NOAA FISHERIES
West Coast Region

Reintroducing Fish Upstream of Rim Dams: Providing Passage to Advance Salmon Recovery in California's Central Valley

Frequently Asked Questions

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The Role of Fish Passage in Salmon Reintroductions

Why is it necessary to reintroduce salmon into historical habitats in the Central Valley?

Salmon and steelhead in California's Central Valley are at risk of extinction in the wild because they lack the availability and range of habitats to be abundant, productive, diverse, and well distributed. The only way to offer the habitat that these fish need is to provide them access to their historic spawning and rearing areas in the upper tributaries above the dams.

NOAA Fisheries' 2014 Central Valley Salmon and Steelhead Recovery Plan calls for reintroducing salmon and steelhead populations into above-dam habitats in key watersheds. A scientific group called the Technical Recovery Team (TRT) provided the foundation for the recovery plan, and these experts recognized that access to higher elevation habitats is essential for a number of reasons. One key reason is that these above-dam habitats are among the few areas in Central Valley rivers likely to remain cold in the face of warming temperatures predicted to accompany climate change. Salmon depend on cold water throughout their life cycle in order to survive

The purpose of these reintroductions is to support recovery of important populations identified in the Recovery Plan. No introductions are being planned at this time for the purpose of rebuilding commercial fish stocks.

Are salmon really native to California's Central Valley? How can they survive in the warm waters of Central Valley rivers?

Millions of wild salmon and steelhead once thrived in the mountains and foothills of California's Central Valley. Sprawling urban centers and agricultural lands have transformed this historical landscape, and the Central Valley's rivers now include infrastructure to support domestic and agricultural water use, hydropower, and flood protection. Dams now block adult fish from more than 90 percent of their historical spawning and rearing habitat, and their populations have declined accordingly. Today, three of the Valley's salmon and steelhead species are protected under the federal Endangered Species Act, in large part because of these changes to the landscape: Sacramento River winter-run Chinook salmon (endangered), Central Valley spring-run Chinook salmon (threatened), and Central Valley steelhead (threatened).

For these salmon and steelhead populations to survive and recover in the wild, they must be able to weather environmental changes that may send their numbers higher or lower. There must be enough adults capable of reproducing and replacing themselves over generations. They must also be well distributed across the landscape so catastrophic events (such as disease or landslides) do not wipe them out.

Salmon and steelhead require cold water throughout their life cycle in order to survive. Water in the lower portions of Central Valley rivers frequently exceeds safe temperatures and is likely to get warmer in the future. For example, the survival of Chinook salmon eggs decreases as water temperatures increase above 56 degrees F (13.3 degrees C). Specifically, cumulative winter-run Chinook salmon mortality between the egg and smolt life stages nearly doubles when temperatures increase from 13.3ºC (56ºF) to 14.4ºC (58ºF). Therefore, habitat at higher elevations is more likely to provide the conditions needed to support healthy salmon and steelhead populations now and for generations to come.

If dams block fish from historical habitat, what fish passage alternatives are available to support fish reintroductions in California's Central Valley?

The Central Valley includes a series of rim dams, most between 100 and 600 feet high that block access to 90 percent of historical salmon spawning and rearing habitat.[1] Providing passage past these large barriers is key to successfully restoring healthy, viable salmon populations.

The *2014 Central Valley Salmon and Steelhead Recovery Plan* lays out clear priorities for areas and locations in which to pursue fish passage programs in the Central Valley. The Plan is guided by a scientifically-based outline of each species' population characteristics. The Plan also clearly states that not all populations need to be viable in order to achieve species recovery. In fact, it lays out only four primary areas for species reintroductions: the McCloud River, Battle Creek, the upper Yuba River watershed, and the San Joaquin River.

Because these rim dams are so tall, reintroducing salmon and steelhead into historical habitats above the dams may require assisted fish passage in both upstream and downstream directions. Generally speaking, to identify the most appropriate fish passage design for a particular project, NOAA Fisheries engineers assess each site's characteristics and take into account fish biology; engineering feasibility; and other management, social, and economic considerations. If engineers determine that conventional fish ladders are technically infeasible to use at a particular location, other fish passage options, including collection-and-transport operations, may be required to provide passage around the dams.

When pursuing fish passage at rim dams, what factors are considered to inform how passage should be designed?

