dams.

TOP 3 ANTHROPOGENIC THREATS

MAJOR DAMS

Scott Dam on the Eel River blocks access to an estimated 290 km (180 mi.) of potential habitat, while Matthews Dam on the Mad River blocks nearly a third of historical steelhead habitat. In addition, these dams reduce streamflows during important migration windows for adult and juvenile steelhead.

ESTUARY ALTERATION

The estuaries of the Eel and Mad rivers and Redwood Creek have been leveed, armored with structures, drained, altered by tide gates, and converted for agricultural and rural development, greatly reducing juvenile nursery habitat. What suitable estuarine habitat remains is subject to high turbidity, poor water quality, and sedimentation from runoff.

AGRICULTURE

In the past two decades, illegal water diversions and subsequent habitat degradation of remote headwater streams for marijuana cultivation has become perhaps the most important limiting factor for juvenile steelhead survival in natal streams.

SUMMARY

While the Level of Concern for Northern California (NC) winter steelhead has remained the same since 2008, the latest research indicates that they are now more susceptible to climate change impacts and are vulnerable to anthropogenic threats.

CONSERVATION ACTIONS

- Implement a statewide steelhead restoration and management plan that identifies specific actions to restore and manage steelhead populations and maintain diversity in California.
- Protect life history diversity at relevant ecological scales to maintain wild steelhead.
- Begin large-scale restoration of the Eel River through the Eel River Action Plan, including dam removal, estuary restoration, and instream habitat enhancement.
- Implement the Mad River Hatchery Genetic Management Plan (2016) to reduce negative impacts of hatchery fish on remaining wild fish.
- Secure water for fish, and reduce diversions for other uses throughout the DPS range.

METRIC	SCORE	JUSTIFICATION
Area occupied	3	Multiple watersheds in CA.
Estimated adult abundance	3	A few thousand wild spawning steelhead present annually in the Mad and Eel rivers combined; other populations (Redwood Creek, Mattole, and Garcia) may contain as many, though information is lacking. Total is likely less than 15,000-20,000.
Intervention dependence	3	Require continuous monitoring, protection from poaching, and habitat improvement for recovery.
Environmental tolerance	4	Broad tolerance in fresh water and may spawn several times.
Genetic risk	4	Genetically diverse with gene flow among populations, although hatchery influence is a concern.
Climate change	1	Vulnerable in most watersheds but possible refuges present. Moyle et al. (2013) vulnerability score is 17/35 (highly vulnerable).
Anthropogenic threats	1	2 High and 7 Medium threats. Dams and estuary alteration preclude recovery of NC winter steelhead.
Average	3.3	LEVEL OF CONCERN: MODERATE
Certainty (1-4)	2-3	Actual numbers of fish poorly known.

CHARACTERISTICS

NC steelhead are larger, on average, than steelhead from other watersheds in California. In general, coastal steelhead in smaller, slower coastal rivers are deeper-bodied, longer, and more robust than steelhead from larger inland rivers.

ABUNDANCE

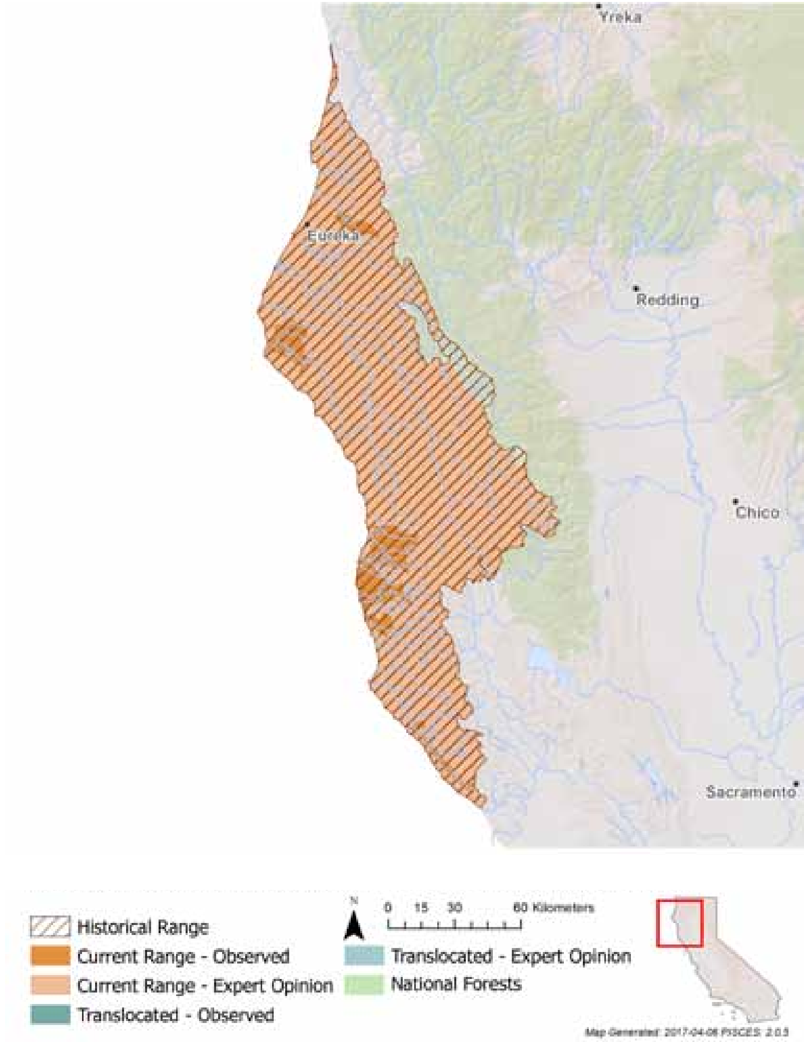
Reliable estimates of NC winter steelhead numbers are lacking because high, turbid flows during migration and spawning periods make safe, reliable sampling impractical. Historically, it is likely that about 200,000 adults returned to spawn in NC steelhead watersheds annually. Optimistically, annual adult returns today are likely less than 20,000 fish.

HABITAT AND BEHAVIOR

NC winter steelhead generally enter estuaries and rivers between September and March, with spawning peaking between December and early April. These steelhead are sexually mature when they arrive at spawning areas, usually after spending two years in freshwater and one year growing at sea. In relatively small coastal watersheds in Mendocino County, many steelhead enjoy a high likelihood of repeat spawning potential due to their relatively short migrations. Most NC steelhead that live to spawn many times are females, and they may account for a significant proportion of returning adults in a given year, depending on the stream. Females can lay between 200 and 12,000 eggs, depending on their size and condition, before migrating back to the ocean by May. Newly emerged steelhead school together and seek shallow waters with gentle currents to grow, while older juveniles maintain territories in faster water and in pool habitats. Juveniles smolt in early spring and migrate to estuaries or the ocean between March and June. Some juvenile steelhead rely on estuaries for rich feeding and growth opportunities, increasing their chances of survival at sea.

GENETICS

The NC steelhead populations show some genetic influence from KMP steelhead. Within the Eel River watershed, there are significant genetic differences between resident Rainbow trout upstream of natural barriers in headwater tributaries and steelhead downstream.



NORTHERN CALIFORNIA WINTER STEELHEAD DISTRIBUTION

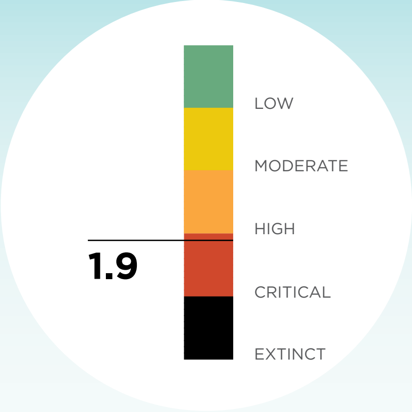
The NC steelhead DPS includes all naturally spawning populations in California coastal river basins from Redwood Creek (Humboldt County) to the Gualala River (Mendocino County). This distribution includes the Eel River, the third largest watershed in California, with its four forks (North, Middle, South, and Van Duzen) and their extensive tributaries. NC steelhead are present today wherever streams are accessible to the ocean and sufficient flows and cool water exist. Some water bodies with no recent direct access to the ocean, such as Big and Stone lagoons in Humboldt County, also contain steelhead, although the source of these fish is unknown.

SOUTH-CENTRAL CALIFORNIA COAST STEELHEAD

Oncorhynchus mykiss irideus

LEVEL OF CONCERN: CRITICAL

South-Central California Coast (SCCC) steelhead are in long-term decline across their range, despite recent recovery actions taken in core watersheds. Without widespread efforts to restore streamflows and improve access to historical habitat, SCCC steelhead will likely be extinct in southern California within 50 years.



Left: Juvenile steelhead. Photo: Glenn Kubacki. Right: San Carpoforo Creek adult steelhead. Photo: Mark Capelli.

CLIMATE CHANGE IMPACT

Climate change will likely exacerbate the decline of SCCC steelhead by reducing the availability and accessibility of usable habitat throughout their range. Under future climate change, streamflows are expected to decrease and water temperatures to increase, creating sources of environmental stressors that threaten steelhead growth and survival. In general, steelhead in southern California will be subject to the greatest increase in duration and intensity of ocean and land-based ecosystem shifts associated with climate change.

TOP 3 ANTHROPOGENIC THREATS

MAJOR DAMS

Dams and diversions throughout the SCCC steelhead range reduce the magnitude and alter the timing of flows and block migration corridors for spawning and rearing steelhead. Water supply and flood control facilities reduce overall streamflows and alter the timing of water availability throughout most of the watersheds in the DPS.

AGRICULTURE

Extensive agricultural development for row crops, orchards, and other crops has significantly degraded mainstem river habitats, floodplains, and estuaries in the SCCC range. Agricultural diversions reduce flows, especially in critical summer and fall months, reduce groundwater recharge and lower water tables, and degrade water quality in streams.

ESTUARY ALTERATION

Estuaries and lagoons provide critical nursery and migration habitats for steelhead. Much of this estuarine habitat has been lost, especially in northern portions of the SCCC steelhead range, through urban encroachment and associated water diversions that impacts all life stages of steelhead.

SUMMARY

NMFS considers the recovery potential for South-Central California Coast steelhead to be low to moderate, with small but consistent runs of adult steelhead into accessible watersheds. Removal of San Clemente Dam in the Carmel River in 2015 opened access to more than 40 km (25 mi.) of habitat, and is aiding in the restoration of more natural streamflows and sediment transport processes.

CONSERVATION ACTIONS

- Secure water for SCCC steelhead through purchasing water rights, setting low flow requirements, incentivizing water efficient land use practices, conservation, using storage tanks, reducing groundwater pumping, and increasing enforcement.
- Restore fish passage on a broad and coordinated scale in core watersheds.
- Expand and improve estuarine/lagoon habitat through regulation of land use practices.
- Update and implement the California Coastal Monitoring Plan protocols to gather critical population data.
- Complete a Fishery Management and Evaluation Plan to coordinate recovery actions.

METRIC	SCORE	JUSTIFICATION
Area occupied	3	Multiple watersheds occupied in small numbers.
Estimated adult abundance	1	Most populations probably contain less than a few dozen spawners, with a total of less than 500 in the entire DPS in recent years.
Intervention dependence	2	Barrier removal, habitat restoration, and updated water management practices are critical to recovery as are restored access to historical spawning, rearing, and refuge habitat and reconnection of resident and anadromous populations.
Environmental tolerance	3	Moderate physiological tolerance; spawning multiple times is uncommon in SCCC steelhead populations
Genetic risk	2	While introgression with hatchery rainbow trout is minimal, limited gene flow among populations make them vulnerable.
Climate change	1	Rated highly vulnerable. Effects on small populations documented.
Anthropogenic threats	1	4 “High” and 2 “Medium” factors.
Average	1.9	LEVEL OF CONCERN: CRITICAL
Certainty (1-4)	3	Little monitoring of most populations. High confidence that the DPS is in serious decline, low confidence in actual population size.

CHARACTERISTICS

South-Central California Coast steelhead in general have longer, streamlined bodies that are suited to the small, flashy streams of central and southern California.

ABUNDANCE

Historically, annual runs of adult SCCC steelhead averaged about 27,000 adults in wet years. Reliable abundance data are severely lacking, but best estimates suggest that less than 500 adults return to fresh water each year to spawn. During historic drought from 2012-2016, there was limited documented spawning in most watersheds across the DPS, suggesting populations may shrink in the next few years.

HABITAT AND BEHAVIOR

The behaviors and habitats of SCCC steelhead are not well documented, but are apparently similar to those of Southern steelhead. In general, they spend one to three years in fresh water, then two to four years at sea before returning to natal rivers to spawn from January to May. In years with low rainfall, such as 2012-2016, lagoon barriers may not breach during the rainy season, making fresh water migrations impossible. Juveniles may migrate from fresh water to lagoons and estuaries, or between reservoirs and tributaries, multiple times in a single year. Immature steelhead typically spend several weeks to months in estuaries, where they grow rapidly to increase their survival at sea. In the Pajaro and Salinas rivers, desiccation of tributary streams in dry years forces juveniles out to sea if estuary mouths are open or upstream into headwaters where perennial streamflows exist.

GENETICS

SCCC steelhead are distinct from Southern steelhead in their genetics and the environmental conditions in which they live. Recent genetic research suggests that juvenile Rainbow trout females are more likely to migrate to sea than males; this could be because their egg production depends on large body size, which increases significantly with time spent at sea.

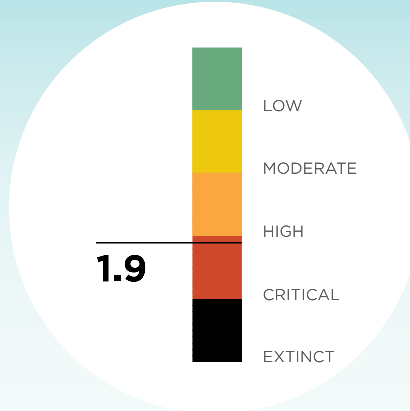
SOUTH-CENTRAL CALIFORNIA COAST STEELHEAD DISTRIBUTION

SCCC steelhead range from the Pajaro River (Santa Clara/San Benito Counties) southward to the southern edge of San Luis Obispo County. The watersheds that historically supported the largest populations of SCCC steelhead include the Pajaro, Salinas, Carmel, and Big Sur rivers. Prior to the 2012-2016 drought, SCCC steelhead were still found in nearly all coastal watersheds in their historical range, including streams with no recent historical records of steelhead, such as Los Osos, Vincente, and Villa creeks (San Luis Obispo County).

SOUTHERN STEELHEAD

Oncorhynchus mykiss irideus

LEVEL OF CONCERN: CRITICAL



Southern steelhead populations are in danger of extinction within the next 25-50 years due to anthropogenic and environmental impacts threatening their recovery. Since its listing as an endangered species in 1997, Southern steelhead abundance has continued to decline to precariously low levels.

Left: Adult and juvenile steelhead, Maria Ygnacio Creek. Right: Signage to protect spawning steelhead, Santa Barbara County. Photos: Mark Capelli.

CLIMATE CHANGE IMPACT

Southern steelhead represent the southern edge of the species' range, and, as such, are critically vulnerable to climate change. They are becoming increasingly exposed to higher water temperatures and flow variability over time. Their continued existence depends on building resiliency to climate change through greater abundance, genetic diversity, and access to diverse habitats.

TOP 3 ANTHROPOGENIC THREATS

MAJOR DAMS

Dams and water storage diversions, such as Matilija Dam in the Ventura River watershed and the Harvey Diversion on the Santa Clara River, have blocked steelhead access to spawning habitats and reduced available rearing habitat for Southern steelhead juveniles.

URBANIZATION

Nearly all Southern steelhead watersheds have been heavily urbanized, which has increased demand for surface and groundwater resources and reduced the quantity and quality of water for steelhead.

ESTUARY ALTERATION

Nearly all estuaries and lagoons, which are critical nursery habitats for juvenile steelhead, have been severely degraded and significantly reduced in size and function in Southern California.

SUMMARY

The abundance of southern steelhead is precariously low throughout their range. Drought, increasing human population pressures, and climate change have contributed to their continued decline.

CONSERVATION ACTIONS

- Reduce surface water diversions and groundwater pumping, increase use of recycled water, and expand conservation measures to improve habitat for Southern steelhead.
- Manage native resident Rainbow trout with Southern steelhead as part of the DPS to acknowledge that resident fish can produce smolts and anadromous offspring under favorable environmental conditions.
- Remove fish passage barriers and expedite dam removal projects including Matilija Dam (Ventura River), Rindge Dam (Malibu Creek), and other passage barrier remediation projects.
- Develop and implement baseline monitoring within the Coastal Salmonid Monitoring framework.
- Remove non-native aquatic species in prime trout habitat.

METRIC	SCORE	JUSTIFICATION
Area occupied	3	Found in most of native range, if scattered; mainly in 4 northernmost rivers, but also in a number of short coastal watersheds in the central and southern portion of the DPS.
Estimated adult abundance	1	Highly variable but with general downward trend and very low abundance in all populations.
Intervention dependence	2	Intensive efforts such as barrier modification, habitat restoration, and restoration of instream flows are essential.
Environmental tolerance	3	Moderate physiological tolerance to existing conditions, although limits are being reached.
Genetic risk	2	Limited gene flow among populations; some hatchery hybridization. Populations very small and geographically isolated.
Climate change	1	Climate change impacts likely throughout their range, exacerbating other factors.
Anthropogenic threats	1	5 High, 6 Medium, 4 Low factors.
Average	1.9	LEVEL OF CONCERN: CRITICAL
Certainty (1-4)	2-3	Actual numbers of fish poorly known.

CHARACTERISTICS

Southern steelhead generally have longer, more streamlined bodies than their northern counterparts to facilitate passage through southern California's characteristic low, flashy streams.

ABUNDANCE

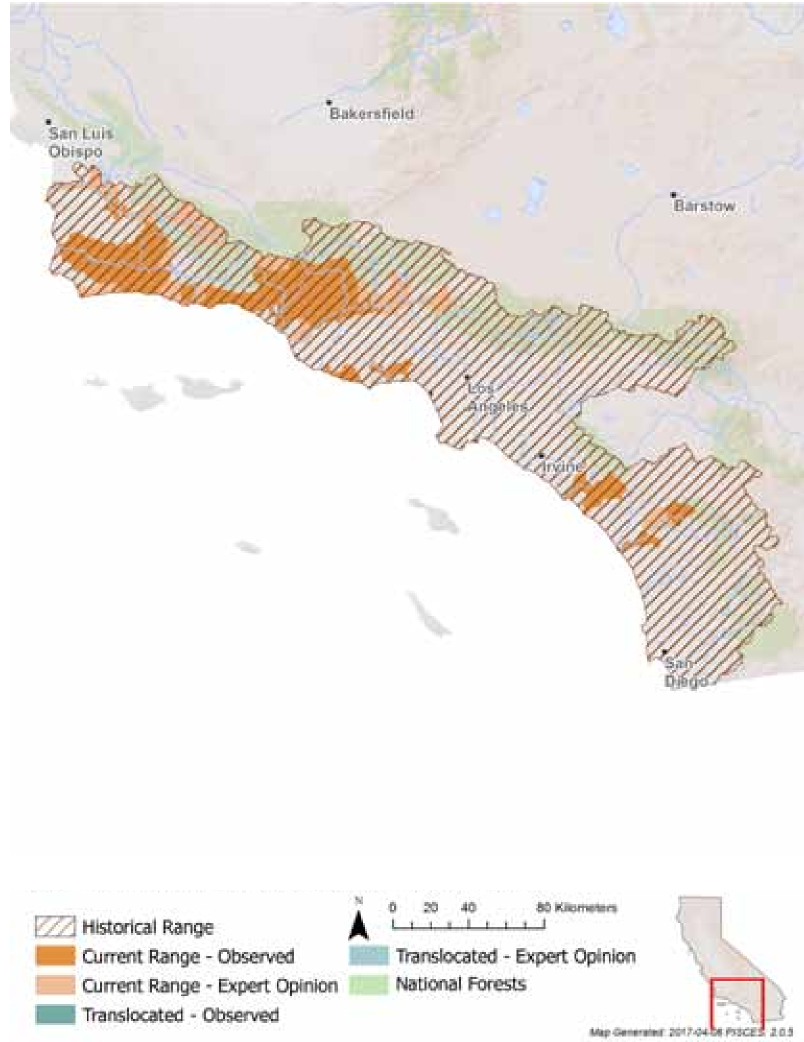
In the 19th Century, the Santa Ynez probably supported the largest runs of Southern steelhead throughout their range, likely between 20,000 to 30,000 adults per year, while the other large watersheds likely supported runs of a few thousand adults per year. In the last five years, the number of adult anadromous steelhead has declined significantly, to the point that it is now rare to see them in the wild.

