

# Spillway Weirs

Celebrating 10 years of service to the Nation



Photo by David G. Rigg



Above: Terry Flores, Northwest River Partners, addresses the audience. Right to left: Lt. Col. Timothy Vail, Commander, Walla Walla District; Elliot Mainzer, Bonneville Power Administration; Lesa Stark, United States Bureau of Reclamation; Rob Lothrop, Columbia River Inter-Tribal Fish Commission; and Rob Rich, Columbia River Towboat Association.

## A revolution in fish passage

The U.S. Army Corps of Engineers, Walla Walla District, marked a decade of safe fish passage over Ice Harbor's spillway during a commemorative event on July 15 that celebrated the 10th anniversary of the installation of a spillway weir at the dam.

In 2005, the first full production spillway weir was installed at Ice Harbor Dam. The era of surface passage began, revolutionizing fish passage and providing one more tool to improve juvenile fish survival at the dams. Testing at Ice Harbor noted about 98 percent

survival for fish passing the dams via the spillway weir.

By 2010, all eight Corps dams on the lower Columbia and lower Snake rivers put surface passage modifications in place for out-migrating juvenile fish, providing an effective route past the dams on their way to the Pacific Ocean. Spillway weirs and smart spill operations benefit juvenile salmon and steelhead by providing safer passage, faster migration, higher in-river survival rates and better water quality.

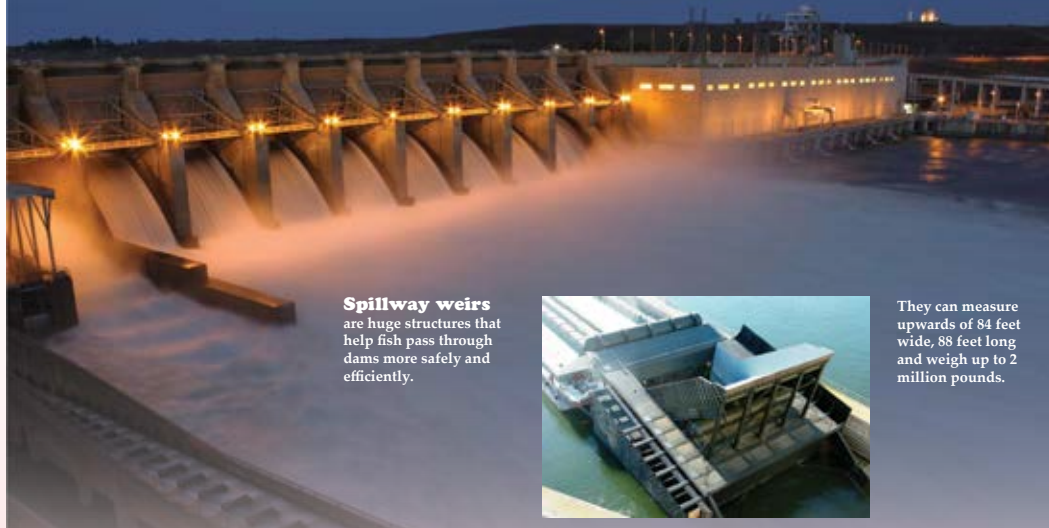
As the largest fish-conservation initiative in the Nation, results are evident by improved fish survival and productivity.

Each of the Snake River stocks have shown marked improvements since aggressive efforts to overhaul the Federal Columbia River Power System began in the mid 1990s. Fish runs in the Columbia Basin, including on the Snake River, have seen record returns in recent years.



Federal, community and industry officials representing fish-management, hydro-power and navigation in the Pacific Northwest joined Corps leaders, including the Corps' Deputy Commanding General Maj. Gen. Richard L. Stevens, to observe the spillway weir in operation and get the latest facts about the Federal Action Agencies' efforts to improve ESA-listed fish survival.

## What is a Spillway Weir?



Spillway weirs are huge structures that help fish pass through dams more safely and efficiently.



They can measure upwards of 84 feet wide, 88 feet long and weigh up to 2 million pounds.

They are manufactured in a factory, shipped on a barge and are attached to a dam's spillway where they act as giant fish slides.



