

Coastal Shores and Wetland Ecosystems in the Northern Appalachian / Acadian Ecoregion

(final draft Anderson 3/31/06)

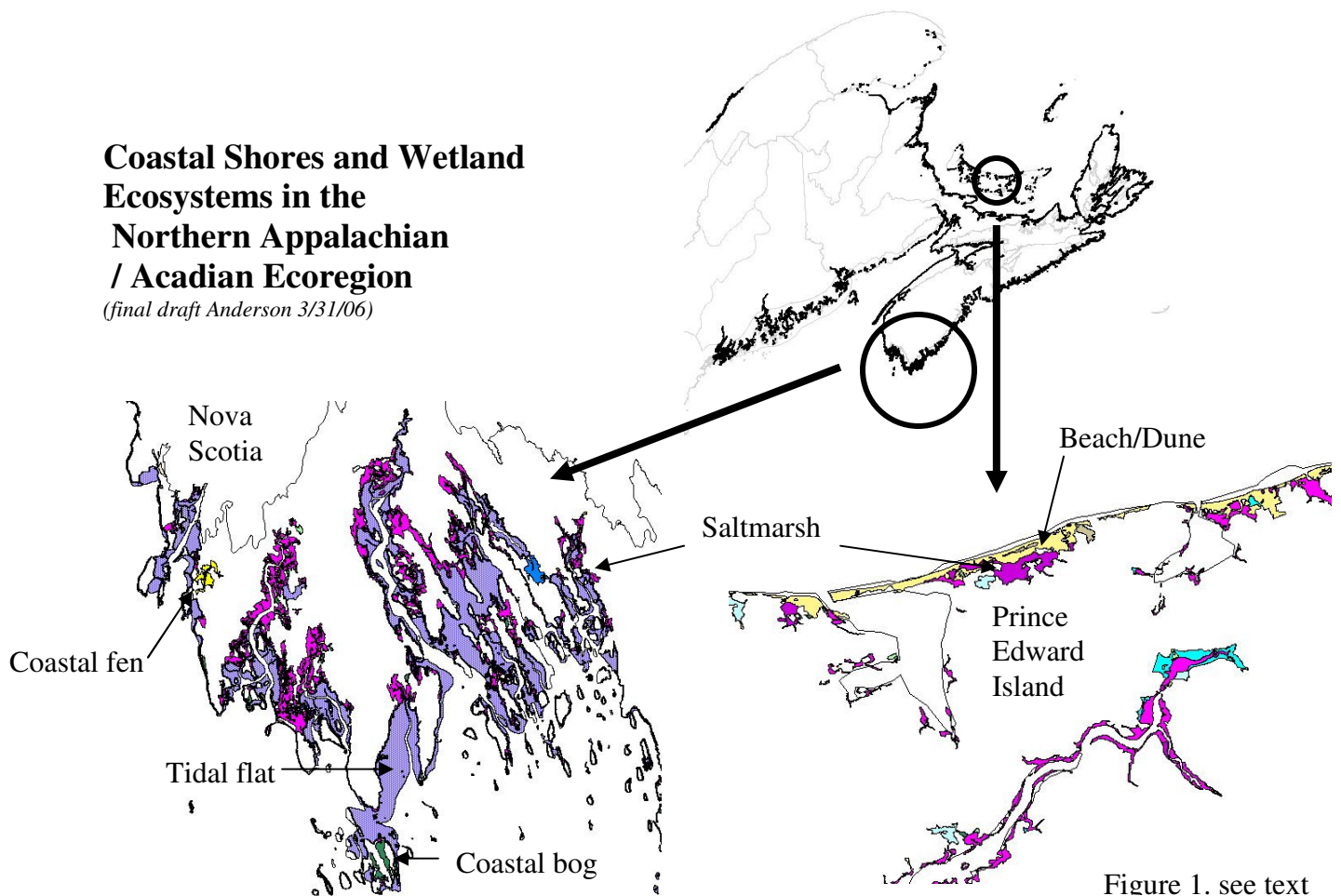


Figure 1. see text

The coastline of the Northern Appalachian /Acadian ecoregion extends for 7,453 miles¹ and is rich with almost 24,000 examples of beaches, salt marshes, tidal flats and distinctive rocky shores. Although coastal wetlands and shores cover less than 1% of the ecoregion (926,664 acres -Table 1) they are one of the most critical habitats in the region for biodiversity. Their importance to rare species, shore birds, and offshore fisheries is well known but population trends and conservation needs of the thousands of specialized organisms, (crabs, shellfish, amphipods and other macro/micro invertebrates) are not clearly understood.

The distribution of coastal features within the ecoregion is correlated with shoreline orientation, exposure and complexity and tidal range. The complicated south-facing shorelines of Maine and Nova Scotia have extensive tidal flats and salt marshes tucked into nearly every cove and harbor (Figure 1). In contrast, the simpler shorelines that flank the Bay of Fundy have fewer examples of these features but terminate with massive tidal flats in the Cobequid Bay and Minas Basin region reflecting a tidal range that is the largest in the world. The east facing shores of New Brunswick and PEI have extensive barrier beaches and dunes while Quebec's beaches and dunes are almost entirely located on the Magdalen Islands. (Table 1, Figure 2).

