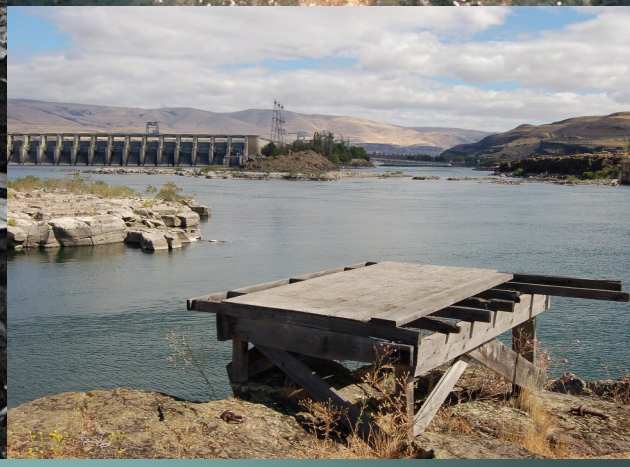
2015

Yakama Nation Fisheries Status and Trends Report:

Hydropower System Operation Overview

With Emphasis on the 2008 Columbia River Fish Accords



Section 4 of a 4 part series

Yakama Nation Fisheries

HONOR. PROTECT. RESTORE.

January 2015

Foreword:

The construction and operation of hydroelectric dams on the Columbia River and throughout the natural resource use area of the Yakama Nation had devastating impacts to the Yakama people and our Treaty-reserved natural resources. Today we are grateful to be here to witness the progress taking place to protect and restore the natural resources that we rely on, but we cannot impede progress because each and every one of us lives in a home and uses the electricity that comes through the lines.

Increased Tribal collaboration and representation on issues such as hydrosystem operation as a result of the 2008 Columbia Basin Fish Accord has enabled the Yakama Nation to help ensure that enough of the right actions are being implemented on behalf of our resources. By voicing concerns when we believe not enough is being done to restore and protect Treaty trust natural resources, we are holding up our promise made in sacred trust to the Creator to be responsible stewards of salmon and the habitats upon which they rely.

The Yakama Nation's advocacy of actions such as improving fish passage so that all species are taken into account, reducing dam passage mortality, and managing flows to improve fish survival and transport to the ocean helps create a more natural river, benefiting all native species. Aggressively working to improve hydrosystem operations and water management in these areas are strategies that help aquatic species to rebuild their populations, to benefit all our people.

By understanding and supporting the positive changes such as that are a result of the Accord, holding all co-signers responsible for their obligations, and by making sure that the fish population trends are going in the right direction, we are safeguarding so that enough is being done to ensure all treaty-trust natural resources of the Yakama Nation can be healthy and productive once again.

Gerald Lewis

Fish and Wildlife Committee

Yakama Tribal Council

Cover photos: Platform fishing at Celilo falls, salmon using a fish ladder, platform fishing after construction of The Dalles dam

2014 Yakama Nation Fisheries Status and Trends Report

The Yakama Nation's Status and Trends Annual Reports (STAR) summarize progress toward achieving recovery goals described in the 2008 Columbia Basin Fish Accords Memorandum of Agreement (Accord). The Accord is intended, in part, to support the implementation of projects and management actions considered necessary to improve the survival of salmon and steelhead listed under the Endangered Species Act (ESA) to the levels described in the National Oceanic and Atmospheric Administration's 2008 Biological Opinion for Federal Columbia River Power System operations. It also provides funding for white sturgeon and Pacific lamprey recovery actions and benefits other species not listed under the ESA.

The purpose of STAR is to: 1) track the implementation of the projects and management actions described in the Accord, 2) report on the biological effectiveness of implemented projects and actions by monitoring trends in the status of salmon and steelhead populations and other species of priority to the Yakama Nation such as white sturgeon and Pacific lamprey, and 3) provide information to tribal leadership to aid in the development of policy direction.

The STAR report consists of four chapters, three of which document progress in implementing restoration work and improvements to management actions, and one that tracks the status and trends of priority species. Leading up to the release of the comprehensive report, the individual chapters are available to the public upon completion.

The sections, in order of release, are:

I — Habitat Restoration

II — Species Status and Trends

III — Hatchery and Reintroduction Programs

IV — Hydrosystem Operation

To ensure the reports reflect current and relevant information, each chapter and the supporting website will be updated regularly.

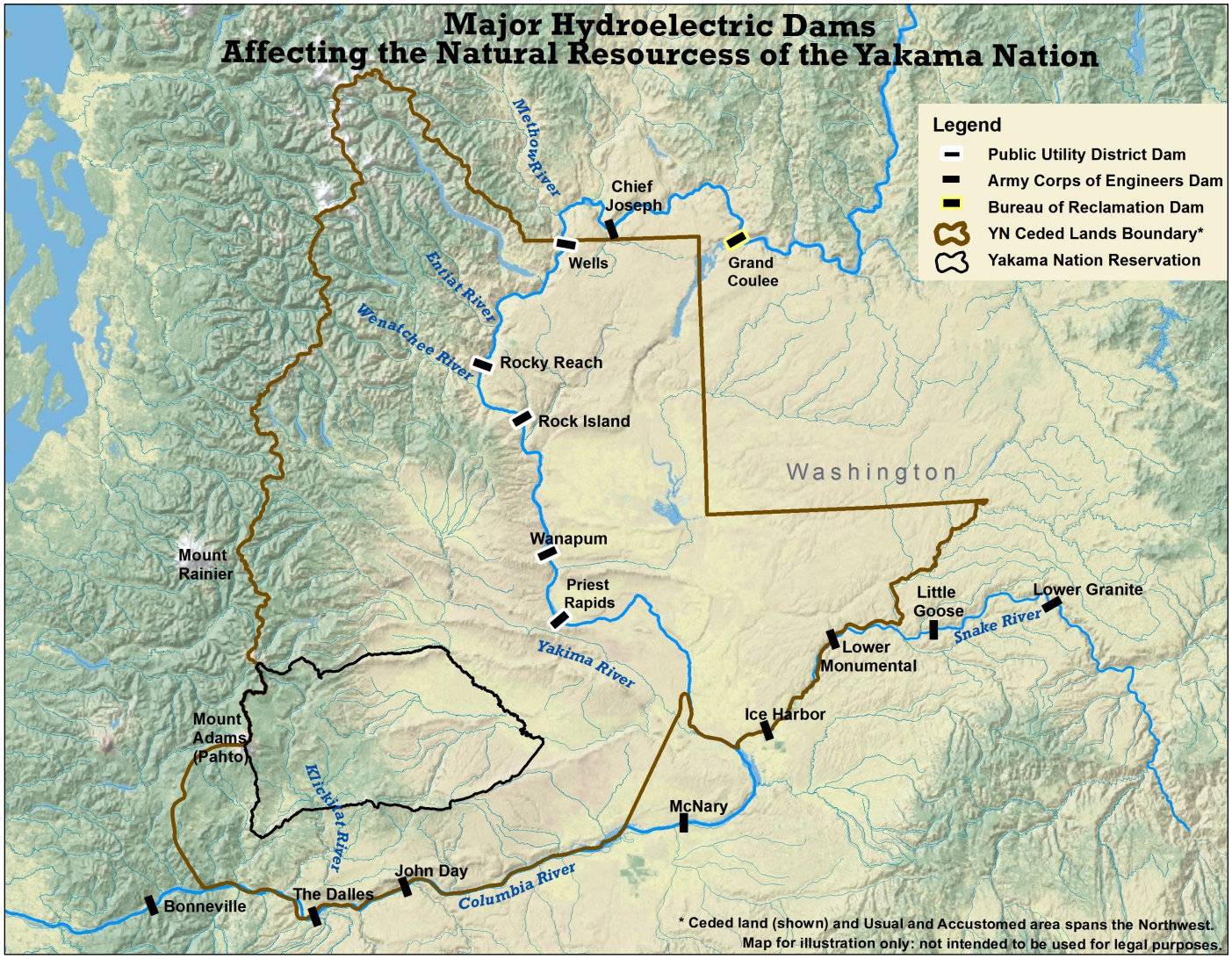
To learn more about the Yakama Nation Fisheries Status and Trends project and to download this report, please visit www.yakamafish-nsn.gov/restore/projects/star

Background

On May 2, 2008, the Yakama Nation signed the Columbia Basin Fish Accords Memorandum of Agreement (Accord) which provides funds to implement fish and wildlife restoration projects throughout the Yakama Nation's Ceded Lands, as well as other areas utilized by aquatic treaty* trust species. This report summarizes fish passage and operational modifications (e.g., spill and flow) to the federally operated dams located on the lower mainstem Columbia and Snake rivers, many of which were fought for by the Yakama Nation and others to be included in the Accord agreement.

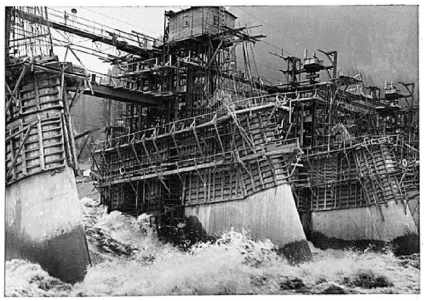
Platform fishing at Celilo Falls

**Yakama Nation Treaty of 1855 (12 stat. 951) with the United States of America.*



Dam Operation and Impacts on Natural Resources

The construction and operation of hydroelectric dams in the Columbia River Basin have significantly impacted fish and wildlife populations important to the Yakama Nation and forever changed the Columbia River ecosystem. Without mitigation for loses, the dams would jeopardize the existence of the Yakama Nation's treaty trust natural resources. As a result, the Bonneville Power Administration, U.S. Army Corps of Engineers, and U.S. Bureau of Reclamation are funding actions to: 1) improve dam facilities for fish passage, 2) increase spawning and rearing habitat, 3) offset hydrosystem-related fish mortality with production programs, and 4) monitor and evaluate actions to ensure the desired benefits are achieved.



