

Appendix A: Northwest Region Vulnerability Assessment Workshop Summary

Prepared by

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Overview of the Region

The Northwest Region of Washington State Parks includes 67 parks³⁰ located in the central and north Puget Sound region, including San Juan Islands (Figure 1). 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).³¹ Other popular parks in the region include Lake Sammamish (more than 1.3 million annual visits), Moran State Park and Birch Bay State Park (almost 800,000 annual visits each), and Saint Edwards State Park (approximately 620,000 annual visits) (*ibid.*).

The Northwest Region also includes many notable historical structures and cultural sites, including the following:

- Fort Casey State Park, on Whidbey Island, is home to a U.S. Army fort constructed in the late 1800s and used World War II.³²
- Peace Arch Park, a day use park located on the border with Canada, includes the Peace Arch Monument. The monument was constructed in 1921 to celebrate the 100th anniversary of the Treaty of Ghent, which ended the War of 1812 between the U.S. and the United Kingdom and created a process for formalizing the final location of the U.S.-Canada boundary. The monument is also recognized as the first structure in the world dedicated to celebrating peace.³³
- Cama Beach State Park includes approximately 50 bungalows, constructed in the 1930s, that can be rented for overnight stays. The park was acquired in 1994 and is also notable as an area historically use by tribes for fishing and hunting.
- Deception Pass State Park includes 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).³⁴ The preserve was historically used by the Tribe for shellfish gathering and beach seining for salmon.³⁵

Northwest region staff priorities in the near term (next 1-2 years) include a continued focus on providing good customer service to parks visitors and ensuring natural and historical resource preservation and protection. Internally, the Northwest Office (along with other regions and headquarters) is still recovering from and adjusting to significant budget cuts in 2011. The cuts affected staffing levels, training opportunities, and other program priorities. Managers are working to restore resources, staffing, and professional training opportunities where possible.

Staff are also looking to develop a model to improve maintenance activities (e.g., determining the right mix of staffing to meet daily maintenance needs plus the capacity to maintain and foster resources into the future). Finally, regional staff are working on ways to prioritize projects and needs for the region.

³⁰ As accounted for in GIS. See Figure 1.

³¹ Personal correspondence, S. Heller, June 14, 2017.

³² Washington State Parks and Recreation Commission, <http://parks.state.wa.us/505/Fort-Casey>

³³ Washington State Parks and Recreation Commission, <http://parks.state.wa.us/562/Peace-Arch>

³⁴ Swinomish Indian Tribal Community, <http://www.swinomish-nsn.gov/resources/environmental-protection/kukutali-preserve.aspx>

³⁵ Swinomish Indian Tribal Community, <http://www.swinomish-nsn.gov/resources/environmental-protection/kukutali-preserve.aspx>

This includes identifying top issues that the region needs to be dealing with and what to focus on.

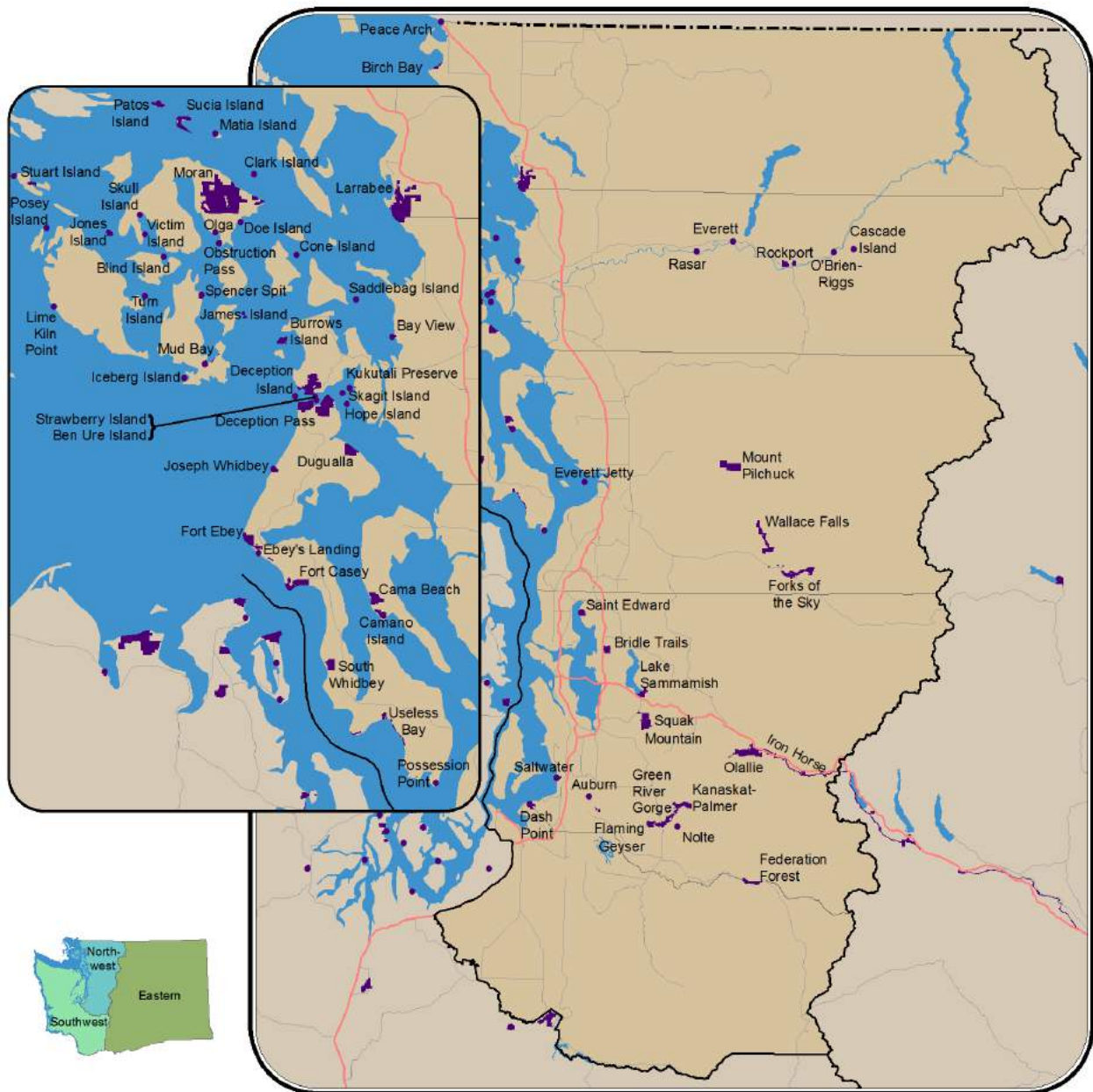


Figure 1. Northwest Region Parks. *Figure source: R. Norheim, UW Climate Impacts Group.*

Key Findings from the Northwest Region Workshop

Input on how climate change could affect Northwest Region parks was solicited through a pre-workshop interview with three staff members and a workshop with Northwest Region staff on May 18, 2017. The pre-workshop interview provided an opportunity to learn more about the region and initial staff thoughts on region-specific climate impacts. Additional staff with responsibilities in management, planning, operations, and stewardship participated in the workshop (six participants in total).

The workshop began with an overview of the project's origins, objectives, scope, and outcomes. The

morning also included presentations on projected climate change impacts on the Northwest Region and highlights from the pre-workshop interviews. Projected climate change impacts include:

- Increasing seasonal temperatures and more extreme heat events;
- Decreasing snowpack;
- Changes in precipitation, e.g., increasing cool season precipitation and decreasing summer precipitation; more intense extreme precipitation; increased risk of landslides);
- Changes in forest health and fire risk; and
- Sea level rise.

A detailed summary of projected changes for the Northwest Region is included in Appendix B. More on the pre-workshop interview and project methodology is included in Section 2 of the assessment report.

Region-wide Discussion

Staff were asked to discuss how different climate change impacts could affect properties, infrastructure, and operations in the Northwest Region. For each impact identified, staff rated 1) the ability to adjust to or accommodate the impact (assuming normal resources and authorities), and 2) the consequence of the impact, taking into account the ability to adjust (Table 1). Where relevant, parks where specific impacts may be an issue were noted. After discussing the range of impacts relevant to the Northwest Region, staff were asked to identify the top three impacts that are likely to be most important to the Northwest Region. Those were:

- Sea level rise and related coastal hazards (e.g., coastal flooding, erosion, storm surge, and permanent inundating),
- Changes in precipitation and hydrology (e.g., extreme precipitation, increased flooding, and a higher risk of landslides), and
- Changes in wildfire risk, forest health, and non-native invasive species.

Sea Level Rise and Related Coastal Hazards

Staff considered sea level rise a top concern given the large number of Northwest Region parks located on the shoreline and the potential costs associated with adapting to sea level rise. Potential impacts noted by staff include permanent loss of low-lying park properties, damage to low-lying park facilities (e.g., buildings, septic systems, parking lots, docks, beach stairs), reduced access to facilities or park features due to higher tidal reach or damage to infrastructure, saltwater intrusion into local groundwater supplies, and exposure of archaeological deposits due to increased erosion.

Changes in Precipitation and Hydrology

The next set of concerns (i.e., impacts that are “hard to adjust to” and “high consequence”) related to the effects of increasing winter precipitation and more intense heavy rain events. More landslides, land movement, or sloughing from bluffs or other unstable slopes can damage trails or other park infrastructure and cut off access to park features. The unpredictable frequency, location, and size of slides makes it difficult to plan for in budgeting processes yet an immediate response is often required, diverting staff and financial resources from other priorities. Furthermore, repairs or permanent solutions to slides can be difficult to fund and permit.

Table 1. Adjustment and consequence rating keys 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.

The potential for problems with septic systems, an increased risk of river flooding, and damage to culverts were also rated as “hard to adjust to” and “high consequence”. More specifically:

- *Septic systems.* Higher groundwater levels and heavier rain events could affect septic system performance, particularly older systems. Relocating systems may be difficult and/or require moving restroom facilities farther from parking lots, creating inconveniences for visitors.
- *Flooding.* The potential for larger flood events could damage parks properties adjacent to rivers, requiring repairs and changes in infrastructure design (e.g., may need to widen bridges to allow passage of higher flood flows).
- *Culverts.* Staff anticipate more problems with culvert capacity because of more intense heavy rain events. The region already has an issue with undersized culverts at several parks. Redesigning culverts to accommodate higher flows can be expensive.

Changes in Wildfire Risk, Forest Health, and Non-Native Invasive Species

The third most important set of impacts for the Northwest Region, according to staff, were impacts associated with changes in forest health, increasing fire risk, and non-native invasive species. The “Ability to Adapt” and “Consequence” ratings for these impacts varied, however. The potential for more tree health issues (due to insects, disease, and pathogens) and an increasing fire risk (due to warmer seasonal temperatures and increasing summer drought stress) will require more proactive management

to avoid campground closures and safety risks. Staff are already actively engaged in managing tree health and fire risk so the ability to adapt to this expected change was considered easy, assuming funding is available. However, staff also noted that aggressive thinning and/or required clearing to remove diseased trees can be difficult in the face of public and political pressure to preserve trees. Tree fall can also have consequences for public safety so the consequence was considered medium.

Expectations that conditions may become more favorable to the spread of non-native invasive species rated “hard to adjust to” and “high consequence.” Regional staff have experience managing non-native invasive species but limited resources for invasive species management and public and political expectations that these invasive species will be eliminated (coupled with legal responsibilities to remove the invasives) add to the challenge of managing non-native invasive species on park properties.

Other Impacts

Other impacts discussed by staff included the expectation the potential for increased visitor use in authorized and unauthorized areas as temperatures warm (with related issues for more wear-and-tear on facilities and trash in unauthorized use areas), the potential for shifts in recreation activities in response to changing conditions (impacts on revenue are uncertain), the potential for more water quality issues at swimming beaches (potentially leading to more beach closures), and increasing water stress at locations with limited water supplies (e.g., San Juan Island Marine Parks). More information on the range of issues discussed is summarized in Table 2 at the end of this section.

“Deep Dive” Discussion

After discussing climate change impacts on Southwest Region properties, infrastructure, and operations by the drivers of those impacts (e.g., increasing temperatures, changes in precipitation, etc.), regional staff selected a limited number of individual parks for discussion on climate change impacts at individual locations. The decisions on which sites to review for the site-specific discussion were made during the workshop. Coastal sites likely to be affected by sea level rise were of particular interest to staff.

Climate Central’s “Surging Seas Risk Zone Map”³⁶ was used to examine how different amounts of sea level rise could affect individual parks. The online tool gives users the ability to enter a specific location and view sea level rise inundation zones associated with up to 10 feet of sea level rise in one foot increments. As a ready-to-use online desktop-tool, the Risk Zone Map tool provided maximum flexibility to view any park requested by staff without having to map all parks in advance. However, the tool does not allow users to integrate their own GIS information into the results. The project team subsequently mapped sea level rise for a select set of locations, based on workshop discussions and additional staff input, using State Parks GIS data and the NOAA sea level rise data³⁷ used in the Surging Seas tool.

A list of the maps produced after the regional workshops are included in Box 1 (see also Appendix D). An example of the maps is shown in Figure 2. The maps show areas potentially affected by +1 foot and +2 feet of sea level rise relative to the ordinary high tide (Mean High High Water mark, or MHHW). A storm surge value of +3 feet is also mapped. This storm surge level is the approximate value of the observed

³⁶ <http://sealevel.climatecentral.org/>

³⁷ NOAA Office for Coastal Management (<https://coast.noaa.gov/digitalcoast/tools/slr.html>)

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 2005³⁸; see also, NOAA's Extreme Water Levels data set³⁹). Surge at individual locations will vary slightly from this value; the value for Toke Point is considerably higher: +5.7 feet. Climate change projections for storm surge are not available, however higher sea level will allow storm 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 for 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).⁴⁰ 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. See Appendix D for the sea level rise maps and more information on the details included in the maps.

The deep dive discussions for individual locations were fairly brief due to time limitations and staff interest in looking at multiple sites, but the exercise proved beneficial to helping staff develop a better visualization of the extent of sea level rise on individual properties and specific pieces of infrastructure that may be affected. Site-specific issues noted during the deep dive discussion included the following:

- *Cama Beach*. Cama Beach includes approximately 50 mid-century bungalows (1930s-50s era) that sit between 10 inches and 30 inches above grade. The site regularly floods with King Tides.

Box 1. Northwest Region sea level rise maps produced based on workshop discussions

Bay View State Park
Birch Bay State Park
Cama Beach State Park
Camano Island State Park
Dash Point State Park
Deception Pass State Park
Fort Casey State Park
Fort Ebey State Park
Iceberg Island State Park
Jones Island State Park
Joseph Whidbey State Park
Larrabee State Park
Lime Kiln State Park
McMicken Island State Park
Obstruction Pass State Park
Posey Island State Park
Saltwater State Park
South Whidbey State Park
Spencer Spit State Park
Turn Island State Park

³⁸ Zervas, C. E. (2005). Response of extreme storm tide levels to long-term sea level change. In OCEANS, 2005. Proceedings of MTS/IEEE (pp. 2501-2506). IEEE.

³⁹ <https://tidesandcurrents.noaa.gov/est/>

⁴⁰ (NRC) National Research Council 2012. *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future*. Washington, DC: The National Academies Press.

