Monitoring Landscape Change in Aniakchak National Monument & Preserve Using Historical Photography

Abstract

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A project was initiated in 2003 to assess landscape changes in the Southwest Alaska Network of National Parks through the use of repeat photography. A total of 214 historical photographs dating back to 1922 have been acquired for Aniakchak National Monument & Preserve. The largest collections were from USGS geologists (19 from 1922), Bernard Hubbard (120 from 1930-1932), and NPS/BLM personnel (71 from 1972-1976). During 2004–2006, 43 photographs were repeated by this project and 69 were repeated by NPS personnel. In addition, 27 new photo monitoring sites were established to facilitate future monitoring.

The landforms and ecosystems of Aniakchak bear the mark of frequent and severe volcanic disturbance. Created 3,500 years ago in a catastrophic eruption event, Aniakchak Caldera remains volcanically active. The most recent eruption in 1931 buried much of the caldera area under tephra, leaving an extensively barren landscape. Since then, vegetation cover has increased markedly at numerous sites in and near the caldera, with riverine and lacustrine areas having recovered the fastest and exposed uplands near the 1931 eruption crater the slowest. Photo-monitoring indicates that although the colonization of barren sites tends to occur at a slow pace, vegetation expansion and diversification after colonization can occur relatively quickly. Beach ryegrass (*Leymus mollis*) and Piper's woodrush (*Luzula piperi*) are the primary pioneering vascular plants in the caldera. Photo-monitoring indicates that Surprise Lake's areal extent has decreased somewhat since the 1930s due to alluvial deposition of 1931 tephra. A recent surge in landslide activity on the north face of Black Nose has resulted in substantial recent changes to the Aniakchak River in The Gates. Outside the caldera, tall shrubs have expanded in the upper Aniakchak River valley at sites first photographed only ~30 years ago, but shrub expansion was not indicated at several coastal sites. Channel migration and associated primary succession were detected at several sites on the upper Aniakchak River floodplain. A range of recent changes to coastal landforms was apparent at Aniakchak Bay.

Landslides in The Gates

Aniakchak River in The Gates in 2005 (Tahzay Jones) and 2006 (Frost). Most of the large boulders in the river channel were deposited after an earthquake in 2005, but the presence of several new boulders in 2006 indicates continued landslide activity on the northern slopes of Black Nose. The Gates appear far less boulder-choked in 1930s and 1970s photography.

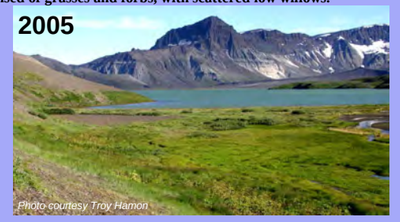
Ecological Succession After Volcanism in Aniakchak Caldera

Black Nose seen from inside Aniakchak Caldera in 1922 (Walter Smith) and 2006 (Frost). Among the oldest in the collection, the 1922 photo indicates that this area was barren well before the 1931 eruption. Beach ryegrass is an important colonizer in the caldera, composing most of the sparse vegetation present at this site in 2006.

Surprise Lake seen from knoll between coves in 1930 (Bernard Hubbard) and 2006 (Frost). Live cover of dwarf scrub and low willows in 2006 appears similar to that preceding the 1931 eruption, indicating that vegetation recovery is at an advanced stage here. The shoreline of Surprise Lake has been modified primarily by alluvial deposition of 1931 tephra.

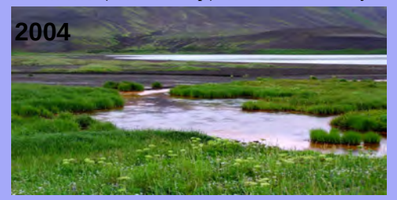
Photos of a cove on the southwestern shore of Surprise Lake in 1930-1931 (Bernard Hubbard) and 2005 (Tahzay Jones) indicate that vegetation recovery has advanced relatively quickly here after burial by tephra in 1931. Vegetation was even more extensive in 2005 than it was immediately before the 1931 eruption. Low willows (primarily *Salix alaxensis* and *S. barclayi*) are much more abundant and Nootka lupine (*Lupinus nootkatensis*) now forms the dominant ground cover. Vegetation recovery has been relatively swift near Surprise Lake, but it has been much slower in areas that were closer to the 1931 eruption site. Primary succession on thick, coarse tephra deposits in the southwestern quarter of the caldera is occurring very slowly, a pace similar to that seen in Katmai's Valley of Ten Thousand Smokes.

Upper Aniakchak River valley in 1931 (Bernard Hubbard) and 2006 (Frost). Tephra covers everything in Hubbard's image, taken just after the 1931 eruption. Scattered beach ryegrass overtops the tephra near the boulder at center. By vegetation recovery is at an advanced stage, primarily comprised of grasses and forbs, with scattered low willows.



North end of Surprise Lake and mouth of creek in 1932 (Bernard Hubbard) and 2005 (Tahzay Jones). The creek originates near the 1931 eruption crater, where tephra fallout was severe. Deposition of tephra has modified Surprise Lake's shoreline and reduced its areal extent. Succession has been rapid on the alluvial flat, but slower on the adjacent hillsides.

Exposed hillside above a Surprise Lake cove in 1972 (Keith Trexler) and 2006 (Frost) revealing the persistence of arctic willows (*Salix arctica*). Dead branches suggest that these long-lived dwarf shrubs were severely damaged by the 1931 eruption, but had recovered by 1972 and have changed little since. Moss cover (*Racomitrium* sp.) has increased markedly.



Warm springs at northwest end of Surprise Lake seen in 1974 (Edward Stondall) and 2004 (Amy Miller). The foreground was dominated by beach ryegrass in 1974, but forbs have since become abundant. This successional sequence is common in the northern half of the caldera. Vegetation has expanded on the alluvial flats near the lake and on the background slopes.

Floodplain & Coastal Dynamics

Upper Aniakchak River and Aniakchak Caldera seen from high bluff in 1922 (Walter Smith) and 2006 (Frost). Channel migration on the river floodplain is evident below the large boulders at center left. Primary succession after a series of severe volcanic and flood events in the recent past has been very slow outside of the active floodplain.

Mouth of Aniakchak River at Aniakchak Bay seen near high tide in 1973 (unknown) and near low tide in 2006 (Frost). The coastal spit remains barren and has shifted somewhat over the 32-year interval. Photographed at nearly the same time in the growing season, tall umbels have become much more abundant where low willows and graminoids were dominant in 1973 near the standing person. Cover of tall alder has not changed significantly.

Shrub Expansion

Upper Aniakchak River area 6 km below The Gates in 1973 (Keith Trexler) and 2006 (Frost). Alder (*Alnus sinuata*) is obvious after only 33 years, obscuring the river terrace at right. Some of the expansion may reflect recovery after disturbance, although some information suggests that alders also were sparse before the 1931 eruption.

Upper Aniakchak River 7 km below The Gates in 1973 (Keith Trexler) and 2006 (G. Frost). Alder and willows have expanded on the low hillside at right. Willows also appear more abundant in the vicinity of the 1973 party's campsite.

Photos of dunes at Aniakchak Bay in 1973 (Keith Trexler) and 2006 (Frost) reveal shrub expansion has not occurred at this coastal site. Herbaceous meadows persist on the hillside, while beach ryegrass dominant in 1973 has given way to more forbs by 2006. Wet graminoid meadow on the flats appears unchanged, while differences in water cover is likely due to tidal stage.