

Preparing Washington State Parks for Climate Change

A Climate Change Vulnerability Assessment for Washington State Parks

June 2017



Prepared by

The University of Washington Climate Impacts Group

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Table of Contents

- 1 Executive Summary 1
- 2 Introduction 5
- 3 Overview of State Parks and the Assessment Approach..... 8
 - 3.1 Assessment Approach 12
- 4 Observed and Projected Changes in Washington’s Climate 16
- 5 Key Findings: Cross-cutting Issues for Regions and Statewide Programs 25
 - 5.1 Changes in Precipitation and Hydrologic Extremes: *Enhanced Seasonal Precipitation, More Intense Heavy Rain Events, Flooding, and Related Effects* 26
 - 5.2 Changes in Snowpack 32
 - 5.3 Changes in Ecosystem Health and Vegetation Disturbance: Wildfire, Tree Health, & Non-Native Invasive Species..... 35
 - 5.4 Sea Level Rise and Related Impacts 40
 - 5.5 Other Climate Change Impacts on State Parks: Increasing Temperatures..... 43
- 6 Conclusions and Next Steps 44
- References..... 47
- Appendix A | Workshop Summaries
 - Northwest Region
 - Southwest Region
 - Eastern Region
 - Statewide
- Appendix B | Climate Summaries
 - Northwest Region
 - Southwest Region
 - Eastern Region
 - Statewide
- Appendix C | Snow Water Equivelant Maps
- Appendix D | Sea Level Rise Innundation Maps

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1 Executive Summary

The Washington State Parks and Recreation Commission manages some of Washington's most valued water bodies, diverse landscapes, and historical properties. The State Parks system includes 125 developed parks, including marine parks, historical parks, heritage sites, interpretive centers, and more than 700 historic properties. The agency also manages significant areas of wetland and riparian habitat, evergreen forest, beaches, rivers, lakes and approximately 500 miles of recreational trails. State Parks provides Washingtonians with the opportunity to connect with the State's diverse natural and cultural heritage sites and to engage in recreational and educational activities. The ability of State Parks to preserve Washington's diverse landscapes and continue to serve as a conduit of outdoor recreation and education is vital to the agency's mission.

Preparation for the impacts of climate change has become critical as the agency strives to create and sustain a healthy parks system. Parks has already experienced many climate related issues which will be exacerbated by climate change. For example:

- Winter flooding has resulted in campsite closures at Potlatch, Belfair, Twanoh, Ocean City, Twin Harbors, and Grayland Beach state parks.
- Low snowpack years, such as the 2014-2015 winter, have resulted in lower Sno-Park permit sales and snowmobile registrations.
- Wildfires have caused temporary park closures and have damaged park infrastructure. Washington's record breaking 2015 fire season resulted in a five-week closure of Alta Lake State Park and damaged large swaths of forested park land.
- In the Northwest Region, the beach and cabins at Cama Beach State Park frequently flood during annual King Tides.

Understanding how climate change may affect State Parks' properties, facilities, operations, and state-wide programs is critical for ensuring State Parks continued ability to provide "memorable recreational and educational experiences." Concerns about the effects of climate change impacts led the Washington State Parks and Recreation Commission to pass a resolution in 2015 directing the agency to develop a climate change preparedness plan.



As an initial step toward developing that plan, the Washington State Parks and Recreation Commission contracted with the University of Washington Climate Impacts Group (CIG) to conduct a climate change vulnerability assessment for State Parks' properties, facilities, operations, and state-wide programs. Understanding the impacts of climate change on State Parks is a necessary foundation for reducing climate risks, protecting Parks' investments, and ensuring continued program success.

This vulnerability assessment combines published literature and data with the expert knowledge of Washington State Parks and Recreation Commission staff and CIG. To begin the assessment, CIG prepared summaries of projected climate change impacts relevant to State Parks from existing literature and data sets (available in Appendix B). CIG then convened four workshops with State Parks staff to assess the implications of climate change impacts on each of the Parks' three regions (Northwest, Southwest, and Eastern) and on statewide programs (Planning, Stewardship, and Winter Recreation). Workshop participants were asked to rate their ability to adjust to projected climate impacts and to rate the expected consequences of the impacts to their mission and responsibilities.

The results from these workshops indicate that the State Parks system is expected to be affected by climate change through a variety of pathways. Over the course of the three regional and statewide workshops four primary climate drivers that are expected to affect State Parks emerged:



Changes in precipitation and streamflow. As temperatures across Washington State continue to rise, a greater fraction of winter precipitation will fall as rain rather than snow, resulting in higher winter streamflows, and lower summer streamflows. The most frequently discussed concerns during project workshops were the potential for more erosion, landslides, washouts, flooding, heavy precipitation events, and stormwater management issues. These impacts may block or limit access to parks, damage infrastructure or facilities, and may require relocation of facilities and campgrounds in low-lying areas.



