The Skagit River System Adapting Restoration Plantings to Climate Change

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We are expecting an average temperature increase of four-degrees Fahrenheit by the 2040s and seven-degrees Fahrenheit by the 2080s in the Pacific Northwest. Rainfall will increase overall but decrease by ten percent during the summer by the 2040s. Reduced snowpack that melts earlier will reduce summer stream flows and increase the frequency and severity of floods and droughts. The soil moisture available on July 1 will decline throughout the North Cascades by up to 35 percent.

As a result, drought stress will reduce forest species' growth and survivorship while wildfires and pathogens alter forest structure and composition. The severity of climate change, the ability of individual plants to acclimate, the ability of plant populations to evolve to new conditions, and the ability of plants to migrate to better conditions will determine how these stressors affect restoration plantings.

The Skagit River System Cooperative was created by tribal resolution to provide natural resource management services for the Swinomish Indian Tribal Community and Sauk-Suiattle Indian Tribe. We plant between 30,000 and 50,000 trees every year in the floodplain of the Skagit River and along its tributaries as part of our mission to recover habitat for salmon. We want to make sure that we are planting forests that will be as resilient as possible to climate change.

Genetic and Species Diversity

Forest health and resilience will rely upon biodiversity to tolerate change and rebound from disturbances. Genetic diversity allows forests to adapt to environmental change through plasticity in traits such as cold hardiness, bud set and break, cone seed release, and pest resistance. Long-lived, woody species have the highest genetic diversity among all plant species. The best predictor of diversity levels within this group is the extent of a species geographic range. Outcrossing breeding systems and wind or animal-ingested seed dispersal also results in greater genetic diversity than other traits. For example, Douglas fir and black cottonwood have high levels of

Plantings along Nookachamps Creek. The Skagit River System Cooperative has installed over 40,000 plants along Nookachamps Creek with funding from the Washington Department of Ecology and the Washington Recreation and Conservation Office. Nookachamps Creek is one of the few tributaries to the Skagit River large enough to support Chinook salmon.

genetic variation. While woody species have more variation within species and within populations than other plant forms, they have less variation among different populations. For example, Sitka spruce has a lot of variation from one tree to another within an area like the Skagit Basin, but there is little difference between the entire populations found in Oregon and Alaska.

That is why we pay attention to the ranges, reproductive traits, and seed distribution methods of the trees used in our restoration plantings. We want to ensure that future forests possess the tools to survive changing environmental conditions. We try to use a high variety of genetic material within each species we plant. We prefer nurseries that harvest small numbers of propagules (i.e., live stakes and seeds) from many plants over large areas and varying microclimates and pay special attention to isolated, disjunct, or marginal populations, which contain rare gene pools. Growers should also harvest throughout the season to capture varying phenology. Variety in bud set, flowering, and fruiting timing may be important to cope with changing seasons. We have discussed this process with vendors and stressed the value of genetic diversity. To increase genetic diversity, we purchase plants from several vendors and collect seed to grow in our own nursery.

We also consider species diversity in our plantings. Different species will be affected by climate change at different levels. Some species will suffer across the landscape. For example, western red cedar has low genetic diversity from a population bottleneck that occurred 6,000 to 10,000 years ago and it may not adapt well to climate change. Other species may suffer on a site-by-site basis due to insect or pathogen outbreaks. Our planting plans incorporate as much structural and species diversity as possible.

Our plantings also incorporate as many flood and drought tolerant species possible. Flood tolerant species include red alder, Oregon ash, western red cedar, black cottonwood, red-osier dogwood, hardhack, Sitka spruce, and willows. Drought tolerant species include cascara, bitter cherry, red flowering currant, pacific dogwood, grand fir, western hemlock, Pacific madrone, big-leaved maple, Garry oak, tall Oregon grape, shore pine, clustered wild rose, and thimbleberry.

Assisted Migration

Plants have adapted genetic variations in response to climate, which shape phenology, morphology, and growth. Plants can migrate in response to changing climate, but models suggest that many species will not be able to migrate fast enough to keep up with future climate change. Because temperature, precipitation, and light control the timing of life history traits, plants will suffer phenological imbalances with altered growing seasons, impacting forest growth and composition.

The Conservation Biology Institute has developed the Seedlot Selection Tool to match seed sources with planting sites based on climate change scenarios. The Department of Forest Ecosystems and Society at Oregon State University and the U.S. Forest Service Pacific Northwest Research Station partnered to develop this tool and used available climate-interpolation models to define seed zones. The Seedlot Selection Tool suggested Hoquiam, Washington as a good seed source for the climate in the Skagit Basin in 2070. We plant up to ten percent of our trees from Hoquiam stock; the remaining 90 percent of our trees come from the Skagit Basin (we are unsure how well the migrant trees will do in today's climate).

Extended Monitoring and Stewardship Timelines

Climate change will increase pest outbreaks. Insects and pathogen populations will increase in the warmer conditions and many insects and some fungi are attracted to pheromones released by stressed plants. As part of our site monitoring, we are monitoring for insect and pathogen outbreaks and treating detrimental outbreaks with pesticides, pheromones, and other techniques. We are also thinning older plantings to increase the ability of the plants to withstand summer moisture stress. We plan to replant if species experience die-offs due to climate change.

James Quintasket, a Swinomish tribal member, working in the Skagit River System Cooperative Nursery. Every year we grow over 15,000 plants to install along salmon streams.