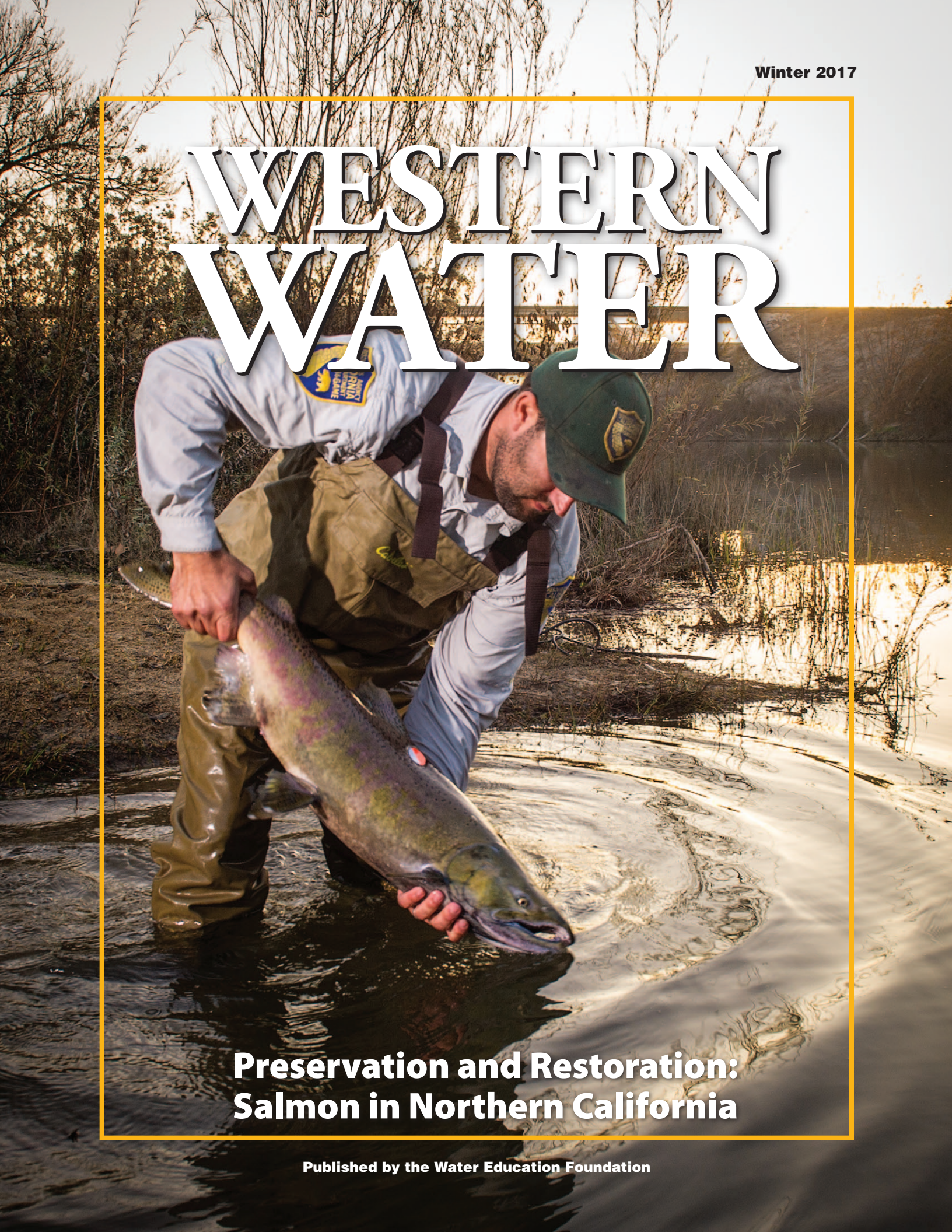
Winter 2017

WESTERN WATER



Preservation and Restoration: Salmon in Northern California

Published by the Water Education Foundation

WATER EDUCATION
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Editor's Note

Wave of change

When a new federal administration takes over in Washington, D.C. – whether it's Democratic or Republican and whether or not it's the same political party in power – questions always abound about what direction policy will take on the federal stage.

In the water world in California, there are several big questions – how will the administration support infrastructure projects, notably the controversial twin tunnels below the Delta known as the WaterFix. And what about the Salton Sea, once championed by the late entertainer-turned-Congressman Sonny Bono and now awaiting an unknown fate at the end of this year.

There are also big questions along the Colorado River, where the rush to get a series of agreements signed before then-President Obama left office never materialized. Two days before Donald Trump's presidential inauguration, Interior Secretary Sally Jewel issued a memo outlining a game plan for avoiding water shortages along the Colorado and underscoring the importance of concluding a drought contingency plan among California, Arizona and Nevada as well as a cooperative agreement known as Minute 32X between the U.S. and Mexico governments to share in reduced water deliveries to prevent reservoirs from falling to critical lows.

So will Trump follow through? Could his positions on immigration and building a wall along the Mexican border play a role?

We will attempt to answer these questions about the Colorado River at our flagship conference of the year, the Executive Briefing, on March 23 in Sacramento, with a panel made up of Lower Basin representatives.

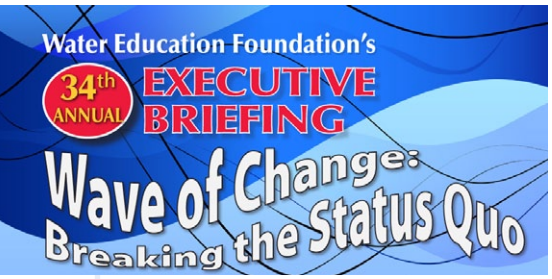
And will the Endangered Species Act, what some consider the nation's most powerful environmental law be at risk? In the water world, it not only protects the listed fish that ply the rivers, but those listed plants, birds and even kangaroo rats that live on their banks or flood plain. This issue of *Western Water* magazine explores what's being done to help endangered salmon, and the different runs that migrate between the ocean and the Sacramento and San Joaquin systems.

