



National Park Service
U.S. Department of the Interior



CLIMATE *Friendly* PARKS

Olympic National Park Action Plan

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OLYMPIC NATIONAL PARK BECOMES A CLIMATE FRIENDLY PARK

As a participant in the Climate Friendly Parks program, Olympic National Park belongs to a network of parks nationwide that are putting climate friendly behavior at the forefront of sustainability planning. By conducting an emission inventory, setting an emission reduction goal, developing this Action Plan, and committing to educate park staff, visitors, and community members about climate change, Olympic National Park provides a model for climate friendly behavior within the park service.

As part of the National Park Service's Pacific West Region, Olympic National Park is involved in the first regional effort within the NPS to become carbon neutral. The Region has developed a vision of having its park operations¹ be carbon neutral by 2016, and of having all of its parks become Climate Friendly Parks Member Parks by 2010. Within the context of this larger vision, Olympic National Park developed the emission reduction and adaptation goals described in this document.

Olympic National Park's goals are, by 2016: (1) reduce greenhouse gas (GHG) emissions from park operations by 30 percent below 2007-levels, (2) reduce total transportation-related emissions, including visitor and concessioner vehicle emissions, by 35 percent below 2007-levels, and (3) develop and implement an adaptation plan addressing the impacts of climate change on natural and cultural resources and infrastructure within the park.

This Action Plan describes measures the park will take to meet these goals. In addition to implementing these measures, Olympic National Park will:

- Monitor progress with respect to reducing emissions and preserving natural and cultural resources and infrastructure.
- Identify additional actions to reduce GHG emissions and preserve natural and cultural resources and infrastructure.
- Revise and update this Action Plan to strengthen existing actions and include additional actions.

THE CHALLENGE OF CLIMATE CHANGE

Climate change presents significant risks and challenges to the National Park Service. At Olympic National Park, increasing temperatures, decreasing snow pack, and changing precipitation patterns may alter park ecosystems, changing vegetation communities, habitats available for species, and the experience of park visitors.

Scientists cannot predict with certainty the general severity of climate change nor its impacts. Average global temperatures on the Earth's surface have increased about 1.1°F since the late 19th century, and the 10 warmest years of the 20th century all occurred in the last 15 years. The single leading cause of this warming is the buildup of GHGs in the atmosphere—primarily carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O)—which trap heat that otherwise would be released into space.

The continued addition of CO₂ and other GHGs to the atmosphere will raise the Earth's average temperature more rapidly in the next century; a global average warming of 4-7°F by the year 2100 is considered likely.² Rising global temperatures will

¹ "park operations" refers to the facilities, vehicles, equipment, etc. that are under the operational control of the park.

² IPCC 2007. Climate Change 2007: The Physical Science Basis. Intergovernmental Panel on Climate Change, Geneva Switzerland. Available online at < <http://ipcc-wg1.ucar.edu/wg1/wg1-report.html>>

further raise sea levels and affect all aspects of the water cycle, including snow cover, mountain glaciers, spring runoff, water temperature, and aquatic life. Climate change is also expected to affect human health, crop production, animal and plant habitats, and many other features of our natural and managed environments.

GOALS AND OBJECTIVES

This Action Plan identifies steps that Olympic National Park can undertake to reduce GHG emissions and adapt to current and future impacts of climate change. The plan presents the Park's emission reduction goals, and associated reduction actions and adaptation strategies to achieve the Park's goals. Strategies and action plan items were developed by working groups at Olympic National Park's Climate Friendly Parks Workshop.³ While the plan provides a framework needed to meet the park's emission reduction and adaptation goals, it is not intended to provide detailed instructions on how to implement each of the proposed measures. The park's Environmental Management System will describe priorities and details to implement these actions.

Olympic National Park aims to:

Reduce GHG emissions from Park Operations to 30 percent below 2007-levels by the year 2016.

Reduce transportation-related GHG emissions, including those from visitor and concessioner vehicle travel, to 35 percent below 2007-levels by the year 2016.

Implement measures that best allow the Park's natural and cultural resources to adapt to the impacts of climate change. Modify infrastructure as needed for sustainable function in new environments created by climate change.

To meet these goals, the park will implement strategies proposed in this plan that relate to the Park's current and future emission inventories. Specifically, the plan recommends four strategies:

Strategy 1: Identify and implement mitigation actions that the park can independently take to reduce GHG emissions resulting from activities within and by the park

Strategy 2: Identify and implement management practices that confer resilience and adaptation of natural resources (species, habitats, and ecosystems), cultural resources (archaeological, historic/prehistoric, and landscapes) and park facilities to new environments created by climate change

Strategy 3: Increase climate change education and outreach efforts

Strategy 4: Monitor progress and identify areas for improvement

³ Original notes from these workshops, including detailed action items not presented in the final plan have been archived by Olympic National Park and are available by request.



GREENHOUSE GAS EMISSION INVENTORY AT OLYMPIC NATIONAL PARK

Naturally occurring GHGs include CO₂, CH₄, N₂O, and water vapor. Human activities (e.g., fuel combustion and waste generation) lead to increased concentrations of these gases (except water vapor) in the atmosphere.

Greenhouse Gas Emissions

GHG emissions result from the combustion of fossil fuels for transportation and energy (e.g., boilers, electricity generation), the decomposition of waste and other organic matter, and the volatilization or release of gases from various other sources (e.g., fertilizers and refrigerants).

In 2007, GHG emissions within Olympic National Park totaled 12,310 metric tons of carbon dioxide equivalent (MTCO₂E). This includes emissions from park and concessioner operations and visitor activities, including vehicle use within the park. To put this number in perspective, a typical single family home in the U.S. produces 10.99 MTCO₂ per year.⁴ Thus, the combined emissions from park and concessioner operations, and visitor activities within the park are roughly equivalent to 1,120 households.

The largest emission sector for Olympic National Park is Transportation, totaling 8,228 MTCO₂E (Fig 1 and Table 1). Visitor vehicle travel within park boundaries produces 93 percent of transportation emissions within the park, and over 62 percent of total emissions from all sources within the park. In contrast, emissions from park operations (which exclude emissions from visitor and concessioner activities) were primarily from purchased electricity to operate park facilities. Emissions from park operations totaled 2,635 MTCO₂E, resulting from Energy (55 percent), Transportation (22 percent), Waste (22 percent), and Other (1 percent) activities (see Figure 2 and Table 2).

⁴ U.S. EPA, Greenhouse Gases Equivalencies Calculators – Calculations and References, Retrieved May 13th, 2009, Website: <http://www.epa.gov/solar/energy-resources/refs.html#houseelec>



FIGURE 1

Olympic National Park 2007 Total Greenhouse Gas Emissions From All Sources by Sector

