IMG NATURAL HISTORY BROCHURE

Climbing More Than a Mountain

The king of mountains in the Lower 48 States is Mount Rainier. Rising 13,211 feet above the surrounding lowlands to a summit altitude of 14,410 feet, Mount Rainier has a greater vertical rise than K2. It is located 50 miles south of the Seattle-Tacoma metropolitan area and is contained within the 235,000-acre Mount Rainier National Park. The Park contains a complex ecosystem extending from lush, temperate rainforest at the mountain's base to a wilderness of glaciers above.

Geology

Rainier is a dormant stratovolcano, a type of volcano that includes many of the world's most beautiful peaks like Fujiyama, Kilimanjaro, and Cotopaxi. Stratovolcanoes are composed of layers of lava, ash, and volcanic rubble. Late season climbers on Rainier will see bedrock that ranges from solid andesite to bouldery mud. As part of his graduate studies in Geology, IMG partner Eric Simonson collected samples of Rainier's rock layers during a climb of Liberty Ridge, which rises steeply through the heart of the old mountain where it is now exposed by glacial erosion.

The oldest rocks in Mount Rainier are around 900,000 years old, which is some 11 million years younger than the Cascade Range that it is built on top of. The present peak developed over the last 500,000 years, and its base now covers 100 square miles. The present summit crater is much younger: 2200 years or less. Rainier is one of a chain of volcanoes paralleling the west coast that were built by magma rising from the subduction zone where oceanic plates are being overridden by the North American plate. Over its short life, Mount Rainier has built itself up and broken itself down on multiple occasions. Remnants of former cones (like Rainier's satellite peak, Little Tahoma) point upwards towards a now vanished summit, which once stood 16,000 feet above sea level.

Stratovolcanoes are notorious for two things: violent eruptions and dramatic collapses. The violence of their eruptions is due to the high viscosity of their silica-rich lavas, which makes them reluctant to flow except under high pressure. Consequently, high pressures build up inside stratovolcanoes until violent blowouts occur like the one that tore off the northern flank of Mount St. Helens in 1980. These explosive eruptions (called Plinian eruptions after Pliny the Elder, who died in one on Mount Vesuvius in A.D. 79) are often accompanied by pyroclastic flows, which are superheated ash that billows out in clouds and avalanches down slopes, obliterating whatever it contacts and melting snow and ice. When an explosive eruption involving pyroclastic flows occurs on a glaciated mountain, mudflows result, and these can extend great distances down river valleys leading away from the volcano. Rainier is currently dormant, meaning that it has not erupted for about 150 years.

Stratovolcanoes are also notorious for edifice collapses, meaning that they tend to fall apart as glacial erosion oversteepens their flanks and steam vents alter the solid rock into mud. A major collapse 5700 years ago carried away the northeastern sector of Rainier's summit. Plunging downhill, this mass of ice, mud, and rock debris raced down the White River all the way to Puyallup and Puget Sound. The depression left in the upper mountain by this landslide is now covered by the upper Emmons and Winthrop Glaciers. The combination of a violent eruptive past, recent edifice collapses, and a large human population living nearby makes Mount Rainier the most dangerous volcano in the Cascade Range.

Glaciers and Snowfields

Mount Rainier is the most heavily glaciated peak in the Lower 48 States with 26 named glaciers and scores of unnamed ones. The Carbon Glacier on the mountain's north side has the lowest terminus altitude (3600 feet) of any glacier in the Lower 48 States, while the Emmons Glacier is the largest (4.3 square miles). Melt waters from Mount Rainier's glaciers drain into the water supplies of a number of nearby towns and cities. It may take a century or so, but what you leave on the upper slopes of Mount Rainier could some day end up in someone's drinking water.

Rainier's glaciers together contain about one cubic mile of ice. There are so many because Rainier's summit lies far above the regional snowline, the altitude where snow that falls during the winter survives unmelted through the next summer. On Rainier the snowline lies around the 6500-foot level, though this is slightly lower on the north side of the mountain and higher on the south side. Given Rainier's massive size, its high summit altitude, and the relatively low snowline, there is a lot of room for snow to accumulate, metamorphose into ice, and then flow downhill as a glacier.

