Kiser Environmental Consulting
Research • Analysis • Results

Global Warming and Litter in Our Northwest National Parks

**Jonathan V. L. Kiser,
William Rhett Kiser, and
Grant R. E. Kiser**

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On the front cover: Wind-induced damage at July Creek Picnic Area in Olympic National Park; and American flag litter, Two Medicine Lake, Glacier National Park, © 2019 Jonathan V. L. Kiser.

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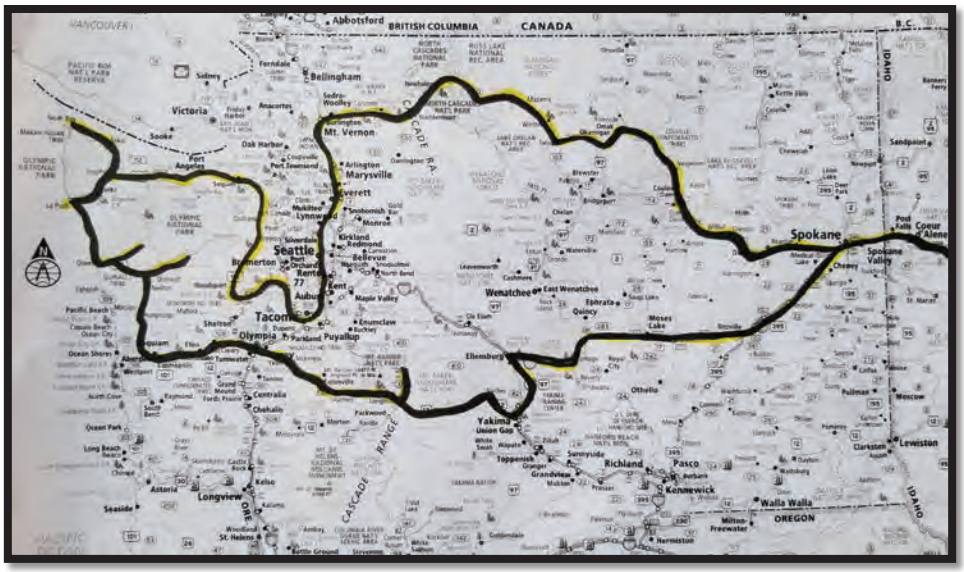
Executive Summary

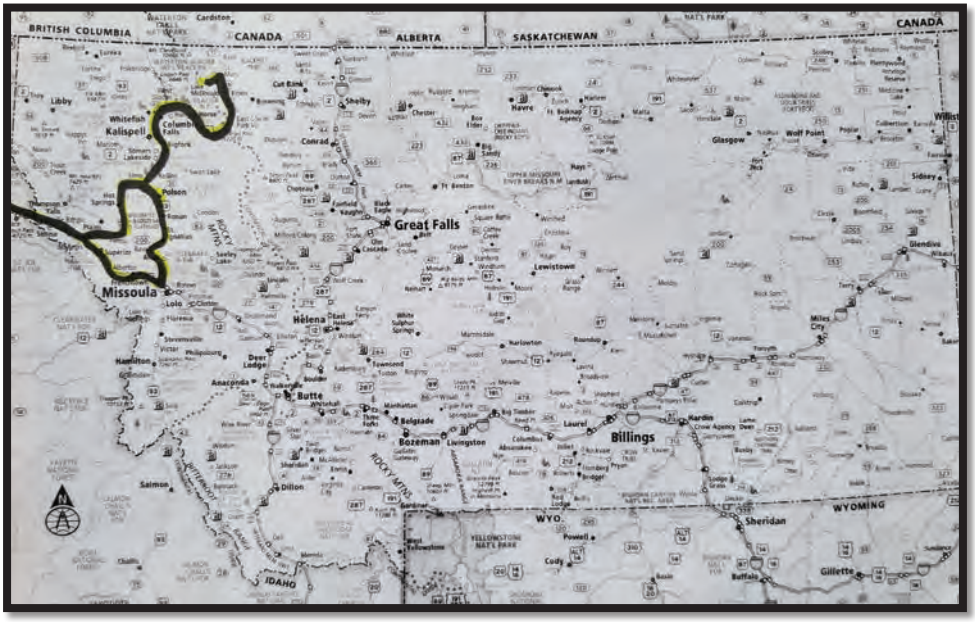
Introduction

This book is part of an on-going Kiser Environmental Consulting (KEC) effort to document environmental issues confronting national parks (NPs) and other protected spaces across the United States. Our effort started in 2013 when KEC visited six national parks in the west (Rocky Mountain, Arches, Great Basin, Yosemite, Redwood, and Crater Lake), met with park rangers, and completed environmental field observations, including in-depth litter surveys. Our first expedition findings were presented in three published books: *Environmental Issues Confronting Our Western National Parks and Other Ecological Misadventures* (2014), *Solving National Park Issues in the West* (2015), and *Litter Crisis in Our National Parks* (2016).

KEC's latest scientific expedition occurred during the period of August 4 through 17, 2018. Starting in Seattle, Washington, we visited four national parks (Olympic, Mount Rainier, Glacier, and North Cascades). We also passed through national forests (NFs), Indian Reservations, state parks, and other locations of interest.



KEC August 2018 Expedition Showing Travels to Seattle, Olympic NP, Mt. Rainier NP, and North Cascades NP, © 2019 Jonathan V. L. Kiser.



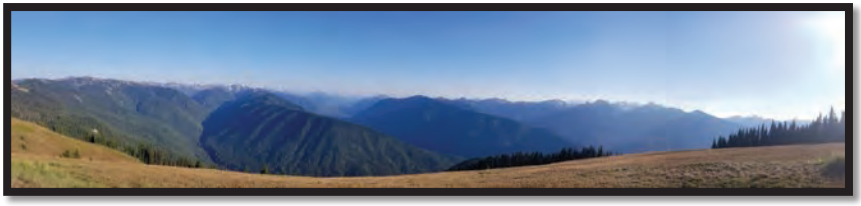
KEC August 2018 Expedition Showing Excursion to Glacier NP, © 2019 Jonathan V. L. Kiser.

The goal for this trip was to document global warming (a.k.a., climate change), from anthropogenic (human) and natural sources, biodiversity, recycling, trash management, and litter. Our ultimate objective is to bring about positive change by generating awareness of the many environmental challenges faced by the NPs. We also are striving to define ways the National Park Service (NPS), industry, the general public, environmental organizations, and other stakeholders can do their part to make conditions better. These are our National treasures and it is up to all of us to respect, honor, and preserve them so they will endure for future generations.

View from Mount Walker, WA in Okanogan-Wenatchee National Forest Looking East, © 2019 Jonathan V. L. Kiser.

Investigation Methodology

At each NP visited, KEC documented global warming by talking with park rangers, reviewing park information, visiting locations where climate change impact could be seen, and documenting our observations with digital photography (Jonathan and Rhett used a Galaxy S8 and Grant used a Galaxy S9). We also recorded flora (plants) and fauna (animals) in each park (all of which could not be included in this book due to space limitations), observed recycling and trash management practices, and completed litter surveys.



Hurricane Ridge Eastern View, Olympic NP, © 2019 W. Rhett Kiser.

For the litter surveys, we counted each piece of litter encountered in and around visitor center parking lots, in trailhead parking lots, at overlooks, along roadways, and on all hiking trails we traveled. In the interest of exploring as much of each NP that time would allow, KEC applied several litter survey approaches: 1) In-depth surveys using a detailed survey form; 2) Visual counts along trails; and 3) Visual inspections from our car along select roadways and in one Glacier NP parking lot. These were backed with select photographic documentation.

For our in-depth parking lot surveys, a 1 to 4 scale was used to describe each location. More specifically, a 1 ranking indicated no litter was found (unfortunately, this never happened), a 2 ranking indicated some litter was present, 3 indicated a littered site, and 4 indicated an extremely littered site.

Twilight at Mount Rainier NP, © Grant R. E. Kiser.

This scale, adapted from the Keep America Beautiful (KAB) template, was used comparatively from one site to another. The ranking score was occasionally adjusted bearing in mind the size of the parking lot being surveyed. Generally, parking lot sites with 1 to 75 pieces of litter received a 2 "Somewhat Littered" ranking; those with > 75 to 200 pieces received a 3 "Littered" ranking; and those with > 200 pieces received a 4 "Extremely Littered" ranking.

KEC's field investigation was supplemented by desk top research relating to global warming and biodiversity. Public domain Internet sources were used for most of the repeat photography showing glacier decline over time. And, unless otherwise noted, the NPS was the source used for desk top information included in this book. Most (but not all) of the Research Team's improvement

suggestions for the areas visited relate to recycling, trash management, and litter.

Special thanks to Tom Matia from the Tremont "South Side" neighborhood of Cleveland, Ohio for inspiring the Fire Risk section in Chapter 1. Peace and Love!

Key Expedition Accomplishments

Provided below are key accomplishment achieved during our August 2018 scientific expedition. Reflected are KEC activities within NP boundaries, in the U.S. Forest Service (USFS) and National Wildlife Refuge (NWR) areas we passed through, and beyond:

- **Estimated number of miles/kilometers (km) hiked: 100/161**
- **Number of miles/km driven (by our trusty Jeep): 2,083/ 3,352**
- **Number of glaciers photo-documented: 21**
- **Number of hiking trail litter surveys: 31**
- **Number of parking lot litter surveys: 28**
- **Total number individual litter pieces counted: 2,732**

Avalanche Creek, Glacier NP, © 2019 Grant R. E. Kiser.

Key Expedition Findings

Global Warming

An overview of global warming impacts KEC found in each NP visited is shown in Exhibit ES1.

Exhibit ES1 – Global Warming Impacts Observed at Each National Park Visited

Climate Change Indicator	Olympic	Mount Rainier	Glacier	North Cascades
Glacier(s) retreating	✓	✓	✓	✓
Warmer ambient air conditions	✓	✓	✓	✓
Drier conditions, increased fire risk	✓	✓	✓	✓
Wind damage event(s)	✓	—	—	—

Sources: KEC 2019, NPS, Public Domain.

A more detailed discussion of each global warming indicator is provided in Chapter 1, and in the individual NP chapters (Chapters 3 through 5, and Chapter 7).

Biodiversity

The KEC Research Team cataloged biodiversity (i.e., flora and fauna) in each NP and other areas visited. We observed and recorded as we traveled, generating thousands of photographs plants, animals, and the incredible environments they inhabit. The best of our evidence is provided in this book, supplemented by additional insights and images from public domain sources.

Sahale Arm Trail, North Cascades NP, © 2019 Jonathan V. L. Kiser.

Litter Survey Results

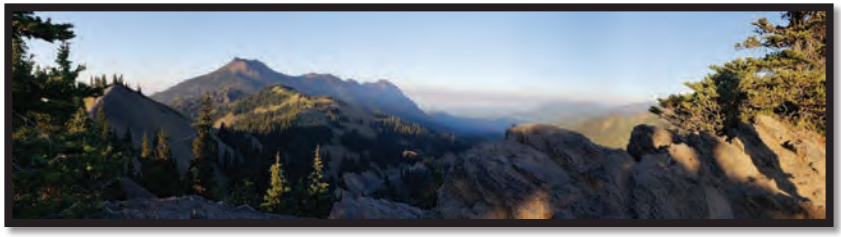
The 2018 expedition allowed KEC to further advance our ground-breaking research documenting the status of recycling, trash management, and litter in our NPs.

ES Exhibit 2 summarizes our findings regarding litter survey results from targeted NP parking lots. What we found was that, on average, Olympic and Glacier had more littered parking lots, followed by Mount Rainier, and North Cascades. While many factors can be attributed to these findings (e.g., parking lots selected, trash management budget, insufficient anti-litter messaging, etc.), one likely big factor is the number of visitors who come to each park. Olympic and Glacier have about three million annual visitors, Mount Rainier has over two million, and North Cascades only about 30,000.

ES Exhibit 2 – Parking Lot Litter Severity Rankings for National Parks Visited

	Olympic	Mount Rainier	Glacier	North Cascades
Average Litter Ranking	3.5	3.0	3.5	2.0

Visual Scale: 1 = No Litter; 2 = Some Litter; 3 = Littered; 4 = Extremely Littered. Source: KEC, 2019.



Hurricane Ridge Northern View, Olympic NP, © 2019 Grant R. E. Kiser.

ES Exhibit 3 breaks down the total number of litter pieces counted

in each NP visited (i.e., in parking lots, along roads, on the trails) and indicates the comparative percentage of the total.

ES Exhibit 3 – Comparison of Total Litter Pieces Counted and Percentage for Each National Park Visited

	Olympic	Mt. Rainier	Glacier	North Cascades	Total
Total Pieces Counted	1,026 (1)	510	904	150 (2)	2,590
Percentage of Total Count	40	20	35	5	100

(1) Includes one roadside composite wrapper.
(2) Includes 11 pieces of litter counted along the Highway 20.
Source: Kiser Environmental Consulting, 2019.

KEC documented the most litter in Olympic (1,026 pieces), followed by Glacier (904 pieces), Mount Rainier (510), and North Cascades (150). 85% of the total litter counted were in Olympic and Glacier. Litter counted in Mount Rainier NP represented 20% of the total and only 5% of the litter total were documented in North Cascades NP.

Paper Litter on Marymere Falls Trail, Olympic NP, © 2019 Jonathan V. L. Kiser.

ES Exhibit 4 reflects the amount of litter counted by the KEC Research Team by material type in each of the 10 NPs visited

during both our 2013 and 2018 expeditions.

ES Exhibit 4 – KEC Litter Count in National Parks Visited During 2013 and 2018 Expeditions

Litter Type	Arches 2013	Crater Lake 2013	Glacier 2018	Great Basin 2013	Mount Rainier 2018	North Cascades 2018	Olympic 2018	Redwood 2013	Rocky Mountain 2013	Yosemite 2013	Total
Cigarette Butts	17	146	160	1	120	35	210	5	6	207	**907**
Food	3	1	82	1	74	14	22	0	0	15	**212**
Metal (1)	3	22	53	1	31	13	38	2	5	19	**187**
Paper (2)	20	104	356	2	164	48	433	184	25	201	**1537**
Plastic (3)	7	8	102	3	43	15	164	63	9	44	**458**
Other (4)	0	12	152	1	78	25	159	1	0	70	**498**
Total	**50**	**293**	**905**	**9**	**510**	**150**	**1026**	**255**	**45**	**556**	**3799**

(1) Includes ferrous and non-ferrous metals.
(2) Includes miscellaneous paper, cardboard, and chipboard.
(3) Includes #1 – #7 plastics.
(4) Includes textiles, wood, glass, mixed material composites, other.
Source: Kiser Environmental Consulting, 2019.

ES Exhibit 4 demonstrates that, among all the 3,799 individual pieces of litter KEC counted in ten NPs, 1,537 of the total (41%) was paper. Cigarette butts represented 24% of the total (907 pieces), with various types of plastic litter representing a distant 12% (458 pieces). 212 pieces of food has been counted (6% of the total), and 187 pieces of ferrous and non-ferrous metal has been documented (5%). The remainder of the litter counted (498 pieces, 13% of the total) includes glass (only four pieces counted in 2018), textiles, wood, mixed material composites, and other materials. One key observation from our 2018 trip was that toilet paper in the

forests was not the major problem KEC encountered during our 2013 expedition.

Bear in mind, when comparing data in ES Exhibit 4, that number amounts are relative to many factors such as the number of surveys completed in each NP, location and type(s) of the surveys, etc. It's the comparative percentage of each litter material type that has the most meaning when comparing one NP to another. This is specified in ES Exhibit 5.

ES Exhibit 5 – Litter Percentage by Material Type in National Parks Visited (KEC 2013 and 2018 Expeditions)

Litter Type	Arches 2013	Crater Lake 2013	Glacier 2018	Great Basin 2013	Mount Rainier 2018	North Cascades 2018	Olympic 2018	Redwood 2013	Rocky Mountain 2013	Yosemite 2013	Total Average % (n=10)
Cigarette Butts	34	50	18	11	24	23	20	2	13	37	**23**
Food	6	0	9	11	15	9	2	0	0	3	**6**
Metal (a)	6	8	6	11	6	9	4	1	11	3	**6**
Paper (b)	40	35	39	22	32	32	42	72	56	36	**41**
Plastic (c)	14	3	11	33	8	10	16	25	20	8	**15**
Other (d)	0	4	17	11	15	17	15	0	0	13	**9**
Total %	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

(a) Includes ferrous and non-ferrous metals.
(b) Includes miscellaneous paper, cardboard, and chipboard.
(c) Includes #1 – #7 plastics.
(d) Includes textiles, wood, glass, mixed material composites, other.
Source: Kiser Environmental Consulting, 2019.

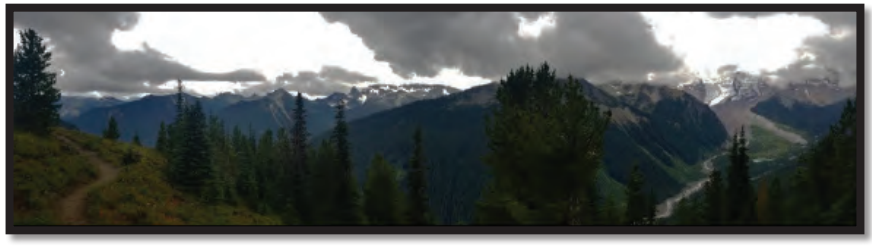
ES Exhibit 5 shows both the percentage of each material type counted for each NP visited in 2013 and 2018, and the average

percentage of each material across all ten NPs. More specifically, Paper ranged between 22% and 72% of the materials counted, with the highest average rate of 41%. This was followed by Cigarette Butts with an average of 23% (2% to 50% range among the individual NPs), and Food and Metal (both with a 6% average). Other Litter, including glass, textiles, wood, rubber, mixed composites, etc. represented 9% of the total litter documented during KEC's 2013 and 2018 expeditions.

2018 KEC National Parks Feedback/Improvement Recommendations

At each NP visited during 2018, the Research Team made observations and generated improvement recommendations. Many of the recommendations provided for one NP are also applicable to other protected areas (at the federal, state, regional, and local levels).

For starters, education is always key when trying to get visitors to properly manage their trash and recyclables. Even on a limited budget, there are steps each NP can take to immediately improve a less than ideal situation.



Silver Lake Trail View of Emmons Glacier (far right), Mount Rainier NP, © 2019 W. Rhett Kiser.

The existing NP "Leave No Trace, Pack Out What You Pack In" policy alone is clearly not working. A supplemental strategy applicable to all NPs would be well-placed signage (e.g., at park entrances, major parking lots, visitor centers, trailheads) with concise, clear, direct messaging noting something like "This is a Litter-Free Zone. . .Please Do Your Part!;" or simply stating "Please Don't Litter." Signage should also incorporate a familiar mascot (e.g., a NP version of USFS's Woodsy Owl) delivering the message. Since humans have the attention span of only about eight seconds (i.e., less than a goldfish!), this type of messaging would

likely be more eye-catching and better received.

Rising Smoke on Howe Ridge, Lake McDonald, Glacier NP, © 2019 Jonathan V. L. Kiser.

Another education tactic for curbing litter along the trails, in parking lots, and elsewhere would be an on-going campaign in Visitor Information Guides and on NP websites. Again, the "Leave Not Trace" policy language should be supplemented with anti-litter messaging including a mascot. In addition, park rangers working in the visitor centers should be trained to proactively remind visitors of the Leave No Trace policy and, specifically, not to litter. Anti-litter talking points for the rangers can include details about how litter adversely impacts the environment, how biodegradable human food is bad for wildlife (and is still a form of litter), where one can find recycling bins throughout the park, the types of recyclables that are acceptable, how graffiti is another form of pollution, etc.

To the extent that the tourist industry makes on-going bus trips to NP locations, travel companies should bear some of the responsibility to educate their patrons not to litter and to use designated receptacles to dispose/recycle of their cigarette butts and other materials. Pamphlets explaining the importance of recycling and proper waste disposal should be passed out on the bus to patrons prior to destination arrival and be made available at all park entrances and visitors centers.

Paper Litter, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

With paper litter being the most prominent material documented, creative approaches are needed to combat this unattractive reminder of irresponsible humans. The example set by an Olympic NP ranger, who we observed using a blower to gather parking lot litter, is a good one for others to follow. Use of this type equipment, preferably with vacuum capability as well, will allow for efficient routine management of paper and other litter in NP parking lots and elsewhere. One random example of such equipment is the Sun Joe SBJ605E 14-Amp Electric Blower/Vacuum/ Mulcher (available on Amazon for $72.99).

Cigarette butt litter, especially in parking lots, also continue to be a problem in the NPs. At a minimum, cigarette butt receptacles should be strategically placed in all major tourist stops in each park. Obvious choices from our 2018 expedition include: Marymere Falls and Ruby Beach in Olympic, Henry Jackson Paradise Visitor Center in Mount Rainier, Apgar Visitor Center in Glacier, and Diablo Lake Overlook and North Cascades Visitor Center in North Cascades NP. A creative idea offered by Congaree NP in South Carolina is to provide smokers with portable cigarette butt containers (using plastic medication-type vials, partially filled with sand) before they hit the trail(s).

Portable Cigarette Butt Container Used in Congaree NP, © 2019 Jonathan V. L. Kiser.

Regarding the collection of recyclables and trash, ideally, bins should be color-coded (blue for recyclables, brown for trash) and labeled with durable, weather-proof lettering (stating what goes in each container), appropriate trash and recycling symbols, and picture images of acceptable materials. Selective feed slot sizes will also help people to make the proper decision when discarding their materials. A uniform system (i.e., similar bin styles and colors) should be applied throughout each park to again make it easier for visitors to do the right thing. Recycling bins should be paired with trash bins consistently. This will help to minimize recyclables being thrown in trash bins and reduce the total amount of materials destined for disposal.

For high-traffic NP locations where there is an on-going major litter problem (e.g., Ruby Beach, Apgar Visitor Center, etc.), strong consideration should be given to installing permanent anti-litter signs with significant fine warnings (e.g., at least $1,000). Also applying monitoring technology (e.g., real-time parking lot monitoring, license plate readers, etc.) should also be considered as supplemental backup (allowing for easier enforcement of the fines).

Ruby Beach Parking Lot Litter, Olympic NP, © 2019 Jonathan V. L. Kiser.

A tougher stand needs to be taken against those who are unwilling to show the full respect our NPs deserve. In light of on-going NP budget concerns, exasperated by President Trump's ill-conceived, narcissistic decision to shut down the federal government (from December 22, 2018 until January 25, 2019, the longest U.S. government shutdown in history), the NPS should partner with nonprofits such as KAB and its private sector members including Coca Cola and Waste Management to help fund these urgently needed programs.

On an even more serious note, now is the time in world history for humans to be more respective of nature in general rather than conquering and destroying it. The shocking video of an evil father and son team illegally and cowardly shooting to death a hibernating black bear mother and her two cubs recently made worldwide news. The incident occurred in April 2018 on Esther Island in Alaska. These losers were caught by video surveillance ruthlessly slaughtering the sleeping mother before silencing the shrieking cubs. The father received only a few months in jail and $10,800 in fines and the son had to pay a mere $1,800 restitution. Both also had their hunting licenses revoked (the father for 10 years and the son for two years). Their punishment should have been Much More Severe!!!

When this unspeakable incident was released to the international media in March 2019, the response from around the globe was one of shock and angry. But until such time perpetrators of bad behavior (whether it be illegally killing wildlife, polluting the environment with litter, dumping toxic chemicals, etc.) are heavily fined, publicly shamed in the media, and confined in jail for a long period, such actions will certainly continue.

Chapter 1
Overview/Background

This chapter provides important insights relating to the complex issues of global warming, biodiversity, plastics recycling, and litter. It is intended to address some of the most pressing environmental concerns we currently face in a manner that is factual and understandable. Too often opposing stakeholders cherry pick soundbites out of context to make the best case for their misguided positions. KEC is only interested in the true facts.

Global Warming

Fact number one, the earth is getting warmer. Fact number two, human activity (e.g., air pollution, deforestation, etc.) is primarily responsible (with small contributions from natural sources such as forest fires). This is the overwhelming consensus of the vast majority of the leading scientists around the world. The U.S. Global Change Research Program (USGCRP) is one such group based in the United States. USGCRP is a program mandated by Congress to coordinate Federal research and investments in understanding the forces shaping the global environment, both human and natural, and their impacts on society.

Mount Rainier from Skyline Trail, Mount Rainier NP, © 2019 W. Rhett Kiser.

In 2017, USGCRP released "Climate Science Special Report: Fourth National Climate Assessment, Volume I." This was authored by scientists and researchers from the U.S. Army Corps of Engineers, National Oceanic and Atmospheric Administration (NOAA) Climate Program Office, University of Washington, Pacific Northwest National Laboratory, National Aeronautics and Space Administration (NASA) Goddard Institute for Space Studies, Oak Ridge National Laboratory, Columbia University, Pacific Northwest National Laboratory, DOE Office of Science, and many more.
A key report finding was that, during the 1951 – 2010 period, the likely range of human (anthropogenic) contribution to global mean temperature increase was 92% – 123% (USGCRP 2017).

Two Medicine Lake, Glacier NP, © 2019 Grant R. E. Kiser.

Carbon Brief, a United Kingdom-based website designed to improve climate change understanding, clarified that a >100% contribution is possible since natural causes like solar activity and volcanoes would likely have had a slight cooling effect during the same period. This would offset some of the human-caused warming (Hausfather 2017).

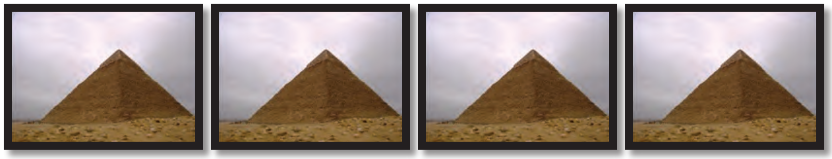
***"Human influence on the climate system is clear, and anthropogenic emissions from greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems"* – Intergovernmental Panel on Climate Change, 2014**

Additional confirmation on human-caused global warming comes from the Intergovernmental Panel on Climate Change (IPCC), a group of 1,300 independent scientific experts from countries across the globe under the auspices of the United Nations. IPCC's Fifth Assessment Report, published in 2014, concluded there's a more than 95 percent probability that our planet has been warmed by human activities over the past 50 years (IPCC 2014).

One obvious indicator is the earth's disappearing glaciers.

Glaciers Retreating

Glaciers (defined as moving bodies of snow and ice larger than 25 acres, vs. snowfields which have no movement) around the world are disappearing due to rising temperatures. NASA reports that, since 1994, glaciers worldwide have been losing a combined total of about 400 billion tons each year. That's the equivalent weight of more than 62,600 Great Pyramids of Giza (NASA 2019, Markings 2017) – taking into account the density of ice (0.9) relative to water (1.0). This glacial decline has contributed to rapid sea level rise, impacted wildlife, and increased wildfire risk (Markings 2017).



The Weight of > 62,600 Great Pyramids = Amount of Worldwide Glacial Melt Lost Annually Since 1994, Sources: NASA and Public Domain.

A 2014 scientific paper published in the journal *Science* concluded that this steady melt of glacial ice was primarily resulting from man-made sources including greenhouse gases (e.g., carbon dioxide, methane, nitrous oxide, released from burning fossil fuels) and aerosols (particulates, smoke) (Marzeion, et al. 2014). The paper's climate change researchers, comprised of professors and related associates from the University of Innsbruck (Austria) and Trent University (Canada), drew their conclusions utilizing 12

climate models, most from the IPCC. Key findings included that human pollution sources caused about 25% of the earth's glacial loss between 1851 and 2010, and about 69% between 1991 and 2010 (Marzeion, et al. 2014).

In a worst-case scenario, the United States Geological Survey (USGS) reports that if all of Earth's glacier ice were to melt, sea levels would rise about 265 feet (ft)/81 meters (m). This would flood every coastal city on the planet (USGS 2019a). In the United States, the USGS reports that while most glaciers are in Alaska (about 27,000 in 2011, with areas they occupy trending downward), others can still be found in California, Colorado, Montana, Nevada, Oregon, Washington, and Wyoming (USGS 2019b).

Sahale Arm Trail, North Cascades NP, © 2019 Grant R. E. Kiser.

A 2017 report completed by the USGS and Portland University concluded that warming temperatures will cause glaciers in the lower 48 states to largely vanish by 2050 (USGS 2017). Further, warming temperatures are responsible for rapidly reducing the size of 39 named glaciers in Montana since 1966. In Glacier NP, for example, all of its named ice formations are expected to be lost within the next few decades. Dr. Daniel Farge, lead USGS scientist, noted that glaciers started to shrink from around 1910 and then entered "rapid and continual" melting from the 1970s onwards (a marked departure from historical norms). Dr. Farge said, "This is the first time in 7,000 years they've experienced this temperature and precipitation. There's no hope for them to survive."

Shrinking glaciers due to global warming were clearly evident in each of the parks KEC visited during our August 2018 expedition. Additional specifics relating to declining glaciers are covered in the individual NP chapters below (Chapters 3 through 5, and Chapter 7).

Grant near Anvil Rock (far right), Mt. Rainier NP, © 2019 W. Rhett Kiser.

Bill Maher Weighs In

On the February 1, 2019 HBO episode of "Real Time," comedian Bill Maher said it well regarding what it may take for decision-makers to take seriously and address adverse climate change impacts. Bill is placing hope on how mad people are going to get when climate change starts killing not just monarch butterflies (*Danaus plexippus*) and all the bees (*Anthophila*) and the whales (*Cetacea*), but stuff much closer to home such as: killing maple trees (*Acer*) (i.e., less syrup for your pancakes) (source: NPR); 60% of wild coffee species are at risk of going extinct (Forbes); less wine production in the traditional wine regions of France, Italy, and Napa Valley by 2050 (i.e., regions could all be too hot to grow grapes) (the Guardian); the banana as we know it is dying (Discover). . .Yes, we have no bananas!; and hotter drier growing seasons also makes it more difficult to grow hops which makes beer (Scientific American).

Warmer, Drier Climate, Greater Fire Risk

The NPS reports that nearly 85% of U.S. wildfires are due to human negligence (e.g., improperly managed campfires, thoughtlessly discarded cigarette butts, arson etc.) (NPS 2018a). When this irresponsibility is coupled with warming global temperatures, the results can be disastrous.

Global warming is creating air conditions that sucks water from plants and soils. This results in drier grasslands, shrubs, and trees that are ready to burn, making the rapid spread of fires an increasing threat. Changes in precipitation (i.e., longer summer dry seasons) can add to this problem. In 2015, the USFS reported

that climate change has led to longer fire seasons (78 days longer, on average, compared to the 1970 season). Twice as many acres are now being burned in the U.S., compared to three decades ago and USFS scientists believe this acreage may double again by 2050 (USFS 2015).

In and adjacent to Olympic NP, between 2003 and 2010, nearly 4,000 acres burned. This was greater than half the acres burned in the 64-year period of 1916-1980. Contributing to this increase was a 2005 policy update to the Olympic National Park Fire Management Plan, allowing park managers to use wildland fires for resource benefit rather than automatically suppress each new start (NPS 2019a).

The issue of fire suppression in our national parklands and forests is often cited by pro-industry stakeholders as the reason for the major wildfires in the West. The claim is that environmentalists want to save all trees at all costs and all fires must therefore be suppressed. This is not the case. Here's a brief look back at the actual fire management history in the U.S.

Fire Scars Near Saint Mary Lake, Glacier NP, © 2019 Jonathan V. L. Kiser.

Following the 1905 establishment of the USFS, its primary task was to suppress all fires on the forest reserves it administered.

When the NPS was established in 1916, it followed the USFS approach and adopted a fire suppression policy that would be in place for the next five decades. However, as early as 1924, environmentalist Aldo Leopold argued that wildfires were beneficial to ecosystems, and were necessary for the natural breeding of various plant and tree species. In 1934, Roy Headley, USFS Chief of Fire Control, proposed that backcountry areas not receive the same level of fire control as front country areas. While this was supported by Leopold and fellow wilderness advocate Bob Marshall, they were overruled and the USFS adopted a policy of suppressing all wildfires by 10:00 am after first being spotted (Pyne, 1982).

In 1944, USFS introduced its Smokey Bear ad campaign to help educate the public that all fires were detrimental. Such efforts resulted in dense forests with too much brush and other undergrowth, susceptible to extreme fires. Fortunately, the NPS fire suppression policy changed in 1968 when it was realized that fire is an essential part of the life cycle of the giant sequoia in California. Since then, the NPS has advocated that fire managers assess the threat of human-caused fire to wildlands and the threat of wildland fires to humans. Where people and property are threatened, all efforts are made to extinguish the fire. If a wildfire is started by lightning in a large NP and/or forest, it may be allowed to burn to benefit the ecosystem. Such benefits include: 1) Preventing larger, more destructive fires by clearing brush from the forest floor; 2) Facilitating seedbed preparation and favorable seed germination; 3) Recycling nutrients; and more (NPS 2018b).

The USFS enacted similar measures in 1974 by changing its policy from fire control to fire management, allowing lightning fires to burn in wilderness areas. This included both naturally caused fire and intentional prescribed fire. In 1978, the USFS abandoned the 10:00 am policy in favor of a new policy that encouraged the use of wildland fire by prescription.

As early as 1924, environmentalist Aldo Leopold argued that wildfires were beneficial to ecosystems, and were necessary for the natural breeding of various plant and tree species.

Remember that, although land use and firefighting tactics can play a role in lowering or raising fire risks, observed and expected climate changes are expected to continue to increase U.S. areas affected by wildfires. And once a fire starts, the warmer, drier conditions can spread them quicker and make putting them out more difficult (Center for Climate and Energy Solutions, 2019). Warmer, drier conditions also contribute to the spread (through higher reproduction rates) of the mountain pine beetle (*Dendroctonus ponderosae)* and other insects that can weaken and/or kill trees. This, in turn, builds up the fuels in a forest.

Rhett and Grant with Smoky Cascades Skies, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

Also bear in mind that where there is fire, there is harmful smoke and ash that can contaminate entire regions covering hundreds of

miles. As wildfires increase in frequency and intensity, more and more parks and communities are at risk.

