Management Assessment Report
Barn Island Wildlife Management Area
Stonington, Connecticut

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INTRODUCTION

Barn Island Wildlife Management Area (BIWMA) is located in the southeastern-most corner of Connecticut, in the town of Stonington. It is the State's largest, most diverse and ecologically significant coastal Wildlife Management Area. A Wildlife Management Area (WMA) is an area of land and water having unique or outstanding wildlife qualities that is managed primarily for the conservation and enhancement of fish and wildlife habitat and to provide opportunities for fish and wildlife-based recreation. The principal function of BIWMA is to provide healthy, undisturbed habitat for resident and migratory fish and wildlife. The property contains an outstanding marsh complex and one of Connecticut's last and largest un-fragmented coastal forests. The authors of this report believe it may be the largest expanse of tidal marshes that are adjacent to undeveloped upland habitat anywhere along the US coast from New York City to Maine. These habitats provide critical resting and feeding habitat for migratory waterfowl, shorebirds, wading birds, songbirds and raptors. The tidal marshes are home to various species of finfish and shellfish, many of which are food for migrating birds and sport-fish such as striped bass and bluefish.

BIWMA was established in 1944. Since that time, 35 property transactions have occurred, resulting in the protection of over 1,000 acres of habitat, including saltwater and freshwater wetlands, mixed hardwood forest, old fields and grasslands. A significant portion of the property was purchased with funds derived from an excise tax on sporting arms, ammunition and archery equipment through the Federal Aid in Wildlife Restoration Program (Pittman-Robertson Act or P-R Program). The P-R Program provides funding to the states for wildlife management and research, habitat acquisition, wildlife management area development, and hunter education. Over the years, many private, municipal and federal partners have contributed funds and in-kind services to assist the DEEP in the acquisition and management of the property. The addition of a 144-acre parcel, acquired in 2004 through a federal, state, municipal and private partnership, made Barn Island the largest coastal wildlife management area in Connecticut. The most recent addition of the 5.75-acre Matson property in 2010, brought the total acreage protected to approximately 1,020.

Thanks to its habitat diversity, BIWMA is home to a vast array of living species, including a number of rarities. The U.S. Fish and Wildlife Service (USFWS) recognizes the area as a regionally significant fish and wildlife habitat (USFWS 2001). The Audubon Society has designated it as a globally significant Important Bird Area (http://netapp.audubon.org/IBA/Site/2096); CT DEEP considers it a critical habitat area (http://www.cteco.uconn.edu/guides/resource/CT_ECO_Resource_Guide_Critical_Habitat.pdf). There are current and historic records for 20 federal or state-listed rare species. Barn Island has undoubtedly had more research conducted on its marshes over the past 65 years than any location in the state, if not in all of New England.

Because Barn Island is an extraordinary natural area within one of the most rapidly developing segments of Connecticut's coast, and it supports a variety of sensitive species and habitats, scientific research, outdoor education, and outdoor recreational uses, the demands placed on the site to accommodate multiple use objectives increasingly subject it to threats and conflicts originating from both within and outside of its property boundaries. No comprehensive management plant exists for BIWMA, and resource management has at times been ad hoc. The purpose of this study was to gather all of the information available about the site and present options for dealing with known issues and threats, as a first step toward the CT DEEP Wildlife Division developing a comprehensive management plan for the property.

The specific goal of this project was to address the following 10 principle management issues identified for BIWMA:

1. Greatest conservation need (GCN) species inventory, habitat assessment and management for species known or expected to occur at Barn Island, in particular, New England cottontail;
2. Forest resources assessment;
3. Responding to known threats to habitat quality such as increasing recreational use, invasive species, and sea-level-rise;
4. Coordinating scientific research in ecologically sensitive areas;
5. Prioritizing research and management of unauthorized encroachments along Barn Island's property boundaries;
6. Managing conflicts among sometimes disparate recreational user groups;
7. Prioritizing WMA property expansion/acquisitions;
8. Cultural resource inventory and management;
9. Prioritizing facilities improvement needs including improved access management; and
10. Fire break barrier area management and maintenance.

Note: All maps prepared for this report are located in Appendix A.

HISTORY

Given the scope of this project, collecting a detailed pre-acquisition history of BIWMA was not practical. Local Native Americans, primarily Pequot and Eastern Niantic people at the time of English settlement in the early seventeenth century, undoubtedly utilized the abundant natural resources available in what is now BIWMA. Unfortunately we were not able to locate information about the precolonial time period for this specific location during the course of this project. Much of the information in this section was derived from research publications and theses that focused on the tidal marshes, but which also included some historical background.

The peninsula at the western boundary of the BIWMA is called Palmer Neck, in honor of the original settler Walter Palmer (Map A). The name Barn Island is derived from the largest forested island, attached to the mainland by a tidal marsh, which historically was called Stanton Island. In the late 1800's, the Burdick's erected a huge barn that could be seen for miles around, and so the name Barn Island took hold. The barn suffered severe damage in the hurricane of 1938 and a fire claimed the remains of it in the 1940's. The deed to the parcel that includes this island refers to a Great Marsh, but no further description of this marsh could be located.

During the American Revolutionary War, the Davis Farm, directly east of BIWMA, provided the Continental Armies with hay harvested from its tidal marsh. This Davis Marsh has since then also been called the Continental Marsh. According to Miller (1948), one farmer grazed sheep on the upland and wetlands of BIWMA, and another farmer grazed cattle on upland adjacent to the marshes. Hay harvesting provided supplemental income and was used as livestock bedding and food. Salt hay was also used as mulch for strawberry gardens. Following the passage of the hurricane of 1938 (flood elevation 10.5 feet NGVD at nearby Pawcatuck Point), Barn Island farmers noted that the high marsh meadows became a wet smooth cordgrass (*Spartina alterniflora*) marsh that could not be hayed (Miller 1948). Some have suggested the breaches across Napatree and the separation of Sandy Point from Napatree changed the tidal range in Little Narragansett Bay. A more likely cause would be compression of the peat by the surge which lowered marsh elevations and favored the observed increases of smooth cordgrass.

Miller (1948) notes that farmers supplemented their food staples and income from the sale of game and pelts. Game was said to be plentiful 50 years earlier and it would appear that a primary game bird was yellowlegs (species unknown). Miller also notes the following:

- A hunter from Newport killed 1, 362 yellowlegs in an 8-year period from 1867 to 1874.
- Mrs. Burdick (a local farmer) killed enough yellowlegs in a single day to pay for a plow harrow.
- Yellowlegs were sold in markets in Boston and New York.
- Duck hunters in the last 20 years (prior to 1948) would expend 3 to 4 boxes of shells to bring a mixed daily bag of 25 ducks (diving) in a day hunt.
- Farmers leased lands to several shooting clubs.

According to Robert Hazard, owner of the parcel that would become the boat launch ramp, more bootleg liquor was landed at this location during Prohibition than any other place along the Connecticut shore (Martin 1964).

In 1944, the United States Naval Department secured a 40.2 acre leasehold from the State of Connecticut and a private owner to use Barn Island proper and adjacent wetlands for aerial dive bombing and machine gun (strafing) practice (Alion Science and Technology, 2007). The leasehold was terminated in 1945.

The Oat & Palmer parcel (aka Billings Point), which lies at the south end of Palmer Neck Road on the west side, was in the blueprint stage of a subdivision for summer cottages when the State of Connecticut purchased the land. The State apparently agreed to keep this land open to the public for picnicking and swimming (Martin 1964).

Acquisition

In the 1940's, waterfowl populations were declining in the Atlantic Flyway and wildlife biologists where identifying approaches to improve waterfowl habitat. The Connecticut Board of Fisheries & Game began the acquisition of tidal wetland and adjacent uplands at Barn Island from 1944 to 1946 (Map B). Nineteen parcels were acquired for a total area of 427.3 acres (Table 1). The largest parcel was the Vargas Farm (#16). Original ownership of these parcels was largely land divided amongst the Stanton and Palmer families.

"The lands were purchased to provide a public shooting ground and a wildlife management area. The state assumed the area would also furnish a certain amount of recreation of the public for picnicking, swimming, boating, shell-fishing, and fishing during the seasons it was not being utilized as a hunting area." (Miller 1948).

The area was expanded by 145 acres in the 1950's with 8 acquisitions, the largest being the Brucker Farm parcels (#21 and #22). A portion of the Brucker wetlands was the last area to be impounded in 1968.

Only one parcel was acquired in 1960, the Stewart Farm of 150 acres (#30). Two parcels of land were acquired in the 1970's adding an additional 73 acres. In 1990, two small parcels were added increasing the area by 24 acres.

Two parcels were purchased in the 2000's; Manousos (144 acres; #33) and Crowley (49 acres, #34, north of the railroad tracks). A golf course had been proposed for the Manousos property. The $920,000 purchase of the Crowley property, consisting of salt marsh, wetlands, and coastal forest acquired from the family in 2009 as an addition to BIWMA, was funded by the

Table 1. List of parcel acquisitions for Barn Island Wildlife Management Area, Stonington, CT, arranged by year and alphabetically by owner name within each year. Parcel # corresponds with label in Map B.

Parcel #	Owner	Acreage	Date
1	Barber, I.M.	51.05	20 Jun 1944
2	Barber, I.M.	18.71	20 Jun 1944
3	Barber, I.M.	37.26	20 Jun 1944
4	Barber, I.M.	4.7	20 Jun 1944
5	Clark, L.R.	18.07	20 Jun 1944
6	Hazard	16.1	24 Jun 1944
7	Hazard	25.21	24 Jun 1944
8	King, H.A.	2.96	18 Aug 1945
9	Lincoln, M.N.	2.23	Dec 1945
10	Lincoln, M.N.	4.11	Dec 1945
11	Lincoln, M.N.	1.34	Dec 1945
12	Mell, M.C.	3.13	7 Dec 1945
13	Miner, L.H.	14.36	29 Jun 1945
14	Nothe, R.H.	5.56	20 Nov 1945
15	Stearns, L.	3.36	31 Aug 1945
16	Vargas, F.A. & J.A.	172.33	20 Jun 1945
17	Lema	3.16	1946
18	Miner, W.A.	4.27	29 Oct 1946
19	Stewart, G.R.	39.37	8 Feb 1946
20	Randall, G.W.	3.14	19 Apr 1950
21	Davis, J.L. & S.	11.39	19 Apr 1950
22	Davis, J. & Gabrielson, M.L.	20.4	19 Apr 1950
23	Haxzhurst & Johnson[1]	11.6	4 Jun 1952
24	Oat, C & Palmer, S.[1]	14.79	20 May 1952
25	Brucker, C.V.[1]	33.07	10 Nov 1953
26	Brucker, C.V.[1]	46.32	10 Nov 1953
27	Bindloss, J.B.	4.18	15 Oct 1957
28	Stewart, C.H[1]	152.3	8 Jun 1964
29	Davis, J.L.[1]	51.43	Jan 1970
30	Davis, J.D.	21.36	21 Jul 1970
31	Davis, L.M.	7.34	24 Apr 1991
32	Davis, L.M.	16.46	24 Apr 1991
33	Manousos	145.35	16 Jul 2004
34	Crowley	48.6	2007
35	Matson	5.75	2011

[1]Properties Acquired with Pittman-Robertson Act Funds

U.S. Environmental Protection Agency (EPA) Long Island Sound Study Stewardship Program Fund and other funds available to the DEEP. The Nature Conservancy of Connecticut played a

critical role in conserving the property in preparation for the DEEP purchase. The Stonington Land Trust worked with the Crowley Family and the DEEP to make the acquisition possible.

The most recent acquisition was the 5.75-acre Matson property (#35), acquired in 2011 with funding from the EPA.

The Federal Aid in Wildlife Restoration Program, known as the Pittman-Robertson Act, or P-R Program, provides funding to the states for wildlife management and research, habitat acquisition, wildlife management area development, and hunter education. As shown in Table 1, a total of 304.3 acres (32 acres tidal marsh and 272 acres upland) of the BIWMA land was purchased with funds derived this excise tax on sporting arms, ammunition and archery equipment.

Infrastructure Improvements

- Between 1944 and 1947, a turn-around/parking area was built at the south end of Palmer Neck Road in the vicinity of the present day boat launch ramp, gravel was laid on Palmer Neck Road, two public outhouses were installed and a foot bridge was constructed across the first tidal creek east of the road (Miller 1948). The bridge allowed public access to the sandy beaches at Cook's Cove.
- Summer cottage on land purchased from Clark in 1944 was maintained and provided student research housing (Miller 1948).
- Six (4' X 6') duck blinds were constructed before the hunting season of 1946; wire fencing was wrapped around the perimeter and prairie cordgrass (*Spartina pectinata*) was threaded through the wire (Miller 1948).
- A ditch 12' wide by 4' deep and 600' long was constructed through the marsh just north of Barn Island proper to reduce travel time by hunters in boats (Bishop 1963).
- The boat launch was established in 1957 (Bishop 1963), expanded in 1976 (Blake-Coleman 1978), and renovated in 2004 using U.S. Fish & Wildlife Service funds. The renovation included adding a docking system that is ADA compliant. The parking area capacity was expanded to accommodate 60 cars with trailers.

Tidal Marsh Impoundment Construction

The first major wildlife management program initiated by the CT Board of Fisheries & Game was the construction of four Impoundments in 1945-47 as a means to enhance tidal wetland habitat for migratory waterfowl, shorebirds, wading birds and muskrat (Table 2; Map C). Another objective was to offset declines in open water habitat (pannes and pools) brought about by the construction of mosquito ditches in 1931-32. In 1968, a dike was constructed across the Brucker Marsh (Impoundment 5) and the dike was equipped with a water control structure (Blake-Coleman 1978); a small bridge that existed to the south referred to by Gross (1966) must

have been removed. In 1970, the original dikes were rebuilt and water control structures were installed (Blake-Coleman, 1978). These structures are probably the small diameter corrugate pipes outfitted with a tide gate on the bay side and a small concrete chamber on the impoundment side. These are present at Impoundments 1, 2, and 3.

Table 2. Information about Impoundment dikes at Barn Island Wildlife Management Area, Stonington, CT, including numbering system, construction date, acres impounded and comments. For locations see Map C, Appendix A.

Impoundment No.	Date Constructed	Acres Impound.	Comments
1 (originally #2)	Spring 1946	13.2	Dike was inundated by highest tides; dike was planted with vegetation.
2 (originally #1)	Fall 1945	73.3	Wooden bulkheads and tidal peat was used as fill (unsuccessfully); Partially removed in 1947 and fill excavated from uplands replaced peat.
3	Fall 1946 - Spring 1947	33.9	
4	Winter 1947	9.9	
5 (Brucker Marsh)	1968		A canal was dredged between Impoundments 4 and 5 to move surplus water to this wetland complex.

Miller (1948) noticed an increase in mosquito breeding in the impoundments and witnessed some early increases in muskrat numbers. Impounding did not appear to increase nesting by black duck. Recommendations to eliminate cattail (*Typha*) were never implemented, and open water habitat was displaced by cattail and later giant reed (*Phragmites australis)*. No quantitative surveys are known regarding wildlife use and so it is not clear how many of the original objectives were fulfilled.

Impounding tidal marshes disconnects them from the estuary and eliminates a critical source of sediment that allows the marsh to grow vertically. A survey by Hebard (1980) indicated that Impoundments 1, 2 and 3 were only 1 to 4 centimeters lower than the adjacent natural marsh. Impoundment 4 was actually 4 centimeters higher. Impoundment 4 was originally a brackish marsh with some sea level fen species and it is likely that this small basin is strongly influenced by groundwater, which may be responsible for creating higher elevations.

Recognizing the impacts of impounding the tidal marshes, wildlife staff sought advice from a plant ecologist in the Natural Resources Center of DEEP, and implemented the recommendation to reintroduce tidal salt water to control cattail and *Phragmites*. Table 3 details improvements to the impoundments which increased tidal flow and helped with tidal marsh restoration.

Table 3. Improvements to Impoundments at Barn Island Wildlife Management Area, Stonington, CT.

