A Provisional Survey of the Macrofungi on Sand Dunes in Prince Edward Island National Park: Three years of observations

2023-2024 Research Report prepared for Parks Canada
Permit #PEINP-2023-45320
April 12, 2025
By Ken Sanderson

Abstract
This report documents a survey of macrofungal diversity in the sand dunes of Prince Edward Island National Park (PEINP), Canada, conducted between 2022 and 2024. A total of 43 species were recorded, including an undescribed *Russula 'sp-IN118'* species previously observed in Kouchibouguac National Park and several other potentially novel taxa. The study highlights the ecological role of fungi in stabilizing dune ecosystems, their associations with key plant species (e.g., *Hudsonia tomentosa* and *Ammophila breviligulata*), and the impact of disturbances such as Hurricane Fiona (2022) on fungal communities. Notably, 27 species appear to be dune specialists, while 16 are generalists. Molecular data and morphological analyses support the identification of unique taxa, including a distinct *Melanoleuca* species and coastal variants of *Laccaria* and *Hygrocybe*. This work lays a foundation for understanding fungal diversity in coastal sand dunes and highlights the potential value of integrating mycological data into coastal management strategies. The report underscores the need for further research to describe new species, assess rarity, and evaluate conservation priorities in these dynamic habitats.

Introduction
Prince Edward Island National Park (PEINP) consists of more than 26 km^2 of the north shore of PEI, including 7 km^2 of sand dunes (PEI, 2010), representing approximately 26% of the national park. Very little is known of the fungal diversity of these sand dunes despite fungi playing a crucial role in the survival, establishment, and growth of plants in coastal sand dunes. Fungi can benefit host plants by quickly exploiting nutrients in freshly buried sand, transferring nutrients, increasing soil aggregation, reducing water stress, increasing tolerance to salinity and salt spray, and transferring carbon between plants (Maun, 2009).

Previously documented inventories list 1265 fungi species for Nova Scotia, 537 for New Brunswick, and 75 for PEI (Malloch, 2010). More recently the 2020 Wild Species Report (Canadian Endangered Species Conservation Council, 2022) listed 92 macrofungi species for PEI, with only one sand dune macrofungus, *Laccaria trullissata*, a common fungus associated with *Hudsonia tomentosa* (Woolly Beachheather) (Redhead, 1989).

Although not included in inventories, several sand dune fungi have been identified on PEI by visiting mycologists. In September of 1994, Dr. Scott Redhead visited the sand dunes at Greenwich and documented four sand dune species, *Astraeus smithii*, *Leccinum arenicola*, *Laccaria trullisata*, and an undescribed white *Russula* (Redhead, 2022). In September of 2009, Dr. David Malloch visited sand dunes on Hog Island and Red Point and documented five sand dune species, *Inocybe cf serotina*, *Inocybe* sp., *Laccaria trullissata*, *Leccinum arenicola*, and *Scleroderma* sp. (Malloch, 2022).

Coastal Sand Dune Habitat Classification
Coastal sand dunes are dynamic, heterogeneous ecosystems composed of diverse microhabitats, each hosting distinct fungal communities. These habitats often overlap and interact in complex ways, making clear boundaries between them difficult to define. The following classifications are based on their associations with different fungi.

Foredunes

The foredune extends from the shoreline to the first parallel dune ridge. This dynamic zone is shaped by wind-driven sand movement and salt spray, with *Ammophila breviligulata* (American Marram Grass) as the dominant vegetation.

Yellow Dunes

Located inland from the foredune, yellow dunes mark a transitional zone toward greater stability. Primarily dominated by *Ammophila breviligulata* (American Marram Grass), they also feature patches of *Morella pensylvanica* (Northern Bayberry), whose dense thickets create sheltered microhabitats for specialized species.

Green Dunes

Green dunes are semi-stabilized areas still influenced by shifting sands. They are primarily vegetated by *Hudsonia tomentosa* (Woolly Beachheather).

Grey Dunes

Grey dunes represent stable, lichen-dominated zones with a dense cover of *Cladonia* spp. (Reindeer Lichens), alongside *Hudsonia*, *Empetrum* (Crowberries), and *Arctostaphylos uva-ursi* (Bearberry).

Heath Dunes

Heath dunes are defined by heath-forming shrubs, including *Empetrum* (Crowberries), *Arctostaphylos uva-ursi* (Bearberry), *Vaccinium* spp. (Blueberries), *Corema conradii* (Broom Crowberry), and *Hudsonia ericoides* (Pine Barren Goldenheather).

