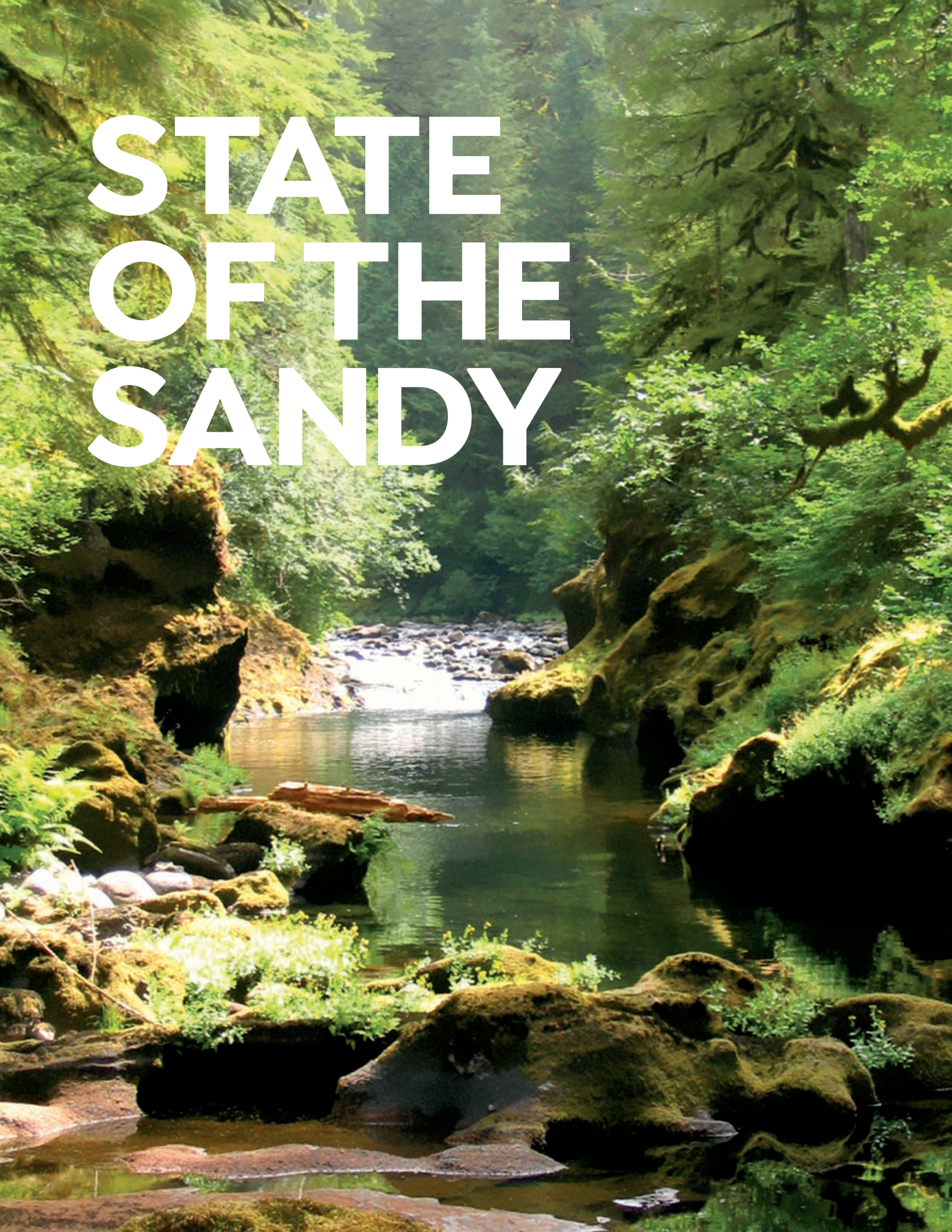
STATE OF THE SANDY

Sandy River Basin Watershed Council

Working together to restore the Sandy River



STATE OF THE SANDY

THE SANDY UNDAMMED:
A Dramatic View of a River and its Wild Salmon in Recovery

Removal of the Marmot dam from the Sandy River in 2007 opened a remarkable chapter in the life of this iconic Pacific Northwest river. Dramatic and unprecedented in its scale and complexity, dam removal was a pivotal leap, and only the first major step toward realizing the Sandy's potential as a wild salmon stronghold.

Undamming the Sandy allowed threatened wild salmon and steelhead uninterrupted access to upstream spawning habitat for the first time in nearly a century. It also catalyzed a coordinated, science-driven push to boost ecological processes that help return the watershed's wild fish to sustainable levels. Historic impacts besides dams had also reduced habitat productivity in key areas. For wild fish to thrive the Sandy would need corridors of functioning floodplains and side channels, healthy streamside vegetation, and a committed community ready to care for the watershed in the long run.

A decade beyond removal of Marmot, and Little Sandy dam a year later, initial results of this conservation campaign are emerging. The collaborative restoration toward wild fish recovery in the Sandy River basin has taken major strides. The following State of the Sandy reviews key changes since dam removal, summarizing the Sandy's progress in three main areas:

- Priority restoration actions accomplished on the ground;
- Numbers of adult and juvenile salmon returning to the Sandy and its tributaries; and
- How human communities connect around stewardship, the river's role as water source and as a well loved recreation haven.

Finally, we'll look at future opportunities to further secure the Sandy's incredible ecological and social legacy, and challenges we may yet need to overcome to sustain the watershed's wild fish and biodiversity for future generations.

The Sandy is emerging as a remarkable success story in the making, a tribute to the resiliency of rivers and the power of voluntary collaboration.

Expert analyses point to indications that dam removal and focused restoration are moving the Sandy in a renewed direction. As the ripples clear from this groundbreaking effort to return a wild river to health, the Sandy is emerging as a remarkable success story in the making. It is a tribute to the resiliency of rivers and the power of voluntary collaboration. We thank the many thousands of individuals and organizations who have joined this effort already, and encourage you to help extend the Sandy's ecological connectivity and integrity for decades to come.

STATE OF THE SANDY

Dam Removal and Basin-wide Restoration in the Sandy

Removal of dams from the Sandy River basin reversed a historic trajectory for the basin that began when Portland General Electric (PGE) completed the Bull Run Hydropower complex in 1913. The 47-foot high Marmot dam diverted flow from the Sandy River, 30 miles from its mouth on the Columbia River. A tunnel excavated through a mountain (historically called the Devil's Backbone because of the difficulty immigrants faced hauling wagons and gear over it on the Oregon Trail) carried diverted water into the Little Sandy River, a tributary of the Bull Run. The Little Sandy dam completely dewatered the stream, sending it along miles of flume on a train-like wooden trestle to a reservoir, then into a powerhouse along the lower Bull Run. PGE built the dams to bring electricity to the growing city of Portland 20 miles east, also powering a trolley line that brought city dwellers for boating and swimming at the reservoir, called Roslyn Lake. The dam generated about 22 MW of electricity, enough to power about 16500 modern homes. In the late 1980s a concrete layer was added to the original earthen structure to strengthen the Marmot dam.

For thousands of years the Sandy and tributaries have been home to vibrant runs of wild salmon and steelhead. The Marmot and Little Sandy dams interrupted the annual fish migration, despite operation of fish passage to move migrating adults upstream. By the late 1980s, the Sandy's native spring and fall Chinook, coho, and steelhead populations were all declining. Wild fish throughout the Columbia basin were listed as threatened under the Endangered Species Act

Sandy (and Marmot dam removal) by the Numbers

1913 Completion date for the Bull Run Hydropower project, including Marmot and Little Sandy dams

Marmot dam removed **2007**
Little Sandy dam removed **2008**

56 Stream miles in the main stem Sandy

220 used by salmon and steelhead

680 total in the basin

955,000 cubic yards of sediment released when Marmot dam was removed

44 Rare, Threatened, and Endangered Species known in the Sandy

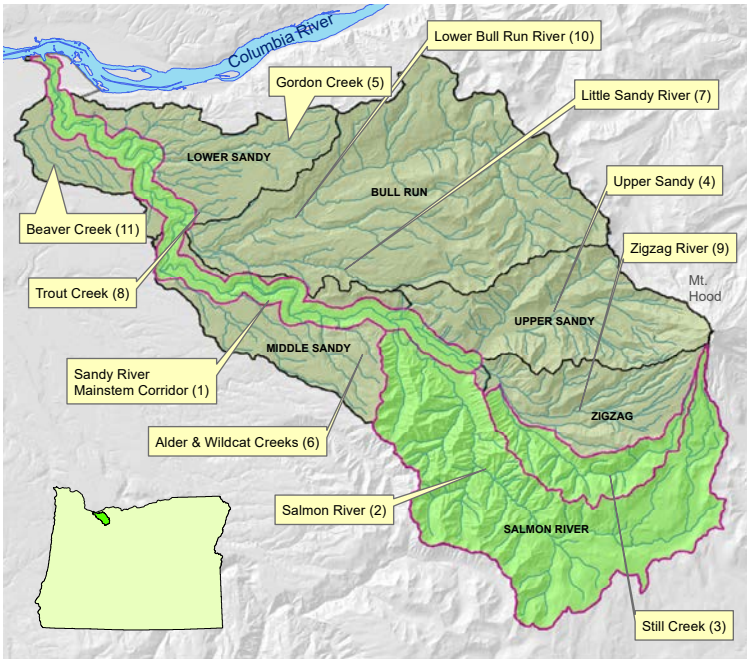
Yellow-billed cuckoo

Restoring Fish Habitat in a Salmon Stronghold

Restoration Activities by Type

	riparian	Planting, invasive species removal, riparian fencing
	instream	Large wood placement, channel alteration
	combined	Multiple activies, including road and wetland improvement
	upland	Grazing, irrigation and invasive plant control
	fish passage	Culvert replacement and dam removal