Impoundment	Date	Comments
1	1978	Four-foot wide aluminum squash culvert was installed in 1978 and the flap gate on an existing 32-inch diameter culvert was removed. Seven-foot diameter culvert added in 1982. In the middle of the Impoundment were two large kidney shaped pools. The improved drainage/tidal range resulted in pool colonization by *Spartina alterniflora* (SA) post 1982.
2	1978	Four-foot wide aluminum squash culvert was installed in 1970 but weir boards in the half round riser maintained an impounded condition. The weir boards were removed in 1978, restoring tidal flow.
3	1987	Two weir boards removed in 1987. Former pond area was exposed at low tide but did not become colonized by SA for several years. The failure of the slide gate on the concrete chamber is likely the cause of the additional drainage of the flat creating conditions suitable for the growth of SA.
4	1987	The culvert was installed in the fall of 1986 but the first growth of vegetation subject to tidal flow would have been the spring of 1987.
5	1992	Tide gates removed. Weir boards removed from one concrete chamber.

Agriculture License Agreements

The DEEP and the former CT Board of Fisheries and Game have long recognized the benefits and services provided through cooperative farming agreements. Under the authority of Connecticut General Statutes, 23-11 and 26-69, the DEEP administers an agricultural license agreement program. The goal of the program is to improve and maintain wildlife habitat on designated department-owned lands through a cooperative effort with compatible agricultural producers. The use of state-owned land for agricultural purposes is consistent with wildlife management practices and the desire to provide diverse habitats for a variety of wildlife. A set of guidelines has been established to insure consistencies in developing and maintaining the agricultural agreements. The agricultural license agreements administered at Barn Island Wildlife Management Area since 1989 are found in Table 4.

Table 4. Agricultural license agreements administered for Barn Island Wildlife Management Area, Stonington, CT.

Agreement No.	Year Initiated	Licensee	Expiration	Acreage	Crops
A-89-84	1989	John Davis	12/31/1993	28	Hay, Silage Corn
A-89-148	1989	Raymond Hoxsie	12/31/1994	28	Sweet Corn
A-90-22	1989	John Davis	12/31/1994	28	Sweet Corn
A-95-55	1995	Raymond Hoxsie	12/31/1999	28	Hay
A-00-22	2000	Raymond Hoxsie	12/31/2004	22	Hay, Sweet Corn
A-01-34	2001	Raymond Hoxsie	12/31/2004	6	Hay, Sweet Corn
A-05-116	2005	Raymond Hoxsie	12/31/2009	10	Hay, Field Corn
A-09-99	2009	Eugene Bessette	12/31/2010	5	Hay, Silage Corn
A-12-37	2012	Eugene Bessette	12/31/2016	5	Hay, Silage Corn

Wildlife Management Activities

1944 (fall) – 1947 (winter) - A total of 220 cock pheasants and 66 hen pheasants were released on the Barn Island Shooting Area (Miller 1948).

1946 (early summer) - Four food patches were plowed, planted and fertilized to provide wintering habitat for pheasant and quail (two patches on Headquarters Island, one patch in old fields of Vargas Farm and one on Palmer Neck); plants included Tartarian buckwheat, Japanese millet, rye and soy bean.

1947 (spring) - Fifteen pair of quail were released on the Headquarters Island in the area designated as an open season for quail (Miller 1948).

1947 (spring) - Three pair of wing-clipped mallards were released in Impoundment 1 to encourage breeding in the Impoundment and potentially produce birds for the fall hunting season.

1940's – The CT Board of Fisheries and Game provided financial aid and housing to the University of Connecticut – Forestry and Wildlife Management for the conduct of graduate student research about waterfowl management at Barn Island (Miller 1948).

1965 – The CT Board of Fisheries and Game established a trial natural area preserve for a period of 3 years to include the wetlands and upland islands south of the boat canal, with continuance dependent upon the conduct of scientific research (Gross 1966). This action preceded the creation of the CT Natural Area Preserve Program by statute, and would have been an internal directive of the Board. The Nature Conservancy had suggested the creation of a natural area to the Board on numerous occasions. This designation would have been a logical extension of the Board's original objectives following acquisition of the Barn Island marshes to foster research as an important tool to guide management decisions. A Map located at the CT DEEP Natural Diversity Database confirms that the "Barn Island Nature Area" was designated by the State Board of Fish and Game 1964-1967. Associated field notes indicate the site was visited in 1971 and 1975.

1998 – 2011- DEEP secured Wildlife Habitat Incentive Program funds from the USDA Natural Resources Conservation Service to manage fields and restore wetlands; there are 17 parcels totaling 37.4 acres that have been managed as old field, and *Phragmites* was controlled on 21 acres of tidal wetland.

2004 - A firebreak was created using funds from the U.S. Forest Service National Fire Plan. The initial break was 25 feet wide, but controlled burning is used to create a 50-foot-wide zone for fuel reduction; the last burn was conducted in 2013 (see Map D, and Firebreaks and Controlled Burning in Management Issues/Needs section of this report).

2006 - Long Island Sound License Plate Program Funds were used to create a native plant garden to the west of Impoundment 1; some of the funds were used to design and purchase education signs that have been placed at the garden.

2007 - Funds from the CT Corporate Wetland Restoration Partnership were used to design an education sign located at the intersection of Dike and Headquarters Roads.

2013- Eagle Scout, Clayton Andrews, and fellow scouts installed 3 bluebird nest boxes each on the recently acquired Matson and Crowley parcels.

2014 – Late in this year, there were a total of 12 pairs of bluebird nest boxes present in the various fields of the former Stewart Farm on the eastern side of BIWMA.

Hunting, Trapping and Other Recreation

BIWMA was originally acquired to provide habitat for migratory waterfowl and for waterfowl hunting, but has always been managed for multiple uses, including all forms of regulated hunting, fishing, trapping, wildlife observation, hiking, and horseback riding, as well as organized outdoor education programs. Pheasants have historically been stocked for hunting at Barn Island. The property has a trail system and a boat launch and parking area located at the southern terminus of Palmer Neck Road that opens to Little Narragansett Bay, allows access to Fishers Island Sound, Long Island Sound and the Atlantic Ocean.

SITE DESCRIPTION

BIWMA is located in the southeastern corner of Stonington and borders a coastal embayment known as Little Narragansett Bay (Map A). The nearshore zone of Southern New England is defined by a series of six interconnected Sounds that form a unique low energy ecosystem complex. Little Narragansett Bay lies at the eastern edge of Fishers Island Sound. Napatree Beach, a coastal barrier in Rhode Island, separates the bay from Block Island Sound. This beach and Sandy Beach greatly reduce the fetch in the bay creating a very low wave energy environment.

Physical Attributes

BIWMA includes approximately 300 acres of tidal marsh with the rest of the management area covered with freshwater wetlands or uplands (Map E). The major landforms are clearly visible in the shaded relief map derived from LiDAR data (Map C). Separating BIWMA from Wequetequock Cove is Palmer Neck ridge/peninsula (A on Map C). To the north of Impoundments 1-3 are the central uplands (B). The Stewart Farm (C; an assortment of fields) lies on a peninsula originating from highlands to the north. The former Burdick farm and cemetery are associated with the eastern most peninsula (D). Various valleys and hollows are visible on the LiDAR map.

The dominant surficial material at BIWMA is glacial till and salt marsh deposits (Map F). Mapped sand and gravel material is found at Brucker Marsh. Excavation of channels in Impoundment 3 in 2014 located additional sand and gravel deposits. Groundwater discharge is strongest in areas of sand and gravel (see Sea Level Fen section) and the eroded marsh edge (Miller and Egler 1950).

Topography and surficial material (Map F) exert a strong influence on the type and distribution of soils (Map G). Soils on hilltops are typically dry and shallow (excessively well drained), mid-slopes are mesic (well drained) and valleys are places were water collects and these tend to support poorly drained and very poorly drained soils. The dominant drainage classes at BIWMA are well drained and tidal.

Existing Diversity

Habitats and Vegetation

Aerial photographs (Maps H-K) show changes in vegetation over time. The photographs from 2012 were used to map the major vegetation types at Barn Island (Map L). The national wetland inventory GIS layer was then used to separate forested uplands and wetlands and 1934 aerial photographs were used to classify forests by age. The area covered by each major habitat type is as follows (See Map L legend for descriptions of vegetation classes):

- Field – 30.9 acres (includes 5 acres managed under an agricultural agreement)
- Forest – 658.2 acres
    - Upland - 554.6 acres
    - Forested wetland - 103.6 acres
- Parking/developed – 1.74 acres
- Tidal marsh – 305.5 acres
- Woodland – 36.26 acres

Table 5 identifies the draft Connecticut Wildlife Action Plan habitat types proposed for the 2015 plan update. The table lists these broad categories and cross-walks them to the communities described in the Vegetation of Connecticut (Metzler & Barrett 2006).

Table 5. Draft Connecticut Wildlife Action Plan habitat types and CT plant communities of Barn Island Wildlife Management Area, Stonington, CT.

Action Plan Habitat Types	CT Plant Communities	Notes
Upland Forest		
Oak Forest	**Black Oak - Chestnut Oak / Black huckleberry community**	Rare
	Northern red oak/Flowering dogwood (*Quercus rubra/Cornus florida*) forests	Abundant
	Northern red oak - Yellow birch/Cinnamon fern community	Frequent
Upland Woodland and Shrub		
Shrublands[1]	**Northern marsh elder/Switchgrass community**	Same as switchgrass below. Shrub dominated areas are likely a variant of the Switchgrass community.
Reverting Field and early successional shrublands		Uncommon, most abundant at Stewart Farm.
Upland Herbaceous		
Coastal dunes	**American beachgrass medium-tall grassland**	Rare and decreasing
Cool season Grasslands		
Forested Inland Wetland		
Forested Inland Wetland	**Red maple/Northern spicebush community**	uncommon
	Black gum/Highbush blueberry coastal seepage forest (variant) – edges of salt marsh	Rare; formerly reduced by past clear-cutting practices

[1] There does not appear to be a suitable category for this habitat type. The draft habitat revisions in the plan make reference to Maritime Shrubs, but no definition is offered.

Table 5 (Continued). Draft Connecticut Wildlife Action Plan habitat types and CT plant communities of Barn Island Wildlife Management Area, Stonington, CT.

Action Plan Habitat Types	CT Plant Communities	Notes
Shrub Inland Wetland/Herbaceous Inland Wetland[2]		
	Switchgrass medium-tall grasslands (sea level fen)	Rare, declining in response to sea level rise. Proposed as a variant of the next listed habitat.
	Twigrush-Spoonleaf-Beaked spike rush Community	Extremely rare - Present at Pawcatuck Point in 1993 – lost to sea level rise; Imp 4a has been altered by *Phragmites*. A few *Cladium* dominant areas are still present at Barn Island.
Tidal Wetland		
Tidal Wetlands (salt, brackish and fresh-tidal)	salt marsh vegetation (polyhaline soils)	
	Smooth cordgrass Community (salt marsh)	Common along creek and ditch banks.
	Saltmeadow cordgrass - Spike grass community (salt marsh)	Long-term in part due to natural restoration (return to pre-ditching condition); accelerated sea level rise may be contributing to decline.
	Saltmeadow cordgrass – Creeping bentgrass community (brackish)	Uncommon brackish meadow, present in Imp 1 (north of dirt road) and Imp 3.
	Slender glasswort - Smooth cordgrass community (vegetated pannes)	Common; two variants present, pannes dominated by forbs or stunted *Spartina alerniflora*.
	Blackgrass	Uncommon and decreasing, largely confined to the levees of creekbanks and Bayfront.
	Pannes	Uncommon but increasing.
	Brackish marsh (oligohaline and mesohaline soils)	
	Blackgrass – Potentilla (brackish marsh)	This is the upland border *Juncus* belt of Miller & Egler; ephermeral – disappears ~20 years and reappears in and over the *Panicum* fen.
	Common Threesquare Community (brackish)	Uncommon and best developed in Imp. 3.
	Pannes (shallow water)	Rare but increasing; black fly larvae habitat.
	Narrowleaf cattail (brackish)	Uncommon best developed in Imp. 3
	Common reed (brackish marsh)	Uncommon; decreasing as a result of tidal flow restoration to the impoundments; cover and height continue to decrease in Imp 4.
Estuarine Aquatic		
Submerged aquatic vegetation	**Widgeongrass permanently flooded vegetation**	Occasional in marsh pools; pool habitat is rare but increasing.
Algal beds	*Cladophora*	Abundant in Little Narragansett Bay; has replaced *Zostera marina*;

[2] The draft plan for 2015 lists fens under the category of shrubs, but the Switch grass/Twigrush fens are not shrub dominated systems. Similar, the sea level fen would belong under the category of Herbaceous Inland Wetland, but there is no corresponding fen subcategory.

The dominant category at BIWMA is Upland Forest and the dominant subtype is Oak Forest. The dominant vegetation type is a mesic Red Oak/Flowering Dogwood forest. However, in the coastal ecoregions of Connecticut, the dominant oak is black (*Quercus velutina*), but red oak (*Quercus rubra)* is present where the soils are moderately well drained (an uncommon soil condition on the coast). More details on the non-tidal vegetation can be found in the Management Issues/Needs section below.

The second most abundant habitat is tidal wetland, which contains nine subtypes (Metzler and Barrett, 2006). Using the National Wetlands Inventory classification, the majority of tidal marsh vegetation would be considered Estuarine Emergent Marsh. Adding the water chemistry modifiers, we can recognize Polyhaline Emergent (i.e., salt marsh) and Mesohaline Emergent (i.e., brackish marsh). Prior to the construction of the dikes, the dominant tidal marsh category was salt marsh with exception of Impoundment 3 and 4. Impoundments 3 and 4 were and are brackish marsh complexes likely the result of a significant reduction in salt content by groundwater.

Species

Information received from the CT DEEP Natural Diversity Database (NDDB) regarding rare species at Barn Island, and observations made by the report team during 2014 is combined with the listing of Greatest Conservation Need Species from the 2005 Connecticut Comprehensive Wildlife Strategy publication and arranged in Table 6. A more detailed discussion can be found in the Management Issue/Needs section of this report. A list of plant species identified during the information gathering process for this report in 2013 and 2014 is included as Appendix B.

Special Designations

- **U.S. Fish and Wildlife Service (USFWS) Significant Coastal Habitats of Southern New England**. Barn Island is a component of the Fishers Island Sound Complex, one of 40 habitat complexes identified by the USFWS in 1991 in southern New England.

- **Global Important Bird Area, Birdlife International**. This program is implemented in the U.S. by Audubon and other local partners.

- **Long Island Sound (LIS) Stewardship Site**. BIWMA was identified as one of 33 inaugural Stewardship Sites in Long Island Sound. The funding for this assessment report was furnished through the LIS Futures Fund Program, administered by the National Fish and Wildlife Foundation, which provides grants for various conservation priorities including the development of management plans for Stewardship Sites (see Acknowledgements). It is likely that some of the recommendations in this assessment report and a future management plan could also be funded by the LIS Futures Fund.

Table 6. Greatest Conservation Need (GCN) species at Barn Island Wildlife Management Area, Stonington CT.

GCN	Common Name	Scientific Name	Source	Status (State)	Status (Federal)	Comment
Most Important	American Bittern	*Botarus lentiginosus*	NDDB	E		
	King Rail	*Rallus elegans*	NDDB	E		
	Least Tern	*Sterna antillarum*	NDDB	T		
	New England Cottontail	*Sylvilagus transitionalis*	NDDB		Candidate	
	Pied-billed Grebe	*Podilymbus podiceps*	Miller (1948)	E		
	Piping Plover	*Charadius melodus*	NDDB	T		
	Roseate Tern	*Sterna dougallii*	NDDB	E		
	Saltmarsh Sharp-tailed Sparrow	*Ammodramus caudacutus*	NDDB	SC		
	Snowy Egret	*Egretta thula*	Survey (feeding)			
	Whip-poor-will	*Caprimulgus vociferous*	NDDB	SC		
	Wood Thrush	*Hylocichla mustelina*	Survey			2
	Yellow-breasted Chat	*Icteria virens*	NDDB	E		
Very Important	Acadian Flycatcher	*Empidonax virescens*	Survey			1?
	Black-and-white Warbler	*Mniotilta varia*	Survey			4
	Great Egret	*Ardea alba*	Survey (feeding)			
	Least Bittern	*Ixobrychus exilis*	NDDB	T		
	Scarlet Tanager	*Piranga olivacea*	Survey			3
	Seaside Sparrow	*Ammodramus maritimus*	NDDB	T		
	Semi-palmated Sandpiper	*Calidris pusilla*	Survey (feeding)			
	Spotted turtle	*Clemmys guttata*	Survey			Forested wetland north of the culvert that connects Imp. 1 and 2.
	Yellow-billed Cuckoo	*Coccyzus americanus*				

Sources: CT DEEP Natural Diversity DataBase (NDDB); field surveys by report authors 2013-14; Survey – field surveys by Connecticut College survey team (2013-2014); Status: E – endangered, SC –special concern, T – threatened, Comments: Numbers are the number of birds observed in Spring/Summer 2014.