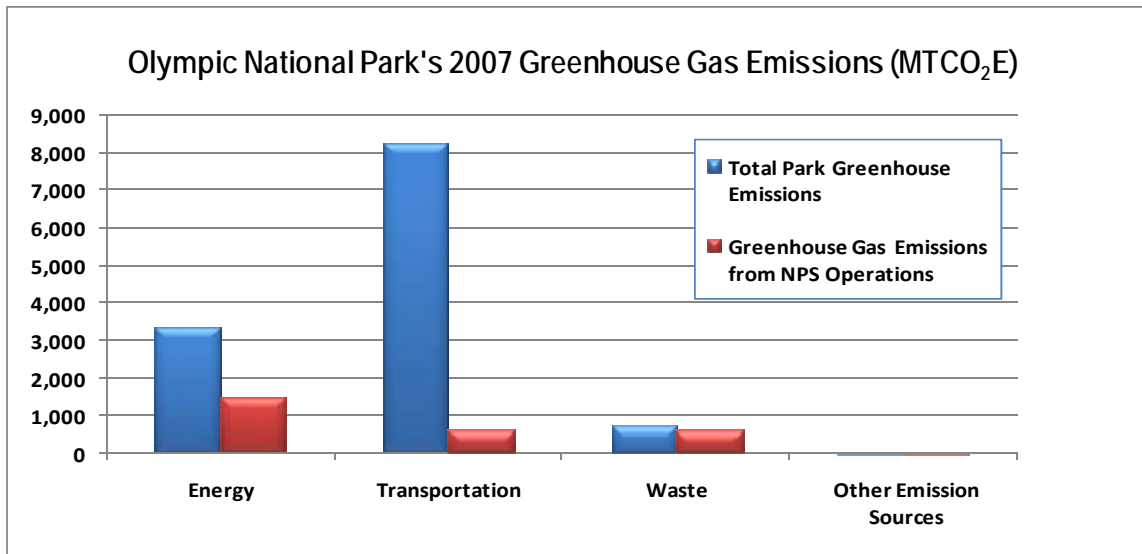


TABLE 1

Olympic National Park 2007 Total Greenhouse Gas Emissions by Sector and Source

	Total Emissions, All Sources (MTCO ₂ E)	% of Total	Park Operations-Only Emissions (MTCO ₂ E)	% of Total Park Operations
Energy	3,337	27%	1,460	55%
Stationary Combustion	462	4%	140	5%
Purchased Electricity	2,875	23%	1,320	50%
Transportation	8,228	67%	580	22%
Mobile Combustion	8,228	67%	580	22%
Waste	707	6%	572	22%
Solid Waste Disposal	706	6%	571	22%
Wastewater Treatment	1	0%	1	0%
Other Emission Sources	37	<1%	22	1%
Refrigeration	34	<1%	22	1%
Other GHG Sources	3	<1%		
Total Emissions	12,310		2,635	



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FIGURE 2

Olympic National Park Operations – 2007. Total Greenhouse Gas Emissions by Sector

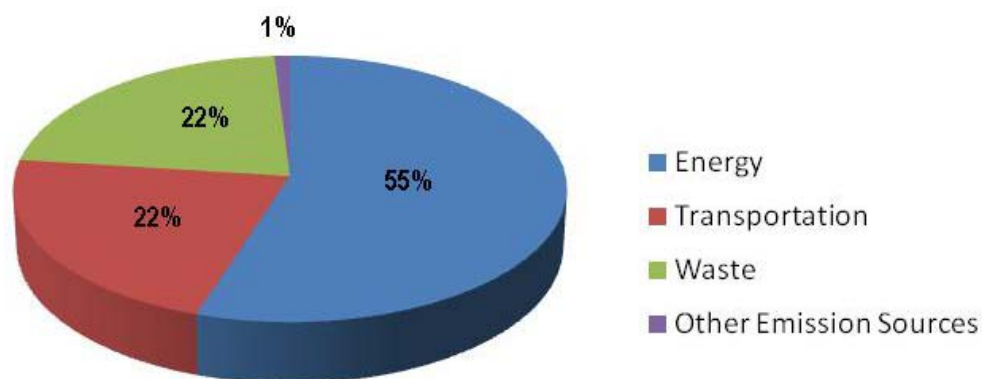


TABLE 2

Olympic National Park Operations – 2007 Greenhouse Gas Emissions by Sector and Source

	Emissions (MTCO ₂ E)	% of Total
Energy	1,460	55%
Stationary Combustion	140	5%
Purchased Electricity	1,320	50%
Transportation	580	22%
Mobile Combustion	580	22%
Waste	572	22%
Solid Waste Disposal	571	22%
Wastewater Treatment	1	0%
Other Emission Sources	22	1%
Refrigeration	22	1%
Total Emissions	2,635	

Note: Totals may not sum due to rounding



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Olympic National Park Responds to Climate Change

The following actions were developed during the CFP workshop hosted by Olympic National Park on February 26 and 27, 2009 in order to meet the park's climate change mitigation and adaptation goals.

STRATEGY 1: REDUCE GHG EMISSIONS RESULTING FROM ACTIVITIES WITHIN AND BY THE PARK

Energy Use Management

Emission Reduction Goal: Reduce Park Operations' energy use emissions to 30 percent below 2007 levels by 2016.

Improving energy efficiency and implementing alternative energy sources reduces park-based fuel use, lowers GHG emissions, decreases electricity consumption, and offers monetary benefits for the park. Emissions inventory results indicate that 55 percent of the park's GHG emissions from Park Operations are from energy consumption. Consequently, Olympic National Park identified actions it will take to reduce energy-related emissions. In implementing these actions, Olympic National Park will prioritize actions according to their costs and benefits as well as their educational potential, and use the best available technologies and procedures.

Progress to Date

Alternative Energy:

- ❖ Park produced Hydro-power provides all electricity to campgrounds and facilities in the Staircase Sub-District.
- ❖ A demonstration wind generator produces power for facilities at Rialto Beach trailhead.
- ❖ Solar powered water systems now serve the Queets & North Fork Quinault Ranger Stations.

Equipment and Building Efficiency Conversions:

- ❖ Park lighting converted to fluorescent or LED fixtures (90 percent complete)
- ❖ 2-stroke engines replaced with 4-stroke engines in small power equipment (chainsaws, lawn mowers, leaf blowers, boat motors) (10 percent complete)
- ❖ Conventional water heaters replaced with "on demand" units where this increases efficiency (10 percent complete)
- ❖ Older appliances replaced with energy-efficient appliances in housing units (25 percent complete).
- ❖ Outdated heating systems replaced with energy efficient units (15 percent complete).
- ❖ Inefficient single pane glass windows in heated buildings replaced with double pane glass (45 percent complete)
- ❖ Insulation installed in heated buildings, including historic structures (90 percent complete).



Energy Use Management - Actions

1 Promote energy efficiency and energy conservation in park-owned facilities

- Evaluate structures to identify weatherization needs.
- Work with Bonneville Power Administration to conduct a park-wide energy audit.
- Evaluate current sub-metering in park buildings and consider additional metering to allow more detailed auditing of electrical energy use in park facilities and equipment.
- Assess park appliances and electronics with energy consumption meters to determine highly inefficient units and target these items for replacement or reduction in use.
- Continue energy efficiency upgrades throughout the park. (e.g. replace single-pane windows with more energy efficient windows; insulate heated buildings, install smart strips and green switches to reduce phantom load⁵ in office spaces).
- Install solar hot water heating where applicable in park housing and buildings. In areas where solar is not effective, replace standard water heaters with more efficient "on-demand" devices.
- Incorporate passive solar in future building designs.

2 Produce clean energy or purchase electricity from a renewable energy provider

- Work with local contractors to investigate solar-ready locations throughout the park, and develop equipment and cost estimates.
- Install peel-and-stick or other photovoltaic systems at viable locations throughout the park.
- Assess the viability of installing additional coastal wind and solar demonstration projects, which could provide electricity to facilities.
- Install two-way metering to allow park facilities to return excess power to the grid.
- Install other demonstration projects (e.g., fuel cell, carbon scrubber) at park visitor centers and facilities.

3 Other

- Incorporate reduction of carbon emissions in all planning efforts through the park's Interdivisional Planning Team.
- Encourage routine communication between divisions toward more efficient and coordinated use of transportation, equipment and labor with respect to common goals.
- Charge batteries, computers, etc. in vehicles during travel.

⁵ Phantom load refers to the electric power consumed by electronic appliances while they are switched off or in a standby mode. A 2000 study at the Lawrence Berkeley National Laboratory found that standby power accounted for around 10 percent of household power-consumption.



Transportation Management

Emission Reduction Goal: Reduce Park Operations transportation emissions to 30 percent below 2007 levels by 2016.

Reducing vehicle miles traveled, improving vehicle efficiency, and using alternative fuels can significantly reduce Olympic National Park's emissions. As the inventory results indicate, GHG emissions from Transportation comprise 22 percent of Park Operations emissions and 67 percent of the park's overall emissions (including visitors, concessioners, and the Olympic Park Institute). Accordingly, Olympic National Park set a goal to reduce overall transportation emissions by 35 percent below 2007 levels by 2016.