When evaluating fish passage alternatives at rim dams, NOAA Fisheries recognizes that each project is unique and requires fishway designs or passage recommendations tailored to the specific dam, species, and management objectives. These considerations include:

- The quantity and quality of blocked, or partially blocked, habitat upstream of the dam, and whether providing fish passage to the available habitat will support near-term and long-term management goals, such as recovering a species or rebuilding commercial fish stocks.
- Whether providing access to the blocked habitat could reduce risk to the species from projected impacts associated with climate change.
- The importance of the individual fish population to overall recovery of the species.
- The technological feasibility of providing upstream and downstream fish passage and the level of engineering complexity.
- Land ownership patterns and the practicality of managing populations on public vs. private lands above rim dams.
- Benefits to the ecosystem and how providing fish passage would contribute to healthy fish runs that support other marine resources, such as marine mammals.

How do you physically reintroduce adult fish upstream of rim dams?

Moving salmon upstream of dams typically requires fish passage in the form of fish ladders or collection-and-transport operations. Fish ladders allow migrating salmon to swim past a barrier using their own swimming ability and behavioral cues, while collection-and-transport programs may move fish past a dam via tanker trucks and/or barges. NOAA Fisheries prefers the use of fish ladders where practical and possible. However, collection-and-transport operations provide successful options to restore upstream passage for many salmon and steelhead populations where fish ladders are not practical or possible, or in cases where collection-and-transport is safer for the fish or offers other, significant advantages (for example, in locations where there isn't enough room to accommodate a ladder). *Please see "Are there examples of effective collection-and-transport programs?" below.*

[1] Yoshiyama, R.M., E.R. Gerstung, F.W. Fisher, and P.B. Moyle. 2001. Historical and Present Distribution of Chinook Salmon in the Central Valley Drainage of California. Contributions to the Biology of Central Valley Salmonids. Vol. 1. California Department of Fish and Game. Fish Bulletin 179. R.L. Brown, ed.

Once adult fish are transported upstream of rim dams, how do their offspring get downstream?

Providing downstream passage for juvenile fish is one of the most significant engineering and biological challenges in reintroduction programs. Offspring of adult migrants transported upstream of a barrier must make their way downstream to the ocean as part of the next generation's life cycle. Providing downstream fish passage is just as critical as providing upstream passage. Juveniles can pass downstream of a dam in one of three ways: spill (juvenile fish pass through spillways over the dam); juvenile collectors (flows attract fish to a structure where they are collected and transported around the dam); or water passed through a portal designed for power generation or water diversion (properly designed screens protect fish from turbines or diversions and guide them downstream through a bypass system). Downstream passage technologies, similar to adult passage, require evaluation of site characteristics, fish biology, and engineering feasibility, among other considerations.

What does successful fish passage look like?

Engineers, including those at NOAA Fisheries, consider several factors when evaluating the success of fish passage designs. Fish passage must be safe, timely, and effective. Risk of physical injury, stress to the fish, and passage delay must be minimal, and the system must be able to pass sufficient numbers of adults upstream and juveniles downstream to support a viable population. Ultimately, fish passage is site-specific, and based on pre-defined collection and population targets.

Isn't dam removal more effective than investing in fish passage programs?

NOAA Fisheries considers various methods of providing fish passage. In some cases, the dam owner may decide removal is appropriate because the costs associated with repairs or passage measures exceed the benefit(s) of the dam. In other cases, dams provide significant economic and societal benefits, such as flood protection and water storage for agricultural and domestic use, and passage alternatives must be considered within a broader context. In California, for example, the Central Valley Project and State Water Project supply drinking water to 25 million people and sustain an agricultural economy that is worth over $40 billion a year.

Investing in fish passage will ensure the public continues to benefit from dams that are useful and valuable. It will also ensure that salmon can access historical habitats to support their long-term recovery, which itself provides significant value to local economies (including through commercial and recreational fisheries) and support for cultural traditions.

Fish passage does require significant investments, and it is difficult to provide precise cost estimates in the early phases of design, as all projects are different. Once passage designs are roughly 30 percent complete, cost estimates become more reliable. For both upstream and downstream passage, costs are influenced by site conditions, designs, and construction. These costs are part of maintaining a dam infrastructure.

Providing Fish Passage via Collection-and-Transport Programs

What is collection-and-transport and how does this passage technology work?