Table 6 (Continued). Greatest Conservation Need species at Barn Island Wildlife Management Area, Stonington, CT.

GCN	Common Name	Scientific Name	Source	Status (State)	Status (Federal)	Comment
Important	Glossy Ibis	*Plegadis falcinellus*	Survey (feeding)			
	Great Blue Heron	*Ardea Herodias*	Survey (feeding)			
	Osprey	*Pandion haliaetus*	Survey (nesting)			
	Ovenbird	*Seiurus aurocapillus*	Survey			4
	Veery	*Catharus fuscescens*	Survey			4
	White-eyed Vireo	*Vireo griseus*	Survey			4
	Willet	*Catoptrophorus semipalmatus*	Survey	SC		
	Willow Flycatcher	*Empidonax traillii*	Survey			
ESA Species (state/federal)	Bayonet Grass	*Bolboschoenus maritimus*	NDDB	SC		Could not relocate Imp. 3a population in 2014
	Black Rail	*Laterallus jamaicensis*	NDDB	E		
	Canada Sand-spurry	*Spergularia canadensis*	Coleman 1978, Miller 1948	T		Forb panne, rare; frequent in 1947
	Red Goosefoot	*Chenopodium rubrum*	NDDB	SC		Restoration of Imp. 1 in 1982 destroyed habitat
	Saltpond Grass	*Leptochloa fusca* spp. *Fascicularis*	NDDB	E		Restoration of Imp. 1 in 1982 destroyed habitat of this species
	Scotch Wild Lovage	*Ligusticum scoticum*	NDDB	E		Declining
	Sea Coast Angelica	*Angelica lucida*	NDDB	E		Not seen in 2014
	Seaside Crowfoot	*Ranunculus cymbalaria*	NDDB	SC		
	Yellow Thistle	*Cirsium horridulum*	NDDB	E		2014, many plants in *Panicum* sea level fen

Sources: CT DEEP Natural Diversity DataBase (NDDB); field surveys by report authors 2013-14; Survey – field surveys by Connecticut College survey team (2013-2014); Status: E – endangered, SC –special concern, T – threatened, Comments: Numbers are the number of birds observed in Spring/Summer 2014.

- **Long Island Sound Sentinel Monitoring Program**. The strategic plan for this program identifies the value of locating sentinel monitoring sites in Stewardship Sites. One of the primary reasons DEEP nominated Barn Island as a Stewardship Site is the long history of research and monitoring since 1946. This long record has recently helped wetland scientists to understand the dynamic nature of the upland edge plant communities of salt marshes/uplands in response to sea level rise.

Access

Vehicle access and parking for visitors to BIWMA is along Palmer Neck Road and from an unpaved access road off Stewart Road that leads to a gravel parking area. At the end of Palmer Neck Road is a 60 space, paved parking lot built to provide parking for boaters who wish to access the tidal marshes of BIWMA and Long Island Sound. Just north of the paved lot where the main, east-west trailhead intersects with Palmer Neck Road, is an unpaved pull-off available for parking. At this location and at the gravel lot off Stewart Road, there are official DEEP sign kiosks with visitor information.

Pedestrian access on the western side of the WMA is available from the previously mentioned trailhead. There are trails leading into the WMA from the eastern parking lot off Stewart Road as well as from the south end of Stewart Road. There is a trail leading into the WMA from Greenhaven Road just east of the railroad tracks and a potential access point with no current trail between 308 and 316 Greenhaven Road. There are also a number of unofficial trails originating from bordering house lots (see the Infrastructure section). The Trails section of this report provides more details on the trail system and access points. Map D shows where trails intersect with roads, boundaries and parking lots.

Cultural Resources

There are a number of cultural and historical sites located in BIWMA. See Map M for locations referred to below.

Burdick – Culver Cemetery

This cemetery is located just east of the trail on the eastern side of BIWMA next to an old stone gate opening. There are gravestones dating from 1793 to 1881 and field stone markers that may indicate Native American graves. Veterans of the War of 1812 are buried in this cemetery. The site does not appear to have been subject to vandalism, with the headstones largely intact. It is becoming overgrown, having not been mowed for a few growing seasons. More information about the cemetery, including photos can be found at the following websites:

http://wellsgenealogy.wordpress.com/2012/09/18/18-sep-2012-burdick-culver-cemetery-in-stonington-ct/

http://www.findagrave.com/cgi-bin/fg.cgi?page=cr&CRid=2199054

Venture Smith Property

Venture Smith (circa 1728 – 1805) was an African taken as a slave as a young boy. He spent the next 25 years as a slave in various locations in southern New England, including the part of Stonington, CT that later became the BIWMA. Smith became famous because he eventually bought his freedom and his story was the first autobiography published of a slave's capture in Africa and life in America. "A narrative of the Life and Adventures of VENTURE, A Native of Africa: But Resident Above Sixty Years in the United States of America," was dictated in 1798.

Most of Venture's time as a slave in the Barn Island area was spent at Thomas Stanton II's farm, the house for which stood in the location of what is now the gravel parking lot off Stewart Road. After 17 years with Stanton, Venture was sold to a number of other slave owners in the region, but eventually purchased his freedom in 1765. After working for five years to earn money to buy the freedom of his wife and children, he purchased 26 acres of land adjacent to the Stanton Farm, in what is now BIWMA.

There was a question as to the exact location and boundaries of the 26-acre parcel that Venture Smith owned in Stonington for four years before selling it to Stanton and moving to Haddam, CT in 1774. In 2009, Marta Daniels and Nancy Byrne published the results of their research which located the parcel, boundary stones marked with letters mentioned in the original deed, and the remains of a house foundation within the parcel. In addition, they located a large glacial erratic on the property called "Venture's Rock" that was previously thought to be boundary stone (Steenburg and Kading 2006), but was not. These locations are accessible from the westernmost field in the field complex adjacent to the Stewart Road parking lot.

Venture Spring

When the State of Connecticut purchased the Stewart farm (containing the Venture property) in 1964, a map of the property was created. This map showed the location of a "Venture Spring". Water from this spring was apparently sold by Venture himself and water was sold from this spring by Venture Rock Bottling Company of Pawcatuck until at least 1922 (Steenburg and Kading 2006, Sampson and Murdock 1922).

Louis "Louie" Bayer Boulder Monument

Louis M. Bayer was a well-known game warden who worked for the Fish and Game Commission of Connecticut (former DEEP). For his substantial "efforts in preserving the Barn Island marshes", Mr. Bayer was honored by the State with placement of an inscribed boulder monument on Palmer Neck Road just north of the boat launch.

Sarah Ann Martin Boulder Monument

An inscribed boulder is located in BIWMA (Map M) to honor Sarah Ann Martin, who donated her property in Old Saybrook to the DEEP to help with coastal preservation. Proceeds from the

sale of that property were used to help purchase the Manousos parcel in 2004 (approximately 144 acres – #33 on Map B) and fund other projects at BIWMA (Community Foundation 2004). The property of Sarah Ann Martin, consisting of a single family dwelling adjacent to South Cove in Old Saybrook, was originally left to the State of Connecticut by Sarah Ann Martin in her will "for use as a focal point for the study and preservation of Connecticut's coastal wetlands and/or other environmentally protective, non-development uses." The State could not utilize the dwelling and had no authority to sell the property. The executors of the estate successfully petitioned the court to allow them to sell the property and donate the proceeds. A competitive bid process for the funds ensued. The DEEP's Division of Land Acquisition and Management, Office of Long Island Sound Programs and the Division of Wildlife submitted two proposals to the Executors of the Estate of Sarah Ann Martin and the Old Saybrook Probate Court for the use of funds. The executors and the court selected DEEP as the recipient and subsequently awarded DEEP a total of approximately $429,000 in 2004. In accordance with DEEP's proposal, portions of the funds were used to complete the acquisition of the Manousos parcel and the remaining money has been setup in a long-term investment fund administered by the Community Foundation of Southeastern Connecticut. Grant monies to be awarded by way of a stewardship account must “further environmental education and research at Bam Island Wildlife Management Area” in accordance with the Sarah Ann Martin Fund Agreement, signed in 2004.

Other Cultural Sites

The foundation of the summer cottage that was used as the headquarters building and housing for research students during the early history of the wildlife management area is located on the former Clark property.

The 1964 property survey map of the Stewart farm showed the location of the grave of a slave named Minerva Stanton.

The remains of what appears to be a root cellar are located on the former Vargas property.

Several borrow pits were likely used for construction of the dikes.

Rights of Way and Easements

Examination of deeds provided by DEEP indicates two ROWs. One is from 1953 and allows access to the Burdick Culver Cemetery. The other, from 1927, is unclear, but may convey ROW to Barn Island proper. Examination of deeds provided by DEEP revealed no easements on DEEP owned parcels.

MANAGEMENT ISSUES/NEEDS

Climate Change and Adaption

A recently completed analysis of marsh response to sea level rise using the Sea Level Affecting Marsh Models (SLAMM) model was used to describe marsh change under the scenario of a 1 meter rise by 2100. The SLAMM model provides predictions of how the tidal marshes will change in the future and identifies the locations of marine transgression. One of the limitations of the model is the use of a very coarse classification for high marsh vegetation. This category is actually composed of multiple plant communities, and currently the dominant types are the wettest wetland communities – the panne communities.

The model predicts that the BIWMA marshes remain predominantly high marsh until 2055 when there is a significant increase in low marsh habitat. Low marsh is dominant by 2085 and there is a significant increase of tidal flats by 2100. Throughout the course of this century there is a gradual conversion of the lower slopes of hills to marsh. The first significant marsh transgression that would create high marsh occurs in freshwater wetlands – scrub shrub or forested wetlands. Transgression occurs onto grassy upland fields in 2085 and 2100. SLAMM confirms that in the hilly Barn Island environment, there are limited potential marine transgression areas for high marsh to develop.

Recommendations for future research priorities are located in the Research section elsewhere in this report.

Additional Discussion

Sea Level Rise

Sea level has been rising since the last glaciers began retreating. Fishers Island Sound was a glacial lake and eventually sea levels rose to the point that the Sound was flooded, and in time, river valleys were flooded. Details regarding the formation of the Sound can be viewed at the Long Island Sound Resources Center website. Rates of sea level rise were initially too fast to sustain the expansive tidal marshes present today. Rates slowed from 5000 to 3000 years ago and by 2000 years ago, the rate was a mere 1 mm/year and the modern tidal marshes emerged. Between the late 1800's and 1980, rates of sea level rise doubled at Barn Island and since 1980 have doubled again (Sallenger et. al, 2012).

While the footprint of Barn Island decreases every year, a key climate change concern is how tidal marshes will respond to accelerated sea level rise and where the future locations of marine transgression will be.

An application of the SLAMM has been recently completed for all of Connecticut thanks to funding from an LISS Enhancement Grant and federal Ocean and Coastal Resources

Management with support from the Coastal Management Program of DEEP. The SLAMM model uses the most recent National Wetland Inventory maps to define the wetland habitat classes and uses estuarine process data (e.g., sediment accumulation rates, suspended sediment data) to model changes in the habitats over different time steps (15-year increments from 2010 to 2100). The project runs four climate change scenarios, but for the purposes of this report, we used the model forecasts for a 1-meter rise by 2100 to illustrate marsh response (Clough, et al. 2015).

Figure 1 shows the SLAM model output for every 15 years for the Palmer Neck, Headquarters Marsh and Impoundment 1 areas of BIWMA. These are representative of marsh changes throughout Barn Island. The vegetation remains dominated by high marsh throughout the period 2010 to 2040. However, between 2040 and 2055 there is a significant replacement of high marsh by low vegetation. By 2070, the dominant vegetation is low marsh. In 2100, significant areas of low marsh are converted to intertidal flat.

Figure 2 shows the upper limits of Impoundment 1 above the Amtrak corridor focusing on the field on the Crowley parcel (to the left of the PEM1R) and the fields in the Wequetequock Cove Preserve (owned by Avalonia Land Conservancy). The inland wetlands on the Crowley property change to transitional salt marsh by 2070. The Avalonia field becomes transitional salt marsh in 2085 and the Crowley field becomes transitional salt marsh in 2100.

The Headquarters upland illustrates the typical but gradual marine transgression of tidal marsh into the uplands (Figure 3). By 2025, a narrow belt of the lower slope of this hill is replaced by transitional salt marsh. In 2014, the lower slope of this hill is a belt of forested wetland dominated by black-gum and the lower slope of this belt supports tidal marsh dominated by black grass (*Juncus gerardii)*. This belt has formed in the last 10 or so years and represents the most recent phase of marsh transgression. The dieback of black gum lags behind the marsh vegetation transgression. The area of upland vegetation continues to decrease out to the year 2100. What the model cannot show due to scale is that the belt of black gum, and hence the lower slope seepage zone, moves uphill with sea level rise. Black gum gradually replaces upland forest and rising groundwater tables likely cause mortality of upland species at the lower slope of the forest upland over time. The rate of forest retreat is approximately 0.5 meters per year.

In Figure 3 to the northeast of the Headquarters upland is a triangular area that is predominantly forested wetland. The Headquarters road creates a low dike on the southeast side of this wetland reducing the incursion of tidal events. Nevertheless, a few tidal species are present adjacent to the road such as marsh-elder (*Iva frutescens)* and seaside goldenrod (*Solidago sempervirens)*. The SLAMM images show the gradual replacement of this forest by high marsh and in 2100, the area is low marsh.

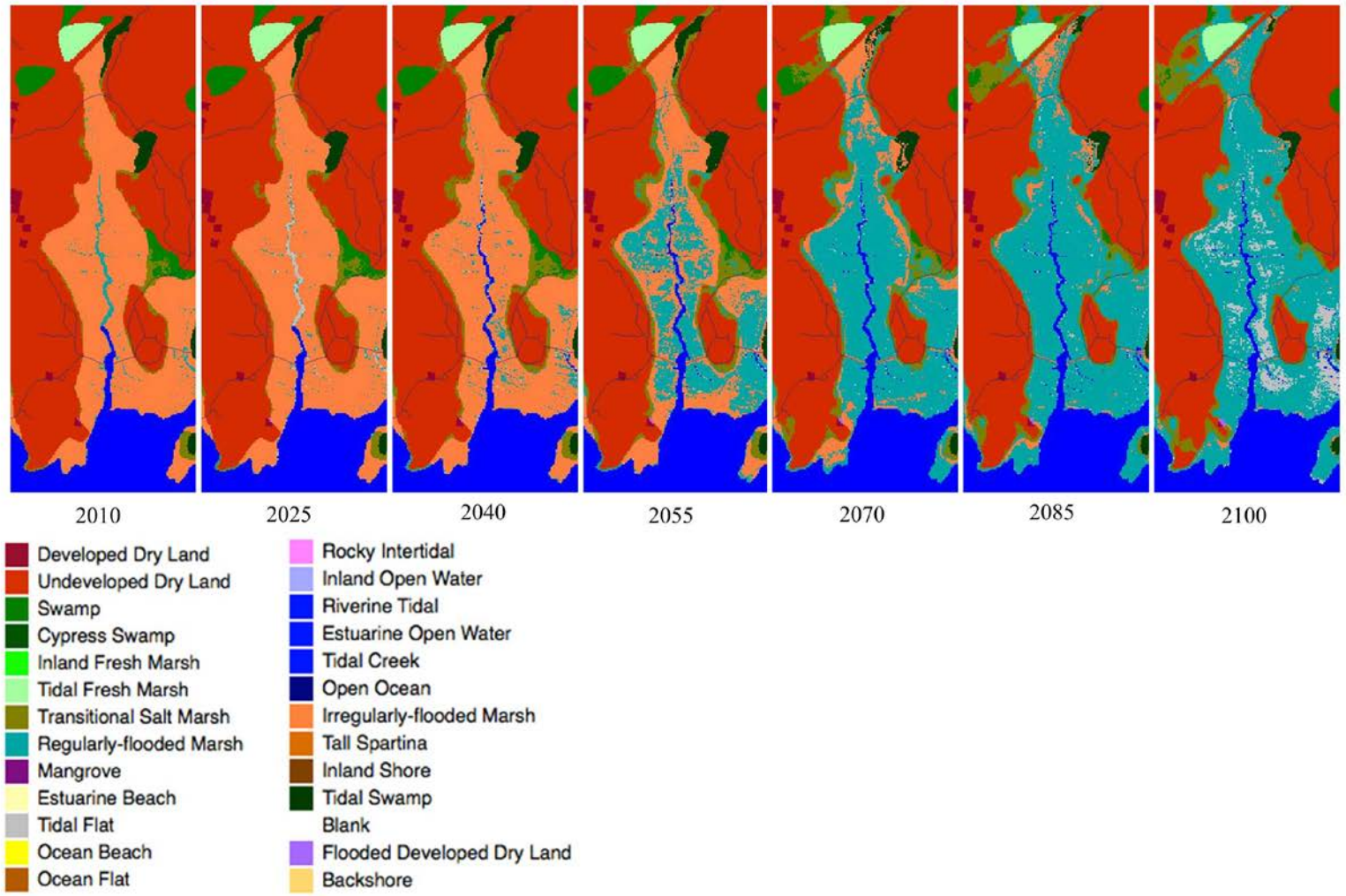

Figure 1. SLAMM model predicted habitat changes with a 1-meter sea level rise by 2100 at the Palmer Neck, Headquarters Marsh and Impoundment 1 area of the Barn Island Wildlife Management Area, Stonington, CT.

