Kiser Environmental Consulting™
Research • Analysis • Results

Solving National Park Issues in the West

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

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On the front cover (clockwise from the top left): Pine beetle damage in Rocky Mountain National Park; Off-trail footprints scarring the landscape and leading to litter in Arches National Park; Water pollution in Yosemite National Park; and the disappearing Wheeler Peak Glacier in Great Basin National Park.

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Executive Summary

Background/Overview

During July 2013, the Kiser Environmental Consulting (KEC) research team (consisting of Jonathan, Rhett, and Grant Kiser) undertook an 18-day expedition to document the environmental health of national parks in the western United States. Flying to Denver, Colorado from Baltimore, Maryland, the research team then drove 4,098 miles in 16 days through vast stretches of amazing landscapes. Our national parks journey started at Rocky Mountain National Park in Colorado and led us west through Arches National Park in Utah, Great Basin National Park in Nevada, Yosemite National Park and Redwood National and State Parks in California, and Crater Lake National Park in Oregon.

KEC National Parks Expedition, July 11 – 28, 2013,
© 2015 Jonathan V. L. Kiser.

We interviewed rangers at each of the six national parks visited, obtained National Park Service (NPS) literature, and completed environmental field observations. The research team's field work included a comprehensive litter survey at each park.

Our goal was to first document environmental challenges faced by each national park through photographs, written observations and findings, and a published report. The subsequent aim was to use the published report to generate awareness of the many environmental hurdles faced by our national parks, and to define ways that the NPS, the general public, industry, environmental organizations, and others can do their part to make conditions better. It is up to all of us to respect and preserve these national treasures so they will endure for future generations.

Investigation Methodology

At each of the National Parks KEC visited, at least one park ranger was interviewed and asked the following survey instrument questions:

- What are the primary environmental problems currently facing the park?
- Where can we see evidence of this in the park?
- What are the sources of these problems? Inside the park? Outside the park?

- What is the park's plan of action for addressing these problems?

- What are the primary hurdles to addressing these problems?

- What can the general public and other stakeholders do to help solve these problems?

- How has climate change impacted the park?

- What overall environmental quality rating would you give the park on a scale of 1 to 4?

  1 = Excellent
  (Intact, highly viable, secure from threat)

  2 = Good

  3 = Fair (Somewhat degraded, vulnerable to continued degradation)

  4 = Poor (Imperiled)

- Rate for each of the following mediums/areas: Air Quality, Water Quality, Land Quality, and Park Infrastructure.

It is important to point out that the issues reported by the park rangers or are those that otherwise reflected in this report do not represent all of the challenges faced by the parks. There is much work to be done to improve the condition and properly preserve our national parks.

In addition, information provided in the Overview sections throughout this report was gathered primarily from NPS brochures and the NPS website. Featured scientific nomenclatures were secured from Internet searches. Further, the rating scale used by KEC for the park ranger interviews mirrored the one used by the National Parks Conservation Association (NPCA) in the June 2011 NPCA report, "The State of America's National Parks."

The research team separately rated each park visited using a comparable scale. Given the short period of time we had to spend in each location, our ratings were based on field observations as we traveled through the parks by car, made roadside stops, stopped at park visitor centers, and hiked on scenic excursions. Table ES Exhibit 1 summarizes KEC's field review criteria pertaining to park environmental and infrastructure quality. The 1 to 4 quality rating (detailed above) was applied bearing the review criteria in mind for each medium/focus area.

ES Exhibit 1 – KEC National Parks
Environmental & Infrastructure Review Criteria

Medium/Focus Area	Review Criteria
Air Quality	Clearness, any visible pollution sources, ease of breathing
Water Quality	Cleanliness, flow, any visible pollution, aquatic life
Land Quality	Any visible pollution, erosion, migration disruptions, other damage
Park Infrastructure	Quality of the roads, buildings, adequacy of signage and staff resources

For the comprehensive litter survey conducted at each park, KEC counted all of the litter encountered, noting the type of material and location where it was found. We used a 1 to 4 litter rating scale which is detailed in ES Exhibit 2.

ES Exhibit 2 – KEC Litter Rating System

Litter Rating	Correlating Site Description
1	Clean Site (No Litter)
2	Site had Some Litter
3	Site was Littered
4	Site was Extremely Littered

This rating system was adapted from the Keep America Beautiful litter scale, and applied in the field in a manner that allowed the research team to compare the amount of litter in one park relative to the others. What amazed and

disappointed us was the extent to which careless people litter within the sanctity the national parks.

Key Findings

Primary investigation findings are provided in the following exhibits:

- ES Exhibit 3 – Ranger environmental and infrastructure ratings for each of the six parks.
- ES Exhibit 4 – KEC environmental and infrastructure Ratings for each park.
- ES Exhibit 5 – KEC national park litter survey results.

ES Exhibit 3 – NPS Ranger
Environmental & Infrastructure Ratings

	Rocky Mountain	Arches	Great Basin	Yosemite	Redwood	Crater Lake
Air Quality	2.0	2.8	1.0	2.0	1.0	1.0
Water Quality	2.0	2.0	1.0	1.0	2.0	0.5
Land Quality	1.0	2.5	3.0	1.0	2.0	3.0
Infrastructure	2.5	2.8	2.0	3.0	2.0	4.0
Individual Park Average Rating	**1.9**	**2.5**	**1.8**	**1.8**	**1.8**	**2.1**
Combined Avg.	**2.0**					

Scale: 1 = Excellent; 2 = Good; 3 = Fair; 4 = Poor.

ES Exhibit 3 reveals that park rangers in three of the six parks visited gave their park Excellent ratings for both Air Quality and Water Quality. Two of the six rangers interviewed indicated Land Quality was in Excellent condition, and none reported better than a Good rating for Park Infrastructure.

When the four individual environmental quality and infrastructure ranger ratings from each individual park are totaled and averaged, the overall park ratings ranged from better than Good for four parks (Rocky Mountain, Great Basin, Yosemite, and Redwood) to better than Fair for the remaining two parks (Arches and Crater Lake).

When the average park ranger ratings for each of the six national parks are combined, the overall average environmental quality and infrastructure rating for all six parks was 2.0 (Good).

By comparison, ES Exhibit 4 shows that KEC rated four of the six parks visited with an Excellent Air Quality rating (Rocky Mountain, Arches, Redwood, and Crater Lake), two parks with Excellent Water Quality (Great Basin and Crater Lake), and no park higher than Very Good (1.5) for Land Quality or Infrastructure.

ES Exhibit 4 – KEC Park
Environmental & Infrastructure Ratings

	Rocky Mountain	Arches	Great Basin	Yosemite	Redwood	Crater Lake
Air Quality	1.0	1.0	1.5	1.5	1.0	1.0
Water Quality	3.0	2.5	1.0	2.0	2.0	0.5
Land Quality	3.0	1.5	3.0	2.0	2.0	2.0
Infrastructure	2.0	2.0	3.0	2.5	1.5	4.0
Individual Park Average Rating	**2.3**	**1.8**	**2.1**	**2.0**	**1.6**	**1.9**
Combined Avg.	**1.9**					

Scale: 1 = Excellent; 2 = Good; 3 = Fair; 4 = Poor.

When the four individual environmental quality and infrastructure KEC ratings from each individual park are totaled and averaged, the overall park ratings ranged from better than Good for three parks (Arches, Redwood, and Crater Lake), to Good for one park (Yosemite), to better than Fair for the remaining two parks (Rocky Mountain and Great Basin).

When the average KEC rating for each of the six national parks visited are combined and averaged, the overall average environmental quality and infrastructure rating was 1.9 (slightly better than Good).

ES Exhibit 5 – KEC Park Litter Survey Results

	Rocky Mountain	Arches	Great Basin	Yosemite	Redwood	Crater Lake
Avg. Litter Rating:	2	2.5	2	3.5	3	3

Scale: 1 = No Litter; 2 = Some Litter; 3 = Littered Site;
4 = Extremely Littered Site.

The comprehensive litter survey results shown in ES Exhibit 5 clearly indicate that, on average, some litter was found at most sites visited within each park. Yosemite National Park was the most littered from an overall, comparative perspective.

It should be noted that, while some site specific litter details and ratings are included in this report, most of the litter results presented are from a higher-level perspective.

Detailed litter results, on a site by site, individual material basis are provided in the separate KEC publication: *Litter Crisis in the National Parks.* This report includes photographic evidence of litter throughout each of the parks visited and specific recommendations on how to effectively address this widespread problem. It is available in the Reports For Sale/News Section of the KEC website at: www.kecgreen.com.

KEC National Park Improvement Recommendations

For each of the six national parks visited, the research team generated a number of improvement recommendations based on our discussions with park officials, literature reviews, and field observations. Note that many of the recommendations provided for one park are also applicable to the other parks.

In other words, report recommendations listed for one park should not be viewed as mutually exclusive with the other parks (even if a particular recommendation is not specifically listed in the other park chapters). For example, additional funding for staffing and park maintenance/improvements is something all of the parks can use. Strategically placed anti-litter signage is another need that applies to all of the parks.

It is also advisable to consider applying successful programs already in place at one park to other parks. For instance, the use of hybrid shuttle buses to reduce air emissions and crowding in the parks that has been successful in parks like Yosemite, may be applicable elsewhere.

Other improvement recommendations provided for one or more of the parks we visited include:

- Tracking the source(s) of observed water pollution and implementing appropriate mitigation measures.

- Expanding education efforts for the general public and other stakeholder groups about fire management issues.

- Installing additional signs at trail heads urging visitors to stay on the designated trails.

- Proactively engaging with the planning process in areas surrounding the parks to minimize the potential impact(s) of proposed development.

- Working with other government agencies and the U.S. Congress to establish no fly zones over the park(s) to minimize the impact of noise pollution.

Also note that some of the recommendations offered by KEC may already be in place to varying degrees at the national parks. In such cases, an expanded effort will most likely be helpful. The scope of this investigation did not allow for an exhaustive assessment of all park programs.

Chapter 1

Rocky Mountain National Park

Overview

The Rocky Mountains were created some 70 million years ago by great earth forces. Some of the exposed granite rocks in Rocky Mountain National Park (RMNP) are at least 1.3 billion years old. During the Ice Age, three major glacial episodes also helped to sculpt the scenery.

RMNP Eastern Entrance, © 2015 Jonathan V. L. Kiser.

There are three distinct ecosystems in the park: The Montane (below 9,000 feet of elevation), the Subalpine (9,000 to 11,400 feet), and the Alpine (above 11,400 feet).

The Montane ecosystem consists of ponderosa pine (*Pinus ponderosa*) forests and picturesque mountain meadows. North-facing slopes escape the drying impact of the sun, and it is on these hillsides where douglas fir (*Pseudotsuga menziesii*), ponderosa pine, lodgepole pine (*Pinus contorta*), and some engelmann spruce (*Picea engelmannii*) grow.

The Subalpine ecosystem features long, cold winters and short, cool summers. Among the park forests, those found in the Subalpine ecosystems are at the highest elevation. They are also subject to the most wind and snow and include Engelmann spruce and Subalpine fir.

The Alpine ecosystem features alpine tundra above the tree line. Fierce weather conditions allow only the heartiest of plants and animals to exist, including low-growing mat and cushion plants, and mammals like yellow-bellied marmots (*Marmota flaviventris*) and pikas (*Ochotona_ princeps*).

RMNP was established as a national park in 1915, one year before the creation of the NPS. It contains more than 110 mountain peaks above 10,000 feet in elevation, and holds 72 named peaks above 12,000 feet, including Longs Peak, the tallest in the park at 14,259 feet. In addition, there are over 150 alpine lakes.

95 percent of the park is protected under the 1964 Wilderness Act, and it is managed in a manner to preserve its wilderness character and natural conditions. In the RMNP visitor brochure, the NPS notes that, “In wilderness,

people can sense being a part of the whole community of life on Earth."

In total, RMNP contains 415 square miles which amounts to 265,000 total acres. During 2014, NPS reported that 3.43 million visitors came here.

Rhett Pointing Out Litter at RMNP Entrance,
© 2015 Jonathan V. L. Kiser.

KEC Field Observations: July 13, 2013

Arriving in RMNP from Estes Park, it was variably sunny, beautiful summer day. Air quality was judged to be Very Good (1.5), based on visibility at the park entrance. At the park entrance sign, the research team documented some litter (2 out of 4 on the scale). We also noted that there is a mobile home park located directly across the street.

RV Park across the Street from RMNP Entrance,
© 2015 Jonathan V. L. Kiser.

The research team then interviewed a park ranger at the Beaver Meadows Visitor Center (park headquarters, elevation 7,840 feet). Details from this interview are provided in the Environmental Challenges, Environmental Solutions, and Ranger Environmental Ratings sections below. The Beaver Meadows Visitor Center is a National Historic Landmark building that was designed by the Frank Lloyd Wright School of Architecture at Taliesin West.

Our journey through RMNP followed along the Trail Ridge Road (Route 34) west toward Grand Lake, Colorado. This Road ultimately reached an elevation of 12,183 feet and, according to the NPS, is the highest major highway in North America.

Once we left the Beaver Meadows Visitor Center, we stopped a few miles down the road to photograph a fenced-in area, aimed at keeping elk out and allowing young trees to grow.

Protective Tree Fencing, © 2015 Jonathan V. L. Kiser.

As the research team continued on and the road began to climb in elevation, there was clear evidence of pine beetle damage to many of the trees.

At our next stop, Many Parks Curve, there were a lot of tourists and quite a bit of litter (2+ on the scale).

RMNP Many Parks Curve Vista, © 2015 Grant R. E. Kiser.

Onward along the Trail Ridge Road we stopped at the Rainbow Curve. Up to this point in the trip, the RMNP infrastructure we had observed (e.g., visitor's center, roads, walls, viewing platforms, interpretive signs) was in Good shape. The Air Quality improved, from a visibility

standpoint, to Excellent, and we were now witnessing remarkable vistas from above the tree line.

The research team next took a four mile hike along the Ute Trail (located at 19 mile marker on the Trail Ridge Road). While doing so, a jet passed overhead creating noticeable noise pollution. There was also a very friendly and inquisitive yellow-bellied marmot, which scampered in and around the rocks and posed for our photos.

Marmot along the Ute Trail,
© 2015 Grant R. E. Kiser.

On way back to the car, there was noise pollution from cars, small trucks, and motorcycles passing along the Trail Ridge Road. The vehicle traffic in RMNP was considerable on this day.

Vehicles along the Trail Ridge Road,
© 2015 Jonathan V. L. Kiser.

Continuing our journey through the park, there was a short traffic jam at Iceberg Pass to allow two elk to pass across the street amidst many motor vehicles. It was quite the sight and fortunately no one hit an elk!

Traffic Jam and Ms. Elk, © 2015 W. Rhett Kiser.

At the Lava Cliffs Parking Area (elevation 12,000 feet), we fortunately did not notice any litter but did see 20 or more elk. Some were about 300 yards from the road, and many more were observed resting below in the valley. The research team also took note of an impressive icefield on the nearby mountain side.

The next destination was the Alpine Visitor Center (elevation 11,796 feet). A park ranger there provided important, additional details relating to climate change impacts within RMNP. Details from our interview with this ranger are provided in the Environmental Challenges section below.

Alpine Visitor Center,
© 2015 Jonathan V. L. Kiser.

Continuing on to Poudre Lake, on the north end KEC encountered very noticeable, colorful water pollution swirling around, and slowly making its way down stream. The source of this pollution could not readily be determined.

Poudre Lake Water Pollution,
© 2015 W. Rhett Kiser.

Next we stopped at Lake Irene (elevation 10,748 feet), and noticed that a historical log cabin near the parking lot

had a damaged chimney. This was the first physical sign of infrastructure deterioration we encountered in RMNP.

Lake Irene Chimney Infrastructure Issue, © 2015 Jonathan V. L. Kiser.

A chipmunk (*Tamias*) greeted us near the cabin, and there was also a sign indicating, "Caution Notice of Herbicide Application from August 2013 to October 2013." One could only wonder if these were the type of chemicals visible in Poudre Lake.

Lake Irene Chemical Application, © 2015 Jonathan V. L. Kiser.

On the short trail leading to Lake Irene, one of the trail fences was partially knocked down. We were once again reminded that park infrastructure in a state of disrepair is aesthetically unappealing. Also, the historic nature of much of this infrastructure makes the need to fix it all the more important. The lack of NPS funding is no doubt a primary reason why we are witnessing this type of deterioration.

Collapsed Fence at Lake Irene, © 2015 Jonathan V. L. Kiser.

Lake Irene itself, while relatively small in size, was beautiful and clean. As we made our way along the short trail to the lake, colorful birds (unidentified) were flying among the tall pines. They made their presence known with loud, distinctive calls.

Traveling next toward the Holzwarth Historic Site (elevation 8,884 feet), there was quite a bit of slope erosion along the road side and multiple places were the barrier walls had been knocked down or collapsed.

We also noticed a lot of unsightly, systematic cutting of trees next to the road (i.e., 25-feet back). A park ranger at the Holzwarth Historic Site subsequently informed us that this was the work of outside contractors hired to create a "safety zone" to prevent trees from falling on the road. The ranger noted that there is so much work to be done at RMNP that NPS staff can't handle it all. The research team was very surprised to see that the contractors were allowed to leave unsightly dead tree remnants along the roadway embankments.

Contractor Clear Cut, © 2015 Jonathan V. L. Kiser.

Even worse, we could plainly see that pine beetle damage was excessive on this western part of the park. Almost entire mountain sides had dead trees stemming from warmer park temperatures leading to exponential beetle population growth.

The park ranger at the Holzwarth Historic Site claimed optimistically that the park's lodge pole pine forest will

survive since history has shown that every 100 to 150 years there is a forest replacing event.

Extensive Bark Beetle Damage in RMNP,
© 2015 Jonathan V. L. Kiser.

For example, in 1851 a major fire came through the area and consumed nearly 12,000 acres. The pine beetle damage is a much slower process than fire, and the ranger further noted there is a lot of new growth in the forest understory.

The ranger also discussed fire management efforts within RMNP, the details regarding which are provided in the Environmental Solutions section below.

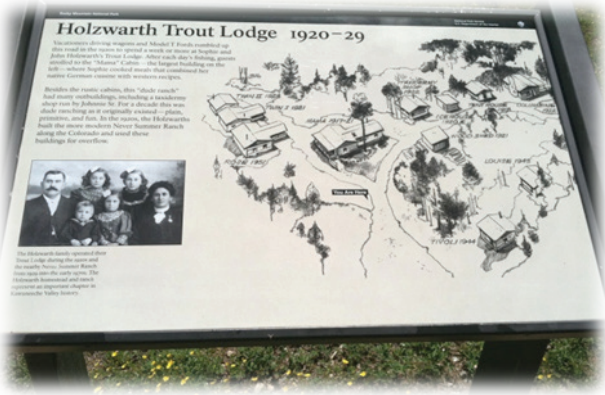
(For more information about the RMNP fires refer to: Franke, M. A., T. L. Johnson, I. W. Ashton, and B. Bobowski. 2015. Natural resource vital signs at Rocky Mountain National Park. Natural Resource Report NPS/ROMO/NRR—2015/946. National Park Service, Fort Collins, Colorado.)

The ranger then informed us about environmental challenges resulting from the Grand Ditch, a man-made water diversion ditch that was clearly visible as a lateral line below the mountain ridge top. Details about the Grand Ditch are provided in the Environmental Challenges section below.

The Holzwarth Historic Site is approached from the Trail Ridge Road by walking across the Kawuneeche Valley. Most of the infrastructure at the site was in Good shape, with the exception of collapsed fencing.

