Status and Trends Monitoring of Riparian and Aquatic Habitat in the Olympic Experimental State Forest

Cover photo: Cathy Chauvin, DNR

Photo: Tracy Petroske, DNR

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Definitions

Endemic – Native species living in only one geographic location.

Habitat Conservation Plan – A federally approved planning document that accommodates management by the Washington State Department of Natural Resources (DNR) on state lands where federally protected species exist. It includes measures to improve habitat and to preserve existing high-quality habitat.

Reach (or Sample Reach) – A section of a stream where data is collected.

Riparian - A riparian area is the interface between land and a stream or river. This term also describes the adjacent plant and animal biome. Plant communities in these areas are called riparian vegetation.

Salmonid – Fish in the Salmonidae family, including salmon and trout. These species are collectively known as salmonids.

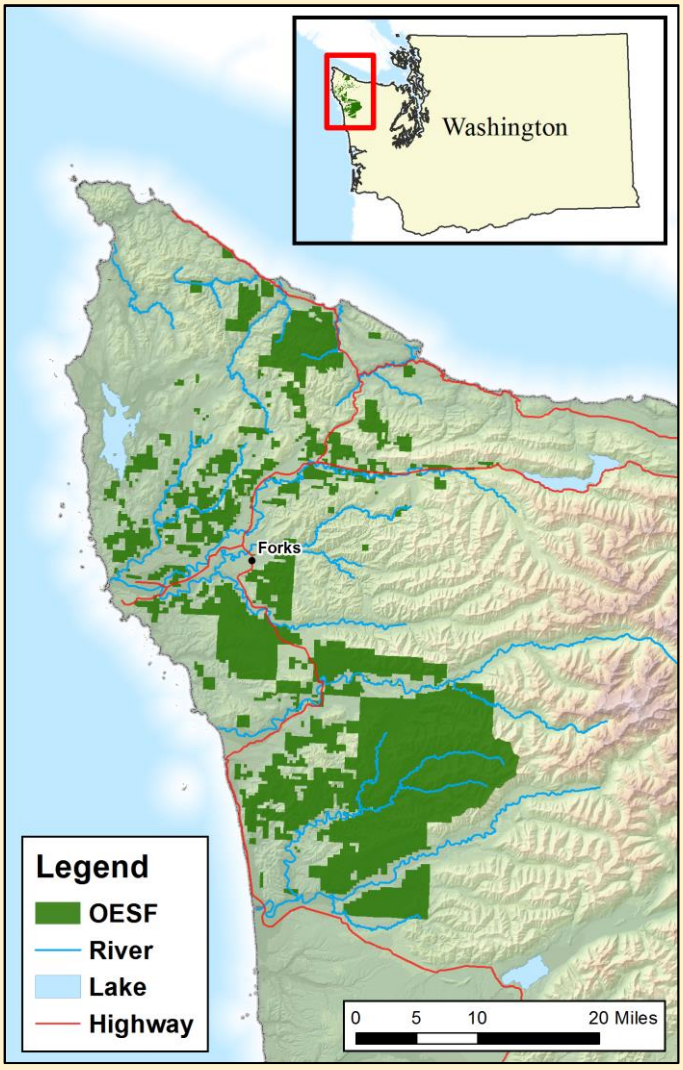
Succession – A process through which the plant and animal species occupying an area change over time, as the species gradually modify their own environment. This continues until a mature system (like old-growth forest) develops, or until a "stand-initiating" disturbance (like fire or a harvesting operation) occurs.

Type 3 Stream – The smallest stream or waterbody known to be used by fish, or potentially used by fish. Fish streams might or might not have flowing water all year.

Status and Trends Monitoring of Riparian and Aquatic Habitat

Status and Trends Monitoring of Riparian and Aquatic Habitat in the Olympic Experimental State Forest (OESF) is conducted to understand long-term changes in habitat conditions in watersheds. The project monitors the effectiveness of the Habitat Conservation Plan's Riparian Conservation Strategy, which aims to maintain and improve habitat for salmonids and other species by protecting the zones around streams, wetlands, and unstable slopes, and through road management planning.