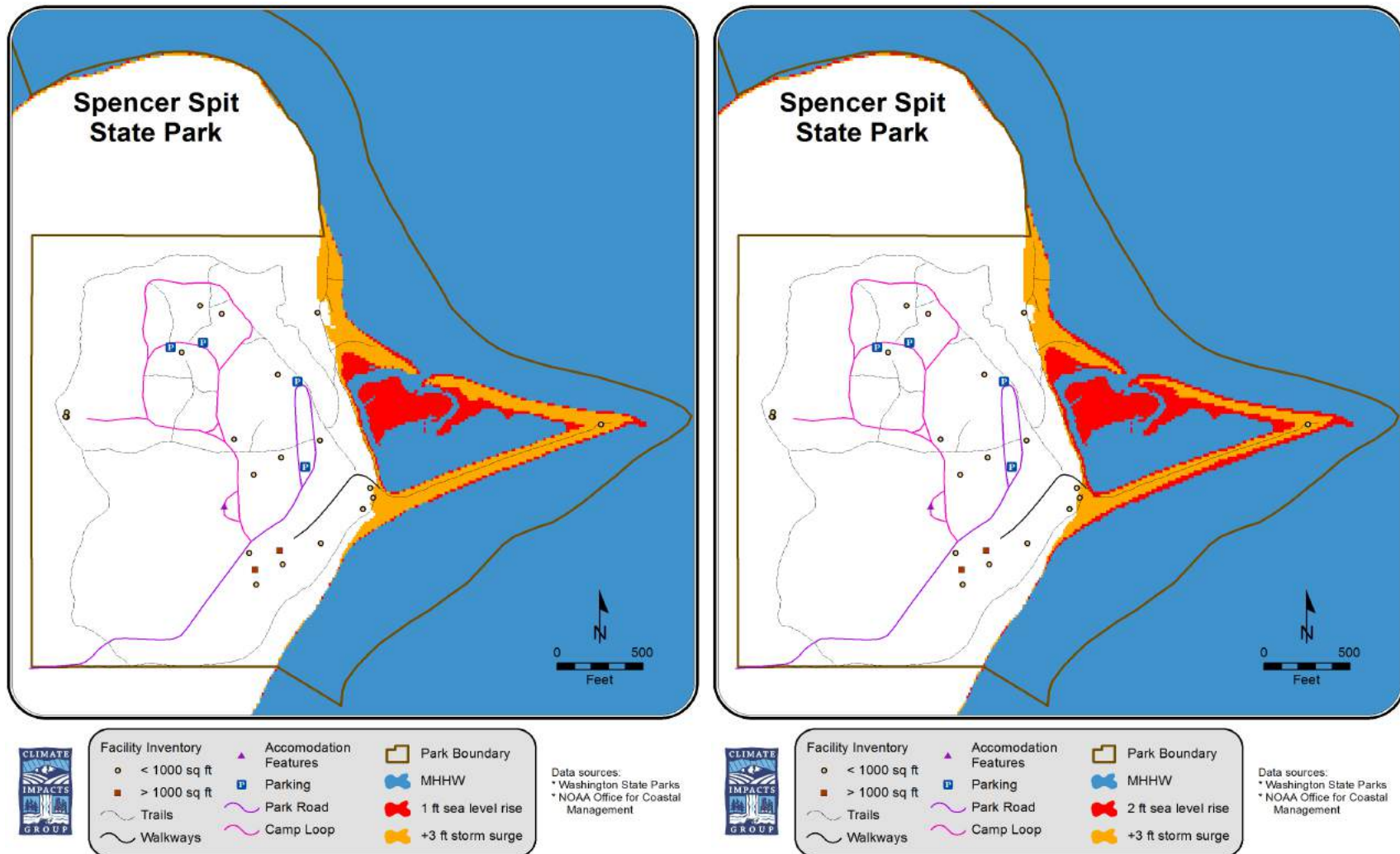


Figure 2. Sea level rise maps for *Spencer Spit* State Park. The +1 and +2 foot sea level rise values shown on the maps are proximate to or within the current range of sea level rise projected for Washington for 2050 (mean of +6 in. with a range of -1 to +19 in.) and 2100 (mean of +24 in. with a range of +4 to +56 in.) (NRC 2012). A 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 can affect the reach of inundation zones over time. Figure source: R. Norheim, UW Climate Impacts Group.

Staff will turn off pump stations when they know there is going to be a high tide and a storm. The cabins may flood depending on water levels and location but staff have time to dry them out before the summer season. Higher amounts of sea level rise (starting around 4 feet) could permanently inundate the cabin area but because the structures and landscape are historic, the agency would likely do more to ensure use of the site for as long as possible (e.g., raising cabins again, sea wall). Development could eventually be moved uphill while keeping structures around for day use or for historical perspective. There is a lot of public interest in this park; that public interest may dictate how sea level rise concerns are ultimately handled. Inundation could also increase the potential for slides from nearby bluffs. Shoreline and bluff erosion could expose more archaeological sites in the park (e.g., tribal sites, mammoth bones), in addition to affecting structures.

- *Deception Pass*. Cranberry Lake is an important revenue source for the Northwest Region; sea level rise impacts on that lake would be a concern. Deception Pass has had a number of forest health issues in the campground area; a group camp site was eliminated due to forest health problems.
- *Bowman Bay*. The Civilian Conservation Corps museum appears to be outside the area affected by sea level rise. The drain field for the septic systems would be affected by four feet of sea level rise, however.
- *Birch Bay*. Birch Bay may be more susceptible to surge given its location. Birch Bay Road includes sewer and electrical lines to nearby communities outside the park. This creates the potential for coastal squeeze between the road and Puget Sound if there is interest in protecting the road because of issues with access and utilities.
- *Lake Sammamish*. Lake Sammamish State Park is one of the most heavily used parks in the region. The park is busy most of the year (especially with new playground). The big issues for Lake Sammamish are urbanization and flooding from Issaquah Creek. If climate change results in bigger and more dynamic floods, the new bathhouse and playground could be affected. Parking can also be an issue. Most of the park is a wetland. The parking lot is near the beach area and on grass; the parking lot is seasonally closed because of flooding. The park also has a history of swim beach closures (1-2x/summer for a few days at a time) due to bacteria. The cause of the contamination is not clear (probably a mix of reasons) but the beach is now getting tested weekly.

Table 2. Preliminary assessment of climate change impacts for Northwest Region parks, as identified and rated by staff during the Northwest workshop.

Projected climate change impacts	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
<p>Increasing temperatures:</p> <ul style="list-style-type: none"> Warmer seasonal temperatures More extreme heat events 	<p>Warmer temperatures can increase unauthorized use of undeveloped properties adjacent to water bodies (e.g., Flaming Geyser SP, Fort Casey). Unregulated use is difficult to manage and results in problems with human waste, litter, and other health and safety issues.</p>	<p>Moderately difficult. Dealing with unauthorized use requires staffing that the region doesn't really have and is not able to budget for.</p>	<p>Moderate. Consequences include trash, staffing issues, drug use, homelessness, damage to natural resources, and impacts on budget.</p>
	<p>Warmer temperatures can lead to heavier use of facilities, trails, and other amenities. This includes increased use of restrooms and septic systems, which will require more maintenance.</p> <p>Warmer temperatures could lead to an extended use season, which would require more staffing and more parking. People may be inclined to park in unauthorized areas, affecting natural resources and creating potential safety concerns.</p>	<p>Relatively easy. Heavier usage during nicer weather is already an issue that the region has to manage.</p>	<p>Low. If enough people choose to come to the parks, it could even be a positive impact (more revenue).</p>
	<p>Warmer temperatures may increase use of water areas, requiring more public safety education and monitoring.</p>	<p>Easy. Staff already deal with water and public safety issues.</p>	<p>Low</p>
	<p>Warmer temperatures could lead to temporary closure of more swim beaches due to fecal bacteria, blue-green algae toxins, or other contaminants that pose a health risk. Recent closures include Bay View State Park (2017) and Anderson Lake (2016). Harvesting of butter clams and varnish clams at Dash Point was closed due to biotoxins. Staff noted that the number of closures and problems with contaminants has been increasing over the last few decades but the reason is unclear.</p>	<p>N/A</p>	<p>N/A Impacts on revenue can be significant if closures occur at more heavily used lakes (e.g., closure of Cranberry Lake at Deception Pass would cost the agency \$7-\$10k/day during summer).</p>

Projected climate change impacts	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
<p>Impacts on snow:</p> <ul style="list-style-type: none"> • Lower snowpack • Shorter snow season • Changes in snow quality are uncertain 	<p>Lower snowpack and earlier snowmelt could increase and/or shift the demand for recreational activities such as mountain biking, offsetting potential recreational impacts in other seasons and at other parks in the region.</p>	<p>Easy</p>	<p>Low</p>
<p>Changes in precipitation:</p> <ul style="list-style-type: none"> • Increasing fall, winter, spring precipitation • More intense/more frequent heavy rain events • Increased soil saturation in winter • Decreasing summer precipitation 	<p>More winter precipitation and heavier extreme precipitation events are likely to lead to more landslides, land movement, or sloughing. These issues are already affecting the region, particularly this year. Staff noted that in the last six months they have seen more land movement than years prior. This includes landslides at Saltwater, Dash Point, and St. Edwards state park. As noted in the interviews, two bungalows at Cama Beach had to be moved because of unstable upslopes. Washouts have also occurred on trails at Olallie (Twin Falls Trail) and at South Whidbey Island SP. Camano Island road washout (over a long period of time).</p>	<p>Hard. Dealing with landslides and related land movement can be costly and there is often no clear solution. The state budget is set every two years but these events can occur without notice and need immediate response. This leaves the region scrambling to find resources for geotechnical reports and permits. Many of the solutions are temporary; fixes could wash out the next year. Permitting for repairs is often complicated - slides tend to happen in areas that are more difficult to permit to begin with.</p>	<p>High. Slides can shut down of facilities, require relocation of facilities, and impact access. Dealing with slides has consequences for the region's fiscal resources and staff time, as noted in the Ability to Adjust column. This can affect the ability to get other scheduled projects done.</p>
	<p>Septic systems would be affected by more rain/heavier rain events. The Northwest Region has numerous old septic systems. The tanks are taking in stormwater, which can compromise performance. Higher groundwater and more soil saturation could exacerbate this. May require putting in more composting toilets or moving facilities uphill, which can put them farther away from parking lots (a problem for visitors).</p>	<p>Hard. Dealing with compromised septic systems is costly and requires advance planning. In a few cases, there is the option of hooking into municipal systems. In other cases, may need to put in composting toilets or move facilities uphill, which can put them farther away from parking lots (a problem for visitors).</p>	<p>High. Failing septic systems can create environmental issues. Solutions may affect visitor convenience, satisfaction.</p>

Projected climate change impacts	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
	More extreme precipitation could damage culverts . Culverts can blow out if not maintained. Capacity is already an issue at Larabee, Camano, and Moran state parks. Culverts have also washed out at Iron Horse Trail.	Hard . May require redesigning culverts and/or making them larger, which is costly.	High , given costs and regulatory issues related to culverts. Cultural sensitivity where culverts are on fish-bearing streams.
	Less summer precipitation, combined with warmer summers and declining snowpack (where relevant), may lead to water restrictions , which can affect the ability to irrigate parks properties and overall water supply issues for restrooms and other facilities. Lower summer precipitation could exacerbate water supply issues in the San Juan Islands Marine parks . Those areas already have a limited water supply (wells that dry up).	Relatively easy . If water restrictions affect irrigation, staff can post information to raise public awareness. Parks is moving to more composting facilities, especially in areas where water is more limited. Visitors will have to bring water to islands where water supply becomes an issue.	Low . Potential for more complaints about brown grass (received many in summer 2015) but public education and signage will help. May affect visits to San Juan Island marine parks.
	<p><i>Other factors discussed but not rated:</i></p> <ul style="list-style-type: none"> • When you have more saturated ground, you can get more damage from the same wind events • Higher ground saturation can create issues for underground electrical equipment (an issue with utilities at Camano Island) • Would higher winter precipitation help offset increased groundwater usage in summer? Possibly but it depends on the aquifer (would not help in San Juan Islands) 		
<p>Changes in hydrology:</p> <ul style="list-style-type: none"> • Higher winter streamflows • Increasing flood risk • Lower, warmer summer streamflows • Longer summer low flow period 	More winter flooding could damage parks facilities , creating additional work for operations and maintenance, and require changes in infrastructure design (e.g., making bridges longer, bigger culverts). Flooding can also create temporary access problems and cause erosion affecting roads and trails.	Hard . Need financial resources to deal with this. Damage may be covered by FEMA in some cases, but only as a one-time repair. If repeat damage or damage not eligible for FEMA funds, the region has to deal with the costs of repair. Complex permitting, design considerations.	High , due to financial implications and impacts on operations, visitor access.
	Lower summer water levels can affect summer recreation opportunities such as river rafting and fishing.	Easy	Low

Projected climate change impacts	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
<p>Changes in vegetation:</p> <ul style="list-style-type: none"> • Increased drought stress • Increased risk of wildfire • Impacts on tree health from insects, disease 	<p>Projected increases in seasonal temperature and more summer drought stress are expected to increase the risk of fire in parks. Northwest Region parks have had fires in isolated areas at Deception Pass, Ft. Ebey, Hope and Jones Islands, and the Index climbing wall. An increased forest fire risk can lead to more frequent or more prolonged burn bans, affecting camper experiences at the park. If/when a fire occurs, park use and access are affected, ultimately impacting revenue. Any fires require a first-line response by Parks staff until other services arrive and restoration post-fire.</p>	<p>Moderately difficult. Addressing an increasing risk of fire requires more proactive forest fuel reduction.</p>	<p>Medium. Consequences are mostly revenue related; revenue can be affected is visits decrease. Parks is also self-insured so there is no insurance to recover costs if you lose a building. The agency can get push back from the public when removing trees for forest health and fuel reduction (public sensitivity to removing trees from parks).</p>
	<p>Projected increases in seasonal temperature and more summer drought stress are expected to leave more trees vulnerable to insects, diseases, or pathogens that compromise tree health. This could lead to more campground closures (e.g., South Whidbey State Park), diseased tree removal (e.g., removal at Moran State Park due to laminated root rot), and impacts on ecological function and the landscape of parks. In general, there will be an increased need for active forest management as changes occur. Two tree fall-related fatalities have occurred in the parks system state-wide in recent years (Lake Wenatchee and South Whidbey.)</p>	<p>Easy, assuming funding is available. Parks staff are already actively engaged in managing tree health. More active management will be required but the people and systems are in place.</p>	<p>Medium. Consequences include potential public safety issues; the opportunity cost of having to spend more on tree management (that funding is not going to other uses). Park appearance can affect ability to make revenue; lots of diseased trees or aggressive thinning to manage risk could run up against public and political pressure and the expectation that Parks is a steward of the natural resources in parks.</p>

Projected climate change impacts	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
	<p>Projected increases in seasonal temperature and changes in precipitation could facilitate the spread of non-native invasive species, although the response of individual invasives will vary (some may benefit from changing conditions while others may not). Non-native invasive species are becoming more of an issue state-wide, particularly along linear trails that run near farmlands and other private property. There are public expectations that Parks will keep invasive species from spreading onto adjoining public lands. More non-native invasive species require more weeding and higher property management costs.</p>	<p>Moderate to hard. While Parks has experience with managing non-native invasive species, there is increased focus on the issue, new areas affected, and not a lot of resources to address the problem. Have had good responses from volunteer groups to help out.</p>	<p>High. Funds spent on more non-native invasive species management are not going to other uses. Non-native invasive species can impact the ecological function and landscape of the park. There is strong public and political pressure to eliminate the invasives; there is a legal responsibility (codified) - if you have non-native invasives, you need to be actively removing it. Deferred maintenance can create more pressure to use herbicides, which is not the preference.</p>
<p><i>Sea level rise:</i></p> <ul style="list-style-type: none"> • Increased coastal flooding • Increased surge, wave energy • Increased erosion • Inundation of low-lying areas • Increased saltwater intrusion in groundwater wells, septic • Changes in nearshore habitat 	<p>Sea level rise is likely to result in a variety of impacts depending on how much and how quickly sea level rises. Noted impacts include the following:</p> <ul style="list-style-type: none"> • Loss of low-lying park lands, including beaches, to permanent inundation • Access to facilities may be disrupted and low-lying parking lots may become unusable for longer periods of time with higher high tides. • Low-lying facilities may be damaged by higher tides, storm surge (already an issue at Cama Beach SP, Spencer Spit, Bayview). • Increased surge, wave energy, and erosion could expose more archaeological deposits, increasing stewardship responsibilities. • Septic systems could be affected by higher sea level and increased ground saturation • Saltwater intrusion, which is already a problem on Lopez Island at Spencer Spit, could become more of an issue, especially in the San Juan Islands. • On the positive side, sea level rise may result in more opportunities to create new wetland areas 	<p>Hard. Dealing with the impacts of sea level rise will be expensive. Parks can raise docks and boat launches but there are limits to how much infrastructure can be raised given the need to ensure access that is compliant with the Americans with Disabilities Act requirements.</p>	<p>High. Sea level rise will affect a lot of Northwest Region properties and what people can do at those properties (due to potential limits on access).</p>

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Overview of Southwest Region Parks

The Southwest Region includes more than 83 state parks located predominantly in southwest Washington and western Puget Sound (Figure 1).⁴¹ 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.⁴² 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.⁴³ Near term (1-2 years) priorities noted by Southwest Region staff are largely centered around maintaining and replacing existing Parks facilities where necessary. About 30% of Region's effort is spent working on new projects and development. Replacing and updating facilities is important and necessary for ensuring that Park facilities are in agreement with existing regulatory compliance regulations (e.g., ADA requirements). Regional staff are also continuing to address staffing issues. Emphasis is on staff retention and, when possible, increasing staffing. More generally, Parks staff are continuing to focus on providing good customer service to parks visitors and ensuring natural and historical resource preservation and protection.