Fence Collapse at Holzwarth Historic Site,

The NPS provides guided tours of this historic location, comprised of a series of cabins built by the Holzwarth family as a guest ranch in the early 1900s. The ranch is located near the Colorado River headwaters, which we got a close view of while crossing a small bridge.



Holzwarth Lodge Interpretive Sign. Source: Public Domain.

Arriving back in the parking lot, a slightly odd-shaped recycling bin came into view. While the types of acceptable materials were not specified on the container, visitors appeared to be using it as there was no noticeable litter in the parking lot area.

Recycling Container in Holzwarth Parking Lot, © 2015 Jonathan V. L. Kiser.

Environmental Challenges (NPS Perspective)

Climate Change

According to the ranger KEC interviewed at the Beaver Meadows Visitor Center, climate change is the primary environmental challenge facing the park. Warmer temperature trends are negatively impacting pikas (an indicator species for detecting ecological effects of climate change), causing them to lose their natural habitat by forcing them into higher elevations.

The ranger also reported that the NPS is monitoring the snow pack depth in RMNP; how quickly it melts, and how water conditions are changing. Snow melt tracking at Bear Lake during the 1981 – 2001 period (a 20-year average), versus the last decade, indicates the snow is melting two to three weeks earlier now. In addition, there has been a drought during the 2010 – 2013 period.

At the Alpine Visitor Center, KEC interviewed another park ranger who provided additional details about the impacts of climate change in RMNP. Since 2010, there have been dramatic changes in the park and quite a bit less snow fall. Ever since the Alpine Visitor Center was built in 1965, the NPS has recorded temperature and weather statistics and climate change is evident.

Climate Change Tracking at Alpine Visitor Center,
© 2015 Jonathan V. L. Kiser.

The Alpine Visitor Center ranger specified that, compared to where they used to see active pika dens 10 – 20 years ago, current dens keep getting higher and higher in elevation. Historically, pika dens were found right around tree line at an elevation of about 11,500 feet, depending upon the slope. Unfortunately, there are fewer dens now being verified at this elevation.

This is significant because pikas can't survive where temperatures are more than 75 degrees Fahrenheit (^{o}F). One day during 2012, the temperature outside the Alpine Visitor Center reached 76 ^{o}F. This was the first time this has happened since temperatures have been recorded at the weather station. Pikas are running out of space and scientists predict that, if current trends continue, they will be extinct worldwide by 2100. In the meanwhile, pikas can still best be viewed in RMNP at the Rock Cut stop along the Trail Ridge Road.

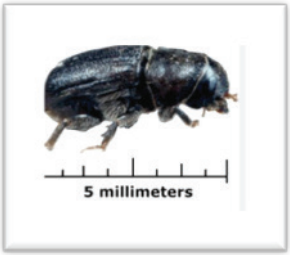
The results of a 40 year study called the Pikas in Peril Project were scheduled to be available by the fall of 2013. (For more information about this project refer to: National Parks Service. "Pikas in Peril Research in Rocky Mountain National Park," Rocky Mountain Network Resource Brief, January 2012.)

American Pika. Source: Public Domain.

Pine Beetles

Another big environmental challenge faced by RMNP is the extensive damage being done by mountain pine beetles (*Dendroctonus ponderosae*) to the lodge pole, ponderosa, and limber pine trees (*Pinus flexilis*). These native insects, that are part of the natural ecosystem, are killing trees in epidemic proportions within the park.

Pine beetles are historically active for a 10-year cycle and then lay dormant for 30 – 40 years. They would typically hatch larvae in the summer but now hatch them both during the spring and later in the summer. Due to warmer temperatures, they are now reproducing twice a year. One beetle can now multiply into a million beetles in 18 months (park ranger interview)!



Pine Beetle. Source: Public Domain.

If the pine trees are healthy and well-watered, they can withstand pine beetle attacks by producing sap. However, due to dry conditions, the trees are not well hydrated and many have succumbed to beetle attacks that started 10 to 12 years ago. This is how long it takes for the fungus generated by the larvae to actually kill a tree. About six years into the cycle, the pine needles turn reddish and fall off. The dry, dying trees are very susceptible to fire at this stage. By the end of the cycle, the trees turn grey and are dead.

Tree Cross Section Showing Pine Beetle Damage, © 2015 Jonathan V. L. Kiser.

Air Quality Issues

According to the park ranger we interviewed at the Beaver Meadows Visitor Center, the park is impacted by excess nitrogen levels from various Denver-based sources (e.g., agricultural, urban, industrial). This translates into nitrogen deposition in the alpine lakes, causing the rapid growth of algae. This plant is short lived, begins to decay, consumes dissolved oxygen in the water, and creates dead zones in which fish and other marine animals and plants cannot survive. Algae increases serve as an early indicator of declining aquatic ecosystem health.

Another impact resulting from increased nitrogen deposition pertains to old-growth engelmann spruce forests on the east side of the Continental Divide. These trees are showing significantly altered chemistry compared to similar forests on the west side, in a manner that may impact the trees' ability to withstand pests.

More than half of the nitrogen emissions in RMNP are from sources of ammonia (NH_3) primarily from fertilizer and livestock. Less than half are generated by atmospheric reactions for nitrogen oxides (NOx) from combustion sources such as power plants, automobiles, fires, generators, and industrial sources. (For more information about nitrogen deposition in RMNP, refer to: Colorado Department of Public Health and Environment, National Park Service, U.S. EPA. "Rocky Mountain National Park Initiative: 2012 Nitrogen Deposition Milestone Report." June 2014.)

Another air quality issue relates to ozone, which is produced by the interaction of nitrous oxides (NOx), heat, and sunlight. Car exhaust from Front Range communities like Denver and Boulder is the main source of NOx being pushed up into RMNP. The park is subject to high ozone levels during warm summer afternoons and evenings.

The NPS reports that 11 different RMNP plant species are susceptible to injury from exposure to high ozone levels. To better understand this dynamic, the NPS is conducting a baseline study of foliar injury (i.e., leaf damage), on a "field glass" magnification level.

The physical evidence of ozone damage may be seen in random distributions of tiny black dots on the leaves. Tiny black dots found in a more organized, in a row pattern are caused by insects.

Other air quality issues are less of a problem in RMNP since winds typically blow west to east and low pressure on the Front Range of the Rockies helps to keep the more polluted air away from the park. NPS reports that visibility in RMNP is generally Good since there are no invading point sources. The ranger also mentioned that they are able to measure minute amounts of air pollution originating from Asia.

Elk Management

Proper management of North American elk *(Cervus elaphus*) is another issue in RMNP. When the park was established, wolves (*Canis lupus*) and grizzly bears (*Ursus*

arctos horribilis) were removed. That left mountain lions (*Puma concolor*) as the only remaining elk predator. When RMNP stopped elk control during the 1960s, the population skyrocketed and they over-grazed the young aspen shoots and willows. This led to a 90% decline in the beaver (*Castor*) population since they used the young aspen shoots to build their dams. Currently, the park's elk population fluctuates between 600 and 800 in the winter.

North American Elk in RMNP,
© 2015 Jonathan V. L. Kiser.

A related issue (featured in the "Oh, Ranger!" Guide to the Parks, RMNP Edition) involves the impact of continuing residential and commercial development surrounding the park. Resulting issues of concern include: The disruption of animal migratory routes, increased pollution and erosion, and disturbances to vegetation, soils, and natural vistas. Park resource stewardship staff continually works to maintain the balance of the park ecosystems, which go beyond park boundaries. Cooperative efforts between the park and the state of

Colorado toward this end include managing elk populations and monitoring air quality.

North American Elk Cow, © 2015 Jonathan V. L. Kiser.

The Grand Ditch

The Grand Ditch poses yet another environmental issue in RNMP. According to the NPS, the Grand Ditch is about 14 miles long, 20 feet wide, and 3 feet deep (on average). Streams and creeks that flow from the highest peaks of the Never Summer Mountains are diverted into the ditch, which flows over the Continental Divide at La Poudre Pass (10,175 feet elevation), delivering the water into the Cache La Poudre River for eastern plains farmers.

The ditch was started in 1890 and completed in 1936. It diverts 20 to 40 percent of the Never Summer Mountains runoff and delivers an average of 20,000 acre feet. It significantly impacts the ecology in the valley below, and the NPS has fought in court to reduce the amount of diverted water.

Grand Ditch across the Never Summer Mountains,
© 2015 Jonathan V. L. Kiser.

In May 2003, a 100 foot section of the ditch breached about 2.4 miles south of La Poudre Pass, causing the water to cascade down the slopes and into the Colorado River. The flood left a visible scar on the mountainside. The Water Supply and Storage Company was ordered to pay $9 million in damages to RMNP as a result of the breach.

Environmental Solutions (NPS Perspective)

Education

According to the ranger we interviewed at the Beaver Meadows Visitor Center, RMNP's main approach to the pine beetle issue is education. RMNP officials are informing the public that climate change is causing nature to do unnatural things. The natural occurrence of beetle damage is happening with unnatural frequency and magnitude due to warmer temperatures. The good news is that the tree species will not get wiped out. This type of message, along with education outreach efforts relating to

air quality, and how to reduce your carbon footprint, have been incorporated into RMNP's Ranger Rick education program.

The NPS provides signage in the park, and offers additional information brochures highlighting these kinds of issues. Part of the purpose of these outreach efforts is to make people aware of what can or should be done on an individual level to improve or avoid the problems of concern. If people are unaware that their actions are part of the problem, it is unlikely that they will change their harmful behavior.

The research team has observed that, too often, people are only concerned about the here and now and what is convenient for them. On-going educational efforts are needed if there is any hope of making enough people aware that their actions need to be in harmony with the natural sanctuary of the national park. Successfully accomplishing this would help improve and preserve park conditions for generations to come.

Air Quality

Solutions to the nitrogen emissions problem in RMNP include improving combustion systems and reducing industrial and tailpipe emissions. Tighter fuel-economy regulatory standards and new technologies aimed at reducing industrial emissions causing ozone and visibility problems will also reduce air emission (i.e., NOx) deposition into the park.

In addition, NH_3 emissions reaching RMNP may be reduced through livestock producers improving feed conversion efficiency, by improving manure management methods, and by matching plant needs with fertilization rates on farms and in commercial and residential landscapes. (For more information about air quality, refer to: Colorado Department of Public Health and Environment, National Park Service, U.S. EPA. "Rocky Mountain National Park Initiative: 2012 Nitrogen Deposition Milestone Report." June 2014.)

Preservation

In the "Oh, Ranger!" Guide to the Parks, RMNP Edition, the preservation section highlights the following suggestions of what visitors can do on the preservation front: 1) Keep wildlife wild. Don't feed the animals since it will create a dependence and lead to a disruption in the balance of nature; 2) Reuse and recycle water bottles, plates, and cups. Refill water bottles, use biodegradable packaging, recycle aluminum cans and glass bottles, and use recycling receptacles available throughout the park; 3) Pack a small litter sack. Pack out litter you encounter along the trail and have the satisfaction in knowing you improved the park's condition; and 4) Volunteer in the parks.

Another preservation solution occurred when RMNP established a back-country permit system in 1972 to limit the number of backpackers using specific areas at any given time. This prevents favorite destinations from being "loved to death."

In addition, park restoration to pre-settlement conditions is another priority. Examples include: 1) Removing a nine-hole golf course in Moraine Park; 2) Closing the downhill skiing facility at Hidden Valley in 1992 and area restoration; 3) Dismantling of several lodges built before the park was established; 4) Eliminating three dams and an aqueduct built before the park and restoring the former reservoirs; 5) Prohibiting damaging recreational activities, such as bicycles on trails and off-road recreational vehicle use; and 6) Restoring old logging roads to their natural condition.

Greening Your Park Initiative

The RMNP News publication indicates that, as part of a "Greening Your Park" notification, plastics #1 through #7, glass, and aluminum can be recycled in park campgrounds and at major park locations. There is also a request to help RMNP reduce the use of plastic water bottles and to bring your own reusable water containers and refill them at park visitor centers.

Elk and Vegetation Management Plan

RMNP's Elk and Vegetation Management Plan was implemented in 2008 to protect willow (*Salix*) and aspen (*Populus tremula*) stands from being wiped out by browsing elk. In the process, important habitat for other wildlife is protected using enclosure fences on the elk winter ranges in the Moraine Park, Beaver Meadows, Kawuneeche Valley, and Horshoe Park areas. The park ranger indicated that the base of these fences are typically 18-inches off the ground so smaller critters can pass under

them. (Note: The fences the research team observed were flush with the ground.)

Pine Beetles

Since there is no effective means of controlling such a large outbreak of pine beetles in the vast RMNP back country (due to warmer park temperatures), beetle populations are largely allowed to evolve under natural processes. Regarding the impact they are causing, RMNP does allow some limited cutting and stacking of dead trees around designated backcountry campsites as a fire-prevention measure. During the winter, teepee shaped slash piles are burned, and some of the wood is sold to the public.

Public Transportation

RMNP offers three free shuttle bus routes to park visitors. Routes include the Hiker Shuttle Express Route, the Bear Lake Route, and the Moraine Park Route. Use of this public transportation system helps to reduce air emissions from motor vehicles.

Fire Management

The ranger we interviewed at the Holtzwarth Historic Site reported that, in June 2013, a lightning strike started a fire nearby (past Green Mountain) that ultimately consumed 604 acres. When the fire first started, park officials allowed it to burn. Then evaluating available resources to properly contain the fire, the decision was made to put it out as soon as possible. Each fire is assessed

in this manner, unlike the past policy of immediately suppressing all fires.

The NPS now acknowledges that forest fires help to create a mosaic of plant communities in different growth stages. Without them, biodiversity declines and leaf litter and deadfall accumulate at a faster rate than they can return nutrients to the soil through decay.

Ranger RMNP Environmental Ratings

The RMNP environmental quality and infrastructure ratings given by the ranger at the Beaver Meadows Visitor Center are summarized in Exhibit 1.

Exhibit 1 – Ranger RMNP Environmental & Infrastructure Ratings

Air Quality	2.0
Water Quality	2.0
Land Quality	1.0
Infrastructure	2.5
Overall Avg.	**1.9**

Scale: 1 = Excellent; 2 = Good; 3 = Fair; 4 = Poor.

The RMNP ranger gave the park a Good rating for Air Quality and Water Quality, an Excellent rating for Land Quality, and between Good and Fair for the quality of park Infrastructure. The ranger's overall average environmental quality and infrastructure rating for RMNP was slightly better than Good.

This suggests, from the NPS perspective, that there is certainly still room for improvement. In addition, the

research team questions the ranger's Excellent rating for Land Quality in light of the extensive pine beetle damage in the park.

KEC RMNP Environmental Ratings

By comparison, the research team's environmental quality and infrastructure field observation ratings for RMNP are shown in Exhibit 2.

Exhibit 2 – KEC RMNP
Environmental & Infrastructure Ratings

Air Quality	1.0
Water Quality	3.0
Land Quality	3.0
Infrastructure	2.0
Overall Avg.	**2.3**

Scale: 1 = Excellent; 2 = Good; 3 = Fair; 4 = Poor.

Details associated with KEC's RMNP environmental and infrastructure ratings shown in Exhibit 2 are provided below.

Air Quality

KEC rated Air Quality in RMNP to be Excellent. This was based on the clarity of the mountain vistas, blueness of the skies, and lack of any visible point source or mobile emissions from motor vehicles while we were in the park.

Water Quality

KEC rated Water Quality in the park to be Fair. This was due to the visible pollution we encountered in a few locations, most notably at Poudre Lake.

Land Quality

KEC rated Land Quality in RMNP to be Fair. This was because of the substantial amount of pine beetle damage, ugly contractor clear cuts along the roadway, and the lingering scarring from the Grand Ditch.

Infrastructure

KEC rated Infrastructure in RMNP to be Good. This was due to the very good condition of the visitor centers and roadways, in spite of the damaged log cabin chimney next to Lake Irene, numerous collapsed trail fences, and damaged roadway walls.

KEC RMNP Litter Survey Results

KEC's litter survey within RMNP encompassed stops at nine locations, including two visitor centers, hiking more than five miles of trails, and traveling about 50 miles along park roads. Based on our count of paper, plastics, metals, and cigarette butts discarded by uncaring visitors, KEC's overall average litter rating for RMNP was 2.0 out of 4. There was some litter found at most sites we stopped to visit, plus along the Trail Ridge Road.

KEC RMNP Improvement Recommendations

1. Secure additional funding for education programs, staff resources, infrastructure maintenance and repair, research, etc. Spreading more public awareness about the problems faced by RMNP is crucial. When people understand that they could be individually contributing to problems in the park they will hopefully adjust their behavior and real progress can be made toward park improvements.

2. Track source(s) of observed water pollution and implement a mitigation strategy. Education of the public and other prospective sources is once again key. A call to action of an educated, motivated general public and other stakeholder groups can help with the push for greater restrictions on the use of fertilizers, industrial site discharges, and the like.

3. Consider the use of verbenone pouches on pine trees to ward off future pine beetle attacks. Given the magnitude of the problem in the park, starting with a targeted test area makes sense. (Note that verbenone is a natural, organic pheromone treatment that tricks the beetles into thinking that the tree is already infested and that they need to look elsewhere for a suitable host.)

4. Ramp up outreach efforts to secure volunteer assistance to improve degraded infrastructure. RMNP staff should lead the effort to solicit and secure assistance from volunteer organizations.

Consider targeting groups like the Boy Scouts and religious organizations. Also consider involving the court system to direct those who have been ordered to provide community service to do so in the park.

5. Strategically place anti-litter signage and cigarette receptacles in parking lots and popular road pull-off locations. During our travels through RMNP, cigarette butts were noticed on the ground at the most popular locations.

6. Specifically implement an anti-cigarette butt campaign including signage with a noticeable logo image at visitor centers, roadside stops and other parking areas.

Anti-Cigarette Butt Campaign Example, © 2015 Jonathan V. L. Kiser.

7. Raise awareness with the same anti-cigarette message in park newsletters and other publications with the aim being to help reduce the litter problem. Also promote among smokers the use of new "all natural" cigarettes, with organic cotton and de-gummed hemp filters packed with flower seeds that can be either composted or literally planted to grow plants.

8. Expand fire awareness and other safety program efforts. Hold demonstrations teaching park visitors how to properly start a fire, properly manage it, and make sure it is fully extinguished.

Longs Peak, the Tallest in RMNP (Elevation 14,259 Feet), © 2015 Grant R. E. Kiser.

Chapter 2

Arches National Park

Overview

The formation of what is now Arches National Park (ANP) started 300 million years ago when saltwater from a nearby ocean flooded the area. Salt deposits then built up, and sand dunes and desert sediments next buried the salt. The sediments then became rock and erosion began. The exposed cracks in the rock allowed water to infiltrate and dissolve the salt. The salt valleys then began to collapse and parallel fractures in surface rock eroded. This set the stage for the formation of arches, balanced rocks, sandstone fins, spires, and monoliths.

ANP Entrance, © 2015 Jonathan V. L. Kiser.

With more than 2,500 natural sandstone arches, the NPS reports that ANP boasts the largest concentration of arches in the world. To qualify as an official stone arch, there must be a length opening of at least three feet long in any direction. There is no width requirement.

ANP was initially established as a national monument by President Herbert Hoover's administration on April 12, 1929. It became a national park on November 12, 1971. The park contains 76,519 acres, and ranges in elevation from 4,085 feet to 5,653 feet. During 2014, About 1.28 million people visited ANP.