The Endangered Species Act was signed into law in 1973 by a Republican president (Richard Nixon), mainly in reaction to the demise of the bald eagle. However the first test of the Act in court was water-related; it involved a tiny fish in Tennessee known as the snail darter and the construction of a dam. Interesting times are indeed ahead. Hope to see you at our Executive Briefing. ❖

– Jennifer Bowles

Happenings...

'Wave of Change' Theme for March 23 Briefing



Finding new sources of water for the future and taking steps to reduce the chance for shortage on the Lower Colorado River under a new federal administration are two of the key topics to be addressed at the Foundation's annual Executive Briefing March 23 in Sacramento.

Also hear from experts on the new California Open and Transparent Water Data Act and implementation of the Sustainable Groundwater Management Act.

This is the premiere water conference! Register today at http://www.watereducation.org/foundation-event/2017-executive-briefing. A special NGO/university rate is available as are attorney credits for an additional fee.

Join a Tour this Spring

Take a break from the routine and join us on a water tour this year. Our field trips give you the chance to see firsthand the projects, places and people that comprise the water debate.

Our **Central Valley Tour** from **March 8-10** visits farms, Friant Dam and the San Luis National Wildlife Refuge. The tour is co-sponsored by the Bureau of Reclamation, Mid-Pacific Region, California DWR, CH2M, ESA, GEI and Turlock Irrigation District.

A private tour of Hoover Dam is a highlight of our **Lower Colorado River Tour April 5-7**. The tour is co-sponsored by the Bureau of Reclamation, Lower Colorado Region, California DWR, CH2M and MWH.

A new **Headwaters Tour** is set for **April 27-28**. The tour will travel through the Sierra Nevada foothills and mountains and around the Lake Tahoe Basin. The tour is co-sponsored by CH2M, HDR and MWH.

The popular **Bay-Delta Tour, June 14-16**, goes deep into California's water hub. The tour is co-sponsored by the Bureau of Reclamation, Mid-Pacific Region, California DWR, CH2M, ESA, GEI, HDR, MWH and Turlock Irrigation District.

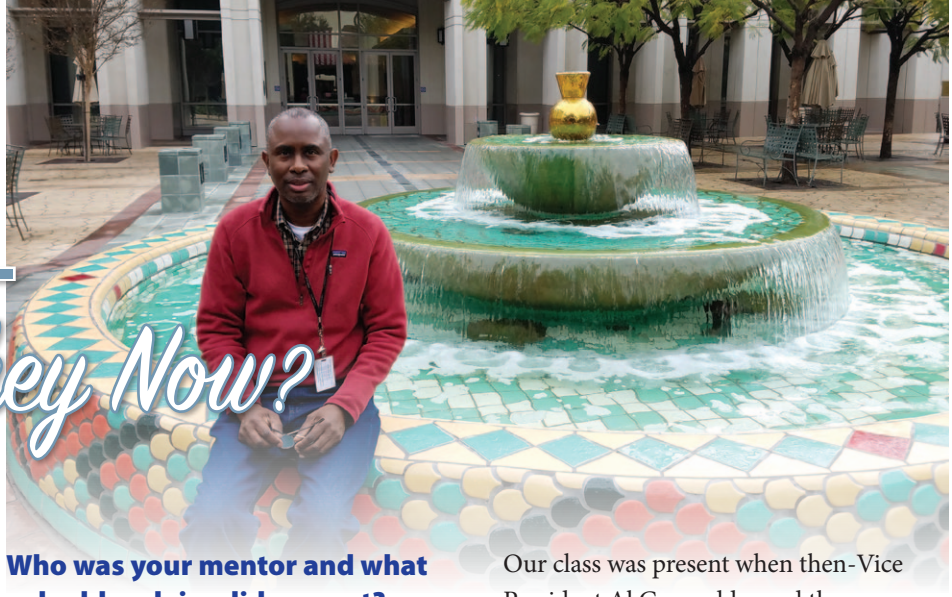
Learn more about each tour and register for early-bird prices online at www.watereducation.org/general-tours.

2017 Water Leaders Selected

The 21st Annual **William R. Gianelli Water Leaders Class** convened in January to kick off the yearlong program. Each class member will be assigned to a high-level mentor as the group researches the future of water storage in California for a report they will present in November to the Foundation's Board of Directors.

Class members are: Richard Aragon, *Rancho California Water District*; Arturo Barajas Jr., *State Assemblymember Joaquin Arambula, D-Fresno*; Ali Barsamian, *WaterSmart Software*; Lyndsey Bloxom, *Water Replenishment District of Southern California*; Megan Brooks, *Delta Stewardship Council*; Ian Buck, *MWH Global*; Heidi Chou, *East Bay Municipal Utility District*; Michael Cook, *River Partners*; Elisabeth Esposito, *Brownstein Hyatt Farber Schreck LLP*; Marcia Ferreira, *MWD of Southern California*; Ana Lucia Garcia Briones, *Environmental Defense Fund*; Andree Johnson, *Bay Area Water Supply and Conservation Agency*; Anusha Kashyap, *CDM Smith*; Angela Llaban, *California Department of Parks and Recreation*; Sara Maatta, *Alameda County Water District*; Sami Nall, *California Department of Water Resources*; Gina Nicholls, *Nossaman LLP*; Donald Portz, *Bureau of Reclamation*; Patrick Scott, *California Department of Water Resources*; Oliver Symonds, *Contra Costa Water District*; and Bobby Vera, *West Yost Associates*. Cook and Barajas received the Anne J. Schneider and William Gianelli scholarships, respectively.

Water Leaders - *Where Are They Now?*



Edgar G. Dymally

Senior Environmental Specialist, Metropolitan Water District of Southern California

Class Year: Inaugural Year 1997
Class Project Theme: Current Views on the CALFED Bay-Delta Program

What do you do?

A large part of my job is to analyze potential legislation and regulation for impacts on Metropolitan Water District of Southern California, its member agencies and the drinking water industry. I'm also active in several trade associations including the Association of California Water Agencies (Vice-Chair, Water Quality Committee). My main responsibility is to ensure that Metropolitan continues to comply with all federal, state and local regulations.

What is the most pressing water issue that you are dealing with?

The drought has created problems for just about every water utility and water supply agency. The changing nature of the industry also presents huge challenges.