Dune Slacks

Low-lying depressions with intermittent moisture, dune slacks host diverse flora such as Vaccinium oxycoccos (Bog Cranberry) and Morella pensylvanica (Northern Bayberry). This inventory focused specifically on their edges, rather than the full extent of these habitats.

Forested Dunes

Forested dunes are older, stabilized dunes colonized by woodland species. Though not a focus of this study, this inventory documented incidental finds on the forest edge.

This survey aimed to enhance understanding of the diversity, distribution, and phenology of macrofungi on sand dunes. The report consolidates findings from two permits, PEINP-2023-45320 and PEINP-2022-41698, and provides a comprehensive summary of the species observed, their locations, and habitat. Key highlights include notable discoveries that contribute to the broader knowledge of macrofungi in this unique habitat and offers recommendations for future research.

Methods

Study Period and Context

This survey was conducted primarily between April 13, 2022, and December 15, 2024. Observations from fall 2021 were included to account for Hurricane Fiona's impact on foredune conditions in 2022.

Site Selection and Survey Design

To identify suitable locations for surveying green and grey dunes, we targeted areas with documented presence of *Hudsonia tomentosa* (Woolly Beachheather), an ectomycorrhizal species indicative of stable dunes (Malloch and Thorn, 1985). These areas were mapped (Fig. 1) using spatial data from the Atlantic Canada Conservation Data Centre (AC CDC, 2022). Foredune locations were identified using Government of PEI aerial imagery (Gov PEI, 2020). Fieldwork employed an intelligent meander survey method (Selva, 2003), focusing on appropriate habitats, seasonality and rain events.

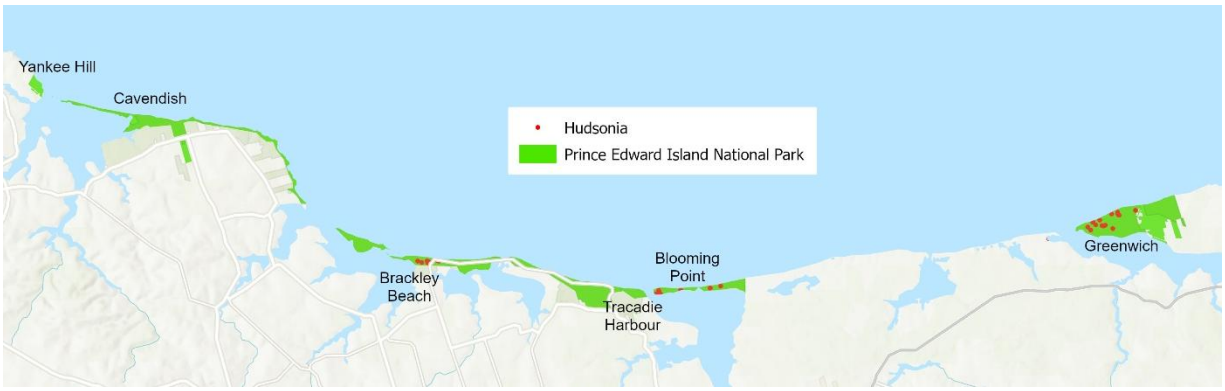

Figure 1. Map illustrating presence of Woolly Beachheather (*Hudsonia tomentosa*) in Prince Edward Island National Park.

Surveyed Sites

Cavendish consists primarily of foredune habitat, including dune scarps (eroded front), embryo dunes, and wash-overs. Yellow dune habitat dominates the leeward side of the dune. Survey effort was concentrated within the first kilometre from the campground access point.

Brackley Beach supports a cluster of stable dunes south of Robinsons Island Road and west of the parking lot. The dune immediately west of the parking lot is a green dune, while smaller southern dunes qualify as grey dunes. A larger, active dune farther west lacks *Hudsonia tomentosa*.

Tracadie Harbour encompasses an extensive foredune system between Darnley and Tracadie Harbour, bordered by a narrow yellow dune on the leeward side. The isolated Tracadie 'Island' to the east contains well-developed yellow and green dune habitats and a small patched of forested dune.

Greenwich exhibits the highest microhabitat diversity, including foredunes, yellow dunes, green dunes, dune slacks, and forested dunes. Primary survey efforts targeted the large parabolic dune north of the Tlaqatik Trail.

Blooming Point is dominated by yellow dunes with a sparse foredune zone. Historically connected to Tracadie "Island," this site had prior records of *Hudsonia tomentosa*, but none were observed during recent surveys.

