Monitoring Landscape Change in Katmai National Park Using Historical Photography

Abstract

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A project was initiated in 2003 to assess landscape changes in the Southwest Area Network of National Parks through the use of repeat photography. By the end of 2004, a total of 265 historical photographs were acquired for Katmai National Park & Preserve (KATM), dating back to 1895. The most abundant collections of photographs were those from Robert Griggs expedition members (94 from 1915-1919), Walter Smith (29 from 1922), Kirtley Mather (22 from 1923), and Victor Cahalane (21 from 1953-1954). George Martin (60 from 1912) and Bernard Hubbard (24 from 1919) provided important collections. During 31 July–7 August 2004, 42 of the photographs were repeated in the vicinity of the Valley of Ten Thousand Smokes, upper Knife Creek, Mageik Creek, and the middle Katmai River. Emphasis was placed on medium range subjects (50-500m distant) related to volcanism, plant succession, shrub expansion, glaciers, landslides, floodplain dynamics, and lakes.

Landscapes in the areas visited in 2004 dramatically reflect a variety of dynamic and interacting processes which have occurred over varying time scales. Virtually overnight, the volcanic eruption of 1912 initiated a sequence of events which formed the Valley of Ten Thousand Smokes, buried much of the region in thick ash deposits, created the Katmai Crater, triggered landslides, and caused catastrophic flooding in the Katmai River valley. Over the 92 years since, other volcanic, fluvial, glacial, and successional processes have exerted diverse effects on the landscape left behind after the 1912 eruption. Many of these effects can be documented, characterized, and interpreted through comparative assessments of historical and repeat photography.

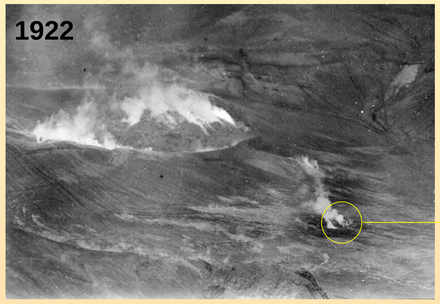
Revegetation of many areas covered by 1912 ashfall and pyroclastic flows has been relatively slow. Repeat photographs suggest that a combination of frequent high winds, windblown pumice, and inorganic soils, which are excessively drained and easily eroded, have hampered the establishment of vegetation. Many of the areas visited in 2004 remain barren, except in sheltered microsites such as old fumarole pits, gullies, and small floodplains. In the upper Valley of Ten Thousand Smokes near Mt. Mageik, rift lakes formed in 1912 have drained and a glacier has retreated significantly since 1919. However, the nearby Knife Creek Glaciers have been relatively stable over the same time period. Continued landslides and fluvial processes have reshaped parts of the Katmai Canyon. Some upland areas in the canyon have revegetated while the Katmai River floodplain remains barren.

Drained Lakes

Photographs of a fissure in the southwest corner of the Valley of Ten Thousand Smokes in 1917 (Robert Griggs) and 2004 (Gerald Frost). Exposures on the fissure walls reveal part of the thick ignimbrite deposits which fill the Valley of Ten Thousand Smokes. Comparisons of these and other photographs taken in the area suggest that a creek draining a retreating glacier near this location may have cut into this basin and drained the lake.

Plant Succession After Volcanism

Photographs taken in 1929 (Bernard Hubbard) and 2004 (Gerald Frost) illustrate plant succession along the floodplain of lower Mageik Creek. In 2004, the foreground vegetation is strongly dominated by pioneer species feltleaf willow (*Salix alaxensis*), fireweed (*Epilobium angustifolium*), and bluejoint (*Calamagrostis canadensis*). Flood events and channel migration have prevented the establishment of vegetation on the active floodplain of Mageik Creek. Pumice-covered slopes in the background now support low willows and varied forbs, sedges, and grasses. Some of these areas, such as the toe slope at center left, appear to have been vegetated in 1929. This may represent remnant vegetation which was not permanently buried by pumice. On upper slopes in the background, continued erosion of ash and pumice deposits is evident and most of these areas are still sparsely vegetated 92 years after the eruption of Novarupta.



