

Bering Land Bridge Tundra Fire Long-Term Monitoring 42 Years after a Fire

Jennifer Barnes, Regional Fire Ecologist, National Park Service Alaska

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During the very warm, dry summer of 1977, several large tundra wildfires occurred in northwest Alaska, including the 258,000 acre Kugruk Hi Fire (BLM #8623) in Bering Land Bridge National Preserve. A set of eight permanent monitoring plots (transects) were established in 1978 by Chuck Racine (and colleagues). They are located along the southwest facing slope of Nimrod Hill, on the east side of Imuruk Lake where tundra vegetation and soils were sampled before the fire in 1973. The permanent plots have been monitored one year post-fire in 1978, followed by sampling in 1979, 1980, 1983, 2001, 2009 and 2019 at 42 years post-fire. This site has provided one of the longest records of post-fire vegetation recovery in tundra in Alaska.

The purpose of these fire effects plots were to detect major changes in structure and composition of vegetation. This includes changes in the cover of vascular and non-vascular plants by species and lifeform, heights of shrubs, and active layer depth over time. For this study area, eight transects were measured with ten 1-m x 1-m quadrats per transect. Data collected within the quadrats included: ocular estimates of vascular and non-vascular species cover, shrub heights, active layer depth measurements, site descriptions, and photographs.

The data was initially summarized by average cover by functional lifeform for sample years (excluding 1979) across all transects (Table 1 and Figure 1). The unburned sites (1973) had the highest lichen cover (11.2%) which has not recovered by 42 years post fire (1.6%). The grasses and forbs peaked 6 years after the fire, started to decline 24 years post fire, and have continued to decline.

Shrubs were broken into functional types of evergreen and deciduous following other papers (Racine et al. 2004). Evergreen and deciduous shrubs increased 24 years after the fire and had recovered to pre-fire levels of shrubs. Thirty-two years after the fire (2009) the shrubs reached their maximum cover. However, by 2019 there was a decrease in the evergreen shrubs, dropping from 21% cover in 2009 to 13.6% in 2019. The tussock forming sedges (*Eriophorum vaginatum* and *Carex bigelowii*) have continued to increase with the maximum cover of sedges measured in 2019 (61%), 42 years after the fire.

Table 1. Average percent cover of vascular plants by functional types for sites by sample year over the past 46 years at the Bering Land Bridge Nimrod Hill Racine plots. Fire occurred in 1977. The number of plots are shown as “n” in the table. The 80% confidence intervals are shown in parentheses.

Year Sampled / Time Since Fire	n	Lichens	Forb Herbs	Grasses	Sedges	Evergreen Shrubs	Deciduous Shrubs
1973 (Pre-Fire)	3	11.2 (6.4 -16.1)	2.3 (1.2 - 3.4)	0	27.8 (9.6 - 46.0)	14.7 (7.9 - 21.5)	17.5 (6.0 - 29.0)
1978 (1 year post)	8	0.6 (-0.2 - 1.3)	1.6 (0.9 – 2.3)	0.7 (0.1 - 1.2)	11.8 (7.2 - 16.5)	2.5 (0.5 - 4.5)	0.6 (0.3 - 0.8)

Year Sampled / Time Since Fire	n	Lichens	Forb Herbs	Grasses	Sedges	Evergreen Shrubs	Deciduous Shrubs
1980 (3 years post)	8	0.01 (0.00 - 0.03)	0.4 (0.1 - 0.7)	1.1 (-0.05 - 2.3)	25.9 (19.0 - 32.8)	2.2 (1.1 - 3.3)	1.5 (0.8 - 2.3)
1983 (6 years post)	7	0.14 (0.01 - 0.3)	11.7 (6.3 - 17.2)	6.4 (1.0 - 11.8)	49.4 (42.1 - 56.7)	8.4 (3.6 - 13.1)	4.3 (3.0 - 5.7)
2001 (24 years post)	8	1.7 (0.9 - 2.5)	5.2 (3.3 - 7.0)	3.8 (1.7 - 5.9)	45.3 (37.5 - 53.1)	18.3 (10.3 - 26.3)	14.5 (8.8 - 20.1)
2009 (32 years post)	8	1.0 (0.5 - 1.5)	3.1 (1.8 - 4.3)	1.7 (0.1 - 3.3)	49.6 (40.8 - 53.4)	20.9 (12.0 - 29.9)	19.0 (11.4 - 26.6)
2019 (42 years post)	8	1.6 (1.1 - 2.1)	2.0 (1.4 - 2.7)	0.2 (-0.02 - 0.5)	61.2 (53.7 - 68.6)	13.6 (8.6 - 18.5)	17.3 (8.7 - 25.8)