Key Findings for the Southwest Region

Input on how climate change could affect Southwest Region parks was solicited through a pre-workshop interview with two staff members and a workshop with Southwest Region staff on May 22, 2017. The pre-workshop interview provided an opportunity to learn more about the region and initial staff thoughts on region-specific climate impacts. Additional staff with responsibilities in management, planning, operations, and stewardship participated in the workshop (seven participants in total).

The workshop began with an overview of the project's origins, objectives, scope, and outcomes. The morning also included presentations on projected climate change impacts in the Southwest Region and highlights from the pre-workshop interviews. Projected climate change impacts include:

- Increasing seasonal temperatures and more extreme heat events;
- Decreasing snowpack;
- Changes in precipitation, e.g., increasing cool season precipitation and decreasing summer precipitation; more intense extreme precipitation; increased risk of landslides);
- Changes in forest health and fire risk; and
- Sea level rise.

A detailed summary of projected changes for the Southwest Region is included in Appendix B. More on the pre-workshop interview and project methodology is included in Section 2 of the assessment report.

⁴¹ Park counts based on GIS data.

⁴² Washington State Parks and Recreation Commission, <http://parks.state.wa.us/486/Cape-Disappointment>

⁴³ Washington State Parks and Recreation Commission, <http://parks.state.wa.us/DocumentCenter/Home/View/1524>

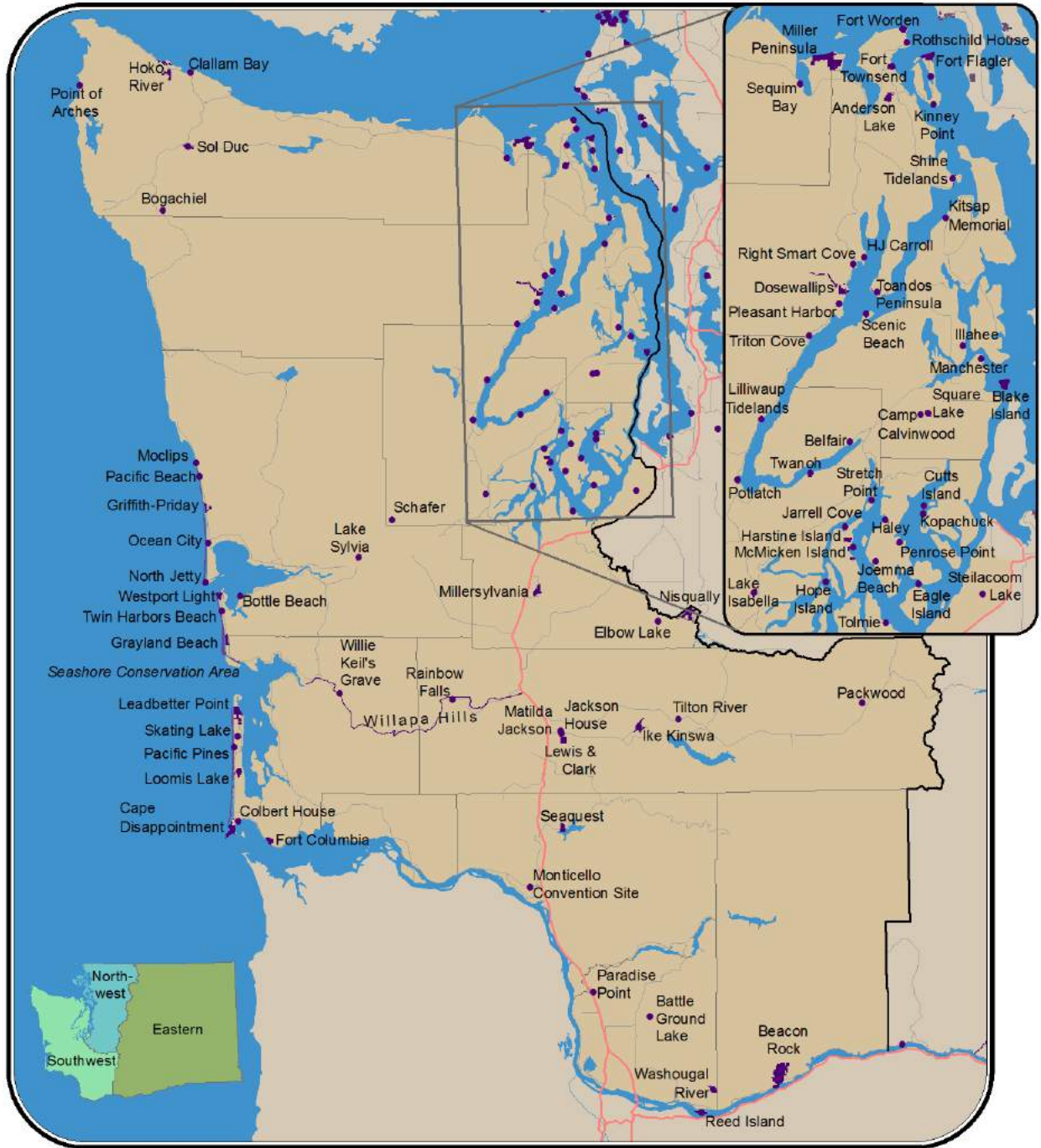


Figure 1. Washington State Parks, Southwest Region. Figure source: R. Norheim, UW Climate Impacts Group.

Region-wide Discussion

Staff were asked to discuss how different climate change impacts could affect properties, infrastructure, and operations in the Southwest Region. For each impact identified, staff rated 1) the ability to adjust to or accommodate the impact (assuming normal resources and authorities), and 2) the consequence of the impact, taking into account the ability to adjust (Table 1). Where relevant, parks where specific

Table 1. Adjustment and consequence rating keys 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.

impacts may be an issue were noted. After discussing the range of impacts relevant to the Southwest Region, staff were asked to identify the top three impacts that are likely to be most important to the Southwest Region. Those were:

- Sea level rise and related coastal hazards (e.g., coastal flooding, erosion, storm surge, and permanent inundating),
- Changes in wildfire risk, forest health, and non-native invasive species, and
- Changes in precipitation and hydrology (e.g., extreme precipitation, increased flooding, and a higher risk of landslides).

More information on these issues and the range of issues discussed by staff during the workshop is summarized below and in Table 2 at the end of this chapter.

Sea Level Rise and Related Impacts

Staff considered sea level rise and related hazards exacerbated by sea level rise (coastal flooding, erosion, storm surge, and permanent inundating) a top concern that is both hard to adapt to and high consequence given the large number of Southwest Region parks located on the shoreline and the potential costs associated with adapting to sea level rise. Potential impacts noted by staff include:

- increased shoreline flooding and permanent inundation of low-lying areas,
- potential closures of parks, facilities, or campsites due to flooding or inundation,
- increased erosion, which could lead to trail loss and/or reduced beach access,

- higher storm surge reach,
- more marine debris on park roads, beaches, and parking lots, and
- an increased risk of saltwater intrusion into wells.

Parks identified as likely to be inundated by staff during the workshop included Bottle Beach, Cape Disappointment, Twin Harbors, and Grayland Beach State Park. Specific facilities in Dosewallips and Potlatch state park are also likely to be affected by sea level rise.

Options for moving low-lying facilities to higher locations may be limited and can be expensive, particularly for historical structures. Staff noted that historical facilities and cultural sites at many Puget Sound parks are already threatened by erosion and storm surge. Examples include Kitsap Memorial, Potlatch, Belfair, Manchester, and Fort Worden state parks.

Erosion and coastal bluff sloughing has also been an issue at southwest parks. For example, bluff sloughing events have occurred at Blake Island, Kopachuck, and Sequim Bay state parks; erosion has affected Manchester and Fort Worden state parks. In some cases, these sloughing and erosion events have limited or blocked access to beaches and trails. Staff noted that that some trails at Kopachuck State Park are slowly falling into Puget Sound as a result of bluff erosion. Parks has made significant efforts to mitigate the effects of erosion; however, erosion continues to be a problem.

Replacing and maintaining shoreline protection structures to address inundation and erosion risks can be difficult and costly. Switching to alternatives like soft shore armoring could be problematic for facilities and parking lots close to the shorelines (e.g., Sequim Bay State Park). Additionally, Parks would be liable if an armoring structure negatively affects an adjacent landowner.

Adapting park water supplies affected by saltwater intrusion would also be difficult. Depending on location, the ability to hook into alternative uncontaminated water sources may be limited. This may require limiting operations or closing facilities where issues cannot be resolved. Belfair State Park and other parks along Hood Canal are more likely to experience these challenges relative to other Southwest Region parks.

Changes in Wildfire Risk, Forest Health, and Non-Native Invasive Species

The next set of concerns considered hard to adjust to and high consequence were projected changes in wildfire risk and tree health, and the potential for more non-native invasive species. As air temperatures rise and summer precipitation declines, tree populations are likely to become drier and more stressed, increasing their susceptibility to drought, disease, and wildfire. Specific insects and diseases of concern include laminated root rot, annosus root rot, cow pie fungus, and *Phellinus pini* (stem rot). Fires have occurred at Beacon Rock and other parks.

Trees damaged by disease or wildfire can become a safety risk to visitors as the trees start to drop branches or fall. This may require heavy pruning or closing campgrounds or day use areas, as has been required at Kopachuck, Schafer, and Twin Harbors state parks. Addressing changes in tree health would require additional staff training to ensure that staff can identify diseased or infested trees. It will also require being more proactive rather than reactionary. For example, emphasis can be placed on treating the entire disturbance agent, not just removing the dead trees. These approaches would require

devoting more staff time to forest health, which would be challenging without additional staff and resources. Increased fire frequency would also require more staff time as Parks staff are the first responders to fires on Parks lands.

Staff also highlighted the increased threat of non-native invasive species as “hard to adjust to” and “high consequence.” While non-natives are already an issue that the Southwest Region must manage, staff noted that it would be challenging to increase the amount of staff time devoted to preventing, identifying, and removing areas of non-native invasive species given limited staff time and resources. This need could run counter to an ongoing public expectation (and legal requirement) that Parks will identify and remove state-listed noxious weeds to reduce spread to adjacent non-Parks properties. If not addressed, more non-native invasive species could degrade habitat and affect relations with adjoining property owners.

Changes in Precipitation and Hydrology

The third most important set of impacts for the Southwest Region, according to staff, were impacts associated with more winter precipitation, more extreme precipitation, increased flooding, and a higher risk of landslides. Staff ranked these impacts as moderately difficult to adjust to and moderate consequence.

Increased winter flooding could cause more extensive damage to park facilities and amenities, including trails, bridges, and campgrounds. This may result in more frequent campsite closures, reduced access, and higher operating and maintenance costs for Parks. For example, Chehalis River flooding in December 2007 destroyed a \$1 million⁴⁴ foot and vehicle entrance bridge at Rainbow Falls State Park when the bridge was struck by woody debris and a dislodged park footbridge carried downriver by floodwaters (AECOM 2012). A water line serving the park was also destroyed. The damage closed the park completely for almost six months and severed the northern and southern parts of the park, effectively closing off access to the south end of the park.⁴⁵ Other parks in the Southwest Region that have closed campsites due to flooding include Potlatch, Belfair, Dosewallips, Ocean City, Twin Harbors, and Grayland Beach state parks. Flooding is also a problem at Schafer State Park (campsites flood annually).

Adapting to more flooding may require moving campsites to higher elevation, as is being done at Schafer State Park. However, these moves can be unpopular with visitors; the public enjoys camping near rivers or the shoreline.

The potential for more landslides is a concern given how ubiquitous steep slopes are in the Southwest Region park system. Landslides can directly damage or block access to parks, trails, beaches, and facilities. Rerouting trails and roads and replacing or repairing infrastructure can be expensive. Sequim

⁴⁴ “Rainbow Falls State Park Back Open Today”, *The Chronicle*, May 23, 2008, http://www.chronline.com/news/article_ab157cf8-134d-5f10-aca5-eee723edd1c8.html

⁴⁵ AECOM 2012. *Final Environmental Assessment: Rainbow Falls State Park Entrance Project Lewis County, Washington*. FEMA-1734-DR-WA (Public Assistance). Prepared by AECOM for the U.S. Department of Homeland Security, FEMA Region X. Available at: https://www.fema.gov/media-library-data/20130726-1831-25045-9010/rainbow_falls_sp_final_ea.pdf

Bay, Manchester, and Lake Sylvia state parks are currently experiencing landslide issues. Access to Cape Disappointment was cut off by a landslide as well.

Another concern related to more cool season (fall, winter, spring) precipitation is the potential impact on construction. The construction window for projects could shrink if conditions are too wet, a problem that has already been an issue in the region according to pre-workshop staff interviews. This may require moving some construction projects to the summer months, when visitation rates are at their highest, or closing parks if maintenance issues are not addressed in time to accommodate visitor use. While the ability to adjust was considered moderate, staff rated the consequences as high. Offseason camping could also be reduced, but this was a low concern relative to other impacts.

Potential issues with summer water supply were also discussed. Warmer temperatures and more extreme heat events increase the chance of water supply interruptions if wells going dry or if water supplies at parks with junior water rights are curtailed. Parks dependent on local municipal water suppliers could see also supplies interrupted if municipal water supplies are strained due to drought (water to parks could be the first place to cut to conserve supplies for other uses). Inadequate water supplies could require trucking water to affected parks or force temporary closure; staff noted that these issues would not be that difficult to adapt to if limited in scale. If the problem becomes more widespread in the region, however, the ability to adjust would become more difficult and the consequences would increase.