HABITAT AND BEHAVIOR

Southern steelhead tolerate warmer water temperatures than their northern counterparts, up to about 25˚C (77˚F), before they seek refuge in pools with cool seeps. They depend on winter rains to provide passage through seasonally opened estuaries and lagoons to reach upstream spawning tributaries. Juvenile steelhead may feed in fresh water for up to three years before migrating to the Pacific Ocean. While anadromous steelhead are only sporadically present in the current population, resident Rainbow trout occupy the upper watersheds of most rivers year-round and may be responsible for maintaining steelhead runs through their offspring when streamflow conditions are favorable. Anadromous offspring from resident parents are common enough to make protection of resident fish an integral component of Southern steelhead recovery.

GENETICS

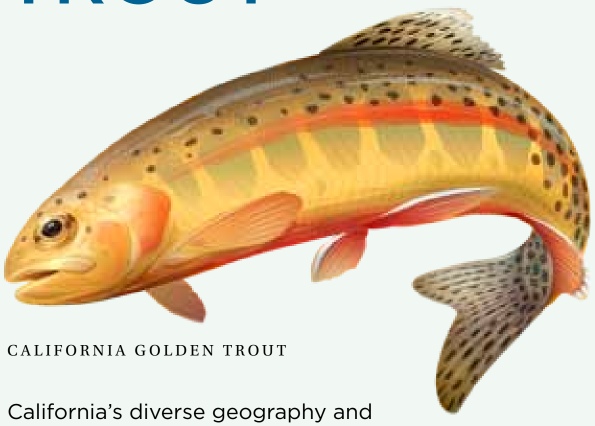
The environmental and genetic factors that underlie their ocean migrations are under active investigation. Populations in the larger watersheds in the northern part of the DPS (Santa Clara, Ventura, Santa Ynez and Santa Maria rivers) have remained un-hybridized, despite decades of stocking hatchery-origin Rainbow trout. Some resident Rainbow trout populations in the southernmost portion of the DPS have hybridized with hatchery-origin fish above barriers such as dams and diversions. However, three populations of pure native Southern steelhead are present in the San Luis Rey, Santa Ana, and San Gabriel rivers today.



SOUTHERN STEELHEAD DISTRIBUTION

Rainbow trout historically populated all coastal streams of southern California with permanent flows, as either resident or anadromous forms, or both. Today, the Southern steelhead range spans over 30,000 square km (about 11,580 square miles), has over 41,500 km (25,785 miles) of mostly intermittent streams, and is home to more than 22 million Californians. The DPS includes all naturally spawned anadromous Coastal Rainbow trout populations downstream of natural and human-made barriers in streams from the Santa Maria River (San Luis Obispo County) to the Tijuana River on the U.S.-Mexico border. They are most abundant in the four largest watersheds in the northern portion of their range: the Santa Maria, Santa Ynez, Ventura, and Santa Clara rivers.

TROUT



CALIFORNIA GOLDEN TROUT

California's diverse geography and climate provide habitat for 11 different kinds of native trout, more than any other state in the contiguous U.S. Five of these species are found nowhere else. In acknowledgment of its uniqueness and importance, the California Golden trout was designated the official State Fish of California in 1947. The state boasts both the rarest – Paiute Cutthroat trout – and the most widespread – Coastal Rainbow trout – trout species, which were transplanted from California to New Zealand, Argentina, and beyond. In 1971, California Trout helped create a special program of the California Department of Fish & Wildlife called the Heritage and Wild Trout Program, which celebrates and draws attention to this diversity by encouraging anglers to "catch and release" these fish. The program provides opportunities for anglersto learn more about the ongoing efforts to conserve them for future generations (www.wildlife.ca.gov/Fishing/Inland/HTC).

HABITAT AND BEHAVIOR

From the rivers of coastal redwood forests, to cold spring-fed streams, to high meadows in the Sierra Nevada, California's native trout have evolved to occupy a variety of habitat types. Native trout that inhabit small, high-elevation streams with short growing seasons – such as California Golden trout and McCloud River Redband trout – are generally small in size, less than about 25 cm (10 in.). In larger habitats, such as food-rich lakes, some species – such as Lahontan cutthroat trout – may grow to 75 cm (30 in.) in length and weigh over 9 kg (20 lbs.).

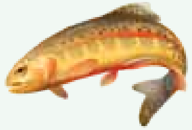
Of the eleven remaining trout species in California, five species saw an increase in Level of Concern since 2008.

Most trout species in small streams have short lifespans of about three or four years, while species in larger habitats may live up to 11 years. All trout species depend on cold, clean water to survive. A few species, such as Goose Lake Redband trout and Coastal Rainbow trout, have populations adapted to spending much of their lives growing in natural lakes or reservoirs before migrating into tributary streams to spawn and complete their life cycles. Yet other species, such as Paiute Cutthroat trout and Kern River Rainbow trout, cannot survive in lakes, despite attempts to increase their range through stocking; these riverine (stream-dwelling) species remain in relatively small stretches of streams for their entire lives. One species, the Coastal Cutthroat trout, may become anadromous (ocean-going) similar to steelhead, or remain in small tributaries throughout their entire life.

California's trout species can tolerate a wide range of environmental conditions, though each individual species is specialized. Some species, such as Little Kern Golden trout, have very limited habitat, occupying only a single small watershed. Various other species evolved remarkable tolerances to high pH (Eagle Lake Rainbow trout), high stream temperatures (Lahontan Cutthroat trout), and high turbidity (Goose Lake Redband trout) enabling them to survive in habitats not suitable for other trout.

Sunrise over Hot Creek. Photo: Kent Blackburn.

BULL TROUT



CALIFORNIA GOLDEN TROUT

COASTAL CUTTHROAT TROUT

COASTAL RAINBOW TROUT

EAGLE LAKE RAINBOW TROUT

SPECIES	2017 SCORE	LEVEL OF CONCERN
Bull Trout	0.0	EXTINCT
California Golden Trout	1.9	CRITICAL
Coastal Cutthroat Trout	2.7	HIGH
Coastal Rainbow Trout	4.7	LOW
Eagle Lake Rainbow Trout	2.3	HIGH
Goose Lake Redband Trout	3.1	MODERATE
Kern River Rainbow Trout	1.4	CRITICAL
Lahontan Cutthroat Trout	2.0	HIGH
Little Kern Golden Trout	2.0	HIGH
McCloud River Redband Trout	1.4	CRITICAL
Paiute Cutthroat Trout	2.1	HIGH
Mountain Whitefish*	3.4	MODERATE

* Mountain whitefish are not trout, but are salmonids.

TOP 3 ANTHROPOGENIC THREATS TO TROUT

ALIEN SPECIES

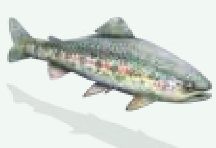
Alien species: Brown and Brook trout have been introduced extensively across California, and are sources of competition and predation for native trout. These non-native species are generally better able to survive in degraded habitats historically occupied by native species.

HATCHERIES

Hatchery-origin Rainbow trout strains have been widely stocked across California for over a century. These fish hybridize with native Redband, Rainbow, Golden, and Cutthroat trout, and their offspring replace genetically pure populations in the limited habitats they still occupy.

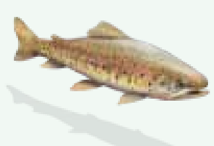
FIRE

Fires may potentially wipe out entire populations through direct mortality, sedimentation and siltation of habitat, and destruction of riparian habitat, especially for species with very limited ranges. Climate change is likely to increase the risk of more frequent and intense fires in California in the future.

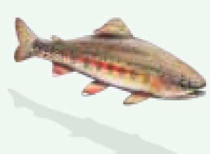


GOOSE LAKE RAINBOW TROUT

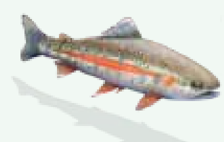
KERN RIVER RAINBOW TROUT



LAHONTAN CUTTHROAT TROUT

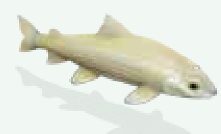


LITTLE KERN GOLDEN TROUT



MCCLOUD RIVER REDBAND TROUT

PAIUTE CUTTHROAT TROUT

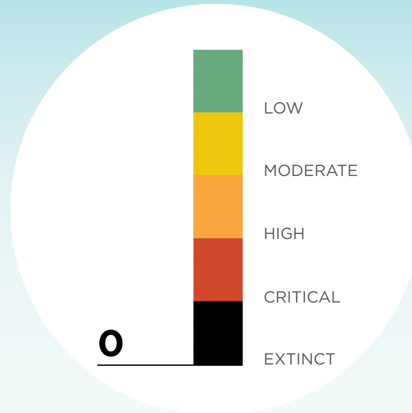


MOUNTAIN WHITEFISH

BULL TROUT

Salvelinus confluentus

LEVEL OF CONCERN: EXTINCT



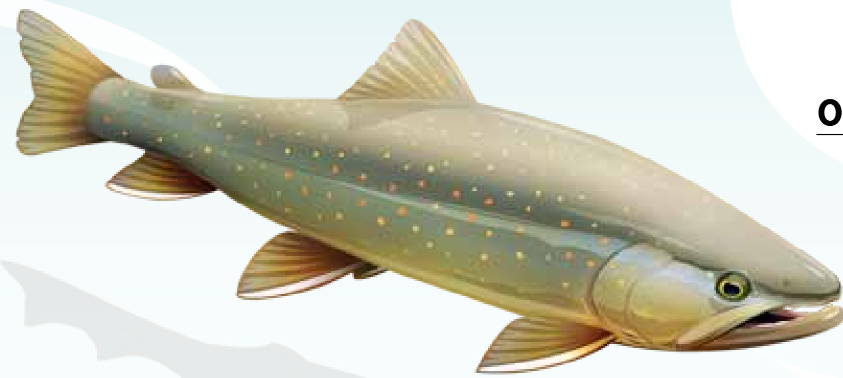


Photo: ODFW.

Bull trout are extinct in their range in California; the last known individual was captured on the McCloud River in 1975. Bull trout were likely in decline for most of the 20th century prior to their eventual extirpation due to construction of Shasta Dam and the subsequent elimination of their food supply.

CLIMATE CHANGE IMPACT

If Bull Trout existed in their known range today, they would be extremely vulnerable to climate change due to their reliance on very cold water and access to many different habitat types that would be increasingly difficult to maintain in a warming and drying climate.

TOP 3 ANTHROPOGENIC THREATS

MAJOR DAMS

Completion of Shasta Dam in 1942 blocked access of all historical salmon and steelhead runs, whose offspring served as key prey for Bull trout. Construction of McCloud Dam in 1965 blocked historical spawning migrations, reduced flows, and increased water temperatures to the point that the river could no longer sustain this species.

HARVEST

Reductions in salmon and steelhead from commercial fishing in the Sacramento River in the late 19th and early 20th centuries reduced prey abundance for Bull trout. Recreational harvest of Bull trout in McCloud Reservoir, in the years following its completion in 1965, also played a role in the demise of this species.

ALIEN SPECIES

The introduction of Brook and Brown trout to the upper McCloud River in the nineteenth century led to increased competition and predation on Bull trout.

CONSERVATION ACTIONS

There are no plans to re-introduce Bull trout to the McCloud River, and so they will remain absent from their historical habitat for the foreseeable future.

CHARACTERISTICS

Bull trout are a large species of trout that specialize in eating fish. They typically thrive in cold water habitats with abundant juvenile salmon or trout that they can ambush from below. Their bodies are dark olive in color, with small red spots on the sides and yellowish spots near the tail and cream leading edges of their fins. Their eyes sit on top of their large, flat heads. Bull trout from the McCloud River were said to reach lengths near 70 cm (about 28 in.) and weigh up to 7.3 kg (about 16 lbs.). The California record was caught in McCloud Reservoir and weighed about 5.1 kg (about 11 lbs.). They are capable of living over twenty years of age.

McCloud River, ideal habitat for Bull trout. Photo: Mike Wier.

Last known angler-caught Bull trout from McCloud River, 1975.

ABUNDANCE

In the 1930s, Bull trout supported a small fishery in the McCloud River. By the 1950s, after the construction of Shasta Dam, they were already scarce throughout the river. The last known Bull trout in California was caught by University of California, Davis graduate student Jamie Sturgess in 1975, tagged, and released.

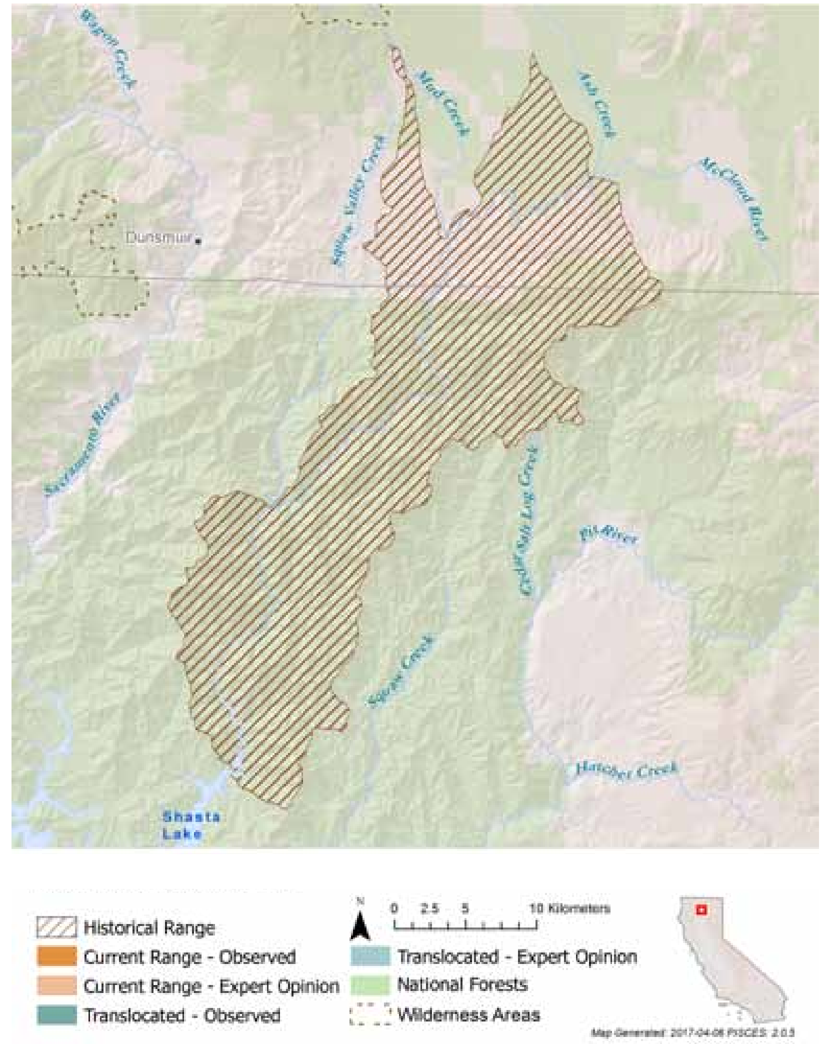
HABITAT AND BEHAVIOR

Bull trout require extremely cold, clear water that historically was present in springs in the McCloud River and some of its tributaries. Bull trout can express a variety of life histories, including a) adfluvial, where juveniles grow in streams, migrate to lakes to mature, and then adults migrate to spawn in natal streams, b) fluvial, where all stages live in streams, but adults migrate to small tributaries for spawning), c) stream resident fish with no separation of life history stages, or d) anadromous, where immature fish and adults undertake repeated estuary and/or ocean migrations to attain large sizes and seek more abundant sources of prey. Adult Bull trout in rivers and smaller streams prefer to live on the bottom in deep pools, and presumably, McCloud River Bull trout fed on abundant Chinook salmon eggs and juveniles year-round. Historically, it is thought that the McCloud River population was fluvial, with fish growing in large pools in the lower river before migrating upstream to spawn in smaller tributaries. Most Bull trout mature at around four or five years of age, and spawning probably took place in September or October when food was most abundant for hatching fry.

GENETICS

Bull trout are members of the char family (Salvelinus), along with the more common but non-native, Brook “trout” that are now widespread in California. From museum specimens, scientists determined that Bull trout in California were distinct enough from other populations to warrant their own ESU if they were still present in California.

Construction of McCloud Dam in 1965 led to the demise of Bull trout in the McCloud River. Photo: Mike Wier.



BULL TROUT DISTRIBUTION

Bull trout were historically found throughout the McCloud River from its mouth to the Lower Falls, and could have potentially lived in the spring-fed upper Sacramento and Pit Rivers as well. Today, the southern extent of their range is in the Klamath River Basin in Oregon and the Jarbridge River Basin in Nevada and range as far north as the Yukon River in British Columbia.

CALIFORNIA GOLDEN TROUT

Oncorhynchus mykiss aguabonita

LEVEL OF CONCERN: CRITICAL

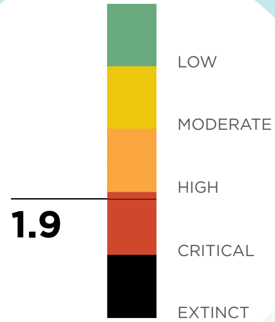


Photo: Val Atkinson.

California Golden trout are likely to become extinct in the wild in the next 50 years. While the Golden Trout Creek (GTC) population is relatively secure, the South Fork Kern River (SFKR) population is threatened by hybridization with hatchery-origin Coastal Rainbow trout, and predation and competition from introduced Brown trout.

CLIMATE CHANGE IMPACT

California Golden trout are critically vulnerable to climate change impacts that will alter the snowmelt-fed streams they depend upon. While the highest portions of the southern Sierra Nevada may continue to retain a great deal of snow as temperatures warm, snowpack may not persist as long into summers in the extensive meadows of the Kern Plateau. As a result, meadows are likely to become drier by the end of summer, which will reduce streamflows.

TOP 3 ANTHROPOGENIC THREATS

ALIEN SPECIES

Hybridization between Coastal Rainbow trout and California Golden trout is a major threat to maintaining the genetic diversity of California Golden trout in their native range. Introduced Brown trout also eat and compete with California Golden trout.

GRAZING

The majority of California Golden trout streams have been grazed by cattle and sheep for the past 130 years, and some stream sections have been severely damaged, reducing the water storage capacity of meadows and total streamflows over time.

RECREATION

Recreational activities such as off-road vehicle use, travel by horse and pack stock, and hiking have degraded some portions of fragile meadow habitats in the California Golden trout range that serve as reservoirs that release cool water in summer and fall months.

SUMMARY

The drought of 2012-2016 caused meadow habitat near Volcano Creek – a key tributary for California Golden trout – to dry almost completely. Due to poor habitat conditions and uncertainty over the duration of drought, a fish rescue was conducted by CDFW in September 2016. These fish are being held for reintroduction as soon as favorable stream conditions allow. Better genetic data have also revealed fewer "pure" populations of California Golden trout exist in the wild than previously thought.

CONSERVATION ACTIONS

- Review and update the 2004 Conservation Strategy.
- Implement revised Conservation Strategy to eliminate non-native trout species.
- Monitor and evaluate barrier performance and collect abundance, distribution, and genetic data to determine Strategy efficacy.
- Restrict grazing and off-road vehicles from sensitive areas.
- Protect streams with pure and slightly hybridized California Golden trout as refuge populations.
- Restore degraded headwater meadows to increase cool streamflows in summer and fall months and enhance species resiliency.

METRIC	SCORE	JUSTIFICATION
Area occupied	1	Unhybridized California Golden trout are confined to a few small tributaries in one watershed.
Estimated adult abundance	3	Volcano Creek populations may be <1,000 but, if other populations with conservation value within native range are counted, the numbers would be much higher, perhaps 50,000.
Intervention dependence	2	Annual monitoring of barrier performance required; continued implementation of Conservation Strategy is critical. Rescued individuals from Volcano Creek will need to be re-introduced based on genetic management strategy.
Environmental tolerance	3	Generally tolerant of a wide range of conditions and habitats within their native range.
Genetic risk	1	Hybridization with rainbow trout is a constant high risk.
Climate change	1	Rated critically vulnerable in Moyle et al. (2013).
Anthropogenic threats	2	1 High, 1 Medium threat.
Average	1.9	LEVEL OF CONCERN: CRITICAL
Certainty (1-4)	4	Well-documented.

