

Climate Change Impacts on Ecosystem Health and Ecosystem Services

A WA-APA Discussion Paper about Community Resilience

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Brief: *Humans rely on intact ecosystems to clean water and air of pollution, moderate temperatures and stormwater damage, provide food, fuel and materials for manufacturing (wood, minerals) as well as providing recreation. Development has fragmented and damaged these ecosystems and their services and climate change will further the damage. Protecting and restoring ecosystems will help our communities maintain their livability.*

Problem

Human activities and development – urban, rural and natural resources – have replaced and fragmented Washington’s natural systems. The result is less habitat for wildlife, damaged ecosystems and reduced ecosystem services, resulting in unintentional costs to society, such as increased flooding, increased air and water pollution, increased temperatures and loss of wildlife. Climate change will likely make things worse by altering the frequency and severity of episodic disturbance events (e.g., wildfire, floods, drought, insect outbreaks). Climate change will also likely alter the location and amount of different habitat types, as sea levels rise, temperatures rise, snow pack diminishes and stream flows change. These changes and ongoing patterns of development can interact to reduce the ecosystem services that our communities rely on.

Along with concern for individual ecosystem elements (aka critical areas), planners can include consideration of ecosystem services as a part of our necessary infrastructure. This will allow us to plan more efficiently and effectively for the future and to make cost-effective decisions that respond to the urgent and long-term issues of climate change.

Observations

The continuing increase in impermeable surfaces from land development prevents groundwater recharge, creates destructive runoff patterns and reduces the treatment capacity of natural systems. Projected hydrologic changes across the state under climate change scenarios are closely linked with future projections of precipitation and temperature. According to projections by the Climate Impacts Group, April 1 snowpack is projected to decrease by nearly 30% across the state by the 2020s, by 40% by the 2040s and [by 65% by the 2080s](#). Seasonal stream flow timing would shift due to decreased snowpack and earlier melt, especially in sensitive watersheds. Levels of summer and fall water storage in the Puget Sound and the Yakima Basin reservoir system would be reduced and would likely result in lower [water supply for all users](#). Reduced stream flows will result in higher concentrations of pollutants from industrial discharges and runoff contaminated with the chemicals we use on our properties (fertilizers, pesticides).

There is a vital connection between wetlands and climate change. Among the most productive ecosystems in the world, wetlands account for 6% of the Earth's land surface, store 20% of its carbon, produce 25% of its food, purify water, and perform a multitude of other ecological functions. Wetlands on non-federal land in the U.S. are disappearing at a rate of 70,000 to 90,000 acres annually. In the 1600s, over 220 million acres of wetlands are thought to have existed in the lower 48 states. By the 1980s, only an estimated 103 million acres remained. And the remaining wetlands are fragmented – cut off from other wetlands and water ways by human development.

For many species, climate change is accelerating long-term trends already associated with other types of human activity, producing a "biodiversity deficit." This is because ecosystems are being destroyed faster than nature can create new ones, and because habitats are being modified faster than species' natural ability to evolve or adapt. The habitat that remains is often fragmented – cut off from other similar habitat by roads and other development – making it harder for species to maintain populations to guarantee survival. Rates of species extinction are currently estimated at one hundred to one thousand times higher than occurred during pre-human eras. In North America, an estimated 36% of fish, 35% of amphibians, 17% of mammals, and 11% of birds are either in jeopardy or already extinct.

For the Northwest region, salmon is both culturally iconic and economically important. Climate plays a crucial role in salmon ecology at every stage of their

life cycle. Rising stream temperatures will reduce the quality and extent of freshwater salmon habitat and kill fish, as in the summer of 2015. In the major river systems of Puget Sound and lower elevation basins in the interior Columbia Basin, increased flooding due to shifts in precipitation patterns and earlier snow melt will harm crucial spawning habitat from [streambed scouring](#).

Climate influences nearly all aspects of forest ecosystems. The world has lost 1.5 billion acres of forest in the last 200 years. Forest fires, insect outbreaks, tree species' ranges and forest productivity are closely tied to climate. The combined climate change impacts on tree growth, regeneration, fire, and insects will fundamentally change the nature of forests, particularly in ecosystems where water deficits are greatest. Due to climatic stress on host trees, mountain pine beetle outbreaks are projected to increase in frequency and cause [increased tree disease and mortality](#). Combined with changes in summer precipitation and temperature, the area burned by regional forest fires is projected to increase significantly.

