COASTAL ENDANGERED PLANT INVENTORY

A report on the Seabrook Dunes, its vegetation and flora

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15 February 1983

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and
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INTRODUCTION

In the summer of 1982 a project was established, funded by the Department of Commerce, NOAA, Office of Ocean and Coastal Resource Management through the New Hampshire Office of State Planning, aimed at contributing to the development of baseline data on coastal resources, particularly plants regarded as rare, threatened, or endangered in New Hampshire. As part of this overall project, particular attention was directed at the Seabrook Dunes. This report provides a description and inventory of the natural dune vegetation with special recognition given to those species considered rare for the state.

The coastline of New Hampshire represents a transitional zone between the typical sandy beaches and barrier beach islands with extensive salt marsh development, characteristic of the coast of the South to Middle Atlantic states, and the rocky coastline characteristic of Maine (Crow and Storks, 1980). Extensive dune and salt marsh habitat once extended from Seabrook to Hampton Beach, and intermittently northward.

A typical coastal dune system consists of a foredune, an interdune, and a backdune. The foredune ridge receives the greatest impact of coastal storms and few species are able to colonize it. Behind the foredune a more stable, yet dynamic, interdune of low, undulating sands supports a more

diversified flora. A backdune formation of higher dunes and deep hollows develops furthest from the beach and is characterized by shrub thickets and sunken forests. The dune ecosystem at nearby Plum Island, Massachusetts represents the best preserved dune system north of Cape Cod (cf. McDonnell, 1979a).

The sand dune ecosystem is important to us ecologically and economically for two reasons: 1) it provides a natural buffer protecting the coast from the impact of severe storms (particularly northeasters) and tropical hurricanes, and 2) it provides recreational opportunities (McDonnell, 1979). In New Hampshire the latter reason has been readily recognized, as the all-too-short coastal zone has experienced intense pressures from development and the pressure on this valuable resource is not likely to ease. Nearly all of the dune habitat has been exploited for resort related purposes. At the Seabrook dunes the once extensive interdune is now replaced by houses and summer cottages and all that remains is a remnant a once healthy sand dune ecosystem. It is this backdune community which is the focal point of this study.

PHYSICAL FEATURES

The Seabrook backdune community, which occupies a site of approximately 56 acres in the southeastern corner of the Town of Seabrook, constitutes the only remnant of sand dune formation in New Hampshire. Designated as "The Sands" on the USGS Hampton Quadrangle topographical map, the Seabrook dunes lie east of the extensive Seabrook salt marsh and the Blackwater River (figs. 2, 3). To the south the dunes are bordered by a small portion of salt marsh which separates the area from adjacent commercial properties. The northern boundary, formed by salt marsh and Cross Beach Road (unimproved), is periodically flooded by high tides. This road leads out onto the marsh to a few residential buildings designated on the topographical map as "Riverside." Just north of Cross Beach Road are additional commercial establishments. To the east, the dunes abut Route 1A for approximately 5440 feet. Along this road, a number of commercial enterprises and residential homes have already obliterated the interdune community and are encroaching on the backdune community (figs. 2, 3).

METHODS

The project, undertaken to provide an inventory of the natural dune vegetation, was divided into two parts: 1) a description of the composition, structure, and distribution

of the vegetation and 2) a floristic documentation of the dune's flora with special recognition given to those species that are considered rare for New Hampshire.

Aerial photos were used to delineate all vegetated areas. These areas were evaluated in the field for physiognomy and species composition. Dominant species were used to describe each vegetation type. Quantitative data analysis using quadrats was not employed.

The floristic study was conducted through a systematic reconnaissance of the area once each week beginning in May 1982 and continuing through October 1982. Collections of all vascular plant species were made and data on relative abundance and habitat were recorded in the field. Voucher specimens were deposited in the Hodgdon Herbarium (NHA) at the University of New Hampshire. The result of this part is a detailed list of the flora.

It should be noted here that the residential properties along Route 1A were circumscribed within the area on the vegetation map because of their direct impact on the dune community. The floristic study was not extended to the private property nor to the roadside immediately adjacent to Route 1A. These disturbed, weedy areas are quite different and no longer reflect the natural dune vegetation.

VEGETATION

Six vegetation types were recognized for the Seabrook backdune community and adjacent salt marsh. These are defined on physiognomy and dominant plant species. The six types are:

1) Sunken Forest
2) Dunegrass
3) Thickets
    a) Tall Thicket
    b) Short Shrub Thicket
4) Wet Swale
5) Salt Marsh
6) Drift-line

The most conspicuous vegetation type is the sunken forest. These heavily wooded areas form in the deeper protected hollows between the highest dunes and it is here that many trees reach their maximum height in the dune community. Surrounding these high dunes and sunken forests are low dunes, with a characteristic grassland appearance where the dunegrass vegetation type is predominant. Scattered among these low dunes is a mixture of shrubby and arborescent thickets. Some thickets are dominated by low shrubs less than 2 meters in height and hence are called short shrub thickets, whereas others are dominated by small trees, over 2 meters in height, and therefore are called tall thickets. In the isolated hollows of the low dunes, wet swales provide a habitat for a number of wetland species. Although the wet swales are few in number, they possess a unique assemblage of plants. The fifth vegetation type, salt marsh, is contiguous with the dune sands on all

sides but the east. This high salt marsh is frequently inundated by high tides throughout the year and the plants are well adapted to this saline environment. To the west the boundary between salt marsh and dunes is somewhat transitional. In these areas, the dunes are very low and periodically experience inundation by very high storm tides which leave behind large amounts of salt marsh debris. These areas form a sixth vegetation type, the drift-line. Following is a description of the six vegetation types, emphasizing the dominant species (cf. vegetation map and aerial photographs, figs. 1, 2, 3).

The vegetation map was constructed from aerial photographs and from on-site evaluations of the individual vegetation types. Although the map suggests abrupt boundaries between the vegetation types, there are transitional zones composed of species from each type.