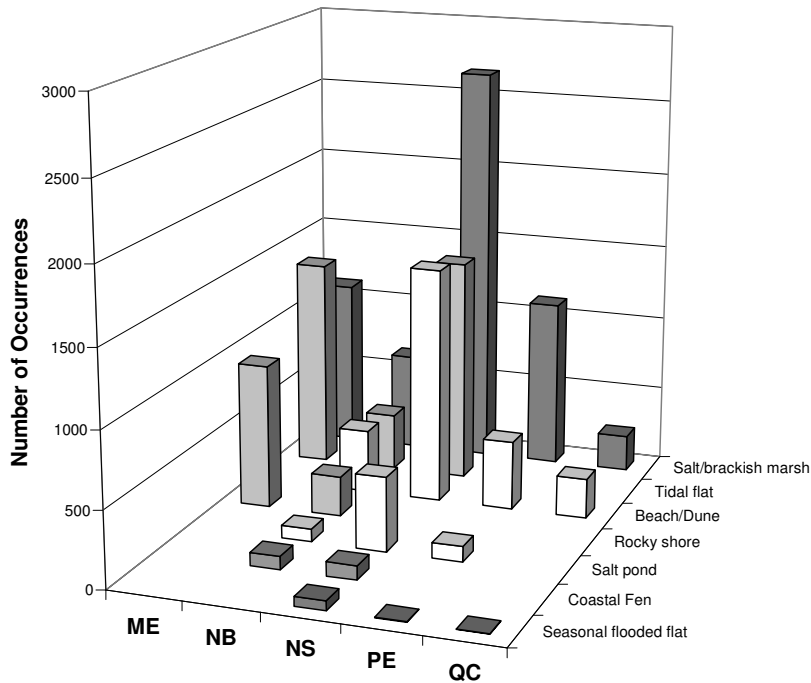
¹ Including the coastline of Prince Edward Island and the Magdalen Islands

Table 1. The amount and size of coastal features within the ecoregion (features under 2 acres are excluded).

Coastal Features	Count	Total Acres	Ave. Size	Min	Max	AV ME	AV NB	AV NS	AV PE	AV QC
Coastal Shores										
Beach/Dune	2,745	47,992	17	0.1	1,095		24	10	19	48
Rocky Shore & Cliff	1,892	15,718	25	0.0	407	3	21	18		
Coastal Wetlands										
Coastal Bog	706	51,513	73	0.1	5,077	?	220	48	58	57
Salt pond	674	16,016	24	0.1	715		31	23	23	
Salt/brackish marsh	6,818	138,384	20	0.0	4,427	6	38	16	15	143
Misc. fresh wetlands	3,409	34,534	101	0.0	749	6	40	67	5	2
Tidal flat	4,039	596,898	148	0.0	49,404	25	114	329		
Aquatic bed	3,469	25,330	7	0.1	205	7	29			
Grand Total	23,950	926,644	39	0.0	49,404	9	52	77	15	90

(Final numbers are in D/NAP/targets/models/90m/coastal/wetnap_cst705.xls
It contains integrated USCANADA data as well as US and Canada separate columns)

Figure 1. The distribution of coastal features by state and province.



Biodiversity and Coastal features

The coastal zone extends landward from the submerged aquatic beds just beyond the low tide line to the terrestrial margin where headlands, cliffs and dunes are found. The latter zone is marked by a definite change in material, physiographic form or a line of permanent vegetation, indicating the limit of the highest storm waves. Ecologists group the coastal shore and wetland features into a number of broadly defined ecosystem types based on structure, processes and composition as described below.

Coastal Shores

Headlands, Cliffs and Rocky shores: The rockbound coast of the ecoregion consists of bedrock shores punctuated by sandy interludes of beaches and dunes. Headlands with steep cliff faces jutting out into the sea are common. Subject to salt spray and wave pounding, headlands can be dramatic features while the related horizontal intertidal zone is the haven of algae, barnacles, snails and limpets. Coastal cliffs and isolated rocky islands are the preferred nesting habitat of black guillemot, black-legged kittiwake, razorbill and common murre. The lower shore zone subject to long periods of tidal inundation forms the habitat of rockweeds and brown seaweeds, mussels and Irish moss.

Mapped examples of rocky shores and cliffs total to 904 miles of linear shoreline. Occurring in almost 2,000 distinct narrow segments averaging 25 acres in area, rocky shoreline is most abundant in areas of granite or mafic bedrock but may be found throughout the coastal region.

Unconsolidated Beach and Dune Complexes: - Beaches are thick accumulations of unconsolidated water-borne, well-sorted sand and pebbles deposited on a shore, or in active transit along it. Dunes are transient mounds of loose, windblown sand, sometimes stabilized with vegetation. Beaches and dunes are ecologically linked but form distinct habitats, the former being periodically inundated and the latter dry and distinguished by vegetation adapted to constant sand burial. Typical plant species of beaches and dunes include: beach grass, sea rocket, sea-beach sandwort, seaside spurge, dusty miller, sea oats, seaside goldenrod, beach heather and bayberry. Although several of these species have wide ranges along the Atlantic coast they are otherwise narrowly restricted to this extremely specific and uncommon habitat. Beach nesting birds such as plovers and terns rely on exposed scrapes and isolation to prevent predation by mammals and other birds. Many are in decline due to loss of breeding habitat.

Beaches cover almost 2249 miles of coast, although contiguous examples are small with two-thirds of the 2745 beach/dune occurrences being less than 10 acres in extent and 82% covering less than 20 acres. In several places, elongate barrier beaches have formed that parallel the shoreline but remain separated from it by a lagoon or marsh. Hog Island, a 1,100 acre barrier beach of Prince Edward Island boasts piping plovers, common terns, beach pinweed and broom crowberry, and is the largest example in the ecoregion.

Coastal Wetlands and Marshes

Tidal flat – Tidal flats are extensive, horizontal tracts of unconsolidated clays, silts, sands and organic materials that are alternately covered and uncovered by the tide. Most are sparsely vegetated but during low tide, shorebirds congregate in tidal flats, sometimes in vast numbers, to feast on their abundant burrowing invertebrates. Tidal flats make up 64% of the coastal wetlands mapped in the ecoregion. The largest example, 49,000 acres in the Minas Basin, is a huge and globally significant stopover site for migratory shore birds

Salt and Brackish marsh – Like tidal flats, salt marshes are flat, poorly drained areas subject to periodic inundation by salt water but salt marshes are covered with a thick mat of grassy salt-tolerant plants. These marshes may be further classified into saline marshes and brackish marshes depending on the salinity of the overwash water. Here they are treated as one system because our mapping units could not reliably separate the two. Brackish marshes typically occur in areas where there is a mixing between fresh and salt water such as at the mouth of a large river. .

