

# Vegetative Recovery Following the 1988 Waring Mountains Fire in Northwest Alaska: 1989-1998



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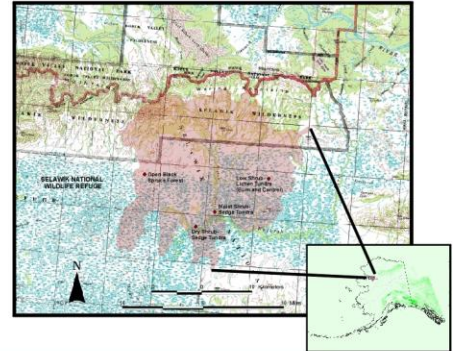
**Abstract:** The Waring Mountains Wildfire of 1988 burned 209,366 acres (84,727 ha) of the Selawik National Wildlife Refuge in northwest Alaska. This fire transected the migration route of the Western Arctic caribou herd. Disruption of the movement of caribou through this area was of major concern due to the large number of people dependent on these animals for subsistence. This study was undertaken to describe and follow the response of the vegetation after the fire. Sites representing four widely distributed vegetation communities were selected for study: Open Black Spruce Forest, Dry Shrub-Sedge Tundra, Moist Shrub-Sedge Tundra, and Low Shrub-Lichen Tundra. Sites were inventoried 1, 2, 4, and 10 years following the fire.

**The Fire:** The lightning-caused Waring Mts. Wildfire (A119) burned between 15 June and 17 September 1988. Ignition occurred in the Selawik Wilderness and spread east and south into the northeast corner of the Selawik National Wildlife Refuge. The final burn measured 23 miles (37 km) east to west, 22 miles (35.4 km) north to south, and 246 miles (396 km) around the perimeter.

Initial suppression was limited to protecting native allotments. In early July, suppression was extended to include prime caribou range. Simultaneously, the weather became hotter, drier, and windier. Fuel mixtures dropped to 3% and 6- to 20-foot flames were observed.

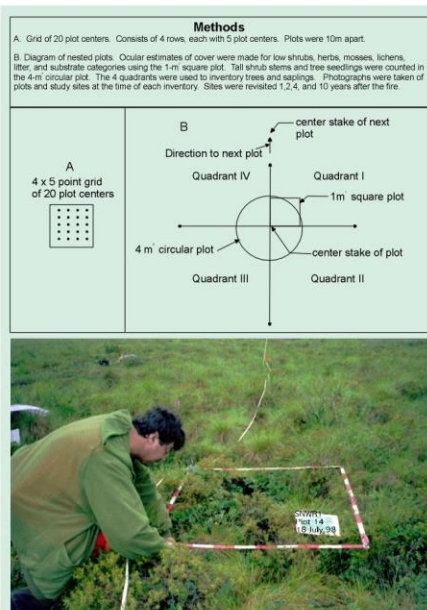
**The Study:** Staff of the Selawik National Wildlife Refuge and The Co-op Wildlife Unit at the University of Alaska were concerned this fire might permanently displace the migrating caribou, and potentially destroy the major subsistence resource of the people living in northwest Alaska.

Two studies were undertaken. One, to track the northward movement of caribou in and through the burned region during the first spring and summer following the fire. The second was to describe the impact of the fire on the burned area and to monitor revegetation. This poster reports findings of the second study.



## Study Questions:

- **Does fire impact all tundra vegetation the same way?**  
The large fire burned all of the above ground vegetation on all of the sites, but burn severity varied from site to site. Severity was least on the sites with moist fuels (Moist Shrub-Sedge Tundra), and greatest on sites with dry fuels (Dry Shrub-Sedge Tundra, Low Shrub-Lichen Tundra).
- **Does fire severity affect vegetation recovery?**  
Species which sprouted from deeper roots, stems and buried seed, or were well insulated, resprouted on all but the most severely burned sites. Growing points located higher in the profile were impacted even in areas of light severity burn.
- **How quickly do tundra communities recover following fire?**  
Recovery was fastest and most complete on the Moist Shrub-Sedge Tundra and Open Black Spruce Forest sites, and slowest and incomplete on the Dry Shrub-Sedge Tundra and Low Shrub-Lichen Tundra types. It appears that fire promotes dominance of low shrubs over small tussocks and lichens on the Dry Shrub-Sedge Tundra sites, and removes sphagnum moss from the Moist Shrub-Sedge Tundra sites.
- **Was the caribou range vegetation destroyed? How long will it take to recover?**  
Caribou continue to pass through and use the burn. They prefer areas with flowering cottongrass (*Eriophorum* spp.) and reindeer lichens (*Cladonia* spp.). Cottongrass was extensive following the fire. Lichens, however, were slow to recover and limited in extent, causing overuse of the few areas of unburned Low Shrub-Lichen Tundra.