Priority Subbasins



Over 120 projects have been completed in the basin since 1997 (above). Of the fish species living in the basin, Chinook Salmon, Coho and Steelhead are listed under the Endangered Species Act at the federal level.

Note: One project can occur in multiple locations on the map and may have taken place over several years, or may be ongoing.

Sandy River Basin Partners analyzed which areas represent anchor habitat (left), ranking those with the highest potential for salmon and steelhead. The main stem Sandy River, Salmon River and Still Creek (shown in bright green) gained top priority.

First phase of Marmot deconstruction in July 2007.

Today Marmot is a year round recreational resource.

(ESA) in 1998-99. Sandy populations had dropped by this time to 10-25% of their historic levels.

Faced with a requirement to comply with the ESA and its prohibition to harm listed species, PGE weighed its options to renew its federal license. Continued operation of the dam would require constructing and operating fish passage. They would need both a ladder for spawning adults to safely return upstream, and a means to safely move migrating juveniles downstream across the dam. Recognizing that dam removal would cost customers less in the long run, PGE committed in 1999 to voluntarily removing Marmot and Little Sandy dams, and their associated infrastructure.

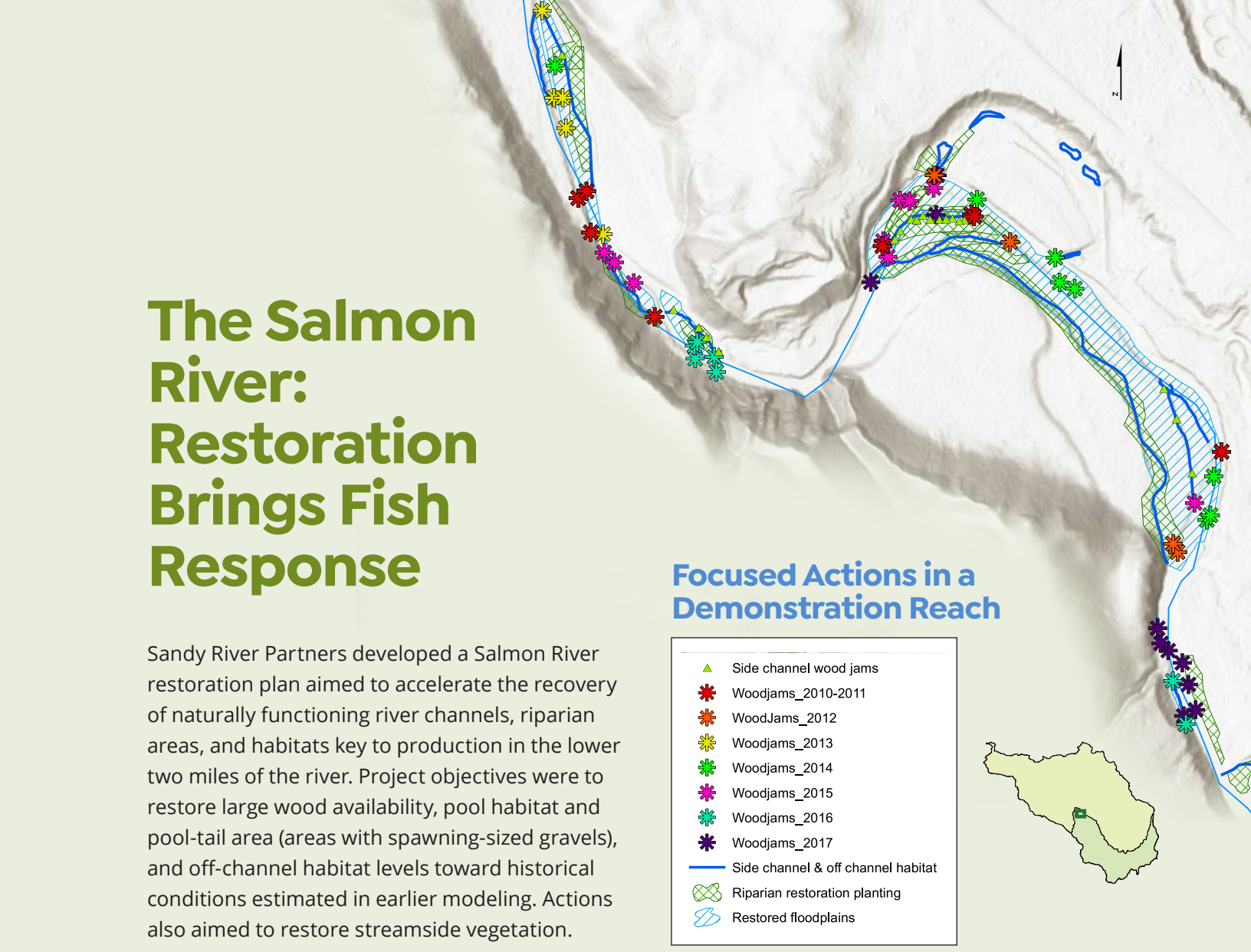
Planning for the physical dam removal took several years. A coalition of agencies and conservation groups consulted with the utility on the terms and process under which PGE would withdraw its hydropower license. No such surrender of a license had occurred before, so the extent of responsibility for river conditions once the dam removed had to be defined. PGE eventually agreed to dismantle the dams, transfer related water rights to the state as instream rights, donate much of the project's land to public ownership, prevent invasives from colonizing those lands, and monitoring river conditions for several years.

Deconstruction at Marmot began in summer 2007, with the river diverted by a temporary earthen coffer dam built behind the once permanent Marmot. On October 19, 2007, as calculated in dam removal plans, a seasonal storm rose with enough force to wash away the temporary dam. An excavator cut a small notch in the coffer dam, releasing first a trickle and then a roaring torrent. Approximately 19 hours later, the entire structure was washed away. The Sandy flowed free for the first time in 94 years.

Restoration Results: Piling on Priority Actions through Collaboration, Partnership, Persistence

The decision to remove dams from the Sandy catalyzed a broad, collaborative restoration campaign that leverages efforts across two counties, dozen of organizations and thousands of volunteers. Motivated by the prospect of a free flowing Sandy, a group of public and nonprofit agencies formed the Sandy River Basin Partners (SRBP) in 1999. Also around that time, the Portland Water Bureau developed a long term plan to comply with the ESA listings and habitat impacts from the water supply dams and operation in the Bull Run.

The Salmon River: Restoration Brings Fish Response



Focused Actions in a Demonstration Reach

Sandy River Partners developed a Salmon River restoration plan aimed to accelerate the recovery of naturally functioning river channels, riparian areas, and habitats key to production in the lower two miles of the river. Project objectives were to restore large wood availability, pool habitat and pool-tail area (areas with spawning-sized gravels), and off-channel habitat levels toward historical conditions estimated in earlier modeling. Actions also aimed to restore streamside vegetation.

The Salmon River is a top priority tributary in Sandy basin restoration plans, rated among the most productive spawning areas in the watershed. Located about 43 miles east of Portland, the Salmon originates from the Palmer Glacier on the southwestern slopes of Mt. Hood, draining an area of 110 square miles. The upper Salmon is within US Forest Service own ership. Portions are protected as federal wilderness, with other areas heavily used for hiking, fishing and recreation. Both Timberline Lodge and Skibowl ski areas lie within the Salmon basin, as well as other recreation sites, snow parks and trails. The lower Salmon is a mixture of federal and privately owned land, with residences, an RV park and a golf resort among its developed areas.