What did you learn during the Water Leaders class that is helping you now?

Knowing and understanding the diverse array of interest groups and players in California water is essential to my job. My time in the class allowed me to meet and understand many of these groups and build relationships. I continue to work with several of my classmates including Denise Kruger, senior vice president of Golden State Water Company.

Who was your mentor and what valuable advice did you get?

My mentor was then-state Sen. Jim Costa, who was chair of the Senate Ag and Water committee and easily one of the most knowledgeable officials on water in the state. He allowed me to shadow him for a whole day that included him chairing his Senate committee. I literally sat next to him during the hearing. We stayed in touch.

What advice do you have for young professionals in the water world?

Broaden the scope of your occupation/career path. Learn as much as you can about your expertise but it's always a smart idea to know the impacts of other disciplines on your career. As a young professional, you should always be able to anticipate change and be ready to accept and embrace it.

Also, for anyone with a technical or scientific background, being able to navigate non-technical/political consideration often poses the greatest challenges.

Any other anecdotes from your time as a water leader?

Our class was present when then-Vice President Al Gore addressed the Foundation's Executive Briefing. Immediately after his speech, we were presented for the obligatory photo op! A photo of me shaking Mr. Gore's hand became a mainstay of the Water Leaders program. I have that framed picture on the wall of my office.

My fondest memory of my time as a water leader was clearly the leadership and relationship with Jean Auer. *[Editor's Note: Auer was a founder of the Water Leaders Program.]* She may have described herself as something of a "mother hen" but I could not think of a better leader or inspiration than Jean. She was always nurturing and supportive of all of our efforts during the class. I miss her and will always remember her as a large part of the water leader experience.

Our one-year Water Leaders program began in 1997, and many graduates have gone on to achieve great things. We profile alums here so you can see where they are now and what they learned during their time with us. For more information on our program, visit www.watereducation.org/water-leaders

Sense of Place

The Salton Sea

Amid desert scrub punctuated with mountains, green farm fields and sparsely populated towns that once thrived as a tourist mecca, the Salton Sea quietly glistens as it beckons more than 400 bird species to its shores in the low desert of southeastern California.

Near the end of each year, bird-watchers shouldering scopes and hoisting binoculars toward the sky take part in the annual Christmas bird count organized by local Audubon chapters.

The sea is also prone to occasional but massive fish kills that leave a rotten-egg stench blowing for miles through the Coachella Valley's tourist enclaves of Palm Desert and Palm Springs.

Created when the Colorado River burst through a canal in 1905 and filled the Salton Sink, its origin wasn't necessarily an accident. For centuries prior, the river would sometimes snake west from its path toward the Gulf of California to fill what was known as ancient Lake Cahuilla, named for the tribe that still calls the area home.

In the 1950s and '60s the lake was a tourist destination and a hub of activity with water skiing, something its late champion, Sonny Bono, remembered fondly taking part in. Today, the sea, fed mostly by irrigation runoff, is saltier than the Pacific and is shrinking due to a water transfer from the water-rich farming region to San Diego. At the end of this year, mitigation water from the Imperial Irrigation District ends, causing concern about its future.

– Jennifer Bowles

To read more about the sea, visit Aquapedia, our online encyclopedia at www.watereducation.org/aquapedia. We will stop at the Salton Sea on our Lower Colorado River Tour in April. Check out http://www.watereducation.org/tour/lower-colorado-river-tour-2017 for more information.

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Metropolitan Water District of Southern California
U.S. Geological Survey
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Map

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On the Cover

Releasing salmon into the San Joaquin River near Fresno in December 2013. The San Joaquin River Restoration Program being implemented by federal and state agencies aims to re-establish one of the most vibrant populations of spring-run Chinook on the West Coast. Photo taken by John Chacon, California DWR

The Water Education Foundation thanks all the sources and experts who reviewed this magazine for balance and accuracy.

The mission of the Water Education Foundation, an impartial, nonprofit organization, is to create a better understanding of water resources and foster public understanding and resolution of water resource issues through facilitation, education and outreach.

Western Water is published by the Water Education Foundation, 1401 21st Street, Suite 200, Sacramento, CA 95811 (916) 444-6240, fax (916) 448-7699.

An annual subscription to this quarterly magazine is $50. The balance of the Foundation's information program may be supported by larger amounts, which are tax deductible. Printed on recycled paper with soy-based ink.

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Web page: www.watereducation.org

ISSN: 0735-5424

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Preservation and Restoration: Salmon in Northern California