Changes in snowpack. The Washington Cascades and Olympic Mountains contain the highest fraction of "warm snow", or snow falling within a few degrees of freezing (32°F), in the continental United States (Mote et al. 2008). As a result, warming winter temperatures associated with climate change are projected to reduce snowpack accumulation and shorten Washington's snow season. These changes are likely to lead to a drop in Sno-Park permit purchases and snowmobile registrations over time. Lower sales would affect annual revenue for the Winter Recreation Program and may reduce emergency budget reserves, leaving the program more vulnerable to year-to-year variability in snowpack and funding.



Changes in ecosystem health and vegetation disturbance. Warming temperatures, declining summer precipitation, and declining snowpack will stress trees and vegetation in ways that are expected to change the prevalence and location of insect and disease damage, increase annual area burned, and increase the area and intensity of droughts (Snover et al. 2013, Mauger et al. 2015). Increased wildfire activity is expected to result in more campsite cancellations, more frequent park closures, costly repairs to damaged

infrastructure, reduced air quality due to smoke, and diversion of staff and resources. Additionally, damage from insects and disease would exacerbate existing forest health issues in many parks, potentially increasing tree fall impacts on park operations.



Sea level rise and related impacts. Sea level is projected to continue rising in Washington State throughout the 21st century. Higher tides and storm surge, erosion, and permanent inundation of low-lying areas are expected to increasingly disrupt or limit access to park beaches and facilities. Relocating low-lying facilities and campsites to higher areas will only be possible if suitable areas exist within a park. Additionally, managing erosion issues is an ongoing and costly challenge for State Parks with few permanent solutions.

The workshops with agency staff also revealed five cross-cutting programmatic issues and concerns that are common across climate change impacts, regions, and statewide programs. These findings include:

- *Siting park infrastructure.* Climate change impacts are likely to affect the design and siting of park facilities. At coastal parks, sea level rise and increased erosion may influence relocation of parking lots, bathroom facilities, and may cause reconsideration of stairway, roads, and trail location. At river parks, increased heavy rain events and larger floods are likely to influence facility siting and design, stormwater management, culverts, bridges, and flood protection.
- *Park access.* Visitor access to parks or specific park amenities (e.g., beachfront, hiking trails) could be blocked more frequently due to climate change impacts. Flooding from sea level rise and storm surge, erosion, landslides, changes in tree health, and wildfire can each prevent access to parks, campsites, trails or beaches for short or long periods. Changes in the location or prevalence of disease or insects can compromise tree health, resulting in more downed or at-risk trees, which can lead to trail, campground or other facility closures.
- *Water Features.* Warming temperatures will increase demand for water features such as rivers, lakes, beaches, and boating facilities. These features are likely to experience more use and may require enhanced management for maintenance and public safety. Additionally, warming water temperatures will likely result in increased algal blooms, increased *Vibrio* outbreaks, and reduced water quality that may result in the closure of designated swimming areas.
- *Park Visits and Revenue.* Climate change impacts could have a range of negative and positive effects on visitation and revenue and will likely vary by park. If river flooding, erosion or tree health concerns lead to campground or trail closures, revenue from user fees are likely to decline. However, warmer summer temperatures may increase summer visitation at western Washington parks, particularly at popular parks and/or parks with water features. A longer warm dry season could increase visitation in the shoulder seasons (Spring and Fall) causing earlier openings and later closing for seasonal parks. This is likely to increase revenues, but will also involve heavier use and increased costs for operations and maintenance of parking lots, trails, amenities, and facilities such as restrooms and septic systems.
- *Historic structures and archeological sites.* State Parks manages a wide range of historic structures and geologic and cultural sites that could be compromised by climate change impacts. Sea level rise, flooding, erosion, wildfire, and landslides may put more historic facilities in harm's way, requiring Parks to move, protect, or abandon facilities.

In addition to highlighting climate change impacts that are anticipated to create new challenges for State Parks and exacerbate existing threats, this assessment revealed that many State Parks staff are

already adjusting to climate change-related impacts such as sea level rise and changes in snowpack, flood risk, wildfire risk, tree health, and water supply reliability. However, responses are typically implemented by individual initiative, and staff noted that gaining approval for infrastructure and design approaches beyond the regulatory and budgetary minimum can be difficult. Climate change is expected to exacerbate the impacts and consequences that currently confront managers. Staff participating in this assessment indicated support for a proactive approach to addressing the increasing pace and scale of climate change impacts.