KEC Field Observations: July 15, 2013

Arriving in Moab, Utah, which is located adjacent to ANP, the sky appeared to be hazy. We continued south on Highway 191, accompanied by plenty of trucks and camper vehicles, en route to our camping destination at the Warner Lake Campground. As we passed by the ANP and continued south, the research team documented tire debris litter on the side of the road, and then encountered hydrofracking and mining operations adjacent to Highway 191.

Fracking Operation in Moab, UT South of ANP,
© 2015 Jonathan V. L. Kiser.

Mining Operation outside Moab, UT South of ANP,
© 2015 Jonathan V. L. Kiser.

KEC Field Observations: July 16, 2013

The following morning, we retraced some of our steps while heading back north to ANP. En route, we passed through a beautiful stretch of the Utah high desert, drove past a number of mining and drilling operations, and then followed a Thomas Fuels Lubricants Chemicals truck for

five miles along U. S. 191 north until we reached the ANP entrance.

The Colorful UT Desert, © 2015 Jonathan V. L. Kiser.

As we approached ANP, the research team couldn't help but notice that the fragile desert in the greater ANP region faces many competing interests including those who are interested in exploiting its energy and mineral resources, those who are interested in the recreational aspects, and those who are interested in exploring/preserving the scenic wonders offered by nature at its finest. Finding the right balance to meet all stakeholder needs is no doubt an ongoing, difficult challenge.

We next by the Visitor Center and interviewed a park ranger. Details from our interview with the ranger are provided in Environmental Challenges, Environmental Solutions, and Ranger Environmental Ratings sections below.

Driving to our first stop inside ANP, Park Avenue, we noticed a lot of litter (3 on the scale) and plenty of tourists.

Human footprints leading up to paper litter (toilet paper?) were also documented off of the clearly designated trails. This proved to us that some careless person was more concerned about their personal needs then the obvious damage they caused to the fragile desert ecosystem.

Apple Core Litter at Park Ave.,
© 2015 Jonathan V. L. Kiser.

Driving next toward the Double Arch parking lot, there were interesting rock formations at every turn, many of which we dutifully named (e.g., cobra rock, guardians of the arches, etc.). Once on the Double Arch trail, we were mindful to bring water to avoid dehydration in the desert heat. The incredible arch definitely lived up to its billing.

Even though we encountered quite a few tourists, the trail and arch area were pretty much litter-free. However,

we did observe several hikers off of the designated trail, impacting the sensitive ecosystem.

Cobra Rock (Left); and Rhett Flipping over the Double Arch (Right), © 2015 Jonathan V. L. Kiser.

Getting back on Arches Scenic Drive, the road infrastructure appeared to be in Good shape. It was then on to notable cultural features in ANP, Wolfe Ranch, and the trailhead to the world famous Delicate Arch.

Wolfe Ranch was operated as a cattle ranch by the area's first white settlers until 1910. The preserved cabin and root cellar remain today, are in Excellent condition, and blend perfectly with the desert environment.

Wolfe Ranch in ANP, © 2015 Jonathan V. L. Kiser.

Our hiking journey to and from Delicate Arch was three miles (it seemed much further in the sweltering heat). On the way, we passed over the Salt Valley Wash and saw an abundance of wildlife: An otter (*Lutrinae*), catfish (*Siluriformes*), dragon flies (*Anisoptera*), a big bullfrog (*Rana catesbeiana*), butterflies (*Rhopalocera*), and other types of fish (unidentified).

This was a virtual oasis with an amazing display of biodiversity. Unfortunately, there was also a lot of litter tossed in the water by thoughtless trail users. The wash water flow was slow, and the water itself was murky and had quite a bit of algae.

Bull Frog in the Salt Valley Wash,
© 2015 Jonathan V. L. Kiser.

We labored on toward Delicate Arch, encountering pieces of paper liter here and there, and were blown away by the exotic landscapes unfolding before us. As we approached Delicate Arch, it was easy to see why it is the state symbol seen on Utah license plates. Delicate Arch stands on the edge of a slip rock bowl and is 46 feet high and nearly 32 feet wide.

Delicate Arch, © 2015 Grant R. E. Kiser (Left);
and © 2015, W. Rhett Kiser (Right).

On the return hike, there was yet more litter along the trail. The white paper was hard to miss lying next to the reddish sandstone. We were hoping that such a paper trail was an accident not being used someone to trace their way back to the car!

Rhett with Litter along Delicate Arch Trail,
© 2015 Jonathan V. L. Kiser.

The research team also stopped at the Rock Art Panel, Ute Indian petroglyphs, located close to the parking lot. These rock drawings were carved between A.D. 1450 and 1650. Ancient graffiti! Fortunately, no modern day "drawings" were observed anywhere near these ancient gems.

Ute Rock Art, © 2015 Jonathan V. L. Kiser.

Our journey through ANP continued, with stops at the Salt Valley Overlook and the Fiery Furnace Viewpoint. Our endpoint destination was the Devil's Garden section of the park. Devil's Garden features a series of rock fins (i.e., narrow sandstone walls) formed by erosion. There were many tourist vehicles parked there.

Devil's Garden, © 2015 W. Rhett Kiser.

Throughout our journey in ANP we encountered a lot of tourists and yet most of the parking lots and the park itself didn't seem to be overly crowded.

Environmental Challenges (NPS Perspective)

Precipitation Pattern Changes

According to the ANP park ranger we interviewed, while area temperatures have remained about the same in recent years, there have been some changes in precipitation patterns. Rain storms are more frequent, but generate less overall annual amounts (i.e., about eight to 10 inches). Historically, rain was heavier during the summer months, with big downpours. Now, there is more rain during the spring and the showers are typically more sustained. This has negatively impacted ANP's biological soil (cryptobiotic) crust (composed of cyanobacteria, algae, lichen, and fungi) by effectively turning it to mush.

Foot Traffic

Throughout ANP is fragile cryptobiotic crust. This biological soil crust prevents soil erosion, absorbs and holds water, and provides nutrients to plants. Unfortunately, the crust is highly susceptible to being destroyed. The compression impact associated with one careless hiker step can kill hundreds of years of crust growth. Signs are posted throughout ANP and information in the ANP Visitor Guide publication asks hikers to stay off the crust by walking only on designated trails, bare rocks, or streambeds.

Don't Step on the ANP Cryptobiotic Crust,
© 2015 Jonathan V. L. Kiser.

The ranger we interviewed emphasized that the best conservation approach is to avoid stepping on the crust. She also indicated that the Windows Section of the park has a lot of examples of both healthy and damaged crust.

Graffiti

Graffiti in the form of words or shapes carved, painted, scratched, and drawn on rocks and other formations are a problem in ANP. Such graffiti are prohibited by law and must be painstakingly removed by park staff. The ANP Visitor Guide encourages visitors to make memories and leave no trace. The research team was happy to not encounter any graffiti during our visit to ANP.

ANP Cryptobiotic Crust Terrain, © 2015 Jonathan V. L. Kiser.

Vehicle Traffic

Traffic congestion in ANP is another concern. During the 1970s, the roadways and park facilities were designed to accommodate 700,000 annual visitors. Within the past five years, Arches has gone from the 40th most visited park to the top 10. More specifically, there were 790,000 visitors during 2008, 1.1 million visitors in 2012, and 1.28 million in 2014. During the busy season (March through October) there is often insufficient parking to meet the demand. Entrance station lines can stretch almost to Highway 191.

In response, a transportation system study was completed and included the possible use of shuttle vehicles. The estimated price tag required to overhaul the ANP transportation system is $1 billion. The U.S. Congress has yet to commit funding for this needed project.

Light Pollution

According to the NPS, ANP used to be beautiful under the night sky but now light pollution from nearby Moab is ruining that beauty.

Air Pollution

Air pollution from sources outside the park are carried by the wind into ANP causing plants to be killed. Cars and other vehicles passing through the park also generate pollution (i.e., air and noise). Over-congested parking lots during the busy season (March through October) result in vehicles idling in the desert heat and contributing to the air pollution problem.

Water

Being a desert environment, water in ANP is very much a precious resource. Two groundwater wells provide water to sinks, toilets, and drinking faucets throughout the park. Two spigots in front of the visitor center provide purified drinking water. Conservation of this limited resource is essential. Wildlife also rely on ANP water sources that include: Springs, washes, pot-holes, seeps, and the Colorado River (forming the southern boundary of the park).

Otter Swimming in Salt Valley Wash, © 2015 Jonathan V. L. Kiser.

The ANP brochure warns visitors that sunscreen or bacteria on humans can contaminate the water and kill organisms living in it. Visitors are advised to carry enough water so the water sources relied upon by wildlife are not disturbed. In addition, the ranger we interviewed indicated there is concern about petrochemicals from nearby mining and other sources entering the area watershed.

Delicate Arch Water Reminder,
© 2015 Jonathan V. L. Kiser.

Salt Cedar

The salt cedar (*Tamarix*) is a non-native plant that grows within ANP, especially along the Colorado River. It effectively squeezes out native plants by quickly establishing dense thickets at the rate of 12 miles per year. Biological control efforts (e.g., use of natural agents such as insects, parasites, and pathogens) to address this problem have been successful in recent years.

Tamarix Trees along the Colorado River Near Moab.
Source: Public Domain.

Threats Outside ANP Boundaries

Along Highway 279 off of U.S. 191 (southwest of ANP) there is a pot ash mining operation. An evaporation mining technique is used here to mine potassium chloride to make fertilizer. There is also copper mining and at least one nearby drilling operation south of ANP.

Moab Drilling South of ANP,
© 2015 Jonathan V. L. Kiser.

In addition, the Moab Uranium Mill Tailings Remedial Action (UMTRA) remediation site is located near ANP along the Colorado River.

According to the U. S. Department of Energy, about one-third of the UMTRA remediation project has been completed. This effort involves moving 16 million tons of uranium tailings from the banks of the Colorado River to a permanent disposal site 30 miles north near Crescent Junction.

This site includes the former Atlas Minerals Corporation uranium-ore processing facility, and encompasses 480 acres of which about 130 acres is covered by a uranium mill tailings pile. DOE restricts access to the radiological control area where the mill tailings and highest concentrations of soil contamination exist.

U. S. DOE UMTRA Site. Source: Public Domain.

The Moab Project ships about 5,000 tons of tailings by train in lidded containers on a daily basis. Shipments began in April 2009 and are expected to continue through about 2025, depending upon appropriated funds. The U.S. DOE claims that the UMTRA risk level is so low at this point that one "can roll around in it and only have one in a million risk of contracting cancer." None of the authors of this report are personally willing to test this claim! (For additional information about UMTRA, refer to: Shenton, Lee. "Moab UNTRA Project Uranium Mill Tailings Remedial Action." November 2015.)

Environmental Solutions (NPS Perspective)

Education

ANP staff focus a lot of their educational efforts on grade school students (Grades one through six). They also sponsor regional field trips throughout the Canyon Country region.

In addition, the ANP Visitor Guide Park News publication serves as an education tool to inform visitors about climate change, conservation of water resources, and other issues.

There are also signage education efforts to protect the park trails. These have not been fully effective as the signs are situated in the ground and people tend to ignore and walk right past them.

This is Not a Trail Sign in ANP,
© 2015 Jonathan V. L. Kiser.

Infrastructure

With 80% of ANP entrance fees eligible to be used for repair, maintenance, and facility enhancement, ANP has dedicated resources to repair/improve trails in the Windows Section and the Devils Garden Picnic Area.

Water

The ANP Visitor Guide Park News publication encourages visitors to use reusable containers when consuming water in the park. Such containers promote the conservation of fuel, water, and landfill space since single use plastic bottles are not being consumed. During 2011, the Park reported that 13,750 pounds of single use plastic bottles were recycled but also posed the question how many more went to landfill?

Light Pollution

About five years ago, ANP was surveyed by the NPS's Night Sky Team and a number of light impacts were identified. In 2010, ANP responded by replacing exterior light fixtures and bulbs with more energy efficient brands. This, in turn, has helped to reduce the light impact on the ANP night sky. Light pollution sources outside the park boundary pose a more different challenge.

Noise Pollution

In 1995, a photovoltaic (solar)/diesel hybrid electrical system was installed at the Devils Garden Campground. This replaced a noisy, polluting diesel generator system that provided power for 52 campsites. 95% of the

campground's electrical needs are now provided by solar power, with the diesel system kicking in on rare cloudy days or when the solar system is down.

Ranger ANP Environmental Ratings

The ranger ratings for ANP environmental quality and infrastructure are summarized in Exhibit 3.

Exhibit 3 – Ranger ANP
Environmental & Infrastructure Ratings

Air Quality	2.75
Water Quality	2.0
Land Quality	2.5
Infrastructure	2.75
Overall Avg.	**2.5**

Scale: 1 = Excellent; 2 = Good; 3 = Fair; 4 = Poor.

The ranger we interviewed gave ANP a better than Fair rating for Air Quality, a Good rating for Water Quality, between Good and Fair for Land Quality, and better than Fair for park Infrastructure. The ranger's overall average environmental quality and infrastructure rating for ANP was between Good and Fair.

Since the ranger rated the park no higher than Good for any of the categories, it is clear that there is needed improvement within ANP. In light of the on-going rise in the number of visitors to the park, plus the many real challenges posed by activities outside the park boundaries, additional funding and volunteer resources will certainly be needed just to keep pace.

KEC ANP Environmental Ratings

KEC's environmental quality and infrastructure ratings for ANP are provided in Exhibit 4.

Exhibit 4 – KEC ANP
Environmental & Infrastructure Ratings

Air Quality	1.0
Water Quality	2.5
Land Quality	1.5
Infrastructure	2.0
Overall Avg.	**1.8**

Scale: 1 = Excellent; 2 = Good; 3 = Fair; 4 = Poor.

Details associated with KEC's ANP environmental and infrastructure ratings are provided below.

Air Quality

KEC's Air Quality rating for ANP was Excellent. The visibility was very clear and there were no physical signs of pollution. This one day field observance contrasts with the better than Fair rating assigned by the park ranger we interviewed. The park ranger rating is no doubt a better reflection of actual Air Quality in ANP, given all the air emission point sources surrounding the park and the longer term perspective offered by the ranger.

Water Quality

KEC's Water Quality rating for ANP was between Good and Fair. Our primary reference point in this high desert environment was the Salt Valley Wash. Even though there was evidence of considerable biodiversity, there was a

considerable amount of algae (an early indicator of declining aquatic ecosystem health) and the water was cloudy and nearly stagnate.

Land Quality

KEC's Land Quality rating for ANP was Very Good. This overall rating holds, even though we did document some erosion and footprints in the fragile environment due to people going off the designated trails.

Infrastructure

KEC's Infrastructure rating for ANP was Good. The main roads were in pretty good condition, the visitor center was well kept, and there appeared to be adequate bathroom facilities.

KEC ANP Litter Survey Results

KEC's litter survey within ANP encompassed stops at nine locations, including two visitor centers, hiking about five miles of trails, and traveling about 45 miles along park roads. Based on our count of paper, plastics, metals, cigarette butts, and food discarded by uncaring visitors, KEC's overall litter rating for ANP was 2.5 out of 4. This means that there was some litter found at most sites where we stopped (plus some along the roadway).

KEC ANP Improvement Recommendations

1. Secure additional funding for education programs, staff resources, infrastructure maintenance and repair, research, etc. Use the popularity of the park

to its own advantage. Consider increasing the park admission fee and link it to specific, high profile efforts that the public and others can identify with and support.

2. Continue to focus public education outreach efforts to increase awareness of the main challenges faced by the park (e.g., protecting ANP's biological soil) and ways individuals can contribute to the solutions.

3. Consider providing visitors with a brief questionnaire touching upon topics such as their favorite park features and their willingness to donate financial support and/or contribute volunteer time that they can fill out while visiting the park or mail in after their visit. Then follow-up with those who have expressed a willingness to help.

4. Implement more obvious (above ground) and strategically placed signage urging visitors to stay on the designated trails. The most obvious possible locations would be near the curb in the parking lots and at the most popular trail heads to make sure visitors can't miss them.

5. Establish fencing and signage in high visitor traffic areas where damage risk to cryptobiotic crust is most likely. Signage should emphasize the importance of this sensitive crust and why it must be preserved as an essential component of the park's ecosystem.

6. Implement a "citizen ranger" program that encourages park visitors to report problems they encounter during their park visit (e.g., infrastructure damage, litter, trail abuse). Establish anonymous "tip lines," and/or suggestion boxes to facilitate timely feedback.

7. Strategically place anti-litter signage and cigarette receptacles in parking lots and popular road pull-off locations. Include more signage reminding people that cigarette butts are litter too and that the park is a "butt free" area.

8. Increase efforts that encourage people to bring their own reusable water bottles. Better promote the concepts of Reduce, Reuse, and Recycle. Reduce the waste associated with single use plastic water bottles. Make people aware of what happens to their single use bottle, how much energy is required to recycle a single bottle, and the resulting carbon footprint impact. Tie the environmental impacts to individual visitor actions with the hope that more awareness will result in changed, more eco-friendly behavior.

9. Join forces with pro-environment local government entities and other like-minded groups to prevent additional development in areas surrounding the park to prevent further light pollution from ruining the night skies, air pollution, and water pollution.

Chapter 3

Great Basin National Park

Overview

Great Basin National Park (GBNP) lies within the Great Basin, a vast region of valleys and mountain ranges stretching from California's Sierra Nevada to Utah's Wasatch Mountains. The NPS reports that the park is located approximately 290 miles north of Las Vegas, sits on the western edge of the Snake Valley, and protects 77,180 acres, including the South Snake Range near the Utah border.

Rhett and Grant at GBNP Entrance with Wheeler Peak in the Background, © 2015 Jonathan V. L. Kiser.

Established in 1986 by the U.S. Congress, GBNP provides an excellent example of a desert mountain island, from sagebrush (*Artemisia tridentate*) at its base to the 13,063-foot summit of Wheeler Peak. There are lakes, streams, ancient bristlecone pine groves, limestone caverns, an alpine glacier, abundant wildlife, and so much more. During 2014, there were only about 107,500 GBNP visitors.

KEC Field Observations: July 17, 2013

Approaching GBNP, we noticed a large section of corrugated pipe along the side of the road. This public awareness item, put in place by the Great Basin Water Network, was bringing attention to one of the major environmental issues facing the region. The Southern Nevada Water Authority in Las Vegas has been pressing for years to tap aquifer water resources around the GBNP. The Authority is targeting water from the area mountains that collects in the desert basins of the Spring and Snake Valleys and desire to transport it south by way of a pipeline. The project has been approved, but fortunately has yet to be funded.

Water Theft Intention in NV,
© 2015 Jonathan V. L. Kiser.

Upon our arrival at the GBNP Visitor Center (in the town of Baker along Route 487), the research team's first observation was that the handicap door access was not working. There was also some litter on the ground at the Visitor Center.

Vehicle Scarring outside GBNP, © 2015 Jonathan V. L. Kiser.

We next then interviewed a park ranger at the Lehman Caves Visitor Center, located further inside the park. Details from our interview are provided in the Environmental Challenges, Environmental Solutions, and Ranger Environmental Ratings sections below.

Then traveling up the Wheeler Peak Scenic Drive, KEC passed through progressive ecosystems, from pinyon - juniper woodlands, through shrubby mountain manzanita (*Arctostaphylos*) and mahogany (*Meliaceae*), into englemann spruce and douglas fir.

As we drove, a tree infested by forest tent caterpillars (FTCs) (*Malacosoma disstrium*) was seen along the side of the road. FTCs are native defoliators of aspen who hatch in the spring. The larvae typically migrate high in the tree to feed on leaf and flower buds. FTC adults are tan, striped moths about 4 cm long.

Forest Tent Caterpillar Moth.
Source: Public Domain.