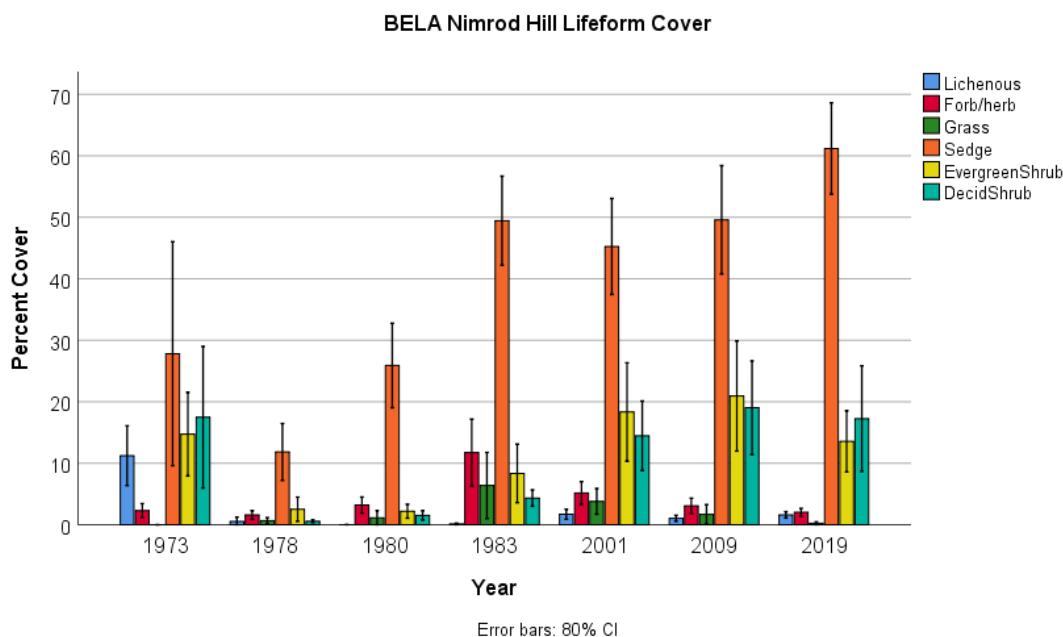


Figure 1. Average percent cover by functional lifeform for all transects by year at the Nimrod Hills tundra fire plots in Bering Land Bridge National Preserve.

Comparing the shrubs by pre-fire vegetation type, the changes in shrub cover species are more apparent. The lower slope tussock-tundra sites (Nim-01 through Nim-05) appear to have a reduction in Labrador tea (RHTO2), cranberry (VAVI), and shrub birch (BENA) cover in 2019, after peaking in 2009 (Figures 2, 3 and 4). The better drained sites on the upper slope (Nim-6 and Nim-7) which were previously considered a low shrub tundra type, have seen an expansion of diamond leaf willow *Salix pulchra* (SAPU15) that was first noted in 2001 (Racine et al 2004) (Figures 3 and 5). Between 2009 and 2019 there has continued to be an increase in cover of willow. Crowberry (EMNI) also appears to continue to increase at the shrub tundra sites. Shrubs at the wet sedge meadow transect (Nim-08) are not as common, but have not returned to pre-fire cover for several species of shrubs (Figures 3 and 4).

The preliminary results from this study show a fairly dramatic drop in cover of evergreen shrubs, predominantly Labrador tea at the tussock shrub tundra sites 40 years after the fire. This may be indicative of paludification or other changes to the soils that could limit the woody shrub growth. The better drained shrub tundra sites appear to continue to see an increase in cover of tall willow over time. Shrubification of tundra has been a topic of interest with increased warming in Alaska. This long term monitoring suggests that there is a limitation of the shrub expansion and that some shrub species such as Labrador tea and shrub birch could see a decrease over time after fire. There has also been minimal recovery of lichens at the site. Based on the pre-fire data the cover of lichens, which were commonly *Cladonia* and *Cetraria* species, have not recovered to pre-fire cover levels. Additional analyses and results will be presented in a report for this study site in 2020.



Figure 2. An example of evergreen shrub reduction in the tussock shrub tundra sites. Photos from a quadrat from Nim-01 shows a reduction in Labrador tea and other shrubs between 2009 (left) and 2019 (right). Tussock sedges have more cover in this quadrat in 2019.