Historic logging, development, and channelization had altered the lower Salmon River. Those actions created a flat channel with little habitat complexity. Only a single log jam was present on the 2-mile project reach. Connectivity was limited between the main channel, side channels and off channel habitats. Logging in the 1930s, and removal of large trees, logs and boulders after 1964 floods, simplified the river. These actions cut off the side channels, meanders, and wood jams that were crucial habitat for salmon and steelhead.

Implementation began in 2010, led by Freshwater Trust and Bureau of Land Management (BLM). The BLM manages extensive portions of the lower Salmon River. The Nature Conservancy led revegetation efforts as part of a broader vegetation restoration coalition. The project prioritized sites

for large wood placement that would best restore connectivity to side channel and off-channel habitats. Large wood added to side channels and off-channel areas improved habitat complexity for juvenile rearing, increased pool and pool-tail habitats. It also increased retention of spawning-sized gravels, while providing adult and juvenile cover. Native plantings and invasive species removal restored streamside plant communities, establishing sources of future large wood.

2.1 miles of main stem Salmon River was improved from 2010 to 2016. Construction of 38 main channel and 20 side channel wood jams added 1,799 pieces of large wood. This reconnected river flows to 2.1 miles of off-channel habitat including side channels, alcoves, and beaver ponds, and restored 28 acres of floodplain habitat. Invasive weeds were removed from 998 acres of riparian areas along 5.5 miles of river on both federal lands and 56 private parcels. Planting crews and volunteers installed 39,000 native trees and shrubs in treated areas, and an additional 42 acres of riparian habitat surrounding restored stream segments.

Monitoring has been completed collaboratively by The Freshwater Trust, BLM, Portland Water Bureau, ODFW, and the USFS, including cross-section and longitudinal profile measurements, pebble counts, large wood surveys, and photo points to observe post-project evolution of restored river conditions. Biological monitoring includes a 20-year commitment to monitor smolt out-migration, and annual spawning surveys for spring Chinook, coho, and winter steelhead. Snorkeling surveys every 2-4 years document juvenile fish use of side channels, off-channel habitats, and main channel wood jams. TNC annually conducted post-planting surveys of riparian plant survivership

Three floods in four years after construction showed how the stream is responding to restoration. Pool numbers, volume, and depths increased to near historical levels in treated areas. Side channel and off-channel lengths increased from 0.1 to 1.0 mile per river mile. Large wood numbers increased from 14 to 414 pieces per river mile. Pre- and post-project photo monitoring documented remarkable increases in spawning-sized gravels at wood jams and side channel inlets, as well as natural accumulation of large wood. Constructed wood jams increased up to seventimes their original size, snagging logs transported during floods. Riparian plantings all exceeded the goal of 60% survival.

Fish response to restored habitats was also notable. Surveyors counted over 10,000 juvenile coho (approximately half the Sandy's total annual coho offspring) and 3,300 juvenile steelhead annually in side channels restored to perennial flow. Juvenile fish densities at main channel wood jams in pools in 2014 were five times greater than that of main channel pools without large wood. Also, significantly more spring Chinook, and winter steelhead spawned in gravel patches next to constructed wood jams.

From 2012 to 2015, spawning surveys by the Oregon Department of Fish and Wildlife (ODFW) indicated that the number of wild winter steelhead spawning in the lower Salmon River increased by 365%. This compares to an average increase of 226% across the rest of the Sandy basin. The number of winter steelhead redds on the restoration reach doubled from 34 redds/mile in 2012 to 68 redds/mile in 2016.

Spring Chinook spawning on the restoration reach in 2016 (40 redds/mile) was three times the long-term average for the lower Salmon. For the second year in a row, 2016 also saw spring Chinook spawner numbers exceeding the long-term average by >150%. The number of adult coho salmon returning to the lower Salmon has increased significantly since restoration efforts began. By 2016, the number of coho spawning in restored side channels doubled, to 22 redds/mile compared to 11 redds/mile in 2009.

The SRBP conducted a scientific assessment of historic habitat conditions. Detailed plans identified steps to recover habitat productivity for specific salmonid species throughout their various life stages. Over 150 years of development and other changes meant that completely recreating historic habitat conditions in the Sandy River Basin was not possible. But the potential remained to recover ecological functions in important river reaches. This would give wild salmon and steelhead the places and conditions they would need to recover. Based on habitat modeling, the Sandy Partners prioritized potential restoration actions by subbasin. Recognizing that while all areas of the basin could be improved, the mainstem Sandy, Salmon River, and Still Creek were ranked as the highest priorities to support key wild fish recovery.

Various partners developed subbasin restoration implementation plans. Each plan identified specific habitat enhancements that could improve key limiting factors to wild fish productivity. Oregon Watershed Enhancement Board (OWEB) statistics show more than 120 restoration projects completed since 1997. SRBP's restoration efforts have garnered awards from the US Forest Service, BLM, American Fisheries Society, and Oregon Parks and Recreation Association.

A culvert in Oxbow Regional Park reconnected year-round flow into a stream and side channel.

Passage Improvements

Dam removals at Marmot and the Little Sandy dams were just the first steps to reconnect access for wild fish. Actions to remove, replace or redesign passage blocking culverts and dams have also occurred at the Sandy River Delta, Alder Creek, Cedar Creek, Still Creek, and the Salmon River. Additional passage improvements are underway in Beaver Creek, to be completed in 2018. Together, these improvements have reopened miles of habitat.

Instream Habitat Enhancements: Reversing Historic Floodplain Degradations

Historic development activity, especially following the record Christmas Day floods of 1964, had reduced habitat quality and connectivity in many of the river's floodplains. In attempts to 'fix' the Sandy after the 1964 flood destroyed 155 houses, many bridges, roads and levees were built to confine the river in its pre-flood channel. Streamside vegetation was cleared on the theory that letting the water through as fast as possible was the best solution to future floods.

Bulldozers confined the Sandy's channel between levees and cleared trees from the floodplain after record floods in 1964.

Those post-1964 flood responses cut off side channels and off-channel habitat that are essential for juvenile fish migration, feeding and development. Historic actions had also severely reduced the distribution of large woody debris and log jams that naturally create pools and hiding places for fish. Restoration plans called for reconnecting side channel and floodplain areas, as well as building large log jams for habitat conditions essential to salmon spawning and rearing.

Sandy River Basin Partners have completed extensive side channel and floodplain restoration, as summarized in the table on page 12.

Bull Run Habitat Conservation Plan

The Portland Water Bureau developed the Bull Run Water Supply Habitat Conservation Plan (HCP) in 2008 to comply with the Endangered Species Act and Clean Water Act for water supply impacts in the Bull Run Watershed. The HCP describes 49 specific restoration actions and other conservation measures the City will undertake over a 50-year period to address flow, temperature and habitat impacts that result from the City's drinking water operations and facilities.

Portland's drinking water supply has come from the Bull Run River since 1895. The Bull Run is approximately 25 miles long. Its watershed drains approximately 140 square miles, most located within the Mt. Hood National Forest. The City of Portland owns the majority of the riparian land along the lower 6 miles of the Bull Run River.

About a quarter of all Oregonians -- 966,000 in 2016 -- get their water supply from the Bull

Run, including residents of Portland, Gresham, Sandy and other surrounding communities. The City diverts approximately 20 percent of the total annual flow of the Bull Run River for water supply from two reservoirs, whose dams block approximately ¾ of the basin's fish habitat. During the summer, the diversion had historically removed almost all of the natural flow, leaving little water in the river for fish. Reduced flow results in decreased habitat for spawning and rearing, as well as increased water temperatures. Changes in water withdrawals could rapidly change flows downstream, adversely altering spawning and rearing conditions for migrating fish. Although temperatures in the Bull Run River are naturally warm in the summer months due to the bedrock substrate and sun exposure, storage of water in the reservoirs causes further warming. Warm temperatures stress rearing and spawning fish.

Bull Run HCP implementation began in 2010, with most measures to be in place by approximately 2024. Some measures take place within the Bull Run, while the remainder address priority restoration targets in the rest of the Sandy. The estimated cost of all measures is $93 million, estimated in 2009.

Conservation so far in the Bull Run includes:

- Meeting minimum flow levels in the lower Bull Run River, as well as requirements to adjust flow downramping (changes in flow);
- Culvert replacement at Walker Creek to improve fish passage in the lower Bull Run;
- Removal of a spillway rock weir below Dam 2 to improve water temperatures and fish passage;
- Placement of (how many) tons of spawning gravel for fish into streams;
- Addressing water temperature targets in the lower Bull Run – HCP targets aim to maintain cold water inflows to the lower Sandy;
- Major improvements to a withdrawal tower at drinking water Dam 2 to meet colder water temperature targets starting in 2014. The tower allows water to be mixed from colder, deeper layers in the reservoir when summer temperatures rise on the surface;
- Acquired 34 acres of land in the lower Bull Run as part of a broad program of conservation easements;
- Monitoring of juvenile fish at three fish traps, adult salmon counts, spawning gravel usage in the lower Bull Run, and habitat surveys of streams.