Yankee Hill is composed mainly of foredune habitat with a limited yellow dune fringe.

Data Collection and Documentation

All observations were recorded via iNaturalist, including:

- Geographic location and date
- Habitat classification
- Photographic documentation
- Morphological/microscopic characteristics (where applicable)
- DNA sequences and related data

Collected specimens were processed for spore prints, dehydrated, and preserved for deposition at the New Brunswick Museum herbarium or DNA sequencing at the Mycota Lab in Michigan.

Results

Between 2022 and 2024, six sites were surveyed 87 times (Table 1), covering a total of 275 kilometers and requiring approximately 170 hours of fieldwork. Additionally, an estimated six visits to Cavendish were conducted in the fall of 2021. Blooming Point was surveyed only once due to damage caused by Hurricane Fiona. Robinsons Island was not included in the sites list as no observations were recorded during 3 visits in 2022. Robinson Island dunes underwent significant re-shaping due to the hurricane and was not visited in 2023 or 2024 to allow more time to recover before further surveying.

Table 1. Number of site visits conducted between April 2022 and December 2024.

Site	2022	2023	2024
Yankee Hill	14	10	8
Cavendish	8	1	3
Greenwich	6	5	6
Tracadie Harbour	5	5	3
Blooming Point	0	1	0
Brackley Beach	4	3	2

As of December 2024, 43 species were observed within Prince Edward Island National Park (PEINP). Preliminary analyses suggest 27 of these species are likely dune specialists (Table 2), while the remaining 16 appear to be habitat generalists (Table 3).

Provisional names have been applied to many species in Tables 2 and 3, reflecting uncertain identity, potential novelty, or the need for further taxonomic study. These temporary designations are documented in MycoMap, where they are linked to supporting DNA sequence data, geographic distribution records, and future taxonomic revisions. This integrated approach enables researchers to concurrently evaluate genetic evidence, occurrence patterns, and ecological context as these taxa undergo formal classification.

Table 2. Annotated list of coastal dune specialist species observed during surveys conducted in fall 2021 and between April 2022 and December 2024 in PEINP.

Species	Location	Habitat	Notes
Peziza ammophila (Dune tulip)	Common foredune species	foredune	
Psathyrella ammophila (Dune cap)	Common foredune species	foredune	The most common and hardy foredune species.
Melanoleuca 'cinereifolia-PEI01' (Dune Cavalier)	Cavendish, Yankee Hill	foredune	The Cavendish location was destroyed by Hurricane Fiona.
Agaricus bisporus (Common Button)	Cavendish	foredune	This could be an introduced population from cultivation or an uncommon native population.
Coprinopsis 'sp-PEI01'	Cavendish, Yankee Hill	foredune	Likely an undescribed species.
Crepidotus sp	Cavendish	yellow dune	Expected to receive a provisional name pending DNA sequencing. Found growing on *Ammophila breviligulata* stems.
Mycena sp. (bayberry)	Yankee Hill	yellow dune	DNA sequence results pending.
Collybiopsis 'hasanskyensis PNW01'	Yankee Hill	yellow dune	Grows on *Ammophila breviligulata* stems. Shares a provisional name with several closely related species.
Coprinellus 'sp-PEI01'	Yankee Hill	yellow dune	Observed twice in 2022; no further records since.
Marasmius 'sp-PEI01'	Yankee Hill, Greenwich, Tracadie Harbour, Blooming Point	yellow dune	Potentially a coastal species rather than dune specific.
Hygrocybe 'sp-PEI01'	Greenwich	yellow dune	North American variant of *Hygrocybe conicoides*
Mutinus 'elegans-PE01'	Greenwich	yellow dune	Dune specificity still under evaluation.