The assessment findings also revealed that each region, and in some cases each park, experiences climate change impacts uniquely. For example, sea level rise is a key concern for many coastal parks since it contributes to erosion, loss of beach area, inundation of coastal structures, and damage to coastal infrastructure such as roads, parking lots, trails, and stairs. In contrast, eastern Washington parks are more likely to be affected by tree health issues, reduced water access, wildfire, and extreme heat. The effects of climate change on a given park will be specific to the park setting, its features, and the geographically specific expression of climate change impacts. While this assessment provides a qualitative indication of expected impacts, these results should be validated at the park level.





2 Introduction

The Washington State Parks and Recreation Commission is responsible for managing Washington's "most treasured lands, waters, and historic places" (WSPRC Mission Statement). However, changing climate conditions pose threats and present opportunities that State Parks must consider as it cares for its resources today and plans for the park system of the future (WSPRC 2016).

Climate change is projected to have significant impacts on State Parks' infrastructure, historical sites, and natural resources. Projected changes include declining snowpack, increasing winter flood risk, declining summer stream flows, increased fire risk, sea level rise, and shifts in species and habitat distributions (Dalton et al. 2013, Snover et al. 2013, Mauger et al. 2015). Understanding the impacts of climate change on State Parks is a necessary foundation for reducing climate risks, protecting Parks' investments, and ensuring continued program success.

To help prepare for the impacts of climate change, the Washington State Parks and Recreation Commission contracted with the University of Washington Climate Impacts Group (CIG) to conduct a rapid climate change vulnerability assessment for State Parks' properties, facilities, operations, and state-wide programs.¹ This assessment was conducted through the lens of the agency's three regions and select statewide programs, Winter Recreation, Stewardship, and Planning.

¹ Properties were defined as the park as a whole, including wildlife, vegetation, and other natural resource features. Infrastructure was defined as campsites, buildings, bathrooms, hookups, and other electrical infrastructure, culverts, waters mains, sea walls, stairs to beaches, docks, and other related physical infrastructure.





The mission of the Washington State Parks and Recreation Commission is to “care for Washington’s most treasured lands, waters, and historic places. State parks connect all Washingtonians to their diverse natural and cultural heritage and provide memorable recreational and educational experiences that enhance their lives.”

Resolution

The Washington State Parks climate change vulnerability assessment was motivated by a resolution passed by the Washington State Parks and Recreation Commission in November 2015. The resolution states that the impacts of climate change “will have an impact on the stewardship, operation, and placement of park resources and facilities” and that “using the best available science on climate change to plan for the care of resources and facilities is environmentally responsible and financially prudent.” The resolution directed that actions taken at all levels of the agency “shall be evaluated in the context of climate change” and it directed staff to form an interdisciplinary team to develop a “climate change preparedness plan based on best available science.”

Existing Climate Risk Management

By their nature, many park assets are sensitive to climate. In interviews and workshops conducted for this assessment, Parks staff reported that they already face a range of climate-related issues, including flooding, seasons of low snowpack, and wildfire.

Based on discussion with staff, climate-related issues for facilities on the west side of the Cascades, include:

- Coastal flooding, erosion, and bluff sloughing that have impacted coastal facilities;
- Flooding, landslides, and land movement that have affected roads, trails, buildings, and other infrastructure (Figure 1);
- Insects and diseases that have affected forest health and public safety;
- Wildfire and fire bans that affect park usage; and
- Impacts on water systems and drain fields due to extreme precipitation.



Figure 1. Flooding at Dosewallips State Park, February 2015. *Image source: Douglas Hinton, Washington State Parks*

With the exception of sea level rise and coastal flooding, many of the issues listed above are also current

concerns for the Eastern region. Fire risk, tree health concerns, and non-native invasive species establishment are of specific concern to parks east of the Cascades.

State Parks staff are actively engaged in responding to and managing the consequences of these climate-related challenges. For example, staff have relocated campsites in areas where river flooding has been problematic (e.g., Schafer State Park) and, where relevant, have installed facilities such as restrooms, boardwalks, and playgrounds designed to accommodate flooding (e.g., Lake Sammamish State Park). In forested parks, crews regularly monitor tree health and remove diseased trees and non-native invasive species at campgrounds and day-use areas. Crews also trim branches and vegetation to create defensible fire spaces around structures. To address concerns related to drought and water supply, parks in eastern Washington are now incorporating more drought-resistant shrubs and trees in landscaping and using less turf. In some cases, management actions have explicitly considered future climate. For example, concerns about sea level rise were factored into proposed restoration activities at Saltwater State Park. The proposal includes relocating a parking lot to avoid flood risk and establishing a platform for mobile food trucks instead of a stationary building that could be damaged by inundation.