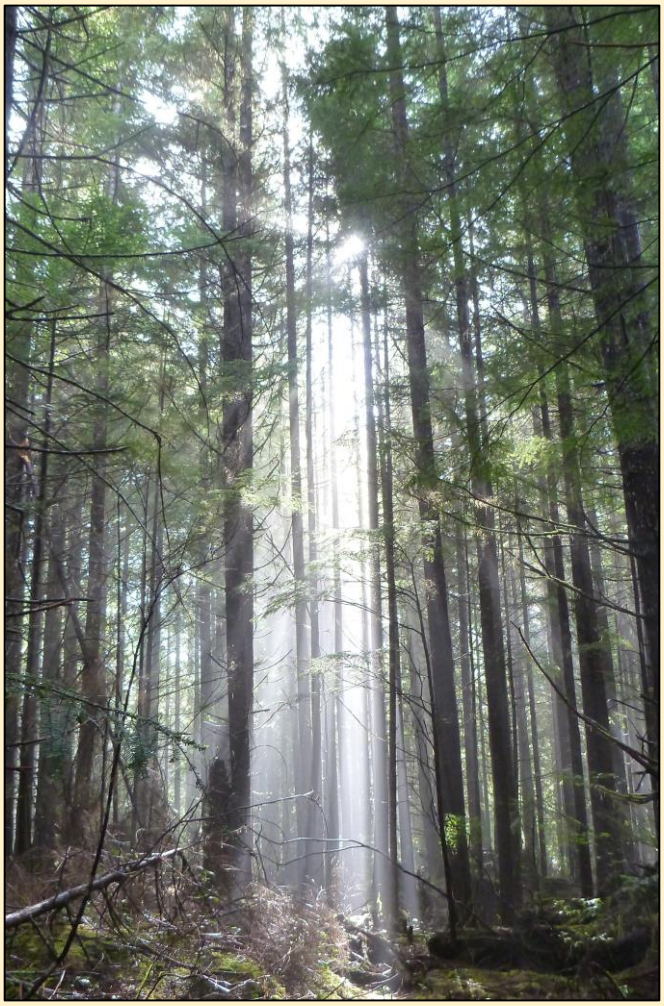
The OESF, located on the west side of Washington's Olympic Peninsula, is a working forest and a living laboratory. It is an extraordinary place of rainforests, rugged terrain, numerous streams and rivers, and rapidly growing trees. These majestic lands provide both quality timber and habitat for native species. Here, DNR intentionally learns by doing, experimenting with new management techniques and conducting research and monitoring.



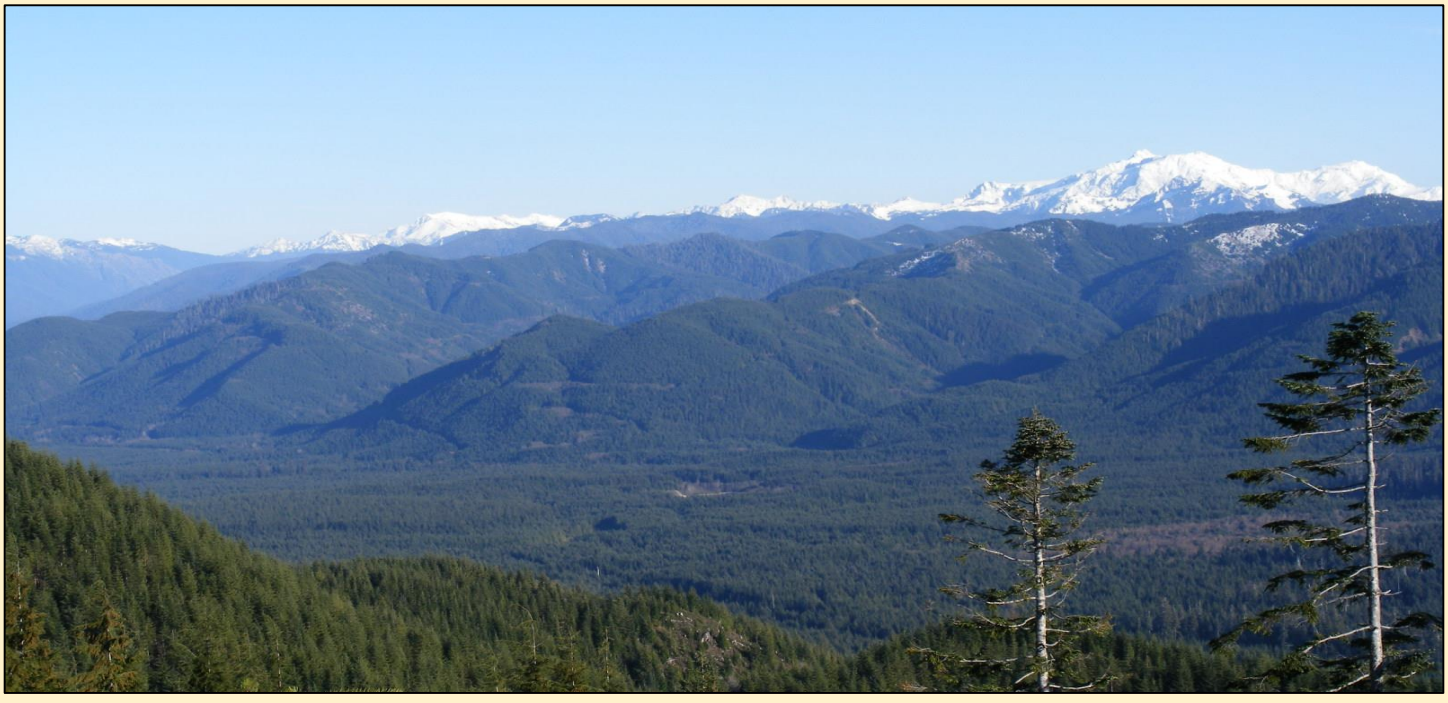
Widespread and intensive timber harvesting occurred prior to the late 1980s in what is today the OESF. Without adequate riparian protections, stream habitat was significantly degraded. Status and Trends monitoring evaluates whether stream habitat is recovering under the habitat protections of the 1997 Habitat Conservation Plan.

Regional Ecology

The OESF is characterized by steep, mountainous terrain that transitions to wide river valleys toward the Pacific Ocean. Elevation ranges from sea level to 3,790 feet (1,155 m). The climate is heavily influenced by the Pacific Ocean, with warm, dry summers and wet but generally mild winters. Annual precipitation ranges from 80 to 170 inches (200 to 460 cm) per year.