According to the Center for Disease Control and Prevention (CDC), wildfire smoke is a combination of gases (carbon monoxide, dioxins, furans, other) and fine particles from burning trees and other plant materials. This smoke can irritate the respiratory system, hurt your eyes, and worsen chronic heart and lung diseases. Paper dust masks commonly found at hardware stores trap large particles (e.g., sawdust), but will not protect lungs from smoke. A "N95" mask, properly worn, will offer some protection (CDC 2018).

During most of KEC's August 2018 expedition, smoke from forest fires was evident. Views were seriously impeded in sections of Olympic NP, along with on Mt. Rainier, throughout Glacier NP, and in the North Cascades region. In addition, some roads were closed due to fires, and air quality was often noticeably diminished.

The same week we left Washington state to return home, air quality in Seattle was so bad that people were advised to avoid going outside and exerting themselves. On August 22, 2018, the Air Quality Index (AQI) in some parts of the city rose to a "very unhealthy" level of 220. With news organization Vox reporting that an AQI of 150 is the equivalent of smoking seven cigarettes a day, Seattle residents were breathing the equivalent of more than half a pack!

August 2018 Seattle Air Quality Equaled Smoking > Half Pack of Cigarettes Daily, Source: Irfan 2018 (Vox News Organization); Cigarette Butt Photographed @ Kautz Creek in Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

At the time, Seattle was surrounded on three sides by smoke moving south from British Columbia, east from the far side of

the Cascades and north from California and southern Oregon. There was also a fire burning in the typically rainy Olympic NF, between Seattle and the Pacific Ocean (Irfan 2018).

More Powerful Wind Events

Researchers at the Climate Change and Impacts Laboratory at the University of California (Santa Cruz), concluded that global warming (driven by increasing atmospheric concentrations of greenhouse gases) is likely to increase wind speeds along the U.S. west coast. Employing a regional climate model, these findings were presented by earth scientist Mark Snyder in a poster titled "Future Changes in Surface Winds in the Western U.S. due to Climate Change" at the December 2008 meeting of the American Geophysical Union (AGU) in San Francisco (Stephens 2008).

Snyder explained, "What we think is going on is that land temperatures are increasing at a faster rate than the ocean temperatures, and this thermal gradient between the land and the ocean is driving increased winds." The UC Santa Cruz Research Team noted that stronger coastal winds may have far-reaching effects including more extreme fire conditions and a cooling effect along the coast that could impact species currently adapted to seasonal changes in fog and temperatures. The good news is that stronger winds would be beneficial for the wind energy industry.

During KEC's first day in Olympic NP, the ranger we spoke with at the Wilderness Information Center leading to Hurricane Ridge mentioned the substantial wind-caused damage on the north shore of Lake Quinault was attributed to climate change. He noted that what made this incident so unusual was that it happened some 20 miles/32 km further inland than the previous norm.

Local reporting at the time of the January 27, 2018 event documented that more than 100 old-growth trees had fallen near the July Creek picnic area and the sides of the blowdown area was about one half-mile long (Sailor 2018).

Wind Damage Flow in January 2018 at July Picnic Area, Olympic NP, Source: Public Domain.

The fallen trees were all facing south and the wind had to come from the north. University of Washington climatologist Cliff Mass pointed out that the winds were not the result of a microburst associated with a strong convection (upward current) or thunderstorm. Rather, Mass believes something called a rotor (cloud) circulation associated with a strong mountain lee (downwind) wave occurred. Evidence suggests that an offshore front approached the blowdown site from the south. Warm air moving above cooler surface air, dropping barometric pressure, plus other factors, led winds to powerfully reverse direction in a rotor wave between the two ridges where Lake Quinault sits.

Impacts on Plants and Animals

Scientists have found that while flora and fauna have some ability to adapt to changing climate conditions, the combination of air pollution and other stressors (e.g., habitat loss) can directly impact biodiversity (Halofsks, et. al 2011).

Both plants and animals will respond individualistically to global warming, some positively others negatively. In the case of plants, warmer temperatures can result in wildflowers and grasses in alpine meadows and subalpine forests being overtaken by trees.

This, in turn, may negatively impact animals (e.g., bees, birds – *Aves*, etc.), who depend on such plants as a source of food. For example, in the subalpine meadows around Logan Pass in Glacier NP, heavy snow packs are declining. This has led to subalpine meadows being invaded by small seedlings, mostly fir, since the snowpack is no longer there to prevent them from becoming established (Gaskill 2018).

On the fauna side, provided below is a look at how some of the animals encountered by the KEC Research Team may be impacted by changing climate conditions:

1) **Garter Snake (*Thamnophis*):** Some cold-blooded (ectothermic) species such as snakes (*Serpentes*) may benefit from warmer temperatures since they don't have the ability to retain heat generated by their metabolism. The KEC Team saw several black and yellow garter snakes in Olympic NP along the Irely Lake Trail.

Garter Snake, Source: Public Domain.

2) **Cascades frog (*Rana cascadae*):** Other cold-blooded creatures like this amphibian living in the Pacific NW, thrive in moist, cool conditions (i.e., wetland habitats) and may suffer in a hotter, drier climate. We saw many Cascades frogs in Olympic NP at Irely Lake.

Cascades Frog, Irely Lake, Olympic NP, © 2019 W. Rhett Kiser.

3) **Hoary marmot (*Marmota caligata*):** Another species we encountered living in a sensitive habitat is the Hoary marmot. Warming temperatures can be expected to reduce snowpack and alter forage foods in the alpine and subalpine habitats that marmots inhabit. KEC saw marmots in Mt. Rainier NP and North Cascades NP.

Hoary Marmots, Skyline Trail, Mt. Rainier NP, © 2019 Grant R. E. Kiser (left) and Jonathan V. L. Kiser (right).

4) **Columbian ground squirrel (*Urocitellus columbianus*):** This rodent species is common in certain regions of Canada and the northwestern United States. It is part of the Marmotini tribe, along with marmots, prairie dogs *(Cynomys)*, chipmunks *(Marmotini)*, and other ground squirrels. The International Union for Conservation of Nature (IUCN) lists the Columbian ground squirrel as a stable species since they are widespread and face no major threats for survival (IUCN 2019). The KEC team saw multiple ground squirrels in Glacier NP, at the Logan Pass Visitor Center (elevation 6,646 ft/2,026 m) and near the Continental Divide (7,185 ft/2,190 m) along the Swiftcurrent Pass Trail.

Columbian Ground Squirrel, Logan Pass, Glacier NP, © 2019 Jonathan V. L. Kiser.

5) **Mountain goat (*Oreamnos americanus*):** This alpine/subalpine species is suspected of being sensitive to global warming. Goats live in high-altitude habitats and rely on cool, rocky terrain to survive. With the mountain peaks in

NPs like Mt. Rainier, Glacier, and North Cascades heating up two or three times faster than the low-lying areas surrounding them, there is concern that this may adversely impact the goats living there. The KEC team spotted mountain goats in North Cascades NP in the Cascades Pass valley and at Blue Lake in Okanogan-Wenatchee NF outside the NP boundary.

Jonathan w/Mama Goat and Her Kid, Blue Lake, Okanogan-Wenatchee NF, © 2019 W. Rhett Kiser.

6) **Moose *(Alces alces):*** The largest and heaviest member of the deer family, moose live in a range of habitats in northern areas having regional snowfall. Since they are typically not found in locations with sustained temperatures exceeding 80 degrees Fahrenheit (°F)/27 degrees Celsius (°C), warming global temperatures may impact Moose habitat. In Glacier NP, warmer winters have resulted moose suffering from rising tick populations being brought further north on whitetail deer. The KEC team saw a moose in Glacier NP near the Swiftcurrent Pass Trail.

Moose Near Swiftcurrent Pass Trail, Glacier NP, © 2019 Jonathan V. L. Kiser.

7) **Generalist Species:** Critters that are less sensitive to global warming are known as generalist species since they can live in different types of environments. Species of this type encountered by the KEC team include: a) North American black bear *(Ursus americanus)* near Tahoma Creek in Mt. Rainier NP; b) Roosevelt elk *(Cervus canadensis roosevelti)* outside Olympic NP; and c) Grizzly bear (*Ursus arctos)* near Many Glacier Hotel in Glacier NP.

Roosevelt Elk Outside Olympic NP, © 2019 J. V. L. Kiser.

Mother Grizzly and Cubs, near Many Glacier Hotel, Glacier NP, © 2019 Grant R. E. Kiser.

If the Planet is Warming Why is it So Cold?

When record cold temperatures hit the Midwest U.S. during January 2019, global warming deniers were quick to point out that calls for alarm over the condition of the planet was a hoax. President Donald Trump tweeted, "WHAT THE hell is going on with Global Waming? (typo) Please come back fast, we need you!" Had Trump consulted NASA and NOAA scientists, they could have helped his basic understanding, as well as his spelling, relating to the fact that the Earth is unmistakably warming (Washington Post 2019).

In February 2019, NASA and NOAA experts announced that 2018 was the fourth-warmest year on record. Further, the five warmest years on record were during the past five years, and 18 of the 19 warmest years have occurred since 2000. Areas near the North Pole are warming more than two times faster than the rest of the globe. This phenomena is called "Arctic Amplification." So why was it so cold in January 2019 with the Midwest and Great Lakes region experiencing record-shattering wind chills from 40 to 60 ^{o}F/4 to 16 ^{o}C below zero? It was due to disruption of something known as a polar vortex. This is a well-known mass of low pressure and cold air over the north polar region during the winter season that sometimes shifts a little further south. A large, powerful high-pressure system originating in the Pacific is needed to displace the pocket of cold air (MacMath 2019). Fortunately,

the January 2019 polar blast didn't last very long (i.e., due to the weakening high-pressure system). Within four days of the most extreme low temperatures, part of the Ohio Valley reached in the 50s – a 100 °F/38 °C temperature swing!

A counterintuitive explanation of the polar vortex is gaining ground in the climate science community. When warm air invades the Arctic Circle, it weakens the polar vortex, displacing cold air masses southward (i.e., suggesting global warming can contribute to a more extreme, wavy jet stream). (Berardelli 2019).

Also remember that the extreme cold weather events in the Midwest U.S. wasn't representative of the remainder of the planet. During the six-day period of January 12 – 17, 2019, the Australian Bureau of Meteorology reported these were all within Australia's ten hottest days on record. One city (Port Augusta near Adelaide) reached 120 °F/49 °C (Regan, et al. 2019).

Logging Impact on Biodiversity

From a global warming perspective, cutting down trees results in both the release of stored carbon dioxide (the primary greenhouse gas responsible for global warming) and the loss of the ability for those trees to absorb existing carbon dioxide from the atmosphere. According to the World Resources Institute, the amount of carbon dioxide being released from tropical deforestation around the world is a source amount that ranks third only behind the countries of China and the U.S. (and ahead of the European Union, India, and Russia) (Gibbs 2018). Tropical tree cover alone can provide 23 percent of the climate mitigation needed over the next decade to meet 2015 Paris Agreement goals (Nunez 2019). Forests also help to regulate local climates by transpiring water (i.e., evaporating from leaves) and shading the ground.

***"Every 100 liters of water a tree transpires (just a fraction of what many trees release each day) provides the energy equivalent of running two central air conditioning units for a day (or 70 kilowatt-hours of electricity)"* – World Resources Institute, October 2018**

And while forests still cover approximately 30% of earth's land area, they are disappearing fast. The World Bank reports that, between 1990 and 2016, the world lost 502,000 square miles/808K km of forest – an area larger than South Africa. Over the past 50 years, about 17% of the Amazonian rainforest has been destroyed (World Bank 2019). In addition, National Geographic reports that livestock grazing, farming, drilling, and mining combined are responsible for greater than 50% of all deforestation (Nunez 2019). Further, logging operations cut down countless trees (to meet the demand for wood and paper products), and growing urban sprawl is to blame for trees being removed to make way for more and more homes and businesses.

Part of the dilemma is that 80% of our planet's land plants and animals inhabit forests. Removing trees eliminates forest canopy, which otherwise blocks sun rays during the day and retains heat at night. Canopy removal results in more extreme temperature swings that can adversely impact plants and animals (Nunez 2019).

On the Olympic Peninsula, logging activities through the end of the 20th century left a scarcity of late-successional forest (trees with an average diameter of overstory conifers > 20-inches and conifer canopy cover > 10 percent). These forests provide high-quality habitat for the northern spotted owl and many other species

(Halofsky, et al. 2011). Until the 1990s, timber management in the Peninsula area generally consisted of clearcutting, broadcast burning, and tree replanting. Douglas fir (*Pseudotsuga menziesii)* was the primary tree species chosen for artificial regeneration. These management practices resulted in the regeneration of over one-third of Olympic NF (ONF) into relatively young even-aged forests. These forests were designed to maximize the production of wood products. The 1994 Northwest Forest Plan shifted this toward more ecological management priorities (i.e., protecting, enhancing, and accelerating late-successional forest conditions). Commercial thinning of trees in ONF now aims to create conditions that improve the potential for fauna habitat and encourage the growth of a diverse understory and multilayered stand structure. Economic considerations are also considered.

Possible benefits associated with thinning young stands (and resulting redistribution of sunlight, moisture, and nutrients) include: Improved tree health, long-term wind firmness, and climate change resilience. Species diversity is enhanced or maintained through reduced competition around ecologically important minor tree species and other vegetation (Halofsky 2011).

On the other hand, the mass removal of trees (clear-cutting without replanting) increases water runoff, leading to soil erosion and muddied waterways. Stream water temperatures may rise due to the tree canopy removal, lowering oxygen levels and possibly harming fish and other aquatic animals. Soil quality also decreases since tree leaves that provide nutrient-rich humus are no longer there. In addition, logging roads and heavy equipment operation compacts the soil, adversely impacting the habitat of dirt-dwelling organisms (Whitmer 2017).

The KEC Team witnessed the horrible aftermath of considerable clear-cutting activity, with little evidence of regenerative plantings, outside Olympic NP.

Logging Aftermath Near Quinault Rain Forest, Outside Olympic NP, © 2019 Jonathan V. L. Kiser.

Plastics and Other Litter Insights

Since the petrochemical industry introduction of plastics to the mass consumer market post-World War II (i.e., Tupperware was launched in 1948), plastics have become a growing environmental menace worldwide. For example, much attention has been given to the five huge and enlarging garbage (mostly plastic) vortex's circulating in the world's oceans.

Unfortunately, our NPs have also been inundated with plastic litter as KEC has already documented in multiple publications (e.g., See the Executive Summary Overview/Background section), and including this one. The types of plastic we found as litter during our 2018 expedition cover the full range of plastics number 1 through 7. Most, but not all (e.g., #6 Styrofoam), of these plastic types had recycling potential if they were not otherwise blindly tossed on the ground in some of our country's most precious places. Exhibit 1 summarizes common plastic consumer materials by recycling number.

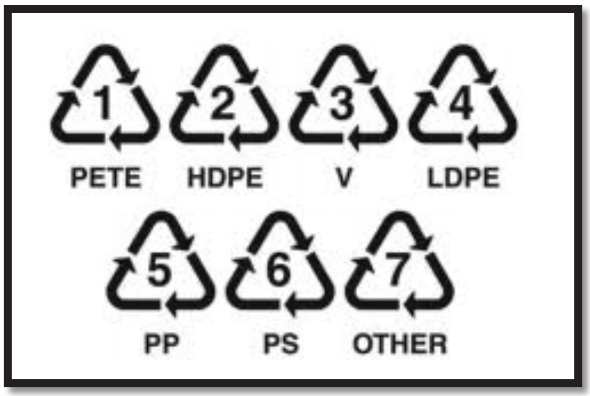
Plastic Litter, Olympic NP,
© 2019 Jonathan V. L. Kiser.

Plastic Litter, Mount Rainier NP (left) and Glacier NP (right),
© 2019 Jonathan V. L. Kiser.

Exhibit 1 – Plastic Material Types by Recycling Number

Plastic Type Number/Name	Material Examples
Plastic – #1 PETE (Polyethylene Terephthalate)	1) Bottles (salad dressing, shampoo, cleaner, soft drink, water, etc.); 2) Cups (soda); 3) Cup lids; 4) Jars (peanut butter); 5) Polyester fibers.
Plastic – #2 HDPE (High-Density Polyethylene)	1) Bags (grocery); 2) Bottles (bleach, cleaner, detergent, juice, milk, shampoo, syrup, water).
Plastic – #3 PVC (Polyvinyl Chloride)	1) Curtains (shower); 2) Flip-flops; 3) Furniture; 4) Piping (water supply); 5) Pleather; 6) Toys; 7) Wrap (food); 8) Ear plugs; 9) Shrink-wrap labels.
Plastic – #4 LDPE (Low-Density Polyethylene)	1) Bags (dry cleaning, newspaper, bread); 2) Bottles (squeezable); 3) Lids (snap-on), 6-pack rings, Wrap (cigarette packs, food).
Plastic – #5 PP (Polypropylene)	1) Bottles (medicine); 2) Caps (bottle); 3) Carpet; 4) Containers (fruit, yogurt); 5) Cups (clear); 6) Flossers (Plackers, etc.); 7) Plates; 8) Scrapper (ice); 9) Straws; 10) Utensils.
Plastic – #6 PS (Polystyrene)	1) Clips/Tags (for bread bags); 2) Cups (colored); 3) Styrofoam (egg cartons, food containers, cups, packing peanuts, plates).
Plastic – #7 Other	1) Auto headlamps; 2) Bags (food storage bags – combination #2 and #5); 3) Compact discs; 4) Containers (snack); 5) Glasses; 6) Wrappers (plastic-only for candy, other food); 7) Miscellaneous hard plastic pieces (hard to identify); 8) Other multi-layer resin composites.

Sources: Kiser Environmental Consulting, 2019 and Public Domain.



Plastics Recycling Symbols, Source: Public Domain.

Some of the plastic litter we encountered were difficult to categorize since only a portion may have remained or they otherwise did not readily fit into a clear recycling number category. In such cases, these materials were counted as either #7 Plastics or in the "Other Litter" category. KEC also applied the "crinkle test" on some materials (e.g., chip bags, other) noting that if it crinkles in hand then it is a composite (multi-material) that can't readily be recycled (if at all).

Most of these composite materials contained both plastic and metal components (e.g., mylar) to enhance their appearance and were therefore accounted for as Other Litter. For example, this typically applied to food and candy wrappers. See Exhibit 2 for examples of Other Litter materials we documented. Some of these items (e.g., hair tie, socks) may have been classified as textiles but, since it was hard to determine the actual material composition, it was counted under the Other Litter category. Specific materials documented by KEC during our 2018 expedition are detailed in the individual NP and NF chapters below (Chapters 3 through 7).

Exhibit 2 – Other Litter Material Examples Documented by KEC

Material Type	Material Composition
Duct Tape	3-layer composite (polyethylene, fabric mesh, rubber-based adhesive).
Hair Tie	Elastic, rubber, and/or cotton.
K-cups	Mixed plastic, paper (filter), aluminum (lid).
Rubber	Natural latex from rubber tree (*Hevea brasiliensis*).
Socks	Variety (wool, acrylic, cotton, nylon, etc.).
Stickers (fruit)	Paper and/or plastic.
String	Variety (hemp, silk, rawhide, linen, etc.).
Wrappers	Multi-materials (paper, aluminum, plastic, etc.).

Sources: Kiser Environmental Consulting, 2019 and Public Domain.

Intentional vs. Inadvertent Littering

Over the many decades KEC has been studying the litter issue, we have documented that not all littering is intentional (but is litter just the same). For example, well-intentioned, environmentally-conscious hikers may stash candy wrappers in their pant pockets and, when they reach for another piece, can lift the wrapper out and drop it on the ground without even noticing. On-going, persistent awareness of ones' actions is needed to combat this reality. A "buddy system" should also be encouraged in NP literature (available on-line, at visitor centers, posted at trailheads) whereby hiking groups look out for one another and pick up the litter their fellow hikers may have unintentionally dropped. In addition, visual trail head signs promoting litter-free behavior should be established at all appropriate NP locations.

“Other Litter” in Olympic NP, © 2019 Jonathan V. L. Kiser.

“Other Litter” in Mount Rainier NP (left) and Glacier NP (right), © 2019 Jonathan V. L. Kiser.

Chapter 2
Seattle/Mount Walker/Dungeness Spit

Overview

Seattle

Seattle, Washington is the largest city in the Pacific Northwest with an estimated population of 659,000 in 2019. Known as the Emerald City, it is situated between Puget Sound and Lake Washington in King County. The Cascade mountains lie to the east and the Olympic Mountains are to the west. Mt. Rainier can be readily seen 90 miles/145 km to the south. The city and its surrounding areas are the home of the Space Needle, Starbucks, Boeing's aircraft assembly plants, Costco, Microsoft, Amazon.com, the University of Washington, and more (World Population Review 2019).

KEC Seattle Field Observations: August 4 – 5, 2018

The KEC Research Team departed Baltimore, MD and flew non-stop to Seattle, WA. During our approach, we were awestruck by the sight of Mount Rainier to the south. In plain view were the snow-capped summit and the Winthrop, Carbon, and Russell Glaciers.

Northern Face of Mount Rainier with (left to right) Winthrop, Carbon, and Russell Glaciers in August 2018, © 2019 Grant R. E. Kiser.

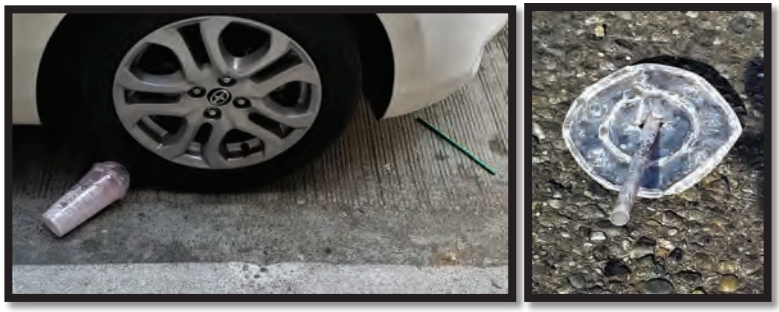
KEC spent the next two days exploring Seattle by foot, light rail train, monorail, and Uber. We visited Pike Place, the Space Needle, University of Washington, Washington Park Arboretum, and many other locations, noting recycling and waste management practices, and, invariably, litter. We hiked about seven miles/11 km in the process.

Seattle, WA Sites, © 2019 W. Rhett Kiser (left) and Jonathan V. L. Kiser (right).

On Top of the Seattle Space Needle, © 2019 Jonathan V. L. Kiser.

In general, we observed a clean city with a non-uniform approach to collect recyclables and trash in public places. More specifically, a three-bin system was available in many locations, allowing for the collection of recyclables (blue bin), compostables (green bin), and trash (brown bin). The best containers were both color-coded and provided images of what materials should go in each. At the University of Washington, we passed a Big Belly solar-powered waste and recycling station and a three-bin system with worn-out material identifiers. A graffiti-ridden sign was hard to miss in the Washington Park Arboretum. Litter, mostly in the form of paper and plastic, was noticed in various downtown locations. No formal litter survey was conducted during our time spent in Seattle.

Graffiti in WA Park Arboretum, Seattle, © 2019 Jonathan V. L. Kiser.



Litter in Seattle, WA, © 2019 Jonathan V. L. Kiser.

Grant at University of WA and Rhett at WA Park Arboretum, © 2019 W. Rhett Kiser (left) and Jonathan V. L. Kiser (right).

KEC Mt. Walker and Dungeness Spit Field Observations: August 6, 2018

The KEC Research Team departed Seattle and headed west toward Olympic NP. En route we made several stops, the first of which was Mount Walker (elevation 2,804 ft/855 m) in ONF. Mount Walker is densely covered with 100-year old Douglas fir trees, in an area once burned by wildfire (USDA 2019). Native Pacific

rhododendrons (*Rhododendron macrophyllum*) grew along the four-mile road to the summit and at both North and South observation points. On a clear day, Puget Sound and Seattle can be seen to the east, and the Olympic range to the west.

Mount Walker South Observation Point Information & Messages Board, © 2019 Jonathan V. L. Kiser.

During our visit, from the South observation point, smoky skies prevented us from seeing the Emerald City. We were only able to make out nearby Quilcene sand Dabob Bays. On the Information & Messages board (at the beginning of the short loop trail) there was a noticeable brown and yellow sign with the USFS Woodsy Owl mascot stating, "NO Garbage Service Please Pack It OUT!" Despite this being a good example of creative anti-litter messaging, four pieces of paper litter were documented nearby.

From the North observation point the view was much clearer and very impressive. Sprawled before us were the glorious Olympic Mountains, including the following noticeable peaks: Mount Constance (elevation 7,756 ft/2,364 m), Warrior Peak (7,340 ft/ 2,237 m), and Buckhorn Mountain (6,988 ft/ 2,130 m). In addition, we saw an inquisitive gray jay (*Perisoreus canadensis*) who was unfortunately being encouraged by four USFS personnel to accept food from their hands. Even more amazing was the fact that one of the employees was capturing this on his cell phone camera, creating self-incriminating evidence in the process!

What a poor example to set. Don't feed the wildlife, dummies!! The distance we walked at both vista points was about 0.25 miles/0.40 km.

View from Mount Walker North Observation Point (left to right): Mount Constance, Warrior Peak, and Buckhorn Mountain, © 2019 Jonathan V. L. Kiser.

The Research Team next traveled north to the Dungeness Spit. At 5.5 miles/8.8 km, the Spit is the longest natural sand spit (an extended stretch of beach stretching out to sea and joined to the mainland at one end) in the U.S. It juts into the Strait of Juan de Fuca from the Olympic Peninsula's northern edge.

The Dungeness Spit, Dungeness National Wildlife Refuge, © 2019 Jonathan V. L. Kiser.

Part of the Dungeness National Wildlife Refuge (Established in 1915 by President Woodrow Wilson), the Spit and the bluffs overlooking it has a wildlife diversity including some 244 bird species, 18 land

mammal species, and 11 marine mammal species (some endangered or threatened) (U.S. Fish & Wildlife Service 2017).

Recycling & Trash Bin, Dungeness Spit, © 2019 J. V. L. Kiser.

Upon arriving in the Spit parking lot, we took note of a large, well-blended and marked recycling/trash bin. A picturesque, 2.4-mile hike to (on a paved path) and from (on a "primitive" unpaved path) the Spit followed. Near the water we encountered an eye-catching display sign showing various litter items and how long it will take for each to degrade in the environment. Another trailside side encouraged visitors to take only pictures and memories. We were happy to not find any litter on the trails and to encounter a blacktail deer (*Odocoileus hemionus*) in the woods. One piece of paper litter was documented back in the parking lot.

Litter Decomposition Timeline Display, Dungeness Spit, © 2019 Jonathan V. L. Kiser.

KEC Seattle/Mt. Walker/Dungeness Spit Feedback/ Improvement Recommendations

Seattle

- On the Space Needle grounds, KEC was impressed with the trash and recycling bins that included strategically-sized openings for materials, plus images of acceptable materials for each bin. To the extent possible, these bin types should be standardized across the city as they provide both visual and physical reminders to help people properly manage their discards.

- Inside the Space Needle, we saw a stream-lined single bin with different-sized openings on the top labeled for recyclables (the largest), compost, and materials destined for landfill. This bin style is less effective as people will not generally take the time to read what material should go where.

Recycling and Trash Bins Near (left) and In (right) the Seattle Space Needle, © 2019 Jonathan V. L. Kiser.

- On the University of WA campus, there were three stand-alone bins (blue for paper, bottles, and cans; green presumably for compostable materials; and black for trash). The lettering on these bins was worn off to varying degrees from the rubbing of incoming materials. New flaps and stickers showing acceptable items would improve these bins. By comparison, the nearby Big Belly collection bins we saw showed acceptable recycling items on the side.

Recycling and Trash Bins in Need of an Upgrade, University of WA, Seattle, © 2019 Jonathan V. L. Kiser.

- In Pikes Place Market, the Research Team documented three side-by-side color-coded bins (blue for recyclables, green for compostables, and brown for landfill) with pictures of acceptable materials. Bravo!

Effective Recycling & Trash Bins, Pikes Place, Seattle, WA, © 2019 Jonathan V. L. Kiser.

- On South Holgate Street (not too far from Starbuck's HQ), we encountered two messy and neglected commercial dumpsters sprayed with graffiti. A definite community eye-sore that should be better managed by the responsible party.

South Holgate Street Mess, Seattle, WA, © 2019 J. V. L. Kiser.

Mount Walker

- The road sign directing motorists to the Mount Walker viewpoint (4 miles away) is battered, worn, and needs a face-lift.

Tattered Mt. Walker Signage, © 2019 J. V. L. Kiser.

- On the Mount Walker South observation point message board, the "NO Garbage Service Please Pack It OUT!" (with Woodsy Owl) sign is tremendous! Not only is it noticeable from a distance (due to the use of large lettering and relatively few words) but use of the well-known mascot is an important and familiar attention-grabber. (Note: Woodsy Owl first made his appearance in September 1971 with the motto "Give a hoot—**don't** pollute!" His current motto is "Lend a hand—care for the land!")

- More Woodsy Owl signs should be strategically placed at popular USFS trailheads and in visitor centers. Specific anti-litter language (e.g., "Please Don't Litter") should also be incorporated since some people might not make the connection between litter and pollution (particularly if it's biodegradable human food).

- "Don't feed the birds or other animals" signage should also be posted on Mount Walker and other location message boards.

- USFS personnel caught feeding the wildlife should be fired for setting a poor example NOT in tune with the agency mission: "To sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations."

Dungeness Spit

- At the Dungeness Spit, the Research Team was impressed with the creative signage informing visitors how long it takes litter to degrade in the environment and to leave nature undisturbed. This type of messaging should be reinforced via trailhead signs and handout brochures. The NPS and USFS should develop and implement similar messaging and informative materials that can be consistently applied throughout their systems. The agencies should team with private sector and non-profit partners for funding support.

Dungeness Spit Trailside Sign, © 2019 J. V. L. Kiser.

- The interpretive plant identification plaques and animal photographs (e.g., rough skinned newt – *Taricha granulosa*) seen along the hiking trail were an added nice touch.

Chapter 3
Olympic National Park

Jonathan Entering Olympic NP, © 2019 W. Rhett Kiser.

Overview

Located in the northwest corner of Washington state, Olympic National Park (ONP) was established on June 29, 1938 and encompasses 922,000 acres (1,441 square miles/2,319 km). In 1988, about 95 percent of the park land was set aside as a formal wilderness. ONP is known for its ecosystem diversity. ONP has more than 60 miles/97 km of Pacific Ocean wilderness coastline, temperate rain forest (found at low elevations along the coast and in the western-facing valleys of the peninsula), subalpine forest, and wildflower meadows (topped by glacier-capped peaks). Eleven major river systems are found in ONP.

Marymere Falls, Olympic NP, © 2019 Grant R. E. Kiser.

Marine fossils discovered in the ONP mountain summits indicate this rock was developed under the ocean. About 30 million years ago, the Pacific Ocean floor plate collided with the North American continental plate. This caused the upper layers of the seabed to rise into the Olympic mountains. Glaciers and streams have been subsequently responsible for the current mountain profiles. At 7,980 ft/2,432 m, Mount Olympus is the tallest peak in the range. The Olympic range is so effective at intercepting moisture-rich air masses from the Pacific that the northeast corner of the Peninsula receives comparatively little rain. More specifically, the town of Sequim receives 17 inches of rain annually compared to 200 inches (mostly snow) at Mt. Olympus less than 30 miles/48 km away.

Glaciers nearly one-mile thick carved out nearby Puget Sound and isolated the peninsula from the mainland. This led to eight plant species and 15 animals evolving here that are unique to the area. Examples include: the Olympic marmot (*Marmota olympus*), Olympic mountain milkvetch (*Astragalus australis olympicus*), Olympic mudminnow (*Novumbra hubbsi*), Beardslee trout (*Oncorhynchus mykiss irideus f. beardsleei*), Crescent trout (*Oncorhynchus clarkii crescenti*), and the Olympic Mazama pocket gopher (*Thomomys mazama*) (National Geographic). During 2018, there were 3.10 million visitors to ONP.

Select ONP Flora and Fauna (left to right): Mountain Milkvetch, Olympic Mudminnows, Lake Crescent Beardslee Trout, Mazama Pocket Gopher, Source: Public Domain.

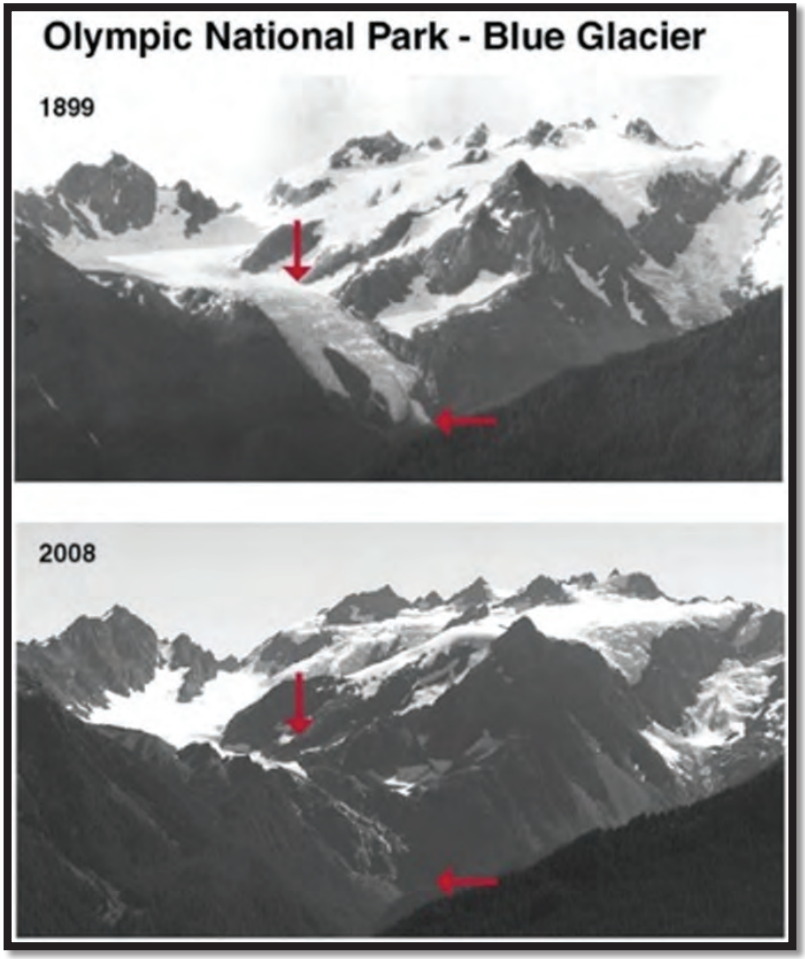
ONP Global Warming

Glaciers in ONP and elsewhere are sensitive climate change indicators. To grow, they must receive more winter snow than evaporates or melts the following summer. If more melts than accumulates, it will shrink. As Earth's climate warms, there is less winter snow and more summer melt and glacial ice is rapidly being lost. The remaining and already lost glaciers in ONP directly reflect this.

