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A Wetland Restoration in the Truelove Lowland of Devon Island

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The Arctic is the land of ice. On the sea alone, ice can cover up to 15 million square kilometers—the vast majority of the region's aquatic surface—and though comparatively little of the land surface is so covered, most of the water in Arctic soil exists as ice (AMAP 1997). The ice in the landscape can take a bewildering array of forms, from above-ground glaciers and ice sheets to below-ground fingers that snake up through the soil, pushing previously buried soil and rocks to the surface. The movements of ice in the soil can orient stones so their vertical axis points up, create circular and polygonal patterns of stones on the soil surface, induce vegetation to grow in polygonal patterns, and create large, discrete hills called pingos that resemble small extinct volcanoes (Fitzpatrick 1997).

Despite the astounding effects of the ice and temperature, and often because of them, the Arctic supports an amazing array of complex ecosystems. As humans have increased their exploration and use of the Arctic, many of these ecosystems have experienced significant damage and are under continual threat for more. This paper will explore an effort to restore a common type of damage to Arctic vegetation, vehicle tracks, in one of the most fascinating and rare ecosystems of the Arctic, a High Arctic Wetland.

In as isolated a region as the Arctic, some might wonder why it is necessary to engage in restoration projects there. One reason is that the destruction of plant cover could become an extremely significant problem if rising global temperatures increase the decomposition of organic matter stored in Arctic soils. The low temperatures of the Arctic inhibit decomposition of organic material by limiting biological activity. Some estimate that in cold continental regions a 95% turnover of organic matter takes 300 years (AMAP 1997). Consequently, the Arctic region contains a disproportionately significant amount of the world's carbon, 12% of the world's global soil carbon (Oechel, *et al*. 1997). If plant cover in the Arctic were to significantly diminish, an important method for fixing carbon and preventing it from entering the atmosphere as a greenhouse gas would be disrupted.

There is no single standard definition of what actually comprises the Arctic. A popular definition of the Arctic is the region north of Arctic Circle. Some define the Arctic in relation to temperature, for instance as the area whose mean July temperature is 14Ú C or lower (Fitzpatrick 1997). Many biologists define the Arctic in terms of vegetative patterns, dividing it into three subregions: the subarctic, Low Arctic, and High Arctic (AMAP 1997). The subarctic consists of the area south of the tree line to where either permafrost (the permanently frozen layer of soil ranging from just a few centimeters to a few meters below the surface) no longer exists, or the forest is dense enough to form a closed canopy. The Low Arctic—or tundra zone—is the area north of the tree line consisting of low shrubs, dwarf heath shrubs, cotton grass communities, and wetlands. The High Arctic starts where the Low Arctic vegetation is replaced by cushion plants, cryptograms, prostrate shrubs, and rosette herbaceous forbs (AMAP 1997, Jeffries 1995).

The wetland discussed in this paper is found in the Truelove Lowland, which is located on the north shore of Devon Island, the fifth largest island in the Canadian Arctic Archipelago. The Archipelago is a group of 20 large and small islands in the High Arctic that extends northward from the North American mainland into the Arctic Ocean. Truelove Lowland is a discrete area of Devon Island, measuring 43 km2, isolated by the ocean on the north, west, and part of the south, and by steep cliffs on the rest that rise 300 m to the plateau that forms the majority of Devon Island (Bliss 1977). Until 8,700 years ago, Devon Island was covered by a glacier. After deglaciation the island slowly rose as the oppressive weight of the ice was removed, rising out of the ocean 107 m and revealing the area of Truelove Lowland. At present the continuing rise of Devon Island matches the water level rise of the oceans (Bliss 1977).

With the rise of the coastal area, offshore bars emerged from the ocean, cutting off coastal lagoons which then became lakes or ponds, or filled to form meadows (Bliss 1977). Twenty or more raised beaches occur at Truelove, ranging from 1–5 m in height, 30–100 m in width, and 500–1000 m in length. The beaches impede water flow to the ocean and combine with the permafrost, which limits the flow of groundwater, to help create the variety of wetlands found in the Lowland (Bliss 1977).

Truelove is a complex mosaic of salt and fresh water marshes, rock outcrops, lakes and ponds, and raised gravely and sandy beaches supporting a wide variety of biota. Wetland areas such as Truelove are very rare in the High Arctic, comprising only 6% of the region and are more similar to areas in the Low Arctic. The Lowland is an oasis of plant cover and open fresh water, providing the food base for numerous birds, muskox, lemming, Arctic hare, and their associated predators such as the Arctic fox and wolves, and making possible a high amount of biological diversity and productivity that is uncharacteristic for this latitude (Bliss 1977). The vast majority of the High Arctic, including the plateau of Devon Island, is classified as either Polar Desert or Polar Semi-Desert, both of which are characterized by a lack of available water for plants and by very discontinuous plant cover (Bliss 1977, Jeffries 1995).