Sunken Forest

In the backdune, four areas have been designated as sunken forests. All of these areas are heavily wooded and dominated by a tall canopy of *Prunus serotina* (black cherry), *Amelanchier stolonifera* (shadbush), *Populus tremuloides* (trembling aspen), *Acer rubrum* (red maple) and occasionally by *Pinus rigida* (pitch pine). The understory is dominated by *Lonicera morrowi* (honeysuckle), *Berberis vulgaris* (barberry), *Toxicodendron radicans* (poison ivy), and *Parthenocissus quinquefolia* (Virginia creeper). In

Vegetation of Seabrook Dunes

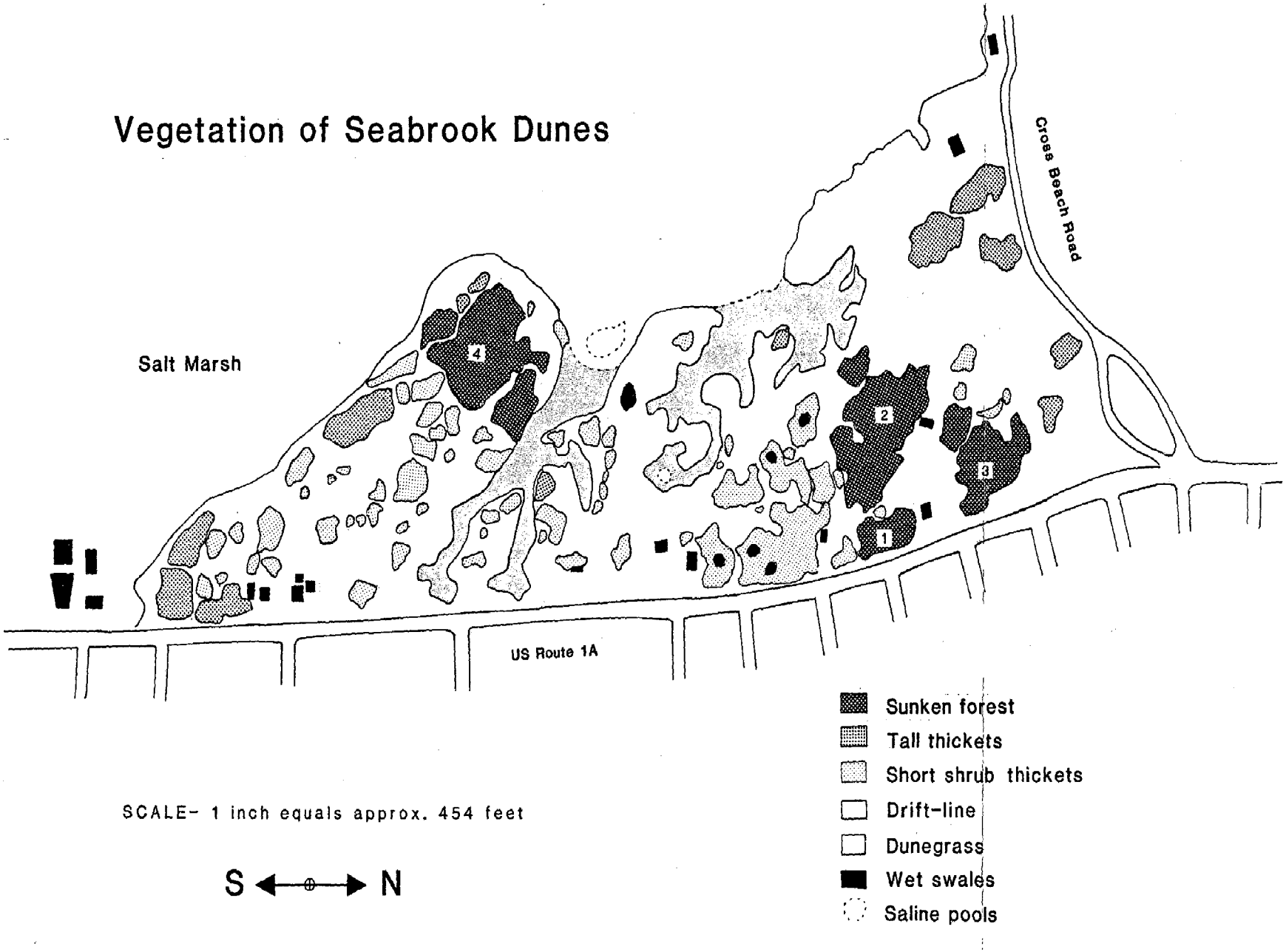
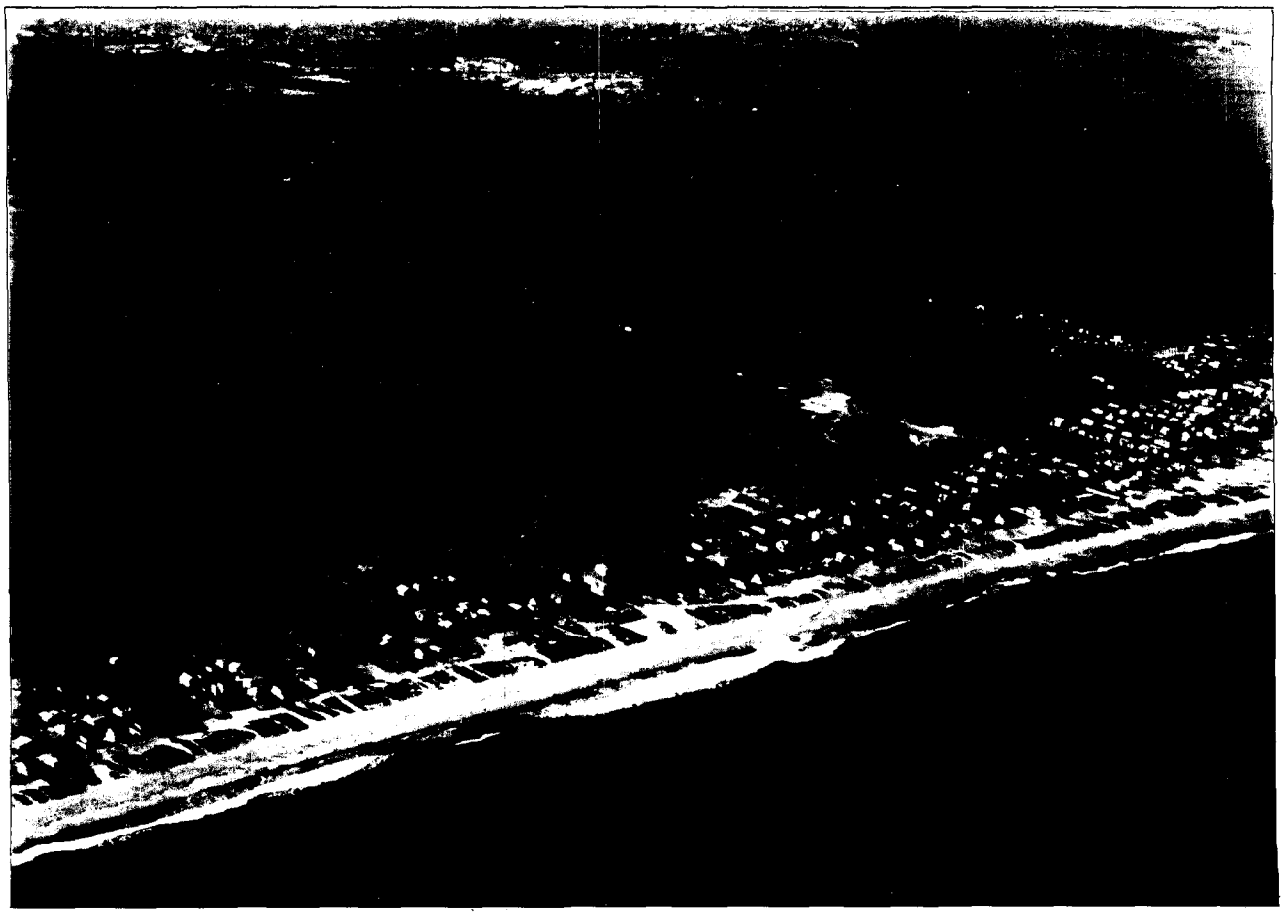