In 2009, the NPS completed a glacier inventory in ONP documenting elevations and surface areas of the larger glaciers. Ice loss volume and impacts on glacial-fed rivers (especially important for aquatic life survival during summer months) were calculated. Results were sobering. In 1982, the park had 266 glaciers (with a combined area of 17.7 sq. miles/45.9 sq. km); in 2009 there were 184 (11.7 sq. miles/30.2 sq. km). A 2015 update revealed the number of ONP glaciers had dropped to 148 (9.5 sq. miles/24.6 sq. km). Further, a comparison of aerial photos from the late 1970s to 2009 indicated a 34% loss of glacier surface area. NPS reports that this is stark evidence of the ongoing impact of human-driven global warming (NPS 2019b).

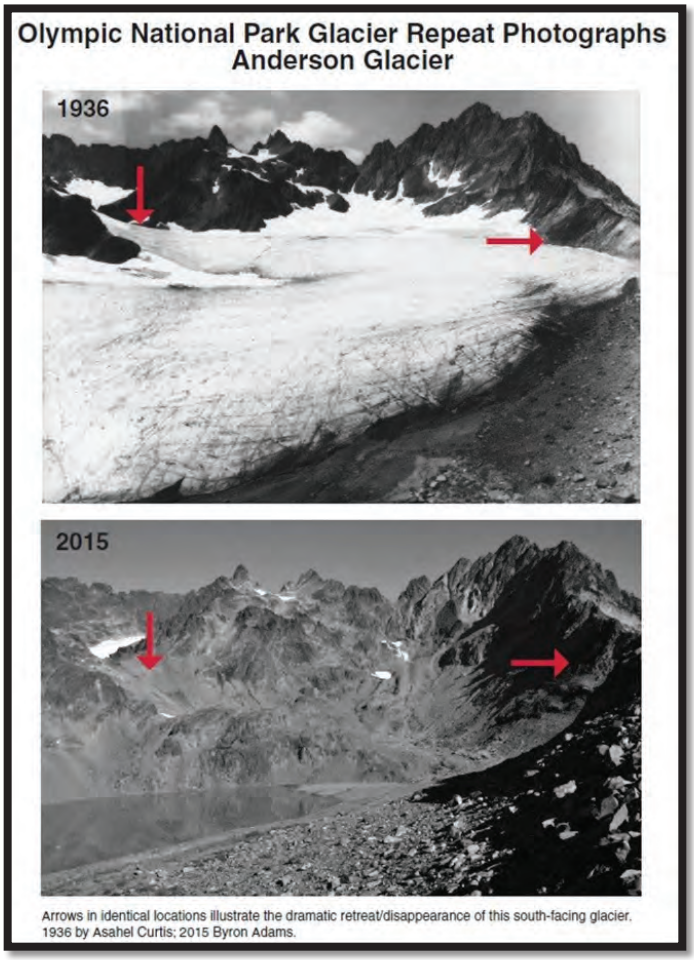
One of the park's largest glaciers is the 2.6-mile long Blue Glacier, descending from Mount Olympus. During the 20-year period from 1995 – 2006, the bottom end (terminus) of the glacier retreated about 325 ft /100 m. Researchers also found the volume of ice (thickness) decreased by at least 15% during the period of 1987 – 2009. Another example of glacier loss is found in the southeastern part of ONP, on

Mount Anderson. Here, the south-facing Anderson Glacier existed until very recent times. Historically over a mile long and hundreds of feet thick, the glacier receded to < 10% of its former size between 1927 and 2009. It had all but disappeared by 2015.



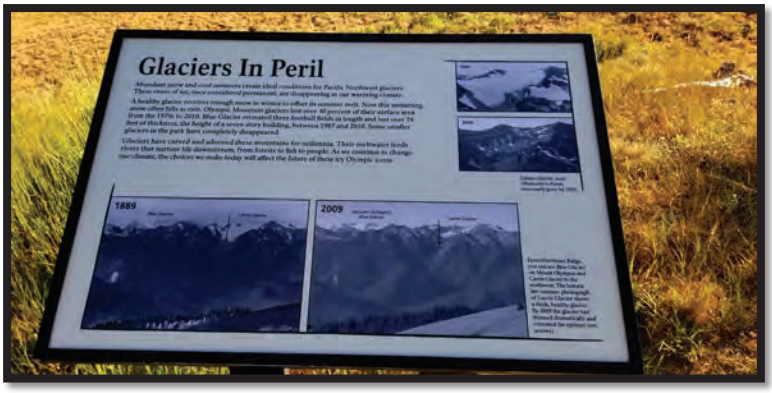
Comparison Photos Showing Blue Glacier Retreating & Thinning, Sources: 1899: ONP Archives; 2008: Jim Patterson, ONP. From Public Domain.

"These critical and beautiful rivers of ice have shaped and adorned the Olympic Mountains for millennia, have rapidly shrunk in just decades. Stark evidence of the ongoing impact of human-driven climate change." **– National Park Service, 2019**



The Disappearance of the Anderson Glacier, Sources: Noted Above. From Public Domain.

During our interview with the park ranger at the Wilderness Information Center leading to Hurricane Ridge, the KEC Research Team learned that the Carrie Glacier (located on Mt. Carrie and Mt. Fairchild with a length of 0.5 miles/0.80 km), is also showing signs of shrinkage due to climate change. This, in spite of still putting on a 30-foot snowpack in 2018. This was reinforced by an interpretive sign near the Hurricane Ridge Visitor Center. Repeat photography of the Carrie Glacier, covering the period 1889 to 2009, clearly show loss of glacier volume by thinning and retreat. Our own glacier photographs from Hurricane Ridge recorded the status of glacial decline as of August 2019.



Glaciers in Peril Sign on Hurricane Ridge, Olympic NP.

Blue (left) and Cary (right) Glaciers from Hurricane Ridge in August 2018, Olympic NP, © 2019 W. Rhett Kiser.

Mount Olympus and Blue Glacier (right) in August 2018, © 2019 Grant R. E. Kiser.

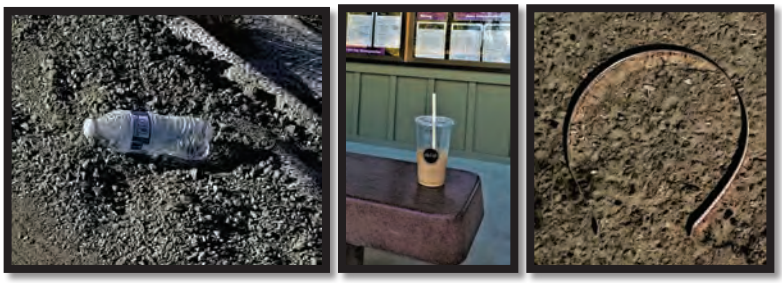
KEC ONP Field Observations: August 6, 2018

Visitor Center – Wilderness Information Center

Our first stop in ONP was the Wilderness Information Center at the northern park entrance outside of Port Angeles, WA. We spoke with a very helpful park ranger who provided guidance on where to see global warming evidence. He also mentioned the park philosophy of "Leave No Trace" aimed at getting visitors to do the right thing. During our time in ONP, KEC found that this message was not consistently posted throughout the park. This, coupled with other lacking measures, undoubtedly contributed to the amount of litter we documented in the parking lots and along the hiking trails we traveled.

Plastic Litter, Wilderness Information Center, Olympic NP, © 2019 W. Rhett Kiser.

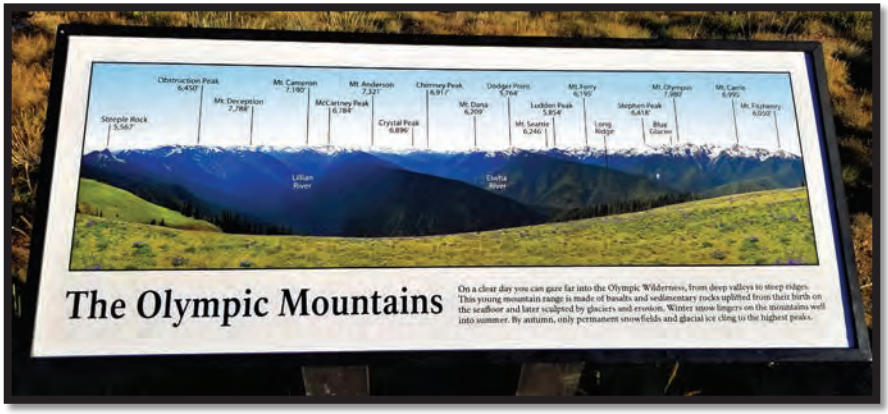
We next conducted our first ONP in-depth litter survey, in the Wilderness Information Center parking lot. 63 total individual pieces were counted. Details relating to this "Somewhat Littered" site (2 on the 1 to 4 scale) are provided in the KEC ONP Parking Lot Litter Survey Results section below.



Wilderness Information Center Litter (including "Chair Litter"), Olympic NP, © 2019 Jonathan V. L. Kiser.

Hurricane Ridge

KEC then headed toward the much-anticipated Hurricane Ridge but were then delayed for a half hour due to road maintenance. As we waited, an active Douglas squirrel (*Tamiasciurus douglasii*) in a nearby tree kept us entertained. The wait was well worth it as we were greeted on the Ridge by the stunning Olympic Mountains backdrop, cotton candy-shaped clouds, and blacktail deer leisurely strolling, grazing, and licking water from the parking lot surface.



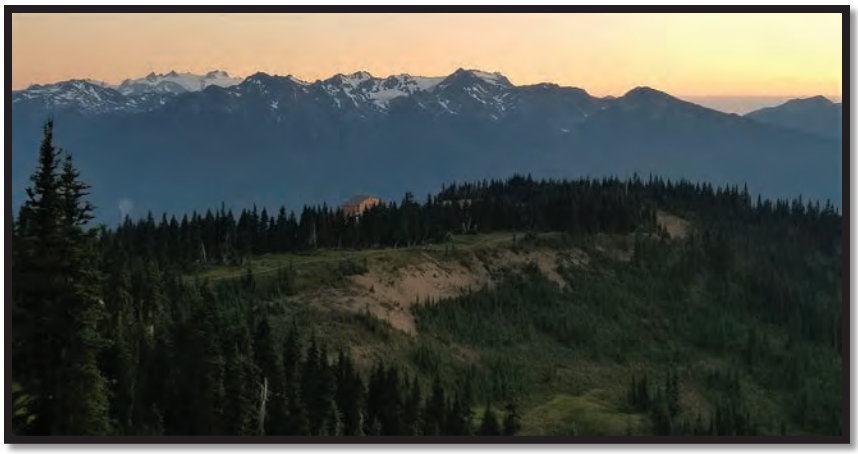
Olympic Mountains Sign on Hurricane Ridge, Olympic NP.

Paper Litter on Hurricane Ridge, Olympic NP, © 2019 Jonathan V. L. Kiser.

The Blue and Carrie Glaciers were seen to the east and there were more deer in the alpine meadows and on the High Ridge Trail. We hiked about three miles/4.8 km along this and the Cirque Rim Trail, passing by rugged mountain hemlock (*Tsuga mertensiana*) and subalpine fir (*Abies lasiocarpa*), absorbing the incredible light along the way.

Hurricane Ridge Visitor Center, Olympic NP, © 2019 Jonathan V. L. Kiser. Note the Trash Bin (far left).

The most beautiful sunset then unfolded before our eyes that Grant described in the following manner, "It looked like a cartoon and was a never-ending gobstopper." There was a radiant glow to the west, with subtle shades of changing colors evolving into a blissful twilight. Quite a remarkable experience. This was contrasted by the site of an overflowing, undersized trash bin next to the Hurricane Ridge Visitor Center. We had also documented a Chewy Chocolate Chip composite wrapper along the road as we journeyed up to the Ridge, a large piece of paper litter on the Ridge, and a cigarette butt on the path leading to the Cirque Rim Trail.



Hurricane Ridge with Mt. Olympus Blue Glacier (left) and Mt. Carrie Glacier (right) in August 2018, Olympic NP, © 2019 W. Rhett Kiser.

Our evening on the Ridge was capped off by a star/planet gazing event hosted by the NPS. It was exciting to get a clear view of the planets Saturn and Jupiter (and many of its moons). Also notable was the double star Elbiria.

Hurricane Ridge Sunset, Olympic NP, © 2019 W. Rhett Kiser.

KEC ONP Field Observations: August 7, 2018

Leaving our overnight accommodation in Port Angeles, WA, the Research Team headed west along U.S. Highway 101. We passed along the southern shore of Lake Crescent (known for its clarity and blue waters, caused by a lack of nitrogen in the water which inhibits algae growth) en route to Marymere Falls.

Lake Crescent, Olympic NP, © 2019 Jonathan V. L. Kiser.

Marymere Falls

Marymere Falls is located south of Lake Crescent and is accessed by a two-mile dusty dirt trail (roundtrip) from the parking lot. Before hitting the trail, KEC completed an in-depth litter survey in the parking lot. 394 total pieces of litter were counted. Details associated with this "Extremely Littered" site (4 on the 1 to 4 scale) are provided in the KEC ONP Parking Lot Litter Survey Results section below.

Marymere Falls Parking Lot Paper Litter and KEC Surveyors, © 2019 Jonathan V. L. Kiser and W. Rhett Kiser (far right).

Marymere Falls Parking Lot Litter, Olympic NP, © 2019 Jonathan V. L. Kiser.

Departing the parking lot, the Team witnessed a half dozen ants (*Formicidae*) attacking a caterpillar (*Lepidoptera*). It was a reminder that nature can be harsh and it's often the survival of the fittest. Continuing our journey toward Marymere Falls, the Team passed through an old-growth lowland forest consisting of alder (*Alnus*), cedar (*Cedrus*), fir, and hemlock (*Tsuga*) trees. Backlight moss hanging from the towering trees glistened like icicles.

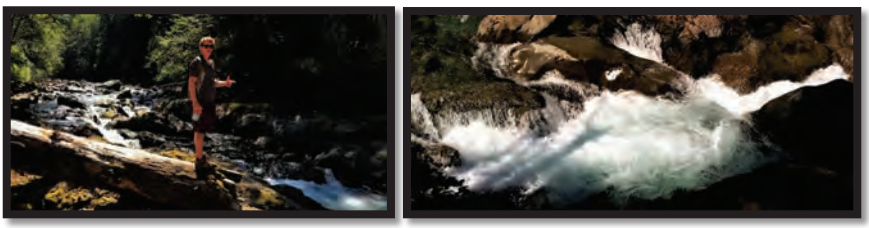
Ants on the Attack, Marymere Falls Parking Lot, Olympic NP, © 2019 Grant R. E. Kiser.

Rhett managed to slip off a rock and fall into Barnes Creek while attempting to take a short cut. And while the 90-foot Marymere Falls was quite inspiring, the "almost guaranteed" piece of paper litter at the upper viewpoint of the falls was there as we arrived. So was a plastic bottle along the trail. On the return hike, two cigarette butts were documented.

Marymere Falls Trail Scenes (left to right): Jonathan and Grant, the Falls, Cigarette Butt at the Falls, Rhett Taking Inventory, Olympic NP, © 2019 Jonathan V. L. Kiser except, far left, W. Rhett Kiser.

Salmon Cascades

After a quick stop along the shore of Crescent Lake to rinse off a bit of trail dust (and document a piece of #3 plastic film wrap), our journey continued at the Salmon Cascades in the Sol Duc Valley. This is a great location to see salmon (*Salmo salar*) migrating up the Sol Duc River (none spotted). We did unfortunately document a piece of orange peel litter along the beautiful 0.5-mile trail.

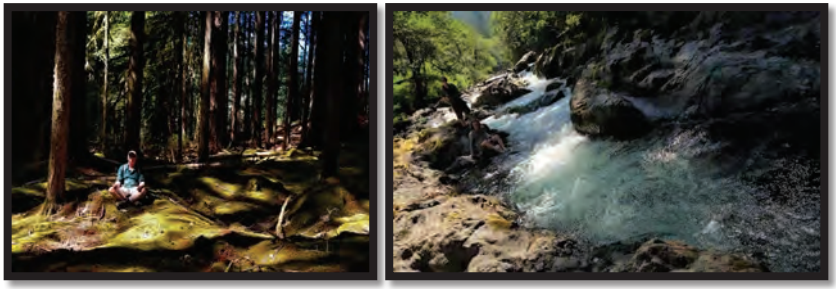


Grant Inspecting Salmon Cascades, Olympic NP, © 2019 Jonathan V. L. Kiser.

Ancient Groves

Continuing on the road to Sol Duc, we next stopped to hike the 0.5-mile Ancient Groves loop trail. One piece of Dole composite packaging and two pieces of paper litter were seen on the ground in the Ancient Groves. We also saw the glistening Sol Duc River and a heavenly, enlightening old-growth forest with a primeval feel. Jonathan exclaimed, "Simply prehistorically divine!"

Dole Packaging Litter, Ancient Groves, Olympic NP, © 2019 Jonathan V. L. Kiser.



Jonathan in a Zen Moment and Grant and Rhett in Sol Duc River, Ancient Groves, Olympic NP, © 2019 W. Rhett Kiser (left) and Jonathan V. L. Kiser (right).

Cape Flattery Makah Indian Reservation

We next traveled back on U.S. Highway 101 west to Route 113 to Route 112 to the Cape Flattery Makah Indian Reservation located on the northwestern tip of the Olympic Peninsula. The western boundary of the reservation is the Pacific Ocean and the northern boundary is the Strait of Juan de Fuca.

Cape Flattery Pacific Coastline, © 2019 Jonathan V. L. Kiser.

The Research Team hiked about 1.5 miles/2.4 km (roundtrip) along the windy Makah's Cape Flattery Trail. We were greeted warmly by old timer "Joe" on the way down to the stunning lookout point 200+ ft/60+ m above the Pacific Ocean. The rocky coastline was filled with large dramatic eroding caves, carved by the relentless, pounding surf. The area had a truly mystical feel about it. No litter was encountered.

Grant (Twice!) and Rhett along the Strait of Juan de Fuca Shoreline with Canada in Background, Near Olympic NP, © 2019 Jonathan V. L. Kiser.

First Beach

We then traveled to Forks, WA (where scenes from the Twilight movie series were filmed) to check in to our hotel, and then journeyed to First Beach (part of the Quileute Indian Reservation) near La Push (a community situated at the mouth of the Quillayute River along the Pacific coast). A piece of paper litter was immediately seen as we arrived on the beach. The setting was otherwise unearthly with crazy giant drift trees strewn about, fading and foggy light conditions, slimy kelp, exotic sea stones, Dungeness crab shells, seagull feathers, and plenty of beach flies. We hiked 0.25 miles/0.4 km along the beach and then dined at the highly recommended Blakeslees Bar & Grill.

Grant at First Beach, Quileute Indian Reservation, © 2019 W. Rhett Kiser.

Rhett and Grant on Giant Drift Log, First Beach, Quileute Indian Reservation, © 2019 Jonathan V. L. Kiser.

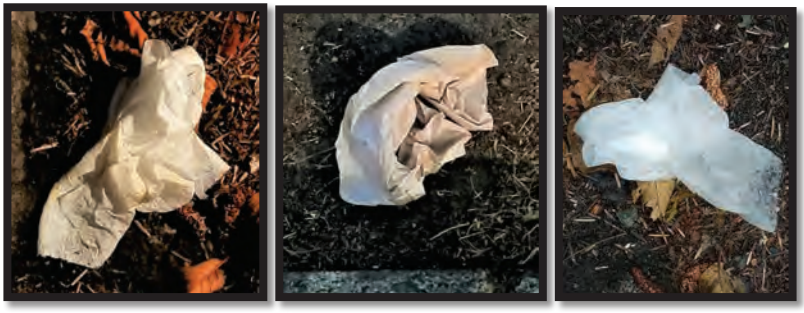
KEC ONP Field Observations: August 8, 2018

Our first destination this day was the Hoh Rain Forest. Stopping briefly at the entrance sign, there was a piece of paper litter on the ground.

Rhett Olympic NP Balancing Act,
© 2019 Jonathan V. L. Kiser.

Hoh Rain Forest Visitor Center

Before hitting the trail for multiple hikes, the KEC Research Team completed an in-depth litter survey in the Hoh Rain Forest Visitor Center parking lot. 109 total pieces of litter were counted. We also took note of two brown-colored bins near the visitor center (one with a small "Aluminum Only" plaque, and the other with no marking). There were also two large trash dumpsters near the big tree in the middle of the parking lot. Details associated with this "Littered" site (3 on the 1 to 4 scale) are provided in the KEC ONP Parking Lot Litter Survey Results section below.



Paper Litter, Hoh Rain Forest Visitor Center Parking Lot Area,
Olympic NP, © 2019 J. V. L. Kiser.

More Litter in Hoh Rain Forest Visitor Center Parking Lot Area, Olympic NP, © 2019 Jonathan V. L. Kiser.

Hall of Mosses

Our first hike in the Hoh Rain Forest was the 0.8-mile Hall of Mosses loop trail. This heavily used trail has a 100-foot elevation gain with a lot of maple trees draped in club moss, lush ferns (*Tracheophyta*), Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*), and other exotic flora. Some of the rain forest landscape had what can best be described as a psychedelic feel to it. We counted two pieces of litter (paper and a plastic water bottle) there.

Grant (left) and Jonathan (right), Hall of Mosses, Olympic NP, © 2019 W. Rhett Kiser.

Spruce Nature Trail

Our next hike was on the nearby, less crowded Spruce Nature Trail where we thoroughly enjoyed strolling along the 1.2-mile loop leading to a memorable, open view of the Hoh River. The path led through new and huge old-growth multi-colored Sitka spruce and western hemlock trees (many towering more than 200 ft/60+ m in the air). The abundant ferns and added sparkle of amazing light play in the forest had us completely mesmerized.

Grant Along the Hoh River, Olympic NP,
© 2019 Jonathan V. L. Kiser.

All in a Row Sitka Spruce and Western Hemlock,
Spruce Nature Trail, ONP, © 2019 J. V. L. Kiser.

There were also helpful interspersed interpretative nature signs, including one describing how new trees grow in a row with supporting (buttressed) roots growing over nurse logs. Eagle-eyed Grant spotted an impressive reishi mushroom (*Ganoderma lucidum*) growing inside a decaying tree trunk. The reishi possesses important medicinal proprieties that are reported to, among other things, improve sleep, lower stress, normalize the immune system,

keep sickness at bay, and improve brain function (Guide to Reishi Mushroom 2019). In addition, the Research Team documented three pieces of paper litter on the trail.

Paper Litter and Reishi Mushroom Inside Decaying Log, Spruce Nature Trail, Olympic NP, © 2019 Jonathan V. L. Kiser (left) and Grant R. E. Kiser (right).

Fallen Giant Nurse Tree, Spruce Nature Trail, Olympic NP, © 2019 Jonathan V. L. Kiser.

Hoh River Trail

Our last hike in the Hoh Rain Forest was a 6.2-mile (roundtrip) venture on the Hoh River Trail to the Tom Creek area. This Lush river valley trail on the Hoh River's north bank was filled with ancient mossy trees with gnarly burls, rushing waterfalls, and radiant ferns in brilliant light. Running out of words to describe the experience, Rhett called it, "Absolutely incredible!" Grant

said, “Jurassic!” and Jonathan added, “Primeval exceptional!” We counted one piece of paper litter on the main trail.

Hoh River Trail, Olympic NP, © 2019 Jonathan V. L. Kiser.

Hoh River Trail, Olympic NP, © 2019 Jonathan V. L. Kiser.

Rialto Beach

The Research Team ended the day by driving back to the coast and hiking about one mile along Rialto Beach. We watched colorful sea stones being embraced by strong Pacific waves, walked across giant drift logs, and stared at exotic offshore sea stacks (described as ghosts of former headlands, with surf eroding islands from the shoreline). One very obvious cigarette butt was seen on the beach.

Contemplative Rhett and Rocks on Rialto Beach, Olympic NP, © 2019 Jonathan V. L. Kiser

Distant Rhett & Grant at Rialto Beach, Olympic NP, © 2019 Jonathan V. L. Kiser.

Cigarette Butt on Rialto Beach, Olympic NP, © 2019 W. Rhett Kiser.

KEC ONP Field Observations: August 9, 2018

Before hitting the road for another full day of adventure, the Research Team enjoyed one of the best eggs benedict with potatoes breakfasts ever, back at Blakeslees Bar & Grill!

Blakeslees in Forks, WA, © 2019 Jonathan V. L. Kiser.

Ruby Beach

Ruby Beach is a true gem along the wild Pacific coastline, located on the southwest coast of the Olympic Peninsula. This beach gained its namesake from the ruby-like crystals that wash up. During our 0.5 miles/0.8 km hike there, we walked around numerous exotic sea stacks (several of which the boys immediately climbed).

Ruby Beach, Olympic NP, © 2019 Grant R. E. Kiser.

We also closely observed shallow tidepools with green sea anemone (*Actiniaria*), navigated large drift logs, took a picture of a colorful Pacific razor clam shell (*Siliqua patula*) (a large marine bivalve mollusk). A trailhead message board included signs reminding us that we were in cougar country (never saw one) and that marine debris should be reported to a provided hotline number.

Grant and Rhett on Top of Ruby Beach, Olympic NP, © 2019 Jonathan V. L. Kiser.

Sea Anemone, Ruby Beach, Olympic NP, © 2019 Grant R. E. Kiser.

Pacific Razor Clam Shell, Ruby Beach, Olympic NP, © 2019 Jonathan V. L. Kiser.

Indeed, there was noticeable litter on Ruby Beach and interspersed among the drift logs, including: a paper tag for sunglasses, a miscellaneous piece of paper, a two-liter plastic coke bottle (#1), a plastic food bag (#2), composite packaging for a Motts food product, a piece of nylon string, a tennis shoe, and a pair of glasses. Eight total pieces. We hiked 0.5 miles.

Motts Litter on Ruby Beach, Olympic NP, © 2019 Jonathan V. L. Kiser.

Shoe Litter on Ruby Beach Drift Log, Olympic NP, © 2019 Jonathan V. L. Kiser.

Paper Litter on Ruby Beach, Olympic NP, © 2019 Jonathan V. L. Kiser.

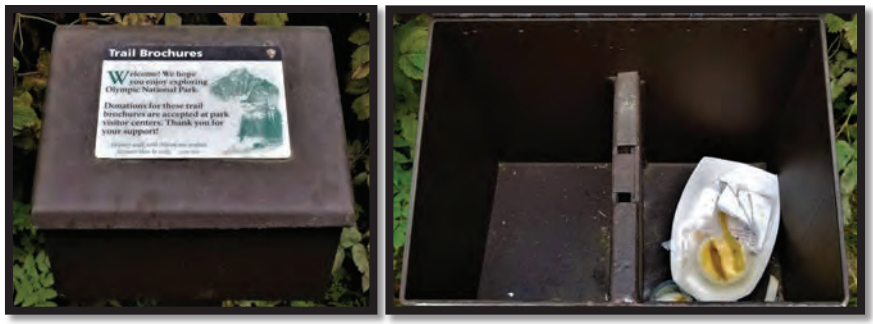
This region is part of the Olympic Coast National Marine Sanctuary which includes 3,188 square miles/5,131 km of marine waters off the Olympic Peninsula coastline. The sanctuary extends 25 to 50 miles/40 to 80 km seaward and covers major submarine canyons and much of the continental shelf. Managed by the NOAA, the Sanctuary promotes tidepool etiquette that includes the following: "Bring a bag with you on every beach outing to pick up any paper, glass, metal or plastic trash that you find" (NOAA 2017).

Plastic Litter Near Ruby Beach, Olympic NP, © 2019 Jonathan V. L. Kiser.

While such etiquette sentiment is good, it also shines a poor reflection on the state of the human condition. How sad it is to realize that there will always be inconsiderate polluting humans (their mommas didn't raise them right!) and other more conscientious people who clean up after them. Now is the time in our world history to get more aggressive using surveillance technology and other means to go after the perpetrators. There should be enforced fines, litter cleanup duty, and media shaming notoriety. Perhaps social media can also be put to productive use in this regard?!

Ruby Beach Parking Lot

Following our memorable beach visit, the KEC Research Team conducted an in-depth litter survey along the short trail leading from the beach and in the Ruby Beach parking lot. We were highly disappointed with the 338 total pieces of litter counted and the disrespect shown by using the Trail Brochures container as a trash bin. Details associated with this "Extremely Littered" site (4 on the 1 to 4 scale) are provided in the KEC ONP Parking Lot Litter Survey Results section below.



Trail Brochures Container Disrespect, Ruby Beach, Olympic NP, © 2019 Jonathan V. L. Kiser.

Litter in Ruby Beach Parking Lot, Olympic NP, © 2019 Jonathan V. L. Kiser.

Cigarette Butt Litter in Ruby Beach Parking Lot, Olympic NP, © 2019 Jonathan V. L. Kiser.

We next traveled south on U.S. Highway 101 past Kalaloch, stopping at South Beach to get one more glimpse of the Pacific Ocean. Then it was on to Queets in the Quinault Indian Reservation to get gas and back into ONP via Route 21. We followed Upper Queets Valley Road in search of the big Sitka spruce tree noted on the NPS map (never found it) and saw the Queets River before we reached the end of the road. There was also what appeared to be a banana slug (*Ariolimax*) slowly making its way across the river rocks. Banana slugs are the largest North American land mollusk capable of growing up to ten inches long and living up to seven years.

Slug Near the Queets River, Olympic NP, © 2019 Grant R. E. Kiser (left) and Jonathan V. L. Kiser (right).

We then decided our time would be better spent in the Quinault Rain Forest and headed there. As we left the Upper Queets Valley, the Research Team encountered a large "Please Pack Your Trash Home" wooden sign along the road along with a predictable large piece of plastic litter lying right below it.

Eye-Catching Anti-Litter Sign and Nearby Plastic Litter, Upper Queets Valley, Olympic NP, © 2019 Jonathan V. L. Kiser.

The other disturbing sight we saw on the way to the Quinault Rain Forest was a former sizeable forested area that had been clear cut. How unfortunate to have such scars upon the land just outside the NP boundary.

Clear Cut Near Quinault Rain Forest, Outside Olympic NP, © 2019 Grant R. E. Kiser.

Quinault Rain Forest Big Cedar

The Research Team re-entered ONP at Lake Quinault and followed the North Shore Road to the Quinault Big Cedar. This amazing tree, which once stood some 174 ft/53 m in the air with a trunk measuring 61 ft/19 m around, crashed to the ground in July 2016 (natural causes). The tree now provides nourishment for the many smaller trees growing on top of and off its sides. There were also brown bracket fungi (*Ganoderma resinaceum*) growing on the tree bark. Unfortunately, we encountered litter nearly every step from the comparatively small parking lot to the Big Cedar and back. 54 total pieces of litter were counted. Details associated with this "Littered" site (3 on the 1 to 4 scale) are provided in the KEC ONP Litter Survey Results section below. We walked about 0.25 miles.

Big Cedar Band-Aid Litter and Jonathan with the Fallen Quinault Big Cedar, Olympic NP, © 2019 Jonathan V. L. Kiser (left) and W. Rhett Kiser (right).

Brown Bracket Fungi and Paper Litter at the Quinault Big Cedar, Olympic NP, © 2019 Jonathan V. L. Kiser.

July Creek Picnic Area

A few miles to the east along the North Shore Road we next stopped at the July Creek Picnic Area. This is the location where, on January 27, 2018, a huge Sitka spruce and Douglas fir were toppled (along with many others) by what meteorologists called a cloud circulation associated with a strong downwind wave (i.e., not a micro burst). The NPS ranger we spoke with at the Wilderness Information Center leading to Hurricane Ridge indicated this event was at least 20 more miles/32 km inland than normal and was due to global warming.

Shattered Giants and Shadowing Paper Litter, July Creek Picnic Area, Olympic NP, © 2019 Jonathan V. L. Kiser.

Our first task here was to complete a litter survey in the small parking lot area. We document the following seven pieces: two cigarette butts, four pieces of paper litter, and one composite wrapper. As we then entered the nearby trail, a crow (*Corvus brachyrhynchos*) soared overhead making his presence known with

loud repeated squawks. The Research Team was then stunned to see the level of destruction caused by the powerful weather event. Cross-sectional parts of a massive tree that had been cleared from the trail boasted some 300 rings (each one representing a year of life). Other giants, toppled like match sticks, were in a twisted heap on the ground, their jagged mangled remnants sticking in all directions. We also, once again, saw the worst in human nature. Some fool(s) had spray-painted multiple tree trunk pieces with nonsensical graffiti.

Graffiti Devastation, July Creek Picnic Area, Olympic NP, © 2019 Jonathan V. L. Kiser.

During our 2.0-mile hike (roundtrip) along the July Creek trail, we witnessed tremendous views of Lake Quinault (and the Colonel Bob Wilderness mountains behind it), saw surviving old-growth trees, ferns, and counted one piece of paper litter on the trail.

Lake Quinault and Colonel Bob Wilderness, Olympic NP, © 2019 Grant R. E. Kiser.

Grant Absorbing the Light, July Creek Picnic Area, Olympic NP, © 2019 Jonathan V. L. Kiser.

Irely Lake Trail

Onward we traveled deeper into the Quinault Rainforest, stopping at the Irely Lake Trail for our next hike in ONP. This 2.2-mile roundtrip excursion was quite remarkable for the biodiversity we encountered including: two garter snakes (small head, black body, yellow stripe), a banana slug, a Pacific Treefrog (*Pseudacris regilla),* eye-watering translucent ferns, bracket fungi, unreal trees, and spectacular evolving forest lighting. Jonathan described it as both, "The Garden of Eden and Stairway to Heaven!"