These and other similar efforts are important foundations for managing current and future climate risks. Climate change is expected to amplify these and other risks by changing the frequency, duration, and intensity of climate-related stressors affecting the parks. This fact, and the fact that each region and program will face climate impacts, points to the need for a coordinated, consistent, and proactive approach. The need for “agency-wide direction, a long-term vision, and best practices for how to address climate change impacts” was also identified by staff during pre-workshop interviews. This assessment helps establish a common understanding across the agency regarding projected changes in Washington’s climate and the expected impacts of these changes on State Parks’ properties, facilities, operations, and state-wide programs. Understanding which regions, programs, and parks are most likely to be vulnerable to the effects of climate change, and why, is critical information necessary to addressing potential negative effects of and sustaining a healthy parks system.

About this Report

This report synthesizes key findings that emerged from the workshops that served as the foundation for the project. Following this introduction, the report briefly summarizes projected climate changes affecting State Parks (Section 4). The report then describes the overarching climate change impact concerns common across regions and programs as identified by State Parks staff (Section 5). Details on the climate change impacts relevant at the regional and program level are provided in the workshop summaries included in Appendix A. The report closes with three additional appendices: the regional climate change projection summaries produced for each workshop (Appendix B), maps of projected changes in snowpack for Washington State and parks regions (Appendix C), and sea level rise inundation maps for selected locations of interest (based on discussion at the workshops; Appendix D).





3 Overview of State Parks and the Assessment Approach

The Washington State Parks system includes 125 developed parks across more than 120,000 acres of land located throughout the state. Its facilities include 19 marine parks, 11 historical parks, 35 heritage sites, 13 interpretive centers, more than 700 historic properties, and approximately 500 miles of recreation trails (WSPRC 2016). State Parks manages nearly 20,000 acres of wetlands, more than 2 million lineal feet of riparian habitat, and more than 15,000 acres of significant habitat supporting rare plants, animals or both (WSPRC 2016). The largest categories of natural resource holdings are evergreen forest (59,029 acres), beaches (8,376 acres), and rivers and lakes (7,877 acres) (Schundler et al. 2015). Parks include Salish Sea shorelines, rain forests, the Palouse, ocean beaches, the Columbia River Gorge, Puget Trough² lowland forests, dry forests, shrub steppes, Columbia Basin reservoirs and coulees, glacial lakes and snow-capped mountains, channeled scablands, and wild rivers (WSPRC 2016).

State parks are designed to provide recreational and educational experiences as well as to protect cultural and historic sites and natural habitats. According to the agency's strategic plan, the role of parks as learning laboratories for natural and cultural heritage is likely to take on greater importance in the coming years (WSPRC 2016). With increasing population growth and development, lands designated for the protection of natural and cultural resources, such as state parks, will become scarcer. As a result, State Parks will become more valuable for research on and interpretation of these resources. A wide range of petroglyphs, pictographs, and other prehistoric Native American cultural resources are under the care and protection of State Parks.

More than 30 million people visit state park facilities every year, generating an estimated \$1.4 billion in annual economic contribution to the state and \$64 million in state general fund tax receipts (WSPRC 2016). State Parks capture 8% of all outdoor recreation participation and approximately 50% of Washingtonians visited a state park in 2013 or 2014 (WSPRC 2016). State Parks are the major facilitator

² The Puget Trough ecoregion is a stretch of land between the Olympics and Willapa Hills (to the west) and the Cascade range (to the east). The ecoregion stretches the length of Washington State, and does not exceed 1,000 ft. in elevation. The region includes coastal lowlands, coastal islands, and low-elevation forested foothills.



of the outdoor recreation economy in Pacific, Grays Harbor, Island, and San Juan counties (WSPRC 2016, Schundler 2015).

The State Parks budget experienced a major contraction during the past decade that continues to influence decisions. In the 2007-2009 biennium State Parks received \$94.5 million from the State General Fund. By the 2013-15 biennium, that support declined to \$8.7 million. The reduced budget caused significant changes within the agency, including staff layoffs, transfers of parks to other entities, consolidated management, and a shift to a seasonal staffing structure. It also created a focus on visitor levels and enhancing the visitor experience. For example, the construction of cabins and yurts, rehabilitation of historic buildings for modern uses such as vacation rentals, and the electrification of RV campsites were all prioritized to generate additional operating revenues for the agency (WSPRC 2012). In addition, the State Legislature established the Discover Pass. Discover Passes are required for vehicles entering land managed by Washington State Parks, Department of Fish and Wildlife, and the Department of Natural Resources. Passes can be bought on an annual basis for \$30, or single visit passes can be purchased for \$10. State Parks currently receives about 80 percent of its budget from earned revenue such as Discover Pass and user fees. The remaining 20 percent is derived from the State General Fund and a litter tax.

Washington State Parks is overseen by the seven-member Washington State Parks and Recreation Commission. The agency is headquartered in Olympia where system-wide services and programs are primarily based, including the three programs assessed in this project (Winter Recreation, Stewardship and Planning). Parks management is divided into three regions: Northwest, Southwest, and Eastern (Figure 2). Regional offices are primarily responsible for managing park operations, including rangers, law enforcement, volunteers, visitor services, interpretation, infrastructure, and maintenance. More on each region and the three statewide programs evaluated in this project is summarized below.