Washington State's approximately 3,000 miles of coastline are diverse, ranging from the sandy beaches and shallow waters of Willapa Bay, to steep rocky shores in the San Juan Islands, to heavily populated, unstable bluffs of the Puget Sound region. The Department of Ecology has estimated between 2 and 13 inches of sea level rise along the Washington coast by 2100. Although sea level rise has received some of the most wide-spread attention, other impacts related to climate change – such as ocean acidification and habitat impact

– have the potential for equally devastating effects on species survival and food resources.

How Local Planners Can Address the Issues

As a part of the update of GMA plans, each jurisdiction will review and revise its designation of critical areas and resource lands as well as the goals and policies related to land use, capital facilities and utilities and parks. Rather than addressing these as separate issues, an integrated vision that recognizes the importance of ecosystems to water supply, flood control, recreation, health and safety is needed. This vision should include planning the community's response to disastrous events expected as a result of our changing climate.

Strategies for Local Jurisdictions

Restore and retain farms and forest lands.

Review adopted maps and policies to ensure that farm and forest lands are protected and development occurs within the urban growth boundary. Use planning and zoning tools to restore and retain the health and vitality of Washington's farms and forest lands. Healthy farms and forests increase carbon sequestration and storage, reduce the releases of GHG emissions, and support the provision of [biomass fuels and energy](#).

Optimize flood control and storm water management codes.

Recognize the value of natural systems for managing flooding economically, and protect and enhance these systems. Require stormwater retention techniques, such as Low Impact Development (LID),

in both public infrastructure and private development to support, enhance and restore natural habitats.

Guide development away from floodplains and barrier beaches.

In order to protect important ecosystem functions, revise zoning, shoreline, and other codes to guide development away from floodplains and away from barrier beaches.

Realign shorelines and critical areas protections.

Align state regulations for both Shoreline Master Programs and critical areas regulations to avoid duplication and to clarify that the science should apply comprehensively and consistently to these important ecosystems.

Increase acquisition of open spaces.

Utilize an ecosystem-based approach in the evaluation of potential open spaces, particularly related to connectivity and functioning. Consider potential acquisitions based on the ability to mitigate an area's vulnerability to climate change and the ecosystem's ability to help the community adapt to climate change. Integrate ecosystem considerations in the planning for new open space use and design. The Regional Open Space Strategy (ROSS) recently completed for the Puget Sound area is an example of this approach.

Protect existing trees and encourage the planting of new trees.

Adopt a tree protection and replacement ordinance, targeting "the right tree for the right place." Require shade trees, preferably native, where feasible and appropriate, in landscape plans for all new development proposals. Kirkland's Tree Preservation Program has earned it

a designation of Tree City USA for the past seven years, see [Project Example](#).

Guide ongoing and proposed research efforts.

Shoreline Management Plans require periodic monitoring of the effectiveness of adopted policies and programs in meeting shoreline protection goals. Local jurisdictions will need a new suite of monitoring and analytical tools to focus on and track the effects of climate change. In order to guide future conservation efforts, these tools must be developed in ways that produce results which can be correlated with corrective actions implemented through local planning. For example, data collection and management in coastal areas should be conducted so as to inform later updates of Shoreline Management Plans.

Likewise, as ecosystems adapt to climate change, the current systems of identifying and evaluating them as habitat and in providing ecosystem services will need to change. For example, the plants currently used to identify wetlands in Washington may change to be more like those commonly found currently in California. Also, a wetland may have limited value for flood storage or water quality, but be an important link between other wetlands or valuable habitats. The value of connectivity between habitats should be emphasized.

Maintain open space connectivity and corridors.

Many of our currently protected areas, whether they are parks, refuges or other conservation areas, are too small and fragmented to maintain the integrity, diversity and health of the populations that are found in these areas. In addition,

species adaptation may require the ability to migrate or relocate as habitat conditions change. The Connected Landscape Project completed by state and federal agencies, including Washington Department of Fish and Wildlife (WDFW) used a landscape-level analysis to define connectivity and corridors, along with priorities for land acquisition to improve ecosystem connectivity. Funding priorities, plans and policies should reflect this information. The Regional Open Space Strategy (ROSS) for the Puget Sound region is an example of this approach.