Salt and brackish marshes are important to many of our rarest birds such as the salt marsh sparrow and willet. Specialized vegetation, exemplified by the dominant spartina grasses, have evolved mechanisms to resist desiccation and maintain salt balance in this extreme setting. Rare or declining plant species include seaside dock, saltmarsh sedge, seashore saltgrass, creeping alkali grass, American sea-blite, and small spikerush.

There are over 6000 discrete salt and brackish marshes in the region ranging in size from 1 to 4000 acres. They occur in all parts of the coastline and amount to 140,000 acres in total. One of the largest (2,288 acres) occurs in the John Lusbie National Wildlife area in Cobequid Bay and is recognized as a globally significant bird area.

Salt pond – Salt ponds are bodies of salt water in a marsh or swamp along the seacoast. They often have distinct shoreline vegetation such as seaside flatsedge and seaside crowfoot.

Tidal marsh – Tidal marsh is a broad term used in this report to encompass both marshes and tidal flats. It refers to any extensive level marsh or flat regularly inundated by high tides.

Coastal Bog – Cool maritime conditions favors the development of extensive bogs and fens in the coastal zone. Much like their inland counterparts these are areas of waterlogged, spongy ground, consisting primarily of mosses, containing acidic, decaying vegetation, such as sphagnum or sedges, which may develop into peat. Coastal bogs tend to be dominated by species such as broom crowberry and cottongrass that are minor components of inland systems. A number of rare orchids and carnivorous plants are found in this environment.

Coastal Zone and Important Bird Areas.

The unique importance of coastal shores, marshes, offshore waters or isolated islands to shorebirds has long been recognized. Many places in the ecoregion have been ranked globally and/or nationally significant for shorebird or seabird concentrations and threatened species. Some of the most important include:

- Northeast Coastal Maine (ME)
- Country Island Complex (NS)
- Sable Island (NS)
- Eastern Cape Sable Island (NS)
- Cobequid Bay (NS)
- Malpeque Bay (PEI)
- Southern Bight, Minas Basin (NS)
- Brier Island (NS)
- PEI National Park (PEI)
- Iles-de-la-Madeleine (QU)

Coastal Shore and Wetland Portfolio Summary

The screening criteria used to locate and identify coastal shore and wetland features most critical to maintaining biodiversity required that each qualifying occurrence:

- Was contiguous and met size criteria:
 - Salt/Brackish marsh over 50 acres or part of a complex over 100 acres
 - Beach/dune over 20 acres
 - Coastal bogs over 75 acres
 - Tidal flats over 100 acres or part of a larger complex
 - Rocky shores and cliffs that were 2 acres minimum and part of a complex including some of the above features
- Were in good landscape settings (Land Cover Index < 30)
- Were in good condition based on ground surveys and expert opinion (corroboration by at least one source)
- Contain other confirmed biodiversity features (element occurrences)

Size criteria for the respective systems were determined by a literature analysis of minimum area requirements for the characteristic breeding species as well as information on the scale of specific disturbances (Tables 2 and 3, Figure 2). Additionally, we examined survey records for species and communities with documented occurrences in Northern Appalachian / Acadian coastal wetland complexes (Figures 3-5).

We used different minimum size criteria for different features. For salt marshes both the literature and evidence from ground surveys suggested that occurrences over 50 acres were more likely to contain rare plant and bird species than smaller examples (Figures 2 and 3). For beach/dune ecosystems the evidence suggested that 20 acres was adequate to ensure that the occurrence could serve as a coarse filter for characteristic beach breeding species such as piping plover (Figure 4). Similarly intertidal flats of 100 acres or greater appear to be adequate in size to serve the needs of many typical species (Figure 5).

Unlike the literature analysis, the patterns derived from the inventory data are correlative and do not imply cause. Additionally, our method of examining size relationships tended to underestimate the size of the whole wetland. For example a tidal marsh dissected by a tidal creek may be registered in our analysis as two discrete occurrences on either side of the creek. A breeding species occurring on one side will be associated only with the size of that half. To get around this limitation we developed a map of coastal complexes based on physical features that unified marsh, tidal flat, beach and salt ponds into a single wetland complex. When the size of the complex is examined relative to associated species the data suggest that many species prefer larger complexes and that those sizes are greater than the minimums derived from each feature individually (Figure 5).

We adjusted our selection criteria to take into account the size of the entire wetland complex as well as the sizes of the individual occurrences within the complex. This allowed some smaller features to be included in the portfolio if they were part of a large wetland mosaic.

Table 2. Birds that appeared to favor small coastal features were species that breed on rocky coastal islands and cliffs or unusual winter sightings. Data are based on USHP and Canadian CDC occurrences but many of these species are not thoroughly or consistently tracked by their respective programs. Only species with 3 or more observations and high level of locational precision are shown.

Common name	Habitat	Average Features size (acres)	Average Size of the wetland complex (acre)
Black Guillemot	rocky cliffs on coastal shores/islands	25	42
Razorbill	coastal islands	23	23
Leach's Storm-Petrel	coastal islands	8	18
Atlantic Puffin	coastal islands	11	14
Brant	winters in sheltered bays	10	10
Gyrfalcon	winters occ along open coast	3	3

Table 3: Birds in relation to coastal feature sizes. Occurrences of these species were used to confirm portfolio examples of coastal shore or wetland features (see data caveats in Table 2)

G_comnam	Habitat	Total observations	% on 0-100 acres	% on 100-500 acres	% on 500-1000 acres	% on 1k-10k acres	% on 10k-50k acres	Ave Feature size
Black-legged Kittiwake	pelagic gull, nest on sea cliffs	3					100	16,683
Red Knot	migrant, tidal flats, beaches	3				67	33	1,379
Semipalmated Sandpiper	migrant, mudflats	4		25	25	25	25	431
Nelson's Sharp-tailed Sparrow	salt marshes	2		50		50		201
Willet	nests in coastal marshes	3		67		33		267
Arctic Tern	breeds on coastal beaches	14	43	14		29	14	4,673
Piping Plover	breeds on coastal beaches	49	6	16	2	53	22	1,453
Common Tern	nests on islands or beaches	82	22	17	4	40	17	3,048
Roseate Tern	offshore islands w pebbly beach	12	42	25		25	8	3,262
Black-headed Gull	coastal marshes, lakes	4	50			50		926
Gadwall	fresh, occ brackish marsh	4	25	50		25		235

Figure 2. Minimum dynamic area for disturbance processes and minimum area requirements for breeding species in Northern Appalachian salt marshes.

