Adam Zack

From: R. Brent Lyles <brent@sanjuans.org>
Sent: Tuesday, January 26, 2021 2:43 PM
To: Comp Plan Update
Subject: Comments on resource lands and climate resiliency
Attachments: Climate and resource lands - Comments from Friends of the San Juans - 26jan2021.pdf

Dear San Juan County CD staff, Planning Commissioners, and members of the County Council,

Please find attached a comment letter about the connections between natural resource lands and climate resiliency. In this PDF, I have also included two helpful resources (which I refer to in my comments), appended to the end of the letter.

Thanks so much for considering these comments, and please feel free to call me if this file fails to transmit faithfully.

Respectfully,

Brent

o o o o o o o o o o o o o o

R. Brent Lyles (he/him) | **Executive Director** | **Friends of the San Juans**
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To: San Juan County Community Development Staff, Planning Commissioners, and Council Members
From: R. Brent Lyles, Executive Director
Date: 26 January 2021
Subject: Comments on the importance of Agricultural and Forest Resource Lands to climate resiliency in San Juan County

Submitted via email to *compplancomments@sanjuanco.com*

At Friends of the San Juans, our mission of protection and restoration spurs us on a daily basis to acknowledge and anticipate the impacts of the climate crisis in the San Juan Islands and across the Salish Sea region. Given the Planning Commission's current discussions of Agricultural and Forest Resource Lands, as well as its renewed focus on local climate resiliency for the County's Comprehensive Plan, it is worth noting briefly both the critical importance of natural resource lands to ensuring climate resiliency and some helpful resources on climate resiliency that are available to County staff, the Planning Commissioners, and SJC Council Members.

The Importance of Agricultural and Forest Resource Lands in Climate Resiliency

The Introduction to San Juan County's Comprehensive Plan identifies climate resiliency as a Key Challenge that the Plan addresses directly, including systems resiliency, carbon sequestration, and more. The following are just a few highlights that support the protection of Agricultural and Forest Resource Lands as strong climate policy to meet this Key Challenge:

- As noted in the Islands Climate Resilience report in 2017, precipitation patterns in the San Juan Islands will likely soon be characterized by drier summers and winters with heavier bursts of rainfall. Less developed land areas like Agricultural and Forest Resource Lands, which have more vegetation and less impervious cover, will hold moisture better during dry summers and discourage immediate runoff during heavy winter rainfall events. In addition to supporting the survival of our local ecosystems, this also has direct implications for recharging our aquifers, on which over half of our population depends for meeting their water needs.[1]
- Producing food locally has two benefits, with respect to climate resiliency: First, the availability of local food will be critical during times when our food-supply chain from the mainland is diminished or cut off by the increasingly frequent natural disasters wrought by climate disruption. Second, producing food locally reduces transportation costs and is thus more "climate friendly," so protecting Agricultural Resource Lands to sustain San Juan County's local agriculture industry helps our community keep its carbon footprint more modest. Policies that encourage regenerative agriculture will be especially effective, in that these practices will keep

[1] Islands Climate Resilience. 2017. Working Toward Climate Resilience in the San Juan Islands. Attached to this comment letter, and available at: https://www.madrona.org/islands-climate-resilience

our local soils from becoming depleted over time. For soils that have already become degraded, a strong climate policy in San Juan County should incentivize the regeneration of these soils through reforestation, no-till practices, and crop rotation, for instance.

- Forests play an enormous role in carbon storage and sequestration, both globally and in the Pacific Northwest in particular. A study in Oregon, included in this submission to the County, found that every acre of forested land that is protected from development has the effect of avoiding 1.4 metric tons of carbon dioxide emissions per year.[2] This is also true of regularly harvested forest lands, where sequestered carbon remains stored in soils, stumps, and roots. Interestingly, maturing trees take up more carbon than old trees, and long-lasting wood products continue to store carbon as well.[3] Protecting existing Forest Resource Lands and increasing the amount of Forest Resource Lands in San Juan County is strong climate policy.
- To increase climate resilience, Agricultural and Forest Resource Lands should be managed for multiple objectives beyond economic production, including carbon sequestration, water quality and capture, biodiversity, and habitat health.[4] Our comment letter on January 10th, 2021, suggested that such "secondary benefits" for Agricultural and Forest Resource Lands be explicitly incorporated into the Comprehensive Plan, such as specifically in its land scoring methodologies, per WAC 365-190-050 (6) and WAC 365-190-060 (3). Further, a strong climate policy in San Juan County should incentivize owners and managers to specifically consider and address these secondary benefits.

Helpful resources on climate resiliency

- In 2014, a community group formed to encourage preparedness for climate-related impacts in the San Juan Islands. This **Islands Climate Resilience** (ICR) group developed a report in 2016 and 2017: *Working Toward Climate Resilience in the San Juan Islands* (cited above, and included with this submission), which is now hosted by the Madrona Institute. The group included staff from the San Juan Islands Conservation District and Friends of the San Juans, as well as interested residents, including educators, artists, climate activists, and conservationists. With sections on expected climate impacts, land, water, energy, and agriculture, the report can serve as an invaluable resource to County staff, Planning Commissioners, and the County Council.
- Washington State University's Center for Sustaining Agriculture and Natural Resources features a number of excellent research and review publications on its Climate Impacts and Adaptation page (http://csanr.wsu.edu/publications-library/climate-change/climate-impacts-adaptation/). These focus on managing agricultural resources during a time of climate change.
- In February 2020, Washington State's Department of Natural Resources released its Plan for

[2] Kline, J. and J. Cathart. 2009. Land use planning: A time-tested approach for addressing climate change. US Department of Agriculture Pacific Northwest Research Station *Science Findings* Issue 103, Salem, OR. Attached to this comment letter, and available at: https://www.fs.fed.us/pnw/sciencef/scifi113.pdf

[3] Gray, A. and T. Whittier. 2017. There's Carbon in Them Thar Hills: But How Much? Could Pacific Northwest Forests Store More? US Department of Agriculture Pacific Northwest Research Station *Science Findings* Issue 195, Salem, OR. Available at: https://www.fs.usda.gov/treesearch/pubs/53931

[4] Peterson, D, Innes, J and K. O'Brian. 2001. Climate change, carbon and forestry in Western WA. US Department of Agriculture Pacific Northwest Research Station PNW-GTR-614 Conference proceedings, Orcas Island, WA. Available at: https://www.fs.fed.us/pnw/pubs/pnw_gtr614.pdf

Climate Resilience, and while our County is unique, the report can be very helpful as a guide and an inspiration for actions, policies, and management recommendations at the local level (https://www.dnr.wa.gov/publications/em_climaterresilienceplan_feb2020.pdf).

- The Washington State Department of Natural Resources' 2020 Forest Action Plan addresses opportunities for proactive management that can increase San Juan County's forest health, promote unique habitats, and foster landscape resiliency to wildfire (https://dnr.wa.gov/publications/rp_2020_forest_action_plan.pdf).

Protecting, sustaining, and thoughtfully managing Agricultural and Forest Resource Lands is one of the most important ways that San Juan County can mitigate the impacts of climate disruption in the San Juan Islands. Robust policies should include managing for the secondary benefits of these lands, noted above, and can meet the goals of the Growth Management Act while supporting the strong desires of our community to protect the Islands' rural and natural character, support our agriculture and forestry industries, and improve our climate resiliency.

Thank you for considering these comments, and if you have any questions about them, please feel free to contact me via email at *brent@sanjuans.org.*

PNW
Pacific Northwest
Research Station

Science
FINDINGS

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"Science affects the way we think together."
Lewis Thomas

LAND USE PLANNING: A TIME-TESTED APPROACH FOR ADDRESSING CLIMATE CHANGE

Jeff Kline

Land use planning in western Oregon has helped maintain the landscape's ability to store carbon.

"What good is a house, if you haven't got a decent planet to put it on?"
—Henry David Thoreau

Land use planning—it's not just about subdivisions and strip mall placement. It can be an integral part of broader environmental policy for addressing climate change. Since its inception in 1973, Oregon's land use planning program has concentrated development within urban growth boundaries. It has also encouraged efficient transportation corridors that include mass transit, bicycling, and other options for getting where we need to go. This pioneering approach to protecting agricultural and forest land has kept an estimated 1.2 million acres of these resource lands from further development. Along with reducing suburban sprawl, keeping forests as forests and farmland in crops has another unexpected benefit—land use planning in western Oregon has helped maintain the landscape's ability to store carbon.

Jim Cathcart, forest resource trust manager with the Oregon Department of Forestry, and Jeff Kline, a research forester with Pacific Northwest (PNW) Research Station in Corvallis, Oregon, quantified these contributions in a study that was incorporated into Oregon's strategy for greenhouse gas reductions.

The increase in atmospheric carbon dioxide (CO_2) is a leading contributor to global climate change. As policymakers grapple with mitigating climate change, two basic methods present themselves: reduce the amount of CO_2 (and other greenhouse

IN SUMMARY

Oregon's land use planning program has protected an estimated 1.2 million acres of forest and agricultural land from development since its inception in 1973. As a result, these resource lands continue to provide forest products and food as well as another unexpected benefit: carbon storage. By keeping forests as forests, land use planning capitalizes on the natural landscape's ability to sequester atmospheric carbon, a key contributor to climate change. Nationwide, however, forest land is the land type most frequently converted to more developed uses. When this happens, carbon storage opportunities are lost, and the new use, such as a housing development, often becomes a net carbon producer.

Scientists from the Pacific Northwest Research Station and Oregon Department of Forestry quantified the carbon storage maintained by the land use planning program in western Oregon. They found these gains were equivalent to avoiding 1.7 million metric tons of carbon dioxide emissions annually—the amount of carbon that would have been emitted by 395,000 cars in a year. Had the 1.7 million metric tons of stored carbon been released through development, Oregon's annual increase in CO_2 emissions between 1990 and 2000 would have been three times what it actually was. As policymakers look for ways to mitigate climate change, land use planning is a proven tool with measurable results.

gasses) emitted in the first place, or find ways to pull some of the excess carbon back out of the air. The study by Cathcart, Kline, and their collaborators suggests that an effective land use planning program can contribute to both these methods.

"The ability of forests to store, or sequester, carbon means they have a key role to play as we try to mitigate the effects of climate change," says Kline. Forests naturally sequester atmospheric CO_2 through photosynthesis and store it as carbon in trees, vegetation, roots, woody debris, and soil. When forests are cleared for more developed uses, much of the sequestered carbon is released back into the atmosphere, and the landscape's ability to sequester more carbon is severely reduced. To further exacerbate the problem, the new land use, such as a housing development, usually becomes a net carbon contributor, especially if it is accompanied by longer commuting times.

Forest land has been the largest source of development nationwide. Between 1992 and 1997, 1 million acres of forest were lost annually in the United States, and by 2030, another 26 million acres could be lost, including 2 million acres in the Pacific Northwest, Kline explains.

Oregon's climate strategy calls for reducing greenhouse gas emissions to 10 percent below 1990 levels by 2020. To find ways to meet this goal, the governor appointed an advisory group in 2004. Working under the Oregon Department of Energy technical team for this group, Cathcart was chair of the biological sequestration subcommittee. "We wanted to know what opportunities existed for storing terrestrial carbon. I knew that maintaining forests was important, but I wasn't sure how to quantify it. Then I met Jeff," recalls Cathcart.

The two scientists met by happenstance at a science fair sponsored by the PNW Research Station in 2004. Kline was presenting a poster describing a land use model developed for a different study. The model could be used to project future land use for western Oregon with and without Oregon's land use program in effect. After talking a bit, the two scientists realized that by using Kline's model and Cathcart's carbon numbers, "We'd be able to figure out how much carbon storage would have been lost without land use planning," Cathcart says. It also enabled the scientists to consider how extensive a role land use planning could play in future carbon sequestration strategies.

KEY FINDINGS

- Oregon's land use planning program yields significant gains in carbon storage through avoided forest land loss. Estimates indicate this storage has been equivalent to avoiding 1.7 million metric tons of carbon dioxide (CO_2) per year. This is in addition to the primary benefits attributed to land use planning such as protection of forest and agricultural land, improved transportation, and more orderly growth.
- Had the 1.7 million metric tons of stored carbon been released though development, Oregon's annual increase in CO_2 emissions between 1990 and 2000 would have been three times what it actually was.
- Oregon's land use planning program will continue to yield carbon storage benefits based on its conservation of productive forest land. By 2024, avoided development on an additional 205,000 acres of forest and agricultural land will yield an additional 3.5 million metric tons of avoided carbon loss, equivalent to roughly a reduction of 12.8 million metric tons of CO_2 emissions.

Jeff Kline

Forest land stores more carbon than other land uses, but is the land type most likely to be developed nationwide.

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UNPLANNED BENEFITS

Much of the impetus for Oregon's land use planning program 36 years ago was to protect commercial forest and farm land from development. Transportation planning was integrated soon after, as policymakers realized the two components could work hand in hand—by clustering development, transportation routes could become more efficient and influence the location and type of future development. Most people weren't thinking about carbon storage and reducing emissions back then, but as Kline and Cathcarts' study found, these benefits were quietly accumulating below the radar.

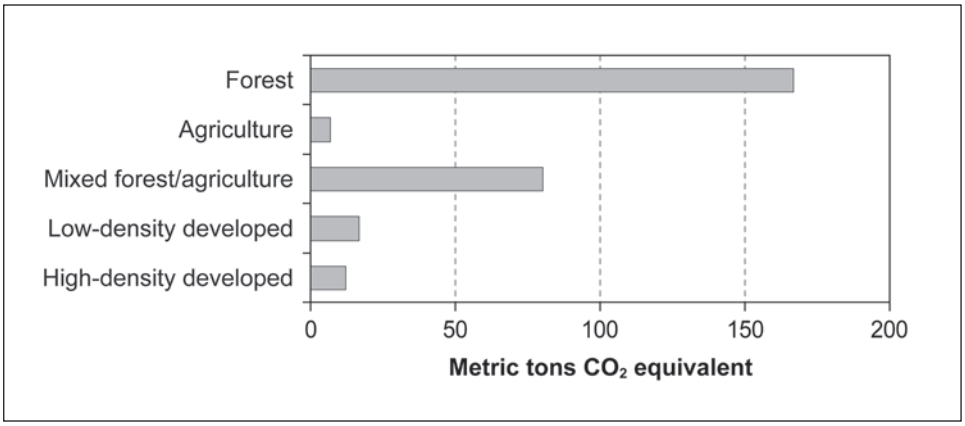
"We estimated carbon benefits for two scenarios: one assuming Oregon's land use planning program as enacted in 1973, and another assuming Oregon's land use planning program was not enacted in 1973," says Kline.

