NOAA FISHERIES

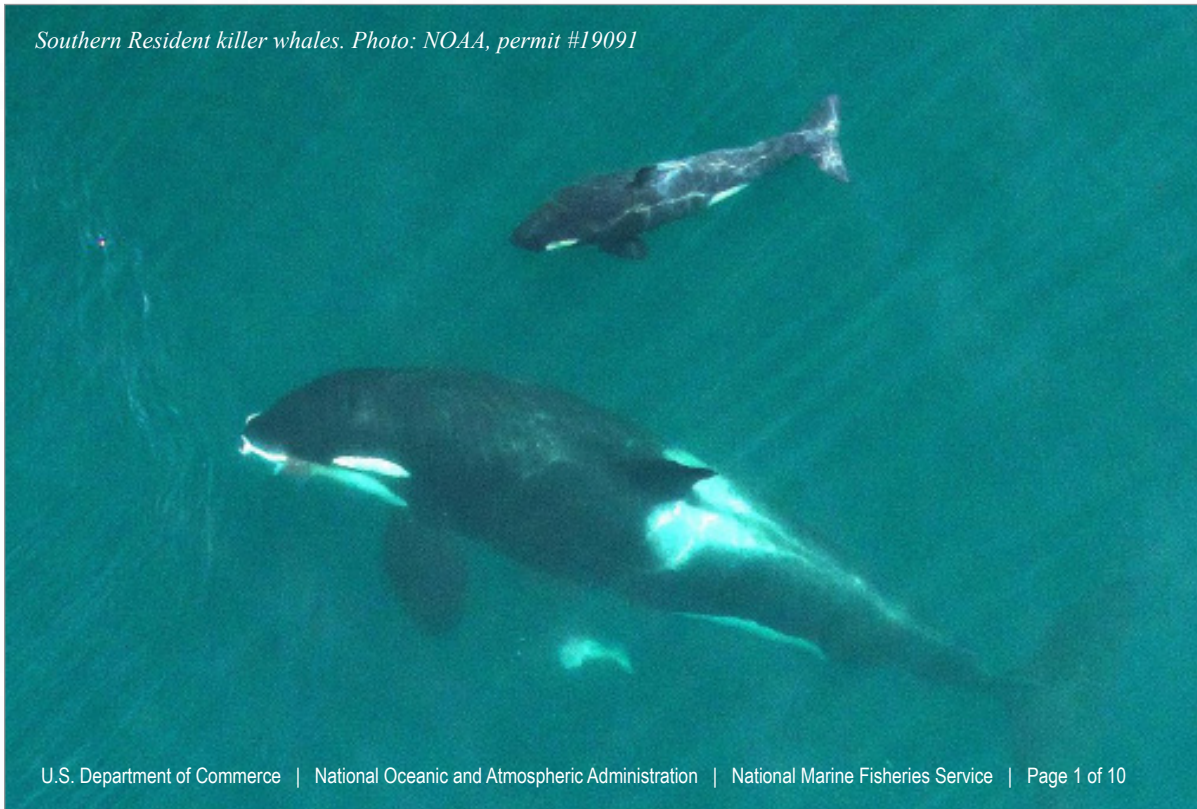
West Coast Region

Questions and Answers on Columbia Basin salmon, Snake River dams and Southern Resident killer whales

Introduction

The U.S. Army Corps of Engineers, Bureau of Reclamation, and Bonneville Power Administration are developing an environmental impact statement on the operations of hydroelectric dams on Columbia River hydrosystem. The role of NOAA's National Marine Fisheries Service (NOAA Fisheries) is to evaluate the impacts of the operations on threatened and endangered species. These include salmon and steelhead listed under the Endangered Species Act (ESA), and endangered Southern Resident killer whales. That evaluation will come in the form of a biological opinion to be delivered to the U.S. Army Corps of Engineers, Bureau of Reclamation, and Bonneville Power Administration, known together as the Action Agencies. It will also outline actions to mitigate those impacts.