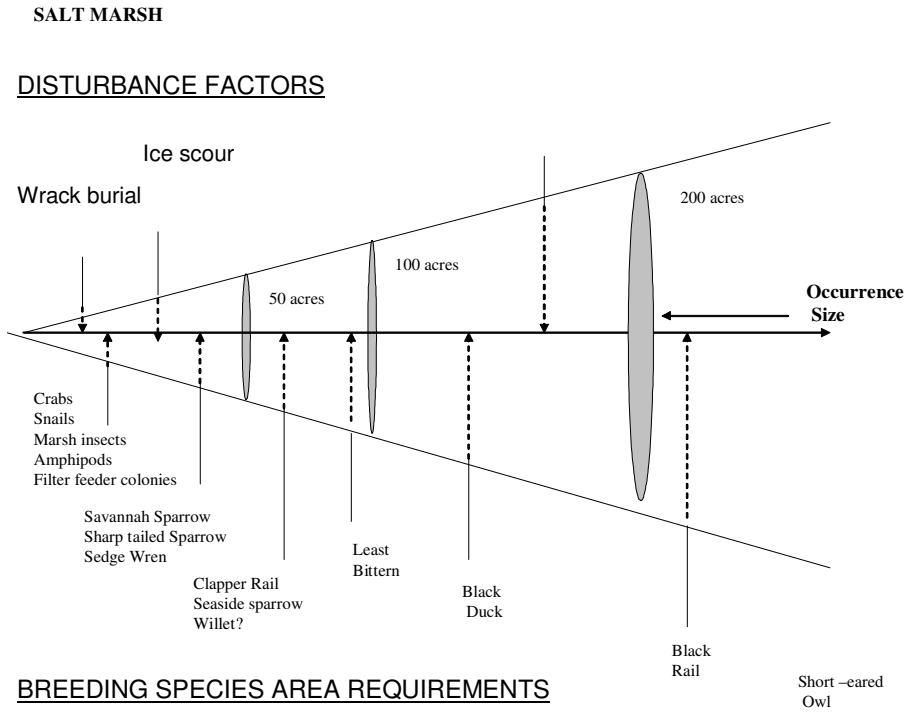


Figure 3. The average size of the tidal marshes and coastal bogs where confirmed occurrences of characteristic species were observed. Data from CDC and Maine Natural Heritage program, restricted to species with 3 or more occurrences and a location precision of 0 to 3. Yellow rail had an average marsh size of 1523 acres, Arctic tern had an average of 47 acres. The grand average was 188 acres.

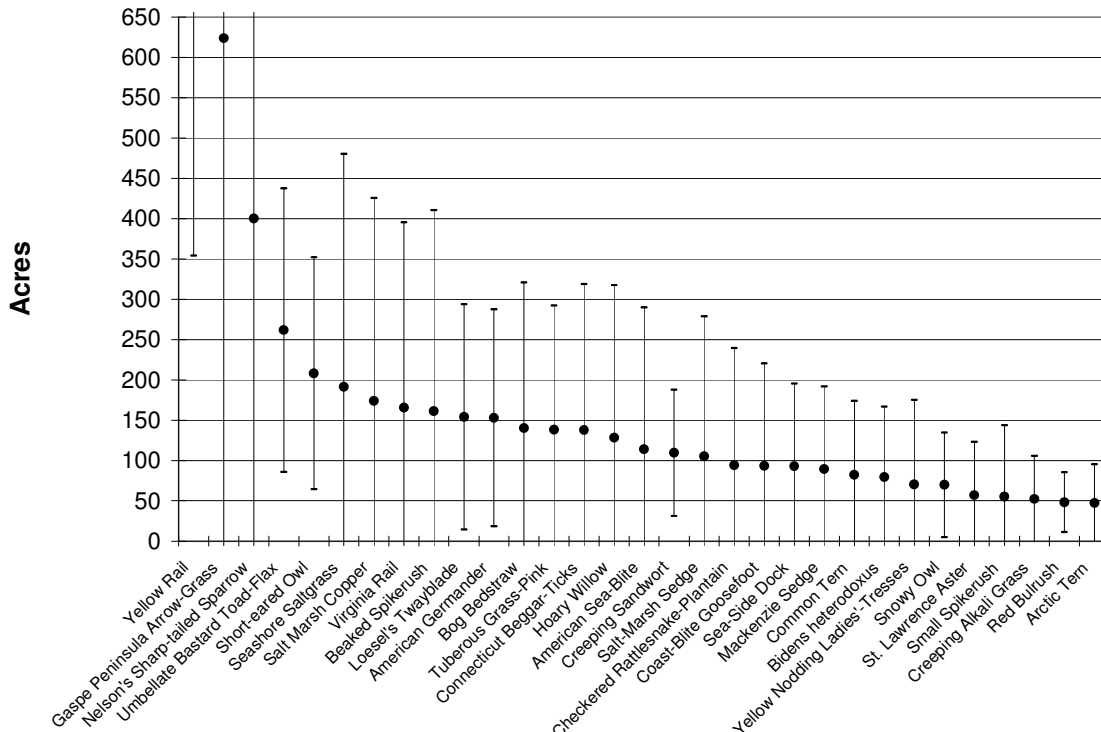


Figure 4. The average size of the beaches and dunes where confirmed occurrences of beach/dune specific species were observed. Data from CDC and Maine Natural Heritage program, restricted to species with 3 or more occurrences and a location precision of 0-3. At the two extremes, beaches where the occurrences of beach pinweed (*Lechea maritima*) were located averaged 632 acres in size, those for the Nova Scotia false foxglove (*Agalinis neoscotica*) averaged 19 acres.