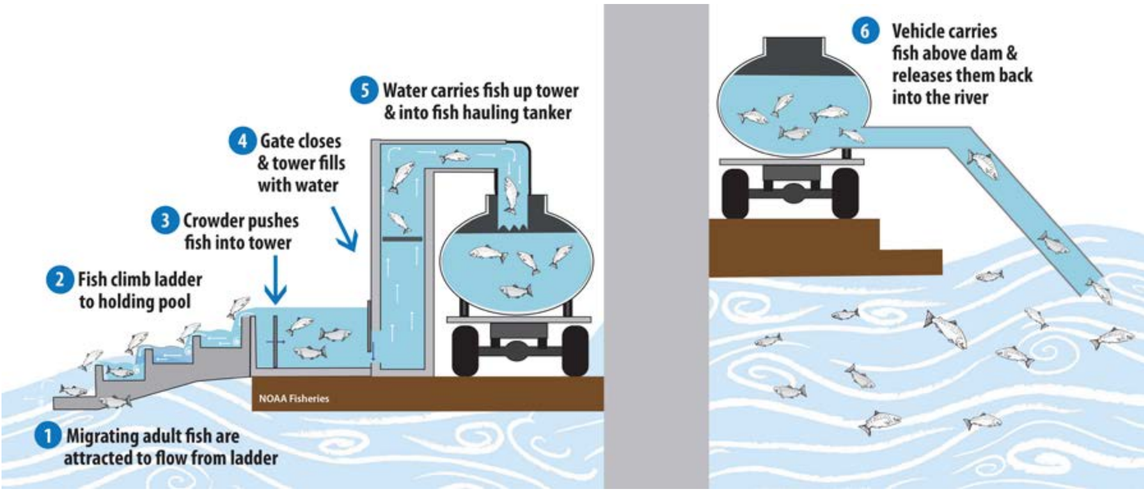
Collection-and-transport programs facilitate *non-volitional* fish passage (meaning that fish are moved around a barrier through outside intervention, as opposed to swimming past the barrier *of their own volition* using behavioral cues). Collection-and-transport programs are used to support upstream and downstream migrations when:

- Tall dams have site or structural constraints that make it infeasible to install a conventional fish ladder;
- Volitional passage technologies cannot effectively support juveniles out-migrating to the ocean;
- Use of this technology reduces migration delay and exposure of juveniles migrating downstream to predators in large reservoirs; and/or
- Environmental conditions, such as a series of dams, preclude safe and efficient volitional passage either for adults migrating upstream or for juveniles migrating downstream.

Facilities are designed to collect migrating fish at one location, transport them around a barrier or sequence of barriers, and release them at a different location. Successful collection-and-transport programs are designed to limit human contact and reduce stress to fish. Each operation is tailored to a particular project, river system, fish species, and set of management objectives. Significant improvements in different types of operations and engineering designs have occurred in recent decades.

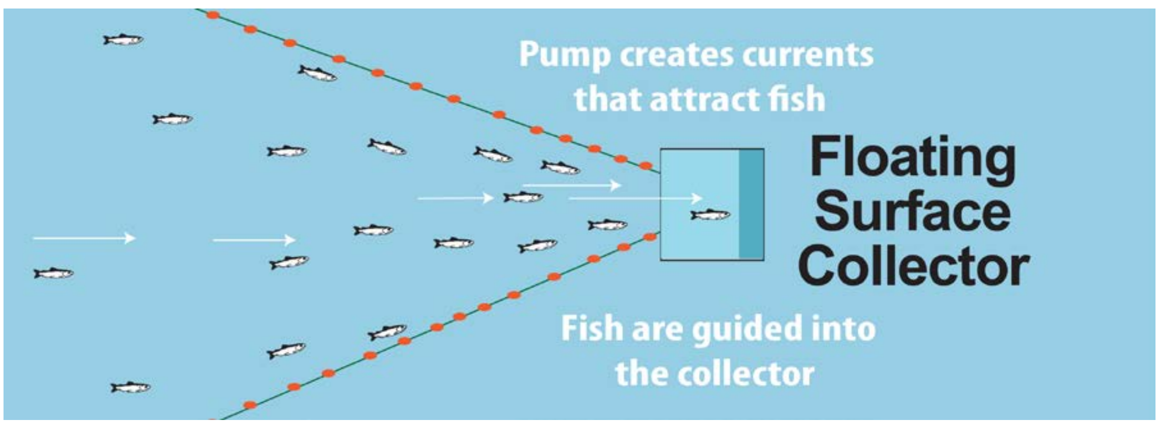
Example of Adult Passage Technology

Under a basic operation, migrating salmon are attracted to flow at the base of a fish ladder. They swim up the ladder to a loading system, where they hold in pools or tanks before transfer into specialized tankers or barges. These vehicles release the salmon into the river on the other side of the dam. Though all collection and transport facilities are different, the diagram below gives an example of an operation using specialized tanker trucks.