Bonneville Dam under construction

Adequate support for the operation and maintenance of passage improvements is critical. The U.S. Army Corps of Engineers' Fish Passage Plan, developed annually through a regional forum that includes the Yakama Nation, describes year-round project operations to protect and enhance fish species. Annual hydrosystem improvements are funded through the U.S. Army Corps of Engineers' Columbia River mitigation budget.

Adult Chinook salmon navigating a fish ladder

Chinook Salmon (Tkwínat; Núsux) and Steelhead (Shusháynsh)

The operation of hydroelectric dams on the lower mainstem Columbia and Snake rivers leads to slower migrations through the reservoirs and provides favorable conditions for predators to prey on out-migrating juvenile chinook and steelhead. Under the current operations plan, combined impacts to out-migrating juvenile salmon and steelhead can result in mortality rates of 50%. Without operation plans and improvements, the survival rates would be much lower. For example, record low run-off combined with a power emergency in 2001 led to reduced spill at Bonneville and The Dalles dams and no spill at the other projects. Consequently, Snake River Chinook and steelhead survival (Snake River to Bonneville Dam) was 26.6% and 3.8%, respectively.

Pacific Lamprey (Asúm; K'súyas)

The operation of hydroelectric dams affects adult and juvenile lamprey migration. When adult fish ladders and downstream bypass systems were designed for salmon and steelhead, the needs of lamprey were not considered. Because adult fish ladders were designed around the needs of salmon and steelhead, successful passage of adult lampreys has been limited due to high velocities, turbulence, unnatural surfaces, and predators. Since migrating juvenile lamprey are weak swimmers, relative to juvenile salmon and steelhead, the fish are susceptible to injury and mortality when passing through the bypasses. The design of these structures is a major contributing factor in the decline of lamprey.

Experimental lamprey ramp design

White sturgeon

White Sturgeon (Wílaps)

Construction of hydroelectric dams has isolated white sturgeon populations by blocking their upstream migration. Elements of the fishways are often too small and the turns too tight for them to navigate. The existence and operation of dams has changed and/or reduced sturgeon spawning and rearing habitats. Isolation and altered habitats have led to the need for artificial production to support declining sturgeon populations.

Yakama Nation Fisheries

Juvenile Fish Passage

River flows, along with configurations and operations at dams, are critical elements that influence how quickly juvenile fish migrate to the ocean. Reducing travel time with more flow improves survival by reducing exposure to predators, warm water, and other stressors. NOAA Fisheries conducts annual evaluations of smolt survival passing through the hydropower system. In addition to the survival studies, the U.S. Army Corps of Engineers estimates project and route-specific survival rates, fish passage distribution (e.g., fish passage efficiency and spill passage efficiency), forebay behavior, travel time, and tailrace exit for juvenile fish, to evaluate the success of fish passage improvements.

The Federal Columbia River Power System Biological Opinion includes passage survival standards for fish passing through each dam of 96% and 93% for spring and summer migrating fish, respectively. Juvenile survival estimates of 86% to 99% have been observed at all Snake River and Columbia River dams; however, uncertainty exists regarding how well these tests represent the range of environmental variation. Passing survival standards in one high-flow year does not necessarily ensure that standards are being met in normal or lower-flow years. Note that these standards are for dam passage only and do not account for potential reservoir or delayed mortality. Performance testing is ongoing at most of the projects.

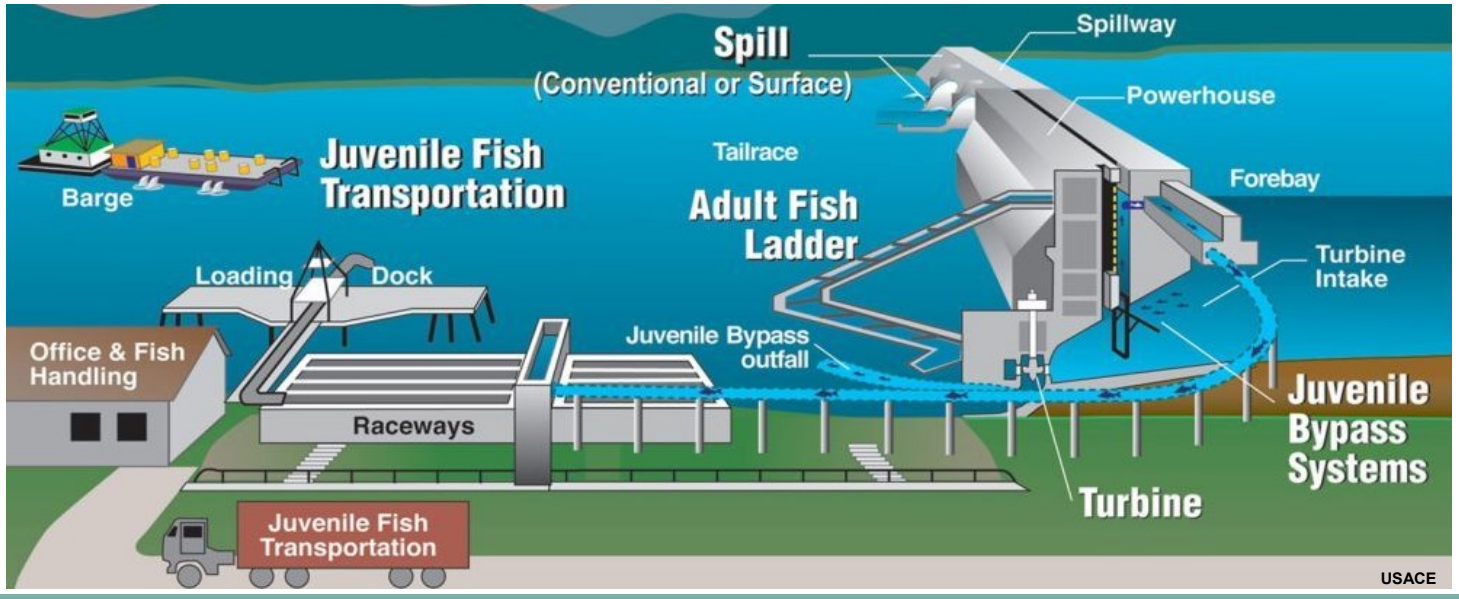
Major improvements to passage structures at hydroelectric dams in the Columbia River Basin have led to improved survival of juvenile salmon and steelhead. Since 2001, the U.S. Army Corps of Engineers has spent over $1.8 billion to study and improve juvenile fish passage and survival through federal Columbia River hydroelectric dams. Examples of these efforts include:

- Surface passage structures and modified spill operations to improve survival of juveniles at the dams
- Screens that divert fish away from turbines
- Improved turbines that reduce harm to fish
- Predator control management
- Flow augmentation (spring-summer operations including spill to speed downstream migrations and improve survival of juveniles)
- Barges and trucks to transport fish past the dams

Although significant progress has been made, opportunities for additional improvements remain.

Juvenile Columbia River Fish Passage: Annual Estimated Whole-System Survival		
Species	**Pre-BiOp***	**Post-BiOp**
Chinook	49%	52%
Steelhead	34%	58%
Sockeye	34%	51%

**BiOp (Biological Opinion, 2008) issued and reported by NOAA Fisheries addressing hydrosystem impacts and goals for protections. Survival rates as reported by NOAA.*



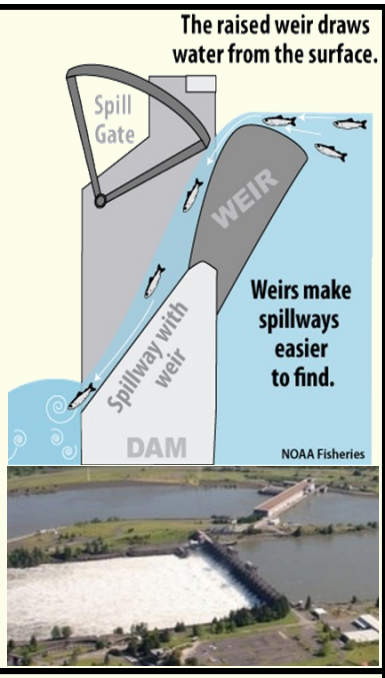
Improving Dam Passage for Juvenile Fish Passage Survival

There are three main passage routes for juvenile salmonids migrating downstream past Columbia River and Snake River dams: 1) surface fish passage, 2) through turbines, and 3) through bypass routes. The best survival is typically through the spillway, while passage through turbines results in the lowest survival. Transport is also used during certain times of the year and under low flow conditions (see page 22).

1) Surface Fish Passage

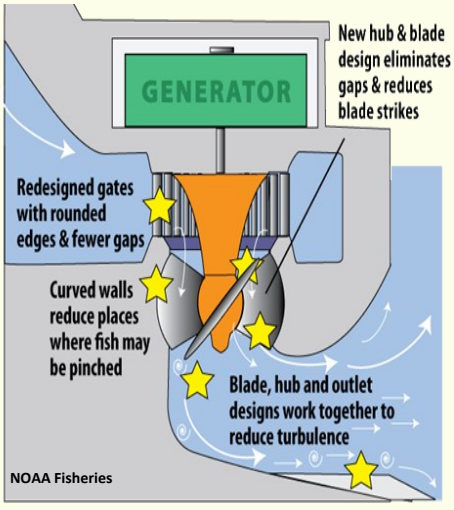
Concerns: Conventional spill gates force juvenile salmon and steelhead, that prefer to travel near the surface, to dive 50-60 feet to pass through the dam.