Glaciers are masses of ice that flow downhill. Multi-year accumulations of snow compact and metamorphose into ice, which continues to thicken until beginning to flow downhill under its own weight. Glaciers are like slow-motion, frozen rivers. Like a river that ends in the sands of a desert, a glacier melts away as it flows downhill into a zone of warmer climate. If the rate of melting is exactly balanced by the rate that new ice is added higher on the mountain, the glacier's terminus remains in one spot; however, this is rarely the case, and slight imbalances between melt rates and accumulation rates cause fluctuations in the downvalley extent and thickness of a glaciers. Most of Rainier's glaciers have undergone net retreats of up to a mile since the late 1800s. Although there were minor readvances in the 1980s, the overall trend has been retreat caused by less winter snow and warmer summers.

Glaciers move ice downhill in three main ways, all nicely illustrated on Mount Rainier. Low on the mountain, below 10,000 feet where the ice and underlying bedrock are relatively warm, glaciers slide on their beds over a layer of meltwater. The second way is through internal deformation. When force is applied to a mass of ice, the ice crystals slowly deform around one another to accommodate the stress. For a glacier on a steep slope, this internal deformation results in a slow-motion, downhill cascade of ice. Together, basal sliding and internal flow move glaciers along at speeds that typically are several feet per day. Glaciers low on the mountain move fastest because both basal sliding and internal deformation occur, while glaciers near the summit move more slowly because there is no water at the glacier's bed for it to slide on.

The third way that glaciers move is via ice avalanches, which occur in places where glaciers flow over bedrock cliffs. Willis Wall at the head of the Carbon Glacier and the Nisqually Ice Cliff near Camp Muir are good places to see glaciers moving through ice avalanching. The underlying bedrock cliffs are either too high or too steep for the glaciers to move over them in a coherent, flowing mass. So they break into blocks of ice that tumble down to the less steep slopes below and there reform into glaciers flowing via basal sliding and internal deformation.

Crevasses are vertical cracks in the surface layers of glaciers. Their presence signals that ice is flowing, and so crevasses are diagnostic of glaciers. Most crevasses are less than 100 feet deep; in comparison, many of Rainier's glaciers are several hundred feet thick, or even more where they flow through confined valleys on the lower mountain. Crevasses form in response to spatial unconformities in glacier flow rates. What this means is that crevasses form where fast-flowing ice pulls away from slow-moving ice upslope. This commonly occurs in places where the underlying bedrock slope steepens, or along the edges of a glacier where fast-flowing ice in the center of the glacier pulls away from the relatively slow-moving ice at the glacier's margin. The smooth, glacier-covered slopes of Rainier hide a complicated subglacial topography created by ancient lava flows, volcanic vents, and landslide scarps. As the glaciers move downhill over this complex surface, their crevasse patterns reflect the hidden surface below.

Glaciers pose numerous hazards to climbers. IMG partner Phil Ersler has spent more of his life on glaciers than many of us have spent in bed, yet he still is adamant about always roping up on glaciers. As Phil points out, the bed of a glacier is a mystery, so the exact location of crevasses is unknowable. Because of the high snowfall and relatively warm temperatures, glaciers on Mount Rainier flow faster than the small, high, cold glaciers in the polar regions or in the Rockies. High flow rates translate into more crevasses, routes that change rapidly, and more ice avalanches.

Snowfields are accumulations of snow that are too shallow or short-lived to metamorphose into ice and begin flowing as glaciers. Some snowfields melt away every summer, while others like portions of the Muir Snowfield that do not melt are border-line glaciers and contain ice at depth. The Muir Snowfield sometimes develops small crevasses and it probably was an active glacier in the late 1800s.

Climate on Mount Rainier is changing, and this is evident in the radical retreats undergone by most glaciers since the late 1800s. Glaciers are useful indicators of long-term trends in climate because they average together the confusing details of short-term climate phenomena. Between 1913 and 1994, the total volume of glacier ice in Mount Rainier's glaciers declined by 25% and it continues to shrink today.