Elsewhere in the Sandy River watershed HCP measures implemented so far include:

- Conservation easements on private land for about 246 acres;
- Four projects that placed of large wood structures to improve fish habitat, with pre- and post-project stream monitoring streams to determine project effectiveness;.
- Fish passage improvements including funding ($3.7 million) to complete improvements on Cedar Creek (approximately 12 miles of stream opened to fish passage), two fish ladders on Alder Creek to open access to 5.5 miles of stream, and partnering with the U.S. Army Corps of Engineers to remove the Sandy River Delta Dam, opening over a mile of the Sandy's historic main channel where it meets the Columbia;
- Led the largest turtle rescue project in Oregon, prior to the Sandy Delta dam removal. Approximately 25 native painted turtles were successfully relocated away from construction activity.

Portland committed to create a Habitat Fund of $9 million, dedicated to partnership habitat projects. Portland has committed approximately $880,000 of Habitat Fund dollars through 2018 to Sandy River Basin Partners for restoration projects.

Adapting Hatchery Management: Sorting out Chinook Strays

Dam removal also altered hatchery operations. With salmon already declining from overharvest, fish propagators began collecting eggs in 1887 on the Sandy and Salmon Rivers. The Sandy station moved downtream of Marmot dam in 1938, and in 1950 to the Oregon Department of Fish and Wildlife (ODFW) hatchery on Cedar Creek that remains in operation today.

Hatchery Chinook and coho released in the Sandy were imported in the 1960s-1970s from the Wilamette, Mackenzie, or Clackamas. Summer Steelhead were introduced in 1975. Releases expanded in the 1980s, reaching an annual peak of about 450,000 Chinook and more than a million smolts total.

The Sandy Hatchery program changed dramatically with ESA listings and planning for Marmot Dam removal, whose fish ladder allowed ODFW to remove hatchery Chinook straying into spawning areas. Interbreeding between hatchery and wild fish reduces genetic diversity, hampering survival of their offspring, a threat to wild fish recovery. Following dam removal, hatchery-origin Chinook spiked to over 75% in parts of the Sandy, far beyond restoration plans' 10 percent maximum.

Oregon Department of Fish and Wildlife personnel use temporary weirs, this one on the lower Salmon River, to trap migrating spring Chinook, preventing hatchery strays from interbreeding with wild fish.

ODFW

Beginning in 2011, ODFW stationed traps each summer at the Zigzag, Salmon, and Bull Run rivers to remove hatchery Chinook, allowing wild fish to pass. Hatchery managers mixed wild fish into breeding, and reduced Chinook releases by two thirds following a legal challenge. Hatchery managers release smolts to the Bull Run River, after weeks imprinting in tanks there, to draw returning adults away from the Sandy. In 2016 the stray rates of hatchery Chinook in the upper Sandy decreased to 10%, with the vast majority of hatchery Chinook caught by anglers or trapped in the Bull Run weir at Dodge Park.

Instream Restoration by the Numbers

Subbasin	Side channel miles restored	Miles of main channel treated	Large wood jams	Total large wood pieces
Salmon	2.1	2.25	67	1,976
Still Creek	8	7.5	240	2,300
Upper Sandy	0.5	1	5	150
Lower Sandy	3.3	4.4	35	406
Totals	**13.9**	**15.15**	**347**	**4832**

Restoring Streamside Forests

Alongside functioning stream channels and floodplains, the forests surrounding the river are critical to watershed health. Diverse native riparian vegetation helps protect water quality, shades streams to maintain cooler temperatures that wild fish need, and supports food webs. Sandy Partners have extensively restored native vegetation, aligning riparian efforts with subbasin habitat priorities to reduce the spread of invasive plants, and maintain healthy forests that will contribute woody debris to restored streams in the long run.

Crews work to restore riparian vegetation.

Members of the Sandy Basin Vegetation Restoration Coalition (SBVRC), a subset of Sandy Partners led by the Nature Conservancy and coordinating with East Multnomah and Clackamas Soil and Water Conservation Districts, ranked 64 sites throughout the basin and prioritized restoration actions. Ten sites were chosen for their proximity to large blocks of undeveloped forested lands within the top two ranked watersheds (Sandy River and Salmon River). Multiple weed treatments reduced the spread of Clematis, ivy, holly, Himalayan blackberry and Knotweed. Followup plantings of native trees and shrubs established dense native understory to resist further establisment of invasive vegetation.

Complementary programs have enhanced streamside vegetation in other Sandy subbasins. East Multnomah Soil and Water Conservation District's *Streamcare* program assisted rural landowners to replant in Beaver, Big and Smith Creeks. Participating residents covered between a fifth to more than half of each stream's length.

SRBWC and CSWCD's Weed Smackdown collaboration has targeted emerging invasives in the lower Salmon and upper Sandy, working with youth crews and volunteers to steward restored riparian zones, hand-pulling thousands of weeds over seven miles of the lower Salmon.

On the Sandy River Delta, the US Forest Service, Ash Creek Forest Management, Confluence, SRBWC, Friends of Trees, Friends of Sandy River Delta, and others have combined to restore 1,000 of 1,500 acres, planting about 1.1 million trees and shrubs.

Riparian Restoration by the Numbers

Program	Acres treated	Trees/ natives planted	Stream miles planted
SBVRC	2619	215,000	19.1
Smackdown	175	400	.25
Sandy Delta	1000	1,066,996	-
Streamcare	597.75	305,893	20.07
Totals	**4391.75**	**1,588,289**	**39.42**

With about 23 percent of the Sandy's area in private ownership, participation from private landowners was critical to the success of these projects. Sandy Partners bring know-how, plants and assistance, but ultimately it is area residents who must sustain stewardship.

Volunteers and youth crews reduce the spread of invasive species along the Salmon River by cutting flowering Policeman's helmet, which can crowd out native plants near streams.

FISH POPULATIONS BEFORE AND AFTER DAM REMOVAL

Signs of Increased Adult Spring Chinook, Steelhead, and Coho; Slower Response in Fall Chinook

A 2010 study of ways to measure the effect of habitat restoration arrived at a contrary conclusion: "Fish? Don't go there." Wild salmon and steelhead populations are affected by a range of factors beyond habitat connectivity and function. So improvement in habitat, while one driver of wild fish recovery, alone may not propel changes in target populations.

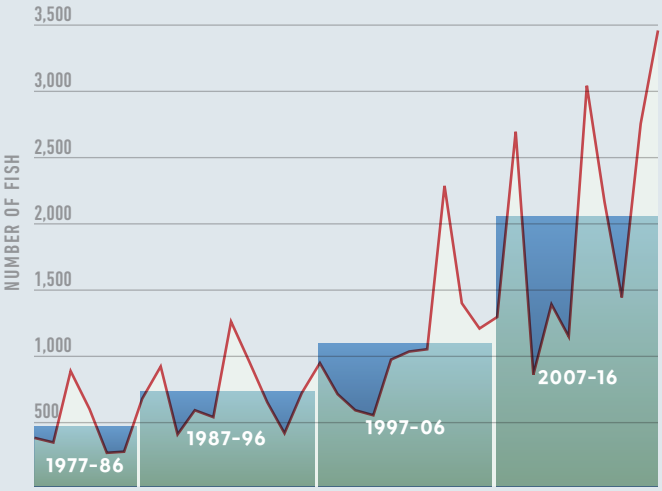
Yet any trends in the Sandy's threatened wild fish populations are essential in evaluating habitat function. State, federal, and local agencies have collaborated to develop comprehensive monitoring of the Sandy's wild fish. Annual counts track spawned carcasses and redds, the gravel nests where salmon spawn, to estimate adult returns. Sampling outmigrating smolts with large metal floating traps produces annual estimates of juvenile fish exiting each tributary. Together, the monitoring opens a view into the otherwise unseen cycle.