Solution: Spillway weirs allow fish to pass near the surface. By 2009, surface passage was installed at all dams on the lower Columbia and Snake rivers. Surface passage is not limited to spillways. Similar benefits are observed at The Dalles and Bonneville dams' powerhouses, where surface passage exists.



2) Turbine Passage

Concerns: Passage through turbines cannot be completely avoided by migrating juvenile fish. Conventional turbines can result in injuries or death to young fish when they hit the blades or turbine walls. Research shows that an average of 13% and 30% of the spring and summer migrants, respectively, pass through the turbines.

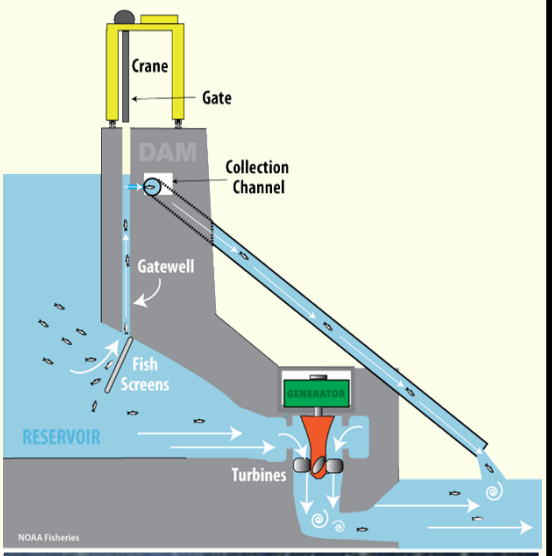


Solution: The U.S. Army Corps of Engineers' Turbine Survival Program evaluates the effects of turbine passage on fish and recommends potential improvements. Studies at dams with new turbines have shown reduced injury rates. New turbines will be installed at Ice Harbor dam in 2016 that may improve lamprey survival as well.

3) Screened Bypass to Avoid Turbines

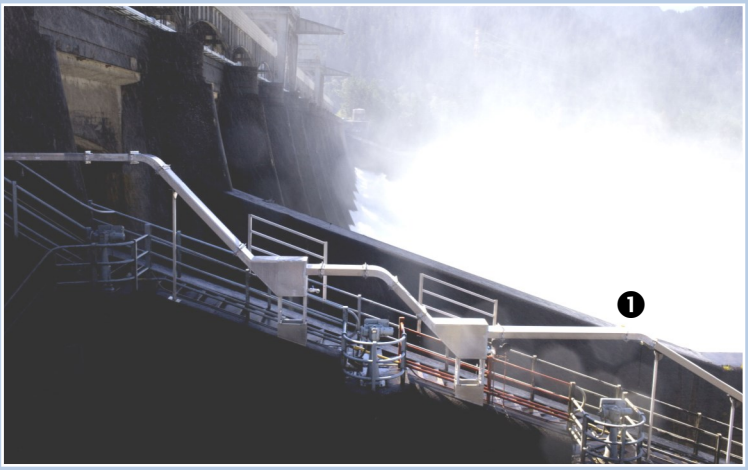
Concerns: Preventing juvenile passage through turbines, where survival is lower.

Solution: By using submersible screens, juvenile fish are diverted away from turbines and into a bypass route that either releases fish downstream or into a fish collection facility. Collection facilities allow for fish to be sampled and returned to the river or transported via truck and/ or barge at Lower Granite, Little Goose, and Lower Monumental dams. Data supports the premise that there is a delayed impact on the survival of bypassed fish when compared to returning adults that used other routes, however, additional research is needed.



Bonneville Dam

Project Spotlight: Pacific Lamprey Passage Improvements



Lamprey ladder at Bonneville Dam

Significant differences in swimming style and behavior exist among lamprey, salmon, and steelhead. Unfortunately, the fact that lamprey are less capable swimmers in high velocity flows was not considered when fish passage facilities were built years ago. Velocities associated with fish ladders are often too high for lamprey to navigate without repeated burst swimming, reattaching, and resting. In addition, their swimming behavior makes it difficult to migrate up fish ladders that have sharp corners and turns. Poor passage can also be attributed to turbulence, poor attraction, unnatural flows, and predators. Challenges associated with passing dams is considered a significant reason for the decline of lamprey.

Lamprey impinged at John Day Dam

To improve adult upriver passage, facilities at Bonneville Dam have been modified to address the needs of lamprey. This has been made possible through modifications to the ladder entrances, the installation of lamprey passage systems at passage problem areas, and adding velocity reducing structures that lead to a collection ramp at the Cascade Island ladder (**1**).