CHARACTERISTICS

California Golden trout take their name from their bright, yellow-gold coloration. Their backs are usually copper, with brilliant golden sides and bright red bands on their flanks. Their bellies are often deep red, and even adult fish retain parr marks. They have large spots on their fins and tail, with black bands and white to yellowish tips. They can grow to 19-20 cm (about 8 in.) and reach a maximum age of nine years in streams. They are capable of growing larger in lakes – the largest Golden trout ever caught, in Virginia Lake (Madera County), weighed 4.5 kg (10 lbs.). Their striking appearance makes them easily recognizable, and led to California Golden trout becoming the official State fish of California in 1947.

ABUNDANCE

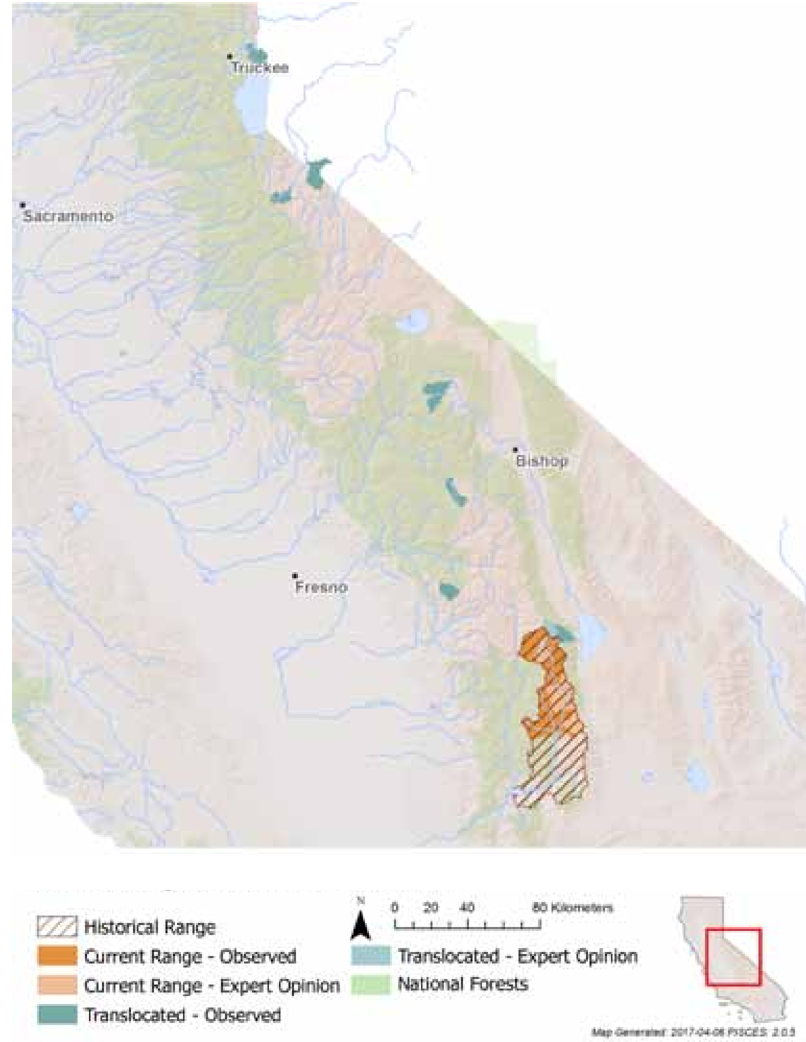
Despite numerous translocations to various watersheds, unhybridized California Golden trout are much less abundant in their native range than they once were. In 1965, an estimated 40,000 California Golden trout inhabited Golden Trout Creek and the South Fork Kern River. At present, only 400-2,600 'pure' California Golden Trout remain in their native habitat in 5 km (about 3 mi.) of Volcano Creek, representing a decrease of 95% from historical numbers.

HABITAT AND BEHAVIOR

California Golden trout live in cold, clear mountain streams in meadows at high elevations over 2,300m (about 7,500 ft.). They prefer to stay in short reaches of streams, such as in pools and beneath undercut banks, for most of their lives. Most of their habitat is made up of riparian meadows in the Golden Trout Wilderness. In rivers and streams, they opportunistically eat both terrestrial and aquatic invertebrates, but eat mostly midges in lakes. Due to the lack of natural predators in their native range, they are more active during the daytime than most other trout species. California Golden trout spawn when they are three or four years old, in late June or July, and in finer substrates than other trout species.

GENETICS

California Golden trout are considered a distinct species by the American Fisheries Society, while some experts consider them to be a subspecies of Rainbow trout. Recent genetic studies have found that California Golden trout and the closely-related Little Kern Golden trout represent two independent lineages derived from Coastal Rainbow trout.



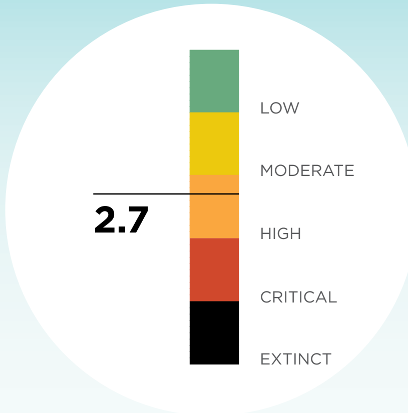
CALIFORNIA GOLDEN TROUT DISTRIBUTION

California Golden trout are native to the South Fork Kern River and its tributaries, Golden Trout Creek and Volcano Creek. As a result of extensive pack train collection and stocking efforts over the last century, they can be found in nearby Cottonwood Lakes and Mulkey Creek, as well as several watersheds in the Sierra Nevada. Expanded stocking has introduced them to more than 300 high mountain lakes and 1,100 km (about 680 mi.) of streams outside their native range, including in Utah, Wyoming, and Montana.

COASTAL CUTTHROAT TROUT

Oncorhynchus clarkii clarkii

LEVEL OF CONCERN: HIGH




Coastal Cutthroat. Photo: Sam Rizza.

Coastal Cutthroat trout populations in California are small, fragmented, and face multiple threats, including cumulative impacts from land use practices. While their numbers appear to be stable in the few watersheds they inhabit it is equally likely that they have declined in response to watershed alteration throughout their range.

CLIMATE CHANGE IMPACT

Coastal Cutthroat trout's reliance on cold, oxygenated water makes them extremely vulnerable to increased stream temperatures and variability in precipitation likely to occur as the climate changes. Recent drought has caused the juvenile migration peak to shift from June-July to May in Redwood Creek (Humboldt County), indicating rapid shifts to changing environmental conditions are possible.

TOP 3 ANTHROPOGENIC THREATS

LOGGING

Logging and construction of associated road networks have caused tremendous impacts to Coastal Cutthroat habitats in California through landslides and erosion stemming from excessive tree removal and road construction on steep, unstable soils.

ESTUARY ALTERATION

Estuaries are important feeding and nursery habitats for Coastal Cutthroat juveniles, yet most estuaries in California have been severely altered and simplified by agriculture, rural and urban development, and associated channelization.

AGRICULTURE

Conversion of estuarine wetlands to agricultural and grazing lands have led to diversions and an influx of fertilizers and other pollutants, which reduce habitat suitability.

SUMMARY

Recent investigations indicate that we know very little about Coastal Cutthroat trout or where they live in California. They depend upon estuaries, and so habitat acquisition, protection, and restoration in the Smith and Klamath rivers, Redwood Creek, and lagoons throughout Del Norte and Humboldt counties is required to improve conditions for Coastal Cutthroat trout.

CONSERVATION ACTIONS

- Conduct abundance and distribution surveys to update information on the current status across their range in California.
- Conduct long-term monitoring and assessment to inform a conservation strategy for the species.
- Undertake estuary restoration in major watersheds to benefit all salmonids, such as in the Eel, Klamath, and Smith rivers and Redwood Creek.

CHARACTERISTICS

Coastal Cutthroat trout are similar in appearance to Rainbow trout, but are generally brassy in color and have more spots spread along their bodies, especially on their fins. They are more slender and bullet-like in shape than Rainbow trout, with pointed heads and forked tails. As juvenile Coastal Cutthroats become smolts to undertake ocean migrations, their spots disappear and the fish become silvery. Most, but not all, Coastal Cutthroats have characteristic red to orange slashes under their lower jaws, though the slashes are rarely visible until the fish are a year or more old.

METRIC	SCORE	JUSTIFICATION
Area occupied	5	Found in many watersheds from Eel River tributaries north to Oregon.
Estimated adult abundance	3	Many populations are genetically isolated by barriers; most appear to be small and fragmented within California.
Intervention dependence	2	Persistence requires improved management of heavily logged watersheds and extensively altered estuaries. At least one tributary to the Salt River required a fish rescue in August 2015, and more may be required if the current drought continues.
Environmental tolerance	2	Prefer water temperatures below 12ºC (approximately 54ºF).
Genetic risk	2	Recent research indicates that hybridization with steelhead, while natural, may increase in degraded watersheds or in the presence of hatchery-origin steelhead; this may affect abundance estimates and fisheries management decisions.
Climate change	2	Most populations exist in small streams or depend upon existing estuary conditions; considerable range-wide vulnerability to climate change.
Anthropogenic threats	3	1 High, 7 Medium threats.
Average	2.7	LEVEL OF CONCERN: HIGH
Certainty (1-4)	3	Information compiled from expert judgment, published and gray literature, and anecdotal evidence.

They are capable of reaching 70 cm (about 28 in.) in length, and 8 kg (nearly 18 lbs.), but rarely exceed 40 cm (16 in.) in California waters. Tagged Coastal Cutthroats in California have been known to live for up to 7 years.

ABUNDANCE

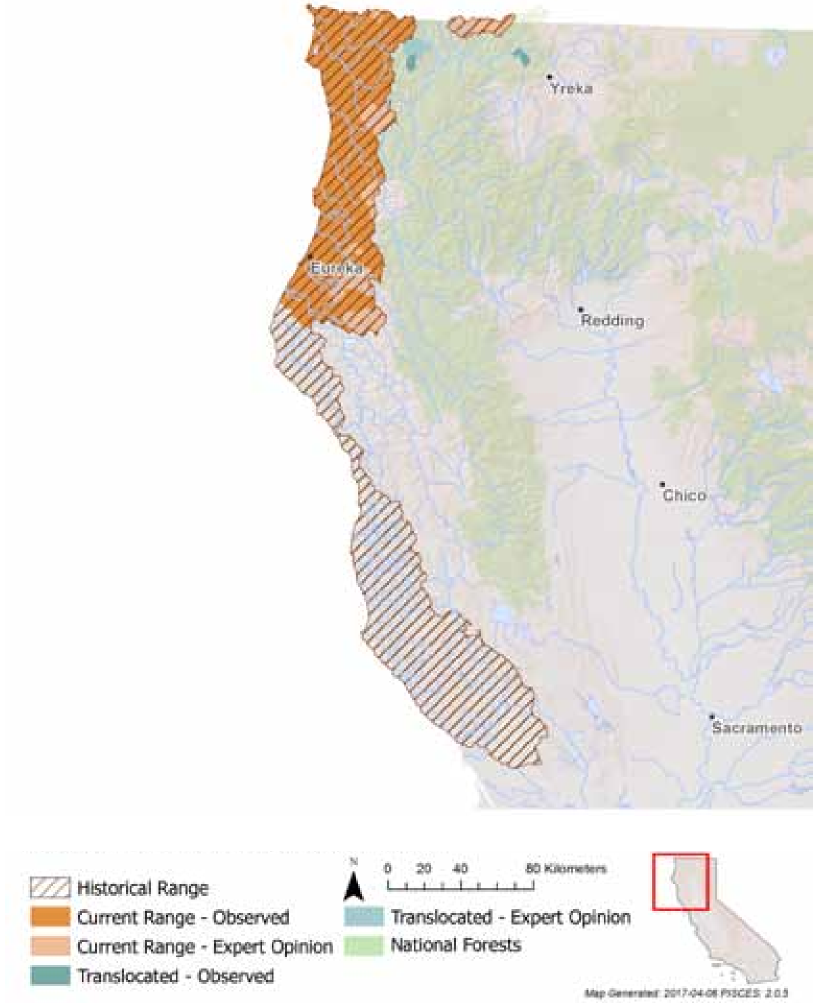
Coastal Cutthroat trout once supported a substantial fishery and were even stocked in the Mad River (Humboldt County) as early as the 1920s to support harvest. Abundance data from California populations are typically incomplete and unpublished, but suggest that Coastal Cutthroat populations are probably significantly smaller than they were historically, and are either currently stable or in decline due to extensive estuary and stream alteration throughout their range in California.

HABITAT AND BEHAVIOR

Coastal Cutthroat trout are the least studied salmonid along the North Coast. They need cool, clean, oxygenated water with ample cover and deep pools for holding during the summer. They prefer small, low-gradient coastal streams with access to estuarine habitats, including lagoons, but may also live in small headwater streams. Coastal Cutthroats lurk in pools with fallen logs or undercut banks that provide shade and cover, where they can ambush small salmon, steelhead, and other fish. They may express one of four different life histories: (1) undertaking salt and fresh water migrations; (2) spending their lives in lakes; (3) dwelling in rivers but seasonally migrating to estuaries; or (4) remaining in small tributaries. Juveniles adopt a history based on habitat and food availability, water quality, temperature, and other environmental factors. Adults between two and four years of age migrate to natal streams after the first substantial rains in the fall, and spawn between December and April.

GENETICS

California's Coastal Cutthroat populations are at the southern end of their range, and are considered part of the Southern Oregon-California Coast DPS for management. While separate species, Coastal Cutthroat and Rainbow trout hybridize naturally, but differences in spawning timing, habitat preferences, and behavior keep them distinct in watersheds where they overlap. In watersheds where hatchery-origin steelhead are present, higher rates of hybridization between the two species have been documented.



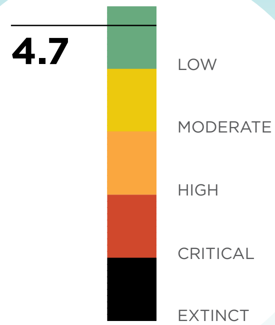
COASTAL CUTTHROAT TROUT DISTRIBUTION

Coastal Cutthroat trout range from Prince William Sound, Alaska, to tributaries of the Salt River (Eel River, Humboldt County). They inhabit most coastal tributaries of major rivers open to the sea and lagoons between the Smith River (Del Norte County) and the Eel River (Humboldt County) in a relatively broad band along the coast. However, updated distribution surveys are needed for this species, as they often inhabit disconnected headwater streams that are now upstream of man-made barriers such as dams, diversions, and culverts.

COASTAL RAINBOW TROUT

Oncorhynchus mykiss

LEVEL OF CONCERN: LOW



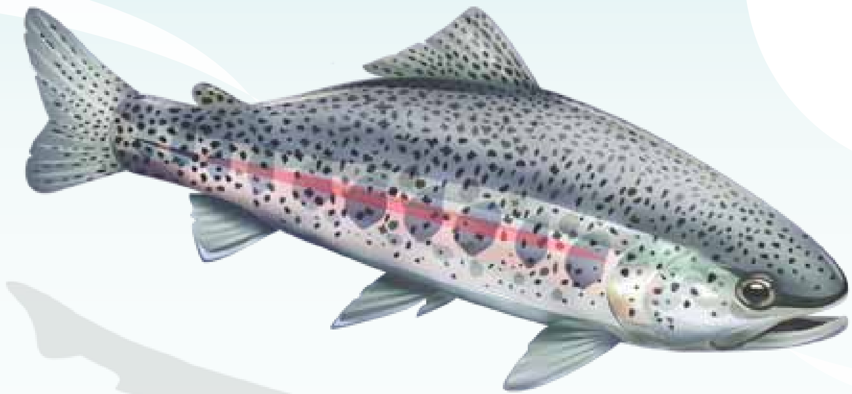


Photo: Phil Reedy

Coastal Rainbow trout are the least vulnerable native trout species in California due to their high tolerance to a wide variety of environmental conditions, multiple life histories, and a large natural and expanded range (through introductions).

CLIMATE CHANGE IMPACT

Climate change is likely to reduce the amount of suitable habitat for Coastal Rainbow trout but there will be sufficient cold water to support many self-sustaining, if reduced, populations. However, they are less vulnerable to climate change than other trout species due to their inherent tolerance for high water temperatures and poor water quality, competitive behavior, abundance, and access to diverse habitats that increase their resilience as a species.

TOP 3 ANTHROPOGENIC THREATS

RESIDENTIAL DEVELOPMENT

Especially at lower elevations, residential development limits populations of Coastal Rainbow trout by placing high demands on limited water supplies through diversions and groundwater pumping, which reduce, degrade, and fragment habitat.

AGRICULTURE

Dams and diversions to support agriculture reduce cold water supply and degrade habitat for Coastal Rainbow trout across California through altered streamflows and increased temperatures.

ALIEN SPECIES

Alien species, such as Brook and Brown trout and bass, limit populations of Coastal Rainbow trout through predation and direct competition, especially in altered habitats.

SUMMARY

While their status score increased slightly since 2008 because they are not considered vulnerable to anthropogenic threats at this time, total Coastal Rainbow trout abundance likely dipped in response to low streamflows and high temperatures associated with California's historic drought from 2012-2016.

CONSERVATION ACTIONS

- Expand projects that increase reliable quantities and quality of cold water habitat.
- Implement management and restoration projects that focus on reconnecting populations of Rainbow trout that are currently separated by barriers and promoting access to diverse habitats to restore genetic diversity.
- Support healthy populations of wild trout for catch-and-release recreational fisheries.

CHARACTERISTICS

Coastal Rainbow trout are incredibly adaptable to different environments and are capable of exhibiting a wide range of coloration. Trout from small streams may be dark olive on the back with a yellowish belly and orange tips on the fins, while lake-dwelling fish tend to be more silver in color. Most Coastal Rainbow trout have heavy, irregular spotting, and spots that radiate outward in lines on the tail and a white belly. The pink to deep red band on their flanks gives the fish its namesake. In waters with access to the ocean, any rainbow trout greater than 41 cm (16 in.) in length are considered to be "steelhead" for management purposes and

METRIC	SCORE	JUSTIFICATION
Area occupied	5	Abundant in California and widely distributed around the world.
Estimated adult abundance	5	Many fish in many populations. Adult abundance probably greater than 500,000 statewide.
Intervention dependence	5	While stream improvements and other activities greatly improve habitat for native and introduced populations, most populations can persist on their own with existing protective laws and regulations.
Environmental tolerance	4	Broad physiological tolerance.
Genetic risk	5	Lots of gene flow among populations.
Climate change	4	Low vulnerability due to widespread populations in diverse habitats.
Anthropogenic threats	5	All threats low.
Average	4.7	LEVEL OF CONCERN: LOW
Certainty (1-4)	4	Well-documented.

catch limits, although resident Coastal Rainbow trout regularly attain this size where habitat is favorable and food is plentiful.

ABUNDANCE

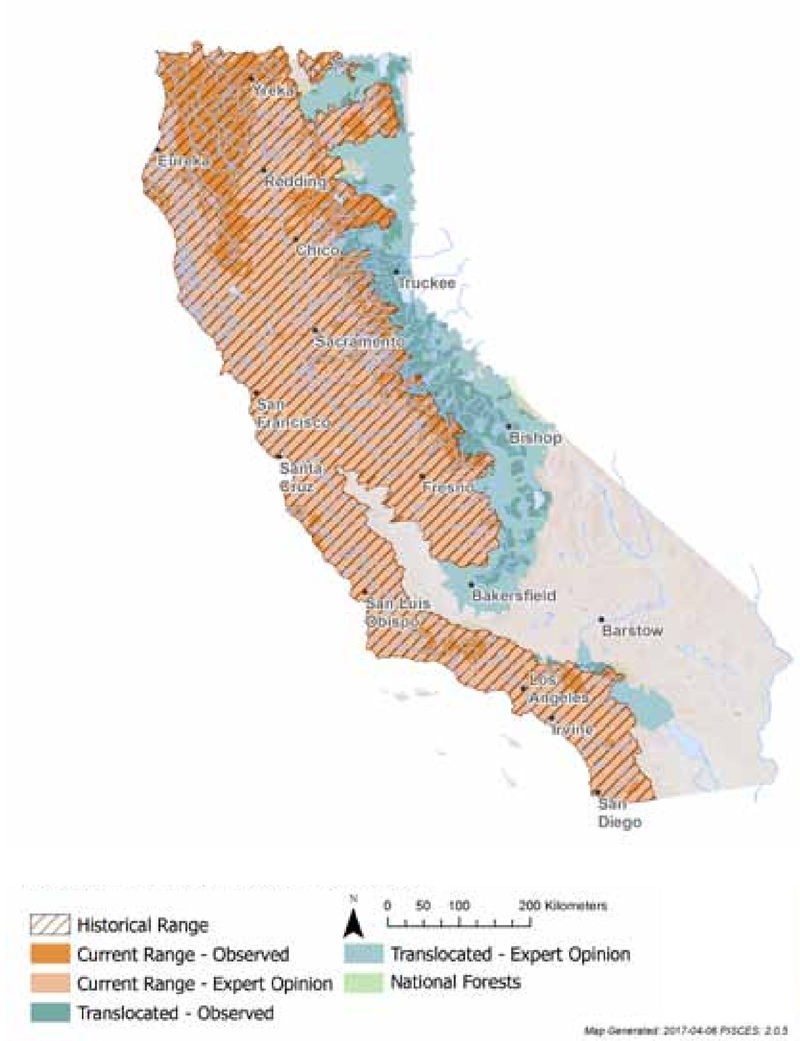
Wild resident Coastal Rainbow trout are more abundant today than they were historically in California due to a long history of introductions by pack mule trains, airplanes, and other means, especially into previously fishless high elevation lakes in the Sierra Nevada. However, Coastal Rainbow trout abundance across California was likely depressed during the historic drought (2012-16) based on drought rescue information from CDFW.