Bracket Fungi, Irely Lake Trail, ONP, © 2019 W. Rhett Kiser.

At Irely Lake, we were happy to see many Cascades frogs even though there was no water to be found in the lake (no doubt a reflection of evolving global warming impacts). We could only wonder how long they could survive under such conditions.

Ferns and Banana Slug, Irely Lake Trail, Olympic NP, © 2019 Jonathan V. L. Kiser.

A VERY Dry Irely Lake, Olympic NP, © 2019 Grant R. E. Kiser.

The Northwest Climate Adaptation Science Center is interested in knowing how adaptive the frogs are as well. During 2017, Center researchers studied why this species is in sharp decline. There are two conflicting impacting factors. First, the Cascades frog is highly susceptible to an aquatic fungal pathogen called Batrachochytrium dendrobatids (Bd). Bd thrives in cooler temperatures. Second, while higher temperatures from climate change may reduce Bd infection rates, warmer water temperatures and drying is likely to negatively impact their habitats. The field study advanced the understanding of how and when managers should intervene to help the at-risk Cascades frog (NCASC 2017).

Bracket Fungi and Tree Spikes, Irely Lake Trail, Olympic NP, © 2019 Grant R. E. Kiser (left) and Jonathan V. L. Kiser (right).

While KEC fortunately did not find any litter on the trail, back in the parking lot we documented two cigarette butts, three plastic bags (#2), and two plastic clips/tags (#6). Seven total pieces.

Along the Irely Lake Trail, Olympic NP, © 2019 Grant R. E. Kiser (first two from left), Jonathan V. L. Kiser (third from left), W. Rhett Kiser (far right).

World Record Sitka Spruce

Our final destination in ONP was the world record Sitka spruce tree located off of South Shore Drive next to Lake Quinault. This tree possessed unreal majesty, that Rhett characterized as, "Prehistoric, like a dinosaur tree!" Especially given the tree's immediate proximity to an adjacent RV campground, strong consideration should be given to erecting a protective perimeter fence. The temptation to get up close and personal with this amazing beauty is hard to resist.

THE Sitka Spruce, Olympic NP, © 2019 Jonathan V. L. Kiser.

Also, the Research Team counted 16 pieces of litter on the 0.25 mile (0.5 mile roundtrip) Sitka Spruce Trail (from the trailhead along South Shore Road to the tree), including: two pieces of non-ferrous (one foil, one can tab); four pieces of paper (including a napkin, a piece along the trail, and two miscellaneous pieces at the base of the tree); a plastic storage bag (#2); five pieces of miscellaneous hard plastic (#7); one shoe lace; and three composite wrappers.

Fabric Litter, Sitka Spruce Trail, Olympic NP, © 2019 Jonathan V. L. Kiser.

As we departed from ONP, beautiful blue hydrangeas (*Hydrangea macrophylla*) lined the roadway. We then traveled through the towns of Olympia and Ashford en route to Mt. Rainier NP. A herd of Roosevelt Elk was seen munching down in an apple orchard on the way. We arrived at our small cabin accommodation, near the NP Nisqually entrance, after dark.

KEC ONP Parking Lot Litter Survey Results

Provided below, in Exhibits 3 through 7 are the detailed results from KEC's parking lot litter surveys in ONP.

Exhibit 3 – Olympic National Park Litter Survey Details
Wilderness Information Center Parking Lot

Litter Type	Count	% of Total
Cigarette Butts	16	25
Food	---	---
Glass	---	---
Metal – Ferrous (Steel)	1	2
Metal – Non-Ferrous (Aluminum foil)	2	3
Paper – Miscellaneous (a)	21	33
Paper – Cardboard	---	---
Paper – Chipboard (e.g., Cereal Box)	---	---
Plastic – #1 PETE (e.g., Bottles; Cups)	3	5
Plastic – #2 HDPE (e.g., Bags – grocery; Bottles – juice, milk, water)	1	2
Plastic – #3 PVC (e.g., Flip-flop; Wrap – food; etc.)	---	---
Plastic – #4 LDPE (e.g., Bags – bread; 6-pack rings); Wrap – cigarette pack; etc.)	2	3
Plastic – #5 PP (e.g., Caps – bottle; Cups; Flossers; Straws; Utensils)	4	6
Plastic – #6 PS (e.g., Clips/Tags – bread bag; Cups; Styrofoam)	---	---
Plastic – #7 Other (Misc. hard pieces; Other multi-layer resin composites)	2	3
Textile (e.g., Cloth, etc.)	---	---
Wood	---	---
Other Litter (Specify) (e.g., Composite material – wrappers); Q-tips, etc.) (b)	11	18
Total	**63**	**100%**

Includes: (a) One straw, a receipt, napkin, other; (b) A lot of wrappers, other.
Source: Kiser Environmental Consulting, 2019.

A "Somewhat Littered" site (3 on the 1 to 4 scale).

Exhibit 4 – Olympic National Park Litter Survey Details
Marymere Falls Parking Lot

Litter Type	Count	% of Total
Cigarette Butts	96	24
Food (a)	12	3
Glass	1	< 1
Metal – Ferrous (Steel)	4	1
Metal – Non-Ferrous (Aluminum foil)	4	1
Paper – Miscellaneous	149	38
Paper – Cardboard	---	---
Paper – Chipboard (e.g., Cereal Box)	---	---
Plastic – #1 PETE (e.g., Bottles; Cups)	7	2
Plastic – #2 HDPE (e.g., Bags – grocery; Bottles – juice, milk, water)	1	< 1
Plastic – #3 PVC (e.g., Flip-flop; Wrap – food; etc.)	---	---
Plastic – #4 LDPE (e.g., Bags – bread; 6-pack rings); Wrap – cigarette pack; etc.)	19	5
Plastic – #5 PP (e.g., Caps – bottle; Cups – clear; Flossers; Straws; Utensils) (b)	4	1
Plastic – #6 PS (e.g., Clips/Tags – bread bag; Cups; Styrofoam)	2	< 1
Plastic – #7 Other (Misc. hard pieces); Other multi-layer resin composites) (c)	34	9
Textile (e.g., Cloth, etc.)	1	< 1
Wood	---	---
Other Litter (Specify) (e.g., Composite material – wrappers); Q-tips, etc.) (d)	60	15
Total	**394**	**100%**

Includes: (a) Five sunflower seeds, six pistachio shells, and one orange peel; (b) One bottle cap and one fork; (c) One glove and one other; (d) One tennis shoe, 14 wrappers (including gum and Oreo cookie), one piece of leather, a pen, a band-aid, a piece of string, other).
Source: Kiser Environmental Consulting, 2019.

An "Extremely Littered" site (4 on the 1 to 4 scale).

Exhibit 5 – Olympic National Park Litter Survey Details
Hoh Rainforest Visitor Center Parking Lot

Litter Type	Count	% of Total
Cigarette Butts	25	21
Food (a)	4	3
Glass	---	---
Metal – Ferrous (Steel) (b)	1	1
Metal – Non-Ferrous (Aluminum foil)	8	6
Paper – Miscellaneous	35	31
Paper – Cardboard	---	---
Paper – Chipboard (e.g., Cereal Box)	1	1
Plastic – #1 PETE (e.g., Bottles; Cups; Lids)	---	---
Plastic – #2 HDPE (e.g., Bags – grocery; Bottles – juice, milk, water)	---	---
Plastic – #3 PVC (e.g., Flip-flop; Wrap – food; etc.) (c)	1	1
Plastic – #4 LDPE (e.g., Bags – bread; 6-pack rings); Wrap – cigarette pack; etc.) (d)	4	4
Plastic – #5 PP (e.g., Caps – bottle; Cups – clear; Flossers; Straws; Utensils) (e)	1	1
Plastic – #6 PS (e.g., Clips/Tags – bread bag; Cups; Styrofoam) (f)	2	2
Plastic – #7 Other (Misc. hard pieces); Other multi-layer resin composites)	9	8
Textile (e.g., Cloth, etc.)	---	---
Wood	---	---
Other Litter (Specify) (e.g., Composite material – wrappers); Q-tips, etc.) (g)	25	21
Total	**109**	**100%**

Includes: (a) One piece of gum, two pistachio shells, one other; (b) A screw; (c) A flip flop; (d) A six-pack ring, other; (e) A purple cap; (f) Two clips, six-pack ring; (g) 11 wrappers, one pin, one fishing lure, rubber O-ring, one wipe (non-woven fabric), other.
Source: Kiser Environmental Consulting, 2019.

A "Littered" site (3 on the 1 to 4 scale).

Exhibit 6 – Olympic National Park Litter Survey Details
Ruby Beach Parking Lot

Litter Type	Count	% of Total
Cigarette Butts	62	18
Food (a)	4	1
Glass	---	---
Metal – Ferrous (Steel)	1	< 1
Metal – Non-Ferrous (Aluminum foil)	14	4
Paper – Miscellaneous (b)	164	49
Paper – Cardboard	---	---
Paper – Chipboard (e.g., Cereal Box)	---	---
Plastic – #1 PETE (e.g., Bottles; Cups; Lids)	5	1
Plastic – #2 HDPE (e.g., Bags – grocery; Bottles – juice, milk, water)	10	3
Plastic – #3 PVC (e.g., Flip-flop; Wrap – food; etc.)	---	---
Plastic – #4 LDPE (e.g., Bags – bread; 6-pack rings); Wrap – cigarette pack; etc.)	8	2
Plastic – #5 PP (e.g., Caps – bottle; Cups – clear; Flossers; Straws; Utensils)	4	1
Plastic – #6 PS (e.g., Clips/Tags – bread bag; Cups; Styrofoam)	---	---
Plastic – #7 Other (Misc. hard pieces); Other multi-layer resin composites)	22	7
Textile (e.g., Cloth, etc.)	---	---
Wood	---	---
Other Litter (Specify) (e.g., Composite material – wrappers); Q-tips, etc.) (c)	44	13
Total	**338**	**100%**

Includes: (a) Three banana peels, one other; (b) One cup, other; (c) Hair band, K-cup, wrappers, sock, balloon, fake finger nails, other.
Source: Kiser Environmental Consulting, 2019.

An "Extremely Littered" site (4 on the 1 to 4 scale).

Exhibit 7 – Olympic National Park Litter Survey Details
Big Cedar Parking Lot and Loop Trail

Litter Type	Count	% of Total
Cigarette Butts	3	6
Food (a)	1	2
Glass	---	---
Metal – Ferrous (Steel)	---	---
Metal – Non-Ferrous (Aluminum foil)	1	2
Paper – Miscellaneous	41	75
Paper – Cardboard	---	---
Paper – Chipboard (e.g., Cereal Box)	---	---
Plastic – #1 PETE (e.g., Bottles; Cups; Lids)	---	---
Plastic – #2 HDPE (e.g., Bags – grocery; Bottles – juice, milk, water)	1	2
Plastic – #3 PVC (e.g., Flip-flop; Wrap – food; etc.)	---	---
Plastic – #4 LDPE (e.g., Bags – bread; 6-pack rings); Wrap – cigarette pack; etc.)	---	---
Plastic – #5 PP (e.g., Caps – bottle; Cups – clear; Flossers; Straws; Utensils)	---	---
Plastic – #6 PS (e.g., Clips/Tags – bread bag; Cups; Styrofoam)	---	---
Plastic – #7 Other (Misc. hard plastic pieces); Multi-layer resin composites)	---	---
Textile (e.g., Cloth, etc.)	---	---
Wood	---	---
Other Litter (Specify) (e.g., Composite material – wrappers); Q-tips, etc.) (b)	7	13
Total	**54**	**100%**

Includes: (a) One orange peel; (b) One K-cup, sock; four composite wrappers, and a band-aid.
Source: Kiser Environmental Consulting, 2019.

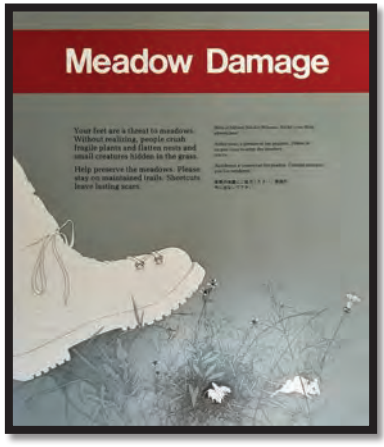
A "Littered" site (3 on the 1 to 4 scale).

KEC ONP Feedback/Improvement Recommendations

- In the Wildlife Information Center parking lot leading to Hurricane Ridge, there is an animal-proof, brown-colored trash and recycling bin (two-bin combination unit). Adding a sticker showing acceptable recyclables would help. Different coloration (e.g., blue for recycling) would further improve the collection system. Consistent application of the same bin style throughout ONP would be most desirable.

Trash and Recycling Bin, Wilderness Information Center, Olympic NP, © 2019 Jonathan V. L. Kiser.

- At the Hurricane Ridge Visitor Center, the posted "Meadow Damage" sign, in multiple languages, is a great reminder for hikers to stay on the maintained trails.



Hurricane Ridge Sign, Olympic NP.

- At the Hurricane Ridge Visitor Center, the two-unit brown trash bins on the left side was overflowing and clearly too small for this popular location frequented by many visitors. More frequent collection is needed to keep the bins from reaching beyond capacity.

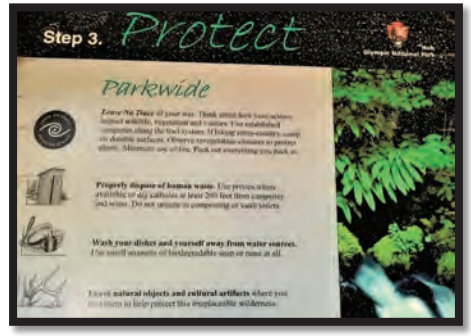
Hurricane Ridge Trash Bin, Olympic NP, © 2019 Jonathan V. L. Kiser.

- In the Marymere Falls parking lot, anti-litter signage and cigarette butt receptacles would help reduce litter at this high traffic area.

- In the Hoh Rain Forest Visitor Center parking lot, the brown-colored bins (one with a small "Aluminum Only" plaque, and the other with no marking) would benefit with the addition of a sticker showing acceptable materials for each bin.

Hoh Rain Forest Visitor Center Parking Lot, Olympic NP, © 2019 Jonathan V. L. Kiser.

- At the Hoh Rain Forest Visitor Center trailhead, the Research Team was happy to see the "Step 3 Project Parkwide Leave No Trace" sign. At a minimum, this type of signage should be in place at all major ONP trailheads. Better yet, since most humans won't take the time to read detailed signage, bold, brief, and direct supplemental anti-litter signs (with mascot) should be posted at each appropriate location.



Hoh Rain Forest Visitor Center Trailhead Sign, ONP.

- In the Ruby Beach parking lot, cigarette butt receptacles, plus prominent, permanent, anti-litter signage (with fines) should be installed, coupled with a litter cam for real time monitoring. Installation of license plate reader technology should also be considered. The existing Marine Debris Hotline sign (with litter mention) is a good start. However, expecting people to remove other people's trash is likely asking too much. More direct, proactive measures need to be taken at this very popular and relatively remote beach location.

Ruby Beach Parking Lot Sign, August 2018, ONP.

- In the Ruby Beach Parking Lot, the four-chute trash bin would benefit with "trash" stickers on the smaller two. Also, the toilet floor needs to be painted.

Ruby Beach Parking Lot Trash Bins and Toilet, Olympic NP, © 2019 Jonathan V. L. Kiser.

- The Quinault Big Cedar parking lot and access trail would benefit from anti-litter signage.

- For the July Creek Picnic Area, anti-litter signage, couple with an anti-graffiti message (with fines and possible jail time for those offenders who are caught), would be advisable. Anti-graffiti messaging should also appear in all ONP publications and on the ONP website.

- In the Irely Lake parking lot, the message board was filled with detailed postings but none relating to litter prevention. This is the ideal place for a prominent anti-litter message (with mascot).

- For the World Record Sitka Spruce, at both access points (trailhead from South Shore Road and the adjacent campground), anti-litter and Leave No Trace signage should be added. Perimeter fencing should be placed around the Sitka Spruce to keep people at a protective distance. This type of fencing should also be placed around the other most popular old-growth trees in ONP.

- Most trails we traveled in ONP were asphalt or other hard surface, in an effort to minimize the impact of the masses. While this made for more physically painful hiking, the Research Team felt this was a worthy compromise. Most people seemed to show respect by staying on the designated trail and not impacting the fragile off-trail areas. Generally speaking, there was a lot of visitor trail stewardship in ONP.

Hurricane Ridge, ONP, © 2019 J. V. L. Kiser.

Chapter 4
Mount Rainier National Park

Mount Rainier NP Entrance, © 2019 Jonathan V. L. Kiser.

Overview

Located in west-central Washington about 35 miles/56 km southeast of Tacoma and 90 miles/145 km southeast of Seattle, Mount Rainier National Park (MRNP) was established in 1899. At an elevation of 14,410 ft/4,392 m, Mt. Rainier is the center-piece of the park and the tallest mountain in the Cascade Range. It is a dormant volcano that is the offspring of volcanic lava eruptions and glacial ice that 5,000 years ago reached a height of 16,000 ft/4,878 m (i.e., prior to a massive ice and rock avalanche). There are 25 major glaciers on Mount Rainier, representing the largest single area of permanent ice in the U.S., outside of Alaska. Melting glacial water supports five major river systems.

Mount Rainier from Paradise Road E, MRNP, © 2019 W. Rhett Kiser.

MRNP covers 369 square miles (594 square km), nearly 60 percent of which is forested, and more than 97 percent of which has a wilderness designation. Coniferous trees predominate, with the lower elevations having dense forests of western red cedar (*Thuja plicata*), giant Douglas fir, and mountain hemlock. At higher elevations up to about 6,000 ft /1,829 m, fir, western white pine (*Pinus monticola*), and other species are found. Subalpine meadows start at about 4,500 ft/1,372 m and give way to alpine meadows above the timberline at about 7,000 ft/2,134 m. During July and August these meadows are filled with blooming wildflowers.

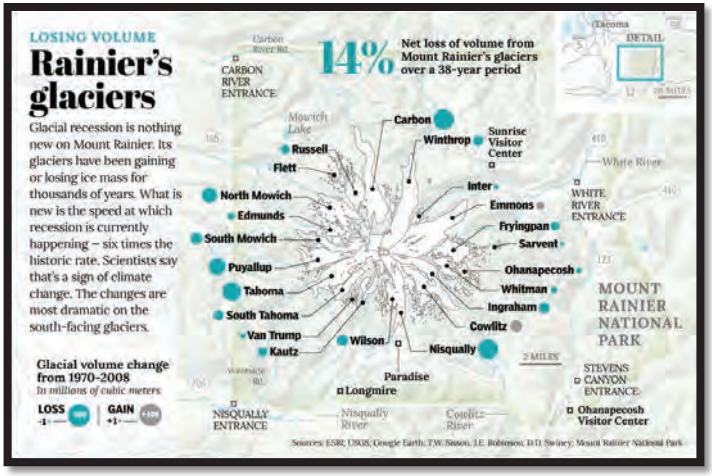
There is also diverse and abundant wildlife in MRNP. More than 220 species of birds have been documented, including hairy woodpeckers (*Leuconotopicus villosus*), warblers (*Parulidae*), Steller's jays (*Cyanocitta stelleri*) , and Clark's nutcrackers (*Nucifraga Columbiana*). Mammals range from black bears, Roosevelt elk, mountain goats, and blacktailed deer (mule deer), to marmots, squirrels (*Sciuridae*), and racoons (*Procyon lotor*).

Select MRNP Birds (left to right): Hairy Woodpecker, Warbler, Steller's Jay, Clark's Nutcracker, Source: Public Domain.

The MRNP region receives large quantities of precipitation annually, especially on Mt. Rainier's western slope. Winter snowfall totals are substantial with the ranger station at the Paradise area recording some of the world's highest annual totals (> 80 ft/24 m). During 2018, there were 2.25 million visitors to MRNP.

MRNP Global Warming

The peak of Mount Rainier was sculpted by glacial ice, and its 25 remaining glaciers and numerous unnamed snow patches (currently covering about 35 square miles/90 km) are important global warming indicators.

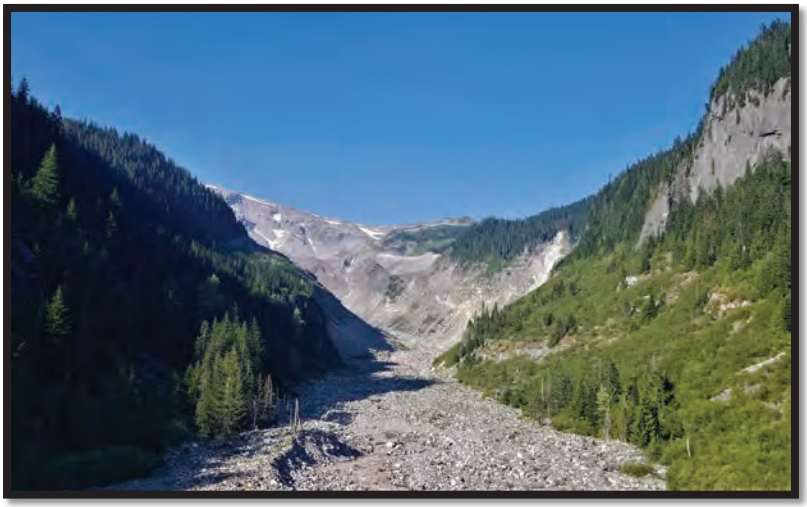


Sources: Shown Above; From: Rob Carson, "Losing Paradise Climate Change is Changing Mount Rainier," December 21, 2014, The News Tribune & The Olympian.

Geologically speaking, Mount Rainier's glaciers have regularly receded and advanced over the past 12,000 years. What has scientists concerned is the speed at which the receding is currently occurring – six times the historical rate over the past few decades. More specifically, between 2003 and 2009, the total volume of ice and continual snow on the mountain decreased as much as 18 percent. One of Rainier's most accessible glaciers, the Nisqually Glacier, has been rapidly receding since 1983. During 2014, it shrank more than three ft/0.9 m every ten days toward the mountain's summit (Carson 2014).

Nisqually Glacier Terminus Recession, Sources: USGS (1966) and Austin Post (2014). From: Rob Carson, "Losing Paradise Climate Change is Changing Mount Rainier," December 21, 2014, The News Tribune & The Olympian.

The KEC Team learned during a park ranger interview in the Henry Jackson Visitor Center that, in 1900, the glacier terminus reached the Nisqually River bridge (visible from the road). Now it is a mile above the road and has lost 39% of its total volume over the past 100 years.



Nisqually River Showing Aggradation Impact, MRNP, © 2019 W. Rhett Kiser.

More evidence of climate-induced receding glaciers is reflected in MRNP's riverbeds filling with rock at an accelerated rate. This is happening through a process known as aggradation, where melting glaciers release huge volumes of rock (formerly ice locked) into the riverbed.

On a positive note, MRNP's forest wilderness serves as a buffer to advancing global warming effects. For starters, trees provide shade and thereby help to cool the forest ground. Through the process of photosynthesis, trees also absorb atmospheric carbon dioxide (the primary greenhouse gas responsible for global warming), store it in its biomass (leaves, branches, trunks, and roots), and release oxygen as a byproduct (needed for human survival!). Due to the large elevation range and acreage associated with MRNP's wilderness, some species can adapt to global warming and others cannot. Vulnerable species who inhabit the MRNP subalpine and alpine environments include the pika (*Ochotona*), cascade red fox (*Vulpes vulpes cascadensis*), and white-tailed ptarmigan (*Lagopus leucura – snow quail*). In addition, warmer water may adversely impact tailed frogs (*Ascaphus*) and native bull trout (*Salvelinus confluentus*) who prefer cold headwater streams.

"Many scientists believe that the melting of Mount Rainier's glaciers fits a pattern of melting glaciers and other weather phenomena worldwide – a pattern known as "global climate change." **– National Park Service, 2018.**

Mount Rainier NP Wilderness Combating Global Warming, © 2019 Grant R. E. Kiser.

Mount Rainier Seeks Citizen Help Through MeadoWatch

The NPS and University of Washington have teamed to establish a long-term data set that will be used to understand global warming impacts in MRNP. Citizens are able to contribute to this research by taking wildflower photos (close enough to identify the species). By date-stamping and geo-tagging (most smartphones have this feature enabled) the photos, each one will indicate when and where wildflowers bloom. The objective is to determine how climate change affects the timing of the seasons. Visit http://www.meadowatch.org/ for additional details.

KEC MRNP Field Observations: August 10, 2018

Skyline Trail to Anvil Rock

The KEC Research Team got an early start for our first day in MRNP, driving directly to Paradise and the Henry Jackson Visitor Center, elevation 5,400 ft/1,646 m. The massive Mount Rainier grew larger before our eyes as we made our scenic roadway ascent. A day-long, 14-mile (roundtrip) hike then started behind the visitor center where

steps leading to the Skyline Trail were engraved with a conservationist John Muir quote that spoke of wonderful sights to come.

Trailhead of Skyland Trail, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

We followed the Skyline Trail to Panorama Point, then to Pebble Creek (along the Muir Snowfield), and ultimately to a birds-eye view of Anvil Rock, elevation 9,584 ft/2,921 m. That meant we experience an elevation gain nearly 4,200 ft /1,280 m)!

Skyline Trail, Mount Rainier NP, © 2019 Grant R. E. Kiser.

Mount Rainier Panorama from Skyline Trail, MRNP, © 2019 Grant R. E. Kiser.

This amazing, strenuous trek offered many spectacular sights, including: four playful marmots trail side and three chipmunks (two at Panorama Point, with a hazy view of the South Cascades Range, and another at 9,000+ ft/2,743+ m near Anvil Rock). We also saw an abundance of colorful alpine wildflowers, the Wilson Glacier Falls (315 ft/96 m tall, 75 ft/ 23 m wide), and direct views of Camp Muir (elevation 10,188 ft/3,105 m). Most importantly, we were able to photograph the Wilson, Nisqually, Paradise, Cowlitz, Ingraham, Whitman, and Ohanapecosh Glaciers! Our glacier images provide a snapshot in time relating to the size and shape of these beauties during the month and year of August 2018.

Climbing the Skyline Trail, Olympic NP, © 2019 Jonathan V. L. Kiser.

Wilson Glacier and Falls (left) Dwarfed by Mount Rainier in August 2018, MRNP, © 2019 Jonathan V. L. Kiser.

Mount Rainier Wildflowers, MRNP, © 2019 Grant R. E. Kiser and Jonathan V. L. Kiser (center).

In addition, the Research Team came upon a well-placed toilet that included helpful instructive signage and blended well into the alpine terrain.

Toilet with the Ultimate View!, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

Jonathan Ascending Alongside the Muir Ice Field, Mount Rainier NP, © 2019 Grant R. E. Kiser.

Jonathan and Grant in Front of Anvil Rock; and Paradise, Cowlitz, Ingraham, Whitman and Ohanapecosh Glaciers in August 2018, © 2019 W. Rhett Kiser (left) and J. V. L. Kiser (right).

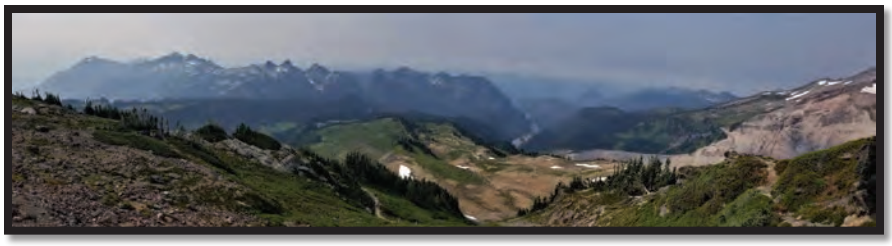
Paradise Glacier (foreground), Cowlitz, Ingraham, Whitman, & Ohanapecosh Glaciers (far right) in August 2018, Mount Rainier NP, © 2019 W. Rhett Kiser.

Giant Crevasse in the Paradise Glacier in August 2018, Mount Rainier NP, © 2019 Jonathan V. L. Kiser (left) and Grant R. E. Kiser (right).

The descending hike was also unique since much of it involved sliding down the Muir Snowfield! On the way, the Research Team encountered a prickly caterpillar, golden ground squirrels, more chipmunks, and friendly fellow hikers.

Grant and Rhett on the Muir Snow Field, Mt. Rainier NP, © 2019 W. Rhett Kiser (left) and Jonathan V. L. Kiser (right).

Caterpillar & Chipmunk along the Skyline Trail, Mount Rainier NP, © 2019 Grant R. E. Kiser.

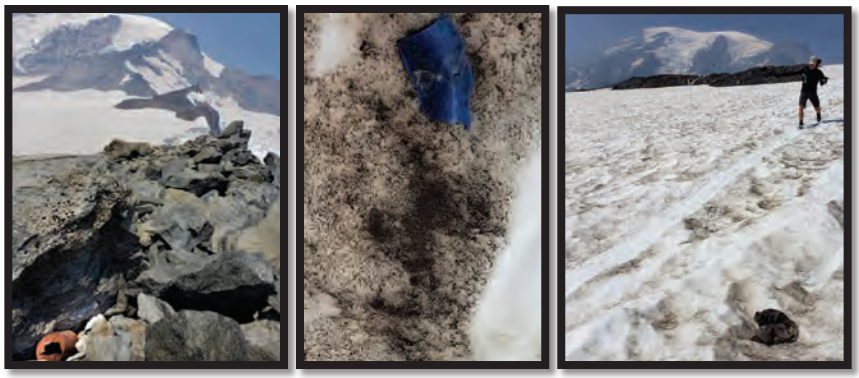


Tatoosh Range from Mount Rainier, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

We also documented the following litter during our Paradise trek: two cigarette butts, a piece of gum, an old rusty tin can, a paper clip, a piece of foil, a piece of nonferrous wire, 20 pieces of miscellaneous paper, two lollipop sticks, a Trident gum wrapper, a blue plastic lid (#2), two pieces of miscellaneous plastic (#7), a blue piece of hard plastic (#7), a piece of wood, three pieces of miscellaneous composite packaging, one "mango orange" piece of composite packaging, a Butterfinger candy bar composite wrapper, a rubber band, and a rubber and metal crampon (guess the hiker only needed one!). 42 total pieces.

Metal and Other Litter on the Skyline Trail, Mount Rainier NP, © 2019 Jonathan V. L. Kiser (left) and Grant R. E. Kiser (middle and right).

Crampon Litter, Muir Ice Field, MRNP, © 2019 W. R. Kiser.



Old Tin Can, Hard Plastic, and Rhett Sliding by Cloth Litter, Mt. Rainier NP, © 2019 Grant R. E. Kiser.

Gum, Paper, and Foil Litter on Skyline Trail, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

Gum Wrapper and Paper Litter on Skyline Trail, MRNP, © 2019 Jonathan V. L. Kiser.

Henry Jackson Visitor Center & Parking Lot (Paradise)

At the end of our unforgettable hike, Rhett spoke with a park ranger in the visitor center about global warming in the park. The ranger discussed the retreat of the Nisqually Glacier and also emphasized that warming temperatures are responsible for pushing the tree line higher on the mountain, disrupting flora and fauna habitat in the process. Seasons are shifting as well, and scientists are geotagging various species to better understand global warming impacts.

Repeat Photos of MRNP Nisqually Glacier, Sources: (left) 1930, Public Domain; (right) 2007, M. L. Hekkers; from: http://glaciers.us/Glaciers-Washington.html.

After then documenting a piece of paper litter inside the visitor center next to the awkwardly worded "Trash Only Please Recycle" garbage bin, the KEC Research Team completed an in-depth litter survey in the visitor center parking lot. 240 total pieces were counted (including the piece inside the visitor center). Details associated with this "Littered Site" (3 on the 1 to 4 scale) are provided in the KEC MRNP Parking Lot Litter Survey Results section below.

Paper Litter Next to Confusing Trash Bin, Henry Jackson Visitor Center, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

Cigarette Butt, Rope, and Pop Corn Litter, Henry Jackson Visitor Center Parking Lot, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

Narada Falls

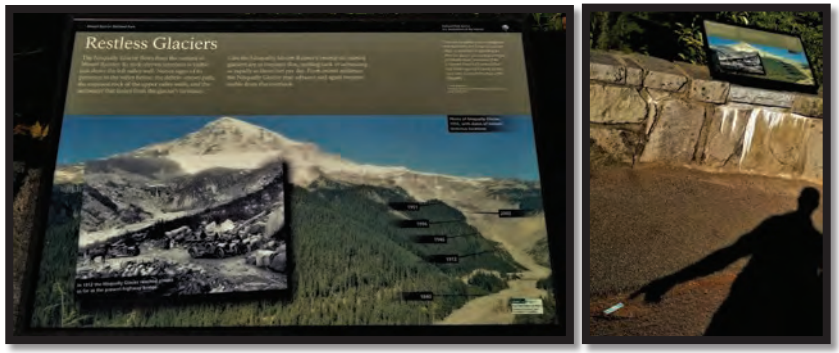
Our next stop was Narada Falls where we took in upper and lower views of the 168-foot/51-meter Paradise River Waterfall plunging over hardened lava. Given its close proximity to Paradise Valley Road, there were a lot of people and too much litter in the comparatively small parking lot and falls viewing areas. 37 pieces of litter were counted. Details associated with this "Littered" site (3 on the 1 to 4 scale) (given the comparatively small area) are provided in the KEC MRNP Parking Lot Litter Survey Results section below. We hiked 0.25 miles /0.4 km at Narada Falls.

Shadow Litter at Narada Falls, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

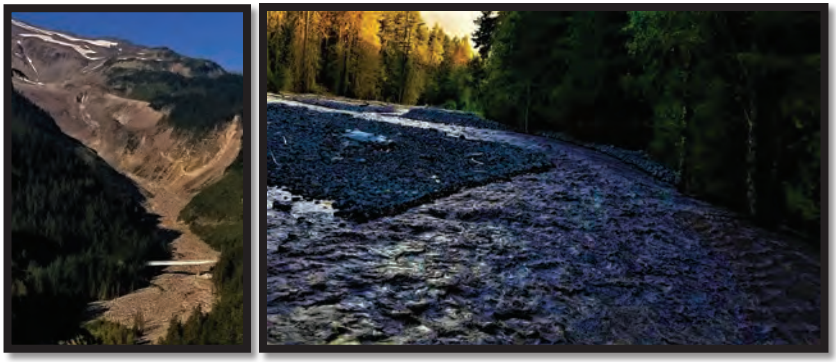
Narada Falls Ground and Hanging Litter, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

More Narada Falls Litter, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

The Research Team then spent some time near Ricksecker Point (off of Paradise Valley Road) to learn more from the Nisqually Glacier interpretive signage there. In 1840, the glacier terminus reached below the car bridge. It was last seen from Ricksecker Point in 1912.