Tracking the Sandy's Wild Fish Populations

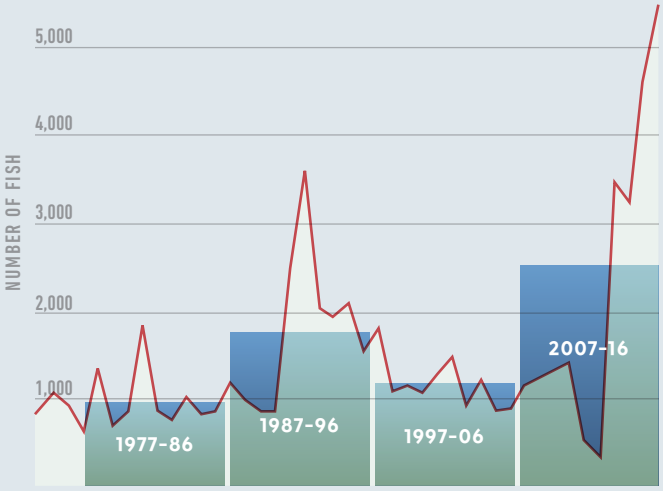
Annual monitoring crews in the Sandy count adult salmon and steelhead carcasses and redds, the gravel nests where fish deposit their eggs while spawning. Those samples are the basis of estimated adult wild fish counts, shown in the graphs below.

A variety of factors affect fish populations, including habitat, hatcheries, harvest, dams, ocean conditions, variations in rain, snow, temperature and climatic factors affecting stream flow, among others. Those factors can lead to significant variations from year to year. The figures below also calculate 10-year averages, comparing the trends over longer periods of time. Three threatened Sandy wild populations, spring Chinook, coho and steelhead, show increases in their 10-year average populations, particularly in the second generation of adult fish returns after dam removal.

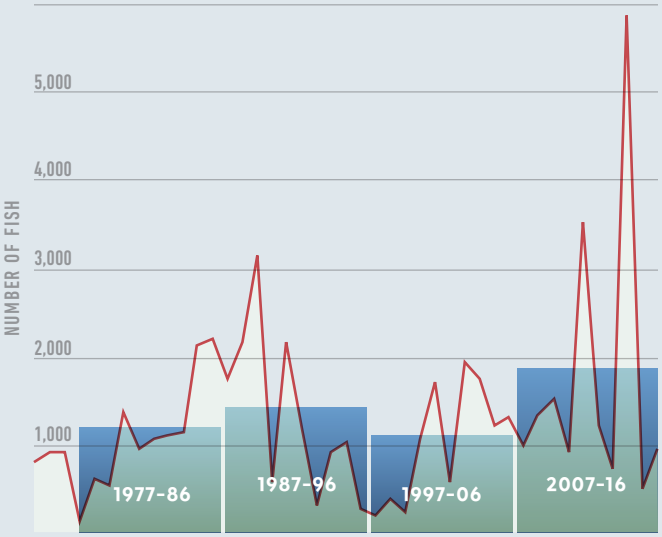
SPRING CHINOOK



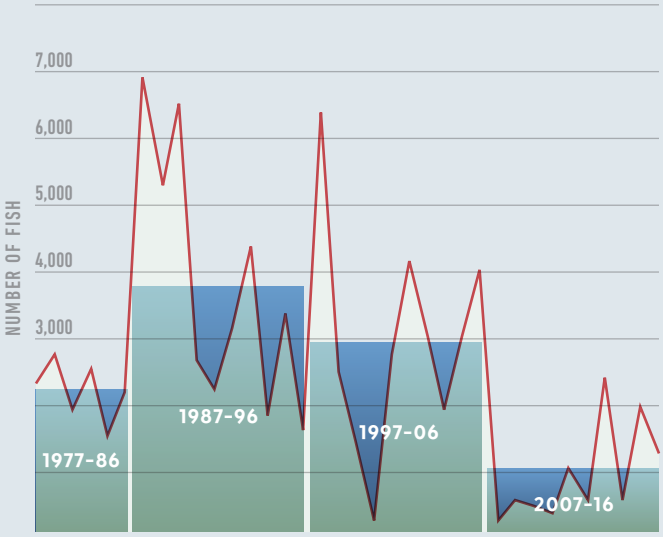
WINTER STEELHEAD



COHO



FALL CHINOOK



10-YEAR AVERAGE — ANNUAL POPULATION

For the Sandy, three populations of target wild salmon and steelhead show measurable growth since dam removal, and subsequent restoration actions, reconnected much of the basin's habitat. According to Oregon Fish and Wildlife Department estimates, adult wild spring Chinook, Coho, and Steelhead in the free-flowing Sandy have increased compared to the decades before their federal threatened listing. Fall Chinook have continued to decline.

For spring Chinook, Coho, and Steelhead, populations have roughly doubled or more in the average since dam removal, compared to the decade before dam removal. Chinook increased by 90 percent; Coho by 137 percent; Steelhead by 123 percent.

Sandy steelhead nearly tripled compared to the decade before their 1998 listing. The most recent four years, representing the second generation of returns since dam removal, have averaged over 4,200 wild steelhead, compared to an average of 1,272 in the 3 previous decades. Analysis comparing the trend in Sandy steelhead numbers with other wild steelhead populations shows stronger growth in the Sandy following dam removal than in nearby dammed rivers and the Oregon coast.

Populations of Fall Chinook have continued to decline since dam removal, although survey conditions make estimates less accurate. Fall Chinook in the decade since dam removal averaged only 978 wild adults, about a third of their population in the decade 1996-2006.

Chum are considered extirpated in the Sandy, although one adult chum was identified in Beaver Creek in 2010.

Where are the Kids? Counting Migrating Juveniles

Several agencies collaborate to sample juvenile salmon migrating out of spawning tributaries, another indicator of population trends from spawning fish. Using large floating "screw traps," biologists identify species, measure, and take scale samples from migrating smolts entering the trap, releasing them after quick data capture.

Conducted for coho and steelhead, smolt monitoring primarily indicates the location, distribution and freshwater production of the species. Streams selected for smolt sampling total 106 miles (56 percent of the total habitat in the Sandy River accessible to anadromous fish). Over 80 percent of the clear water stream miles are included. Smolt monitoring covers nearly the full range of environmental conditions that salmon and steelhead encounter in the Sandy River Basin and is considered by the Sandy River Basin Partners monitoring group to constitute a representative index for the entire basin for steelhead and coho.

Juvenile estimates included here are based on the first eight of a planned 20-year monitoring effort. Because smolt trapping covers 11 separate subbasins, an emerging notion of where the Sandy's fish emigrate from comes through. The movements of juvenile salmon and steelhead within the Sandy basin, between emergence as fry and emigration as smolts, is not yet fully understood but is also the target of investigation.

Smolt monitoring has identified areas with intriguing productivity. Beaver Creek, the Sandy's lowermost tributary, has measured as many as 9% of all of the Sandy's coho juveniles in some years. The Bull Run represents about half the watershed's juvenile steelhead emigration, but only a small proportion of habitat miles available below drinking water dams.

Still Creek: A Stream Restored in Five Years

Aside from the Salmon River, Still Creek provides the highest densities of spawning and rearing habitat for salmonids in the Sandy River basin. Those characteristics ranked Still Creek a top SRBP priority and a focus within the Forest Service's Watershed Condition Framework, leading to a subbasin action plan for restoration completed in 2017.

Still Creek originates below the Palmer Glacier and a series of springs on Mt. Hood's west side, fed by year-round snowpack at the highest elevations. About 98% of the watershed's 14,412 acres is located within National Forest. Bisected by Highway 26, the watershed is a popular area for hiking, fishing, and camping. Private lands within the watershed include parts of the communities of Government Camp, Rhododendron, and the Faubion/Zigzag areas. Additionally, 129 recreational residences line the lowest 3 miles of the stream.

From 2012 through 2017, the Forest Service, Freshwater Trust, and Sandy partners worked through a list of 19 projects, 8 essential instream elements, and 11 supporting actions to mitigate the effect of roads and other sources of sediment and contaminants. Instream restoration work occurred in 8 stream segments with similar

Log jams help deposit gravel that salmon use to build spawning nests, called redds.

characteristics, between river mile 0, Still Creek's confluence with the Zigzag River, to river mile 8.01. A ninth project area enhanced the lower 0.65 miles of Still Creek's largest tributary, Cool Creek.

Though specific restoration actions varied for each project area, three objectives guided instream actions:

(1) increase large woody debris (LWD),

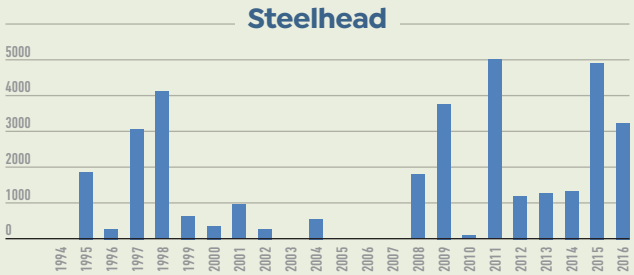
(2) enhance aquatic habitat, and

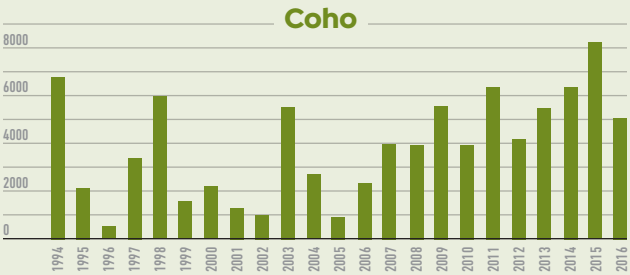
(3) restore floodplain connectivity.