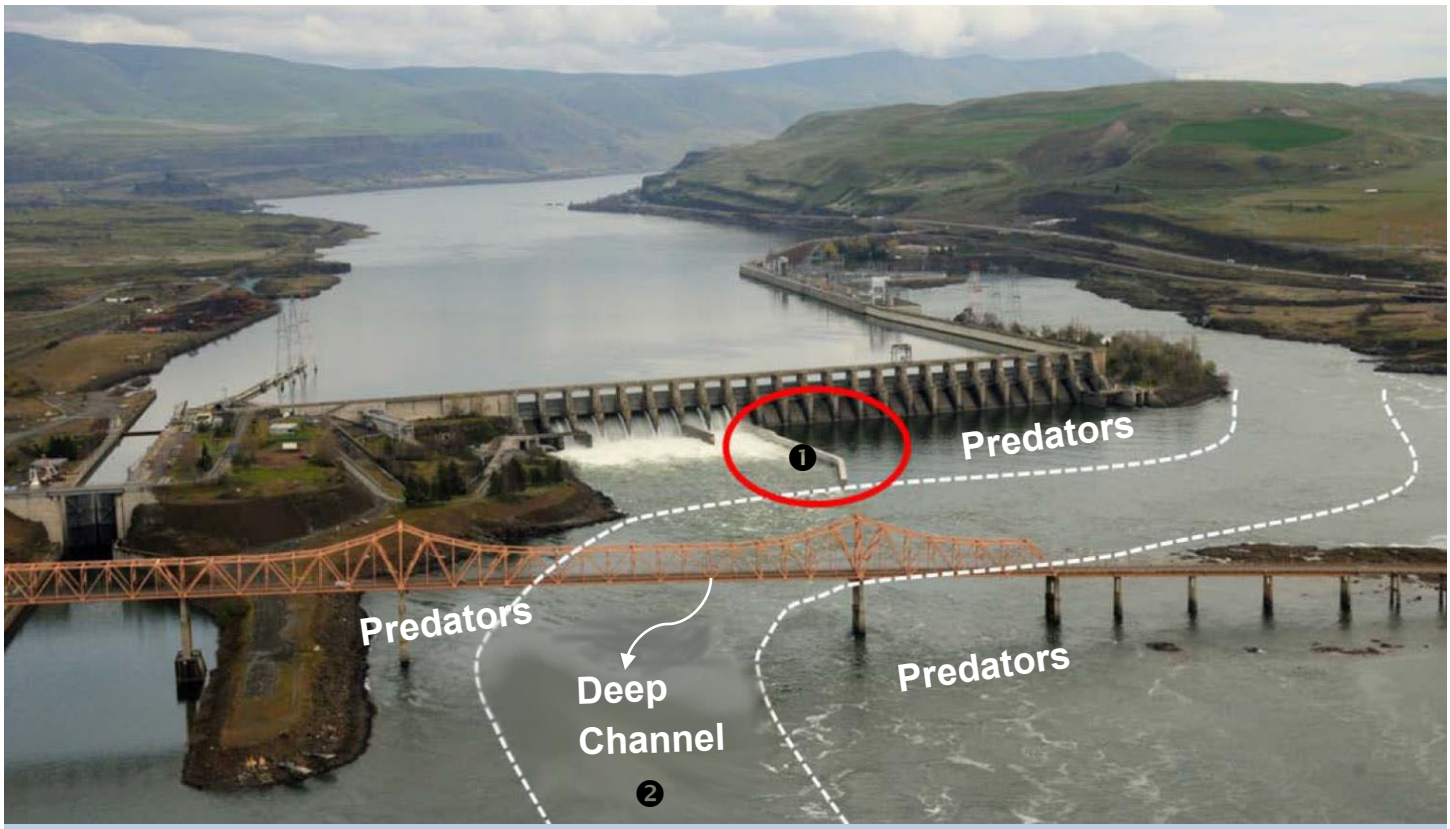
Bonneville Dam Improvements

Action	Species	Project Status	Intended Benefit
Juveniles			
Spring spill: April 10 - June 15 (on-going)	Salmon and Steelhead	⊙	Improves survival and reduces travel time
Summer spill: June 16 - August 31 (on-going)	Salmon and Steelhead	⊙	Improves survival and reduces travel time
Modify sluiceway to improve surface flow at Powerhouse 1 (2009)	Salmon and Steelhead	●	Improved fish passage efficiency and reduced forebay delay
Reduce gaps around Powerhouse 1 turbines (minimum gap turbine runner) (2009)	Salmon and Steelhead	●	Improved survival of fish passing through turbines
Modify screened bypass system at Powerhouse 2 (2008)	Salmon and Steelhead	●	Improved fish guidance efficiency and reduced gatewell residence time
Install shallow water guidance screen at Powerhouse 2 (2008)	Salmon and Steelhead	●	Increased corner collector efficiency and reduced forebay delay
Complete corner collector (2004)	Salmon and Steelhead	●	Improved surface passage for juveniles
Improve second powerhouse juvenile bypass	Salmon and Steelhead	⊙	Improves passage for juveniles
Test BiOp goal performance	Salmon and Steelhead	⊙	Confirmed if modifications reduced impacts of dams enough to reach goals
Adults			
Chum spawning flows - Maintain tailwater elevation below Bonneville Dam at 11.5 feet beginning the first week of November (when chum arrive) and ending by December 31 (on-going)	Chum	⊙	Provides adequate conditions for chum spawning in the mainstem Columbia River in the area of the Ives Island complex and access to Hamilton and Hardy creeks for spawning
Haze sea lions (on-going)	Salmon and Steelhead	⊙	Reduces predation by sea lions on salmon, steelhead, white sturgeon, and other species
Improve Bradford Island ladder system (2013)	Salmon and Steelhead	⊙	Improves reliability of upstream adult passage
Install Washington shore lamprey flume system (2013)	Lamprey	⊙	Provides an alternate route around the fishway entrance during upstream migrations
Install sea lion exclusion gates at all adult fish ladder entrances (2006)	Salmon and Steelhead	●	Prevents sea lions from entering the fish ladders and/or passing into Bonneville Reservoir
Improve Cascades Island ladder entrance (2009)	Lamprey	⊙	Guides lamprey out of the main fish ladder and into alternative routes, also improves lamprey passage conditions at the ladder entrance
Install lamprey passage structures	Lamprey	⊙	Provides more successful adult lamprey passage
Concerns			
➔ Because the Powerhouse 1 sluiceway outfall is not in an ideal location for tailrace exit, there is a need to review survival data, under a range of flows, to determine if the location of the sluiceway affects survival.			
➔ Spillway survival, under the current spill program, is not as high as it could be. The lower than desired survival may be related to stilling, tailrace erosion, and debris.			
➔ Powerhouse 2 bypass survival/descaling issues due to debris and poor hydraulic conditions affect passage for all species.			
➔ Performance testing was successful during a high-flow, high-spill year. Additional testing is ongoing and further improvements may be needed depending on test results.			

○ **Not Started** ⊙ **In Progress** ● **Completed**

Yakama Nation Fisheries

The Dalles Dam

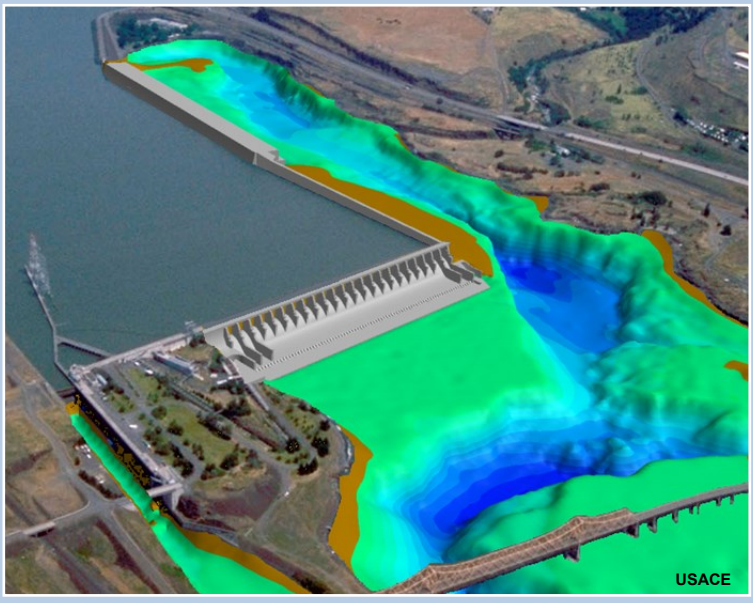


Project Spotlight: Improved Spillway Wall

Approximately 80% of the juvenile salmon and steelhead that migrate past The Dalles Dam pass through the spillway. Concentrations of predators in the tailrace limits juvenile survival. In recent years, two approaches (i.e., juvenile bypass system and guidance wall) were evaluated to improve juvenile survival through the tailrace.

Although the juvenile bypass system was similar to those built at other facilities, studies showed that The Dalles Dam juvenile bypass system was plagued with technical challenges and extraordinary expense associated with construction and operation.

In 2010, the U.S. Army Corps of Engineers built a guidance wall (**1**) extending 850 feet downstream from the spillway. This structure guides juvenile fish away from areas where predators concentrate and keeps the fish in the deepest and fastest water, considered the safest section of the river for them, directly downstream from the tailrace (**2**).



Imagery below The Dalles Dam, showing structure of deep channel contours (in blue).

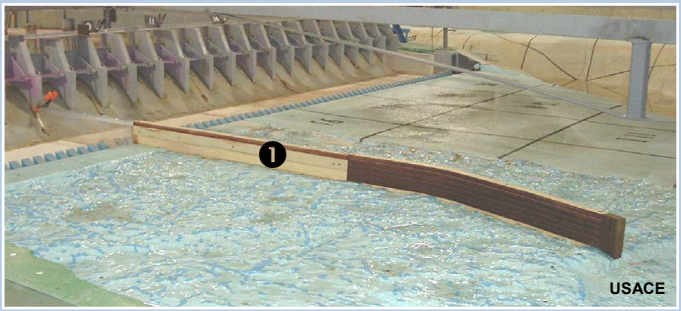
The Dalles Dam Improvements

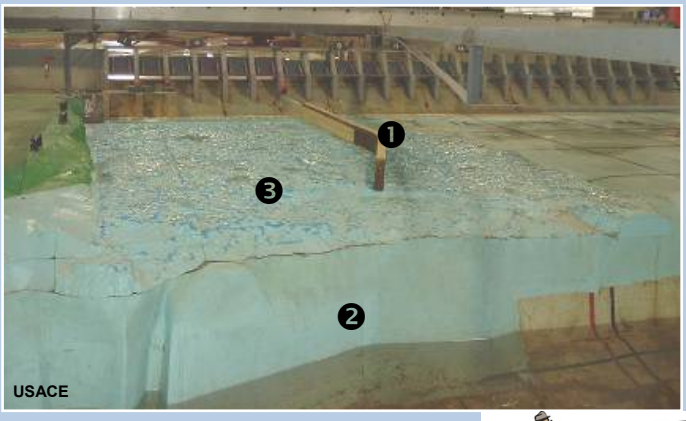
Action	Species	Project Status	Intended Benefit
Juveniles			
Spring spill: April 10 - June 15 (on-going)	Salmon and Steelhead	⊙	Improves survival and travel time
Summer spill: June 16 - August 31 (on-going)	Salmon and Steelhead	⊙	Improves survival and travel time
Improve turbine operation (2011)	Salmon and Steelhead	●	Improved survival through turbines
Complete spillway wall (2010)	Salmon and Steelhead	●	Increased direct and indirect juvenile survival through surface fish passage
Install improved avian wire array (2011)	Salmon, Steelhead, Lamprey	●	Improved avian predation deterrent program
Test BiOp goal performance	Salmon and Steelhead	●	Confirms if modifications reduce impacts of dams enough to reach goals
Adults			
Fix east ladder back-up water supply system (2013)	Salmon and Steelhead	⊙	Returns adult salmon and steelhead use of north ladder to pre-spillwall conditions, improves reliability of upstream adult passage
East fish ladder diffuser plating and ramps installed	Lamprey	●	Provides more successful adult lamprey passage
Improve lamprey passage	Lamprey	⊙	Provides more successful adult lamprey passage
Concerns			
➔ To improve adult passage reliability, the east ladder needs a supplemental water supply. Efforts to address this issue are in progress.			
➔ To ensure project operation and configuration do not change, three spillway gates need to be repaired. Without the repairs, it may not be possible to maintain the survival benefits.			
➔ Bird wires and mobile hazing, via boats, are essential at the project to control avian predators.			
➔ To ensure the east ladder does not become too crowded during peak adult returns, evaluate modifying project operations by shifting some of the passage to the north ladder via spill.			

○ **Not Started** ⊙ **In Progress** ● **Completed**

Project Spotlight: Improved Spillway Wall, Continued

With the spillway wall in place, studies in 2011 showed that 96% of tagged yearling Chinook successfully passed The Dalles Dam, a 4% increase compared to the 2004 and 2005 test results. Also in 2011, 99.5% of the downstream migrating juvenile steelhead survived. Note that variable environmental conditions can affect results from one year to the next, however, and 2011 was a high flow year which likely improved survival.





*Photos from a 1:80 physical model of The Dalles Dam and guidance wall (**1**). The wall directs smolts to the deep drop-off (**2**) and fast-moving water to avoid predators. The stilling basin rock floor (**3**) is contoured to actual bottom contours of the site.*

Yakama Nation Fisheries

John Day Dam

Project Spotlight: North Ladder Improvements

The John Day Dam north fish ladder count station has consistently had a high percentage of downstream movement (fallback), that increases passage times through the ladder, adding stress to the fish. In 2009, the U.S. Army Corps of Engineers started a project to improve passage, decrease downward movement, and reduce/eliminate the jumping that was occurring in the north fish ladder. To address the problems, a flow pattern was created (**1**) that forced adult fish migrating upstream to swim through a continuous series of turns. Also, direct upstream passage routes (**2**) were built to eliminate jumping and holding by salmon and steelhead. Monitoring confirmed that jumping was eliminated and that downstream movement was significantly reduced.