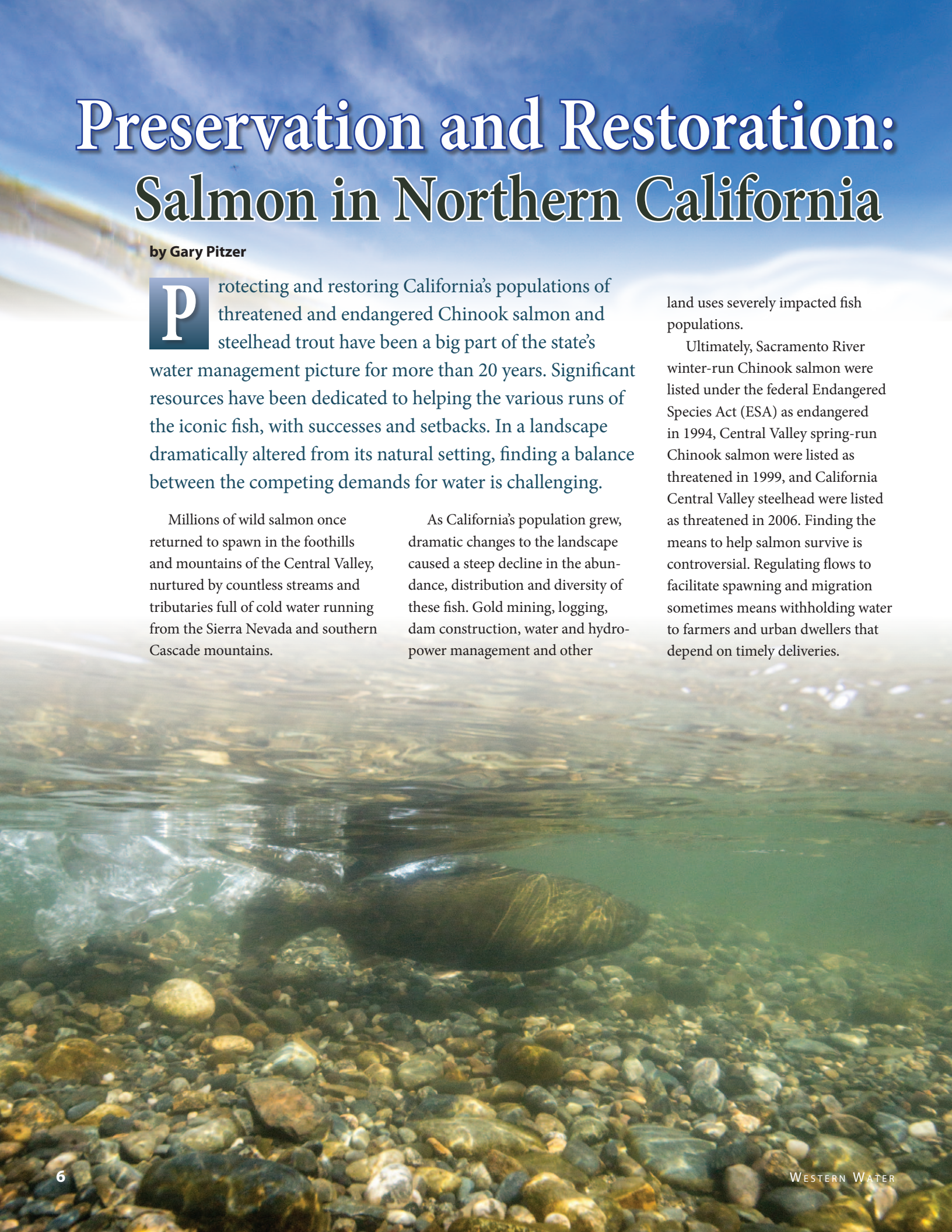
by Gary Pitzer

Protecting and restoring California's populations of threatened and endangered Chinook salmon and steelhead trout have been a big part of the state's water management picture for more than 20 years. Significant resources have been dedicated to helping the various runs of the iconic fish, with successes and setbacks. In a landscape dramatically altered from its natural setting, finding a balance between the competing demands for water is challenging.

Millions of wild salmon once returned to spawn in the foothills and mountains of the Central Valley, nurtured by countless streams and tributaries full of cold water running from the Sierra Nevada and southern Cascade mountains.

As California's population grew, dramatic changes to the landscape caused a steep decline in the abundance, distribution and diversity of these fish. Gold mining, logging, dam construction, water and hydropower management and other land uses severely impacted fish populations.

Ultimately, Sacramento River winter-run Chinook salmon were listed under the federal Endangered Species Act (ESA) as endangered in 1994, Central Valley spring-run Chinook salmon were listed as threatened in 1999, and California Central Valley steelhead were listed as threatened in 2006. Finding the means to help salmon survive is controversial. Regulating flows to facilitate spawning and migration sometimes means withholding water to farmers and urban dwellers that depend on timely deliveries.



Balancing water deliveries with environmental needs is a complicated process fraught with peril. In 2009, the Delta Reform Act required the State Water Resources Control Board (State Water Board) to come up with appropriate flow criteria for the Sacramento-San Joaquin Delta (Delta). In their 2010 report, State Water Board staff noted the complexity of the matter:

"While folks ask 'How much water do fish need?' they might well also ask, 'How much habitat of different types and locations, suitable water quality, improved food supply and fewer invasive species that is maintained by better governance institutions, competent implementation and directed research do fish need?'" the report said. "We cannot know all of this now, perhaps ever, but we do know things that should help us move in a better direction, especially the urgency for being proactive. We do know that current policies have been disastrous for desirable fish. It took over a century to change the Delta's ecosystem to a less desirable state; it will take many decades to put it back together again with a different physical, biological, economic, and institutional environment."

Scientists are busy on several fronts in an effort to better understand all life stages of the species so that better tools can be developed to ensure their survival. Spearheading the effort is the National Marine Fisheries Service (NMFS), which in 2016 included the winter-run Chinook salmon as one of eight "Species in the Spotlight" among the most at risk for extinction in the near future. "The ongoing drought has intensified California's water management challenges and accentuated the urgent and critical need to reintroduce winter-run Chinook salmon populations into their historical habitat [in the upper Sacramento Valley], an area which is not dependent on Shasta Reservoir storage and is somewhat buffered from drought by the influence of cold water springs," NMFS' 2016 Winter-run Chinook Salmon Five-Year Action Plan says. (NMFS also is known as NOAA Fisheries. The National Oceanic and Atmospheric Administration is an agency within the Department of Commerce.)

According to the 16-page publication, "the survival and recovery of winter-run Chinook salmon cannot be achieved without establishing additional populations."

Measuring the relative health of the state's various runs of Chinook salmon is a year-to-year endeavor, with many factors influencing the number of returning fish. Along their entire range, Chinook salmon complete their life cycle in two to eight years, but the vast majority of Central Valley Chinook complete their life cycle in two to four years, with three years being the most frequent.

The spawning Chinook adults of 2016 were born in 2013 during the depths of the drought, meaning there were fewer of them to begin with because of egg mortality. Biologists also said poor ocean conditions last year mean the salmon returning to the rivers and creeks in the upper Sacramento Valley are smaller, which in turn reduces the number of eggs each female lays.

While drought is nothing new to California, the dry period commencing in 2012 has been especially hard on salmon, pushing the abilities of federal and state agencies to deal with the crisis. Record-low river levels meant hatchery-raised smolts had to be carried in trucks downstream in 2014 and 2015.

"The last three years have really been more intense and long-term than earlier periods," said Josh Israel, biologist with the Bureau of Reclamation (Reclamation) at the 2016 Bay-Delta Science Conference in Sacramento. "Many people think we are on the verge of a mass extinction event. Hopefully, we can understand it before it's too late."