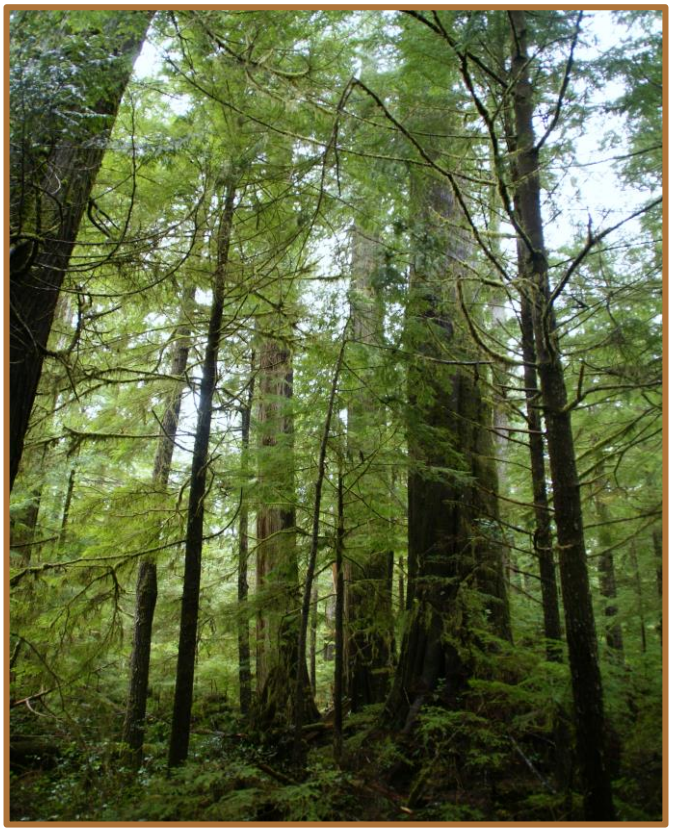


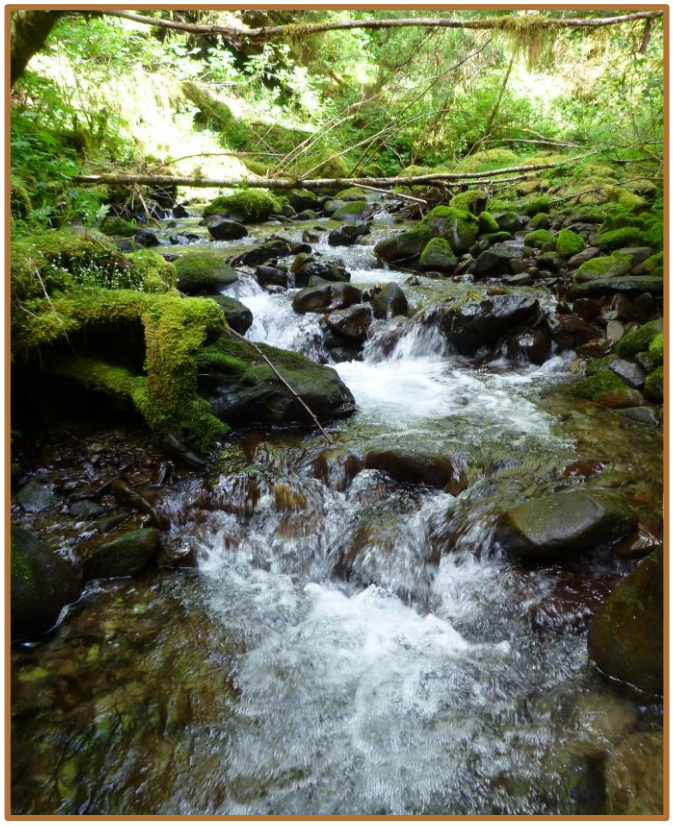
The OESF is dominated by dense conifer forests of western hemlock, Sitka spruce, Douglas-fir, western redcedar, and Pacific silver fir. Red alder is common along stream banks and in valley bottoms.



With its heavy rainfall, the OESF has a dense network of streams. The Status and Trends program monitors the smallest class of fish-bearing streams, known as Type 3 streams, with an average channel width of 16 feet (4.8 meters).

Many stream valleys have evidence of past landslides that altered in-stream and riparian habitats. Such disturbances occur naturally at a low frequency, but they were increased significantly by the intensive forest harvest and road building practices of the mid-20th century. Today, these riparian areas are in the process of recovering from those disturbances.





OESF waters are home to nine species of the salmon family (*salmonids*). In the small streams monitored in Status and Trends, juvenile coho salmon, steelhead/rainbow trout, and coastal cutthroat trout are the most common species.

The Olympic Peninsula is also a refuge for rare and threatened species such as northern spotted owls, marbled murrelets, and many amphibians and plants.