Key instream restoration accomplishments included the addition of 2,300 pieces of large

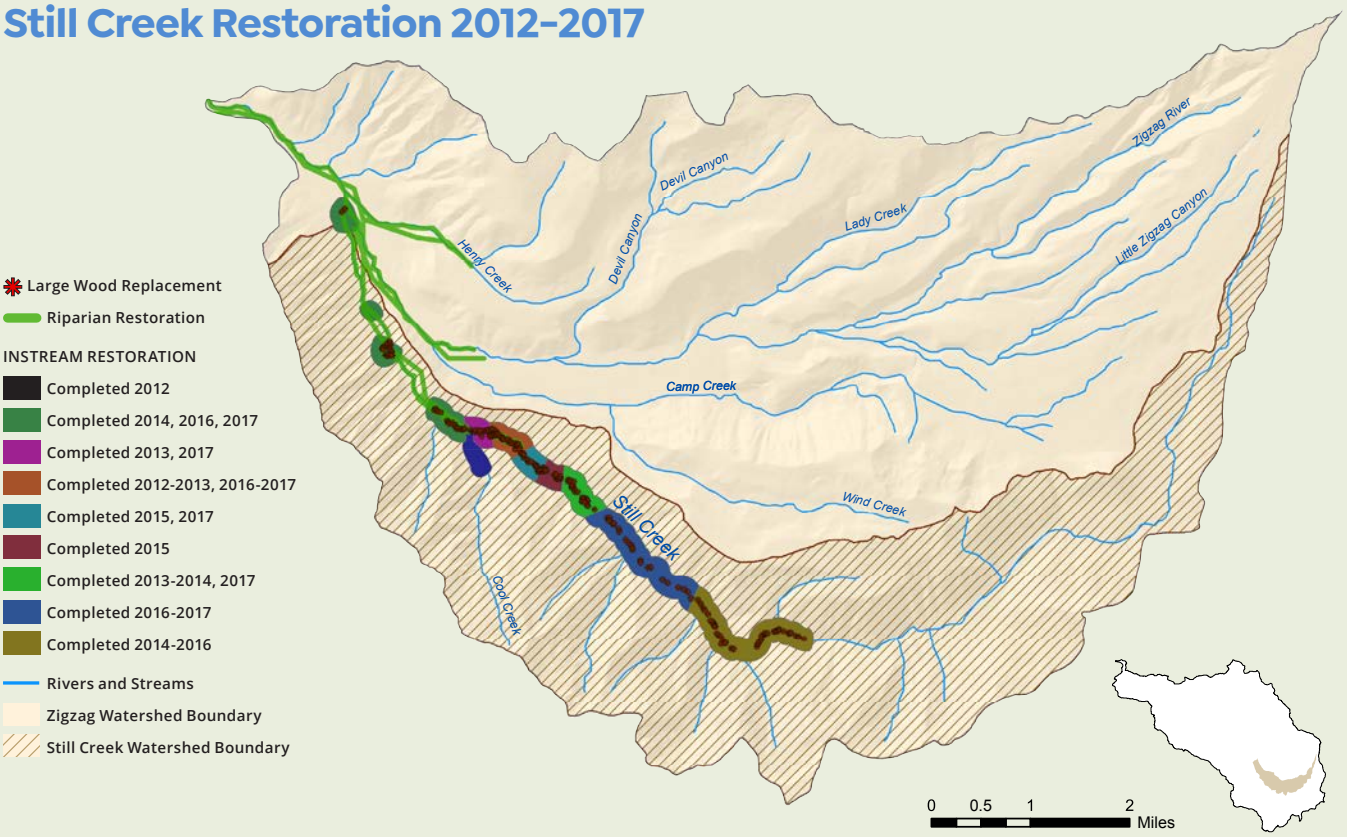
Two Decades of Juvenile Monitoring

Still Creek juvenile smolt counts from recent years reflect growth after habitat restoration.





Still Creek Restoration 2012–2017



woody debris (LWD) to the stream, the creation of 240 log jams, the reconnection of 6.5 miles of side channel habitat, and the formation of 62 main channel pools. Additionally, the removal of 5 log weirs in Cool Creek opened 0.65 miles of previously unavailable habitat to migrating salmonids

Other restoration actions reduced impacts from logging and other human activities, increasing Still Creek's resiliency for future climate change. Over 700 feet of berms were removed to allow the stream to spread across the floodplain during flood events. About a third of a mile of skid trails have been replanted with native trees and shrubs. Schools and community groups brought 225 volunteers, who contributed 45,000 volunteer hours to supporting work like tree planting, invasive weed removal, and salmon carcass distribution.

Pre and post project habitat surveys show substantially increased large wood and log jam densities in the creek and side channels. Survey crews found 62 additional main channel pools had formed — a 70 percent increase from pre-project conditions — the vast majority caused by additions of LWD. The total length of side channel increased from an estimated 1 mile prior to restoration to nearly 7.5 miles after restoration. Surveyors also measured increased gravel deposition around installed log jams.

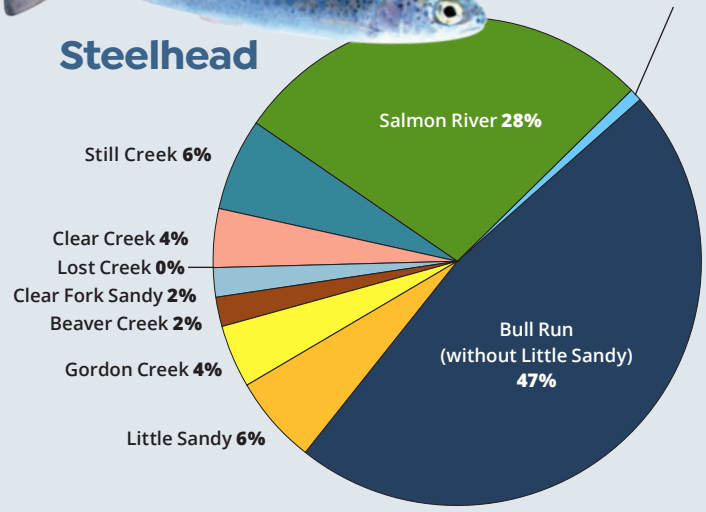
Monitoring crews observed juvenile salmonids utilizing log jam structures as early as two weeks after their construction. Snorkeling surveys have documented the use of off-channel habitats by juvenile coho and steelhead, increased spawning, and an growth in coho smolt out-migration over the past two years. Still Creek's restored large wood, log jams, and re-established side channels, pools, and habitat diversity will continue to provide important habitat, promote complex channel dynamics, and recruit additional large woody debris into the future.

Examining the Exodus

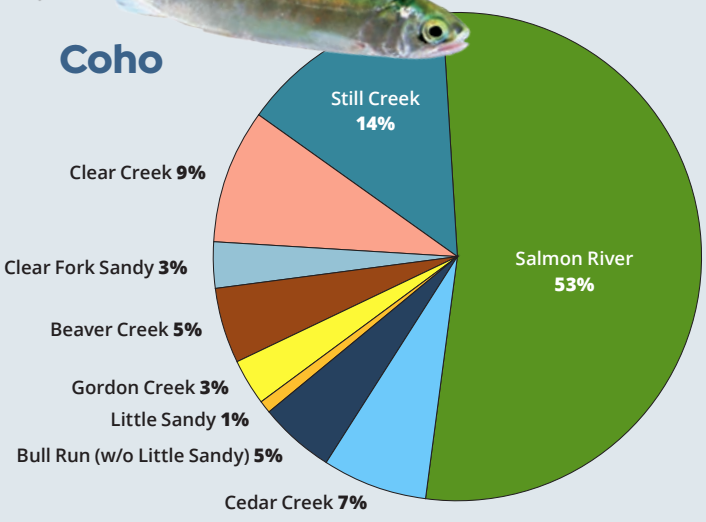
Smolt monitoring shows a large proportion of steelhead emigrating from the Bull Run, and about half the juvenile coho departing the Salmon River. Figures represent the average percentage of all smolts over five years surveys.