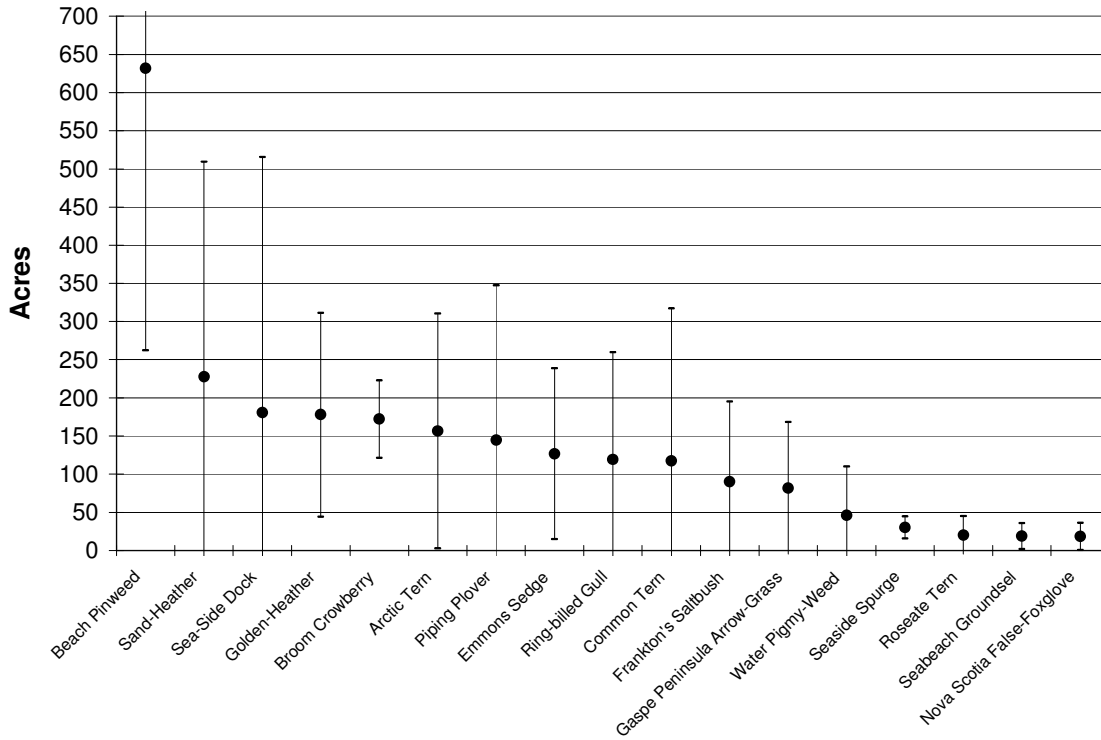
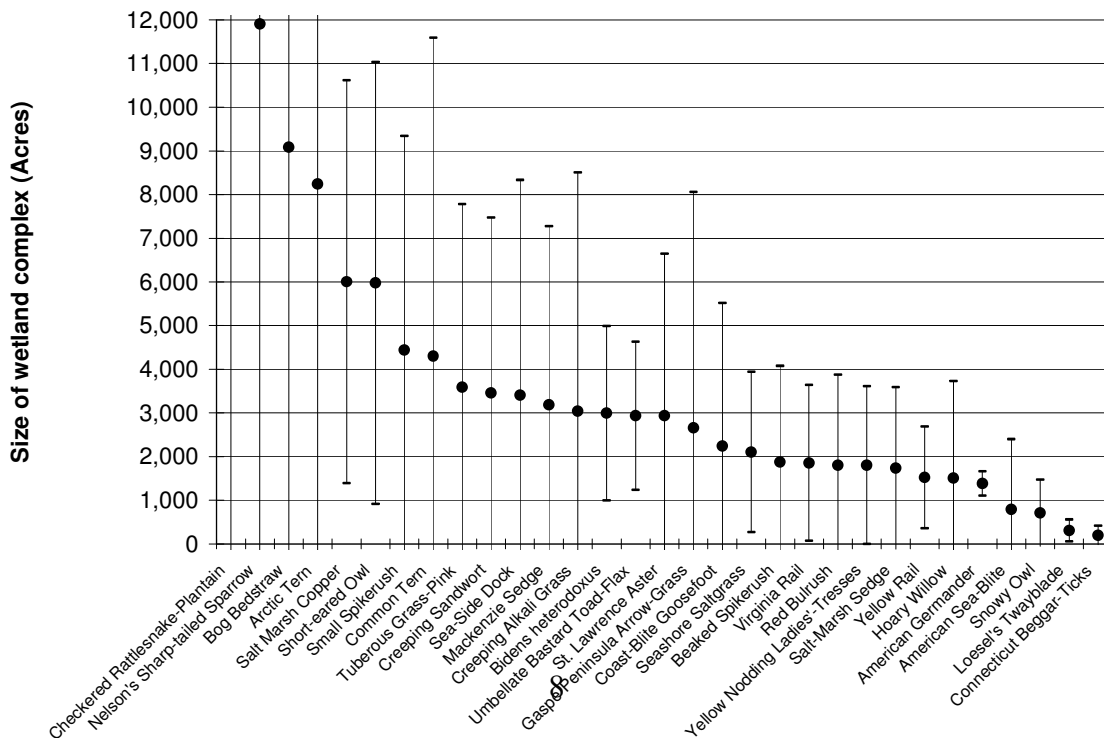


Figure 5. The average size of the coastal wetland complexes where confirmed occurrences of characteristic species were observed. Data from CDC and Maine Natural Heritage program, restricted to species with 3 or more occurrences and a location precision of 0 to 3.