## Plant Community Response to Fire

All new plant growth following fire develops from one of the following:

**Shoots:** All plants have shoots. Any plant that escapes the touch of flame or the heat of fire will survive. Plants with less than 70% crown destruction and no root loss may also survive. Plant growth may be stimulated by the increase in available nutrients following the fire.

**Basal Stem, Roots, Rhizomes:** Plants of some species can be stimulated to produce vegetative shoots following fire. The amount of survival depends on the depth of the burn and the depth and quantity of available roots and rhizomes. Species with a deep root/rhizome profile are most likely to survive and sprout.

**Seeds:** Viable seeds are available on-site if at least part of the seedbank survives the fire. Seeds may also be dispersed to the site from adjacent areas. Fire can stimulate seed germination by removing the overburden, opening cones, and preparing adequate seedbeds.

**Burn Severity:** The duration and depth of heat penetration into the soil and plant tissues determines burn severity. Severity on a site reflects how readily vegetation is heated, dried, and ignited.

**Site Resiliency:** Resiliency is the innate ability of the community to regenerate by natural means following fire. This can be predicted based on species present and condition of vegetation and seedbank on-site before the fire. Resiliency is determined by:

- the amount of vegetative material available from which sprouts develop
- the amount of seed available on site
- the amount of off-site seed within dispersal distance
- profile location of potential "growing points" within the stand

**Site Stability:** Fire changes the surface albedo and removes insulating vegetation. This results in soil warming and melting of permafrost. This can lead to soil slumping and/or surface erosion, deepening of the active layer, and changes in the water table. Sites with shallow permafrost are impacted the most.

**Acknowledgments:** This study was initiated by Biologists Mike Spindler (Selawik National Wildlife Refuge (SNWR)) and Dave Klein (Co-op Wildlife Unit, University of Alaska), with assistance from Refuge Manager Jerry Stroebele (SNWR). Vegetation surveys were conducted by Joan Foote (Institute of Northern Forestry), Rachel Brubaker (Biologist, SNWR), and summer technicians. Support for the project continued under Refuge Manager Leslie Kerr (SNWR) and Fire Management Officer Bob Rebarchik (Koyukuk/Nowitna NWR). The project was also supported by Regional Fire Coordinators Red Sheldon and Larry Vanderlinden (U. S. Fish and Wildlife Service). Photographs were provided by Joan Foote and Bob Rebarchik. Karin Lehmkuhl (Koyukuk/Nowitna NWR), Joan Foote, and Bob Rebarchik designed the posters.



# Vegetative Recovery Following Fire in Northwest Alaska: Open Black Spruce Forest Community



General site view (1998) showing approximate pre-burn densities of black spruce (*Picea mariana*).

**Site Description:** Open spruce with lower canopies of scattered tall shrubs and herbs, continuous low shrubs, and feathermoss. Occurs on lower, south facing slopes of the Waring Mountains.

**Site Resiliency:** Good; Black spruce cones, and shoot producing shrubs/graminoids present in the soil profile.

**Burn Severity:** Severe; Surface vegetation consumed; mineral soil exposed; adventitious shoots initiated from roots, rhizomes, and buried stems present. However, all is dominated by invading mosses and liverworts.

**Recovery:** Started immediately; Graminoids and shrubs sprouted, but invading mosses quickly dominated.

**10 Year Progress:** Low shrubs displaced graminoids and herbs; tall shrubs and tree seedlings are 30-50 cm tall. Feathermoss and alder absent.

**Future:** Trees and tall shrubs will increase in height, low shrubs will increasingly dominate the undercanopy. Eventually feathermoss and/or alder will return to the site.



**Year 1**  
An alder (*Alnus crispa*) skeleton stands over liverwort (*Marchantia polymorpha*). No black spruce seedlings present.

**Year 2**  
Graminoids (*Carex bigelowii*, *Arctagrostis latifolia*) and fireweed (*Epilobium angustifolium*) are extensive. A few black spruce seedlings are now present.

**Year 4**  
Grasses now 1m tall. Black spruce seedlings are more numerous.

**Year 10**  
Sedge (*C. bigelowii*) displacing grass (*A. latifolia*). Black spruce seedlings now ~50cm tall.

**Year 1 (1989)**

**Year 2 (1990)**

**Year 4 (1992)**

**Year 10 (1998)**



The prominent charred surface is penetrated by shoots of Arctic polargrass (*A. latifolia*), and blueberry (*Vaccinium uliginosum*). However, the less visible invading moss (*Ceratodon purpureus*) already has extensive cover (30%). Resin birch (*Betula glandulosa*) shoots visible in upper left corner.