Example of adult fish passage using a fish ladder and specialized tanker vehicle

Floating surface collectors are another form of collection-and-transport technology that supports downstream fish migration. Under this design, a barge located in a reservoir, is equipped with a series of submerged screens, water pumps, fish-holding chambers, a fish-evaluation station, equipment-control rooms, and a fish-loading facility. Floating surface collectors are able to adjust to the fluctuations in water levels behind the dam, and water pumps provide flow that attracts juvenile salmon into a collector facility. Once inside the structure, fish are held in specially designed tanks and transferred to an evaluation station where scientists collect data on collection effectiveness, migration size and composition, and fish health. After evaluation, fish are transported by tank trucks below the dam(s) and held for a brief period in stress-relief ponds before continuing their seaward journey.



Juvenile fish collection for transport using a floating surface collector

What are the effects of the collection-and-transport passage method on adult fish?

All migrating fish naturally experience some level of stress. NOAA Fisheries designs fish passage facilities, whether volitional or non-volitional, to minimize stress, injuries, and passage delays. Collection-and-transport technologies have improved significantly in recent decades, and the state-of-the-art collection-and-transport methods of today have minimal adverse effects on migrating adult salmon and steelhead.

While the act of collecting, handling, and transporting adult salmon and steelhead around passage barriers does cause some additional stress, studies demonstrate that these fish are able to quickly recover (*i.e.*, their stress levels decline to background levels) and resume their normal behavior (Wagner and Driscol 1994; Barton, 2002).[2]

Are there examples of effective collection-and-transport programs?

Yes. Collection-and-transport programs have been used at 19 projects across the Pacific Northwest, with successful results. Two examples are described below.

Baker River Hydroelectric Project

In Washington's Baker River, NOAA Fisheries and Puget Sound Energy designed and installed floating surface collectors (FSC) at the Baker River Hydroelectric Project. The downstream passage technology contributed to the recovery of sockeye salmon that, as recently as the mid-1980s, faced extinction in this river system. In 1987, for example, 71 sockeye salmon migrated to the ocean. In 2014, after the installation of the FSCs in 2008 and 2013, over one million juvenile fish, predominantly sockeye, completed the same migration. The data for adult returns shows similar improvements. In 1985, 99 adults returned to the Baker River, while in 2015, over 50,000 adults returned.

These returns are noteworthy, and they are the direct result of over 9 years and 200 meetings, site visits, and workshops, all conducted in a spirit of collaboration aimed at achieving Baker River project relicensing, consultation, and passage design. Today, these sockeye returns are able to support tribal and recreational fisheries for the first time in decades.

Midway through work on the Baker River project, NOAA Fisheries realized that the bottleneck to success was getting juvenile salmon out of the system. An FSC ultimately allowed us to achieve our desired outcome. FSCs represent the next generation of downstream fish passage technology, and are routinely recognized as the gold standard in the industry. The Baker River project's FSCs provide the industry and regulators with proven designs that are now incorporated at other projects, including the Cushman, Clackamas River (North Fork Dam), Lewis River (Yale Dam), and Pelton-Round Butte Hydroelectric projects, and at the Cougar Dam.

Mud Mountain Dam

Mud Mountain Dam is located in Washington's White River watershed. Adult steelhead and Chinook, pink, and coho salmon are collected and transported upstream of the project, while juveniles pass downstream via tunnels in the dam. Historically, passage at the dam resulted in significant delay and low survival rates. In 2015 the U.S. Army Corps of Engineers changed operations to achieve a higher survival rate (95 percent) for juveniles. They did so by discharging most inflowing water through an outlet that has been demonstrated to be safer during the peak outmigration. Additionally, over the short term, they are improving adult passage by removing hazards at the diversion dam while they design and construct a modern collection-and-transport system that will be in place by 2020. This short-term change in operations has resulted in 2,000 Chinook and over one million pink salmon successfully migrating through the project.