(For more information about FTCs, refer to: Durham, Gail. "Forest Pest Conditions in Nevada 2011." Nevada Division of Forestry. February 2012.)

Forest Tent Caterpillar Damage,
© 2015 Jonathan V. L. Kiser.

Continuing to an elevation of about 8,000 feet on Wheeler Peak Scenic Drive, it was apparent in a number of places that guard rails would be more than appropriate. One swerve to the right and our car would have plunged to a place none of us wanted to go.

Safety Guardrails Lacking in GBNP,
© 2015 Jonathan V. L. Kiser.

Our next stop was at the Osceola Ditch trail, where we learned that near here, in 1877, placer gold was discovered. During 1884 - 1885, the Osceola Gravel Mining Company constructed a 16 mile ditch, known as the West Ditch, to carry the water from six creeks on the West side of the Snake Range to their placer mining operations.

In 1889, construction began on the 18 mile East Ditch, to collect water from Lehman Creek and its tributaries on the east side of the range. Several hundred men using hand tools, wagons, horses (*Equus ferus caballus*), and mules (*Equus mulus*) labored ten months to complete the ditch.

By 1905, mining activity at Osceola all but stopped due to a shortage of water. Over the years, Osceola has produced $3.5 million worth of gold.

Osceola Ditch Trail Sign. Source: Public Domain.

This section of Osceola Ditch near the Wheeler Peak Scenic Drive was very overgrown with a lot of fallen trees and other debris. There was considerable pine beetle damage but also verbenone pouches on a few trees. As previous noted, verbenone is a natural, organic pheromone treatment that tricks the beetles into thinking that the tree is already infested and that they need to look elsewhere for a suitable host.

However, according the U. S. Department of Agriculture Forest Service, verbenone has limitations that include:

- The pouches are only effective for one season and must be replaced annually.

- It is not recommended for widespread, general forest use unless forest management, such as thinning or other stand improvement activities, is planned in the near future.

- Verbenone often does not protect all treated trees or areas, particularly when MPB populations are high.

- It should be considered only one component of an Integrated Pest Management (IPM) program.

- Additional IPM activities should be implemented, such as: Removing infested trees, thinning stands to reduce overcrowding, and monitoring beetle activity until beetle pressure subsides.

Pine Beetle Verbenone Treatment,
© 2015 Jonathan V. L. Kiser.

(For more information about the use of verbenone to control pine mountain beetles, refer to: United States Department of Agriculture Forest Service Northern and Intermountain Regions. "Using Verbenone to Protect Trees from Mountain Pine Beetle.")

As we continued along the rugged trail one-way for about one-half a mile, amazing, colorful rocks, and cacti (*Cactaceae*) came into view.

KEC then continued up the Scenic Drive, ascending some 3,400 feet in 12 miles. The road was in a bad state of disrepair in many sections, including at the Mather Overlook. There were also many chipmunks scurrying among the rocks near the overlook areas.

Wheeler Peak Drive Infrastructure Decay,
© 2015 Jonathan V. L. Kiser.

Approaching the Wheeler Peak Campground at the top of the drive, we were surrounded by a thick, subalpine forest that included limber pine, spruce, and aspen.

Our next excursion was a 4.6 mile hike (roundtrip) to the foot of the Wheeler Peak Glacier. Following the Bristlecone-Glacier Trail, we passed over the pristine Lehman Creek, and through the subalpine forest. There was clear evidence of strong wind damage (twisted trees), along with more beautiful rocks. We next encountered limber and bristlecone pines (*Pinus longaeva*) at elevations ranging from 9,500 to 11,000 feet.

Pristine Lehman Creek (Left); and Twisted Pine (Right), © 2015 Jonathan V. L. Kiser.

Along the Bristlecone Interpretive Trail section, we hiked among some of the oldest trees on earth, some more than 3,000 years old! According to the NPS, the Great Basin bristlecone pines are remarkable for their great age and their ability to survive adverse growing conditions. They grow very slowly in isolated groves just below tree line, in harsh conditions. Cold temperatures, a short growing season, and high winds. This makes their wood very dense and resistant to insects, fungi, rot, and erosion. Since vegetation is very sparse, fire destruction is limited.

Jonathan with 3,200 Year-Old Bristlecone Pine, © 2015 W. Rhett Kiser.

Bristlecone pine seeds are occasionally cached by birds at lower elevations. There they grow more rapidly and can live to be 300 to 400 years old. Even when they die, their high resin content prevents these trees from rotting.

Bristlecone pines are often confused with limber pines, since both can be found growing together at the same elevations and look similar. Bristlecone needles are about one inch long, and grow in packets of five. The needles completely surround the branches. The tree gets its name from the cones whose scales are each tipped with a claw-like bristle.

Limber pine trees, on the other hand, have needles in packets of five that are one and one-half to three inches long, and grow only towards the ends of the branches. Also, the cones of the limber pine do not have bristles.

As the research team reached the Glacier Point stop along the trail there was a picture of the Wheeler Peak Glacier showing retreat over time. This was yet another visual reminder that climate change is real.

Wheeler Peak Glacial Rock Field, © 2015 Grant R. E. Kiser.

There was also an unidentified plant that smelled like a skunk and an insect (also unidentified) that was making a lot of noise like a locust (*Schistocerca gregaria*) at this elevation.

The Bristlecone-Glacier Trail ultimately took us to the foot of the Wheeler Peak Glacier. Crossing across the rocky slopes of glacial debris was quite challenging.

Wheeler and Surrounding Peaks from the Glacier Trail,
© 2015 Grant R. E. Kiser.

The Wheeler Peak Glacier is the only alpine glacier in Nevada, and one of the southernmost glaciers in the United States. It sits at the base of Wheeler Peak, in a protected cirque around 11,500 feet in elevation. The glacier measures 300 feet long and 400 feet wide. The exact depth of the glacier is unknown.

With continued warming predicted, the NPS estimates it is likely the glacier will disappear in as little as 20 years. Unfortunately, there doesn't appear to be much anyone can do to immediately reverse this trend.

Wheeler Peak Glacier at GBNP,
© 2015 Jonathan V. L. Kiser.

Heading back down the Wheeler Peak Scenic Drive on our way out of the park, it was quite noticeable how hazy the Snake Valley was below. The NPS reports that visibility at GBNP declines after periods of sustained northeasterly winds carry in air pollution from sources in the Salt Lake City area (nearly 240 miles away) and the Intermountain Power Plant near Delta, Utah (about 100 miles away).

Snake Valley in the Haze, © 2015 Jonathan V. L. Kiser.

Environmental Challenges (NPS Perspective)

Climate Change

According to the park ranger we interviewed at the Lehman Caves Visitor Center, GBNP's Wheeler Peak Glacier from the Plasticine Period is melting. It is expected to only have a few years left before it will be down-graded to an icefield due to climate change.

In addition, endemic species found in the Great Basin Snake Mountain Range, including the holmgrem's buckwheat plant (*Eriogonum holmgrenii*) and Nevada primrose (*Primula cusickiana* var. *nevadensis)*, are also threatened by climate change. (For more information about species of concern within GBNP, refer to: National Park Service. "Great Basin National Park Species of Management Concern." October 2014.)

Holmgrem's Buckwheat Field. Source: Public Domain.

Groundwater Withdrawal

The ranger indicated that there is concern about the proposed Southern Nevada Water Authority groundwater withdrawal from the Spring and Snake Valleys. Park water resources are also likely to be impacted from such an action, as might cave fauna. Unique cave life, including several cave millipede (*Idagona lehmanensis*) (a new genus) and a pseudo scorpion (*Pseudoscorpionida*), could be negatively impacted as well.

Light Pollution

GBNP has unique, dark night sky, and light pollution from outside the park is a threat. Park officials have taken an official position against light pollution that can be seen from as far away as Las Vegas and Salt Lake City.

Unhealthy Forest

Another environmental issue faced by GBNP is an unhealthy forest. Due to the density of the forest, it is difficult to conduct a controlled burn. A major forest fire at this point would be devastating. Over the years, short-sighted fire suppression efforts in GBNP have led to the pinyon (*Pinus edulis*) and juniper pine (*Juniperus*) trees taking over parts of the park that would historically be sage brush. This, in turn, has led to pygmy rabbits (*Brachylagus idahoensis*) and sage grouse (*Centrocercus urophasianus*) being pushed out.

GBNP Juniper Tree Encroachment on Sage Brush,

Environmental Solutions (NPS Perspective)

Education

The ranger we interviewed indicated that education is essential to improving the park environment. People should act responsibly and adapt their behavior while at GBNP to reduce their carbon footprint. Visitors should contact Congress to express their concerns about challenges faced by the park.

Air Quality

While GBNP boasts very clean air, it is susceptible to four sources of air pollution: mobile (automobiles, trains, planes); stationary (oil refineries, factories, power plants); area (agriculture, fire places, development); and natural (wildfires, volcanic eruptions).

GBNP participates in three national Air Quality Monitoring programs aimed at increasing the understanding of air pollution impacts in national parks. The three air quality monitoring networks include: 1) The Clean Air Status and Trends Network (CASTNET); 2) National Atmospheric Deposition Program/National Trends Network (NADP/NTN); and 3) The Interagency Monitoring of Protected Visual Environments Program (IMPROVE).

CASTNET was established by U.S. EPA and the National Oceanic and Atmospheric Administration (NOAA), with the goal of assessing the effectiveness and impact of Title IV of the 1990 Clean Air Act Amendments

through a large-scale monitoring network. CASTNET was designed to compile a scientific data base through routineenvironmental monitoring and provides dry deposition estimates recorded at each site. CASTNET complements the NADP/NTN which provides information on precipitation chemistry and wet deposition values.

The IMPROVE monitoring program was established, per the 1977 Clean Air Act Amendments, to aid the creation of Federal and State Implementation Plans for visibility protection in Class I areas (*156 national parks and wilderness locations*). (For more information about air quality in GBNP, refer to: National Park Service. "Air Quality Monitoring History Database." November 5, 2015.)

Night Sky Protection

GBNP boasts among the darkest night skies in the U.S. On most nights there is the potential to see over 6,000 stars, planets, the Milky Way, and more. The park celebrates this feature through weekly astronomy programs, holiday and special astronomy events, meteor viewing parties, and more.

GBNP also promotes astronomy through a written brochure that explains light pollution and the need for night sky protection. The brochure explains that bad lights not only spoil our view of the stars, but can confuse and harm wildlife, waste energy, create light trespass, and create glare.

Biodiversity Program

During 2013, GBNP initiated a new biodiversity program in partnership with the Encyclopedia of Life (EOL). In an effort to expand knowledge about the park's biodiversity, a Great Basin Community has been created on EOL that includes collections of mammals, plants, and insects found in GBNP. Visitors are encouraged to take pictures while in the park and upload photos of organisms to the EOL Flickr group for subsequent posting on the Great Basin EOL page. Visitors are also encouraged to sign up at: www.eol.org/communities/112.

Ecosystem Restoration

GBNP has undertaken projects that use fire as a change tool in maintaining healthy ecosystems and plant communities. The goal is to reduce excessive fuel loads (i.e., dense underbrush) and restore resilient plants.

For years, natural fires were suppressed leading to plant communities becoming choked with vegetation. As the time between fires increases, conifer (*Pinophyta*) canopies extend and expand, and grass, shrubs, and aspen trees die. Evidence of this pattern within GBNP can be seen in the shape of sagebrush "skeletons" in pinyon and juniper woodlands and aspen stands now towered over by white fur (*Abies concolor*).

Ranger GBNP Environmental Ratings

The ranger's environmental quality and infrastructure ratings for GBNP are shown in Exhibit 5.

Exhibit 5 - Ranger GBNP
Environmental & Infrastructure Ratings

Air Quality	1.0
Water Quality	1.0
Land Quality	3.0
Infrastructure	2.0
Overall Avg.	**1.8**

Scale: 1 = Excellent; 2 = Good; 3 = Fair; 4 = Poor.

The ranger gave an Excellent rating for Air and Water Quality, a Fair rating for Land Quality, and a Good rating for the quality of park Infrastructure. The ranger's overall average environmental quality and infrastructure rating for ANP was better than Good.

The Excellent rating for both Air and Water Quality are bolstered by the fact that GBNP is in a remote location away from polluting sources, and receive considerably less visitors then the other parks visited by the research team. During 2014, GBNP ranked 50th out of 59 national parks in terms of visitors. The Fair rating for Land Quality speaks primarily to the health of the GBNP forests and the lack of resources needed to properly manage them.

KEC GBNP Environmental Ratings

KEC's GBNP environmental quality and infrastructure ratings are shown in Exhibit 6.

Exhibit 6 - KEC GBNP
Environmental & Infrastructure Ratings

Air Quality	1.5
Water Quality	1.0
Land Quality	3.0
Infrastructure	3.0
Overall Avg.	**2.1**

Scale: 1 = Excellent; 2 = Good; 3 = Fair; 4 = Poor.

Details associated with KEC's GBNP ratings are provided below.

Air Quality

KEC's Air Quality rating for GBNP was Very Good. There were no visible signs of pollution inside the park, but there was general haziness (reflecting pollution from far away northeast sources) in the nearby Snake Valley as the day progressed.

Water Quality

KEC's Water Quality rating for GBNP was Excellent. The water sources we encountered were sparkling clear and beautiful. Nonetheless, before drinking water from GBNP mountain streams, park officials recommend either boiling or filtering it to kill any microscopic bacteria.

Land Quality

KEC's Land Quality rating for GBNP was Fair. This was due to the damage caused by pine beetles and tent caterpillars, the overgrown forest areas (and the major fire threat they pose), and the declining glacier (a reflection of climate change).

Infrastructure

KEC's Infrastructure rating for GBNP was Fair. This was due issues like the lack of guard rails at high altitudes along the Wheeler Peak Scenic Drive, poor road quality in a number of places, and the visitor center handicap door button not functioning.

KEC GBNP Litter Survey Results

KEC's litter survey within GBNP encompassed stops at nine locations, including two visitor centers, hiking more than five miles of trails, and traveling about 30 miles along park roads. Based on our count of paper, plastics, and food waste discarded by uncaring visitors, KEC's overall litter rating for GBNP was a 2.0 out of 4. This means that there was some litter found at most sites we visited and along the Wheeler Peak Scenic Drive. It also reflects that, while there are far fewer visitors at GBNP then the other parks we visited, they are still littering way too much.

KEC GBNP Improvement Recommendations

1. Ramp up outreach efforts to secure volunteer assistance to improve degraded infrastructure. Consider reaching out to groups like the Boy Scouts

and religious organizations who are community service oriented.

2. Expand education outreach programs. More visitor awareness should be raised regarding proper preservation etiquette. When people are made aware that their actions are adversely impacting the environment, there is at least an improved chance that they will stop what they have been doing.

3. Allow small forest fires to promote a healthy ecosystem. Also pursue selective, controlled burns to bring about restoration of the GBNP ecosystem to a healthier natural state.

4. Team together with like-minded agencies and other groups to discourage development that can lead to further light pollution. Continue to raise awareness of the problems associated with light pollution.

5. Talk to the U.S. Congress about securing additional funding for park protection and other programs. This is particularly important for GBNP in light of how few paying visitors come to this park compared to most of the others.

6. Consider creative fundraising initiatives tied to primary park challenges. One example could include silent auctions with proceeds going toward designated projects of interest to the public and other stakeholder groups. Use the Internet to facilitate participation on an international level.

7. Establish anti-litter signage in strategic park locations (e.g., visitor centers, popular roadway stops, and trail heads).

8. Encourage recycling by allowing visitors to recycle items like bottles, cans, and paper at the park visitor centers in exchange for "I Recycled Today at GBNP" stickers or other inexpensive "give-aways" aimed at promoting good feelings for positive actions taken on behalf of the environment.

9. Partner with other government agencies and stakeholder groups to back efforts that will lead to further regulation of air emission point sources in Delta, Utah and the Salt Lake City region.

10. Stay vigilant about and strongly resist any attempts by Las Vegas or others to "steal" water from area sources.

Wheeler Peak, the Tallest in GBNP (Elevation 13,063 Feet), © 2015 W. Rhett Kiser.

Chapter 4

Yosemite National Park

Overview

According to the NPS, the granite walls, spires, and cliffs of Yosemite National Park (YNP) originated 100 million years ago from granitic magma from within the earth. About 35 million years ago, dramatic uplift began which resulted in the Sierra Nevada Mountains.

Grant and Rhett at YNP Eastern Entrance,

Subsequently, periods of glaciations occurred and rivers of ice flowed down canyons and stream courses. In Yosemite Valley, where the granite contained vertical cracks and joints, moving ice tore away the fractured rock, leaving behind such impressive sights as Half Dome.

Yosemite Valley was first encountered by white prospectors in 1851 during the gold rush when they were chasing the Native Americans into the mountains. The Indians were being starved out and had come down from the mountains to help themselves to gold miner deer and horses.

Yosemite was first set aside for protection during the American Civil War by President Abraham Lincoln when he signed the Yosemite Grant in 1864. The grant deeded Yosemite Valley and the Mariposa Grove of Big Trees to the state of California. In 1889, naturalist John Muir and Century Magazine Editor Robert Underwood Johnson initiated a campaign to make the high country surrounding Yosemite Valley, including two watersheds, into a national park.

The following year, the U. S. Congress set aside more than 1,500 square miles of "reserved forest lands" soon to be known as Yosemite National Park. It took a meeting between John Muir and President Theodore Roosevelt, to have the Mariposa Grove and Yosemite Valley ceded from California's control and included with the national park in 1903.

The NPS reports that YNP has 747,956 acres and is about the size of Rhode Island. During 2014, 3.88 million visitors came here.

KEC Field Observations: July 18, 2013

Approaching Yosemite National Park from the east, KEC entered the park via Tioga Pass on the Tioga Road (Route 120 west). Once inside the park, our first impression was that the trees were beautiful and did not show any signs of pine beetle infestation. The impressive waterfall that greeted us alongside the Tioga Road was a refreshing sight!

Tioga Pass leading to YNP, © 2015 W. Rhett Kiser.

The research team's next stop was the Tuolumne Meadows Visitor Center where we interviewed a park ranger. Details from our interview with the ranger are provided in the YNP Environmental Challenges, Environmental Solutions, and Ranger Environmental Ratings sections below.

Coming and going from the visitor center, we documented quite a bit of litter in the parking lot. In addition, the building infrastructure was old and not in pristine condition. There was also toilet paper all over the

floor in the men's bathroom. Facility maintenance was clearly lacking.

Bathroom Neglect, YNP Visitor Center,
© 2015 Jonathan V. L. Kiser.

We next backtracked east on the Tioga Road to hike the Lembert Dome trail, and passed by what appeared to be park employee housing made from plywood and canvas. Nothing fancy!

YNP Staff Housing in Tuolumne Meadows,
© 2015 Jonathan V. L. Kiser.

The 2.8 mile hike (roundtrip) passed through a wonderful pine forest leading to the exposed granite face of Lembert Dome. From the top of Lembert Dome a clear view of Mt. Lyell and Mt. Maclure could be seen to the south. Mt. Lyell's downgraded glacier (now classified as an icefield) was in clear view from our vantage point.

Grant and Rhett on Top of Lembert Dome,

On the way back to the car, the research team was confronted with major noise pollution along the Lembert Dome Trail. This was caused by an overhead jet. The annoying sounded disrupted the otherwise tranquil forest for more than a minute, and we speculated that it might be military training-related.

We next drove west along the Tioga Road west and stopped at Tenaya Lake to see a big restoration project that had been completed there during Summer 2012. This High Sierra lake is surrounded by lodgepole forests, granite domes, and Yosemite's vast wilderness. It is the largest natural lake in YNP.