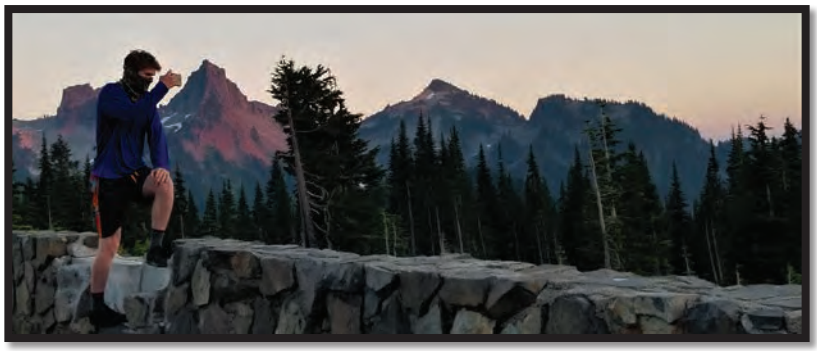
The Retreat of the Nisqually Glacier and More Shadow Litter, MRNP, © 2019 J. V. L. Kiser.



No Nisqually Glacier in Sight from Ricksecker Point (left) and Tahoma Creek (right), Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

It was then off to the historic National Park Inn for some much-deserved food and beer, and then toward the MRNP Nisqually entrance, stopping at Tahoma Creek to observe muddy water passing quickly toward the Nisqually River. This was one of the many sites that experienced damage during the November 2006 flood (following some 18-inches of rainfall in 36 hours). While experiencing the wonders of nature there, we heard a rustling in the nearby thicket and witnessed a large black bear ramble on by. We were not able to capture the moment with a clear photo. No litter documented.

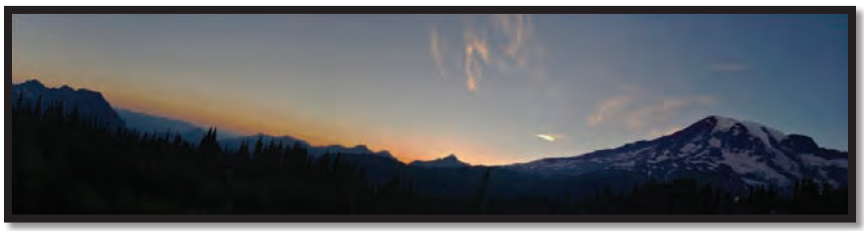
The team then decided to return to Paradise to take advantage of the star gazing event being hosted by the NPS. Heading up, we saw a six-point buck along the roadside. An amazing sunset then unfolded, reflecting off of Pinnacle Peak (6,562 ft/2,000 m) and other Tatoosh Range Peaks.



Grant and the Tatoosh Range, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

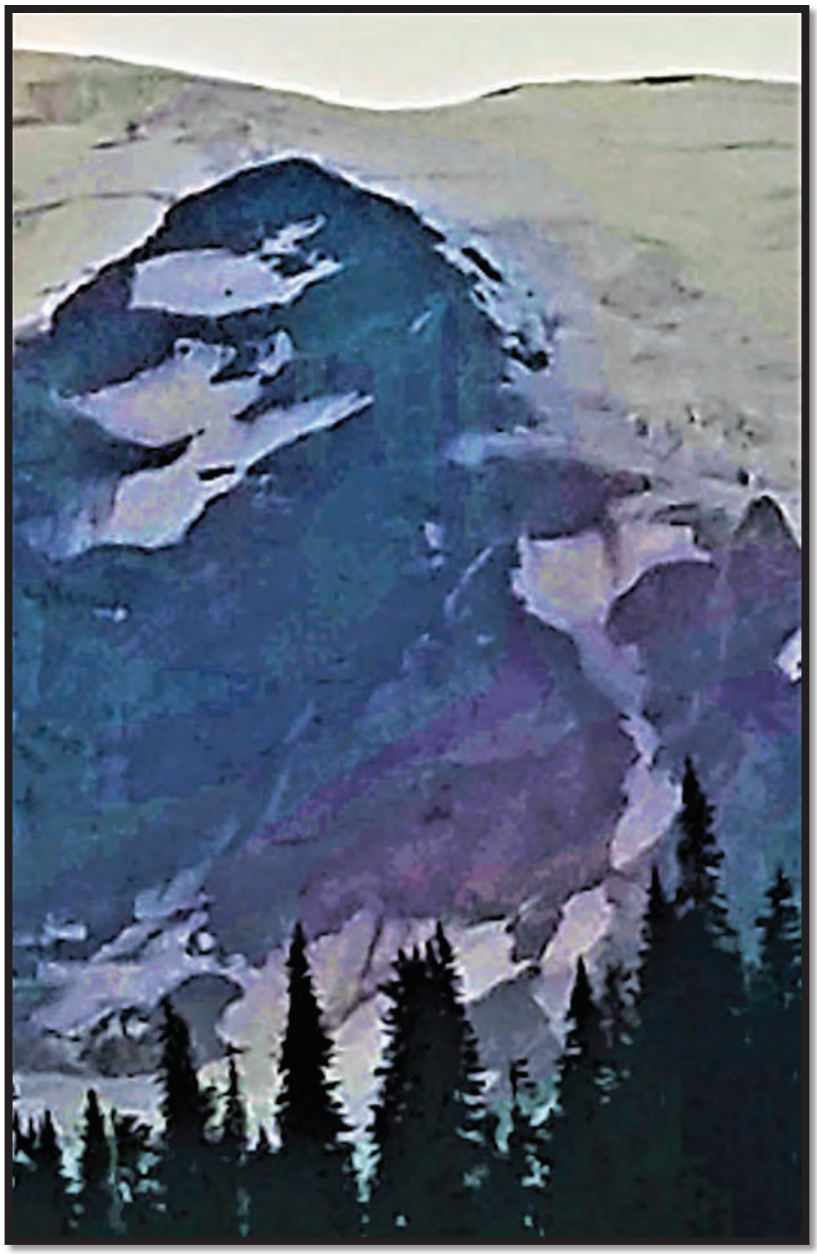
Pinnacle Peak (center) in Tatoosh Range, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

Rhett Capturing the Sunset Vista, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.



Rainier Day's End, Mount Rainier NP, © 2019 Grant R. E. Kiser.

Back at Paradise, and using our imagination, we also saw a formation on the mountainside we dubbed the "Flying Rainier Witch."



The Flying Rainier Witch, Mount Rainier NP,
© 2019 W. Rhett Kiser.

During the NPS star-gazing program, we were able to get clear and reasonably close-up views of Mars and Saturn. We then ventured off to visit the historic Paradise Inn where we appreciated well-

designed, multi-material recycling bins in the main lobby. We ended the evening by finding a location to get a fabulous view of the Milky Way and multiple shooting stars. What a wonderful stimulating experience!

Mount Rainier Ridge Silhouette, MRNP, © 2019 Jonathan V. L. Kiser.

KEC MRNP Field Observations: August 11, 2018

Kautz Creek

Our second (and last) day in MRNP started by following Paradise Valley Road from the Nisqually entrance. We stopped at Kautz Creek where we witnessed a Ranger using a leaf blower to manage litter and other debris in the parking lot. The Research Team then crossed the road to check out a creek-side interpretive area. In 1947, Kautz Creek was subject to a substantial mudflow that knocked down trees and altered the regional terrain. Unfortunately, KEC counted 17 pieces of litter here, including: six cigarette butts, three pieces of foil, seven pieces of paper, and a piece of miscellaneous plastic (#7).

Cigarette Butt and Paper Litter at Kautz Creek, MRNP, © 2019 Jonathan V. L. Kiser.

***"The bridge and surrounding group was shaking like an earthquake. The water level of Kautz Creek was rising at an alarming rate, and when we left, logs were striking the abutments and flying right over the bridge."* – Assistant Superintendent Harthon Bill, 1947**

Box Canyon Picnic Area

We then drove past Paradise, through a foggy Stevens Canyon, and on to the Box Canyon Picnic Area. After a pit stop in the spotless bathroom, we very much enjoyed a 1.5-mile (roundtrip) hike on the Box Canyon Trail to a small waterfall on the rushing, crystal-clear Stevens Creek. The Team marveled at glacial-smoothed rocks along the Creek.

Rushing Waters of Stevens Creek, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

Glacier-Smoothed Rocks and Stevens Creek, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

We also watched a banana slug slowly slime its way across the forest floor and noted one piece of paper on the trail. A litter count in the parking lot followed, yielding the following results: two cigarette butts, a piece of foil, three pieces of paper, a piece of plastic wrap (#4), a small plastic straw (#5), a pink fabric hair band, a piece of nylon fabric, and a piece of black duct tape – 11 total pieces. A "Somewhat Littered" site (2 on the 1 to 4 scale).

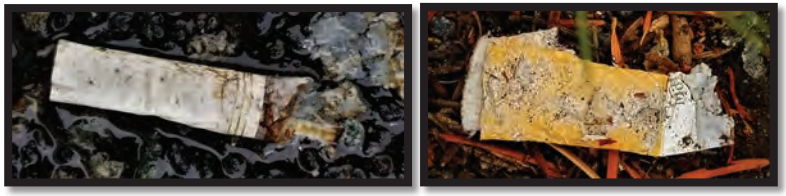
Grant Pointing Out Pink Hair Band Litter in Box Canyon Picnic Area Parking Lot, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

Continuing on, we stopped at the Box Canyon of the Cowlitz overlook and learned that the canyon rises 100 ft /30 m above the Cowlitz River. Amazing jagged rocks, covered with multi-colored vegetation, made the scene even more remarkable.

Box Canyon of the Cowlitz, Mount Rainier NP, © 2019 W. Rhett Kiser.

Box Canyon of the Cowlitz, Mount Rainier NP, © 2019 Jonathan V. L. Kiser (left) and Grant R. E. Kiser (right).

The Research Team then conducted an in-depth litter survey in the parking lot and overlook bridge areas. 45 individual pieces were counted. Details associated with this "Littered" site (3 on the 1 to 4 scale) (given the comparatively small area) are provided in the KEC MRNP Parking Lot Litter Survey Results section below.



Cigarette Butt Litter, Box Canyon of the Cowlitz Parking Lot, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

More Litter, Box Canyon of the Cowlitz Parking Lot, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

Still More Litter, Box Canyon of the Cowlitz Parking Lot, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

Grove of the Patriarchs

We stopped next at the popular Grove of the Patriarchs. A 1.0-mile roundtrip hike led us through an old-growth forest, across the stellar Ohanapecosh River (with "rainbow" river rocks) via a rickety suspension bridge, and past stunning Douglas fir (some up to 250 ft /76 m tall and over 1,000 years old!), Western red cedar, and Western hemlock.

A small Mount Rainier Wilderness Regulations sign along the trail indicated, "No Fires, Pets, or Bicycles," but did not include "No Litter." This undoubtedly contributed to the cigarette butt, four pieces of paper, and piece of composite packaging we documented on the forest floor. Six total pieces of litter.

Zen Grant Over the Ohanapecosh River, Grove of the Patriarchs, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

The Research Team then conducted an in-depth Grove of the Patriarchs parking lot litter survey. 111 total pieces were counted. Details for this "Littered" site (3 on the 1 to 4 scale) are provided in the KEC MRNP Parking Lot Litter Survey Results section below.

Grove of the Patriarchs Giants, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

Twin 1,000-Year Old Douglas Fir (left and right) and Other Giant (middle), Grove of the Patriarchs, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

Sunrise Emmons Glacier Vista to the Silver Lake Trail

It was then on to our final destination in MRNP, Sunrise (elevation 6,400 ft/1,951 m), the highest reachable point by vehicle in the park. We completed a breathtaking 1.5-mile (roundtrip) hike along the Sunrise Rim Trail to the Silver Forest Trail. The Research Team was rewarded with a wide array of spectacular wildflowers (purple aster – *Asteraceae*, other) in the mountain meadows, plus distant views of Emmons Glacier on the northeast flank of Mount Rainier.

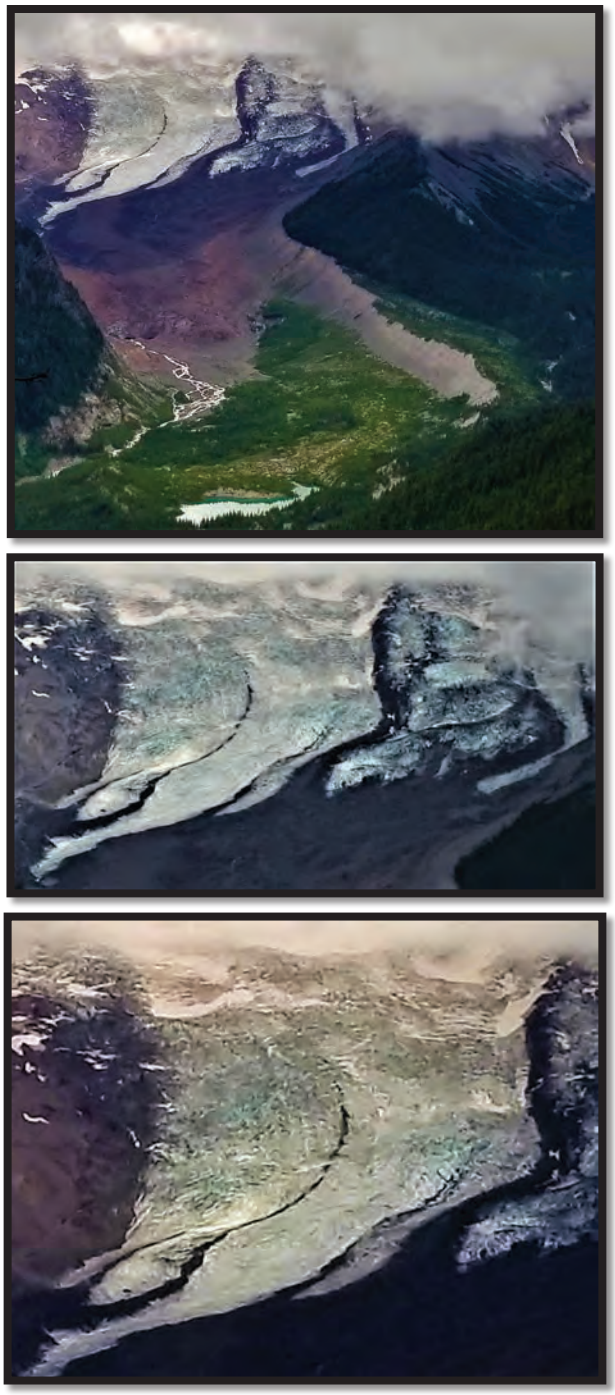
Wildflowers Along the Silver Forest Trail, Mount Ranier NP, © 2019 Jonathan V. L. Kiser (left) and Grant R. E. Kiser (right).

Along the Silver Forest Trail, Mount Rainier NP, © 2019 Grant R. E. Kiser.

The Emmons Glacier has the largest surface area (4.3 square miles/6.9 square km) of any glacier in the contiguous United States. We also were stunned by the presence of Tamanos Mountain (elevation 6,790 ft/2,070 m) and the Cowlitz Chimneys (South, elevation 7,605 ft/2,318 m; Middle, elevation 7,421 ft/2,262 m, and North, elevation 7,015 ft/2,138 m).

The Emmons Glacier Story, Silver Forest Trail, Mount Rainier NP.

Tamanos Mountain (center) and Cowlitz Chimneys (right) from Silver Forest Trail, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.



Emmons Glacier in August 2018, Mount Rainier NP,
© 2019 Jonathan V. L. Kiser.

Cowlitz Chimneys, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

When rain started to fall, we hurried back to the parking lot. We were happy to not see any litter on the trail but did document the following in the wet Sunrise parking lot: two pieces of miscellaneous paper, one paper receipt, a piece of paper with "wings" printed on it, a piece of plastic wrap (#3), and a piece of foam rubber. Six total pieces. Time did not allow completion of an in-depth survey.

Paper Litter on Sunrise Visitor Center Parking Lot, MRNP, © 2019 J. V. L. Kiser.

The KEC Research Team then left MRNP along Route 123 and drove toward Glacier NP in Montana. We passed through White Pass in the Okanogan-Wenatchee NF and stopped at Bron Yr Aur brewing company in Naches, WA along U.S. Route 12. We then continued through desert flats along Interstate 90 (dodging "killer tumbleweeds"), passed through Spokane, WA, and stopped at Coeur d'Alene, ID for the evening. Had some fine BBQ and great conversation with the owners and bartender at the Relic Smokehouse and Pub.

Magnificent View near the Mount Rainier NP Ohanapecosh Entrance, © 2019 Grant R. E. Kiser.

KEC MRNP Parking Lot Litter Survey Results

Provided below, in Exhibits 8 through 11, are the detailed results from KEC's parking lot litter surveys in MRNP.

Exhibit 8 – Mt. Rainier National Park Litter Survey Details
Henry Jackson Visitor Center (Paradise) Parking Lot

Litter Type	Count	% of Total
Cigarette Butts	69	29
Food (a)	45	19
Glass	2	< 1
Metal – Ferrous (Steel)	1	< 1
Metal – Non-Ferrous (e.g., Aluminum foil) (b)	14	6
Paper – Miscellaneous	45	18
Paper – Cardboard	---	---
Paper – Chipboard (e.g., Cereal Box)	---	---
Plastic – #1 PETE (e.g., Bottles; Cups; Lids)	3	1
Plastic – #2 HDPE (e.g., Bags – grocery; Bottles – juice, milk, water)	---	---
Plastic – #3 PVC (e.g., Flip-flop; Wrap – food; etc.)	---	---
Plastic – #4 LDPE (e.g., Bags – bread; 6-pack rings); Wrap – cigarette pack; etc.)	2	< 1
Plastic – #5 PP (e.g., Caps – bottle; Cups – clear; Flossers; Straws; Utensils) (c)	5	2
Plastic – #6 PS (e.g., Clips/Tags – bread bag; Cups; Styrofoam)	---	---
Plastic – #7 Other (Misc. hard plastic pieces); Multi-layer resin composites) (d)	11	5
Textile (e.g., Cloth, etc.) (e)	5	2
Wood	11	5
Other Litter (Specify) (e.g., Composite material – wrappers); Q-tips, etc.) (f)	27	12
Total	**240**	**100%**

Includes: (a) Popcorn, other; (b) Two pieces of wire, one key, other; (c) One straw, other; (d) One car taillight, a zip tie, other; (e) Two pieces of rope, other; (f) Six fruit stickers, four ear plugs, two pieces of gum, one hair tie, nine wrappers, one zipper, other.
Source: Kiser Environmental Consulting, 2019.

A "Littered" site (3 on the 1 to 4 scale).

Exhibit 9 – Mount Rainier National Park Litter Survey Details Narada Falls Parking Lot and Vista Point Trail

Litter Type	Count	% of Total
Cigarette Butts	4	11
Food (a)	6	16
Glass	---	---
Metal – Ferrous (Steel)	---	---
Metal – Non-Ferrous (Aluminum foil)	---	---
Paper – Miscellaneous (b)	22	59
Paper – Cardboard	---	---
Paper – Chipboard (e.g., Cereal Box)	---	---
Plastic – #1 PETE (e.g., Bottles; Cups; Lids)	---	---
Plastic – #2 HDPE (e.g., Bags – grocery; Bottles – juice, milk, water)	---	---
Plastic – #3 PVC (e.g., Flip-flop; Wrap – food; etc.)	---	---
Plastic – #4 LDPE (e.g., Bags – bread; 6-pack rings); Wrap – cigarette pack; etc.) (c)	1	3
Plastic – #5 PP (e.g., Caps – bottle; Cups – clear; Flossers; Straws; Utensils)		
Plastic – #6 PS (e.g., Clips/Tags – bread bag; Cups; Styrofoam)	---	---
Plastic – #7 Other (Misc. hard plastic pieces); Multi-layer resin composites)		
Textile (e.g., Cloth, etc.) (d)	1	3
Wood	---	---
Other Litter (Specify) (e.g., Composite material – wrappers); Q-tips, etc.) (e)	3	8
Total	**37**	**100%**

Includes: (a) Four pistachio shells and two orange peel pieces; (b) A Ricola wrapper, a red paper wrapper, a piece of paper with "vanilla" printed on it, and 19 miscellaneous pieces; (c) Plastic wrap piece; (d) White cloth; (e) A KitKat composite wrapper piece, pink string, black nylon strap. Source: Kiser Environmental Consulting, 2019.

A "Littered" site (given the comparatively small area) (3 on the 1 to 4 scale).

Exhibit 10 – Mount Rainier National Park Litter Survey Details
Box Canyon of the Cowlitz Parking Lot

Litter Type	Count	% of Total
Cigarette Butts	18	40
Food (a)	1	2
Glass	---	---
Metal – Ferrous (Steel)	---	---
Metal – Non-Ferrous (Aluminum foil)	5	12
Paper – Miscellaneous	9	20
Paper – Cardboard	---	---
Paper – Chipboard (e.g., Cereal Box)	---	---
Plastic – #1 PETE (e.g., Bottles; Cups; Lids)	---	---
Plastic – #2 HDPE (e.g., Bags – grocery; Bottles – juice, milk, water)	---	---
Plastic – #3 PVC (e.g., Flip-flop; Wrap – food; etc.)	---	---
Plastic – #4 LDPE (e.g., Bags – bread; 6-pack rings); Wrap – cigarette pack; etc.) (b)	3	7
Plastic – #5 PP (e.g., Caps – bottle; Cups – clear; Flossers; Straws; Utensils) (c)	1	2
Plastic – #6 PS (e.g., Clips/Tags – bread bag; Cups; Styrofoam)	---	---
Plastic – #7 Other (Misc. hard plastic pieces); Multi-layer resin composites) (d)	1	2
Textile (e.g., Cloth, etc.) (e)	1	2
Wood	---	---
Other Litter (Specify) (e.g., Composite material – wrappers); Q-tips, etc.) (f)	6	13
Total	**45**	**100%**

Includes: (a) An orange peel; (b) Plastic wrap; (c) Bottle cap; (d) Cigar mouthpiece tip; (e) One piece of cotton gauze; (f) Four composite bag pieces, one Ricola cough drop composite bag, one band-aid.
Source: Kiser Environmental Consulting, 2019.

A "Littered" site (given the comparatively small area) (3 on the 1 to 4 scale).

Exhibit 11 – Mt. Rainier National Park Litter Survey Details
Grove of the Patriarchs Parking Lot

Litter Type	Count	% of Total
Cigarette Butts	18	16
Food (a)	21	19
Glass	---	---
Metal – Ferrous (Steel)	---	---
Metal – Non-Ferrous (Aluminum foil)	3	3
Paper – Miscellaneous (b)	45	41
Paper – Cardboard	---	---
Paper – Chipboard (e.g., Cereal Box)	---	---
Plastic – #1 PETE (e.g., Bottles; Cups; Lids)	---	---
Plastic – #2 HDPE (e.g., Bags – grocery; Bottles – juice, milk, water)	2	< 2
Plastic – #3 PVC (e.g., Flip-flop; Wrap – food; etc.)	---	---
Plastic – #4 LDPE (e.g., Bags – bread; 6-pack rings); Wrap – cigarette pack; etc.)	2	< 2
Plastic – #5 PP (e.g., Caps – bottle; Cups – clear; Flossers; Straws; Utensils)	---	---
Plastic – #6 PS (e.g., Clips/Tags – bread bag; Cups; Styrofoam) (c)	3	3
Plastic – #7 Other (Misc. hard plastic pieces); Multi-layer resin composites)	1	< 1
Textile (e.g., Cloth, etc.)	---	---
Wood	---	---
Other Litter (Specify) (e.g., Composite material – wrappers); Q-tips, etc.) (d)	16	15
Total	**111**	**100%**

Includes: (a) 21 orange peel pieces, one pistachio shell; (b) A lollipop stick, other; (c) Three bag clips/tags; (d) Two fruit stickers, duct tape, a golf ball (Pro V1), rubber band (natural rubber), 11 wrappers.
Source: Kiser Environmental Consulting, 2019.

A "Littered" site (3 on the 1 to 4 scale).

KEC MRNP Feedback/Improvement Recommendations

- While litter was clearly present throughout MRNP, the KEC Research Team was heartened by the presence of a ranger actively managing trash and recyclables in the Kautz Creek parking lot. The use of a leaf blower was an efficient management tool to help with this on-going challenge (one with a vacuum would be ideal). We also were happy to not notice too much litter along the major roadways as we traveled through the park.

- At the Paradise Trails sign location behind the Henry Jackson Visitor Center, "Leave No Trace, Pack it in Pack it out" and "Please Don't Litter" signs should be added.

- The rest room on the Skyline Trail is not only well-blended into the surrounding environment but also has meaningful signage to help instruct humans to "doo" the right thing!

Sign in the High-Elevation Bathroom, Skyline Trail, Mount Rainier NP.

- At the Henry Jackson Visitor Center, rangers should make anti-litter literature available to the public. Also, the trash bins labeled "Trash Only Please Recycle" send a confusing message and doesn't readily allow people to actually recycle since there did not appear to be any nearby recycling bin. Color-coded (e.g., blue) recycling bins should be placed next to all trash bins with labels showing acceptable materials.

Feed slots with selective sizes/shapes will further help people place the right materials in the correct bin(s). This type of system should be duplicated consistently throughout MRNP.

- In the Henry Jackson Visitor Center parking lot, strategically placed cigarette butt receptacles will help to reduce the obvious problem associated with this persistent and pervasive material. Anti-litter signs (with fines) would also help. Vacuum equipment should be regularly used to collect parking lot litter.

- At Narada Falls, anti-litter signs and cigarette receptacles would help. The small metal Wilderness Regulations signs make no mention of the "Leave No Trace" policy or "No Littering" and the area undoubtedly suffers as a result.

Narada Falls, How About "Pack It In Pack It Out. No Litter" As Well?!

- At Ricksecker Point near the Nisqually Glacier signage, add anti-litter signage.

- Next to the historic National Park Inn (in front of the Longmire General Store), there is another "Trash Only Please Recycle" bin but no accompanying recycling bin. In terms of trash management, it's typically asking too much of "mere humans" to do something right if they are then not provided with an opportunity to immediately do it.

Trash Only Bin with No Recycle Bin Option Nearby, Longmire General Store, MRNP, © 2019 Jonathan V. L. Kiser.

- In the lobby of the Paradise Inn, there are attractive recycling bins for individual materials (aluminum cans, plastic, glass, garbage, compost) and separate, adjacent paper recycling and trash bins. While this was great to see, it begs a few questions: 1) If source segregation is available to this degree at this location, how are the other recyclables that are collected in a more aggregated manner around MRNP then separated?; and 2) Are the aggregated recyclables typically too contaminated to be saleable in stricter recycling markets? It seems that one consistent recycling collection and sorting approach would be the best way to achieve maximum recycling results in MRNP.

Attractive Recycling and Trash Management Options, Paradise Inn, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

- In the Box Canyon Picnic Area parking lot, KEC commends MRNP for the very clean bathroom and for the color-coded, animal-proof, recycling (green) and trash (brown) bins, with acceptable material images. Replace the peeling recycling symbol stickers.

Spotless Bathroom at Box Canyon Picnic Area, MRNP, © 2019 J. V. L. Kiser.

Peeling Trash and Recycling Bin Labels, Box Canyon Picnic Area, Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

- At the Box Canyon of the Cowlitz parking lot location, cigarette receptacles and anti-litter signage would help.

- At the Grove of the Patriarchs parking lot and trailhead, new stickers are needed for the green recycling bins and brown trash bins. Real life images of acceptable recyclable materials would help further. Another insufficient Wilderness Regulations sign there should be supplemented with anti-litter signage.

Peeling Trash and Recycling Bin Labels, Grove of Patriarchs Parking Lot,Mount Rainier NP, © 2019 Jonathan V. L. Kiser.

- At the Sunrise Visitor Center parking lot, litter could hopefully be reduced by placing “Please Don’t Litter!” stickers on the green recycling and brown trash bins.

Chapter 5
Glacier National Park

Glacier NP West Entrance, © 2019 Jonathan V. L. Kiser.

Overview

Located in northwestern Montana and adjoining the Canadian border, Glacier National Park (GNP) was established in 1910 and consists of more than one million acres. In 1932, the U.S. and Canada decided to create the world's first international Peace Park by combining GNP with adjacent Waterton Lakes NP (129,700 acres – 1,583 square miles/2,549 sq. km). GNP also straddles the Continental Divide which is the great ridge of the Rocky Mountains. To the east is the watershed flowing to the Mississippi River and Hudson Bay, to the west is the watershed flowing to the Pacific Ocean.

GNP gets its name from the great rivers of glacial ice that formed its landscape more than 10,000 years ago. Today, U-shaped valleys, 762 lakes, more than 200 waterfalls, and some 150 named mountains over 8,000 ft/2,438 m (Mt. Cleveland is the highest at 10,466 ft/3,190 m), help to define the stunning scenery that is GNP. The steep western slopes are covered in dense forests of fir (*Abies*), spruce (*Picea*), lodgepole pine, cedar (*Cedrus*), and hemlock (*Tsuga canadensis*). Alpine meadows display flowering heathers (*Calluna vulgaris*), glacier lilies (*Erythronium grandiflorum*), and bear grasses (*Xerophyllum tenax*). Prairie grasslands spread eastward across the drier plains toward land outside GNP now occupied by the Blackfeet nation.

Near St. Mary Entrance, Glacier NP, © 2019 Grant R. E. Kiser.

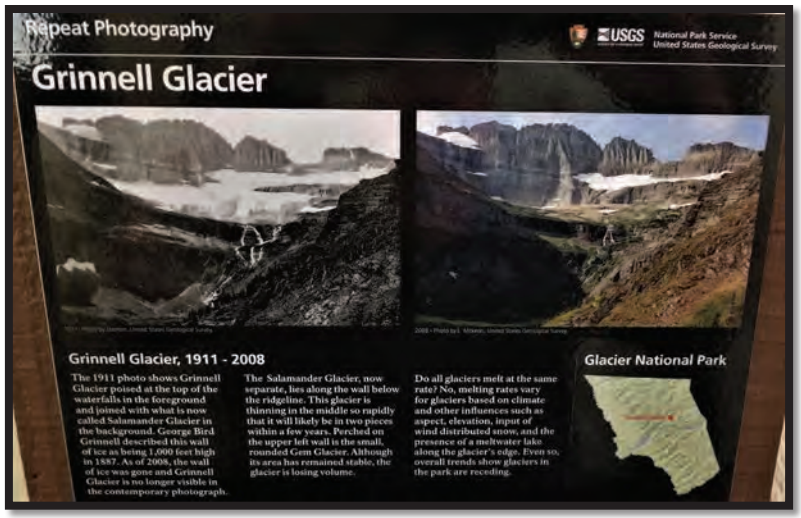
Nearly 2,000 plant species color the landscape and provide shelter and food for 260 bird species and more than 60 native mammals. Mammals include bighorn sheep, mountain goats, grizzly and black bears, elk, deer, and moose. Gray and black wolves (*Canis lupus*) began returning in the mid-1980s after having been eradicated from the GNP region in 1936. Also, six amphibian species live in GNP including the Long-toed salamander (*Ambystoma macrodactylum*) and Boreal toad *(Anaxyrus boreas)*.

Select GNP Flowers and Amphibians (left to right): Glacier Lilly, Boreal Toad, Purple Aster, and Long-Toed Salamander, Source: Public Domain.

During the 18th and much of the 19th century, the Blackfeet Indians inhabited the area now contained within GNP. Dating back to 1913, the Great Northern Railway built numerous accommodations throughout the park. At present, the NPS (working with a multitude of stakeholders including the state of Montana, the Blackfeet Tribe, the Canadian government, and private companies) is trying to protect critical habitats of both water and land animals. Oil, gas, coal, and logging projects near the park's respective boarders are the real threat of concern (National Geographic). During 2018, there were 2.97 million visitors to GNP.

GNP Global Warming

Global warming is threatening the health of GNP's ecosystems. Of the 150 glaciers that existed in GNP in the late 19th century, as of 2015, only 26 remain larger than 25 acres. The largest, Harrison glacier (410 acres), has decreased 19% over the past 50 years. Other GNP glaciers have declined by up to 85% (USGS 2017). This was determined through repeat photography and other methods, where scientists have measured glacier mass, area, and meltwater temperatures over a period of time. The USGS Repeat Photography Project allows backcountry hikers to help by re-photographing glaciers. Participation involves printing historic glacier photos found on the USGS website (www.usgs.gov), locating and photographing the repeat photo in GNP, and submitting photos and copyright agreement to USGS.



Disappearing Grinnell Glacier Repeat Photography, Glacier NP.

Warming winters in GNP are bringing more rain, rather than glacier-forming snow. Even when there is a heavy snow season, the increasing heat of spring and summer is melting it away quicker. Spring snow melts are now occurring at least two weeks earlier than they were in the 1960s and this impacts wildlife, fire management, regional water supplies, and agriculture (USGS 2017). More specifically, endemic animal species (those existing in only one geographic region) such as the wolverine (*Gulo gulo*), may decline with the reduction of alpine habitat. They are dependent on persistent spring snow cover for denning, and warmer temperatures reduce both the availability of suitable sites and the connectivity between sites.

***"Most scientists now believe that pollutants released into the air by humans, especially carbon dioxide, have significantly contributed to climate change."* – National Park Service, 2018**

Also found in Alpine areas are a rich diversity of endemic plants. Some plants are slow to migrate or disperse, compared to annual or invasive plants. Like in other NPs KEC visited during the

2018 expedition, the last century of warming temperatures in GNP have resulted in subalpine tree species encroaching into higher elevations. Warming temperatures can also be expected to facilitate the spread of the mountain pine beetle infestation in GNP (due to more frequent breeding). This will cause more trees to die, impacting habitats and increasing the risk of wildfires. Earlier snowpack melt-out can also be expected to increase the number of hot days, thus expanding the fire season (USGS 2019c).