Tests where spillway weirs have been installed indicate survival through these structures ranges from approximately 95-100 percent.



## How do Spillway Weirs work?

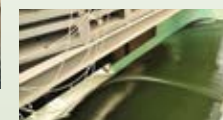
Spillway weirs, or fish slides, allow juvenile salmon and steelhead to pass the dam near the water surface under lower accelerations and lower pressures, providing a more efficient and less stressful dam passage route.

Most Columbia River Basin juvenile salmon and steelhead tend to stay in the upper 10 to 20 feet of the water column as they migrate downstream to the ocean.

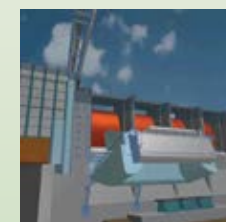
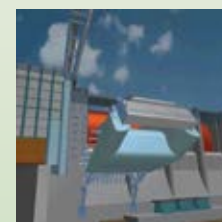
The configuration of juvenile fish passage routes at the Corps' lower Columbia and Snake river dams causes juvenile fish to dive to depths of 50 to 60 feet to find passage routes.



Spillway weirs are mounted onto a dam's forebay where they draw fish toward their smoother water flow over the spillway.



Spillway weirs at Ice Harbor, Lower Granite and Lower Monumental Dams are designed to be 'removable,' by controlled descent to the bottom of the dam forebay. This capability permits the spillway to perform to its original flow



capacity during major flood events.



## What are the types of Spillway Weirs?

The Corps began the spillway weir program in 2001 to improve juvenile fish passage over spillways and reduce the number of juveniles

entering the powerhouse. Juvenile fish tend to stay in the top 10 to 20 feet while migrating downstream. Spillway weirs allow migrating

juveniles to forgo diving 50 to 60 feet to get under the partially raised spillway gate and freely pass over the weir and dam.

### Removeable

A prototype Removeable Spillway Weir was installed at Lower Granite Dam on the lower Snake River in 2001, followed by the Ice Harbor Spillway Weir in 2005 and the Lower Monumental Dam Spillway Weir in 2007.



The Removeable Spillway Weir was the first type of spillway weir—a fixed, semi-permanent structure that occupies one spillway bay. Air is added or removed from tanks incorporated into the structure to either raise it up to its operational position in the spillway, or lower it to its stowed position on the riverbed.

### 2nd Generation

In 2007, the Corps developed the 2nd Generation Spillway Weir. It is lighter, more portable than an RSW, can easily be shipped in sections, and is easier to maintain.

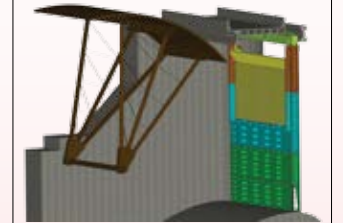


2nd Generation Spillway Weirs were installed at Little Goose and McNary Dams. They use a gantry crane to change weir segments to adjust the weir's height to change the amount of water flowing over it.



### Adjustable

The next generation of weirs is the Adjustable Spillway Weir (ASW). The ASW is similar to the TSW in some respects. Both are portable with segmented components that slide into position inside the spillway. The biggest difference is the ASW has its own dedicated and self-contained hoist structure installed at the top of the weir.

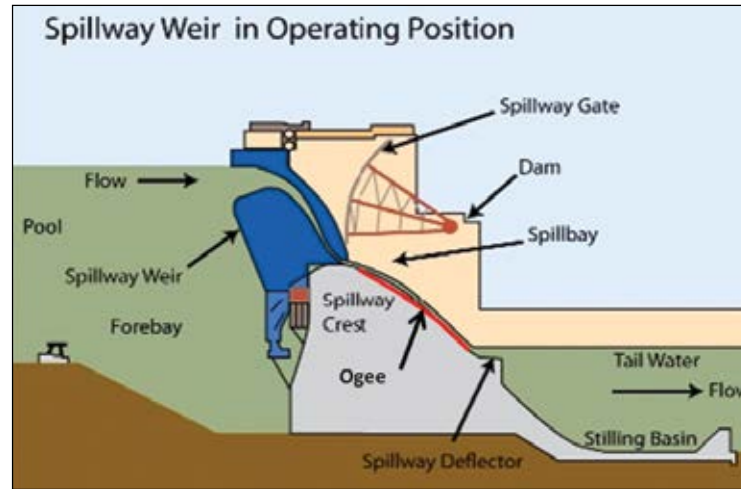


The weir crest can be raised and lowered as needed to change discharge over the weir to manage water levels during spring run-off or summer flows, or possible night operations. Surface passage structures are now in place at all the Corps' Columbia and Snake River dams.