Climate and Weather

With no topographic barriers between it and the open Pacific, Rainier can experience extreme weather that strikes with little warning. Maximum average precipitation occurs on the western slopes of the mountain where moist Pacific air first contacts the mountain, rises, cools, and dumps rain and snow. This creates a pronounced rain shadow on the mountain's eastern side where the climate is drier. Both rainfall and snowfall reach maxima at altitudes between 5000 and 7000 feet. At Paradise, average winter snowfall is 52 feet, which is why the Park Service must install support braces in the Paradise Lodge every fall to prevent it from collapsing. IMG partner, George Dunn took his first trip to Mount Rainier with his high school climbing club to dig a snow pit at Paradise for a scientific study. Their mega-trench, which took several days to complete, revealed a 72-foot snow pack that spring. Compared to Paradise, the upper mountain above 12,000 feet has a dry, Antarctica-like climate with almost no rain and little snowfall, much of which blows away in the high winds.

Snow can fall at any time of the year at high altitudes on Rainier, but the general cycle of seasons is *autumn* in September and October, *winter* from the first snowfall in mid- to late October until late March, then *spring* until mid-May, and finally *summer* from then until September. Late winter frequently sees one or more week-long intervals of high pressure conditions resulting from southward outbreaks of polar air that block Pacific storms and bring stable, clear, but cold conditions to the upper mountain. The heaviest snow falls often occur in March and April as storm tracks are pushed southwards by high-pressure cells sitting over Alaska and western Canada. Unstable weather often persists into July until the northward expansion of the Pacific High pressure system pushes storms back towards Alaska and leaves the Pacific Northwest under clear skies. These stable conditions often last into October.

Snow Avalanches

Within the annual cycle of weather are the shorter cycles of storms, which in turn drive one of the most fearsome natural hazards on Rainier: snow avalanches. Every 5-8 days in winter and spring, a new cyclonic storm spins across the North Pacific and collides with Mount Rainier. These storms vary in the amount of snow they drop, their windiness, and the air temperatures they bring. These variations determine the type of snow crystal that falls, and so each storm contributes a slightly different type of snow layer to the winter snow pack. During fine spells between the storms, this snow pack is modified further by the sun, which can melt the snow surface leaving ice layers, or by the cold night air, which can create layers of powdery hoar frost. Once buried within the snow pack, these variations in structure determine its stability, which would not be a concern if we were talking about a foot of snow on a prairie in Kansas. But on Rainier we are talking about a 52-foot snow pack resting on steep slopes.

Snow avalanches occur when different snow layers do not bond well together and the snow pack becomes unstable. If the next storm arrives and dumps several feet of new snow on this unstable foundation, the snow pack can shear along some plane of weakness like a layer of ice or hoar frost at depth. Even big avalanches start out small at a spot where the gravitational stresses are the greatest, or where the bonds between the snow layers are weakest, or where IMG partner Paul Baugher places his explosives. Paul is an avalanche expert working in ski areas in Washington State and consulting for the National Park Service about avalanche safety on Mount Rainier. He has seen some big avalanches on Rainier: some with fracture lines measured in miles. The spring meadows are full of the debris of these winter avalanches. Snow avalanches, like forest fires, are a vital natural process that continually reshapes the Park’s landscape.

Forests, Meadows, Fellfields

The oxygen concentration in the air you breathe at 14,410 feet is roughly half that at sea level, so climbing Mount Rainier means ascending through the lower half of the Earth’s biosphere, the envelope of life. This lower half of the biosphere contains 99% of the planet’s animals and plants, its greatest cities, its most productive agricultural areas, and most of its cell phones. The top of the biosphere is, for practical purposes, the summit of Everest, but in fact very little goes on much higher than the summit of Rainier besides some coca chewing and yak herding. Viewed from Rainier’s summit, this life-rich layer is remarkably thin.

Mount Rainier is ringed by bands of distinct plant communities. When you drive into the Park at Ashford or White River, you are in the Western Hemlock Zone dominated by western hemlock, Douglas fir, and red cedar. The road to Longmire passes through patches of old growth forest, some of which are 500 to 1000 years old. The biomass of old-growth forest around the base of Mount Rainier is similar in size to that of a tropical rain forest. A single 1000-year old Douglas fir tree may contain as many as 100 other plant species clinging to its branches and sprouting from its trunk. Broken branches, holes, and downed trees also create important wildlife habitat. Douglas fir is an early successional species, meaning that its seedlings establish best in full sunlight and mineral soil. Their presence in the old-growth forest is a legacy of forest fires that occasionally burn even these damp woods. Before European contact, similar forest mosaics of old growth and younger stands regenerating after fires covered much of the Puget lowlands.

