Cover Photos (clockwise from left):

Splash pools[1], Devils Island, Ashland County
Interdunal pond on Julian Bay[2]**,** Stockton Island tombolo, Ashland County
Sand River estuary[2], Mouth of the Sand River, Bayfield County.

1. Photograph by Emmet Judziewicz, WDNR
2. Photograph by Eric Epstein, WDNR.

This report is available on the Internet. The website contains the most recent information for this project and is available through the Bureau of Endangered Resources at http://www.dnr.state.wi.us/org/land/er/.

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A Data Compilation and Assessment of Coastal Wetlands of Wisconsin's Great Lakes

Final Report

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PROJECT DESCRIPTION

The state of Wisconsin is bordered by Lake Superior to the northwest and Lake Michigan to the east. The 820 miles of combined shoreline make up a complex arrangement of ecosystems that contain a rich variety of natural features. Wetlands near the coasts of both lakes provide rich habitat for plants and animals and greatly influence the larger ecosystem processes of the Great Lakes Ecosystem. As transition zones (or ecotones) between land and water, coastal wetlands are often rich in species diversity and provide critical habitat for migratory and nesting birds, spawning fish, and rare plants. However, various types of development and recreation continue to impact coastal wetlands and limit their capacities to perform important ecosystem functions.

Numerous inventories and reports have been completed pertaining to coastal wetlands throughout Wisconsin. For example, the Bureau of Endangered Resources (BER) has completed a number of important inventory and data assessment projects over the last decade aimed at improving our understanding of coastal ecosystems and coastal wetland sites, in particular. However, at the time when this project was initiated (1999) a comprehensive synthesis of coastal wetland information for the Great Lakes had not been completed. Moreover, significant inventory gaps existed throughout the coastal zone in Wisconsin.

The focus of this project was to conduct an assessment of existing coastal wetland data to determine ecologically significant coastal wetland sites within the Lake Michigan and Lake Superior basins. The goals were to identify inventory gaps for guiding future inventory and planning efforts by the Bureau of Endangered Resources and others. The project was implemented in three phases, each one building incrementally upon the previous phase, as follows:

Phase 1: The first year of the project was, primarily, a survey of existing studies and resulted in the identification of 64 Primary Sites within the coastal zones of Lakes Michigan and Superior, including 28 sites near Lake Superior and 36 sites near Lake Michigan. The significance of the sites was determined based on the current level of information available. However, it was acknowledged that large data gaps existed, especially for Lake Michigan coastal wetlands. These gaps were identified focusing on NHI-related data (rare plants, animals, natural communities, and other natural features) and documented as part of the final report (Merryfield 2000) for this phase of the project. Phase I was completed in 2000.

Phase 2: Phase 2 was initiated in October, 2000 with the goal of filling some of the most critical data gaps and developing preliminary products intended, ultimately, to serve as the basis for public documents to be developed in subsequent phases. Several work items were completed including a “windshield survey” of 26 of 36 Lake Michigan Primary Sites (as defined in Phase 1). In addition, prioritization criteria for evaluating the “known ecological significance” of coastal wetland sites were developed and applied to all 64 sites to develop a “top 10” list of priority sites for both Lake Michigan and Lake Superior. Next, future inventory needs for all 64 coastal wetland sites were identified and a prioritized list of sites with large “data gaps” for both Lake Michigan and Lake Superior was developed. In addition, we initiated extensive data gathering

for missing bird and fish data. Two primary databases were procured, the Wisconsin Breeding Bird Atlas and the Wisconsin Fish Species database, in addition to a number of other important but smaller databases. Finally, we began efforts to make all of the above information available in draft format through a website and a prototype CD-ROM that would contain project reports, site descriptions for the 64 coastal wetland sites identified during Phase 1, and photographs of important ecological sites and features. The preliminary website contained the basic structure for a comprehensive overview of the information collected by BER throughout the coarse of the Coastal Wetland Assessment project. The website was made available through the Wisconsin Bureau of Endangered Resources website (http://www.dnr.state.wi.us/org/land/er/).

Phase 3: The current phase of the project was initiated in 2001 with the primary goals of 1) continuing to gather and incorporate coastal wetlands data into BER's Biological Conservation Database (BCD), 2) filling in data gaps as resources allowed through limited field inventory for high ranking sites identified during phase 2, and 3) developing the products that began in Phase 2 (coastal wetlands website, CD-ROM, and technical report including site descriptions). The ultimate intended outcome of the project (Phase IV) will be a publicly distributed product in an easy-to-read format, filled with pictures, maps and graphics that would help increase public awareness to the importance of coastal wetlands in Wisconsin. The basis for these products would be the ecologically significant sites, their site descriptions, and the regional and local ecological importance of each site.

COASTAL WETLANDS BACKGROUND AND SIGNIFICANCE

Wetlands found near the coasts of the Great Lakes include marshes, bogs, fens, sedge meadows, shrub swamps, hardwood swamps, coniferous swamps, spring seeps, and others. Wetlands specific to the Great Lakes coasts include freshwater estuaries, interdunal wetlands, ridge and swale systems, and lakeplain prairies. While there is no universally accepted definition of a coastal wetland, there are some significant characteristics distinguishing them from their inland counterparts and other wetlands found along the coast. Coastal wetlands exist because of their historic and present-day interactions with the Great Lakes. They serve as spawning grounds for fish, stopovers or staging grounds for migratory and breeding birds, and critical habitat for many rare plants and animals.