Across the West Coast, dams pose a substantial obstacle to salmon recovery. These obstacles range from large dams on major rivers that may or may not include fish passage, to smaller barriers, such as outdated culverts where roads cross and block smaller tributary streams. Improvements in fish passage and removal of dams and barriers reflect important steps in recovering West Coast salmon and steelhead. NOAA Fisheries works with dam operators, land managers, tribes, communities, and other critical partners to improve passage and move salmon and steelhead toward recovery. This is especially true with respect to the lower Snake River Dams, which are the focus of these questions and answers.



Southern Resident killer whales. Photo: NOAA, permit #19091

Are Columbia Basin salmon in a continuing decline?

The last 10 years have seen some of the highest salmon returns to the Columbia Basin since Bonneville and other dams were built and, more recently, some of the lowest. Those fluctuations demonstrate that salmon numbers do not increase or decrease in a straight line, but vary widely depending primarily on ocean conditions and other environmental factors. The ocean is the "source of the most important and highly variable mortality" in the salmon life-cycle, according to the Northwest Power and Conservation Council's Independent Scientific Advisory Board.[1]

Many Columbia Basin salmon and steelhead are listed as threatened or endangered, while some have never been listed. Okanogan and Wenatchee River sockeye have returned in recent years in large numbers and support active fisheries, for example. Upper Columbia summer/fall Chinook, Deschutes River fall Chinook salmon, and Middle Columbia spring Chinook also remain unlisted.

The condition of ESA-listed stocks of salmon and steelhead vary. Upper Columbia spring Chinook and Snake River sockeye are among the most imperiled stocks, holding on in small numbers, while Snake River fall Chinook salmon have moved further towards recovery. Snake River fall Chinook have returned to spawn in numbers not seen since the decades prior to listing, and biologists reviewing their status have found them much improved, though still designated as threatened. Mid-Columbia steelhead have also improved substantially and are approaching de-listing abundance and productivity goals.

In terms of overall numbers, the Columbia River system in the last decade has seen the highest salmon returns since the first major federal dams were built in the late 1930s, with Chinook salmon returns topping one million annually in 2013-2015 before ocean conditions declined. Hatcheries produced many of the fish to support fisheries and offset the impacts of the dams. More salmon and steelhead smolts migrate out of the Columbia system now than before the dams were built, most of them from hatcheries.[2]

Salmon and steelhead stocks support other animals in the ecosystem, including California sea lions, seals, and seabirds. Pinnipeds prey on salmonids of all ages, while seabirds feed on juvenile salmonids first heading to the ocean. Some of these animals were once also at-risk but have increased in number with conservation measures. Predators now consume more Chinook salmon on the West Coast than fishermen catch, according to a 2017 analysis of what happens to Chinook from West Coast rivers. Once targeted by bounties and market hunting, for example, California sea lions have since rebounded and consumed an estimated 700,000 Chinook salmon of varying ages in 2015.[3] Salmon recovery efforts have largely supported that demand while further improving the status of many salmon and steelhead stocks. In some cases, the many mouths to feed has posed risk to the salmon and steelhead prey of these predators. Therefore, until these at-risk salmonid species recover, management of predation in certain areas is carried out, such as in the Columbia and Willamette Rivers.[4]

Climate change may test the resilience of many salmon stocks on the West Coast as river and ocean temperatures increase over time and ocean acidification affects the marine food web.[5]

Spawning Fall Chinook salmon adults. Photo: Ryan Hagerty, USFWS

Do the lower Snake River dams cut salmon and steelhead off from their spawning habitat?

The lower Snake River dams are among the most recent large dams to be built in the Columbia Basin, and provide passage for both adult and juvenile salmon. Improvements in their design and operation since their construction now provide some of the most advanced and effective fish passage systems anywhere. Adult salmon swim upstream through fish ladders, while juvenile fish migrating downriver to the ocean pass through dams via either hydroelectric turbines, bypass systems or spillways. New surface passage systems allow juvenile salmon and steelhead to pass through spillways at the surface, where they naturally migrate. Adult survival through the dams is often very high, although elevated temperatures in reservoirs they pass through can reduce their survival in summer months.