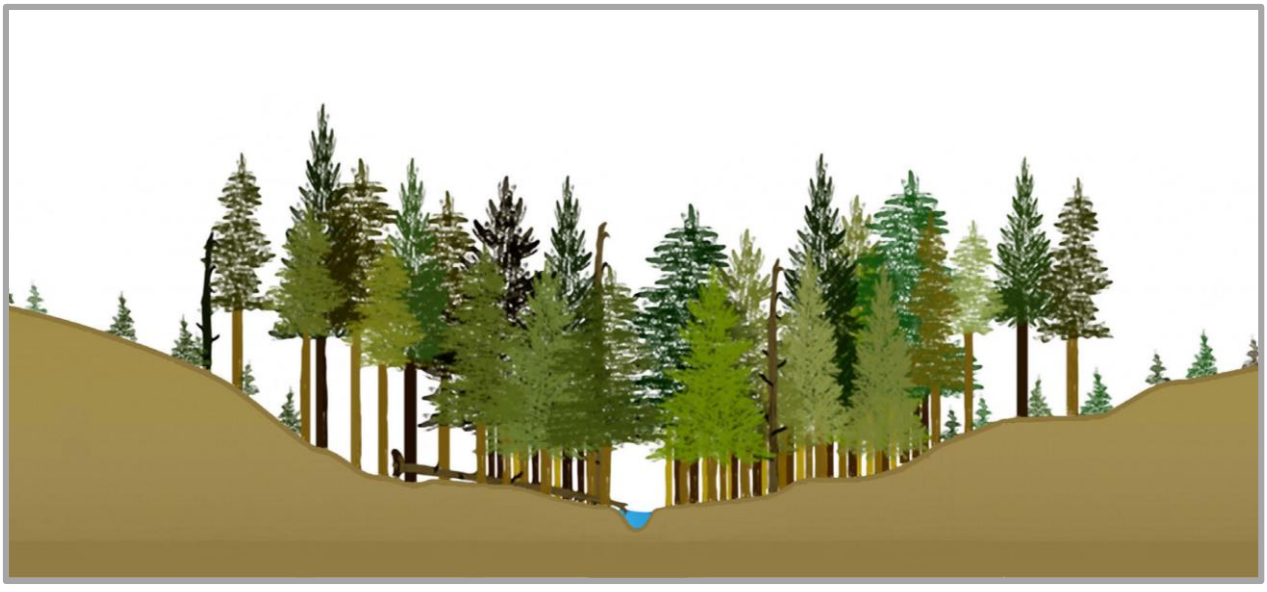
Deer, elk, bear, and cougar are common inhabitants, along with some endemic species like the Olympic marmot, Olympic snow mole, and the Olympic torrent salamander.

Purpose

The purpose of this long-term monitoring program is to determine whether DNR's Riparian Conservation Strategy is producing the desired riparian and aquatic habitat conditions.

Riparian and aquatic environments are influenced by processes occurring in the streams and adjacent forests. These include natural processes, such as forest succession and natural disturbances, but human activities including forest management and road construction also influence streams.

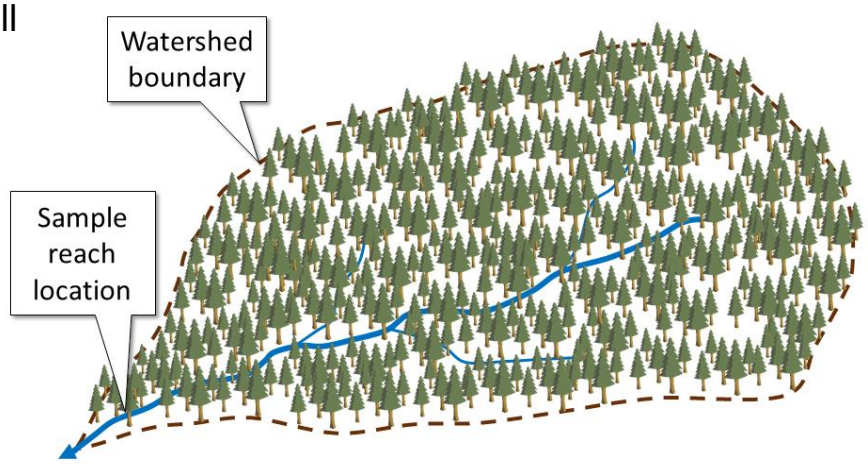
A major component of DNR's riparian forest management is the use of "buffers" of unharvested forest surrounding streams, rivers, and wetlands. In the OESF, buffers extend at least 100 feet (30 m) on either side of the stream's floodplain and are expanded to include sensitive features such as unstable slopes and adjacent wetlands.

