

Report on the Ecological Importance of Owls Head Crown land

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Background

We have no connection to or affiliation with either of the Applicants in this matter, and we have not been retained by anyone to provide this report. This report constitutes our objective expert opinion on the ecological importance of the Owls Head Crown lands and the likely consequences of building golf courses on this property.

We offer these comments as independent experts on plant ecology and the ecological importance of the Owls Head Crown lands, for the express assistance of the court, and this report is comprehensive concerning the relevant information in this matter.

We are willing to respond to questions concerning our expert opinion on this matter as quickly as we are able. Should our opinion in this matter change, or should we become aware of a material fact that was not considered during the preparation of this report, we will notify both parties immediately in writing. Furthermore, we are willing to testify at Court, to follow the Court's directions, and to apply independent judgment when assisting the court.

All of the material facts presented in this report were found by us through our research, save for those facts for which we have provided references. We have provided references below in addition to our expertise and unpublished data.

Data used to inform this report and our knowledge of Owls Head Provincial Park crown lands were collected as a part of an independent research study on the biodiversity of coastal barrens in Nova Scotia. We describe methodology used in the below methodology section. These quantitative data were not collected for the purposes of an environmental assessment or a wetland delineation. We completed no formal survey of fauna at Owls Head and did no survey of Species at Risk at the site. We address these limitations throughout the report where relevant.

We draw attention to anything that could reasonably lead to a different conclusion. There are no theoretical explanations for our conclusions that we have excluded, nor relevant theory that we have rejected.

We have a high degree of confidence in the conclusions of this report, given that there are no contradicting or contrasting data or theories of which we are aware.

Methodology

Study objective:

The objective of the research study we conducted and from which data we use to inform this report was to:

- a) define variability in plant species composition, abundance and distributions within and among coastal barrens sites and,
- 2) determine what measurable environmental variables may be correlated with this variability.

We collected data to address these primary research questions. Our data is not a substitute for an environmental assessment or wetland delineation.

Survey dates:

This study was conducted throughout the growing season in 2011 with Owls Head surveyed in June 2011.

Although our conclusions are based primarily on data collected in 2011, we also visited the site in 2016 and 2017 to collect data on the biology of plant species present at the site. These data are not provided since they are not relevant to conclusions within this report. However, we note that at that time of our 2016 and 2017 field surveys at Owls Head, vegetation communities remained present as described herein this report. As with all plant communities, there can be some change in vegetation over time. We do not anticipate changes to plant communities at the site would have occurred to any extent that would change the conclusions or data presented in this report.

Study site identification:

Study sites, including Owls Head Provincial Park, were identified through our analysis of air photos and GIS data including: Nova Scotia Department of Lands and Forestry Spatially Related Forest Resources Information System (SRFR - 2010), target species occurrence data from the Atlantic Canada Conservation Data Centre and, Nova Scotia Museum of Natural History (2010) and, ongoing research data from our projects to describe and classify barrens vegetation from across Nova Scotia (at the time more than 100 sites with data and field notes were available to us).

20 Study sites including Owls Head were selected based on the following priorities: lack of current anthropogenic disturbance, geological representation, full coverage of geographical range of coastal barrens in Nova Scotia, sites are situated directly adjacent to the coast, ie. < 500m from the shoreline (from Oberndorfer and Lundholm 2009). Site boundaries were determined using polygons from SRFR data.

Study design:

Using a random number generator in MS excel, we identified a random (1500m long) segment of the ocean coastline. The ocean coastline was determined using publicly available GIS data from Nova Scotia Department of Lands and Forestry. The selection of a random section of coastline ensured the collection of data from unbiased sampling locations.

Along this 1500m segment of coastline, we sampled along transects (straight lines) oriented in a grid pattern that was consistent between the 20 coastal barren sites in our study. The grid consisted of five transects, spaced 300m apart (numbered 1-5), oriented perpendicular to the coastline. Along these transects, we sampled at 100m intervals, starting from continuous vegetation at the ocean shoreline (sample "a"), to a maximum distance through continuous coastal barren of 500m (sample "f"). 500m was selected as a maximum sampling distance because Oberndorfer and Lundholm (2009) determined this distance to approximate the extent of direct coastal influence (eg. Salt spray) on the vegetation of coastal barrens in Nova Scotia. The 100 and 300m sampling intervals were selected for feasibility because they enabled the greatest quantity of samples to be captured during our limited time (field season is timed with the growing season of June through August). Additionally, we placed a sample on the coastline of each transect to capture data on coastal vegetation types such as salt marshes (sample "cr").