Results

Our goal was to identify a minimum of **40 examples per sub-region in which they occur**. This goal of 1440 individual occurrences totals to about 13 percent of all the coastal features in the ecoregion or an estimated 17% of all features by area (using the minimum size criteria). After examining the distribution of the occurrences across gradients, we redistributed the goal of 1440 across the sub-regions in proportion with the number of possible occurrences. (Table 4)

We identified 2311 critical occurrences in 90 key complexes. This is more than the number needed to meet our minimum goal, however many of these occurrences are sub-units of a larger complexes. We met or surpassed the specific goals for each sub-region except for beach/dune features in the Acadian Highlands, and Nova Scotia Hills.

Candidate and Supporting occurrences

In addition to the critical occurrences, this analysis encompassed a large number of less notable, or poorly surveyed coastal shores and wetlands that did not meet our screening criteria for being a critical feature. We accounted for their potential contributions to biodiversity by sorting them into two categories and totaling the amounts of each.

- *Candidate occurrence*: A feature that met the criteria for size and landscape context but for which we had no verification or corroboration as to their condition and biodiversity contribution. These may be added to the portfolio after ground verification and are a logical place to focus inventory efforts.
- *Supporting occurrence*: A feature that did not meet the criteria for size and landscape context but may play a supporting role in supplementing the critical sites.

Many of the candidate and supporting occurrences already occur on protected reserves and thus are part of the *de facto* conservation picture for the region. Because conserved examples of these occurrences may serve to bolster biodiversity protection we included them in some of our analyses for context. However, *candidate and supporting occurrences were not counted as contributing to the portfolio goals*.

Occurrences, Sites and Goals

When measured by area, the critical sites account for 44 percent of all coastal features, more than the estimated 13 percent because the critical sites were consistently larger than the average or minimum size.

As discussed in the introduction, we have no certainty that it is possible to protect all coastal biodiversity using only a proportion of the landscape. We used numeric goals to hone our focus on the most critical sites. The methods were designed to insure that conservation is focused on the most functional examples in the most intact landscapes possible. They are scaled in size to work effectively as coarse filters for all biodiversity and the occurrences have verification as to quality by one to several sources. By these criteria, this is the set of sites that will have the greatest influence and the highest chances of protecting biodiversity over centuries.

Table 4a. Goals and Distribution for critical occurrences of coastal features except for tidal flats.

Feature	ELC_name	Goal	TC	CP	CU	PC	PS	OU	T	S
Dune	Acadian Highlands	7	31	8	23		2	26	59	24
	Acadian 'Uplands'	9	1	0	1		7	61	69	-8
	Atlantic Coast	118	220	35	185	3	60	665	948	102
	GoM, BoF, Minas Basin	34	27	7	20		20	222	269	-7
	Northumberland - Bras D'Or	161	371	105	266	4	70	841	1286	210
	Nova Scotia Hills & Drumlins	14	0	0	0		9	105	114	-14
Beach/Dune Total		343	650	155	495	7	168	1920	2745	307
Bog	Acadian Highlands	0	3	0	3			1	4	3
	Acadian 'Uplands'	0	0	0	0			3	3	0
	Atlantic Coast	55	111	10	101	2	8	323	444	56
	GoM, BoF, Minas Basin	3	4	1	3		1	19	24	1
	Northumberland - Bras D'Or	25	69	17	52		6	128	203	44
	Nova Scotia Hills & Drumlins	3	1	0	1		1	26	28	-2
Coastal Bog Total		88	188	28	160	2	16	500	706	100
Cliff and Rocky Shore	Acadian Highlands	3	8	3	5	2		10	20	5
	Acadian 'Uplands'	58	20	0	20		9	437	466	-38
	Atlantic Coast	16	56	13	43		3	67	126	40
	GoM, BoF, Minas Basin	105	140	45	95		62	645	847	35
	Northumberland - Bras D'Or	6	4	1	3		2	43	49	-2
	Nova Scotia Hills & Drumlins	3	0	0	0		1	24	25	-3
Cliff and Rocky shore Total		191	228	62	166	2	77	1226	1533	37
Salt Pond	Acadian Highlands	1	7	0	7			1	8	6
	Acadian 'Uplands'	3	0	0	0			23	23	-3
	Atlantic Coast	30	47	3	44		8	187	242	17
	GoM, BoF, Minas Basin	1	1	0	1		1	8	10	0
	Northumberland - Bras D'Or	45	66	21	45	1	22	273	362	21
	Nova Scotia Hills & Drumlins	4	0	0	0		2	27	29	-4
Salt Ppond Total		84	121	24	97	1	33	519	674	37
Salt Marsh	Acadian Highlands	8	45	1	44		1	22	68	37
	Acadian 'Uplands'	49	58	0	58		10	323	391	9
	Atlantic Coast	143	284	40	244	2	53	804	1143	141
	Gaspe Peninsula	5	11	1	10		1	26	38	6
	GoM, BoF, Minas Basin	139	323	38	286		24	764	1112	184
	Northumberland - Bras D'Or	322	389	63	326	6	106	2075	2576	67
	Nova Scotia Hills & Drumlins	63	13	2	11	1	11	477	502	-50
	Temiscouata Hills - St. John Uplands - North	5	1	0	1			42	43	-4
	Salt/brackish marsh Total		733	1124	145	980	9	206	4533	5873
Grand Total		1440	2311	414	1898	21	500	8698	11531	871

Goal = the portfolio goal

TC = total number of critical occurrences identified and located.

CU = Critical occurrences that occur on lands managed for extraction or are unprotected.

CP = Critical occurrences that occur on lands explicitly protected for biodiversity.

PC = Candidate occurrences that occur on lands explicitly protected for biodiversity.

PS = Supporting occurrences that occur on lands explicitly protected for biodiversity.