Two Medicine (left) and Baring Falls (right) areas, Glacier NP, © 2019 Grant R. E. Kiser.

In addition, this warming trend will greatly decrease the major sources of groundwater recharge and summer runoff. This will reduce the availability of water during the growing season, adversely impact stream habitats for fish and invertebrates (animals lacking a backbone), plus alter riparian (along river/stream banks) vegetation communities (due to lower groundwater tables) (USGS 2019c).

KEC GNP Field Observations: August 12, 2018

We departed Coeur d'Alene, ID first thing in the morning and headed toward GNP along Interstate 90. The Team then drove north on Route 135 at St. Rigis, passed over the Flathead River in Perma (Flathead Indian Reservation), followed Route 382 north to Route 28 to Route 93, en route to our hotel in Kalispell, MT (next to the Pacific Steel and Recycling operation). The mighty Rocky Mountain Flathead Range appeared to the east as we neared Kalispell. After checking into the hotel, we made haste to GNP for unforeseen afternoon adventures.

Flathead Lake and the Rockies, Near Kalispell, MT, © 2019 Jonathan V. L. Kiser.

Apgar Visitor Center

Our first stop in GNP was the Apgar Visitor Center where Rhett interviewed a ranger about global warming in the park and learned that one source of grizzly bear food, the army cutworms (the immature form of the adult moth (*Euxoa auxiliaris*) is threatened by warming air temperatures. During the summer, hundreds of thousands of moths of the army cutworm escape the hot prairies to the east and burrow away in loose rocky slides of cool GNP alpine areas. Grizzly bears turn these rocks over in search of food for a few weeks during late summer and feast on an estimated 40,000 moths per day (some 20,000 calories)! As tree lines continue to push higher due to climate change, the army cutworm's habitat is diminishing.

The KEC Research Team then completed an in-depth litter survey in the visitor center parking lot. In spite of available trash and recycling bins next to the visitor center and in the parking lot, 518 total pieces of litter were counted (by far the most of any single site during this expedition). Details for this "Extremely Littered" site (4+ on the 1 to 4 scale) are provided in the KEC GNP Parking Lot Litter Survey Results section below.

Trash Dumpsters in the Apgar Visitor Center Parking Lot, Glacier NP, © 2019 Jonathan V. L. Kiser.

Litter in the Apgar Visitor Center Parking Lot, GNP, © 2019 J. V. L. Kiser.

More Apgar Parking Lot Litter, Glacier NP, © 2019 Jonathan V. L. Kiser.

Composite Package and Orange Peel Litter, Apgar Visitor Center Parking Lot, Glacier NP, © 2019 Jonathan V. L. Kiser.

Sprague Creek Campground

We next followed the Going-to-the-Sun Road toward Logan Pass and decided to check out the Sprague Creek campground along the shore of Lake McDonald. What we found were hundreds of thousands of amazing purple, black, brown, white, grey, yellow, pink, green, and other colored rocks along the shoreline and in the lake. Lake McDonald fills a basin carved out by Ice Age glaciers and is the largest in GNP. It is 472 ft/144 m deep and 10 miles/16 km long.

Lake McDonald Rocks, Glacier NP, © 2019
Grant R. E. Kiser (left) and Jonathan V. L. Kiser (right).

What we noticed next was a growing billow of brown and grey smoke rising up from the forest across the lake. A dry lightning strike (from a thunderstorm that produces thunder and lightning, with most or all of its precipitation evaporating before reaching the ground) had ignited the fire the night before, and it was quickly growing before our eyes. Deep Purple's classic song "Smoke on the Water" (fire in the sky!) immediately came to mind, along with the sad realization that where there is smoke there is also hazardous air emission due to incomplete combustion. (Note: As of September 2018, this fire, known as the Howe Ridge Fire, had burned over 15,000 acres in GNP.) No litter survey was conducted at the Sprague Creek campground where we walked about 0.25 miles.

Lake McDonald and Howe Ridge Smoke, Glacier NP, © 2019 Jonathan V. L. Kiser.

It was then on to the Lake McDonald Lodge, a 3-1/2-story rustic lodge built in 1913 with a large open lobby and massive fireplace. In 1987, the lodge was designated a National Historic Landmark. The large-scale Swiss-style chalet was most impressive, and the many animal heads on the walls and interior Indian motif were quite intriguing. We also briefly checked out the nearby boat ramp area and tried our best not to run into the many people milling about. No litter survey was conducted here.

Lake McDonald Lodge, Glacier NP, © 2019 Jonathan V. L. Kiser.

Avalanche Lake Trail

We continued on toward the Avalanche Creek campground and couldn't help but notice the haze from the growing Howe Ridge Fire was already beginning to obstruct some of the mountain views. At the campground, the Research Team was impressed with a large interpretive sign showing and describing the difference among three tree species found in the forest (western red cedar, western hemlock, and black cottonwood – *Populus trichocarpa*).

Tree Type Signage at Avalanche Creek Campground, Glacier NP.

We then embarked on a 4.5-mile (roundtrip) hike to Avalanche Lake along the heavily traveled Avalanche Lake Trail. KEC encountered very friendly people and witnessed an amazing mix of increasingly smoky blue skies, clear water, colorful rocks, and so much more. In one section of the forest there obvious signs of some type of fierce wind activity as the tops of some trees were missing and other huge trees were twisted and left in splinters. There were also super-sized boulders, the largest of which the boys insisted on climbing and sliding down.

Along the Avalanche Lake Trail, Glacier NP, © 2019 Grant R. E. Kiser.

Jonathan and Grant, Avalanche Lake Trail, Glacier NP, © 2019 W. Rhett Kiser.

Wind Damage and Jonathan Breathing Smoke, Avalanche Lake Trail, Glacier NP, © 2019 Jonathan V. L. Kiser (left) and W. Rhett Kiser (right).

Avalanche Lake was simply gorgeous. Its brown-colored water lapped the shoreline, while tall, steep mountain cliffs with cascading waterfalls towered above it on three sides. We totally felt a positive energy flow at the lake. It was a great place to ponder reality. After a while, a "mean breeze" kicked in and whirled across Avalanche Lake in our direction. It was a cosmic scene. "Just unbelievable," said Rhett. "Plain unreal" added Jonathan. As the forest fire smoke began to directly invade the lake area, an outer-worldly effect resulted.

Smoke on the Rise Near Avalanche Lake, Glacier NP, © 2019 W. Rhett Kiser.

The subtle changes in light were indescribable and the natural beauty of it all proved to us that God lives! We took a moment of silence out of genuine respect. Grant then said, "Intergalactic." Rhett said, "Astonishing." Jonathan said, "Some phenomenal, wild-ass country."

Avalanche Lake, Glacier NP, © 2019 Grant R. E. Kiser (left) and Jonathan V. L. Kiser (right).

On our return hike, we encountered a chipmunk munching away on someone's cliff bar (don't feed the wildlife!), saw what appeared to be a beautiful penny bun fungus (*Boletus edulis*), were captivated by western hemlock pinecones, intrigued by a pumpkin face tree burl, and documented water pollution (source unknown) in a small cove section of Avalanche Creek.

Fungus, Moss, and Pinecone, Avalanche Lake Trail, Glacier NP, © 2019 Grant R. E. Kiser (left) and Jonathan V. L. Kiser (right).

Pumpkin Face Burl and Avalanche Creek Water Pollution, Avalanche Lake Trail, Glacier NP, © 2019 Grant R. E. Kiser (left) and Jonathan V. L. Kiser (right).

We were then once again blown away by the rushing powerful rapids of the Creek streaming over, across, and around impressive boulders near the trailhead. Rhett described this time and space as "Interstellar!" This hike truly reflected happy human moments with nature.

Avalanche Creek, Glacier NP, © 2019 Jonathan V. L. Kiser.

The down side was the 31 pieces of litter the Research Team documented on the trail, including: 24 pieces of paper, a squeezable plastic red spike ball (#7), the plastic end of a hiking pole (#7), three composite wrappers, a rubber band, a miscellaneous piece of rubber.

At the trailhead, we diverted onto the 0.5-mile Trail of the Cedars Nature Loop and observed what we could in the low-light conditions. No litter was documented on the Loop. Then, as we were packing up our gear in the parking lot, there was a flash of activity with a NPS ranger vehicle quickly driving in and coming to a screeching halt. The ranger then hastily announced the park was being evacuated due to the escalating Howe Ridge Fire!

Composite Litter in Avalanche Lake, Glacier NP, © 2019 Jonathan V. L. Kiser.

On the way out, we stopped a few times to catch a glimpse of the growing fire that was glowing bright orange against the darkening skies. By that time, the fire had reached the edge of Lake McDonald and there was literally smoke on the water and ash falling from the sky. The park would be closed from the west entrance on Going-to-the-Sun Road leading to Logan Pass section for the remainder of our GNP visit.

Avalanche Lake Trail Litter, Glacier NP, © 2019 Jonathan V. L. Kiser.

Howe Ridge Fire, Glacier NP, August 12, 2018, © 2019 Jonathan V. L. Kiser.

KEC GNP Field Observations: August 13, 2018

Two Medicine Lakes North Shore Trail

Realizing that the GNP west entrance was closed due to the Howe Ridge Fire, we opted to start our day by driving around the park parameter to the east and then north on US Highway 2, next to the Middle Fork of the Flathead River. Along the way there were roadway signs warning of another wild fire south of the NP boundary. We then entered GNP from the east along the Two Medicine Road and stopped at the Two Medicine Campstore for advice relating to which morning hike to take. The Two Medicine Lake glistened in the morning sun!

Two Medicine Lake, Glacier NP, © 2019 Jonathan V. L. Kiser.

We followed the recommended North Shore Trail to Twin Falls then circled back to the Campstore via the South Shore Trail. It was about a 7.0-mile journey that none of us will soon forget. There were ducks (*Anatidae* – specific species unidentifiable) in the distance on Two Medicine Lake, awe-inspiring glacier-carved peaks and lake, a Ruffed grouse (*Bonasa umbellus)* mother and her baby, amazing rocks, a garter snake in the brush, a beaver-inhabited wetland area (south shore), huckleberry bushes (*Vaccinium membranaceum*) (the fruit from which are loved by bears, birds, other wildlife, and people alike!), inspiring trees (fir, spruce, and lodgepole pine), and more.

Ruffed Grouse and Colorful Landscape, Two Medicine North Shore Trail, Glacier NP, © 2019 Jonathan V. L. Kiser.

Two Medicine North Shore Trail with Gooseberries, GNP, © 2019 Grant R. E. Kiser.

Two Medicine North Shore Trail, Glacier NP, © 2019 W. Rhett Kiser.

Two Medicine North Shore Trail with Rhett and Grant in Front of Pumpelly Pillar, Glacier NP, © 2019 Grant R. E. Kiser (left) and Jonathan V. L. Kiser (right).

At Twin Falls, two wonderful cascades flowed off the eastern slopes of Pumelly Pillar (7,625 ft/2,324 m) located in the Lewis Range. Rhett and Grant forged ahead to explore the rushing waters above the falls and Rhett spotted a large pile of bear scat complete with huckleberry seeds (the perfect fertilizer for seed germination and plant growth). Jonathan was a step behind and lost his cell phone/camera climbing to the top of the lower falls. The boys subsequently joined in on the desperate, hour-long search for the lost phone/camera (to no avail).

Bear Scat Near Twin Falls, Glacier NP, © 2019 W. Rhett Kiser.

Twin Falls Images, Glacier NP, © 2019 Jonathan V. L. Kiser and Grant R. E. Kiser (far right).

The return hike offered plenty of inspiring sites which were dutifully captured with our two remaining cell phone cameras.

Above Twin Falls (left) and Two Medicine Creek (right), GNP, © 2019 Grant R. E. Kiser.

Two Medicine Lake and Rising Wolf Mountain (9,514 ft/2,900 m), Glacier NP, © 2019 Grant R. E. Kiser.

Two Medicine Lake from South Shore Trail, Glacier NP, © 2019 Jonathan V. L. Kiser.

Beaver Habitat and Twisted Tree, Two Medicine South Shore Trail, Glacier NP, © 2019 Grant R. E. Kiser (left) and Jonathan V. L. Kiser (right).

Once back at the Campstore, we informed the rangers who recorded our contact information and promised to be in touch if anyone turned it in. There was the added concern that the phone/camera was not protected with a security code, allowing anyone to use the phone plus access the thousands of photos and contacts.

To boost Jonathan's spirits, Rhett offered to share his camera for the remainder of the trip and also stated that it was definitely possible that some good-hearted hiker might find and return it. Still, the realization of all those lost photos and that we would be leaving the area in little more than 24-hours, was a bitter pill to swallow.

Miraculously, two weeks after returning from the expedition, Jonathan received a call from a young gentleman named Jacob from East Glacier (living there among the Blackfeet Nation while undertaking global warming work focusing on beaver behavior in GNP). His hiking party had found the phone in the water at the bottom of Twin Falls! Ironically, Jacob was able to call because there was no security code blocking access to the phone numbers, He mailed the phone, it still worked, the photos were recovered, and a "finder's fee" show of gratitude was sent his way! The U.S. flag litter image next to Twin Medicine Lake (gracing the cover of this book), along with thousands of other critical pictures, would not have otherwise been available. Thank you Jacob!!

Jonathan Eying Composite Dorito Package on the Two Medicine Lake Shore, Glacier NP, © 2019 Grant R. E. Kiser.

During our hike to and from Twin Falls, the KEC Research Team counted 21 pieces of litter including: a cigarette butt, a Jolly Rancher hard candy, six pieces of miscellaneous paper, a plastic bottle cap (#5), a piece of string, the small U.S. flag, a Dorito chip composite bag, and nine other miscellaneous pieces. Once again, there was no anti-litter messaging at trail heads or on any of the trail signs we encountered.

Litter on the Two Medicine Trail, Glacier NP, © 2019 Jonathan V. L. Kiser.

Paper Litter on Two Medicine Trail and Cigarette Butt Next to Upper Twin Falls, Glacier NP, © 2019 Jonathan V. L. Kiser (left) and Grant R. E. Kiser (right).

Two Medicine Campstore Parking Lot

The Research Team next completed an in-depth litter survey in the Two Medicine Campstore parking lot. 159 total pieces of litter were counted. Details for this "Littered" site (3 on the 1 to 4 scale) are provided in the KEC GNP Parking Lot Litter Survey Results section below.

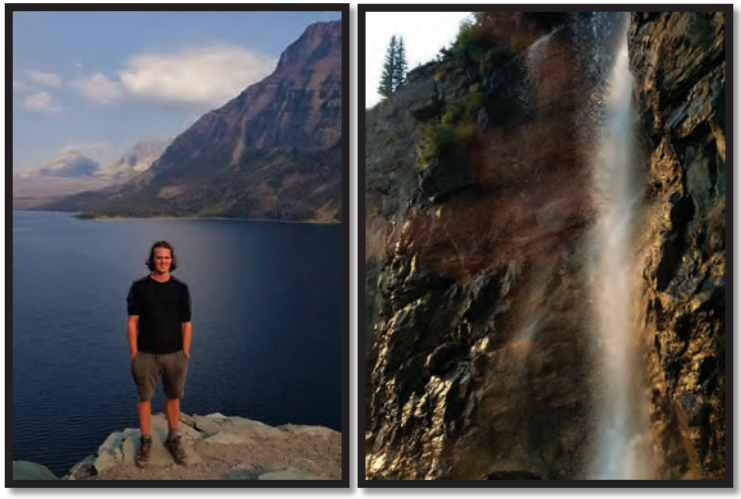
Litter in the Two Medicine Campstore Parking Lot w/Sinopah Mountain (8,271 ft/2,521 m) Looming, GNP, © 2019 J. V. L. Kiser.

We next traveled to St. Mary, MT along Routes 49 and 89 and re-entered GNP. There was widespread evidence of forest fire damage in this part of GNP. The imposing Divide Mountain (8,665 ft/2,641 m) was also in plain view. Continuing on, the Research Team traveled on the Going-to-the-Sun Road toward Logan Pass.

Forest Fire Damage in Front of Divide Mountain, Near St. Mary Entrance, Glacier NP, © 2019 Jonathan V. L. Kiser.

Logan Pass Visitor Center

The stupendous vistas along Going-to-the-Sun Road to the Logan Pass Visitor Center were blanketed in an increasing haze of smoke. The distinct smell of smoke filled the air. We stopped at a number of overlooks to take in the escalating view of Saint Mary Lake below (10 miles/16 km) long and up to 300 ft/91 m deep), were grateful for the brown, animal-proof trash bin found at one of the overlooks (no litter seen nearby), passed through a tunnel carved through the mountain rock, passed a roadside waterfall plunging loudly on its way, and passed forest landscape that still showed heavy damage from the July 2015 Reynolds Creek Fire.



Rhett on Top of St. Mary Lake and Going-To-The Sun Road Waterfall, Glacier NP, © 2019 Jonathan V. L. Kiser (left) and Grant R. E. Kiser (right).

On the asphalt paved walking trail behind the visitor center, we read important interpretive signage about the former Clements Glacier, now a snowfield, at the base of nearby Clements Mountain (elevation 8,760 ft/2,670 m). We also learned about existing glaciers that are disappearing, about keeping a safe 25-yard distance from mountain goats and longhorn sheep, and about pikas, a climate indicator species. In addition, we were entertained by two golden ground squirrels scampering about. While walking about 0.25 miles, the Research Team documented a piece of paper litter on the ground next to a trash bin.

Disappearance of the Clements Glacier, 1914 and 2010 Repeat Photography Signage, Logan Pass, Glacier NP.

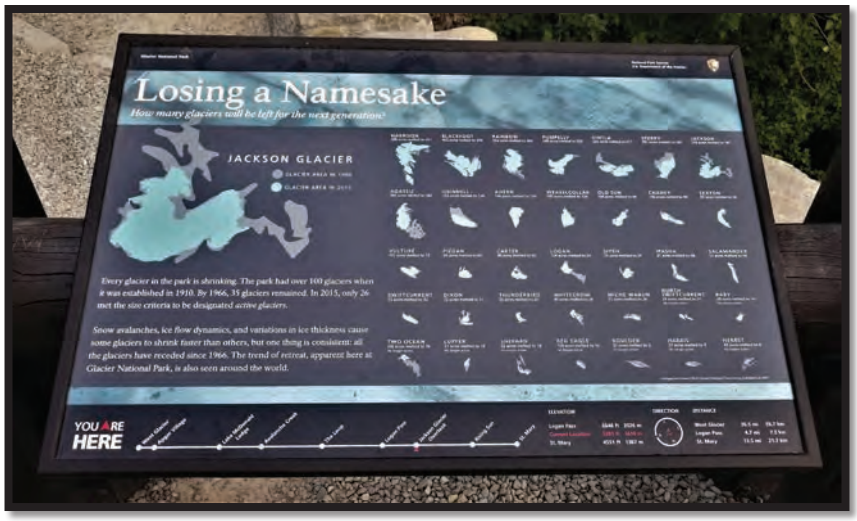
Clements Mountain and Snowfield in August 2018, Glacier NP, © 2019 Jonathan V. L. Kiser.

KEC then completed a slow, drive-by litter survey (due to a lack of time) in the Logan Pass Visitor Center parking lot (mostly empty at that point). 53 pieces of litter were counted as part of this less than comprehensive survey. Details for this "Littered" site (3 on the 1 to 4 scale) (based on not fully covering the entire parking lot) are provided in the KEC GNP Parking Lot Litter Survey Results section below.

On the Road to St. Mary from Logan Pass, Glacier NP, © 2019 J. V. L. Kiser.

On our descending journey east (on Going-to-the-Sun Road), we stopped at different pull-outs, including the Jackson Glacier Overlook. Fabulous interpretive signs discussed the Jackson Glacier (which could be seen at a distance through the haze) and showed how much the remaining GNP glaciers had melted between 1966 and 2015. During this time period, Jackson Glacier shrunk from 316 acres to 187 acres.

The Jackson Glacier in August 2018, GNP, © 2019 J. V. L. Kiser.



Where Are All the Glaciers Going Interpretive Sign, Jackson Glacier Overlook, Glacier NP.

The KEC August 2019 photographs of the select glaciers we had time to see in GNP provide another visual reference point of how global warming is impacting the GNP environment. Fortunately, no litter was documented at the Jackson Glacier Overlook.

Sun Rift Gorge and Baring Falls Trail

Our last stop of the day was at the Sun Rift Gorge leading to the Baring Falls Trail. We quickly admired the Gorge, a deep, narrow passage with dead tree debris piled up, and rushing water passing through it, before continuing on our hike (0.8 miles/1.3 km roundtrip) to Baring Falls. Edible huckleberries were plentiful along the trail and a welcomed part of the post-Reynolds Creek Fire rejuvenating landscape. Thimbleberries (*Rubus parviflorus*) were also there.

Baring Falls was certainly a worthwhile sight for the little amount of effort required to reach it. And then there were the 21 pieces of litter found along the trail and in the small roadside parking lot. Two cigarette butts, 16 pieces of paper, one safety pin (at the falls), and two miscellaneous pieces of plastic (#7).

Baring Falls with Safety Pin Litter (right), Glacier NP, © 2019 Grant R. E. Kiser.

Near St. Mary, Glacier NP, © 2019 Grant R. E. Kiser.

Near St. Mary, Glacier NP, © 2019 Grant R. E. Kiser.

KEC GNP Field Observations: August 14, 2018

This morning we had to once again skirt around the southern and eastern boundaries of GNP due to the worsening Howe Ridge Fire to reach our target destination, Many Glacier. We accessed the Many Glacier entrance (adjacent to Lake Sherburne) via the town of Babb on the Blackfeet Indian Reservation. We then checked in at the Many Glacier Information Center (actually a temporary trailer due to Center renovations) and were advised to spend the day on the Swiftcurrent Pass trail. This was great advice!

Swiftcurrent Pass Trail to the Continental Divide

Our incredible 14+ mile roundtrip hike began at west end of the Swiftcurrent Motor Inn parking lot and took us to Swiftcurrent Pass at the Continental Divide and back. As we hit the trail, directly in front of us was a peculiarly looking Black Longhorn Pine Sawyer Beetle (*Monochamus*). The antennae on this male were twice as long as his body. Sawyer beetles can be quite destructive. If they infect freshly cut pine logs, they can cause a 30–40% loss in value due to the tunnels their larvae bore. Further along the trail there was a plump chipping chipmunk.

Longhorn Pine Sawyer Beetle and Chipmunk on Swiftcurrent Pass Trail, Glacier NP, © 2019 Jonathan V. L. Kiser.

Carrying on, we stopped briefly at Fishercap Lake (where water pollution was seen), passed through a quaking aspen (*Populus tremuloides)* grove, acknowledged edible huckleberry and thimbleberry shrubs, passed Redrock Lake and Falls (absurdly brilliant red rocks!), and journeyed on past Bullhead Lake (making lots of noise to ward of any bears who might be in the area). The very hazy, smoky conditions did not slow us down, but we did make use of face masks brought to lesson impact from the foul air.

Fishercap Lake Water Pollution, Glacier NP, © 2019 Jonathan V. L. Kiser.

Bullhead Lake with Mt. Grinnell, Glacier NP, © 2019 Jonathan V. L. Kiser.

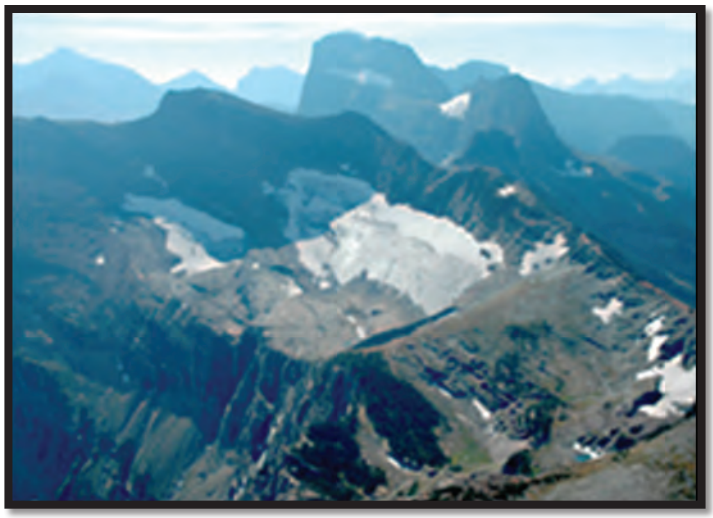
Then came the fun part, a 2,400 ft/732 m elevation gain in less than three miles/4.8 km starting with multiple switchbacks up a steepening trail. This led to the Swiftcurrent Headwall, near a several hundred ft/60+ m waterfall being fed from a melting icefield above. It was then cautious hiking around a number of ascending bends next to a sheer cliff, including one known as the Devil's Elbow (one missed step and you're a goner!), and eventually to more levelized terrain leading to the Continental Divide.

Waterfall Cascading Down the Swiftcurrent Pass Trail Headwall, GNP, © 2019 Jonathan V. L. Kiser.

Near the Continental Divide on Swiftcurrent Pass Trail, Glacier NP, © 2019 Grant R. E. Kiser.

The views of the Swiftcurrent Valley far below and of crazy tall glacial peaks like Mt. Grinnell (elevation 8,852 ft/2,698 m) were dreamlike. Windmaker and Bullhead Lakes were mere ponds of themselves. Loose rocks of all colors and shapes were on dazzling display near the Pass, as were chatty ground squirrels. And to top it all off was a direct view of the melting Swiftcurrent Glacier (55 acres in 1966, 42 acres in 2015)!

Cosmic Rock, Swiftcurrent Pass Trail, Glacier NP, © 2019 Jonathan V. L. Kiser.



Swiftcurrent Glacier from Near Swiftcurrent Pass in 2006, Glacier NP, Source: Public Domain.

Swiftcurrent Glacier (left) in August 2018, Glacier NP, © 2019 J. V. L. Kiser.

Swiftcurrent Glacier Close-Up in August 2018, Glacier NP, © 2019 Jonathan V. L. Kiser.

Jonathan Descending Down the Swiftcurrent Pass Trail, Glacier NP, © 2019 G. R. E. Kiser.

Grant in Front of Mount Grinnell, Glacier NP, © 2019 Jonathan V. L. Kiser.

Masking the Worsening Air Quality on the Swiftcurrent Pass Trail, GNP, © 2019 J. V. L. Kiser.

Retracing our steps down to the Swiftcurrent Valley, we noticed water pollution in Swiftcurrent Creek. The Team then took in more dazzling flora and fauna ranging from wildflowers, what appeared to be an Arctic fritillary butterfly (*Boloria chariclea*), and chipmunk, to thimbleberries, another ground squirrel, and even a bull moose (eating bush and tree vegetation).

Water Pollution in Swiftcurrent Creek, Glacier NP, © 2019 Jonathan V. L. Kiser.

Flora and Fauna Along Swiftcurrent Pass Trail, Glacier NP,

Grant on the Redrock, Swiftcurrent Pass Trail, Glacier NP, © 2019 Jonathan V. L. Kiser.

Redrock Falls, GNP, © 2019 J. V. L. Kiser.

There were friendly hikers as well. And where there are people, the Research Team documented the following ten pieces of litter along the Swiftcurrent Pass Trail: an orange peel, a sunflower

seed, a piece of foil, a piece of paper, three hair ties, a band-aid, a composite snack wrapper, and a rubber O-ring.

Orange Peel Litter High Above Bullhead Lake, Swiftcurrent Pass Trail, GNP, © 2019 J. V. L. Kiser.

Swiftcurrent Pass Trail Parking Lot

At the end of our phenomenal trek, the KEC Research Team completed an in-depth litter survey in the Swiftcurrent Pass Trail Parking Lot. 90 individual pieces were counted. Details for this "Littered Site" (3 on the 1 to 4 scale) are provided in the KEC GNP Parking Lot Litter Survey Results section below.

We then checked out the classic Many Glacier Hotel (built as a

series of rustic chalets by the Great Northern Railway during 1914 – 1915) nestled on the shores of Swiftcurrent Lake.

Many Glacier Hotel Along Swiftcurrent Lake, GNP, © 2019 Jonathan V. L. Kiser.

Over a well-earned beer and dinner, we had a nice conversation with two young ladies from New York who informed us where to find a repeat photo exhibit in the hotel relating to glaciers. This was called, "Losing a Legacy: A photographic story of disappearing glaciers," and included many remarkable past and present pictures. More information about this on-going documentation can be found at the following USGS web link: https://www.usgs.gov/centers/norock/science/losing-legacy-photographic-story-disappearing-glaciers?qt-science_center_objects=0#qt-science_center_objects.

The KEC Research Team, Swiftcurrent Pass Trail, Glacier NP, © 2019 Jonathan V. L. Kiser.

Grinnell Glacier in 1934, Marble Photo, Courtesy of GNP Archives, USGS Losing a Legacy Exhibit in Many Glacier Hotel.

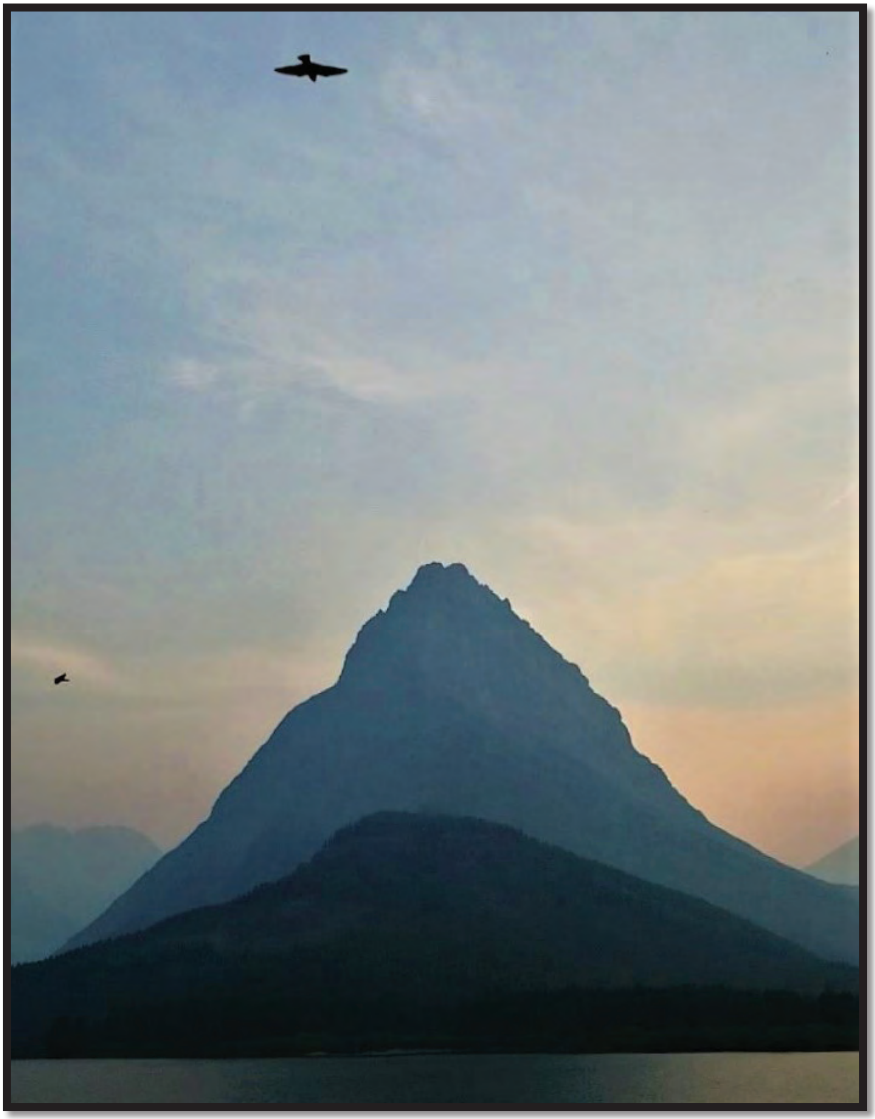
Grinnell Glacier in 2008, Lisa McKeon Photo, USGS, USGS Losing a Legacy Exhibit in Many Glacier Hotel.

Grinnell Glacier 1924, Morton Elrod Photo, USGS
Losing a Legacy Exhibit in Many Glacier Hotel.

Grinnell Glacier in 2008, Lisa McKeon Photo, USGS,
Losing a Legacy Exhibit in Many Glacier Hotel.

The Research Team then spent a few minutes soaking in the outrageous view from the hotel's front porch. Overhead, Cliff swallows (*Petrochelidon pyrrhonota*) emerged in rapid succession from their jug-like nests under the Many Glacier Hotel eaves to

take soaring flight loops around Swiftcurrent Lake. Quite the sight! The stunning lake, the hazy skies, the jagged Grinnell Peak, Mt. Wilbur, Ahern Peaks, and others (reminding us of Milford Sound on New Zealand's South Island) made for an indescribably beautiful scene!



Cliff Swallows in Flight Over Swiftcurrent Lake, Glacier NP, © 2019 Jonathan V. L. Kiser.

Cliff Swallows Nests, Many Glacier Hotel Eaves, Glacier NP, © 2019 Jonathan V. L. Kiser.

And just when we thought it couldn't get any better, as we began our drive out of GNP along Route 3, two grizzly bear cubs, following by their mother in close pursuit, came sliding down the nearby loose rock embankment. As they ran across the road in front of us, the second cub stopped and looked back, making sure mom was coming. All three were then down the road embankment and into the woods out of sight. What an amazing and cute sight to behold! Not to be outdone, a herd of cattle briefly blocked our way a few miles further down the road!!

Cattle Traffic Jam, Near Glacier NP Many Glacier Entrance, © 2019 W. Rhett Kiser.

KEC GNP Parking Lot Litter Survey Results

Provided below, in Exhibits 12 through 15, are the detailed results from KEC's parking lot litter surveys in GNP.