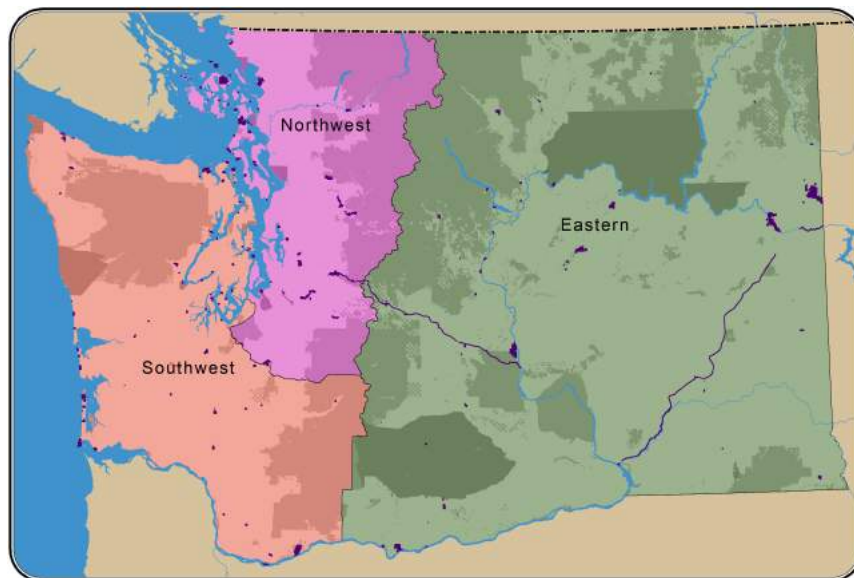


Figure 2. Washington State Parks regions. Purple areas show the locations of parks within each region. Darker shading indicates tribal reservations and lighter shading indicates national parks and national forests. *Figure source: R. Norheim, UW Climate Impacts Group.*

Regions

Northwest Region. The Northwest Region includes 67 parks located in the central and north Puget Sound region, including marine parks in the San Juan Islands. The Northwest Region includes Deception Pass State Park, the agency's sixth largest park by area and its most visited park (almost 2.7 million visits in 2015).³ Other popular parks in the region include Lake Sammamish (more than 1.3 million annual visits), Moran State Park (almost 800,000 annual visits), Birch Bay State Park (almost 800,000 annual visits), and Saint Edward State Park (approximately 620,000 annual visits)³. The Northwest Region also includes many notable historical structures and cultural sites, including Fort Casey State Park, Peace Arch State Park, Cama Beach State Park, and Kukutali Preserve, the nation's first park to be co-owned and co-managed by a federally recognized tribe and a state government (in this case, the Swinomish Indian Tribal Community and Washington State Parks).⁴

Southwest Region. The Southwest Region includes more than 83 state parks located predominantly in southwest Washington and western Puget Sound. The Southwest Region includes Cape Disappointment State Park, home to the oldest operating lighthouse in the Pacific Northwest and the terminus of Lewis and Clark's 1803 expedition to the West.⁵ The region also includes the Seashore Conservation Area, which was created in 1967 to preserve public access to undeveloped Pacific Coast shoreline. The area protects publicly-owned beaches up to the ordinary high tide line from the south boundary of the Quinault Indian Nation Reservation on the Olympic Peninsula to the mouth of the Columbia River.⁶

Eastern Region. The Eastern Region of Washington State Parks includes 56 parks⁷ located in central and eastern Washington. The Eastern Region includes Mount Spokane State Park, the agency's largest park by area (13,054 acres) and a popular location for skiing, snowmobiling, and summer recreation (Figure 3). Annual average attendance at Mt. Spokane State Park is around 550,000 visits (WSPRC 2010). Other popular parks in the region include Riverside State Park (Spokane; almost 1.3 million visits each year) and Sun Lakes-Dry Falls State Park (approximately 1 million visits annually) (Schundler et al. 2015, WSPRC 2003).



Figure 3. Snowmobiling at Mt. Spokane State Park.

Statewide Programs

Winter Recreation Program. The Winter Recreation Program has four employees who manage winter recreation activities at more than 120 Sno-Parks in the Washington Cascades and eastern Washington. Sno-Parks are divided into one of three types: Non-Motorized Sno-Parks (approximately 40 parks⁸), Snow Play Sno-Parks (5 parks⁹), and Snowmobile Sno-Parks (approximately 80 parks¹⁰; Figure 3). Approximately 3,000

³ Personal correspondence, S. Heller, June 14, 2017.

