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Ecology and Floristics of Knife Island, a Gull Rookery on Lake Superior

JOHN M. BERNARD,* DONALD W. DAVIDSON,** and RUDY G. KOCH***

ABSTRACT—Certain aspects of the ecology and floristics of Knife Island, Minnesota, a small gull rookery on the north shore of Lake Superior, were studied. 63 species of vascular plants, and 23 species of Bryophytes were collected, including one newly recorded in this state. Very high levels of soil organic matter, phosphate, and potassium were present, and low pH levels (ranging from 3.6 to 4.2) were found. These levels appear to reflect the intensive use of the island by the herring gulls. It is concluded that the major factor controlling the development of the flora and vegetation of Knife Island is the herring gull population.

Knife Island is a small, rocky island approximately 300 x 800 feet in size located just off the North Shore of Lake Superior at the village of Knife Island.

The island is of particular interest because it is a rookery for large numbers of Herring Gulls (*Larus argentatus*) during the early summer. Hofslund (1959) stated that the island supports at least 250 breeding birds per year. He banded some 500 young in one year. He further noted that most of the nests are located on bare rock on the mainland side of the island. Hofslund (personal communication) states that the number of breeding birds present may have increased since the 1959 report.

There is little published information on the effect birds and their excrement have on vegetation, and more reports were found on Great Blue Heron Rookeries. Fahey (1968) noted dead and dying red and white pine trees in the Great Blue Heron (*Ardea herodias*) colony at Kirk Lake, Minnesota, and Hanlon (1956) noted that shrub underbrush was killed by excrement in the Heron Island Rookery he studied, also in Minnesota. D. W. Davidson (unpublished) noted large numbers of dead red pines and restricted development of ground vegetation in a Great Blue Heron Rookery on Basswood Lake in southern Ontario, Canada.

One other small island on the North Shore (Beaver Island) has been studied (Lakela, 1948). She noted birch-conifer forest developed on the island which had a flora typical of the adjacent mainland. She also noted a Herring Gull Colony on Beaver Island, but did not discuss the possible impact of nesting activities on the flora and vegetation of the island. Hofslund (1952, 1959) has previously conducted extensive banding and migration

pattern studies on Knife Island, in conjunction with the Duluth Bird Club.

Our objective was to determine what effect the large population of birds has had on the flora, vegetation, and soils of this small island.

Geologically, Knife Island is an extension of the Stoney Point Sill (Diabase) which extends along the north shore just south of the island, then emerges on the surface as Knife Island (Schwartz, 1949, Dr. John W. Green, personal communication).

Collecting trips for this study were made in the summer of 1968 and fall of 1969. Vascular species were collected on both trips while Bryophytes were collected in 1969 only. Voucher specimens of all plants cited are located in the Wisconsin State University—Superior. Some duplicate Bryophyte collections were deposited in the University of Minnesota Herbarium in Minneapolis.

Soils were collected in 1969 from the 0-10 cm. depth at 4 locations selected to represent characteristic areas of bird activity.

Results and observations from three areas

There are three distinct areas on the island: 1) the gently sloping lake side, which is essentially bare rock exposed to periodic intense wave action, 2) the mainland side, characterized by a vertical rock cliff approximately one meter high at the northeast end to three meters high at the southwest end, and 3) a small forest of Mountain Ash (*Pyrus americana*) in the middle of the island.

The shore side and much of the small forest both are modified by Gull activities. White excrement almost covers the rock surfaces, and dead birds are common in crevices. The white color of excrement on the rocks is readily visible from the Knife Island Harbor (nearly half a mile away). The interior of the small forest is mostly bare and trampled.

The small forest is almost entirely Mountain Ash, with a few paper birch (*Betula papyrifera*) and one white spruce (*Picea glauca*). Several large dead fir (*Abies balsamea*) and several saplings of that species were noted. The shrub and herb layers were sparse. An extensive growth of Yew (*Taxus canadensis*) is the only undergrowth of particular importance in the forest, and is located in the forested interior of the island.

The Green Alder (*Alnus crispa*) and Ninebark (*Phy-*

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TABLE 1. List of Vascular Plants from Knife Island, Minnesota.