Fig. 1

Fig. 2. Aerial photograph of Seabrook Dunes. 1982.
Photo courtesy of USDA-ASCS, Rockingham Co., NH

Fig. 3. Oblique aerial view of Seabrook Dunes. 1978.
Photo by Garrett E. Crow



addition, many herbaceous species are common: Aralia nudicaulis (wild sarsaparilla), Maianthemum canadense (false lily-of-the-valley), Arenaria lateriflora (grove sandwort), and Smilicina stellata (false Solomon's seal). In the open areas along the fringes of the sunken forests, Myrica pensylvanica (bayberry) and Prunus maritima (beach plum) are very abundant.

Dunegrass

The vegetation of the low dunes is dominated by grasses and other low herbaceous plants. Ammophila breviligulata (beach grass) is the most abundant species and particularly important in dune stabilization. It spreads rapidly by underground stems and colonizes open sands. Andropogon scoparius (little blue stem) and Danthonia spicata (poverty-grass) are common grasses in the southern portion of the backdune community. Common plants are Lathyrus japonicus (beach pea), Lechea maritima (pinweed), Polygonella articulata (joint weed), and Cyperus filiculmis (sedge). Solidago sempervirens (seaside goldenrod) is very abundant throughout this vegetation type. In addition, large mats of Hudsonia tomentosa (beach heather) carpet areas of the low dunes.

Thickets

The most difficult vegetation type to characterize is the mixture of shrubby and arborescent thickets that occur throughout the low dunes. This catagory has been subdivided into two types: tall and short shrub thickets.

The tall thickets, the less common of the the two, form in the more stable areas of the low dunes and share species in common with the sunken forests. They differ in that the trees are smaller and the shrub layer very dense. The canopy in the tall thickets varies but it is most often composed of Populus tremuloides (trembling aspen), Prunus serotina (black cherry), Amelanchier stolonifera (shadbush), and occasionally Acer rubrum (red maple) and Pinus rigida (pitch pine). Other species common to the tall thickets are Amelanchier canadensis (shadbush), Rosa virginiana (rose), Parthenocissus quinquefolia (Virginia creeper), Berberis vulgaris (barberry), Viburnum recognitum (arrow-wood) and the ubiquitous Toxicodendron radicans (poison ivy).

The second thicket type, the short shrub thicket, is widespread on protected slopes and hollows of the low dunes. Two species, Myrica pensylvanica (bayberry) and Prunus maritima (beach plum), form extensive stands. Other common species associated with the short shrub thickets are Rosa virginiana (rose), Achillea millefolium (yarrow), Oenothera parviflora (evening-primrose), Polygonum scandens (false buckwheat) and Toxicodendron radicans (poison ivy).

Wet Swale

Two types of wet swales occur in the hollows of the low dunes. One is largely a cranberry swale with Vaccinium macrocarpon (large cranberry) forming large dense mats where the other, the Juncus swale, is dominated by thick stands of Juncus balticus (rush). Bordering each swale, Aronia prunifolia (purple chokeberry), Ilex verticillata (winterberry), Triadenum virginicum (marsh St. John's-wort), and Toxicodendron radicans (poison ivy) are very common.

Salt Marsh

The high marsh bordering the backdune is dominated by the salt marsh grasses Spartina patens and Spartina alterniflora. Among these grasses Limonium carolinianum (sea lavender), Plantago maritima (sea plantain), and Triglochin maritima (arrow-grass) are very common. Along the upper edge of the marsh, Juncus gerardi (black-grass) and Distichlis spicata (spike grass) form dense stands with Salicornia europaea (glasswort), Suaeda linearis (sea-blite), S. maritima (sea-blite), and S. richii (sea-blite).

Drift-line

Many low areas along the border of the salt marsh and backdune community are occasionally inundated by very high storm tides. As the tides subside they leave behind large amounts of salt marsh detritus and debris such as boat

fragments, tires, cans, bottles, and an occasional shoe. This debris separates the dune grasses from the more salt tolerant species. Few plants can grow through these dense piles of debris, but along the lower edge Spergularia marina (sand-spurry) borders thick stands of Spartina patens (salt marsh grass). Limonium carolinianum (sea lavender) and Puccinellia maritima (alkali-grass) are also common. The drift-line area is conspicuously lower in species diversity as compared with the numerous salt tolerant species occupying the high salt marsh.