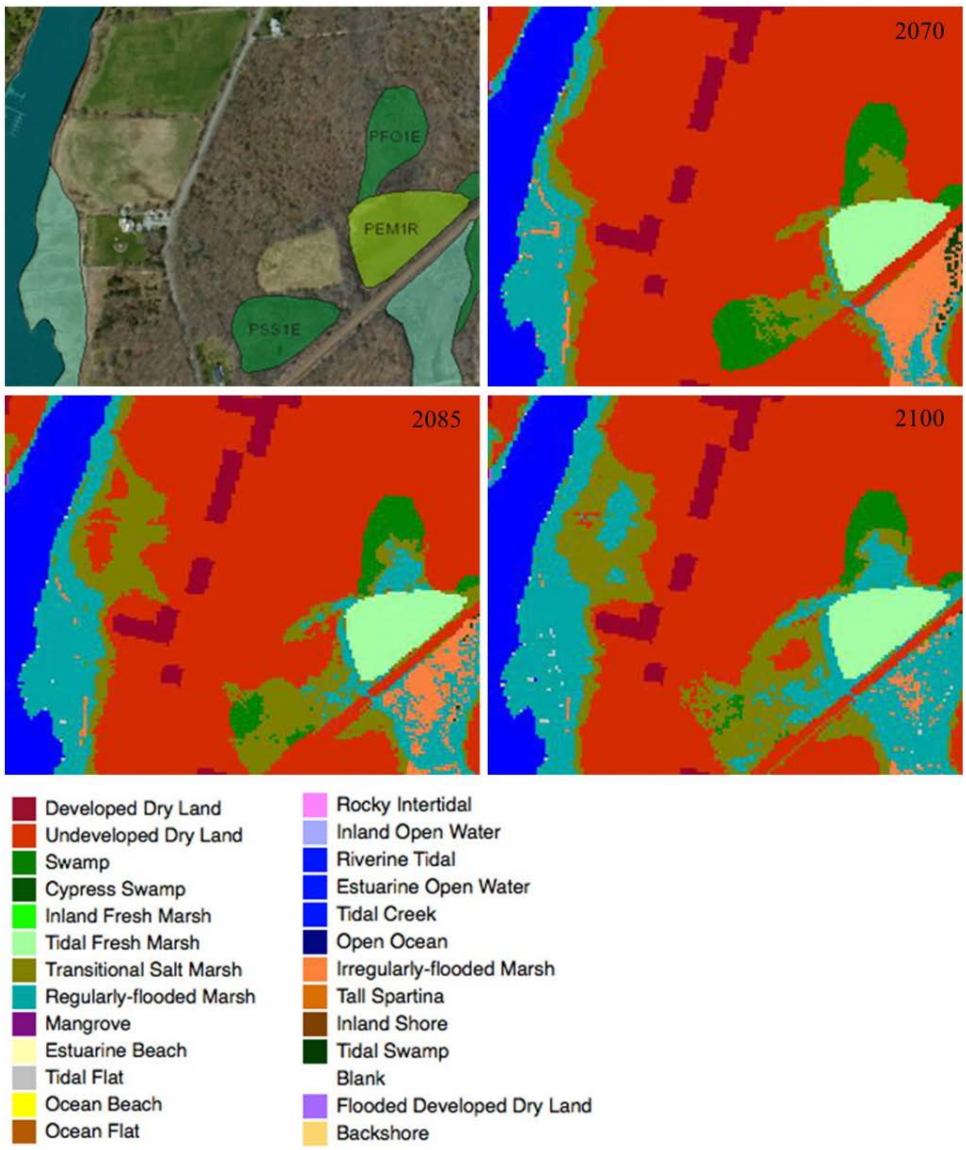

Figure 2. SLAMM predicted habitat change north of railroad tracks focusing on fields on the Crowley parcel of Barn Island Wildlife Management Area and Avalonia Land Trust's Wequetequock Cove Preserve, Stonington, CT. Categories of National Wetland Inventory map are shown in upper left image (PEM1R – freshwater tidal; PSS1E – palustrine scrub shrub and PFO1E – palustrine forested). SLAMM outputs for 2070, 2085 and 2100 are upper right, lower left and lower right, respectively.

The NWI mapping does not show the sea level fens and thus the SLAMM model does not show the gradual conversion of sea level fen to tidal marsh. In the short term, we predict that the primary areas of marine transgression that create new high marsh habitat will be at the location of the fens, namely the sandy ridges alongside Brucker Creek and the area between Impoundments 4 and 5.

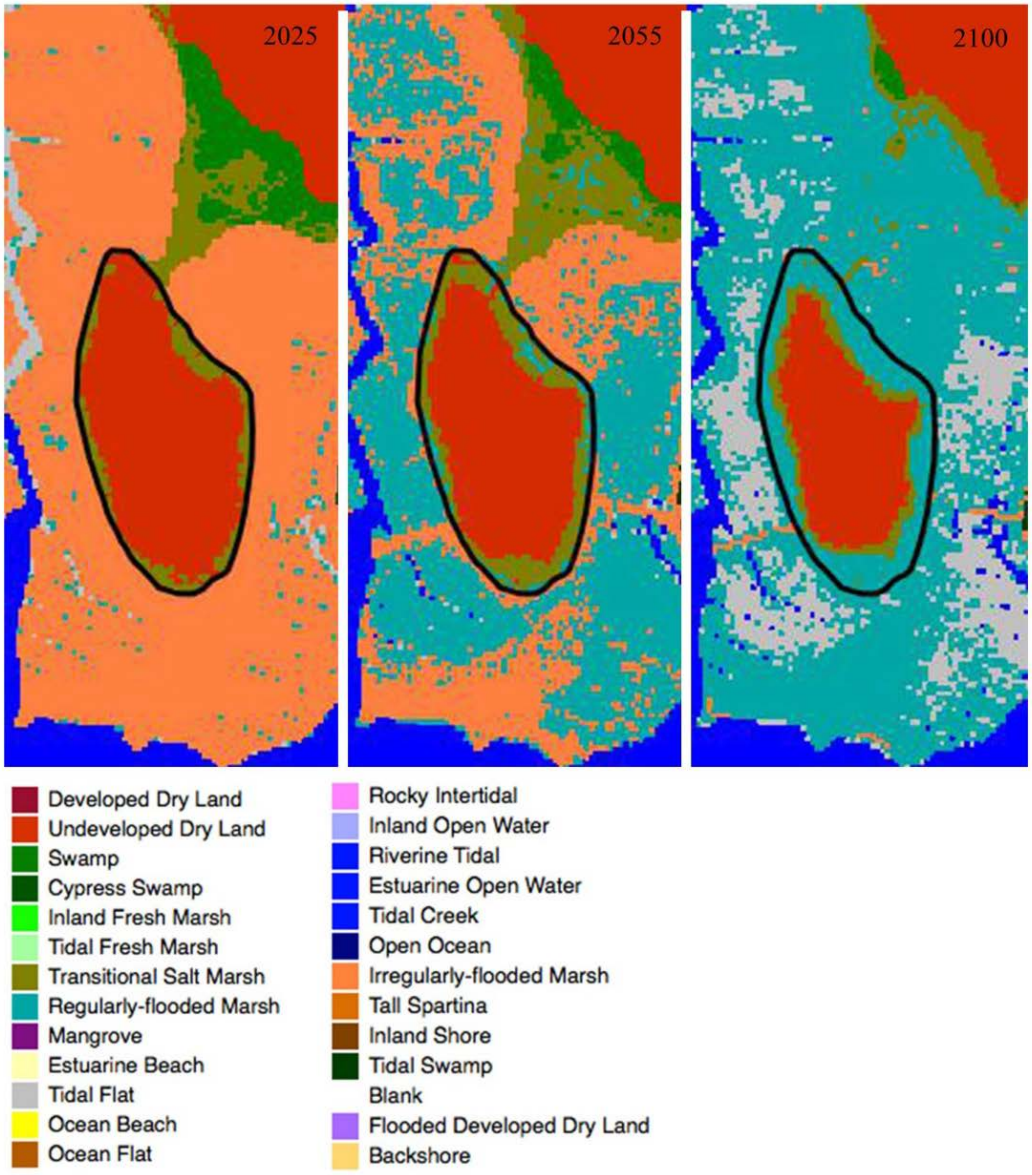

Figure 3. SLAMM predicted habitat changes at the Headquarters upland, in order from left to right 2025, 2055 and 2100, Barn Island Wildlife Management Area, Stonington, CT. The initial model upland boundary is represented by a black line.

In 2003, Connecticut College and the Natural Resources Conservation Services installed nine elevation benchmarks at Barn Island, three on bayfront marshes, three on interior marshes and three in the Impoundment 1 restoration marsh. Triplicate sites are needed for statistical purposes. At these locations, a horizontal aluminum bar-shaped rod in placed upon the benchmark and a series of nine vertical pins are used to track marsh elevation along up to nine fixed directions. These are called surface elevation tables (SET). The purpose of these measurements is to track marsh elevation response to sea level rise. Figure 4 shows long-term sea level rise at the New

London tide gauge from 1939 to 1979 and from 1980 to 2013. Rate of sea level rise has doubled since 1980 in this location.

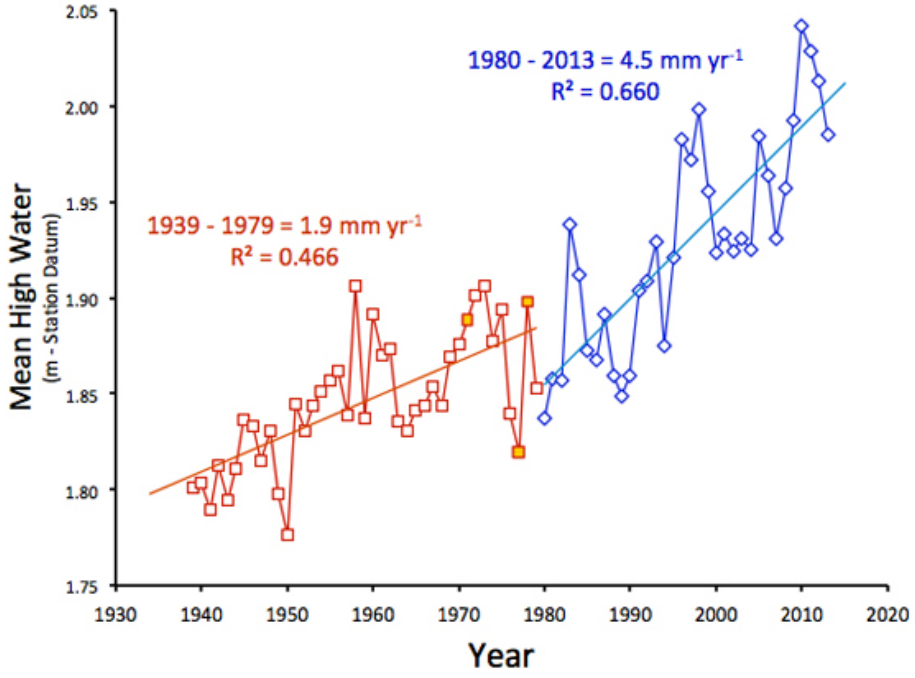

Figure 4. Mean high water trends at the New London, CT tide gauge (Source: Dr. R. Scott Warren, Connecticut College).

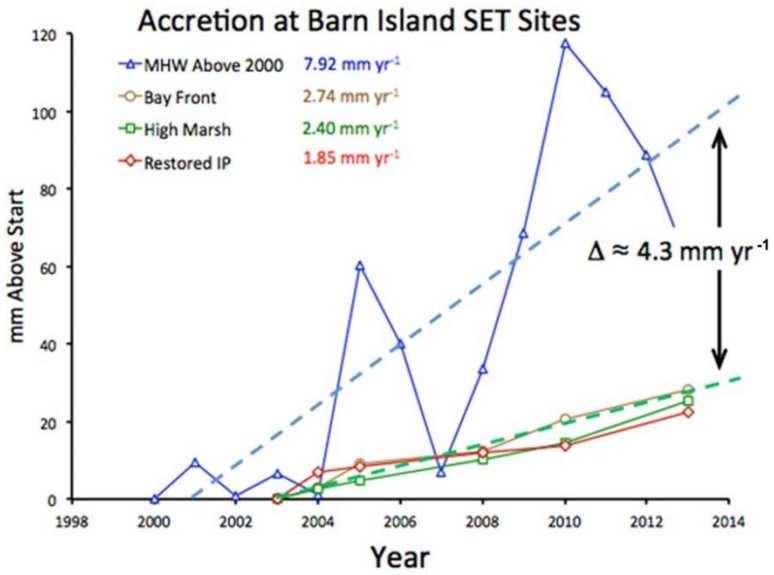

Figure 5. Surface elevation change trends at Barn Island Wildlife Management Area, Stonington, CT (Source: Dr. R. Scott Warren, Connecticut College).

Figure 5 shows the results of the surface elevation change at Barn Island as compared to a trend curve for mean high water. Surface elevation changes are greatest on the bayfront marshes, where sediment input from the bay and tidal creeks is highest, and smallest in Impoundment 1. The trend line for mean high water is nearly 8 mm/yr., however this may be an excessively high value produced by the arbitrary time frame of the SET record. For example, Figure 4 shows a general decline in sea level from 1996 to 2007, suggesting a longer time period is needed for comparison of the tidal trends relative to surface elevation change.

Shoreline Change

As sea level rises, the shoreline tends to retreat in a landward direction. However, in the case of very sheltered locations, tidal wetland shorelines may remain stable and vertical growth of tidal peat can prevent erosion of the shore. Little Narragansett Bay has a small fetch that is less than 2 miles in length. This fetch however, is still capable of generating small waves with the capacity to erode wetland shoreline.

Figure 6 shows historic shorelines from a topographic sheet (1882) and an aerial photo (2006). The top image shows the seaward edge of the Headquarters Marsh and the middle image shows Bloom's Point. The latter also shows historic landward boundaries of tidal marshes and illustrates the gradual marsh transgression onto upland habitat. The bottom image shows calculations of net shoreline change where the data sources define the shoreline as mean high water. This is a new method developed through a collaboration of DEEP, UConn CLEAR and CT SeaGrant. In the segment that corresponds to the Headquarters Marsh shoreline, the interpreted rate of shoreline changes ranges from -0.159 to -0.256 meters/year.

