Fish Assemblages

EVEN DURING SUMMERTIME AT OLYMPIC NATIONAL PARK, the rivers and streams remain bitterly cold. While mild in comparison to the winter, the weather is often wet and overcast, with biting winds and ominous storm clouds arriving with relative frequency. The conditions might be unfavorable for the teams of scientific researchers who bundle into dry suits and jump into these frigid rivers, but they are perfect for the fish that the researchers come here study.

Each summer, teams of National Park Service biologists gear up in dry suits and snorkels to swim among the Olympic salmon, trout, charr, and mountain whitefish, counting fish populations in some of the best remaining salmonid habitat in the contiguous United States. They do this as part of the fish assemblages Vital Sign monitoring program of the North Coast and Cascades Network (NCCN), taking a living census of the park's salmonid population in an effort to track the status of one of the Pacific Northwest's greatest indicators of overall ecosystem health.

As one of the few animal families to fill an essential role in freshwater, marine, and terrestrial ecosystems, salmonids are an especially sensitive and vital resource to the ecosystems of the Northwest, and they are also one of the largest single sources of nutrients in the region's rivers. Research has shown that salmonid carcasses, eggs, and their fry contribute between 20 to 40 percent of the total phosphorus, nitrogen, and carbon loads in Pacific Northwest streams.

"They're essentially packets of nutrients that return back and fertilize these flowing water areas," said NPS biologist Sam Brenkman, lead researcher for the fish assemblages monitoring program.

By: James Andrews

Program Objectives

1. Monitor native and non-native fish species in 10 rivers across Olympic National Park to determine seasonal and annual trends among the park's fish populations.
2. Report observations to park managers, the public, and anglers.

Photo: Male pink salmon observed while snorkeling in the Elwha River, Olympic Peninsula, Washington. Photo courtesy of John McMillan

These "packets of nutrients" fill several roles: They prey on other fish and invertebrates, they provide a source of food to numerous wildlife species, and they constitute a multi-million dollar industry for commercial, sport, and tribal fishing. From a scientific perspective, salmonid species represent the greater ecosystem health because of the way streams channel and concentrate the effects of environmental impacts in their watersheds. Environmental changes that occur anywhere in a watershed will inevitably influence the health of the stream's aquatic organisms, allowing streams to essentially summarize the effects of nearby environmental impacts. Yearly mating migration of salmon into streams also accounts for some of the most significant marine-to-terrestrial nutrient transfers.

Olympic National Park is home to 33 native species of freshwater and anadromous fish that invigorate the park's numerous lakes and nearly 3,500 miles of rivers and streams (Anadromous fish, such as salmon, spawn in freshwater, travel to saltwater to mature, and then return to freshwater to spawn). Currently, Olympic is the only park in the NCCN to implement fish assemblages Vital Sign monitoring, and the program could not have been enacted at a more appropriate park. Olympic contains the largest number of wild salmonids of any national park in the contiguous United States, with more than 70 distinct populations. Five species of Pacific salmon are found in the park, as well as a variety of other salmonids in the form of steelhead and cutthroat trout, bull trout, Dolly Varden, and mountain whitefish, with some species residing in freshwater year-round while others migrate to sea for part of their life.

Along with the native fish, the park has become an adopted home to six invasive species, as well as indigenous and non-indigenous hatchery-raised fish. Generally less fit than their wild counterparts, hatchery fish may influence wild populations through interbreeding by reducing its genetic strength. Non-native hatchery fish may also pose the risk of transmitting diseases to wild fish and impacting survivorship of wild salmonids through direct competition for food, though the degree to which this occurs at Olympic National Park is uncertain.

The region's fish face a number of other threats, including climate change, habitat degradation, and overharvest in commercial and sport fisheries. The parks of the NCCN contain some of the last remaining free-flowing rivers in the contiguous United States, as many of the nation's salmon-spawning rivers have been dammed or otherwise impacted by human development. Still, five fish species in the network are currently listed as 'threatened' under the Endangered Species Act, and commercial fishing in the region makes up an $850 million industry annually.

"We have tremendous pressure on the fishery resources at Olympic National Park," Brenkman said. "I think some of the work we're doing is important because, for the first time in the history of the park, we're starting to develop datasets where we can actually detect trends in how well or not so well these fish populations are doing."