The scientists estimated that 1,221,000 acres of forest and agricultural land in western Oregon would have been converted to more developed uses without the land use planning program. By maintaining these lands, the gains in carbon storage are equivalent to avoiding 1.7 million metric tons of carbon dioxide emissions per year. That's the amount of carbon that would have been emitted by 395,000 cars in a year (assuming each car gets 25 mpg and is driven 12,000 miles annually), explains Kline.

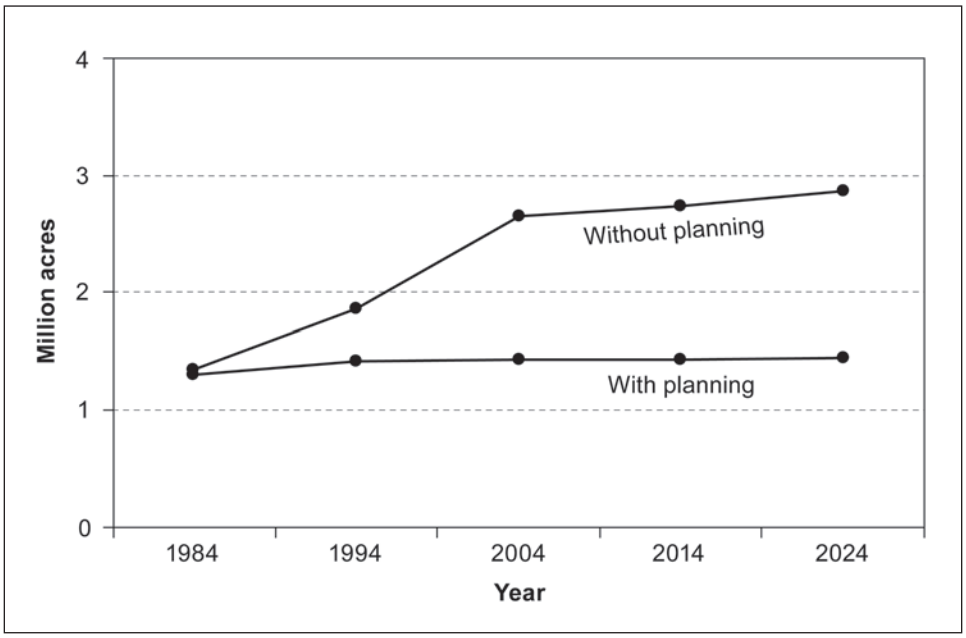
Had the additional 1.7 million metric tons of stored carbon been released through development, Oregon's annual increase in CO_2 emissions between 1990 and 2000 would have been three times what it actually was.

"Had we not had the land use policy, we would have had sizeable more emissions, and that's before we were even concerned about carbon storage," says Cathcart. "Now that it's something we're aware of, we can shore this up, but it has to be a conscious policy decision to keep a land use policy in place to do this."

Their projections suggest that if maintained, Oregon's land use planning program will continue to yield carbon storage benefits based on its conservation of productive forest land. By 2024, avoided development on an additional 205,000 acres of forest and agricultural land will yield an additional 3.5 million metric tons of avoided carbon losses, equivalent to roughly a 12.8 million metric ton reduction in CO_2 emissions, or 0.64 million metric tons CO_2 per year.



Estimated average amount of CO_2 stored per acre by different land uses in western Oregon.



The estimated cumulative loss of forest and agricultural land to low-density or greater development in western Oregon with and without the state's land use planning program.

CONSERVATIVE ESTIMATES

"Our findings are pretty conservative because we didn't consider the carbon stored in soil and dead wood," says Kline. "The forest land-use class will have more of this than other land-use classes, so carbon savings are actually greater. We were just looking at avoided forest loss. If you factor in other benefits like more compact development, people driving less, using public transportation, then it would be even higher," he explains.

Cathcart agrees, adding, "In our land cover assumptions, we assumed that the forest being lost to development was 25-year-old Douglas-fir, when in actuality, the trees are probably older than that and so would have stored more carbon."

Because this analysis simply looked at aboveground carbon stocks, the model indicated that moderately developed land stores more carbon than agricultural lands. "We don't want this to be misinterpreted," says Cathcart. "The increase in carbon storage on moderately developed lands comes from landscaping, shade trees, and grass, for example. In this analysis we assumed that agricultural land was cultivated in annual crops, not something like orchards or Christmas trees, which store more. We only accounted for changes in carbon stock arising from development. We didn't account for the higher carbon footprint of average domestic use over agriculture."

RECOGNIZE WHAT WORKS

Long-lasting wood products, such as 2 by 4s, continue to store carbon even after the tree has been cut. Forest land that is actively managed for timber is replanted after each harvest, and thus over time, stores more carbon than land that is harvested once before development. "It may simply be the act of maintaining or increasing the amount of land area in forest cover that is the most important action to take," explains Cathcart.

"All you hear about is developing a cap and trade program or carbon market—a policy approach that has not been used that much," says Kline. A cap and trade program, as generally envisioned, would include carbon offset opportunities where an entity, such as an electrical power plant, could buy carbon credits from a landowner whose property provides an increased level of carbon storage. A key part, though, requires a cap, presumably set by the federal government, limiting the amount of carbon that can be emitted before the entity would be required to buy or trade carbon credits for the rights to emit more carbon. Some people think that a carbon cap and trade program can work in a similar fashion and with similar success as the sulfur dioxide (SO_2) market established in the 1990s by the Environmental Protection Agency.

"There's potential for markets to work," says Kline, "but a carbon market will be more complex than the SO_2 market. With SO_2 there were a lot fewer producers involved—SO_2 pollution generally came from a known number of coal-fired electrical plants." Carbon dioxide, on the other hand is emitted by every breathing being on Earth. Sulfur dioxide emissions also led to an immediate and visible problem: acid rain. This created a greater sense of urgency in the general public than climate change has, a problem commonly perceived as occurring in the nebulous future.

When the SO_2 market was created, explains Kline, "People were reacting to the acid rain that had been damaging and killing trees in the Northeastern United States. People could see the effects of SO_2 pollution and they pressured politicians to change things. The immediate effects of CO_2 and climate change are not as visible or certain in the collective mind of the public, so the public may not be as motivated to act as quickly."

"While we wait for stronger climate change policies to be implemented, we don't want to forget about what we're already doing," says Kline. "Existing forest land conservation policies and programs can make significant contributions to addressing climate change until the issues involved with carbon trading and offset programs are resolved, or society becomes more amendable to taxing carbon emissions."

Jeff Kline

By maintaining forest and farm land, Oregon avoided an estimated 1.7 million metric tons of carbon emissions annually between 1974 and 2004.

Jeff Kline

Oregon's land use planning program has encouraged high-density development within urban growth boundaries.

Land use planning has its own uncertainties, however. In the last 10 years, there have been several challenges to Oregon's land use planning program, and voters have approved some changes to it. Relative to other approaches

WRITER'S PROFILE

Rhonda Mazza is a science writer with the Pacific Northwest Research Station.

to forest land conservation, land use regulations and zoning can be implemented and administered at relatively low cost to governments. There is, however, "a persistent tension between society's desire to both conserve land and uphold certain private property rights," explains Kline.

Ballot Measure 37, which weakened the land use planning program, passed in 2004 but then was overturned and modified in 2007 by Measure 49. "Given the passing of Measures 37 and 49, it creates some uncertainties about the future of land use planning in Oregon. Pointing out these broader environmental benefits becomes an important factor to add to the debate. It has to be a conscious policy decision to use land use planning as a way to mitigate climate change," says Kline.

LAND MANAGEMENT IMPLICATIONS

- Land use planning is typically implemented to facilitate more orderly and efficient use of land, conserve forest and farm lands, and facilitate transportation planning. These results suggest that land use planning also can be an important part of larger strategies focused on lowering greenhouse gas emissions and mitigating climate change.
- Traditional approaches such as land use planning and conservation easements and others that retain land in forest cover remain relevant methods for storing carbon and offsetting CO_2 emissions even as policymakers focus on newer and perhaps less tested policy alternatives.
- Informing the public about the carbon sequestration benefits of land use planning is important, particularly in Oregon where voters are periodically asked to reassess the value and appropriate extent of land use planning.

COMPLEMENTARY APPROACHES

"Mitigating the effects of climate change will likely take a variety of approaches," says Kline. Lifestyle choices play a big part in the amount of carbon that is emitted, but policies and programs can create the opportunity to make choices that leave a smaller carbon footprint. For example, a gas tax or road toll can raise the cost of commuting so that commuters want to drive less and live closer to where they work. A land use program that provides clustered development around alternative transit options makes driving less a more feasible option.

"At a minimum, you don't want policies to work against each other, and ideally you want them to work together," says Kline. "If people want to live closer in because commuting costs are going up, and land use planning is helping them live closer to work, then that's a good example of complementary policy."

"We can have smart development to minimize loss of forest value," says Cathcart. Conservation easements and private land trusts are some of the other ways to protect forest and agricultural land from further development. Another possibility is developing ecosystem service compensation programs. For example, landowners could receive a credit for avoided development. And if and when carbon trading and offset programs or markets more fully develop, they will offer another approach.

In the meantime, says Kline, "existing forest land conservation policies and programs can make significant contributions to addressing global climate change."

Jeff Kline

Landscaping can help increase the carbon storage capacity of developed land.

"No matter how complex global problems may seem, it is we ourselves who have given rise to them. They cannot be beyond our power to resolve."

—Daisaku Ikeda

FURTHER READING

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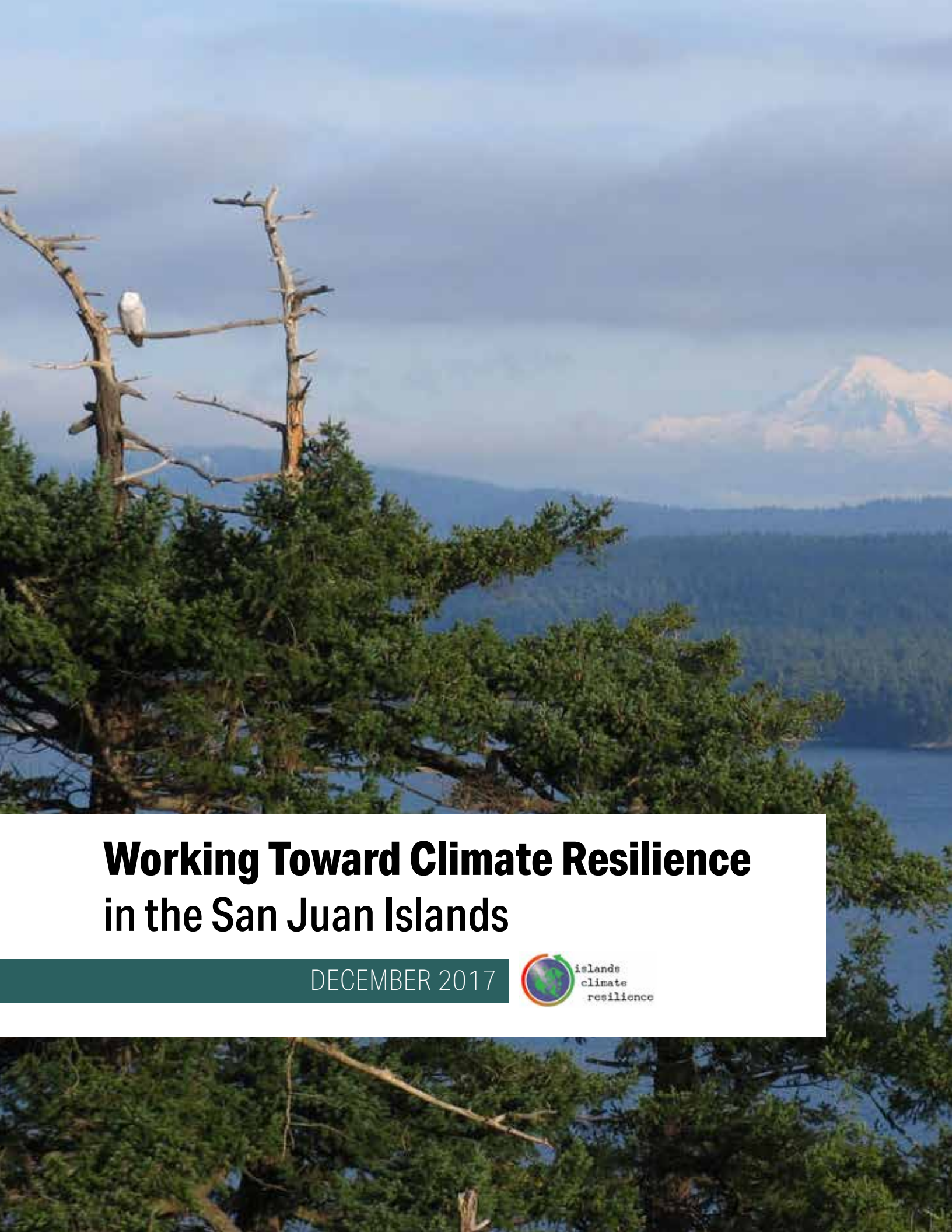

Working Toward Climate Resilience
in the San Juan Islands

DECEMBER 2017

islands climate resilience

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Introduction

This report was developed in 2016 and 2017 by the Islands Climate Resilience (ICR) group, a grassroots group formed in 2014 to encourage preparedness for climate-related impacts in the San Juan Islands. The current steering committee includes staff from the San Juan Islands Conservation District and Friends of the San Juans, as well as interested residents who are educators, artists, climate activists, and conservationists. ICR has organized several awareness-raising events in the Islands over the last few years.

This document provides an initial overview of what we know about climate change projections and potential vulnerabilities in four sectors: water, terrestrial ecosystems, energy, and agriculture. We have also included preliminary ideas about adaptation measures that could help address our climate change vulnerabilities. These ideas are intended to serve as a basis for further discussion in the Islands community.

This is intended to be a living document, not a plan. As additional resources become available, Islands Climate Resilience (as of January 1, 2018, a program of the Madrona Institute) will collaborate with others in the community to look at additional sectors—such as health and infrastructure—and pursue further analyses to better understand local vulnerabilities. We will also continue to evaluate and seek input on the potential adaptation measures, and share them with our local policymakers.