The restoration study site is in one of the gently sloping wet meadows of the Lowland. *Carex aquatilis* var. *stans* (Arctic water sedge) is the dominant vegetation in undisturbed areas with *Eriophorum angustifolium* (common cotton-grass) an important associate (Forbes 1993). The vascular plants *Arctagrostis latifolia* ssp. *latifolia* (polar grass), *Dupontia fisheri* ssp. *psilosantha*, *Juncus biglumis* (two-flowered rush), *Saxifraga hirculus* (yellow marsh saxifrage), and *Pedicularis sudetica* (lousewort) also occur. The abundant moss cover is primarily composed of three species, *Calleirgon giganteum*, *Drepanocladus revolvens,* and *Meesia triquetra* (Forbes 1993).

Sometime in the 1960's, but no later than 1971, a tracked vehicle similar to a bulldozer drove across the meadow (Forbes 1992). Heavy vehicle travel can be especially harmful in the Arctic. By destroying the vegetative cover, vehicles—and especially tracked vehicles—remove the insulating layer above the permafrost. This can cause part of the permafrost to melt, and the meltwater can subsequently evaporate and/or flow away leaving the soil dry and unsupported. The soil level then falls below the ground level of the adjacent undisturbed areas, creating a low spot that can fill with water. This leads to a number of changes in the hydrological, floral, faunal, and soil physical and chemical characteristics of the area. These characteristics usually recover very slowly, if at all (Kevan *et al*. 1995, Forbes 1992, Forbes 1998). It is not reported why the vehicle drove across the meadow, but no further use of tracked vehicles in the Lowland has been reported either.

To repair the damage caused by vehicle tracks, it is necessary to reestablish the vegetative cover. One obvious way to accomplish this is to sow seed. In the High Arctic, however, few species produce viable seeds (Oksanen & Virtanen 1997, Forbes 1993). As described by Forbes (1993), in July 1972 Paul Barrett wanted to determine if cloned transplants of native species would survive and grow in denuded areas and thus serve as a restoration alternative to seeding. Scientific investigation of a particular restoration technique was therefore the primary motivation for Barrett's restoration.

Barrett divided a portion of the disturbed meadow into 19 blocks measuring 0.5 X 5.0 m each (the blocks being narrow and long as were the tracks). In all of the blocks he transplanted vegetative shoots of *Carex aquatilis* var. *stans* from adjacent undisturbed sites into the ruts. In addition, some of the blocks were filled in with sods of bryophytes from the adjacent meadow so the rut would be brought to level with the surrounding undisturbed area.

In 1990 Forbes visited the site to study the results of Barrett's work. He studied two plots in particular, one that received *Carex* transplants and bryophyte sod and had seasonally moving water, and one which received *Carex* transplants only and had standing water. He used these two plots for detailed studies of the restoration results. Forbes reported that after 18 years, at a glance the plots that Barrett had planted looked entirely restored—the *Carex* plants clearly the dominant vegetation—and blended in well with the surrounding undisturbed vegetation. Tracks in naturally recovering areas were still clearly visible, and vegetative cover was still diminished. One surprise he did encounter, however, was the abundant presence of blooming *Eriophorum scheuchzeri* in the area that had received bryophyte sod in addition to *Carex* transplants, even though *Eriophorum scheuchzeri* was not present in any of the adjacent undisturbed areas of the meadow. Forbes concluded that the *Eriophorum scheuchzeri* had germinated from seeds in the seed bank that had been brought along with the bryophyte sods.

Upon closer inspection, Forbes discovered that compared to an adjacent undisturbed site with similar hydrology, the plot with bryophyte sod and moving water had only slightly less plant cover (43.2% vs. 46.7%) and similar species diversity (although with a slightly different make up due to the presence of *Eriophorum scheuchzeri* and the complete absence of *Arctagrostis latifolia* ssp. *latifolia*). In the plot that received *Carex* transplants only and had standing water, plant cover was also similar to a control site, but species diversity was significantly reduced, 4 species out of 8 being completely absent and the population of one, *Eriophorum angustifolium*, being significantly reduced in favor of *Carex.*

Since the primary reason for the restoration was scientific inquiry, the real measure of success for the restoration was whether it produced useful data. Under those terms the restoration was successful, for it demonstrated that vegetative planting is a viable and productive strategy for Arctic restoration efforts. This is significant, for many Arctic plants—especially those in wetland areas—have difficulty propagating sexually (Oksanen & Virtanen 1997). In addition, plant growth in the Arctic can proceed very slowly, thus restoring vegetation from seed may not be useful if establishing ground cover quickly is a necessity in order to prevent erosion (Billings 1987). However, if none of the transplants had survived and if the cause for their failure could have been determined, this too would have been useful information.