Erosion rates will likely increase due to the projected increase in the strength of hurricanes. Should Sandy Point to the southwest disappear in whole or part, the fetch will increase and wave energy will increase. Such a change should increase shoreline erosion rates.

Changes in Temperature and Precipitation

Warming temperatures will cause shifts in the distribution of species. At Barn Island, we focus on four species: Scotch lovage (*Ligusticum scothicum*), seacoast angelica (*Angelica lucida*), American holly (*Ilex opaca*) and northern arrow-wood (*Viburnum dentatum* var. *venosum*). The first two species are state listed species under the Endangered Species Act and both are northern seacoast species at their southern range limit. Populations of these forbs are confined to eastern Long Island and Fishers Island Sounds. Since these species are at or near their southern range limits, their ranges are expected to contract and the species should retreat northward.

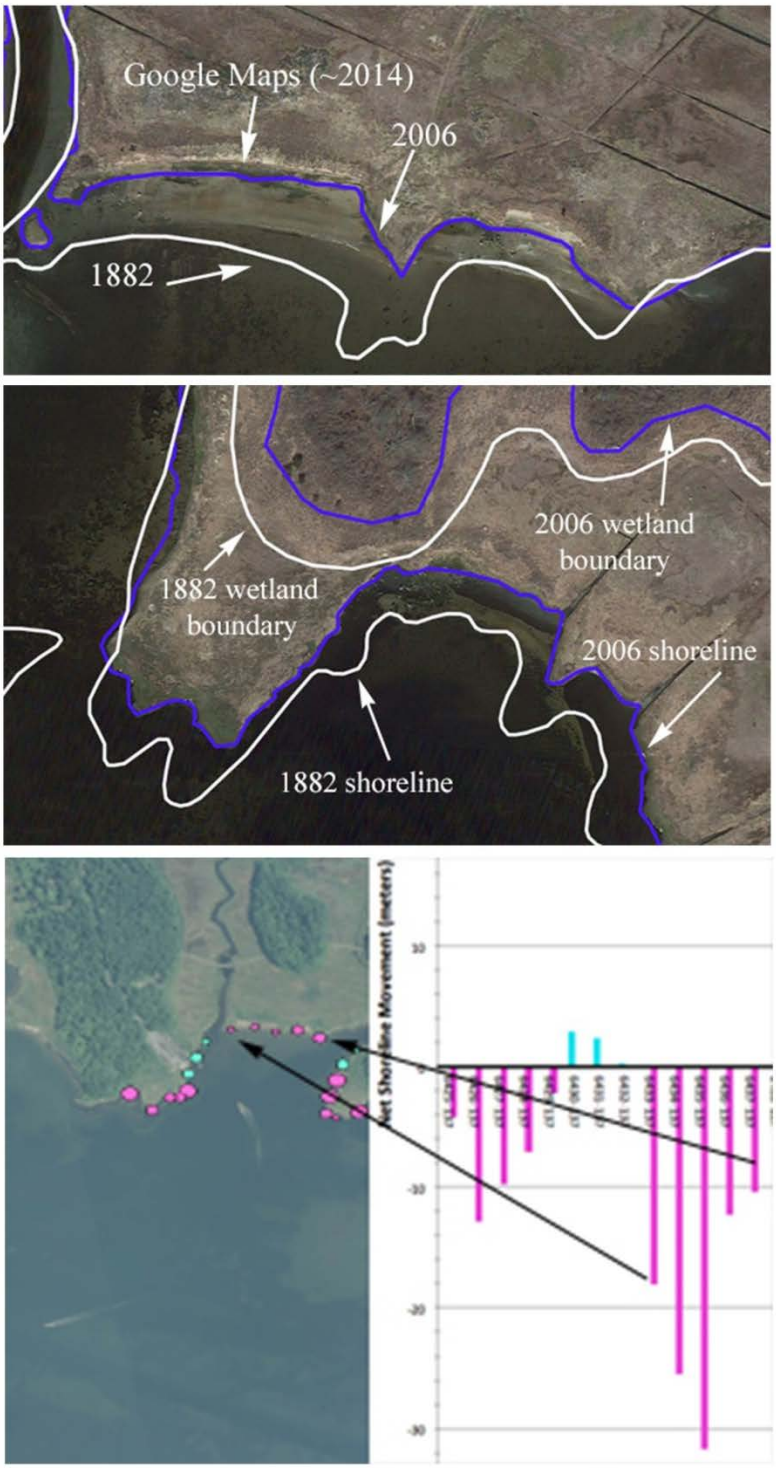

Figure 6. Shoreline changes at the Headquarters Marsh (top image) and Bloom's Point (middle image), Barn Island Wildlife Management Area, Stonington, CT. Bottom image shows a calculation of net shoreline movement from 1882 to 2006.

American holly was considered for listing as a state rare species in the 1970's, but further review of the only suspected native plant at Waterford was considered to be non-native. In southern New England, American holly is present in the coastal forests from Cape Cod to Westerly, RI. In 2013 and 2014, the forests where searched for this holly. In 2013, a seedling was located just west of Impoundment 4 and in 2014, two mature trees were located in the woods at eastern Barn Island on lands formerly owned by Brucker. One of these is present in the Burdick cemetery. Additional plants are expected to be found at Barn Island. Although this species in not considered native in Connecticut, it is considered native only a few miles to the east in Rhode Island.

A shrub with similar distribution is northern arrow-wood, which is also present in Westerly, RI. Variety *venosum* and the common var. *lucidum* were reported by Hebard (1980) at Barn Island, with a single specimen of var. *venosum* found between Impoundments 4 and 5. The voucher specimen has not been relocated to confirm the identification.

A recommendation beyond BIWMA management planning is that plant ecologists review the coastal vegetation of southern New England to reassess the boundary of coastal ecoregions. An analysis of regional temperature similar to that performed by Taylor (1927) might help to refine ecoregion boundaries. For example, Taylor found that the Montauk Point peninsula on Long Island, surrounded by ocean water, is much cooler, especially in spring, than central and western Long Island. It seems possible that Barn Island, in the eastern most area of the state and closest to open ocean, may be in a similar microclimate zone.

Eelgrass

Little Narragansett Bay has seen a shift of its aquatic vegetation from eelgrass (*Zostera marina*) to filamentous algae, a typical trend in nutrient enriched estuaries. Research (Bintz et. al 2003) has shown that rising water temperatures interact with high nitrogen levels to increase eel grass mortality. Thus, reductions in nitrogen loading alone may not be enough to reverse the declining eelgrass populations.

Education

Barn Island WMA is actively used for research and environmental education and has been for decades. In addition to the wide diversity of habitats and species and the extensive area of salt marshes, educators are also interested in the history of manipulation through the building and removal of impoundments across a series of valley salt marshes. Organized groups from both formal and informal educational organizations visit BIWMA year-round. Regular users include, but are not limited to, Connecticut College, University of Connecticut, Williams-Mystic Maritime Studies Program, Mystic Marinelife Aquarium, Dennison Pequotsepos Nature Center and Audubon Connecticut. Many visitors not associated with organized educational programs come to Barn Island to observe and learn about nature, especially bird life on the marshes.

Information was gathered about educational uses of BIWMA using a questionnaire and holding a subsequent meeting. A number of issues were raised and discussed and some recommendations were developed.

Management Recommendations/Options

Potential conflict between educational groups and hunters

- Provide information at Barn Island and on DEEP's website explaining that hunting financed the purchase of a significant portion of the property and that hunting is the original and one of the continuing purposes of the area.
- Clearly post calendars of when hunting is allowed, showing the dates of the various seasons and emphasizing that no hunting occurs on Sundays.

Volunteers – how to organize and effectively use them

- Identify projects and activities that could lend themselves to volunteers and identify groups that are interested in conducting volunteer actions. It may be possible to secure some level of funding for a volunteer coordinator from the Long Island Sound Study or LIS Futures Fund, especially once a management plan is in place.

Improving Bird Viewing Opportunities

- Identify strategic locations where viewing blinds can be built and seek funding to construct them.

Funding

- Identify potential sources of funding once educational (and research) priorities are agreed upon. The Sarah Ann Martin Fund in the Southeast Connecticut Community Foundation is specifically available for this purpose at BIWMA. The Mystic Marine Life Aquarium is a Coastal American Learning Center, which could be the source of funding for projects. Audubon CT is starting to administer a fund generated by mitigation payments. The Long Island Sound Futures Fund might supply funding for recommendations in this assessment report.

Permits, Permissions, Locations

- Direct educational group visitors below college age interested in marine and salt marsh habitats to use the area west of Palmer Neck Road on Wequetequock Cove. This will minimize disturbance to areas used for research and higher level education east of Palmer Neck Road.

- Create an online form that would allow educators to register planned activities. DEEP can monitor the registrations to make certain that educators are complying with all requirements contained in the management plan.
- Post signage explaining education and research procedures. This can appear on the website, but should also be physically posted on site. A letter explaining procedures could also be sent to the Southern New England Marine Educators Association, which could be forwarded to association members. DEEP might also enlist the aid of the State Department of Education to contact schools regarding the rules for BIWMA.

A complete report on the Barn Island Education and Research Meeting, including a summary of the meeting, and pre-meeting questionnaire results, may be found in Appendix C.

Greatest Conservation Need and State-Listed Species

Table 6 (p.15-16) enumerates species of Greatest Conservation Need (GCN) and those listed under the Endangered Species Act that are or were known to be present at BIWMA. GCN species are based upon the 2014 draft list of species for the 2015 Wildlife Action Plan revision. Sources include the CT DEEP Natural Diversity Database, Master's Thesis research and personal observations. Some of the listed species are neotropical migrants that were observed during the Spring and Summer of 2014 at Barn Island. With regards to personal observations of bird species, the listed neotropical migrants are presumed to be nesting, but no attempt was made to implement the protocols of the Connecticut Breeding Bird survey. A further study will be required to confirm these as breeding species. The table also notes species such as Glossy Ibis, which use the tidal wetland pannes for foraging, but nesting does not occur at Barn Island.

A complete listing of all birds observed and heard during the field work for this report during 2014 is found in Appendix D. BIWMA is included as a "hot spot" on the eBird website, where there is an extensive species list.

Plant Species

The 2015 Wildlife Action Plan will include certain plants (i.e., globally rare G1-G3 species) for the first time, however none of those species are present at Barn Island. There are currently four plant species listed as State Endangered at BIWMA. Of these, two have not been seen is decades. The saltpond grass (*Leptochloa fusca*) is a historic record and the population that was present in Impoundment 1 disappeared with the installation of a 7-foot diameter culvert in 1982. *Chenopodium rubrum* had been reported by Hebard (1980) in Impoundment 1 and this species has not been observed since the tidal flow restoration of 1982.

Scotch lovage (*Ligusticum scothicum*) is associated with the location of the highest wracklines of the year. The largest populations of this plant was known from the southern end of Barn Island (proper) and this population was observed in 2014. A small population had existed on the eastern

dike segment of Impoundment 3, but no plants could be found in 2014. It appears with sea level rise, the position of the high wrackline is now at the elevation of the top of the dike. The slopes of the dike are being colonized by *Juncus gerardii* in response to sea level rise. A few scattered individuals were seen on the dike at Impoundment 5 and were at the top elevation of the dikes.

State Endangered seacoast angelica (*Angelica lucida*) is a large, tall and conspicuous species, and according to Miller & Egler (1950) it was present in the *Panicum* belt (sea level fen) but outside their sampling plots. Miller (1948) describes the habitat as edges of tidal wetlands. This species may still occupy the annual wrackline as noted above for Scotch lovage. Individuals have been observed in the last several decades but were not seen in 2014.

In the survey of *Panicum* dominated sea level fens in 2014, it was discovered that State Endangered yellow thistle (*Cirsium horridulum*) was present in the *Cladium-Panicum* fen to the east of Impoundment 5. A second population was found between the boulders at kayak parking spaces at the boat launch ramp and the tidal marsh of Wequetequock Point. Several flowering individuals had escaped the DEEP mowing machine. This habitat was also fen. The team began searching all of the *Panicum* fens for yellow thistle and many new populations were located, all in fen habitat. It is likely that this does not represent an increase in the population, but rather a species whose actual numbers have never been adequately assessed. Miller & Egler (1950) note that this plant has a high fidelity to the sea level fen. The *Panicum* belt is still under review as a sea level fen but it appears that yellow thistle is restricted to the wet portions of the belt, not the mesic upper slope locations. Nichols (1920) also reported that this same association occurred in coastal Connecticut. A survey of online herbaria (Yale and UConn) confirms that this species is only reported at the upland borders of tidal wetlands.

As noted in the Sea Level Fen section of this report, this habitat is declining and also migrating upslope in response to sea level rise. With the abandonment of fields and pastures, the lower wet slope of the uplands has been progressively colonized by the black-gum (*Nyssa sylvatica*). It is likely that clear-cutting in the past converted black gum forested wetlands into *Panicum* sea level fens. The sea level fen on the east side of Impoundment 1, where yellow thistle was reported in 1993, is no longer present and no yellow thistle was located. The critical habitat of yellow thistle is unstable, migrating and decreasing.

The State Special Concern sedge, the saltmarsh tuber-bulrush (*Bolboschoenus maritimus)* was first discovered at Barn Island in the late 1980's during a review of proposed open marsh water management (OMWM) at Impoundment 3a. The OMWM plan was modified to not drain the vegetated pannes which was the habitat of this sedge. This plant has been seen in this Impoundment in subsequent years but could not be found in 2014 for a new tidal drain installed in winter 2014 had drained the panne habitat. The central and western portions of Impoundment 3 should be surveyed for this species where three-square bulrush (*Schoenoplectus pungens)* is

present. On the Connecticut River this is also the habitat where saltmarsh tuber-bulrush is found. Portions of this area were also ditched and drained in winter 2014.

The State Threatened Canada sand-spurry (*Spergularia canadensis*) has been reported by Miller (1948) and Blake- Coleman (1978) as frequent in tidal wetlands and rare in pannes, respectively. This species should be present, but it was not observed or searched for in 2014.

New England Cottontail (Sylvilagus transitionalis)

The New England cottontail rabbit (NEC) is listed as a priority species in Connecticut's Wildlife Action Plan and identified as one of nine spotlight species within the USFWS-Region 5 area. It has also been designated as a "Candidate species" for Threatened or Endangered status by the USFWS. The species has experienced an 86% decline in its historic range and within these areas 60% of occupied habitats are considered population sinks. The NEC is the only native rabbit to Connecticut and continues to be jeopardized by development, habitat fragmentation and natural plant succession. Suitable NEC habitat can be targeted and managed with a rapid benefit to the species, as well as 47 other GCN species which include 23 birds, 3 amphibians, 4 reptiles, 7 mammals, and 10 butterflies and moths.

BIWMA lies within the Ledyard-Coast Focus Area, one of twelve designated NEC management zones in Connecticut. The Focus Area covers 64,267 acres. There are nearly 3,650 acres of land managed by DEEP of a total of approximately 7,800 acres of secured lands (public and private open space, and farmland preservation lands). Although there are over 2,000 acres in municipal lands included in this number, many of the municipal and some land trust parcels are subdivison "set asides". Consequently, these parcels are generally small (about 360 acres of parcels that are less than 10 acres each) and probably of little use to NEC. This fact makes the potential management of state-owned parcels of particular significance. The three large coastal CT DEEP properties (Harkness Memorial State Park/former Verkades property, Bluff Point State Park/Haley Farm State Park, and BIWMA) all hold very good potential for habitat development and enhancement.

Although NEC have not been documented as of yet by sampling conducted at Barn Island (2001-3 and 2010-13), they have been documented within the focus area and are known to be located within 3.5 miles of BIWMA. A 1992 research paper on the systematics and biogeography of the NEC (Chapman et al., 1992) indicates that the authors examined seven museum specimens from Barn Island, although the collection dates are not noted. Given the size of BIWMA and the limited intensity of sampling efforts thus far, it seems possible that NEC may be present on the property.