Climate Change Overview

INTRODUCTION

This chapter provides an overview of observed and projected changes in climate for the Puget Sound region. This will provide context for understanding the potential impacts on the natural and community resources in the San Juan Islands, as discussed in subsequent chapters.

Except where otherwise noted, this information comes from a recent report from the University of Washington Climate Impacts Group that incorporates a review of existing scientific literature as well as downscaled climate projections.[1]

OBSERVED CHANGES IN CLIMATE

Observed changes in the regional climate include:

- **Temperature:** Temperatures in the Puget Sound region increased by approximately 1.3 degrees Fahrenheit from 1895 to 2014. All but six years between 1980 and 2014 were warmer than the average annual temperature for the 20th century.
- **Precipitation:** Spring precipitation in the Puget Sound lowlands increased by more than 27 percent between 1895 and 2014. Otherwise, there are no significant long-term trends in seasonal precipitation and overall annual precipitation for the region. However, most studies have found increases in the frequency and intensity of heavy rainfall in Western Washington.
- **Sea level rise:** Sea level, as measured at the Friday Harbor tide gauge, rose nearly 3 inches between 1934 and 2008.
- **Water temperature:** Across the Puget Sound, marine water temperatures increased by 0.8 to 1.6 degrees Fahrenheit between 1950 and 2009.
- **Ocean acidification:** Worldwide, the oceans have absorbed about 30 percent of the carbon dioxide generated by human activities over the last 250 years.[2] A 2010 study estimated that ocean acidification had led to a decrease in pH of 0.05 to 0.15 units in Puget Sound so far.[3] The increased acidity reduces the availability of calcium carbonate, which is needed for young shellfish and larvae to form their shells.

1 Mauger, G.S., J.H. Casola, H.A. Morgan, R.L. Strauch, B. Jones, B. Curry, T.M. Busch Isaksen, L. Whitely Binder, M.B. Krosby, and A.K. Snover, 2015. State of Knowledge: Climate Change in Puget Sound. Climate Impacts Group, University of Washington, Seattle.

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3 Feely, R., Alin, S., Newton, J., Sabine, C.L., Warner, M., Krebs, C., and Maloy, C. The Combined Effects of Ocean Acidification, Mixing, and Respiration on pH and Carbonate Saturation in an Urbanized Estuary. Estuarine, Coast, and Shelf Science. 88:4, pp. 442-449.

PROJECTED CHANGES IN CLIMATE

Projected future climate changes in our region include:

- **Temperature:** In the Puget Sound region, the average year is projected to be 4.2 to 5.5 degrees Fahrenheit warmer by the 2050s than it was in the late 20th century. Heat waves are projected to intensify.
- **Precipitation:** Projections do not show major changes in annual precipitation amounts. However, summers are expected to be drier, and future occurrences of heavy rainfall, especially in the winter, are expected to be more frequent and more intense.
- **Wildfires:** Climate change is expected to increase fire activity in the Puget Sound region due to warmer air temperatures and drier conditions. Across the Pacific Northwest, the area burned is projected to double by 2040 relative to 1916–2006 levels.[4] The San Juan Islands will likely be affected by smoke even when the wildfires themselves are on the mainland.
- **Sea level rise:** Sea level rise in Friday Harbor could be at least 5 inches by 2050 and 1.5 feet by 2100.[5]
- **Shoreline erosion:** By 2100, coastal bluffs in San Juan County may erode by approximately 100 to 155 feet in areas with high exposure to wind and waves, and 75 to 115 feet in areas with less exposure (relative to 2000) under moderate and high emissions scenarios, respectively.[6]
- **Water temperature:** Coastal sea surface temperatures in the Northeast Pacific Ocean near the Puget Sound are projected to increase by 2.2 degrees Fahrenheit by the 2040s, relative to historic trends in the late 20th century.
- **Ocean acidification:** Ocean acidification will continue, with pH in global oceans projected to decline by 0.14 to 0.32 by 2100 compared to 1986 to 2005 averages.[7] Increased acidity will further harm local shellfish and related recreational and commercial fisheries. For example, San Juan Island mussels were shown to have 40 percent weaker threads to attach to surfaces when grown in water with increased acidity, which can cause mussels to fall during harvesting and decrease yields.[8]

The following chapters describe the anticipated impacts from these changes in climate on the San Juan Islands' terrestrial ecosystems, freshwater, energy, and agriculture. They identify existing practices that increase our resilience to impacts and suggest steps we can take to further prepare for the future.

4 Washington State Department of Ecology. 2012. Preparing for a Changing Climate: Washington State's Integrated Climate Response Strategy.

5 Calculated from Tables 5.3 and A.2 in National Academy of Sciences (2012) Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future, using 75% of the rise projected for Seattle (based on the comparative trends for Friday Harbor and Seattle with barometric pressure and vertical land motion adjustments incorporated).

6 MacLennan, A., J. et al., 2013. Sea Level Rise Vulnerability Assessment for San Juan County, Washington. Prepared by Coastal Geologic Services for Friends of the San Juans.

7 Intergovernmental Panel on Climate Change (IPCC). 2013. Working Group 1, Summary for Policymakers. Available at: www.climatechange2013.org/images/uploads/WGIAR5-SPM_Approved27Sep2013.pdf

8 O'Donnell, M. et al., 2013. Mussel byssus attachment weakened by ocean acidification. Nature Climate Change, 3(6): 587-590.

Water Resources

INTRODUCTION

The San Juan Islands have a single source for all of our freshwater resources: precipitation.[9] The rain that falls on each island is the only way our lakes and ponds are refreshed, and our groundwater is recharged. The Islands' water supplies are not sourced from rivers that flow from distant lands or snow melting on mainland peaks. The fresh water on each island is isolated by the surrounding seawater.

The climate in the San Juan Islands is highlighted by our glorious but dry summer seasons and our overcast winters with frequent precipitation. Our summers are very dry, as only a small portion of the total annual precipitation falls in that season. What precipitation does occur in the summer months does not contribute to recharge in any meaningful way; we depend primarily on winter rains to recharge our lakes and aquifers.

In the summertime, demand for water rises sharply due to the arrival of tourists and summer residents, as well as irrigation applications. It is common for San Juan County water systems to see summer demand be more than double the annual monthly average. Summer water use spikes in the San Juan Islands partly due to outdoor water use. Eastsound Water undertook a study of its summer residential water uses and found that the top six percent of water uses accounted for 26.5 percent of the total residential water use.[10]

Future increases in the island population are likely to lead to more competition for a finite water supply. Continued development means that increases in impervious surfaces also have the potential to reduce groundwater recharge. Water is a public resource that is critical for meeting the needs of the human population as well as wildlife.

Given the critical role that water plays in our health, our lifestyle, our economy, and our environment, effective water resource planning and management are vital to our future. These planning and management efforts will need to consider projected climate change impacts, in addition to other stresses.

9 With the exception of a limited but growing amount of water collected through desalination plants.

10 Paul Kamin report to the 2016 Eastsound Water Annual Meeting.

ANTICIPATED CLIMATE CHANGE IMPACTS ON ISLAND WATER RESOURCES

Climate changes in the Pacific Northwest are likely to impact the San Juan Islands' water resources in a number of ways. As noted in the earlier chapter on climate change projections, the best available science on climate change in the Pacific Northwest suggests that the San Juan Islands' total annual precipitation is likely to remain similar to historic levels. Seasonal distribution of rainfall may change, and more of the rain may fall in more intense events.

It is during the summer when water resource stresses will be most obvious and potentially problematic. By mid-century, summer dry seasons will likely be warmer and longer, which could exacerbate water scarcity concerns. Climate change could extend the period between the end of the late winter recharge and the start of the next recharge season. The finite water in our lakes, streams, and aquifers will have to be "stretched further." At the same time, drier summers could increase demand for water for gardens and landscaping.

Meanwhile, climate change will also mean that our winters will feature slightly milder temperatures and perhaps more heavy precipitation events, which could contribute to more runoff. Finally, sea level rise could lead to increased saltwater intrusion into our water sources.

The remainder of this section highlights the importance of two components of our water—surface water and groundwater—and the potential consequences of climate change impacts on these components.

Surface Water

Most of the Islands' larger water systems depend on surface water. According to the 2004 San Juan County Water Resources Management Plan, 40 percent of the county's population receives its drinking water from surface water systems. Of the county's nine water systems with at least 100 connections, seven utilize surface water (see *Table 1* on the following page).

SUMMER DROUGHT PREDICTIONS

During the summer drought of 2015, most water systems in the San Juan Islands saw a significant increase in water use. Eastsound's increase in June, for example, was 20 percent over the previous year.* The drought of 2015 is emblematic of what a normal summer could be in the future, and can therefore give us a sense of what to expect.

*Eastsound Water Users Association *2016 Annual Report*

Throughout the summer, the only available water resource that the Islands' largest water purveyors can access to meet their customer needs, aside from some that are turning to desalinization facilities, is that stored in their lakes. Each of the lakes is drawn down to varying degrees during the summer. Trans-evaporation can be a significant portion of the summer drawdown. Warmer summers, a longer dry season, and increased evaporation could therefore present increasing challenges to these water systems in the future. Currently, the dry season is estimated to run from mid-June through the end of September, or roughly 15 weeks. Extending this by even just two weeks would mean that available water in these lakes would have to be stretched to last 13 percent longer.

Warm summer temperature can also have a significant impact on the quality of water in lakes. Summer's longer days, increased sunlight, and warmer temperatures stimulate biologic activity. The potential for more summer algae blooms in lakes could create difficulties for existing water treatment plants. Friday Harbor's Trout Lake has had algae bloom issues in the past.

Table 1. San Juan County's nine water systems

Source: SENTRY database, WA Department of Health.

Water System	Island	Source Type	Source	Connections
Friday Harbor, Town of	San Juan	Surface water	Trout Lake	1,808
Eastsound Water Users Association	Orcas	Surface & Ground water	Purdue Lake	1,300
Rosario	Orcas	Surface water	Cascade Lake	223
Roche Harbor Water System, Inc.	San Juan	Surface water	Briggs Lake	445
Doe Bay Water Users Association	Orcas	Surface water	Mountain Lake	276
Olga Water Users, Inc.	Orcas	Surface water	Cascade Creek / Mountain Lake	130
Fisherman Bay Water Association	Lopez	Ground water		152
Orcas Highlands Association, Inc.	Orcas	Surface water	Cascade Lake	117
Cape San Juan Water District	San Juan	Ground water		143

Recently, Roche Harbor expanded their Briggs Lake reservoir. This kind of measure may be an option for helping to address climate change, but it can be challenging. The Roche Harbor project was more than 15 years in the making, requiring significant environmental review, procurement of water rights from the Department of Ecology, land acquisition for the expanded footprint of the dams, and changes to their water treatment plant. Raising Briggs Lake also triggered significant water quality issues that required water system shut downs and management adjustments.

The increased risk of wildland fires due to climate change also has the potential to adversely impact surface water reservoirs. Soils and groundcover in burned areas are less stable and more susceptible to erosion. Runoff from burned areas can adversely impact reservoir water quality. Most of San Juan County's largest water systems do not have a backup water source, relying predominantly on surface water. These systems could be adversely affected if their reservoirs were fouled by runoff choked with sediment from burned surroundings. While there are fewer lightning strikes in the San Juans compared to east of the Cascades, other factors contribute to forest fire risk in the islands, including development in hard-to-reach areas, limited water resources for fire-fighting in the summertime, campfires, and fuel buildup as a result of a long era of fire suppression.

Ground Water

San Juan County has over 5,000 groundwater wells, or one for every three people.[11] These wells are dependent on water stored in underground reservoirs called aquifers. There are multiple groundwater aquifers on each of the larger islands in the San Juan Islands. Water levels in these aquifers fluctuate seasonally, being drawn down during the summer and refilled during the winter.

11 DOE well log database.

The San Juan Islands have a very low aquifer recharge rate. Only a small portion of our precipitation actually finds its way into our aquifers (see *Table 2* below). The vast majority of precipitation instead becomes part of stormwater run-off, evaporates, or is absorbed into the soil.

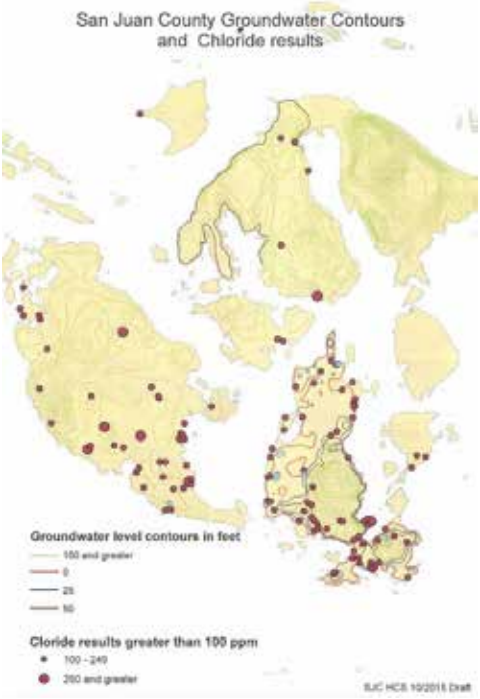
Any diversion or diminishment of groundwater recharge—whether from climate change or other factors, such as diverting stormwater, diverting water to ponds, or covering a recharge area with an impervious surface like pavement—could directly affect water availability.

Table 2. Annual recharge amounts by island, and compared to other places in the region

Source: USGS 2004.

Island	Average Annual Recharge Amount	Percent of total rainfall
Lopez	2.49 inches	9%
San Juan	1.99 inches	6%
Orcas	1.46 inches	5%
Shaw	1.44 inches	5%

The extended summer dry season projected in climate change scenarios may lead to additional stress on aquifer capacity in some parts of the Islands. Already, it is not uncommon to hear locals in the summer say, "My well has gone dry!" When that happens, water is bought and trucked in, or wells are deepened. In the new drought conservation plan for the Islands, Al Mauldin—who has been drilling wells in the San Juan Islands since the 1970s—is quoted as saying that he saw more wells deepened during the summer of 2015 than in any previous year since 1979.[12] It is likely that climate change will mean that more wells will be unable to meet the demand placed on them during the summer season.