Around the 2500-foot altitude on Rainier, you pass upward into the Silver Fir Zone. Most of the Park's road systems are in this forest zone. Other important tree species here are Alaska yellow cedar, Engelmann spruce, and lodgepole pine. Forests in this zone tend to burn more frequently than those in the Western Hemlock Zone and are also more disturbed by snow avalanches. The forest floor here is more open than the fern- choked jungle in the zone below.

Above the 4000-foot level is the Mountain Hemlock Zone dominated by mountain hemlock, subalpine fir, silver fir, and Alaska yellow cedar. These trees grow wherever avalanche tracks allow them, and the avalanche tracks contain thickets of alder shrubs. Tree cover becomes thinner with increasing altitude as treeline is approached, which varies from 5500 to 7000 feet on different sides of the mountain.

Mount Rainier's famous subalpine meadows occur along the upper edge of the continuous forest. These meadows of heather and wildflowers start blooming in June and continue through August. They owe their existence to the mountain's thick winter snow packs. This is because plants living in the subalpine zone often spend 7 months buried under snow, and then must crowd their life cycles into the remaining 2-3 months before summer ends in late August. Very few trees or shrubs are able to survive on this schedule, so the smaller, faster living plants take over. Many of the vegetation patterns you see on the mountain are related one way or the other to snow. Avalanche tracks are everywhere in the subalpine zone. Even rugged tree-line species like subalpine firs tend to grow on topographic high points where the snow pack is thinner and melts fastest.

The alpine zone starts where the highest, twisted groves of subalpine fir and mountain hemlock end. In the Muir Corridor, this is about the 6500-foot level. The highest plants occur on Cathedral Rocks around the 11,000-foot level. In between, a surprising diversity of plant communities exists. Heather meadows grow in moist pockets on ridges up to the 8500-foot level on Muir Ridge, and botanical research has shown that some of these heather meadows have survived in place for almost 10,000 years, which makes them one of the Park's oldest life forms. Fell fields are gravelly areas supporting scattered clumps of plants. Close inspection of a fell field reveals a number of different, miniature-sized flowering plants, many of which are dependent on stones for shelter and warmth. On the north side of the mountain, between the 8000- and 9000-foot level, rosette-shaped plants of the rare species, *Draba aureola* grow on rock-strewn ridges and cleavers. Pulling up stones to build tent platforms destroys these plants. Another specialized group of plant species inhabits the beds of melting snow patches. These are the champions of the abbreviated life cycle, some actually beginning growth before the overlying snow completely melts away. Talus slopes may look sterile but in fact they support scattered plants, some of which live only in this habitat. Lichens are widespread on sheltered rock surfaces on talus slopes. Snow tends to melt off of talus sooner than from other habitats, and the stones act as heat-absorbing mulch favorable to certain species.

Animals

There are 56 mammal species and 142 birds recorded from Mount Rainier National Park. The ones you are most likely to notice include Columbian black-tailed deer, elk, mountain goats, Douglas squirrels, golden-mantled ground squirrels, marmots, and pikas. More elusive are black bears, mountain lions, coyotes, porcupines, and red foxes. Both grizzly bears and wolves probably lived in the Park before European contact. On your way up the mountain, you will probably see marmots foraging in the subalpine meadows, laying on fat for their annual 6+ months of hibernation. Their whistles serve as calls to warn family members that predators are lurking nearby. Pikas are rarely seen but often heard squeaking from within talus. Their burrows are marked by the piles of hay drying outside before being stored for winter consumption.

Some stand outs among the birds are grey jays, who will find you sooner or later; grouse whose drumming fills the subalpine forests in early summer; golden eagles whose plank-like, enormous wings are unmistakable; the ubiquitous ravens; and rosey finches, small grey and reddish birds that nest in crags high on the mountain. The infamous spotted owl inhabits old-growth forests on the lower mountain. Starting in May, varied thrushes fill the subalpine forests with their long trills.