The importance of wetlands for performing various ecological services is well documented, and they have long been recognized as one of the most important ecosystems on Earth (Mitsch and Gosselink 1993). They are sometimes characterized as the "kidneys" of the landscape because of their functions in hydrological and chemical cycles and because they intercept wastes from both natural and human sources. Wetlands play an important role in cleansing polluted waters, preventing floods, protecting shorelines, and recharging groundwater aquifers. Wetlands are also important as carbon sinks on a global scale.

Wetlands throughout Wisconsin provide critical habitat for a diverse set of both aquatic and terrestrial plant and animal species. A number of coastal wetland sites host extremely rich assemblages of flora and fauna, including dwarf lake iris (*Iris lacustris*) and Piping Plover (*Charadrius melodius*), both of which are rare globally. Some rare plant species such as the coast sedge (*Carex exilis*), English sundew (*Drosera anglica*) and marsh bedstraw (*Galium palustre*), a Wisconsin special concern species, are found only in coastal wetlands. Long-term monitoring stations along the Great Lakes have documented high concentrations of migratory birds, over 100 of which are Neotropical Migrants or birds that winter in the Neotropics or southward (Finch 1991). The Great Lakes serve as migrant corridors and coastal wetlands offer critical food and shelter resources. In addition, some of the larger forested wetlands along Lake Michigan serve as ecological refuges for breeding bird species that are now more commonly found in northern Wisconsin. Table 1 lists many of the rare plants and animals tracked by NHI that have been documented within the Primary Sites for this project along with their state and federal status, where applicable.

Table 1. Rare animals and plants tracked by the Natural Heritage Inventory Program that have been documented within the Primary Sites.

Group	Common Name	Scientific Name	State Status	Federal Status
Beetle				
	Beach-Dune Tiger Beetle	*Cicindela hirticollis rhodensis*	SC/N	
	A Water Scavenger Beetle	*Cymbiodyta acuminata*	* SC/N	
Bird				
	Henslow's Sparrow	*Ammodramus henslowii*	THR	
	Long-Eared Owl	*Asio otus*	SC/M	
	Pine Siskin	*Carduelis pinus*	SC/M	
	Swainson's Thrush	*Catharus ustulatus*	SC/M	

Group	Common Name	Scientific Name		State Status	Federal Status
	Evening Grosbeak	*Coccothraustes vespertinus*		SC/M	
	Black-Throated Blue Warbler	*Dendroica caerulescens*		SC/M	
	Cape May Warbler	*Dendroica tigrina*		SC/M	
	Yellow-Bellied Flycatcher	*Empidonax flaviventris*		SC/M	
	Acadian Flycatcher	*Empidonax virescens*		THR	
	Merlin	*Falco columbarius*		SC/M	
	Connecticut Warbler	*Oporornis agilis*		SC/M	
	Gray Jay	*Perisoreus canadensis*		SC/M	
	Barn Owl	*Tyto alba*		END	
	Tennessee Warbler	*Vermivora peregrina*		SC/M	
	Great Egret	*Ardea alba*	*	THR	
	Great Blue Heron	*Ardea herodias*	*	SC/M	
	Lesser Scaup	*Aythya affinis*	*	SC/M	
	Redhead	*Aythya americana*	*	SC/M	
	American Bittern	*Botaurus lentiginosus*	*	SC/M	
	Common Goldeneye	*Bucephala clangula*	*	SC/M	
	Red-Shouldered Hawk	*Buteo lineatus*	*	THR	
	Piping Plover	*Charadrius melodus*	*	END	LE
	Black Tern	*Chlidonias niger*	*	SC/M	
	Northern Harrier	*Circus cyaneus*	*	SC/M	
	Yellow Rail	*Coturnicops noveboracensis*	*	THR	
	Snowy Egret	*Egretta thula*	*	END	
	Common Moorhen	*Gallinula chloropus*	*	SC/M	
	Common Loon	*Gavia immer*	*	SC/M	
	Bald Eagle	*Haliaeetus leucocephalus*	*	SC/FL	LT,PD
	Least Bittern	*Ixobrychus exilis*	*	SC/M	
	Common Merganser	*Mergus merganser*	*	SC/M	
	Red-Breasted Merganser	*Mergus serrator*	*	SC/M	
	Black-Crowned Night-Heron	*Nycticorax nycticorax*	*	SC/M	
	Osprey	*Pandion haliaetus*	*	THR	
	American White Pelican	*Pelecanus erythrorhynchos*	*	SC/M	
	Red-Necked Grebe	*Podiceps grisegena*	*	END	
	Louisiana Waterthrush	*Seiurus motacilla*	*	SC/M	
	Caspian Tern	*Sterna caspia*	*	END	
	Forster's Tern	*Sterna forsteri*	*	END	
	Common Tern	*Sterna hirundo*	*	END	
	Hooded Warbler	*Wilsonia citrina*	*	THR	
Bug					
	A Water Measurer	*Hydrometra martini*	*	SC/N	
Butterfly					
	Mottled Dusky Wing	*Erynnis martialis*		SC/N	
	Broad-Winged Skipper	*Poanes viator*		SC/N	
	Bog Fritillary	*Boloria eunomia*	*	SC/N	
	Swamp Metalmark	*Calephelis muticum*	*	END	
	Two-Spotted Skipper	*Euphyes bimacula*	*	SC/N	
	Dion Skipper	*Euphyes dion*	*	SC/N	
	Dorcas Copper	*Lycaena dorcas*	*	SC/N	
	Bog Copper	*Lycaena epixanthe*	*	SC/N	
	Mulberry Wing	*Poanes massasoit*	*	SC/N	
Caddisfly					
	A Bizarre Caddisfly	*Lepidostoma libum*	*	SC/N	
Dragonfly					
	Lake Darner	*Aeshna eremita*	*	SC/N	