HABITAT AND BEHAVIOR

Coastal rainbows mature when they are two or three years old, and rarely live more than five or six years. They generally spawn in spring to early summer, from February to June depending on stream temperatures, but have been known to spawn during the winter months in Putah Creek (Solano County) and may spawn year-round in spring-fed streams such as the Fall River (Shasta County) without strong seasonal cues such as flow or temperature. Fish that spend their entire lives in fresh water rarely attain sizes greater than 70 cm (28 in.), but lake-dwelling fish may grow larger. In rivers and streams, they feed on aquatic and terrestrial insects that drift in the water column, and may occasionally eat fish and frogs, especially as they grow larger. They may feed on small invertebrate worms or insect larvae on the bottom of some rivers and lakes. In lakes and reservoirs, they frequently feed on fish such as Threadfin shad. Coastal Rainbow trout owe their success to their ability to adapt to a wide variety of habitats. They are capable of being stream residents, lake residents, or migratory between these habitats. Coastal Rainbow trout that express one life history are capable of having offspring that take on another life history if habitat is available.

GENETICS

Coastal Rainbow trout are defined in this report as self-sustaining Rainbow trout populations that are (a) isolated above natural barriers as the result of geologic activity (landslides, waterfalls, etc.), (b) isolated above anthropogenic barriers, such as dams, and/or (c) introduced by people into isolated areas, such as historically fishless lakes of the Sierra Nevada. While all Coastal Rainbow trout likely had steelhead ancestors, populations upstream of major dams today have been found to be more genetically similar to other above-dam populations than they are to fish downstream of dams. Despite over a century of widespread stocking of hatchery strains of Coastal Rainbow trout in California, many populations above man-made barriers share relatively little genetic material with hatchery Rainbow trout.



COASTAL RAINBOW TROUT DISTRIBUTION

Coastal Rainbow trout were originally present in virtually all perennial coastal streams from San Diego north to the Smith River (Del Norte County), and in most rivers in the Central Valley from the Kern River north to the Pit River near Alturas (Modoc County). Resident Coastal Rainbow trout were typically found upstream of natural barriers, such as waterfalls or rockslides, which were too difficult for steelhead to pass. Today, due to numerous introductions, Coastal Rainbows are found in virtually all streams where suitable habitat exists, including the once-fishless Sierra Nevada north of the upper Kern River Basin and lakes and streams in the Cascade Range and Trinity Alps.

EAGLE LAKE RAINBOW TROUT

Oncorhynchus mykiss aquilarum

LEVEL OF CONCERN: HIGH

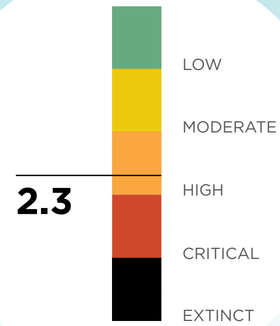


Photo: Gerard Carmona-Catot.

While recent progress has been made to improve access to spawning habitat in Pine Creek, Eagle Lake Rainbow trout (ELRT) do not exist as a self-sustaining wild population because of its dependence on hatchery propagation.

CLIMATE CHANGE IMPACT

Climate change will likely have two major impacts on Eagle Lake Rainbow trout: decreased streamflows and changing lake conditions. With more precipitation in the Mount Lassen region likely to fall as rain instead of snow in the future, spawning migrations into Pine Creek may become problematic, and alkalinity levels of the lake could shift over time, making its waters inhospitable to trout.

TOP 3 ANTHROPOGENIC THREATS

ALIEN SPECIES

Non-native Brook trout have taken over Pine Creek, the only spawning tributary of Eagle Lake. They compete with and displace Eagle Lake Rainbow trout.

HATCHERIES

Eagle Lake Rainbow trout are dependent upon collection and artificial spawning at the Pine Creek fish trap for distribution to nearby hatcheries for hatching and raising juveniles.

HARVEST

A trophy trout fishery is managed closely by CDFW, but harvest impacts may be selecting for larger fish over time, with unknown impacts on the population.

SUMMARY

Removal of non-native Brook trout in Pine Creek, the sole spawning tributary for Eagle Lake Rainbow trout, began in 2007. The Pine Creek fish trap was modified in 2012 to allow passage of spawning fish upstream for the first time in decades. Cattle have been excluded from meadows along Pine Creek to allow riparian habitat to rebound. In 2015, a joint Conservation Agreement that focuses on implementing restoration projects that enhance watershed function and increase spawning and juvenile nursery habitat was signed.

CONSERVATION ACTIONS

- Work with conservation partners in the U.S. Forest Service, U.S. Fish & Wildlife Service, and CDFW to restore a wild, naturally-spawning population of Eagle Lake Rainbow trout in Pine Creek by promoting access and controlling non-native brook trout populations.
- Implement effective restoration programs that enhance spawning and rearing habitat in Pine Creek and its tributaries.
- Implement an adaptive genetics management plan that can be incorporated into the conservation strategy to protect the genetic integrity of these rare fish.

METRIC	SCORE	JUSTIFICATION
Area occupied	1	Endemic only to Eagle Lake watershed.
Estimated adult abundance	4	Includes hatchery fish.
Intervention dependence	1	Persistence depends on trapping fish for hatchery spawning, rearing and restocking annually, and allowing passage on Pine Creek.
Environmental tolerance	4	One of most tolerant, long-lived forms of Rainbow trout.
Genetic risk	3	Although operated to maximize diversity and minimize artificial selection processes, hatchery rearing has presumably altered genetics; possible selection against longevity and fitness in the wild is of concern, particularly for stream forms; accidental hybridization in hatcheries possible.
Climate change	1	Rated critically vulnerable in Moyle et al. (2013).
Anthropogenic threats	2	One High and five Medium threats.
Average	2.3	LEVEL OF CONCERN: HIGH
Certainty (1-4)	4	Well-documented.

CHARACTERISTICS

Eagle Lake Rainbow trout look similar to Coastal Rainbow trout, but have finer scales and the snout is frequently rounded. They have numerous small, irregular spots along their back and fins. They grow quickly and are capable of reaching lengths up to 72 cm (28 in.) and weights of 4.5 kg (10 lbs.).

ABUNDANCE

Abundance of Eagle Lake Rainbow trout is not known due to lack of comprehensive studies on their population. Presumably, the numbers depend on the stocking allotment of fish into the lake in a given year from young reared at Crystal Lake and Darrah Springs Fish Hatcheries. Since the population is dependent on hatchery production, it is presumably stable.

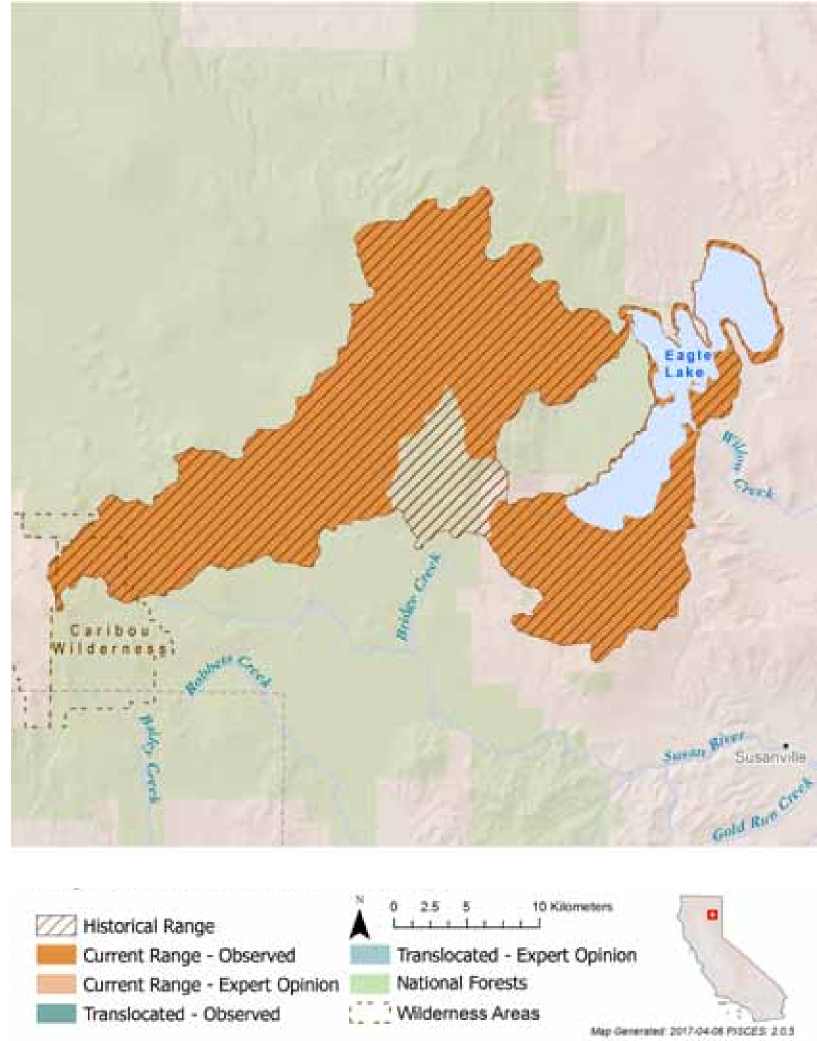
HABITAT AND BEHAVIOR

Eagle Lake Rainbow trout are known for their adaptability to both the highly alkaline waters of Eagle Lake and the spring-fed tributaries to Pine Creek where they historically spawned. They are capable of rapid growth due to the abundant food in Eagle Lake, making them desirable as a hatchery strain of fish. They may live up to 11 years of age, and mature slowly, usually at about age three.

Eagle Lake. Photo: Melanie McFarland

GENETICS

The most recent genetic evidence suggests that Coastal Rainbow trout invaded Eagle Lake via a historical connection between the Feather River and Pine Creek and became stranded. These fish have two fewer chromosomes (58) than other Rainbow trout.



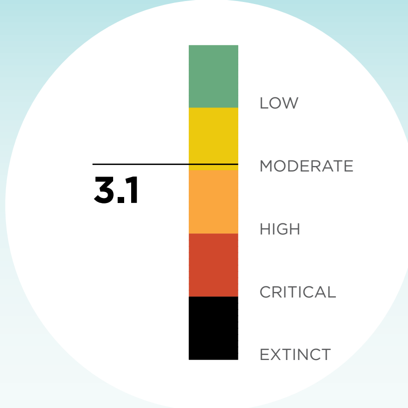
EAGLE LAKE RAINBOW TROUT DISTRIBUTION

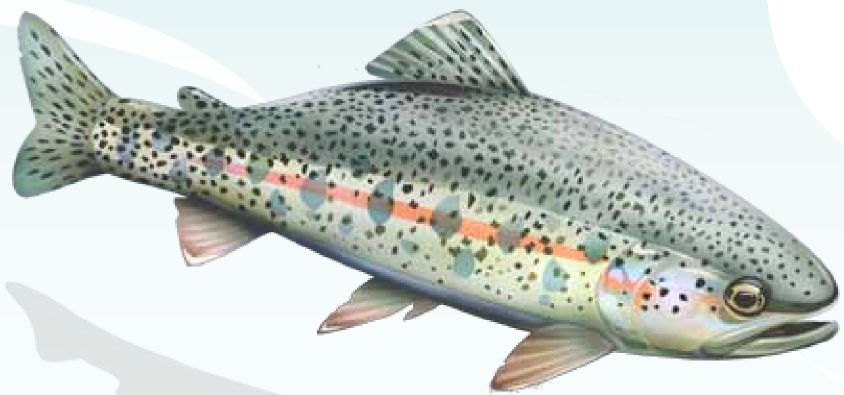
Eagle Lake Rainbow trout are found only in Eagle Lake (Lassen County) and its major tributary, Pine Creek. They have been raised in the Mount Shasta and Darrah Springs fish hatcheries and subsequently planted across the United States and Canada due to their tolerance for harsh conditions and rapid growth.

GOOSE LAKE REDBAND TROUT

Oncorhynchus mykiss newberrii

LEVEL OF CONCERN: MODERATE





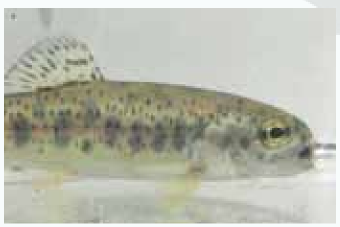


Photo: Matt Hernandez.

Goose Lake Redband trout do not face immediate risk of extinction. However, California populations are not secure because they are mostly small, largely isolated, and, during drought periods, the lake population disappears and stream populations contract.

CLIMATE CHANGE IMPACT

Summer stream temperatures are often near the upper thermal tolerance of Goose Lake Redbands. Temperature increases, coupled with more severe and frequent drought, cause Goose Lake to dry completely are likely to increase extinction risk in the next century.

TOP 3 ANTHROPOGENIC THREATS

AGRICULTURE

Dams and water diversions to support widespread agricultural uses in the basin reduce streamflows and increase water temperatures; these impacts are compounded by drought.

GRAZING

Headwater streams containing Redbands have been heavily grazed historically, and more recently, resulting in reduced riparian cover, channelization, erosion, and stream degradation.

HARVEST

While legal fishing is mostly catch-and-release and pressure is light, poaching of adults during spawning runs when they are most vulnerable may be a problem.

SUMMARY

From 2013-2015, Goose Lake dried up entirely, reducing the overall abundance of the population and causing remaining Goose Lake Redband trout to seek refuge in tributary streams.

CONSERVATION ACTIONS

- Remove barriers and restore stream-lake connectivity to allow Goose Lake Redbands to migrate between the lake and tributary habitats.
- Improve management of headwater areas to protect streams from livestock grazing and other stressors with exclusion fencing, off-channel water sources for livestock, and altered land management practices adjacent to riparian habitat.
- Work with partners to fully implement the Goose Lake Fishes Conservation Strategy restoration and conservation actions and necessary monitoring functions.

CHARACTERISTICS

Goose Lake Redband trout were once so abundant they were harvested commercially and sold to nearby logging camps in California and Oregon. They look similar to other Redband trout, with yellowish bodies, brick-red lateral stripes, heavy spots on the body, and white-tipped fins. Fish in streams keep their parr marks, or dark ovals along their sides, for their entire lives, while adults in the lake take on a silvery coloration. In Goose Lake, fish historically attained lengths up to 70 cm (28 in.), while stream-dwelling fish rarely grow larger than 25 cm (10 in.).

METRIC	SCORE	JUSTIFICATION
Area occupied	4	Present in six streams in California and 13 in Oregon.
Estimated adult abundance	3	Populations greatly reduced in drought years.
Intervention dependence	4	Long-term decline reversed by restoration actions; over 220 Redbands were rescued from Cold Creek during drought in 2014 and 2015; may require future rescue if drought conditions persist.
Environmental tolerance	4	Indirect evidence suggests they are more tolerant than most salmonids of adverse water quality.
Genetic risk	3	Genetic risks are currently low; potential impacts from isolation of headwater populations need investigation.
Climate change	2	Distribution in isolated, small streams increases probability of extirpation due to prolonged drought.
Anthropogenic threats	2	One High and two Medium threats.
Average	3.1	LEVEL OF CONCERN: MODERATE
Certainty (1-4)	2	Mostly ‘grey’ reports and expert opinion.

ABUNDANCE

Historically, Goose Lake and its tributaries likely supported thousands of spawning adult fish annually. More recently, abundance estimates in California tributaries were about half of estimates from a decade or two earlier, or on the order of several hundred year-old trout per mile.

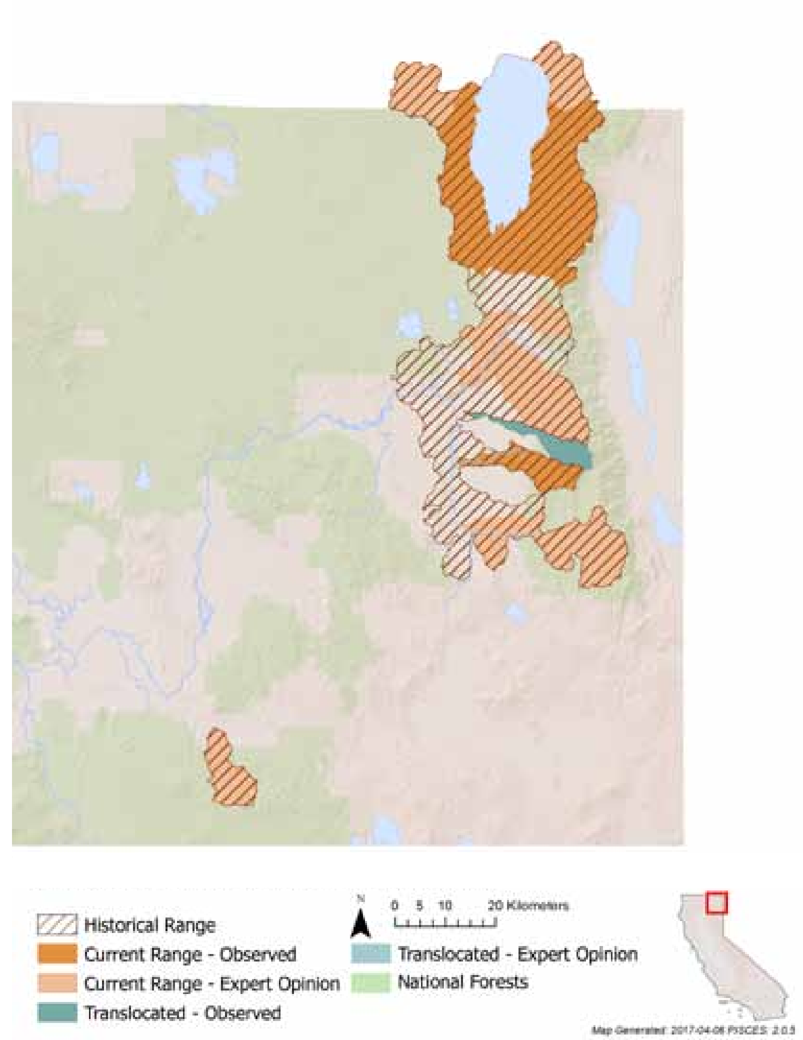
Goose Lake. Photo: Paul Divine.

HABITAT AND BEHAVIOR

Goose Lake Redband trout are adapted to live in the highly alkaline, cool, and shallow waters of the vast Goose Lake, which sits 1,430 m (about 4,700 ft.) above sea level. Goose Lake is approximately 76 km (47 mi.) long and 19 km (12 mi.) wide when full, yet is only about 3 m (10 ft.) at its deepest point. High prevailing winds in this desolate region regularly churn the waters, making the waters extremely turbid but rich with invertebrates for trout to feed on. Redbands can take on two different life histories to exploit this harsh environment. Some fish are born in tributary streams and migrate to the lake to grow larger before returning to spawn in their home streams. Other fish reside in cold, clear headwater tributary streams for their entire lives without undertaking lake migrations. Spawning migrations follow snowmelt and rain in the spring, usually during late March or in April, with most spawning occurring in May. Spawning fish are mostly made up of three-year-old adults, which appear pale in color, perhaps resulting from time spent in the lake’s turbid waters. In the lake, the trout feed on Goose Lake Tui chub, Tadpole shrimp, and other abundant invertebrates, while in streams, the Redbands mostly eat insects and fly larvae.