Where are Smolts Coming From?

Steelhead



Coho



Smolt traps sample juvenile migrating salmon and steelhead in 11 streams around the Sandy each year, including this one in Beaver Creek.

Juvenile monitoring also shows what happened where the second dam was removed. Recolonization of the Little Sandy River by steelhead after the removal of Little Sandy Dam in 2008 appears to have been immediate and sustained, although steelhead production decreased in 2016. The first year that steelhead smolts were expected to result from the first steelhead adults spawning in the newly reopened portion of the stream was 2011. The Little Sandy 2011 steelhead smolt population was comparable in terms of smolts per stream length and area to streams of similar size that were never blocked to steelhead, like Gordon Creek or Still Creek.

Removal of the Little Sandy Dam in 2008 allowed rapid repopulation by wild steelhead.

PEOPLE AND THE SANDY

A Crossroads for Fish, Wildlife and Culture

As long as people have lived in the Northwest, the Sandy has been a crossroads of human, fish and wildlife populations. Ancestors of Columbia Basin Tribes, from today's Confederated Tribes of Grand Ronde and Confederated Tribes of Warm Springs, lived, hunted, fished and gathered in the area. Local Chinookan people greeted Lewis and Clark's expedition when it arrived at the Sandy Delta in 1805, and on its return in 1806.

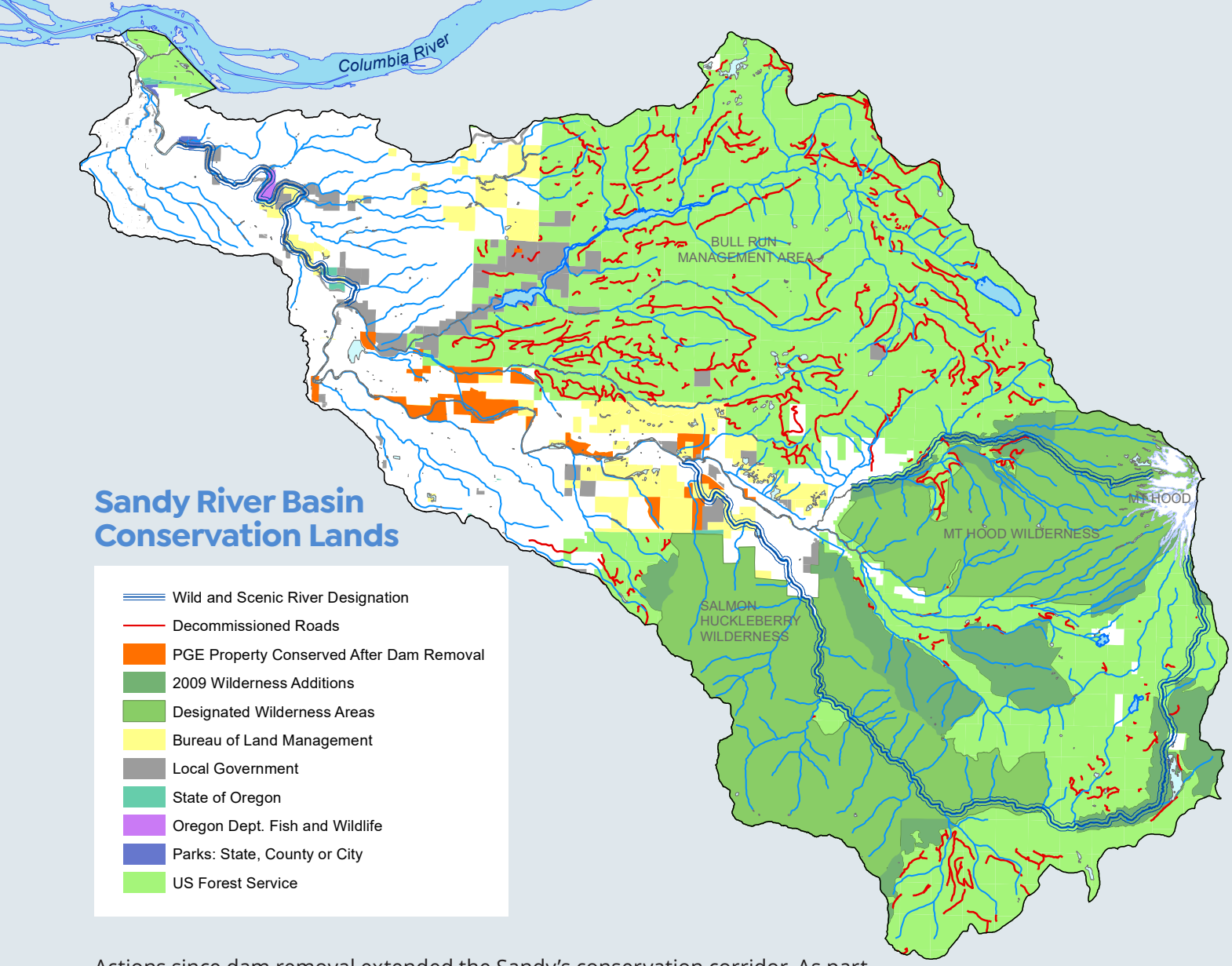
When the Barlow Road established a land route for immigrants around Mt. Hood and through the Sandy, the state territorial legislature's authorization in 1845 recognized native presence in the area. The territorial legislature acknowledged the role of Tribal people who provided essential aid to arriving settlers: "That nothing in this act shall be so construed, to exempt persons from paying toll, who may employ Indians to drive their cattle, horses, &c., along said road."

Communities in and around the Sandy now support an increasingly diverse population of about 145,000 people. The communities of Corbett, Troutdale, Gresham, Sandy and Mt. Hood Villages together have grown almost 25 percent since 2000, particularly Sandy (98%) and the unincorporated areas of the Villages of Mt. Hood (66%).

The Sandy serves far more people than those who live within the watershed boundaries, playing a key role in the region's economy, above and beyond its potential as anchor habitat for wild fish. The Bull Run represents water supply for nearly a quarter of Oregon's population. Breweries, coffee

shops and other water-dependent businesses have become signature elements of the region's quality of life, and major contributors to the local economy.

Millions visit the Sandy year round for recreation, relaxation, beauty and solace. Public land agencies have counted significant growth in year-round use. A study of the area known as Mt. Hood villages, including trails, ski areas Timberline and Skibowl, and other popular venues, estimated 34,000 average day-use visitors in fall months, rising to 129,000 in winter months. Overnight visitation ranges from 11,000 per fall month, peaking at 34,000 people per summer month. Visitation and popular sites also reflects the Sandy's central



Sandy River Basin Conservation Lands

- Wild and Scenic River Designation
- Decommissioned Roads
- PGE Property Conserved After Dam Removal
- 2009 Wilderness Additions
- Designated Wilderness Areas
- Bureau of Land Management
- Local Government
- State of Oregon
- Oregon Dept. Fish and Wildlife
- Parks: State, County or City
- US Forest Service

Actions since dam removal extended the Sandy's conservation corridor. As part of its dam license surrender, PGE donated its Sandy holdings to Western Rivers Conservancy, which conveyed them to the Bureau of Land Management. Forest service wilderness was extended in the Sandy, adding protection to areas in the Salmon, Zigzag and Upper Sandy. Extensive Forest Service road decommissioning removed or disconnected miles of former logging roads.

The former Marmot Dam site is now a recreation area open from May through October and operated by the Bureau of Land Management.

Habitat Where the People Are: Restoration in the Main Stem Sandy

The main stem Sandy gained top ranking as anchor habitat for salmon and steelhead, serving as the migration corridor for all fish species, whether juveniles heading downstream toward the ocean, or adults returning to spawn. The main stem Sandy is also home to the most people. Private ownership extends from unincorporated villages and neighborhoods along the Mt. Hood National Forest, through portions of Sandy, Gresham, and Troutdale. The main stem represents a corridor of protected local, state, federal and Metro recreation lands that serve thousands of visitors each year. Restoration in the main stem Sandy must work where people are, alongside homes, parks, roads, bridges and infrastructure.

Efforts in the Lower Sandy grew from Metro's 2010 habitat assessment, prioritizing five key actions in an 8-mile reach between Dabney State Park (six miles from the Columbia) to Oxbow Regional Park (river mile 14). Beginning in 2012, Metro, Bureau of Land Management, SRBWC, and the Portland Water Bureau began implementing the five projects. The Happy Creek project reconnected a perennial stream that had been blocked when Oxbow was built, guiding flow into a side channel with large engineered log jams. Two years later, SRBWC and Metro restored a side channel alongside nearby YMCA Camp Collins, a facility that serves 12,000 visitors every year. In 2016, Metro and Portland Water Bureau completed two additional projects, across from Oxbow.