In this example, one of the main bottlenecks to passage success was the lack of flow for fish to migrate through 21 miles of the White River. Once flows were increased, salmon and steelhead populations, especially populations of pink salmon, quickly responded. The collection-and-transport system being designed for this project will accommodate the increase in salmon abundance resulting from these newly restored flows.

This success did not happen overnight. NOAA Fisheries has been working through an Endangered Species Act consultation with the U.S. Army Corps of Engineers since 2012 on the Mud Mountain Dam project. With an end date of 2020 for construction of the collection-and-transport system, this represents eight years of cooperative investment among multiple stakeholders to ultimately finish the project.

How are hatchery fish factored into determining the effectiveness of collection-and-transport programs?

Both wild and hatchery fish can be transported above barriers, and decisions about whether passage of hatchery fish is appropriate are based on specific biological goals and objectives identified for individual reintroduction programs. Due

[2] Wagner, E.J., and D.M. Driscoll. 1994. Physiological stress responses of cutthroat trout to loading by fish pump, conveyor, or dip net. Journal of Applied Aquaculture (4)1. Pages 19-27.

Barton, B.A. 2002. Stress in Fishes: A Diversity of Responses with Particular Reference to Changes in Circulating Corticosteroids. Integrative and Comparative Biology. 42:517-525.

to state-of-the-art collection-and-transport facilities with improved collection and sorting methods, both wild and hatchery fish encounter minimal stress and demonstrate high survival rates (e.g., $\geq$ 98 percent for adult fish), making this type of passage a successful tool to move fish—regardless of their origin—past a barrier to continue their migration.

Providing successful fish passage is a separate consideration from overall management of hatchery fish. Decisions about conservation goals and how fish passage programs support these goals shape how to manage hatchery fish and inform overall management of a passage program both below and above a barrier. When evaluating passage programs, managers must consider:

- The number of hatchery fish on the spawning grounds and competition with their wild counterparts;
- The goals for an individual population's genetic make-up and how gene flow between hatchery and wild fish may influence this; and
- Species conservation and fisheries production goals.

With these considerations in mind, collection-and-transport programs have served as an effective tool to allow managers to control the influence of hatcheries on wild fish. Some hatchery programs, for instance, are designed to prevent hatchery fish from passing upstream of a barrier to prevent the adverse influence of hatchery fish on a wild population. In other instances, hatchery fish are selectively passed upstream of a barrier to enhance the abundance of natural spawners and, in the longer term, facilitate establishment of a self-sustaining population. These are just two of a number of different ways to operationally address overall genetic diversity goals of a specific reintroduction program.

In California, the Hatchery Science Review Group report of 2012 provided recommendations to reform certain hatchery practices. These reforms are currently being implemented, and they are separate from discussions regarding species reintroduction. There are currently no active discussions in California to create passage programs at large dams to enhance commercial fisheries. The reintroductions currently planned in California are specifically intended to meet species recovery goals. To jump start reintroduction efforts, conservation hatchery practices may be needed during initial phases. As the reintroduced population takes hold and becomes more viable through natural production, the conservation hatchery would be phased out.

Are collection-and-transport programs and other fish passage programs a solution for salmon recovery?

Fish passage programs, including collection-and-transport, are critical to advancing salmon recovery in many watersheds. Without the ability to restore and sustain salmon populations through these operations, some species cannot be recovered. Collection-and-transport programs are one tool among many used to restore Pacific salmon and steelhead protected under the Endangered Species Act.

In general, threatened and endangered salmon and steelhead face multiple threats, and reintroduction alone, regardless of passage type, will not be sufficient to achieve species recovery. In addition to being blocked from spawning habitat by dams, salmon face many other challenges throughout their life. For example, lost and degraded rearing habitat, water withdrawals, and predation by non-native fish all contribute to poor survival for Central Valley spring-run Chinook salmon and steelhead juveniles swimming through the Sacramento River and Delta. All of the key threats to salmon and steelhead will need to be addressed to recover these species.

What considerations, beyond providing fish passage in a particular watershed, go into recovering salmon and steelhead?

Fish passage is one consideration among many that inform salmon and steelhead recovery efforts. For example, in the Sacramento and San Joaquin river basins, over 94 percent of historical riparian habitat and over 95 percent of historical wetlands are no longer available to support healthy fish runs. Additionally, over 95 percent of the original 550 square miles of tidal wetlands in the Delta are gone (TBI 2003).[3] In addition, degradation of accessible habitat, altered stream flows, warm water temperatures, reduced Delta outflows, predation by non-native fish, and legacy effects of hatcheries all contribute to the current status of the Central Valley's listed species.