Both polargrass and blueberry are more extensive. Moss continues to dominate. Resin birch has grown taller.



The low shrub canopies have expanded in both area and height. Polargrass is taller and more dense. Resin birch is taller. Small spruce seedlings now present on site (not in this plot).



Blueberry has now displaced polargrass. Resin birch is now ~30cm tall. The spruce seedling shown above is ~25cm tall.



Dead sphagnum mound and charred ground dominate beneath a skeleton of resin birch (*Betula glandulosa*). A few graminoid shoots (*A. latifolia*, *C. bigelowii*) are present.



Water temporarily fills depression. Fireweed (*E. angustifolium*) shoots have now joined the herb component. Moss (*C. purpureus*) continuous on non-sphagnum surfaces.

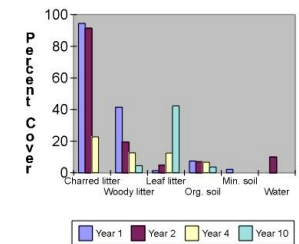
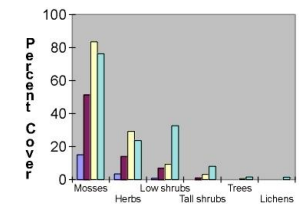


Graminoids now dominate, but moss remains in previous water-filled depression.



Moss remains extensive beneath graminoids and low shrubs. Black spruce seedlings now ~50cm tall.

## Post-Fire Changes in Ground Cover: Vegetation, Litter, and Soil Categories





## Vegetative Recovery Following Fire in Northwest Alaska: Moist Shrub-Sedge Tundra Community



General view (1995) showing a water filled depression that developed after the fire due to reduced surface albedo and increased soil temperatures. The permafrost table dropped from 20cm to 50cm in the ten years following the fire.

**Site Description:** Large sedge tussocks dominate, but shrubs and sphagnum moss fill the depressions between the tussocks. Occurs in high water table areas of the low plateau and is always underlain by shallow permafrost.

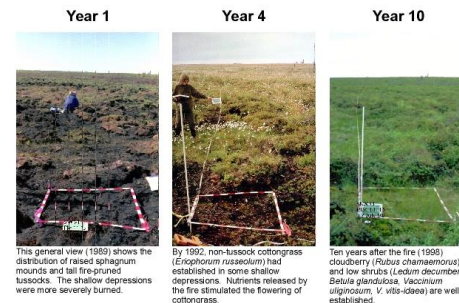
**Site Resiliency:** Very resilient; dominant species produce shoots following fire. Fire impacts to sphagnum are low due to high moisture content.

**Burn Severity:** Severe; large tussocks were well pruned and sphagnum moss was killed.

**Recovery:** Immediate; shoots from shallow rooted cloudberry appeared immediately on sphagnum mounds. Low shrubs and sedges sprouted quickly. Sphagnum did not immediately recover.

**10 Year Progress:** Tussocks and shrubs doing very well, but sphagnum recovery is slow. Water-filled depressions have increased in size and depth, reflecting the increase in active layer thickness.

**Future:** Tussocks and low shrubs will continue to thrive unless the water table rises sufficiently to drown tussock roots. Sphagnum and wet-tolerant sedges will expand to displace dead tussocks as soil moisture increases.



This general view (1989) shows the distribution of raised sphagnum mounds and tall fire-pruned tussocks. The shallow depressions were more severely burned.

By 1992, non-tussock cottongrass (*Eriophorum ruscocolum*) had established in some shallow depressions. Nutrients released by the fire stimulated the flowering of cottongrass.

Ten years after the fire (1998), cloudberry (*Rubus chamaemorus*) and low shrubs (*Ledum decumbens*, *Betula glandulosa*, *Vaccinium uliginosum*, *V. vitis-idaea*) are well established.

Year 1 (1989)

Year 2 (1990)

Year 4 (1992)

Year 10 (1998)



Plot 15

The first cloudberry (*R. chamaemorus*) shoots developed quickly from surviving rhizomes located in burned sphagnum mounds. Some cottongrass tussocks (*Eriophorum vaginatum*) also produced new shoots.



Cottongrass and cloudberry are well established. Shoots of Labrador tea (*L. decumbens*), blueberry (*V. uliginosum*), and resin birch (*Betula glandulosa*) are now common.



No new species have arrived. Those present are thriving. Cottongrass continues to bloom profusely.