Variables measured at each sampling location were selected to capture the greatest range of environmental gradients of importance to coastal barrens vegetation in Nova Scotia within our limited time and budget. These variables were informed by Oberndorfer and Lundholm (2009) and Porter (2013), the latter being based on standardized methodology for ecosystem classification used by the Province of Nova Scotia. See table below for list of variables and methods of measurement.

When it was not possible to access a predetermined sample location because of the presence of open water (e.g. a lake), we took a compass bearing and placed our sample in the nearest accessible vegetation in-line with the transect orientation. A map of actual sampling locations is provided. We noted the presence of the rare Broom Crowberry dwarf shrubland in the field and collected two field samples at non-random locations. The purpose of this was to document their occurrence at the site, of interest to our ongoing research on the ecology of Nova Scotia's barrens ecosystems.

Our sampling design was established for consistency and objectivity with respect to our study objectives. Because we did not survey the entirety of Owls Head and omitted taxa from our survey (e.g. we did not survey animal wildlife, lichens, etc), the resulting data underestimates the actual biodiversity of the site. Plant species and vegetation communities are not fully represented by our data. Thus, conclusions reached in this report are likely to underrepresent the site's full conservation significance. For example, we are aware of reports of Piping Plover nesting at Owls Head. We made no effort to document the presence or absence of Piping Plover while surveying the site.

Although we identified extensive bog wetlands at Owls Head, we also did not conduct a formal wetland delineation. For example, we made no effort to look for hydric soil indicators. Therefore, we are unable to determine whether some of our samples can formally be considered wetlands. We specify these uncertain cases.

Sample unit: We used a 1x1 m square shaped quadrat. Note: a quadrat is a portable frame for sampling vegetation within a defined area. The terms “Plot”, “Sample”, “Sample Plot” and “Quadrat” are used throughout this report interchangeably. Each refers to our 1x1 m defined sampling area from which we collected data on plant species and their environment.

Identification of eelgrass beds:

We incidentally noted the presence of eelgrass along the coastline and confirmed the presence of eelgrass beds at the site using aerial imagery. We did not collect any quantitative data from the marine environment. Thus, we do not know the area of the eelgrass beds adjacent to the site. We consulted with eelgrass expert, Dr. Jeff Barrell, Physical scientist at Department of Fisheries and Oceans (DFO) to validate our observation that the marine environment adjacent to Owls Head supports an eelgrass bed (personal communication, March 18 2020).

Identification of wetlands from sample plot data:

We identified wetlands on the subject property according to the vegetation, soils, and topographical data that we collected. We indicate sample plots where we cannot be certain about without additional data. We did not delineate the extent or area of wetlands at the site.

Variables measured:

Variable measured	Method of measurement	Relevance
<i>Dependent (response) variables:</i>		
Vascular plant species presence and abundance	Point intercept method (following Oberndorfer and Lundholm 2009). Species identified according to Roland and Zinck (1998) and Hinds (2000)	Used to determine species presence and abundance, distribution, diversity, contributed to determining plant community type and wetland status.
<i>Independent (explanatory) variables:</i>		
Soil depth, litter depth	Methods adapted from Oberndorfer and Lundholm (2009)	Soil
Microtopographic class	Methods from Porter (2013), Adapted from Luttmerding et al (1999)	Topography
Meso slope position	Methods from Porter (2013), Adapted from Luttmerding et al (1999)	Topography
Slope length class	Methods from Porter (2013)	Topography
Aspect, Slope gradient	Compass with clinometer (details in Porter 2013)	Topography
Substrate cover (including % exposure of rock, mineral soil, humus, open water, woody materials)	Point intercept method (following Oberndorfer and Lundholm 2009)	Environmental data
Elevation	GPS coordinates with horizontal accuracy of 6m were corrected using ArcGIS10 using a 1:10,000 Digital Elevation Model that has a vertical accuracy of better than 1m and pixel resolution of 20m	Topography
Geographic location	Handheld GPS with 6m Accuracy	Environmental & spatial data
Distance to the coast	Determined in ARC GIS using “near” function from GPS location to “coastline” data	Environmental data (ie. exposure)