Other Impacts Discussed

Southwest Region staff identified a range of potential issues associated with increasing temperatures, including the potential for more park visitors in the shoulder seasons (spring, fall) and during extreme heat events (see Table 2 for details). Parks with water features are most likely to see higher visitation rates during those extreme heat events. The strain on parking facilities would also increase. Warming temperatures may also shift regional patterns of park visits. For example, warming may increase the number of people traveling from eastern Washington (where people may consider it too hot) to visit parks west of the Cascades.

The impacts of warming stream and lake temperatures on recreational fishing and water quality issues related to algal blooms and bacteria were also discussed. As water temperatures increase, the amount of habitat suitable for salmon is likely to go down while habitat suitable for bass increases. This could affect recreation opportunities and incur high ecological consequences.

Algal blooms in lakes are a concern because of the potential consequence to human health prior to detection. Warmer temperatures during summer can increase algal bloom issues in lakes. If specific algal thresholds are reached, Parks is required to close recreational access to the affected lakes. Staff noted that Anderson Lake State Park currently experiences algal blooms.

Similarly, warmer summer water temperatures can increase the potential for *Vibrio* outbreaks in coastal areas, lakes, rivers, and streams, particularly in the southern Hood Canal region. *Vibrio* outbreaks may require shutting down swimming or shellfish harvest areas; however, staff noted that they have not seen any reductions in park use where those closures occur, so the impact is easy to adapt to.

“Deep Dive” Discussion

After discussing climate change impacts on Southwest Region properties, infrastructure, and operations by the drivers of those impacts (e.g., increasing temperatures, changes in precipitation, etc.), regional staff selected a limited number of individual parks for discussion on climate change impacts at individual locations. The decisions on which sites to review for the site-specific discussions were made during the workshop. Coastal sites likely to be affected by sea level rise were of particular interest to staff.

Climate Central’s “Surging Seas Risk Zone Map”⁴⁶ was used to examine how different amounts of sea level rise could affect individual parks. The online tool gives users the ability to enter a specific location and view sea level rise inundation zones associated with up to 10 feet of sea level rise in one foot increments. As a ready-to-use online desktop-tool, the Risk Zone Map tool provided maximum flexibility to view any park requested by staff without having to map all parks in advance. However, the tool does not allow users to integrate their own GIS information into the results. The project team subsequently mapped sea level rise for a select set of locations, based on workshop discussions and additional staff input, using State Parks GIS data and the NOAA sea level rise data⁴⁷ used in the Surging Seas tool.

A list of the maps produced after the workshop are included in Box 1 (see also Box 2 regarding issues related to mapping outer coast parks). An example of the maps is shown in Figure 2 (see Appendix D for maps). The sea level rise maps show areas potentially affected by +1 foot and +2 feet of sea level rise relative to the ordinary high tide (Mean High High Water mark, or MHHW). 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 2005⁴⁸; see also, NOAA’s Extreme Water Levels data set⁴⁹). Surge at individual locations will vary slightly from this value; the value for Toke Point is considerably higher: +5.7 feet. Climate change projections for storm surge are not available; however, higher sea level will allow storm 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 for 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).⁵⁰ A third representation of potential sea level rise risk is found by

Box 1. Southwest Region sea level rise maps produced based on workshop discussions

Belfair State Park
Blake Island State Park
Bottle Beach State Park
Dosewallips State Park
Fort Flagler State Park
Fort Worden State Park
Illahee State Park
Kopachuck State Park
Manchester State Park
Potlach State Park
Scenic Beach State Park
Tolmie State Park
Twanoh State Park

⁴⁶ <http://sealevel.climatecentral.org/>

⁴⁷ NOAA Office for Coastal Management (<https://coast.noaa.gov/digitalcoast/tools/slr.html>)

⁴⁸ Zervas, C. E. (2005). Response of extreme storm tide levels to long-term sea level change. In OCEANS, 2005. Proceedings of MTS/IEEE (pp. 2501-2506). IEEE.

⁴⁹ <https://tidesandcurrents.noaa.gov/est/>

⁵⁰ (NRC) National Research Council 2012. *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future*. Washington, DC: The National Academies Press.

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).

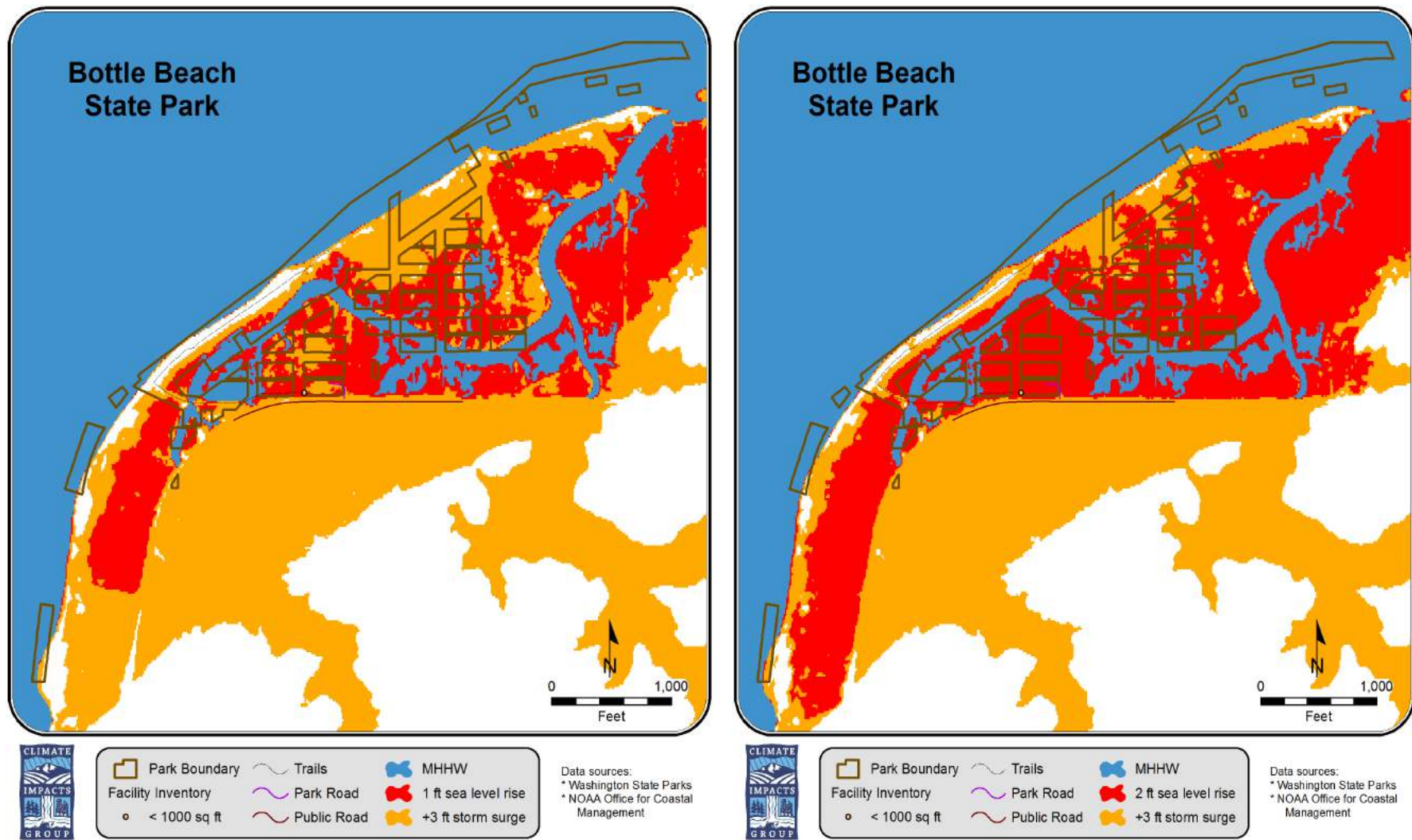


Figure 2. Sea level rise maps for Bottle Beach State Park. The +1 and +2 foot sea level rise values shown on the maps are proximate to or within the current range of sea level rise projected for Washington for 2050 (mean of +6 in. with a range of -1 to +19 in.) and 2100 (mean of +24 in. with a range of +4 to +56 in.) (NRC 2012). A 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 can affect the reach of inundation zones over time. *Figure source: R. Norheim, UW Climate Impacts Group.*

Box 2. A Note About Mapping Sea Level Rise for the Outer Coast Beach Parks

In mapping the sea level rise inundation zones for Ocean City State Park, the project team discovered a discrepancy in how the DEM vertical datum and tidal datum (which is used to determine the boundaries of the Mean High High Water mark) aligned for the park. The problem, which originates in the underlying NOAA sea level rise data, results in an incorrect placement of the sea level rise zones relative to the shore. The finding is consistent with staff comments during the workshop suggesting that the map was under-representing the projected reach of the inundation zones, even at very high levels. The issue for Ocean City State Park and how far it extended down the outer coast beach areas was unresolvable before the conclusion of the project. As a result, no sea level rise maps for beach areas on the outer coast were mapped. The one exception to this outer coast exclusion was Bottle Beach State Park, which is located on the south end of Grays Harbor.

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.

The deep dive discussions for individual locations were fairly brief due to time limitations and staff interest in looking at multiple sites, but the exercise proved beneficial to helping staff develop a better visualization of the extent of sea level rise on individual properties and specific pieces of infrastructure that may be affected. Site-specific issues noted during the deep dive discussion included the following:

- *Manchester State Park.* The largest concern for this park is related to erosion and wave action on the north side of the park. With 4 feet of sea level rise, road access to structures within the Manchester State Park are inundated. However, staff noted that they were not particularly concerned about the impacts of sea level rise to Manchester State Park because the park's campsites and major facilities are not directly affected according to the Surging Seas Risk Zone Map. The facilities that do fall within the inundation area on the mapping tool are not unique or of historical significance, and are therefore of lower priority.
- *Blake Island State Park.* Sea level rise would increase erosion rates and inundate coastal areas of the park. Of particular importance is the inundation of the marina area and the day-use area with heavy day-use activity. Blake Island State Park is considered a unique area, and therefore the potential inundation of popular day-use areas was of concern to the Southwest Region staff.
- *Ocean City State Park.* This park currently experiences standing water issues in areas where swales are present. Interestingly, staff noted that Ocean City State Park currently experiences more extensive flooding (during heavy rain events) than what is shown on the Surging Seas Risk Zone Map (see Box 2). Ocean City State Park is largely in a buffer zone due to the presence of wetlands on the eastside of the park. Parks is looking into additional development at this park,

and this prompted discussion of whether it is logical to develop in the park given the inundation shown on the Surging Seas Map, or whether there are alternative development strategies would increase this park's resilience to sea level rise (e.g., movable structures). This mapping exercise also motivated a discussion of how much effort should be placed into protecting facilities and property in the projected inundation zone. Staff noted the need for guidelines on when to protect and when to walk away from a site.

- *Twanoh State Park*. The Southwest Region is actively working on a restoration project in Twanoh State Park, which involves removing some of the shoreline armoring in the area and focusing on shoreline restoration. Sea level rise will likely have implications for this restoration project. This state park also contains many historic sites (e.g., park buildings built in the 1930s by the Civilian Conservation Corps), which would likely be inundated with sea level rise. While these buildings could potentially be moved to higher ground or further from the shorelines, this relocation would destroy the integrity of the cultural landscape, which is largely intact.
- *Westport Light State Park*. This park has experienced significant losses from beach erosion near the South Jetty. The US Army Corps of Engineers have filled eroded coastal regions of this park with dredged material twice in the past 25 years. This park will likely continue to experience erosion issues with sea level rise.
- *Dosewallips State Park*. This park already experiences significant flooding issues from the adjacent Dosewallips River. After examining the Surging Seas Risk Zone Map, regional staff determined that day-use park areas would be affected by saltwater inundation and that the majority of the campsites would not be affected by rising seas, but will likely still be affected by flooding of the Dosewallips River.

Table 2. Preliminary assessment of climate change impacts for Southwest Region parks, as identified and rated by staff during the Southwest workshop.

Climate change impact drivers	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
<p>Increasing temperatures:</p> <ul style="list-style-type: none"> • Warmer seasonal temperatures • More extreme heat events 	<p>Warmer temperatures and more extreme heat events may increase park use in the region and shift regional visitation patterns. For example, warmer temperatures during shoulder seasons (i.e., spring and fall) could increase use during those seasons and more extreme heat events could increase visits to parks with water features (e.g., lakes). Increasing summer visits would put an additional strain on parking facilities. These stresses would be compounded when extreme heat events occur on days of peak visitation (e.g., holiday weekends). Warming may also increase the number of people traveling from eastern Washington (where people may consider it too hot) to visit parks west of the Cascades.</p>	<p>Moderate. Parks in the Southwest Region are already at capacity during summer months. More visitors during shoulder seasons would require shifting park staffing levels, or hiring seasonal staff for a longer season. Increased use during shoulder seasons would also result in more wear and tear on facilities, trails, and lawns. Parks may need to develop more water recreation activities (e.g., lake recreation).</p>	<p>Moderate to High. Increased park use will generate more revenue; however, it also increases staffing needs and operations and maintenance costs (e.g., for water and sewer maintenance). If funding is not available to support the adaptation of facilities, consequences may include failure of park facilities (i.e., sewage, parking, wells) that would likely negatively affect visitor convenience and satisfaction.</p>
	<p>Warmer temperatures will continue to raise stream temperatures, potentially reducing the number of sites suitable for recreational salmonid fishing, while increasing sites suitable for bass fishing.</p>	<p>Hard. While Parks are planting riparian vegetation to shade aquatic ecosystems (slowing the warming of rivers and streams), there is little more they can do to control water temperatures in the Parks.</p>	<p>Low. While warming stream and river temperatures have a high ecological consequence, the impact to Parks is expected to be minimal. Parks may see a change in how people recreate in Parks, or which fish species they are fishing for (i.e., bass instead of salmon).</p>

Climate change impact drivers	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
	Warmer temperatures during summer can increase algal bloom issues in lakes . If specific algal thresholds are reached, Parks is required to close recreational access to the affected lakes.	Easy to Hard , depending on the scope of the impact. If algal blooms remain limited in scope, it will be easy to adjust to (but not preferred). However, if the issue becomes more widespread it will prove <i>hard</i> for Parks to adjust. If lake closures result in people choosing to not to visit Parks, there is little the agency can do.	Low to High , depending on the scope of the impact. Water recreation activities occurring in affected lakes prior to detection can place users at increased risk of potential health issues from exposure. Other consequences include restricting access to affected water bodies, which could negatively affect Parks if heavily used lakes are closed and visitation declines.
	Warmer temperatures during summer can increase the potential for <i>Vibrio</i> outbreaks in coastal areas, lakes, rivers, and streams . Parks in the southern region of the Hood Canal area are particularly susceptible to these outbreaks.	Easy . Staff already deal with <i>Vibrio</i> outbreaks in several of the parks. Park staff also noted that campsites have still been full during <i>Vibrio</i> outbreaks.	Low to Moderate , depending on the scope of the impact. Consequences include closures of areas to shellfish harvesting or swimming.
Impacts on snow: <ul style="list-style-type: none"> • Lower snowpack • Shorter snow season • Changes in snow quality are uncertain 	Lower snowpack and earlier snowmelt could reduce lake levels during summer recreation .	Moderate . There is a small number of freshwater boating facilities in the Southwest Region, so it is unlikely that the issue will be too widespread.	Moderate . If water levels drop too low, boat ramps may close to ensure the safety of users and boat facility infrastructure. This may reduce visitation if parks users are attempting to use boat launches.
	Lower snowpack and earlier snowmelt will likely lengthen the Parks' use season (e.g., extending into the spring and fall shoulder seasons). There will likely be fewer snow-related closures to Parks.	Moderate .	Low . Changes could contribute to higher revenue; issues related to higher use (see <i>Temperature</i> section, this table) are also relevant but were not raised during discussion of this impact.
	<i>Other factors discussed but not rated:</i> <ul style="list-style-type: none"> • Increased variability in general creates more staffing challenges. 		