GENETICS

Goose Lake Redband trout are most similar to trout of two adjacent basins: the Warner Basin in California, Oregon and Nevada, and the Chewaucan Basin in Oregon. Recent genetic studies indicate a close relationship between Goose Lake Redbands and neighboring Warner Lakes Redbands and their distinctiveness requires further study.



GOOSE LAKE REDBAND TROUT DISTRIBUTION

Goose Lake Redband trout inhabit Goose Lake, its many tributaries in Oregon and California, and a few select tributaries to the upper Pit River near Alturas (Modoc County). They are present today in six Goose Lake tributaries in California and four Pit River tributaries in far northeastern California.

KERN RIVER RAINBOW TROUT

Oncorhynchus mykiss gilbertii

LEVEL OF CONCERN: CRITICAL

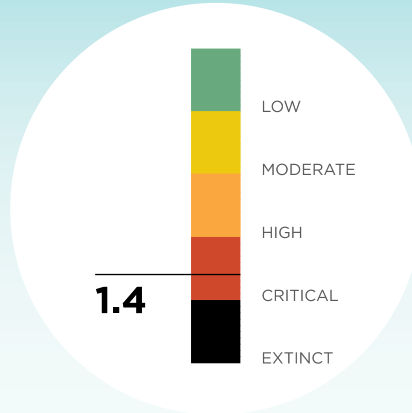


Photo: Bill Brubaker.

Kern River Rainbow trout have a high probability of disappearing as a distinct entity in the next 50 years, if not sooner. The greatest threat is hybridization with Coastal Rainbow trout, but competition and predation from invasive Brown and Brook trout may also be contributing to its decline.

CLIMATE CHANGE IMPACT

The small, isolated, headwater streams that support most pure populations will be subject to increased drying and warmer temperatures due to climate change. Climate change will likely also change precipitation patterns (more rain, less snow in the Sierra Nevada) and make severe droughts more common across California in the future.

TOP 3 ANTHROPOGENIC THREATS

ALIEN SPECIES

The most critical threat to Kern River Rainbow trout is hybridization with Coastal Rainbow, California Golden, and Little Kern Golden trout. Predation by, and competition with Brown and Brook trout is also a major threat.

HATCHERIES

Kern River Rainbow trout are hybridized with Coastal Rainbow and California Golden trout in much of their historical range due to well-documented hatchery stocking in the past.

GRAZING

While less severe recently, the long history of grazing livestock (mostly sheep) in the Kern River Basin has degraded meadow, riparian, and stream habitat that support Kern River Rainbow trout. These impacts also increase the potential impacts of catastrophic fire or drought on the species by reducing suitable stream habitat.

SUMMARY

The most recent genetic evidence suggests that there are far fewer relatively “pure” Kern River Rainbow trout populations than previously thought left in the wild, and that many trout thought to be Kern River Rainbows are actually Kern River/Coastal Rainbow trout hybrids. Drought conditions have desiccated headwater meadows and some portions of streams, reducing the availability of cold water during summer months and elevating stream temperatures to levels that are harmful to trout.

CONSERVATION ACTIONS

- Complete and implement the draft Kern River Rainbow Trout Conservation Strategy as soon as possible.
- Use a conservation hatchery to increase numbers of Kern River Rainbow trout and genetic diversity among populations in the wild.
- Review, revise, and implement grazing management to restore ecological function of watersheds.
- Regularly sample populations to determine distribution, abundance, and genetic structure, and to identify any changes in the species’ status.
- Assess, prioritize, and restore riparian and headwater meadows to boost water storage capacity, restore critical habitats, and bolster resiliency to climate change.

METRIC	SCORE	JUSTIFICATION
Area occupied	1	Found in 4-6 small tributaries and short reaches of the Kern River.
Estimated adult abundance	2	High uncertainty about size of populations.
Intervention dependence	1	Barriers must be maintained, planting of hatchery fish managed (preferably eliminated), grazing managed, and other actions.
Environmental tolerance	3	Presumably fairly tolerant as most Rainbow trout are but not tested.
Genetic risk	1	Hybridization with introduced Rainbow trout and California golden trout a constant high risk to its distinctiveness.
Climate change	1	Rated critically vulnerable in Moyle et al. (2013).
Anthropogenic threats	1	1 Critical, 1 High, and 4 Medium Threats. Continued stocking of hatchery Rainbow trout in Kern River is an ongoing threat.
Average	1.4	LEVEL OF CONCERN: CRITICAL
Certainty (1-4)	3	Least-studied of three native trout in the Kern River Basin.

CHARACTERISTICS

Kern River Rainbow trout look similar to Coastal Rainbow trout, but have a slight gold hint. They have many fine, irregular spots all over their bodies, and larger fish may have a rosy streak along their sides.

ABUNDANCE

There are little to no abundance data on unhybridized Kern River Rainbow trout populations. Kern River Rainbow trout were once abundant and widespread in the upper Kern River Basin and were subject to intensive angling pressure. Since the nineteenth century, overexploitation, habitat degradation and, most importantly, hybridization with other trout has reduced populations to a small fraction of historical numbers. Based on CDFW surveys in 2009 and expert judgment, they currently persist in about 20 km (12 mi.) of small streams. Using the best estimates of approximately 200-1,500 trout per km (1.2 mi.), total numbers of Kern River Rainbow trout are likely between 4,000 and 30,000 fish, though are likely at the lower end of this range due to habitat degradation and hybridization. The majority of remaining unhybridized Kern River Rainbows are upstream of natural and/or man-made barriers and isolated from other populations, and their status could deteriorate rapidly due to a lack of population connectivity.

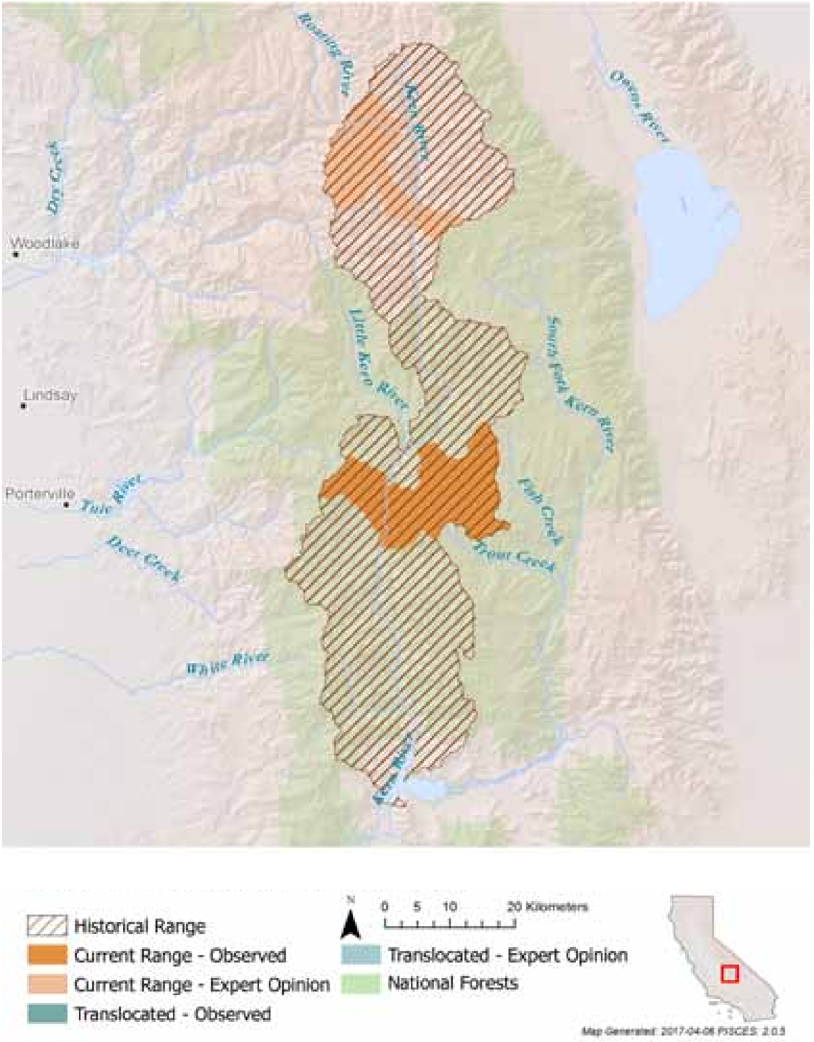
Evolution Valley. Photo: Matt Hernandez.

HABITAT AND BEHAVIOR

Almost no life history studies have been conducted on Kern River Rainbow trout. Presumably, they share similar habitat with Coastal Rainbow trout in high elevation streams. They historically grew to large sizes, as much as 71 cm (28 in.) and 3.6 kg (8 lbs.), although fish over 25 cm (10 in.) are rare today. More research is needed on the behaviors and habitat requirements of this rare species.

GENETICS

Kern River Rainbow trout are a distinct subspecies of Rainbow trout that likely resulted from natural hybridization of Coastal Rainbow trout with Little Kern Golden trout several thousand years ago. They are most genetically similar to California Golden trout and Little Kern Golden trout than they are to present-day Coastal Rainbow trout.



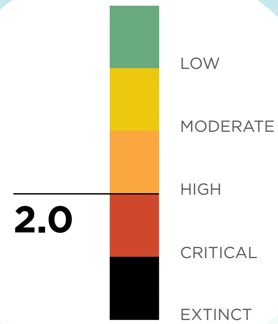
KERN RIVER RAINBOW TROUT DISTRIBUTION

Historically, Kern River Rainbow trout could be found throughout the Kern River and its tributaries in Tulare County. Today, most populations can only be found far upstream of Lake Isabella within the Sequoia National Forest or Sequoia National Park lands.

LAHONTAN CUTTHROAT TROUT

Oncorhynchus clarkii henshawi

LEVEL OF CONCERN: HIGH



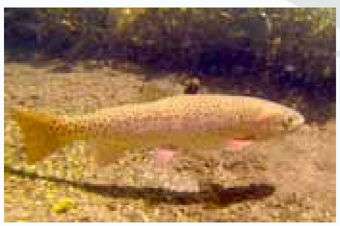


Photo: Mike Wier.

Despite significant efforts in recent years, wild, self-sustaining Lahontan Cutthroat trout in California face a large and increasing risk of extinction over the next 50 years due primarily to the presence of non-native trout and degraded habitats throughout their range.

CLIMATE CHANGE IMPACT

Lahontan Cutthroat trout are critically vulnerable to climate change because they are already constrained to marginal habitat. They face barriers such as waterfalls upstream, while downstream habitats are occupied by alien species and hybrid trout and are too warm to tolerate. Climate change is expected to reduce habitat availability by reducing Sierra Nevada snowmelt during summer months.

TOP 3 ANTHROPOGENIC THREATS

ALIEN SPECIES

Non-native trout introductions (from decades of legal and illegal stocking) pose the single greatest threat to the continued persistence of Lahontan Cutthroat trout in California through competition for limited resources and predation.

HATCHERIES

Competition and hybridization with hatchery-origin Rainbow trout from decades of stocking is a major threat to the genetic integrity and long-term survival of Lahontan Cutthroat trout.

FIRE

More frequent and intense wildfires throughout the Lahontan Cutthroat trout range are expected due to decades of fire suppression policies and climate change, and have the potential to extirpate small, isolated populations.

SUMMARY

Local extirpations in marginal habitat have decreased the abundance and distribution of Lahontan Cutthroat trout (LCT). Increased restoration actions in the Truckee and Walker rivers and Independence Lake, fish rescues, and reintroduction programs inside and outside of their historical range will help expand the species into restored habitats.

CONSERVATION ACTIONS

- Ramp up alien species removal, such as Brook, Brown, and Rainbow trout, with appropriate education and outreach efforts.
- Maintain Lahontan Cutthroat in current habitats and reintroduce them to historical habitat where practicable.
- Assess and prioritize current and potential Lahontan Cutthroat trout habitats for restoration.
- Reduce stream diversions, reconnect fragmented floodplain and riparian habitats to stream reaches, and improve instream habitat.
- Explore use of a conservation hatchery and associated genetic management plan to maintain genetic diversity and serve as source populations for future reintroduction efforts.
- Assess, prioritize, and restore riparian and headwater meadows to boost water storage capacity, restore critical habitats, and bolster resiliency to climate change.

METRIC	SCORE	JUSTIFICATION
Area occupied	2	Multiple watersheds in California, but no connectivity among them.
Estimated adult abundance	2	Most wild populations have significantly less than 1,000 fish each, with the lacustrine habitats and Upper Truckee River as the exceptions.
Intervention dependence	1	Hatchery program using wild brood stock required for persistence.
Environmental tolerance	5	LCT are fairly long-lived and demonstrate broad physiological tolerance and are iteroparous.
Genetic risk	1	Hybridization risk and loss of genetic variation is well documented and the major threat to the species.
Climate change	1	LCT are extremely vulnerable to climate change in all watersheds inhabited.
Anthropogenic threats	2	1 Critical and 2 High Factors.
Average	2.0	LEVEL OF CONCERN: HIGH
Certainty (1-4)	4	Peer reviewed literature, agency reports, grey literature, and professional judgment.

CHARACTERISTICS

Lahontan Cutthroat trout are the largest subspecies of Cutthroat trout, capable of weighing over 9kg (20 lbs.). Their color varies based on their habitat: lake-dwelling fish are pale gold or silver with pink or purple hues along their flanks and gill plates and greenish-bronze to dark olive backs. Lahontan Cutthroat trout found in streams are usually much smaller than those found in lakes, and may exhibit purple or bluish hues along their flanks and parr marks. Yellow to red slash marks under their mouth gives them their 'cutthroat' name.

ABUNDANCE

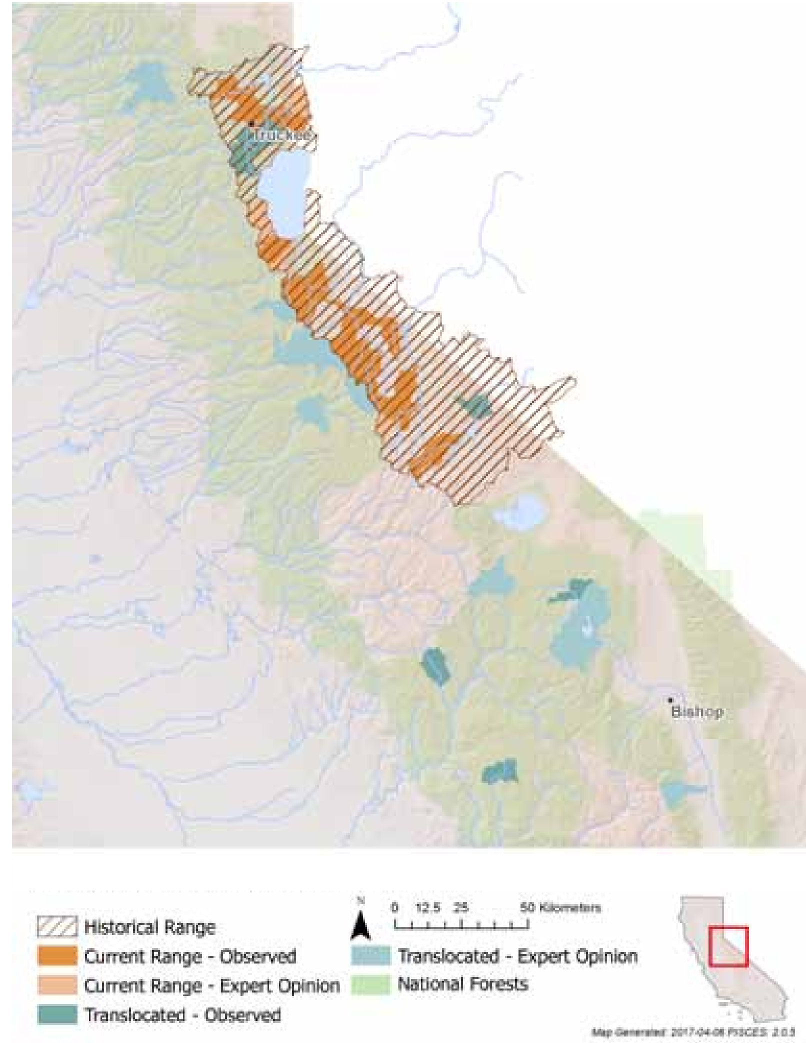
Lahontan Cutthroat trout persist in less than 5% of their original stream habitat and a mere 0.4% of their original lake habitat in California. Wild, self-sustaining populations in headwater streams in California likely total only a few hundred fish each, with the possible exception of the Upper Truckee River. Local extirpations of isolated populations likely occurred during California's historic drought from 2012 -2016, further reducing the species' remnant populations throughout their range. To help combat the continued declines, populations have been established in nine creeks outside of their native range in California through stocking from source populations and protected by man-made and natural barriers. With the help of many partners, alien species removal, especially of Rainbow and Brook trout in Slinkard and Silver creeks, has become an essential component of expanding the species' range.

HABITAT AND BEHAVIOR

Lahontan Cutthroat trout are very adaptable and capable of withstanding conditions that few other trout could survive. They are highly tolerant of alkaline waters, high stream temperatures, and low dissolved oxygen that has allowed them to flourish in harsh, arid environments. While these fish can grow large in lakes, they must spawn in streams. Ensuring healthy stream habitats are available to lake-dwelling Lahontan Cutthroats is critically important to allow them to complete their life cycle. Spawning typically occurs from April through July, though fall spawning has been documented in some populations. They feed primarily on terrestrial and aquatic invertebrates, leeches, and small fish as they grow larger.

GENETICS

Lahontan Cutthroat trout are closely related to the Paiute Cutthroat trout found in the Carson River Basin. They readily interbreed with Redband, Cutthroat, and Rainbow trout, making them especially vulnerable to hybridization.



LAHONTAN CUTTHROAT TROUT DISTRIBUTION

Historically, Lahontan Cutthroat trout were found across the Lahontan Basin in Southern Oregon, Eastern California and Northern Nevada. The Western Lahontan segment of the species encompasses fish in their current range in California, including populations in the Carson, Truckee, and Walker drainages, Lake Tahoe tributaries, and some lakes. Once found in the Susan River drainage, Lahontan Cutthroat trout since have been transplanted to other basins in California to help boost their populations in different geographies.

LITTLE KERN GOLDEN TROUT

Oncorhynchus mykiss whitei

LEVEL OF CONCERN: HIGH

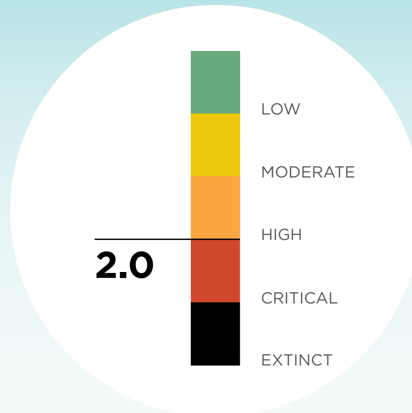


Photo: Mike Wier.

The Little Kern Golden trout is vulnerable to extinction in its native range in the next 100 years. The recovery of Little Kern Golden trout is ongoing, and the focus on reducing hybridized populations is shifting to improving genetic diversity, population connectivity and size, and expanding the species' distribution.

CLIMATE CHANGE IMPACT

Under climate change, low streamflows typical of fall months may become particularly stressful for Little Kern Golden trout because the Kern River Basin experiences reductions in groundwater and warmer stream temperatures during this time. The high elevation of the southern Sierra Nevada may at least partially offset predicted reductions in snowpack.

TOP 3 ANTHROPOGENIC THREATS

HATCHERIES

Little Kern Golden trout remain threatened by hybridization with hatchery Coastal Rainbow trout and California Golden trout, which were stocked throughout the Kern River in the past. Stocking of Rainbow trout and non-native species in the Kern River has since been halted.

ALIEN SPECIES

Hybridized populations and remnant Rainbow trout populations continue to threaten the genetic integrity of Little Kern Golden trout by fragmenting unhybridized populations. Their isolation from one another likely promotes inbreeding and further reduces their genetic diversity.

FIRE

With such small, isolated populations, fire can increase vulnerability of Little Kern Golden trout to other stressors, change watershed processes, cause siltation, and lead to a loss of habitat. Recent fires (e.g., Lion Fire) have directly impacted core conservation streams by burning riparian habitat and meadows that supply cold water through warm summer months.