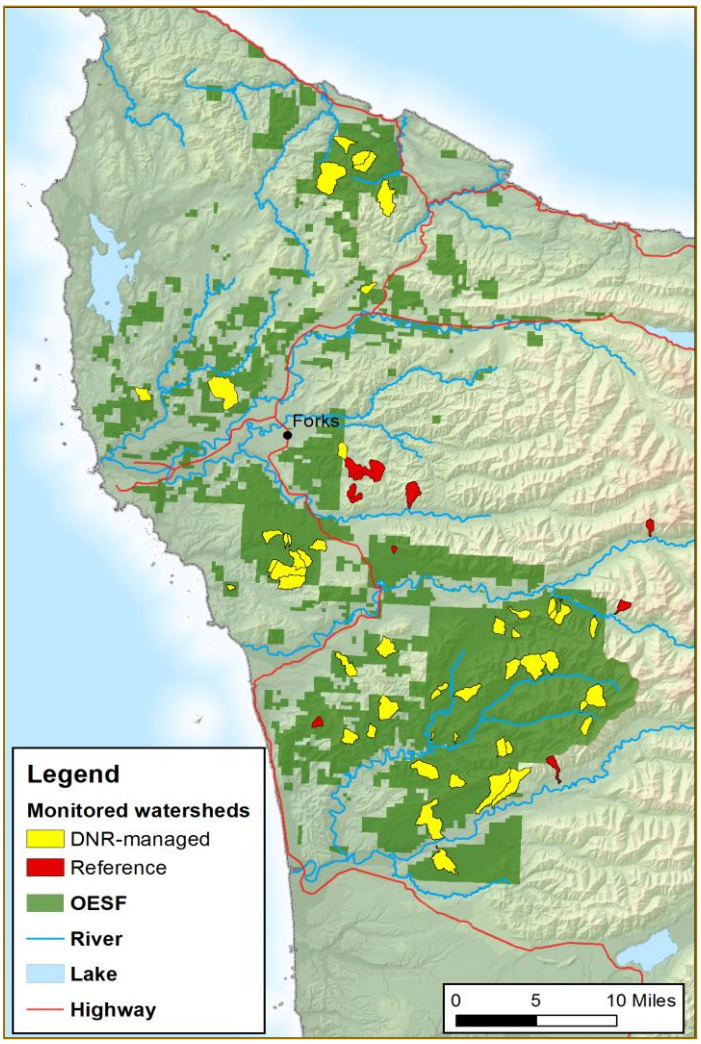


Unharvested stream buffers are part of DNR's Riparian Conservation Strategy. Trees in these buffers offer shade, reduce erosion, and provide dead wood and leaf litter to riparian habitats.

Habitat Sampling

Status and Trends monitoring has been ongoing since 2013. Data are collected from 50 DNR-managed and 12 reference watersheds. The DNR-managed watersheds were selected to represent the full range of ecological conditions across the OESF. Reference watersheds provide information on natural habitat variation in places where there has never been timber harvest.





Monitored watersheds range in size from 40 to 1,650 acres (15 to 670 hectares). Near the outlet of each watershed, a stream sample reach is established where all monitoring takes place. Effects of forest management within the watershed are expected to be evident at the sample reach because it is the most downstream point in the watershed.

Habitat Sampling

We monitor nine indicators of habitat quality to learn about current conditions and identify potential changes over time. These indicators are linked to habitat for salmonids and other aquatic and riparian species. For each indicator, several different metrics are used to measure habitat quality; examples of metrics are listed in italics.

Channel Morphology
Stream channel shape, gradient, and erosion

Channel Substrate
Particle sizes, fine sediment

Stream Flow
Velocity, volume per minute

Water Temperature
Summer maximum temperature

Channel Habitat Units
Pool frequency, size, and depth

In-Stream Wood
Size, frequency, decay of logs

Riparian Microclimate
Air temperature, humidity

Stream Shade
Forest canopy closure

Riparian Vegetation
Tree species and size

For more information, read the full Status and Trends Monitoring study plan.

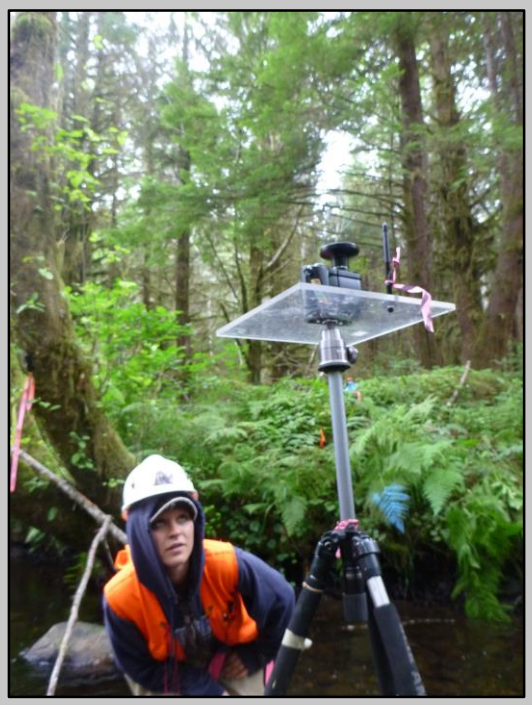
The nine habitat indicators are sampled at different time intervals according to the rate at which they are expected to change. The three indicators that change most rapidly — stream flow, stream temperature, and riparian microclimate — are sampled at very short intervals by automated sensors. The other indicators are measured by scientific technicians at longer intervals. Many of the measurements are taken in summer because that is when juvenile salmonids are most sensitive to habitat conditions. In summer, water temperatures are at their warmest and stream flow is at its lowest.

Habitat indicator	Streams sampled	Sample interval
Stream flow	12	15 minutes
Stream temperature	62	1 hour
Riparian microclimate	10	2 hours
Channel morphology	62	5 years or less
Channel substrate	62	5 years or less
Channel habitat units	62	5 years or less
In-stream wood	62	5 years or less
Stream shade	62	5 years
Riparian vegetation	62	10 years

On the following pages, we discuss several of the habitat indicators we monitor.