Preferred habitat for NEC is early successional shrub and young forest thickets with a very dense understory that is virtually impenetrable (20,000 stems per acre). These thickets are particularly critical during the winter months as escape cover from predators and harsh weather. Brush piles,

along with stonewalls, farm equipment and other human artifacts, provide cover throughout the year, particularly if vegetation is not dense enough.

In coastal Connecticut such habitats exist in abandoned pastures, especially those with dense raspberry (*Rubus sp.*) and greenbrier (*Smilax sp.*) patches, forests that have been recently clear cut and allowed to regenerate, and in forests recovering from recent disturbances by intense storms. This type of habitat does exist in places at Barn Island, however the high stem density areas are generally dominated by invasive exotic woody species such as multiflora rose (*Rosa multiflora*), shrub and vine honeysuckles (*Lonicera* spp.), burning bush (*Euonymus alatus*), Asiatic bittersweet (*Celastrus orbiculatus*) and others. This potentially creates a management conflict between the effort to remove invasive exotic plant species and the need to preserve and expand NEC habitat.

Research recommendations for GNC species are located in the Research section elsewhere in this report.

Management Recommendations/Options

- Yellow thistle and Scotch lovage occur on the dikes, and are likely to be affected by mowing to maintain vistas and reduce common reed. However, mowing probably is a net benefit to these species by suppressing plant competition, especially of invasive species such as common reed. Much of the yellow thistle, a biennial, will have only a basal rosette of leaves in a given year, and thus be low enough to not be cut during mowing. Where the dike road meets the forest edge east of the Brucker Marsh, the sea level fen is moving onto the road and yellow thistle is present on the road edge.
- Some of the listed marsh birds on the GCN list are benefitting from the restoration of panne habitat. At the same time, high marsh grass habitat is decreasing and retreating to the pre-ditching primary habitat, the bayfront levees, thus decreasing habitat for marsh sparrows. Management objectives will need to be identified for the suite of wetland species, and this will likely create some conflicts. Barn Island may not be a priority area for protecting marsh sparrow habitat.
- New England Cottontail
    - Continue to survey for NEC at Barn Island utilizing the Potential NEC Habitat Map (Map N).
    - Expand the amount of NEC habitat present, as discussed in the Forest Habitat and Management section.
    - If habitat is increased, and surveys fail to find NEC on site, consider re-introduction efforts.

Field Habitat and Management

Only 34.6 acres (3.3 % of the total area) of BIWMA are currently in vegetation that can be considered upland fields or old fields (Map L). For the purpose of this report the term field refers to early successional habitat in which herbaceous vegetation, especially grasses, are the dominant life form. Most of the fields also contain varying amounts of trees and shrubs, especially red-cedar (*Juniperus virginianus*).

The majority of field habitat, approximately 28 acres, is located at the eastern edge of BIWMA on the former Stewart Farm, but this habitat type is not completely contiguous because areas of young forest have grown up between former agricultural compartments in places where rocky and sloping surfaces make mowing difficult. This acreage also includes a small area of agricultural lease property that is planted to corn. There are also two small fields totaling about seven acres isolated within forest vegetation on the western side of the WMA, off Palmer Neck Road on the Crowley and Matson parcels.

DEEP is also managing two fields owned by the Avalonia Land Conservancy located between Palmer Neck Road and Wequetequock Cove just north of the railroad tracks and west of BIWMA's Crowley parcel (Figure 7). These fields, also part of the former Crowley Farm, were continuously in management for hay production until it was jointly acquired by the DEEP and the Avalonia Land Conservancy in 2011. The property, named the Wequetequock Cove Preserve, has 1,000 feet of frontage on the Cove, one of Connecticut's least developed coves still largely in private ownership. The acquisition permanently protects 16-acres of coastal grassland known to provide breeding habitat for grassland dependent birds including Bobolink, a State-designated species of special concern. The site's grassland also includes the fringes of a 21-acre salt marsh that is slowly migrating upland into the fields in response to sea-level rise in Fishers Island Sound. This marsh is part of a larger 350-acre tidal marsh complex extending from the Pawcatuck River to Wequetequock Cove. The marsh provides critical nesting habitat for the Saltmarsh sparrow, a species of special concern that has been targeted as a conservation priority due to the loss of its breeding habitat within the salt marshes of the Northeastern United States. The $1,512,500 purchase price of this property was largely funded by a grant through the USDA's Natural Resource Conservation Service Grassland Reserve Program (GRP). Contributions from an additional 8 partnering organizations included: CT DEEP, Avalonia Land Conservancy, the Sarah Ann Martin Fund, Town of Stonington Conservation Commission, Stonington Land Trust, New Haven Bird Club, CT Ornithological Society, and CT National Audubon Society.

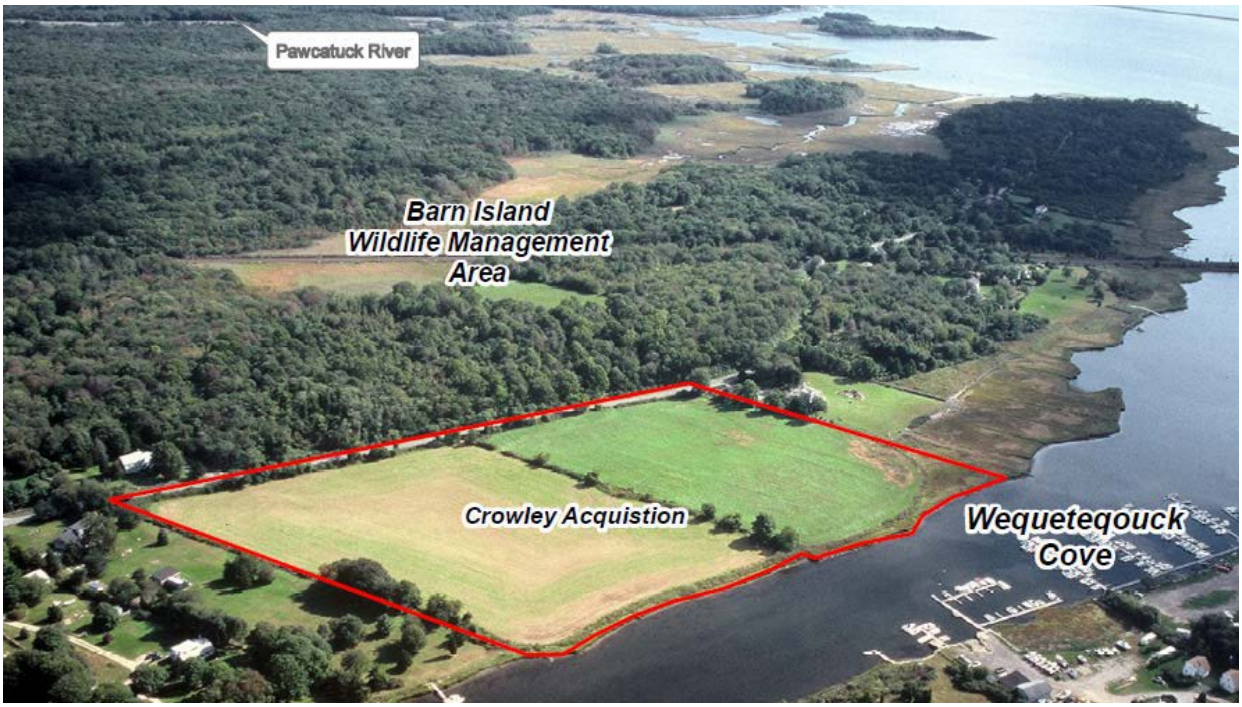

Figure 7. The Wequetequock Cove Preserve, Stonington, CT, identified as the Crowley Acquisition in this image (Kozak, 2011).

Management Recommendations/Options

To preserve and expand early successional habitat and control invasive exotic plants, it is recommended that intensive management be continued in the Barn Island fields. Since larger contiguous areas of old field habitat are known to be able to support more species of concern than smaller, isolated patches within forests, some effort should be made to remove trees between sections of nearby fields. Priority should be given to clearing the less rocky, less steep places that could be more readily mowed or burned in the future. Effective methods of reclaiming and maintaining old field vegetation are:

1. Mechanical clearing. Cut trees, including most if not all red cedars, in the fields. There may be enough large trees to trade this work for cedar posts. Mow all fields as low as possible with necessary equipment (flail mowers and brush hogs if done soon, or if not, a heavy-duty, drum type brush cutting machine like a "Brontosaurus").
2. Chemical treatment for woody plant control. In areas where control of trees, shrubs and vines is desirable, especially in the higher, drier fields with potential to become warm season grasslands, a chemical treatment is recommended (Dreyer 2001; Dreyer and Kline 2005). Approximately one month after mowing, apply an herbicide such as Crossbow (active ingredients Garlon and 2, 4 -D) at fairly low concentrations (~1 %) using a tractor mounted boom spray rig over resprouting fields. These chemicals do not kill monocots, so all grasses, sedges, lily family plants, etc. will survive and eventually thrive thanks to the release from competition with woody plants. Most woody plants will be root killed, and this herbicide

combination is especially effective on invasive wood plants in this region. Effects on broadleaved herbaceous plants will vary, with some surviving. Depending on the effectiveness of the treatment (evaluated one year after chemical application), spot re-treatments should be utilized.

3. Prescribed burning. It is recommended that DEEP personnel perform spring season controlled burns on the former Stewart Farm fields on an approximately three year rotation for the purpose of encouraging warm season grasses and other fire tolerant natives and to prevent reseeding of invasive exotic species. Observation of the effects of controlled burning over a period of 30 years at the Connecticut College Arboretum has shown that seedlings of problem invasive species are not fire tolerant, so that unlike mowing, periodic burning can prevent reestablishment in old fields (Niering and Dreyer 1989). Many native field species can be categorized as either fire increasers, or fire neutral. If burning is not possible, mowing yearly in early spring is recommended. A staggered schedule could be developed with either mowing or burning to allow some fields to have taller denser vegetation and provide refuge for animals during and after maintenance.

Some of the lower lying fields at the former Stewart Farm will not be suitable for conversion to warm season grassland and could be simply brush mowed (and not herbicided) on some cycle that would allow them to be dominated by dense low woody growth for multiple years. This could provide habitat for some shrubland and young forest specialist species.

Additional Discussion

Because the BIWMA fields are remnants of hundreds of years of pasturing, haying and some cultivation, they are not dominated by native, warm season grasses, but by introduced cool season, primarily European species used by past farmers. Warm season grasses, especially broomsedge (*Andropogon virginicus*) and switch grass (*Panicum virgatum*) are only present in some of the higher, better-drained locations. Warm season grasses can slowly be favored by mowing fields in spring after the cool season species have begun their growth cycle, but before the warm season grasses have broken dormancy.

All fields at Barn Island have some admixture of woody plants in them, especially red cedar (*Juniperus virginiana*) ranging from 2 to nearly 50% cover, and various pioneer tree species and invasive exotic shrubs. Red cedar has been allowed to reach mature size in most of the fields. Fields in lower slope positions, with more moisture and possibly deeper, more fertile soils, are dominated by broad leaved herbaceous species, especially goldenrod (*Solidago* spp.) and shrubs, especially multiflora rose (*Rosa multiflora*), autumn olive (*Eleagnus umbellata*) and black/raspberries (*Rubus* spp.). There is a small area of corn being planted annually by a local farmer in the southeastern most section of the former Stewart Farm fields.

The DEEP Wildlife Division utilized the Natural Resources Conservation Service (NRCS) Wildlife Habitat Incentive Program (WHIP) funding to keep fields at Barn Island in an early successional state for wildlife conservation purposes. Various practices including “Brontosaurus”

brush clearing, brush hogging, and chemical applications were used to control woody growth between 2000 and 2009. By late 2014 there had been two to three growing seasons since the last mowing in the former Stewart Farm fields.

The fields on the western Land Conservancy of BIWMA have been mowed annually since they were acquired by the State and Avalonia. Late season 2014 clearing and mowing on the Matson parcel appeared to be expanding the area of field and discouraging invasives. The Wequetequock Cove Preserve was continuously in management for hay production until it became conservation land. It is now mowed annually by DEEP. The information contained in this Management Assessment Report, as well as resource information and input provided by Audubon Connecticut and Avalonia Land Conservancy, will be used by the DEEP Wildlife Division to develop an annual work plan for the property as required under the Grassland Reserve Program easement.

If all mowing, burning and chemical applications were to cease, vegetation succession would proceed and woody plants, many already existing as small plants in the fields, would grow up and eventually shade out the old field species. During the first decade or two this process would develop habitat that would likely be suitable for species of concern such as New England cottontail, blue-winged warbler and yellow-breasted chat.

The potential benefits of not intervening in the successional process must be weighed against two significant negative effects, the loss of increasingly rare old field habitat and the explosion of undesirable invasive exotic plants, which already have a strong foothold in the fields.

Firebreaks and Controlled Burning

A fire break project at BIWMA was initiated due to concern expressed by the local fire chief about the increased risk of wildfire in a developing coastal community, in what is known as the "wildland-urban interface.” The last wildfire at Barn Island was in 1985 or 86. The project goals were both to improve road access for emergency vehicles to fight fires should they start, and also to reduce fuel loads along the roads. In effect, the roads themselves and the areas adjacent to the roads could function as fire breaks.

In 2004, DEEP received a Hazard Mitigation Grant from the U.S. Forest Service’s National Fire Plan for $9,500 which was used at BIWMA. Two-thirds of the funds went toward mechanical (excavator) brush clearing that was the first phase of the project. A 25-foot-wide zone was cleared along 7,300 linear feet of the WMI’s interior road system east of Palmer Neck Road. An additional 500 linear feet was treated similarly from Palmer Neck Road west towards the water to widen and add fill/stone to internal access (unimproved) roads.

There are two main fire break roads, which correspond to the unimproved, gravel, driveable roads at BIWMA as shown on Map D. First is the road that runs across most of the impoundment dikes from just north of the boat launch parking area east to the meadows west of Stewart Road.

The second road is the roughly half circle that forks off the dike road to the north on the east side of Impoundment 1. Roughly halfway through the upland forest section of BI it turns east, then southeast, eventually connecting with the first road near the south-most meadows off Stewart Road.

In conjunction with this project, controlled spring season burns were conducted for fuel reduction in vegetation along some sections of access roadsides over the past 10 years. The goal was to create approximately a 50-foot-wide black zone before extinguishing the flames. The most recent controlled burn was in 2013 on a section of road going north-south on the east side of Impoundment 1. Controlled burning is expected to continue as time and opportunities present themselves.

Management Recommendations/Options
It should be noted that the sides of the unimproved roads used as firebreaks are also the locations for some of the largest areas of infestation by exotic invasive woody plants, especially the longest east-west road that follows the dikes. Roadsides in general are dispersal corridors for invasive species, and the disturbance associated with widening the roads and clearing the roadsides at BIWMA clearly encourages establishment and spread of undesirable species. Burning could be used to help control the invasive species, and we suggest that invasive species be considered in future burning plans.

Forest Habitat and Management

Two-thirds (approximately 700 acres) of BIWMA is forested. Forest types were categorized in two ways. First, the vegetation was divided into age categories and into upland and wetland habitat based on aerial photographs and wetland GIS layers as described in the Site Description section above (Map L). Second, species composition was used to identify the habitat categories as described in the Habitats and Vegetation section above. Species composition data from 276 plots sampled in summer 2014 was used to map the habitat categories (Map O). These plots were located in a grid with one plot per hectare. At each plot the basal area of each tree species was estimated using a 10X forestry prism and common shrubs and herbs were recorded.

More than 60% of the forest area was categorized as Red Oak/Flowering Dogwood or Red Oak/Yellow Birch (which were difficult to distinguish based on the composition data). About 15% of the forest area was forested wetlands in the Red Maple/Northern Spicebush category and another 15% was young or transitional forest dominated by a combination of red cedar, sassafras (*Sassafras albidum*) and black cherry (*Prunus serotina*). The remaining forest was either Black Oak/Black Huckleberry dominated ridge tops (~2%) or a black gum dominated seepage area at the edges of the saltmarshes (~5%).