Abies balsamea (L.) Mill.
Acer spicatum Lam.
Achillea millefolium L., forma *millefolium*
Actaea rubra (Ait.) Willd.
Agropyron trachycaulum (Link.) Malte. var. *glau-*
cum (Pease & Moore) Moore
Agrostis alba L., var. *alba*
Agrostis scabra Willd.
Alnus crispa (Ait.) Pursh.
Aster ciliolatus Lindl.
Aster simplex Willd.
Beckmannia syzigachne (Steud.) Fern.
Betula papyrifera Marsh.
Calamagrostis canadensis (Michx.) Beauv. var. *can-*
adensis
Campanula rotundifolia L.
Capsella bursa-pastoris (L.) Medic.
Cardamine pensylvanica Muhl.
Cinna latifolia Griseb.
Cirsium arvense (L.) Scop.
Cirsium vulgare (Savi) Tenore
Clintonia borealis (Ait.) Raf.
Cornus stolonifera Michx.
Deschampsia caespitosa (L.) Beauv.
Diervilla lonicera Mill.
Dryopteris spinulosa (Mull.) Watt. var. *spinulosa*
Epilobium angustifolium L.
Erysimum cheiranthoides L.
Galeopsis tetrahit L.
Glyceria grandis S. Wats.
Gnaphalium uliginosum L.
Hordeum jubatum L.
Impatiens capensis Meerb.
Lonicera canadensis Marsh.
Matricaria matricarioides (Less.) Porter
Physocarpus opulifolius (L.) Maxim.
Picea glauca (Moench) Voss
Plantago major L.
Poa annua L.
Poa compressa L.
Poa glauca Vahl.
Poa interior Rydb.
Poa palustris L.
Polygonum aviculare L.
Polygonum cilinode Michx.
Populus tremuloides Michx.
Potentilla norvegica L.
Prunus pensylvanica L. f.
Pyrus americana (Marsh.) D. C.
Ranunculus acris L.
Ribes glandulosum Grauer
Ribes oxyacanthoides L.
Rorippa islandica (Oeder) Borbas
Rosa acicularis Lindl.
Rosa blanda Ait.
Rubus parviflorus Nutt.
Rubus setosus Bigel. (sensu lat.)
Rubus strigosus Michx.
Sambucus pubens Michx.
Tanacetum vulgare L.
Taxus canadensis Marsh.
Trifolium repens L.
Urtica dioica L.
Viola sororia Willd.

socarpus opulifolius), shrubs common in rocky crevices on the entire north shore area, also were present in similar situations on Knife Island.

In total, 63 species of vascular plants were collected. They included six trees, 12 shrubs, 30 herbaceous forbs, 13 grasses, and two ferns (Table 1). In addition to the vascular plants, we collected 23 species of Bryophytes (Table 2). Most of the Bryophyte species (11) were collected in the forest, seven on the shore side, and five on more or less exposed, bare soil.

One species of moss, *Plagiothecium latibricola* is a species new to Minnesota. It is a small and relatively rare species which has been reported from Newfoundland, Nova Scotia, New Jersey, Ontario, and Wisconsin.

The soil was very shallow in the forest under the Mountain Ash trees. The pH of the four samples taken from various locations on the island ranged from 3.6 to 4.2. Very high levels of soil organic matter, phosphate, and potassium were present (Table 3).

Bird activities affect vegetation

It appears that the major factor governing the flora and vegetation of Knife Island is the Herring Gull population. The large number of resident birds, the nesting activities, the trampling of the soil, and the large amount of excrement all tend to restrict plant development.

Plants are found primarily in crevices on the shore side of the island and in the forest proper, where there is less bird activity. Any tree seedling or herbaceous species is subject to trampling and death if not thus protected.

The soil data also illustrate the profound influence of the bird population on this island. The low pH values and the very high organic matter, phosphorus, and potassium levels probably inhibit the growth of some plant species. The higher values of phosphorus and potassium were found where bird activity was greatest. As examples, phosphorus and potassium levels in the forest interior (where bird activities are reduced) were less than half of the levels in the open and edge areas. These values are all far greater than in similar soils not exposed to bird activity.

The soil samples were taken in late fall after gull activity had lessened. It is possible that soil nutrient values then are lower than during nesting time. Rainfall certainly flushes nutrients off the island into Lake Superior.