Modifications to the north ladder were completed to improve conditions for migrating lamprey. Since lamprey are unable to attach to the 90 degree corners that are often found in fishways, the north ladder was built with rounded corners (**3**) to help lamprey pass potential problem areas.

John Day Dam Improvements

Action	Species	Project Status	Intended Benefit
Juveniles			
Spring spill: April 10 - June 15 (on-going)	Salmon and Steelhead	⊙	Improves survival and reduces travel time with spill
Summer spill: June 16 - August 31(on-going)	Salmon and Steelhead	⊙	Improves survival and reduces travel time with spill
Improve turbine operation (2011)	Salmon and Steelhead	●	Improved survival through turbines
Two spillway weirs installed (2008) and improved (2013)	Salmon and Steelhead	●	Improved juvenile fish survival through surface flow outlet modifications- Reduced forebay delay and improved tailrace exit to improve fish passage efficiency
Install improved avian wire array (2010)	Salmon and Steelhead	●	Improved avian predation deterrent program
Test BiOp goal performance	Salmon and Steelhead	⊙	Confirms if modifications reduce impacts of dams enough to reach goals
Adults			
Modify John Day Dam northern ladder entrance (2009)	Lamprey	⊙	Improves entrance to fish ladder and provides alternate route for lamprey passage via a lamprey passage structure
Modify upper sections of north ladder (2011)	Salmon, Steelhead, Lamprey	●	Improved upstream adult passage conditions
Install lamprey trapping system and diffuser plating at south fish ladder (2012-2014)	Lamprey	⊙	Provides more efficient collection of lamprey at the dam for translocation and research
Concerns			
➔ Low turbine survival			
➔ Currently, 30% and 40% spill are being tested; however, it remains unknown which approach will be selected. More fish were observed using the spillways during the 40% spill test. Studies have shown that the return rates for fish that used the bypass as compared to spill can be classified as poor.			
➔ The ability of fish to successfully exit from the bypass outfall area may be limited.			
➔ Long-term maintenance of bird-deterrent wires is essential to protect against avian predation.			

○ **Not Started** ⊙ **In Progress** ● **Completed**

Project Spotlight: Keyhole Entrance and Lower Ladder Modification

In 2011, the entrance and lower section of the John Day Dam north fish ladder were modified to improve its performance for salmonid and lamprey upstream passage. The ladder, with its deeper keyhole-shaped entrance (**1**), includes 3/4 inch lamprey-specific diffuser grating to prevent entrapment at a dead end. The edges of the entrance were rounded (**2**) for the lamprey who have trouble navigating sharp corners. Structures (bollards) on the bottom (**3**) and the wide entrance reduce velocities and provide the lamprey with places to rest as they migrate through the new lamprey passage system.

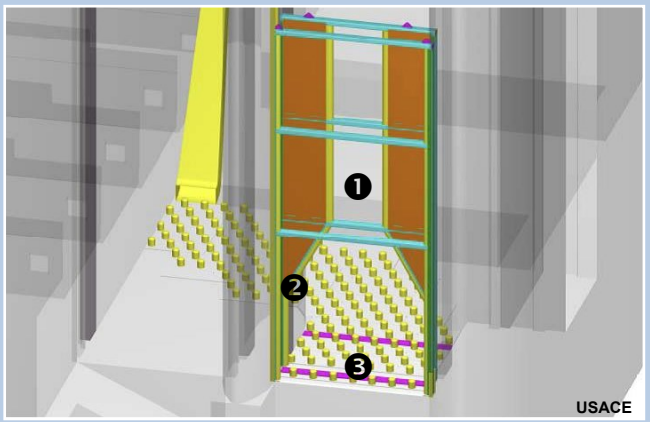


Illustration of the keyhole entrance weir and velocity reducing structures leading to the ramp.

Yakama Nation Fisheries

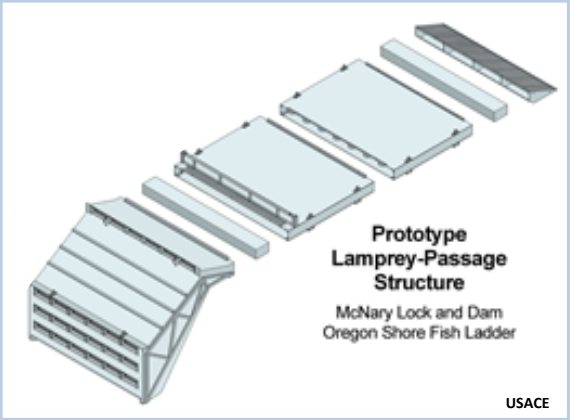
McNary Dam

Project Spotlight: Adult Pacific Lamprey Passage Improvements

Studies have shown that it is difficult for lamprey to enter the fish ladder at McNary Dam. Because the ladder was built for salmon and steelhead, the entrance is located in the upper portion of the water column where the water velocity is high. Unlike salmon and steelhead, lamprey move along the bottom of the river. Ideally, lamprey passage routes should be located lower in the water column.

Passage modifications are critical to improve conditions for lamprey migrating up rivers to their spawning areas. With a better understanding of the migratory behavior and passage needs of lamprey, the U.S. Army Corps of Engineers installed a prototype fish passage system 30 feet below the surface of the river. To create more favorable conditions for lamprey passage, the structure contains baffling that reduces the velocity of the water where lamprey enter the structure.

To better monitor lamprey, the fish passage facility is fitted with PIT-tag detection equipment, video cameras, and sonar imaging (DIDSON) equipment to track the migrations of lamprey and learn more about their passage behavior.



Lamprey ramp design and installation at McNary Dam

McNary Dam Improvements

Action	Species	Project Status	Intended Benefit
Juveniles			
Improve turbine operation (2013)	Salmon and Steelhead	●	Improved survival through turbines
Relocate juvenile bypass outfall (2012)	Salmon and Steelhead	●	Improved fish passage and successful exit, improved survival of bypassed fish
Improve debris management system (2011)	Salmon and Steelhead	⊙	Reduces injury of bypass and turbine passed fish
Install surface flow outlet/ spillway weir (2007-09)	Salmon and Steelhead	⊙	Improved juvenile fish passage efficiency and reduced forebay delay
Test BiOp goal performance	Salmon and Steelhead	⊙	Confirm if modifications reduce impacts of dams enough to reach goals
Adults			
Install lamprey openings in fish ladders (2010)	Lamprey	●	Provided alternative upstream passage route through the fish ladder with resting spots.
Build customized deep water entrance to Oregon shore fish ladder (2013)	Lamprey	●	Improved ability for lamprey to migrate upstream
Improve lamprey passage	Lamprey	⊙	Improves adult lamprey passage success
Concerns			
➔ Actions need to be taken to address avian predation. In recent years, there have been problems with fish survival in the tailrace area.			
➔ Successful fish passage has been impaired by debris.			
➔ Steelhead fallback has been problematic during periods of no spill. Efforts are ongoing to evaluate this issue.			
➔ Because targets for performance testing were not met, action agencies must decide whether to retest or accept the higher spill levels as the new spill target.			

○ **Not Started** ⊙ **In Progress** ● **Completed**

Pacific Lamprey Passage

Information collected from monitoring efforts will help the region develop and manage passage facilities to improve conditions for upstream lamprey migrations. If the design used at McNary Dam proves successful, the entrances of other dams in the Columbia River Basin may be fitted with similar structures.

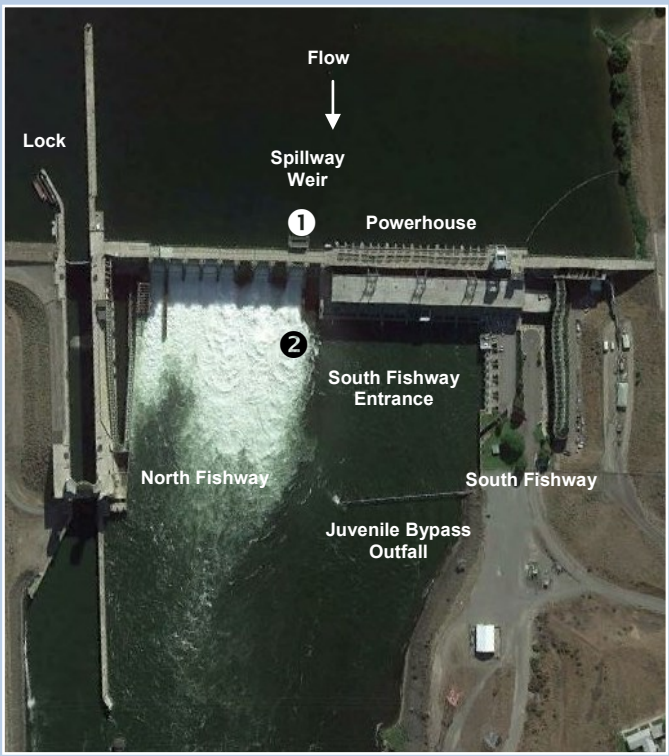
This project was completed through a collaborative approach among tribes (including the Yakama Nation), states, government, and other interested entities.

Yakama Nation Fisheries

Ice Harbor Dam

Project Spotlight: Modifications to Spillway Chute and Spill Deflectors

The removable spillway weir in spillway bay 2 ***(1)*** is the primary passage route for downstream migrating juvenile salmon and steelhead. Tests and hydraulic models have shown that there is potential for injury to juvenile fish passing over the spillway due to its steep slope and abrupt transition to the surface of the existing spill deflector. To resolve this condition, the U.S. Army Corps of Engineers intends to modify the spillway chute and the spill deflector in spillway bay 2, as well as add a new, permanent extension to the downstream end of the spillway pier between bays 1 and 2 (**2**). The work is expected to be completed by February 2015.