Progress to Date

- ❖ Actively replacing GSA leased motor pool vehicles with fuel efficient hybrid vehicles as they become available.
- ❖ "Right-sizing" vehicles as they are replaced with an emphasis on smaller, more fuel efficient vehicles when possible.
- ❖ Initiation of shuttle systems for Hurricane Ridge and the Sol Duc has begun through the park's 2008 General Management Plan. Pursuit of alternative transportation for these areas is a high priority goal for the park.
- ❖ Maintaining a schedule that organizes staff movement within the park to improve efficiency. Foremen meet at the beginning of each workday to identify opportunities for shared crew travel.
- ❖ Winter plowing operations at Hurricane Ridge have been reduced to high use periods (weekends & holidays).
- ❖ Use of local (within park) sources of gravel & wood reduces transportation of materials for roads and trails.

Transportation Management Actions

Reduce fuel consumed by visitor vehicles

1 Develop integrated local and regional public transportation systems

- Develop effective public transportation and shuttle systems for the most popular locations at Olympic National Park.
 - In conjunction with the NPS Denver Service Center, prepare a detailed feasibility study of potential shuttle systems for Hurricane Ridge and the Sol Duc Hot Springs Resort.
 - Investigate an additional shuttle route from the Forks Transit Center to Hoh Rainforest.
 - Investigate opportunities to tie shuttle systems to existing public transportation systems in Clallam and Jefferson Counties.
- Work with the Olympic Peninsula Tourism Commission and entities in the Seattle/Tacoma metropolitan area to expand and promote shuttles to the park and the Olympic Peninsula.
- Work with concessioners to develop cooperative shuttle tours and opportunities.



2 Incentivize energy efficient means of transportation

- Create incentive programs for visitors to use energy efficient modes of travel.
 - Work with concessioners to offer discounts on services or redeemable merchandise coupons if visitors arrive in hybrid or fuel efficient vehicles.
 - Explore offering bicyclists and bus riders discounted or free entrance into the park⁶.
 - Assess potential for incentive programs through the private sector (e.g. car manufacturers could offer a free park pass with a purchase of an energy efficient vehicle).
- Make cycling convenient within park boundaries.
 - Focus on developing partnerships to promote bicycling throughout the area.

Reduce fuel consumed by NPS and concessioner vehicles

3 Continue to replace Park's current fleet with more energy efficient vehicles

- Build on the 2008 Fleet Management Study to develop a Fleet Management Plan, to encompass these and additional actions.
- Increase average fleet fuel efficiency by 10 mpg by 2012.
- Achieve fuel efficiency goal by replacing current GSA leased vehicles with hybrid or smaller vehicles whenever possible (i.e., "right-size" fleet). This action will require negotiations with and support from GSA.
 - Formalize guidelines for fleet specifications to improve efficiency.

4 Expand energy efficient intrapark transportation options for park staff

- Maintain a schedule that organizes staff movement within the park to improve efficiency and continue the practice of crew meetings at the beginning of each workday to identify opportunities for shared travel.
- Coordinate travel in weekly team leadership meetings.
- Coordinate with other divisions to move tools, staff and equipment (e.g. sending tools & mail with fee couriers) most efficiently.
- Consider cross-training to eliminate the need for specialized staff to travel to remote locations unnecessarily.
 - Example (currently in use): Hoh rangers currently collect and ship water samples for a long term monitoring study. By training local staff, a physical science technician does not have to travel from Port Angeles weekly.
- Identify fund source to subsidize bus passes for park employees.

⁶ While Olympic NP may propose or investigate incentive opportunities, any adjustment to NPS fees would require policy changes on a national level.



5 Increase the use of alternative fuels in NPS and concessioner equipment

- Establish the goal of using B20 (20 percent biodiesel blend) in all park diesel vehicles.
- Implement recommendations of the recent fleet study to decrease petroleum consumption and increase the use of alternative fuels as available.
- Explore developing a partnership or purchase agreement with the county and other partners to create a viable market for biodiesel in the area. Potential partners include: Coast Guard, City, Tribes, County, School Districts, State DOT, and the Port of Port Angeles.

6 Other

- Continue to replace two-stroke engines with more efficient four-stroke engines in boats, snowmobiles and other equipment.
- Use webinars, video or teleconferencing for meetings in order to limit business and intrapark travel. In areas with limited internet access, partner with concessioners which have access to high speed internet.
- Encourage employees to bicycle or car pool to work.
- Encourage staff car pooling by establishing information and support services for staff.
- Train employees about fuel efficient driving habits and proper maintenance of vehicles. This training would include information on topics such as proper tire pressure and appropriate driving speeds.
- Establish Olympic as a "no idling park".

Waste Management

Emission Reduction Goal: Reduce Park Operations waste emissions to 20 percent below 2007 levels by 2016 through waste diversion and reduction.

The connection between waste and GHG emissions may not be obvious. However, waste management—in the form of source and solid waste reduction—can dramatically reduce GHG emissions. Landfills are the largest human-generated source of CH₄ emissions in the United States. Waste from Olympic National Park facilities routinely travels hundreds of miles to a landfill in eastern Oregon. Reducing the amount of waste sent to landfills reduces CH₄ emissions caused by decomposition as well as the CO₂ & N₂O emitted from the transportation of waste. The less we consume in terms of products and packaging, the less energy is used and fewer GHGs are emitted.

Olympic National Park's Park Operation activities emitted 572 MTCO₂E from waste management in 2007. Diverting or reducing the park's waste stream through increased recycling efforts and waste management will reduce the amount of waste sent to landfills. The following strategies are proposed to meet the park's waste emission reduction goal:



Progress to Date

- ❖ Recycling mixed paper, cardboard & aluminum cans at park headquarters.
- ❖ Recycling aluminum in all park campgrounds.
- ❖ Recycling metal, wood and concrete produced from park maintenance activities.
- ❖ Reusing building materials whenever practical.

Waste Management Actions

1 Increase and improve recycling.

- Conduct a baseline evaluation of current waste stream.
- Pursue opportunities to provide recycling services to park sub-districts.
- Discourage the use of all disposables such as cups and plates in park buildings.

2 Establish new plans and policies that promote waste reduction.

- Prepare a park-specific green procurement plan including standard operating procedures (SOPs).
- Create recycling & waste SOPs for park facilities. Clearly label trash receptacles in all buildings, indicating what materials are recyclable.
- Develop a new Integrated Solid Waste Action Plan (ISWAP) that provides recommendations to manage recycling and potentially composting, and identifies other efficiency opportunities. As part of ISWAP, investigate and review contracts for efficiency gains in recycling, and recommend options for staffing to oversee waste management operations.

3 Work with partners and involve the public.

- Continue park participation with Clallam County Solid Waste Action Committee.
- Reduce trash collection in remote areas (including vehicle-accessed areas) by encouraging visitors to “pack it out”.
- Investigate opportunities to work with other national, state and /county parks to purchase a propane tank compactor for recycling tanks discarded in campgrounds.
- Explore opportunities for full use of reusable building materials removed from park facilities.



STRATEGY 2: DEVELOP AND IMPLEMENT A PLAN TO ADAPT TO CURRENT AND FUTURE IMPACTS OF CLIMATE CHANGE

While every effort must be made to curb future impacts of climate change through GHG reduction actions such as those proposed in Strategy 1, the impacts of climate change are being seen around the globe. Atmospheric GHG concentrations are increasing, but even if these concentrations could be stabilized at today's levels, past emissions will continue to cause warming of the planet through the end of this century.⁷ Adaptation strategies through proactive, "anticipatory planning" will be an important complement to curbing emissions in seeking to promote resilience of resources and ecosystems to the effects of climate change.⁸

While it is important to recognize that the science around adaptation planning is rapidly evolving, the following steps should be considered: 1) establish a measurable baseline that is informed by science, 2) develop key partnerships both among agencies or organizations (National Park Service, Forest Service, NGO's, etc.) and individuals (managers, policy makers, and scientists) that will be affected by any actions taken, 3) develop a plan, 4) implement adaptive management, and finally, 5) revisit and revise the plan based on experience and updated science.

Climate change impacts that affect Olympic National Park include increased temperatures, loss of glaciers and snowpack, changes in precipitation patterns, and altered stream flow patterns. Many of these impacts are interrelated, and make adaptation planning a complicated task. For example, increased temperatures and changes in precipitation can affect forest regeneration, forest productivity, species distributions, and large scale disturbance patterns from fire, insect outbreaks, and direct mortality. The potential for large scale disturbances of park resources and infrastructure highlights the need for proper adaptation strategy planning and implementation. The actions discussed below represent the beginning of this process for Olympic National Park.