FLORA OF SEABROOK DUNES

The following list of vascular plants documents the flora of the Seabrook dunes study area. The list is arranged alphabetically by family under the general catagories of ferns, gymnosperms, and angiosperms (flowering plants--monocots and dicots). Within each family, genera and species are also listed alphabetically to facilitate the use of this flora. Identifications were primarily based on Gray's Manual of Botany (Fernald, 1950) and A Manual of Vascular Plants of Northeastern United States and Adjacent Canada (Gleason and Cronquist, 1963). Voucher specimens cited as "CZ" were collected by one or more of the authors.

Particular attention was given to those species of the backdune community that are considered rare for the state. These species are asterisked on the floristic list and special notes on their abundance, distribution and habitat follow the floristic list.

FERNS AND FERN ALLIES

OSMUNDACEAE (Royal Fern Family)

Osmunda cinnamomea L. (cinnamon fern). Occasional; in sunken forest and wet swale. CZ 304, 502.

Osmunda regalis L. (royal fern). Occasional; in sunken forest. CZ 300.

POLYPODIACEAE (Fern Family)

Onoclea sensibilis L. (sensitive fern). Occasional; in moist areas of shrub thicket behind ridge of dune. McDonnell 928.

Thelypteris palustris Schott. (marsh fern). Uncommon; in wet swale. CZ 654.

GYMNOSPERMS

CUPRESSACEAE (Cypress Family)

Juniperus communis L. (common juniper). Uncommon; in thickets. CZ 80, 657.

PINACEAE (Pine Family)

Pinus rigida L. (pitch pine). Uncommon; a few trees in sunken forests and thickets. CZ 13, 68, 606; Crow 2515.

ANGIOSPERMS

DICOTS

ACERACEAE (Maple Family)

Acer rubrum L. (red maple). Common; in sunken forest. CZ 15, 31, 656.

ANACARDIACEAE (Cashew Family)

Rhus copallina L. (dwarf sumac, shining sumac). Uncommon; a few plants on fringes of sunken forest. CZ 233, 405.

Rhus typhina L. (staghorn sumac). Occasional; in thickets and on fringes of sunken forests. CZ 205, 495.

Toxicodendron radicans (L.) Kuntze (poison ivy). Abundant; throughout backdunes. CZ 152.

AQUIFOLIACEAE (Holly Family)

Ilex verticillata (L.) Gray (winterberry). Occasional; in wet swales and thickets and uncommon in sunken forest. CZ 207, 212, 400, 503, 504, 515, 588, 659.

ARALIACEAE (Ginseng Family)

Aralia nudicaulis L. (wild sarsaparilla). Common; in sunken forests. CZ 8, 50, 103, 513.

ASCLEPIADACEAE (Milkweed Family)

Asclepias syriaca L. (common milkweed). Frequent; in low dune area and occasional in sunken forest. CZ 180, 226.

ASTERACEAE/COMPOSITE (Sunflower Family)

Achillea millefolium L. (yarrow). Frequent; on edge of sunken forest, in low dune areas, and in thickets. CZ 86, 111, 125, 230, 493, 640. (including Achillea lanulosa Nutt.)

Ambrosia artemisiifolia L. (common ragweed). Uncommon; in disturbed area in low dune areas. CZ 438.

*Artemisia caudata Michx. (wormwood). Occasional in low dune areas with a few plants at the northern edge of Sunken Forest No. 2 and northern thicket; edge of abandonded building. CZ 318, 371, 481, 580; McDonnell 920.

Aster linariifolius L. (aster). Occasional; in low dune areas. CZ 652.

Chrysanthemum leucanthemum L. (ox-eye daisy). Occasional; in disturbed area on edges of sunken forest. CZ 95.

Erigeron canadensis L. (horseweed). Occasional; in roadside areas. CZ 404.

Erechtites hieracifolia (L.) Raf. (fireweed). Occasional; in low dune areas and thickets. CZ 623, 648.

Gnaphalium obtusifolium L. (catfoot). Occasional; in low dune area. CZ 486, 564; Crow 2489.

Hieracium florentinum All. (king devil). Occasional; in low dune areas. CZ 78.

Hieracium pilosella L. (mouse-ear). Uncommon; in disturbed area on edge of sunken forest. CZ 90.

Lactuca biennis (Moench) Fern. (wild lettuce). Frequent; in wet swale and on the edges of thickets and sunken forests. CZ 403, 433, 508, 627.

Solidago rugosa Ait. (goldenrod). Occasional; in sunken forests and thickets. CZ 397, 571, 619, 642.

Solidago sempervirens L. (seaside goldenrod). Common; in low dune area and edges of thickets and sunken forests. CZ 506, 570, 587, 635.

BERBERIDACEAE (Barberry Family)

Berberis vulgaris L. (common barberry). Common; in sunken forests. CZ 10, 36, 46, 94, 102, 206, 396, 497, 582.

BETULACEAE (Birch Family)

Betula populifolia Marsh. (gray birch). Single tree in wet swale. CZ 77.

BRASSICACEAE/CRUCIFERAE (Mustard Family)

Barbarea vulgaris R. Br. (common winter-cress). Occasional; along roadside. CZ 92.

Cakile edentula (Bigel.) Hook. (sea-rocket). Common; in low dune areas and edges of thickets. CZ 196, 571.

Sisymbrium altissimum L. (tumble-mustard). Common; edge of sunken forest. CZ 108.

CAPRIFOLIACEAE (Honeysuckle Family)

Lonicera X bella Zabel (hybrid honeysuckle). Common; in sunken forest. CZ 6.

Lonicera morrowi Gray (honeysuckle). Common; in sunken forest and thickets. CZ 9, 99, 240, 258, 644.

Sambucus canadensis L. (common elderberry). Occasional; in sunken forests. CZ 182, 201, 234.

Viburnum recognitum Fern. (arrow-wood). Common; in thickets, sunken forests, and wet swales. CZ 127, 237, 436, 608, 639.

CARYOPHYLLACEAE (Pink Family)

Arenaria lateriflora L. (grove sandwort). Common; in sunken forests and wet swale. CZ 3, 48, 51.

*Arenaria peploides L. (seabeach sandwort). One plant on west side of Rt. 1A about 15 meters from turnoff to Riverside, about 4 meters from edge of road in strand line. CZ 665.

Lychnis alba L. (white cockle). Occasional; along roadside. CZ 93.