SUMMARY

Recent genetic studies indicate that remaining populations of Little Kern Golden trout are small, isolated, and susceptible to inbreeding and loss of genetic diversity. Non-native Brown trout appear to have been removed from the majority of Little Kern Golden trout native habitat, and large cascades and a barrier in the lower portion of the river block their movement upstream. Hatchery-origin Rainbow trout are no longer stocked in the Little Kern River Basin, and hybridization threats have been reduced as a result.

CONSERVATION ACTIONS

- Identify all unhybridized and slightly hybridized populations.
- Prepare a conservation strategy and genetic management plan.
- Conduct habitat assessments to prioritize future restoration actions.
- Establish refuge populations through translocations.
- Continue to use and manage structural barriers to minimize hybridization but improve connectivity between unhybridized populations.
- Revise grazing management plans and use riparian fencing to protect Lion, Grey, and Loggy meadows to provide critical habitat and enhance species resiliency to climate change.

METRIC	SCORE	JUSTIFICATION
Area occupied	1	Unhybridized populations occur in just 5 or 6 stream segments. With the exception of Coyote Creek (adjacent drainage), there are no other populations outside the Little Kern drainage.
Estimated adult abundance	2	Probably less than 5,000 adults in 5 isolated populations.
Intervention dependence	3	Requires intervention to maintain unhybridized populations, prevent invasions of alien trout, and promote population connectivity.
Environmental tolerance	3	Presumably fairly tolerant, as are most Rainbow trout, but not tested.
Genetic risk	1	Significant as populations are fragmented. Ongoing threats from hybridization and loss of genetic diversity through inbreeding and genetic drift.
Climate change	1	Critically vulnerable to range reductions and habitat alteration from climate change.
Anthropogenic threats	2	1 High and 1 Medium threat.
Average	2.0	LEVEL OF CONCERN: HIGH
Certainty (1-4)	4	Recent publications and USFWS 5-year review.

CHARACTERISTICS

Little Kern Golden trout are similar in appearance to California Golden trout but their coloration is more subdued. Their backs are often olive to brass in color, with more and smaller spots along their flanks than California Golden trout.

ABUNDANCE

A few decades ago, the population of Little Kern Golden trout was estimated to be about 4,500 fish spread across a few of small watersheds. A small handful of sub-populations have been determined by recent genetic study to be relatively 'pure.' If it is assumed that adding these populations yields a habitat range spanning 50 km (31 mi.) of small streams, with about 300 one-year old fish per km (500 per mi.), then total numbers could reach as high as 15,000 fish. If only unhybridized fish are counted, then there are only perhaps 5,000-6,000 Little Kern Golden trout left within their native range.

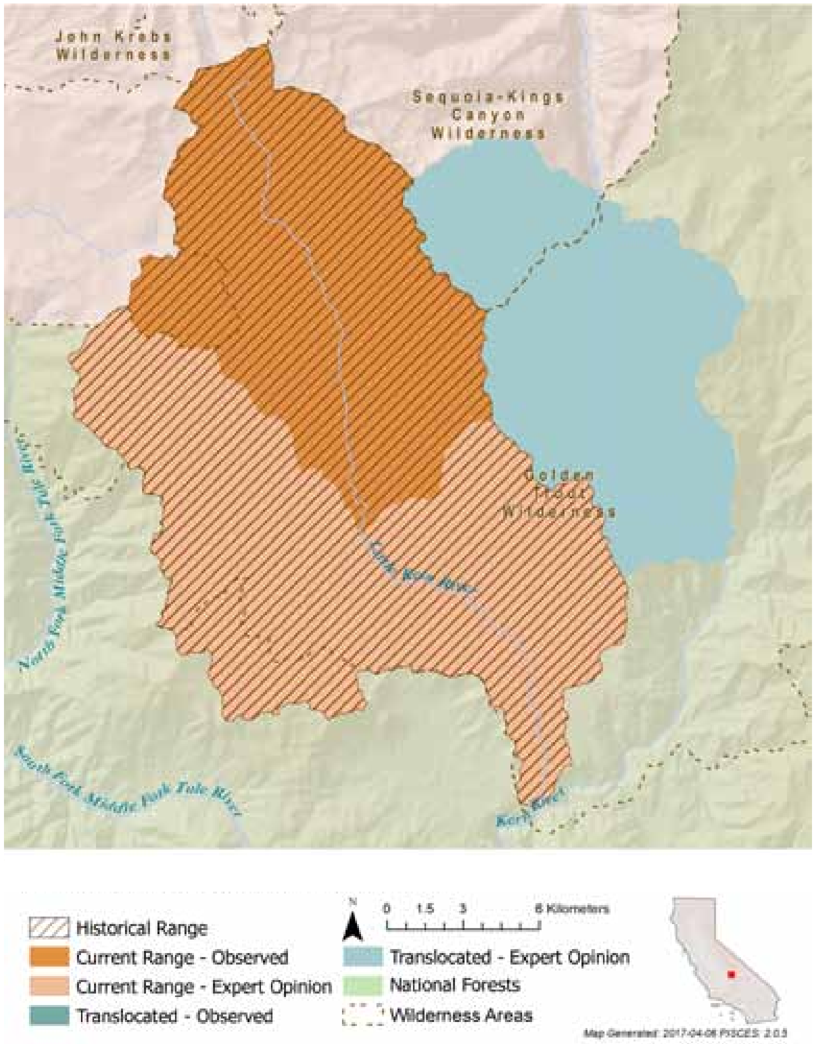
HABITAT AND BEHAVIOR

The life cycle and behavior of this species is not well studied, but is presumably similar to that of California Golden trout. They are adapted to living in small, meandering meadow streams and high gradient tributaries characteristic of the Little Kern River Basin. Little Kern Goldens generally produce fewer eggs than other trout species, and individual fish have smaller ranges than most other trout species.

Ideal habitat for the Little Kern Golden. Photo: Mike Wier.

GENETICS

Both Little Kern Golden trout and California Golden trout represent distinct evolutionary lineages of Coastal Rainbow trout. However, the two species of Golden trout are more similar to one another today than they are to Coastal Rainbows.



LITTLE KERN GOLDEN TROUT DISTRIBUTION

Little Kern Golden trout were historically isolated to roughly 160 km (about 100 mi.) of streams in the Little Kern River and its tributaries by natural barriers such as waterfalls and cascades. Hybridization with non-native trout reduced their habitat range to less than 16 km (10 mi.) of streams in the 1970s. By the year 2000, after decades of restoration, barrier management, and reintroduction through stocking, their habitat was restored to over 51 km (32 mi.) of streams and three lakes. Relatively "pure" Little Kern Golden trout can be found today in upper North Fork Clicks Creek, Upper Clicks Creek, Trout Meadow Creek, Little Kern River above Broder's Cabin, and the Little Kern River above Wet Meadows Creek in Sequoia National Forest (Tulare County).

McCLOUD RIVER REDBAND TROUT

Oncorhynchus mykiss stonei

LEVEL OF CONCERN: CRITICAL

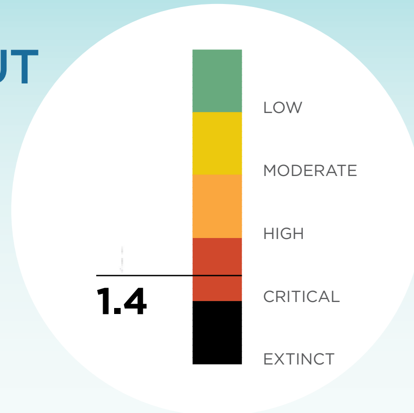


Photo: Craig Ballenger

McCloud River Redband trout populations are very small, fragmented, and exist in limited and isolated habitat. Their status could change rapidly, particularly in relation to predicted climate change impacts such as reduced snowpack and precipitation increasingly falling as rain instead of snow.

CLIMATE CHANGE IMPACT

McCloud River Redband trout are critically vulnerable to climate change because of the small size of their populations, the small streams they inhabit, and their isolation from one another. Remaining McCloud Redband streams are already subject to seasonal reductions in flow, but future reductions in snowpack as expected with climate change may dramatically reduce available habitat, as was seen during the 2012-2016 drought.

TOP 3 ANTHROPOGENIC THREATS

HATCHERIES

Decades of stocking non-native Rainbow trout in the McCloud River Basin in the past created hybrid Redband-Rainbow populations in many streams. These fish pose an ongoing, major threat to McCloud Redbands through competition and hybridization.

FIRE

Decades of fire suppression in the McCloud River Basin has built up potential fuels sources, which has increased the potential for large, high intensity fires that could potentially wipe out one or more McCloud River Redband populations.

GRAZING

Grazing has occurred for over 125 years in the McCloud River Basin, which has degraded riparian and stream habitat significantly through sedimentation and streamflow alteration. Today, much of Sheepheaven and lower Trout creeks have been fenced to exclude cattle, but this could change in the future.

SUMMARY

The recent drought has caused many McCloud River Redband trout streams to dry, causing CDFW to rescue hundreds of fish and bring them into the Mount Shasta Hatchery during 2013. These last resort rescue efforts greatly reduced mortality in the remaining population. These fish were reared, spawned, and then released back into their native habitat in September 2016 after average precipitation returned to the McCloud River Basin.

CONSERVATION ACTIONS

- Work with the McCloud Redband Core Group to implement the 2014 Inland Redband Conservation Agreement to manage land uses in the McCloud River Basin.
- Establish a McCloud River Redband trout refuge that contains all current Redband streams and suitable reaches of potential future habitat for translocations.
- Use a captive broodstock program to protect the genetic integrity of McCloud River Redbands and facilitate CDFW's 2013 Upper McCloud River Redband Trout Reintroduction Plan.

CHARACTERISTICS

McCloud River Redband trout are similar in appearance to other Redbands, with yellow to orange bodies, dark oval parr marks on their sides, and white-tipped fins. The characteristic brick-red stripe on their sides is a defining feature, similar to that of the California Golden trout. Many, but not all, McCloud River Redbands have teeth on their tongues and an orange slash along the throat, characteristics more typically associated with Cutthroat trout.

METRIC	SCORE	JUSTIFICATION
Area occupied	1	Four 'core' populations are clustered fairly close to each other and all are in Upper McCloud watershed, so are treated as one 'watershed.'
Estimated adult abundance	1	Population prior to the 2012-2016 drought was likely somewhat less than 3,000 fish over 8 cm (3 in.), with each stream having 100-1,000 fish. In drought years, total numbers of fish of this size likely totaled less than 1,250 fish.
Intervention dependence	2	Drought necessitated rescue of several populations and relocation to holding facilities until natural conditions improved. Ongoing implementation and recent revision and expansion of a formal Conservation Strategy is critical for survival.
Environmental tolerance	3	It is likely they are fairly tolerant of high temperatures, as are other Redband trout, but water quality in their small streams has to be monitored during drought years.
Genetic risk	1	Hybridization risk with rainbow trout is high; small isolated populations result in genetic bottlenecks and inbreeding depression.
Climate change	1	Vulnerability is high in all streams because of small size and cumulative effects of a changing climate and drought.
Anthropogenic threats	2	1 High and 4 Medium threats.
Average	1.4	LEVEL OF CONCERN: CRITICAL
Certainty (1-4)	4	Most published information is on Sheepheaven Creek population, though recently more studies have come from Edson, Moosehead, and Swamp creeks habitats.

ABUNDANCE

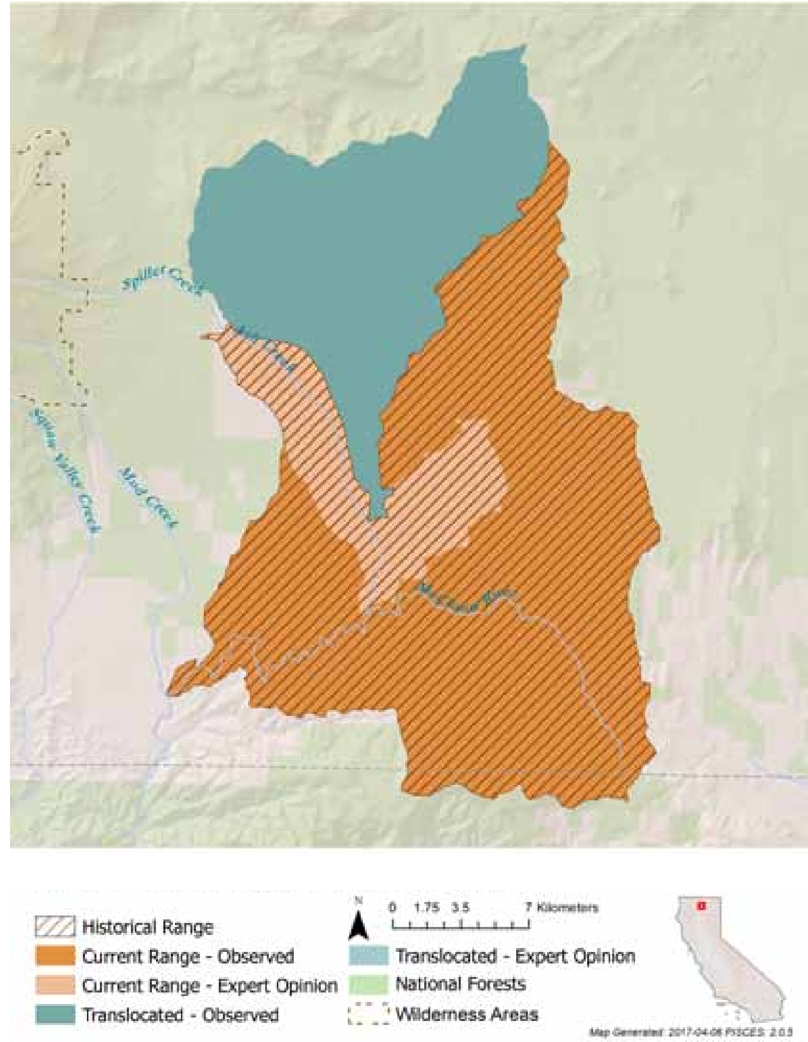
Estimated numbers of McCloud River Redband trout in the past were highly variable and ranged from 53 to 1,100 per km (about 85 to 1,770 trout per mi.) throughout their range. According to a 2011 CDFW survey, the total population of McCloud River Redband trout was about 3,560 fish. During recent drought years, 1,597 trout were rescued from Sheepheaven, Swamp, Edson, and Moosehead creeks, likely leaving less than 1,250 fish over 80 mm (3 in.) in the wild.

HABITAT AND BEHAVIOR

Sheepheaven Creek is a small, spring-fed stream at an elevation of 1,433 m (nearly 4,600 ft.). Very cold, clear water trickles from volcanic soils between 10-13°C (50-55°F) year-round and runs a short distance before returning underground. Other McCloud River Redband trout streams are generally small, with riffles and small pools providing cover, especially if they contain fallen trees. McCloud River Redbands are small trout; the largest adults often measure less than 21 cm (about 8 in.). They can become territorial and even cannibalistic under some circumstances. Like most other Redband trout, they spawn in late spring from May to June.

GENETICS

Hybridization between Coastal Rainbow trout and Redband trout is a natural event. However, due to planting of Rainbow trout upstream of natural barriers such as waterfalls, hybridization has become a primary threat to McCloud River Redbands. While there are currently four, and possibly as many as six, isolated populations of McCloud River Redband trout, recent genetic analyses show that fish in Sheepheaven Creek are distinct from the others. A formal McCloud River Redbands Hatchery and Genetic Management Plan is forthcoming from CDFW.



MCCLOUD RIVER REDBAND TROUT DISTRIBUTION

McCloud River Redband trout once ranged throughout the mainstem McCloud River above Middle Falls and its tributaries, and perhaps the lower river and its tributaries as well. Potential habitat, including the upper McCloud River, encompasses about 98 km (about 61 mi.). Today, they persist only in four small (< 2 km, or 1.2 mi.) isolated streams upstream of the McCloud River's Middle Falls that disappear underground into highly porous volcanic rock before connecting with the mainstem McCloud River downstream.

PAIUTE CUTTHROAT TROUT

Oncorhynchus clarkii seleniris

LEVEL OF CONCERN: HIGH

Photo: Bill Somer.

Paiute Cutthroat trout have a high likelihood of extirpation in their native range within 50-100 years without continued commitment to intense monitoring and management. All populations are small and isolated, and are susceptible to hybridization and local environmental changes.

CLIMATE CHANGE IMPACT

Climate change in the arid Eastern Sierra is likely to increase water temperature, decrease streamflow, reduce snowpack, and cause more frequent cycles of drought and catastrophic fire. Paiute Cutthroats are vulnerable to any changes in precipitation patterns because the streams they inhabit are very small and some may become dry during droughts.

TOP 3 ANTHROPOGENIC THREATS

ALIEN SPECIES

Competition and hybridization with alien trout, especially California Golden, Lahontan Cutthroat and Coastal Rainbow trout, with which they readily interbreed, are major threats to Paiute Cutthroat trout. Hybridization leads to a loss of genetic diversity and can occur rapidly in small populations due to genetic bottlenecks.

FIRE

A single large fire could potentially wipe out most remaining Paiute Cutthroat trout due to their small population in fragmented, isolated habitat in a single watershed. Fires can destroy riparian habitat, increase sedimentation, and smother habitat with silt and ash.

GRAZING

Historically, the Silver King Basin was subject to heavy grazing from livestock that caused degradation of riparian habitats. Grazing allotments in the basin were permanently closed in 1994, but riparian habitat is still in recovery; it has shown marked progress with narrowing and deepening channels in meadow sections of Silver King Creek.

SUMMARY

A multi-year hybrid trout removal effort on Silver King Creek and its tributaries concluded in 2015, restoring unimpeded access to over 17 km (approximately 11 mi.) of stream habitat for Paiute Cutthroat trout (PCT). Monitoring surveys in 2015 and 2016 found some individuals from refuge populations in tributaries have already re-colonized downstream areas of Silver King Creek. Drought desiccated some stream segments, while some tributary streams were subject to total freezing that reduced population numbers.

CONSERVATION ACTIONS

- Conduct follow-up monitoring of reintroduction efforts for at least three years to determine progress of hybrid removal, restoration activities, and re-colonization of historical habitat by Paiute Cutthroats.
- Prepare and implement a long term conservation strategy with CDFW, U.S. Forest Service, U.S. Fish & Wildlife Service, academics, and other stakeholders to adaptively manage future recovery efforts.
- Continue to monitor existing populations to determine progress of restoration activities and re-colonization of historical habitat.

METRIC	SCORE	JUSTIFICATION
Area occupied	2	Occupies several watersheds, but connectivity between headwater populations has recently been established on Silver King Creek.
Estimated adult abundance	2	The largest effective population may be less than 1,000 individuals, but most are much smaller.
Intervention dependence	2	Human assistance required to maintain and increase genetic diversity through reintroduction efforts and protection of limited habitats.
Environmental tolerance	2	Actual physiological tolerances not known, but adapted for small cold-water headwater streams, which suggests limited tolerance.
Genetic risk	1	Genetic diversity is very low.
Climate change	3	Vulnerable because streams are very small and some may become dry during droughts.
Anthropogenic threats	3	2 High, 1 Medium threat.
Average	2.1	LEVEL OF CONCERN: HIGH
Certainty (1-4)	4	PCT well documented in peer-reviewed literature, in government agency reports, and USFWS reviews.

CHARACTERISTICS

Paiute Cutthroat trout have very few spots above the lateral line, and iridescent copper, green, or pink body coloration. All Paiute Cutthroat have a red-orange slash under the jaw for which they are named, and retain parr marks into adulthood. They rarely reach more than about 25 cm (10 in.) in length owing to the high elevation, low productivity streams they inhabit. The largest PCT was captured in a lake outside its native range, and measured 46 cm (18 in.) long and weighed 1.1 kg (about 2.4 lbs.). The native habitat of this species is the smallest of any known salmonid in North America, making them the rarest trout species on Earth. They nearly went extinct due to hybridization with non-native trout, but Joe Jaunsaras, a Basque herdsman, began transferring fish in 1912 above a natural barrier at Llewellyn Falls, saving the species.