CLIMATE

Owls Head is situated in the Eastern Shore Ecodistrict 820. This region is distinguished by extended periods of fog and for being “the coldest coastline on the mainland” (Neily et al 2017). Owls Head is also considered an extremely wind-exposed site (Keys et al. 2017).

SOIL

The site is characterized by shallow soils and repeating ridges of exposed bedrock. Owls Head is underlain by soils of the Rockland series. Rockland soils are defined as “areas where at least 60% of the land is exposed bedrock or the till is extremely stony”. Notably, “The land has little value except for water storage or wildlife” (MacDougall et al 1963).

Our data reveal a mean soil depth of 22cm across the sampling area.

Also present along the shoreline of Owls Head are deposits of windblown and wave-transported sands considered of the Coastal Beach soil series as mapped by MacDougall et al (1963). Peat deposits associated with wetlands occur on the site but are not included on these maps. The depth of peat on site exceeds 1.5m in places.

We did not specifically measure nutrient content or pH (acidity) of soils at Owls Head. However, it is widely established that all coastal barrens and bogs in Nova Scotia are characterized by their nutrient-poor, acidic soils. In our study of nearly 200 barrens from Nova scotia there are no exceptions (Porter et al.

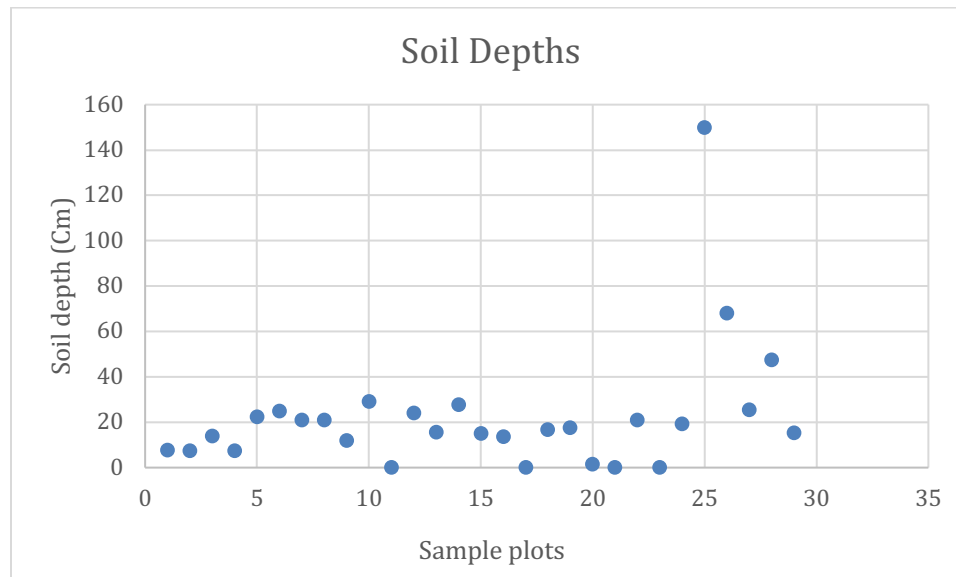


Figure 1. Scatter plot of soil depths reveal the range of soil depths within our sampling area. The mean soil depth across the site is 22cm. 82% of plots have less than 25 cm of soil. Soil depths of 0 occur on bedrock ridges, and soil depth exceeding 1M occur within bog wetlands.

FLORA OF OWLS HEAD

Our data reveal the vegetation of Owls Head consists of a coastal barren and bog habitat complex. The composition of plant communities present at the site is representative of coastal barrens and bogs found within the Eastern Shore Ecodistrict. Vegetation is comprised of species adapted to the harsh climatic and edaphic (soil) conditions present at the site. The distribution of plant communities at Owls Head is spatially patterned in close association with the topographic conditions established by the distribution of bedrock ridges.