It also sits immediately adjacent to Highway 120, is very popular, and has experienced considerable negative human impact. Impact examples include: 1) Extensive roadside parking that has led to vegetation compaction and denuding along large stretches of the northern lake bank; 2) Trail widening and erosion from hikers veering off designated trails; and 3) Litter left behind by careless visitors.

In October 2010, YNP released the Tenaya Lake Area Plan to address these types of issues. The Plan's Executive Summary states, "The plan includes conceptual designs for ecological restoration areas, parking areas, trails, access improvements, visitor facilities, and shuttle stops. The purpose of the Tenaya Lake Area Plan is to guide management actions by the NPS in order to protect resources and provide opportunities for appropriate high-country visitor experiences at Tenaya Lake." (For more information about this issue, refer to: Yosemite National Park. "Tenaya Lake Area Plan Environmental Assessment." National Park Service. October 2010.)

Along the wetland, eastern portion of Tenaya Lake, the research team observed roped off areas for restoration. There was severe erosion under the walkway, and we got the clear impression that someone could certainly get hurt walking along this path.

Tenaya Lake Infrastructure Decay,
© 2015 Jonathan V. L. Kiser.

On the western, more rocky section of the lake shore, there was a beach with quite a few people. It was shocking to see how much litter was there. The extremely littered section was rated by the research team to be a 4+ out of 4 on the litter scale.

In addition, there were old, grimy trash and recycling receptacles near the parking area that were obviously not being fully used. We couldn't help but wonder, with all the people passing through and being the cause for the litter problem, whether YNP could tax them in some manner (i.e., as part of the park entrance fee).

Such a litter fee could be used to implement an adequate park waste management and recycling program. This could include more user-friendly, modern collection bins, more staff resources, and a public education component that would proactively address this obvious problem issue.

At our next stop, Olmsted Point, the NPS had completed an impressive restoration about five years ago in response to the excessive tourist volumes. The NPS enlarged the parking area, a trail was installed to better channel foot traffic to the vista point, stairs were installed, and other infrastructure improvements were made.

Prior to closing this stop point for two summers to complete the restoration work, Olmsted Point was also well known for park animals mooching food from people. Fortunately, we did not see any of this behavior.

Flip-Flop Litter at Olmsted Point (Left), © 2015 Jonathan V. L. Kiser; and Olmsted Point Half Dome View (Right), © 2015 W. Rhett Kiser.

The park ranger forewarned us that there weren't any trash cans at Olmsted Point since there is no budget for staff to drive 30 minutes one-way to pick it up! There must be some method to this madness as we did not observe much litter here (except, most notably, for an abandoned flip flop in the parking lot).

While exploring Olmsted Point, another jet flew overhead creating more than a minute of noise pollution. The terrible sound lingered and temporarily spoiled the tranquility of the moment.

The research team continued on the Tioga Road and navigated a number of roadway rough spots (i.e., infrastructure decay). There was pine beetle damage along the roadway in this section, and the Forbidden Fire could be seen smoldering off in the distance. This fire resulted from a single tree being struck by lightning on May 21, 2013.

We then entered the Yosemite Valley, via the Big Oak Flat Road and the south side of Yosemite Valley Drive, and stopped at the Cathedral Beach roadside turnout to view El Capitan. This is the world's largest solid granite monolith that extends about 3,593 feet from base to summit along its tallest face. Rock climbers were spotted camped out high on the rock face.

Predictably, there was a tremendous amount of litter at the Cathedral Beach turnout (4 out 4 on the scale), again indicating the inexplicable disregard people have for the

very sacred ground and place they have traveled so many miles to admire.

El Capitan (Left), © 2015 W. Rhett Kiser; and Climber on Rock Face (Right), © 2015 Grant R. E. Kiser.

There was moderate traffic as we continued up the Yosemite Valley toward the Ahwahnee Hotel, a National Historic Landmark built in 1927. It was good to see a hybrid public transportation bus en route, which is part of the "free" YNP shuttle service offered in the Valley. This service helps to reduce air emissions from automobiles and campers (i.e., less vehicles are being driven when tourists use the public system) and lessons vehicle congestion in the Valley as well.

A little closer to the Ahwahnee, we documented a completely full campground and lots of activity at the Upper Pines location. We then spent some time touring the grounds and first floor of the Ahwahnee before calling it a day in YNP.

With the large number of people and commercial facilities in the Yosemite Valley, YNP was a far different national parks atmosphere than anything we had thus far encountered.

Yosemite Valley, © 2015 Grant R. E. Kiser.

Exiting the park along El Portal Road en route to our camp site, it was obvious that the Merced River water level was quite low. It made sense to us that the lack of snow over the past few winters was a contributing factor.

KEC Field Observations: July 19, 2013

On the way to Glacier Point, our first destination of the new day, the research team stopped at the Tunnel View parking lot to take in a classic view of the Yosemite Valley. Sadly, the parking lot was teaming with tour buses, cars, RVs, and tourists, many striking ridiculous poses in front of the world famous panorama. Litter was everywhere, especially cigarette butts from bus tour patrons.

The scene illustrated the worst of the tourist mentality. It was hard to watch hundreds of people scrambling to be photographed with the valley providing the perfect backdrop, and then leaving behind something for YNP to remember them by in the form of a candy wrapper, plastic bottle, used piece of gum, or other litter.

Continuing on to Glacier Point Road, we spotted road kill and the lack of safety guard rails in a number of dangerous spots. There were also a number of rough patches in the road.

Yosemite Valley from Washburn Lookout Point, © 2015 Grant R. E. Kiser.

The Washburn Lookout Point was next, where we saw beautiful views, a lot of litter, and protective barriers with signs encouraging people to stay on the designated trails. In spite of these well-marked signs, some tourists still climbed over the barriers to more quickly get to their desired vantage point.

Give Plants at Chance! at Washburn Lookout Point, © 2015 Jonathan V. L. Kiser.

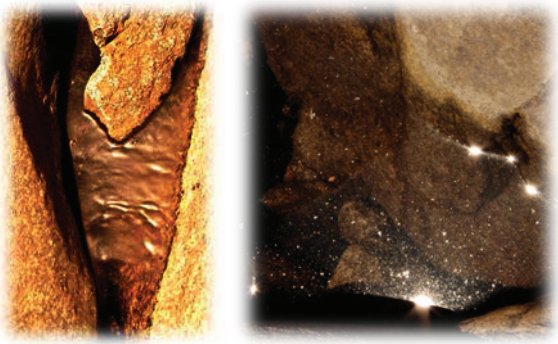
Finally arriving at Glacier Point, there were two tour buses and a Fosters Farm Dairy truck with its idling engine spewing air pollution. The parking lot had some litter, lots of cars, and even more people. One of the tour guides was waving her lit cigarette around. As the research team walked past her and headed toward the point, we were tempted to wait around to see if she one among the many careless smokers who believe that YNP's parking lots are also their own personal ash tray.

Idling Dairy Truck (Left); and Cardboard Litter at Glacier Point (Right), © 2015 Jonathan V. L. Kiser.

Our next destination was Bridalveil Fall back toward the Yosemite Valley floor. The parking lot was completely full and there were hundreds of tourists slipping and sliding their way up the slick granite path leading to the base of the fall.

Bridalveil Fall in Yosemite,
© 2015 Grant R. E. Kiser.

There was water pollution in several small pools below the fall. We suspected the source was sunscreen lotion that had washed off the skin of tourists who were swimming in the large pool at the base of Bridalveil Fall. Not surprisingly, litter was also evident along the trail and especially in the parking lot.



Water Pollution below Bridalveil Fall,
© 2015 Jonathan V. L. Kiser.

On the way to the Yosemite Valley Visitor Center, we stopped by the Merced River and encountered more water pollution and litter along the river bank.

Merced River Water Pollution (Lower Left),
© 2015 Jonathan V. L. Kiser.

The research team then boarded the free hybrid shuttle bus that looped through the valley, and stopped at the Yosemite Valley Visitor Center. There we asked several rangers for the NPS Climate Change brochure and were told that no one had ever asked for one before! This was unbelievable and sad, since there are nearly four million YNP annual visitors. After much searching, one of the

rangers found a dusty stack of climate change brochures hidden under the counter.

The rangers expressed gratitude for our interest and making them aware that the brochures even existed. They also confirmed that the Yosemite Fall water volume was down considerably for that time of year and that there was a climate change exhibit now on display featuring John Muir's work conducted in 1872 on Mt. Maclure.

We found the Yosemite Valley Visitor Center to be relatively clean (from a litter standpoint), and the John Muir climate change exhibit to be quite interesting.

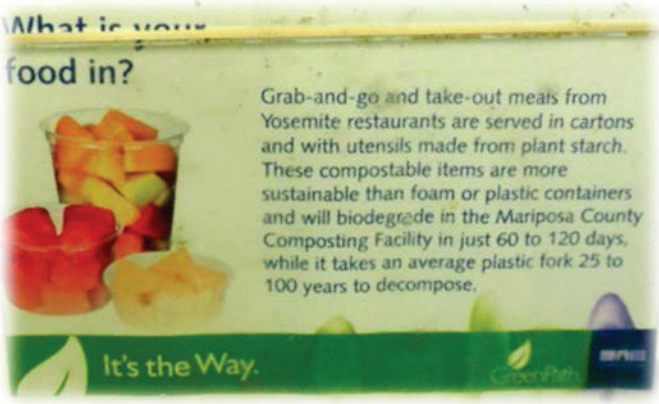
A 1.1 mile loop hike to the base of lower Yosemite Fall followed. We traveled the gradual and tranquil trail through mature woods, and passed huge rocks and historic signs relating to John Muir. The NPS reports that, at 2,425 feet high, Yosemite Fall ranks as the 5th tallest waterfall in the world (ten times higher than Niagara).

Lower Yosemite Fall, © 2015 Jonathan V. L. Kiser.

Near the base of the fall there was a direct vantage point of Half Dome, the granite crest that rises some 4,737 ft above the Yosemite Valle floor. Some litter was observed along the trail near Yosemite Fall.

Half Dome from Yosemite Fall, © 2015 Jonathan V. L. Kiser.

We next stopped by the Yosemite Lodge at the Falls for some much needed food and drink and noticed a sign on our table indicating that takeout meals from YNP restaurants are served in cartons and utensils both made from plant starch. These products will biodegrade in the Mariposa County Composting Facility within 60 to 120 days. Quite impressive since plastic utensils require 25 to 100 years to decompose. This was one of the better indicators we encountered of a progressive environmental program at YNP.



Yosemite Cafeteria Sign. Source: Public Domain.

KEC's next stop was at the Mariposa Grove by way of the Wawona Road. It was a windy, scenic journey that led us past the 19th century Wawona Hotel.

Built in 1876, the Wawona is one of the oldest California mountain resort hotels. It has a classic Victorian design and 104 guest rooms. The hotel appeared to be in excellent shape.

Wawona Hotel, © 2015 Jonathan V. L. Kiser.

Mariposa Grove is situated near Yosemite's south entrance, and contains, according to the NPS, about 500 mature giant sequoias (*Sequoiadendron giganteum*). These amazing trees have been recorded to grow up to 311 feet high with a maximum diameter of about 40 feet. Their bark is up to 31 inches thick. From a total volume standpoint, they are the largest living things known to humans. The giant sequoias grow only on the Sierra Nevada's western slope.

Giant Sequoias in the Mariposa Grove, © 2015 W. Rhett Kiser.

Following the trail from the parking lot, the research team immediately documented litter all along the way. We

passed by the Fallen Monarch which fell more than 300 years ago but has not decayed due to the tannic acid in the wood.

There was also forest fire damage evidence in the grove. It was good to learn from interpretive signs that these massive trees are fire resistant due to their thick protective layer of nonresinous bark and elevated crowns.

The trail next led to the Grizzly Giant, which is one of the world's largest trees and is estimated to be 1,800 years old. The NPS documents that the tree has a diameter of more than 29 feet, and volume of more than 34,000 cubic feet!!

We then walked through the California Tunnel tree, which was cut in 1895 as a marketing scheme to attract visitors and to allow coaches and Model T's to pass through it.

On the return hike, we passed by a giant, fallen sequoia that had been carved up in a big way by tourists. Back in the parking lot, the research team made a major observation: There was a trash can full of recyclable plastic bottles at the grove entrance and no alternative recycling bin to put them in.

This was not the only location we visited where this was the case. The clear conclusion is that YNP does not provide visitors with an easy way to recycle plastic bottles, even at the most popular destinations. Perhaps this is

another indication of budget constraints or perhaps it's simply a reflection of materials mismanagement. The bottom line is that a lot of plastic is being thrown out in YNP which should be recycled.

CA Tunnel Tree (Top Left); Sequoia Graffiti (Bottom Left); Mariposa Grove Grizzly Giant (Top and Bottom Right), © 2015 Jonathan V. L. Kiser.

KEC then decided to race back to Glacier Point to catch the sunset. A coyote (*Canis latrans*) greeted us along the roadway as we drove. Glacier Point was full of people, with rangers telling tales, painters capturing the evening glow, and all admiring the early evening glow!!

Wiley Coyote along Glacier Point Road,
© 2015 W. Rhett Kiser.

KEC Field Observations: July 20, 2013

This morning we drove through the YNP one last time and counted more litter along the banks of the Merced River inside the park entrance. Litter was also consistently seen along the Route 120 roadside as we made our way out of the park toward San Francisco.

Environmental Challenges (NPS Perspective)

Air Pollution

During our ınterview with the park ranger at the Tuolumne Meadows Visitor Center, KEC learned that studies completed on YNP soils, snow, and water find the presence of agricultural pesticides, herbicides, and fertilizers transported here in the form of airborne particles from the Central Valley (50 miles from the edge of the

park). Prevailing winds are from the west, so it blows across the Central Valley and onto YNP. Air pollution (in the form of smoke and other atmospheric pollutants – smog) from San Francisco and the Central Valley also contribute to YNP air quality issues.

Water Quality

Yosemite comprises two watersheds, the Tuolumne River and the Merced River. That is what John Muir was trying to protect (i.e., his vision) since it wouldn't do any good to protect one river corridor or one mountain peak. The goal was to protect the entire watershed with all of the flora and fauna associated with it. YNP's border is a watershed boundary, which continues on into Mammoth Mountain, Mammoth Lake, Mono Lake, and other destinations.

The Tuolumne River starts at Mount Lyell within YNP and flows to the Hetch Hetchy Valley (in the northwestern section of YNP) where it is collected in a man-made reservoir. A lot of this collected water is piped to the San Francisco Bay area. The remainder flows to the Central Valley where it is diverted for use by several towns, and agricultural operations. The Tuolumne River then joins the Sacramento River and flows on to the Delta.

Ironically, while people can swim, fish, and do other things in the river in the Tuolumne Meadows area of the park (upstream from the reservoir), no contact is allowed with the water at the Hetch Hetchy Reservoir itself.

YNP's Tuolumne River, © 2015 Jonathan V. L. Kiser.

Given the dry climate, millions of visitors, and other demands, the ranger we interviewed noted that there is never enough water supply in this ecosystem. Some 300 employees living nearby within the park, coupled with all the visitors, and stock animals result in some 50,000 gallons of water per day being drawn from the Tuolumne River a few miles upstream from the Tuolumne Meadows. This diversion creates possible issues for the Meadows and/or the YNP animals.

By comparison, the Merced River headwaters start at an elevation of 8,017 feet at the foot of the Clark Range, in the southeastern corner of YNP. The Merced River flows for 145 miles westward through a series of gorges and canyons that lead to the flat Central Valley plains. The river flows through the Little Yosemite Valley before dropping 594 feet over YNP's Nevada Falls and 317 feet over Vernal Falls,

creating what is known as the "Giant Staircase." The river then passes into and through the Yosemite Valley, and beyond through the scenic Merced Gorge.

Merced River with El Capitan,
© 2015 Jonathan V. L. Kiser.

A NPS study of YNP river values baseline conditions, indicates there have been occasional lead, cadmium, and mercury concentrations above freshwater criteria in the Merced River. Given the close proximity of river to development, these pollutants may have originated as impervious surface runoffs (e.g., from parking lots, roads) or leakage from underground storage tanks or landfills. (For more study information, refer to: National Park Service. "River Values Conditions Report." Yosemite Planning Division, 2011.)

According to the ranger, during the 2011 – 2013 period, YNP snow fall has been down 45 to 50% of "normal." This is in contrast to the 2010/2011 winter, when there was heavy snow fall that filled up all of the reservoirs and persisted through the summer. The Visitor Center didn't open until mid-July of 2011 due to the excessive amounts of snow. The bottom-line is that precipitation fluctuations are still occurring.

Fire Management

The NPS has changed its fire management policy over the past 30 years. Park officials used to suppress everything and discovered that this caused an excessive buildup of forest undergrowth that eventually resulted in really big fires. Officials have since discovered that it is healthier for the ecosystem to let the natural fires burn (i.e., so long as they don't get too much out of control).

Climate Change – YNP Glacier

The ranger noted that Jonathan Javis, the 18th Director of the NPS, has stated that climate change is real and has been exasperated by human actions. One area where this is very evident is the YNP glacier.

The NPS reports that glaciers created much of the scenery of Yosemite, including iconic features such as Half Dome. Glaciers are defined as long-lasting ice masses that arise from the accumulation of snow, and move downhill by flowing and sliding. A glacier's health is determined by the amount of winter snowfall compared to summertime melting of snow and ice. The movement of a glacier is

primarily determined by the glacier's thickness and steepness. Because they are sensitive to environmental conditions, glaciers are important indicators of climate change.

According to a YNP scientific study completed in 2013, the former Lyell Glacier (which used to be the largest glacier in park) has stagnated (i.e., ceased its downhill movement). The adjacent Maclure Glacier is still moving at its historical rate.

Mt. Lyell (w/Downgraded Glacier on the Left) and Mt. Maclure (to the Right), © 2015 Jonathan V. L. Kiser.

Data collected from the stakes placed on the former Lyell Glacier showed that no movement has occurred within the last several years. The former Lyell Glacier has decreased in size by about 60% since 1900, and has thinned by approximately 120 vertical feet. Stagnation of the former Lyell Glacier prompted park geologist Greg Stock to note in 2013, ". . . the lack of movement suggests that the term 'glacier' no longer accurately describes this feature." The ranger we interviewed classified Lyell as an icefield.

The YNP team also measured the Maclure Glacier, where John Muir first documented movement of this glacier in 1872. They mimicked Muir's measurements in 2012 by measuring stakes over the same period of the melt season. Despite a similar amount of ice loss as the Lyell Glacier, the YNP team found that the Maclure Glacier continues to move about one inch per day. This is the same rate that Muir measured. (For more information about the Lyell Icefield and Maclure Glacier, refer to: National Park Service. "Yosemite National Park's Largest Glacier Stagnant." February 4, 2013.)

Climate Change – Fire Threats

According to the ranger we interviewed, another noticeable effect of YNP climate change is drier winters in recent years. This translates to longer fire seasons, more available fuel, and the real possibility that future fires will threaten people, structures, and roads, and burn down large sections of the forest. During 2013, the Rim Fire, which began August 17, 2013 in the Stanislaus National Forest, burned over 255,000 acres. Approximately 77,254 of these acres were in YNP.

Climate Change – Endangered Species

Another impact of climate change is that amphibians world-wide are dying. In YNP, the sierra nevada yellow legged frog (*Rana sierrae*) is about to be put on the endangered species list. The park ranger reported that the frogs used to be so plentiful that when you would walk

through a meadow, hundreds would jump before you stepped on them. Now you are lucky to find one.