Ice Harbor Dam Improvements

Action	Species	Project Status	Intended Benefit
Juveniles			
Spring spill: April 3 - May 30 (on-going)	Salmon and Steelhead	⊙	Improves fish passage efficiency and reduces forebay delay (reducing passage time)
Summer spill: June 1 - August 31 (on-going)	Salmon and Steelhead	⊙	Improves fish passage efficiency and reduces forebay delay (reducing passage time)
Replace turbine unit 2 (2012)	Salmon and Steelhead	⊙	Improved the survival of fish passing through turbines and reduced oil spill potential
Improve turbine operation (2011)	Salmon and Steelhead	⊙	Improved survival through turbines
Modify guidance screen (2010)	Salmon and Steelhead	⊙	Dam safety requirements related to the bypass system
Install spillway weir (2005)	Salmon and Steelhead	●	Improved juvenile fish passage success and reduced forebay delay by improving the bypass system
Improve removable spillway weir chute and deflector (2014-15)	Salmon and Steelhead	●	Reduces injury and improves survival of spillway passed fish
Improve turbine design	Salmon and Steelhead	⊙	Improved survival for fish passing through turbines
Test BiOp goal performance	Salmon and Steelhead	○	Confirms if modifications to reduce the impacts of dams are enough to meet goals
Adults			
Install lamprey openings in fish ladders (2012)	Lamprey	●	Provided lamprey with an alternative passage route with resting spots
Repair or replace north shore fishway back-up water supply	Salmon and Steelhead	●	Improves reliability of upstream passage for adults
Concerns			
➔ A potential problem may exist relative to the long-term survival of fish that have used the bypass.			
➔ Performance testing needs to be conducted. There are some concerns with forebay delay and spill levels.			

○ **Not Started** ⊙ **In Progress** ● **Completed**

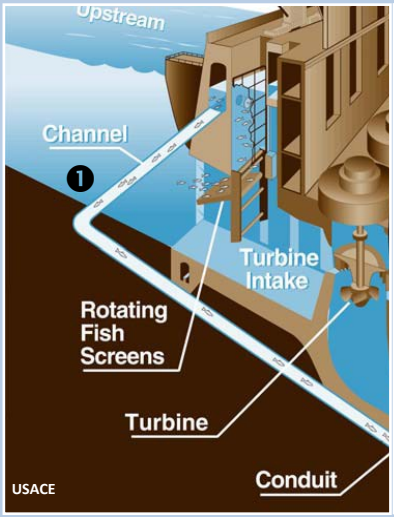
Juvenile bypass outfall at Ice Harbor Dam.

Yakama Nation Fisheries

Lower Monumental Dam

Project Spotlight: Relocate Juvenile Bypass Outfall

To improve survival of by-passed juvenile fish, the juvenile outfall bypass pipes (**1**) were moved to a location with better flow conditions, reducing the opportunity for predation. The bypass outflow was moved from a location of 250 feet downstream from the dam to a new location of 2,100 feet downstream (**2**) and extending 500 feet from the bank (**3**).



Lower Monumental Dam Improvements

Action	Species	Project Status	Intended Benefit
Juveniles			
Spring spill: April 3 - May 31 (on-going)	Salmon and Steelhead	⊙	Improves survival and reduces travel time
Summer spill: June 1 - August 31 (on-going)	Salmon and Steelhead	⊙	Improves survival and reduces travel time
Transport fish based on flows and dates (on-going)	Salmon and Steelhead	⊙	Transport "spreads the risk" of decreased survival under certain river conditions (e.g., low-flow) when extra spill is not possible
Improve turbine operation (2013)	Salmon and Steelhead	⊙	Improved survival through turbines
Relocate juvenile bypass outfall (2012)	Salmon and Steelhead	●	Improved successful exit, and improved survival of bypassed fish
Install spillway weir (2008)	Salmon and Steelhead	●	Reduced forebay delay and improved direct and indirect juvenile fish survival with bypass improvements
Test BiOp goal performance	Salmon and Steelhead	⊙	Confirm if modifications reduce impacts of dams enough to reach goals
Adults			
Install lamprey openings in fish ladders (2012)	Lamprey	●	Provided alternative passage route with resting spots.
Concerns			
➔ A potential problem may exist with harmful levels of dissolved gasses in the water using the current spill pattern, which also results in fewer fish passed through the spillway. To ensure required spill passage efficiencies are met, alternative spill patterns should be explored.			
➔ The level of benefit from fish transport, as well as the continuation of the practice, are questionable at this project.			
➔ Performance tests were met during a high-flow year but not during a low-flow year. Action agencies must decide whether to retest or accept higher spill levels as the new target.			
➔ Due to damage, Unit 1 cannot be operated in full operating range and has to be locked into one position. As flows reduce, the unit is difficult to operate properly, compromising tailrace conditions.			

○ **Not Started** ⊙ **In Progress** ● **Completed**

Spotlight - Sockeye (Kálux)

During the pre-treaty era, 150,000 sockeye returned annually to the Snake River Basin. Impassable dams, low flows, and deteriorated river conditions led to population declines resulting in the species being listed as federally endangered in 1991. By 1992, only one fish returned to spawn. To restore sockeye populations, tribal, state, and federal fish managers have relied on hatchery production, habitat improvements, and modifications to hydro-operations (e.g., Accord-mandated spill). With 2,392 adult sockeye passing Ice Harbor Dam in 2014, Snake River sockeye are slowly recovering, but the fragile state of the sockeye populations can affect other fisheries. Because incidental catch of sockeye must be minimized, other fisheries may experience closures to protect migrating adult sockeye. For sockeye to once again thrive in the Snake River Basin and elsewhere in the Columbia River Basin, efforts to improve flows and passage must continue.

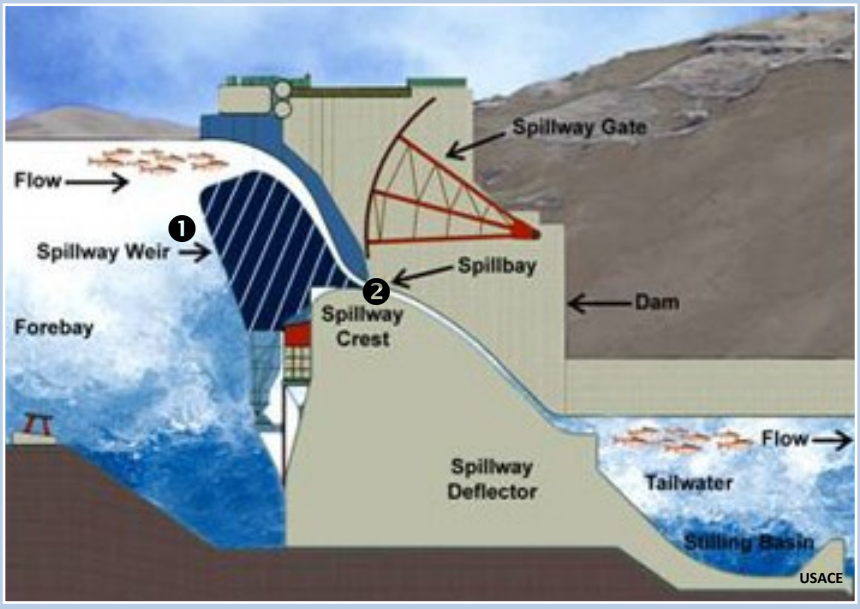
Yakama Nation Fisheries

Little Goose Dam

Project Spotlight: Surface Spillway Weir

To improve survival of juvenile salmon and steelhead migrating downstream past Little Goose Dam, the U.S. Army Corps of Engineers installed a spillway weir to provide fish passage near the water surface.

The spillway weir (**1**) fits inside the dam's spillway, raising the opening and allowing juvenile fish to pass near the surface, rather than having to dive 50 to 60 feet to pass through the deep spillway openings (**2**). Surface spill passage provides a more efficient and less stressful route for the young fish.



Since the completion of the weir, studies have shown that the structure has led to improved survival of migrating juvenile salmon and steelhead.

With the installation of the Little Goose Dam weir, surface fish passage facilities now exist at all U.S. Army Corps of Engineers dams on the lower Snake River.