Laccaria trichodermophora	Greenwich	yellow and green dune	Occurs with or without *Hudsonia tomentosa*. Current name will likely be revised to a provisional designation based on new data.
Laccaria trullisata	Brackley Beach, Greenwich, Tracadie Harbour	green dune	Fruiting begins mid-August, unlike *L. trichodermorpha* (mid-September), and is associated with *Hudsonia tomentosa*.
Astraeus smithii (Earthstar)	Brackley Beach, Greenwich, Tracadie Harbour	green dune	Primarily fruits in fall, but wind-dispersed persistent fruiting bodies can be found year-round.
Cortinarius impolitus	Brackley Beach	green dune	Provisional name shared with closely related species; subject to revision.
Cortinarius psammocola	Brackley Beach, Greenwich, Tracadie Harbour	green dune	
Hebeloma sordidulum	Brackley Beach, Greenwich, Tracadie Harbour	green dune	
Cortinarius 'sp-MA02'	Greenwich	green dune	First recorded in 2024; also known from Cape Cod, Massachusetts dunes.
Cortinarius 'sp-PEI02' (Dermocybe)	Greenwich	green dune	Likely an undescribed species; specimens under review by *Dermocybe* expert.
Discinella 'sp-PE01'	Greenwich	green dune	Two known populations at Greenwich.
Lactarius pubescens	Greenwich, Tracadie Harbour	green dune	
Thelephora 'terrestris-PEI01'	Greenwich	green dune	Patchy distribution but frequently found on *Hudsonia tomentosa*.
Russula 'sp-IN118'	Tracadie Harbour	green dune	Only observed on dunes supporting *Lechea maritima*. Provisional name shared with related species; specimens and DNA data sent to an expert for analysis.
Hygrocybe substrangulata	Greenwich	dune slack	Likely not dune-specific; further study required.
Leccinum arenicola	Greenwich, Tracadie Harbour	green, grey, and heath dune	
Rhodocybe 'tugrulii-NB01'	Brackley Beach	grey dune	

Table 3. Annotated list of generalist species observed on coastal sand dunes during surveys conducted in fall 2021 and between April 2022 and December 2024 in PEINP.

Species	**Location**
Alloclavaria purpurea	Greenwich

Amanita muscaria guessowii	Greenwich
Bovista 'aestivalis-IN01'	Yankee Hill
Crucibulum laeve	Cavendish, Yankee Hill, Greenwich, Tracadie Harbour
Cyathus stercoreus	Yankee Hill, Tracadie Harbour
Gymnopus perforans subsp. Transatlanticus	Greenwich
*Leccinum sp. (*spruce)	Greenwich
Leccinum 'sp-IN02'	Greenwich
Leccinum 'sp-NJ01'	Greenwich
Marasmius oreades	Yankee Hill
Marasmius wettsteinii	Yankee Hill
Mycena filopes	Yankee Hill
Mycena sp. (spruce)	Greenwich
Pleurotus sp	Yankee Hill
Rickenella fibula	Greenwich
Russula (greenish)	Yankee Hill

Discussion

Surveying macrofungi is challenging due to specific fruiting seasons, moisture requirements, and the short lifespan of sporocarps (fruiting bodies). This is further complicated by a lack of knowledge on species diversity and their phenology. The 2022 field season presented significant challenges due to unusually dry conditions, with prolonged periods between rainfall events that hindered optimal fungal fruiting. Compounding these difficulties, Hurricane Fiona struck during the peak of the fruiting season, causing extensive damage to the dunes, restricting access to study sites, and likely reducing the diversity of fungi observed. Similarly, the 2024 season was affected by a persistent drought that extended through late summer and fall, with substantial rains only arriving in November, further limiting fungal activity and diversity during the critical fruiting period.

Foredune species also seemed specific to their habitat requirements, with fruiting more common closer to the leading edge of *Ammophila breviligulata* growth than further back from the shore. This is likely due to the reduced vigor of *Ammophila breviligulata* as sand accretion is reduced and the importance of the nutrients from salt spray (Maun, 2009). Dune scarps significantly reduce available habitat for foredune species of fungi unless the dune scarps are low. Embryo dunes and washovers tend to provide more favorable habitat as demonstrated by Cavendish.

Given a lack of other alternatives, *Hudsonia tomentosa* and *Lechea maritima* are the presumed ectomycorrizhal partners to many different fungi in stable dunes. Not all *Hudsonia* seem to be acceptable given that the old, forested dune ridge in Greenwich, that crosses the Greenwich Dunes Trail and terminates at the parabolic dune, has many smaller *Hudsonia* patches and open sand, yet none of the dune fungi fruiting on the parabolic dune were found in this habitat. *Hudsonia tomentosa*, with its extensive root system could act as a fungal nursery of sorts to *Lechea maritima*, which has a much smaller root system. *Lechea*, like the smaller patches of *Hudsonia*, may not be able to support robust

fungal partnerships independently, but could take advantage of a fungal population already being supported by *Hudsonia*. *Arctostaphylos uva-ursi, Empetrum spp,* and *Vaccinium spp.* are also associated with one or more species of fungi.