The plight of the frog reflects a quadruple whammy: 1) Climate change; 2) The frogs don't have as much water as they need and it's too warm; 3) Some of the water has pesticides in it wafting up from the Central Valley; and 4) There is a fungus effecting them (i.e., that turns their skin hard, not allowing them to breathe through their skin, and leads to death). The source of this fungus is unknown at this point.

The one federally-listed endangered species currently found in YNP is the bighorn sheep (Ovis canadensis).

Invasive Trout

To encourage recreational activities, non-native trout were first introduced into YNP during the 1880s. This has led to an imbalance in the ecosystem due to the trout eating frog (Anura) and toad (Bufo bufo) eggs, and tadpoles (Pollywog).

Over the decades, the frogs and toads have not been able to evolve defenses against the trout. Recent efforts to remove four types of non-native trout to help restore the balance of nature have not been successful.

Today, the brown trout (Salmo trutta) is only one of the seven non-native trout species in YNP. The trout introduction program created so long ago has created a negative domino effect and has backfired from a biodiversity standpoint.

Close-up of Brown Trout, Non-Native to YNP.
Source: Public Domain.

Balancing Park Versus Visitor Interests

Since YNP is the size of the state of Rhode Island, there are huge management issues, especially those relating to human activities. The NPS has been working on the Tuolumne and the Merced River Plans for decades. Following a big flood that hit during the 1990s, park officials tried to implement changes that would be good for the park scientifically and ecologically. Visitors responded negatively because camp grounds were closed and roads removed.

When people were told that there would no longer be horseback riding since it was damaging to YNP, they responded by saying their fathers and grandfathers rode horses in Yosemite, and that it was their right to do so as well. Visitors want the status quo but, with upwards of four million people passing through YNP annually, this is not sustainable.

The ranger noted that it's a horrible tight rope to walk trying to provide people with access and to protect YNP at the same time. (For more information about the 2013 Tuolumne and Merced River Plans, refer to: 1) National Park Service. "Tuolumne Wild and Scenic River, Draft Comprehensive Management Plan and Environmental Impact Statement, Yosemite National Park, January 2013; and 2) National Park Service. "Merced Wild and Scenic River Draft Comprehensive Management Plan and Environmental Impact Statement, Yosemite National Park, January 2013.)

The YNP Superintendant's worst nightmare is to get a call from an angry congressman or senator. Therefore, the Superintendent has made it known that YNP policies should be such so that phone calls from congress members (e.g., Diane Feinstein calling about not removing horses from Yosemite Valley) are minimized. YNP issues are often very political and there are many more opinions on the human interest side than there are on the pro-nature side.

Environmental Solutions (NPS Perspective)

Go Green Initiatives

Actions taken by YNP officials to "Go Green" include: 1) Use of electric compact fluorescent light tubes; 2) Installation of 2,800 solar panels at the YNP El Portal Administrative Complex (YNP's primary maintenance facility, its largest wastewater treatment plant, and administrative offices), producing about 800,000 kWh per year (about 30% of the complex's annual electricity); 3) Solar-powered housing; 4) Compostable utensils and

Biodiesel Hybrid Shuttle in the Yosemite Valley,
© 2015 Jonathan V. L. Kiser.

plates; 5) Hybrid, biodiesel shuttle buses; 6) Minimal staff automobile usage; 7) Recycling centers for glass, paper, aluminum, cardboard, and plastics #1 - #7 year-round at the Village Store and seasonally at the Curry Village Recreation Center. Visitors are also encouraged to recycle materials in green recycling receptacles in campgrounds, picnic locations, residential areas, and at roadside turnouts.

Recycling Containers at Tuolumne Visitor Center,
© 2015 Jonathan V. L. Kiser.

Education

The YNP Seasonal Highlights publication provides visitors with important insights about the park. In the Protecting Park Resources section, visitors are reminded that they are the park's most important guardians. Visitors are asked to report illegal acts such as: Feeding or approaching animals, collecting plants, hunting, picking up archeological items, using metal detectors, driving vehicles into meadows, biking off of paved roads, camping outside of designated campgrounds, and more.

Fire Management

During our visit, there was a fire burning between the Tioga Road and the Yosemite Valley, named the Forbidden Fire. It started May 21, 2013 with a lightning strike and is a very slow burning fire. Since there is no park infrastructure in this area, Park officials have opted to let the fire burn for more than two months. YNP officials felt that the area could probably use a good burn.

The YNP Forbidden Fire Diagram. Source: Public Domain.

Junior Ranger Program

There is a volunteer Junior Ranger program in YNP (and other national parks) and one of the Junior Ranger jobs is to pick up litter. While we saw a bag outside the Tuolumne Meadows Visitor Center with some litter in it (presumably from efforts conducted earlier that day), there was still quite a few missed pieces in the parking lot and other locations. We were told by the ranger that 100 kids come through daily picking up trash, but we saw no direct evidence of this in YNP or any of the other parks we visited during the entire trip.

Research and Studies

One of the activities YNP does to address environmental concerns is a lot of scientific research. Study topics range from invasive plant removal to declining animal species. YNP also encourages others to advance such research and provides support to sanctioned researchers in the form of free camp sites and other through means.

The park also serves as a public meeting place for scientific symposiums that cover topics such as fire science, hydroclimatology, bird surveys, and archeology. In addition, YNP sponsors the first park-based social science branch, which focuses on visitor use and user capacity issues.

Restoration Approach

YNP has a huge budget but also a huge expense, with the most employees and one of the largest land areas among all of the national parks. The ranger we interviewed

mentioned the first rule in any restoration effort is to do no harm. Park officials do the least damaging thing that will fix the problem and not cause more problems in the future.

With regard to the previously mentioned 15 to 20-year River Plans, YNP officials are devoting dwindling available budget resources toward fixing the worst problems. They go down the needs list as far as the budget will allow, taking public feedback into account.

Meadow Restoration

When people walk into YNP meadows, soils become compacted, plants are damaged, and habitats can be crushed. Restoration projects include the removal of drainage ditches and old roadbeds, and the installation of boardwalks to prevent trampling. Visitors are advised to stay on maintained trails and boardwalks.

Trail Maintenance

The NPS, with support from the Yosemite Conservancy, the CA Conservation Corps, and park volunteer groups, routinely fill and replant trail ruts. To minimize erosion and otherwise prevent trail infrastructure deterioration, hikers are encouraged to stay on the trails and not to cut corners on switchbacks.

Air Quality

According to the NPS, an extensive air-monitoring program exists in YNP to track pollutant impacts. There are three park monitoring station areas. The Turtleback Dome site monitors ozone, visibility, nitrogen deposition (dry),

and meteorology; Several Yosemite Valley sites monitor for fine particles, ozone, and meteorology; and the Hodgdon Meadow site monitors wet deposition.

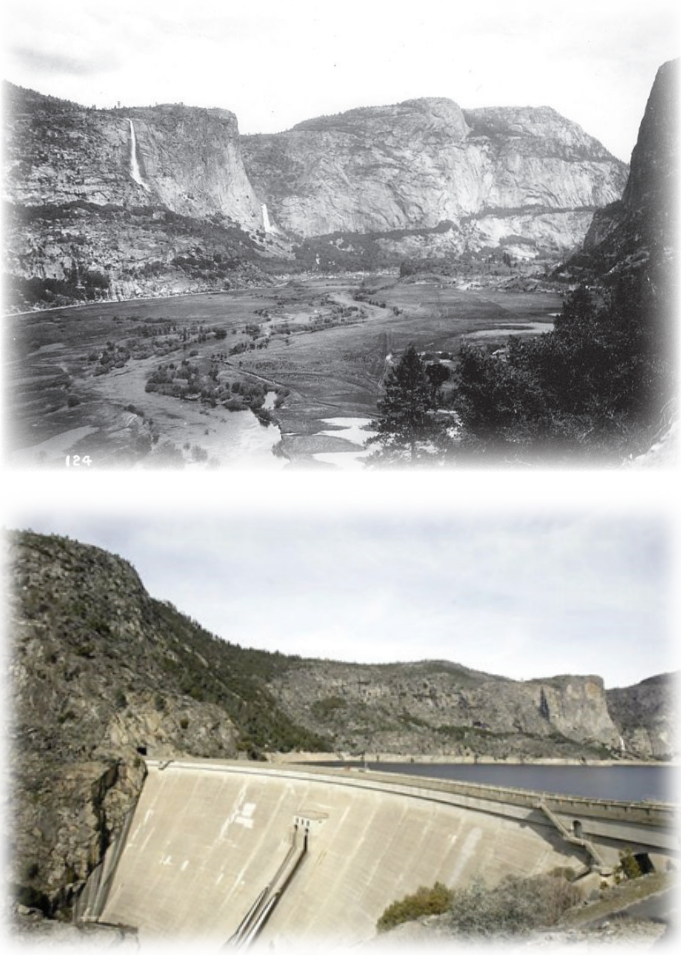
Water Quality

In an effort to protect the excellent water quality in the Merced and Tuolumne River corridors, the NPS collects and reports on water quality data. Specifically tracked are: Nutrients, total phosphorous and total dissolved phosphorous, E. coli, and total petroleum hydrocarbons. (For more information about YNP water quality and sewer management, refer to: National Park Service. "Water Quality and Sewer Management, Water Quality Consumer Confidence Reports," Yosemite National Park, 2014; and "Sewer System Management Plans," Yosemite National Park, 2013.)

Hetch Hetchy Reservoir Vote

The Hetch Hetchy Valley, through which the Tuolumne River runs in the northwestern section of the park, was very similar to the Yosemite Valley. It had big, wide grassy areas, waterfalls, and tall granite peaks. That all changed in 1923 when a dam was completed and the valley was flooded to serve as a water supply source for San Francisco In November 2012, there was a ballot measure in San Francisco to remove the Hetch Hetchy dam. While most folks said it would never go anywhere (i.e., 2% support at best), there was a big grass roots movement and they achieved a large turnout. The water company became quite nervous when it found out that 40 percent of the people

want to remove the dam! Unfortunately, the dam continues to stand, at least for the time being.



Hetch Hetchy Valley Before (Top); and After the Dam (Bottom). Source: Public Domain.

Ranger YNP Environmental Ratings

The ranger's YNP ratings for environmental quality and infrastructure are provided in Exhibit 7.

Exhibit 7 - Ranger YNP
Environmental & Infrastructure Ratings

Air Quality	2.0
Water Quality	1.0
Land Quality	1.0
Infrastructure	3.0
Overall Avg.	**1.8**

Scale: 1 = Excellent, 2 = Good, 3 = Fair, and 4 = Poor.

The ranger gave a Good rating for Air Quality, an Excellent rating for Water Quality and Land Quality, and a Fair rating for the quality of park Infrastructure. The ranger's overall average environmental quality and infrastructure rating was better than Good. Details associated with the ranger's rating of YNP are provided below.

Air Quality

The ranger we interviewed at the Tuolumne Meadow Visitor Center said that Air Quality in YPN is not perfect, but Good. Air visibility issues are generally not a problem unless there is a fire. During 2012, an RV caught fire causing huge flames to go up a steep canyon wall that was hard to fight. Air quality in YNP suffered due to smoke and people had to be evacuated.

Water Quality

The Ranger indicated that, in the Tuolumne Meadows River section of the park, the Water Quality is Excellent. This is because YNP and the City of San Francisco are

trying hard to keep it that way for the Hetchy Hetchy water supply system. The City gives money to educate people on why and how to keep the water from becoming polluted. The Merced River watershed is Very Good but the seven mile Yosemite Valley section is the problem area. Overall, the ranger still gave the Merced River watershed an Excellent rating.

Land Quality

There is a lot of trail damage in YNP due to the large number of visitors. Many YNP trails run side-by-side and people expand them by not observing the designated paths. On the other hand, the ranger was not sure about any long-term damage impact resulting from logging practices that took place here over 100 years ago.

During the period between World War I and 1930, over one-half-billion board feet of timber were felled in the Yosemite area. (Note that one board foot equals the volume of a one-foot length of a board one foot wide and one inch thick.) Logging activities ceased when John D. Rockefeller, Jr. and the federal government bought out the Yosemite Lumber Company.

A study is now being conducted in the Tuolumne Meadows by PhD UC Davis students investigating the impact of domestic sheep grazing in the area. During the 1800s, there were thousands of grazing sheep in the park. The verdict is still out regarding any permanent damage they may have caused.

Overall, the ranger stated that YNP's Land Quality is Excellent. 95% of the park is comprised of wilderness quality land (i.e., one may not see another person for days), and the park continues to properly manage the remaining, most popular five percent.

Infrastructure

The ranger noted that YNP receives less and less money each year and has been consistently losing ranger positions. In addition, park buildings are "cute" but old. For example, the Tuolumne Meadows Visitor Center was built in 1932 but is fortunately in good shape. There is no money to fix the center plus, being a YNP landmark building, there are historical compliance issues that would need to be addressed. For these reasons, the ranger gave YNP an Infrastructure rating of Fair.

KEC YNP Environmental Ratings

KEC's environmental quality and infrastructure ratings for YNP are provided in Exhibit 8.

Exhibit 8 - KEC YNP
Environmental & Infrastructure Ratings

Air Quality	1.5
Water Quality	2.0
Land Quality	2.0
Infrastructure	2.5
Overall Avg.	**2.0**

Scale: 1 = Excellent; 2 = Good; 3 = Fair; 4 = Poor.

Details associated with KEC's YNP ratings shown in Exhibit 8 are provided below.

Air Quality

KEC's overall Air Quality rating for YNP was Very Good. In the eastern area of the park, including Lembert Dome, the air quality was Excellent. Same with the southern area of the park, including Mariposa Grove.

In the Yosemite Valley, with all the camp sites, vehicles, food service operations, the air quality was Good. In addition, the views were a bit hazier in the Valley.

Water Quality

KEC gave YNP an overall Water Quality rating of Good. While the Tuolumne River water quality appeared to be Excellent, in Yosemite Valley at the base of Bridal Veil Fall and Yosemite Fall, we noticed oily film accumulating in some places (likely resulting from suntan lotion used by swimmers upstream in the pools below the falls).

The Merced River also revealed some pollution in the form of foam (type not identified), downstream from the campground and commercial operations in Yosemite Valley. Based on our visual inspection, these Yosemite Valley locations were rated to have Fair water quality.

Land Quality

KEC's Land Quality rating for YNP was Good, based on the limited amount of the park we were able to see over a two day period. We saw some areas where hikers had trampled the ground, some locations where trees had suffered pine beetle damage, and there was evidence of fire in certain park areas.

Of course, fire is now viewed by the NPS to be a good thing for the ecosystem, so long as it originates from natural sources and is not threatening to people or park infrastructure.

Infrastructure

KEC's Infrastructure rating for YNP was between Good and Fair. Near the Lembert Dome trail, we saw old housing, made from plywood and canvas. This was not energy conservation efficient, nor otherwise impressive. We also documented crumbling road sections and the need for guard rails in various locations.

On the other hand, we witnessed improved infrastructure at Olmsted Point, and deluxe visitor accommodations at the Ahwahnee hotel. The KEC rating takes into account the size of YNP and park official efforts to make improvements in spite of budget constraints.

KEC YNP Litter Survey Results

KEC's YNP litter survey encompassed stops at about 26 locations, including two visitor centers, hiking more than 12 miles of trails, and traveling about 190 miles along park roads. Based on our count of paper, plastic, metals, cigarette butts, and other materials discarded by uncaring visitors, KEC's overall litter rating for YNP was a 3.5 out of 4 on the scale. This means that most of the sites we visited (and especially the most popular locations) were very littered.

KEC YNP Improvement Recommendations

1. Establish a no fly zone over YNP and beyond the borders to the point that planes and other aircraft cannot be heard.

2. Secure additional funding for education programs, staff resources, infrastructure maintenance and repair, research, etc. Engage the public and other park stakeholders in the fundraising process by finding out what areas are of most interest and encouraging them to contribute directly or to support outreach efforts for government funding. Also consider creative public-private funding initiatives that will generate positive public relations for the private sector partner.

3. Specifically consider providing visitors with a brief questionnaire touching upon topics such as their favorite park features and their willingness to donate financial support and/or contribute volunteer time that they can fill out while visiting the park or mail in after their visit. Then follow-up with those who have expressed a willingness to help.

4. More visible educational materials regarding park impacts from climate change need to be made available to the public. According to the ranger in the Yosemite Valley Visitors Center, we were the first to ever ask about a climate change brochure! A more proactive, prominent campaign is clearly needed to bring this topic to the park visitors. The same can be said about the other parks we visited.

5. Implement more obvious and strategically placed signage urging visitors to stay on the designated trails. For trails leading to waterfalls, include signage asking hikers to stay out of the water due to concerns about water contamination from sunscreen and human bacteria.

6. Make visitors aware at the park entrances and visitor centers that litter is a big problem in the park and that hefty fines will be enforced for anyone caught contributing to this problem. Follow up with litter fine enforcement.

7. Strategically place anti-litter signage, litter fine signs, and cigarette receptacles in parking lots and popular road pull-off locations. Indicate on the signs and in park literature what happens to the litter that is carelessly thrown on the ground. One message concept might include showing an iconic park image with and without litter in the foreground and the caption reading, "Which scene to you prefer to remember your park by?"

8. Specifically implement an anti-cigarette butt campaign including signage with a noticeable logo image at roadside stops and parking areas.

9. Raise awareness with the same anti-cigarette message in park newsletters and other publications with the aim being to help reduce the litter problem. Also promote among smokers the use of new "all

natural" cigarettes, with organic cotton and de-gummed hemp filters packed with flower seeds that can be either composted or literally planted to grow plants.

Anti-Cigarette Butt Campaign Example,
© 2015 Jonathan V. L. Kiser.

10. Beef up litter pickup efforts at the most popular YNP locations.

11. Create educational anti-litter DVDs/videos in various languages and show them on shuttles, in visitor's centers, etc. Provide tourists with convenient, obvious places to dispose of trash and recycle plastic and other materials.

12. Encourage recycling by allowing visitors to recycle items like bottles, cans, and paper at the park visitor centers in exchange for "I Recycled Today at GBNP" stickers or other inexpensive "give-aways" aimed at

promoting good feelings for positive actions taken on behalf of the environment.

13. Step up efforts to properly manage trash and recyclables in YNP. One option would be to install solar trash and recyclables compactor bins. These will not only reduce the frequency of materials collection and improve trash and recyclables management efficiency, but also promote alternative energy.

14. Consider establishing a waste management/ recycling/litter fee as part of the park entrance fee to be used to implement an adequate park waste management and recycling infrastructure, anti-litter efforts, and staffing resources.

15. Consider charging hourly fees for visitor parking at the lots leading to the most popular park destinations, especially if those destinations are services by the "free" hybrid bus service.

16. Encourage more walking/hiking/biking/use of public transportation to reduce car/truck emissions.

Chapter 5

Redwood National and State Parks

Overview

Origins of Redwood National and State Parks (RNSP) date back to 1918 when a national campaign was launched by paleontologists to preserve the tallest trees in the world with a link to our evolutionary past. Scientific community interest then led to the creation of three North Coast redwoods state parks: Prairie Creek in 1923, Del Norte in 1925, and Jedediah Smith in 1929.

RNSP Southern Entrance, © 2015 Jonathan V. L. Kiser.

Interest in preserving the trees' natural setting in the Coast Range and the associated animals and plants led to the creation of Redwood National Park in 1968. The U.S. Congress approved its 48,000 acre expansion in 1978.

The national park boundary encircles the three state parks and provides increased protection of the ancient redwood forests. RNSP is a cooperative management effort of the NPS and the California Department of Parks and Recreation.