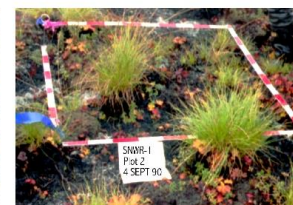


Cottongrass and shrubs have increased in height and cover. Recovery of these species is essentially complete.



Plot 20

These three cottongrass tussocks produced new shoots shortly after the fire, and were already blooming in the first post-fire growing season. Cloudberry is present on burned sphagnum mounds.



Both cottongrass and cloudberry are expanding. Labrador tea is beginning to appear.

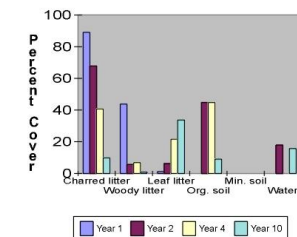
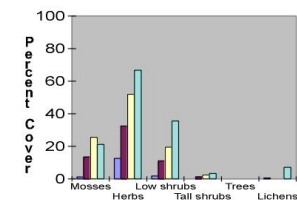


Cottongrass tussocks are well developed. The area between tussocks is filled with cloudberry and Labrador tea.



Cottongrass tussocks are quite large. Blueberry (*V. uliginosum*) has arrived and overtopped the cloudberry. Resin birch (*B. glandulosa*) is visible in the lower right.

### Post-Fire Changes in Ground Cover: Vegetation, Litter, and Soil Categories



# Vegetative Recovery Following Fire in Northwest Alaska: Dry Shrub-Sedge Tundra Community



A site view during the first post-fire growing season showing blackened soil surface, extensive moss, and occasional graminoids (*Arctagrostis latifolia*, *Calamagrostis canadensis*, and *Carex bigelowii*)...

**Site Description:** Scattered small tussocks intermixed with low growing resin birch, willow, and ericaceous shrubs. Occurs on the upper slopes and ridgetops of the lowland plateau.

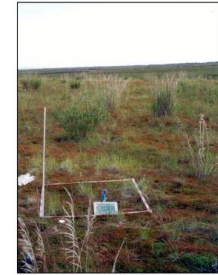
**Site Resiliency:** Lacking; shrubs are mostly surface sprouters; tussocks are too small to withstand pruning by fire.

**Burn Severity:** Severe; surface vegetation consumed; mineral soil exposed; invading mosses quickly covered the exposed mineral soil. Little vegetation developed during the first two growing seasons following fire.

**Recovery:** Very slow; on-site species slow to regenerate; Invading mosses established quickly and were extensive.

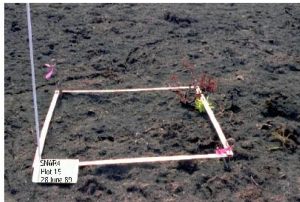
**10 Year Progress:** Mosses still dominate; grass clumps are scattered and stand over 1m tall. Willows, resin birch, and low shrub patches occur sporadically. Immature lichens are beginning to appear.

**Future:** Still unclear; grasses appear to be displacing sedges, though the latter are present. The moss layer is sufficiently deep to discourage the establishment of new seedlings.



A general view in 1998 showing scattered grasses, sedges, and willow (*Salix* sp.) above a continuous layer of moss (*Polytrichum juniperinum*).

Year 1 (1989)



Plot 15

This bareness of this charred surface indicates the fire killed most roots and rhizomes on this site. Note the single new shoot of diamond willow (*Salix planifolia* ssp. *pulchra*) that sprouted from the base of the burned willow.

Year 2 (1990)



Invading mosses (*P. juniperinum*, *Ceratodon purpureus*) are expanding, and grass shoots (*C. canadensis*) have established.

Year 4 (1992)



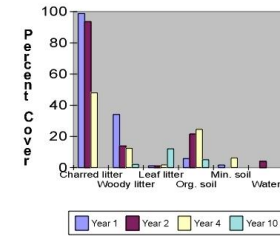
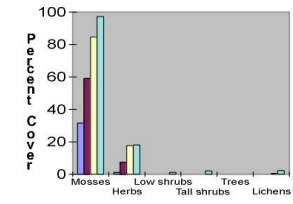
Cracks in the soil indicate drier site conditions. Mosses remain extensive and grasses and willow have grown taller.

Year 10 (1998)



*Polytrichum* moss is sufficiently tall and dense to discourage the establishment of arriving seeds. Single stem grasses (*C. canadensis*) are declining, while clumps of polargrass (*A. latifolia*) are expanding. Diamond willow is now ~50cm tall.

## Post-Fire Changes in Ground Cover: Vegetation, Litter, and Soil Categories



Plot 20



Vegetation survived only on the dead sphagnum mound appearing in the upper right. Invading moss (*C. purpureus*) is beginning to colonize the charred ground surface.