OU = Other occurrences that occur on lands managed for extraction or are unprotected.

T = total # of occurrences. **S** = portfolio sufficiency

Table 4b. Goals and Distribution for critical occurrences of tidal flats. Legend as for 4a

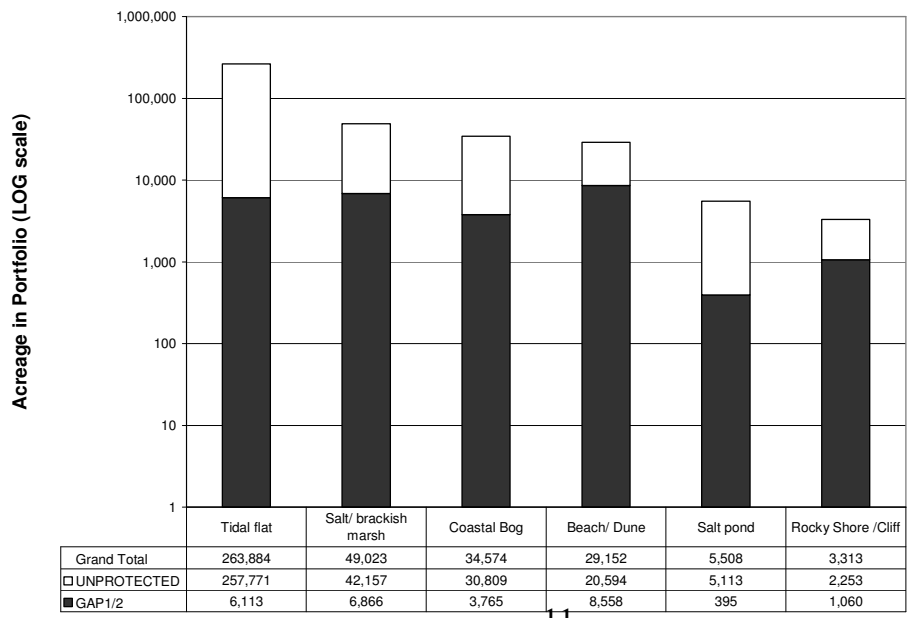
Group	ELC_name	Goal	TC	CP	CU	PC	PS	OU	T	S
Tidal flat	Acadian Highlands	1	9	0	9			9	18	
	Acadian 'Uplands'	52	163	0	163		2	592	757	-1
	Atlantic Coast	76	60	6	54	6	53	983	1102	
	Gulf of Maine, Bay of Fundy, Minas Basin	63	177	3	174	1	19	716	913	-1
	North Atlantic Coast Ecoregion	51	502	0	502			243	745	-4
	Northumberland - Bras D'Or 'lowlands'	23	78	15	63	3	13	244	338	-
	Nova Scotia Hills & Drumlins	11	2	0	2		1	163	166	
	Tidal Flat Total		280	991	24	967	10	88	2950	4039

Distribution and current protection status of the coastal feature portfolio.

Our portfolio identifies 90 key sites of critical shoreline encompassing 423,052 acres and 1720 features - each site being composed of either a single outstanding feature or a complex mosaic of many features. Collectively they constitute only one half of one percent of the ecoregion (excluding off-shore tidal flats that are outside the mapped ecoregion boundary) Our focus was on critical rocky shores/cliffs, beaches, salt marshes, tidal flats and coastal bogs, but the sites encompass other shoreline features.

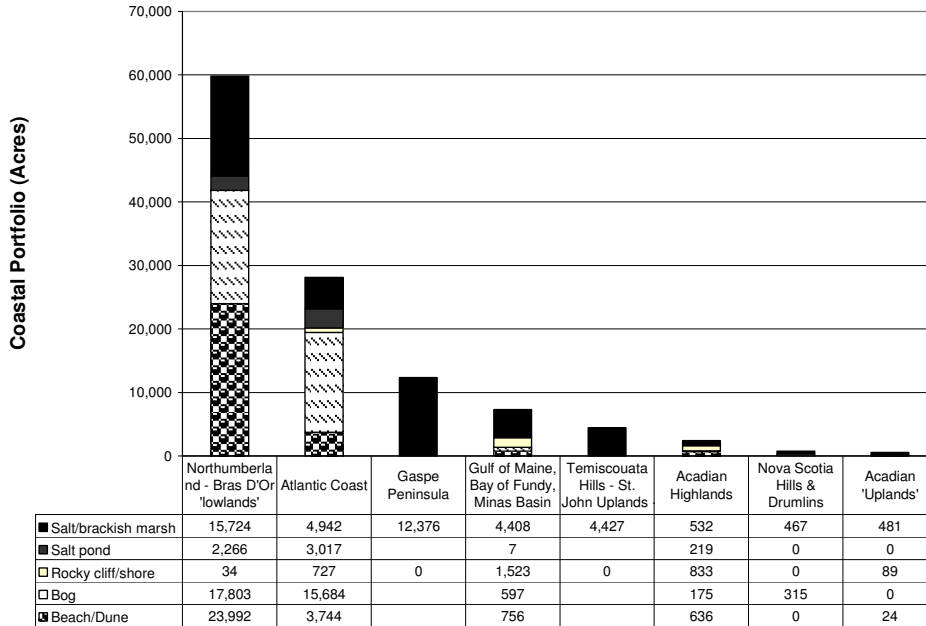
Tidal flats form such a large percentage of the area they tend to obscure patterns formed by the smaller features. Because of this, Figure 6 is shown on a log scale and the two subsequent figures (Figure 7 and 8) show the distribution of coastal features excluding tidal marshes. The land protection status of critical tidal flats is shown in relation to all other features in Figure 9.

Figure 6 the amount of each coastal feature captured by the 90 wetland complexes identified in this analysis. A log scale is used to smooth out the discrepancies in amount from over 300,000 acres of tidal marsh to 1000 acres of rocky shore and cliff. The amount on protected land (GAP status 1 or 2) is shown in black.