Saltwater intrusion is also a threat to the San Juan Islands' groundwater. The introduction of saltwater contaminates groundwater and can render wells unusable. There are already multiple nearshore wells that are affected by saltwater intrusion. Fresh groundwater normally has chloride levels under 30 mg/l. The figure at right shows locations where chlorides have been found over 100 mg/l, which is considered symptomatic of a seawater intrusion potential.[13] Saltwater intrusion is

12 San Juan County Drought Conservation Plan.

13 EPA's maximum contaminant level for chlorides in potable water sources is 250 mg/l.

expected to increase as climate change brings rising sea levels. The seawater/freshwater balance can also be disturbed by over-pumping a well, which means that more water has been withdrawn than the well can sustainably produce.

Lopez Island's geology creates the highest potential for seawater intrusion. It is also more dependent on groundwater than San Juan or Orcas.

Ecosystems

Our island biodiversity, natural resources, living amenities, tourism industry, and property values rely on having healthy freshwater habitats. Freshwater habitats in the islands have already been altered through non-climate stressors like invasive species, livestock grazing, fish blockages, ditches, water appropriation, filling and grading of wetlands and streams, pollution, riparian devegetation, and increased pulses of runoff from impervious surfaces. Additional pressure from climate change stressors further affects the health of these ecosystems.

Water Conflicts

As we have seen around the world, when the demand for water begins reaching the capacity of the available resources, conflicts invariably arise. Potential sources of conflict in the San Juan Islands include conflicts between human users drawing from the same supply, and conflicts between human and non-human users drawing from the same supply. Specific examples could include:

- Over-withdrawals that impair water availability. This could include over-withdrawal by one exempt well owner that impairs the production of a neighboring well, or over-withdrawal from a shoreline water system that leads to seawater intrusion and contamination of an entire aquifer.
- A senior water right holder seeking shut-off of a junior water right holder to protect their "First in Time, First in Right" status.
- Conflicts resulting from existing over-allocation of water resources: the amount available is far less than what has already been officially allocated.[14]
- Tradeoffs between human use and natural resource needs, such as drawing water from watersheds (e.g., False Bay Creek) that need it to support fish.
- One of the consequences of increased conflict is increased litigation, which in turn can divert resources and time from County, state, federal, and land managers.

In Washington, there are longstanding water laws that exist to address these types of conflicts. Unfortunately, these laws can promote excessive water use by those who want to protect their water allocations, and they do not attempt to allocate water equitably among all users based on demonstrated need. The most successful outcomes in

14 The 2004 San Juan County Water Resource Management Plan indicates that as of about 2002, the state had legally allocated approximately 580-870% of the available water for withdrawal. Fortunately, many users do not currently use the full amount that they have been allocated, and septic systems may return some water to the aquifer. Still, the over-allocation may become more of a problem—particularly in the densely developed areas—when water supplies diminish further.

situations of limited resource availability are created when the issues are approached proactively in ways that strive to understand and respect all parties' needs.

POTENTIAL ECONOMIC IMPACTS

The local population increases substantially in the dry, summer season, with the arrival of tourists and part-time seasonal residents who own second homes in the islands. The County has estimated that on any given summer date, there are as many summer residents, vacation home visitors, and hotel guests on the island as there are year-round residents.[15] Any future water shortage could limit the capacity of our hospitality industry to meet the needs of visitors, challenge their operations due to additional water use restrictions, or increase their costs and potentially oblige them to raise prices for their customers. Limits to the availability of fresh water would, at best, lead to increased costs, and, at worst, insufficient supply to meet demand. This in turn could possibly have a dampening effect on the local economy.[16]

In addition to the water needed by hotels, vacation rentals, and guest houses during the tourist and summer resident season—which peaks in the driest months—changes in water availability can have other impacts on the islands' economy. Water uses at risk include:

- **Development**: Proven water supply necessary for building permits for planned real estate/subdivision development.
- **Events**: Catering for events (e.g., weddings) where large amounts of water are required to comply with state regulations.
- **Gardening, farming, and livestock:** Increased home garden and commercial agriculture irrigation and livestock watering needs due to drier, hotter summers.

EXISTING EFFORTS

There are a number of existing plans and ongoing programs and projects that directly or indirectly help to build climate resilience in the water sector. These include the following:

- The **San Juan County Water Resource Management Committee (WRMC)** serves as the designated planning unit for watershed planning under the Watershed Management Act of 1998. The WRMC has worked with the County to produce reports on local groundwater monitoring, desalination systems, water supply recommendations, and surface water storage, among others.

- **San Juan County Health and Community Services** is the lead agency for water resource planning in San Juan County and works in partnership with the WRMC and its subcommittees.

- The San Juan Islands Conservation District has developed a **drought conservation plan** in collaboration with San Juan County's Water Resource Management Committee and the Islands Climate

15 San Juan Scenic Byway Corridor Management Plan. https://www.visitsanjuans.com/sites/default/files/uploads/sb/section-5.pdf

16 In 2014, leisure and hospitality accounted for 25.8% of San Juan County jobs: https://fortress.wa.gov/esd/employmentdata/reports-publications/regional-reports/county-profiles/san-juan-county-profile

Resilience (ICR) Water Resiliency Work Group. This plan provides an overview of water management within the county, resource conditions and concerns, and conservation, mitigation, and adaptation strategies to address seasonal drought. Funding for the initial draft of the plan was provided by the Washington State Conservation Commission and the Natural Resources Conservation Service, and planning coincided with the ICR Water Resiliency Work Group process.

- Some places in the islands have **tiered water rate structures** that charge more for incrementally greater water use in order to encourage conservation. Eastsound has some of the highest surplus water rates in the state and among the County's lowest per person water use, due in part to implementing a tiered water rate system.[17] Friday Harbor also has tiered charges for single family residential water users.[18] In the summertime, Friday Harbor promotes conservation with a surcharge for multi-family residences and commercial water users.[19] In particularly dry years, if the town council passes a resolution determining that a moderate, severe, or critical drought is occurring, rates are increased further for water used beyond a certain threshold, and those users are notified by letter of their excessive use.[20]

- The County's GIS department has assisted with multiple **water resource studies**, such as mapping water rights and water system boundaries. The department has also helped to map precipitation runoff to better track stream flow.

- The County has installed **groundwater monitoring networks** on Lopez and in Eastsound, the two most sensitive groundwater aquifers in the county.

- The SJICD offers a variety of **resources to assist landowners to offset costs to implement Best Management Practices** for water conservation and drought mitigation.[21]

- **Federal agencies** (e.g., the U.S. Department of Agriculture) and **state agencies** (e.g., the Washington State Department of Agriculture, the Department of Natural Resources, the Department of Ecology, and the Office of the Washington State Climatologist) provide assistance programs, climate data, seasonal forecasts, and information to help communities cope with drought.

- There are **financial assistance programs for agricultural producers** that want to implement conservation practices; these include the Agricultural Management Assistance Program, the Environmental Quality Incentives Program, and the Conservation Stewardship Program, among others.

17 Presentation at the 2016 Eastsound Water Annual Meeting, https://eastsoundwater.org/wp-content/uploads/2016/11/2016-Annual-Meeting-Facilities-Report.pdf. EWUA tiered rate structure, https://eastsoundwater.org/wp-content/uploads/2016/08/2016-ewua-RATES.pdf.

18 Single family residential water users are charged $7.20 per 1,000 gallons for the first 3,500 gallons per month; $9.00 per 1,000 gallons for the next 3,500 gallons, $11.95 per 1,000 gallons for the next 3,500 gallons, and $14.35 per 1,000 gallons for anything above 10,500 gallons in a month (on top of the base charge) (Friday Harbor Municipal Code Chapter 13.05). The fourth tier was added in 1999, and the revenue from this tier helps fund the local water conservation program (Friday Harbor Water System Plan Update, June 2013).

19 In 1996, the rate structure was updated so that multi-family residences and commercial water users can be subject to rate increases during 'summer,' defined as June through September. In 2000, for example, that meant an increase from $3.80 to $4.75 per 1,000 gallons. (Friday Harbor Water System Plan Update, June 2013)

20 Friday Harbor Municipal Code, 13.05.060 Drought water rates.

21 San Juan County Drought Plan.

ADAPTATION MEASURES

A Water Resiliency Work Group was organized following an ICR-sponsored panel of local water resource experts discussing The Future of Water Resources in the San Juan Islands. Following the presentation to the community, ICR extended an invitation to interested community members and water resource experts to participate in a work group to develop a water resiliency plan as part of a larger San Juan Islands Community Climate Resiliency Action Plan. Information about the resulting work group membership, structure, and goals can be found in Appendix 1.

The ICR Water Resiliency Work Group met throughout 2016 to discuss needs and adaptation measures. The following measures were identified by the work group and are presented here in unranked order.

Wells

- **Meter all new wells and encourage voluntary metering of old wells.** San Juan County Code requires meters on all new sources. Ideally, all water sources would be metered, and the metering data would be collected and available for research. New technologies are making this cost-effective and less intrusive. All meters should be read and data recorded on a regular basis. In addition to providing information that can inform responses to climate change, water metering data is necessary for protecting individual water sources from potential impairment.
- **Implement smart water metering in priority areas.** San Juan County could implement an "incentivized" smart metering system for private well owners and Group B systems. New technology is available to allow a property owner to monitor the water use from their well online and receive leak detection alerts electronically. Smart meters can also report water use to a central database.
- **Encourage all well owners to do depth-to-water measurements of their wells at least twice yearly**. The County might consider this as a fee-for-service, benefiting by acquiring the data in the process. Depth-to-water measurement is particularly important for shoreline wells.

Water Systems

- **Design water system rates to further encourage conservation.** Tiered water rate structures that charge more for incrementally greater water use have been proven to decrease water use by the highest uses. Water systems in the county can continue to update their rates to incentivize more water conservation.
- **Require that water systems be operated by certified water system operators.** Currently San Juan County requires new water systems to hire a certified "water system operator or water system management agency" as part of the permitting/approval process. Unfortunately, there is no requirement that the water system continue to employ an operator or manager after it is approved, or to continue to properly manage the water system after it is approved. The majority of County-regulated water systems are not run by certified operators. Certified operators—or County-trained neighborhood operators—would improve water system efficiency, water system reporting and compliance, and public health.

Efficient Use

- **Educate homeowners and gardeners on efficient outdoor water use.** Water systems, the Conservation District, and other public agencies could develop and distribute educational materials on efficient outdoor water use. Trainings could also help homeowners be more judicious water users.
- **Work with agricultural producers, Master Gardeners/ landscapers, and the Agriculture Guild to promote the efficient use of water.** Encourage drip irrigation, mulching, native plants, xeriscaping, and other low-intensity water use practices for landscaping and gardens. On farms, improve rates of water infiltration into soil by planting high residue crops (e.g., corn, small grains, cover crops), using reduced tillage methods, and applying animal manure. Ensure that irrigation pipes do not have leaks, and optimize the timing and amount of irrigation water based on crop needs.
- **Promote indoor water conservation practices at residences, businesses, and public buildings.** These include installing low-flow toilets and showerheads, fixing leaky faucets, and washing full loads of laundry.
- **Conduct a visitor campaign.** Educate summer visitors and residents about the challenges facing the Islands' water resources, and the actions they can take to help.
- **Encourage on-site greywater reuse.** Greywater, the water from tubs, sinks, and washing machines, can be used to water trees and gardens, saving potable water for drinking and cooking. Greywater reuse is regulated in Washington State. In San Juan County, which uses the regulations adopted in 2007, fruit trees or bushes may be irrigated by a septic drain field. Laundry water can be used for garden irrigation, but a tank, filter, and permit from the local health officer are required. More recent greywater regulations have been adopted in Washington State, but they have not yet been adopted in San Juan County.
- **Encourage Washington State to draft ways to permit and ensure the safe operation of Reclaimed Water Reuse systems.** Our Urban Growth Areas each have well-run sewer systems, which effectively treat and then discharge almost 250,000 gallons of water per day into the Sound. The technology exists for a water treatment plant to take the discharge of our sewer systems, remove all contaminants, including pharmaceutical residuals, and reintroduce the water back into our aquifers or the potable water distribution system. Reclaimed water reuse is being successfully done around the world, with much lower energy demands than desalination. Washington State's Department of Health has not yet developed the regulations to permit and monitor such a system.

- **Incentivize water use efficiency by publishing relevant data and developing standards for Group B systems.** Many systems waste water. The state's Water Use Efficiency Rule applies only to larger Group A water systems managed by the state. San Juan County should explore developing "water use efficiency standards" for the 250 Group B (3-14 connections) that it regulates. We can also incentivize testing for and repairing leaks in individual residential water systems.
- **Encourage an examination by the Washington State Department of Health** of rules that currently allow—or lead to—wasteful water practices in the restaurant and hospitality industries (including homeowners doing Airbnb and vacation rentals). Advocate for regulatory changes that push these industries to be more water efficient.

Ecosystems

- **Protect and restore freshwater habitats.** We need to increase protection and restoration efforts.

Research and monitoring

- **Provide funding to maintain and expand the County's groundwater monitoring capacity.** The groundwater monitoring networks on Lopez and in Eastsound require continued attention to remain functional. The data from these networks also requires regular analysis to detect trends and provide early warning signs of over-withdrawal or changing conditions. Meanwhile, there are no data loggers recording groundwater levels on San Juan Island.
- **Increase the capacity of the existing County GIS department.** GIS (Geospatial Information Systems) is a vital data management tool, and the County's GIS department has done multiple water resource studies. Maintaining and strengthening the capacity of this department is important to the County's ability to identify and monitor water resource challenges.
- **Conduct additional research on local sea level rise projections.** Sea level rise presents a significant threat to our groundwater resources. In the Puget Sound area, rising seas may be partially moderated by our rising land mass.
- **Collect additional data on agricultural water use.** There are very limited data on how much water the agricultural producers in the Islands use, but it could be an important part of the water resource protection puzzle.[22] The County Council could task the Agriculture Resource Committee to undertake a more extensive study of water use associated with our local agricultural industry. Key questions could include: 1) Where, when and how is water a limiting factor for agricultural production in the islands? 2) What does the future of agricultural production look like in the islands? 3) Will water shortages change the crops that can be grown in the islands?
- **Conduct surveys or studies** to better understand current water usage patterns and amounts for landscaping and home gardens in the Islands.

22 The 2012 USDA Census of Agriculture reported that San Juan County had 343 acres of irrigated land, a decrease from 393 acres in 2007.