Stream Shade

Why is stream shade important? Stream shade is one of the primary factors influencing stream temperature, which in turn affects aquatic life, including salmonids. When there is insufficient shade, streams can get too warm for juvenile salmon and other species to survive. But some sunlight is needed for photosynthesis by stream plants, microalgae, and cyanobacteria, which provide food for macroinvertebrates. These in turn provide food for salmonids and other aquatic residents.



How is stream shade affected by forest management? Prior to the late 1980s, forest harvesting rarely left enough trees along streams to provide shade. Policies changed during the 1990s, and DNR's 1997 State Lands Habitat Conservation Plan requires buffers of unharvested forest on each side of the stream. Today, we are interested in how much shade these buffers provide.

How do we measure stream shade? Hemispherical photos are taken in the center of each stream along the sample reach (shown above). Software is used to analyze photos (example below) and calculate shading.

Results: How shaded are streams in the OESF? In DNR-managed watersheds, stream shade averaged 94%, or only 6% open sky. This high level of shade is a result of dense riparian forests. As these forests age over decades and centuries, gaps form and shade is expected to slightly decrease.

Riparian Vegetation

Why is riparian vegetation important? Stream-adjacent vegetation—including trees, shrubs, and other plants—provides shade, stabilizes stream banks, influences riparian microclimate, and contributes wood and leaf litter to streams. Riparian forests support a wide variety of life forms including riparian-obligate species such as the coastal tailed frog.

How is riparian vegetation affected by forest management? Today, many of the riparian forests in the OESF reflect the legacy of 20th-century harvests. The previously harvested riparian zones now contain younger, more uniform forests than once existed.

How do we measure riparian vegetation? All the trees are measured on two 0.44-acre (0.18-hectare) plots at each sample reach. Understory plants, such as shrubs and ferns, are measured on smaller plots.

Results: Current riparian forests vary in structure and composition, a result of local ecological conditions and past timber harvests. The 116 plots fell into four groups:

Primary overstory trees	Plots (%)
Small conifers, averaging 11 inches (28 cm) diameter	9
Medium conifers, averaging 16 inches (40 cm) diameter	37
Large conifers, averaging 23 inches (59 cm) diameter	37
Red alder, averaging 15 inches (39 cm) diameter	17

In-Stream Wood

Why is in-stream wood important? In-stream wood plays a key role in creating high-quality stream habitat for salmonids and other aquatic species. It shapes the stream channel, creates complex features including pools, traps nutrient-rich sediments, and provides cover for fish. Anticipated climate changes are expected to reduce stream flow in summer and increase stream temperature. In-stream wood may help to mitigate these impacts on habitat because it can lead to formation of deep pools with cool water.

How is in-stream wood affected by forest management? Trees in the riparian zone are the source of in-stream wood. Forest management in this zone—both current and historical—affects the composition of today's forest, including the size and species of trees.

How do we measure in-stream wood? Every piece of wood in the stream sample reach greater than 4 inches (10 cm) diameter and 6 feet (2 m) long is inventoried.

Results: Larger pieces of in-stream wood, particularly large conifer logs, provided key functionality including the highest rates of pool formation and sediment storage. For each additional foot (0.3 m) in length, a log was 9% more likely to form a pool; for each additional inch in diameter, a log was 5% more likely to be pool-forming.