Group	Common Name	Scientific Name		State Status	Federal Status
	Green-Striped Darner	*Aeshna verticalis*	*	SC/N	
	Arrowhead Spiketail	*Cordulegaster obliqua*	*	SC/N	
	Swamp Darner	*Epiaeschna heros*	*	SC/N	
	Amber-Winged Spreadwing	*Lestes eurinus*	*	SC/N	
	Ski-Tailed Emerald	*Somatochlora elongata*	*	SC/N	
	Forcipate Emerald	*Somatochlora forcipata*	*	SC/N	
	Hine's Emerald	*Somatochlora hineana*	*	END	LE
	Black Meadowhawk	*Sympetrum danae*	*	SC/N	
	Violet-Masked Glider	*Tramea carolina*	*	SC/N	
Fish					
	Lake Sturgeon	*Acipenser fulvescens*	*	SC/H	
	American Eel	*Anguilla rostrata*	*	SC/N	
	Bloater	*Coregonus hoyi*	*	SC/H	
	Least Darter	*Etheostoma microperca*	*	SC/N	
	Banded Killifish	*Fundulus diaphanus*	*	SC/N	
	Longear Sunfish	*Lepomis megalotis*	*	THR	
	Redfin Shiner	*Lythrurus umbratilis*	*	THR	
	Greater Redhorse	*Moxostoma valenciennesi*	*	THR	
Frog					
	Blanchard's Cricket Frog	*Acris crepitans blanchardi*	*	END	
	Bullfrog	*Rana catesbeiana*	*	SC/H	
Grasshopper					
	Blue-Legged Grasshopper	*Melanoplus flavidus*		SC/N	
	Lake Huron Locust	*Trimerotropis huroniana*		END	
	Seaside Grasshopper	*Trimerotropis maritima*		SC/N	
Leafhopper					
	Red-Tailed Prairie Leafhopper	*Aflexia rubranura*		END	
Mammal					
	Northern Myotis	*Myotis septentrionalis*		SC/N	
	Pigmy Shrew	*Sorex hoyi*	*	SC/N	
Moth					
	Oithona Tiger Moth	*Grammia oithona*		SC/N	
	Phyllira Tiger Moth	*Grammia phyllira*		SC/N	
	An Owlet Moth	*Macrochilo bivittata*		SC/N	
	Liatris Borer Moth	*Papaipema beeriana*	*	SC/N	
	Silphium Borer Moth	*Papaipema silphii*	*	END	
Other					
	Bird Rookery			SC	
	Migratory Bird Concentration Site			SC	
Plant					
	Striped Maple	*Acer pensylvanicum*		SC	
	Climbing Fumitory	*Adlumia fungosa*		SC	
	Roundstem Foxglove	*Agalinis gattingeri*		THR	
	Pale False Foxglove	*Agalinis skinneriana*		END	
	Prairie Milkweed	*Asclepias sullivantii*		THR	
	Maidenhair Spleenwort	*Asplenium trichomanes*		SC	
	Cooper's Milkvetch	*Astragalus neglectus*		END	
	Prairie Dunewort	*Botrychium campestre*		END	
	Moonwort Grape-Fern	*Botrychium lunaria*		END	
	Mingan's Moonwort	*Botrychium minganense*		SC	
	Spoon-Leaf Moonwort	*Botrychium spathulatum*		SC	
	Prairie Indian Plantain	*Cacalia tuberosa*		THR	
	American Sea-Rocket	*Cakile edentula*		SC	