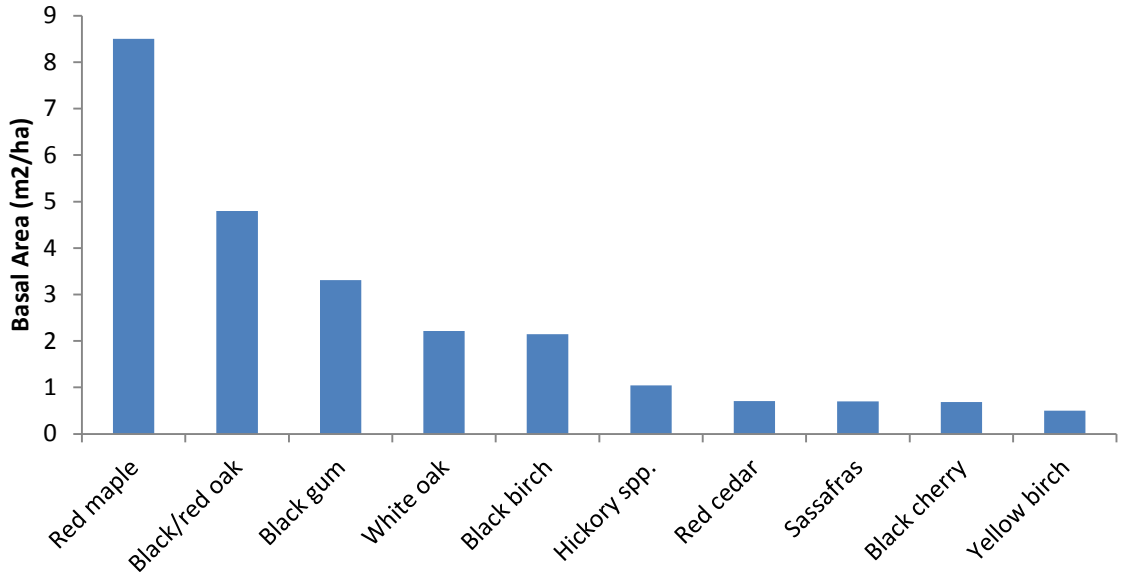

Figure 8. Common tree species at Barn Island Wildlife Management Area, Stonington, CT. All tree species with >0.5m2 per hectare basal area are included. This includes >95% of the total basal area.

Red maple (*Acer rubrum*) is the most common tree species, followed by red and black oaks (*Quercus rubra and Q. velutina*) and black gum (*Nyssa sylvatica;* Figure 8). BIWMA's forests are different from most Connecticut forests because of the abundance of black gum. The most frequent shrub species are highbush blueberry (*Vaccinium corymbosum*; 66% of plots), common greenbrier (*Smilax rotundifolia*; 35%), sweet pepperbush (*Clethra alnifolia*; 31%) and southern arrowwood (*Viburnum dentatum* var. *lucidum*; 20%).

In general the non-tidal areas of BIWMI are dominated with fairly young forest. In the absence of management, the forests will continue to age and develop characteristics of older forests, but patterns may vary by community type.

Mature upland forest (Red Oak/Flowering Dogwood, Red Oak/Yellow Birch and Black Oak/Black Huckleberry) – These forests are still dominated by relatively young trees that are mostly even age as the forest develops after the abandonment of agriculture. Species composition is not likely to change dramatically as the light-requiring early successional species are no longer present. Average size of trees will increase and density will decrease as trees die due to competition. This will lead to forests with greater variation in tree size and greater complexity.

Forested wetlands (Red Maple/Northern Spicebush) – These forests will also continue to age, but may also be affected by changes in hydrology due to climate change. Low lying forested wetlands may be inundated with salt water as sea level rises, which may lead to diebacks.

Black gum seepage communities – These forests are likely to be affected by rising sea level. There is already evidence of mortality in black gum along the forest edges and this band is likely to move inland in many areas.

Young/transitional forest – These forests are still dominated by early successional trees such as black cherry, red-cedar and sassafras. They also typically are heavily invaded by non-native shrubs and vines. Without management these forests may transition to older forests as these light-requiring species die out and are replaced by oaks and maples. However, there is some evidence that thick invasive shrub and vine cover can delay or even prevent the development of a closed tree canopy. This may be occurring in some parts of the management area.

Management Recommendations/Options

If a goal of management is to create and maintain potential habitat for the New England cottontail, there are three potential options:

Option 1 – Selectively manage young/transitional forest to maintain dense shrub thickets.

There are seven blocks (ranging from 5 – 20 acres) of young/transitional forest at BIWMA that could be managed to provide habitat for the New England cottontail (Map N). Much of the habitat in these areas is currently young forest dominated by largely invasive shrubs and vines and early successional trees. Selected removal of trees in these areas could help maintain the dense thickets. Blocks 5-7 are smaller and contain a mixture of fields, open woodlands and young forest but could be connected to form a larger block. Any management of Blocks 1, 2, or 4 should seek to protect the salt marsh edges which can contain rare and endangered plant species.

The benefit of using these areas as habitat for the New England cottontail is that they are already dense and heavily invaded. Thus, they would be relatively easy to manage for this purpose and the management would not lead to a spread of invasive species at BIWMA. As resources allow, efforts could be made to favor the native thicket species (e.g. blackberries [*Rubus* spp.] and greenbrier [*Smilax* spp.]) that are also present in these areas. However, efforts to manage invasive species are best focused elsewhere.

Option 2 – Allow woody plant growth to continue in areas of the fields.

Parts of the fields are already being invaded by shrubs and young trees and this could be allowed to continue by stopping mowing in these areas. This could be combined with management in adjacent young forests to create a larger area of potential habitat. This approach would reduce the amount of open habitat for plant and animal species dependent on open spaces.

Option 3 – Cut areas of more mature forest to create early successional habitat.

This would involve removal of timber and opening up additional habitat. This would likely lead to increased spread of invasive species within the management area and the reduction in older

and more complex forest habitats. Given the abundance of younger habitat at the site, we recommend avoiding these older forests unless timber harvesting is also a goal.

Infrastructure

Roads and Parking

Palmer Neck Road is a paved, town road that provides the main access to BIWMA via the boat launch and parking area. It is in adequate condition. The gravel or unimproved road leading from Stewart Road west to the gravel parking area allows access to the WMA from the eastern side. It is in poor condition and can be difficult for passenger vehicles to navigate.
The main parking areas are the paved lot associated with the boat launch at the south end of Palmer Neck Road, and the gravel lot off Stewart Road. The paved lot is in good condition. The gravel lot is in fair condition. Both lots appear to be adequately sized.
The remaining access points (Map D, points 3-5 and 6, if access point is developed) have space for limited parking but it is unclear if parking is allowed.

Management Recommendations/Options
1. Consideration should be given to either improving or annually re-grading the access road from Stewart Road.
2. Consider improving the gravel lot off Stewart Road.
3. At the unidentified access points, either parking spaces should be marked or it should be clearly indicated that parking is not allowed and visitors should be directed to the two main access points for parking.

Trails

There are 14.4 miles of trails at Barn Island. All of the existing trails were mapped and categorized based on how established they were and potential actions (Map P). Based on comparison to a trail survey previously done by the Denison Pequotsepos Nature Center, there appear to be many unofficial trails that have been created in the past few years. Many trails show evidence of mountain bike use as rocks and logs have been moved around to allow bike passage.

In 2003, a project conducted by Eagle Scout Philip Banker included establishing a 3 mile interpretive trail by creating a brochure with a trail map indicating points of interest and short descriptions of the those locations (Appendix E). He also installed wooden posts with numbers corresponding to the information in the brochure. This is currently the only trail official recognized by DEEP on BLWMA.

There is a high density of trails at Barn Island which can lead to increased spread of invasive species and potential fragmentation of habitat. We recommend that some trails be closed to reduce the impacts and that an official trail system be created with blazed trails and maps.

Management Recommendations/Options

- Utilize and advertise the Philip Banker Trail Guide Map as the official visitor trail. Update the map and points of interest.
- Consider blocking access to the most sensitive trails and using vegetation to hide entrances to little used trails.
- Determine policy for trails leading onto adjacent properties. Three potential options for closing trails are:
  - close them at the junction nearest the property boundary as indicated on the map, or
  - post a sign at the property boundary, indicating that it is the edge of public land, or, if there are no issues with the property owner, maintain the status quo. There appears to be a network of trails on the Davis property that connects with some of these trails.
- Consider extending the trail to create a new access point to the WMA off of Greenhaven Road.
- Consider whether all trails should be open to all allowed uses (foot traffic, horses, mountain bikes) or if some trails should be restricted to certain uses. Currently we did not see evidence of conflict among users, but there is some evidence that use by mountain bikers is increasing.

Additional Discussion

All trails were categorized at BIWMA as follows (Map P):

Unimproved roads (4.9 miles). These unimproved roads include the firebreaks and the dike trails and form the basic loop of trails and connect to several access points to the WMA.

Major trails (2.7 miles). These are single track trails that are well developed and apparently well used. They supplement the unimproved roads by allowing access to the northern part of the WMA, creating additional loop trails, and providing an additional access point.

Proposed closure trails (1.8 miles). These are trails that are noted as possibilities for closure for a variety of reasons. Those indicated with a 1 in Map P are new trails that go through wetland areas and have the potential to cause significant damage if they receive higher use. Those indicated with a 2 are well-used trails that lead into the Davis property to the north of state-owned property. The rest of the proposed closure trails are partially overgrown trails that do not seem to have a lot of use and are mostly small loop trails off of the major trails.

No maintenance (0.9 miles). Most of these are trails that are close to existing trails and do not lead to new locations. Depending on how much desire there is to reduce the density of trails, these could be added to the proposed closure list but are not as high priority for closure. A second group of trails in this category are those leading to individual houses on adjacent property. We would propose that these trails not be maintained or included on official trail maps.

Minor trails (4.1 miles). These trails allow access to additional areas of the WMA and/or appear regularly used, but not at the same level of the major trails.

We have included a map of the unimproved roads and major trails that could be used as a supplement for a mapped system of blazed trails (Map D – excluding individual access trails). If a more extensive official trail system is desired, some or all of the minor trails could be included.

Additional Access Point. One particular trail related issue is the potential for developing access to the WMA from Greenhaven Road. There is a 20-foot-wide access between 308 and 316 Greenhaven Road (Figure 9). It is not currently obvious from the road that this is state-owned property. There is already a trail that leads almost to this access point (see trail labelled 3 on Map P) so this access could be developed with little effort. This point would provide pedestrian access for the neighborhoods off of Greenhaven Road.

Figure 9. Potential access to Barn Island Wildlife Management Area off of Greenhaven Road, Stonington, CT.

Boundaries and Signage

The boundaries of BIWMA were last marked by Wildlife Division staff in 2012. A summary of boundary needs and encroachments for all WMAs in Eastern Connecticut was compiled in January 2013 and provided to DEEP's Property Management Division. Notations made for BIWMA included the following: 1) There are no maps (only deeds) in the District's files for the first Barn Island purchases. Some of these boundary lines need to be reestablished. The internal lines should be checked; they may need to be eradicated. 2) On the Palmer Neck side, N/F Lema and N/F Blindloss sections need to be re-surveyed to reestablish lost lines. Some monument and drill holes are missing. 3) Stewart Road entrance needs to be re-surveyed to reestablish the location of the State's access. Neighbor to the south modified the area and the neighbor to north cut down trees along stonewall leaving only the trees with State land boundary signs. Wildlife Division needs assistance from DEEP Property Management in relocating and defining the boundary lines in this area so that a shield sign can be installed to assist the public in locating the entrance and parking lot. 4) The lawns of some of the houses within the Wequetequock Passage development have encroached onto State land. The boundary line needs to be reestablished.

Signage at BIWMA includes roofed, wooden kiosks with regulation boards at the two main entrances; metal boundary markers; a regulation board at the launch; and interpretive panels at various locations, especially at the overlook near the Palmer Road main entrance.

Management Recommendations/Options

- At the major access points (Map D, points 1 &2) we recommend adding signs with information about the WMA as well as allowed and prohibited uses. In particular we recommend information about the history of Barn Island (including that it was funded in part with Federal Aid in Wildlife Restoration funds), information about hunting seasons, and information about what uses are allowed and what are not, and instructions for educators and researchers. Signs with trail maps should also be included at these access points along with indication that visitors should stay on marked trails.
- At the remaining access points (Map D, points 3-5 and 6, if access point is developed) at least the information about uses and trail maps should be included on signs.
- We recommend that the official trails be marked with blazing. Although a lower priority, we recommend that signs with trail maps be added at some or all of the major trail junctions within the WMA (indicated with * on Map D; one already present at Point 7).
- Update Philip Banker's 2003 points of interest brochure (see Trails section) and install new wooded posts with numbers corresponding to the brochure. Make the brochures available online as printable pdf files and in brochure boxes at the east and west main entrances.

Native Plant Entry Garden

In 2005, the CT DEP Office of Long Island Sound Programs received a $28,200 Long Island Sound Futures Fund Grant (2005-0191-020) grant to install a demonstration garden of native coastal plants at a location south of the main entrance trail, east of Palmer Neck Road and just north of the boat launch parking area. The location overlooks the tidal marsh system below the dikes and had already been selected for installation of a previously funded series of large interpretative educational panels. The DEP partnered with the Connecticut College Arboretum, which supplied the plant list and garden design and supervised plant installation, and with the Denison Pequotsepos Nature Center who were responsible for garden maintenance.

The project objectives were to 1) familiarize visitors with native plants suitable for landscaping in coastal locations; 2) stabilize a site which had been cleared and used for deposition of dredged sediment from the recent boat launch renovation; 3) provide ADA compliant access to the interpretive signs in an attractive and educational setting; and 4) better accommodate groups visiting the site, including providing gathering areas for outdoor education.

Mary Villa, Connecticut College Arboretum Curator/Information Manager designed the site plan and planting plan in consultation with Arboretum Director Glenn Dreyer (Figure 10). Mary also supervised the installation of the plantings by CT DEP staff. The dredge spoils were not the ideal substrate due to poor drainage and low pH. Lime and topsoil were brought in to form raised planting bed areas with chip-sealed gravel trails and gathering areas between them. Plants included beach plum (*Prunus maritima*), bayberry (*Morella caroliniensis*), sweetfern (*Comptonia peregrina*), shadbush (*Amelanchier canadensis*), pasture rose (*Rosa virginiana*), highbush blueberry, switch grass, little and big bluestem, asters (*Aster* spp.) and goldenrods (Figure 11). Unfortunately, maintenance in this garden had not been adequate over the ensuing years, and the plantings became overrun by weeds, particularly the highly invasive mugwort (*Artemesia vulgaris*).

In 2013, as part of a project conducted by Eagle Scout, Clayton Andrews, and funded by the Sarah Ann Martin Fund, an additional bench was installed and the garden was weeded.

Management Recommendations/Options

Option 1 – Mobilize DEEP staff and/or local volunteers to rehabilitate the plantings and ensure annual maintenance of the garden area. Given the difficultly of assuring adequate, long term volunteer maintenance of these kinds of projects, it is recommended that outside funds be sought for a volunteer coordinator to regularly assemble volunteers to assist with garden maintenance and possibly other projects.

Option 2 – If it is not possible to maintain the entry plantings, the information panel at the entrance to the garden should be removed. The panel describes the benefits and ways to use native species in coastal plantings, and the unmaintained state of this garden unfortunately argues against this type of landscaping approach.