U.S. Fish & Wildlife Service via Wikimedia Commons

Plan for resilience.

Use a watershed approach to complete an ecosystem services analysis and identify priority conservation and

restoration areas that can increase natural resiliency and protect vulnerable communities. Identify regulatory and non-regulatory mechanisms that local jurisdictions can use to conserve and protect those areas. Take early action to eliminate or control non-native invasive species that take advantage of climate changes, especially where they threaten native species or current ecosystem function. Strengthen and increase the capacity of natural systems to respond to droughts, stream flow changes, and flooding by adopting land use policies and best practices to reduce impervious surfaces, protect surface water quality, improve infiltration, and reduce stream erosion and sedimentation.

Reduce the use of chemicals and synthetic compounds.

Encourage development and businesses to reduce the use of chemicals and synthetic compounds in their construction and building materials, operations, products, and services. Encourage landscape design, park maintenance, and agriculture that reduce or eliminate the use of pesticides, herbicides, and synthetic fertilizers, since these are threats to fragile ecosystems and endangered species. Adopt new procedures for the maintenance of public lands and provide education to private property owners to encourage them to adopt these practices also.

Provide incentives to reduce water use and require conservation.

Use available programs and incentives to promote education about water conservation. Design outreach activities at different levels, targeting those who make no efforts to conserve as well as those who need additional guidance to increase their conservation

achievements. [See Spokane's water stewardship program as an example.](#) Provide incentives and requirements to use green building techniques, as certified by the USGBC or other rating authorities. Mandate approaches to new development, as well as operations of businesses and agriculture that reduce the use of water. Require conservation in ongoing operations and maintenance activities, such as restricting the use of water for cleaning outdoor surfaces and vehicles or promoting water-efficient irrigation systems and landscapes. Adopt water conservation pricing, e.g., tiered rate structures, to encourage efficient water use. Adopt water efficiency retrofit ordinances that require upgrades as a condition of issuing permits for renovations or additions and for the sale of residences and buildings.



Columbia River near Rooster Rock, 1973. Environmental Protection Agency via Wikimedia Commons

Reuse water.

Encourage and remove barriers to the use of rainwater, gray water and wastewater on-site for non-potable water needs, employing innovative wastewater treatment techniques that minimize or eliminate the use of chemicals. Promote the use of gray water and reclaimed water that can be used for industrial and irrigation purposes to help offset the

potential impacts of climate change on summer stream-flows and water supplies.

Encourage use of native plants

Encourage or mandate the use of native plants in landscaping for new developments and publicly owned spaces to provide habitat for native insects, amphibians, birds, etc. that are in decline. Also, provide incentives to reduce the amount of lawn area, since it uses a disproportionate amount of water in summer when it is scarce, is a monoculture not supportive of native species, and is the source of much of the fertilizer and pesticide run-off from residential and recreation areas. [Spokane's Water Stewardship Plan provides a good example.](#)

Prepare for projected climate change impacts

Adjust routine operations, maintenance and inspection, and capital budget expenses to prepare for more frequent and intense storms, floods, landslides, wildfires, and extreme heat events. Often, restoring or enhancing natural systems will be the most cost-effective approach. Restore riparian zones, estuaries, wetlands, and floodplains by implementing appropriate conservation, restoration, and other land stewardship actions and practices, such as mitigation banking, so that they can effectively manage increased runoff from more intense storms and floods.

Implement a Green System Development Charges (SDC) program.

Develop a program using Green SDCs (gSDCs) charges to support the acquisition and maintenance of natural areas to assure their continued production of ecosystem services. Lands

acquired under this program may include headwaters of drinking water supplies, filtering wetlands or riparian areas, or groundwater recharge areas.

Create ecosystem services special districts.

Use of a special district, much like a utility district, allows for the costs of acquiring, maintaining or developing ecosystem services to be distributed fairly across all residents and businesses that receive their benefits. This is the preferred option when data or metrics for ecosystem services are difficult to determine in developed areas, and only generalized assessments can be developed.