We documented coastal shrubland dominated by the species *Gaylussacia baccata* with lesser amounts of the shrubs *Kalmia angustifolia* and *Rhododendron canadense*. Shrubland dominated by *Gaylussacia baccata* is apparently the most abundant community type on the property. We documented low coastal shrubland dominated by the species *Juniperus communis* and *Corema conradii*. These dwarf heaths are distributed across the site on the exposed crests of bedrock ridges with shallow soil. We documented wetlands, especially bogs, at the site. These bogs are associated with either old ponds and lakes or occur in depressions between the bedrock ridges. They are also widespread. Treed areas occur primarily in the periphery of the site and sheltered depressions and are dominated by the species *Abies balsamea* and *Picea mariana*. Coastal beach and other wetland and lakeshore vegetation also occurs.

Our sampling design includes transects that are oriented perpendicular to the shoreline of Long Cove. Because the bedrock ridges run in a similar orientation, our sampling may have missed capturing some ecologically important features.

See attached data for a complete list of vegetation species present in our sampling area.

FAUNA OF OWLS HEAD

Our study was conducted for the purposes of better understanding plant species and community diversity on coastal barrens (see objective in methods section). We did not conduct any formal survey of birds or other animals on the property. For this reason, we are unable to fully report on the ecological value of Owls Head, only its environment and vegetation communities. We did make incidental observations of the following animal species on the property, provided for reference:

Species Common name	Species Scientific name	Observation evidence
Great Blue Heron	<i>Ardea herodias</i>	observed
Red Fox	<i>Vulpes vulpes</i>	observed
Eastern Coyote	<i>Canis latrans</i>	scat observed
Snowshoe Hare	<i>Lepus americanus</i>	observed
White-tailed Deer	<i>Odocoileus virginianus</i>	observed

Table 1. Incidental animal wildlife observations. Animal wildlife and their habitat were not included in our study and this list should not be considered comprehensive.

WETLANDS:

Figure 2. Distribution and area of wetlands previously identified at Owls Head by the Government of Nova Scotia, according to public database (source: <https://nsgi.novascotia.ca/plv/>, Accessed March 16 2020). A total of 7.5 Ha of wetland are identified on the subject property. An additional 9.9 Ha occur on adjacent privately-owned interconnected lands to the southwest. This does not represent a complete wetland inventory or delineation.