Many improvements in recent years have also focused on boosting juvenile survival. For instance, spilling more water over dams carries more juvenile fish through spillways, which in many cases provide safer and faster passage than other routes. Many dams on the Columbia and Snake rivers also now feature surface passage systems that allow the juvenile fish to pass through spillways near the surface of the river where they naturally migrate. That improves survival and speeds their trip through the dams so they reach the Columbia River estuary faster, taking advantage of a last growth opportunity that can boost their likelihood of survival in the ocean.

In contrast, some other dams lack fish passage. For example, the dams in Hells Canyon do not include fish passage and block access for Snake River species to much of their historic spawning habitat. Chief Joseph Dam, above Grand Coulee Dam, also blocks passage on the upper Columbia River.

Juvenile fish pass through the four lower Snake River dams with direct survival rates averaging about 70 to 75 percent.[6] In rivers without dams, survival of juvenile salmon does not reach 100 percent due to predation and other factors, so it is not clear how much of the mortality through the lower Snake River dams is directly attributable to the dams.

Another uncertainly in fish survival is what is called delayed, or latent, mortality. This refers to mortalities suffered by fish after they pass through the dams from the stress or injury associated with passage. Since delayed mortality happens after the fish pass the dams, it is difficult to measure, and estimates vary widely. One argument for breaching the Snake River dams is that doing so would reduce delayed mortality effects. If those effects are large, then reducing the impacts through dam removal could, in turn, yield greater returns of adult salmon and steelhead.

Hells Canyon. Photo: Shutterstock

Are Southern Resident killer whales starving to death?

For many years Southern Resident killer whale health and numbers showed a correlation with Chinook salmon abundance. For instance, coastwide fish abundance was linked to successful reproduction and survival. However a new Risk Assessment that analyzed the impacts of fishing on orca prey found that relationship has weakened.[7] In the last decade the Southern Residents have declined even in times of increasing or stable Chinook salmon abundance, at levels that had previously accompanied increases in whale numbers, the Risk Assessment found.

Researchers cite several reasons why whale numbers may not reflect the abundance of their salmon prey so closely. The small number of whale births and deaths in any year represent such a small sample size that they provide little statistical power to detect these relationships. The reduced correlation may also suggest that other factors besides prey are at play in the continuing decline of the Southern Resident population.

Prey availability is one main threat to the whales. Vessel noise and traffic and pollutants in coastal and marine waters are two other main threats. It is essential to address all three of these threats to help the whales recover. Even with abundant prey, the whales must be able to successfully hunt, have sufficient rest, and be healthy enough to reproduce successfully. Recent research has indicated that inbreeding and disease may also pose a risk to the population.

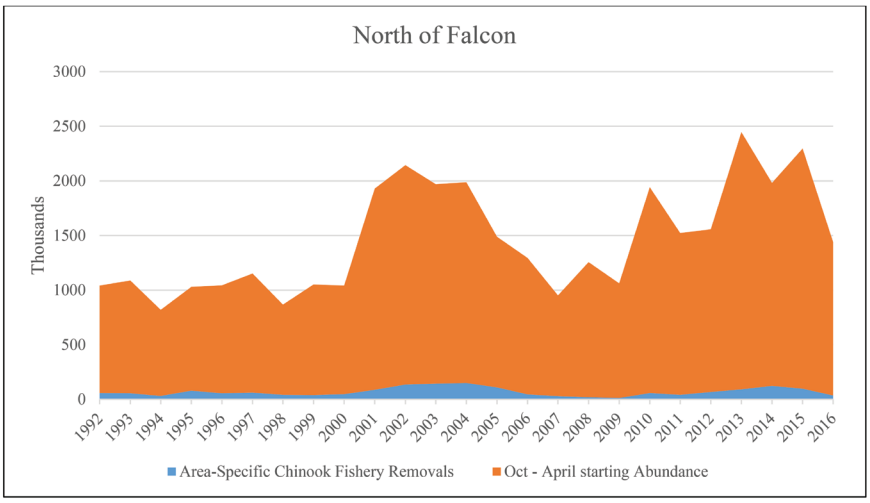


Figure 1 Graph from the PFMC Risk Assessment illustrates the average abundance of adult Chinook salmon off the northern Oregon and Washington coast in orange, and those fish removed by ocean salmon fisheries in blue.