Natural Resources

For decades, national parks of the U.S. have preserved various ecological landscapes, species, and cultural sites and resources. The species that comprise these ecosystems and the landscapes they inhabit are changing in response to global warming. Effects on ecosystem function and species diversity of natural systems are expected to be among the most severe.⁹ Actions described here are the beginnings of an adaptation strategy proposed to reduce the severity of impacts to park resources from climate change. These are a subset of the larger list of actions developed during the workshop (Appendix A).

Projected Future Climate

- Partner with Climate Impacts Group (CIG) at University of Washington to assess the feasibility of additional downscaling of regional climate models to inform Olympic National Park and other local land management decisions.

Hydrology and Water Resources

⁷ IPCC 2007. Climate Change 2007: The Physical Science Basis. Intergovernmental Panel on Climate Change, Geneva Switzerland. Available online at < <http://ipcc-wg1.ucar.edu/wg1/wg1-report.html>>

⁸ Easterling, et al. 2004. Environment: Coping with Global Climate Change – The Role of Adaptation In the United States. Prepared for the Pew Center for Global Climate Change.

⁹ Ibid.



- Complete baseline inventories and fully fund monitoring activities to move future conservation strategies forward.
- Evaluate coverage of stream gauges and maintain and augment these gauges.
- Assess source areas for sediment.

Vegetation

- Sustain and potentially enhance current monitoring programs.
- With partners, develop a guide to identify invasive species throughout the region.
- Assess potential problematic invasive species and develop a comprehensive management plan to prioritize and address invasives issues.
- Develop invasives training for Park and stakeholder staff.
- Identify functional groups of species that are important to the overall functionality of specific ecosystems.
- Collaborate with Olympic National Forest and managers in coastal British Columbia to assess the vulnerability of endemic species and develop management options.
- Begin to identify priorities when addressing management of endemic species.
- If environmental conditions or disturbance regimes change to create new site conditions, consider reintroducing or moving native species according to habitat requirements (e.g., Bear Grass, Skokomish).

Wildlife

- Establish a baseline inventory of high elevation species.
- Develop a vulnerability assessment to identify most at-risk species.
- Evaluate potential management strategies such as predator control, habitat manipulation, and species reintroduction.
- Evaluate fish distribution baseline maps and develop protocols to update these.
- Sustain fish assemblage monitoring.
- Encourage the development of a multi-stakeholder approach to conserve fisheries in the face of climate change. Consider proposing the Olympic Peninsula as a sentinel site to evaluate the impacts of climate change on salmon fisheries and develop a conservation strategy.

Soil

- Ensure that soil survey is completed (scheduled for 2017), and accelerate if possible.
- Establish baseline information on nutrient cycling and erosion in terrestrial systems.

Cultural Resources



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In many instances, national parks were created to preserve a particularly special American cultural resource, or, since their inception, have discovered that they contain significant cultural resources. As identified during the Climate Friendly Parks Workshop, these resources include historic structures, ethnographic resources, archeological resources, and cultural landscapes. The integrity of these cultural resources can be affected by physical changes in the landscape due to climate change. Olympic National Park has developed the following actions to preserve as many of the cultural resources within the park boundaries as possible.

Historic Structures

- Document historic resources within the park.
- Perform vulnerability assessment of current historic structures and map.
- Identify any additional documentation of structures that needs to be performed.
- Identify trigger point for protecting, moving or removing structures, and evaluate potential management actions.
- Develop communication strategy to inform extended community of decision process.

Archeological Resources

- Evaluate the existing models of coastal vulnerabilities. Perform gap analysis on whether these resources are sufficient to make decisions.
- In collaboration with the Tribes, perform vulnerability assessment of coastal resources.
- Identify trigger point for protecting, moving or removing resources. With Tribes, evaluate the various scenarios for management action.

Ethnographic Resources

- Work with Tribes and other partners to sustain and potentially augment current monitoring programs of both terrestrial and aquatic treaty resources, including traditional food sources.
- Work with Tribes and other partners to evaluate what current stressors on resources can be removed or reduced.
- Enhance current programs that support resilience (e.g., current exotics removal programs).

Infrastructure

To enable visitors to experience the resources and features of national parks, each park has a physical infrastructure that may include roads, trails, bridges, culverts, buildings, and utilities. These facilities represent a significant investment that can be affected to varying degrees by climate change. Olympic National Park recognizes the potential for its infrastructure to be impacted and has developed the following actions to understand and plan for the impacts of climate change to better protect its physical resources.

Circulation (Roads, Trails, etc.)

- Engage extended community and Tribal partners in scenario planning and discussions of potential management options.



- Link road and trail strategies with those of other Peninsula land managers. Complete comprehensive structural condition assessment of roads and trails. (e.g. perform surveys, complete culvert inventory, etc., obtain high resolution aerial imagery including LIDAR)
- Perform vulnerability assessment of current infrastructure with respect to potential climate change impacts and related geomorphologic processes.
- Identify potential management options to address vulnerabilities. Consider relocation of infrastructure.
- Develop a better understanding of alternative structure options and potential management implications. Be more proactive about experimenting with alternative structures.
- Identify potential funding sources and promote policy or procedural changes where there are impediments to obtaining funds for climate-change related solutions.
- Institute revegetation planning and implementation for all areas in which infrastructure has been removed.
- Develop an IDIQ contract for storm damage to road infrastructure to allow for quicker response and repairs.

Facilities (Buildings, Structures, etc.)

- Perform a vulnerability assessment of all facilities.
- With partners including Olympic National Forest, Washington State Parks, Washington Department of Natural Resources, county parks, etc., describe the recreation facilities, camp areas, etc. that are available on the Peninsula, evaluate the potential for climate change to alter or eliminate these features, and develop a joint plan to provide for desired recreation opportunities on the Peninsula into the future.
- If dictated by budget or workload, consider consolidating facilities and reducing services that require ongoing repair and replacement due to storms.
- Proactively use engineered log jams or other "fish-friendly" tools where feasible for the purpose of protecting road sections having high probability of damage from flood events.

Utilities

- Determine and document the locations of all utilities, including a comprehensive condition assessment of current utilities.
- Perform a vulnerability assessment of current utilities.
- Incorporate potential climate change impacts into management of current renovation projects.



STRATEGY 3: INCREASE CLIMATE CHANGE EDUCATION AND OUTREACH

Climate change is a complex and easily misunderstood issue. Olympic National Park can play an integral role in communicating about climate change to a vast audience. A better understanding of the challenges and benefits of reducing GHG emissions can motivate staff, visitors, and community members to incorporate climate friendly actions into their own lives. Olympic National Park recognizes that the greatest potential impact the park can have on mitigating climate change is through public education. Thus, the park sees public education as an end goal of any climate initiative. From increasing the efficiency of public transportation to developing a green purchasing program, the actions Olympic National Park takes to address climate change serve as opportunities for increasing the public's awareness of climate change.

Key Messages

Implementing effective education and outreach programs requires a focused set of messages to relay to appropriate audiences. Olympic National Park recognizes this fact and has developed several key messages to educate park staff, visitors, partners, and gateway communities about climate change. Messages that the Park developed during its workshop include:

- Climate change is real and humans are increasing the rate of occurrence and intensity of its impacts.
- Climate change affects you while you are at the Park as well as when you go home.
- The current science behind climate change and the impacts being seen at the park include:
 - Impacts of snow pack and glacier loss, e.g., impacts to water quality and fish species.
 - Larger winter floods and the resulting loss (temporary or permanent) of roadway networks.
 - Increased severity of storm events and sea level changes.
 - Forest pest outbreaks and the resulting increase in fire danger.
 - Temporal and spatial species shifts.

Park Staff

Incorporate climate change into park staff training, events, and performance plans

Developing a climate change education program for park staff is vital to increasing awareness about climate change among park visitors and fostering a sense of collective responsibility among staff to help reduce park emissions. By incorporating climate change education into staff-development programs, Olympic National Park will enable its staff to demonstrate their commitment through leading by example, and providing visitors with the tools and resources they need to reduce GHG emissions in the park and in their own communities. Potential actions include:

- Lead by example through hosting zero-waste events. Events could include lunch for volunteers and staff, seasonal dinner, Junior Ranger Day, and Perspective Series.
- Incorporate more messages about best green practices for energy and waste management in orientation materials.
- Include climate change topic and Climate Friendly Parks discussion during annual seasonal training.