⁴ Swinomish Indian Tribal Community, <http://www.swinomish-nsn.gov/resources/environmental-protection/kukutali-preserve.aspx>

⁵ Washington State Parks and Recreation Commission, <http://parks.state.wa.us/486/Cape-Disappointment>

⁶ Washington State Parks and Recreation Commission, <http://parks.state.wa.us/DocumentCenter/Home/View/1524>

⁷ Park counts for the three Park regions based on GIS data.

⁸ <http://parks.state.wa.us/452/Non-Motorized-Sno-Parks>

⁹ <http://parks.state.wa.us/647/Snow-Play-Sno-Parks>

¹⁰ <http://parks.state.wa.us/304/Snowmobile-Sno-Parks>



miles of trail are dedicated to snowmobiling; another 300 miles of trail is reserved for non-motorized activities, such as downhill and cross-country skiing, snowshoeing, skijoring (Figure 4),¹¹ dog-sledding, “fat tire” biking, tubing, and general snow play (WSPRC 2016). Ninety-five percent of the Sno-Park system trails are located on U.S. Forest Service land.

The Winter Recreation Program is self-supported via sales of winter recreation permits and snowmobile registrations. Operational responsibilities at Sno-Parks include plowing parking lots, trail grooming, and providing and maintaining sanitation facilities. Parks provides these services from December 1-March 31, depending on funds and weather. If funds are insufficient, Parks may end services early at some locations. Sno-Park parking permits end April 30.



Figure 4. Skijoring in a Sno-Park. Photo credit: *Washington State Parks, via Twitter post on November 12, 2015.*

Planning. The Planning Program has five employees, and is responsible for long-term facility planning (typically a 20-30-year planning horizon), land acquisition and classification (e.g., determining zones for specific uses within parks), and partnership building. Planning also conducts public outreach on larger public policy issues affecting parks and manages interpretive programs, volunteer programs, and resource tracking (e.g., energy use).

Stewardship. The Stewardship Program has 16 full-time employees, and is responsible for protecting and managing natural and cultural heritage resources located in Washington State parks. These include:

- More than 700 historic properties, such as historic forts, lighthouses, an historic court house, and various structures built by the Civilian Conservation Corps (Figure 5);
- Natural resources of conservation significance, including lowland old growth forest, habitat used by threatened and endangered species, and areas with unique plant associations found only in state parks;
- Native ecosystem resilience, health, and function; and
- Undeveloped areas of the park system (90% of the land base), which serve as the backdrop for most recreational activities and are the top reason that people visit state parks.



Figure 5. One of the kitchen shelters built by the Civilian Conservation Corps (CCC) in the 1930s. Millersylvania State Park.

¹¹ Skijoring is a winter recreation activity that involves pulling a skier by horse, dog(s), or motor vehicle (<https://en.wikipedia.org/wiki/Skijoring>)

The Stewardship Program is also responsible for managing potential risks associated with wildlife, tree health, pests and disease, exotic species control, wildfire, and providing statewide coordination of environmental review and compliance.

Assessment Approach

The Washington State Parks climate change vulnerability assessment was designed to provide an initial qualitative assessment of how climate change may affect park properties, infrastructure, and operations. Conducted between April and June 2017, the assessment combines available information from published literature, data, tools, and methodologies with the expert knowledge of Washington State Parks and Recreation Commission staff and the University of Washington Climate Impacts Group. The assessment focused on projected changes through 2100.

To begin the project, CIG developed brief summaries of projected climate change impacts relevant to State Parks by drawing on existing literature and data sets (see Appendix B). This information was prepared for use in vulnerability assessment workshops with Parks staff. CIG also conducted a total of 10 pre-workshop phone interviews with representatives from each Statewide program and region to develop a better understanding of the current management priorities, how extreme events currently affect Parks, and concerns about climate change impacts. The interviews included the following questions:

1. What are the current near-term (1-2 year) and longer term priorities for your work?
2. How do current extreme events or climate-related stressors affect what you do or manage for?
3. How has your program or region considered or addressed climate change thus far?
4. What are the issues that come to mind when you think about climate change impacts on your program or region?
5. What would you like to get out of this vulnerability assessment?

The second phase of the project involved vulnerability assessment workshops (Figure 6). CIG staff convened four workshops with State Parks staff to evaluate how climate change is expected to affect State Parks. The first workshop focused on three statewide programs: Winter Recreation, Planning, and Stewardship (10 participants). The remaining three workshops focused separately on each of the agency's three regions: the Northwest (six participants), Southwest (seven participants), and Eastern (eight participants) regions.

Workshop discussions were structured to identify and evaluate climate-related risks and implications for State Parks properties, infrastructure, and operations. To help differentiate the potential importance of different impacts, workshop participants were asked to rate the agency's ability to adjust to or accommodate climate change impacts based on normal resources and authorities.