Terrestrial Ecosystems

INTRODUCTION

The geological and anthropological history of the San Juan Islands has shaped the ecosystems that we see today. The Islands' unique position—in close proximity to mountains and with exposure to the Strait of Juan de Fuca—has helped create a range of habitats that are home to a variety of species. Relatively dry forests, dominated by Douglas fir trees offering perches for bald eagles, great horned owls, and over 200 other species of birds, are interspersed with prairies and agricultural fields. Small and seasonal freshwater streams offer habitat for salmon and connect the land to the sea, pouring out into tidal wetlands, mudflats, and eelgrass beds. These dynamic and highly productive estuarine habitats in turn support shellfish and forage fish populations. The San Juan Islands' nearshore environment eventually gives way to marine waters, where orca whales and other marine mammals and invertebrates can be found.

The ecosystems of the San Juan Islands not only support animal and plant populations; they are also the foundation of many of our livelihoods. Tourists come from all over the world to hike through our forests, kayak along our shorelines, fish in our lakes and rivers, and view our wildlife. The Islands are home to numerous local, state, and national protected areas, including the San Juan Island National Historical Park and the San Juan Islands National Monument, which attract visitors and help ensure that our local ecosystems are protected.

Our island ecosystems are already facing challenges due to environmental changes. Saltwater intrusion is placing stress on our freshwater and nearshore ecosystems. Eelgrass beds have dramatically declined for reasons not well understood.

Human modifications to the landscape also place stress on our ecosystems. Connectivity among forest and prairie habitats is threatened by development. Impervious surfaces and agricultural fertilizers increase pollution runoff into waterways. As more people travel to the San Juan Islands to live or visit in the coming years, these challenges are expected to intensify.

Native American populations traditionally practiced fire management systems that were effective in creating habitat and reducing fire risk. The removal of fire as part of the ecosystem has therefore also dramatically

altered the landscape. Non-native plants and animals also put native populations at a disadvantage, especially seabirds. And while we do not know exactly what role predators played in the past, their removal and subsequent change in behavior and population density of deer and other mammals has altered the habitat structure with impacts on the density and diversity of songbirds, plants, and invertebrates.

Considering that our ecosystems are critical to the San Juan Islands economy and way of life, it is the responsibility of our residents, businesses, and local government leaders to support and protect ecosystem health so our community can thrive. As we manage our ecosystems, it will be vital to address climate change impacts as well as other stressors to ensure long-term resilience.

ANTICIPATED CLIMATE CHANGE IMPACTS ON ISLAND TERRESTRIAL HABITATS

The terrestrial ecosystems of the San Juan Islands are likely to experience myriad impacts from climate change. As noted in other chapters, the best available science indicates that the San Juan Islands' total annual precipitation is likely to remain similar to historic levels. However, the seasonal distribution of rainfall may change, and the summer dry season will likely be warmer and longer in duration by mid-century. Island ecosystems and the plants and animals inhabiting them will be stressed during these dry seasons.

The following sections summarize the importance of several terrestrial ecosystems and the potential consequences of climate change impacts on these ecosystems.

Coastal Wetlands and Flats

Changes in climate pose several threats to wetlands in the San Juan Islands, which have already undergone significant conversion since the mid-1800s through diking and draining.[23] Changes in the timing and amount of precipitation may significantly affect wetland habitats by altering the hydrologic regime. Faster rates of evaporation and slower recharge may lead to the drying out of wetlands, potentially converting habitat into other types.[24] More frequent heavy rainfall events during the winter have potentially positive impacts by creating side channels or expanding habitat, but there are also potentially negative impacts including increased erosion and fewer opportunities for water storage, depending on the capacity of coastal wetlands to manage higher volumes of water. Any of these changes could impact the vegetation composition and available habitat for aquatic species.

23 U.S. Fish and Wildlife Service, Protection Island and San Juan Islands NWRs, Comprehensive Conservation Plan, 2011. https://www.fws.gov/pacific/planning/main/docs/WA/docsprotectionIs.htm. Accessed 9/12/17.

24 Washington Department of Fish and Wildlife, Washington's State Wildlife Action Plan, 2015 Update, 2015. http://wdfw.wa.gov/publications/01742/wdfw01742.pdf. Accessed 9/12/17.

Sea level rise and saltwater intrusion could also impact wetland habitats, possibly leading to changes in vegetation composition and a greater likelihood of eutrophication (excess concentration of nutrients) in intertidal freshwater wetlands.[25] In the case of tidal salt and brackish marshes and flats, sea level rise may result in submergence of these habitats and loss of vegetation in the absence of sufficient sediment accumulation to encourage migration inwards. Meanwhile, ocean acidification could stimulate algal growth, thus altering the chemical balance and vegetative composition of nearshore ecosystems.[26] These altered marine conditions will affect the growth and survival of shellfish.

Changes in precipitation patterns could also impact tidal salt and brackish marshes by affecting salinity levels, with decreasing rainfall during the summer supporting higher salinity levels, potentially altering vegetation composition.[27] Meanwhile, more intense rain events in the winter could increase runoff and lead to higher levels of nutrients and contaminants, threatening the health of vegetation and aquatic biota. This threat is exacerbated by the enclosed nature of many inlets and bays of the San Juan Islands, such as Westcott and Garrison Bays, which limits the flushing of sediment and nutrients.[28]

Moist Forests and Shrub Swamps

Reduced summertime precipitation will lead to declines in summer stream flow. Especially during drought, lower stream flow decreases the water available to riparian vegetation, with potential impacts on growth and survival.[29] As habitats become less suitable to moisture-dependent vegetation, the species composition may shift toward more drought-tolerant species. Lower summertime stream flow will likely lead to a decline in vernal pools and may lead to warmer temperatures in those that are created, negatively affecting salmonid habitat.[30]

Meanwhile, stream flow may increase during the winter as more rain falls during more intense events. These events will test the capacity of stream systems and riparian areas to manage higher flows. Juvenile salmonids in these streams will have to seek refuge in side channels and other protective habitat during these events.

Changes in seasonal distribution of rainfall, specifically with more frequent and heavier winter events and possibly flooding in some places, may also affect vegetation in precipitation-

25 Ibid.

26 Port Gamble S'Klallam Tribe Natural Resources Department, Climate Change Impact Assessment, In collaboration with Cascadia Consulting Group and the University of Washington Climate Impacts Group, 2016.

27 Ibid.

28 National Park Service, San Juan Island National Historical Park, Environmental Factors. https://www.nps.gov/sajh/learn/nature/environmentalfactors.htm. Accessed 9/12/17.

29 Washington Department of Fish and Wildlife, Washington's State Wildlife Action Plan, 2015 Update, 2015.

30 Whitely Binder, L., H. Morgan, and D. Siemann, Preparing for Washington State Parks for Climate Impacts: A Climate Change Vulnerability Assessment for Washington State Parks, 2017. https://cig.uw.edu/wp-content/uploads/sites/2/2014/11/WA-Parks-Vulnerability-Assessment.pdf. Accessed 9/12/17.

sensitive habitats. Vegetation types that are better adapted to the altered precipitation regime, such as hardwoods, smaller trees, and younger age classes, may become more common.[31] In addition to composition, vegetation establishment and succession may also be altered by the more frequent flood events.

At the same time, some of the areas that were cleared, ditched, and drained in the past to support agricultural activities are changing again as habitat restoration efforts revert some of these sites back to wetlands. As woody vegetation returns, it can hold water on the landscape later in the season. Some flooding events in those sites may therefore be reflective of historical patterns. Climate variability will also continue to play a role in our weather, with some particularly wet years and some particularly dry years. In other words, attribution of specific flooding events to climate change will be challenging.

Dunes, Coastal Bluffs, and Beaches

Rising sea levels and more intense storm events with increased wave action and coastal erosion represent the greatest climate-related stressors to sand dune and coastal bluff habitats. Coastal bluffs are expected to be particularly sensitive to sea level rise. One study projects that coastal bluffs in San Juan County could recede by 75 to 100 feet by 2100 (relative to 2000) as a result of sea level rise.[32] Dunes may also shift landward, with implications for habitat conversion.

Sediment from coastal erosion of bluffs may reinforce beaches and other coastal areas, providing important nearshore habitat, but excess sediment could fragment or bury certain habitat types, such as eelgrass beds.[33] Shoreline armoring and other modifications are common in the San Juan Islands, and although these practices are undertaken in an effort to protect properties and infrastructure, they undermine the ecological functioning of coastal ecosystems[34] and may in fact exacerbate erosion on the margins and on adjacent properties.

Coastal disturbances from erosion and waves may also lead to a decline in sand dunes' stabilizing and protective vegetation, making dunes even more vulnerable to disturbances from erosion, wave action, and wind.[35]

31 Washington Department of Fish and Wildlife, Washington's State Wildlife Action Plan, 2015 Update, 2015.

32 A. J. MacLennan, J. F. Waggoner, J. W. Johannessen and S. A. Williams, "Sea Level Rise Vulnerability Assessment for San Juan County, Washington," Prepared by Coastal Geologic Services for Friends of the San Juans, 2013.

33 J. Czuba, C. Magirl, C. Czuba, E. Grossman, C. Curran, A. Gendaszek and R. Dinicola, "Sediment Load from Major Rivers into Puget Sound and its Adjacent Waters," U.S. Geological Survey, 2011.

34 U.S. Fish and Wildlife Service, Protection Island and San Juan Islands NWRs, Comprehensive Conservation Plan, 2011. https://www.fws.gov/pacific/planning/main/docs/WA/docsprotectionIs.htm. Accessed 9/12/17.

35 Washington Department of Fish and Wildlife, Washington's State Wildlife Action Plan, 2015 Update, 2015.

Upland Grasslands and Meadows

Projected increases in summer temperatures and occurrence of drought due to climate change are not likely to negatively impact upland grasslands and meadows, and could in fact benefit these habitats as they are already well-adapted to warm, dry conditions and periodic drought.[36]

Drought may exacerbate fire risk in grasslands, and possibly increase the frequency or severity of fire. These changes could inhibit the regeneration of native species and support non-native and invasive species growth. However, increased fire occurrence could also be beneficial to grasslands by removing conifers and shrubs. In the absence of fire or other removal mechanisms, warmer temperatures will support conifer encroachment into grasslands.[37]

Dry Forests and Woodlands

Changes in climate such as increasing temperatures and declining precipitation during the summer will stress trees and vegetation in dry forest ecosystems on the San Juan Islands, making them more vulnerable to disturbance events.[38] Under these conditions, insect outbreaks and disease are more likely to affect trees.[39]

The San Juan Islands have a number of wildfire responses each year, and for many years the local fire department has successfully contained these fires. Climate change, however, will increase the risk. Increasing drought, for example, may increase the frequency and severity of fire, which represents one of the most significant climate stressors to dry forests and woodlands in Washington, although it may be less of a risk in the Islands given their physical separation from forests on the mainland.[40] Fire suppression practices have altered the structure and composition of forests, including the growth of more shade- and fire-tolerant species, and can exacerbate the threat of fire. Land use practices—particularly logging and/or clearing land for agricultural purposes—also plays a role. The forest structure has become homogenous—in terms of age, size, and species of trees—and overstocked, increasing its vulnerability to fire and disease.

Disturbances present opportunities for non-native and invasive species to become established, potentially compromising the integrity of forest habitats. That said, disturbances also open the possibility for the development of mixed-age stands and restoration activities that can increase the diversity and resilience of habitats.

36 Ibid.

37 Ibid.

38 Whitely Binder, L., H. Morgan, and D. Siemann, Preparing for Washington State Parks for Climate Impacts: A Climate Change Vulnerability Assessment for Washington State Parks, 2017.

39 Washington Department of Fish and Wildlife, Washington's State Wildlife Action Plan, 2015 Update, 2015.

40 Ibid.

ANTICIPATED CLIMATE CHANGE IMPACTS ON SPECIES

Climate change impacts on the terrestrial ecosystems and habitats of the San Juan Islands bear significant implications for their flora and fauna. Many species hold economic and cultural value for the San Juan Islands community, underscoring the importance of considering how they may be affected by climate change. The specific impacts on habitats and species will depend on their particular vulnerabilities to climate changes, but generally speaking will likely include shifts in habitat extent and quality with potential for an overall decline in availability of key habitats in the San Juans.[41] Species composition and distribution is likely to shift as well, and species may exhibit altered phenology and behavior.[42] Potential impacts on specific species are identified below.

- Many **salmonids**—including coho, chinook, and steelhead trout—are rated as being moderately to highly vulnerable to climate change impacts with a high degree of confidence.[43] Although there are not many fish-bearing streams in the San Juan Islands, the Islands still provide critical habitat for these populations. The nearshore environment of the San Juans is very important for juvenile salmonids from around the region, in particular for foraging outflow from wetlands. Salmonids are likely to experience reduced summer rearing habitat due to lower water flows and fewer vernal pools, as well as increased temperatures. Meanwhile, higher winter flows from more heavy precipitation events could pose challenges to overwintering habitat. These changes could alter salmonids' behavior as well as their growth, reproductive success, and health.

- Island biogeography has led to fewer **terrestrial animal species** in the San Juan Islands than on the mainland. These species—including the Columbia blacktail deer, bats, and reptiles—will experience challenges related to climate change.[44] Higher temperatures may stress the animals, as will less summer precipitation that could limit water and food resources, ultimately making species more susceptible to disease. Warmer temperatures will support over-winter survival of insects, increasing the likelihood of outbreaks. In turn, these different impacts could alter animal behavior, reproduction, and survival.

- **Amphibians** that rely on aquatic habitats on the San Juans will face pressure from warmer temperatures and less precipitation during the summer, potentially affecting behavior, growth, and survival. The Islands host species like long-toed salamanders, rough-skinned newts, and Northwestern salamanders, though some are found only in a few places.

41 Ibid.

42 Ibid.

43 Ibid.

44 National Park Service, San Juan Island National Historical Park, Environmental Factors. https://www.nps.gov/sajh/learn/nature/environmentalfactors.htm. Accessed 9/12/17.