Necropsies have identified a variety of proximate reasons for the deaths of Southern Residents, including reproductive complications, infections, and ship strikes. While many whales that die are never recovered, the limited number of stranding investigations have not identified whales as starving. In many cases, however, no cause of death could be identified. Researchers also believe risk factors can compound each other. Even if a whale is not starving, for example, reduced food availability can compound other health risks such as disease or infection that could impact a whale that is malnourished or whose immune system is compromised more than one that is well-fed and healthy. So prey abundance remains a recovery priority, but recovery efforts cannot overlook other factors, either.

Southern Resident killer whales. Photo: Dawn Noren, NOAA

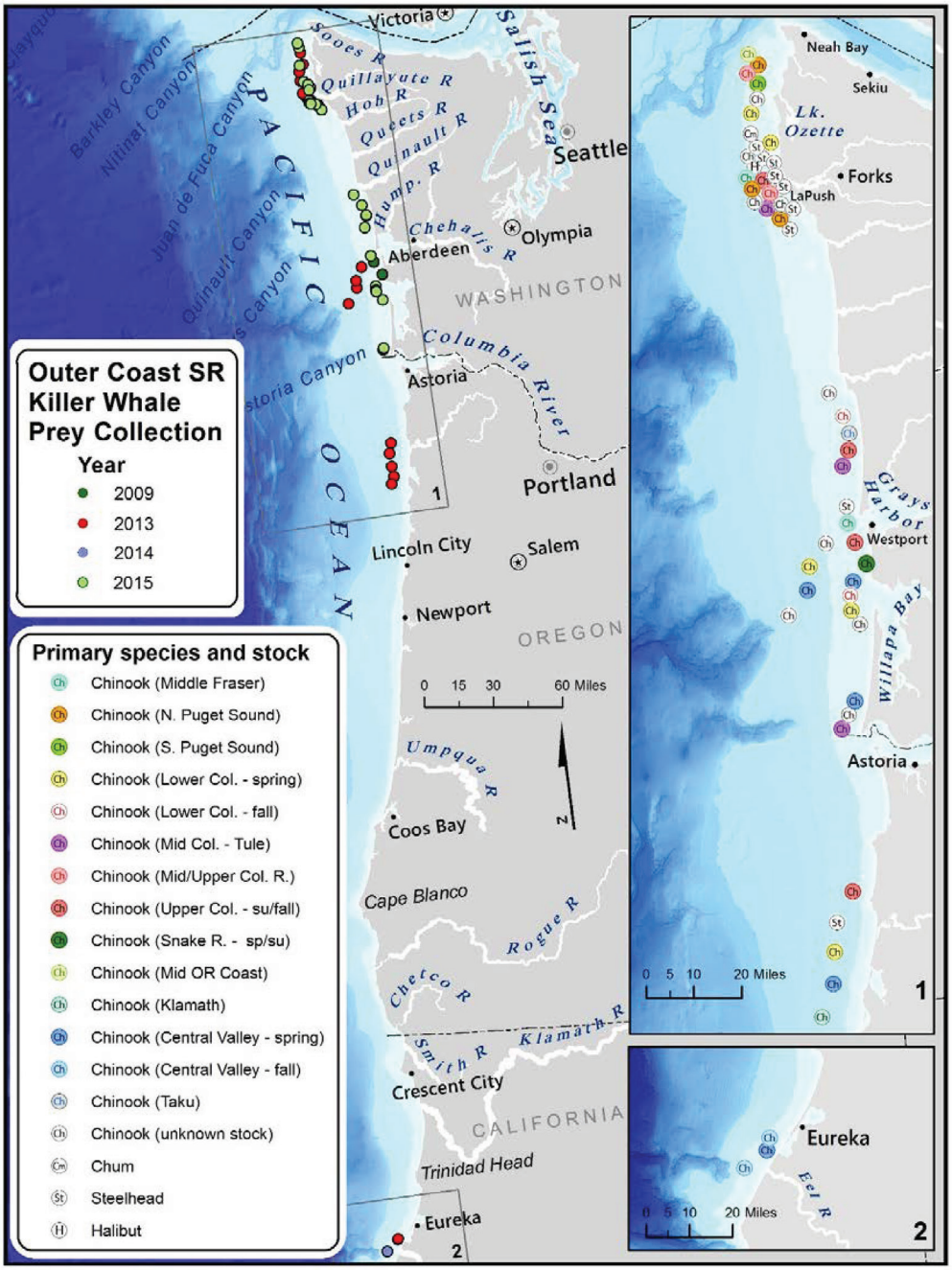


Figure 2 Map from Southern Resident killer whale critical habitat proposal illustrates where scientists collected samples of fish consumed by Southern Residents on the outer coast.

Do Southern Resident killer whales depend primarily on Snake River salmon?

Studies of Southern Resident prey have examined the DNA of scraps of salmon they ate and fecal samples to determine which stocks of salmon they rely on over the course of the year. This information is included in a Risk Assessment [8] developed to evaluate the impacts of fishing on orca prey, and the supporting documents for a proposal to expand critical habitat for the endangered Southern Residents.[9] It indicates that the whales feed on a wide range of stocks from rivers in and around the Salish Sea and the West Coast. Most of their summer diet when the whales are in the Salish Sea is Chinook salmon from the Fraser River, with an increasing component of coho salmon in late summer and sometimes a share of sockeye salmon.[10]

Two of the three Southern Resident pods regularly feed off the West Coast, especially in winter, where they encounter fish from many different salmon stocks including fish from as far south as the Sacramento and Klamath rivers or as far north as Puget Sound stocks or those from the Columbia River. While the whales prey primarily on Chinook salmon, they also