Figure 6. State Parks staff participating in the Eastern Region workshop. *Figure source: UW Climate Impacts Group.*

They were then asked to rate the consequence of each impact, taking into account the ability to adjust (Table 1). Each workshop identified vulnerabilities common to State Parks within the region or a program while also providing an opportunity to discuss issues specific to individual properties.

Table 1. Ability to adjust and consequence rating keys used by staff during project workshops for rating climate change impacts.			
Ability to Adjust	Easy to adjust to or accommodate (“a blip”)	Moderately difficult to adjust to or accommodate (“this would be a hassle, but we could deal with it”)	Hard to adjust to or accommodate (“this would be a big problem”)
	Minor adjustment would be required to maintain service/meet overall program objectives, and this additional action can be easily accommodated.	Additional action or adjustment would be required to maintain service/meet overall program objectives, but the adjustment can be made if needed.	Substantial and/or costly action would be required to adjust to this impact. This impact would be very difficult to accommodate.
Consequence	Low consequence (“a blip”)	Moderate Consequence (“this would affect us in a meaningful way, but we could deal with it”)	High Consequence (“this would be a major issue for our program”)
	The climate change impact would have a minor impact on what we do, how we do it, and/or what’s required to meet our program responsibilities.	The climate change impact would have a moderate impact on what we do, how we do it, and/or what’s required to meet our program responsibilities. The objectives/services could still be largely met, but notable tradeoffs will be required and/or some losses in service may be incurred.	The climate change impact would have a significant impact on what we do, how we do it, and/or what’s required to meet our program responsibilities.

As part of the workshop approach, the project team and staff viewed sea level rise scenarios for various locations of interest identified by staff during the workshop. Because of the large number of coastal properties in the park system and the short amount of time available to complete the project, the project team initially used Climate Central’s Surging Seas¹² viewer to explore the impact of different sea level rise scenarios during the workshops. The project team subsequently developed a set of sea level rise maps integrating GIS information on facilities, roads, and other park features for the subset of parks that staff chose to view during the workshop (Appendix D; Figure 7). The maps show areas potentially affected by +1 foot and +2 feet of sea level rise relative to the ordinary high tide (the Mean High High Water mark, or MHHW; Figure 7). A storm surge value of +3 feet is also mapped. This storm surge level is the approximate value of the observed 1% annual probability water level (i.e., the 100-year storm tide) for the Puget Sound region and outer Washington coast, excluding Toke Point, and relative to MHHW (Zervas 2005; see also, NOAA Extreme Water Levels¹³). Surge at individual locations will vary slightly from this value; the value for Toke Point is considerably higher: +5.7 feet (Zervas 2005). Research

¹² Available at: <http://sealevel.climatecentral.org/>

¹³ Available at: <https://tidesandcurrents.noaa.gov/est/>

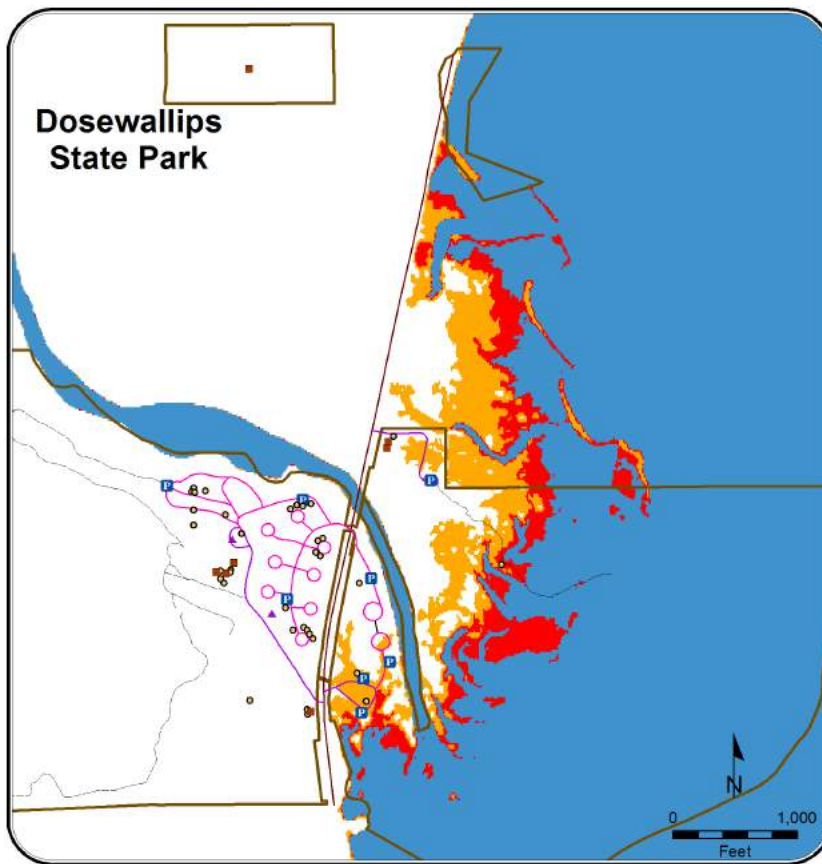


does not project any change in maximum storm surge at this time, however higher sea level will increase the potential for damage by storm surge by allowing surge to reach further inland.