Federal recovery plans identify key threats facing salmon and steelhead populations and outline actions that should be completed to recover the protected species. NOAA Fisheries' *2014 Central Valley Salmon and Steelhead Recovery Plan*, for example, sets goals and prioritizes watersheds and actions for the Sacramento-San Joaquin basin by

[3] The Bay Institute of San Francisco (TBI). 2003. *From the Sierra to the Sea: The Ecological History of the San Francisco Bay-Delta Watershed*. http://www.thebayinstitute.org/page/detail/164.

considering the factors that affect species' viability, including abundance, productivity, spatial structure, and diversity, as well as the threats impacting those parameters.

Salmon Reintroductions in the Central Valley & the Role of Collection-and-Transport Programs

Where are efforts to reintroduce salmon and steelhead above rim dams underway in California's Central Valley?

NOAA Fisheries and partners are working to re-establish viable populations of salmon and steelhead in key watersheds throughout California's Central Valley. In some areas, reintroductions are underway, while others are still in the planning phase. These include:

1. Reintroducing Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon upstream of Shasta Dam to the McCloud and/or Upper Sacramento rivers. A pilot reintroduction feasibility plan is being developed by the U.S. Bureau of Reclamation in collaboration with NOAA Fisheries, the U.S. Fish and Wildlife Service, the California Department of Fish and Wildlife, and the California Department of Water Resources.
2. Reintroducing Central Valley spring-run Chinook salmon, and potentially Central Valley steelhead, to the North Yuba River upstream of Englebright Dam. Through the Yuba Salmon Partnership Initiative, NOAA Fisheries, California Department of Fish and Wildlife, Yuba County Water Agency, American Rivers, Trout Unlimited, and the California Sportfishing Protection Alliance are evaluating options for reintroducing fish to 30 miles of free-flowing cold water habitat.
3. Reintroducing Central Valley spring-run Chinook salmon to the San Joaquin River. Through the San Joaquin River Restoration Program, NOAA Fisheries, the U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, California Department of Fish and Wildlife, California Department of Water Resources, National Resource Defense Council, and Friant Water Authority are actively reintroducing spring-run Chinook to the river system. Through an Endangered Species Act Section 10(j) experimental population designation, NOAA Fisheries and partners are using fish raised in hatchery facilities to re-establish the population. In 2016, spring-run Chinook were released into the river, marking the first time in 66 years those fish swam in the river.
4. Reintroducing Central Valley steelhead and spring, fall, and winter-run Chinook salmon to Battle Creek. The California Department of Fish and Wildlife is developing a reintroduction implementation plan that is expected to be released in the fall of 2016.

Will collection-and-transport be used in reintroduction efforts in the Central Valley?

Collection-and-transport programs are being evaluated as a method to reintroduce salmon into the upper Yuba River and McCloud and/or Upper Sacramento rivers, similar to successful efforts already underway in the Pacific Northwest. *Please see "Are there examples of effective collection-and-transport programs?" above.*

In the Yuba River, specially designed facilities and trucks would be used to collect Central Valley spring-run Chinook salmon downstream of Englebright Dam and transport them upstream of New Bullards Bar Dam, where they would be released into the North Yuba River. If this alternative is selected, more than 30 miles of historical spawning habitat would be re-opened to this threatened species. Similar efforts would occur for juvenile out-migrants. The program would collect and safely transport juvenile salmon in the winter and spring by collecting them upstream of New Bullards Bar Dam and releasing them downstream of Englebright Dam. An intensive monitoring program would evaluate the condition of fish and overall success of the collection-and-transport program. If successful, similar passage methods might be used for Central Valley steelhead.

Similarly, the U.S. Bureau of Reclamation and partners are evaluating strategies for reintroducing Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon upstream of Shasta Dam in 2017. As required by *NOAA Fisheries' Biological Opinion and Conference Opinion on the Long-Term Operation of the Central Valley Project and State Water Project*, the U.S. Bureau of Reclamation is moving forward with its Shasta Dam Fish Passage Project to reintroduce winter- and spring-run Chinook salmon to the McCloud and/or Upper Sacramento rivers. The first phase of the project will be small-scale and use collection-and-transport passage techniques. The U.S. Bureau of Reclamation will evaluate the effectiveness of these fish passage methods and will assess how winter- and spring-run Chinook salmon, at all relevant life stages, utilize the newly accessed habitat in the reintroduction area. A monitoring and evaluation program will be conducted and will inform appropriate next steps for the full-scale reintroduction program, which may also include wild Sacramento River spring-run Chinook salmon.