Exhibit 12 – Glacier National Park Litter Survey Details
Apgar Visitor Center Parking Lot

Litter Type	Count	% of Total
Cigarette Butts	106	20
Food (a)	63	12
Glass	---	---
Metal – Ferrous (Steel)	---	---
Metal – Non-Ferrous (Aluminum foil) (b)	21	4
Paper – Miscellaneous	190	37
Paper – Cardboard	---	---
Paper – Chipboard (e.g., Cereal Box) (c)	4	< 1
Plastic – #1 PETE (e.g., Bottles; Cups; Lids)	3	< 1
Plastic – #2 HDPE (e.g., Bags – grocery; Bottles – juice, milk, water)	4	< 1
Plastic – #3 PVC (e.g., Flip-flop; Wrap – food; etc.) (d)	2	1
Plastic – #4 LDPE (e.g., Bags – bread; 6-pack rings); Wrap – cigarette pack) (e)	13	3
Plastic – #5 PP (e.g., Caps – bottle; Cups – clear; Flossers; Straws; Utensils) (f)	16	3
Plastic – #6 PS (e.g., Clips/Tags – bread bag; Cups; Styrofoam)	2	< 1
Plastic – #7 Other (Misc. hard plastic pieces); Multi-layer resin composites)	14	3
Textile (e.g., Cloth, etc.)	---	---
Wood	1	< 1
Other Litter (Specify) (e.g., Composite material – wrappers); Q-tips, etc.) (g)	79	16
Total	**518**	**100%**

Includes: (a) A Dorito chip, a piece of gum, a milkshake, 20 nuts, eight orange peel pieces, 15 peanut shells, 11 pistachio shells; six sunflower seeds, other; (b) One can, one Molson beer can, one dime, a tobacco tin, other; (c) One granola box, a cigarette pack, a coffee holder, other; (d) One shrink-wrap bottle label; (e) Two cigarette wrappers, a flosser, other; (f) A bottle cap, a fork, five fork pieces, a spoon, other; (g) A Lays potato chip bag, four band-aids, two hair bands, one feather, three pieces of rubber, one rubber band, a sticker, two pieces of string, one piece of duct tape, 60 miscellaneous wrappers, one gum wrapper, one popsicle wrapper, other. Source: Kiser Environmental Consulting, 2019.

An "Extremely Littered" site (4+ on the 1 to 4 scale).

Exhibit 13 – Glacier National Park Litter Survey Details
Two Medicine Lake General Store Parking Lot

Litter Type	Count	% of Total
Cigarette Butts	33	21
Food	5	3
Glass	---	---
Metal – Ferrous (Steel)	---	---
Metal – Non-Ferrous (Aluminum foil)	14	9
Paper – Miscellaneous	62	39
Paper – Cardboard	---	---
Paper – Chipboard (e.g., Cereal Box)	1	< 1
Plastic – #1 PETE (e.g., Bottles; Cups; Lids)	---	---
Plastic – #2 HDPE (e.g., Bags – grocery; Bottles – juice, milk, water)	---	---
Plastic – #3 PVC (e.g., Flip-flop; Wrap – food; etc.)	1	< 1
Plastic – #4 LDPE (e.g., Bags – bread; 6-pack rings); Wrap – cigarette pack; etc.)	3	2
Plastic – #5 PP (e.g., Caps – bottle; Cups – clear; Flossers; Straws; Utensils)	5	3
Plastic – #6 PS (e.g., Clips/Tags – bread bag; Cups; Styrofoam)	6	4
Plastic – #7 Other (Misc. hard plastic pieces); Multi-layer resin composites)	---	---
Textile (e.g., Cloth, etc.)	---	---
Wood	1	< 1
Other Litter (Specify) (e.g., Composite material – wrappers); Q-tips, etc.) (a)	28	18
Total	**159**	**100%**

Includes: (a) One band-aid, composite wrappers, other.
Source: Kiser Environmental Consulting, 2019.

A "Littered" site (3 on the 1 to 4 scale).

Exhibit 14 – Glacier National Park Litter Survey Details
Logan Pass Parking Lot

Litter Type	Count	% of Total
Cigarette Butts	1	2
Food (a)	3	5
Glass		
Metal – Ferrous (Steel)		
Metal – Non-Ferrous (Aluminum foil) (b)	4	8
Paper – Miscellaneous (c)	20	38
Paper – Cardboard	---	---
Paper – Chipboard (e.g., Cereal Box)	---	---
Plastic – #1 PETE (e.g., Bottles; Cups; Lids)	---	---
Plastic – #2 HDPE (e.g., Bags – grocery; Bottles – juice, milk, water) (d)	1	2
Plastic – #3 PVC (e.g., Flip-flop; Wrap – food; etc.)	---	---
Plastic – #4 LDPE (e.g., Bags – bread; 6-pack rings); Wrap – cigarette pack; etc.) (e)	3	5
Plastic – #5 PP (e.g., Caps – bottle; Cups – clear; Flossers; Straws; Utensils) (f)	8	15
Plastic – #6 PS (e.g., Clips/Tags – bread bag; Cups; Styrofoam) (c)		
Plastic – #7 Other (Misc. hard plastic pieces); Multi-layer resin composites) (g)	6	11
Textile (e.g., Cloth, etc.) (h)	1	2
Wood		
Other Litter (Specify) (e.g., Composite material – wrappers); Q-tips, etc.) (i)	7	12
Total	**53**	**100%**

Includes: (a) One pretzel and two miscellaneous pieces; (b) One can and three can tabs; (c) Three paper straws and 17 miscellaneous pieces; (d) Grocery bag; (e) Two six-pack rings and one wrap; (f) Three bottle caps, two forks, a knife, a miscellaneous utensil, a straw; (g) A pen, a zip tie, four miscellaneous plastic pieces; (h) A head band; (i) Two pieces of rubber, two rubber bands, a sticker, a hair tie, and a composite wrapper. Source: Kiser Environmental Consulting, 2019.

A "Littered" site (due to less than comprehensive drive-by methodology) (3 on the 1 to 4 scale).

Exhibit 15 – Glacier National Park Litter Survey Details
Swiftcurrent Parking Lot

Litter Type	Count	% of Total
Cigarette Butts	17	20
Food (a)	8	9
Glass	1	1
Metal – Ferrous (Steel)	1	1
Metal – Non-Ferrous (Aluminum foil)	11	12
Paper – Miscellaneous	31	35
Paper – Cardboard	---	---
Paper – Chipboard (e.g., Cereal Box)	---	---
Plastic – #1 PETE (e.g., Bottles; Cups; Lids)	---	---
Plastic – #2 HDPE (e.g., Bags – grocery; Bottles – juice, milk, water)	---	---
Plastic – #3 PVC (e.g., Flip-flop; Wrap – food; etc.)	---	---
Plastic – #4 LDPE (e.g., Bags – bread; 6-pack rings); Wrap – cigarette pack; etc.)	4	4
Plastic – #5 PP (e.g., Caps – bottle; Cups – clear; Flossers; Straws; Utensils) (b)	3	3
Plastic – #6 PS (e.g., Clips/Tags – bread bag; Cups; Styrofoam) (c)	1	1
Plastic – #7 Other (Misc. hard plastic pieces); Multi-layer resin composites)	2	2
Textile (e.g., Cloth, etc.)	---	---
Wood	1	1
Other Litter (Specify) (e.g., Composite material – wrappers); Q-tips, etc.) (d)	10	11
Total	**90**	**100%**

Includes: (a) Two pieces of popcorn, sunflower seeds, other; (b) A utensil, other; (c) A bag clip/tag; (d) Dental floss, two wrappers, other.
Source: Kiser Environmental Consulting, 2019.

A "Littered" site (3 on the 1 to 4 scale).

KEC GNP Feedback/Improvement Recommendations

- At the Apgar Visitor Center parking lot, the Research Team documented the most litter (by far) of all locations visited during our 2018 expedition. The tall grass in the middle and around the parameter of the parking lot made things worse by trapping all types of accumulating litter. Cigarette butt receptacles, anti-litter signs with fines (and enforcement), anti-litter literature inside the visitor center, weed-whacking/otherwise cutting the parking lot grass, use of vacuum equipment to collect the litter, etc., would all help to improve the unacceptable condition of this parking lot. Use of a blowing device would not be as practical, particularly when all of the cars are present during peak hours.

Apgar Visitor Center Parking Lot, Glacier NP, © 2019 Jonathan V. L. Kiser.

- At the Avalanche Creek Campground, adjacent brown bins (one for trash, the other for aluminum recycling) would be improved if a sticker showing acceptable types of materials were attached. Color-coding (i.e., green for recyclables) would be another step in the right direction. Similar bins leading to the restrooms could also benefit in the same manner. Strategically placed cigarette butt receptacles are also recommended.

- At the Trail of Cedars trailhead, anti-litter signage would be helpful.

- In the Two Medicine Campstore parking lot, there is a recycling bin with one select size opening for "Aluminum, Tin, and Steel Only," and two openings for "Plastic Bottles No Lids Please." The lettering on this bin is worn out and needs to be replaced. A sticker with acceptable material images would help further.

Two Medicine Campstore Parking Lot, GNP, © 2019 Jonathan V. L. Kiser.

- Next to the Two Medicine Campstore, attractive combination trash and aluminum recycling bins, and combination paper and glass recycling bins make effective use of symbols and big bold lettering to help people properly segregate their materials.

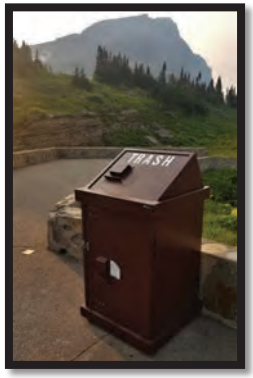
Next to Two Medicine Campstore, GNP, © 2019 J. V. L. Kiser.

- At Two Medicine Lake, it would be useful to add anti-litter messaging to trailhead signage leading to Twin Falls (e.g., North Shore Trail, Old Man Lake North Shore Trail).

- On the Going-to-the-Sun road St. Mary Lake overlook, it would be helpful to provide a color-coded (blue) recycling bin next to the lone brown trash bin that is currently there. An anti-litter sticker on the side of the bins would be a helpful reinforcing message.

Going-to-the-Sun Road Overlooking St. Mary Lake, Glacier NP, © 2019 Jonathan V. L. Kiser.

- Likewise, at the Logan Pass Visitor Center, a color-coded recycling bin (with anti-litter sticker) should be placed next to the lone brown trash bin along the paved walkway. Strategically placed cigarette butt receptacle(s) near the parking lot and visitor center entrance would also be advisable.



Logan Pass Visitor Center, GNP, © 2019 J. V. L. Kiser. Note paper litter on the left.

- Inside the Many Glacier Hotel, the fancy wooden bins for trash and aluminum and trash and paper have the same-sized top openings. This is not ideal. Modification of the recyclable hole (smaller) would help to minimize trash contamination.

Many Glacier Hotel Lobby, Glacier NP,
© 2019 J. V. L. Kiser.

- Outside the Many Glacier Hotel, the collection bins for trash, aluminum, paper, glass, and aluminum/plastic and trash (unmarked) suffer from all being brown. Again, it would help if the recycling bins could be further differentiated with stickers showing acceptable materials. Recycling and trash bin style uniformity -coded with strategic material images) throughout GNP would be ideal.

Outside Many Glacier Hotel, Glacier NP,
© 2019 Jonathan V. L. Kiser.

Chapter 6
Okanogan-Wenatchee National Forest

Washington Pass Overlook, Okanogan-Wenatchee NF, © 2019 Grant R. E. Kiser.

Overview

The Okanogan-Wenatchee National Forest (OWNF) encompasses more than four million acres (1.5 million of which are wilderness areas) along the east slopes of the Cascade Range in Washington state. Managed by the USFS, it lies on the eastern boundary of North Cascades NP. During 2018, OWNF serviced some three million visitors, nearly 700 miles of roadway were maintained, repaired, or improved, and more than 126,000 acres were burned by wildfires. There are 1,246 miles of maintained trails and four downhill ski areas. In addition, about 300 local jobs were supported through timber and other forest products harvested from the OWNF.

The KEC Research Team spent time there the day before heading into North Cascades NP. For additional information about OWNF, go to the following web address: https://www.fs.usda.gov/detail/okawen/home/?cid=FSEPRD535345.

KEC OWNF Field Observations: August 15, 2018

Getting an early start from Kalispell, MT, the Research Team followed Route 93 south to Route 28 to Paradise, MT and then back to Interstate 90 heading west. At Spokane, WA, we diverted onto Route 2 toward Davenport, WA, and took Route 174 toward the Grand Coulee Dam near Mason City, WA. The dam is on the Columbia River and was constructed between 1933 and 1942 to generate hydroelectric power and provide irrigation water. The Grand Coulee has a nameplate-capacity of 6,809 MW, making it the largest U.S. power station. While there, we met with a NPS ranger who provided us with invaluable insights and suggestions regarding how we should best spend our time in the Northern Cascades.

Dirt Mound on the Colville Indian Reservation, © 2019 Grant R. E. Kiser.

Onward we then traveled, following Route 155 through the barren Colville Indian Reservation, then briefly stopped at our overnight accommodation in Omak, WA. Anxious to get at least one hike in for the day, the Research Team passed through Winthrop, WA (a well-preserved old-west town on Route 20) and entered the OWNF where a lot of forest fire damage was evident.

Forest Fire Evidence, Okanogan-Wenatchee NF, © 2019 J. V. L. Kiser.

Washington Pass Overlook

We next stopped at the Washington Pass Overlook along the North Cascades Scenic Highway and were happy to see the same "No Garbage Service Please Pack It Out!" Woodsy Owl sign (i.e., that we had seen on top of Mount Walker) posted on the trailhead message board. We then hiked the short loop trail to an observation point where the Team experienced amazing 180-degree views of prominent jagged Cascade peaks. Most stunning of these was the Liberty Bell Group. This granite rock mountain is known for some of the best rock climbs in Washington and consists of: Liberty Bell Mountain (7,720 ft/2,353 m), Concord Tower (7,560 ft/2,304 m), Lexington Tower (7,560 ft/2,304 m), the North Early Winter Spire (7,760 ft/2,365 m), and South Early Winter Spire (7,807 ft/2,380 m).

Liberty Bell Group from the North (left to right): South Early Winter Spire, North Early Winter Spire, Lexington Tower, Concord Tower, and Liberty Bell, WA Pass Overlook, Okanogan-Wenatchee NF, © 2019 Grant R. E. Kiser. Note: Blue Lake Peak is seen to the left of South Early Winter Spire.

The Research Team also counted the following pieces of litter there: three cigarette butts (two in an "ash tray" found on the trail), two pieces of paper, and a piece of foil. A total of six pieces. Our next stop was the Blue Lake Trail.

Blue Lake Trail

This highly enjoyable 4.4-mile /7.0-km hike (roundtrip) with a 1,050 ft/320 m elevation gain had us passing through subalpine forest to the pristine, transparent, iridescent Blue Lake. Flora and fauna abounded while the striking Liberty Bell Group loomed above.

Liberty Bell Group from the West (left to right): Liberty Bell, Concord Tower, Lexington Tower, North Early Winter Spire, and South Early Winter Spire, Blue Lake Trail, Okanogan-Wenatchee NF, © 2019 Grant R. E. Kiser.

Liberty Bell Group Close-Up, Blue Lake Trail, OWNF, © 2019 Jonathan V. L. Kiser.

There was a Ruffed grouse that took flight before us on the trail, a momma mountain goat and her kid at the edge of Blue Lake, Cascades frogs, pesky mosquitos (*Culicidae*), a marmot, an Arctic fritillary butterfly, and a swarm of yellowjackets (*Vespula vulgaris*) flying in and out of their in-ground nest. Wild flowers added to the mountain spender.

Ruffed Grouse Taking Flight on the Blue Lake Trail, Okanogan-Wenatchee NF, © 2019 Grant R. E. Kiser (left) and W. Rhett Kiser (right).

Blue Lake, Okanogan-Wenatchee NF, © 2019 Jonathan V. L. Kiser.

Blue Lake Trail Fauna and Flora, Okanogan-Wenatchee NF, © 2019 W. Rhett Kiser (left), Jonathan V. L. Kiser (center), and Grant R. E. Kiser (right).

Yellow Jacket House, Blue Lake Trail, © 2019 Grant R. E. Kiser.

The KEC litter count along the trail included: a sunflower seed, three pieces of paper, a piece of string, and two pieces of charred wood at the trailhead. Seven total pieces. The KEC Research Team then completed an in-depth litter survey in the Blue Lake Trail parking lot. 122 total pieces were counted. Details for this "Littered" site (3 on the 1 to 4 scale) are provided below.

We then had an awesome dinner at Carlos 1800 Mexican Grille and Cantina in the old west town of Winthrop, WA. We also admired a fancy wooden trash and recycling bin on the street corner equipped with silhouettes of acceptable materials for each differently shaped slot.

Creative Trash and Recycling Bin, Winthrop, WA, © 2019 Jonathan V. L. Kiser.

KEC OWNF Parking Lot Litter Survey Results

Provided below, in Exhibit 16, are the detailed results from KEC's parking lot litter survey in OWNF.

Exhibit 16 – Okanogan-Wenatchee National Forest
Litter Survey Details, Blue Lake Trailhead Parking Lot

Litter Type	Count	% of Total
Cigarette Butts	15	12
Food (a)	6	5
Glass (b)	1	< 1
Metal – Ferrous (Steel)	---	---
Metal – Non-Ferrous (Aluminum foil)	5	4
Paper – Miscellaneous	48	40
Paper – Cardboard	---	---
Paper – Chipboard (e.g., Cereal Box)	---	---
Plastic – #1 PETE (e.g., Bottles; Cups; Lids)	---	---
Plastic – #2 HDPE (e.g., Bags – grocery; Bottles – juice, milk, water)	---	---
Plastic – #3 PVC (e.g., Flip-flop; Wrap – food; etc.)	---	---
Plastic – #4 LDPE (e.g., Bags – bread; 6-pack rings); Wrap – cigarette pack; etc.)	---	---
Plastic – #5 PP (e.g., Caps – bottle; Cups – clear; Flossers; Straws; Utensils)	1	< 1
Plastic – #6 PS (e.g., Clips/Tags – bread bag; Cups; Styrofoam)	---	---
Plastic – #7 Other (Misc. hard plastic pieces); Multi-layer resin composites)	16	14
Textile (e.g., Cloth, etc.)	---	---
Wood	4	3
Other Litter (Specify) (e.g., Composite material – wrappers); Q-tips, etc.) (b)	26	21
Total	**122**	**100%**

Includes: (a) Orange peel, banana peel; (b) Lens; (c) Snack wrappers, K-cup, string, shoelace, duct tape, lip balm, Q-tip, two band-aids, other.
Source: Kiser Environmental Consulting, 2019.

A "Littered Site" (3 on the 1 to 4 scale).

KEC OWNF Feedback/Improvement Recommendations

Washington Pass Overlook

- The Woodsy Owl "No Garbage Service Please Pack It Out!" sign posted on the trailhead message board is great. This serves as a good example of the type of consistent, recognizable messaging that should be applied by the NPS. Additional Woodsy Owl slogans should be used incorporating the words "No Litter!"

Desirable WA Pass Overlook Sign, OWNF.

- The "Smoke follows beauty. . ." sign on the same message board is also good since it includes an image and the message that toxins are released from openly burning garbage.

WA Pass Overlook Sign, OWNF.

- The Research Team was confused by what appears to be a cigarette ashtray by the Washington Pass observation point. Unless otherwise needed, it should be removed or clearly identified as not being for butts! If it is an ashtray, some type of cover is advisable to prevent butts from blowing away.

Is This Really an Ashtray?!, Washington Pass Observation Point, © 2019 Jonathan V. L. Kiser.

Blue Lake

- The Blue Lake Trailhead roadside sign lettering (i.e., U.S. Department of Agriculture) is showing signs of wear and needs to be repaired.

Worn Sign Along Route 20, Okanogan-Wenatchee NF, © 2019 J. V. L. Kiser.

- In the Blue Lake Trail parking lot, large Woodsy Owl anti-litter signs should be strategically posted (including at the beginning of the access driveway from Route 20).

- At the Blue Lake Trailhead on the message board, a Woodsy Owl anti-litter sign should be included.

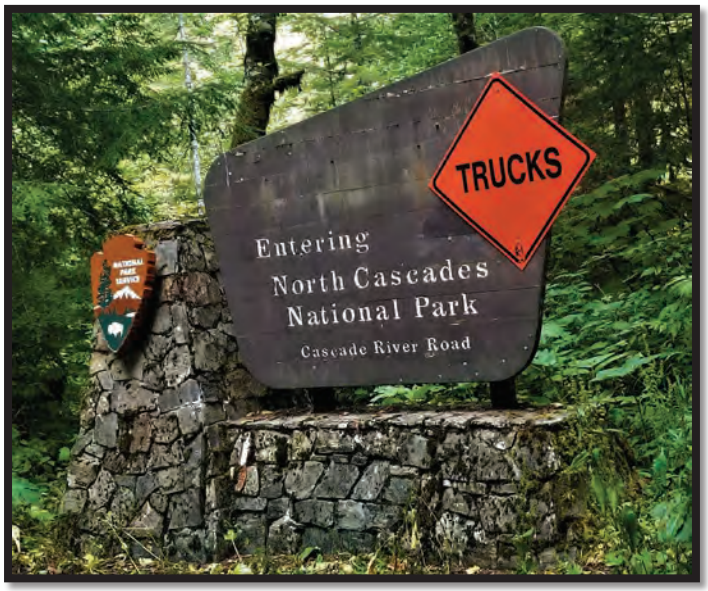
Blue Lake Trailhead Message Board, Missing Woodsy Owl.

- Cigarette butt receptacles and the use of vacuum equipment to pick up litter on a regular basis would further help to improve the condition of this parking lot.

- The "Protect Our Fragile Subalpine Environment" sign near Blue Lake is tremendous. Consider placing similar anti-litter reminders along the trail with pictures and less words.

Informative Blue Lake Environment Protection Request.

Chapter 7
North Cascades National Park



North Cascades NP Cascade River Road Entrance, © 2019 W. Rhett Kiser.

Overview

Located about 115 miles/185 km northeast of Seattle, WA, North Cascades National Park (NCNP) was established in 1968 to preserve the rugged North Cascade Mountain Range region commonly referred to as the North American Alps. NCNP consists of North and South Units (504,781 acres), as well as the Lake Chelan (61,947 acres) and Ross Lake National Recreation Areas (117,575 acres). Nearly 94 percent of the total acreage has a wilderness designation.

Sahale Mountain and Glacier, NCNP, © 2019 J. V. L. Kiser.

The steep, jagged peaks found in NCNP reflect the roots of the collision zone between the slowly moving plates of oceanic rock and the North American Continent that started some 90 million years ago. Goode Mountain, in the South unit, is NCNP's highest point at 9,206 ft/2,806 m. More than 300 glaciers, plus additional snowfields, are currently found on the mountain slopes that feed hundreds of streams, lakes, and ponds and support fisheries, recreation, agriculture, and hydroelectric operations. Most of the melt flows into the Skagit River except in the south where the melt flows into the Stehekin River and on into Lake Chelan.

There are more than 1,600 vascular plant (*Tracheophyta*) species in NCNP, along with the presence of Pacific silver fir (*Abies amabilis*) and the dominant hemlock on the western mountain slopes. The drier eastern mountain slopes have drought-resistant trees, including pine and fir. The lower valleys support ancient western red cedar, and broad-leaved trees, including alder, willow (*Salix*), and poplar (*Populus*). There are also ferns, flowering plants, and hundreds of mushroom (*Agaricus bisporus*) species in NCNP.

North Cascades NP Flora, © 2019 Jonathan V. L. Kiser.

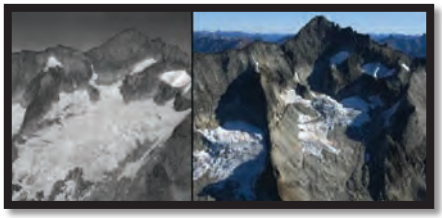
In addition, wildlife is abundant and diverse. Mammals range from black bears, mountain goats, and mule deer, to pikas, marmots, and several bat (*Chiroptera*) species. Bobcats (*Lynx rufus*), mountain lions (*Puma concolor*), gray wolves, lynx (*Lynx canadensis*), wolverines, and grizzly bears have also been spotted in NCNP. And more than 200 bird species have been identified in the NCNP region. These birds range from year-round residents such as American dippers (*Cinclus mexicanus*), red-breasted nuthatches (*Sitta canadensis*), and Steller's jays, to migratory songbirds (*Passeri*) and hummingbirds (*Trochilidae*). Bald eagles (*Haliaeetus leucocephalus*) winter along the Skagit River to hunt spawning salmon. Reptiles, including several snake species and painted turtles (*Chrysemys picta*), and amphibians such as Pacific giant salamanders (*Dicamptodontidae*), are also found in NCNP.

Select NCNP Mammals (left to right): Bobcat, Gray Wolf, Lynx, Wolverine, Source: Public Domain.

During 2017, there were only 30,326 visitors to NCNP North and South Units (attributed to lack of amenities and inaccessibility). How this was determined is unclear since there are no attended entrance gates leading into NCNP that we are aware of.

NCNP Global Warming

With over 300 glaciers covering 42-square miles/68 km, NCNP has about one-third of all the glaciers in the lower 48 states. Unfortunately, all of the glaciers are retreating and, since the late 1800's, about 56 percent of the park's ice cover has been lost. This has translated to a 25 percent summer streamflow reduction in the Skagit River watershed (equivalent to 44 years of water supply for Skagit County) (NPS 2019c).



Vanishing Forbidden Glacier in 1960 and 2005, Sources: NPS, Post (left) and Scurlock (right).

The NPS has observed additional global warming effects in NCNP, including:

- **Diminished mountain snowpack.** Since 1950, the mean winter freezing level has risen about 650 ft/198 m due to an increase of mean winter minimum temperatures of 5° F/-15° C at elevation stations above 4,000 ft/1,219 m.

- **Elevating forest line.** Over the past 50 years, the forest line in NCNP has risen more than 400 ft/122 m.

- **Warming streams and rivers.** With climate-sensitive bull trout requiring water temperatures of less than 55° F/13° C, warming waters are of clear concern. Seven of the 13 major NCNP stream systems already exceed the threshold temperature.

- **Increased Whitebark Pine (*Pinus albicaulis*) mortality.** To date, native mountain pine beetles have killed about 1% of this tree species. As seen in at an extensive level in Rocky Mountain National Park in Colorado, warmer temperatures increase pine beetle reproductive activity which will result in more whitebark pine trees dying.

- **Loss of wetlands.** Extended summer dry periods, reduced snow pack, and higher evapotranspiration (process by which water is transferred from the land and other surfaces to the atmosphere by evaporation) are expected to alter and reduce high-elevation, shallow wetlands in NCNP, along with the habitats for invertebrates and amphibians and water and food for mammals and birds.

- **Changing butterfly distributions.** Warming air temperatures are expected to alter the flight distribution of butterflies (*Rhopalocera*). The Cascade Butterfly Program at NCNP and MRNP allow citizen scientists (volunteers) to work with NPS biologists monitoring the abundance of subalpine butterflies and plant phenology (the study of cyclic and seasonal natural phenomena). NCNP, MRNP,

OWNF, and Mount Baker-Snoqualmie NF use ten 0.6 mile/1.0 km survey routes to monitor trends. These entities are also working collaboratively under the banner of the North Cascadia Adaptation Partnership. The aim of the Partnership is to implement climate adaptation tactics and strategies across six million acres of the northern Cascade Range. More information about volunteering for the Cascades Butterfly Project may be found at: https://www.nps.govarticles/cascades-butterfly-project.htm.

NCNP is taking other actions to address the global warming challenge. During 2009, NCNP became a Climate Friendly Park, following the completion of a baseline greenhouse gas inventory and a Climate Action Plan. Goals of the Plan include:

- Reduce greenhouse gas emissions in the park (i.e., from energy, transportation, waste management, and other sources).
- Increase climate change outreach and education efforts.
- Develop and implement a plan to adapt to climate change.
- Continuously evaluate and improve program performance.

***"…from a scientific standpoint, the evidence that humans have impacted the global climate by causing the warming of .75 °F over the last 50 years is inescapable, especially when looking at the weather records we have from other events like retreating glaciers and shrinking snowpack."* – Philip Mote, Ph.D. Washington State Climatologist, 2018**

KEC NCNP Field Observations: August 16, 2018

With another full day ahead, the Research Team departed Omak, WA and followed Route 20 west toward NCNP. Once inside the park boundary, we stopped at multiple observation points including the Diablo Lake Overlook.

Diablo Lake, NCNP, © 2019 Jonathan V. L. Kiser.

Diablo Lake Overlook Parking Lot

From this scenic vista point, we could see Cascade peaks through the hazy, forest fire-impacted atmosphere, and the powder blue lake (due to glacial runoff) below. The Team also read helpful interpretive signs and learned that Diablo Lake is a man-made reservoir created by damming the Skagit River in 1930. It provides hydroelectric energy to Seattle.

Diablo Lake Overlook, NCNP, © 2019 Jonathan V. L. Kiser.

The KEC Research Team then noted attractive trash and mixed recycling bins in the parking lot and completed an in-depth litter survey. 47 total pieces of litter were counted. Details for this "Somewhat Littered" site (2 on the 1 to 4 scale) are provided in the KEC NCNP Parking Lot Litter Survey Results section below.

Diablo Lake Overlook Litter, NCNP, © 2019 J. V. L. Kiser.

Continuing west on Route 20, we spotted the following additional litter along the road: a piece of foil, an aluminum can, six pieces of paper, a miscellaneous plastic piece (#7), a shirt, and a piece of wood. 11 total pieces.

North Cascades Institute Environmental Learning Center

We next made a quick stop at the non-profit North Cascades Institute Environmental Learning Center next to Diablo Lake. The Learning Center hosts a variety of activities in support of its mission to "conserve and restore Northwest environments through education." The Research Team briefly spoke to an attendant behind the information counter, purchased a few postcards, and looked for litter on the way back to the car (didn't find any!). For more information about the Institute, go to: https://ncascades.org/discover/learning-center.

Gorge Creek Falls Parking Lot

The KEC Research Team continued on Route 20 west, stopping next at the Gorge Creek Falls. There was a great view of the cascading water of Gorge Creek from the roadway bridge, along with a well-placed, roadside anti-cigarette butt litter sign (the only one of its kind we saw).

Gorge Creek Falls, NCNP, © 2019 J. V. L. Kiser.

We next completed an in-depth litter survey in the Gorge Creek Falls parking lot. 20 total pieces of litter were counted. Details for this

"Somewhat Littered" site (2 on the 1 to 4 scale) are provided in the KEC NCNP Parking Lot Litter Survey Results section below.

Gorge Creek Falls Parking Lot, NCNP, © 2019 J. V. L. Kiser.

North Cascades National Park Visitor Center

Our next stop was the North Cascades Visitor Center where we spoke with a ranger about global warming and our pending hike up to the Sahale Glacier (highly recommended by the ranger working near the Grand Coulee Dam). We then observed the Picket Range from behind the visitor center.

Through the hazy conditions we could make out (from left to right): Pinnacle Peak ("The Chopping Block," elevation 6,805 ft/2,074 m), Mount Terror (8,151 ft/2,484 m) and the Terror Glacier (to the right of the prominent ridge barrier), and Mount Degenhardt (8,004 ft/2,440 m).

The Picket Range Sign, Behind NCNP Visitor Center.

The Picket Range (on left), Pinnacle Peak (far left), Inspiration Peak (far right), NCNP, © 2019 Jonathan V. L. Kiser.

The Research Team then completed an in-depth litter survey in the parking lot. 53 total pieces were counted. Details for this "Somewhat Littered" site (2 on the 1 to 4 scale) are provided in the KEC NCNP Parking Lot Litter Survey Results section below.

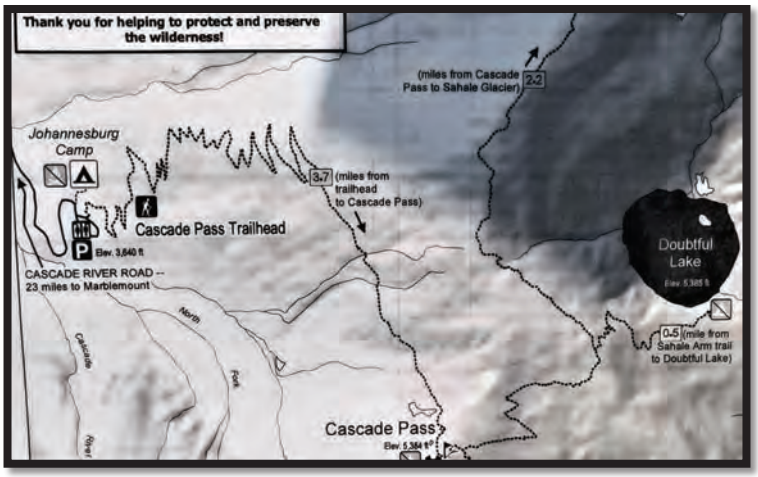
Cascades Peak (left) and Johannesburg Mountain, NCNP, © 2019 Grant R. E. Kiser.

Cascades Pass Trail to Sahale Arm Trail to Sahale Glacier

Onward we traveled to Marblemount where we picked up Cascades River Road and snaked our way along the Cascades River through old-growth forest, over the rocky and very impressive Boston Creek, and ultimately 22 miles/35 km to the Cascade Pass Trailhead Parking Lot (elevation 3,600 ft/1,097 m).

Towering some 4,000 ft/1,210 m above us were the sheer walls of Johannesburg Mountain (elevation 8,200 ft/2,499 m) and Cascade Peak (7,428 ft/2,264 m). Both have hanging glaciers (which flow down the mountainsides and meet an abrupt end at the edge of a cliff) that occasionally slough off ice and rock down to valley below. Helpful signage at the trailhead information board displayed our hike route and separately discussed the Cascades Butterfly Project Subalpine Research.

Boston Creek, Cascade Peak, and Johannesburg Mountain, NCNP, © 2019 Jonathan V. L. Kiser (left) and Grant R. E. Kiser (right).