Table 4 compares certain aspects of Beaver Island (Lakela, 1948) with Knife Island. While Lakela's studies showed that Beaver Island supported a Birch-conifer forest including five different conifers and three different deciduous trees, Knife Island has only Mountain Ash as an important tree species, with both large coniferous species either dead (*Abies balsamea*) or with a rotten center (*Picea glauca*).

Notably lacking from the flora of Knife Island were many species typical of northern forest conditions which are found by Lakela on Beaver Island associated with the dominant conifer vegetation, thus confirming the concept that the flora of Knife Island is more of a "weedy" nature. Totally lacking from Knife Island were the following species found on Beaver Island, and all typical of

TABLE 2. List of Bryophytes from Knife Island, Minnesota.

<i>Amblystegium juratzkanum</i> Schimp.
<i>Brachythecium digastrum</i> C. M. & Kindb.
<i>B. plumosum</i> (Hedw.) BSG.
<i>B. reflexum</i> (Starke) BSG.
<i>B. rutabulum</i> (Hedw.) BSG.
<i>Bryum argenteum</i> Hedw.
<i>Ceratodon purpureus</i> (Hedw.) Brid.
<i>Funaria hygrometrica</i> Hedw.
<i>Grimmia alpicola</i> Hedw. var. <i>rivularis</i> (Brid.) Broth.
<i>Haplocladium microphyllum</i> (Hedw.) Broth.
<i>Heterophyllum haldanianum</i> (Grev.) Kindb.
<i>Homomallium adnatum</i> (Hedw.) Broth.
<i>Hygroamblystegium tenax</i> (Hedw.) Jenn.
<i>Hygrohypnum luridum</i> (Hedw.) Jenn.
<i>Leptodictyum trichopodium</i> (Schultz) Warst.
<i>Leskea gracilescens</i> Hedw.
<i>Lophocolea heterophylla</i> (Schrad.) Dumort.
<i>Mnium punctatum</i> Hedw.
<i>Orthotrichum anomalum</i> Hedw.
* <i>Plagiothecium latibricola</i> BSG.
<i>Pogonatum alpinum</i> (Hedw.) Rohl.
<i>Pohlia nutans</i> (Hedw.) Lindb.
<i>Pylaisia polyantha</i> (Hedw.) BSG.
*New State Record

northern coniferous forests; *Lycopodium* (five species), *Thuja occidentalis*, *Cornus canadensis*, *Polypodium virginianum*, *Woodsia ilvensis*, *Aster macrophyllus*, *Linnaea borealis* L. var. *americana*, *Arctostaphylos uva-ursi*, *Vaccinium* (3 species), *Pyrola* (2 species), *Aralia nudicaulis*, *Osmunda* (2 species), and *Maianthemum canadense*.

The shrub stratum on the two islands also was considerably different. On Beaver Island Lakela noted that it was "well developed." Knife Island shrubs were clumped and scattered. The herbaceous situation seemed to be similar; well developed herb stratum on Beaver Island and poor on Knife Island.

Of the 63 species collected in this study, 26 also were reported by Lakela on Beaver Island. Beaver Island has 10 species of sedges, but none were found on Knife Island.

Most of the species on Knife Island, whether reported from Beaver Island or not, were weedy species from the mainland. They are with a few exceptions species capable of surviving the impact of the Herring Gull activity on this small island.

The conditions of the Gull Rookery on Knife Island are somewhat similar to those found in the rookeries of the Great Blue Heron, although not as severe in their expression. The typical impact of the Great Blue Heron is to modify the vegetation. Trees are killed in the heron rookeries (Fahey, 1968, and Davidson unpublished observations) and understory vegetation is drastically modified. In the present study, however, there has not been widespread devastation of the vegetation and flora by the activities of the Herring Gulls, only extreme modifica-

TABLE 3. Soil, pH, Organic Matter, Phosphorus and Potassium Levels from Various Sites on Knife Island.

Location	pH	Organic Matter Tons/Acre	P Pounds/Acre	K
Forest Interior	3.6	>150	110	180
Edge of Island	4.0	>150	400	475
Edge of Island	3.9	>150	230	440
Open, Trampled area	4.2	>150	400	600

tion. Nevertheless, it does seem that the major factor controlling the development of the flora and vegetation of Knife Island is the Herring Gull population.

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