consume some other salmon such as chum and sockeye, and some marine species such as halibut. Salmon stocks have different ocean migration patterns that often reach far into the Pacific Ocean. The return of adults from some of those stocks overlaps closely with the range of Southern Residents, and others less so. For instance, Puget Sound stocks overlap most fully with the Southern Residents, ranking highest in a priority list developed with the Washington Department of Fish and Wildlife.[11] The Southern Residents also prey on fish from the Snake River as well as many other parts of the Columbia River Basin, including the upper Columbia and especially the lower Columbia River below Bonneville Dam. The overlap with those stocks is more limited in time and place.

Fish from the Snake River were likely historically important to the Southern Residents in greater numbers than they now occur. However, NOAA Fisheries has determined in biological opinions that hatchery fish make up for Columbia Basin salmon lost to the impacts of the dams in terms of prey abundance for the Southern Resident killer whales.

Chinook hatchery. Photo: Sutterstock

Should hatchery fish be counted as prey available to the orcas?

When large federal dams were built in the Columbia and Snake River basins, part of the planned mitigation for their impacts was the construction and operation of fish hatcheries. This is also true for dams in other watersheds in Washington and California. Decision-makers at the time chose to make up for the lost fish production from habitat above the dams by expanding hatchery production. NOAA Fisheries provides Congressionally authorized funding through the Mitchell Act for many of these fish hatcheries, which together produce close to 40 percent of the millions of hatchery fish released in the Columbia River Basin each year. These hatchery fish, as well as those from other programs like conservation hatcheries, have therefore become an important source of Chinook salmon for the Southern Resident killer whales, especially the pods that forage near the mouth of the Columbia River in winter. In addition, some hatcheries have begun producing additional fish to supplement the availability of prey for the Southern Residents.