Group	Common Name	Scientific Name	State Status	Federal Status
	Low Calamint	*Calamintha arkansana*	SC	
	Sand Reed-Grass	*Calamovilfa longifolia* var *magna*	THR	
	Cuckooflower	*Cardamine pratensis*	SC	
	Beautiful Sedge	*Carex concinna*	THR	
	Handsome Sedge	*Carex formosa*	THR	
	Smooth Black Sedge	*Carex nigra*	SC	
	Richardson Sedge	*Carex richardsonii*	SC	
	Dune Thistle	*Cirsium pitcheri*	THR	LT
	Crinkled Hairgrass	*Deschampsia flexuosa*	SC	
	Thickspike	*Elymus lanceolatus* ssp *psammophilus*	THR	
	Seaside Spurge	*Euphorbia polygonifolia*	SC	
	Western Fescue	*Festuca occidentalis*	THR	
	Yellow Gentian	*Gentiana alba*	THR	
	Northern Comandra	*Geocaulon lividum*	END	
	Limestone Oak Fern	*Gymnocarpium robertianum*	SC	
	Dwarf Lake Iris	*Iris lacustris*	THR	LT
	Large-Flowered Ground-Cherry	*Leucophysalis grandiflora*	SC	
	Broad-Leaved Twayblade	*Listera convallarioides*	THR	
	American Gromwell	*Lithospermum latifolium*	SC	
	Fly Honeysuckle	*Lonicera involucrata*	END	
	Fir Clubmoss	*Lycopodium selago*	SC	
	Indian Cucumber-Root	*Medeola virginiana*	SC	
	Clustered Broomrape	*Orobanche fasciculata*	THR	
	One-Flowered Broomrape	*Orobanche uniflora*	SC	
	Chilean Sweet Cicely	*Osmorhiza chilensis*	SC	
	Small-Flower Grass-Of-Parnassus	*Parnassia parviflora*	END	
	Pale Beardtongue	*Penstemon pallidus*	SC	
	Pale Green Orchid	*Platanthera flava* var *herbiola*	THR	
	Hooker Orchis	*Platanthera hookeri*	SC	
	Large Roundleaf Orchid	*Platanthera orbiculata*	SC	
	Braun's Holly-Fern	*Polystichum braunii*	THR	
	Bird's-Eye Primrose	*Primula mistassinica*	SC	
	Giant Pinedrops	*Pterospora andromedea*	END	
	Small Yellow Water Crowfoot	*Ranunculus gmelinii*	END	
	Northern Black Currant	*Ribes hudsonianum*	SC	
	Canada Gooseberry	*Ribes oxyacanthoides*	THR	
	Sand Dune Willow	*Salix cordata*	END	
	Tea-Leaved Willow	*Salix planifolia*	THR	
	Tufted Club-Rush	*Scirpus cespitosus*	THR	
	Torrey's Bulrush	*Scirpus torreyi*	SC	
	Heart-Leaved Skullcap	*Scutellaria ovata*	SC	
	Low Spike-Moss	*Selaginella selaginoides*	END	
	Bluestem Goldenrod	*Solidago caesia*	END	
	Sticky Goldenrod	*Solidago simplex* var *gillmanii*	THR	
	White Mandarin	*Streptopus amplexifolius*	SC	
	Small-Flowered Woolly Bean	*Strophostyles leiosperma*	SC	
	Lake Huron Tansy	*Tanacetum huronense*	END	
	Reflexed Trillium	*Trillium recurvatum*	SC	
	Purple False Oats	*Trisetum melicoides*	END	
	Narrow False Oats	*Trisetum spicatum*	THR	
	Northern Wild-Raisin	*Viburnum cassinoides*	SC	
	Smooth Black-Haw	*Viburnum prunifolium*	SC	

Group	Common Name	Scientific Name		State Status	Federal Status
	Long-Spur Violet	*Viola rostrata*		SC	
	Round-Leaved Orchis	*Amerorchis rotundifolia*	*	THR	
	Swamp-Pink	*Arethusa bulbosa*	*	SC	
	Lake-Cress	*Armoracia lacustris*	*	END	
	Slim-Stem Small-Reedgrass	*Calamagrostis stricta*	*	SC	
	Autumnal Water-Starwort	*Callitriche hermaphroditica*	*	SC	
	Floating Marsh-Marigold	*Caltha natans*	*	END	
	Fairy Slipper	*Calypso bulbosa*	*	THR	
	Assiniboine Sedge	*Carex assiniboinensis*	*	SC	
	Hair-Like Sedge	*Carex capillaris*	*	SC	
	Crawe Sedge	*Carex crawei*	*	SC	
	Coast Sedge	*Carex exilis*	*	THR	
	Elk Sedge	*Carex garberi*	*	THR	
	Northern Bog Sedge	*Carex gynocrates*	*	SC	
	Shore Sedge	*Carex lenticularis*	*	THR	
	Livid Sedge	*Carex livida* var *radicaulis*	*	SC	
	False Hop Sedge	*Carex lupuliformis*	*	END	
	Michaux Sedge	*Carex michauxiana*	*	THR	
	Many-Headed Sedge	*Carex sychnocephala*	*	SC	
	Sparse-Flowered Sedge	*Carex tenuiflora*	*	SC	
	Sheathed Sedge	*Carex vaginata*	*	SC	
	Ram's-Head Lady's-Slipper	*Cypripedium arietinum*	*	THR	
	Small Yellow Lady's-Slipper	*Cypripedium parviflorum*	*	SC	
	Showy Lady's-Slipper	*Cypripedium reginae*	*	SC	
	Tufted Hairgrass	*Deschampsia cespitosa*	*	SC	
	English Sundew	*Drosera anglica*	*	THR	
	Slenderleaf Sundew	*Drosera linearis*	*	THR	
	Flat-Stemmed Spike-Rush	*Eleocharis compressa*	*	SC	
	Spike-Rush	*Eleocharis mamillata*	*	SC	
	Slender Spike-Rush	*Eleocharis nitida*	*	END	
	Capitate Spikerush	*Eleocharis olivacea*	*	SC	
	Few-Flower Spikerush	*Eleocharis quinqueflora*	*	SC	
	Robbins Spikerush	*Eleocharis robbinsii*	*	SC	
	Marsh Willow-Herb	*Epilobium palustre*	*	SC	
	Downy Willow-Herb	*Epilobium strictum*	*	SC	
	Marsh Horsetail	*Equisetum palustre*	*	SC	
	Variegated Horsetail	*Equisetum variegatum*	*	SC	
	Russet Cotton-Grass	*Eriophorum chamissonis*	*	SC	
	Hairy Fimbristylis	*Fimbristylis puberula*	*	END	
	Marsh Bedstraw	*Galium palustre*	*	SC	
	Lesser Fringed Gentian	*Gentianopsis procera*	*	SC	
	Vasey Rush	*Juncus vaseyi*	*	SC	
	Marsh Blazing Star	*Liatris spicata*	*	SC	
	Auricled Twayblade	*Listera auriculata*	*	END	
	White Adder's-Mouth	*Malaxis brachypoda*	*	SC	
	Adder's-Tongue	*Ophioglossum pusillum*	*	SC	
	Marsh Grass-Of-Parnassus	*Parnassia palustris*	*	THR	
	Arrow-Leaved Sweet-Coltsfoot	*Petasites sagittatus*	*	THR	
	Smooth Phlox	*Phlox glaberrima* ssp *interior*	*	END	
	Heart-Leaved Plantain	*Plantago cordata*	*	END	
	Leafy White Orchis	*Platanthera dilatata*	*	SC	
	Prairie White-Fringed Orchid	*Platanthera leucophaea*	*	END	LT
	Pink Milkwort	*Polygala incarnata*	*	END	