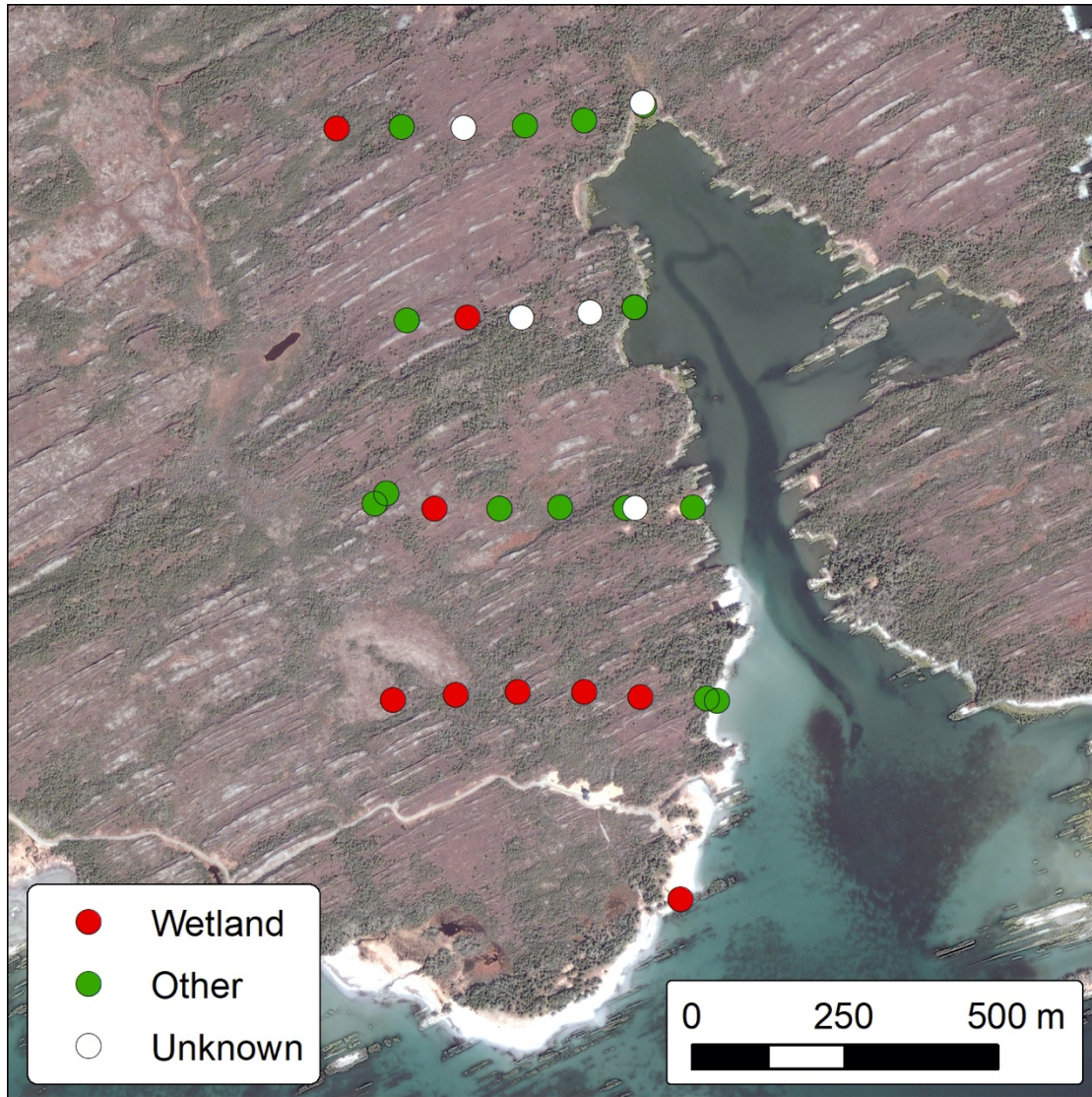
Legend	wetland type	area (Ha)
	Marsh (provincial lands)	4.2
	Swamp (provincial lands)	3.3
	Bog (adjacent private lands)	9.9



Table 2. Quantity and proportion of sample plots within our study area that are wetlands. This does not represent a complete wetland inventory or delineation.

Plot Samples	Wetland habitat status		
	wetland	other (not wetlands)	unknown
sample size (# plots / 29)	9 plots	15 plots	5 plots
proportion of sample plots (%)	31 %	52 %	17 %

Figure 3. Map of sampling locations at Owls Head and their wetland status. This does not represent a complete wetland inventory or delineation.



AREA OF WETLANDS:

Our field data (table 2, Figure 3) reveal that there is a greater extent of wetlands than previously mapped by the province of Nova Scotia (figure 2). This discrepancy in area and type of wetlands is usual and would be expected because it reflects our on-site sampling methodology in comparison with remote sensing techniques used to classify wetlands in the provincial database. Both data sets should be considered incomplete in their presentation of the occurrence and distribution of wetlands at Owls head.

Without a formal wetland delineation field survey, it is not possible to accurately identify the exact area in Ha of wetlands occurring on the property. We believe the area of wetlands on the property to be greater than the 7.5 Ha mapped. Our data reveal that at least 31% of our sampling area is wetland.

TYPES OF WETLAND:

The Province of Nova Scotia noted swamp and marsh wetlands in their database on the property. We noted also bog wetlands across the property. *Bog wetlands* at Owls Head consist of those associated with old waterbodies (lakes, ponds), and those that have developed in wet depressions between bedrock ridges. Drainage in depressions between the ridges can be poor, restricted by shallow bedrock where rainwater accumulates. These bog and bedrock ridge features are distributed widely across the property. As our study pertains to coastal barrens, we did not explore the property for treed wetlands and these types of wetlands are also not usually possible to detect from air photo delineations by the province.



Figure 4. A Bog wetland between bedrock ridges at Owls Head. These bogs identifiable by the occurrence of a wetland peat deposit in a depression and the abundance of wetland indicator species as pictured (for example: *Eriophorum* spp.)