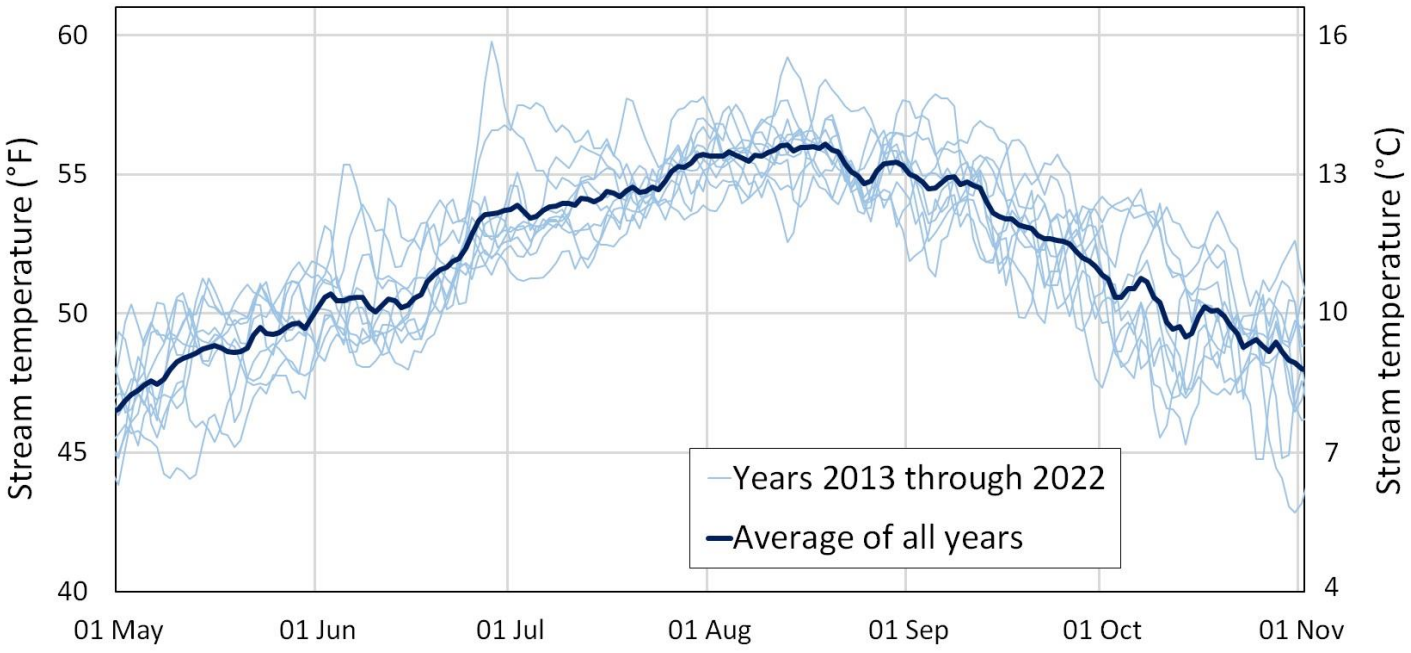
Stream Temperature

Why is stream temperature important? Stream temperature affects the productivity, health, and life histories of all aquatic life, including salmonids. A summertime stream temperature below 61°F (16°C) is optimal for salmonids in the OESF.

How is stream temperature affected by forest management? Before stream buffers were part of DNR's riparian management, harvest of the riparian forest significantly increased sunlight, leading to warmer stream temperatures.

How do we measure stream temperature? Sensors, not much larger than a coin, have been recording water temperature every 60 minutes, year-round in all sample reaches since 2013.

Results: We have learned that stream temperature varies significantly from year to year and that the temperature of a given stream can be predicted by factors such as the elevation of the watershed, the amount of direct sunlight the watershed receives, and whether the stream flows over bedrock. The average temperature of all streams remained below the 61°F (16°C) temperature threshold, and individual streams rarely had summers when they exceeded the threshold (<5% of the time).

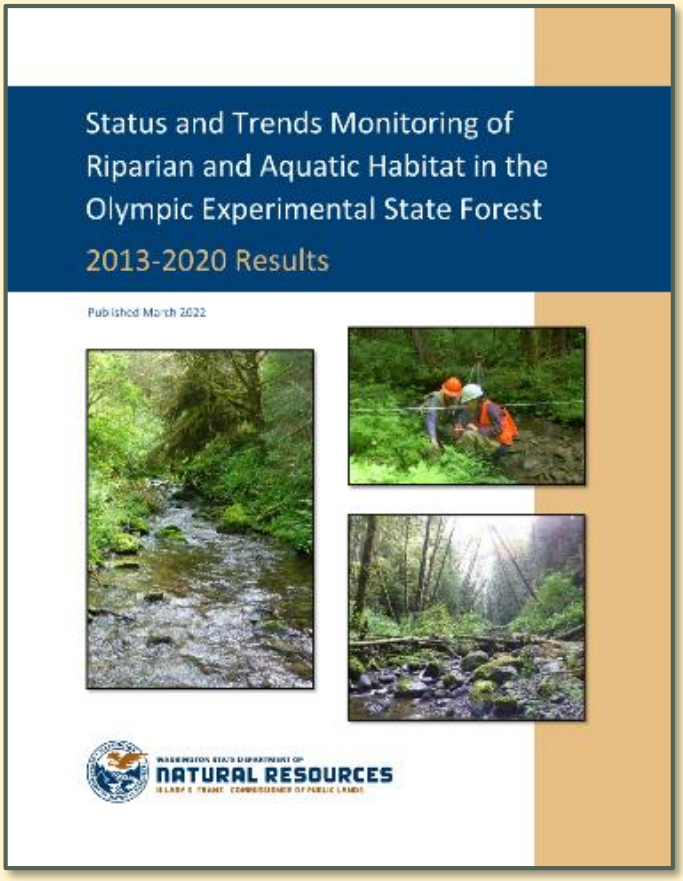


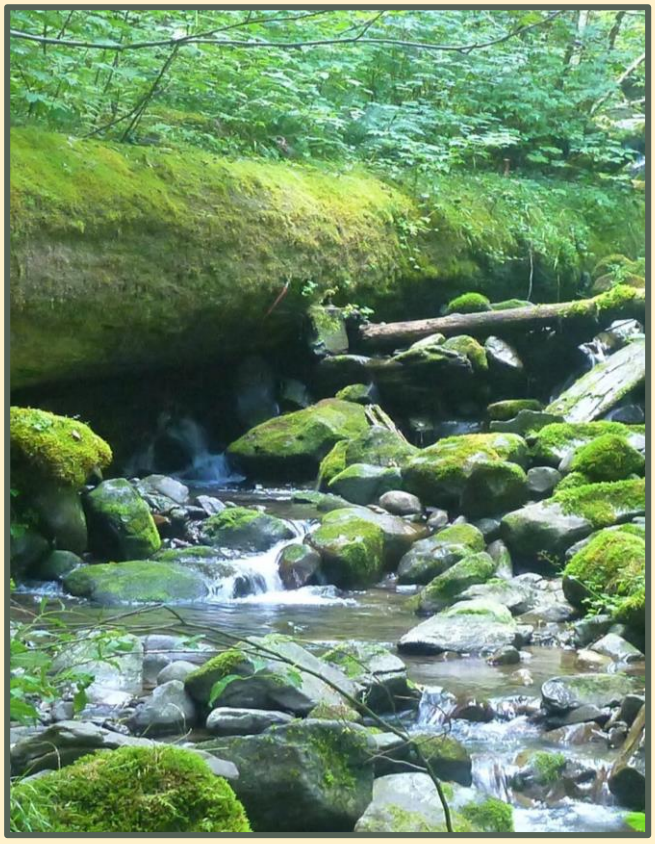
Average daily temperature of all streams in DNR-managed watersheds from 2013 to 2022.