Forbes judged the restoration a success for creating a binding plant cover. Potential erosion was alleviated and signs of muskox browsing indicated that at least these two important functions had been restored. Although not structurally identical to undisturbed areas, the restored areas were similar, and they supported more vegetation and species than the naturally recovering areas.

The unexpected appearance of *Eriophorum scheuchzeri* raised the important question of the role of seed banks in Arctic restoration projects. This is an area about which little is presently known, and in this particular case it is difficult to assess the role of *Eriophorum scheuchzeri* in the restoration. On the one hand it did provide a significant amount of stabilizing cover, but it was not part of the original floral makeup of the area, and the effects of its presence are unknown. The implications of this technique on the recruitment of unexpected species from the seed bank remain to be answered.

No one has reported on the site since 1990, and Forbes has not visited it since his initial investigation (Forbes, personal communication). It is unfortunate that the site's remoteness has precluded more frequent observations so that the rate of recovery could be reliably tracked. It is unclear how long it took for the site to reach an acceptable level of recovery, and whether the eighteen years between investigations also represents an amount of time necessary for a successful restoration in the Arctic to take hold. Even without that information, the restoration site at Truelove Lowland is important as a long-term study in Arctic restoration for demonstrating that vegetative transplanting is a viable technique for restoring a significant portion of the function and structure lost due to a human-caused disturbance. This is especially noteworthy given that human-caused disturbances several centuries old and of a much smaller scale are still detectable today (Forbes, 1996). Although vegetative transplanting is very labor intensive and might not be feasible over a wide area, it is important to know that for disturbed areas of significant value, such as a High Arctic wetland, this technique has a good chance for successfully restoring a good amount of structure and function. Also, given the prevalent use of tracked vehicles in the Arctic, it is good to have a proven technique for repairing the damage caused by tracks.

References

Arctic Monitoring and Assessment Program. 1997. *Arctic pollution Issues: A State of the Arctic Environment Report*. AMAP: Oslo.

Billings, W. D. 1987. Constraints to plant growth, reproduction, and establishment in Arctic environments. *Arctic and Alpine Research*. Vol. 19, no. 4, pp. 357–365.

Bliss, L. C. Introduction, in Bliss, L. C., editor. 1987. *Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem*. University of Alberta Press: Edmonton.

Fitzpatrick, E. A. 1997. Arctic soils and permafrost. In: Woodin, S. J. and Marquiss, M. (eds).*Ecology of Arctic Environments*. Blackwell Science: Oxford.

Forbes, B. C. 1992. Tundra disturbances studies, I: long-term effects of vehicles on species richness and biomass. *Environmental Conservation*. Vol. 19, no. 1, pp. 48–58.

Forbes, B. C. 1993. Small-scale wetland restoration in the High Arctic: a long-term perspective. *Restoration Ecology*. Vol. 1, no. 1, pp. 59-68.

Forbes, B. C. 1996. Plant communities of archaeological sites, abandoned dwellings, and trampled tundra in the eastern Canadian Arctic: a multivariate analysis. *Arctic*. Vol. 49, no.2, pp. 141–154.

Forbes, B. C. 1998. Cumulative impacts of vehicle traffic on High Arctic tundra: soil temperature, plant biomass, species richness and mineral nutrition. *Nordicana*. Vol. 57, pp. 269–274.

Jeffries, R. L. 1995. Tundra, Arctic, and Subarctic In: Nierenberg, W. A., (ed). *Encyclopedia of Environmental Biology*. Academic Press: San Diego.

Kevan, P.G., *et al*. 1995. Vehicle tracks on High Arctic tundra: their effects on the soil, vegetation, and soil arthropods. *Journal of Applied Ecology*. Vol. 32, pp. 655–667.

Oechel, W. C. 1997. Effects of CO2 and climate change on Arctic ecosystems. In: Woodin, S. J. and Marquiss, M. (eds). *Ecology of Arctic Environments*. Blackwell Science: Oxford.

Oksanen, L. and Virtanen, R. 1997. Adaptations to disturbance as a part of the strategy of Arctic and alpine plants. In: Crawford, R. M. M. (ed). *Disturbance and Recovery in Arctic Lands : An Ecological Perspective*. Kluwer Academic Publishers: Boston.