Spergularia marina (L.) Griseb. (sand-spurrey). Common; in salt marsh. CZ 217, 374, 598.

CELASTRACEAE (Staff-tree Family)

Celastrus orbiculatus Thunb. (bittersweet). Occasional; in sunken forest. CZ 105.

Celastrus scandens L. (climbing bittersweet). Uncommon; in thicket. CZ 594.

CHENOPODIACEAE (Goosefoot Family)

Atriplex glabriuscula Edmondston (orach). Occasional in wet pan near salt marsh. Crow 2512.

Atriplex patula L. var. littoralis (orach). Common; in salt marsh. CZ 599, 607.

Chenopodium album L. (pigweed). Common; in low dune areas. CZ 368, 369, 482, 509, 605; Crow 2506. (including Chenopodium lanceolatum Muhl.)

*Salicornia bigelovii Torr. (dwarf saltwort, dwarf glasswort). Occasional; at north end of Seabrook backdunes in area inundated by very high tides. Few plants in open mud/sand patches. CZ 667; Hodgdon and Steele 40452.

Salicornia europaea L. (glasswort, chickenclaws). Common; in salt marsh. CZ 491, 597.

*Salicornia virginica L. (woody glasswort, leadgrass). Locally abundant; in high marsh north of dunes and Cross Beach Road, adjacent to Rt. 1A. CZ 575, 666; Hodgdon and Steele 10584, 15104.

Suaeda linearis (Ell.) Moq. (sea-blite). Occasional; in salt marsh. CZ 489.

Suaeda maritima (L.) Dumort. (sea-blite). Occasional; in salt marsh. CZ 604; Crow 2491.

Sueada richii Fern. (sea-blite). Occasional; in salt marsh. CZ 603, 664.

CISTACEAE (Rockrose Family)

*Hudsonia tomentosa Nutt. var. tomentosa (beach heather, false heather, beach heath). Common; in low dune areas. CZ 55, 67, 88, 478, 581, 593; Szepan 1090-413; Crow 2499.

Lechea maritima Leggett (pinweed). Common; in low dune areas. CZ 322, 376, 389, 484, 569, 663; Crow 2498.

CLETHRACEAE (White Alder Family)

Clethra alnifolia L. (sweet pepperbush). Uncommon; in sunken forest. CZ 100.

CLUSIACEAE/GUTTIFERAE (St. John's-wort Family)

Hypericum gentianoides (L.) BSP. (orange-grass). Occasional; along roadside. CZ 388.

Hypericum perforatum L. (common St. John's-wort). Occasional; on edges of sunken forests and in thickets. CZ 184, 185, 198, 204, 297.

Triadenum virginicum (L.) Raf. (marsh St. John's-wort). Occasional; in wet swale. CZ 380, 658.

ERICACEAE (Heath Family)

Gaylussacia baccata (Wang.) K. Koch (huckleberry). Common; in thicket behind ridge of dune. McDonnell 952.

Lyonia ligustrina (L.) DC. (maleberry or male-blueberry). Common; in shrub thicket behind ridge of dune. McDonnell 949.

Vaccinium corymbosum L. (highbush blueberry). Uncommon; in sunken forest. CZ 26, 29.

Vaccinium macrocarpon Ait. (large cranberry). Locally abundant; in wet swales. CZ 183, 211, 381, 576.

EUPHORBIACEAE (Spurge Family)

Euphorbia esula L. (leafy spurge). Occasional; in sunken forests and low dune areas. CZ 7, 45, 87, 209.

Euphorbia polygonifolia L. (seaside spurge). Occasional; low dune areas. CZ 321, 662.

FABACEAE/LEGUMINOSAE (Bean Family)

Lathyrus japonicus Willd. (beach pea). Occasional; in low dune areas. CZ 58, 91, 199.

Trifolium arvense L. (rabbit-foot clover). Common; edge of sunken forest. CZ 434.

Trifolium repens L. (white clover). Common; edge of sunken forest. CZ 107.

FAGACEAE (Beech Family)

Quercus velutina Lam. (black oak). Occasional; in sunken forest. CZ 203.

LYTHRACEAE (Loosestrife Family)

Lythrum salicaria L. (purple loosestrife). Occasional; edge of sunken forest. CZ 302.

LAMIACEAE/LABIATAE (Mint Family)

Teucrium canadense L. (American germander). Common; on edge of sunken forest. CZ 298, 439, 520, 647. (including var. angustatum Gray and var. occidentale (Gray) McClintock and Epling)

MYRICACEAE (Bayberry Family)

Comptonia peregrina (L.) Coult. (sweet fern). Occasional; edge of sunken forest. CZ 27.

Myrica pensylvanica Loisel. (bayberry). Abundant; in thickets and edges of sunken forests. CZ 17, 20, 32, 69, 97, 200, 492, 613, 637; Crow 2495, 2497.

ONAGRACEAE (Evening-primrose Family)

Epilobium glandulosum Lehm. (willow herb). Occasional; in wet swale. CZ 578.

Oenothera parviflora L. (evening-primrose). Common; in low dune areas and on edge of sunken forest. CZ 195, 398,

435, 480.

PAPAVERACEAE (Poppy Family)

Chelidonium majus L. (celadine). Occasional; on edge of sunken forest. CZ 153.

PLANTAGINACEAE (Plantain Family)

Plantago maritima L. ssp. juncoides (Lam.) Hulten (seaside-plantain). Common; in salt marsh. CZ 378.

PLUMBAGINACEAE (Leadwort Family)

Limonium carolinianum (Walt.) Britt. (sea lavender). Common; in salt marsh. CZ 216, 270; Crow 2490. (including Limonium nashii)

POLYGONACEAE (Buckwheat Family)

Rumex acetosella L. (sheep-sorrel). Frequent; on edge of sunken forests and in low dune areas. CZ 49, 71, 84, 194.

Polygonella articulata (L.) Meisn. (jointweed). Common; in low dune areas. CZ 483, 562, 568, 626, 641; Crow 2496.

Polygonum scandens L. (climbing false buckwheat). Frequent; on shrubs in thickets and on edges of sunken forests. CZ 440, 517, 617, 643.

PRIMULACEAE (Primrose Family)

Lysimachia quadrifolia L. (whorled loosestrife). Common; along roadside. CZ 156.