Mosses (*C. purpureus*, *P. juniperinum*) are expanding. Scattered shoots of sedge (*Carex bigelowii*) have appeared. Note the small cranberry (*Vaccinium vitis-idaea*) and resin birch (*B. glandulosa*) seedlings on the sphagnum mound.



Sedge (*C. bigelowii*) is thriving, but the mosses remain dominant. Resin birch and cranberry are developing. Minute immature lichens are beginning to appear.



Sedge cover has expanded above the moss layer. Labrador Tea (*Ledum decumbens*) has become established in small amounts, while other shrubs continue to flourish. More immature lichens are present.



# Vegetative Recovery Following Fire in Northwest Alaska: Low Shrub-Lichen Tundra Community



Reindeer lichen (*Cladonia* sp.) surrounds crowberry (*Empetrum nigrum*) and cranberry (*Vaccinium vitis-idaea*).

**Site Description:** Dominated by reindeer lichens, but with a substantial low-shrub component. Occurs on sandy plateau soils downwind from the Kobuk sand dunes. A well used caribou trail served as a fire-break between the unburned and burned sites.

**Site Resiliency:** Poor; Lichens burn readily, and low shrubs in this community resprout from basal stems.



Caribou (*Rangifer tarandus*) use this area extensively during spring/fall migration.

## Unburned Lichen Tundra

**Burn Severity:** None.

**Disturbance:** Caribou use intensified.

**10 Years of Impact:** Lichen cover deteriorated from 95% in good condition to <5% in good condition.

**Future:** If grazing intensity continues, lichens will disappear and low shrubs will increase.

## Burned Lichen Tundra

**Burn Severity:** Severe; lichens and many roots and rhizomes destroyed.

**Recovery:** Slow; shrubs were slow to produce shoots, and lichens disappeared.

**10 Year Progress:** Low shrubs and mosses predominate. Immature lichens are developing on the mineral soil.

**Future:** Area will remain as low shrub tundra for some time. Lichens will invade after some time if site is undisturbed.



Year 2 (1990)

Lichens dominate and are nearly continuous. Patchy low shrubs have substantial cover, and little other vegetation is present. Very little exposed mineral soil.



Year 4 (1992)

Lichens are somewhat less extensive. Low shrub cover has changed little. Exposed mineral soil has increased somewhat.



Year 10 (1998)

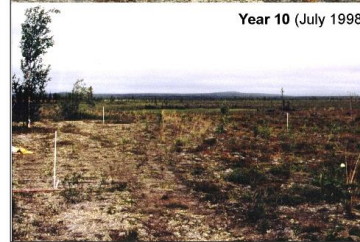
Lichen cover has decreased dramatically. Low shrub cover remains fairly constant. Exposed mineral soil and dead lichen litter predominate. Change is due to increased use by caribou.

Unburned



Year 2 (Sept. 1990)

Ground cover is predominantly charred lichens, other litter, and bare mineral soil. Some lichens have begun to invade, and an occasional live shoot (graminoid or low shrub) has appeared.



Year 10 (July 1998)

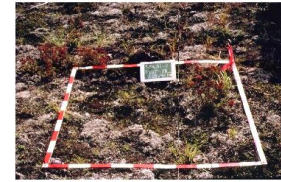
Mosses, graminoids and low shrubs have increased and are more visible. Labrador tea (*Loiseleuria procumbens*) is present near the upper corners of the plot. Sedge (*Carex bigelowii*) is also evident in the plot.

Burned

Site is dominated by Labrador tea, alpine azalea (*Loiseleuria procumbens*), sedge, and moss (*Polytrichum juniperinum*). Immature lichens are present, but crowberry (*Empetrum nigrum*) has not returned.



Year 2 (1990)

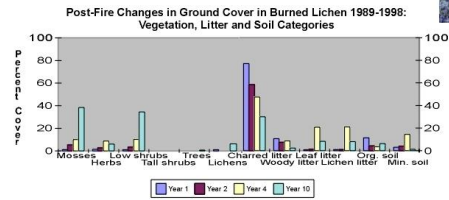
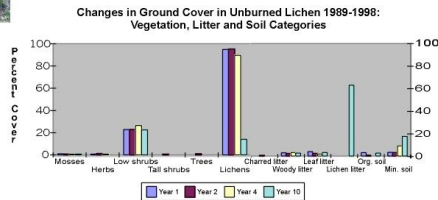


Year 4 (1992)



Year 10 (1998)

Plot 8 - Unburned



Plot 8 - Burned



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