Most green dune species seemed to prefer fruiting in the exposed sandy spaces adjacent to *Hudsonia*. *Leccinum arenoicola* were mainly observed growing in the thick of their ectomycorrhizal partner, as was *Thelephora 'terrestris-PEI01'*, suggesting a preference for that location. *Hygrocybe 'sp-PEI01'*, likely a saprotrophic fungus, was observed near or far from *Hudsonia*, both in yellow and green dune habitats, but only in more stable dune habitat. *Laccaria trichodermorpha* will grow in open sand near *Hudsonia*, or just with *Ammophila breviligulata*.

Hurricane Fiona (September 17, 2022) significantly damaged the coastal sand dunes across PEI. While this greatly impacted the survey effort it also provided an opportunity to observe how different species responded to this impact. Six weeks after Fiona, on November 6th, nine *Psathyrella ammophila* were observed on the South Rustico embryo dune. These were the only foredune fungi observed post Hurricane Fiona in 2022. In 2023, *Psathyrella ammophila* was patchy, but prolific, in its previously known locations, but was typically further back on the foredune then previously observed. *Peziza ammophila, Melanoleuca 'cinereifolia-PEI01'* and *Agaricus bisporus* were not observed again until 2024. *Coprinopsis 'sp-PEI01'* did fruit in 2023 and 2024 but has remained sparse and patchy compared to its original distribution. *Coprinellus 'sp-PEI01'* has not been observed since Hurricane Fiona.

Hurricane Fiona also breached the interior dune at Tracadie Harbour, allowing storm surge to flood large patches of *Hudsonia tomentosa*. In 2024 these patches have only just started to recover, and few fungi have been observed in these areas.

As fungal diversity is poorly understood, it is hard to determine which species are rare or uncommon. There were, however, many interesting discoveries, and ultimately more questions, with each species observed. Here are some of the highlights:

- There are four or more *Laccaria* spp. that can be found on coastal sand dunes. *Laccaria trullisata* has very distinct spores, but *Laccaria trichodermorpha* and the other species are harder to separate.
- *Melanoleuca 'cinereifolia-PEI01'* is a different species than its European counterpart and needs to be described. It is currently only recorded on PEI.
- An undescribed *Russula* sp., first found in Kouchibouguac National Park in 1981, was documented in PEINP on the stable dunes at Tracadie 'Island'.
- *Agaricus bisporus*, the common white button mushroom found in grocery stores, is growing wild on sand dunes at Cavendish.
- Twelve of the dune specialists were first DNA sequenced from PEI and half of those have not been found elsewhere.

In the 2022-2024 seasons 100 species of macrofungi were observed on the sand dunes of PEI. Future effort in surveying both foredune and stable dune habitat in PEINP will undoubtedly document more of

these species, and others yet to be discovered. Pituamkek National Park Reserve has more heath and grey dune habitat than in PEINP.

Priorities for next year's survey:

- Locate undescribed white *Russula* sp. observed in 1994 in Greenwich. More specimens are required to describe species and DNA sequence.
- Survey foredunes of Greenwich, Blooming Point and Robinson's Island.
- Survey the forested dune ridge at Greenwich in more detail.
- Continue to document changes to fungi in response to Hurricane Fiona damage.

Literature Cited

AC CDC, 2022. Maritimes Hudsonia species locations from the Atlantic Canada Conservation Data Centre.

Canadian Endangered Species Conservation Council, 2022. Wild Species 2020: The General Status of Species in Canada.

Gov PEI, 2020. Prince Edward Island Orthomap 2020.

Malloch, D., 2022. Personal communication on dune fungi on Prince Edward Island.

Malloch, D., 2010. Fleshy fungi (Basidiomycota) of the Atlantic Maritime Ecozone. In Assessment of Species Diversity in the Atlantic Maritime Ecozone. NRC Research Press, Ottawa, Canada., 107–151.

Malloch, D., Thorn, R.G., 1985. The occurrence of ectomycorrhizae in some species of Cistaceae in North America. Can. J. Bot. 63, 872–875. https://doi.org/10.1139/b85-113

Maun, M.A., 2009. The biology of coastal sand dunes. Oxford University Press, Oxford ; New York.

PEI, 2010. Corporate Landuse Inventory 2010.

Redhead, S.A., 1989. A biogeographical overview of the Canadian mushroom flora. Can. J. Bot. 67, 3003–3062. https://doi.org/10.1139/b89-384

Selva, S.B., 2003. Using calicioid lichens and fungi to assess ecological continuity in the Acadian Forest Ecoregion of the Canadian Maritimes. For. Chron. 79, 550–558. https://doi.org/10.5558/tfc79550-3