Trientalis borealis Raf. (star flower). Occasional; in sunken forest. CZ 54.

RHAMNACEAE (Buckthorn Family)

Rhamnus frangula L. (buckthorn). Occasional; in sunken forest. CZ 231.

ROSACEAE (Rose Family)

Amelanchier canadensis (L.) Medic. (shadbush). Common; in sunken forests and in thickets. CZ 12, 22, 59, 65, 221, 232, 496, 590.

Amelanchier stolonifera Wieg. (shadbush). Common; in sunken forest and in thickets. CZ 24, 34, 596, 614, 645.

Aronia arbutifolia (L.) Ell. (red chokeberry). Occasional; in wet swale and sunken forests. CZ 18, 43, 53, 213, 316.

Aronia prunifolia (Marsh.) Rehder (purple chokeberry). Common; in thickets, wet swales, and edge of sunken forsts. CZ 64, 501, 514, 577, 660; Crow 2492.

Crataegus chrysocarpa Ashe. (hawthorne). Frequent; in sunken forests and in thickets. CZ 2, 40, 299, 393, 443.

Fragaria virginiana Duchesne (wild strawberry). Local; in sandy area at edge of thicket behind ridge of dune. McDonnell 944.

Prunus maritima Marsh. (beach plum). Abundant; on edges of sunken forests and thickets. CZ 16, 41, 126, 224, 263, 320, 494, 583, 591, 610, 646; Crow 2505.

Prunus pensylvanica L. (pin-cherry). Uncommon; in sunken forest. CZ 23.

Prunus serotina Ehrh. (black cherry). Common; in sunken forests and in thickets. CZ 25, 56, 63, 66, 70, 227, 239, 392, 595, 612, 621, 636; Crow 2501.

Prunus virginiana L. (choke-cherry). Frequent; in sunken forests. CZ 5, 30, 33, 44, 208, 259; Crow 2504.

Rosa virginiana Mill. (low rose). Common; in thickets, sunken forests, and low dune areas. CZ 109, 129, 155, 235, 273, 516, 618, 624, 649.

Rubus allegheniensis Porter (common blackberry). Occasional; edge of sunken forest. CZ 228.

Rubus idaeus L. var. strigosus (Michx.) Maxim. (red raspberry). Occasional; edge of sunken forest. CZ 79.

Spiraea latifolia (Ait.) Borkh. (meadow sweet). Occasional; in low dune area and edges of wet swales and sunken forests. CZ 181, 236, 301, 382.

Spiraea tomentosa L. (hardhack). Occasional; in thickets. CZ 500.

RUBIACEAE (Madder Family)

Galium aparine L. (spring-cleavers). Occasional; in sunken forests. CZ 85, 616.

Houstonia caerulea L. (bluets). Uncommon; edge of sunken forest. CZ 106.

SALICACEAE (Willow Family)

Populus tremuloides Michx. (trembling aspen, small-toothed aspen). Common; in thicket area. CZ 589.

SAXIFRAGACEAE (Saxifrage Family)

Ribes hirtellum Michx. (common gooseberry). Common; on edge of sunken forest. CZ 28, 229; McDonnell 931.

SCROPHULARIACEAE (Figwort Family)

Linaria canadensis (L.) Dumont (old-field toadflax). Occasional; in low dune area and along roadside. CZ 62, 387.

SOLANACEAE (Nightshade Family)

Solanum dulcamara L. (nightshade). Frequent; in sunken forests. CZ 104, 154, 225, 261, 394.

Solanum nigrum L. (black nightshade). Uncommon; in sunken forests. CZ 615.

VITACEAE (Grape Family)

Parthenocissus quinquefolia (L.) Planch. (Virginia creeper). Common; in sunken forest and thicket areas. CZ 305, 395, 499, 592, 609, 620, 638; Crow 2493.

Vitis labrusca L. (fox grape). Common; in sunken forest. CZ 37.

Vitis riparia Michx. (frost grape). Uncommon; in thicket area. CZ 585.

MONOCOTS

CYPERACEAE (Sedge Family)

Carex silicea Olney (sedge). Occasional; in low dune areas and sunken forest. CZ 274, 573; Crow 2510.

Carex pensylvanica Lam. (sedge). Abundant; on edge of sunken forests and in low dune areas. CZ 21, 42, 75.

*Cyperus grayii Torr. (Gray's sedge). Frequent; in low dune area. CZ 219, 306, 383, 384, 390, 485, 561, 566; Crow 2502; Storks 230.

Cyperus filiculmis Vahl (sedge). Common; in low dune area and roadside. CZ 220, 325, 367, 377, 409, 447, 451, 455, 458, 467, 471, 473, 558, 560, 567.

Scirpus atrocinctus Fern. (dusky wool-grass). Local; wet swale. CZ 215.

JUNCACEAE (Rush Family)

Juncus balticus Willd. (rush). Common; in wet swale. CZ 35, 47, 214, 269.

Juncus gerardi Loisel. (black-grass). Abundant; in salt marsh. CZ 267, 653.

Juncus greenei Oakes and Tuckerm. (Greene's rush). Occasional; in thicket. CZ 505.

Juncus tenuis Willd. var. tenuis (rush). Local; wet swales. CZ 315, 317, 399, 401, 402, 579.

JUNCAGINACEAE (Arrow-grass Family)

Triglochin maritima L. (arrow-grass). Occasional; in wet swales in low dune areas. CZ 72.

LILIACEAE (Lily Family)

Maianthemum canadense Desf. (false lily-of-the-valley). Abundant; in sunken forests. CZ 1, 52, 96, 512.

Polygonatum pubescens (Willd.) Pursh. (Solomon's seal). Uncommon; in sunken forest. CZ 11.

Smilacina stellata (L.) Desf. (false Solomon's seal). Common; in sunken forests and thickets. CZ 19, 39, 98, 110, 238, 510, 586.

POACEAE/GRAMINEAE (Grass Family)

Agrostis alba L. (redtop). Occasional; in low dune area. CZ 650.

Agrostis scabra L. (ticklegrass). Frequent; in low dune area. CZ 74.

Agropyron repens (L.) Beauv. (quack-grass). Occasional; in low dune area and edge of thickets. CZ 197, 268.