While drought is nothing new to California, the dry period commencing in 2012 has been especially hard on salmon, pushing the abilities of federal and state agencies to deal with the crisis.

Multiple restoration projects have been completed or are ongoing in the northern Sacramento Valley along the namesake river and its creeks to help salmon, aided by state and federal agencies and local water users. On the San Joaquin River south of Sacramento, it remains to be seen whether a population of spring-run Chinook can be re-introduced into a system so changed by water diversion and flood control projects.

The San Joaquin River Restoration Program being implemented by Reclamation and other federal and state agencies aims to re-establish one of the most vibrant populations

of spring-run Chinook on the West Coast. Draining the southern portion of the Central Valley, the San Joaquin River originates in the highest peaks of the Sierra Nevada and flows toward the Delta. The program includes habitat restoration, river reconfiguration and hatchery facilitation. After more than 70 years since its extirpation, progress in reviving the salmon run has been a challenge.

"Early on in the program, the hope was to have a connected river with all the necessary improvement projects done by 2014," said Jeff Abrams, fisheries biologist with NMFS' San Joaquin River Basin Branch. "Although progress has been made, that hasn't happened as we have discovered that restoring the river is a more involved process than initially anticipated."

Scientists are doing a variety of things to better understand how to preserve, protect and restore what were once-thriving salmon populations in Northern and Central California.

"We are trying to look at the entire life cycle, not just one thing or another," Maria Rea, assistant regional administrator with NOAA Fisheries, said at the science conference.

The most vulnerable fish is the winter-run Chinook, which have been hammered by more than five years of drought and other factors that have driven their numbers to near extinction.

"Without marshalling our resources and heightening our engagement with vital partners, Sacramento River winter-run Chinook salmon may be lost to future generations," NMFS' Action Plan said in reference to the long drought.

Adult winter-run Chinook salmon migrate from the ocean to Sacramento River spawning areas from December through July. The winter-run is one of four runs found in the river. The winter-run stand apart from fall-run because although they come up river in the winter, they stay in fresh water for a longer period of time – not spawning until summer. The fall-run spawn within weeks of migrating from the ocean to the fresh water. Spawning for winter-run has to occur in cold water (56 degrees Fahrenheit) and takes place from late-April to mid-August.

Despite efforts to maintain that temperature, officials haven't been able to meet that standard – especially during the recent drought. "Things started getting really bad in 2014," said Eric Danner, research ecologist with NMFS, speaking at the science conference. "We ran out of cold water half way through."

Salmon are anadromous fish. They are born in fresh water, spend most of their lives in the sea and return to fresh water to spawn, usually to the same waterway in which they were hatched. Thus they are vulnerable to ecological challenges in the ocean and the state's streams and rivers.

In its update of the Bay-Delta Water Quality Control Plan, the State Water Board is calling for increased instream flows for the Sacramento and San Joaquin rivers and their tributaries to protect fish, which means less water for rights holders.

"The odds of [salmon] survival are decreasing and will continue to decrease unless action is taken," State Water Board Chair Felicia Marcus wrote after a new draft of the first phase of the plan update was released in September 2016.

The rate of diversion on the Stanislaus, Tuolumne and Merced rivers, "at critical times of the year, well over 60 percent – and in some cases and times more than 80 percent," is not sustainable, Marcus wrote, noting that salmon and steelhead "are in serious decline."

In response, a coalition of more than two dozen government and water user organizations in Stanislaus and Merced counties lashed out at the plan, calling it a "water grab … without mitigation or due analysis of impacts."

There is concern from Sacramento River water rights holders as well.

"We don't think we have the luxury in the state of California with 39 million people to do mass evacuations of water storage without a real specific purpose in mind," David Guy, executive director of the Northern California Water Association (NCWA) told the State Water Board at a Dec. 7 public hearing on the science used for the updated water quality plan. "We've got to find a better approach that works for 2016 and looking forward."

Guy said he's concerned the updated water quality plan could disrupt many of the existing standards painstakingly enacted through the years.

"Importantly, all of these flow agreements were finalized and executed since the last update of the Bay-Delta Water Quality Control Plan," he said. "Let's be careful about unwinding some of these agreements, some of which took 30 years and a couple trips to the Supreme Court."

The Winter-Run

Preventing the extinction of winter-run Chinook is a part of the re-consultation between fisheries biologists and federal and state water managers regarding operations of the Central Valley Project (CVP) and State Water Project (SWP). The process, part of the required compliance with the ESA, is controversial and has a history of legal disputes about the level of pumping that is safe for fish. That acrimony will not be going away soon with the winter-run in such a precarious place.

"For the next 10 years we are living with a risk of extinction criterion," Israel said. "There has been a reduction in viability, which we can see through the increased risk of extinction."

Rea pointed to work being done to restore habitat on Battle Creek and improve salmon passage with dam removal and new fish ladders in Shasta and Tehama counties, a project that will set the stage for the re-introduction of a winter-run population. Re-introductions "are not a panacea and they are not simple," she said. "In this case, we have to do it because we have no other option."

The species has been battered by poor feeding conditions in the ocean and a multiyear drought, equipment malfunctions and water management decisions. According to NMFS, Shasta's insufficient supply of cold water in 2014 led to the mortality of approximately 95 percent of wild winter-run Chinook salmon eggs and fry.

"On average, the temperature of the water is warmer," Danner said. "They are running out of cold water in September and October."

Water managers strive to maintain a 56 degree Fahrenheit water temperature for salmon "as far down the [Sacramento] river as they can," Danner said, adding that salmon egg survival "is well below 50 percent on average" because of elevated temperatures. The first year of the recent drought, 2012, saw an egg survival rate of 32 percent, followed the next year by a rate of 25 percent.

A temperature control device installed at Shasta Dam in 1997 allows for water to be drawn from various levels in the reservoir, helping Reclamation achieve the right conditions for downstream fish but it did not prove to be enough with the drought.

In 2015, NMFS selected winter-run Chinook salmon as one of the eight species under its jurisdiction most in danger of imminent extinction. With such a dire prediction, there is urgency for government and non-government agencies to take stepped-up measures to save the fish.