Salt marsh -

We incidentally noted the presence of salt marsh wetland in mineral sediment associated with shallow tidal flats anchored between rock exposures in the sheltered environment of Long Cove. These locations were outside the extent of our study design, thus we have no additional data on their species composition or extent on the property.

CONNECTIVITY OF WETLANDS:

Air photos reveal the presence of streams and depressions with open water that connect wetlands at Owls Head. Given the presence of these open streams, the relative elevations on the property, and the wide distribution of wetlands across Owls Head, it is reasonable to assume that wetlands are interconnected across the property and adjacent privately owned lands. For example, the mapped bog wetland on adjacent private lands to the southwest (9.9ha as mapped, figure 1) is likely to be interconnected with hydrology of crown lands of the subject property.

BIODIVERSITY OF WETLANDS:

Species richness within our nine 1x1m wetland sample plots ranged from 3 to 21 unique species. The average species richness of these wetland sample plots is 15. The single plot that had less than 12 species also featured a substantial area of exposed rock. Our study did not identify lichen and bryophyte species meaning the total species richness of flora within each sample plot is underestimated.

LIMITED OCCURRENCE OF GRASS AND GRASS-LIKE PLANT SPECIES PRESENT AT OWLS HEAD

Table 1. Graminoid (grass, sedge, rush) species found at Owls Head, their frequency of occurrence at the site (# plots occurred within), associated habitat and notes relevant to interpretation of their presence at the site.

species	# plots	habitat	relevant notes
<i>Ammophila brevigulata</i>	4	beach	specialist of sandy beaches
<i>Deschampsia flexuosa</i>	1	barrens	
<i>Juncus balticus</i>	1	wetlands	facultative wetland species
<i>Poa compressa</i>	1	disturbed area	
<i>Phleum pratense</i>	1	disturbed area	
<i>Carex stricta</i>	1	bog	obligate wetland species
<i>Carex nigra</i>	1	bog	facultative wetland species
<i>Eriophorum vaginatum</i>	1	bog	obligate wetland species
<i>Carex exilis</i>	2	wetland	obligate wetland species
unidentified grass specimen	1	beach	? <i>Spartina pectinata</i>

Summary: Our data reveal the site supports a limited abundance and distribution of grass and grass-like plant species. With the exception of one sample plot, grass-like species found in our study are specialists of wetland, barren and beach habitats.

Specifically: Our data revealed the presence of ten (10) graminoids (grass-like plant species) present at Owls Head. Of these ten species, three are known from upland (non-wetland, non-beach) habitats. Of these three species, two (*Poa compressa* and *Phleum pratense*) were found in the same sample plot in a small disturbed area near the shoreline of the site. This location is the only area on site we observed that supported grasses associated with lawns or old field habitats. The third upland grass species we identified, *Deschampsia flexuosa*, is a common plant on coastal barrens. At Owls Head, it was documented within one sample plot. Additional grass-like species include *Ammophila brevigulata*, a specialist of sandy dunes and beaches, and several sedges and rushes of wetlands habitats. One grass specimen was collected from a beach habitat but this specimen was misplaced. Our field notes mention presence of the tidal wetland species *Sporobolus michauxianus* (*Spartina pectinata*), but this species was not present in our data. Our field notes did not include incidental observations of any additional graminoid species.

Since we did not survey the entirety of the property, this may not be a complete inventory. However, we believe it to be an adequate representation of the graminoid flora present at the site and are not aware of other data that would suggest the presence of habitat suitable for turf-forming or non-specialist grass species elsewhere at Owls Head. Air photos reveal habitat is continuous across the property.

GLOBALLY RARE PLANT COMMUNITY

Owls Head Provincial Park Reserve supports Coastal Broom Crowberry heathland. This plant community occurs widely on the bedrock ridges across the subject crown lands property and adjacent privately-owned lands. This is a globally rare plant community is notable of the eastern shore ecoregion (Neily et al 2017; Porter et al. unpublished).