*Ammophila breviligulata Fern. (beach grass). Abundant; in low dune areas. CZ 128, 266, 319, 487, 547; Crow 2508; Storks 233.

Andropogon scoparius Michx. (little bluestem). Common; along roadside and low dune areas, edges of thickets and sunken forests. CZ 386, 442, 507, 518, 625, 655.

*Aristida tuberculosa Nutt. (seabeach needle grass). Locally abundant; on roadside, west side of Rt. 1A in dry sand, and in low dune area, especially in northern portion of study area. CZ 385, 437, 479, 565; Crow 2513; Storks 231; Hodgdon and Steele 10494.

Bromus tectorum L. (downy chess). Common; in sunken forest and low dune areas. CZ 38, 61, 130, 223, 260, 391.

Calamagrostis canadensis (Michx.) Nutt. (blue-joint). Common; edge of sunken forest. CZ 60, 262.

Danthonia spicata (L.) Beauv. (poverty-grass). Common; southern low dune area. CZ 265.

Digitaria ischaemum (Schreb.) Muhl. (small crabgrass). Common; on disturbed sites, particularly along road across dune and around foundation of abandoned building. McDonnell 945.

Digitaria sanguinalis (L.) Scop. (crabgrass). Occasional; along roadside and in low dune areas. CZ 441, 651.

Distichlis spicata (L.) Greene (spike-grass). Common; in salt marsh. CZ 379.

Festuca ovina L. (sheep's fescue). Occasional; in low dunes areas. Crow 2511.

Festuca rubra L. (red fescue). Frequent; on edge of sunken forest. CZ 57.

Panicum lanuginosum Ell. var. fasciculatum (Torr.) Fern. (panic grass). Occasional; in low dune area. CZ 73.

Phleum pratense L. (timothy). Occasional; on edge of sunken forest. CZ 202.

Poa pratensis L. (Kentucky bluegrass). Occasional; edge of sunken forest. CZ 24, 264.

Puccinellia maritima (Huds.) Parl (alkali-grass). Common; in salt marsh. CZ 89, 222, 272, 370, 372, 373.

*Puccinellia paupercula (Holm.) Fern. and Weath. var. alaskana (Scribn. and Merr.) Fern. and Weath. (alkali-grass). Occasional; edge of salt marsh. CZ 633.

Spartina alterniflora Loisel (saltwater cordgrass). Common; short form in wetter areas of high salt marsh. CZ 488; McDonnell 961.

Spartina patens (Ait.) Muhl. (salt-meadow grass, salt marsh grass). Common; in salt marsh. CZ 210, 271, 375.

ENDANGERED SPECIES

In the fall of 1978 a report prepared at the University of New Hampshire entitled Rare and Endangered Plant Species in New Hampshire (Storks and Crow, 1978) was published enumerating 398 vascular plant taxa which were regarded as sufficiently rare in the state to warrant their protection through habitat preservation. Of these, a total of 37 species (9%) are coastal (including Great Bay estuarine system), some of which are known only from a single town or single site (Crow and Storks, 1980).

The coastal region has experienced continued intense pressure from developmental interests. One heavily impacted area is the Seabrook dune site. Nine species found at the dunes are listed. Five are regarded "endangered," two are given "threatened" status and two are treated as "rare" (Crow and Storks, 1980; Storks and Crow, 1978).

While the rare and endangered plants species list does not enjoy official recognition by State law, the list was adopted by Governor Gallen's Advisory Council on Growth. Its Natural Areas Committee recommended the establishment of a program to protect rare, threatened and endangered plant species in New Hampshire (OSP, 1981) and The Nature Conservancy, working under contract with the Office of State Planning, viewed the list as a key element of their proposed N. H. Natural Heritage Program (TNC,1980).

Endangered

Arenaria peploides var. *robusta*
Aristida tuberculosa
Cyperus grayii
Hudsonia tomentosa var. *tomentosa*
Salicornia virginica

Threatened

Ammophila breviligulata
Salicornia bigelovii

Rare

Artemisia caudata
Puccinellia paupercula var. *alaskana*

All nine are typically restricted to the coastal sand dune or salt marsh habitat. Notes on relative abundance, distribution and location in the Seabrook backdune community are provided for each. They are presented in alphabetical order.

Ammophila breviligulata beach grass

Poaceae/Gramineae

This robust perennial beach grass is the dominant species in the dunegrass vegetation type in the low dune area at the Seabrook study site. It also occurs on the foredune at Seabrook Beach and in several sandy areas along the New Hampshire coast, especially along roadsides and near residential areas where the natural vegetation has managed to persist. *Ammophila breviligulata* is critical to the stabilization of the dunes. The Seabrook dune population of this species is the most significant site in the state.

Arenaria peploides seabeach sandwort

Caryophyllaceae

Only one site, consisting of a single plant, was found on the New Hampshire coast during the 1982 field season. This particular plant is located at the north end of the backdune where Cross Beach Road meets Route 1A. It lies just above the strand line, very close to the pavement of Route 1A. This site was observed in October 1982, but was originally discovered by Frank Richardson in 1973 (Breeding *et al.*, 1974; Richardson, pers. comm.). The Seabrook site is particularly significant since it represents the only occurrence in the state. The species appears to be declining in Massachusetts; it has not been collected on Plum Island since 1915 and may have been extirpated there (McDonnell, 1979a).

Aristida tuberculosa seabeach needle grass

Poaceae/Gramineae

Seabeach needle gras grows scattered throughout the low dune area. It iss locally abundant on the northwest side of the backdune and along the side adjacent to Route 1A. In addition, it is frequently present on vacant lots and roadsides in the residential neighborhoods (the original interdune area) at Seabrook Beach. This species, restricted to only one town in New Hampshire, is also listed on the regional list of rare and endangered plants of New England

(Crow *et al.*, 1981). It is most apparent in late August by the conspicuously twisted glumes on the fully mature flower spike.

Artemisia caudata wormwood

Asteraceae/Compositae

This member of the daisy family is occasionally found along the edges of the thickets and on the northern fringe of sunken forest No. 2. Outside of the study area, it is frequent along the New Hampshire coast in sandy sites, especially on the foredune at Seabrook Beach. This deep-rooted biennial grows for one season as a rosette of finely dissected green leaves, then puts forth a tall inflorescence of inconspicuous flowers the second year. The entire plant dies at the end of the second year. It is readily recognized throughout the growing season.