Climate change impact drivers	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
<p>Changes in precipitation & hydrology:</p> <ul style="list-style-type: none"> Increasing fall, winter, spring precipitation More intense/more frequent heavy rain events Increased soil saturation in winter Decreasing summer precipitation Higher winter streamflows Increasing flood risk Lower, warmer summer streamflows Longer summer low flow period 	<p>Increasing fall, winter, and spring precipitation could negatively impact the construction window.</p>	<p>Moderate. It is challenging to work in wet conditions where the groundwater level is higher than normal.</p>	<p>High. Consequences include delaying construction to the summer months during peak park usage, which could affect visitor experiences, or closing parks due to maintenance issues which were not addressed.</p>
	<p>An increase in the frequency and intensity of heavy precipitation events could reduce offseason camping. Users are less likely to make offseason reservations if it is cold, and very wet.</p>	<p>Easy. Staff are already used to dealing with variable registration levels during non-peak seasons.</p>	<p>Low. Revenue could be affected if people choose not to purchase Discover Passes early in the season. However, there could also be a rebound effect where people just delay the purchase until summer months so net consequence for revenue is unclear.</p>
	<p>Increased winter flooding could damage park facilities. Issues are likely to stem from both river flooding and stormwater management.</p>	<p>Moderate. Facilities and infrastructure may need to be rebuilt or repaired depending on the extent of damage. Staff may also have to dredge debris and rock deposited in creeks by floods. In areas where repeat flooding becomes problematic, campgrounds may need to be relocated (if there is suitable land for campsites at higher elevations)</p>	<p>Moderate. Campsite closures can affect revenue if alternate sites are not available. At the same time, more frequent or more extensive repairs related to flood damage may increase operating costs.</p>
	<p>If more landslides occur, the slides could reduce access to trails, interrupt trail networks, damage infrastructure and facilities, and affect access within the parks if,</p>	<p>Moderate.</p>	<p>Moderate. Consequences include loss of trail systems, loss of access to restrooms, added cost of rerouting trails, roads, infrastructure.</p>

Climate change impact drivers	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
	<p>for example, the landslide blocks a park road or damages access to a beach.</p> <p>Less summer precipitation, combined with warmer summers and declining snowpack (where relevant), could reduce water supply in southwest parks and/or cause wells to go dry (e.g., Belfair State Park). Parks operating with junior water rights are more likely to be affected by supply interruptions. This could also be an issue for Parks that are dependent on municipal water suppliers as those suppliers could hold off supplying water to parks if supplies are limited by drought.</p> <p>A lower water supply could also create increased challenges for parks that irrigate even as the demand for irrigation increase.</p> <p><i>Other factors discussed but not rated:</i></p> <ul style="list-style-type: none"> Septic issues can arise because of flooding and heavy precipitation events. Dosewallips State Park built a \$6 million sewage treatment plant, in part because day-use toilets did not flush during high tide. 		
<p><i>Changes in vegetation:</i></p> <ul style="list-style-type: none"> Increased drought stress Increased risk of wildfire Impacts on tree health from insects, disease Changes in non-native 	<p>Increasing tree stress (via changes in insects and disease) and wildfire could require more vigilant and intensive forest management on Parks land. This includes more tree removal/heavy pruning.</p>	<p>Hard. Will need to increase staff training to identify signs of tree stress. Addressing impacts would be more effective if emphasis can be placed on treating the causal agent, not just removing the dead trees. This will be difficult since it would require devoting more staff time and resources to forest health (unclear if those resources will be available). Increased fire frequency would also require more staff time as Parks staff are the first responders to fires on Parks lands.</p>	<p>High. Dead or diseased trees in developed areas pose a threat to both day-users and campers. The need for more tree removal/heavy pruning would increase operating costs and affect visitor experience. More diseased or dead trees could result in campsite closures due to public safety concerns.</p>

Climate change impact drivers	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
invasive species	Changes in tree health and non-native invasive species could increase habitat degradation.	Hard.	High.
	<i>Other factors discussed but not rated:</i> <ul style="list-style-type: none"> Following fires, increased runoff would be an issue if trees/vegetation has been removed. 		
<i>Sea level rise:</i> <ul style="list-style-type: none"> Increased coastal flooding Increased surge, wave energy Increased erosion Inundation of low-lying areas Increased saltwater intrusion in groundwater wells, septic Changes in nearshore habitat 	Sea level rise will lead to more shoreline flooding and an increased potential for permanent inundation. Bottle Beach, Cape Disappointment, Twin Harbors, and Grayland Beach state park are likely to be inundated due to low-lying areas. Specific facilities in Dosewallips and Potlatch state park will likely be affected by sea level rise.	Hard. Making these Parks resilient to shoreline flooding and permanent inundation is very expensive. Additionally, there may be limited options if there are no suitable sites to move facilities or campsites, limiting the amount of adjustment that can occur.	High. Inundation and closure of parks will negatively affect visitation, especially if Cape Disappointment and Grayland Beach state park experience closures. There may also be public pushback on possible relocation areas (i.e., individuals like camping by the water).
	Sea level rise and higher storm surge are likely to increase erosion at parks and exacerbate issues with shoreline protection structures and replacements. Some areas already have to be evacuated during large winter storms. Areas likely to be affected include the Seashore Conservation Area and areas where current bulkheads need to be replaced (e.g., Sequim Bay and Illahee).	Hard. Erosion control is difficult to sustain and expensive. Significant efforts have already been made to ameliorate the effects of erosion on Parks property (e.g., Manchester, Fort Worden, Blake Island state parks); however, many of these parks are still experiencing significant erosion issues. Replacing hard armoring with soft shore armoring could prove problematic for facilities and parking lots close to the shorelines (e.g., Sequim Bay State Park).	High. Erosion may have significant impacts on access to beaches and other park amenities, which could affect park visitation. More maintenance or replacement of protection structures will increase operational costs.

Climate change impact drivers	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
	As shorelines change (due to rising seas) there will be issues that arise due to regulatory compliance issues . It will be more challenging to do things in the parks as local ordinances are changed to account for sea level rise, especially in regards to failing retaining walls. While Parks is not required to protect adjacent landowners, Parks would be liable if an armoring structure negatively affects an adjacent landowner.	Moderate. This is already a part of what Parks does, but any additional efforts would be dependent on availability of staff, resources, and the nature of the changes.	Moderate. Changes in regulatory compliance issues would affect how Parks designs facilities, structures, etc., and it would also affect where they can be built, and how much they would cost. It would likely be similar to compliance with ADA regulations; once included as a requirement it would be another factor that is incorporated into park design and planning.
	Higher storm surge would increase the amount of marine debris , which would be an issue in some locations.	Easy.	Low. The presence of marine debris can negatively affect access to the park and park facilities. More frequent debris removal will result in increased removal costs.
	Sea level rise and related impacts increase the vulnerability of historical structures and archaeological sites to damage . This is currently a significant problem in Puget Sound parks. Examples include: Kitsap Memorial, Potlatch, Belfair (cultural), Manchester, and Fort Worden state park.	Hard. Moving old structures is expensive. In addition, changing the location of a historical structure would negatively impact its integrity, since it would no longer be in its original location.	High. These are areas of significance for State Parks. They are also an attraction for visitors.
	Sea level rise increases the risk of saltwater intrusion into wells . Most seashore parks are reliant on public/private water systems. Belfair State Park and all of the state parks in Hood Canal could be affected by this.	Hard. Limited ability for individual parks to be able to hook into alternative (uncontaminated) water sources.	Moderate. Saltwater intrusion into wells can prove to be financially costly for Parks. It may also reduce operations, or result in closures where issues cannot be resolved.

Appendix A: Eastern Region Vulnerability Assessment Workshop Summary

Prepared by

Harriet Morgan, Lara Whitely Binder, and Dan Siemann
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Overview of Eastern Region Parks

The Eastern Region of Washington State Parks includes 56 parks located in central and eastern Washington (Figure 1). 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. Annual average attendance at Mt. Spokane State Park is around 550,000 visits.⁵¹ Other popular parks in the region include Riverside State Park (Spokane; almost 1,300,000 visits each year)⁵² and Sun Lakes-Dry Falls State Park (approximately 1,000,000 visits annually).⁵³

Near-term (next 1-2 years) priorities noted by Eastern Region staff include a heavy focus on evaluating how current staffing levels align with the 2017-2019 budget. The Region's focus over the past 20 years has been on the rehabilitation of existing Parks facilities, as budget and staffing constraints have limited the pursuit of new development. Staff hope to increase staffing and continue to implement capital improvement projects.

Key Findings for the Eastern Region

Input on how climate change could affect Eastern Region parks was solicited through a pre-workshop interview with two staff members and a workshop with Eastern Region staff on May 31, 2017. The pre-workshop interview provided an opportunity to learn more about the region and initial staff thoughts on region-specific climate impacts. Additional staff with responsibilities in management, planning, operations, and stewardship participated in the workshop (eight participants in total).

The workshop began with an overview of the project's origins, objectives, scope, and outcomes. The morning also included presentations on projected climate change impacts on the Eastern Region and highlights from the pre-workshop interviews. Projected climate change impacts include:

- Increasing seasonal temperatures and more extreme heat events;
- Decreasing snowpack;
- Changes in precipitation, e.g., increasing cool season precipitation and decreasing summer precipitation; more intense extreme precipitation; increased risk of landslides); and
- Changes in forest health and fire risk.

A detailed summary of projected changes for the Eastern Region is included in Appendix B. More on the pre-workshop interview and project methodology is included in Section 3 of the assessment report.

Discussion

Staff were asked to discuss how different climate change impacts could affect properties, infrastructure, and operations in the Eastern Region. For each impact identified, staff rated 1) the ability to adjust to or

⁵¹ *Mount Spokane State Park Master Facilities Plan, Draft Environmental Impact Statement* (2010), Washington State Parks and Recreation Commission. Available at: <http://parks.state.wa.us/DocumentCenter/Home/View/1468>

⁵² Schundler, G., Mojica, J., Briceno, T. 2015. *Economic Analysis of Outdoor Recreation at Washington's State Parks*. Earth Economics, Tacoma, WA.

⁵³ *Sun Lakes-Dry Falls State Park Management Plan* (2003), Washington State Parks and Recreation Commission. Available at: <http://parks.state.wa.us/DocumentCenter/Home/View/1563>



Figure 1. Washington State Parks, Eastern Region. *Figure source: R. Norheim, UW Climate Impacts Group.*

accommodate the impact (assuming normal resources and authorities), and 2) the consequence of the impact, taking into account the ability to adjust (Table 1). Where relevant, parks where specific impacts may be an issue were noted. After discussing the range of impacts relevant to the Eastern Region, staff were asked to identify the top three impacts that are likely to be most important to the Eastern Region. Those were:

- increasing heavy rain events and the potential for more flooding,
- Changes in wildfire risk, forest health, and non-native invasive species; and
- declining snowpack and a shorter snow season.

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.

Increasing Heavy Rain Events and the Potential for More Flooding

Staff considered increasing heavy rain events and the potential for more flooding (a subset of the issues associated with changes in precipitation and hydrology) to be a top concern given the number of Eastern Region parks potentially affected by these changes (all of them) and the costs and challenges of responding to the heavy rain and flooding. In pre-workshop interviews, staff noted that the region has had to make flood-related repairs at several parks over the past several years, including Mount Spokane State Park and Pearrygin Lake State Park. Staff have also had to deal with significant flooding and debris management issues in areas affected by wildfire. Potential impacts associated with more intense heavy rain events and winter flooding include damage to park facilities; damage to undersized culverts, footbridges, and trails; increased erosion and debris; and campsite closures in flooded sites. Staff rated the ability to adapt to these impacts as “moderate to hard” in most cases. Consequences were considered “moderate” or “high.” and included increasing repair costs, reduced access to park amenities, park closures, and lost revenue.

Changes in Wildfire Risk, Forest Health, and Non-Native Invasive Species

The next set of concerns included an increased risk in wildfire, the potential for more tree health issues due to insects and disease, and non-native invasive species driven by warming air temperatures, declining summer precipitation, and lower snowpack. These changes were considered hard to adapt to and high consequence partially due to the widespread nature of these problems in the region currently.

Wildfires are a frequent problem in eastern Washington. More wildfires would divert staff time and resources away from planned work to deal with wildfire issues and lead to reduced air quality near parks (which can lead to cancellations), park closures, and costly repairs to facilities. A 2015 fire at Alta Lake State Park significantly damaged a camp loop and required replacement of power lines and facilities. Trees damaged by fire can create safety hazards for park visitors and require removal from areas in proximity to campgrounds, trails, and other areas accessed by the public. Staff also noted that more burn bans can result in campsite reservation cancellations. The ability to quickly evacuate campgrounds in the event of a fire is always a concern in high fire risk areas (e.g., 25-mile Creek in Lake Chelan).

Even in the absence of fires, an increase in high fire risk conditions would require more frequent or prolonged burn bans at parks, affecting visitor experiences (cancellations are common when burn bans go into effect). Extensive thinning to reduce fire risk may also affect visitor experiences and reduce visits to affected sites. The net result is a higher potential for lower revenue, lower visitor satisfaction, and increased operating expenses in areas affected by more wildfire.

Changes in tree health due to an increase in insects and disease would exacerbate existing challenges with forest health issues in many parks in the Eastern Region (e.g., Lake Easton State Park). Western bark beetle has been a notable concern for the Eastern Parks Region. Diseased trees can become a safety risk to visitors as the trees start to drop branches or fall. This may require closing campgrounds or picnic areas. Parks does an annual tree hazard assessment to identify trees that may be a public safety concern, whether on a trail, picnic site, or campsite.

Projected increases in seasonal temperatures and changes in precipitation regimes could also facilitate the spread of non-native invasive species in the Eastern Parks Region, increasing the obligation on Parks to limit the spread of non-native invasive species such as napweed, puncturevine, Russian thistle, and Canada thistle. Issues related to changes in vegetation were rated as “hard to adjust to” and “high consequence”.

Parks’ forest management strategy includes aggressive thinning and a thorough tree health evaluation aimed at 1) reducing the spread and susceptibility of trees, and 2) identifying trees which may present public safety concerns in the future. Further declines in forest health conditions may require the use of more insecticides to limit beetle infestation and increased monitoring of forest health conditions, both of which would increase costs and require more staff time. More issues with tree health could also reduce revenue by requiring closure of more campsite and day-use area due to public safety concerns over falling branches and trees.

Declining Snowpack and a Shorter Snow Season

The third most important set of impacts for the Eastern Region, according to staff, were impacts associated with declining snowpack and a shorter snow season. Staff ranked these impacts as moderately hard to adjust to and high consequence. As air temperatures warm, a greater fraction of winter precipitation will fall as rain instead of snow. Additionally, warmer spring temperatures will likely result in snowmelt occurring earlier in the year, shortening the snow season. Lower snowpack and a shorter snow season is expected to reduce winter visitation to parks where winter recreation is the main draw (e.g., Mount Spokane, Lake Easton, and Iron Horse state park). While this impact is limited to a

subset of sites in the eastern region, Winter Recreation Program revenue is used to support many Eastern Region staff. Impacts on Winter Recreation Program revenue could therefore affect Eastern Region program staffing.