This monitoring program collects data on numerous trends, including population numbers, species composition, and the extent of non-native and hatchery fish among assemblages. With an extensive understanding of seasonal and annual trends in these fish populations, NPS staff can make more informed management decisions regarding one this iconic Northwest resource. And by annually sampling populations in 10 rivers across Olympic National Park, researchers can make accurate projections on the health of the ecosystem as a whole.

Monitoring Strategy

The primary goal of the fish assemblages monitoring program is to determine trends in the fish populations of Olympic National Park. But what trends do NPS researchers actually watch? The study is much more extensive than a head-count (or, in this case, a fin-count). The monitoring program outlines five factors that researchers chart seasonally and annually:

1. Species composition: How many of each species are present in relation to the whole fish population?

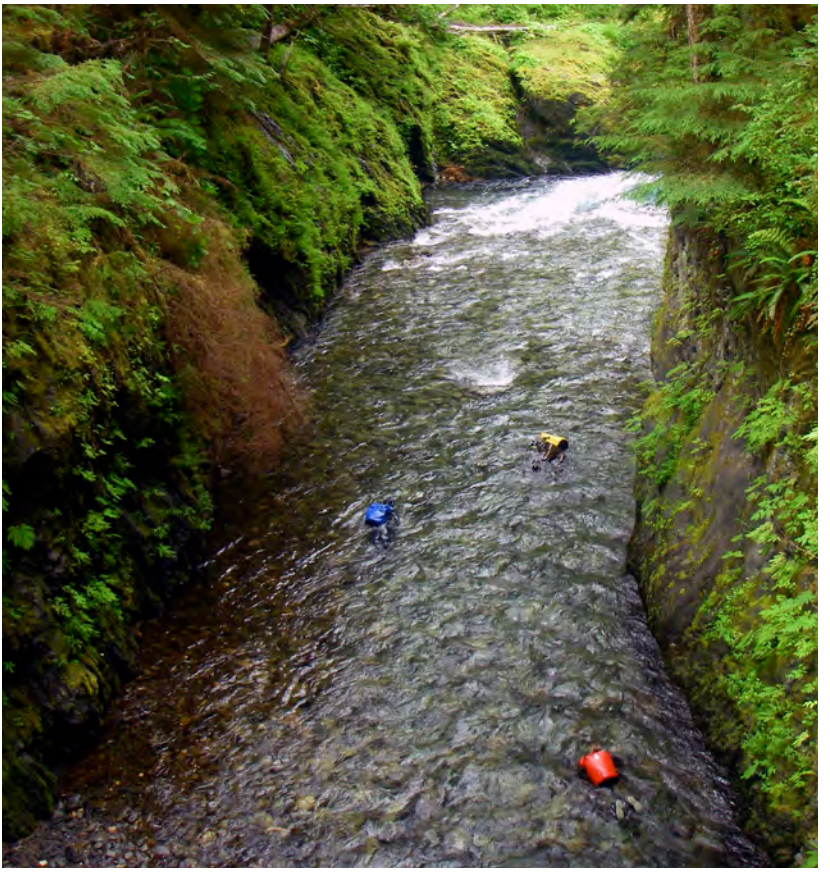
2. Relative abundances: How many fish are present compared to previous years? How many fish are counted per kilometer of waterway?

3. Timing of migration for adult fish: When does each anadromous species return to freshwater to reproduce?

4. Extent of non-native and hatchery fish: How many native fish are present compared to non-native? How many wild fish are present compared to hatchery fish?

5. Water temperature: What is the temperature of the water during key phases of a species' lifecycle? How do changes in temperature affect fish populations?

To adequately monitor this range of trends, NPS biologists have established a series of sampling sites in 10 rivers across Olympic National Park. Based on trends they observe by consistently counting fish in selected rivers between June and September each year, the program's coordinators can make estimations of park-wide fish populations. In a typical season, two pairs of research



Snorkelers count and estimate sizes of fish species in the East Fork Quinault River, Olympic National Park, Washington. NPS/OLYM

technicians will survey each site up to eight times, though scheduling can sometimes prove precarious.

"Our protocols vary depending on the weather day-to-day," said NPS lead fisheries technician Phil Kennedy. "Literally, it's a morning-by-morning call on where to send the crews out and what the task will be."