SRBWC also identified four instream restoration opportunties in the upper and middle Sandy, between the former Marmot dam site (river mile 30) and the Zigzag River confluence. Working with the Columbia Land Trust and neighboring homeowners at Timberline Rim, SRBWC completed the first floodplain reconnection in 2016. Actions

Levee removal and log jams steered flow into the Columbia Land Trust floodplain, reconnecting habitat and reducing erosion risk to downstream homes in Timberline Rim.

removed 200 feet of post-1964 levee and built five large log jams to guide water into the a side channel most of the year. With 500 homes immediately downstream, the project was also calculated to absorb a portion of the river's erosive force during flood events, reducing potential flood risk.

At the Sandy Delta where the river meets the Columbia, removal of a small 1935 dam in 2013 reconnected 1.2 miles of channel, combining efforts by the U.S. Army Corps of Engineers, Bonneville Power Administration, and Portland Water Bureau. Lower Columbia Estuary Partnership removed historic water control structures that reconnected another 1/3 mile of channel to the Columbia, and placed 100 large pieces of wood over 1.8 miles of wetland channel that will provide habitat in high flow periods.

Like other priority sub-watersheds, extensive invasive species removal and native streamside vegetation restoration surrounded main stem instream restoration projects. Oxbow project areas re-vegetated 115 acres. At the Delta, replanting has covered two-thirds of the Delta's 1,500 acres of forest, clearing blackberry and other invasives and installing over a million native trees, shrubs and other plants.

Where Fine Refreshments Flow

The Portland metro area holds a well-earned reputation as a craft beer and coffee mecca. Essentially, every pint brewed in Beervana and every coffee in coffeetopia begins with Sandy basin water from the Bull Run. Conservation, efficiency and changes in population show that consumption had declined slightly even as population grows. Clean water from the Sandy's healthy forests is the vital fluid of the area's lifestyle and economy. Drink up!

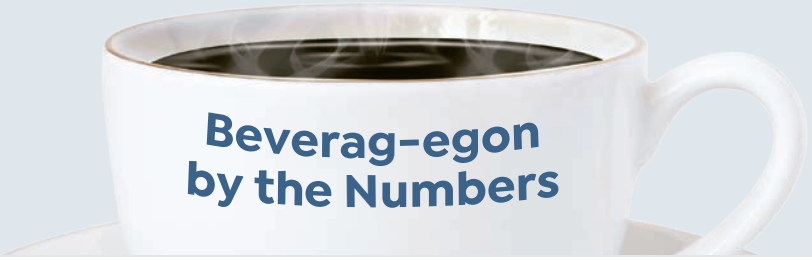
Beverag-egon by the Numbers

38 in 2007 • **105** in 2017 — Craft Beer brewers in the Portland Metro area

Number of coffee shops in Portland (600 independent) **737**

in 2007-08 **884,300**
in 2015-16 **966,600**
Total people served by Portland Water Bureau

Gallons consumed
35.5 billion in 2007-08
33.5 billion in 2015-16



role as an outdoor destination. Use at the Sandy Ridge bike trail, opened in 2012, grew from 30,000 its first year to nearly 93,000 in 2016. The Sandy Delta's over 100,000 annual visitors makes it the second most popular site in the Columbia Gorge National Scenic Area, behind only Multnomah Falls.

People also play critical roles in the Sandy's restoration and stewardship. Thousands have participated in native tree planting, invasive species removal, trash cleanups and other activities to care for the Sandy. For the State of the Sandy to remain strong for biodiversity, residents and visitors will need to continue the long tradition of caring for the watershed as the basin and region's populations grow.

Community planting days at the Sandy River Delta bring hundreds of volunteers, essential part of restoration in the basin.

SEVEN STEPS:
Sustaining the Sandy's Future

The Sandy's first free flowing decade has witnessed major strides toward ecological reconnection and recovery. But it will take more than one decade to reverse impacts from more than a century of development. Further action in restoration, stewardship and the social commitment to a healthy watershed will be necessary to advance the progress since dam removal, build on the river's positive trends, and cope with broad ecological and social forces affecting the basin.

Next Restoration Priorities

1 With instream work in Still Creek largely completed, restoration partners will need to complete remaining Salmon River tributaries and main stem Sandy priority actions. The US Forest Service will pursue additional work in Upper Sandy tributaries, including the Sandy's Clear Fork, Lost Creek, and Cast Creek.

Completing the Connections

2 Culvert improvements in upper Sandy tributaries Conway Creek and Henry Creek would improve impeded fish passage, reconnecting several miles of coho and steelhead spawning habitat. Mt. Hood Community College is considering dam removal at Kelly Creek in Gresham, where an artificial pond adds as much as four degrees — to stream temperature in summer months, a level potentially lethal to fish. Culvert improvements scheduled on Beaver Creek and Kelly Creek above the pond will also improve the Sandy's lowermost tributaries.

Restoration Effectiveness: Digging into Sandy Science

3 The Sandy's extensive monitoring will yield more learning about how rivers recover. Smolt monitoring is planned for 20 years to identify trends and distribution by 2029. Genetic samples collected during adult and juvenile population surveys represent a living research library, holding the potential to relate parentage and productivity: how many smolts fish does each sampled spawning pair produce, and how do areas of the basin support various species?

Not Just for Fish: Supporting other vulnerable wildlife

4 The Sandy is home to a full range of Pacific Northwest fish, wildlife, birds, and plants. The 2010 Oregon Natural Heritage Suvery identified 31 fish, bird, amphibian, reptile and plant species in the Sandy that are rare, threatened or endangerd. Pacific Lamprey and Eulachon (smelt) have been added to the threatened aquatic concerns. The Sandy Delta is among a handful of

sites that have seen a threatened Yellow-billed cuckoo, recently listed threatened. The Delta's rare western painted turtle population, discovered in wildlife rescue efforts prior to dam removal there in 2013, is also a target for habitat conservation in an area with increasing recreational use.

Coping with Continued Development

5 Regional population growth and development will continue to affect the Sandy. A Clackamas County study of erosion risk from channel migration estimated that at least 450 current homes in the upper Sandy lie within a high risk zone, likely to be impacted by future storms. Potential changes to riverside development rules, and application of green infrastructure to manage rain such as that planned at the Mt. Hood Community College campus stormwater retrofit, may be necessary to reduce urbanization's effects as population grows.

Adapting to Climate Change

6 Climate modeling predicts changes in precipitation patterns, rising snow levels, warmer summer temperatures, and lower and warmer stream flows that could stress salmon and other aquatic life. Climate may raise the value of the Sandy's connected, free-flowing corridor in the Lower Columbia. Compared to the Columbia, the Sandy runs three degrees Celsius cooler in summer, making Sandy river a cold water refugia for migrating salmonids. The good news: modeling from the Columbia River Intertribal Fish Commission shows intensive riverside forest restoration can offset some or all of the predicted stream temperature increases associated with climate change.

Extending the Fellowship of the Undammed

7 The Sandy and its restoration is a living case study in community-based collaboration. This effort holds the potential to prove that dam removal and prioritized, collaborative, voluntary restoration at watershed scale can make a measurable, lasting difference. In the Sandy, this potential exists alongside and in the face of rapid metropolitan growth. More than 1,100 dams have been removed in the U.S. over the past four decades. A scientific review showed that that rivers recover quickly, and that migrating fish will recolonize undammed rivers given the chance. The Sandy has been and can continue to be a pioneer in an extensive, nationwide corps of rivers and their living communities that are renewed through dam removal and a broad community commitment to ecological recovery.

SRBWC

ACKNOWLEDGEMENTS

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Cover by Scott Wright; Back cover by Josh Kling

The Sandy River Basin Watershed Council

The Sandy River Basin Watershed Council (SRBWC) is a leader in collaborative habitat restoration throughout the Sandy River and its tributaries. Watershed residents and land management agencies organized the SRBWC in 1997 to gather community efforts around conservation and restoration of the river's ecological, cultural and historic values.

Sandy River Basin Partners

In 2000, a partnership of public and private organizations convened an effort to coordinate recovery of anadromous fish species in the Sandy River Basin. This effort was prompted by two significant events: (1) the 1998 and 1999 listings of steelhead and Chinook as threatened species under the federal Endangered Species Act; and (2) Portland General Electric's 1999 announcement of their intent to remove the Little Sandy and Marmot dams. The partners recognized that the basin was changing and that the effort in the coming decades would best be accomplished by coming together to define common restoration goals and to leverage each other's resources.

Sandy River Basin Watershed Council

Working together to restore the Sandy River

sandyriver.org