Lower snowpack and the transition to more winter rain is also likely to result in more frequent road washouts, reducing access to Sno-Parks and associated revenue from those sites. The potential for more intense heavy rain events may further exacerbate this issue. For more details on projected climate change impacts on the Winter Recreation Program, see the Statewide Workshop summary in Appendix B.

Other Impacts

Other impacts discussed by Eastern Region staff included the potential for:

- extended use seasons and increased visitation rates during the shoulder seasons as temperatures rise,
- an increase in the number and frequency of heat-related medical responses,
- increased demand for irrigation and water use at parks during summer months, and
- lower groundwater levels, which can increase well maintenance requirements, impact water quality (e.g., nitrate levels), and/or require water use restrictions.

In pre-workshop interviews for the Eastern Region, staff noted that there are many arid sites in the Eastern Region which require irrigation. Impacts on summer water use would be more of an issue at newer parks with junior water rights; many of the older parks in the region have senior water rights and are therefore less likely to see their water rights curtailed during drought. Staff also expect that it will become more difficult to open new parks in the region given projected climate impacts on summer water supplies, which are already limited in eastern Washington. More information on the range of issues discussed is summarized in Table 2.

“Deep Dive” Discussion

A separate “Deep Dive” Discussion into individual parks in the Eastern Region was not necessary given the level of detail in the discussion of the region-wide parks and the time required to complete the regional discussion.

Table 2. Preliminary assessment of climate change impacts for Eastern Region parks, as identified and rated by staff during the Eastern Region workshop.

Projected climate change impacts	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
<p>Increasing temperatures:</p> <ul style="list-style-type: none"> • Warmer seasonal temperatures • More extreme heat events 	<p>Warmer temperatures may extend the use seasons of the parks. This will likely result in opening parks earlier in the year and could result in heavier use during shoulder seasons (September, October, April, and May).</p> <p>Parks may see declines in camping reservations during the hottest months due to high temperatures and burn bans.</p>	<p>Hard. This would prove challenging for operations because it would require increasing the budget to support additional staff during the extended season. It would also be challenging to hire seasonal staff for an extended season because many Parks seasonal staff are college students, and would be unable to arrive for seasonal work earlier in the spring and/or finish work later in the fall due to class start and end dates.</p>	<p>Moderate. While increased use would affect Eastern Region Parks, the region already deals with this challenge and could likely find a solution. If park use seasons are extended and there are no staffing increases, Parks would likely be understaffed for a portion of the year which would strain operations in individual parks and could potentially reduce the levels of customer service that staff can provide to visitors. If sufficient funding was available to support additional staff, the consequences of increased use would likely be reduced. Additionally, if the park visitation rates increase it will likely mean more revenue, which helps deal with some of the impacts.</p>
	<p>Warmer temperatures are more extreme heat events will likely increase the number and frequency of heat related medical/first aid responses. Staff highlighted Riverside State Park, which has over 80 miles of hiking and equestrian trails, as a park which frequently responds to multiple heat-related medical issues per summer.</p>	<p>Easy. This is an issue that the Eastern Region currently deals with (incidents have been increasing). As a result, parks are relatively well equipped to deal with this impact.</p>	<p>Low. May warrant more public education efforts from Eastern Region Park staff to communicate the risks of dehydration on hot days, and the risks of swimming and boating in cold rivers and lakes.</p>

Projected climate change impacts	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
	<p>Warmer temperatures and drier summers could require increased irrigation to maintain vegetation in the region. The public has an expectation that Parks will provide areas of green landscaping, whether that be grass fields or plants. Regional staff noted that they received public complaints in Riverside State Park regarding grassy areas that were drying out and browning during summer months.</p>	<p>Moderate. The ability to adjust to this impact will likely be park-specific as it is heavily dependent on the parks annual water rights (junior vs. senior). For example, newer parks will have more water use restrictions than an older park (which may have senior water rights), and therefore may be less likely to increase irrigation to keep grassy areas green throughout summer. Adapting to this impact may require park-specific decisions regarding what plants should be planted (i.e., plant drought tolerant, native species) and reducing the footprint of a park (i.e., total area) which is irrigated. Ability to adjust to this impact may also be limited by broken sprinkler heads, challenges related to pumping efforts, and water filtration issues.</p>	<p>Moderate. Consequences include negative push-back from the public if there is a decline in manicured grassy areas, or a reduction in the number or quality of turf fields used for community sports or activities.</p>
	<p>Other issues noted but not rated:</p> <ul style="list-style-type: none"> Increasing summer temperatures may require upgrading more RV sites to accommodate higher energy demands for RC air conditioning so visitors can stay comfortable. Staff suggested looking to southwestern states (e.g., Arizona and New Mexico) to see how parks which are currently hot and dry manage campsites and parks. 		
<p>Impacts on snow:</p> <ul style="list-style-type: none"> Lower snowpack Shorter snow season Changes in snow quality are uncertain 	<p>Declining snowpack and a shorter snow season length may lead to increased variability in winter recreation opportunities, and may impact Parks programs that depend on snow. Parks that currently dependent on snow for winter visitation include Mount Spokane, Lake Wenatchee, Fields Spring, Lake Easton, Squilchuck, and Pearrygin state park.</p>	<p>Moderate. Parks that have historically been dependent on snowpack for winter visitation may need to transition over to a more traditional park management model. Impact is limited to parks that are reliant on snowpack for winter visitation.</p>	<p>High. Parks dependent on winter recreation (e.g., Mount Spokane, Lake Easton, and Iron Horse state park) may experience declines in winter visitation and revenue. Many Eastern Region staff are supported by the Winter Recreation Program. Therefore, declining snowpack would likely lead to a reduction in staff supported by the Winter Recreation Program.</p>

Projected climate change impacts	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
<p>Changes in precipitation & hydrology:</p> <ul style="list-style-type: none"> Increasing fall, winter, spring precipitation More intense/more frequent heavy rain events 	<p>Declining summer precipitation coupled with declining snowpack could increase the potential for lower groundwater levels. This could impact park wells and water quality (e.g. high nitrate levels, sand intrusion into well water), require more well maintenance, and/or require restrictions on water use.</p> <p>More issues with summer water supplies could make it more difficult to open new parks in the region (water supply/rights may not be available for drilling new wells).</p>	<p>Moderate. The ability to adjust will largely be park specific. For example, if a park needs to drill a new well an important consideration will be what kind of water rights the park holds (junior vs. senior). May be challenging for parks to drill new wells.</p>	<p>Moderate. Water quality and quantity impacts may affect ability to meet summer water demands, affecting visitor experience. Ability to grow the portfolio of parks in the region may become more difficult.</p>
<ul style="list-style-type: none"> Increased soil saturation in winter Decreasing summer precipitation Higher winter streamflows Increasing flood risk Lower, warmer summer streamflows 	<p>Increased soil saturation, coupled with declining snow, during winter months could increase the risk for winter landslides, affecting winter trail and road maintenance.</p>	<p>Moderate. The ability to adjust to this impact will largely be park specific. May need to modify culverts, ditch lines, and trails to accommodate increased winter runoff; necessary modifications and repair within the parks will require increased funding. Road washout would be a serious concern for some of the parks with heavier visitation, as it may result in revenue losses (e.g., Mount Spokane State Park).</p>	<p>Moderate. Can increase operating and maintenance costs. Access to parks and park features may be limited where landslides occur, affecting review and concentrating use in other areas.</p>
<ul style="list-style-type: none"> Longer summer low flow period 	<p>Increasing fall/winter/spring precipitation and related flooding could damage park infrastructure and regional trail systems. Eastern Region staff noted that over the past several years the Eastern Parks Region has completed flood related repairs at a number of parks, including Mount Spokane State Park and Pearrygin Lake State Park.</p> <p>Damage to trails may be accelerated if visitors hike or bike on saturated, muddy trails.</p>	<p>Easy to Hard. The ability to adjust to this impact will depend on whether Park's response is reactive or proactive (i.e., if reacting, hard; if proactive, easier assuming sufficient funding and staff are available). Parks would likely need to install larger culverts, rethink footbridge design, and increase the amount of freeboard under bridges – all of which require funding and staff time. Footbridges are very expensive to</p>	<p>High to Moderate (if reacting, high; if proactive, moderate). Access to park facilities or park features may be limited by washouts, flooding, etc. as well as repairs. This which would concentrate users in other areas of the park. May affect revenue. Operating and maintenance costs could increase.</p>

Projected climate change impacts	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
		replace and it is challenging to get permits.	
	Higher flood waters may require the relocating park facilities and campgrounds .	Hard. This is an expensive process which will require a high level of staff effort. Additionally, the ability to adjust to this impact is contingent on the park having suitable areas for campsite or facility relocation.	High. Process is costly. May affect visitation, particularly if campsites have to be closed. Closures would affect revenue.
	Warmer temperatures and wetter springs may increase the abundance and proliferation of bugs and mosquitos in the parks. Warming temperatures may facilitate the spread of mosquitos to higher elevations. Regional staff noted that the Eastern Region is currently experiencing significant mosquito issues at Lake Wenatchee, Steamboat, and Potholes state park.	Moderate to Hard. This could require an increase in insecticide application, despite a public opinion that Parks should be using less insecticide. Additionally, if an increase in insecticide application requires a permit, this process will likely have a lengthy timeline.	High. Consequences of increased mosquito populations include dissatisfied parks visitors, and could potentially result in closures of parks if mosquito presence becomes unbearable to visitors. While mosquitos are not currently vectors of human disease in the Pacific Northwest, it would drastically increase the consequence of this impact if they did become vectors of human disease.
<p><i>Changes in vegetation:</i></p> <ul style="list-style-type: none"> • Increased drought stress • Increased risk of wildfire • Impacts on tree health from insects, disease 	Projected increases in seasonal temperatures and changes in precipitation regimes could facilitate the spread of non-native invasive species in the Eastern Parks Region , although the response of individual weeds will vary (some may benefit from changing conditions while others may not). Species of specific concern to the Eastern Region include: napweed, puncturevine, Russian thistle, Canada thistle. Increasing abundance of non-native invasive species could require more vigilant and intensive management on Parks land.	Hard. This impact is currently a challenge for Eastern Region Parks. Increases in the spread or proliferation of non-native invasive species would only exacerbate this current challenge. Increasing pesticide is not always desired by park visitors.	High. Consequences include closing specific park areas which have been sprayed with pesticide. Increased pesticide application would also require more frequent communication/education efforts between Parks and visitors about why they are not able to recreate in areas which have been recently sprayed. There are also potential consequences from adjacent land owners and county weed boards who do not want these weeds spreading onto lands adjacent to Parks property.

Projected climate change impacts	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
	<p>Projected increases in seasonal temperature and more summer drought stress are expected to increase the risk of fire in parks. This is expected to lead to reductions in air quality due to smoke, more frequent park closures, and the diversion of staff to deal with fire issues. An increased fire risk may also result in more frequent burn bans, which often result in cancellation of campsite reservations. Depending on the location of a fire, DNR staff may occupy Parks campsites in close proximity to the fires they are responding to, limiting the space that can be used by paying visitors.</p>	<p>Hard. Will require an increase in staff time, financial resources, and increased focus on proactive fire management. Ameliorating the impacts of increased fire risk would be extremely time consuming.</p>	<p>High. Consequences include lost revenue, costly repairs to facilities, and difficulties completing previously scheduled work. Fire damage to park forests and vegetation or thinning to reduce fire risk may affect visitor experience, which can reduce visitations and revenue at those sites.</p>
	<p>Projected increases in seasonal temperature and summer drought stress are expected to leave more trees vulnerable to insects or diseases that compromise tree health.</p>	<p>Hard. While Parks has been gearing up for responding to tree health issues in recent years, the largest challenge for the region will be the scale of the problem (region wide). Parks is unable to spray every tree to prevent insect infestation or diseases. Therefore, Parks' response will largely come down to proactive forest management (i.e., removing susceptible trees before they are infested or become diseased), which will require an increased staff effort, training, and financial resources.</p>	<p>High. Consequences include having to close parks or sections of parks (e.g., campgrounds) due to public safety concerns surrounding falling branches. Clear-cutting trees that are infected or susceptible to infection may be negatively received by the public if they want to recreate in forested parks, diminishing visitor experience.</p>

Appendix A: Statewide Programs Workshop Summary

Prepared by

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Overview of Statewide Programs Evaluated in the Workshop

The Washington State Parks climate change vulnerability assessment included an assessment of three programs that bridge multiple regions: Stewardship, Planning, and Winter Recreation. Each of these programs is briefly summarized below.

Winter Recreation. The Winter Recreation Program manages winter recreation activities at more than 120 snow parks in the Washington Cascades and eastern Washington. Sno-Parks are divided into one of three types: Non-Motorized Sno-Parks (approximately 40 parks⁵⁴), Snow Play Sno-Parks (5 parks⁵⁵), and Snowmobile Sno-Parks (approximately 80 parks⁵⁶). Approximately 3,000 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, skijoring⁵⁷, dog-sledding, “fat tire” mountain biking, tubing, and general snow play (WSPRC 2016).⁵⁸

The Winter Recreation Program is self-supported via sales of winter recreation permits and snowmobile registrations. Operating responsibilities at Sno-Parks include plowing parking lots, trail grooming, and providing and maintaining sanitation facilities. Parks will provide 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.

Trail grooming is the program’s largest operational expense. Ninety-five percent of the Sno-Park system trails are located on US Forest Service (USFS) land. An interagency agreement with the USFS allows State Parks to run the winter recreation program on those lands. Parks reimburses the USFS through agreements for education and enforcement services, trail grooming, snow removal and some sanitation services.

Priorities for the Winter Recreation Program are focused on trying to restore the program’s operating budget to a level that would allow for more trail grooming and increased snow removal from parking lots. The goal for trail grooming is 2006 grooming funding levels, which predates significant budget cuts that began in 2011. Winter 2016-17 is the first year that the program met this goal (grooming was increased by 20%). The program is also updating its strategic plan and developing ways to respond to increased demand in the I-90 corridor, which is tied to population growth in the Puget Sound region. Other priorities include safety education and permit enforcement.

Planning. The Planning Program is responsible for long-term facility planning, land acquisition and classification (e.g., determining zones for specific uses within parks), and planning for overall park function and capacity. 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). A major near-term priority for Planning Program staff is completion of park Classification and

⁵⁴ <http://parks.state.wa.us/452/Non-Motorized-Sno-Parks>

⁵⁵ <http://parks.state.wa.us/647/Snow-Play-Sno-Parks>

⁵⁶ <http://parks.state.wa.us/304/Snowmobile-Sno-Parks>

⁵⁷ Skijoring is a winter recreation activity that involves pulling a skier by horse, dog(s), or motor vehicle (<https://en.wikipedia.org/wiki/Skijoring>)

⁵⁸ (WSPRC) Washington State Parks and Recreation Commission. 2016. *2014-2019 State Parks Strategic Plan: May 19, 2016 Update*. Olympia, WA. Available at <http://parks.state.wa.us/DocumentCenter/View/7663>

Management Planning (CAMP) efforts at Palouse Falls and Lions Ferry, Riverside state park, Wallace Falls, and other locations. CAMP is a multi-stakeholder, multi-stage planning process used to establish management priorities, land classification zones, and a long-term park boundary for individual parks.