Lost Habitat

More than 150 years ago, the Delta was a much different place. Braided by a vast network of channels, the Delta would flood regularly from the pulse of snowmelt-fed runoff, providing an ideal habitat for juvenile salmon making their way to the ocean.

"Streams and rivers once ran freely from high in the mountains to downstream reaches, meandering naturally through lowland and floodplain habitats, connecting with coastal estuaries and the Pacific Ocean,"

notes the California Water Action Plan. "The variability of natural water flows in this complex system created vibrant and resilient habitat for many species and functioned to store water, recharge groundwater, naturally purify water, and moderate flooding."

Today, more than 80 percent of the Central Valley's historic floodplain has been lost as marshy areas were diked and flows redirected to accommodate farming, flood control, navigation and urban development. Upstream dams blocked salmon passage into the higher elevations and altered the downstream flow regime. Forced into relatively narrow migration routes, salmon face a variety of threats, including eggs being washed away in a flood, predation of various life stages, out-migrating smolts getting lost in the Delta and adults being caught by fishermen.

The Sacramento River is unique because it is home for four runs of Chinook salmon – thus, the species is present in the system all year, with adults either migrating upstream to spawn or smolts outmigrating to the ocean. In addition to the spring-run and winter-run Chinook, steelhead and green sturgeon are protected under the ESA.

"It's tough being a California salmon," fish biologist Miranda Tilcock wrote in an Oct.30 post at the California Waterblog. "There are many manmade and natural perils and predators, including humans, which want to eat you. Their life is like a horror movie! Each salmon egg has a 1 in 1,000 chance of returning to spawn. Numerous additional dangers, beyond those above, affect salmon at every life stage."

In Northern California, the tributaries flowing from the southern Cascades provided essential spawning ground for winter-run Chinook salmon.

"Amazingly, [the winter-run] still exist even thought their historical habitat doesn't," said Steve Lindley, director of the fisheries ecology division at NMFS Southwest Fisheries Science Center, at the science conference.

Salmon have evolved to endure varying environmental conditions but the drought of 1976-1977 took a toll on the winter-run, said Lindley, who described the effect as a "collapse." Less than a decade later, the species was listed as threatened under the ESA followed by an endangered classification in 1994. NMFS embarked on a mission to save the winter-run, in the process determining the necessary criteria for de-listing.

"We need stable population sizes but not all influenced by hatcheries," Lindley said.

Location is a crucial element in maintaining adequate water temperature. In the lower American

The six-year drought has taken its toll on Shasta Dam and reservoir, shown here in August 2014. Federal fisheries officials say an insufficient supply of cold water released downstream in 2014 led to the mortality of approximately 95 percent of wild winter-run Chinook salmon eggs and fry.

River, the largest tributary of the Sacramento, the arrival of fall-run Chinook salmon to spawn usually coincides with the time when ambient water temperatures are cooling.

"We are concerned with the fall-run and want to use our human tools – temperature control and our cold water pool – so we can get the water down to a suitable temperature," said Tom Gohring, executive director of the Sacramento Water Forum. "Ideally, you would like to get there in October, but in a drought, we are just stuck and completely waiting for nature."

The Water Forum – a coalition of business, agriculture, nongovernmental organizations, water managers and local governments – has for about 20 years concentrated on ensuring that adequate conditions exist for steelhead and fall-run salmon to spawn naturally in the lower American River as well as to return to the Nimbus Fish Hatchery below Folsom Dam on the American River so eggs can be harvested from the hens. While the fall-run is not protected under the ESA it helps to support the commercial ocean salmon fishery. Folsom releases often are used to help meet water quality standards in the Delta, reducing the amount of water available behind the dam for later release for spawning fish.

Each year, Reclamation has to ensure the supply of cold water in Folsom Lake, a reservoir on the American River near Sacramento, is used judiciously between protecting steelhead and reserving enough for a decent fall-run salmon spawning period.

"It's complicated institutionally and regulatorily because steelhead are listed as threatened," Gohring said. "They are doing a very difficult balancing act."

Folsom Dam is equipped with three temperature control shutters that can be lowered or raised manually to determine the depth at which water is permitted to enter the dam's three power penstocks and turbines. Each of the three intakes is enclosed by the temperature control system that supports a set of 45 removable, 13-foot-high shutter panels. Each group of 45 shutters is arranged in five vertical columns of nine panels each.

"You could improve conditions for fish every year if you had something like a straw that reaches down into the deepest part of the reservoir," Gohring said.

The biological opinion for operation of the CVP requires Reclamation to study and potentially upgrade its temperature management hardware at Folsom – a process that includes improving the existing shutters so they don't leak and the possible installation of a device to access cold water below the power penstocks.

The U.S. Army Corps of Engineers has proposed replacing the existing system with two 13-foot-tall panels in each of five new vertical tracks. These new tracks and panels will be placed between the five piers comprising the existing temperature control structures on each of the three Folsom power penstocks. The proposal is still in the design phase, according to Reclamation.

Suitable Habitat

Salmon are affected by a wide variety of factors in the ocean and on land, including climatic conditions, dams, habitat loss, urbanization, agricultural and logging practices, water diversion and predators.

Winter-run Chinook salmon juveniles rear in the fresh water for several months before migrating out to the Pacific Ocean where they spend one to three years feeding before returning to fresh water to spawn.

"Winter-run salmon have a unique, diverse life history," Israel said. "They spend a lot of time in the ocean and face intense pressure in the fresh water environment."

Winter-run salmon enjoyed resurgence in 2005 and 2006 as the numbers of fish topped 17,000. The abundance was the result of wet conditions in the late 1990s and early 2000s that facilitated egg production and fish migration, according to Jon Rosenfield, lead scientist with the Bay Institute.

Numbers rebounded in 2013, though far less than 2006, the result of what Rosenfield described as "very wet" 2011.

NMFS' Action Plan notes that between 2003 and 2013 the abundance of spawning adults ranged from a high of 17,197 in 2007 to a low of 738 in 2011, with an average of 6,298.

"The population subsists in large part due to agency-managed cold water releases from Shasta Reservoir during the summer and artificial propagation from Livingston Stone National Fish Hatchery's winter-run Chinook salmon conservation program," the plan says.