In 1963, the tallest tree in the area was 369 feet in the Tall Tree Grove. Today, the tallest known redwood tree is 379 feet tall, located in the Redwood Creek watershed. For more information, go to: (National Park Service. "Park Guides." Redwood National and State Parks California, 2014).

The NPS reports that RNSP contains 131,983 acres, of which 71,715 acres are federal and 60,268 acres are state. Old-growth forest comprises 38,982 acres. During 2014, there were about 429,000 visitors to RNSP.

KEC Field Observations: July 23, 2013

The research teams' first stop at RNSP was the southern entrance sign. 60 pieces of litter were counted in the 100 yard area surrounding the sign! We then traveled along Highway 101 north through the small town of Orik, California, past a tourist shop with a wooden Bigfoot statue outside. Highway 101 passes in and out of RNSP in a number of locations.

The next stop was the Kuchel Visitor Center to interview a park ranger. Details from this interview are provided in the Environmental Challenges, Environmental Solutions, and Ranger Environmental Ratings sections below.

Continuing north, we stopped at the 300-acre Lady Bird Johnson Grove, where the Redwood National Park was dedicated in 1968. Unfortunately, there were 20 pieces of paper litter along the trail.

Grant at Lady Bird Grove,
© 2015 W. Rhett Kiser.

The research team then passed over Redwood Creek which showed some evidence of water pollution (a 2.0 out of 4). Former logging activities have resulted in the creek being filled with silt. In addition, there were a few pieces of litter near Redwood Creek, more litter at the nearby, former CRD Timber & Logging facility location, and still more litter along Highway 101 a short distance away.

Litter at the Old CRD Timber & Logging Facility,
© 2015 Jonathan V. L. Kiser.

The research team next journeyed toward Fern Canyon in Prairie Creek Redwoods State Park via a windy dirt road, along God Bluffs Beach. There were many signs indicating we were passing in and out of Tsunami zones in this seacoast region.

Approaching Fern Canyon, there were two large Roosevelt elk *(Cervus canadensis)* bulls and we were able to take some good pictures of them from a reasonably safe distance. They had large antler racks and weighed in at more than 1,000 pounds each!

Rhett and Grant with Bull Elk near Gold Bluffs Beach, © 2015 Jonathan V. L. Kiser.

Fern Canyon has California native ferns *(Pteridophyta)* covering 33 – 49 foot sheer walls, giving it a primeval habitat quality. The prehistoric ambience led to the canyon being used as a filming location for *The Lost World: Jurassic Park*, BBC's *Walking with Dinosaurs* and IMAX's Dinosaurs Alive!

Grant and Rhett in Fern Canyon, © 2015 Jonathan V. L. Kiser.

While in Fern Canyon, we encountered a banana slug (*Ariolimax columbianus*), documented a few pieces of litter, and saw some water pollution.

Fern Canyon Banana Slug, © 2015 Grant R. E. Kiser.

On our drive back to rejoin Highway 101, there was some trail infrastructure repair underway.

Trail Infrastructure Repair near Gold Bluffs Beach, © 2015 Jonathan V. L. Kiser.

The next stop was the Big Tree Wayside where the 1,500 year-old Big Tree, measuring 304 feet tall with a near 22 foot diameter, proudly stands. We hiked three miles along the South Fork Trail reaching as far as the intersection with the Rhododendron Trail. As usual, litter was found on and around the trail.

The Big Tree, © 2015 Jonathan V. L. Kiser.

Litter along the South Fork Trail, © 2015 Jonathan V. L. Kiser.

The research team then headed north and stopped to hike along the Ah-Pah Interpretive Trail. There we witnessed the impressive results of post-logging road removal and hill slope rehabilitation. Trailside exhibits explained how the land was reclaimed. It was very difficult to see any evidence of logging activity at this point.

Ah-Pah Trail Restoration Sign. Source: Public Domain.

Accommodations that evening were at the Mill Creek campsite in Del Norte Coast Redwoods State Park.

KEC Field Observations: July 24, 2013

Leaving the campsite early in the morning, the research team journeyed north to Crescent City and stopped at the Battery Point Lighthouse. The California coast was very scenic from this vantage point, and we caught a distant southern view of the coast redwoods with mist and fog engulfing them.

Crescent City Coastline, © 2015 Grant R. E. Kiser.

There were sea otters (*Enhydra lutris*) in the water, seals (*Pinnipedia*) resting on the docks, a stray cat (*Felis catus*) hiding in the rocks, crabs (*Brachyura*), and a starfish (*Asteroidea*) (a.k.a., sea star).

Sea Otter near Crescent City, © 2015 Jonathan V. L. Kiser.

Regrettably, the U.S. pacific coast has recently been experiencing massive die-offs of sea stars and scientists are trying to determine the cause. They are calling the disease sea star wasting syndrome. It is a sure sign that the ecosystem is not healthy. (For more information, refer to: National Park Service. "Pacific Rocky Intertidal Monitoring: Trends and Synthesis. Sea Star Wasting

Syndrome." Bureau of Ocean Energy Management, November 18, 2015.)

Healthy Sea Star among the Rocks near Crescent City, © 2015 Jonathan V. L. Kiser.

We continued on, following the unpaved Howland Hill Road (Route 199) for two miles, and stopping for a hike on the Boy Scout Tree Trail in the Jedediah Smith Redwoods State Park. There was litter in the parking area.

Litter at the Boy Scout Tree Trail Trailhead, © 2015 Jonathan V. L. Kiser.

Onward to the Stout Memorial Grove in the Jedediah Smith Redwoods State Park. This 44-acre grove, adjacent to the Smith River (the last major free-flowing river in the state), was donated to the Save-the-Redwoods League in 1929 .

Rhett and Grant with the Stout Tree,
© 2015 Jonathan V. L. Kiser.

The Stout Tree was huge, with a height of 325 feet and a diameter of nearly 17 feet! Regrettably, there was some water pollution in a stream feeding into the Smith River. We also documented paper litter, including some near the footbridge crossing the river to the Jedediah Smith campground. (For more information, refer to: California Department of Parks and Recreation. "Jedediah Smith Redwoods State Park." 2015.)

Water Pollution (Middle) near Stout Grove,
© 2015 Jonathan V. L. Kiser.

Environmental Challenges (NPS Perspective)

Climate Change

According to the RNSP ranger we interviewed at the Kuchel Visitor Center**,** a study is now underway to determine if there is any impact from climate change on the redwoods. Steve Sillet at Humboldt State University is leading the investigation.

Rainfall amounts have been down in recent years during the summer and the fear is that if it gets too hot in the summer the area fog could disappear. The outstanding question is what impact, if any, will this have on the world's tallest trees?

Illegal Marijuana Operations

RNSP is combating the diversion of water from illegal marijuana (*Cannabis*) growing operations on or near park lands. In September 2008, an interagency anti-drug task force raided a marijuana plantation that contained 9,564 plants and covered approximately five acres on steep terrain. This growing site was within six miles of the world's tallest tree. Five Mexican nationals were detained for questioning.

During 2010, two people were arrested who were supplying a neighboring complex. RNSP has established a long-term, focused patrol which is responsible for preventing new activity. Other national parks, like Yosemite, Sequoia, and Kings Canyon, face the same issue.

According to the NPS, a one-acre growing plot can translate to 10 acres of disturbance when consideration is given to the growers' camps, the trails they cut through the landscape, the dumpsites they create, and the irrigation lines they install. Chemicals and fertilizers used in the operations contaminate streams and enter the food chain by poisoning animals that are then fed upon by scavengers.

Small mammals and rodents are targeted by the growers so they don't eat the plants. Larger animals are killed for food. Those behind these destructive operations are often Mexican drug cartels. (For more information about this illegal practice, refer to: Repanshek, Kurt. "Battle Against Marijuana Growers Temporarily Closes Crystal Cave at

Sequoia National Park." National Parks Traveler. August 27, 2009.)

Watershed Damage

The 1978 expansion of RNSP included a 33,000 acre protection zone upstream from the parks in Redwood Creek's watershed. This protective zone serves as a critical guard against adverse impacts from timber harvesting outside the park. Since 1978, a large-scale restoration effort has been initiated and continues to be undertaken.

According to the NPS, the goal has been "to minimize erosion caused by past land management activities and to encourage the recovery of the natural ecosystems to their predisturbance conditions." It's a massive and expensive undertaking and the park's watershed continues to suffer from soil erosion and sedimentation stemming from past logging activities.

Downstream, water quality continues to suffer as well, along with habitat for threatened steelhead trout (*Oncorhynchus mykiss*) and coho salmon (*Oncorhynchus kisutch*). (For more information, refer to: Redwood Creek Watershed Group. "Redwood Creek Integrated Watershed Strategy." June 22, 2006.)

Burl Poaching

There are also poaching issues in RNSP relating to the removal of burls from the trees. A burl is a hard conglomerate of many dormant buds. The original single bud grew, but failed to develop into a branch. The irregular

growth proceeds to divide and redivide until a lump (burl) has formed. Some of the over growth is actually a form of scar tissue, resulting from a past injury to the tree.

Burls are attractive to poachers since they yield a very peculiar and highly figured wood, prized for their beauty and rarity. They are sought after by artists, wood sculptors, furniture makers, and others.

Coast Redwood Burls, © 2015 Jonathan V. L. Kiser.

Environmental Solutions (NPS Perspective)

Watershed Restoration

According to the park ranger we interviewed, restoration efforts to the Redwood Creek watershed, a previously logged area, have shown positive results. Stream obstructions have been removed and second growth forests have been thinned. Some 220 miles of old logging roads have been returned to a natural state. In addition, a gravel plug was put in place to prevent the Town of Orick from flooding.

As a result of such initiatives, threatened chinook (*Oncorhynchus tshawytschaand*), coho salmon, and some steelhead trout counts are beginning to come back in Redwood Creek. An on-going objective is to reverse the impact of sediment runoff which has filled in deep creek holes where salmon would otherwise breed.

The Formation of the Redwood Creek Watershed Group in 2004 was another important step taken to improve erosion control and prevention throughout the watershed. The group is comprised of private landowners and agencies who manage most of the watershed from its headwaters to the estuary. (For more information, refer to: Redwood Creek Watershed Group. "Redwood Creek Integrated Watershed Strategy." June 22, 2006.)

Elk Migration

The NPS is monitoring Roosevelt elk migration patterns in RNSP. Roosevelt elk is the largest land mammal in the parks, with adult male bulls weighing up to 1,200 pounds. There were literally as few as 15 of these beautiful creatures left in California in 1925. Fortunately, through the protection of critical habitat in places like Prairie Creek Redwoods State Park, the population is once again abundant.

Bulls will aggressively guard their harems and park literature advises that approaching the elk is not only hazardous but is against state law. People should observe them from a safe distance.

Bull Elk near Gold Bluffs Beach,
© 2015 Jonathan V. L. Kiser.

Education

Education is one of the important keys to preserving RNSP. There are two outdoors schools located within the parks, the Howland Hill Outdoor School near Crescent City and the Wolf Creek Education Center near Orick, California. Their primary focus is field studies relating to wetland, stream, prairie, and old-growth forest communities. RNSP offers interpretive programs as well.

The ranger we interviewed also suggested being aware of threatened and endangered species, not leaving any food crumbs that may attract critters, and not otherwise feed the wildlife.

The Lady Bird Johnson Grove Nature Trail brochure reminds visitors that flowers and plants in the parks are

protected by law and not to pick them. The Prairie Creek Redwoods State Park brochure adds that visitors should help to keep the park clean and litter free. "If you bring it in, take it back out."

The Del Norte Coast Redwoods State Park brochure points out that visitors should stay on established trails (to avoid compacting the soil near tree roots) and use a detailed trail map or GPS to avoid getting lost on unmarked logging roads. The Jedediah Smith Redwoods State Park brochure adds that visitors should purchase firewood at the park to avoid spreading tree diseases, and that pets are not allowed on the trails.

Air Quality/Carbon Footprint Reduction

According to the ranger, efforts have been taken to improve RNSP air quality. Highway 101 is now diverted around the seven mile Newton Scenic Parkway to minimize air emissions from diesel trucks and other motor vehicles.

Carbon Footprint Reduction/Climate Change Mitigation

RNSP has teamed with Humboldt State University to design and install renewable and conserving energy systems at various park facilities. For example, a solar hot water system is now in place at the Thomas Kuchel Visitor Center. Further, a photovoltaic solar system is operational at the Wolf Creek Outdoor School, meeting 10% of the facility's annual electricity needs.

Sustainability Initiatives at RNSP. Source: Public Domain.

During 2010, the NPS developed a RNSP Action Plan to address concerns about climate change. RNSP became climate friendly parks and completed a greenhouse gas (GHG) emission inventory. During in-house staff meetings, a response strategy was developed to meet the parks' climate change mitigation goals. These included: 1) Reducing GHG emissions resulting from activities within and by the parks, focusing on energy use, transportation, and waste management/recycling; 2) Increasing climate change education and outreach, focusing on park staff, visitor outreach, and local community outreach; and 3) Evaluating progress and identifying areas for improvement. (For more information about the action plan, refer to: National Park Service. "Climate Friendly Parks. Redwood National and State Parks Action Plan." 2010.)

Ranger RNSP Environmental Ratings

The ranger RNSP environmental quality and infrastructure ratings are provided in Exhibit 9.

Exhibit 9 - Ranger RNSP
Environmental & Infrastructure Ratings

Air Quality	1.0
Water Quality	2.0
Land Quality	2.0
Infrastructure	2.0
Overall Avg.	**1.8**

Scale: 1 = Excellent; 2 = Good; 3 = Fair; 4 = Poor.

The ranger gave RNSP Air Quality an Excellent rating, and a Good rating for Water Quality, Land Quality, and Infrastructure. The ranger's average environmental quality and infrastructure rating for RNSP was better than Good, indicating there is still room for improvement in three of the four categories of interest.

In spite of the Excellent Air Quality rating, airborne pollutants from nearby logging and mining operations, vehicles, wood smoke, agriculture, and power plants, remain a threaten that must proactively be guarded against.

KEC RNSP Environmental Ratings

KEC's RNSP environmental quality and infrastructure ratings are shown in Exhibit 10.

Exhibit 10 - KEC RNSP
Environmental & Infrastructure Ratings

Air Quality	1.0
Water Quality	2.0
Land Quality	2.0
Infrastructure	1.5
Overall Avg.	**1.6**

Scale: 1 = Excellent; 2 = Good; 3 = Fair; 4 = Poor.

Details associated with KEC's rating of RNSP are provided below.

Air Quality

KEC's Air Quality rating for RNSP was Excellent. We traveled through some beautiful spaces with the trees providing a huge carbon sink, generating oxygen. The foggy and misty conditions we experienced are an integrated, essential part of the ecosystem (with both contributing moisture to the forest during the dry summer months).

Water Quality

KEC's Water Quality rating for RNSP was Good. It was very clean for the most part but we did observe and documented pockets of pollution, including white suds in the Fern Canyon Home Creek and the Stout Memorial Grove creek leading into the Smith River.

Land Quality

KEC's Land Quality rating for RNSP was Good. Even though a large portion of this area was heavily logged in

the past, the RNSP is doing a good job of restoring the land. We didn't detect any logging evidence while hiking on the trails. However, there was some wear and tear on some of the trails where people would walk around the trees, and veer off of the designated paths.

Infrastructure

KEC's Infrastructure rating for RNSP was Very Good. Other then the "trail closed for construction" sign along the Gold Bluffs Road, and the eye sore of the former CRD logging operation site near Lady Bird Johnson Grove, the facilities in the parks appeared to be in fine shape.

KEC RNSP Litter Survey Results

KEC's litter survey within RNSP encompassed stops at about one dozen locations, including one visitor center within the parks, hiking at least six miles of trails, and traveling about 60 miles along park roads. Based on our count of paper, plastic, metals, cigarette butts, and other materials discarded by uncaring visitors, KEC's overall litter rating for RNSP was a 3. This means that, unfortunately, there was litter found at most sites we visited.

KEC RNSP Improvement Recommendations

1. Secure additional funding for education programs, staff resources, infrastructure maintenance and repair, research, etc.

2. Consider providing visitors with a brief questionnaire touching upon topics such as their favorite park

features and their willingness to donate financial support and/or contribute volunteer time that they can fill out while visiting the park or mail in after their visit. Then follow-up with those who have expressed a willingness to help.

3. Expand the focus of education outreach efforts relating to how climate change is impacting the RNSP and how visitors, as individuals, can reduce their own carbon footprint. By raising awareness, hopefully bad behaviors will improve.

4. Step up efforts to team with elected officials and other stakeholders who support the mission of the NPS and are willing to back policies that will preserve RNSP for generations to come.

5. Execute more obvious and strategically placed signage urging visitors to stay on the designated trails.

6. Strategically place anti-litter signage, litter fine signs, and cigarette receptacles in parking lots and popular road pull-off locations. Signage should emphasize that these majestic forests are not waste paper receptacles. Mention of the Great Pacific Garbage Patch, which is a collection of marine debris litter in the North Pacific Ocean, would also be appropriate. This patch, also known as the Pacific trash vortex, is comprised of the Western Garbage Patch, located near Japan, and the Eastern Garbage Patch, located between the U.S. states of Hawaii and California.

7. Hold litter cleanup events and encourage volunteer participation from the public and other stakeholder groups. Enforce littering fines in an effort to raise needed money and to change this bad behavior that was observed throughout the RNSP.

8. Implement a hybrid shuttle bus service to take visitors to popular trails and other park locations. This would help to further reduce air pollution and reduce congestion within the parks.

Jonathan with Giant Redwood Friend in RNSP, © 2015 W. Rhett Kiser.

Chapter 6

Crater Lake National Park

Overview

Crater Lake National Park (CLNP) is located in Southern Oregon, 100 miles east of the Pacific Ocean. It is part of a volcanic chain that extends along the crest of the Cascade Range and includes two other peaks that are part of national parks (Mount Rainier and Mount Lassen).

Western Entrance to Crater Lake National Park,
© 2015 Jonathan V. L. Kiser.

The lake was formed 7,700 years ago when the 12,000 foot high volcanic Mount Mazama erupted and collapsed to form a caldera. This eruption was connected with plate tectonics. A plate carrying oceanic crust pushed into what is now the northwestern United States.

The lava flows that followed sealed the caldera and additional, smaller eruptions created other park features such as Wizard Island, which projects 764 feet above the lake's surface. (For more information, refer to: National Park Service. "Crater Lake. Plan Your Visit." 2015.)

Rhett and Grant's First View of Wizard Island,
© 2015 Jonathan V. L. Kiser.

Original proposals by a man named William Steel to make Crater Lake a national park were met with much argument from sheep herders and mining interests. In 1893, the lake received some protection as part of the Cascade Range Forest Reserve. Crater Lake was finally

designated as a National Park by President Theodore Roosevelt in 1902. CLNP protects 183,000 acres. (For more information, refer to: Crater Lake Institute. "Crater Lake National Park: Administrative History by Harlan D. Unrau and Stephen Mark," 1987.)

Crater Lake is the deepest lake in the U.S. (1,958 feet) and seventh deepest in the world. It receives its water only from rain fall (69 inches annually on average) and considerable snow melt (averaging 533 inches annually). Evaporation and seepage prevent the lake from becoming any deeper.

According to the NPS, the lake contains five trillion gallons of water. There are no river or stream inlets contributing silt, sediment, or pollution, and there are no coal-fired point sources of air pollution nearby. As a result, Crater Lake is considered to be the clearest and cleanest large body of water in the world. The extraordinary, deep blue color of the water results from the combination of the clarity and purity of the water, its great depth, and the way light interacts with the water.