Stewardship. The Stewardship Program 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; and
- Unique natural resources, including lowland old growth forest, habitat used by threatened and endangered species, and areas with unique plant associations found only in state parks; and
- Native ecosystem resilience, health and function.

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

Stewardship Program staff identified a range of near-term (i.e., next 1-2 years) program priorities during the pre-workshop interview. Reducing wildfire risk and enhancing forest health is a major focus, driven in part by recent very large wildfire years (e.g., 2014 and 2015). Prioritizing properties for maintenance is another priority. State Parks has a \$500 million dollar maintenance backlog. To help prioritize sites for repairs and improvements, staff have adopted criteria for ranking historic properties and will use those criteria to prioritize sites. Staff are also conducting an extensive GIS exercise to pull together data on Significant Natural Areas (SNRs). The work will help staff identify and assess high priority natural resources, current and desired conditions for those resources, and costs for accomplishing those desired conditions.

Key Findings for Statewide Programs

Input on how climate change could affect statewide programs was solicited through pre-workshop interviews and a workshop with statewide program staff on April 20, 2017. The pre-workshop interviews provided an opportunity to learn more about each program and initial staff thoughts on program-specific climate impacts. The interviews included up to two staff members from each program. Additional staff participated in the workshop (10 participants in total).

The workshop began with an overview of the project's origins, objectives, scope, and outcomes. The morning also included presentations on projected climate change impacts on Washington State and highlights from the pre-workshop interviews. Projected climate change impacts include:

- Increasing seasonal temperatures and more extreme heat events;
- Decreasing snowpack;
- Changes in precipitation, e.g., increasing cool season precipitation and decreasing summer precipitation; more intense extreme precipitation; increased risk of landslides);
- Changes in forest health and fire risk; and
- Sea level rise.

A detailed summary of projected changes for the state is included in Appendix B. More on the pre-workshop interview and project methodology is included in Section 2 of the assessment report.

Discussion

Staff were divided into three breakout groups (Winter Recreation, Planning, and Stewardship) and asked to discuss how climate change impacts could affect properties, infrastructure, and operations associated with each program. Projected climate change impacts discussed during the workshop include:

- Increasing seasonal temperatures and more extreme heat events;
- Decreasing snowpack;
- Changes in precipitation, e.g., increasing cool season precipitation and decreasing summer precipitation; more intense extreme precipitation; increased risk of landslides);
- Changes in forest health and fire risk; and
- Sea level rise.

For each impact identified, staff rated 1) the ability to adjust to or accommodate the impact (assuming normal resources and authorities), and 2) the consequence of the impact, taking into account the ability to adjust (Table 1). Where relevant, parks where specific impacts may be an issue were noted. After discussing the range of impacts relevant to their program, staff were asked to identify the top three impacts that are likely to be most important to those programs.

While the order of top climate change impact concerns varied between programs, common climate change concerns identified by staff across all three statewide programs included sea level rise, changes in precipitation and hydrology, declining snowpack, and changes in vegetation (including forest fire risk and changes in forest health) (Table 2). Issues of concern for each program are summarized below.

Winter Recreation

Declining snow and a shorter snow season (changes in snow). Projected declines in snowpack and a shorter snow season are a top concern for the Winter Recreation Program. Changes in snow quality could also affect the Winter Recreation Program, although projections for changes in snow quality are not available.

The Winter Recreation Program is a self-funded program based on annual sales of daily and seasonal Sno-Park permits and snowmobile registration; the revenue raised through these sales determines the operating budget for the following season. Changes in snow cover and snow quality can affect sales and registrations, resulting in variable program revenue from year to year. For example, during the snow drought of 2014-15, registration dropped 30% as snowmobilers and snowshoers delayed purchasing permits, reducing operating revenue for 2015-16. Lower snowpack is likely to reduce permit sales and snowmobile registrations and leave the program revenue more sensitive to year-to-year variability. Changes in snowpack also affect plowing and grooming costs. High snowpack years (e.g., winter 2016-17) create an opportunity to place extra funds in an emergency reserve.

Table 1 Adjustment and consequence rating keys 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.

Table 2. Top climate change concerns, by program, as identified by program staff during the Statewide programs workshop.

Program	Projected Changes: Top Concerns
Winter Recreation	Declining snowpack and a shorter snow season (changes in snow) Increasing winter precipitation and more intense heavy rain (changes in precipitation) Increased risk of forest fires and changes in forest health (changes in vegetation)
Planning	Sea level rise Increased risk of forest fires, changes in forest health, and potential for expansion of non-native invasive species (changes in vegetation) Increasing winter precipitation, more intense heavy rain, and increased flooding (changes in precipitation and hydrology)
Stewardship	Increased risk of forest fires, changes in forest health, and potential for expansion of non-native invasive species (changes in vegetation and other impacts to significant natural resources) Increasing winter precipitation, more intense heavy rain, increased flooding, and drier summers (changes in precipitation and hydrology) Sea level rise

Rain-on-snow events can also increase plowing and grooming costs by making snow heavier and more difficult to move. If plowing costs exceed the amount budgeted, Winter Recreation may stop plowing some Sno-Parks before the season ends or pull funds from other budgets (e.g., maintenance) to keep access open.

Projected declines in snowpack due to climate change may reduce plowing costs, but there are limits to this benefit; if snowpack is too low, the ability to operate lower and mid-elevation Sno-Parks may be affected, reducing revenue. Rain-on-snow events will continue to be an issue near snowline in the coming decades although the area affected by rain-on-snow becomes smaller as snowpack declines and snowline moves higher in elevation.

Increasing winter precipitation and more intense heavy rain (changes in precipitation). Another climate change-related concern for Winter Recreation is increasing winter precipitation and more intense heavy rain. Increased soil saturation leads to more downed trees, especially during wind events. Downed trees can block access to Sno-Park facilities and trails. A notable example was the winter of 2015-16, during which time “precipitation came on like a fire hose,” leading to a record number of downed trees for Winter Recreation and a high number of road washouts. According to staff, the program did not recover until February.

Winter Recreation is responsible for removing downed trees during the operating season (Dec 1-March 31), so the financial costs to the program of more downed trees are two-fold: the costs of clearing the downed trees plus lost recreation fees if downed trees keep an area out of service for an extended period. The impact of these closures on revenue is amplified by the limited operating season for Winter Recreation; closures affecting sites for multiple weeks can end up being a significant portion of the operating season depending on snow conditions. If the trees are downed during other times of the year, tree removal is done by the landowner (USFS, private landowners, etc.). Impacts on Winter Recreation revenue for out-of-season downed trees only occur if the trees have not been cleared in time for winter operations.

More extreme precipitation can also lead to landslides and road washouts, limiting access to Sno-Parks and reducing usable trails for the program. Declining snowpack and a rising snowline will contribute to these impacts; as snowpack declines and the snowline rises, more areas previously armored by snow become exposed to increasing winter rain and more extreme precipitation events.

Road repair for natural debris slides is the landowner’s responsibility. This leaves the Winter Recreation Program dependent on the landowner’s ability to make a timely repair. For example, Orr Creek Sno-Park has been closed since December 2015 due to washout of USFS 23. The same storm event led to multiple washouts, downed trees, and a landslide at other nearby Sno-Parks (Figure 1). In another case, a snow and rockslide on Forest Road 83 in late January 2017 blocked access to Marble Mountain Sno-Park—a popular site with parking for nearly 250 vehicles—for two weeks until the USFS could clear the slide.⁵⁹

⁵⁹ [“Snow, rocks cleared to open popular Mount St. Helens area”](#), Allan Brettman, *The Oregonian/OregonLive*, February 13, 2017.

Emergency reserve funds were used to quickly clear the snow that accumulated behind the slide and re-open the Sno-Park.

Increased risk of forest fires and changes in forest health due to climate change impacts on insects and diseases (changes in vegetation). Summer wildfire can lead to Sno-Park closures if access roads are damaged and/or if the fire leaves large areas of standing dead trees that are considered fall hazards. The USFS will close off these areas for safety reasons until the dead trees can be cleared, which can sometimes take years. For example, approximately 42 miles of Sno-Park routes in the Kings Lake System have been closed since the 2015-16 season due tree health and safety concerns resulting from the 2015 Tower Fire in Colville National Forest. Winter salvage logging in fire-damaged forests can also lead to temporary closures.

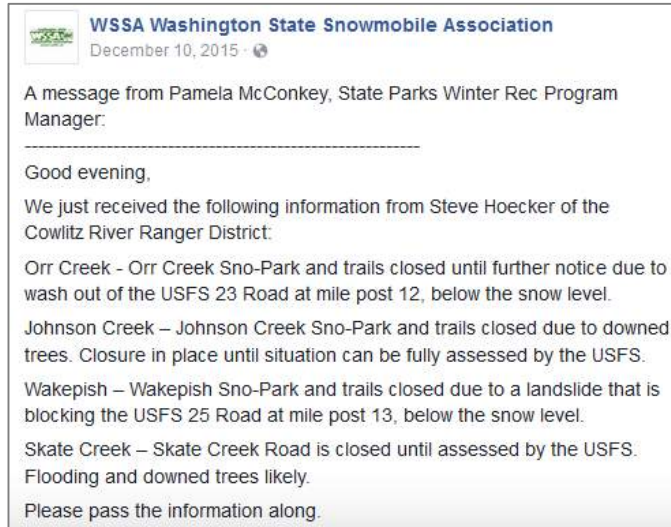


Figure 1. Flooding, landslides, and downed trees impacts on Sno-Parks access, as announced in a Facebook post to the Washington State Snowmobile Association.

Adapting program operations to decreasing snowpack may require moving Sno-Park access points (e.g., parking lots) to higher elevations. This kind of shift would create several challenges. First, moving the Sno-Parks may require building new roads at a time when the USFS is focusing more on decommissioning roads. Second, moving Sno-Parks to higher elevation will reduce usable trail miles. Staff estimated that moving the system up in elevation could shrink the amount of usable trail miles from 3,300 miles to 1,500 miles. Moving to higher elevation would also push more trail users into avalanche territory, increasing safety risks. Staff also expect more road washouts, downed trees, and problems with access with more winter precipitation and more intense heavy rain events. Finally, staff expect more closures related to winter logging as fire risk increase.

Planning

Key concerns for Planning were climate change impacts affecting facility siting and infrastructure design. This included impacts associated with sea level rise, changes in vegetation (i.e., an increased risk of forest fires, changes in tree health, and non-native invasive species), and changes in precipitation and hydrology.

Sea level rise. Planning staff considered sea level rise a top concern given the potential loss of low-lying park lands, the number of historic structures that may be affected by sea level rise and higher storm surge, the implications of sea level rise for site planning and infrastructure design, and the potential costs associated with adapting to sea level rise. Staff noted that sea level rise could reduce the size of parks where upland acquisition is not an option. Options for moving park facilities to higher ground may also be limited unless more upland areas are acquired. Retreat has already been considered in a few

locations, although not explicitly in response to sea level rise. For example, Parks had plans to relocate campground facilities at Twin Harbors and Cape Disappointment state parks prior to the economic recession in the late 2000s but those plans were put on hold after the downturn.

Sea level rise will also exacerbate problems with coastal erosion and bluff stability. Staff noted significant problems with shoreline erosion at Manchester State Park, the site of several historic structures dating back to the early 1900s. Parks is using soft armoring to control erosion at this point. Cama Beach and Sequim Bay were also noted as areas where sea level rise and slope stability (exacerbated by heavy rainfall) have been issues. A third concern with sea level rise noted by staff is saltwater intrusion into groundwater supplies. This is already a concern at Blake Island State Park. Saltwater intrusion could also be exacerbated by higher demands on groundwater supplies as summer temperatures increase.

Increased risk of forest fires, changes in forest health, and potential for expansion of non-native invasive species (changes in vegetation). Another issue considered by Planning staff to be “hard to adapt to” and “high consequence” is changes in vegetation. The potential for more wildfire and tree health issues may require reconsidering how facilities are sited in areas where fire risk is increasing. More tree health issues also increase risks to public safety. Finally, the potential for more wildfire raises concerns about the ability to quickly evacuate campgrounds. Noted high fire danger areas included 25 Mile Creek (near Lake Chelan) and Squilchuck State Park (near Wenatchee).

Increasing winter precipitation, more intense heavy rain, and increased flooding (changes in precipitation and hydrology). Changes in precipitation and hydrology, particularly the potential for more extreme precipitation events and flooding, were also identified as issues that would be hard to adapt to in most cases and high consequence. Expectations for more intense heavy rain events, increased erosion, and bigger floods will require rethinking assumptions made around facility siting and design, stormwater management, culverts and bridges, erosion control, and flood protection. Options to move facilities may be limited and infrastructure design options that go beyond minimum permit requirements and increase project costs will be hard to implement. Maintaining public access under these conditions may become more challenging as well, creating potential inequities for disabled visitors if Parks is unable to restore access to levels that provide access for all users. Staff also noted that changes in hydrology may require additional environmental impact mitigation, although it is uncertain how likely this would be.

Other issues. Other issues identified by Planning staff included the potential for more visitors with warmer temperatures and potential pressure to open parks earlier (both considered manageable from an ability to adapt perspective but with notable consequences to operations and maintenance).

Stewardship

Key concerns for Stewardship were climate change impacts affecting historic structures and ecosystem resilience. This included impacts associated with changes in vegetation (i.e., an increased risk of forest fires, changes in tree health, and non-native invasive species), changes in precipitation and hydrology, and sea level rise.

Increased risk of forest fires, changes in forest health, and potential for expansion of non-native invasive species (changes in vegetation). Climate change impacts are likely to directly and indirectly affect numerous habitats, ranging from eelgrass beds and estuaries, to coastal forests and balds. The potential for more forest fire and problems with tree health due to climate change impacts on forest insects and disease were considered moderately difficult to adapt to (“medium”) but “high” consequence given the associated risks for archaeological sites and habitats. More specifically, an increase in forest fires could expose more archaeological sites. As those sites are exposed, the risk of vandalism at those sites increases. Off-site artifact storage may need to be expanded to safely store archaeological finds.

One of the greatest impacts of wildfire is the loss of significant habitats and the expansion of invasive species. Some habitats are so limited that the loss of even one can have an impact on the global conservation status of a species or habitat. Non-native invasive species expand in the wake of fire, especially where the ground is disturbed by firefighting personnel and equipment.

In addition to wildfire, other disturbance events can also create opportunities for expansion of non-native invasive species, such as cheatgrass and Scotch broom, into native habitats where they have the potential to negatively impact species or habitats of conservation concern. Staff are already working on fuels reduction and invasive species control but additional resources would be needed to address an expansion of these problems. Uncertainty about the ecological consequences of more fire and non-native invasive species and what it may mean for environmental stewardship responsibilities contributed to the “high” consequence rating for changes in vegetation.

Increasing winter precipitation, more intense heavy rain, increased flooding, drier summers (changes in precipitation and hydrology). Changes in precipitation and hydrology are expected to affect parks in ways that were both considered “hard to adapt to” and “high consequence.” More winter precipitation and more intense heavy rain events could lead to more trail erosion and washouts, a greater chance of landslides and land movement, and flooding. Higher groundwater levels, which can lead to more localized flooding, may also become a more common problem. Any of these changes could damage historical buildings and expose more archaeological sites, increasing the potential for vandalism. Staff rated these impacts as “hard to adapt to” given the limited ability to be proactive on these issues, the high cost to historical structures, and the potential for sensitive habitats to be affected.

At the other end of the water volume spectrum, Stewardship staff noted that drier summers and lower summer streamflows could increase water demand at parks. Securing additional water rights to meet demand would be difficult for newer parks with junior water rights. Lower summer water levels could also have negative impacts on salmon and related environmental restoration activities.