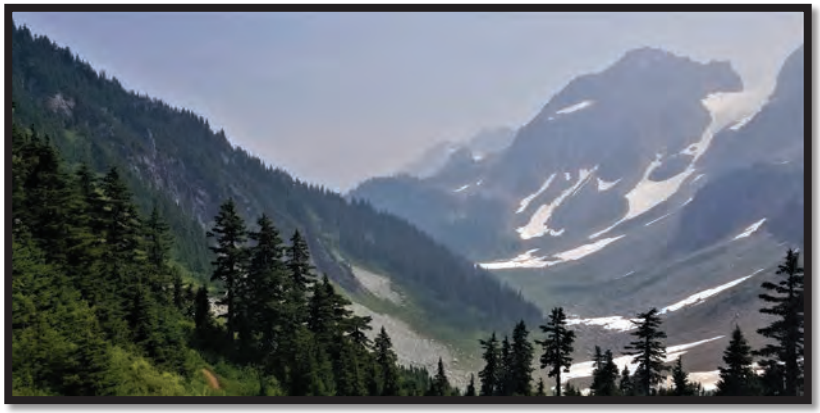


Sahale Glacier Trail Route Map, Cascade Pass Trailhead Parking Lot, NCNP.

As we embarked on our > 13-mile trek (roundtrip) to the top of the Sahale Glacier (a 4,000 foot/1,219 m elevation gain) and back, we weren't quite sure what to expect. We soon found out the hike wouldn't be easy as we steadily climbed through 36 switchbacks! Our next interim stop was Cascade Pass (3.7 miles/5.9 km from the trailhead). Passing across a large rock field, the Pass came into view and there before us was an indescribably beautiful glacier-carved valley.

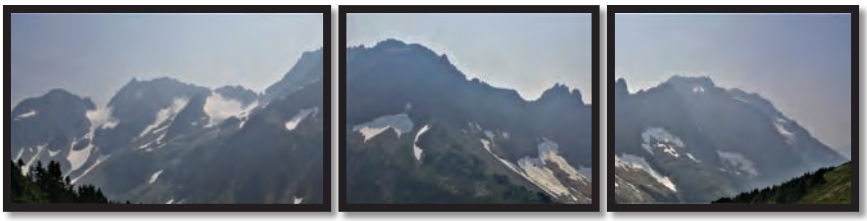
Grant and 36 Switchbacks?!!, Cascade Pass Trail, NCNP, © 2019 J. V. L. Kiser.

Approaching Cascade Pass, NCNP, © 2019 Jonathan V. L. Kiser.



Cascade Pass with Pelton Peak and Yawning Glacier, NCNP, © 2019 Jonathan V. L. Kiser.

On our right was a North Cascades mountain ridgeline with spectacular stature (from left to right): Pelton Peak (7,140 ft/2,176 m), Yawning Glacier (on the east slopes of Magic Mountain), Magic Mountain (7,610 ft/2,320 m), the Cache Col Glacier (on the east slope of Mix-up Peak), Mix-up Peak (7,460 ft/2,274 m), the Triplets (7,240 ft/2,210 m), Cascade Peak, and Johannesburg Mountain. Grant commented, "Simply exquisite!"



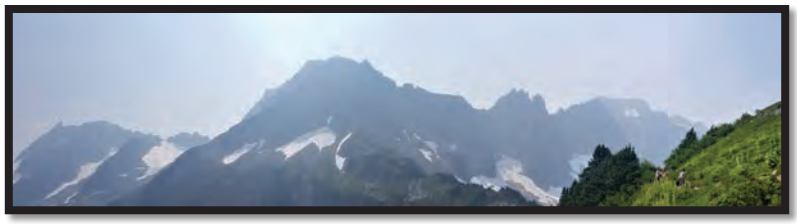
Mountains and Glaciers Above Cascades Pass (left to right): Pelton Peak, Yawning Glacier, Magic Mountain, Cache Col Glacier, Mix-up Peak, Triplets, Cascade Peak, and Johannesburg Mountain as of August 2018, NCNP, © 2019 Jonathan V. L. Kiser.

Unfortunately, both the Yawning and Cache Col Glaciers are dying. During the period of 1850 to 1950, the Yawning Glacier terminus retreated 1,017 ft/310 m and Cache Col Glacier retreated 1,181 ft/360 m. During 1950 to 1979, Yawning gained 115 ft/35 m and Cache Col Glacier lost another 82 ft/25 m. During 1980 to 2006, Yawning lost 246 ft/75 m, and Cache Col lost an additional 236 ft/72 m (Pelto 2019).

Ever in the waste management state of mind, Jonathan next checked out the nearby privy and unfortunately found the immediate area to be less than tidy (two pieces of paper and underwear were discovered on the ground).

Composter Sign at Cascades Pass and Start of Sahale Arm Trail, NCNP, © 2019 Jonathan V. L. Kiser (left) and Grant R. E. Kiser (right).

We then headed up the Sahale Arm Trail leading to the Sahale Glacier and saw a mountain goat in the distance making its way across the rocky terrain. A bit higher up, on yet another switchback, there was a Ruffed grouse settled into the expansive surrounding alpine meadow.



On the Sahale Arm Trail, NCNP, © 2019 Jonathan V. L, Kiser.

The Hills are Alive Below the Sahale Mountain and Glacier, NCNP, © 2019 J. V. L. Kiser.

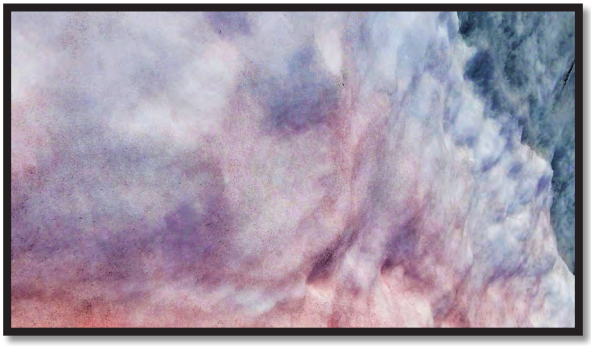
About three quarters of a mile /1.2 km above the Cascade Pass, we crested a rounded shoulder (elevation ~6,000 ft/~1,828 m) and there before us were the unmistakable Sahale Mountain (8,681 ft peak/2,626 m) and Glacier – Sahale is a Native American word meaning "high place." In addition, Doubtful Lake (surface elevation 5,385 ft/1,641 m, 1,201 ft/366 m wide and 1,348 ft /411 m long) could be seen a great distance below.

Doubtful Lake with (left to right) Pelton Peak, Yawning Glacier, Magic Mountain, Cache Col Glacier, and Mix-up Peak, From Sahale Arm, NCNP, © 2019 J. V. L. Kiser.

Continuing upward, we next heard repeated shrill whistling from what turned out to be several marmots standing at attention by their dens communicating with one another. Scanning the steep terrain below the trail, we learned the reason why. A very large black bear was resting on a small snow patch! We watched intently as he got up, turned around, and slowly made his way further down the mountain toward Doubtful Lake. What a mesmerizing sight!

Marmot Sounding the Alarm About Black Bear Below, Sahale Arm Trail, NCNP, © 2019 Grant R. E. Kiser.

The color of the snow the bear had been resting on was a pinkish – red which we first mistook as blood. We soon learned from fellow hikers that this coloration is actually caused by a pervasive single-celled green algae (*Chlamydomonas,* a.k.a. "watermelon snow/snow algae").



Watermelon and Soot Snow, Sahale Arm Trail, NCNP, © 2019 J. V. L. Kiser.

During springtime in alpine regions of the world, a tiny migration occurs. The algae wake up from their dormant state under the snowpack and take advantage of snowmelt to swim to the surface (dividing and photosynthesizing as they go). At the top they turn red and create what is widely known as watermelon or pink snow. Also in the process, the algae absorb UV light, warming not only itself, but melting the surrounding snow (Burdick 2017).

Although watermelon snow has long been known as a natural phenomenon (Aristotle was aware of it some two thousand years ago), scientists have recently discovered that the algae had reduced the amount of sunlight reflected by some glaciers in Scandinavia (Burdick 2017). In the process, there was an increase in the amount of sunlight absorbed causing faster melting. Worse yet, the algae can flourish when it comes into contact with nutrients added by ash, dust, and soot (which themselves accelerate ice sheet melting). Not good.

Forbidden Lake with (left to right) Pelton Peak, Yawning Glacier, Magic Mountain, Cache Col Glacier, Mt. Formidable (in back), and Mix-up Peak, NCNP, © 2019 Grant R. E. Kiser.

Moving upward and onward, we soon passed through a crazy cool and difficult to navigate rock field above the tree line. Small loose rocks (scree) and big ones too surrounded us with dramatic colors and shapes. KEC named one rock formation along the ridge in this area "The Tiki Man!"

The Tiki Man (left), Sahale Arm Trail, NCNP, © 2019 Jonathan V. L. Kiser.

Grant and Rhett Making Their Way Up Sahale Arm, NCNP, © 2019 Jonathan V. L. Kiser.

Looking to our northwest, we saw the jagged ridge line of Eldorado Peak (8,868 ft/2,703 m), and the Eldorado and Inspiration Glaciers below it. Words could not adequately describe the magnificence! Eldorado Glacier is thin and sits on steep smooth granitic rock. In 1979, the Glacier was just beginning to retreat (Pelto 2019). It is about .85 mi/1.3 km long, 1.2 mi/1.9 km wide at its terminus, and descends from 8,400 to 7,000 ft/2,560 to 2,073 m.

Eldorado Glacier is connected to Inspiration Glacier on its upper slopes, and this glacier is about 1.5 mi/2.4 km long, 2 mi/3.2 km wide at its terminus, and descends from 8,500 to 6,800 ft/2,600 to 2,100 m (Wikipedia 2019). As we drew closer to Sahale Glacier, the sites kept getting more spectacular.

Eldorado Glacier, Eldorado Peak, and Inspiration Glacier (left half of picture), NCNP, © 2019 Grant R. E. Kiser.

Rhett and Grant Approaching Sahale Glacier, NCNP, © 2019 J. V. L. Kiser.

Jonathan Nearing Sahale Glacier Camp, NCNP, © 2019 W. Rhett Kiser.

The Research Team then came upon the stark Sahale Glacier Camp (elevation 7,600 ft/2,316 m). This was little more than a series of rocks piled in a circle on flat spots to protect campers from the fierce high-altitude winds.

Sahale Glacier Camp with Yawning Glacier, NCNP, © 2019 Grant R. E. Kiser.

When the Research Team finally reached the bottom of the glacier, Rhett and Grant decided to continue higher toward the Sahale Peak and Jonathan opted to further explore the glacier at this altitude (~7,900 feet/~2,408 m).

Grant and Rhett Traversing Sahale Glacier, NCNP, © 2019 Jonathan V. L. Kiser.

The Sahale Glacier is located on the mountain's south slope and is about 0.25 miles/0.4 km in length. It descends from 8,200 to 7,800 ft/2,500 to 2,400 m. According to North Cascade Glacier Climate Project researchers, between 1850 and 1950, Sahale Glacier retreated 853 ft/260 m. It retreated another 39 ft/12 m from 1950 to 1979 and 197 ft/60 m between 1979 and 2015. Since 1979, it is reported that the glacier has not thinned dramatically (Pelto 2019).

The Sahale Glacier, NCNP, © 2019 Jonathan V. L. Kiser.

Sahale Glacier is separated by ridges from the Quien Sabe Glacier to the north and Davenport Glacier to the northeast. During the period of 1850 to 1950, the Quien Sabe Glacier terminus retreated 4,101 ft/1,250 m. During 1950 to 1979, Quien Sabe gained 180 ft/55 m, and during 1980 to 2006, Quien Sabe lost 512 ft/156 m (Pelto 2019).

Upper Davenport Glacier (left) and Rhett at the Top of Sahale Glacier, NCNP, © 2019 Grant R. E. Kiser.

Getting closer to the mountain summit, Grant exclaimed, "This is surreal but really real. . .wewwww! It's a wonderland!" Wisely deciding to stop at the bottom of the final 80-degree snowfield below the summit (reaching ~8,400 feet /~2,560 m), Rhett remarked, "This last part is really sketch." Surveying the panorama, he then added, "Pretty awesome!"

Grant Pointing Out Steep Grade Near Sahale Mountain Summit, NCNP, © 2019 Grant R. E. Kiser (left) and W. Rhett Kiser (right).

Sahale and Boston Mountain Peaks, NCNP,
© 2019 Grant R. E. Kiser.

North Cascades Splendor, NCNP, © 2019 Grant R. E. Kiser.

Panorama Showing Sahale Peak and Davenport Glacier
(left half of picture), NCNP, © 2019 Grant R. E. Kiser.

As they began their descent, Grant ventured closer to the mountain side edge and captured some tremendous views of the adjacent Davenport Glacier (0.20 miles/0.32 km in length, resting between 8,000 and 7,500 ft/2,400 and 2,300 m) (Wikipedia 2019).

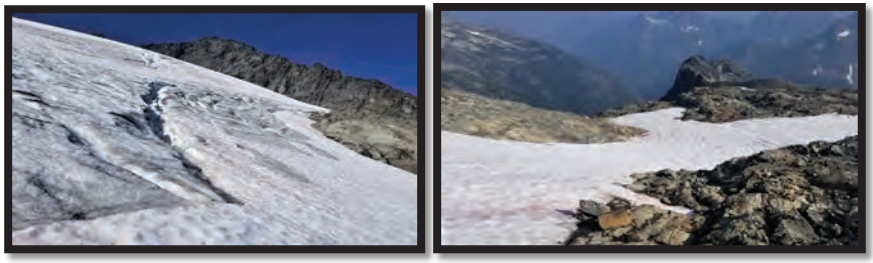
Grant Sliding Down Sahale Glacier, NCNP, © 2019 W. Rhett Kiser.

In the meantime, Jonathan crossed the Glacier below, getting an up-close and personal look into multiple, deep aqua blue crevasses (falling in one of these would have been certain death), along with black and pink-colored ice. As alluded to above, the black coloration is caused by soot and dust (with one possible source, we encountered the next day, being pollution from the Marathon – Anacortes Oil Refinery located to the southwest on Fidalgo Island). It's known as cryoconite and is the product of man-made air pollution and forest fires.

Sahale Glacier Crevasses, NCNP, © 2019 J. V. L. Kiser.

Sahale Glacier and Peak, NCNP, © 2019 J. V. L. Kiser.

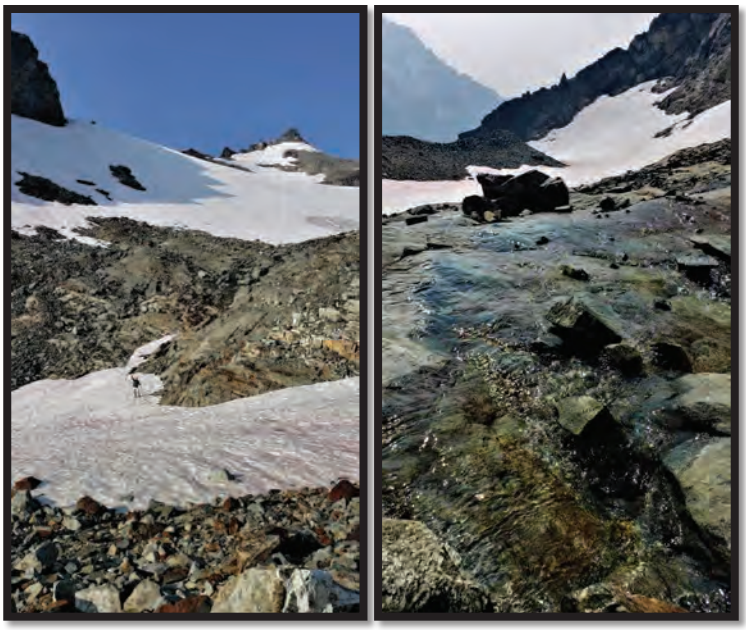
Jonathan sadly listened to the glacial creak and moan and watched it melt, drip by drip by drip near several rock out-croppings. It was intense, insane, and totally humbling. He said, "Sitting alone with the glacier was truly a highpoint in a lifetime experience! Standing next to a deep crevasse in the middle of the Sahale Glacier was certainly one of the most intense things I have ever done." Jonathan added, "Even with the hazy conditions due to widespread wild fires, this area is unbelievable, a true heaven on earth!" From the Sahale Glacier vantage point, the Research Team was able to get an unforgettable birds-eye look at the region's peaks, valleys, and glaciers.



The Sahale Glacier, NCNP, © 2019 Jonathan V. L. Kiser.

Goodbye Sahale. . .Drip, Drip, Drip, NCNP,
© 2019 Jonathan V. L. Kiser.

During our descent, we saw more amazing rocks (including a large chunk of quartz), were greeted once again by multiple marmots, witnessed glacial melt racing toward Doubtful Lake, communicated with two hikers who were looking to reach the Sahale Campground, enjoyed improved lighting over Cascade Pass, and had a race with the setting sun as it persistently creeped out from behind a distant mountain ridge. The last mile of our adventure (in the middle of the 36 switchbacks) was completed in relative darkness. Fortunately, we brought along our pocket flashlights!



Jonathan Leaving Sahale and Glacial Melt Heading Toward Doubtful Lake, NCNP, © 2019 W. Rhett Kiser (left) and Jonathan V. L. Kiser (right).

Rhett Pointing Out Where the Research Team Traveled and Doubtful Lake, Sahale Glacier, and Peak, NCNP, © 2019 Jonathan V. L. Kiser.

Descending Sahale Arm Trail, NCNP, © 2019 Jonathan V. L. Kiser.

Marmots Still Standing Guard, Sahale Arm Trail, NCNP, © 2019 Jonathan V. L. Kiser.

North Cascades Sunset, NCNP, © 2019 W. Rhett Kiser.

Following the Sun, NCNP, © 2019 Grant R. E. Kiser.

In terms of litter documented during the hike, we spotted the following 17 items: a piece of gum, an orange M&M candy, a ferrous cylinder, a piece of wire, six pieces of paper, a bottle cap (#5), three miscellaneous plastic pieces (#7), a head band,

underwear next to the human waste toilet composter at Cascade Pass, and a piece of red rubber. Back in the parking lot, we documented four additional large pieces of paper with the aid of our Jeep headlights.

Litter on Cascade Pass Trail, NCNP, © 2019 Jonathan V. L. Kiser.

Litter on Sahale Arm Trail, NCNP, © 2019 Grant R. E. Kiser.

More Litter on Sahale Arm Trail, NCNP, © 2019 Grant R. E. Kiser.

Litter in Cascade Pass Trailhead Parking Lot, NCNP,
© 2019 Jonathan V. L. Kiser.

KEC NCNP Parking Lot Litter Survey Results

Provided below, in Exhibits 17 through 19, are the detailed results from KEC's parking lot litter surveys in NCNP.

Exhibit 17 – North Cascades National Park Litter Survey Details
Diablo Lake Overlook Parking Lot

Litter Type	Count	% of Total
Cigarette Butts	12	25
Food (a)	5	11
Glass	---	---
Metal – Ferrous (Steel)	---	---
Metal – Non-Ferrous (Aluminum foil) (b)	4	9
Paper – Miscellaneous	16	34
Paper – Cardboard	---	---
Paper – Chipboard (e.g., Cereal Box)	---	---
Plastic – #1 PETE (e.g., Bottles; Cups; Lids)	---	---
Plastic – #2 HDPE (e.g., Bags – grocery; Bottles – juice, milk, water)	---	---
Plastic – #3 PVC (e.g., Flip-flop; Wrap – food; etc.)	---	---
Plastic – #4 LDPE (e.g., Bags – bread; 6-pack rings); Wrap – cigarette pack; etc.) (c)	1	2
Plastic – #5 PP (e.g., Caps – bottle; Cups – clear; Flossers; Straws; Utensils)	---	---
Plastic – #6 PS (e.g., Clips/Tags – bread bag; Cups; Styrofoam)	---	---
Plastic – #7 Other (Misc. hard plastic pieces); Multi-layer resin composites)	1	2
Textile (e.g., Cloth, etc.) (d)	2	4
Wood	---	---
Other Litter (Specify) (e.g., Composite material – wrappers); Q-tips, etc.) (e)	6	13
Total	**47**	**100%**

Includes: (a) Three pieces of orange peel and two pistachio shells; (b) Three foil pieces and one can tab; (c) A bottle wrap; (d) A cloth hair band and a miscellaneous piece of cloth; (e) Five composite wrappers and a pencil. Source: Kiser Environmental Consulting, 2019.

A "Somewhat Littered" site (2 on the 1 to 4 scale).

Exhibit 18 – North Cascades National Park Litter Survey Details
Gorge Creek Falls Parking Lot

Litter Type	Count	% of Total
Cigarette Butts	3	15
Food (a)	3	15
Glass	---	---
Metal – Ferrous (Steel)	---	---
Metal – Non-Ferrous (Aluminum foil) (b)	3	15
Paper – Miscellaneous	5	25
Paper – Cardboard	---	---
Paper – Chipboard (e.g., Cereal Box)	---	---
Plastic – #1 PETE (e.g., Bottles; Cups; Lids)	---	---
Plastic – #2 HDPE (e.g., Bags – grocery; Bottles – juice, milk, water)	---	---
Plastic – #3 PVC (e.g., Flip-flop; Wrap – food; etc.) (c)	1	5
Plastic – #4 LDPE (e.g., Bags – bread; 6-pack rings); Wrap – cigarette pack; etc.)	---	---
Plastic – #5 PP (e.g., Caps – bottle; Cups – clear; Flossers; Straws; Utensils)	---	---
Plastic – #6 PS (e.g., Clips/Tags – bread bag; Cups; Styrofoam)	---	---
Plastic – #7 Other (Misc. hard plastic pieces); Multi-layer resin composites)	1	5
Textile (e.g., Cloth, etc.) (d)	2	10
Wood	---	---
Other Litter (Specify) (e.g., Composite material – wrappers); Q-tips, etc.) (e)	2	10
Total	**20**	**100%**

Includes: (a) Two sunflower seeds and a pistachio shell; (b) One foil;
(c) An ear plug; (d) A shoelace and miscellaneous piece of fabric;
(e) Dog poop. Source: Kiser Environmental Consulting, 2019.

A "Somewhat Littered" site (2 on the 1 to 4 scale).

Exhibit 19 – North Cascades National Park Litter Survey Details
NCNP Visitor Center Parking Lot

Litter Type	Count	% of Total
Cigarette Butts	20	38
Food (a)	4	8
Glass	---	---
Metal – Ferrous (Steel)	---	---
Metal – Non-Ferrous (Aluminum foil) (b)	2	4
Paper – Miscellaneous	11	21
Paper – Cardboard	---	---
Paper – Chipboard (e.g., Cereal Box)	---	---
Plastic – #1 PETE (e.g., Bottles; Cups; Lids)	---	---
Plastic – #2 HDPE (e.g., Bags – grocery; Bottles – juice, milk, water)	---	---
Plastic – #3 PVC (e.g., Flip-flop; Wrap – food; etc.) (c)	3	5
Plastic – #4 LDPE (e.g., Bags – bread; 6-pack rings); Wrap – cigarette pack; etc.)	3	5
Plastic – #5 PP (e.g., Caps – bottle; Cups – clear; Flossers; Straws; Utensils)	---	---
Plastic – #6 PS (e.g., Clips/Tags – bread bag; Cups; Styrofoam)	---	---
Plastic – #7 Other (Misc. hard plastic pieces); Multi-layer resin composites)	2	4
Textile (e.g., Cloth, etc.)	---	---
Wood	2	4
Other Litter (Specify) (e.g., Composite material – wrappers); Q-tips, etc.) (d)	6	11
Total	**53**	**100%**

Includes: (a) One piece of gum, two pumpkin seeds, and a tea bag; (b) One beer bottle cap and one can (at lookout point); (c) Food wrapping; (d) One water bottle label and five wrappers.
Source: Kiser Environmental Consulting, 2019.

A "Somewhat Littered" site (2 on the 1 to 4 scale).

KEC NCNP Feedback/Improvement Recommendations

- Generally speaking, the litter survey results in NCNP revealed less litter than in the other three national parks visited during this expedition. This, no doubt, reflects the substantially fewer people who visit this park. Nonetheless, litter was found in every parking lot and on each trail that we traveled. To combat this, consistent, eye-catching, prominent messaging at each trailhead and in parking lots stressing to "Please Don't Litter" would help. Consistently-styled, color-coded recycling (blue) and trash (brown) bins (plus strategically-placed cigarette receptacles) located near these signs would also be useful.

- At the Diablo Lake Overlook, the attractive recycling bins (green tops) and trash bins (brown) were effectively differentiated. "Mixed Recycling" on the recycling bins would be improved with stickers showing acceptable materials. Cigarette butt receptacles, anti-litter signs (with fines), and the use of vacuum equipment to pick up litter, would all help to improve the condition of this overlook area.

Diablo Lake Overlook Recycling and Trash Bins, NCNP, © 2019 J. V. L. Kiser.

- At the Gorge Creek Falls parking lot, the solid green recycling bins would benefit from the addition of stickers showing acceptable materials, and consistent materials messaging. There is some confusion relating to acceptable

recyclables, since some bins allowed mixed materials, others only said "recycle" and had openings allowing only bottles and cans, still others specified "bottles and cans," and still others indicated "#2 HDPE Plastic Bottles & Jugs Only." At the trailhead, there is yet another different style trash and recycling bin (same color, made of wood, with no acceptable material images). A clearer, more unified system will facilitate people doing the right thing and reduce contamination in the recyclables stream. Anti-litter signage should also be added to the trailhead message board near the parking lot.

Gorge Creek Falls Parking Lot, NCNP, © 2019 Jonathan V. L. Kiser.

Gorge Creek Falls Parking Lot Trailhead, NCNP, © 2019 J. V. L. Kiser.

- The "Flick It Ticket $950 Fine" sign along Route 20 east at Gorge Creek Falls was a welcomed sight (and the only one we documented in NCNP). More of these signs should

be strategically placed along Route 20 in both directions, plus in popular parking lots. They should be supported with nearby, strategically-placed cigarette receptacles. The fines should also be increased. The use of license plate reader technology and publicized parking monitoring cameras should be considered. Litterers caught in the act should be sent a citation and their names published in areas newspapers.

Gorge Creek Falls Route 20 East Sign, NCNP, © 2019 Jonathan V. L. Kiser.

- At the North Cascades Visitor Center, consistent, additional strategically-placed recycling/trash bins and cigarette butt receptacles, plus anti-litter signs (with fines), and the use of vacuum equipment to pick up litter should be considered.

- In the Cascades Pass Trailhead parking lot, eye-catching, prominent anti-litter reminders would likely help to improve the trail and parking lot litter realities we discovered.

KEC Final Day Field Observations: August 17, 2018

The final day. Leaving our overnight accommodations in Mt. Vernon, WA, we decided to rest our overexerted bodies and explore (by Jeep) the inner WA coastline north of Seattle. Heading west on Route 20, we crossed onto Fidalgo Island and soon noticed the Marathon – Anacortes Oil Refinery spewing nasty smoke north toward NCNP (about an hour away).

After a brief drive through Anacortes, WA, we headed south on Route 20. The Team then passed over the most impressive Deception Pass suspension bridge onto Whidbey Island. The bridge is 177 ft/54 m high and was built during the 1930s by the Civilian Conservation Corps. Our next stop was in the Deception Pass State Park.

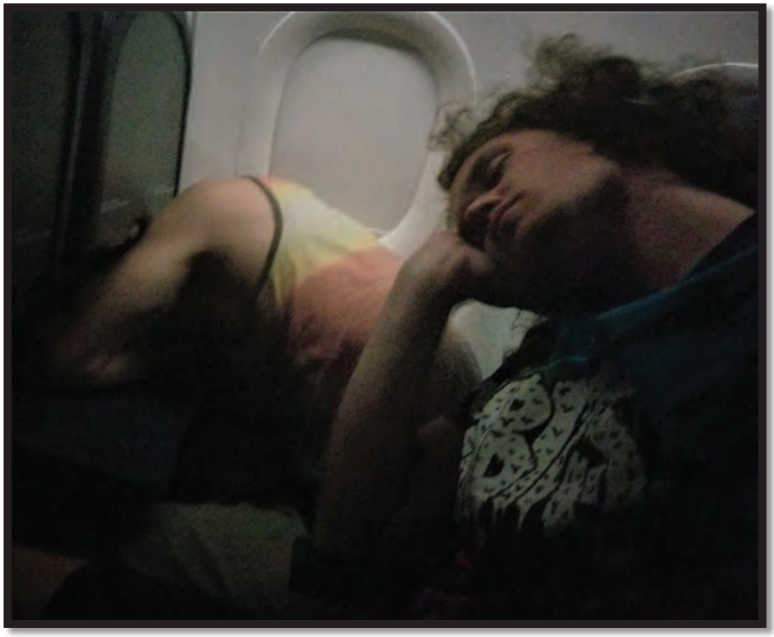
Grant at Deception Pass Bridge, Deception Pass State Park, © 2019 Jonathan V. L. Kiser.

In the Deception Pass State Park, we undertook a 0.5 mile (roundtrip) slow-paced walk via the Pacific NW Trail down to the water's edge in Macs Cove. Grant then made a quick dash to the top of the nearest jagged cliff for one final great view.

Prominent Anti-Litter Sign, Deception Pass State Park, © 2019 Jonathan V. L. Kiser.

There were beautiful sea stones covering the shores along the Strait of Juan de Fuca, as the suspension bridge loomed overhead. We then completed a really slow-paced 0.5 miles/0.8 km (roundtrip) walk along the Goose Rock Perimeter trail (never did see that darn goose!). No litter survey was executed.

After exploring a number of other interesting island destinations, we endured a terribly congested commute back to the Seattle airport along an overly busy Interstate 5 south. This was overshadowed by a truly wonderful final Washington State meal at Anthony's in the airport. Out of this world salmon tacos!! We then caught the redeye flight back to Baltimore, MD.



A Well-Earned Rest on Flight Back East,
© 2019 Jonathan V. L. Kiser.

During our drive home to the Shenandoah Valley of Virginia, the Research Team marveled at the remarkable scientific expedition we had just completed!

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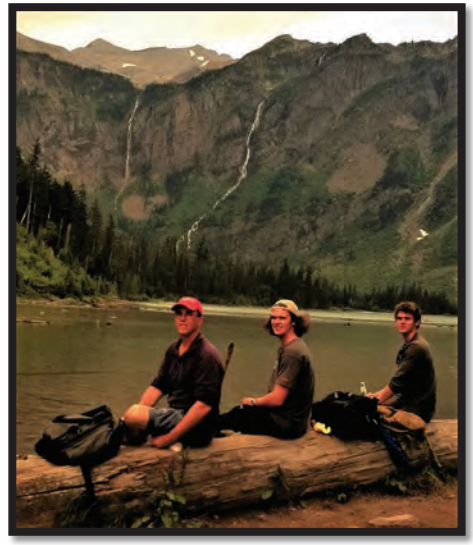

The KEC Research Team: Jonathan, Rhett, and Grant, Avalanche Lake, Glacier NP, August 2018.

Jonathan V. L. Kiser, M.B.A. has been the President of Kiser Environmental Consulting since 1995 and provides services in the following areas: Program management, technical research, writing, and analysis, quality assurance/control/management, full cost accounting assessments, due diligence, benchmarking surveys, environmental audits, regulatory compliance, and strategic planning. His areas of subject matter expertise include: NEPA, integrated waste management, recycling, renewable energy, global warming/climate change, air quality, pollution control, energy conservation, and litter management.

Mr. Kiser has more than 40 years of experience working on behalf of public and private sector organizations internationally. Jonathan's early environmental efforts were for the Sanibel-

Captiva Conservation Foundation dating back to 1976. While there, he tagged alligators and sea turtles, completed an invasive flora species field investigation, and photo-documented barrier island erosion patterns. From 1991 to 1995, Jonathan served as a founding Director for the Integrated Waste Services Association in Washington, D.C. Prior to this, he was a Manager at the National Solid Wastes Management Association, Director of the Medical Waste Institute, and was the Energy Conservation Project Liaison for Case Western Reserve University.

Jonathan received his M.B.A. from George Washington University, and his B.S. in Resource Economics from the University of New Hampshire. He has more than 90 environmental publications and has taught extensively on related topics. Mr. Kiser is a Research Associate with the Columbia University Earth Engineering Center for Sustainable Waste Management in New York City, a member of James Madison University's Collaboration for Environment, Health and Safety, and a long-standing member of the Solid Waste Association of North America.

William Rhett Kiser is a 2019 graduate from Virginia Polytechnic Institute and State University (a.k.a. Virginia Tech) with a B.S. in Chemical Engineering. Mr. Kiser has accepted a position with ABB, a pioneering technology leader. He is a researcher, an outdoor enthusiast, and international traveler. Rhett has seven environmental publications to his credit, including:

1. Striving Towards Zero Waste to Minimize Your Community's Carbon Footprint. Jonathan, Kea, W. Rhett, and Grant Kiser. Kiser Environmental Consulting. February 2014.

2. Environmental Issues Confronting Our Western National Parks and Other Ecological Misadventures. Jonathan, W. Rhett, and Grant Kiser. Kiser Environmental Consulting. December 2014.

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1. Striving Towards Zero Waste to Minimize Your Community's Carbon Footprint. Jonathan, Kea, W. Rhett, and Grant Kiser. Kiser Environmental Consulting. February 2014.

2. Environmental Issues Confronting Our Western National Parks and Other Ecological Misadventures. Jonathan, W. Rhett, and Grant Kiser. Kiser Environmental Consulting. December 2014.

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Global Warming and Litter in Our Northwest National Parks is the latest in an on-going KEC effort to document essential environmental issues faced by protected areas in the United States. This book features the results from our August 2018 scientific expedition in the following national parks: Olympic, Mount Rainier, Glacier, and North Cascades. Observations from the Okanogan-Wenatchee National Forest in Washington state and other locations are also included.

Critical discussions relating to global warming indicators such as retreating glaciers, increased fire risks, stronger wind events, and biodiversity impacts are included, along with ground-breaking litter, waste management, and recycling insights. Hundreds of dramatic photographs add compelling visual evidence, and KEC improvement recommendations make this a must read for all public land managers and other interested stakeholders.

It is the authors' desire that this book will generate greater awareness relating to alarming global warming impacts, the persistent litter problem, and inadequate waste management practices found in some of America's most sacred places. In the process, we hope this will help to bring about real-world human actions to reverse these conditions.

Jonathan Kiser, MBA, is the KEC President and author of more than 90 publications on timely environmental issues. Rhett and Grant Kiser, KEC Research Team members, are outdoor enthusiasts and recent college graduates from Virginia Tech.

"It is up to all of us to respect and preserve these national treasures so they will endure for future generations."

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