The dwarf, trailing shrub called Broom Crowberry (*Corema conradii*) that predominates the flora of these heaths is an endemic species to northeastern North America, meaning this species can be found nowhere else in the world. In Canada, this plant only occurs within the maritime provinces and Quebec and within that limited range, Broom Crowberry is only common in Nova Scotia.

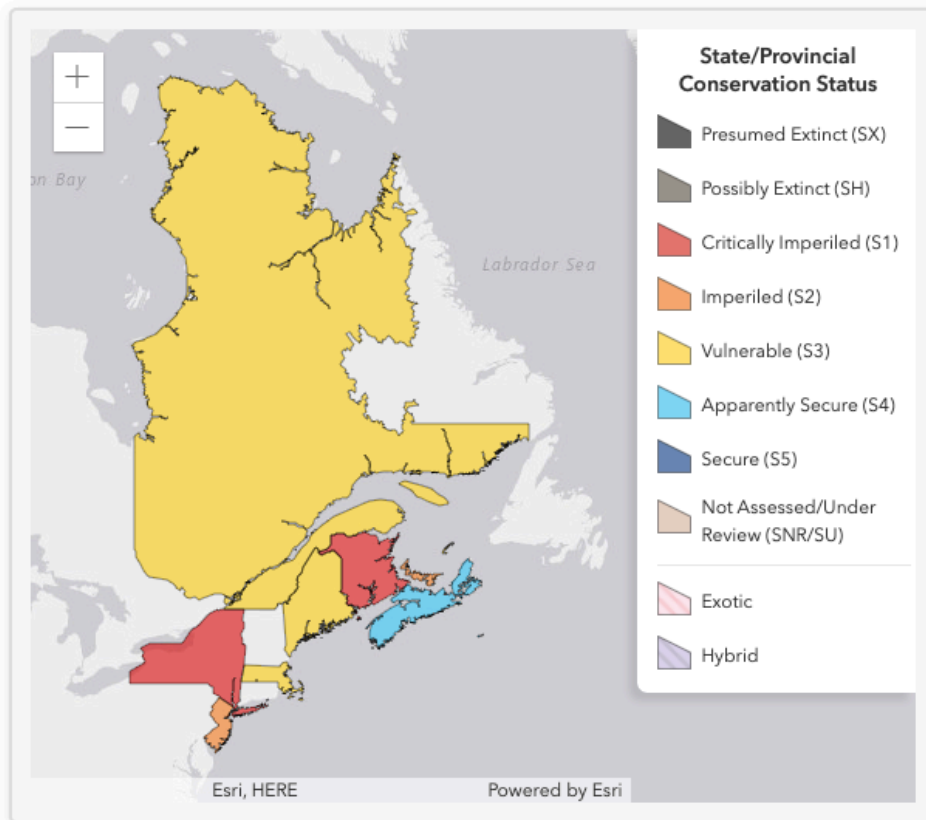


Figure 5. Global distribution of the species Broom Crowberry, map from Natureserve (2020). Broom Crowberry as a species is rare throughout this limited range, with the exception of Nova Scotia. Within Nova Scotia, it is not common on coastal barrens. It is better known from inland habitats such as sand barrens. The coastal broom crowberry community present at Owls Head is not found elsewhere in Canada outside of Nova Scotia and we are not aware of any literature or research to suggest it would be present in any American states. We provide a map of the dominant species distribution because there is currently no map for the distribution of this plant community.



Figure 6. Shallow soils on the bedrock ridges at Owls Head support the Globally Rare Broom Crowberry Coastal Dwarf Heathland plant community. This plant community is distributed across the entirety of Owls Head crown lands.

EELGRASS

The marine environment around Owls Head supports meadows of eelgrass. Eelgrass is formally considered an Ecologically Important Species (ESS) for its functional role in protecting shorelines and supporting marine biodiversity. Eelgrass requires pristine water conditions and is not tolerant of nutrient pollution. (DFO 2009)


CONCLUSIONS:

1. Soil depths at Owls Head rarely exceed 25cm (with the exception of deep wetland peat deposits). There is a limited capacity for the site to support any grass species at present. The sensitive and widespread coastal Broom Crowberry heaths at Owls Head are also associated with shallow soil conditions. In order for the site to support any turf forming grass species associated with a golf course, soils would be needed. Introduction of soils to this site would significantly alter the ecosystem of Owls Head. Addition of soils to the site would irreversibly alter the site in its entirety. Addition of soils to the site would directly destroy vegetation by either smothering or excavation of surficial materials, and/or indirectly destroy vegetation communities by establishing an environment capable of supporting deeper-rooting plant species that would out-compete barrens vegetation.
2. All of the ecosystems present at Owls Head are characterized as nutrient-poor ecosystems. Bogs, Barrens and eelgrass beds are characterized by species adapted to the nutrient conditions currently present. Golf courses require the use of fertilizers. Introduction of nutrients to this environment would lead to the loss of plant species and communities associated with the nutrient-poor environment. Nutrient runoff from fertilizers is also widely known to result in the destruction of eelgrass meadows in the marine environment (e.g., see DFO 2009). Given the low elevation, shallow bedrock, long coastline, and widespread wetlands on the property it seems unlikely that traditional mitigation strategies (e.g. silt curtains) would be feasible or effective at preventing runoff siltation and/or nutrient deposition.
3. Owls Head features widespread wetlands. A golf course development at this site would seem to conflict with Nova Scotia's Wetland Conservation Policy, in that it would lead to (1) unavoidable loss of wetlands, and (2) loss of wetlands of special significance, which include (a) salt marsh, and (b) biodiverse wetlands.
4. If it is the case that Piping Plover nest on the beaches of Owls Head as was reported by Nova Scotia Department of Environment, Protected Areas Branch, in summaries of the conservation values of this site, the construction and use phase of any development at this site are likely to interact with the critical habitat of this federally listed species at risk. A Federal environmental assessment would be necessary to determine impacts to Piping Plover. We conducted no survey of avifauna present at the site but are aware the adjacent protected lands within the Eastern Shore Wilderness Area and 100 Wild Islands conservation lands are of great ecological importance for many bird species and as well these species are sensitive to anthropogenic disturbances such as the increased presence of people (noise, lights etc.) within their habitat.
5. Coastal Barrens in Nova Scotia in general cannot be considered low-diversity ecosystems (Oberndorfer and Lundholm 2009; Cameron and Bondrup - Neilsen 2013, Porter 2013). This site specifically cannot reasonably be considered to be low in biodiversity.
6. Given the landscape pattern of repeating bedrock ridges, the sensitive wetland and coastal Broom Crowberry heath features are distributed across its entirety. Thus, interactions between the environment and a development would cause unavoidable damage. We expect that a development at this site would entirely destroy the ecological values of the site.

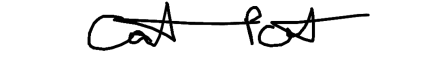
In our opinion, the sale of the Owls Head Crown land property to a private golf course developer would destroy this ecologically important habitat if the developer carries out his proposal for the golf courses. The topography and geology of Owls Head is such that developing the proposed three golf courses on this property would require massive earthworks, which will destroy the native plant communities occurring on the property.

In the event that the purchaser of the Owls Head Crown land does not build golf courses on this land, we remain concerned that the sale of the land, in and of itself, removes the Province's ability to conserve the ecologically critical plant communities on this property and to allow for continued study of this property's unique biodiversity.

Signed this 23d ___ day of _March, 2020



Jeremy Lundholm, PhD



Caitlin Porter, MSc

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Peer-reviewed publications by authors.

We, Jeremy Lundholm and Caitlin Porter have worked to study the ecology of barrens in Nova Scotia for 15 and 10 years respectively. Our CVs are attached and we provide a list of relevant peer-reviewed publications below.

2020

In addition to the following peer-reviewed published works, we have recently completed a technical report on the plant communities of barrens in Nova Scotia, in collaboration with Provincial scientists. This work is largely complete but is currently being formatted for publication and has not yet been publicly released. It represents research conducted over a period of ten years and survey of nearly 200 barrens study sites in Nova Scotia. We believe this ongoing project demonstrates our expertise on the subject matter contained within this report.

Porter, C., Basquill, S., Lundholm, J. Classification of Heathlands and Related Plant Communities On Barrens Ecosystems in Nova Scotia. Unpublished Data (Tech Report in prep).

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