In 1997, scientists recorded a 142 foot world record for water clarity at Crater Lake. By comparison, Lake Tahoe in California has a water visibility depth of about 70 feet. The lake is about five miles wide and is surrounded by steep rock walls rising up to 2,000 feet above the lake's surface. (For more information, refer to: National Park Service. "Crater Lake. Reflections Visitors Guide." Summer/Fall 2012.)

According to the Crater Lake Institute, an independent, non-profit organization and park partner, and the NPS, four major forest types make up the dominant park ecosystems. These include the ponderosa pine forest at an elevation of about 4,500 feet, the lodgepole pine forest at about 5,000 feet, the mountain hemlocks (*Tsuga mertensiana*) at about 6,000 feet, and the whitebark pines (*Pinus albicaulis*) which extends from about 7,500 feet to the top of Mt. Scott, the highest point in the park (8,929 feet). The whitebark pine zone is more an open woodland than a forest. Other tree types found in CLNP include white fir, douglas fir, and shasta red fir (*Abies magnifica*).

Since it was established as a national park before commercial logging reached the High Cascades, CLNP's forests are almost entirely old growth. Few of these trees grow taller than 150 feet, due to the volcanic soil quality and the harsh winter climate.

According to the NPS, during 2014, CLNP received about 535,500 visitors.

KEC Field Observations: July 24, 2013

The research team's first CLNP stop was at the western entrance sign. There we documented litter in the form of three cigarette butts and two pieces of paper. Just beyond the park entrance sign there was an aluminum beer can along the road side. KEC also noticed that many of the pine trees were suffering in the area.

Ailing Pines inside CLNP Western Entrance,
© 2015 Jonathan V. L. Kiser.

Driving beyond the CLNP entrance area, the research team documented a lot of litter along Munson Valley Road leading up to the Western Rim Drive. Rim Drive, built between 1931 and 1940, is the 33-mile scenic road that encircles Crater Lake.

We arrived at the Steel Visitor Center just before closing and interviewed a park ranger. Details from our ranger interview are provided in the Environmental Challenges, Environmental Solutions, and Ranger Environmental Ratings sections below. Our journey continued along West Rim Drive and frequent stops were made to take in the spectacular views.

CLNP Discovery Point, © 2015 Jonathan V. L. Kiser.

We spent some time at Discovery Point, where gold prospector John Hillman first set eyes on the Lake in 1853. Whitebark pines and mountain hemlocks lined the cliff edges and established a natural frame for Wizard Island in the distance. Regrettably, litter was counted at this stop.

Paper Litter near Watchman Overlook, © 2015 Jonathan V. L. Kiser.

At the Watchman Overlook stop, Rhett and Grant climbed to the top of Watchman Peak (elevation 8,013 feet) and were rewarded with a panoramic view of Wizard Island and the surrounding lake environment. In the parking lot, Jonathan documented yet more litter.

Crater Lake from Watchman Overlook, © 2015 Grant R. E. Kiser.

Heading toward our campsite destination for the evening outside CLNP near Diamond Lake, we followed the Crater Lake Highway to the north through the Pumice Desert. This broad flat area in the northern section of the park has few plants due to the scarcity of organic matter. After the Mt. Mazama eruption, this desert was covered (in some places) with pumice and ash more than 200 feet deep.

KEC Field Observations: July 25, 2013

This morning we returned to CLNP via the northern entrance. There was a lot of litter along the stretch of road covering the park entrance to the Rim Drive. Our journey then continued around Crater Lake on the Rim Drive toward the east.

Crater Lake Morning View, © 2015 Jonathan V. L. Kiser.

As a few deer crossed the road in front of us, the morning light created a glowing mountain ridge image reflecting against the lake that was remarkable. This setting was dampened by a plastic bottle that had been left roadside by some inconsiderate visitor.

At the Cleetwood Cove parking lot, which serves as the trail head access point for the hike down to the edge of Crater Lake, we counted 145 pieces of litter! Cigarette butts mostly, paper products, and more.

The research team then hiked down to the edge of the lake, for a closer look at the crystal clear, refreshingly cold water. The water felt and tasted great (20% more pure than drinking water). A group of tourists passed by in a large motor boat managed by CLNP. Weather permitting, this

service operates from June through mid September and includes trips around the lake and to Wizard Island.

CLNP Boat Tour Service, © 2015 Jonathan V. L. Kiser.

Along the shoreline, we observed non-native signal crayfish (*Pacifastacus leniusculus*) moving around the rocks. They appeared to be just below the surface of the lake, but were actually about four feet underwater. The water clarity was really noticeable.

The signal crayfish was introduced into Crater Lake around 1914 and has expanded to fill over half of the lake's shoreline habitat. In the process, they appear to be displacing the locally-adapted population of mazama newts (*T. granulosa mazamae*) that occur nowhere else in the world. (For more information, refer to: National Park Service. "How are crayfish affecting Crater Lake." 2015.)

Invasive Crayfish at Crater Lake, © 2015 Jonathan V. L. Kiser.

On the return hike up to the parking lot, the research team documented extensive infrastructure repair that was underway on a stone fence. Given the long winters and lack of financial resources, we couldn't help wondering when this much needed work would actually be completed.

Cleetwood Cove Trail Infrastructure Repair,
© 2015 Jonathan V. L. Kiser.

Unfortunately, we also observed that a trail bench had been vandalized with knife carvings. Yet another example of insensitive people being more interested in fulfilling their own needs at the expense of everyone else.

Cleetwood Cove Trail Bench Vandalism, © 2015 Jonathan V. L. Kiser.

Continuing to make our way around East Rim Drive, the research team observed how clear the air was, and how good the land looked. We then followed a one-mile spur, the highest paved road section in Oregon, to the Cloudcap Overlook. Thousands of whitebark pines were seen here, dwarfed and shaped by the area high winds.

Crater Lake from Cloudcap Overlook, © 2015 W. Rhett Kiser.

Infrastructures issues in this section of CLNP included pot holes in most of the parking lots and a missing interpretive sign.

Missing Interpretive Sign, © 2015 Jonathan V. L. Kiser.

Continuing around the lake, we passed Mount Scott, (the highest CLNP peak at 8,934 feet) and documented additional road infrastructure deterioration.

East Rim Drive Infrastructure Decay, © 2015 Jonathan V. L. Kiser.

Our next stop was the Pumice Castle Overlook. According to the NPS, the Pumice Castle is part of an extensive lenticular bed of fragmental pumice outcropping on the crater wall. It is about 1,300 feet above the level of the lake, and 400 feet below the crater rim.

Pumice Castle at CLNP, © 2015 W. Rhett Kiser.

The research team next came upon the Phantom Ship Lookout, where the road was largely litter-free, but suffering from noticeable wear and tear.

Phantom Ship at CLNP, © 2015 W. Rhett Kiser.

The Phantom Ship is a solid lava fragment exposed by erosion. It's 400,000 years old, as long as a football field, and as tall as a 16-story building!

Continuing on, the road condition became bumpy and pothole filled in many places, guard rails were missing, and rock slides were evident. The good news was that rugged beauty abounded all around.

Our final CLNP stop was Vidae Falls, a 100-foot, spring-fed creek that descends over a glacier-carved cliff. It was certainly worth seeing. (For more information, refer to: National Park Service. "Crater Lake Waterfalls." November 2010.)

CLNP Vidae Falls, © 2015 Jonathan V. L. Kiser.

Environmental Challenges (NPS Perspective)

Climate Change

According to the CLNP ranger we interviewed at the Steel Visitor Center, climate change has led to Crater Lake's surface water temperature being steadily on the rise. About ten years ago, the water temperature during the summer months averaged about 55 °F. It now reaches into the 70s.

Further, the bell weather pikas lived on Wizard Island up until 1992. After that, warming weather conditions no longer allowed them to exist there. Ancient pika scat is still evident.

Contributing to this situation is logging activity one-half mile from the CLNP boundary. Such activity has accelerated the rise in air temperatures since the removed trees can no longer cool the ground. Summer air temperatures now can reach the 90s instead of the upper 70s which was more common in the past.

Invasive Aquatic Species

The ranger indicated there is ongoing concern about the potential for invasive aquatic species such as zebra clams (*Dreissena polymorpha*) being introduced into Crater Lake. Fortunately, this has yet to happen. Nonetheless, concern over swimmers introducing non-native species into the lake has prompted CLNP to place a moratorium on long-distance swimming activities.

Insect Tree Impacts

According to the Crater Lake Institute, several forest insect species which cause tree damage are commonly found in CLNP. These species include: 1) The mountain pine beetle - damaging ponderosa and lodgepole pine; 2) The western pine beetle – damaging ponderosa pine; and 3) The balsam woolly aphid (*Adelges piceae*) – damaging subalpine and other true firs.

The non-native pathogen fungus that causes white pine blister rust (a plant disease that produces a reddish-brown discoloration of leaves and stems) is occasionally found on whitebark pine within the park. The fungus inhibits the white pine from regenerating.

Between 1923 and 1933, there was an extensive outbreak of the mountain pine beetle in the lodgepole pine forests of the park. The outbreak moved from north to south, and by 1925 the beetles were killing an estimated 200,000 trees north of CLNP. These attacks often speeded the succession to fir and hemlock forests. Limited bark beetle buildups in the park occurred in 1946, 1947, 1948, and 1957.

During the 1960s, the NPS undertook limited chemical control of beetles in the ponderosa forests along roadways. At present, insects are not considered a serious threat to CLNP's forests and no control measures are in effect. (For more information, refer to: Crater Lake Institute. "Plant Communities and Terrestrial Ecosystems of Crater Lake National Park," 2015.)

Careless Drivers

Road kill from careless drivers is issue at CLNP. Deer and marmots are the primary victims. People need to slow down, be more aware of their surroundings, and show more respect toward the CLNP environment.

Infrastructure Needs

According to the ranger we interviewed, CLNP needs to secure several millions of dollars to establish a "real visitor center." The Steel Visitor Center where we stopped appeared to be in Good shape but it was comparatively small and old.

Trash Management/Litter

The ranger reported that park maintenance personnel do a good job of picking up and otherwise managing the trash generated in the park. KEC's litter survey in the park determined that this was definitely not the case. Understaffing may be the cause of the obvious litter problem at CLNP. Litter not only physically degrades the appearance of CLNP, but also poses a threat to wildlife that eats it and may alter the natural feeding habits of the animals.

Paper Litter at Watchman Overlook,
© 2015 Jonathan V. L. Kiser.

Women

The ranger also singled out women from an environmental impact perspective since they are apparently primarily responsible for leaving a lot of toilet paper along the CLNP trails. From what KEC documented here and at the other parks visited on this trip, this issue is not unique to CLNP. The research team is also confident that men and non-adults are contributors to this obvious problem.

Environmental Solutions (NPS Perspective)

Aquatic Invasive Species

While CLNP has no official policy banning scuba diving, snorkeling, or long distance swimming in the lake, there is currently a moratorium. The concern is that snorkels, diving gear, wet suits, and other equipment could serve as vectors for the introduction of non-native organisms into Crater Lake. Likewise, to prevent the introduction of non-native organisms, fishing in the lake is limited to artificial lures and flies only. No organic bait of any kind (e.g., fish eggs, PowerBait, live or dead fish) may be used.

Lake Closed to Scuba, Snorkeling, and Long Distance Swimming, © 2015 Jonathan V. L. Kiser.

Education

Education of the general public is key to protecting the park from an environmental perspective. The Crater Lake Reflections Visitor Guide publication informs visitors about park policies, recycling, and other helpful information. For example, pets must be kept on a leash and are restricted to developed areas. Solid pet excrement must be picked up immediately and disposed of in a trash receptacle. In addition, feeding, touching, disturbing, or approaching wildlife is prohibited.

Don't Feed the Chipmunk,
© 2015 Jonathan V. L. Kiser.

Recycling

The Crater Lake Visitor Guide Reflections publication reports that combination trash/recycling bins can be found at more than 20 locations around the park. All bins accept trash and recyclables, and acceptable recyclables are limited to aluminum cans and plastic bottles. The Rim Village Café also accepts aluminum cans and plastic bottles for recycling.

Prescriptive Fires

Following 100 years of fire suppression practices, the CLNP now subscribes to prescribed burns to encourage a healthy ecosystem. Such burns cycle nutrients, provide conditions which favor wildlife, reduce the number of trees susceptible to insect attack and disease, reduce fire hazards, and promote new life and growth.

Different habitats result from fires. For example, woodpeckers are not as prevalent as they once were since the trees where they used to find insects have been burned.

Trolley Tours

Ranger-guided trolley tours circle Crater Lake via the Rim Drive on a daily basis (weather permitting). These climate-controlled trolleys are powered by compressed natural gas and emit 30 – 40% less air pollution than gasoline-powered vehicles.

Support Your Park Initiatives

The Crater Lake Reflections Visitor Guide publication includes a page encouraging visitors to shop in the visitor center bookstore. All proceeds from visitor purchases are invested back into the park. Visitors are also encouraged to buy Crater Lake license plates. Money from plate sales goes into an endowment that funds the operation of the park's Science and Learning Center. (For more information about this Center, refer to: National Park Service. "Crater Lake Science and Learning Center," 2015.)

In addition, visitors are encouraged to volunteer their time to help the park, and to contribute to the Crater Lake Trust. The trust is a non-profit organization that raises private funds to support park projects and connect the park with surrounding communities.

Insect Monitoring

According to the Crater Lake Institute, there is currently a CLNP cooperative program with the U.S. Forest Service utilizing infrared aerial photography to monitor insect populations and infestation trends within the park. (For more information, refer to: Adamus, P. R., D. C. Odion, G. V. Jones, L. C. Groshong, and R. Reid. 2013. Crater Lake National Park Natural Resource Condition Assessment. Natural Resource Report NPS/NRSS/WRD/NRR—2013/724. National Park Service, Fort Collins, Colorado.)

Ranger CLNP Environmental Ratings

The ranger ratings for CLNP environmental quality and infrastructure are provided in Exhibit 11.

Exhibit 11 - Ranger CLNP Environmental & Infrastructure Ratings

Air Quality	1.0
Water Quality	0.5
Land Quality	3.0
Infrastructure	4.0
Overall Avg.	**2.1**

Scale: 1 = Excellent, 2 = Good, 3 = Fair, and 4 = Poor.

The ranger gave RMNP Air Quality an Excellent rating, a better than Excellent rating for CLNP Water Quality, a Good rating for Land Quality, and a Poor rating for the quality of park Infrastructure. The ranger's average environmental quality and infrastructure rating was slightly less than Good.

The Water Quality rating of better than Excellent was the best rating among all the feedback provided by rangers in the six parks we visited. By comparison, the Poor Infrastructure rating was the lowest and reflected not only the impact of long, harsh winters but also lack of park resources to adequately address obvious needs.

KEC CLNP Environmental Ratings

KEC's environmental quality and infrastructure ratings for RMNP are shown in Exhibit 12.

Exhibit 12 - KEC CLNP
Environmental & Infrastructure Ratings

Air Quality	1.0
Water Quality	0.5
Land Quality	2.0
Infrastructure	4.0
Overall Avg.	**1.9**

Scale: 1 = Excellent; 2 = Good; 3 = Fair; 4 = Poor.

Details associated with KEC's rating of RMNP are provided below.

Air Quality

KEC's Air Quality rating for CLNP was Excellent. The visibility was very clear and there were no physical signs of pollution.

Water Quality

KEC's Water Quality rating for CLNP was better than Excellent. The stream by the Steele Visitor Center was pure and Crater Lake itself lived up to its billing as the cleanest large body of water on earth!

Land Quality

KEC's Land Quality rating for CLNP was Good. This rating takes into account the erosion we saw along the roadway and on various hill sides and the one area of damaged trees near the western entrance.

Infrastructure

KEC's Infrastructure rating for CLNP was Poor. CLNP's infrastructure was the worst among all the parks we visited. Roads were in rough shape, edges were deteriorating, and pot holes were found along the road and in a number of parking lots.

Further, interpretive signs were missing, and there was an unsightly port-o-potty left on the side of the road for construction workers.

Likely contributing factors to this Infrastructure problem include a lack of park resources and the extreme seasonal weather swings and snow fall levels.

KEC CLNP Litter Survey Results

KEC's litter survey within CLNP encompassed stops at about 14 locations, including one visitor center, hiking about four miles of trails, and traveling more than 60 miles along park roads. Based on our count of paper, plastic, metals, cigarette butts, and other materials discarded by uncaring visitors, KEC's overall litter rating for RMNP was 3.0 out of 4. This means that there was litter found at essentially all of the sites we visited.

KEC CLNP Improvement Recommendations

1. Secure additional funding for education programs, staff resources, infrastructure maintenance and repair, research, etc. Continue to apply creative means of doing this.

2. Consider providing visitors with a brief questionnaire touching upon topics such as their favorite park features and their willingness to donate financial support and/or contribute volunteer time that they can fill out while visiting the park or mail in after their visit.

3. Encourage volunteer organizations like the Boy Scouts and community-minded religious organizations to assist with litter pickup events, infrastructure repair, and other areas of park needs.

4. Focus more educational outreach materials and other programs on the impact of climate change on CLNP.

5. Execute more obvious and strategically placed signage urging visitors to stay on the designated trails, and for motorists to avoid killing animals on the roadway.

6. Strategically place anti-litter signage, litter fines signs, and cigarette receptacles in parking lots and popular road pull-off locations.

7. Implement a litter fine enforcement program as a way to gain more control over the problem and to generate much needed revenue.

8. Bolster existing recycling efforts, by giving visitors who recycle items like bottles, cans, and paper at the park visitor centers a “I Recycled Today at CLNP” stickers or other inexpensive “give-aways” aimed at promoting good feelings for positive actions taken on behalf of the environment.

9. Continue to carefully manage the boat tour program to minimize any adverse impact on the lake’s water quality.

10. Continue to maintain the informal restrictions on scuba diving, long-distance swimming and other human aquatic activities to help ensure Crater Lake remains in pristine condition.

Mount Scott, CLNP’s Highest Peak (Elevation 8,934 Feet),

About the Authors

Jonathan V. L. Kiser, M.B.A. and President of Kiser Environmental Consulting, specializes in satisfying client needs through a variety of services. These include: Program management, technical research, writing & analysis, quality assurance/control/management, full cost accounting assessments aimed at reducing program costs, 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, climate change, air quality, pollution control, regulatory compliance, energy conservation, litter management, and more.

Mr. Kiser has more than 40 years of experience working on behalf of public and private sector organizations on assignments throughout the U.S. and internationally. Jonathan's first environmental assignments were for the Sanibel-Captiva Conservation Foundation. This 1970s work focused on tagging alligators and sea turtles, a field survey investigating the impact of invasive species on area mammals, and documenting the erosion patterns of barrier islands. From 1991 to 1995, Jonathan served as a founding Director for the Integrated Waste Services Association (IWSA) in Washington, D.C. Prior to this, he worked as a Manager at the National Solid Wastes

Management Association and served as Project Liaison for an EnergyConservation Program sponsored by University Circle, Inc. and Case Western Reserve University in Cleveland.

Jonathan received his M.B.A. from George Washington University, and B.S. in Resource Economics from the University of New Hampshire. He has more than 80 publications and has extensively taught environmental topics across the U.S., in Europe, Australia, and Thailand. Mr. Kiser has also served on numerous technical peer review committees and coalition group efforts, is a Research Associate with the Columbia University Earth Engineering Center for Sustainable Waste Management, a member of James Madison University's Collaboration for Environment, Health and Safety (CEH&S), and a long-standing member of the Solid Waste Association of North America (SWANA).

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