- **Trees**, including Douglas fir, Western hemlock, Western red cedar, Grand fir, and Madrone, will likely be stressed by less summer precipitation. Species that grow in the drier areas of the San Juan Islands along ridge tops and on south- and west-facing slopes will be particularly vulnerable.[45, 46] Drier conditions may cause trees to be more susceptible to disease and insect outbreaks, which may be more likely to occur as warmer temperatures during the winter could support greater insect survival. Although wildfire is less common in Western Washington than Eastern Washington, it could pose a risk to forest resources if drought occurs. Tree phenology is likely to shift with changes in seasonal distribution of precipitation and increasing temperatures.[47] The extent of suitable habitat may increase for some species, while for others it may be reduced.

- There are over 200 species of **birds** in the San Juan Islands that utilize forests, wetlands, and nearshore habitats.[48] In particular, the tidal wetlands, mudflats, and eelgrass beds that support forage fish populations are key resources for food, which will likely be stressed from warmer temperatures. At the same time, many shorebird species rely on nearshore rocky shoals for critical nesting habitat, and these areas may be threatened by sea level rise.

- **Forage fish** species, such as Pacific herring and surf smelt, depend on rearing habitat in the eelgrass beds and tidal wetlands around the San Juans.[49] These habitats may experience declines in quality and extent due to increased coastal erosion, runoff, and sea level rise. Declines in dissolved oxygen content and warmer temperatures may also limit the area of suitable habitat and could alter forage fish behavior.[50]

- Wild and cultivated **shellfish** in the nearshore environments around San Juan Islands will face significant pressure from ocean acidification, which will inhibit their growth.[51] Increased runoff from more intense winter precipitation, coastal erosion, and warmer temperatures will decrease water quality, affecting growth and survival. These stressors may cause shellfish to be more sensitive to pollutants and contaminants.[52] At the same time, sea level rise will shift and possibly reduce

45 U.S. Fish and Wildlife Service, Protection Island and San Juan Islands NWRs, Comprehensive Conservation Plan, 2011.

46 San Juan Islands Conservation District, Ecosystems, 2016. https://www.sanjuanislandscd.org/ecosystems/. Accessed 9/12/17.

47 Washington Department of Fish and Wildlife, Washington's State Wildlife Action Plan, 2015 Update, 2015.

48 National Park Service, San Juan Island National Historical Park, Environmental Factors.

49 Ibid.

50 Port Gamble S'Klallam Tribe Natural Resources Department, Climate Change Impact Assessment, In collaboration with Cascadia Consulting Group and the University of Washington Climate Impacts Group, 2016.

51 Ibid.

52 Washington Department of Fish and Wildlife, Washington's State Wildlife Action Plan, 2015 Update, 2015.

the extent of suitable habitat, thus limiting populations. Other key crustaceans like krill and amphipods are also being adversely affected by ocean acidification, which will in turn threaten other marine species that depend on them as a food resource.

- **Orca whales**, **Dall's porpoises**, **Pacific Harbor seals**, and other **marine mammals** living in the waters surrounding the San Juan Islands will also be affected by the impacts on terrestrial and nearshore island ecosystems. Pressures on salmonids and other fish that provide direct or indirect food sources may place stress on local populations, potentially forcing marine mammals to travel away from the San Juans in search of food.[53] Water quality impacts from more coastal erosion and increased runoff from heavier winter precipitation is likely to affect habitat quality, food supply, and mammals' health.[54]

EXISTING PROGRAMS, PROJECTS, AND PLANS

The Terrestrial Managers Group contributed to a high-level climate impacts risk analysis in spring 2017, including a pre-meeting survey and an in-person dialogue (see Appendix 5). Based on survey results and the meeting discussion, it appears there are numerous existing programs being implemented by terrestrial managers in the San Juan Islands that directly or indirectly contribute to building climate resilience in terrestrial ecosystems. As the following list indicates, current programs most commonly address risks of invasive species and wildfires. Although there appear to be fewer existing efforts that address other climate impacts, the list is not representative of all efforts currently taking place in the San Juans. For instance, climate change in general has been mentioned in some of the more recent management plans, such as the Land Bank's Limekiln/Deadman Bay/Westside plan currently in progress.

Therefore, this list is a sample of the existing efforts to address climate change impacts. Many of the listed actions are also fairly limited in terms of geographic scope across the archipelago, and there is room for scaling many of them up.

- Existing **invasive species** populations are being addressed through manual eradication and ongoing

53 U.S. Fish and Wildlife Service, Protection Island and San Juan Islands NWRs, Comprehensive Conservation Plan, 2011.

54 Ibid.

monitoring. Preventative steps being taken include monitoring, collection and propagation of native seed, protection of native-dominated landscapes, and education and outreach.

- Mitigation efforts for **wildfire risk** currently include some management plans and practices to measure and reduce fuel loads, such as through controlled/prescribed burns and planned thinning.
- **Sea level rise and saltwater intrusion** are being addressed through shoreline enhancement projects to allow beach migration, incorporating sea level rise projections into estuary restoration practices, and conducting outreach to landowners and managers.
- Efforts to adapt to **precipitation changes** include residential and commercial water catchment systems to utilize rainwater, preservation of forests, land protection, and riparian vegetation enhancements.
- Measures being taken to prepare for **warmer air temperatures** include improved insulation of buildings and preservation of forests.
- **Warmer stream temperatures** are currently addressed through projects to re-plant riparian vegetation as well as fencing to protect riparian zones from being trampled by animals.
- Efforts to prepare for **changes in phenology** include ongoing monitoring and adaptive planning and management, including allowing for changing priorities.

ADAPTATION MEASURES

The following suggested adaptation measures were developed by the Islands Climate Resilience group and members of the Terrestrial Managers Group. The measures are presented here in unranked order, but grouped into three categories: on-the-ground implementation, information and planning, and coordination.

These ideas are intended to serve as a basis for further discussion in the Islands community. As additional resources become available, Islands Climate Resilience will collaborate with others to pursue further analyses to better understand local vulnerabilities and refine these adaptation strategies. Policymakers will need more concrete recommendations to address the anticipated impacts of climate change.

On-the-Ground Implementation

- **Provide avenues for species migration** to build resilience. Seek out opportunities to provide connectivity between conservation areas and to conserve vertical and horizontal (slope aspect) gradients to support migration of plant and animal species over time. Consider assisted migration activities in terms of resource costs and benefits.
- **Identify and protect refugia** for vulnerable species and life-cycle stages. Wet forests and perennial wetlands are especially important. For shore birds, increase protections of rocks and islets that will remain above projected sea level rise for shore bird nesting, roosting, and rearing. Look for opportunities to acquire and protect shore areas from human and predator (e.g., cats, rats) disturbance on more populated islands.

- **Increase efforts to prevent and control invasive species.** There should be a focus on controlling new occurrences and on species with a high capacity to alter or destroy habitat.
- **Adapt management to a new fire regime.** Plan for the increased likelihood of wildfire through management strategies, such as the use of prescribed fires, which can reduce the likelihood of catastrophic fire and provide benefit to ecosystems that evolved with naturally occurring fire.
- **Support habitat diversity** for natural adaptation. Adjust management strategies to keep forests and other habitats as diversified as possible to allow for natural adaptation.
- **Consider climate impacts during restoration activities.** Examples include the use of natural shading to provide conservation of moisture in dry sites and the planting of trees alongside streams to reduce runoff and retain fresh water resources.
- **Enhance water supply.** Pursue opportunities for water catchment and retaining fresh water on the landscape, including wetland restoration.

Information and Planning

- **Consider climate change impacts in planning and management**, such as integrating adaptation actions into the Shoreline Management Plan and emergency management plans. For infrastructure in particular, early planning for impacts of sea level rise and accompanying erosion is needed when constructing, repairing, and maintaining roads, docks, trails, campsites, and other infrastructure. Planners should consider migrating recreational and transportation facilities from areas that are most at risk. These steps will reduce ecological impacts and improve safety.
- **Limit human impacts on ecosystems and habitats** through management efforts. In particular, conduct a visitor use study to manage increasing visitors to the San Juan Islands in the future.
- **Pursue opportunities to support research on:**
    - **Ecosystems, habitats, and species.** The terrestrial ecosystems of the San Juan Islands have many unique characteristics that remain understudied and less understood. The next step toward adaptation and resilience planning is to more robustly describe existing ecosystems and habitats and their overall conditions. These efforts should occur across jurisdictions to create a shared foundation and language from which to plan at an ecosystem level, and could occur in a variety of ways, ranging from targeted efforts led by professional ecologist(s) to larger scale surveys coordinated between jurisdictions and Islands.
    - **Vulnerabilities to climate change impacts.** The San Juan Islands have unique characteristics—including geology, geography, soils, climate, and weather—which make existing climate change vulnerability studies, such as the State Wildlife Action Plan, less relevant to the Islands' specific resources and species. Research should examine climate change impacts as they specifically relate to the Islands' characteristics to account for the distinct implications for local ecosystems. In particular, there is a need for more accurate modeling of general and seasonally dependent fire risk, as the current understanding is based on averaging climate readings from locations outside of the Islands.

- **Conduct consistent monitoring of habitats and species**—in particular, inventory types, percentages, and locations of habitat. There is also a need for mapping existing invasive species, new occurrences, and monitoring change over time.
- **Produce land cover maps and accompanying data to prioritize conservation.** In addition to fundamental research on ecosystem and climate change impacts, a key step toward resilience planning is producing a land cover map and accompanying data for the San Juan Islands using the most appropriate scale for use in planning and management efforts. Mapping efforts should take into consideration soil types, existing land cover, and historic land cover, to the extent feasible. Use mapping and monitoring data to inform conservation priorities, aiming for representation of each eco-type and protection of places with high cultural and economic value.
- **Explore alternative adaptation strategies.** These may include, but are not limited to:
    - **Assisted migration.** In anticipation of shifts in distribution and declining populations of existing species, consider enhancement or replacement by introducing plant and animal species to support establishment of future populations.
    - **Biodiversity.** Consider the costs and benefits of selecting seeds or specimens from outside the San Juan Islands region, particularly from areas with a warmer climate, to use for restoration purposes to provide greater resilience in the face of climate change impacts.
    - **Biochar.** Explore opportunities for biochar production to enhance soil fertility and ability to retain moisture, sequester carbon, and reduce impacts from burning while engaged in fire ecology restoration efforts. Having biochar and composting systems in place locally will increase our self-reliance and reduce the greenhouse gas emissions associated with shipping out organic waste and bringing in compost.
    - **Engage the community in resilience and restoration efforts.** Use community forums to educate the public about climate change impacts and make stewardship part of the joy and responsibility that people feel when choosing to live in the San Juan Islands. Promote public/private partnerships by using programs like Firewise.

Coordination

- **Inform and equip resource managers to carry out collaborative adaptive ecosystem management.** The Terrestrial Managers work group offers a foundation for disseminating research and fostering shared experiences around adaptive management. Future efforts should focus on:
  - **Setting up a system for tracking and sharing new science, experiences, and management strategies** to strengthen resilience, such as through a working group under the San Juan Islands Conservation District or other entity.
  - **Assessing gaps in knowledge** on an annual basis that could be addressed through additional research, funded by the Terrestrial Managers group.
  - **Reducing barriers for collaboration with Canadian counterparts** including natural resource managers, researchers, and other stakeholders.
- **Organize a Terrestrial Managers sub-group to create a response plan** to guide managers in addressing climate change impacts when making management decisions. Ideally, the plan would be customized for the Islands.
- **Promote coordination for building resilience among organizations** that influence ecosystem management. Ideally, pursue an Islands-wide comprehensive strategy that leverages and pools resources. There has been success in these efforts, such as the Terrestrial Managers work group facilitating San Juan County's embrace of the Leave No Trace Guiding Principles and Ethic.
- **Support and enhance the Salish Seeds native plant nursery** to provide native plants for restoration and enhancement activities. Specifically, expand the nursery's current operational focus on prairie/savannah species to include other habitats. Increased access to native plants for restoration purposes could increase demand to support development of operations on a commercial scale, ultimately increasing the local native plant populations and strengthening resilience across public and private lands.
- **Support creation of a compost facility** for green waste associated with land management activities to reduce carbon associated with burning and transportation, and to provide resources to build and regenerate soil.

Agriculture

INTRODUCTION

Agriculture is a central element of the scenic character, economy, and culture of the San Juan Islands. Historically, farmland has been a vital component of the San Juan Islands' landscape. Native Americans managed local ecosystems in a regenerative manner, conserving resources for future generations. The first Euro-American settlement was the Hudson's Bay Company Sheep Farm in 1853. Farming continued in the Islands with a succession of products including Island fruits (first Italian prune plums, then apples and pears in the 1880s-1920s), dairy (peaking in the 1920s when the Islands were known throughout the region as the "fruit basket of the state"), and currently with island beef, lamb, and shellfish holding regional significance. Besides food production, farmland also provides important ecological services and supports native habitats in the Islands.

Within the last decade, agriculture in the San Juan Islands has experienced change and growth. According to the most recent USDA Farm Census, the number of farms has increased from 225 to 274; together, these farms cover nearly 16,000 acres of land. Local farmers now specialize in crops such as grass-fed meats, berries, tree fruits, and year-round production of vegetables for market, as well as fiber, lavender, and herbs. Increased construction of greenhouses and hoop houses has allowed year-round production of crops that would typically die in the cold winter weather, and also helps production of heat-loving crops such as tomatoes, peppers, melons, and herbs. Regardless, climate change can and does put agriculture at risk.

As keen observers of weather patterns, local famers can recount that agriculture in the San Juan Islands is already experiencing impacts from climate change.

ANTICIPATED CLIMATE CHANGE IMPACTS ON AGRICULTURE

According to the University of Washington's Climate Impacts Group, climate change will likely have both positive and negative impacts on agriculture. On the positive side, warming is expected to increase the length of the growing season and increases in atmospheric CO2 concentrations could increase the production of some crops. On the negative side, increases in heat stress, decreases in summer water availability, increases in flood risk, and changes in the range and timing of pests may damage crops and livestock.[55]

55 G. S. Mauger, J. H. Casola, H. A. Morgan, R. L. Strauch, B. Curry, T. M. Busch Isaksen, L. Whitely Binder, M. B. Krosby and A. K. Snover, "State of Knowledge: Climate Change in Puget Sound," Climate Impacts Group, University of Washington, 2015.

Changes in temperature and rainfall are of most concern to local farmers. Improved water management on the land is key to the future of local agriculture.