At least once a week during the surveying season, a monitoring team snorkels down 5 kilometers (3.1 miles) of each of the 10 rivers: Bogachiel, Dosewallips, Elwha, Calawah, East Fork Quinault, North Fork Quinault, North Fork Skokomish, South Fork Hoh, Sol Duc, and North Fork Sol Duc. The program's coordinators selected these sampling sections of rivers based on the safety of their summer low-flow conditions, their level of visibility during the surveying season, and their relative importance to resident species. Because of fund-

ing limitations, the program only tracks adult fish, so it focuses on rivers large enough to support populations of mature adults.

Of the 33 native species found in the park, the program tracks trends on 13 key salmonid species, including bull trout, cutthroat trout, steelhead trout, mountain whitefish, and each of the park's species of salmon, such as pink, chum, and Chinook. Mountain whitefish are by far the most abundant, typically outnumbering the next most abundant species by 3-to-1 or more, but their small size (averaging around 6 inches, but up to 20) leaves them susceptible to predation by larger fish such as bull trout.

Snorkel surveys report salmonid counts in terms of average number of fish per species per kilometer. For example, in a typical 5 km sample section, a survey team might see an average of 300 mountain whitefish, 100 bull trout, 30 cutthroat, and 5 Chinook per kilometer. Because of all the variables involved in counting live animals while floating down a flowing river, the snorkeling count method does not ensure that every fish gets counted. Properly trained pairs of technicians, however, will count approximately 65 to 70 percent of the sampling site's total number of fish, with very consistent results among different teams of divers.

Data Collection

If you take a riverside hike through Olympic National Park during the summer and encounter two dry-suited snorkelers floating downstream, seemingly excited by sightings of fish, do not be alarmed—these are likely National Park Service scientists at work. Despite how it may appear, snorkeling is the most efficient and least costly method of surveying fish populations in rivers. It is also the least invasive to the fish, as all surveying is done by-sight with no physical contact.

Every river survey is conducted by a pair of trained fish monitoring technicians who float down-river with the current, each watching for fish from the channel midpoint over to their respective right- or left-hand banks. While floating, the divers count any salmonid greater than approximately 15 centimeters (6 inches) in length, categorizing them according to species, size class, and hatchery or wild origin. Technicians can easily distinguish hatchery fish from wild ones by noting that the hatchery fish's adipose fin was removed (or "clipped") prior to release. (The adipose fin is the small fin on the spine between the dorsal fin and the tail fin.) But telling these fish apart in a fleeting instant while underwater is the hard part.

"It takes a trained eye to identify these fish, but once the eye learns, it becomes pretty second-nature," Brenkman said. "It can be very exciting in some of these rivers when you have a pool with woody debris and there's a mixed species assemblages. Being able to identify those fish quickly is an essential skill."

Each technician requires a significant amount of training before the sampling season begins, and they must pass a swift-water river rescue course. Thankfully, the sampling season coincides with the time that the waters are at their safest and most clear.

In the water, technicians cannot carry a clipboard and pen to keep track of each fish, so the program has adopted a low-tech tallying method: They write their counts on recording plates, which are simply PVC pipes cut lengthwise and strapped to each technician's forearm. After counting a school of fish, a technician will surface to quickly write the number of fish on the pipe with a pencil under the appropriate categories on a table that classifies fish according to species, size class, and origin. At the end of the 5 km survey, the technicians transfer their counts to a paper data sheet.

Floating through a river survey takes anywhere from 3 to 5 hours, depending on the strength of the current. After adding in the time it takes to drive to and from a trailhead, hike out to the site and back, gear up, and eat somewhere during all of that, surveying trips can easily turn into 10-hour-plus endeavors.

"You're cold, you're hot, you're wet, you're dry. It's exhilarating, but exhausting at times," Brenkman said. "My crews love their jobs."

Current Trends

Including three years of pilot studies, the fish assemblages monitoring program has been operational since 2005. After five summers of monitoring, crews have conducted 380 river surveys, covering nearly 2,000 kilometers (1,240 miles) of waterways and counting more than 180,000 individual fish observations. In 2010, the program added two new river sampling sites, and technicians completed 72 surveys across 10 rivers in Olympic National Park, spotting 28,800 fish.

Prior to implementation of the fish assemblages monitoring program, general knowledge of fish populations in any of the NCCN parks was severely limited. Researchers have conducted fish counts in the network since the late 1980s, but few counts were structured to the level of quality assurance now expected in the Vital Signs monitoring program. Through the program, the network now has a continual source of knowledge on this sensitive resource, indefinitely tracking its health and informing management decisions in accordance with the trends observed.