What We've Learned So Far…

Nearly a decade of monitoring provides a clear picture of the current ***status*** of habitat conditions, though ***trends*** observed so far must be interpreted with caution because they represent only a short time interval in the context of ecological change.
A comprehensive description of this monitoring program with results from all nine habitat indicators was published in 2022.

Click to open the 2022 report



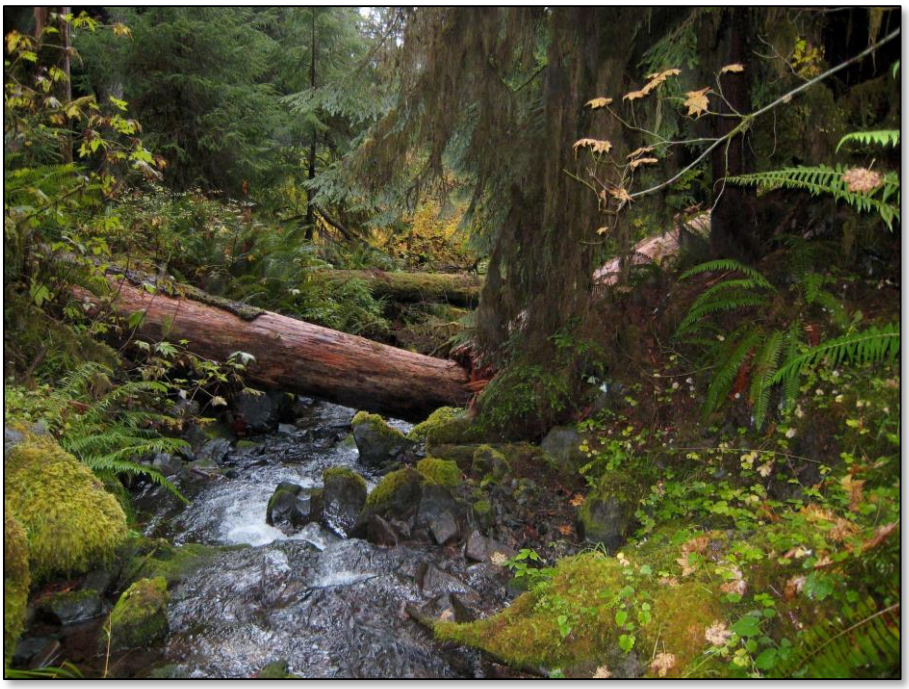


Status results show that DNR's Riparian Conservation Strategy for the OESF is providing key habitat benefits. Specifically, all sampled streams were found to be well-shaded, and stream temperatures and riparian microclimate remained cool during summer.

However, some aspects of habitat are still recovering from intensive 20th-century timber harvesting. Riparian forests have regenerated vigorously, but they have not yet developed the diverse, complex structure typical of old forests. Past riparian harvests also interrupted the supply of in-stream wood by removing many large trees that could otherwise have provided key habitat functions.

DNR is studying active approaches to restoring riparian habitat, to more quickly provide populations of aquatic and riparian species improved habitat conditions. One such program is DNR's Riparian Forest Restoration Strategy, which promotes development of old-forest conditions in the riparian zone.

A new study, the T3 Watershed Experiment, has similar goals for the riparian forest but will also add logs to streams to make immediate habitat improvements. What we learn through Status and Trends monitoring is used to guide land management planning in the OESF and beyond.



Collaborations & Related Projects

- Riparian Validation Monitoring in the OESF was initiated in 2016 to provide data on salmonid populations in the same watersheds that Status and Trends monitors for habitat conditions. This way, habitat conditions can be related to fish abundance. Electrofishing (photo) is used to temporarily stun the young fish which are then counted, measured, and released.

- The Status and Trends project is conducted in collaboration with the USDA Forest Service Pacific Northwest Research Station, which has provided scientific consultation, field equipment and assistance, and peer-reviews.

- Data collected during Status and Trends Monitoring has been used in graduate student and post-doctoral research projects on hydrology, microclimate, stream temperature, and stream nutrients.

- DNR collaborated with Olympic National Forest under the Good Neighbor Authority to conduct status and trends monitoring in six reference watersheds close to the OESF.

For more information about the OESF and all our ongoing monitoring projects, please visit: https://www.dnr.wa.gov/oesf

Contact for OESF research:
Teodora Minkova
OESF Research and Monitoring Manager
360-902-1175
teodora.minkova@dnr.wa.gov

Contact for Status and Trends monitoring:
Warren Devine
Natural Resource Scientist
warren.devine@dnr.wa.gov