- Educate and promote positive habits through park trainings and reminders. Develop a “culture of conservation” among park staff and promote this idea to park visitors (e.g. positive habits: reduced idling, checking tires for appropriate pressure, driving at appropriate speeds, walking or bicycling when patrolling campground loops).
- Discussion of Climate Friendly Parks program on staff Intranet.
- Consider including a monthly feature story on climate friendly actions in Park monthly newsletter.
- Create an electronic “all-employee” handbook that includes Climate Friendly Parks information.
- Include Climate Friendly Action Items in employee performance plans

Visitor Outreach

Understanding climate change and its consequences is essential to initiating individual behavioral change. Olympic National Park realizes that it has a unique opportunity to educate the public in a setting free from many of the distractions of daily life. By using existing materials, developing park-specific materials, highlighting what the park is currently doing about climate change, and encouraging visitors to reduce emissions, Olympic National Park can play an important role in educating the public about climate change.

Develop appropriate climate change messaging for different audiences

Olympic staff recognize the many different audiences that visit the Park, including recreational and non-recreational park visitors, “virtual visitors” who visit the park online, school-aged visitors, local and out of town visitors, local tribes, and external audiences such as the Scouts, 4-H clubs, fishing groups, elder-hostels, and Friends of Olympic National Park. Reaching these various audiences with climate change information requires appropriately focused messaging. The park has developed a number of strategies to reach these various audiences effectively. These strategies include:

- Consider the varied visitor audiences when developing new educational materials.
- Acknowledge that many people want to do more and are ready to take action if the park provides the incentive.
- Explain climate change impacts to visitors, but also include the equally important part about “what you can do” messaging.
- Coordinate with other national parks (experiencing similar impacts) for consistent messaging.
- Build on the commonly held notion of “protecting park resources” (i.e., “don’t pick the flowers”), and adapt the message for climate change to the appropriate range of audiences.

Reach out to park visitors before, during, and after their visit

Olympic National Park has developed a staged approach to its outreach to visitors. The actions developed during the workshop were organized into three categories: reaching the visitors before, during and after a visit to the park.

Before the visit:

- Develop a “Plan your Visit” Web page that helps people plan a climate-friendly visit.
- Publicize public transportation options to and from the park.



- Encourage and incentivize bus-friendly visits.
- Develop a “Leave No Trace” or “Leave No Carbon” challenge. Encourage visitors to plan zero-impact or low footprint visits.
- Encourage visitors to use 12 Climate-Friendly Tips sheet that is available on the web.
- Work with tourist groups to encourage use of climate-friendly business practices.
- Update park handouts for mailings.

During the visit:

- Make it easy to participate in the park’s climate friendly actions by providing visitor tips and alternatives for reducing, reusing, and recycling in the park.
- Work with concessionaires to provide educational material about why it’s important to take action, steps the park is taking, park goals and how visitors can help.
- Feature climate-friendly tips and articles in the *Bugler* (ONP’s seasonal visitor newsletter).
- Include climate friendly messages and activities when revising the Junior Ranger activity book.
- Include tips and Do *Your Part!* information during evening programs, and incorporate climate change messages in personal services.
- Publicize the Region’s vision of carbon neutrality by 2016.
- Highlight actions that the park is implementing to address climate change through various mediums (e.g. park website, pamphlets, displays)
- Post climate friendly tips on campground bulletin boards, for example pack out recyclables and garbage, build small fires, etc.
- Create a reusable bag or tote for visitors to use during and after their visit to the Park.

After the visit:

- Promote use of metal water bottles and water filters at home (discourage use of *plastic water bottles*).
- Encourage visitors to implement climate friendly actions at home.
- Promote *Do Your Part!* in various outlets throughout the Park.
- Provide information about volunteer opportunities, e.g., tree planting projects and other NPS conservation activities.



Local Community Outreach

The gateway communities surrounding Olympic National Park and the local tourism industry can play a significant role in supporting Olympic National Park's GHG reduction goals. As such, when appropriate, park staff will assist local communities with incorporating climate change messages into community events and find partners to promote climate change education at those events. Park staff will use their knowledge of climate change resources to help local communities engage in climate friendly actions. Potential actions include:

- Establish exhibit area at local festivals, county fairs and partner facilities (Fiero Lab, Dungeness River Center, etc.) where people can learn about Climate Friendly Parks and sign up for *Do Your Part!*
- Support climate-friendly purchasing and business practices by working with the Chamber of Commerce.
- Encourage small-scale mass transit (e.g., ways of car pooling and taking buses).
- Utilize Seattle and Tacoma metropolitan shuttles as education and outreach opportunities about reducing GHG emissions.

Coordinate with agency partners, vendors and volunteers

In addition to park staff, gateway community members and other entities directly involved in park operations should be well informed about climate change and the park's efforts to reduce GHG emissions.

STRATEGY 4: EVALUATE PROGRESS AND IDENTIFY AREAS FOR IMPROVEMENT

By taking the actions established in strategies 1, 2, and 3 above, Olympic National Park plans to reduce its emissions to the specified goal and begin adapting to the impacts of climate change. Achieving these goals will require an ongoing commitment by the park, which may include subsequent emission inventories, monitoring of adaptation success, additional mitigation and adaptation actions, and reevaluation of goals. As part of this strategy, Olympic National Park will:

- Monitor progress with respect to reducing emissions and preserving natural, cultural and physical resources. This will include subsequent emission inventories to evaluate progress toward goals stated in this action plan.
- Develop additional emission mitigation and adaptation actions beyond those listed in this plan.
- Periodically review and update this plan.
- The park will track climate friendly actions through the environmental management system.



CONCLUSION

Olympic National Park has a unique opportunity to serve as a model for its many recreational visitors (nearly 3 million recorded visits in 2007).¹⁰ This report summarizes the operational actions the park commits to undertake to address climate change. Specifically, the park realizes its ability to educate the public and serve as a valuable model for citizens. By seriously addressing GHG emissions within the park and sharing its successes with visitors, Olympic National Park will help mitigate climate change far beyond the park's boundaries.

The National Park Service faces an uncertain future due to the possible effects of climate change. However, by seriously addressing climate change impacts and reducing emissions, Olympic National Park will reduce its contribution to the problem while setting an example for its visitors. The strategies presented in this Action Plan present an aggressive first step towards moving Olympic National Park to the forefront of Climate Friendly Parks.

¹⁰ Olympic National Park: Park Statistics. Available online at: <http://www.nature.nps.gov/stats/viewReport.cfm>



APPENDIX A: LIST OF WORK GROUP PARTICIPANTS

Olympic National Park

Steve Acker	Forest Ecologist
David Allen	Plant Propagation Specialist
Bill Baccus	Physical Scientist
John Boetsch	Data Manager / Plant Ecologist
Janis Burger	Resource Education Supervisor
Dean Butterworth	Outreach Education Specialist
Steve Butterworth	Energy Conservation Coordinator
Jennifer Chenoweth	Environmental Protection Specialist
Joshua Chenoweth	Biological Technician
Dave Colthorp	Buildings & Campgrounds Supervisor
Jeff Doryland	FMMS Coordinator
Carl Elleard	Civil Engineer
Susan Ferrel	Supply Technician
Jerry Freilich	Research Learning Network
David Fuller	Administrative Officer
Ellen Gage	Historical Architect
Paul Gleeson	Chief of Cultural Resource Management
Karen Gustin	Superintendent
Nancy Hendricks	Environmental Protection Specialist
Lisa Hilt	Concessions Specialist
Roger Hoffman	GIS Specialist
Cat Hoffman	Chief of Natural Resource Management
Barb Maynes	Public Information Officer
Larry Lack	Trail Crew Foreman
Jon Preston	Resource Education
Reed Robinson	Chief of Maintenance
Ruth Scott	Resource Management Specialist
Paul Seyler	Utilities Foreman
Mike Sorenson	Environmental Management/Safety Officer
Kathy Steichen	Chief of Resource Education
Catharine Thompson	Plant Ecologist
Les Young	Road Crew Foreman