ABUNDANCE

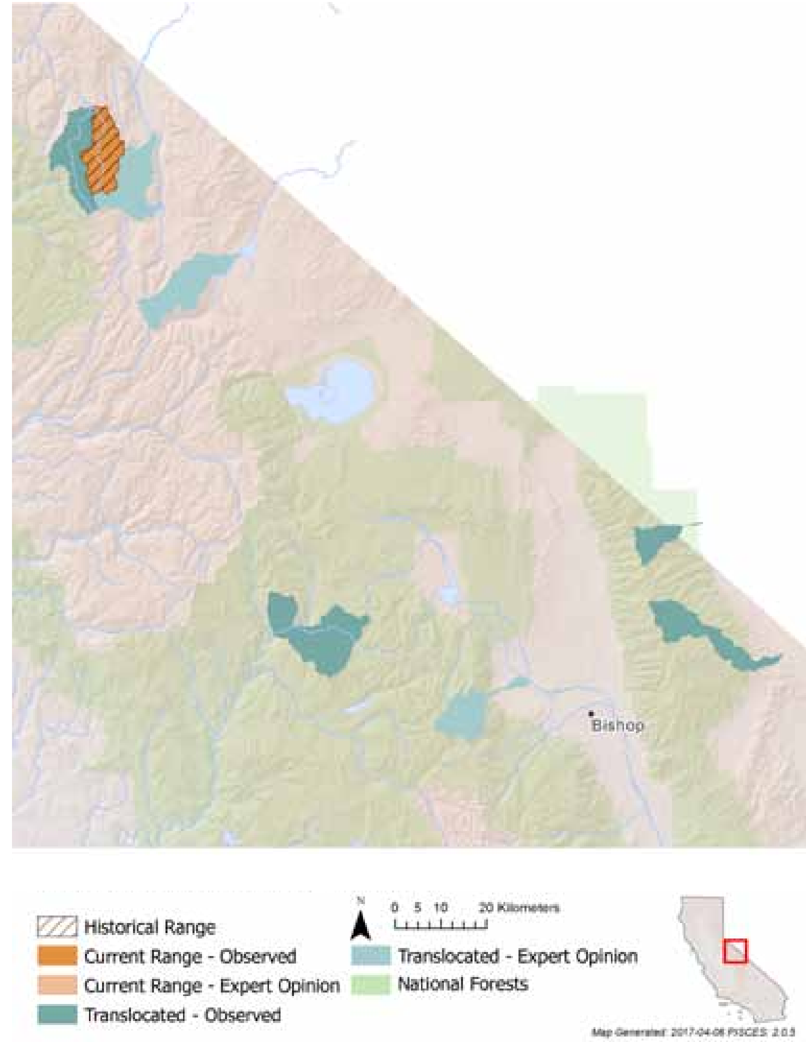
Paiute Cutthroat trout populations likely declined in the last three years due to reduced streamflows in summer and anchor ice in winter resulting from drought. Remaining populations are small, isolated by barriers and cannot interbreed. Nine streams currently support small (400 to 700 fish each) but stable populations of pure Paiute Cutthroat trout.

HABITAT AND BEHAVIOR

Paiute Cutthroat trout life expectancy is about 3-4 years in the wild, although some individuals may live up to 6 years. They mature at 2 years of age, and only have the potential to successfully spawn two or three times over their lifespan. Spawning takes place in July, and eggs hatch in August and September. They rarely migrate very far from where they were reared or introduced. Adult Paiute Cutthroats are territorial, defending their established territories in desirable pool habitat from others. Deeper pool habitat and overhanging vegetation provide important refuge and overwintering areas for this species.

GENETICS

The Paiute Cutthroat trout is very closely related to the Lahontan Cutthroat trout, and is the least genetically diverse trout species of trout in California. Today, populations of Paiute Cutthroats share the most genetic material with Lahontan Cutthroat trout from Independence Lake (Nevada Co.), as opposed to Lahontan Cutthroat populations found just downstream in the Carson River.



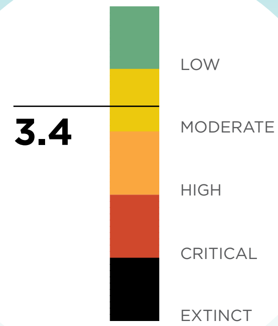
PAIUTE CUTTHROAT TROUT DISTRIBUTION

Paiute Cutthroat trout are native only to Silver King Creek, a tributary of the East Fork Carson River located at an elevation of about 2,400 m (about 7,900 ft.) in the Carson-Iceberg Wilderness in Humboldt-Toiyabe National Forest (Alpine Co.). Five pure populations of PCT exist in Coyote Valley, Corral Valley, Four Mile Canyon, and Upper Silver King creeks upstream of a historical barrier at Llewellyn Falls. Many introductions of Paiute Cutthroat have been attempted outside the species' native range over the last six decades, though only Cottonwood and Cabin creeks (Mono Co.), Stairway Creek (Madera Co.), and Sharktooth Creek (Fresno Co.) have self-sustaining populations. There are no known populations of lake-dwelling Paiute Cutthroat trout in California.

MOUNTAIN WHITEFISH

Prosopium williamsoni

LEVEL OF CONCERN: MODERATE



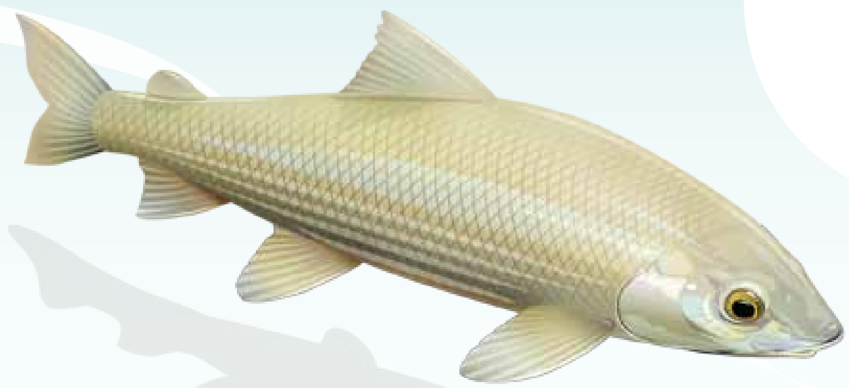


Photo: CDFW.

Mountain whitefish persist in some fragmented water bodies in California, but their overall abundance and distribution are reduced from historical levels and may be continuing to decline. Population estimates and comprehensive distribution surveys are lacking; while their overall status remains uncertain, it appears to have declined.

CLIMATE CHANGE IMPACT

They are highly susceptible to climate change impacts because they are constrained to low-gradient sections of rivers, do not effectively colonize high-gradient headwater streams that could provide refuge from increasing stream temperatures, and are often out-competed by nonnative fishes better adapted to warmer temperatures.

TOP 3 ANTHROPOGENIC THREATS

MAJOR DAMS

Mountain whitefish cannot survive in impounded lakes, and only remain in natural Tahoe Basin lakes. Dams support myriad diversions for agricultural and other purposes throughout their range, and reduce water quantity and quality for Mountain whitefish, which generally require colder and cleaner water than other salmonids in California.

RESIDENTIAL DEVELOPMENT

Development in the popular Tahoe Basin has increased significantly in the past several decades, leading to greater water withdrawals and degradation of water quality for Mountain whitefish through pollution.

ALIEN SPECIES

Non-native species, such as Brown and Brook trout, throughout the range of Mountain whitefish increase predation and competition for limited resources and may limit their populations.

SUMMARY

Based on current limited research, Mountain whitefish populations appear to have become constrained by poor water quantity and quality throughout their range. Ongoing water diversion and drought have combined to reduce suitable available habitat for the species.

CONSERVATION ACTIONS

- Conduct a population study to determine distribution and abundance of Mountain whitefish.
- Include Mountain whitefish in CDFW management and restoration currently focused on other salmonids that overlap their range, such as Lahontan Cutthroat trout.
- Consider reducing current daily bag limits of 5 Mountain whitefish per angler/day until reliable abundance data are available.
- Expand ongoing negotiations in the Tahoe, Carson, Walker, and Truckee basins that keep water in streams and enhance habitat for all native fishes.

CHARACTERISTICS

Mountain whitefish are not trout, but rather a unique-looking relative of trout and grayling with an olive/dusky green back and large silver scales. They are one of the most widely distributed salmonids, but are not well studied in California. They have a downturned mouth that allows them to feed on the streambed, and a prominent adipose fin. In streams, they tend to be relatively small, usually less than 25cm (10 in.), but may reach up to about 35cm (14 in.) and 2kg (4.4 lbs.) in lakes.

METRIC	SCORE	JUSTIFICATION
Area occupied	4	Present in three watersheds and several lakes.
Estimated adult abundance	4	Numbers appear to be declining in many streams so this number may be high.
Intervention dependence	4	Populations persist but intervention will be needed if their decline continues.
Environmental tolerance	3	Whitefish appear to be more physiologically tolerant than many salmonids, live at least 5 years and may spawn several times; however, they require high water quality and low temperatures.
Genetic risk	4	Genetics have not been studied but most populations are isolated from one another.
Climate change	2	Whitefish are likely to be negatively affected by decreased flows, warmer temperatures and increased diversions but persist in lakes.
Anthropogenic threats	3	4 Medium threats.
Average	3.4	LEVEL OF CONCERN: MODERATE
Certainty (1-4)	2	Grey literature, survey data, and professional judgment.

ABUNDANCE

Basic distribution and population data for Mountain whitefish are generally lacking, so their overall status in California remains uncertain. While still present in much of their limited range, their populations are disconnected and seemingly shrinking. The absence and low densities of Mountain whitefish observed over the last several years in surveys around Lake Tahoe may indicate that the status of this species has declined since 2008.

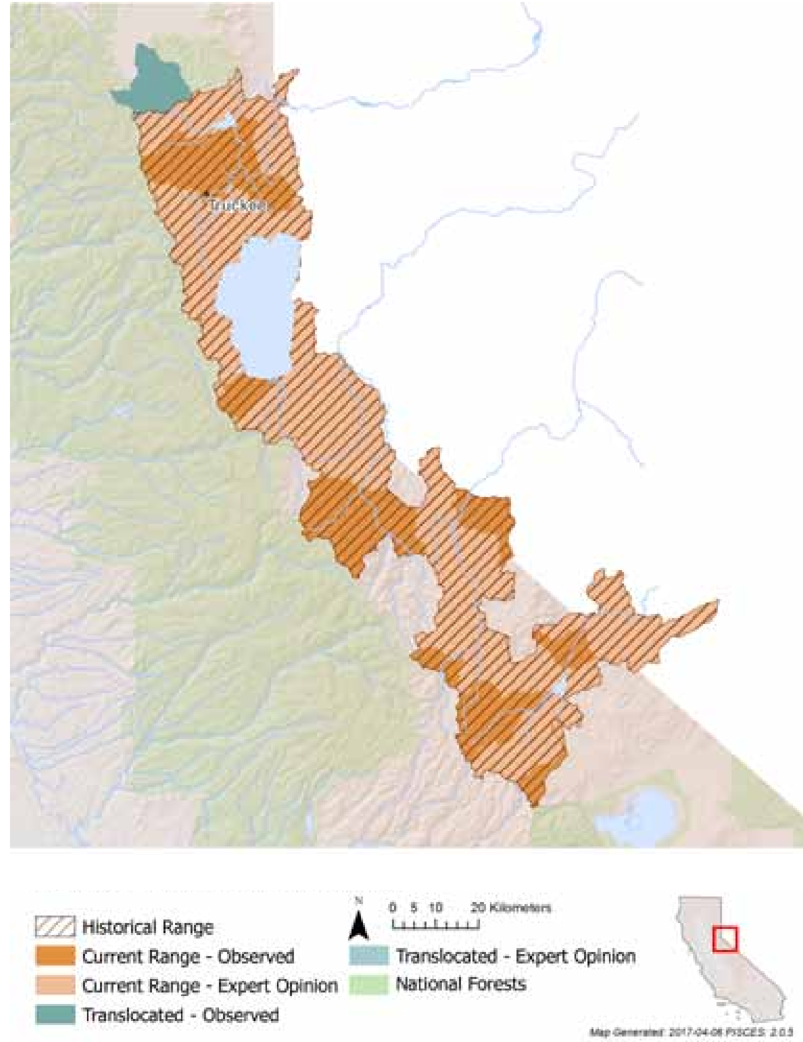
HABITAT AND BEHAVIOR

Mountain whitefish are capable of living to more than 10 years of age, depending on habitat and food availability. They frequently shoal in groups of 5 to 20 fish close to the bottom of streams and lakes. They tend to feed on benthic aquatic insects in deep, slow pools, especially at dawn or dusk, but will rise through the water column to opportunistically prey on drifting invertebrates. Their general feeding and holding patterns only slightly overlap with those of closely related trout. From October through December, Mountain whitefish return to natal streams to scatter their small, adhesive eggs over gravel. They are generally less tolerant of warm water temperatures than other trout species with which they co-occur.

Ideal habitat for Mountain whitefish. Photo: Mike Wier.

GENETICS

The Lahontan Basin population (Nevada and California portions of the range) of Mountain whitefish in North America are distinct, due to geographic isolation from other populations, and may eventually deserve their own taxonomic designation.



MOUNTAIN WHITEFISH DISTRIBUTION

Mountain whitefish historically occupied similar habitats to Lahontan Cutthroat trout on both the California and Nevada sides of the Sierra Nevada. Their current range in California includes the Lower, Little, and Upper Truckee, East Fork Carson, and East and West Walker river drainages on the east side of the Sierra Nevada, and perhaps the West Fork Carson River as well. They can also be found in natural lakes, including Tahoe, Independence, Cascade, and Fallen Leaf lakes.

METHODOLOGY

SPECIES STATUS ASSESSMENT

For this report, the following methods were used to assess the status of all 32 kinds of salmon, steelhead, and trout in California.

SELECTION OF SPECIES

The research team used species, subspecies, Evolutionary Significant Units (ESUs), or Distinct Population Segments (DPSs) - taxonomic categories already recognized by state and federal natural resource agencies for management as "species."

The research team also recognized a few distinct life history variants of Chinook salmon and steelhead (e.g., summer steelhead) that are not yet recognized as distinct entities by all management agencies. They nonetheless possess, in our judgment, sufficient significant evolutionary, ecological, and genetic differences to merit being treated as distinct taxa. This report focuses solely on native California salmonids. It does not include introduced species: Brown trout, Brook trout, Lake trout, Kokanee salmon, or Colorado Cutthroat trout. Dr. Peter Moyle's laboratory group at UC Davis has been continuously evaluating California's fish fauna since the first edition of *Inland Fishes of California* (1976) and the first edition of *Fish Species of Special Concern in California* (1989). The language has evolved and expanded as research has become available, and this report represents the evolution of those assessments to provide snapshots in time of species status under current trends.

LITERATURE COMPILATION

The research team conducted a literature review to: (1) update information for each taxon; (2) analyze detailed summaries for taxa not adequately treated in previous reviews; and (3) find 'gray' literature such as agency administrative reports not used in previous accounts. The team also consulted with over sixty individuals and experts from fishery management agencies familiar with each taxon to obtain unpublished and anecdotal information and gain a better understanding of local conditions.

PRODUCTION OF SPECIES ACCOUNTS

The full, peer-reviewed species accounts, or "main accounts," are literature reviews with extensive documentation and have been published as *Salmon, Steelhead, and Trout in California: Status of Emblematic Fishes, Second Edition.*

From these accounts, the research team produced condensed accounts that are presented in this report. These condensed accounts necessarily leave out many important details found in the main accounts, and readers should consult the main accounts as the basis for the information where questions arise. Each main account was drafted using a standard format, with sections for species description, taxonomic relationships, life history, habitat, abundance, threats, climate change, status scoring analysis, and conservation recommendations.

All drafts were reviewed and revised by the research team until they were satisfied with the accuracy of the drafts and then underwent a final review by at least one, but in many cases more than one, external biologist familiar with the taxon and its status.

EVALUATION OF STATUS

The status of each species was evaluated using a set of seven criteria scored using the rubric found in Table 2. Those scores were then averaged to produce an overall score for each species - the Level of Concern (Table 3). A reliability index was provided for each account based on the certainty of available information (Table 4).

OVERALL ANALYSIS

The team summarized the status rankings for all 32 taxa and for each of the seven criteria and compared the Level of Concern of all taxa to those found in the first edition of the State of the Salmonids report to determine trends in status. The comparisons were made using verbal assessments based on the accounts and status scores, rather than comparing the status scores from the two accounts directly. Numerical status scores were not directly compared between years due to: (1) greatly improved metrics for species distribution and abundance; (2) an improved metric for climate change, based on a study by Moyle et al. (2013); and (3) addition of a new metric that quantified anthropogenic effects (Table 5). We decided the two scoring systems were different enough that the scores should not be directly compared, so we instead used the assessment categories from the 2008 report: extinct, critical concern, high concern, moderate concern, and low concern.

TABLE 2: STATUS SCORING RUBRIC SUMMARY TABLE

SCORE	1	2	3	4	5
AREA OCCUPIED: **INLAND**	1 watershed/ stream system in California only	2-3 watersheds/ stream systems without fluvial connections to each other	3-5 watersheds/ stream systems with or without fluvial connections	6-10 watersheds/ stream systems	More than 10 watersheds/ stream systems
ANADROMOUS:	0-1 self-sustaining populations	2-4 self-sustaining populations	5-7 self-sustaining populations	8-10 self-sustaining populations	More than 10 self-sustaining populations
ESTIMATED ADULT ABUNDANCE	Less than or equal to 500	501 – 5,000	5,001 – 50,000	50,001 – 500,000	500,000 +
INTERVENTION DEPENDENCE	Captive broodstock program or similar extreme measures required to prevent extinction	Continuous active management of habitats (e.g. adding water to streams) required	Frequent (usually annual) management actions (e.g. removal of alien species)	Long-term habitat protection or improvements (e.g. restoration) but no immediate threats	Self-sustaining populations require minimal intervention
ENVIRONMENTAL TOLERANCE	Extremely narrow physiological tolerance in all habitats	Narrow physiological tolerance in all existing habitats or broad limits but species may exist at edge of tolerances	Moderate physiological tolerance in all existing habitats	Broad physiological tolerance under most conditions likely to be encountered	Physiological tolerance rarely an issue for persistence
GENETIC RISK	Fragmentation, genetic drift, and isolation by distance, due to migration, and/or frequent hybridization with related fish	Limited gene flow among populations, although hybridization can be a threat	Moderately diverse genetically, some gene flow among populations; hybridization risks low	Genetically diverse but limited gene flow to other populations due to reductions in habitat connectivity	Genetically diverse with gene flow to other populations
CLIMATE CHANGE	Vulnerable to extinction in all watersheds inhabited	Vulnerable in most watersheds inhabited	Vulnerable in portions of watersheds inhabited	Low vulnerability due to location, cold water sources and/or active management	Not vulnerable, most habitats will remain within thermal tolerance ranges
ANTHROPOGENIC THREATS	1 or more threats rated critical or 3 or more threats rated high	1 or 2 threats rated high - species could be pushed to extinction in the foreseeable future	No high threats but 5 or more threats rated medium; no single threat likely to cause extinction but in aggregate could push species to extinction in the foreseeable future	2-4 threats rated medium - no immediate extinction risk but in aggregate threats reduce population viability	1 threat rated medium, all others low; known threats do not imperil the species

TABLE 3. LEVELS OF CONCERN OF CALIFORNIA'S SALMONIDS

Status categories, score ranges, and definitions.

STATUS/LEVEL OF CONCERN	STATUS SCORE	DEFINITION
EXTINCT	0.0	Extirpated from inland waters of California.
CRITICAL	1.0-1.9	High risk of extinction in the wild; abundance critically low or declining; current threats projected to push species to extinction in the wild in 10-15 generations.
HIGH	2.0-2.9	High risk of becoming a critical concern species; range and abundance significantly reduced; trajectory to extinction in 15-20 generations if no actions taken.
MODERATE	3.0-3.9	Declining, fragmented and/or small populations possibly subject to rapid status change; management actions needed to prevent increased conservation concern.
LOW	4.0-5.0	Populations are not in significant decline; abundant and widespread.

TABLE 4. CERTAINTY OF INFORMATION FOR STATUS EVALUATION

	CERTAINTY SCORE
1	Status is based on professional judgment, with little or no published information.
2	Status is based on professional judgment augmented by moderate amounts of published or gray literature or management agency administrative reports.
3	Status is based on reports found mainly in the in gray literature with some information in peer-reviewed sources but where gaps existed in some important areas (e.g. genetics).
4	Status is based on highly reliable information, with numerous accounts in the peer reviewed and management agency literature.

TABLE 5. ANTHROPOGENIC THREATS SCORING

Criteria for ratings assigned to anthropogenic threat factors with correlated timelines.