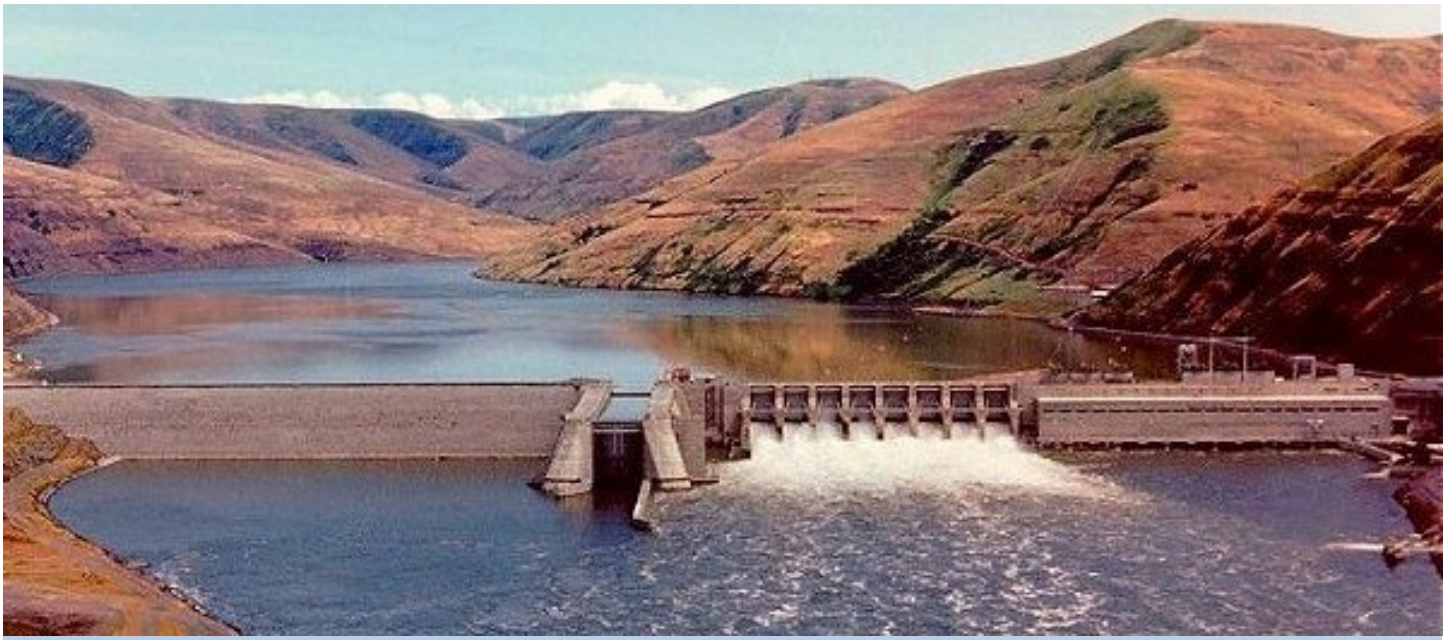
Little Goose Dam Improvements

Action	Species	Project Status	Intended Benefit
Juveniles			
Spring spill: April 3 - May 31 (on-going)	Salmon and Steelhead	⊙	Improves survival and reduces travel time
Summer spill: June 1 - August 31 (on-going)	Salmon and Steelhead	⊙	Improves survival and reduces travel time
Operate turbine Unit 1 to upper 25% of the 1% best efficiency range - provides disruption of eddy in front of powerhouse that delay migration (on-going)	Salmon and Steelhead	⊙	Improves successful exit of juvenile fish and migration of adult fish past dam
Transport fish based on flows and dates (on-going)	Salmon and Steelhead	⊙	Transport "spreads the risk" of decreased survival under certain river conditions (e.g., low-flow)
Improve turbine operation (2014)	Salmon and Steelhead	⊙	Improved survival through turbines
Install spillway weir and deflector (2009)	Salmon and Steelhead	●	Reduced forebay delay and improved survival of juvenile fish by bypass improvements
Relocate juvenile bypass outfall (2010)	Salmon and Steelhead	●	Improved successful exit, and improved survival on bypassed fish
Complete actions for permanent spillway weir	Salmon and Steelhead	⊙	Reduce forebay delay and improve direct and indirect survival of juvenile fish
Test BiOp goal performance	Salmon and Steelhead	⊙	Confirms if modifications reduce impacts of dams enough to reach goals
Adults			
Operate turbine Unit 1 to upper 25% of the 1% best efficiency range - provides disruption of eddy in front of powerhouse that delay migration	Salmon and Steelhead	⊙	Improves successful exit of juvenile fish and migration of adult fish past dam
Install lamprey openings in fish ladders (2013)	Lamprey	●	Provided alternative passage route with resting spots.
Investigate and reduce adult passage delays and blockages during spill	Salmon and Steelhead	⊙	Improves reliability of adult upstream passage
Concerns			
➔ During summer low-flow conditions (between 60-80kcfs), tailrace spill patterns that delay adult passage have been investigated. Implementation of improvements are under review.			
➔ The north adult ladder needs to be repaired.			
➔ Because there is concern about long-term survival for some species passing through this bypass, additional research is needed.			
➔ To ensure standards are met for all flow conditions, there is a need to continue improvements and performance testing. The performance standards were not met the during summer low flows of 2013.			

○ **Not Started** ⊙ **In Progress** ● **Completed**

Yakama Nation Fisheries

Lower Granite Dam



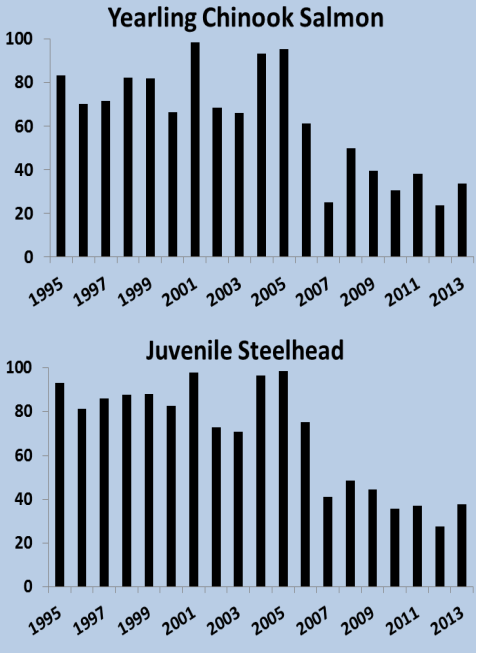
Project Spotlight: Spill and Juvenile Transport

The most effective passage route for juvenile salmonids past dams is through spill. To increase survival, spill has been mandated by court order (through the Accord and required in the BiOP) to occur from April 10 through August 31 at most of the federal Columbia River Basin dams.

During low-flow conditions, sufficient spill may not be available. To reduce mortality as fish migrate past the lower Snake River dams, fish are diverted away from the dams, placed in barges/trucks, transported downstream and released below Bonneville Dam. Transportation helps to eliminate the additional mortality that could occur if these fish were to pass through the numerous dams and reservoirs during low flow and warm water conditions.

Studies have shown that transported fish may lose their homing instinct or fail to return for reasons that are not understood. Studies have shown that during some conditions, more transported fish have survived to the release locations below Bonneville Dam than fish that migrated downstream without assistance. However, under some conditions, fish that migrated without assistance returned in greater numbers as adults than the fish that were transported downstream in barges and trucks as juveniles. The “delayed mortality” of transported fish is a subject of ongoing research.

Juvenile fish are collected for barge transport at Little Goose, Lower Granite and Lower Monumental Dams, but are not collected at Ice Harbor Dam and are no longer collected from McNary Dam. Since 2006, changes in spill levels and dam improvements like surface weirs has led to a reduction of over 50% of the number of fish that have needed to be transported annually.



Percent of fish transported 1995-2013 (NOAA)

Lower Granite Dam Improvements

Action	Species	Project Status	Intended Benefit
Juveniles			
Spring spill: April 3 - May 31 (on-going)	Salmon and Steelhead	⊙	Improves survival and reduces travel time
Summer spill: June 1 - August 31 (on-going)	Salmon and Steelhead	⊙	Improves survival and reduces travel time
Transport based on flows and dates (on-going)	Salmon and Steelhead	⊙	Transport "spreads the risk" of decreased survival under certain river conditions (e.g., low-flow) when extra spill may not occur
Improve turbine operation	Salmon and Steelhead	○	Improved survival through turbines
Install new juvenile fish facility and make improvements to opening (2012)	Salmon and Steelhead	⊙	Improved survival for all collected fish using a bypass system
Install prototype spillway PIT-tag monitoring system	Salmon and Steelhead	○	Improve monitoring of ESA-listed salmon and steelhead – confirms if modifications reduce impacts of dams enough to meet goals
Test BiOp goal performance	Salmon and Steelhead	○	Confirms if modifications reduce impacts of dams enough to meet goals
Adults			
Investigate and improve water supply for adult trap (2010)	Salmon and Steelhead	⊙	Improved performance to operate at full capacity without affecting fishway back-up water supply for adult passage
Modify fishway to improve passage conditions impaired by temperature ranges	Salmon and Steelhead	⊙	Improved passage conditions for adult fish
Investigate and reduce adult passage delays	Salmon and Steelhead	⊙	Improves reliability and reduces potential stress of adult upstream passage
Replaced valve and JFF upgrade may bring more reliable cool water to trap.	Salmon and Steelhead	⊙	Improve supply of cool water for adult trap to operate effectively at low flows
Concerns			
➔ After passing through the bypass, sub-yearlings tend to congregate in the tailrace area, delaying downstream migration.			
➔ To ensure the adult ladder operates effectively at low flows and increased river temperatures, work to improve water supply needs to continue.			
➔ During low flows, adults are delayed in the tailrace area. The delays negatively impact upstream migration.			
➔ Due to damage, Unit 1 cannot be operated in full operating range and has to be locked into one position. The unit is difficult to operate properly and creates poor tailrace conditions for adults and juveniles.			
➔ Facility improvements and performance testing must continue.			

○ **Not Started** ⊙ **In Progress** ● **Completed**

Spotlight: Adult Passage Issues at Lower Granite Fish Ladder

Due to its relatively high location in the water column, the water supply intake for the Lower Granite Dam fish ladder withdraws warm water during the summer. As a result, the water in the ladder tends to be warmer than the water in the tailrace and forebay. This temperature difference discourages adult salmon and steelhead from entering and exiting the fish ladder. The U.S. Army Corps of Engineers is modifying the water intakes to allow for the withdraw of water from deeper in the water column, providing cooler water throughout the ladder and to the adult fish trap. This is a high priority activity, as it is the only fish ladder at the dam. Contracting limitations and the need to close the fish ladder to perform the modifications have limited the implementation of corrective actions.