Group	Common Name	Scientific Name		State Status	Federal Status
	Seaside Crowfoot	*Ranunculus cymbalaria*	*	THR	
	Brown Beakrush	*Rhynchospora fusca*	*	SC	
	Whip Nutrush	*Scleria triglomerata*	*	SC	
	Low Nutrush	*Scleria verticillata*	*	SC	
	Marsh Ragwort	*Senecio congestus*	*	SC	
	Ohio Goldenrod	*Solidago ohioensis*	*	SC	
	Northern Bur-Reed	*Sparganium glomeratum*	*	THR	
	Waxleaf Meadowrue	*Thalictrum revolutum*	*	SC	
	Veined Meadowrue	*Thalictrum venulosum*	*	SC	
	Sticky False-Asphodel	*Tofieldia glutinosa*	*	THR	
	Common Bog Arrow-Grass	*Triglochin maritima*	*	SC	
	Slender Bog Arrow-Grass	*Triglochin palustris*	*	SC	
	Hidden-Fruited Bladderwort	*Utricularia geminiscapa*	*	SC	
	Northeastern Bladderwort	*Utricularia resupinata*	*	SC	
Salamander					
	Four-Toed Salamander	*Hemidactylium scutatum*	*	SC/H	
Snail					
	Pleistocene Catinella	*Catinella exile*		SC/N	
	A Land Snail	*Catinella gelida*		SC/N	
	Sculpted Glyph	*Glyphyalinia rhoadsi*		SC/N	
	Brilliant Granule	*Guppya sterkii*		SC/N	
	Cherrystone Drop	*Hendersonia occulta*		THR	
	Dentate Supercoil	*Paravitrea multidentata*		SC/N	
	White-Lip Dagger	*Pupoides albilabris*		SC/N	
	Black Striate	*Striatura ferrea*		SC/N	
	Eightfold Pinecone	*Strobilops affinis*		SC/N	
	A Land Snail	*Succinea bakeri*		SC/N	
	Oval Vallonia	*Vallonia excentrica*		SC/N	
	Tapered Vertigo	*Vertigo elatior*		SC/N	
	Midwest Pleistocene Vertigo	*Vertigo hubrichti*		END	
	Iowa Pleistocene Vertigo	*Vertigo iowaensis*		SC/N	
	Six-Whorl Vertigo	*Vertigo morsei*		SC/N	
	Deep-Throated Vertigo	*Vertigo nylanderi*		SC/N	
	Boreal Top	*Zoogenetes harpa*		SC/N	
Snake					
	Northern Ringneck Snake	*Diadophis punctatus edwardsii*		SC/H	
	Butler's Garter Snake	*Thamnophis butleri*		THR	
Turtle					
	Wood Turtle	*Clemmys insculpta*	*	THR	
	Blanding's Turtle	*Emydoidea blandingii*	*	THR	

* Indicates an aquatic species. See Appendix C for an explanation of state and federal status.

Coastal wetlands near Wisconsin's Great Lakes include several important natural communities and other natural features such as Forested Ridge and Swale, Great Lakes Dunes, and Interdunal Wetlands. Many of the natural community types tracked by NHI that have been documented within the coastal study area for this project are listed below. Brief descriptions of these community types can be found in Appendix C.

Community Types documented within the Coastal Zone

- Alvar
- Boreal Forest
- Dry-Mesic Prairie
- Forested Ridge And Swale
- Great Lakes Barrens
- Great Lakes Beach
- Great Lakes Dune
- Moist Cliff
- Northern Dry Forest
- Northern Dry-Mesic Forest
- Northern Mesic Forest
- Oak Woodland
- Southern Mesic Forest
- Alder Thicket
- Black Spruce Swamp
- Boreal Rich Fen
- Calcareous Fen
- Emergent Aquatic
- Emergent Aquatic - Wild Rice
- Floodplain Forest
- Great Lakes Alkaline Rockshore
- Hardwood Swamp
- Interdunal Wetland
- Lake--Shallow, Hard, Drainage
- Lake--Shallow, Hard, Seepage
- Lake--Shallow, Very Hard, Drainage (Marl)
- Lake--Soft Bog
- Northern Sedge Meadow
- Northern Wet Forest
- Northern Wet-Mesic Forest
- Open Bog
- Poor Fen
- Shore Fen
- Shrub-Carr
- Southern Sedge Meadow
- Springs And Spring Runs, Hard
- Springs And Spring Runs, Soft
- Stream--Slow, Hard, Warm
- Submergent Aquatic
- Tamarack (Poor) Swamp
- Wet-Mesic Prairie

LAKE MICHIGAN COASTAL ZONE

The Lake Michigan shoreline is varied, ranging from gently sloping glacial lakeplain of Kenosha County in the southeastern corner of the state to the rocky cliffs of the Door Peninsula and Grand Traverse Islands in the northeast. The shoreline along the eastern side of Green Bay, including the Door Peninsula, features clay bluffs, sand and gravel beaches, and dolomite cliffs that reach a height of 150 feet above the bay (Anderson et al. 2002). The Lake Michigan shoreline of Door County consists of low dolomite cliffs and ledges, extensive horizontal exposures of dolomite "beach," active beach and dune systems, shallow embayments with extensive marsh and meadow associations, and complex ridge and swale systems that harbor an intricate mosaics of wetland and upland plant communities. Red clay bluffs derived from glacio-lacustrine deposits, ranging from 10 to 70 feet in height, characterize the Lake Michigan shore of southern Door County, south to Milwaukee County. Sand beaches, active dunes, and forested ridge and swale systems interrupt the bluffs from Point Beach (Manitowoc County) south to Kohler-Andrae Dunes (Sheboygan County). Wetlands are scarce along this stretch of the lakeshore but a major dune complex situated south of Sheboygan contains interdunal wetlands and separates a large wetland bordering the Black River from the waters of Lake Michigan.