Another significant physical driver in the Islands is heavy wind and the damage it causes. Storms in the region may increase in frequency and severity, which could pose a risk to agriculture operations, particularly by damaging greenhouses and hoop houses. However, studies have not yet identified a clear projected change in wind patterns or the strength of low-pressure systems in the Puget Sound region as a result of climate change.[56]

Local farmers have noticed the current farm season growing schedule shifting by one month, with heavy rains in the spring making soil super-saturated and necessitating delays in planting. This observation is supported by an increase in the 10-year running average of cumulative precipitation during March, April, and May from 6.6 inches in 1900 to 7.83 inches in 2012.[57] Farmers have also experienced some severe summer droughts, most recently in 2015. There is also concern about the migration of pests; for example, the praying mantis recently appeared for the first time on farmland Islands-wide, with unknown impacts on agriculture.

EXISTING PROGRAMS, PROJECTS, AND PLANS

Only a few programs and projects are currently in place that address climate impacts on agriculture. Other plans and ideas have been discussed with Island farmers at the annual San Juan Islands Agricultural Summit in recent years. Four projects and programs are noted below.

- **Soil Health Project.** There is growing recognition that soil health and vitality is crucial to long-term agricultural viability. With financial assistance from the Washington State Soil Health Committee, the San Juan Islands Conservation District (SJICD) has begun a local study of soil health with implications for a changing climate. A healthy soil filled with diverse microbes holds water better in dry seasons, improves drainage in wet seasons, resists erosion, diminishes root disease, sequesters carbon, and provides the nutrients to sustain healthy crops in a variety of climatic conditions.
- **Biochar Project.** The SJICD has launched a biochar education and production project that invites local farmers and foresters to make charcoal as a soil amendment that sequesters carbon in the soil for up to 10,000 years. Biochar can improve soil health and water-holding capacity. It is also an important strategy in healthy forest management with increased pressure of fire due to climate change and increased

56 Research shows that storms will likely carry more moisture but may not have stronger winds. UW Climate Impacts Group communication.

57 Western Regional Climate Center, https://wrcc.dri.edu/spi/divplot1map.html

incidence of drought, and lack of active forest management. Biochar kilns are available for use on three islands on a rotating basis. There are also several local non-profit and commercial operations providing biochar education and products in San Juan County.[58]

- **Soil Carbon Challenge.** The Soil Carbon Challenge is a 10-year monitoring program of the SJICD that will measure soil carbon change on a farm plot on San Juan Island. Increasing soil carbon improves soil health. This effort encourages local farmers to increase carbon sequestration.
- **No-Till Drill Program.** The SJICD is in the process of purchasing a no-till drill—a piece of farming equipment that provides the least disturbance of the soil—for use on island farms on a pilot basis. No-till drilling decreases impact on soil microbes and fungal networks which leads to healthier soils and more resilient plants, and it can also reduce the loss of soil carbon associated with repeated tillage. Up to ten island farms will participate in this program over a five-year period to assess the utility of no-till drilling on local farmland. No-till agriculture is fundamental to carbon farming.[59]
- **Crop Variety Evaluation.** Washington State University (WSU) Extension is conducting on-farm crop variety evaluations and site-specific temperature monitoring. This will help farmers identify varieties that are well suited to current and future growing conditions.
- **WSU Master Gardeners.** Trained volunteers diagnose over 100 plant problem samples and respond to over 1,400 requests for information from the public per year. This program provides a front-line resource for the identification and documentation of novel pests, diseases, and introduced plant species.

ADAPTATION MEASURES

Assuming the accuracy of the scientific consensus on climate change and its implications for agriculture, climate-resilient farming would appear to be a wise course to follow for agricultural operations in the San Juan Islands. The carbon farming model, coupled with agroecological and regenerative principles and an emphasis on soil health, bears close study and active pursuit if we are to ensure a positive agricultural future in the Islands. As David Montgomery, University of Washington Professor of Geomorphology, states, "the foundation for the next agricultural revolution will be rooted in how we think about the soil."[60]

The following suggested specific adaptation measures were developed by the Islands Climate Resilience group and a small group of local farmers affiliated with the San Juan Islands Agricultural Guild, San Juan Island Farmers Market,

58 http://restorechar.org/sell-charcoal/#market

59 Montgomery, David. Growing A Revolution: Bringing Our Soil Back To Life. New York, New York, W.W. Norton & Company, 2017.

60 Ibid.

San Juan County Agricultural Resources Committee, and San Juan Islands Conservation District. The measures are presented here in unranked order. As additional resources become available, Islands Climate Resilience will collaborate with others to pursue further analyses to better understand local vulnerabilities and refine these adaptation strategies.

It is also worth highlighting that while this report is not focused on climate change mitigation—reducing greenhouse gas emissions—a number of these adaptation measures would have climate change mitigation co-benefits.

On-the-Ground Implementation

- **Provide soil testing for organic matter Islands-wide.** Soil organic matter not only sequesters carbon, but also improves soil fertility, resulting in better crop yields, pH buffering, disease prevention, and water-holding capacity. Voluntary Stewardship Program participants will receive free soil testing, including carbon measurements, through the San Juan Islands Conservation District.
- **Consider more aggressive rainwater harvesting in the Islands** through potential cost-share programs managed by the San Juan Islands Conservation District.
- **Accelerate the Soil Carbon Challenge** to include more farms in carbon sequestration efforts, potentially providing biochar, compost, and woody debris to farmers who do not have the necessary biomass.
- **Encourage management practices for carbon sequestration and crop diversity** in both annual crop production and perennial crop production. Annual crop production practices, for example, would include organic and conservation agriculture, annual tree cropping/strip intercropping, intensification practices, regenerative agriculture practices, alley cropping, contour hedgerows and living terraces/living fences and hedgerows, windbreaks, riparian buffers, and pasture cropping. Perennial crop production practices include multistrata agroforestry systems, coppiced woody plants, herbaceous biomass crops, and woody agriculture.[61]
- **Encourage management practices for carbon sequestration in livestock production**, including pasture and grazing management, compost application, silvopasture, fodder banks and pollard species/perennial feed and fodder, and restoration agriculture techniques.[62]

61 For more information, see:
Toensmeier, Eric. The Carbon Farming Solution: A Global Toolkit of Perennial Crops and Regenerative Agriculture Practices for Climate Change Mitigation and Food Security. White River Junction, VT, Chelsea Green Publishing, 2016.
Jones, Christine. www.amazingcarbon.com.
ACRES USA, The Voice of Eco-Agriculture. Greeley, CO, Vol. 46, No. 9, September, 2016 and Vol. 47, No. 10, October, 2017.

62 Ibid.

- **Increase efforts to reduce agriculture-related carbon footprint** (GHG emissions) by promoting:
  - Buying local products/produce versus off-island transported products/produce.
  - Reductions in fossil fuel use.
  - Limited pesticide use.

Information, Education, and Outreach

- **Explore interest in agroecological intensification of existing farmland** to reduce the need for additional land clearing for agriculture, as part of a current farmland preservation strategy.
- **Demonstrate productive restoration using perennial crops on local public and private agricultural lands** (e.g., San Juan County Land Bank and San Juan Preservation Trust lands) to develop strategies and practices that work best in this changing climate regime. This demonstration project should include keyline plowing and terracing, biochar, compost application, and rainwater harvesting as examples of important agroecological practices.
- **Consider launching a multimedia public relations campaign** to support the above efforts.

Coordination

- **Include a yearly focus/dialogue on climate change at the annual San Juan Islands Agricultural Summit.** This will help promote coordination among agricultural organizations across the islands on these issues.
- **Organize a carbon farm project similar to the Marin Carbon Project**[63] in the San Juan Islands by creating a partnership with other agricultural organizations/farms.

63 www.marincarbonproject.org

Energy

INTRODUCTION

San Juan County receives all of its electricity from the Bonneville Power Administration, with approximately 86 percent from hydropower.[64] This electricity is delivered to the islands by the Orcas Power and Light Cooperative (OPALCO) through submarine cables. In early 2014, OPALCO established the San Juan Islands Energy Roundtable to provide input on efforts to improve energy efficiency and promote renewable energy. The group is comprised of energy professionals and community members focused on promoting clean energy, and is facilitated by the San Juan Islands Conservation District (SJICD).

The Energy Roundtable participants, in partnership with the Energy Leadership Team, developed the December 2014 San Juan Islands Energy Plan with the aim to "develop a resilient energy system integrated with a vibrant economy and thriving ecosystem." SJICD and OPALCO have worked collaboratively with the Energy Roundtable to implement the plan. While most objectives in the plan have been addressed, the over-arching goals and mission remain the same. The over-arching goals are to:

- Engage the community and students in energy issues.
- Reduce energy waste and use energy wisely.
- Increase local renewable energy generation.
- Reduce our carbon footprint.

ANTICIPATED CLIMATE CHANGE IMPACTS ON ENERGY

Energy Availability

Climate change has already altered and will continue to alter snowpack and streamflows in the western United States, affecting when and how much water is available for all uses, including electricity generation. Hydropower dominates Washington's energy system, supplying two-thirds of the electricity for the state. Summertime hydropower production is projected to decline 9 to 11 percent by the 2020s and 12 to 15 percent by the 2040s.[65] Meanwhile, summer demand for energy will increase significantly due to greater electricity needs from air conditioning as well as population growth. This change in supply and demand is expected to increase electricity costs for consumers. Hydropower production is likely to increase in the winter (4 to 5 percent by the 2040s), but not enough to fully offset the decrease in the summer.[66]

64 https://www.opalco.com/power-system/fuel-mix/

65 Hamlet, A.F., S.Y. Lee, K.E.B. Mickelson, and M.M. Elsner. 2010. Effects of projected climate change on energy supply and demand in the Pacific Northwest and Washington State. Climatic Change 102(1-2): 103-128.

66 Hamlet et al. 2010.

Increased Demand

The San Juan Islands are a climate refuge, with fairly moderate seasons. According to the Office of Financial Management, the resident population of the Islands will likely continue to grow, increasing demand for resources and energy use. Changing consumption patterns—such as vehicle types, as noted below—will also have an effect on energy demand and emissions.

Desalination

The Islands have experienced saltwater intrusion in some wells near the shoreline. With the sea level anticipated to rise further as the climate continues to change, saltwater intrusion could increase. Currently, there are 14 desalination plants in the county that provide drinking water for several neighborhoods, without which development and residential occupancy would be restricted. The process of desalination requires significant energy use. San Juan County has more desalination plants than any other county in the United States. As the need for water increases, there will likely be additional need for desalination, further increasing energy demands.

Electric Vehicles

Many residents in San Juan County are transitioning away from fossil-fueled vehicles and purchasing electric vehicles (EVs) to reduce greenhouse gas emissions. Across Washington State, newly purchased or leased clean alternative fuel and plug-in hybrid vehicles increased over 250 percent from fiscal year 2016 to fiscal year 2017.[67] While EVs are a lower-carbon alternative to conventional cars, keeping them charged places an increased load on the electrical grid. Some EV owners in the Islands are using home-generated renewable energy to charge their vehicles, while others are considering buying in to the upcoming community solar project to offset charging needs.

EXISTING PROGRAMS, PROJECTS, AND PLANS

The Energy Roundtable, in collaboration with SJICD and OPALCO, has continued to implement programs and projects, including:

- Engaging the community and students in energy issues through:
  - Outreach events such as speakers and Green Home Tours.
  - In-classroom education such as the Cool School Challenge.
- Increasing local renewable energy generation, including through a new community solar project on Decatur Island.
- Reducing our carbon footprint, such as through an Electric Vehicle Campaign.
- Identifying opportunities to advance a resilient energy system through the Comprehensive Plan Update.

67 These include the purchase or lease of a new passenger car, light duty truck, and medium duty passenger vehicle which is powered exclusively by clean alternative fuels or a plug-in hybrid capable of traveling at least 30 miles using only battery power, and is on the list of qualifying vehicles as determined by DOL. https://dor.wa.gov/sites/default/files/legacy/Docs/Pubs/Misc/DOLVehicleCount.pdf

OPALCO offers home energy snapshots to evaluate opportunities to increase efficiency and reduce wasted energy. It has education and rebate programs to encourage homeowners to increase the energy efficiency of their homes.

OPALCO is also launching a large-scale community solar project on Decatur Island in 2018. Most of the energy produced on Decatur will be used immediately, but some will be stored in a vanadium flow battery storage system to curtail future peak demands, or potentially for emergency services during major outages.

ADAPTATION MEASURES

Opportunities and existing plans for adapting to climate change impacts include increasing local renewable energy generation and water conservation measures, improving local policies, and providing outreach and education to residents and visitors. Many of these measures have climate change mitigation benefits, as they directly reduce greenhouse gas emissions.

The following suggested adaptation and mitigation measures are intended to serve as a basis for further discussion in the Islands community. As additional resources become available, Islands Climate Resilience will collaborate with others to better understand local vulnerabilities and refine these adaptation strategies. The measures are presented here in unranked order.

Local Renewable Energy Generation

- **Encourage the installation of solar systems on more island buildings.** Grid-connected solar systems in San Juan County produce over 5,800 kWh annually. There are also several homes with solar panels that are not grid-connected. With the new production incentives recently approved the state legislature, now is a good time to install solar systems in the Islands.
- **Advance community solar projects.** As noted above, OPALCO is launching a community solar project on Decatur Island in 2018 and other community solar projects are anticipated in the future.

Energy and Water Conservation

- **Continue to encourage islanders to improve the energy efficiency of their homes.** Approaches include weatherization, insulation, window upgrades, heat pump heaters, and heat pump water heaters.
- **Implement water conservation measures.** Water conservation is closely linked to energy use. Transporting water uses electricity, as does desalination. The water chapter of this report has more specific recommendations related to encouraging the efficient use of water.
- **Install rainwater collection systems.** Installing new rainwater collection systems at homes and businesses could help offset the need for transporting water and for desalination. It will also help build resilience to changing precipitation patterns and increased incidence of drought.