Yakama Nation Fisheries

Efforts to Reduce Predation on Juvenile and Adult Fish

In the Columbia River Basin, construction and operation of hydro-facilities have led to conditions that enhance opportunities for predators to consume a large number of juvenile and adult salmon, steelhead, and other fish species. To reduce predation, the U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, and Bonneville Power Administration fund efforts to control predators with the goal of improving the survival of juvenile and adult salmon and steelhead.

Sea Lions

Columbia River salmon, steelhead, white sturgeon, and lamprey face threats from sea lions below Bonneville Dam. In recent years, the number of sea lions preying on salmon and steelhead, between February and June, has increased significantly. Sea lions annually consume thousands of returning adult fish. In addition, sea lions eat a significant number of adult white sturgeon and have been observed eating lamprey.

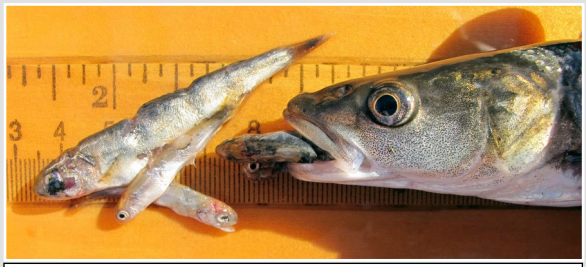
- Efforts: Hazing techniques, exclusion devices, relocation, and lethal measures are used to reduce the presence of sea lions below Bonneville Dam
- In 2013, 2,928 salmon and steelhead (2.4% of the run) were consumed by sea lions below the Bonneville Dam
- In 2013, 635 white sturgeon were consumed (down from 2,498 in 2012)
- 58 sea lions have been removed since 2008

Northern Pikeminnow

Sport Reward Fishery Program

Northern pikeminnow are native to the Columbia River Basin. Construction of dams resulted in environmental changes that have led to increased predation on out-migrating juvenile fish.

- Goal: Reduce the average size and reduce the number of older fish that disproportionately prey on salmon and steelhead smolts
- Reward for pikeminnow over 9 inches caught in the Columbia and Snake rivers
- From 1991 through 2011, 3.9 million pikeminnow removed
- Pikeminnow harvested in 2011 resulted in an estimated 35% reduction in the number of salmon and steelhead hat would have been eaten by pikeminnow



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Caspian Terns and Double-Crested Cormorants

Estuary

Tern and cormorant populations have increased significantly in the last 20 years. Between 2010-2013, the estimated annual smolt consumption by cormorants and terns was 19 million and 5 million, respectively.

- Goal: Redistribute 60% of the East Island tern colony to alternative sites in Oregon and California away from the Columbia River
- Goal: Reduce the cormorant population using privacy fences, nest destruction, hazing, and lethal take (when necessary) to reach the ~5,000 pair estuary BiOp goal

Inland Avian Predation Management (Columbia Plateau/Mid-Columbia Region)

Nesting colonies of terns are found on Goose, Crescent, and Blalock islands, whereas cormorants are nesting on Foundation Island. In 2012, terns consumed 730,000 juvenile steelhead.

- Goal: Reduce predation by hazing terns away from Goose and Crescent islands and attracting them to out-of-basin nesting sites
- Goose Island: Haze, potentially modify substrate, and take eggs
- Crescent Island: Haze, plant willows/vegetation, construct berms, and take eggs
- Lower Snake River dams: Non-lethal hazing and lethal removal (if hazing is unsuccessful)

Note: Non-lethal hazing also conducted at all federal lower Columbia and Snake river dams, with limited lethal removal of gulls at McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite dams.

Yakama Nation Fisheries

Glossary

2008 Columbia River Fish Accords	Legal agreement signed by the Yakama Nation and several other tribes and agencies to mitigate for the impacts of dams on fish.
BiOp	Biological Opinion. Issued by NOAA Fisheries, an opinion about the impacts of the federal hydrosystem, with goals for protecting salmon and steelhead listed under the Endangered Species Act.
BPA	Bonneville Power Administration. Federal entity that markets and distributes energy produced by federal hydroelectric dams. It is part of the U.S. Department of Energy.
bypass	A channel or conduit in a dam that provides a route for fish to move through or around the dam without going through the turbines.
(corner) collector	A system at a dam that collects and holds the fish approaching the dam for later transportation or moves them through or around the dam without going through the turbines (e.g., at Bonneville Dam).
ESA	Federal Endangered Species Act. Used to protect species at risk of going extinct.
FPE	Fish passage efficiency: proportion of juvenile fish passing a dam through non-turbine routes.
hydroelectric	Electricity generated by hydropower systems by utilizing the force of falling water (e.g., from behind a dam to turn turbines).
fallback	Fish that migrate partially or all the way up over a dam, and then go back downstream, expending extra time and energy in their attempt to reach spawning grounds.
fishway	Passage created to help fish get past a barrier (e.g., fish ladders).
flume	An open artificial channel or chute carrying a stream of water, as for furnishing power, conveying logs, or as a measuring device. (Also used for natural channels down a narrow gorge).
forebay	The area of a dam's reservoir that is immediately upstream from the powerhouse.
gatewell	The slot on the upstream face of a concrete dam where hydraulic gates are stored when not used to close the turbine intakes. The gatewell typically houses the fish screening device.
hydrosystem	Series of dams that span rivers and affect migratory fishes and river conditions. In the Columbia River Basin, the term generally refers to the mainstem hydroelectric dams in the Columbia and Snake Rivers.
memorandum of agreement	A legal document written between parties to cooperate on an agreed upon project or meet an agreed objective.
NOAA	National Oceanic and Atmospheric Administration. A federal agency that is part of the U.S. Department of Interior, involved with fisheries management on a federal level, as well as marine commerce, weather and coastal monitoring and warnings.
operation targets	Goals for how to operate dams for flow and spill, negotiated in order to balance the needs of natural resources and power generation. Achieving operation targets is dependent on annual flow conditions and in-season management.
PIT-tag	Passive integrated transponder. A tiny tag that is inserted in a fish that enables its presence and direction of movement to be recorded as it passes by a receiver antenna.
powerhouse	A primary part of a hydroelectric dam where the turbines and generators are housed and where power is produced by falling water rotating turbine blades.
salmonid	Salmon and steelhead.
sluiceway	An artificial channel, that carries a portion of the current of a stream, canal, or other larger body of water.
smolt	Juvenile salmon that are migrating to the ocean.
spillway	The channel or passageway around or over a dam through which excess water is released or "spilled" past the dam without going through the turbines. Spill gates control this flow.
tailwater	The water surface immediately downstream from a dam or hydroelectric power plant.
SPE	Spillway passage efficiency: proportion of juvenile fish passing a dam through the spillway(s).
treaty-trust resources	Natural resources that occur in the usual and accustomed places for harvest, the rights to which are protected by the Yakama Nation's Treaty of 1855 (12 stat. 951) with the United States of America.
turbine	A mechanism in a dam that rotates with the force of water and produces electricity.
USACE (or USCOE)	United States Army Corps of Engineers. A U.S. federal agency under the Department of Defense, responsible for the operating of 12 of the 14 Federal Columbia River Power System dams on the Columbia and Snake rivers and has responsibility over numerous other large-scale public works throughout the nation and world.
USBOR	United States Bureau of Reclamation. A federal agency in the Department of the Interior, responsible for water resource management, especially throughout the West for irrigation, water supply, and hydroelectric power generation.

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Photo	Credit	Year	Page
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Adult salmon climbing a fish ladder	BPA	-	cover
Fishing platform below The Dalles Dam	Historic	2010	cover
Gerald Lewis, Fish and Wildlife Committee, YN Tribal Council	YN	2014	2
Platform fishing at Celilo Falls, Columbia River	Oregon Historical Society #65995	historic	4
Bonneville Dam, under construction	Courtesy Franklin C. Roosevelt Library	ca. 1930s	5
Experimental lamprey ramp	University of Idaho, C. Caudill	2013	5
White sturgeon	USGS	-	5
Dam fish passage illustration	USACE	-	6
Surface flow, Bonneville Dam picture	BPA		7
Turbine picture, Bonneville Dam	BPA	-	7
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Juvenile bypass outfall, Bonneville Dam	BPA	-	7
Bonneville Dam, aerial photo	USACE	-	8
Lamprey impinged, John Day Dam	USACE	~1996	8
Lamprey ramp ladder, Bonneville Dam	Jamie Francis, The Oregonian	2010	8
The Dalles Dam, aerial photo	USACE	2010	10
The Dalles Dam, spillwall physical model photos	USACE	-	10-11
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Lamprey ramp schematic, photo	USACE	2014	14
Pacific lamprey	USFWS	-	15
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Lower Monumental Dam	USACE	-	18
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Sea lion eating Pacific lamprey	Anonymous/ ODFW	-	24
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Sea lion eating sturgeon	Lyn Topinka	2010	24
Northern pikeminnow, having eaten juvenile salmon	ODFW	-	24
Northern pikeminnow sport reward sign	ODFW	-	24
Caspian tern eating lamprey, East Sand Island	OSU/RTL/USGS	2009	25
Double-crested cormorant	OSU/RTL/USGS	-	25

HONOR

PROTECT

RESTORE

Funding Provided By:

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