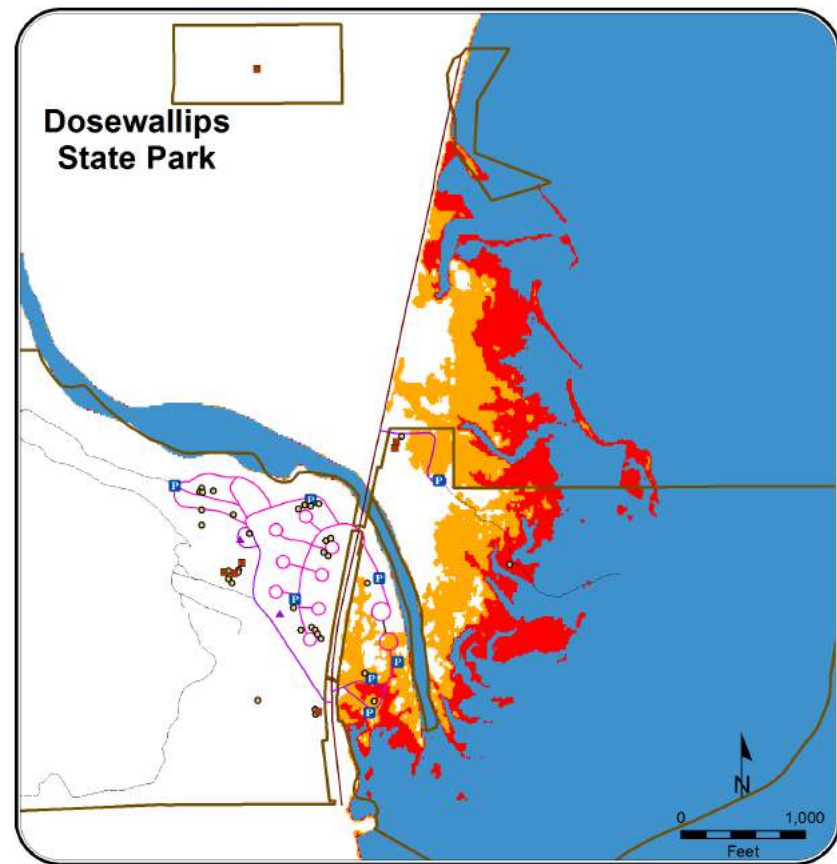
The +1 and +2 foot sea level rise values shown on the maps are proximate to or within the current range of sea level rise projected for Washington by 2050 (mean of +6 in. with a range of -1 to +19 in.) and 2100 (mean of +24 in. with a range of +4 to +56 in.) (NRC 2012). A third representation of potential sea level rise risk is found by combining the value of the mean increase in sea level rise for 2100 (+2 feet) with the +3 feet storm surge level. This combined value (+5 feet, or +60 inches) illustrates areas that could be permanently inundated by the current upper estimate for sea level rise in 2100 (+56 inches).

It is important to remember that while the maps are useful for showing areas that are likely to be permanently inundated or affected by higher surge, the maps are not able to capture the dynamic effects of coastal erosion and bluff sloughing. These processes can influence how sea level rise affects a park by changing the shape of a coastline over time and altering sediment movement in the nearshore. This also means that the size of the projected inundation/storm surge zones should not be the sole determinant for interpreting how sea level rise affects parks. This is particularly true in the Puget Sound region, where many beaches are narrow and backed by coastal bluffs.





Data sources:
 * Washington State Parks
 * NOAA Office for Coastal Management



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 * Washington State Parks
 * NOAA Office for Coastal Management

1 **Figure 7.** Sea level rise maps for Dosewallips State Park. The +1 and +2 foot sea level rise values shown on the maps are proximate to or within the current
 2 range of sea level rise projected for Washington for 2050 (mean: +6 inches, range: -1 to +19 in.) and 2100 (mean: +24 inches, range: +4 to +56 in.) (NRC 2012).
 3 A 1% annual probability storm surge value of +3 feet is also mapped. The maps do not capture the dynamic effects of coastal erosion and bluff sloughing, which
 4 can affect the reach of inundation zones over time, or the combined impacts of more river flooding with higher sea level. *Figure source: R. Norheim, UW*
 5 *Climate Impacts Group.*