Policy Development

- **Examine adaptation measures in other island communities**, such as Islands Trust, for new ideas.
- **Continue to coordinate meetings and discussions** between the Energy Roundtable, Islands Climate Resilience, OPALCO, and the County government to plan and implement measures that can reduce energy demand, reduce greenhouse gas emissions from electricity usage, and increase energy efficiency.
- **Consider ways to advance resilient, low-carbon energy in the Comprehensive Plan update.** For example:
    - The Plan could require all new heated buildings in San Juan County to be more energy efficient, incentivize small building footprints, and promote renewable energy sources.
    - The Plan could require higher basic energy standards for new construction and major renovations such as Energy Star Plus certification, and LEED certification for major projects.
    - The Plan could include a policy to review and upgrade policy and building codes/standards to provide incentives for improving the efficiency of homes, and their water systems and energy systems. Efficient energy systems include heat pump space heaters and water heaters, insulation, air sealing, and weatherization.
    - The prior Comprehensive Plan had a policy to provide opportunities within land use designations for the development and use of alternative energy resources that are compatible with the natural environment. The policy can be updated to emphasize those that will directly contribute to a reduction in greenhouse gas emissions.
    - The Plan could include a policy to promote "dark sky" lighting.[68] This includes fixtures that are fully shielded and have low color temperature. It reduces light pollution, benefiting wildlife and migrating birds as well as resident and tourist stargazers. These efforts can also reduce energy use by focusing on providing lighting where it is really needed and using energy-efficient bulbs.

Boat Electrification

- **Coordinate with the Marine Resources Committee** to promote the electrification of boats to reduce the use of fossil fuels.

Outreach and Education

- **Conduct a visitor campaign.** This could be coordinated with the one proposed in the water chapter. Educate summer visitors and residents about ways to reduce energy use, and the local and global benefits of doing so.
- **Expand the Cool School Challenge to an annual inter-island competition.**

68 http://www.darksky.org/lighting/lighting-basics/

Appendices

1. ICR Water Resiliency Work Group Structure and Membership
2. Additional Information about the San Juan County Water Resource Management Committee
3. Additional Resources and Reports on Water Resources in the Islands
4. "The Future of Water Resources in the San Juan Islands" Community Panel Agenda (2015)
5. Summary of Terrestrial Managers Meeting Session (2017)

Appendix 1.

ICR Water Resiliency Work Group

Water Resiliency Work Group Tasks:

- Summarize anticipated challenges/impacts to local water resources under a changing climate;
- Identify existing programs, projects, and plans (County, State, NGOs, etc.) that help address specific impacts;
- Identify gaps in knowledge and programs; complete SWOT (strengths, weaknesses, opportunities and threats) analysis;
- Brainstorm strategies, and develop a short list of Adaptation Measures;
- Share findings and with key stakeholders for feedback and complete draft Water Resiliency Plan chapter.

Water Resiliency Work Group Structure:

The Islands Climate Resilience group served as the umbrella organizing the overall process and work group. Other key actors included:

- Lead Organization: San Juan County Water Resource Management Committee;
- Supporting Organizations: San Juan Islands Conservation District, San Juan County Health & Environment, Cascadia Consulting, Seattle, WA;
- Other Support: Islands residents who have attended recent ICR events and signed up to volunteer assistance;

Work Group members and roles:

- San Juan County Water Resource Management Committee representatives: Vicki Heater (Waldron), Paul Kamin (Orcas), Kyle Loring (SJI)
- San Juan Country Public Health & Environment: Kyle Dodd (SJI)
- San Juan Islands Conservation District representative: Linda Lyshall (SJI, ICR)
- Work group advisor, co-facilitator: Nora Ferm Nickum (Cascadia Consulting Group, Seattle)
- ICR liaison/ Meeting coordinator: Kari Koski (SJI)
- Chair: Jennifer Thomas (SJI)
- Co-chair: Loren Johnson (SJI)
- Meeting notes: Carol Kibble (SJI)
- Information, resources & background gathering: Steve Ulvi (SJI), Jana Marks (SJI), Patti Garcia (SJI), Alison Longley (SJI), Tom Munsey (Orcas)
- Other Meeting Attendees: Lovel Pratt (ICR, SJI), Jane Wentworth (ICR, SJI), Doug McCutchen (ICR, SJI), Ethan Schmidt (SJI)

Appendix 2.

Additional Information about the San Juan County Water Resource Management Committee

Goals:

- Retain enough water in streams and wetlands to protect water quality and support diverse, healthy, and abundant plant and wildlife communities.
- Integrate water supply planning with growth management planning and determine the availability of water supplies in approved growth areas.
- Establish a county resource management program that addresses all water use, including exempt wells and alternative sources, and includes decision-making based on long-term development and analysis of resource information.

http://www.sanjuanco.com/439/Water-Resource-Management

Available on-line:

- San Juan County Water Resource Management Committee reports and studies, 1997-2015 Funding by Washington State Department of Ecology
- San Juan County Watershed Management Action Plan and Characterization Report, 2000
- Lopez Village Water Supply Report, 2003
- San Juan County Water Resource Management Plan, 2004
- East Orcas Water Supply Report, 2006
- Eastsound Water Supply Report, 2008

Appendix 3.

Additional Water Reports and Resources

Note: Most of these are available on the WRMC website.

- San Juan County Drought Plan, https://static1.squarespace.com/static/57732786f5e231100a586a29/t/57b73432414fb51e1ec906
- Is Seawater Intrusion Affecting Groundwater on Lopez Island, Washington? USGS, 1998
- Estimates of Groundwater Recharge, USGS WRIR 02-4114
- San Juan County Final Monitoring Report, Huxley College, 1999
- San Juan County Technical Assessment, Pacific Groundwater Group, 2002
- Lopez Village Model Report, Pacific Groundwater Group, 2003
- San Juan County Stream Gauge Report, DTA, 2003
- Multi-purpose Surface Water Storage Assessment, Montgomery Water Group, 2004
- Interim Aquifer Protection Report, Eastsound, Pacific Groundwater Group, 2008
- San Juan County Groundwater Monitoring Report, Pacific Groundwater Group, 2008
- San Juan County Groundwater Monitoring Report, Pacific Groundwater Group, 2009
- San Juan County Groundwater Monitoring Report, Pacific Groundwater Group, 2011
- San Juan County Groundwater Monitoring Report, Pacific Groundwater Group, 2012-20013
- San Juan County Groundwater Monitoring Report, Pacific Groundwater Group, 2015
- Status of Desalination in San Juan County, Mayo, 2009
- San Juan County Groundwater Sub-Basins and Water Level Contours, Pacific Groundwater Group, 2010
- WRIA 2 Basin Report (municipal water rights by groundwater basin), HCS, 2013
- East Orcas Water Budget Study, RH2, 2015
- Groundwater quality results 2015, HCS

Other reports and databases:

- Eastsound Nitrate Study, Chazen, 2010
- Well Monitoring Report (Lopez Village), Richey, 2003
- Final False Bay Flow and Habitat Assessment, Washington Water Trust, 2012
- AnnualReports&WorkPlans-2007-2015
- HdyroDB, Doug Kelly (well log database), Located in N:\Environmental Hea\Drinking Water\Welldata\HydroDB\SJC-HydroData.mdb
- San Juan County Water Level DB (for analyzing datalogger results), PGG, Located in N:\Environmental Hea\WRIA\Monitoring\MonitoringDatabasefromPGG\San_Juan_WL_AC2003_V2.03.zip
- San Juan County Code 8.06, revisions 1999-2015
- San Juan County Water Systems, Polaris mapping application, 2015

Washington State resources:

- EPA Water Sense Program: Saving Water in Washington, https://www3.epa.gov/watersense/docs/washington_state_fact_sheet.pdf
- USGS Washington Water Science Center, https://wa.water.usgs.gov/water_issues/watercensus.htm
- Washington State Department of Ecology Water Resources, http://www.ecy.wa.gov/programs/wr/wrhome.html
- Washington State Department of Ecology: Climate Change Effects on Water Resources, http://www.ecy.wa.gov/climatechange/2012ccrs/water.htm

Appendix 4.

"The Future of Water Resources in the San Juan Islands" Community Panel Agenda

Monday, November 16, 2015, 6:00 PM – 8:30 PM

Purpose and Goals

ICR- Increasing understanding of water resources and needs in the county

What is Currently Known about Water Resources in the San Juan Islands?

Vicki Heater, SJC Water Resource Management Committee Member What are Current Water

Usage and Conservation Efforts?

Paul Kamin, SJC Water Resource Management Committee Member

What are Our Habitat Needs?

Kimbal Sundberg, SJC Water Resource Management Committee Member

What are Our Agricultural Needs?

Tom Schultz, Former WSU Extension Director

What are the Current Water Use and Systems Regulations?

Grey Water Systems: Kyle Dodd, WRMC Member

Reclaimed Water & Catchment Systems: Peter Kilpatrick

Desalination Systems: Paul Kamin, WRMC Member

Water Panel Community Discussion

All Water Panel Q&A

Evaluation and Interest Survey

Appendix 5.

Summary of Terrestrial Managers Meeting Session

Terrestrial Ecosystems Climate Change Risk Assessment

March 30, 2017

Session goals

- Contribute to a coarse-scale climate impacts risk analysis for terrestrial ecosystems in the San Juan Islands.
- Discuss priorities and explore potential strategies for building climate resilience in these ecosystems.
- Highlight some next steps for individuals, organizations, and the Terrestrial Managers Working Group.

Survey inputs

The meeting was built around the answers given on questionnaires that were sent out to the participants prior to the meeting. We received responses from 26 people. This was not a statistically rigorous survey, so we are reporting on overall trends here, rather than quantitative results.

Impacts of most concern

Respondents felt that changes in precipitation timing and amount (including drought and storm flows), changes in phenology, and sea level rise were likely to pose the most risk to habitats and species in the San Juan Islands. They indicated that they expected increased stream temperatures and changing wildfire risk to pose relatively fewer challenges given the local environment in the San Juan Islands. This question was asked again during the meeting, and participants used clickers to vote on the top three climate change impacts. Results mirrored what was heard through the online survey.

Specific places and species that are likely to be at risk

Online survey respondents most often mentioned shoreline ecosystems, including low-lying coastal areas, dunes, beaches, estuaries, intertidal zones, pocket beaches, and feeder bluffs. A few also mentioned Oak savannah remnants, prairie, and moist forests. Specific sites mentioned as vulnerable included American Camp, Spencer Spit, Crescent Beach, Lopez Tombolo, Odlin Park, and Mitchell Hill.

Specific species that are likely to be at risk

The most common responses regarding vulnerable species included salmonids, forage fish, and species—like birds and orcas—that are dependent on those species. Respondents also mentioned the Island marble butterfly, sand-verbena moth, Western red cedar, firs, sharp-tailed snake, black oystercatcher, and amphibians.

Vulnerable habitat types

Survey respondents categorized habitat types in the following way:

Vulnerability level	Habitat type
High	Tidal/coastal wetlands Aquatic vegetation and exposed flats Vernal pools
Moderate	Forest and shrub swamps Moist forests and woodlands Sparsely vegetated uplands Upland grasslands and meadows Riparian vegetation
Moderate / Low	Peatlands
Varied responses	Dry forests and woodlands Sand dune vegetation

Existing efforts

Terrestrial managers are already implementing numerous programs that help to build resilience to climate change, even if that is not the explicit purpose of these programs. Further adaptation efforts can learn from and build on these initiatives.

Programs to address wildfire risk and invasive species appear to be particularly common. The following table summarizes existing efforts mentioned in survey responses and workshop discussions.

Impact	Wildfires	Invasive species	Sea level rise, intrusion	Precipitation change
Existing efforts	• Management plans • Controlled/ prescribed burns • Planned thinning • Measuring fuel loading	• Monitoring • Manual eradication • Collection and propagation of native seed • Protection of native-dominated landscapes • Education and outreach	• Landowner and manager outreach • Estuary restoration that considers SLR projections • Shoreline enhancement to allow beach migration	• Water catchment systems • Forest preservation • Land protection • Riparian vegetation enhancement

As noted in the table below, there appear to be fewer current efforts—at least among those represented at the meeting—that help to address some other impacts, like increased stream or air temperatures.

Impact	Warmer air temperatures	Warmer stream temperatures	Changes in phenology
Existing efforts	• Insulating buildings • Forest preservation	• Revegetating waterways • Fencing to protect riparian zones	• Adaptive planting strategies • Monitoring • Allowing for adaptive management and changing priorities

Gaps and ideas

The survey asked respondents for their ideas about additional measures that could be taken—by their organizations or others—to build the resilience of terrestrial ecosystems to future climate change impacts. Those ideas were then grouped into three categories: on-the-ground implementation, information and planning, and coordination.

On-the-ground implementation

- Water catchment.
- Retain fresh water on the landscape.
- Identify and protect refugia.
- Plant trees alongside streams and restore wetlands.
- Preserve wet forests and perennial wetlands.
- Assist in migration of species.

Information and planning

- Consistent monitoring.
- Integrate actions into other plans (e.g., SMP, emergency management).
- Educational forums.

Coordination

- Island-wide comprehensive strategy, pool our resources, coordinate.
- Increase collaboration for landscape-scale adaptive management.
- Annually assess gaps in knowledge where the Terrestrial Managers group can work together to fund research that will support management decisions.
- In the discussion, the following additional suggestions were raised:
- Manage increased visitors and limit human impacts on habitats.
- Identify the most treasured places and work to protect those.
- Organize a Terrestrial Managers sub-group to create a response plan, customized for the Islands, which would serve as a document to point to when approaching decisions. The strength of the Terrestrial Managers group is that they can be more responsive and nimble than the federal government.
- Create a working group under the San Juan Islands Conservation District or another entity to track and share the science and make recommendations.
- Keep forests as diversified as possible to allow for natural adaptation.
- Use community programs like "Firewise" to promote public/private partnerships. Make stewardship part of the joy and responsibility that people feel when choosing to live here.
- Build resilience for species by building refugia.
- Conduct a visitor use study.
- Support basic science.
- Follow the model of the work that the Terrestrial Managers group did to get San Juan County to embrace the Leave No Trace Guiding Principles and Ethic. Do something similar to promote resilience-building efforts.

Discussion

There was a discrepancy in what the managers saw as the biggest threat for changes in the Islands' climate (changing precipitation), and what adaptation measures they felt their agency could/would take on. No adaptive measures were discussed to directly address changing precipitation.

Participants identified the shoreline and low-lying coastal properties as areas where it would be particularly difficult to implement adaptation measures. One reason cited was the broad scope of impacts—ocean acidification, saltwater intrusion, flooding by rising seas, and erosion. Many of these areas felt beyond human control. Another reason was the high cost of moving structures. For the most part, meeting participants weren't focusing on these impacts in their jobs, which made the task also seem less comfortable.

In contrast, participants identified the habitats with the fewest foreseen changes as those where climate change issues could be tackled most easily. For example, peatlands, grasslands, and drier forests have plants that are already adapted to drier summer conditions.