The southern Wisconsin shore has areas of gently sloping, low sandbanks fronted by wide beaches. Between Port Washington and Milwaukee, bluffs composed of red till and assorted stratified deposits reach heights of 140 feet, decreasing to 25 feet near Kenosha. The bluff bases normally have narrow beaches of sand or cobbles and contain few wetlands. South of Kenosha there is an extensive but degraded dune system and the nationally significant Chiwaukee Prairie, an area of extremely high significance to many rare or declining native plants and animals.

The approximately 70-mile long Door Peninsula extends into Lake Michigan, separating the waters of the lake from those of Green Bay, and is one of the most sensitive areas on the Lake Michigan shoreline. The concentration of rare species and natural communities make it one of the highest conservation priorities in Wisconsin and the entire Great Lakes region. Many globally rare species are found within the Door Peninsula because of the unique interrelationships of its geographical position, climate, geology, glacial history, and soils. The Peninsula forms the western edge of the Niagara Escarpment, a dolomite bedrock feature of Silurian Age that arcs through Upper Lake Michigan and extends east to western New York State. The western shore of the peninsula features cliffs that reach heights of 150 feet above the surface of Green Bay. To the east the land slopes gently towards the Lake Michigan shore where low rocky ledges, sand dunes, embayments, estuaries, and ridge and swale systems have been formed by wind and wave action over time. Many of the lakes on the eastern side of the Door Peninsula were once bays of post-glacial Lake Nippising but are now separated from Lake Michigan by shoreline sand deposition. Ridge and swale topography occurs at several places along the Lake Michigan coast of the Peninsula featuring complex vegetation patterns and supporting many rare species. In addition, the dolomite Niagara Escarpment forms the shoreline of portions of the Peninsula and creates unique communities such as cliffs, talus slopes, spring seepages, and alvar (Anderson et al. 2002) which in turn support rare, highly specialized plants and invertebrates.

The natural beauty and biological richness of the Door Peninsula have made it one of Wisconsin's most popular destinations, and the demand for tourism and second-home building warrants serious conservation concern. Major threats to the Door Peninsula coastal wetlands include habitat loss, fragmentation, and isolation, as well as chemical contamination and sedimentation. For example, loss or alteration of wetlands occurs through wetland filling, hydrologic disruption, road and utility corridor construction and maintenance, and forest clearing. Another major concern is groundwater contamination from failing septic systems and leaking underground storage tanks. In addition, surface waters may be contaminated by erosion due to development or agriculture. Groundwater contamination is a particular problem because of the shallow soils and fractured dolomite bedrock that underlies the Peninsula. Contaminants entering these soils are not adequately filtered and travel rapidly to groundwater aquifers (The Nature Conservancy, Grimm et. al., 1994 and Valvassori 1990)

LAKE SUPERIOR COASTAL ZONE

The Wisconsin shoreline of Lake Superior contains a diverse array of natural features. Among the most distinctive and noteworthy are the freshwater estuaries and sand spits that characterize the southwestern Lake Superior shoreline, the wave carved sandstone cliffs of the northern Bayfield Peninsula and Apostle Islands, and the floristically rich "red clay" wetlands that occupy ancient lacustrine deposits. Red clay wetlands are especially well developed near the City of Superior. Important wetland communities of the Lake Superior coastal region include marsh, fen, bog, sedge meadow, shrub swamp, lowland hardwood forest, and conifer swamp. Extensive beds of emergent, submergent, and floating-leaved aquatic plants occur in the shallower waters of the estuaries, partially protected from wind, wave and ice action by the sand spits situated at the mouths of streams entering the lake. The larger sand spits typically contain beach, dune, and pine forest communities, and where the dunes are active interdunal swales support unusual assemblages of wetland plants. The coastal wetland complexes receive heavy use by migratory birds, particularly in the spring. The larger coastal wetlands also host significant populations of nesting birds and spawning fish, as well as many resident herptiles and invertebrates. (For a fuller discussion of Wisconsin's Lake Superior wetlands see Epstein 1997 and Epstein et al. 1997).

ECOLOGICAL LANDSCAPES

The Wisconsin DNR has mapped Wisconsin into areas of similar ecological potential and geography into units known as Ecological Landscapes (Map 1). This classification is based on aggregations of subsections from the National Hierarchical Framework of Ecological Units (NHFEU) (Avers et al. 1994). The NHFEU and the Ecological Landscape systems delineate landscapes of similar ecological pattern and potential across the state in a way that is meaningful and useful to resource administrators, planners, and managers.

The areas adjacent to the Lake Michigan and Lake Superior coasts differ from inland portions of the state because the lakes influence temperature, humidity, and precipitation. In addition,

fluctuating water levels and disturbance patterns affect these landscapes. Each of the landscapes that occur in the two coastal zones is summarized below. Greatly expanded descriptions will be available soon in the "Wisconsin Ecological Landscapes Handbook"(DNR 2002).