U.S. Army Corps of Engineers Photos



# Spillway Weirs help increase fish survival

By Brad Trumbo

To improve the effectiveness of spillway operations for fish passage, Walla Walla District biologists and engineers came together to design and install spillway weirs at the District's lower Snake River and McNary dams. The District's first permanent spillway weir was installed at Lower Granite in 2001.

Juvenile anadromous salmonids (i.e. salmon and steelhead [smolts]), in the Columbia River Basin generally migrate in the upper 10 to 20 feet of the water column.

However, passage routes at dams on the lower Columbia and Snake Rivers require smolts to dive to depths of 45 to 60 feet to

enter a passage route, such as a powerhouse intake.

Differences between the depth of migrating smolts and the depth of traditional dam passage routes can result in delays in migration and increased exposure to predators as smolts search for a passage route.

Generally, spillway weirs draw spill from the top 10 to 15 feet of the water column providing a constant velocity draw with a hydraulic signature extending upstream to 400 feet into the forebay encompassing the depth of out-migrating smolts.

The hydraulic influence of a spillway weir provides significant attraction flow

for smolts, thus increasing the proportion of smolts passing a dam via spillway compared to powerhouse and generally decreasing passage and migration delays.

A removable spillway weir (RSW) was installed in spillbay 2 at Ice Harbor Dam in 2005. As with all new construction and configuration changes for fish passage, District biologists evaluated injury and survival of smolts passing the new RSW.

Study results estimated smolt injury rates at two percent for fish released at mid-depth and nearly 16 percent for fish released near the RSW crest. The injury rates for fish at the mid depth were similar to post construction evaluation results for other spillway weirs; however, the injury rates for smolts passing close to the crest were much higher than expected relative to spillway weirs at other Projects.

Forty eight hour survival was estimated at approximately 96 percent and the high injury rate for smolts passing close to the crest may translate to delayed mortality and increased predation in the tailrace.

Approximately 25 percent to 75 percent of out-migrating smolts pass Ice Harbor Dam via the RSW, thus identifying the cause of and addressing the high injury rates for smolts passing near the RSW crest is important to improving survival for Snake River fish.

District hydraulic engineers compared Ice Harbor Dam RSW passage data from



Photo by Idaho Fish and Game

## Fish survival through each spillway weir at Corps Snake River Dams is 95-100%

sensors and hydraulic modeling to spillway weir conditions at other projects. These comparisons indicated that the RSW flow was separating from the ogee above the deflector due to the steep slope of the Ice Harbor Dam spillway chute resulting in an increased injury rate for fish passing close to the RSW crest.

To address the high injury result from the 2005 study, District engineers designed a new ogee and deflector shape for Ice Harbor's spillbay 2 in 2014.

The new shape included decreasing the slope of the ogee and providing a gentler transition into the deflector and tailrace. Spillbay 2 construction was complete in March, 2015 and biological testing occurred in April.

Yearling Chinook salmon supplied by Dworshak National Fish Hatchery were balloon and radio tagged and directly released into spillbay 2 to pass the RSW at one and a half feet above the crest, identical to the 2005 study.

Researchers recaptured 335 fish resulting in estimated 48 hour survival of approximately 98 percent and only one and a half percent injury. Relative to the 2005 study results, it is clear that the redesign and reshaping of spillbay 2 was a tremendous success and will provide a substantial fish passage benefit for out-migrating smolts passing Ice Harbor's most effective fish passage route.



Juvenile fish (smolts) were balloon and radio tagged to validate survival and assist in redesigning and reshaping Ice Harbor Lock and Dam's spillbay #2.

## Fish Survival trending upwards