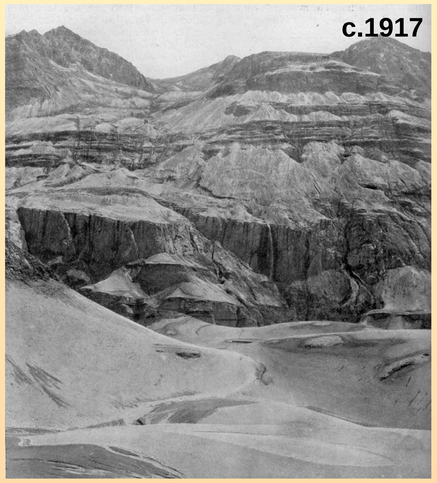
Photographs of the Novarupta area from the summit of Baked Mountain in 1922 (Walter Smith) and 2004 (Gerald Frost). Fumaroles, which were active in 1922, now offer microsites that are relatively favorable to the establishment of vegetation. Low willows, dwarf shrubs, and a diverse assemblage of forbs, sedges, and grasses line the fumarole pit pictured at right, while exposed areas on the valley floor are sparsely vegetated. Factors hindering the reestablishment of vegetation in the Valley of Ten Thousand Smokes include abrasion by windblown ash & pumice, winter desiccation, and inorganic soils which erode easily and lack moisture. Many of these factors are ameliorated in microsites, such as fumarole pits. Several other vegetated fumarole pits are visible in the 2004 photograph (upper right). Vegetated sites such as these are likely to be of high value to wildlife in the Valley of Ten Thousand Smokes; birds such as Least Sandpiper, Snow Bunting, and American Pipit were observed foraging in the fumarole pit at right in 2004.

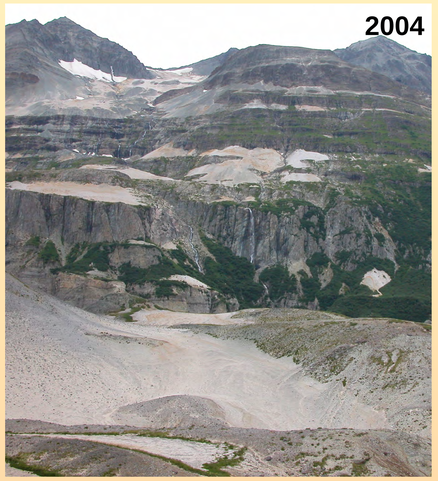
Glacial Retreat

Photographs of a glacial valley at the base of Mt. Mageik in the southwest corner of the Valley of Ten Thousand Smokes from 1918 (Jasper Sayre) and 2004 (Gerald Frost). The glacier has receded around the corner to the left and tundra vegetation has already established in portions of the valley floor. The 1918 photograph indicates that this glacier, unlike the relatively stable Knife Creek Glaciers east of Novarupta, did not receive thick, insulating deposits of pumice and ash during the 1912 eruption. This was probably an important factor contributing to the glacier's rapid retreat.

Shrub Expansion

Photographs taken near the terminus of the second and third Knife Creek Glaciers in 1954 (Victor Cahalane) and 2004 (Gerald Frost) provide comparative views of primary succession 42 and 92 years after the eruption of nearby Novarupta. In both photos, vegetation is dominated by low feltleaf willow (*Salix alaxensis*). Many individual willows visible in the 1954 photograph were still present in 2004, although they have not grown much taller than the shrub in front of the person in the 1954 photo. New vegetation is particularly evident in the small gullies on the knoll at center. Scattered willows have also established on the pumice-covered surface of the glacier in the background. Continued gully erosion of volcanic pumice & ash deposits is evident in the foreground. The second and third Knife Creek Glaciers (middle background) appear to have advanced slightly since 1954.





Photographs showing the south wall of Katmai Canyon (background) and pumice-covered knolls at the base of Mt. Katmai (foreground), circa 1917 (Robert Griggs) and 2004 (Gerald Frost). Today, tall shrub communities strongly dominated by alder (*Alnus sinuata*) are evident on the canyon walls, while alpine tundra is visible on upper slopes. Alders have colonized some ash deposits, but vegetation is most extensive in areas which were not ash-covered in the c. 1917 image, or where subsequent ash slides have exposed the original ground surface. On the nearby knolls, vegetation recovery has been relatively slow, likely hampered by continued gully erosion of the loose pumice surface. The small pumice & ash-covered glacier at upper left appears to have remained stable.

Landslides and Channel Migration

Photographs of upper Katmai Canyon circa 1917 (Clarence Maynard) and 2004 (Gerald Frost), taken from the southern slopes of Mt. Katmai. Following a large landslide on the flank of Mt. Katmai (left), colluvium temporarily dammed the upper Katmai River (center). This feature is still apparent in the 2004 image, but much of the colluvium to the right has been eroded and the river floodplain has widened due to channel migration. Colluvium of more recent small landslides, visibly darker in the 2004 photo, has covered much of the upper portion of the lighter 1912 colluvium. Tall alder shrub and alpine tundra vegetation is present on the canyon walls at right in the 2004 image, however the c. 1917 image indicates that many of these areas were not buried in ash & pumice. Very little vegetation has established on the river floodplain.