THREAT RATING	CRITERIA	TIMELINE
CRITICAL	Could push species to extinction.	3 species generations or 10 years, whichever is less.
HIGH	Could push species to extinction.	10 species generations or 11-50 years, whichever is less.
MEDIUM	Unlikely to drive a species to extinction by itself but contributes to increased extinction risk.	Next 100 years.
LOW	May reduce populations but extinction unlikely as a result.	Next 100 years.

GLOSSARY

ADFLUVIAL life history in which juvenile fish are born in streams, migrate to lakes to feed and grow, and then migrate back to natal streams as adults to spawn

ADIPOSE FIN a small, fleshy fin on the back of salmonids near the tail that is sometimes clipped off salmon and steelhead to allow easy differentiation from wild fish for management purposes

ALEVIN A newly hatched salmonid that is still carrying the yolk sac Amphipods a group of crustaceans without a carapace, or exoskeleton Anadromous fish that are hatched in fresh water, migrate to and mature in salt water, and return to fresh water to spawn

ANTHROPOGENIC human-induced or exacerbated, as in climate change Barrier a manmade structure such as a dam or culvert which prevents fish passage in a stream

BENTHIC occurring at the bottom of a body of water, such as a river or lake

BROODSTOCK a group of sexually mature individuals of a cultured species that is kept separate for breeding purposes, such as to support hatchery operations

CALIFORNIA CURRENT a Pacific Ocean current that moves south along the western coast of North America, beginning off southern British Columbia, and ending off southern Baja California

CENTRAL VALLEY a large, flat valley that dominates the central portion of California; the northern half is referred to the Sacramento Valley and its southern half as the San Joaquin Valley

CLIMATE CHANGE refers to the human-induced increase in the average temperature of the Earth's near-surface air and oceans and changes in its precipitation and wind patterns

COBBLE naturally rounded rock fragments between 2 1/2 inches and 10 inches in diameter

CODED WIRE TAG a small magnetized wire injected into the snout of juvenile fish to track their migrations to support research and management

CONJUNCTIVE USE the practice of storing water on the surface of the Earth in groundwater basins in wet years, and then withdrawing it for use during dry years

COPEPOD a group of small crustaceans that inhabit most fresh water habitats and oceans

CRITICAL HABITAT a specific geographic area, whether occupied by a special-status species or not, that is determined to be essential for the conservation and management of special status species

CRUSTACEANS animals, including crabs, shrimp and crayfish that have a hard shell instead of a skeleton and that usually live in water

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE (CDFW) the California state agency tasked with managing California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public

DISSOLVED OXYGEN oxygen freely available in water and necessary for the lives of fish and other aquatic organisms

DISTINCT POPULATION SEGMENT (DPS) a term with specific meaning under the Endangered Species Act when used for listing, delisting, and reclassification purposes to describe a population that may be added or deleted from the list of threatened and endangered species; applied here to steelhead

DRAINAGE a group of interconnected streams whose main channel enters an ocean, estuary, or the main-stem of a basin

ECOSYSTEM a recognizable unit on the landscape that includes organisms, their environment, and all the interactions among them

EFFECTIVE POPULATION SIZE the average number of individuals in a population that contribute genes to the succeeding generations

ENDANGERED SPECIES under the Endangered Species Act, any species that is likely to become extinct within the foreseeable future throughout all or a significant portion of its range

ENDANGERED SPECIES ACT (ESA) the federal Endangered Species Act that was enacted by Congress in 1973 in response to an alarming decline of many animal and plant species. The ultimate goal of the Act is to return threatened and endangered species to the point where they no longer need the law's protections

ENDEMIC SPECIES a species native and confined to a certain region; usually with a comparatively restricted distribution

ESTUARY/ESTUARINE the area or habitat where fresh and salt water mix at the mouth of a river, used as rearing and feeding habitat by many fish species and other animals

ENTRAINMENT the incidental trapping of fish and other aquatic organisms in water diverted from streams, rivers and reservoirs; the process of drawing fish into diversions, along with water, resulting in the loss of such fish

ESCAPEMENT those fish that survive natural mortality and harvest, and make up a spawning population

EVOLUTIONARY SIGNIFICANT UNIT (ESU) a term used by the National Marine Fisheries Service to denote a population or group of populations of salmon that is substantially reproductively isolated from other populations and contributes to the evolution of the species

EXTANT still in existence or surviving

EXTIRPATED a species that has been eliminated from a particular area, but still exists elsewhere; locally extinct

EXTINCT a species that no longer exists in any habitat on Earth

EXPERT JUDGMENT based on the professional opinions of experts; used here as biologists best guesses

FAUNA all of the animal life of any particular region or time

FISHERY specific species of fish, area of water or seabed, fishing method, class of boats, people involved in catching or processing fish, or a combination of these

FLOODPLAIN the low area along a stream or river channel into which water spreads during floods; can be valuable feeding habitat for salmonids and provide refuge from high flows

FLUVIAL a life history in which fish are born in rivers or streams and spend their entire lives there

FORBEARANCE refraining from exercising a legal water right; used to keep water in streams on a temporary basis without permanently giving up the right to that water

FRY a stage of development in young salmon or trout; during this stage the fish is usually less than one year old, has absorbed its yolk sac, is rearing in the stream, and is between the alevin and parr stage of development

GENETIC DIVERSITY the total number of genetic characteristics in the makeup of a species that allow populations to adapt to changing environmental conditions

GENETIC RISK the probability of an action or inaction having a negative impact on the genetic character of a population or species

GILL covers the outer covering of the gill chamber which opens and closes to allow water to pass over the gills for respiration

GRAY LITERATURE refers to material that is not formally published, such as institutional or technical reports, working papers, business documents, and conference materials

GRILSE a salmon that has spent only one winter at sea before returning to fresh water to spawn

HABITAT the physical, chemical, and biological features of an area that supplies food, water, shelter and space necessary for a particular species' existence

HALF-POUNDER an immature steelhead that spends only a few months at sea, enters fresh water in spring, feeds until the following winter, then migrates to sea again before returning to spawn

HEADWATERS the source or upper part of a lake, river, or stream

HOMOGENOUS all alike, as in a loss of genetic diversity leads to homogenized populations

HYBRIDIZE/HYBRIDIZATION to breed plants or animals of different varieties or species in order to create offspring having characteristics of each; here used to highlight breeding of related but distinct species

HYDROLOGY the movement of water across the landscape, including the water cycle

INTROGRESSION the spread of genes from one population or species into another as a result of hybridization

INVERTEBRATE an animal without a backbone, many of which serves as prey for salmonids

ITEROPAROUS reproducing more than once in a lifetime Juvenile fish from one year of age until sexual maturity

KELT a salmonid that has spawned but not yet returned to sea Kype the distinctive hooked jaw that male salmonids develop during spawning

LACUSTRINE a life history where fish spend their entire lives in lakes

LIFE HISTORY a series of changes an organism undergoes during its lifetime, or the timing of key events in an organisms' lifetime, such as sexual maturation and behavior

NATAL STREAM stream of birth, where a fish hatches

NATIVE SPECIES an indigenous stock of fish that has not been substantially affected by genetic interactions with non-native stocks or by other factors and is still present in all or part of its original range

NET PEN a mesh enclosure used to confine juvenile salmon and allow them to acclimate to brackish or salt water before release

NATIONAL MARINE FISHERIES SERVICE (NMFS) a federal agency and division of the Department of Commerce, responsible for the stewardship of the nation's living marine resources and their habitat

PARR the stage in sea-going trout and salmon prior to the smolt stage and migration to salt water

PARR MARKS distinctive vertical, dark oval markings on the sides of young salmon or trout

PEER REVIEWED LITERATURE scientific writing or research that has undergone evaluation by other experts in the field to judge if it merits publication or funding

PIKEMINNOW *(Ptychocheilus spp.)* a torpedo-shaped fish with an olive-green and gold back, white belly, and black stripe on its side; a major natural predator on juvenile salmonids in California

PISCICIDE a chemical substance which is poisonous to fishes

POOL a relatively deep, still section in a stream

REACH a section of stream defined in a variety of ways such as the section between tributaries or a section with consistent characteristics

REAR to bring to maturity

REDD a circular or oval-shaped depression excavated by adult female salmonids with their tails where eggs are laid

REINTRODUCTION putting a species back into a former habitat Resident describes species of fish which spend their entire lives in fresh water

RESILIENCE the ability of ecosystem or species to withstand ecological disturbance while maintaining its normal patterns of operation and function

RESTORATION/CONSERVATION HATCHERY a hatchery designed to produce fish for restoration purposes rather than for recreational purposes

RICHNESS the number of different species represented in an ecosystem

RIPARIAN HABITAT the terrestrial habitat adjacent to streams, lakes, estuaries or other waterways

RIVERINE situated on or in a river or its banks

ROTENONE a plant-based, odorless, colorless, piscicide commonly used for removing fish from a stream

RUN the time at which a fish swims back up the rivers in which they were born to spawn

SALMONID any member of the taxonomic family Salmonidae, which includes all species of salmon, trout, char, whitefish and grayling

SEDIMENTATION fragmentary material that originates from the weathering of rocks or the additions of materials from manmade activities into a river Smolt the third stage in the development of a trout, salmon or char, when the small, silvery fish have undergone physical changes to allow them to begin their migration from fresh water to the sea

SPAWN the release and fertilization of eggs

SPAWNING RUN the migration of fish to the place where they mate and lay their eggs

STEELHEAD a form of Rainbow trout that migrates from the stream in which it was born to the sea and back to its home stream to spawn

STRAYING the behavior of fish to migrate or return to non-natal streams for various purposes such as feeding, exploration, or spawning

STRONGHOLD a place that provides sufficient habitat quantity and quality to serve as a refuge for a species

TAXONOMIC (singular: taxon, plural: taxa) a taxonomic category such as family, genus, species that refers to a distinct natural group

TERRESTRIAL from the Earth, as in land-based invertebrates that fall into streams and become prey for trout

THREADFIN SHAD *(Dorosoma petenense)* a non-native fish species common in large rivers and reservoirs

THREATENED any species which are vulnerable to extinction in the near future, as defined by the federal Endangered Species Act

TRAP-AND-HAUL the capture and transport of juvenile or adult fish around barriers, such as dams; two-way trap and haul involves trucking adult salmonids around dams to spawn, and juveniles are then captured as they migrate downstream and released downstream of dams and diversions

TRIBUTARY a stream that feeds into a larger stream; also called a feeder stream

TRANSLOCATION the intentional capture, movement, and release of a species for a specific purpose, such as to expand its range or establish a refuge population

TROPHY fish a prized, large-sized fish pursued for sport

TRUCKING use of specialized, insulated tanker trucks to transport fish

TUI CHUB *(Gila bicolor)* a minnow that is an important food source for Lahontan Cutthroat trout

WATERSHED the area of land that water flows across or under on its way to a river, lake or ocean; includes all surface waters and adjacent estuaries and marine areas

ZOOPLANKTON microscopic animals in water which form the important beginnings of food webs for larger animals

ACKNOWLEDGMENTS

SOS II: Fish in Hot Water is the culmination of the dedication, passion, and selflessness of dozens of individuals over the last 18 months. Thanks go first and foremost to Dr. Peter B. Moyle, who recently and deservedly retired from a long and highly distinguished career at the University of California, Davis, where he studied and communicated the importance of California's native fish species and their conservation throughout California. He has trained and inspired generations of fisheries biologists, ecologists, and scientists and instilled in them a conservation ethic to help preserve and protect the remarkable and diverse fishes of California. Dr. Moyle served on California Trout's Board of Directors for many years, and continues to guide our work today. He drove this project from its inception in 2008 through the second edition in 2017. Without his inspiration, dedication, vast knowledge, and tireless work ethic, this undertaking could not have been completed. Thank you for teaching, guiding, and inspiring us all.

Peter has long said "The fish don't lie." We agree. And if they could speak, they would surely thank you too.

California Trout is deeply grateful to our supporters whose financial contributions helped make the second edition of the *State of the Salmonids* a reality. Specifically, we would like to thank the Darrell and Lauren Boyle family, the Mary A. Crocker Trust, the J. Vance Huckins Fund of the Tides Foundation, and the American Fisheries Society – Western Division. Our sincere thanks to you.

We appreciate the leadership of Patrick Samuel and Dr. Rob Lusardi who worked closely to pull this project together. They were tireless in their efforts to talk with experts, dig for data, and write species accounts, all while Patrick became a new dad and Rob finished his PhD.

We would especially like to thank Tracey Diaz for her keen organization and messaging savvy, Jane Brady for driving the creative vision and exceptional design of this report, Paul Waters for his remarkable original illustrations that help bring these fish to life, Megan Nguyen and Nicholas Santos for their meticulous cartography, and John Fellner for his generous donation toward the binding and printing of this report.

Thank you.

The information underpinning this report could not have been obtained without the help and support of the University of California, Davis Center for Watershed Sciences and our management partners at the California Department of Fish and Wildlife, the National Marine Fisheries Service, and numerous individuals who generously provided their time and expertise to the research and information, expert opinions, peer reviews, photos, and countless other helpful suggestions. Those individuals include, but are not limited to: Val Atkinson, Philip Bairrington, Ethan Bell, Kent Blackburn, Roger Bloom, Sara Borok, Jim Bowker, Bill Brubaker, Jennifer Bull, Conrad Calimpong, Mark Capelli, Gerard Carmona-Catot, Joel Casagrande, Diana Chesney, Mary Claire Kier, Emily Cooper, Flora Cordoleani, LeRoy Cyr, Rosi Dagit, Mike Dege, Doug DeRoy, Paul Divine, Walt Duffy, Jen Edgar, Brian Ellrott, Bjorn Erickson, Joe Ferreira, Molly Finger, Josh Fuller, Sean Gallagher, Justin Garwood, Michelle Gilroy, Kitty Griswold, Anders Halverson, Meredith Hardy, Scott Harris, Bret Harvey, Matt Hernandez, John Hileman, Andy Hill, Stephanie Hogan, Ed Homich, Josh Hull, Mike Hupp, Jim Inman, Josh Israel, Patrick Jarrett, Andrew Jensen, Matt Johnson, Rachel Johnson, Morgan Knechtle, Jonathan Koehler, Glenn Kubacki, Cathryn Lawrence, Dana Lee, Dennis Lee, Michelle Leicester, Robert Leidy, Ken Lindke, Jay Lund, Dean Marston, Jonathan Matthews, Dana McCanne, Kate McLaughlin, Chad Mellison, Michael Miller, Travis Neebling, Jennifer Nelson, Jonathan Nelson, Erin Noesser, Freddy Otte, Stephen Phillips, Sam Plemons, Phil Reedy, Allan Renger, Seth Ricker, Sam Rizza, Andrea Schreier, Tom Schroyer, Erin Seghesio, Hilda Sexauer, Kevin Shaffer, Rachel Simmons, Lisa Sims, Wade Sinnen, Bill Somer, Michael Sparkman, Stan Stephens, Stephen Swales, Ross Taylor, Brian Vais, Ryan Watanabe, Jeff Weaver, Nina Erlich-Williams, Severn Williams, Richard Wong, and Ron Yoshiyama: thank you all.

The guidance and support of Curtis Knight and the entire California Trout staff, and past and present Board Members was essential for realizing our goals and finalizing the document. Thank you to California Trout staff Alisan Amrhein, Craig Ballenger, Redgie Collins, Sandi Jacobson, Jacob Katz, Melissa Racklyeft, Gaby Roff, Julie Seelen, and Mike Wier for your input, photos, numerous edits, and reviews. We appreciate all the help from the entire team.

We apologize to anyone whom we may have inadvertently failed to list here but had a hand in the generation of this report. Any errors or omissions that appear are the responsibility of California Trout.

Sincerely,
California Trout Staff and Board of Directors

ABOUT CALIFORNIA TROUT

California Trout is a leading nonprofit organization whose mission is ensuring there are resilient wild fish thriving in healthy waters for a better California. Established in 1971, California Trout revolutionized fisheries management in California through restoration, pursuing “Wild and Scenic” designation to protect rivers, and rallying to establish catch and release as the predominant modern angling ethic.

Today, CalTrout solves complex resource issues balancing the needs of fish and people. Working and living in local communities, developing innovative, science-based solutions that work for the diverse interests of fish, farms, commerce, and the community. These proof-of-concept project successes establish precedent, empower partners and influence statewide policy.

California Trout’s work is funded by individuals whose generosity is leveraged to obtain government and foundation grants and partnerships, multiplying even small gifts to accomplish large multi-million dollar projects.

Visit CalTrout.org and join us to ensure wild fish will thrive in healthy California waters for generations to come.

BOARD OF GOVERNORS AND CALTROUT STAFF

Drew Bassak
Chair

Steve Rogers
Vice Chair

Richard West
Treasurer

Rick Kaufman
Secretary

Linda Ach
Gary Arabian
Tony Brookfield
George Choe
Andy Eckert
Bill Epstein
Edward De La Rosa
Dick Galland
Loretta Keller
Tom Larsen
Charles Linker
Laurie McLellan
Bob Payne
Bob Rosenberg
Scott Tucker
Paul Vais
Jeff Williams

SAN FRANCISCO CENTRAL OFFICE

Curtis Knight
Executive Director

Alan Roesberry
Finance Director

Gaby Roff
Institutional Giving Director

Julie Seelen, CFRE
Advancement Director

Tracey Diaz
Marketing and Communications Director

Redgie Collins
Staff Attorney

Patrick Samuel
Conservation Program Coordinator

Melissa Racklyeft
Grants Associate

Alisan Amrhein
Marketing and Development Associate

Nathan Lubarov
Compliance Manager

Casey Sullivan
Donor Database Associate

CENTRAL CALIFORNIA

Jacob Katz, Ph.D.
Senior Scientist, Central Valley

NORTH COAST

Darren Mierau
North Coast Program Director

Mary Burke
Project Manager

MT. SHASTA/KLAMATH

Drew Braugh
Mt. Shasta Program Director

Tuli Potts
Program Coordinator

Craig Ballenger
Fly Fishing Ambassador

SIERRA HEADWATERS

Mark Drew, Ph.D.
Sierra Headwaters Program Director

Levi Keszey
Watershed and Outreach Coordinator

Janet Hatfield
Project Manager

Mike Wier
Field Reporter

SOUTHERN CALIFORNIA

Candice Meneghin
Conservation Program Manager

Sandra Jacobson, Ph.D.
Coalition Coordinator

UC DAVIS CENTER FOR WATERSHED SCIENCES

Rob Lusardi, Ph.D.
CalTrout-UC Davis Wild and Coldwater Fish Scientist

CONTACT

360 Pine St., 4th Floor
San Francisco, CA 94104
(415) 392-8887
info@caltrout.org

www.caltrout.org

Photos clockwise from top left:

1) Wallace Weir groundbreaking to prevent stranding of adult salmon in the Central Valley. Photo: Jacob Katz.

2) High Sierra meadow where restoration work boosts water storage capacity and carbon sequestration. Photo: Mike Wier.

3) The Nigiri Project at Knaggs Ranch where science has proven that reconnecting historic floodplain rearing habitats benefits fish and people.

4) 2017 Meadows Conference where over 20 State and Federal, non-profit, environmental, academic and private agencies signed an MOU in support of the CalTrout-led Sierra Meadows Strategy.

5) Installation of woody debris at Hat Creek to restore instream habitat. Photo: Val Atkinson.

6) Newly installed Hat Creek pedestrian bridge that reconnects trail segments, decreasing streambank erosion. Photo: Val Atkinson.

7) Fall River PIT tagging to track wild trout migration, growth rates, genetics, and population structure. Photo: Mike Wier.

1

6

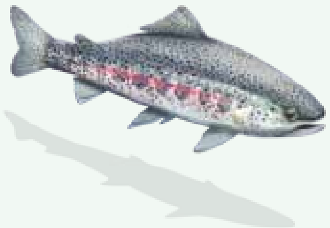
7

5

2

3

4



“Something will have gone out of us as a people
if we ever let the remaining wilderness be destroyed;
if we permit the last virgin forests to be turned
into comic books and plastic cigarette cases; if we drive
the few remaining members of the wild species into zoos
or to extinction; if we pollute the last clear air and dirty
the last clean streams and push our paved roads
through the last of the silence … We simply need that
wild country available to us … For it can be a means
of reassuring ourselves of our sanity as creatures,
a part of the geography of hope.”

Wallace Stegner

CALIFORNIA TROUT

FISH · WATER · PEOPLE

360 Pine Street, 4th Floor San Francisco, CA 94104 · 415 392 8887 · www.caltrout.org