There is no evidence that the Southern Residents distinguish between hatchery and wild fish, although they are known to favor the largest, oldest salmon. Historically salmon were bigger than hatchery or wild fish are on average today, which may force the whales to expend more energy to forage.[12]

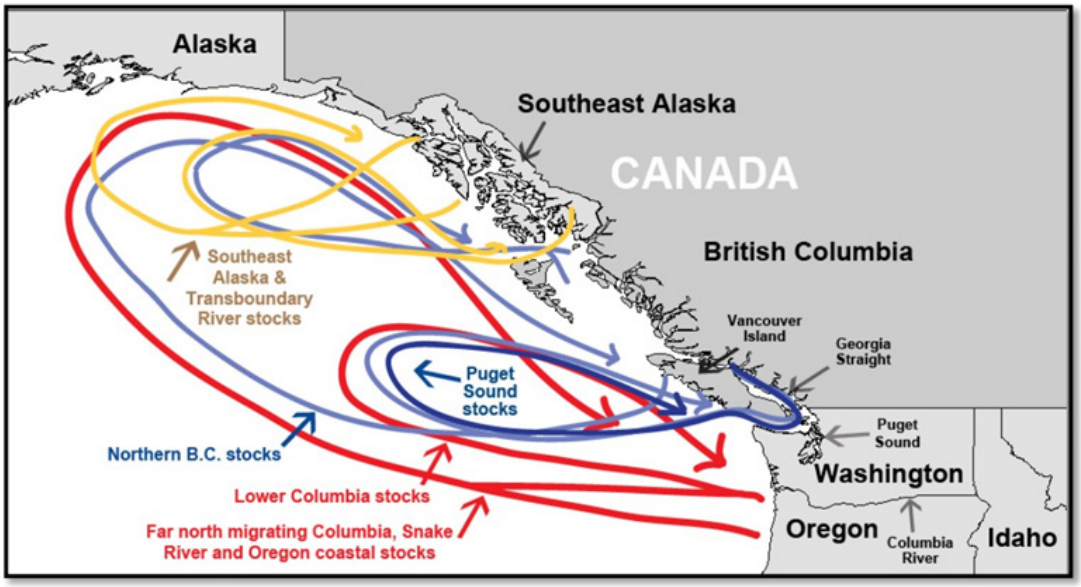


Figure 3 Migration patterns of different West Coast and Alaska Chinook salmon stocks. Different stocks overlap with the range of Southern Resident killer whales in different areas and times of year.

Will breaching the lower Snake River dams recover Columbia River salmon?

There are 13 stocks of salmon and steelhead in the Columbia Basin that are listed as threatened and endangered under the Endangered Species Act. Four of those 13 stocks return to the Snake River. The four are Snake River steelhead, Snake River spring/summer Chinook, Snake River fall Chinook, and Snake River sockeye, the last of which is among the most imperiled Columbia Basin species. Current modeling shows that these four stocks would significantly benefit from dam breaching and aid in their rebuilding and recovery. The other nine species return to other parts of the Basin, and may be affected by different dams. These include fish from the upper and lower Columbia Basin andthe Willamette River. For example, dams on tributaries of the Willamette River pose an obstacle to recovery of Willamette River Chinook salmon. Upper Columbia spring/summer Chinook salmon may be among the most imperiled Columbia Basin stocks but would not be affected by breaching the Snake River dams because they do not return to the Snake River.

Will breaching the lower Snake River dams save the Southern Resident killer whales?

The Southern Resident killer whales consume salmon from a range of West Coast rivers including the Puget Sound, Fraser, Columbia and Snake, Sacramento, Klamath, and coastal rivers in Oregon and Washington. Chinook stocks from different rivers travel through different parts of the ocean that may vary in condition, leading to different levels of adult returns. This diversity of rivers across many hundreds of miles helps the whales hedge their bets so that if one or more rivers suffers low returns they have other options to turn to, and provides some resilience to large environmental patterns that might affect different portions of the ocean and salmon abundances along the coast differently. NOAA Fisheries worked with the Washington Department of Fish and Wildlife to develop an analysis of Chinook salmon stocks that are important to Southern Residents, which showed that the Snake River is one of many salmon rivers the whales rely on. Other rivers around the Salish Sea, where the whales typically spend much of the year, ranked higher in terms of value to the whales.

Snake River fall Chinook salmon ranked high on the list, close to salmon from the upper Columbia River, Fraser River, and lower Columbia River.