National Park Service



CLIMATE Friendly PARKS

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www.nps.gov/climatefriendlyparks

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 Matt Rose
 Leigh Welling

Energy Conservation Coordinator
 Air Resources & Climate Change Liaison
 Environment Program Specialist
 Climate Change Coordinator

US Congress

Judith Morris

District Representative - Congressman Norm Dicks

National Parks & Conservation Association

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Online Advocacy Manager

NOAA Marine Sanctuary

Lauren Bennett
 George Galasso

Assistant Sanctuary Manager

Quileute Nation

Mel Moon
 Jennifer Hagen

Natural Resources Director
 Marine Biologist

Clallam County

Mike Doherty
 Sam Fox

Clallam County Commissioner
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Betsy Wharton
 Helen Freilich
 Bob Campbell

City of Port Angeles Deputy Mayor
 Port Angeles Recycling Coordinator
 Port Angeles Marine Life Center

City of Sequim

Jeff Edwards

Parks Manager

Peninsula College

Erin Drake

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Marla Hanify
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Climate Change Board



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www.nps.gov/climatefriendlyparks

Forever Resorts - Hurricane Ridge

Gary Wood

Forever Resorts - Lake Crescent Lodge

Hillary Baker
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Kalaloch Lodge

Amanda Lovelady

Log Cabin

Becky Rice

Sol Duc Hot Springs Resort

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Climate Communications Expert
Climate Communications Expert

CHG Emissions Expert



APPENDIX B: CONCESSIONER CFP PROGRESS TO DATE

Concessioners at Olympic National Park have already made significant headway in reducing their GHG emissions. This appendix describes their progress so far. Representatives from each concession were involved in the Climate Friendly Parks workshop and will be developing strategies for further reducing their carbon footprint.

Kalaloch Lodge

Energy Management:

- As equipment is put out of service, new equipment purchased is all energy star and any chemicals in them are earth-friendly. All lighting is being replaced with energy efficient bulbs as a phased project.
- Each year, single pane cabin windows are being replaced as a phased project.
- Housekeeping is trained to turn down the heat, and close windows when done cleaning cabins and rooms.
- All employees turn off lights when rooms are not in use. Employees are required to turn off all computers in offices when not in use.
- Replacing all lighting in storage areas with motion sensor lighting.
- As a phased project we have been installing low flow Oxygenic ARAMARK Standard shower heads and low flow toilets where possible.

Transportation Management:

- Vehicles are serviced regularly.
- In February 2009, a no idle policy was established for company vehicles.
- Concessioner utilizes electric carts in place of gas vehicles for maintenance, and landscaping.
- Employees share rides when possible when traveling to meetings etc.
- New policy of purchasing gift shop items locally when possible.
- One hybrid vehicle in fleet.

Waste Management and Other Emission Sources:

- Recycle all cardboard, newspapers, paper, printer cartridges, & batteries. Concessioner will have in place by the end of the summer, a method of recycling of glass, plastic, and aluminum by utilizing their laundry truck that is already going to Aberdeen.
- Currently using Recycled Green containers for all to-go meals and drinks in the restaurant.
- Employees are required to use a mug or water bottle when getting beverages.
- Restaurant oil is picked up and utilized in making biodiesel on the Peninsula.
- Organics are composted in partnership with local Hoh Hum Farm
- Policy states that all photocopies are to be double sided to reduce on paper usage. Policy in place to only print when necessary, most documents should be reviewed in their electronic version.

Education and Outreach:



- The lodge promotes Earth Day Everyday, by giving guests a gift certificate of \$15 (to offset Park fee) for arriving in an earth friendly vehicle (pedal power, hybrid, biodiesel, etc).
- Kalaloch Lodge has re-adopted the stretch of highway Park Boundary to Park Boundary to ensure the roadway and the natural environment is clean and preserved.
- Concessioner is training all new and current employees about their Green initiatives.
- Green Thread Corporate program, carrying gift shop products that are recycled or sustainable.
- Planning a "mug and go" program, where visitors purchase a biodegradable travel mug and get free coffee.

Log Cabin Resort

Energy Management:

- Replaced five small inefficient washing machines in the Linen House to a single high efficiency washer
- Replaced five small electric dryers with a single more efficient gas dryer.
- Replaced three large electric hot water heaters with "on demand" propane hot water heater.
- Laundry service in rooms for extended stays is every three days to conserve on the environment unless otherwise requested from guests.
- All lighting at the resort has been changed to more efficient fluorescent fixtures.
- Replaced two propane deep fryers with one small electric fryer.
- Replaced two large propane grills, ovens and broiler with a small electric grill and large electric convection oven.
- Electric equipment that falters is being replaced with energy efficient designs.
- Changed restaurant menu to eliminate the use of a three door cooler.

Transportation Management:

- The resort encourages its employees to rideshare or ride the bus (resort will pick employees up at bus stop).
- Electric golf carts are used for transportation around the resort and for garbage retrieval.
- Organic and local food products are purchased for the restaurant.

Waste Management and Other Emission Sources:

- The laundry system has been changed to green bulk containers.
- Canvas tote bags are available in each room to carry purchases from the store in order to cut down on throw away paper bag usage.
- Recycle bins are positioned throughout the resort and recycle containers are in each room.
- Packing peanuts and empty ink cartridges are recycled.

Lake Crescent & Hurricane Ridge Lodge

Energy Management:

- Decreased propane use by 92.68 MMBtus
- Continued Energy Conservation Awareness program
- Continued conversion of exterior sodium lighting to Compact Fluorescent
- Continued replacement of incandescent with fluorescent where possible
- Increased awareness of Energy Conservation through signage and employee training
- Replaced one refrigeration unit with Energy Star rated unit



- Eliminated use of one air conditioning unit
- Reduced the use of some exterior lighting for winter months

Waste Management and Other Emission Sources:

- Continued recycling program and increased visibility with new signage and additional containers.
- Reduced waste to landfill by 68,320 lbs. from previous year.
- Added to number of recycle containers with new in-room guest use boxes.

Sol Duc Hot Springs Resort

Energy Management:

- As equipment is put out of service, new equipment purchased is all energy star and any chemicals in them are more earth-friendly.
- All lighting has been replaced with energy efficient bulbs where possible.
- A power-down switch has been installed in the vending machine.
- Outdoor lighting is on a timer, and in the winter there is a motion detector on outdoor lighting by the lodge only.
- Cabins and Motel buildings have been insulated and have energy efficient windows.
- Housekeepers are encouraged to turn down the heat and close windows when done cleaning cabins
- Employees to turn off lights not in use

Transportation Management:

- Carefully plan trips to Port Angeles so that trucks are full in both directions.
- Organize rideshares whenever possible.
- Use local foods and gift shop items whenever possible to help eliminate transportation services.

Waste Management and Other Emission Sources:

- Recycle cardboard, glass, aluminum, plastic, newspapers, paper, printer cartridges & batteries.
- In 2009, will switch all "to-go" restaurant products to recycled products.
- Replaced two washing machines with one high efficiency commercial washer.
- Lost & Found items at the end of the season and retired bed linens, and food items are turned over to local charities.
- Installed low flow, waterless urinals, automatic shut off sink faucets and showerheads in public areas

Education and Outreach:

- Developed a display... "Make a Commitment - Make Earth Day Everyday" for the main lodge which discusses the environmentally friendly changes the resort has made.
- Provide a coupon incentive for any overnight guests arriving in an earth-friendly mode of transportation.



APPENDIX C: POTENTIAL CLIMATE IMPACTS

During the Olympic National Park Climate Friendly Parks workshop, the Adaptation work group was provided with the following tables of potential impacts from climate change.