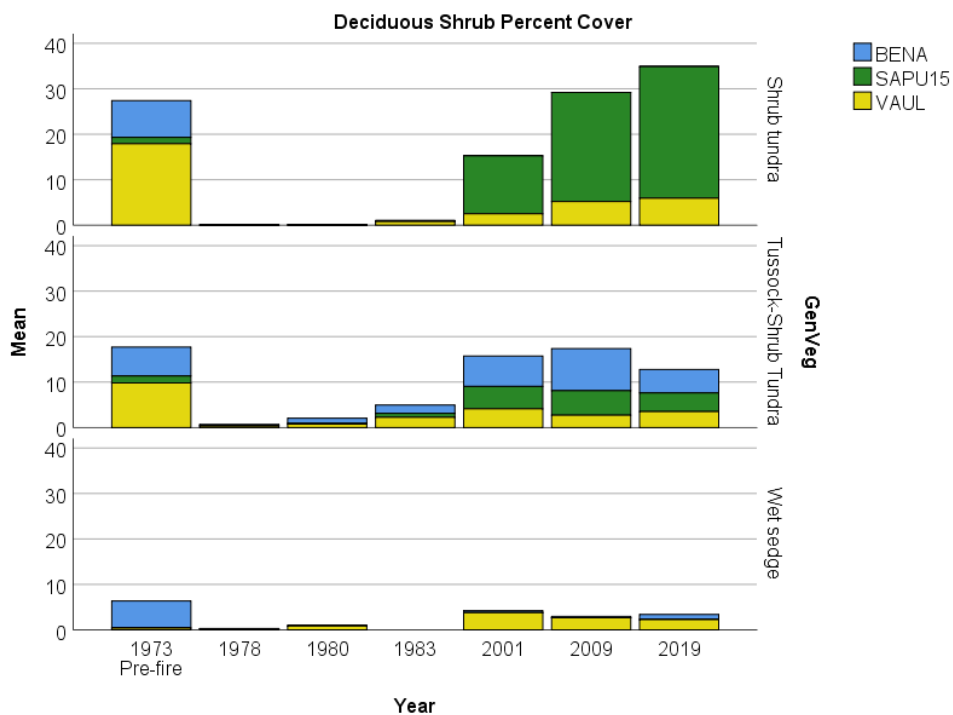


Figure 3. Average percent cover of dominant deciduous shrub species organized by general pre-fire vegetation type and sample year at the Nimrod Hills tundra fire plots in Bering Land Bridge National Preserve. Species are dwarf birch (BENA), diamond leaf willow (SAPU15), and blueberry (VAUL).

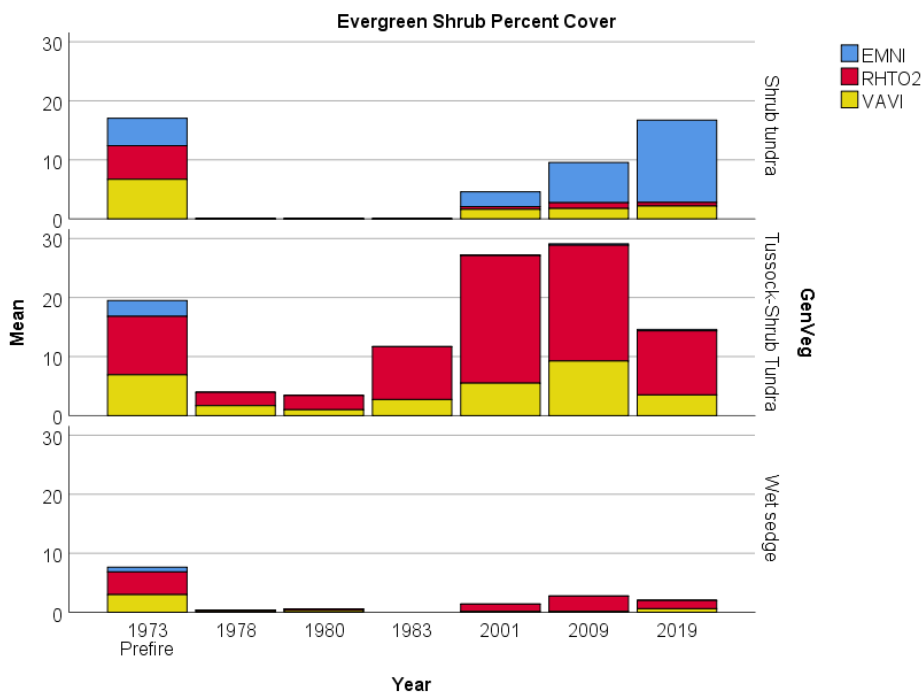


Figure 4. Average percent cover of evergreen shrub species organized by general pre-fire vegetation type and sample year at the Nimrod Hills tundra fire plots in Bering Land Bridge National Preserve. Species are crowberry (EMNI), Labrador tea (RHTO2), and bog cranberry (VAVI).



Figure 5. Transect Nim-06 photos from 1973 (pre-fire) low shrub tundra, 1978 (1 year post fire) high severity burn, 1983 sedge meadow, and 2019 open willow. Willows have expanded on this site since the fire in 1977. (1973 -1983 photos C. Racine, 2019 photo NPS/Barnes)