Develop a community-wide water budget

Calculate the inputs and outputs of water in the community. To achieve water balance, the inputs (precipitation, surface flow and piped in water) should equal the outputs (run-off, evapotranspiration, and infiltration). Develop mechanisms to achieve a water balance.



Dry River Bed; NOAA 2009 from Wikimedia Commons

Develop market-based mitigation programs.

A market-based system of tradable credits may be used to meet goals for

protecting ecosystem services when measurements of ecosystem services are available for an area. In this system, credit requirements are set for new development, assuring that lost ecosystem services are replaced by conservation of other areas. Credit trading also leads to increased revenue options for conservation-minded owners and permits lower cost mitigation for developers.

Project Examples

Regional Open Space Strategy (ROSS)

In 2012, a partnership of local, state and federal agencies, non-profit organizations and private corporations used an ecosystem services approach to identify and evaluate open space benefits and strategies to protect the areas and benefits in the Puget Sound. By planning across technical areas, ROSS looked at the full open space system and developed a collective, multiple benefit vision for future planning and investment. Green infrastructure can and should be positioned alongside transportation and other foundational investments as a necessary dedication of public and private resources to shape future development and ensure community well-being.

Kirkland Tree Protection

In 2009 the City of Kirkland received national recognition for being a “Tree City USA” for the seventh year. Each year, The Arbor Foundation awards this title to communities that meet four standards: having a tree board or department, a tree care ordinance, a community forestry program with an annual budget of at least \$2 per capita, and an Arbor Day observance and proclamation.

Kirkland has implemented comprehensive regulations that provide

for protection, maintenance and replacement of the city’s trees. Furthermore, in 2008 the city council adopted the 20-Year Forest Restoration Plan to restore and maintain the city and publicly-owned natural areas. Much of the plan is being implemented through restoration efforts of the Green Kirkland Partnership, a program that promotes community stewardship.

Spokane Water Stewardship Plan

Through its Water Stewardship Program, Spokane is encouraging water conservation by providing education and incentives for residents and businesses to conserve water. The city is offering rebates to retailers to replace 1,000 sq. ft. of lawn with non-irrigated, drought tolerant landscaping and is currently developing an indoor rebate program. In addition, the program provides resources on water saving practices through print advertisements, radio spots and their website.

Mid-Columbia Ridges to Rivers Open Space Network (RRON Plan)

In late 2007, citizens, groups, and public officials in the Mid-Columbia region of Southeastern Washington identified the need for a regional open space and trails plan that takes a more comprehensive view than the isolated city and county plans we now use. These entities came together to form a working group known as the Ridges to Rivers Open Space Network Steering Committee to look on a regional level at how best to use their natural assets to benefit the economy; provide access for recreation, education, and health; and preserve natural and aesthetic values.

There is no line on a map that defines where the Mid-Columbia is. It generally

extends from the Saddle Mountains and the Hanford Reach National Monument to the north to the Columbia River to the south and from the Palouse and Snake Rivers to the east to the Rattlesnake Ridges and Horse Heaven Hills to the west. One goal of the Ridges to Rivers Open Space Network steering committee and board of directors is facilitating cross-jurisdictional planning and dialog.

Puyallup River Watershed: An Ecological Economic Characterization

In June 2011, Earth Economics completed a characterization of the Puyallup River watershed and its ecosystem services intended to be used to evaluate the best way to resolve issues such as flooding, water quality, water supply, habitat restoration by the multiple jurisdictions and agencies in the watershed.

Additional Resources

Connected Landscape Project: Statewide Analysis, Washington Wildlife Habitat Connectivity Working Group, December 2010 <http://www.waconnected.org>

Open Space Valuation for Central Puget Sound, Chadsey, M., Christin, Z., Fletcher, A., 2015.
<http://www.eartheconomics.org/FileLibrary/file/Reports/Earth%20Economics%20ROSS%20ESV%202015.pdf>

Regional Open Space Strategy, Regional Open Space Partnership, March 2014,
<http://www.openspacepugetsound.org/>

River Restoration to Avoid Flood Damage, The Economics of Ecosystems and Biodiversity, 2010
<http://www.teebweb.org/resources/case-studies>