Superior Coastal Plain

The Superior Coastal Plain is Wisconsin's northernmost Ecological Landscape and comprises 93% of the Lake Superior coastal zone. This landscape is bordered on the north by southwestern Lake Superior and on the south by the Northwest Sands, the Northwest Lowlands, and the North Central Forest. The climate in this area is strongly influenced by Lake Superior, resulting in cooler summers, warmer winters, and greater precipitation compared to more inland locations. Exposed coastal areas are subject to significant disturbance from windstorms, waves, ice, currents, and periodic water level fluctuations. These disturbance regimes play a significant role in determining both the landform and vegetation characteristics of the shoreline ecosystems. The major landform in this Ecological Landscape is a nearly level plain of lacustrine clays that slopes gently northward toward Lake Superior. The comparatively rugged Bayfield Peninsula separates the clay plain into two disjunct segments. The present clay plain forest has been fragmented by agricultural use, and today approximately one-third of this landscape is non-forested. Most of the open land is in grass cover, having been cleared and then subsequently pastured or plowed. Aspen and birch forests occupy about 40% of the total land area, having increased in prominence over the boreal conifers. On the Bayfield Peninsula, second-growth northern hardwood forests are interspersed among extensive early successional aspen stands. Older forest successional stages are now rare throughout the Superior Clay Plain. An archipelago of sandstone-cored islands, the Apostles, occurs in Lake Superior just north and east of the Bayfield Peninsula. Wave carved sandstone cliffs bracket stretches of the Peninsula and also occur along the margins of several of the islands. Sand spits are a striking feature of the Lake Superior shoreline, typically separating the waters of the lake from inland lagoons and wetlands. The spits support rare and highly threatened natural communities such as beaches, dunes, interdunal wetlands, and pine barrens, and these in turn are inhabited by specially adapted plants and animals.

Northern Lake Michigan Coastal

This Ecological Landscape includes Green Bay, as well as the northern part of the Door Peninsula, comprising 22% of the Lake Michigan Coastal zone. Its landforms consist of the Niagara escarpment, a prominent dolomite outcropping along the east side of Green Bay, a lacustrine plain along the west side of Green Bay, and ground moraine elsewhere. The influence of Lake Michigan moderates extreme temperatures. Soils are very diverse; in some areas, lacustrine sands are found overlying clays or bedrock within only a few feet of the surface. In the Door Peninsula, soils are typically stony loamy sands to loams. Poorly drained sands are common in the lake plain or in depressions between dunes and beach ridges. On the western side of Green Bay, the ground moraine is composed mostly of moderately well drained, rocky sandy loams interspersed with lacustrine sands and clays, and peat and muck also common. Current vegetation consists of more than 60% non-forested land, most of which is in agricultural crops, with smaller amounts of grassland, wetland, shrubland, and urbanized areas. Forested lands are dominated by maple-basswood, with smaller amounts of lowland hardwoods, aspen-birch, and lowland conifers. High quality areas of exposed alkaline bedrock beach occur on the northern

Door Peninsula, providing habitat for many rare plants. In addition, several islands lie off the Door Peninsula and these also provide critical habitat for rare species and colonially nesting birds.

Central Lake Michigan Coastal

The Central Lake Michigan Coastal Ecological Landscape stretches from southern Door County west across Green Bay to the Wolf River drainage, then southward in a narrowing strip along the Lake Michigan shore to central Milwaukee County. This landscape comprises 58% of the Lake Michigan Coastal Zone. Summers are cooler, winters are warmer, and precipitation levels are greater in the eastern part of this landscape than at locations farther inland, owing to the influence of Lake Michigan. Dolomites and shales underlie the glacial deposits that blanket virtually all of the Central Lake Michigan Coastal Ecological Landscape. The dolomite Niagara Escarpment is the major bedrock feature, running across the entire landscape from northeast to southwest. Series of dolomite cliffs provide critical habitat for rare terrestrial snails, bats, and specialized plants. The primary glacial landforms are ground moraine, outwash, and lakeplain. The topography is generally rolling where the surface is underlain by ground moraine, variable over areas of outwash, and nearly level where lacustrine deposits are present. Important soils include clays, loams, sands, and gravels. Certain landforms, such as sand spits, clay bluffs, beach and dune complexes, and ridge and swale systems, are associated only with the shorelines of Lake Michigan and Green Bay. Today approximately 84% of this Ecological Landscape is non-forested. The remaining forest consists mainly of mesic maple-basswood or maple-beech types, or lowland hardwoods composed of soft maples, ashes, and elms.

Southern Lake Michigan Coastal

The Southern Lake Michigan Coastal Ecological Landscape is located in the southeastern corner of Wisconsin along Lake Michigan and comprises 18% of the Lake Michigan Coastal Zone. The landforms in this Ecological Landscape are characteristic of glacial lake influence, with ridge and swale topography, clay bluffs, and lake plain along Lake Michigan. Soils typically have a silt-loam surface overlying loamy and clayey tills. Maple-basswood-beech forests once dominated the northern portion of this landscape and oak forest, oak savanna and prairies were prevalent in the south. Also, wet, wet-mesic, and lake plain prairies were, historically, common in this landscape. Today, dairy and cash grain agriculture and intense urban development dominate most of the area. Only about 8% of the Ecological Landscape is forested and only 1% is public land. There are some areas of wet-mesic and wet prairie but only small preserves remain since the landscape is heavily disturbed and fragmented. Because of this isolation, fragmentation, and high level of disturbance, non-native plants are abundant.