Why is collection-and-transport considered the best method for providing passage in these areas?

Partners are evaluating numerous alternatives for fish passage in the Yuba River, including the installation of fish ladders and the removal of Englebright Dam. There are challenges with each of these passage methods. At 260 feet high, and with additional site constraints, Englebright Dam's configuration may prevent installation of an effective fish ladder. The reservoir also holds 28 million cubic yards of sediment, and releasing this sediment below the dam could increase flood risk. In addition, some of the sediment is contaminated with arsenic, mercury, and other toxic substances from historical mining practices of the Gold Rush era. For dam removal to occur, flood risk to downstream communities would have to be mitigated and the contaminated sediments addressed (and possibly removed). Removal of the dam would additionally require Congressional action, but if authorized to proceed, salmon would still not have access to the best habitat in the North Yuba River upstream of New Bullards Bar Dam, which is over 600 feet high. Alternatively, the use of a collection-and-transport program in the Yuba River will re-connect threatened salmon to over 30 miles of prime habitat and contribute to the species' recovery, and it can be achieved expeditiously.

In the McCloud and Upper Sacramento rivers, the U.S. Bureau of Reclamation is evaluating alternatives for a successful reintroduction program. They are implementing a pilot program to assess a variety of biological issues and engineering challenges. During the pilot phase, the U.S. Bureau of Reclamation will initiate a collection-and-transport operation to evaluate the biological response of Sacramento River winter-run and Central Valley spring-run Chinook salmon in the McCloud and/or Upper Sacramento rivers. After the pilot program is completed and evaluated for effectiveness, additional passage options will be assessed, including volitional passage and collection-and-transport methods.

What role do hatchery fish play in reintroduction efforts?

When reintroducing fish to historical habitats, it is important to consider the abundance and genetics of the source fish to be used to re-establish the population. A recolonization strategy can either use wild fish to naturally recolonize the habitat, transplanted fish from another watershed, hatchery releases, or a combination as appropriate. In some cases, hatchery fish must be used to spur fish recolonization and initial production because the number of wild fish is not sufficient to implement a reintroduction strategy without potentially harming the wild population. In many situations, hatchery fish should be used as the source population in the early phases of a reintroduction. Then, as the population grows, long-term management efforts will focus on limiting hatchery influence to protect the genetic integrity of the wild offspring.

When hatchery fish are chosen as the source population for a reintroduction, fish are often selected from conservation hatchery programs. Conservation hatcheries preserve the genetic legacy of a species facing extinction by maximizing genetic diversity. These programs serve to supplement salmon populations until they are determined to be self-sustaining in the wild. To advance reintroductions, the programs collect small numbers of broodstock (either wild, or carefully selected fish from mitigation hatcheries based on genetic or phenotypic characteristics) to raise in a conservation hatchery setting. The fish are then genetically tested, and spawned according to a breeding matrix that minimizes hatchery influence and increases genetic diversity from the available population. The offspring are then reintroduced to rivers where they can recolonize the newly available habitats.

Will hatchery fish be used to reintroduce fish in the Central Valley?

In the Central Valley, reintroducing salmon to target watersheds will contribute to the species' long-term recovery by improving the populations' geographic distribution, productivity, diversity, and abundance, thereby reducing the current risk of extinction. Reintroductions may use hatchery fish to initiate these programs because the number of wild fish are too low.

In the McCloud and Upper Sacramento rivers, the U.S. Bureau of Reclamation's Shasta Dam Fish Passage Project will reintroduce Sacramento River winter-run and Central Valley spring-run Chinook salmon to cold water habitat above Shasta Dam in 2017. For winter-run Chinook salmon, the reintroduction program will initially use fish from the Livingston Stone National Fish Hatchery[4] because wild Sacramento River winter-run Chinook salmon numbers are

[4] In the first phase of the reintroduction in the McCloud River, the U.S. Bureau of Reclamation will move approximately 120 Sacramento River winter-run Chinook salmon adults and their offspring from the Livingston Stone National Fish Hatchery

critically low, and the Livingston Stone's Chinook Salmon Conservation Program is conserving the last remaining genetic resources of this highly endangered species.