Rea said "we have to improve the science for temperature management" and praised the "significant cooperation" from water rights holders in the Sacramento Valley and Reclamation this year to protect the fish.

Nigiri Project

NCWA, American Rivers, California Trout and The Nature Conservancy are engaged in the Sacramento Valley Salmon Recovery Program, which also benefits other fish such as steelhead and green sturgeon.

"There has been tremendous progress on projects that have had a positive impact on salmon, yet more work is ahead," according to a fact sheet. "As we look forward, the next salmon recovery priorities include fish passage improvements and high-priority fish screens, re-managing flows and habitat improvements."

Because of the many stressors salmon face, having suitable habitat is crucial in order for the more vulnerable species to survive.

"There has been research in the south Delta that has shown that the best route for salmon to actually make it to the Delta is to get into the pumps, get salvaged there and get trucked downstream, which tells me the habitat isn't there," said Louise Conrad, a senior scientist with the California Department of Water Resources. "They're not having success on their own."

Improving fish passage means recognizing the important role of floodplain habitat for juvenile salmon and adults returning to spawn.

"There is a stark difference between the broad expanse of a floodplain and a channeled river," Conrad said at the science conference. "We know the [floodplain] biological community is much richer and more productive."

In an interview, Conrad said flow is a necessary component for salmon but so is an adequate environment – habitat that provides food and refuge from predation.

"When we talk about flows I think it's important to have that balance of discussing the fact that if you have the water, the fish have to have someplace to go," she said. "There has been a problem historically with adult salmon migrating upstream and instead of staying in the Sacramento River proper going up into the Yolo Bypass and then up into Knight's Landing/Ridge Cut, which leads into the Colusa Drain and that is not spawning habitat."

Conrad is part of an experiment called the Nigiri Project that examines how flooded farm fields can benefit the health of juvenile salmon. State agencies and environmental groups have been working with landowners to facilitate floodplain restoration in concert with agricultural production. Hatchery-raised salmon have been released on flooded rice fields at the Knaggs Ranch property on the Yolo Bypass to document their growth rate compared to those reared in an agricultural canal and in the Sacramento River.

"We have learned a lot in the past five, going on six years that we have been doing this," she said. "We have learned that it absolutely holds purpose, it is absolutely possible for fish to grow at really exceptional rates. That doesn't mean we have addressed all the questions that there are about this potential strategy."

Foremost is the matter of whether the Nigiri Project strategy will work in the long-run.

"The proposed beneficiaries for this work are wild fish," Conrad said. "We have not had the opportunity to really see if you keep farms flooded past their normal period of draining, do wild fish get there and do they colonize those fields and really grow there? We've only been able to work with hatchery fish that we've manually brought on site. That's not our operating goal for a real management action."

Scientists have been monitoring the health and growth of hatchery fingerlings released on flooded rice fields at the Knaggs Ranch property in the Yolo bypass.

The McCloud River in Siskiyou County is the main target for winter-run restoration as is Battle Creek in Shasta and Tehama counties.

"The fish can get in [Battle Creek] more or less but there still needs to be some restoration to make water temperatures suitable," Lindley said.

Reclamation is one of the partners in the Battle Creek restoration project, a collaborative of the Pacific Gas and Electric Company, U.S. Fish and Wildlife Service, NOAA Fisheries, the Federal Energy Regulatory Commission, State Water Board and the California Department of Fish and Wildlife.

"Re-introducing winter-run Chinook salmon to the cold water, spring-fed habitat in Battle Creek is critical to preventing the species' extinction," NMFS' action plan says. "Currently, with only one population, the Sacramento River winter-run Chinook salmon ESU is at high risk of extinction. Establishing a second population will contribute to the species' viability by increasing its abundance and productivity, and improving its spatial structure and diversity."

Ultimately, NMFS wants to see three populations of winter-run salmon in the Upper Sacramento River watershed, one in the McCloud River southeast of Mount Shasta, the current one below Lake Shasta and one in Battle Creek.

"It probably is doable, the question is how quickly the re-introduction can occur," Lindley said.

Furthermore, there is the possibility of having to rely on the area below Shasta as winter-run habitat, instead focusing on the other rivers that flow in to the lake such as the upper, or "little" Sacramento River that have some habitat.

"If you can get the fish [above] Lake Shasta, they are probably a lot more resilient to drought," Lindley said. "It's an easy thing to collect the adults at the base of Keswick Dam and take them up above the lake and let them go in the river. The harder part is when the juveniles come down the river. They are not able to deal with a reservoir like that and we need to catch them before they get it in it and transfer them to the river below. It can be pretty challenging."

Flows and Water Project Operations

Salmon are in the middle of the struggle regarding management of the pumping operations of the CVP and SWP, specifically because of the limits on the water that can be exported to contractors during certain times of the year in order to protect juvenile fish migrating out to the ocean. It's a dispute that has stretched out for many years and involves science, politics and legal wrangling.

The State Water Board's recent recommendation for more instream flows for fish has reignited the long-standing complaint by agricultural interests about the perceived unfairness and arbitrary nature of the decision to halt and/or reduce export pumping, an action they say has not helped boost the populations of salmon and other threatened and endangered species.

"It makes no sense to position our serious drought-related situation as 'fish vs. farming,' as if the two are mutually exclusive," Johnny Amaral, deputy general manager of Westlands Water District, wrote in a 2016 *Fresno Bee* op-ed. "Those of us who live in the San Joaquin Valley know that water policies over the last 10 years have devastated not only our agriculture-dependent local economy. Ironically, in what feels like the ultimate case of adding insult to injury, they have also resulted in near extinction of several fish populations."

The salmon fishing industry has struggled to stay viable amid the declining numbers. In 2008, the Pacific Fishery Management Council canceled the ocean fishing season. Since that time, fishermen have urged state and federal agencies to help protect their livelihood.