Sea level rise. Stewardship staff felt that the ability to adapt to sea level rise would vary by site but the overall consequences would still be high. A key concern overall is the large number of historical structures and archaeological features that could be threatened by inundation, higher storm surge, and erosion. The cost of moving or protecting these sites will be high. Stewardship staff also noted that sea level rise could impact a variety of species and their associated habitats, including eelgrass beds, salt marshes, and coastal forests and prairies. A notable impact would be a threat to nesting habitat used by the western snowy plover, a shorebird listed as threatened under the Endangered Species Act and

endangered in Washington State. Parks has a significant portion of that species' habitat in Washington State.

Other notable impacts. Like Planning staff, Stewardship staff linked warming seasonal temperatures to the likelihood of higher visitor use at facilities, including higher demand in what is currently considered the shoulder season. Use in these seasons could lead to impacts on natural resources, such as breeding wildlife. Recreational preferences may also shift in ways that affect Stewardship and require Parks to adapt operations and facility planning.

Table 3. Preliminary assessment of climate change impacts for Winter Recreation, Planning, and Stewardship programs, as identified and rated by staff during the Statewide Programs workshop.

WINTER RECREATION			
Projected climate change impacts	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
<p>Increasing temperatures:</p> <ul style="list-style-type: none"> Warmer seasonal temperatures More extreme heat events 	<p><i>No directly relevant impacts on winter recreation; mediated through other impacts (e.g., changes in snow, drought stress on vegetation)</i></p>	n/a	n/a
<p>Impacts on snow:</p> <ul style="list-style-type: none"> Lower snowpack Shorter snow season Changes in snow quality are uncertain 	<ul style="list-style-type: none"> Low snowpack can result in a shorter season and reduced permit sales. Rain-on-snow events will continue to be an issue near the snowline, even as that snowline moves up. Current issues related to management of rain-on-snow events continue in Sno-Parks located in future snowline transition zones. 	<p>Medium. Can use a snow park zone methodology to reach higher elevations (as a way of adjusting to lower snowpack) but need room for parking, which can be difficult. Can adjust season lengths for warmer locations.</p>	<p>High. Although some adjustment is possible, the net result of projected losses in snowpack is potential loss of the program (no snow = no revenue= no services).</p>
<p>Changes in precipitation:</p> <ul style="list-style-type: none"> Increasing fall, winter, spring precipitation More intense/more frequent heavy rain events Increased soil saturation in winter Decreasing summer precipitation 	<ul style="list-style-type: none"> Increased winter precipitation and more intense heavy rain events may lead to more erosion, landslides, and washouts, affecting trails and roads to Sno-Park facilities. Even when people can still access the trails, grooming and other equipment cannot, affecting the ability to maintain trails. Increased ground saturation can lead to more downed trees, particularly during wind events. The downed trees can block trails, requiring removal by Parks, the US Forest Service, or private landowners. 	<p>Hard. Landslides and erosion can be expensive to deal with and Winter Recreation does not have a budget for road repair; repairs are the landowner’s responsibility (e.g., USFS, private landowners, other state agencies). If the landowner does not repair the road, sites may need to be closed.</p> <p>Hard. Parks is responsible for clearing downed trees during the operating season (via contractors). The downed trees</p>	<p>High. Loss of access to Sno-Park sites and trails can have a significant impact on service levels and revenue.</p> <p>High. Winter Recreation has a limited season for making revenue; any loss of access to Sno-Park sites and trails can</p>

WINTER RECREATION			
Projected climate change impacts	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
		need to be cleared quickly to maintain service levels. It can take days to restore access to small amounts of trail after large blowdown events.	impact service levels and revenue.
Changes in hydrology: <ul style="list-style-type: none"> Higher winter streamflows Increasing flood risk Lower, warmer summer streamflows Longer summer low flow period 	<ul style="list-style-type: none"> Higher winter streamflows may lead to more river and streambank erosion, including bridge scour and trail erosion. 	Hard. Repairs can be difficult and costly.	High. Washouts and damage to water crossings (or even concern about potential damage) can lead Sno-Park closures, affecting service levels and revenue.
	<i>Other issues discussed but not rated:</i> <ul style="list-style-type: none"> Changes in groundwater levels can cause sinkholes but they are geographically scattered 		
Changes in vegetation: <ul style="list-style-type: none"> Increased drought stress Increased risk of wildfire Impacts on tree health from insects, disease 	<ul style="list-style-type: none"> Fires can result in loss of forests adjoining trails and damage access roads (via the fire or post-fire erosion). Some recreationalists like the terrain that fire opens up but it can also lead snowmobilers into more dangerous areas, creating safety risks. Post-fire tree mortality and potential for more insects, disease, and pathogens affecting tree health can increase the risk of downed trees on Sno-Park roads and trails. Post-fire tree mortality can lead the US Forest Service to block off large areas considered dangerous (e.g., due to hazard trees). These closures can last years, affecting Sno-Park activities for an extended time. Winter logging after a big fire (sometimes permitted by the USFS) will require temporary closure of trails and/or Sno-Parks in that area. 	Hard. Downed trees and/or closures required by winter logging do not take a long time to adjust. Only shut out for a season or two. Can recover quickly. If snowpack is less and the trail systems move up in elevation, winter logging could be a larger issue.	High. Can increase trail maintenance costs, delay opening of trails (e.g., 2015-16), or lead to trail or Sno-Park closures for safety reasons.

PLANNING			
Projected climate change impacts	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
Increasing temperatures: <ul style="list-style-type: none"> Warmer seasonal temperatures More extreme heat events 	<ul style="list-style-type: none"> Warmer temperatures are likely to increase visitation to Parks, especially the more popular Parks. Increased potential that those parks will be “overrun.” 	Medium. Heavier usage during nicer weather is already an issue that the region has to manage; however, this increase could be more difficult to manage at more popular parks.	Moderate. Planning processes for higher volume areas are more difficult.
	<ul style="list-style-type: none"> Staff may see pressure to open parks earlier (for those that are closed seasonally) 	Easy. Opening earlier is relatively easy to accommodate (note: see regional workshops for potential issues related to staffing).	High. Earlier openings would have additional costs for operations.
	<ul style="list-style-type: none"> Warmer temperatures may require re-thinking orientation of buildings and other infrastructure (e.g., how/where to put parking). 	Easy to medium. Adjusting site design and planning with climate change in mind is relatively easy for new sites but gets more challenging with existing sites	Medium. May have additional costs and you are deciding on infrastructure that has to last 30 years or longer.
	<ul style="list-style-type: none"> Warmer temperatures may lead to higher groundwater use. 	Hard, where water may be limited and/or water rights are an issue.	Medium. May increase costs to some degree.
Impacts on snow: <ul style="list-style-type: none"> Lower snowpack Shorter snow season Changes in snow quality are uncertain 	<ul style="list-style-type: none"> Lower snowpack may require adjusting assumptions about the viability of snow-dependent sites and long-term plans for current and future sites. Lower snowpack may impact relationships with recreation advocacy groups and affect revenue. 	Easy to hard. The ability to adjust to different assumptions about winter recreation could be hard, depending on the site. For example, Mt. Spokane would be hard, Lake Easton would be moderate, other locations might be easy. Changes are generally not hard to propose but implementing the changes can be hard.	Medium. Revenue can be affected but there are fewer parks where snow is an issue relative to other Parks (looking system-wide). Public may become less supportive of Parks’ priorities if relationships with recreation advocacy groups change.

PLANNING			
Projected climate change impacts	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
<p>Changes in precipitation:</p> <ul style="list-style-type: none"> Increasing fall, winter, spring precipitation More intense/more frequent heavy rain events Increased soil saturation in winter Decreasing summer precipitation 	<ul style="list-style-type: none"> More winter precipitation and heavier extreme precipitation events will require rethinking how Planning handles stormwater. Most stormwater facilities are dealing with low level rain versus downpours. This may require going above minimum permit requirements. 	<p>Medium to hard. Designs will need to leave more room to manage stormwater (e.g., parking lot sizing to handle stormwater runoff). May have to include more filtration rather than dissipation. Going above permit requirements would be difficult.</p>	<p>Medium to high. May increase project costs, for which may be difficult to secure funding.</p>
	<ul style="list-style-type: none"> Heavier winter precipitation may lead to more erosion on steep slopes and trails. Increased erosion could affect where structures are sited along cliffs and trails, including culvert and footbridge design, and public access. 	<p>Hard. Dealing with erosion can be difficult and costly; anything that increases the costs of infrastructure can be a hard sell to make. Maintaining public access can be difficult.</p>	<p>High. Budget implications if design solutions are costly. Impacts on access can create social equity issues; if unable to fully address loss of access due to erosion, the resulting conditions may mean that people with disabilities won't be able to access park amenities while able-bodied visitors still can). Lost revenue if a favorite site is inaccessible. Parks may need to buy more land to get to an easier spot.</p>
<p>Changes in hydrology:</p> <ul style="list-style-type: none"> Higher winter streamflows Increasing flood risk Lower, warmer summer streamflows 	<ul style="list-style-type: none"> Higher winter streamflows may lead to more streambank erosion, including bridge scour and erosion of trails adjoining rivers and streams. This may require changes in where Planning locates facilities in proximity to rivers and streams and how facilities, culverts, bridges, and trails are designed. Changes in hydrology may require more environmental impact mitigation, although it is not clear how likely this would be. 	<p>Medium to Hard. For some parks, you can't get out of the flood zone (e.g., Flaming Geyser) or have limited space to move facilities. May have to look at acquiring property to make those moves. Changes to infrastructure design and increased</p>	<p>High, due to financial implications and potential obligations associated with more environmental mitigation (if required).</p>

PLANNING			
Projected climate change impacts	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
<ul style="list-style-type: none"> Longer summer low flow period 		environmental mitigation can be costly.	
<i>Other issues discussed but not rated:</i> <ul style="list-style-type: none"> Lower summer water levels could reduce flows over popular scenic waterfalls, potentially leading to fewer visits. 			
<p>Changes in vegetation:</p> <ul style="list-style-type: none"> Increased drought stress Increased risk of wildfire Impacts on tree health from insects, disease 	<ul style="list-style-type: none"> The potential for more issues with tree health would require changes in how facilities are sited in relation to trees and could result in more campground closures. More tree health issues increase risks to public safety. 	Hard. Although tree health is an issue staff already deal with, changing facility siting can be difficult.	High. Taking out trees can be difficult; people are emotionally tied to the trees.
<p>Sea level rise:</p> <ul style="list-style-type: none"> Increased coastal flooding Increased surge, wave energy Increased erosion Inundation of low-lying areas Increased saltwater intrusion in groundwater wells, septic Changes in nearshore habitat 	<ul style="list-style-type: none"> Sea level rise may require changes in facility siting and design. Sea level rise could increase bluff erosion and affect beach and sand migration (e.g. Cape Disappointment). Loss of low-lying park lands, including beaches, to permanent inundation may shrink park sizes. Historical structures may become more vulnerable to damage from sea level rise and storm surge. 	Hard. Dealing with the impacts of sea level rise will be expensive.	High, due to cost implications. For example, boating facilities would have to be designed with taller piles.

STEWARDSHIP			
Projected climate change impacts	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
<p>Increasing temperatures:</p> <ul style="list-style-type: none"> Warmer seasonal temperatures More extreme heat events 	<ul style="list-style-type: none"> Warmer temperatures could increase park visits in the shoulder seasons and shift visitor preferences, the seasonality of recreation. Warmer temperatures and more extreme heat events could increase pressure to use air conditioning 	<p>Medium. Can make adjustments but effects on habitat and ecology may be difficult to mitigate.</p>	<p>High. Could affect nesting season and have bird/human impacts</p>
<p>Impacts on snow:</p> <ul style="list-style-type: none"> Lower snowpack Shorter snow season Changes in snow quality are uncertain 	<p><i>No impacts directly related to changes in snow discussed; related impacts on streamflow discussed in hydrologic change</i></p>		
<p>Changes in precipitation:</p> <ul style="list-style-type: none"> Increasing fall, winter, spring precipitation More intense/more frequent heavy rain events Increased soil saturation in winter Decreasing summer precipitation 	<ul style="list-style-type: none"> More winter precipitation and more intense heavy rain events could wash out more trails, requiring repairs (where possible) or re-routing of affected trails. More winter precipitation and more intense heavy rain events could lead to increased landslides and contribute to more erosion, affecting historical buildings. More winter precipitation could raise groundwater levels in winter, contributing to localized flooding in low elevation areas. Lower summer precipitation could increase the demand for water even as getting water rights for new park becomes more difficult. 	<p>Hard. Increased erosion may require moving facilities, which is difficult to do. The ability to be proactive is limited.</p>	<p>High. Potential for costly damage to or loss of historical structures. Re-routing trails can lead to creating other trails that can affect habitats and species. Sensitive habitats may be affected (e.g., wetlands).</p>
<p>Changes in hydrology:</p> <ul style="list-style-type: none"> Higher winter streamflows 	<ul style="list-style-type: none"> The potential for bigger floods and increased erosion could impact historical buildings and expose more archaeological sites, increasing potential for vandalism of those sites. 	<p>Hard. See reasons related to changes in precipitation. Additionally, threats to or increased exposure of</p>	<p>High. Potential for costly damage to or loss of historical structures.</p>

STEWARDSHIP			
Projected climate change impacts	Related impacts(s) to the region and/or individual parks	Ability to adjust	Consequence
<ul style="list-style-type: none"> Increasing flood risk Lower, warmer summer streamflows Longer summer low flow period 	<ul style="list-style-type: none"> Lower summer streamflow would negatively affect salmon, vernal pools. Lower summer streamflows and lower water levels at water features (where that occurs) could affect visitation. 	archaeological sites may require enlarging off-site artifact storage.	
<p>Changes in vegetation:</p> <ul style="list-style-type: none"> Increased drought stress Increased risk of wildfire Impacts on tree health from insects, disease 	<ul style="list-style-type: none"> More frequent and/or larger fires could expose archaeological resources, increasing potential for vandalism of those sites. Expansion of non-native species such as cheatgrass or Scotch broom (Class B non-native invasive species) could negatively affect native habitats. 	Medium. Staff are already working on fuels reduction, managing invasives, and reducing habitat fragmentation by increasing habitat connectivity along elevation gradients. An expansion of these activities would require additional resources.	High. Ecological consequences of more damage to tree health and fire in the Parks system is not well understood. Native species/habitats may be degraded or lost entirely.
<p>Sea level rise:</p> <ul style="list-style-type: none"> Increased coastal flooding Increased surge, wave energy Increased erosion Inundation of low-lying areas Increased saltwater intrusion in groundwater wells, septic Changes in nearshore habitat 	<p>Parks has a lot of historical structures and archaeological features (e.g., shell middens) near the shore or on coastal bluffs that could be threatened by erosion, higher storm surge, or inundation.</p> <p>Coastal species/habitats may be lost. For example, shoreline habitat for western snowy plover (listed as Threatened under the Endangered Species Act) could be negatively affected by rising sea level.</p>	Will vary by site. Some places will be easier to adjust than others. Dealing with the impacts of sea level rise will be expensive. Sea level rise may require moving or abandoning facilities. Some parks don't have room to move to higher ground or are highly constrained by local plans, federal regulations, floodplain regulations, etc. Engineering solutions that may not be allowed.	High, due to cost implications and loss of irreplaceable species/habitats. For snowy plover, State Parks has a significant portion of that species' habitat in Washington State so losses of that habitat could have important implications.