In the case of the San Joaquin reintroduction, the San Joaquin River Restoration Program is implementing a conservation hatchery program with the Salmon Conservation and Research Facility. This program will collect limited numbers of fish, spawn them so the population grows, and then release them into the river. The program includes two phases. The first phase, which is now underway, is initially using Central Valley spring-run Chinook salmon from the Feather River Hatchery. The second phase will entail collecting fish in the wild. Currently in phase one, fish are collected, making sure their parents' adipose fins are clipped to limit hatchery influence. They are then raised for three years in the Salmon Conservation and Research Facility, spawned according to a genetic spawning matrix to increase population numbers, and then released into the San Joaquin River. This program will be phased out after a self-sustaining population is re-established.

In the Yuba River, one of the first goals is to select the source stock to be used for reintroduction. The primary goal of source stock selection is to identify the stock(s) with the highest likelihood of establishing a self-sustaining, naturally reproducing population in the upper Yuba watershed. Potential stock sources for reintroduction into the Yuba may be comprised of eggs, juvenile, and adult Chinook salmon and steelhead from one or more source populations of either natural or hatchery origin. In general, reintroductions have a greater potential for success when the donor populations' life histories are compatible with the habitat and environmental conditions present in the reintroduction area (as modified by other restoration efforts). Stock sources from populations closer in proximity to the reintroduction area typically have a greater likelihood of success because they are more liable to be adapted to the local environment.

What role will biological monitoring play in evaluating the success of collection-and-transport programs in these reintroductions?

Biological monitoring and evaluation plays a pivotal role in assessing the effectiveness of all fish passage methods, including collection-and-transport programs. Among other metrics, on-the-ground monitoring will evaluate whether moving fish into the reintroduction area using collection-and-transport programs contributes to fish successfully recolonizing the newly accessed habitat, or whether managers need to refine strategies as the program progresses. But providing fish passage is only one management consideration in rebuilding a self-sustaining population. These fish must also successfully complete the remainder of their migration to and from the Pacific Ocean, and habitat and ocean conditions significantly influence fish survival.

Will fishing be affected by reintroducing protected salmon and steelhead into these areas?

The Endangered Species Act provides a number of tools to support reintroduction of listed species, while simultaneously accounting for social and economic considerations, such as angling. Section 10(j) of the Endangered Species Act allows NOAA Fisheries to designate populations as "experimental" and this allows otherwise lawful activities, such as angling, to continue without individuals incurring liability. NOAA Fisheries is developing a Section 10(j) experimental population designation for the Shasta Dam Fish Passage Project and the Yuba Salmon Partnership's Yuba River reintroduction, while a Section 10(j) designation is already in place for the San Joaquin program.

Concurrently, the California Department of Fish and Wildlife is developing a "no take" regulation for the reintroduced Chinook salmon to ensure those fish would be released immediately if accidently caught by an angler. These measures will prohibit targeted angling of the reintroduced fish, but will make allowances for anglers who incidentally hook reintroduced Chinook salmon while they are otherwise complying with existing fishing regulations. New fishing opportunities may be available as the reintroduced population grows to a sustainable level.

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upstream of Shasta Dam. NOAA Fisheries anticipates using hatchery fish for the first three years of the reintroduction program because it will likely take at least two generations (8 to 10 years) using hatchery broodstock to establish a spawning population that includes wild fish. However, the proportion of hatchery fish utilized for the reintroduction program is expected to decrease over time as the population grows and naturally spawning fish begin to recolonize the habitat. When monitoring and evaluation indicates that there are sufficient wild returns, the program will shift to using natural-origin broodstock from adults returning to the reintroduction area.

Are Central Valley salmon and steelhead recovery efforts focused exclusively on fisheries reintroductions?

The Central Valley is a highly modified system of rivers, wetlands, and Delta channels, and recovery is a long-term endeavor that involves pursuing multiple actions simultaneously. The *2014 Central Valley Salmon and Steelhead Recovery Plan* not only identifies key watersheds to pursue fish passage alternatives to support recovery planning, but it also calls for restoring flood plain habitat, improving flows at key times of year, reducing effects of diversions, and minimizing by-catch of listed salmon in recreational and commercial fisheries.