Cyperus grayii Gray's sedge

Cyperaceae

This member of the sedge family is restricted to the Town of Seabrook, where it grows on the low dunes of the study area. It occasionally grows on the foredune and along sandy roadsides at Seabrook Beach. It can only be distinguished from another similar, but common sedge, when it is in flower.

Hudsonia tomentosa var. tomentosa — beach heather

Cistaceae

Hudsonia tomentosa var. tomentosa, found only in two towns in the state (Seabrook and Rye), occurs in both the foredune and backdune and occasionally in vacant lots in the residential area of Seabrook Beach. In the study area, Hudsonia tomentosa forms large mats on the low dunes where it is well adapted to shifting sands. McDonnell (1981) found this species exhibited greatest sensitivity to trampling of all the dune flora of Plum Island. When this low, blue-green leaved plant blooms in June, bright yellow flowers carpet portions of the low dune area. Closely related Hudsonia tomentosa var. intermedia occurs in only 3 towns in central New Hampshire.

Puccinellia paupercula — alkali-grass

Poaceae/Gramineae

This grass of saline sites occurs scattered on the high salt marsh, particularly in the drift-line area. It is sometimes difficult to distinguish this species from depauperate plants of its close relative Puccinellia maritima.

Salicornia bigelovii glasswort

Chenopodiaceae

This species is typically a salt marsh plant and is occasionally found on the New Hampshire coast in highly saline pannes on the high marsh. A few plants were found in a low area at the north end of the Seabrook dunes study area (south of Cross Beach Road and adjacent to Route 1A). This tiny annual is very inconspicuous most of the year and best recognized in late summer when it reaches its maximum growth.

Salicornia virginica woody glasswort

Chenopodiaceae

This species of *Salicornia* is locally abundant at the edge of the salt marsh bordering the north side of Cross Beach Road and northward along the western side of Route 1A to the nearby commercial properties. It is readily recognized throughout the growing season.

SITE EVALUATION

Three of the nine rare and endangered species, Aristida tuberculosa (seabeach needle grass), Arenaria peploides (seabeach sandwort), and Cyperus grayii (Gray's sedge), are restricted to the dune community at Seabrook. Although locally abundant at Seabrook dunes, Aristida tuberculosa is considered endangered not only for New Hampshire, but for the New England region as well (Crow et al., 1981). Only a single plant of Arenaria peploides was found at the north end of the backdune. It represents the only presently known site for New Hampshire.

The population of Hudsonia tomentosa (beach heather) at Seabrook is the largest coastal stand in New Hampshire. Until a small site was located in the Town of Rye during the course of this project, it was thought to occur only in Seabrook.

The other five rare elements are restricted to the coastal region but occur in a few other coastal towns. However, the Seabrook population of Ammophila breviligulata, the beach grass, is the most significant (best developed, most natural) in the state. Artemisia caudata (wormwood) is likewise best represented in Seabrook. The salt marsh rarity Salicornia bigelovii (Bigelow's glasswort) is somewhat scattered in the extensive salt marsh ecosystem in coastal New Hampshire. Its even rarer relative, Salicornia virginica (woody glasswort) is much more restricted; the

population at the Seabrook dune study site was found to be the largest (albeit still rather small) along the New Hampshire coast.

This underscores the importance of the dune community at Seabrook as a key element in the preservation of some of New Hampshire's rare flora. But the Seabrook community is, itself, threatened with extinction, and as it goes, so goes the last remnant of a natural dune system for the entire state of New Hampshire.

Perhaps the major threat to these populations is the impact of four-wheel drive and off-road vehicles. Access points from Route 1A and Cross Beach Road provide entrance to the many trails and paths that criss-cross the dunes. A recent town map depicts a road, Old Beach Road, transecting the dunes from Route 1A and running along the western boundary.

The damage done by these vehicles is readily visible (figs. 4, 5). The vehicles are driven up over small dunes, tearing up vegetation and exposing the dunes to wind erosion. A walk throught the dunes usually reveals a number of sites where vehicles have become stuck in the sand and great efforts were used to extract them. Large ruts from spinning tires are indicative of these sites.

Fig. 4. Four-wheel drive vehicle churning up sand of dunes. 1979. Photo by Garrett E. Crow

Fig. 5. Vehicle damage on dunes. 1982. Photo by Garrett E. Crow

By far, the greatest ecological damage has been done to the dunegrass vegetation in the low dunes area, the area where most of the rare species grow. While tall trees and shrubs of the sunken forests and thickets bar entrance into these areas, the loose sand created by vehicle damage destabilizes the dune system causing blowouts and dune movement, eventually resulting in the burial of whole sunken forests. Early stages of this can be readily observed at Sunken Forest No. 2.

The following recommendations are offered:

Recommendation 1. It is essential to halt the continuation of damage to the dunes caused by off-road vehicles. Fencing off the areas may not be practical, but pilings spaced to prevent vehicle access to the dunes at strategic locations could be installed. Signs announcing prohibition of vehicles will also be needed. Cooperation of the Seabrook police to enforce the prohibition is essential.

Recommendation 2. Further real estate development along the edge of the dunes should be prohibited in order to maintain the integrity of the backdune community.

Recommendation 3. Efforts should be made to establish the backdune community as a "Seabrook Dunes Natural Preserve" under the New Hampshire Natural Areas Program to provide protection of this site, with its unique flora and rare plants. The site should also be monitored by a group designated by the Natural Areas Program, such as the Society for the Protection of New Hampshire Forests or The Nature Conservancy.

All nine of these rare species are strictly dune or salt marsh plants and their existence is dependent on this unique habitat. Embodied in the federal Endangered Species Act of 1973 is the important concept of Critical Habitat. If the rare and endangered plants of the coastal zone are to survive we must also take an ecosystems approach. It is

impractical to provide protection for every site in New Hampshire were rare plants or animals occur. Thus, when several rare elements occur at a single locality it is indicative of a unique and very valuable habitat and a high priority should be placed on protection for the whole ecosystem on which the organisms depend for their survival. Therefore, preservation of the remaining Seabrook dunes community, with its nine rare species, must be seriously considered by the State of New Hampshire and the Town of Seabrook.

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