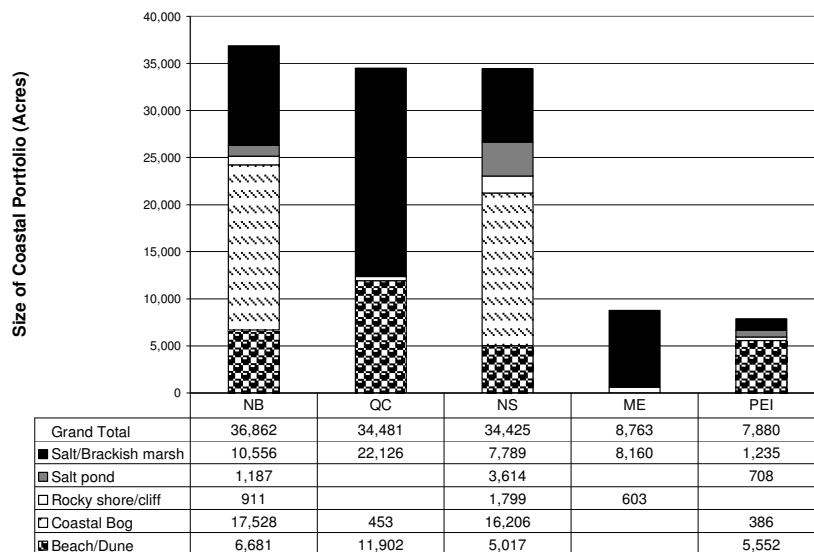
The portfolio is distributed across subregions to reflect the natural distributions of features across gradients (Figure 7). The Northumberland coast of New Brunswick and Nova Scotia have more than twice the number of portfolio occurrences than any other region. The fact that the Gaspé and Temiscouata Hills primarily feature salt marshes may reflect data limits. Further research is needed on other features in these subregions

Figure 7. Coastal Portfolio across subregions (tidal flats excluded)



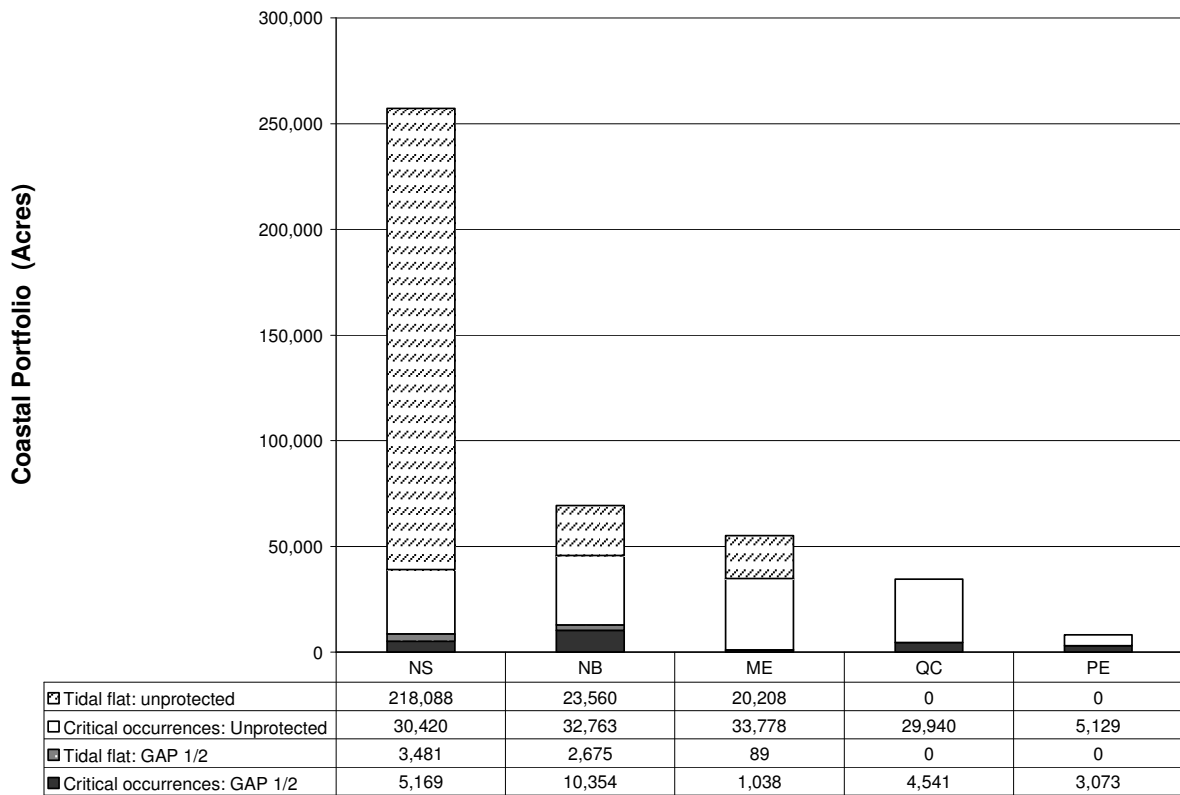
The portfolio is unevenly distributed by province and state with New Brunswick, Quebec and Nova Scotia having the bulk of the portfolio and some states (NH, VT, NY) not having any coastal shoreline in this ecoregion.

Figure 8. The coastal portfolio by state and province (tidal flats excluded).



Examination of the current land protected status indicates that New Brunswick is furthest along on protecting coastal features with over 13,000 acres of the critical portfolio occurrences being on land with a GAP 1 or 2 status. Our analysis does not account for coastal zone legal policies which are one of the primary conservation tools for coastal features.

Figure 9. Land protection status of tidal flats and other coastal features in the Northern Appalachian /Acadian ecoregion by state and province. Tidal flats are separated from all other critical occurrences (salt marshes, beach dune systems, coastal bogs, rocky cliffs and shores) that are aggregated in this figure because of the inequities of size.



Sites: Site lists are found in Appendix A