Two of the three Southern Resident pods commonly feed during winter along the Washington Coast and around the mouth of the Columbia River, signaling that those are important foraging areas for the whales. Some research has indicated that salmon returning to the Snake River provide an important source of late-winter food for those pods.[13] However, the whales rely on different runs such as fish returning to the Fraser River in British Columbia in other parts of the year. In addition, J-pod does not travel the outer coast to the extent that K and L-pod do, and likely eat different proportions of those stocks or a different combination of stocks. The best option for long-term recovery of both salmon and the whales is restoring habitat across a diversity of West Coast rivers. Greater returns of adult salmon to the Snake River could make more prey available to the Southern Resident killer whales at certain times of the year in certain places where the whales overlap with the extended migration patterns of Snake River stocks. However, even if successful, recovery of Snake River fish alone is unlikely to reverse the continuing decline in whale numbers.

That is why NOAA Fisheries and our partners are pursuing a recovery strategy that addresses multiple threats, and particularly focuses on habitat improvements across multiple West Coast river basins. Improving river and stream habitat gives juvenile salmon the refuge and food that they need to grow larger before reaching the ocean, which improves their odds of survival in the ocean. We are also using the list of stocks most important to the whales to help prioritize habitat restoration funding where it will most benefit the fish and the whales that depend on them.[14]

Southern Resident killer whale. Photo: NOAA, permit #19091

What successful recovery strategies are underway for Snake River salmon and steelhead?

NOAA Fisheries has found in its biological opinions that for most species juvenile habitat is a serious limiting factor, as much of the complex stream habitat where juvenile fish historically spawned and reared, has given way to development. Those biological opinions have called for extensive restoration and other improvements in that habitat. In several cases that restoration has involved the removal of barriers such as road crossings with culverts that block salmon, or even larger diversion or other dams that have no fish passage and consequently cut off all the habitat above them. This is especially true for Snake River spring/summer Chinook salmon and Snake River steelhead, both of which spawn in tributaries with steelhead sometimes using seasonal waters that go dry during part of the year. While large areas of habitat remain blocked, restoration has increased the capacity of tributaries to support more juvenile fish in habitat once lost to development.

Restoration of habitat in the Columbia River Estuary may be especially important to certain stocks, which use productive estuary habitat to bulk up before entering the ocean. Survival in the ocean is strongly related to the size of fish, so the bigger the salmon, the better the chances it will return as an adult to spawn. Some reaches of the lower Columbia River have lost more than 90 percent of the vegetated wetland habitat that is so crucial to juvenile survival and success.[15]

The best route to recovery will employ the recovery actions that have the best return, whether they involve habitat improvements, hatchery modifications, dam breaching, or some combination of those. The tradeoffs among different actions are complex, and the appropriate focus of great scrutiny.

Juvenile salmon and steelhead from the Snake River basin also suffer substantial mortality in the tributaries of the Snake before they ever reach the first major hydroelectric dam. In some years, more than half of juvenile fish from hatcheries or tributaries in the upper Snake River system disappear before they reach Lower Granite Dam, the uppermost federal dam on the lower Snake River.[16] The cause of this mortality is not clear. Larger predatory fish may consume the young fish, or they may be affected by deteriorated water quality. Reducing this mortality could lead to more fish reaching the ocean.

Another serious impact on fish comes from predators – birds, fish, and marine mammals. Historic development of the Columbia Basin introduced exotic fish species that prey on young salmon and steelhead, and birds such as Caspian terns and double-crested cormorants in many years consume a significant share of juvenile salmon as they migrate downriver to the ocean. Some studies have found that the impact of introduced fish species on salmon and steelhead has approximated or exceeded the impacts of the other frequently mentioned threats of hydropower, hatcheries, harvest, and habitat.[17] Sea lions also sometimes prey on a substantial number of spring-migrating adult fish returning to the Columbia and Snake Rivers. A recent study found that the survival of spring-run Chinook salmon dropped by almost one-third for every addition of roughly 470 sea lions in the Columbia River.[18] The adult fish are especially valuable because they have survived almost through their entire complex and challenging life cycle and are close to spawning the next generation.