> **"When we talk about flows I think it's important to have that balance of discussing the fact that if you have the water, the fish have to have someplace to go."**
>
> *– Louise Conrad, California DWR*

"Let's be clear. Leaving a little bit more water in the San Joaquin River and its tributaries is absolutely benefiting humans since that water will translate into more salmon fishing and salmon for people to eat," John McManus, executive director of the Golden Gate Salmon Association said in a statement after the State Water Board's recommended flow increases for the San Joaquin River mainstem. "No one should be surprised that salmon and salmon fishing families are being harmed when 80 percent of the San Joaquin River is diverted and never makes it to

where nature intended it to go. The excessive water diversions have killed California's salmon. California was a natural paradise until we killed much of it by unwise development and the extreme water diversions on the San Joaquin River and its tributaries are prime evidence."

Management of water pumping operations has alternated between fish-friendly and exporter-friendly during the past 10 years, with applications of science being refuted, reasserted and fought over in court. A 2009 biological opinion by NOAA Fisheries, which was the result of a lawsuit brought by environmentalists, was challenged by water agencies.

A federal court found that portions of the biological opinion were "arbitrary," "capricious" and "unlawful" and remanded the biological opinion to NOAA Fisheries. In 2014, the Ninth Circuit Court of Appeals reversed that decision, declaring that the lower court had created a "battle of experts" that violated the Administrative Procedure Act's "arbitrary and capricious" standard of review.

Despite the brouhaha, environmentalists believe more must be done to protect salmon populations.

"The biological opinions are minimally protective," said Gary Bobker, Rivers and Delta program director with The Bay Institute. "They are not really enough to turn the tide for this species and certainly now that the [Water Infrastructure Improvements for the Nation Act] has passed, the fate of those protections is really in doubt."

Hurdles to Restoration

A decade ago, the resolution of an 18-year lawsuit between the Natural Resources Defense Council and the federal government regarding the operations of Friant Dam on the San Joaquin River set the stage for a plan to re-establish what was one of the largest Chinook salmon runs on any river on the West Coast, with as many as 500,000 adult spawners each year, according to the state Department of Fish and Wildlife.

The San Joaquin River Restoration Program aims to bring those fish back but the task hasn't been easy. None of the fish released into the river in 2014 returned in 2016, the typical spawning cycle.

"There are still a lot of hurdles for the fish to get through," Abrams said. "There are high levels of mortality."

The old fish ladder at the Fremont Weir on the Sacramento River at the Yolo Bypass. There are plans to modify the 2-mile weir so it is more suitable for fish habitat.

"When they put in the rim dams on the San Joaquin basin, on top of the other stressors, [the spring-run Chinook salmon] became extirpated from the entire San Joaquin side of the Central Valley," said Abrams, NMFS' San Joaquin River Basin Branch.

Federal legislation subsequent to the settlement of the lawsuit called for the restoration and maintenance of fish populations in "good condition" in the main stem of the San Joaquin River below Friant Dam to the confluence of the Merced River, "including naturally reproducing and self-sustaining populations of salmon and other fish."

Drought was a significant contributor to fish loss and "there's hope" that the 2016 release will see better results, he said.

Construction is slated to begin in 2017 on the $23.7 million San Joaquin River Salmon Conservation and Research Facility that will produce spring-run Chinook salmon for the river.

The Hardest Step

Despite the altered environment in which salmon live, fisheries experts envision a future where improvements in water quality and habitat boost the numbers of fish reared in the wild.

"An increasing reliance on hatcheries is not what we are looking for long-term," Lindley said.

There are plans to modify the two-mile, earthen Fremont Weir on the Sacramento River and the Yolo Bypass near Davis to make it more suitable for fish habitat. "The idea is to enhance the connectivity between the Yolo Bypass and the Sacramento River," Conrad said.

During high flows, some water goes over the Weir and into the bypass whenever the river rises above 33 feet, a flood control mechanism that protects the city of Sacramento. The problem, Conrad said, is flooding is not happening all that frequently and even when it does happen it can be "very flashy."

Changes are needed to better mimic natural conditions, Conrad said.

"The idea is to increase the frequency and duration of flooding and to do that to target those modifications to the Weir such that we are likely to see those floodplain benefits for fish at the time they would be present."

Reviving salmon populations means providing sufficient flows and sculpting waterways to provide natural function.

"We need to restore the habitat mosaic along the migration corridor," Lindley said.

It means increasing flows, in the case of the San Joaquin River, re-watering stretches that have been dry more often than not. Restoration of the San Joaquin is controversial – farmers are angry about the reallocation of water back to the environment and are skeptical that a salmon population can return. However, a court ruling found that the construction of Friant Dam was done without adequate consideration to preserving the salmon population, as called for in the California Fish and Game Code.

"Given Fish and Game Code 5937, not maintaining native fish populations below the dam wasn't appropriate," Abrams said. "The settlement will result in some change, and people are nervous about it but I'm hopeful that people will see that we can all continue to work together on this."

The flow issue is a difficult one – it remains to be seen what comes of the State Water Board's updated Bay-Delta Water Quality Control Plan as well as new federal legislation that promises more water to people south of the Delta. Guy, for one, believes the issue goes beyond simply leaving more water in the rivers for fish.

"We have dedicated 1.3 million acre-feet of water for Delta outflow over the last decade," he told the State Water Board. "That's more water than is in Folsom Reservoir at its capacity and the question it raises is 'Has that water benefitted fish?' I suspect most people would say it has not."

Water temperature is crucial to salmon survival. It's believed better science and improved technology can prevent a repeat of a mass mortality event.

"In 2016, we maintained temperatures," Rea said. "That's a note of hope for this species."

On the American River, Gohring and his cohorts are looking to install a management regime that makes sense for people and the environment.

"We took the existing flow standard developed in 2006 and we figured out a way to make it operate in a way that we can get the water to be significantly colder," he said. "It involves having a little chunk of carryover storage behind the dam – we reduce minimum flows in the early part of year and hold it in reserve behind [the]dam – and that basically helps develop a bigger cold water pool, particularly in the driest years when the fish are most sensitive. We are in talks with Reclamation right now to convince them this is a good thing to do and a better way to operate."

Salmon fingerlings raised at the Oroville Fish Hatchery.

While work continues on the updated Bay-Delta Plan, an army of people continues its work to save the winter-run. In its action plan, NOAA Fisheries says the actions taken by the agencies and all its partners can "turn the trend around for this species from a declining trajectory to a trajectory toward recovery." ❖

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