Three other Ecological Landscapes, Northwest Sands, North Central Forest, and Southeast Glacial Plains overlap the coastal zone. Each of these landscapes represents only 2-4% of the area of the coastal zone for their respective coast, so they are not described here. See the Wisconsin Ecological Landscapes Handbook (DNR 2002) for descriptions of these and other Landscapes found in Wisconsin.

METHODS

STUDY AREA

The study area (Map 2) was established during Phase I of this project (Merryfield 2000) based on the following criteria:

1) **Ecological Landscapes[1].** Ecological Landscapes that are especially significant to Wisconsin's Great Lakes coasts and coastal wetlands include the Superior Coastal Plain, the Northern Lake Michigan Coastal, Central Lake Michigan Coastal, and the Southern Lake Michigan Coastal.

2) **Buffer area.** Wetlands that are within 6 miles of either the Lake Michigan or Lake Superior shoreline.

PRIMARY SITE SELECTION AND DATA ACQUISITION

Sixty-four primary coastal wetland sites were identified during the first phase of this project (WDNR 2000) using three main sources of information: a synthesis of over 40 reports found through a literature search, several other sources of data (including aerial photographs, Wisconsin Wetland Inventory GIS coverage, NHI Element Occurrence data, Ecological Landscapes of Wisconsin, Door Peninsula, Wisconsin Critical Habitat & Natural Areas Protection Plan, Manitowoc County Coastal Wetlands, as well as other GIS coverages), and evaluation and review by NHI staff. All 28 of the Lake Superior sites had been previously identified through a two-year study conducted by NHI (Epstein et al. 1997). Primary Lake Michigan sites were extracted from five additional sources of information (Herdendorf et al. 1981, WDNR 1980, Southeastern Wisconsin Regional Planning Commission 1997, Door County Land Use Forum 1999, and Water Resources Management Graduate Students 1998). Each of the information sources used to extract primary sites was summarized in a report prepared following phase one (Merryfield 2000). The sites resulting from Phase one had generalized site boundaries that included non-wetland areas in some cases. Site boundaries were digitized and delineated on a map included with the phase one report.

Because many of the Lake Michigan Primary sites were identified either from the literature or older DNR file information, "windshield surveys" were conducted on 26 of the 36 Lake Michigan sites during Phase 2. These reconnaissance surveys were designed to identify and prioritize areas for which more detailed future field surveys were needed. During the reconnaissance surveys, photographs were taken for the CD-ROM and web-based products associated with this project. Additional photographs were collected and limited plant surveys were conducted during Phase 3 for sites where the NHI database had insufficient or outdated data. NHI staff visited as many of these sites as project resources allowed.

[1] The boundaries for several of the Ecological Landscapes have changed since Phase 1 of the project. Map 1 contains the current Ecological Landscape boundaries.

Several existing sets of data were procured as part of this project in an attempt to fill data gaps and improve our understanding of the significance of the Primary Sites. Several large gaps in existing information were identified during Phase One, particularly for birds and fish. During the remaining phases of the project, active field ornithologists were contacted, and five major bird databases were procured. Efforts were made to contact the original data collectors for the Wisconsin Breeding Bird Atlas, one major data set that had not been incorporated into DNR files. A statewide fish database was procured from Don Fago, WDNR to address one of the other important information deficiencies. Finally, a methodology was developed for incorporating all of the useable data into NHI's Biological Conservation Database. Data for natural communities and rare species tracked by NHI are included in the individual site descriptions.

SITE PRIORITIZATION

Sites were ordered numerically during Phase Two of the project based on several attributes including site size, number and quality of element occurrences, development pressure, and whether the site had been surveyed for a number of different taxa or natural communities. This ranking was useful for determining which sites should be visited during Phase 3 to gain additional information. However, large disparities with respect to the amount of available data skewed several of the site rankings. Also, visits to several of the sites during 2001 revealed that rankings had been inflated due to a basic lack of information. For some of these sites, quality should have ranked lower due to poor size, quality, and/or condition.

Ordering was also difficult because of differences between Lake Superior and Lake Michigan sites in regard to the amount and quality of available information. BER was able to perform a comprehensive, detailed evaluation of the Lake Superior sites through a past major funding initiative; Lake Michigan has not received a comparable treatment. In addition, the Lake Superior sites are generally of higher quality, although some of this difference may be due to the initial pre-screening performed as part of the aforementioned study. Further, comparing sites that are quite different ecologically may be of limited use. A set of sites may contain very different natural community types. For example, lakeplain prairie occurs only at Chiwaukee and cannot be compared with other sites, and almost all of the freshwater estuary sites are on Lake Superior, with the notable exception of Mink River, and cannot be compared with Lake Michigan sites. Although these sites are not directly comparable, regional distribution and status of the communities and associated rare species (obtained from sources such as The Nature Conservancy's ecoregional planning initiative for the Great Lakes and other state's Heritage programs) does allow for a degree of prioritization, when combined with individual site size, context, and condition. Some sites are presently in poor condition but represent a potential opportunity for habitat restoration because of factors such as large size, remnant patches of good quality native vegetation, public ownership, and/or location. Several sites are relatively small and somewhat degraded, but contain rare species that are known only from a few populations in the entire state.

Because of these limitations, we did not order the sites numerically during Phase 3 of the project. Instead, important features of each of the sites are included in the description and a list of "exemplary sites" is included in this report.