Note: to reduce “bulk” of the document, this could be redone without the table format

<i>SECTORS AND POTENTIAL IMPACTS TO OLYMPIC NATIONAL PARK</i>		
Sector	Sub-Sector	Impacts
	Hydrology & Water Resources	<ul style="list-style-type: none"> • Increases in frequency of heavy precipitation events; floods in western WA are expected to increase due to the combined effects of warming and increasingly intense winter storms (Hamlet 2009). • Large and more frequent floods resulting in substantial changes in sediment transport and channel formation processes. This will likely affect ecological processes that are sensitive to changes in the probability distributions of high flow events such as habitat stability, biodiversity, and trophic structure (Konrad and Booth 2005, Hamlet and Lettenmaier 2007). • More winter precipitation falling as rain instead of snow, earlier snow melts, and associated changes in river flow that includes relative increases in the spring and relative decreases in the summer months (Mote et al. 2005, Barnett et al. 2008). Higher likelihood of rain on snow events, compounding runoff in watersheds. • Reduction in snow cover and total snowpack, reducing water availability and changing seasonality of runoff patterns. • A loss of summer/drought base flow in streams and rivers with loss of glaciers and permanent snowfields. • Increase in extreme runoff and flooding events; increased winter flows; earlier and reduced spring and summer flows. Cool season runoff (October to March) projected to increase 20 percent by 2040. Warm season (April to Sept) runoff projected to decrease 25 percent by 2040. (WACCIA, 2009) • Warmer stream and lake temperatures resulting from increased air temperatures and decreased runoff from mountain snowpack. • The following actions apply to all bullets above: • <i>Action: Partner with Climate Impacts Group (CIG) at University of Washington to assess whether downscaling regional climate models to inform Olympic's management decisions. Ensure that this information is readily available.</i> • <i>Action: Evaluate coverage of stream gauges and maintain and augment.</i>



		<ul style="list-style-type: none"> • <i>Action: Assess source areas for sediment.</i>
	Aquatic Ecosystems	<ul style="list-style-type: none"> • Loss of rocky intertidal habitat due to rapid sea level rise. • Impacts to rocky intertidal species due to warmer maximum air temperatures during spring and summer low tides. • Global Climate change has the potential to alter the physical and chemical nature of the nearshore coastal ocean and those changing conditions can influence the introduction and persistence of both exotic and native pathogens which affect intertidal organisms. (e.g. withering disease in black abalone, NIX in OLYM razor clam populations). • Increased ice-free periods and warmer water temperatures of mountain lakes may affect health and composition of aquatic species, especially zooplankton, aquatic insects or amphibians. • Warmer summer temperatures, decreased snowpack and increases in UV may reduce suitable habitat for and increase stress to amphibians species. • Invasives
	Vegetation	<ul style="list-style-type: none"> • Forest line and treeline may increase due to higher temperatures and decreased snowpack • Increases of invasive plant species. • <i>Action: With partners, develop a guide to invasive species throughout region.</i> • <i>Action: Assess potential problematic invasive species and develop a comprehensive management plan to prioritize and address invasives issues.</i> • <i>Action: Develop training for park and stakeholder staff.</i> • Changes in species composition and structure of forests in response to higher temperatures and drought stress. • Increased mortality in forest tree species populations due to increased disease and insect distribution (Steve Acker will revise). • Subalpine meadows change due to increased tree establishment (especially on the west side of the park where mountain hemlock is abundant) and changes in forb:grass ratios. • Riparian forests change in extent and composition due to variable stream flows, greater disturbance from floods and higher temperatures. • Following action pertains to previous four bullets: • <i>Action: Sustain and potentially enhance current monitoring programs.</i> • <i>Action: Identify functional groups of species that are important to the overall functionality of specific ecosystems.</i> • <i>Action: Collaborate with Olympic National Forest and managers in coastal BC to assess vulnerability of endemic species and develop management options.</i>



		<ul style="list-style-type: none"> • <i>Action: Begin to identify priorities when addressing management of endemic species.</i> • <i>Action: Consider reintroduction of native species if change in disturbance regime warrants it (e.g., Bear Grass, Skokomish).</i> • The growing season is likely to continue to lengthen, possibly including earlier onset of flowering. Populations of insects and other animals may decline if timing of their life-histories does not change along with the plants. • <i>Action: Identify ways to partner with the National Phenological Network as well as other observational monitoring programs.</i> • <i>Action:</i>
	Wildlife	<ul style="list-style-type: none"> • Climate change potentially affecting most freshwater life history stages of trout and salmon. <ul style="list-style-type: none"> • Warming temperatures will increasingly stress coldwater fish in the warmest parts of our region (Hamlet, 2009). Rising stream temperatures will likely reduce the quality and extent of freshwater salmon habitat. The duration of periods that cause thermal stress and migration barriers to salmon is projected to at least double by 2080. (WACCIA, 2009) • Increased frequency and severity of flood flows during winter can affect over-wintering juvenile fish and incubating eggs in the streambed. Eggs of fall and winter spawning fish, including Chinook, coho, chum and sockeye salmon and bull trout, may suffer higher levels of mortality when exposed to increased flood flows. Higher winter water temperatures could also accelerate embryo development and cause premature emergence of fry (ISAB 2007). • <i>Action: Evaluate fish distribution baseline maps and set up system for updating maps.</i> • <i>Action: Sustain fish assemblage monitoring!</i> • <i>Action: Encourage the development of a multi-stakeholder approach to conserve fisheries in the face of climate change. Consider putting forth Olympic peninsula as a sentinel site for understanding impacts of climate change on salmon fisheries and the development of a conservation strategy.</i> • <i>Action: Assess strategies and tools available to the park in protecting infrastructure that are "fish-friendly."</i> • Changes in timing of migration, reproduction, dormancy and productivity for many animal species will occur. • High elevation species such as the Olympic Marmot, Mazama Pocket Gopher, Heather Vole, which rely on subalpine meadow and alpine habitats will be impacted by loss or changes in habitat or pressure from species such as coyotes expanding their distribution.



		<ul style="list-style-type: none"> • <i>Action: Establish a baseline inventory of high elevation species.</i> • <i>Action: Develop vulnerability assessment to identify most at risk species.</i> • <i>Action: Evaluate potential management strategies such as predator control, habitat manipulation, and species reintroduction.</i> • Pollinator populations utilizing the subalpine areas may be effected by increases in tree islands and changing phenology of flowering plant species. • Invasive species Goats, Barred Owls, Brook Trout, Green Crabs, • <i>Actions: Develop understanding of how climate change induced habitat change will affect current and/or future populations of invasive species including the marine environment.</i>
	Disturbance (fire, pests, pathogens, avalanche)	<ul style="list-style-type: none"> • Increasing length of fire seasons, severity of fires and number of acres burned due to decreases in summer precipitation and soil moisture. • <i>Action: Monitor ecosystem response after fire occurrence.</i> • <i>Action: Evaluate fire management planning and policy and consider how climate change impacts may affect policy. Coordinate with the Forest Service, Dept. of Natural Resources, Tribes, and other entities.</i> • Increasing forest impacts from pests & pathogens due to expanding ranges and decreased winter mortality of pests (i.e. increased winter temperatures facilitate pathogen/pest survival). • <i>Action: Monitor introduction of exotic insects and fungi.</i> • <i>Action: Ground truth over-flight information from the Forest Service on pests and pathogens.</i> • <i>Action: When possible, consider implementing citizen science programs to enhance monitoring programs for pests and pathogens.</i> • <i>Action: Preserve White Bark Pine seeds.</i> • Possible increases in the frequency of stand replacing wind storms, altering the structure and composition of park forests. • Avalanche tracks decreasing in number and size due to decreases in winter snow pack. This may affect animal populations such as black bears & elk which utilize these areas.
	Soil/Sediment Impacts	<ul style="list-style-type: none"> • Increasing precipitation intensity may increase the severity of extreme events such as landslides slides and debris flows .(Hamlet, 2009) • Loss of glaciers mobilizing large reservoirs of fine sediments stored beneath them. • Loss of snowpack leading to increased land slide risk and increased sediment loadings (Hamlet, 2009) • <i>Action: Ensure that soil survey happens (scheduled for 2017), and accelerate if possible.</i> • <i>Action: Establish baseline information on nutrient cycling and erosion in terrestrial systems.</i>
Cultural	Historic Structures	<ul style="list-style-type: none"> • Loss or damage of historic structures from wildfire, flooding, wind