In the alpine zone, some of the most intriguing animals are invertebrates, including the ice worm (*Mesenchytraeus solifugus*) and the Mount Rainier snow roach (*Grylloblatta rainierensis*). Ice worms are inch-long, black worms that live inside permanent snowfields and slow-moving glaciers. They inhabit the water-filled interstices between ice crystals where they feed on bacteria, single-celled algae, and pollen. Groups of ice worms rise to the snowpatch surface during summer afternoons when fog or low clouds obscures the sun. Also a resident of snowfields, the snow roach belongs to a primitive insect group distantly related to grasshoppers and roaches. The female snow roach is larger than the male, reaching a length of about one inches. They only are active on summer nights, when they scurry over the snow foraging for other insects that have been blown there and trapped by the cold. During the day, snow roaches hide under stones along the snowfield margin. They are thought to live for a Biblical seven years and produce only seven eggs. Snow roaches are adapted to temperatures near freezing and will die if held in your hand. The animal living highest on Mount Rainier is a species of daddy-long legs (phalangid) that inhabits the crest of Cathedral Rocks, where it scavenges wind-blown insects.

Human History

At the time of European contact, Native Americans belonging to the Nisqually, Cowlitz, Yakima, Puyallup, and Muckleshoot tribes hunted and gathered plant foods on the slopes of Mount Rainier. The mountain was known by the Puyallup people as Tacobet, meaning “mother of waters.” In 1792, Captain George Vancouver became the first European to sight Mount Rainier and he named the mountain after a friend, Rear

Admiral Peter Rainier. The mountain was first climbed in 1870 by Hazard Stevens and P.B. Van Trump. John Muir made the ascent in 1888, later describing the site of Camp Muir as one of the most desolate spots he had ever spent a night. Fay Fuller completed the first female ascent of the mountain in 1890 wearing a bloomer suit of blue flannel and a straw hat. In recent years, about 10,000 people attempt the ascent annually, most through Camp Muir. In 2005, independent climbers had a 44% success rate and guided climbers a 60% success rate. Approximately ten deaths occur annually due to rock fall, falls, and to hypothermia associated with severe weather.

Mount Rainier National Park and Conservation

Established in 1899, the park now welcomes around 2 million visitors per year. Together with the mission of hosting these visitors, the National Park Service has a mandate to preserve the park's unique natural heritage. The result is a constant balancing act between resource preservation and public use. The need for balanced management extends into the climbing zone, where climbers have caused waste-disposal problems, damaged fragile fellfields, and degraded the quality of the wilderness experience available to other visitors.

IMG is dedicated to helping the Park Service successfully manage the impacts of climbers on Mount Rainier, all the way from the entrance gate to the summit. Our Environmental Manager oversees a program aimed at controlling the impacts that IMG groups have on the Rainier environment. IMG groups follow Leave No Trace practices and follow strict procedures involving waste containment, removal, and recycling.

Mount Rainier needs your help. From the summit on a clear day, you can see that Mount Rainier National Park is an island in a sea of clear-cut logging, agricultural fields, and suburbs. High ozone levels occasionally occur in the park during the summer when air pollution drifts onto the mountain from nearby cities. Human-caused global warming is likely to be involved in the widespread glacier retreat now occurring on the mountain. As climate warms, the habitats of plants and animals are being driven upslope into ever-shrinking areas on the mountain.

There are several things you can do to help preserve and restore Mount Rainier and its unique ecosystem.

- IMG actively supports Washington's National Park Foundation (WNPF), a nonprofit organization dedicated to strengthening the connection between the American people and the three National Parks in Washington (Rainier, Olympic, and North Cascade). Private donations to the WNPF Endowment are helping maintain the Wonderland Trail system in Mount Rainier National Park.
- IMG's Environmental Manager organizes habitat-restoration work parties under the supervision of National Park managers. Ask about participating in the next one.
- When you return home, remember the view from Rainier's summit: our planet's biosphere is very thin. Major threats to Mount Rainier like air pollution, global warming, and habitat loss are coming from the world outside of the Park. We are all part of that outside world and everyone can help reduce these threats by taking action at home.