According to Brenkman, significant trends in salmonid populations take approximately 10 years at a minimum to emerge from the data, as the majority of these fish spend anywhere from 3 to 7 years at sea before returning

to spawn in the park's rivers. A yearly history of counts in the North Fork Skokomish River shows that populations vary dramatically from year to year, so long-term sampling is essential to distinguishing true trends from natural fluctuation. For example, a 1995 survey in the river counted roughly 200 bull trout, while a survey in the same site the following year counted closer to 300, and two years later the number fell down near 100. The initial years of this monitoring program's surveys will help establish a range of variation to be considered "normal" or "natural." While the program's coordinators prefer to gather more data before making conclusions on trends, their work has already revealed some interesting information on the demographics of the park's salmonid populations.

"Probably one of the most alarming things that we're observing is the ratio of wild to hatchery fish, particularly apparent in the steelhead," Brenkman said. "In some of our reference sites, roughly 50 percent of the steelheads are hatchery fish."

At other sites, such as in the Sol Duc River, researchers might not see a single hatchery fish. Overall, after five years of surveys, researchers have observed that hatchery fish account for 14 percent of the park's Chinook salmon and 39 percent of its summer steelhead trout. The early data also indicate that these two species face critically low population numbers: A typical survey will report only one or two summer steelhead sightings per kilometer of stream, while the same survey might count 15 bull trout, 60 rainbow trout, and 150 mountain whitefish per kilometer.

From a historical perspective, today's salmonid runs add up to only a small fraction of pre-19th century numbers. The Environmental Protection Agency estimates that, on average, Pacific salmon runs between southern British Columbia, Washington, Oregon, and northern California have fallen below 10 percent of their historic numbers (Lackey 2010). Through efforts from the NCCN's monitoring program, the health of Pacific Northwest salmonids will be much more meticulously tracked and analyzed into the future, providing more accurate expectations for future populations.

"From my personal perspective, the most interesting and rewarding aspect of this job is bringing the information to the public, the anglers, and the scientific community. I give a lot of presentations every year and always try to show some information from the monitoring program," Brenkman said. "Most people, when they think of salmon, they think of food on their plate or a fish on their hook. But when we can show them pictures of the fish in their park, you see them light up. It's powerful to be able to convey this information to the public for these beautiful animals."

Contact Information

Science Learning Network

Dr. Jerry Freilich, OLYM	jerry_freilich@nps.gov	360-565-3082
Michael Liang, NOCA	michael_liang@nps.gov	360-854-7305
Dean Butterworth, OLYM	dean_butterworth@nps.gov	360-565-3146

Inventory and Monitoring

Dr. Mark Huff, MORA	mark_huff@nps.gov	253-306-4473

Landscape Dynamics

Dr. Catharine Thompson, OLYM	catharine_thompson@nps.gov	360-565-2979
Natalya Antonova, NOCA	natalya_antonova@nps.gov	360 854-7312

Climate

Bill Baccus, OLYM	bill_baccus@nps.gov	360-565-3061
Rebecca Lofgren, MORA	rebecca_a_lofgren@nps.gov	360-569-6752
Mike Larrabee, NOCA	mike_larrabee@nps.gov	360-854-7333

Mountain Lakes

Dr. Steven Fradkin, OLYM	steven_fradkin@nps.gov	360-928-9612
Reed Glesne, NOCA	reed_glesne@nps.gov	360-854-7315
Barbara Samora, MORA	barbara_samora@nps.gov	360-569-2211 x3372

Glaciers

Dr. Jon Riedel, NOCA	jon_riedel@nps.gov	360-854-7330

Landbirds

Dr. Patti Happe, OLYM	patti_happe@nps.gov	360-565-3065
Robert Kuntz, NOCA	robert_kuntz@nps.gov	360-854-7320

Intertidal

Dr. Steven Fradkin, OLYM	steven_fradkin@nps.gov	360-928-9612

Forest Vegetation

Dr. Steve Acker, OLYM	steve_acker@nps.gov	360-565-3073
Mignonne Bivin, NOCA	mignonne_bivin@nps.gov	360-854-7335
Lou Whiteaker, MORA	lou_whiteaker@nps.gov	360-569-2211 x3387

Fish Populations

Sam Brenkman, OLYM	sam_brenkman@nps.gov	360-565-3081

Elk

Dr. Patti Happe, OLYM	patti_happe@nps.gov	360-565-3065

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