Resources		<p>storms, debris flows, avalanche destruction</p> <ul style="list-style-type: none"> • <i>Action: Perform vulnerability assessment of current historic structures and map.</i> • <i>Action: Identify any additional documentation that needs to be performed of structures.</i> • <i>Action: Identify trigger point for protecting, moving or removing structures – Evaluate the management action.</i> • <i>Action: Develop communication strategy to inform extended community of decision process.</i>
	Archeological Resources	<ul style="list-style-type: none"> • Loss of coastal midden & village sites (on first coastal terrace) through erosion and inundation associated with sea rise and increased coastal storm intensity. • Inundation of coastal petroglyphs from sea level rise. • Following actions are regarding first two bullets: • <i>Action: Evaluate the existing models of coastal vulnerabilities. Perform gap analysis on whether these resources are sufficient to make decisions.</i> • <i>Action: In collaboration with the Tribes, if necessary perform vulnerability assessment of coastal resources.</i> • <i>Action: Identify trigger point for protecting, moving or removing resources – With Tribes, evaluate the various scenarios for management action.</i> • Exposure of undocumented archeological sites from retreating permanent snow fields. • Exposure of undocumented archeological sites from erosion of second marine terraces (currently unexposed). • Following actions are regarding previous two bullets: • <i>Action: Identify and map out potential high risk areas for 1) potential for exposure of archeological sites and 2) visitor interaction with and damage to sites.</i> • <i>Action: Explore or develop a plan for protection and/or curation.</i>
	Ethnographic	<ul style="list-style-type: none"> • Loss of or changes in timing and availability of traditional foods (salmon) due to changes in runoff patterns and water quantity and quality. • Decrease in traditional food resources (intertidal species) due to higher temperatures during spring low tide series, beach scouring during storm events, diseases (NIX, PSP & domoic acid), and ocean acidification. • Invasive exotic plants or erosion may impact growth of traditionally gathered/medicinal plants in changing ecosystems. • Damage to forest resources such as old growth cedar (for use in canoes etc.) due to wildfire, windstorms, and thermal stress. • Following actions are regarding first four bullets: • <i>Action: Work with Tribes and other partners to do the following:</i>



		<ul style="list-style-type: none"> • <i>Action: Sustain and potentially augment current monitoring programs of both terrestrial and aquatic treaty resources, including traditional food sources.</i> • <i>Action: Evaluate what current stressors on resources can be removed or reduced.</i> • <i>Action: Enhance current programs that support resilience – e.g., current exotics removal programs.</i> • Increased wildfire may affect traditionally managed coastal bogs/prairies, and certain species such as Bear Grass. • <i>Action: Work with Tribes and other partners to do the following:</i> • <i>Action: Evaluate the impact of interaction of fire and climate change on resources.</i> • <i>Action: Re-evaluate coastal areas during revision of fire management plan (2010).</i> • Loss of subalpine meadows could affect ethnographic sites. • <i>Action: Perform vulnerability assessment of resources.</i> • <i>Action: Identify any additional documentation that needs to be performed of sites.</i>
	Cultural Landscapes	<ul style="list-style-type: none"> • Maintenance requirements for cultural landscapes will likely change (easier/more difficult) • Invasive exotic plants obscure or alter cultural setting. • Floods and increased fire may alter cultural settings including cultural trees, paths, fencelines, roads, etc.
Facilities	Circulation (Roads and Trails)	<ul style="list-style-type: none"> • Increases in storm and flood events resulting in more damage to roads and trails that are located in floodplains or at other risky locations. Increased winter runoff and higher sediment loading could cause damage or blockage of existing culverts (drainage and stream flow changes). • Higher soil moisture levels and higher intensity rain events likely causing an increase in landslides damaging roads and trails. In particular: Quinault and Hoh road infrastructures. • <i>Action: Link strategy with Forest Service's current efforts.</i> • <i>Action: Engage extended community and Tribal partners to engage in scenario planning and discuss potential management options.</i> • <i>Action: Perform comprehensive structural condition assessment (perform surveys, walk culverts etc., high resolution aerial imagery including LIDAR).</i> • <i>Action: Perform vulnerability assessment of current infrastructure with respect to potential climate change impacts and related geomorphologic processes.</i> • <i>Action: Identify potential management options to address vulnerabilities – consider relocation of infrastructure.</i> • <i>Action: Develop better understanding of alternative structure options and potential management implications. Be more proactive about</i>



		<p><i>experimenting with alternative structures. Workshop with road management and other partners in advance of emergency events.</i></p> <ul style="list-style-type: none"> • <i>Action: Identify potential future funding sources and understand impediments to obtaining current funding sources.</i> • <i>Action: Develop systematic re-vegetation plan.</i> • <i>Action: Develop IDIQ contract for storm damage to road infrastructure.</i> • Increasing elevations for snow lines may reduce needs for plowing on park roads, in particular the extent/frequency of plowing on Hurricane Ridge Road. • Increasing coastal erosion from sea level rise could damage park roads. • <i>Action: Start conversation with state regarding management of Highway 101.</i>
	Structures	<ul style="list-style-type: none"> • Structures in floodplains could be damaged by flooding (buried, undermined, or destroyed) or by changing river conditions and channels. Increased coastal erosion from sea level rise could damage park and concessioner operated structures. Includes campgrounds. High priority areas include: The Hoh, Northfork Quinault, Staircase, Kalaloch, Altaire Campgrounds. Other areas include: Quinault Ranger Station and Maintenance Area, The Hoh Visitor Center and Operational Facilities, and Elwha Historic District. • <i>Action: With partners, evaluate need for sustainable camp sites throughout the peninsula and develop goal for number of camp sites available within park.</i> • <i>Action: Evaluate and document vulnerable priority camp site areas, visitor center, and other structures.</i> • <i>Action: Experiment with an engineered log jam at The Hoh and Northfork Quinault.</i> • <i>Action: Potentially relocate and stabilize banks at Staircase.</i> • Increased frequency and intensity of wind storms could damage structures. • Increased fire events could damage park structures.
	Utilities	<ul style="list-style-type: none"> • Utilities in floodplains could be damaged by flooding or by changing river conditions and channels and higher water tables. • Increased frequency and intensity of wind storms could damage utility systems (e.g. overhead lines). • Increased coastal erosion from sea level rise could damage park utilities. • Increased fire events could damage park utility systems. • Water and waste water management will become a greater concern (e.g. Hurricane Ridge). • Less water in the summer could impact the operation of existing hydroelectric systems.



		<ul style="list-style-type: none"> • <i>Action: Assess and document institutional knowledge of utilities.</i> • <i>Action: Perform a comprehensive condition assessment of current utilities.</i> • <i>Action: Perform a vulnerability assessment of current utilities.</i> • <i>Action: Incorporate potential climate change impacts into management of current renovation projects.</i>
	Fleet Management	<ul style="list-style-type: none"> •
Protection & Visitor Services	Recreation	<ul style="list-style-type: none"> • Increased storm and flood events may make it difficult to keep roads and trails open to the public. • Decreased snow pack may limit duration of winter activities, including downhill skiing opportunities. • Increased coastal erosion from sea level rise could damage park trails, campgrounds, and wilderness facilities, concession operated facilities, and reduce or change coastal recreation opportunities. • Increased fire events could result in closures of areas to recreational use. • Recreational fishing opportunities may be impacted by changes in anadromous fish populations and intertidal species. • Overall, changes to park resources affecting visitor experience and opportunities (i.e. smaller meadows, changes in wildflower shows, fewer & smaller glaciers).
	Emergency Response	<ul style="list-style-type: none"> • Increased fire events would result in increased emergency responses. • Increased frequency and intensity of floods and windstorms would result in increased emergency responses.
Interpretation & Education	Resource Education	<ul style="list-style-type: none"> • Changes in themes and curriculum to reflect changing conditions (as appropriate) • Do Your Part!
	Visitor Programs	<ul style="list-style-type: none"> • Changes in themes and messages. • Increasing reliance on novel media and technology to reach audience/public • Encourage visitors to reduce their carbon footprint in their daily lives and as part of their tourism experience