A variety of management measures are underway to address predators, from a reward program for catching predatory fish, to hazing or removal of sea lions that prey on adult fish. That has led to greater returns of some of the most critically endangered populations of salmon and steelhead.

Should we stop eating local salmon to leave more for the whales?

We all want to promote recovery of the Southern Residents. It may seem logical that if we eat less of their favored food, Chinook salmon, more will be available to the whales. However, harvest levels are set to ensure that fish return to rivers in enough numbers to spawn the next generation. The Pacific Fishery Management Council and NOAA Fisheries consider the needs of the whales and other endangered species when setting salmon fishing seasons each year.

In addition, much fishing takes place near the mouths of rivers where salmon are returning after the whales have already had an opportunity to prey on them. A science panel formed by the Pacific Fishery Management Council developed a Risk Assessment examining the impacts of fishing on prey available to the whales. It found that the Washington Coast is the area of the U.S. West Coast where salmon abundance is most important to the whales, and is also where fisheries on average remove the smallest share of fish. From 2006 to 2016, fishing removed an annual average of 3.3 percent of the average 1.6 million Chinook salmon in that area. Indeed, natural variability in overall salmon numbers has greater effect on prey availability for the whales than fishing does. NOAA Fisheries in 2020 set a precautionary threshold where additional actions to benefit whales would be considered if salmon abundance drops to a certain level. In the 2020-2021 season, abundance projections exceeded the threshold. We continue to work with the Pacific Fishery Management Council to consider Southern Residents in fishery management decisions.

The loss and degradation of habitat has become more of a limiting factor for Puget Sound Chinook populations than fishing impacts, which have declined over the last two decades, according to a NOAA Fisheries biological opinion weighing impacts of fisheries in Southeast Alaska.[19] Most of the harvest takes place as the fish migrate through waters off Alaska and British Columbia. We have worked through the Pacific Salmon Commission to reduce harvest in those waters too. The bottom line is that while different salmon stocks face different impacts, multiple safeguards and consideration of the needs of the Southern Residents ensure that salmon fishing off the U.S. West Coast remains sustainable.

Can NOAA Fisheries mandate the removal of the Snake River dams?

NOAA Fisheries cannot mandate the removal of the lower Snake River dams. NOAA Fisheries weighs in on Columbia Basin salmon recovery in multiple ways. For example, we have developed recovery plans for each species of salmon and steelhead in the Columbia River Basin that spell out what it will take to recover the stock. We also review federal actions such as the operation of the Columbia and Snake River dams for their impacts on ESA-listed species, including salmon and steelhead and Southern Resident killer whales. This is called a consultation, and NOAA Fisheries recommends additional actions that we believe will help minimize impacts of the action on listed species. In previous consultations on the operation of the federal dams, NOAA Fisheries has found that the number of fish produced by fish hatcheries in the Columbia Basin more than make up for losses attributable to the dams.

The U.S. Army Corps of Engineers advises that breaching dams requires congressional action because it would in effect be changing the legislated purpose of the dams.

More information on Southern Resident killer whales:

Recovery Planning and Implementation
www.fisheries.noaa.gov/west-coast/endangered-species-conservation/southern-resident-killer-whale-recovery-planning-and

Connection between salmon fisheries and killer whales
www.fisheries.noaa.gov/west-coast/endangered-species-conservation/effects-salmon-fisheries-southern-resident-killer-whales

Southern Resident killer whale Recovery Plan
www.fisheries.noaa.gov/resource/document/recovery-plan-southern-resident-killer-whales-orcinus-orca

Story Map: Saving the Southern Residents: Turning the Tide for the West Coast's Beloved Killer Whales
https://noaa.maps.arcgis.com/apps/Cascade/index.html?appid=3405e6637bf74e998d4ebe992c54f613

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[9] National Marine Fisheries Service West Coast Region, September 2019. Proposed Revision of the Critical Habitat Designation for Southern Resident Killer Whales, Draft Biological Report (to accompany the Proposed Rule). https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/critical-habitat-southern-resident-killer-whales

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