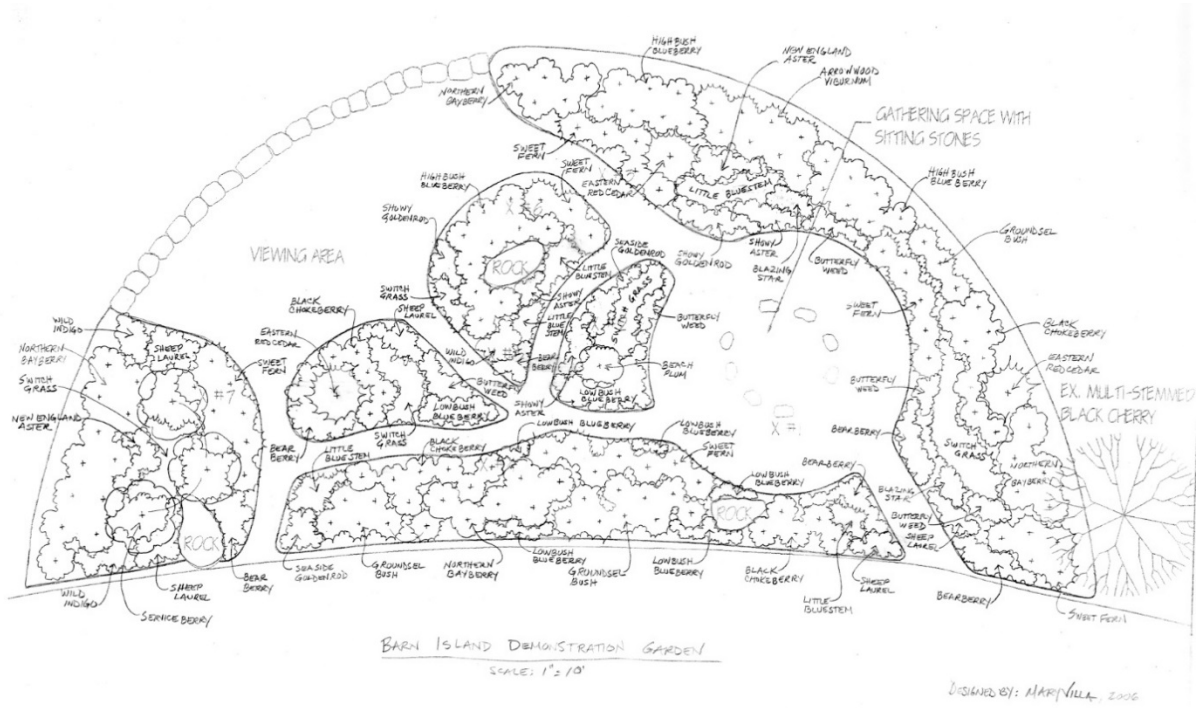

Figure 10. Site plan for native plant garden at Barn Island Wildlife Management Area, Stonington, CT.


Figure 11. Appearance of native plant garden at Barn Island Wildlife Management Area, Stonington, CT, shortly after completion

Dikes

Much has already been mentioned about the dikes that formed the five impoundments at Barn Island. Presently their most important function is as unimproved roads across the tidal marshes, allowing access for visitors on foot, and for maintenance and emergency vehicles. Currently the greatest concern is that, with rising sea level, marsh vegetation is moving up the slopes of the dikes. Permits are required to perform any activities in tidal marshes, thus maintenance, reinforcement, and making the dikes higher may all need permits in the future.

Invasive Species

Upland Areas

Invasive plant species are a major challenge in parts of the WMA. They are particularly abundant on Palmer Neck (west of Impoundment 1), along the dike trails, in and around the fields, and in the southeastern corner of the WMA (Map Q). There is some evidence that invasive plant species are spreading along trails, particularly the unimproved roads.

The number of each invasive species was measured within a 10m radius of each of the 279 vegetation plots and in 192 additional plots located every 100m along major trails (Map R). Invasive species were found in 52% of the vegetation plots located in the sampling grid and in 83% of the plots along trails. The most common invasive plant species are oriental bittersweet (*Celastrus orbiculatus*), multiflora rose (*Rosa multiflora*), Japanese honeysuckle (*Lonicera japonica*) and bush honeysuckle (*L.* sp.; Figure 12)

Analysis of the 279 vegetation plots on the grid shows that the two best predictors of where the invasive species occur in the uplands are habitat and distance from forest edge. Invasive species are much more common in open sites and young forest (Figure 13) and in forested areas within 50 feet of the forest edge and much less common in forested areas more than 500 feet from the nearest edge (Figure 14).

Management Recommendations/Options

1. Parts of the WMA are heavily impacted by invasive species and control or eradication in these areas will be time consuming and costly. In some of these areas invasive species make up most of the shrub and ground layer vegetation. Much of the northern part of the WMA, however, has few or no invasive species. We recommend that management efforts focus on containing the invasive plant species in the areas where they currently are abundant. The initial steps would be to remove the few scattered patches of invasive species that are distant from any heavily invaded area. If resources are available for additional control, the three larger patches along trails in the center of the WMA could be targeted for control.

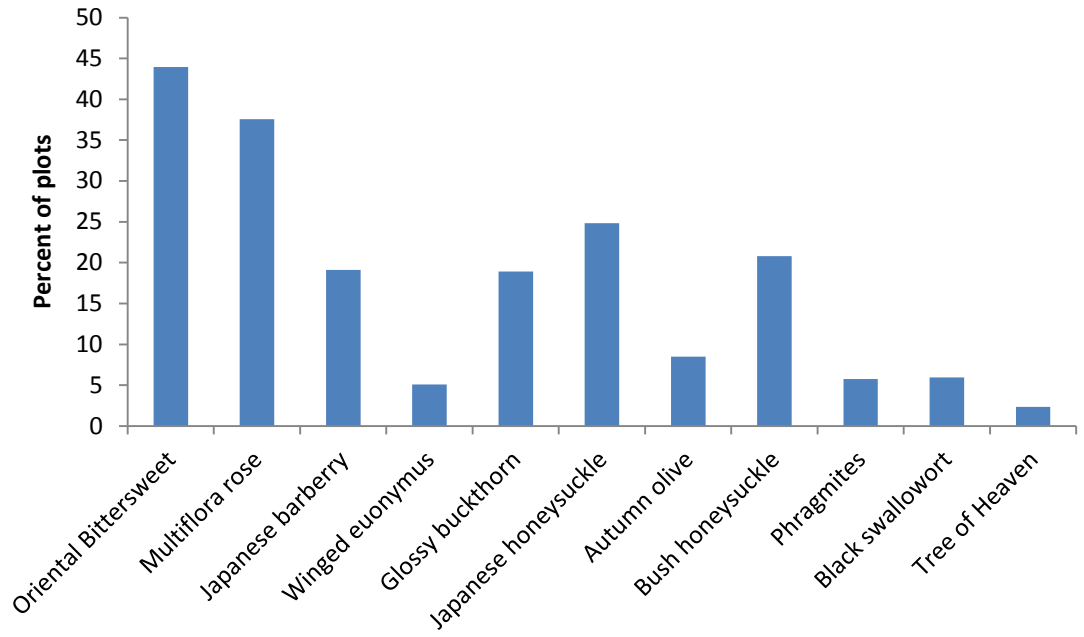

Figure 12. Occurrence of common invasive plant species at Barn Island Wildlife Management Area, Stonington, CT. Bars indicate the percent of the 471 plots where each species occurred. Additional invasive species found in fewer than 2% of plots are black locust (*Robinia psuedoacacia*), Japanese stiltgrass (*Microstegium vimineum*) and Norway maple (*Acer platanoides*).

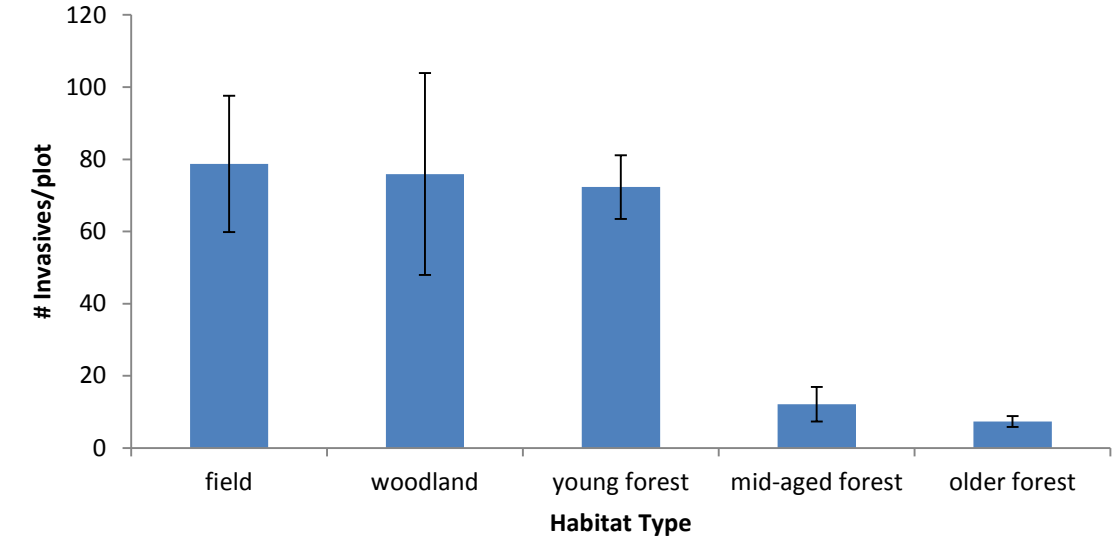

Figure 13. Abundance of invasive plant species in different habitat types at Barn Island Wildlife Management Area, Stonington, CT.

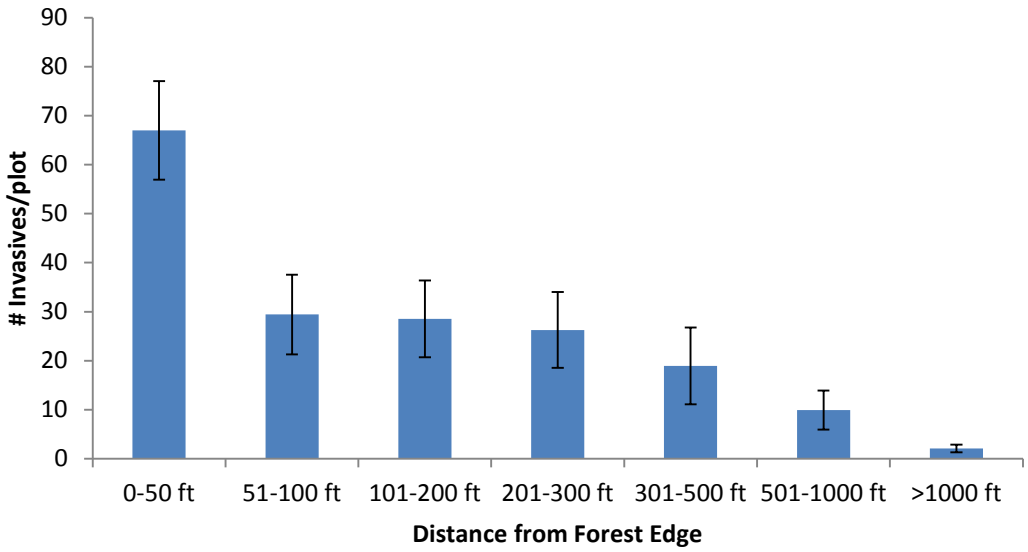

Figure 14. Effects of distance from forest edge on abundance of invasive plant species in forested plots at Barn Island Wildlife Management Area, Stonington, CT.

Phragmites

Common or giant reed *(Phragmites australis*) is the most abundant invasive species in the tidal wetlands of BIWMA, and restoration of tidal flow to the impounded marshes has served as an effective control.

In the late 1940's, *Phragmites* was rare but the dike construction of the Impoundments created ideal habitat for it. Tidal flow restoration increased salinities and has greatly reduced its areal extent, which is now confined to upland borders, with the exception of Impoundment 4, a brackish marsh. *Phragmites* continues to decline in height and abundance in this Impoundment, but the restoration of brackish meadows is a very gradual process given the lower soil salinities.

The primary areas where *Phragmites* represents a priority management issue are the sea level fens in Impoundment 3 and between Impoundments 4 and 5. In the latter, most of the biodiversity of the fen has been lost. *Phragmites* has also colonized some of the small fen areas such as in Impoundments 1 and 2. Some of these small areas can support significant populations of the rare plant yellow thistle (*Cirsium horridulum*) and monitoring should identify which ones warrant *Phragmites* control, for example at Wequetequock Point. The fen areas in Impoundment 3 and between 4 and 5 will be the next significant marsh transgression areas of high marsh vegetation and it is expected that unless controlled, *Phragmites* will become the dominant species in those transgression sites.

DEEP has controlled *Phragmites* at the head of Impoundment 1, below the Amtrak corridor, which has been a key practice to protect a sea level fen dominated by smooth saw-sedge

(*Cladium mariscioides)*. This area should be monitored to determine if retreatment is required in the future.

One final target area for *Phragmites* control is the tidal wetland north of the Amtrak corridor associated with Impoundment 1. This is a potential site for tidal flow restoration at the access road crossing. The condition of the culvert under the Amtrak corridor is unknown at this time. If it is determined that tidal flows can be increased to this wetland, and that salinities reaching this location are high enough, DEEP should consider this control method.

Management Recommendations/Options

- Implement *Phragmites* control in Impoundment 3 and between Impoundments 4 and 5 to protect sea level fen. Smaller fens around Barn Island may also require treatment as these small areas can support populations of the state endangered yellow thistle.
- Evaluate the need for *Phragmites* control above the Amtrak corridor associated with Impoundment 1.

Future Land Acquisition – Adjacent Properties

A number of properties near BIWMA are of interest as potential additions to the WMA (Map S; Table 7). The two largest unprotected parcels adjacent to Barn Island are owned by the Davis family and total 168 acres. The first (#7 on Map S and Table 7) is 120 acres north of Barn Island with frontage on Green Haven Road. The second (#13) is 48 acres on Osbrook Point Road with 0.6 mi of frontage on the Pawcatuck River. The Stonington Land Trust (SLT) has acquired a three year option, beginning in December 2012, to purchase a conservation easement on both parcels (*The Day*, New London, 12/27/2012). They are attempting to raise $2 million for the project and were near to achieving this goal by late 2014. The proposed easement does not allow public access, except for twice a year. If these two parcels are successfully placed under an easement, the entire 422-acre Davis Farm will be protected by easements (#9, 10 and 12 are already protected).

Camp Kitchtau, owned by the Westerly Council, Boy Scouts of America (BSA; #8 on Map S), is the next largest property. It is located on the east side of Barn Island, to the west of the end of Stewart Road. This parcel is already protected from development and DEEP staff indicated that the property reverts back to the donors if BSA no longer wants it (a copy of the deed was not available).

To the west of BIWMA, two adjacent properties are owned by Avalonia Land Conservancy and protected for conservation (#1 and #11 on Map S). Parcel #1 is managed by the DEEP in cooperation with the Avalonia Land Conservancy

There are a series of small lots (under 10 acres) along the east and west sides of Palmer Neck Road. DEEP recently acquired the Matson property at 207 Palmer Neck Road, a 5.75-acre lot

Table 7. Description of parcels near Barn Island Wildlife Management Area, Stonington, CT, including owner, acreage and comments.

#	Parcel Owner	Acres	Description
1	Avalonia - Palmer Neck	16.06	Wequetequock Cove Preserve. Fields and saltmarsh west of Palmer Neck Rd. and north of railroad tracks. Owned by Avalonia Land Conservancy.
2	146 Palmer Neck	6.30	Lot with "castle" house W of Palmer Neck Rd., N of railroad tracks.
3	Crowley parcel	3.66	Adjacent to 146 Palmer Neck, west of Palmer Neck Rd. and north of railroad tracks.
4	Pantani	6.18	E of Palmer Neck Rd., S of railroad tracks.
5	260 Palmer Neck	4.79	S of railroad tracks, W of Palmer Neck Rd.
6	Marcos	6.80	N of 260 Palmer Neck.
7	Davis - Greenhaven North	117.60	On central/north border of BIWMA with Green Haven Rd. frontage.
8	Westerly BSA	22.51	Boy Scout property with development restrictions.
9	Davis - Greenhaven East	39.34	South of Greenhaven Rd. and north of Osbrook Point Rd. Northern part of existing Davis farm.
10	Davis - Osbrook Point West	147.35	Large parcel E of Barn Island and W of Osbrook Point Rd. Has conservation easement.
11	Avalonia - Osbrook Point	10.08	Saltmarsh E of Barn Island. Owned by Avalonia Land Conservancy.
12	Davis - Osbrook Point East	44.75	SE of Osbrook Point Rd. Southern part of existing Davis farm.
13	Davis - Osbrook Point South	45.91	Southeast of Osbrook Point Rd. and south of Davis Osbrook Point East. Includes shoreline on Pawcatuck River.
14	Middle Island	7.4	Inholding owned by the Johnstone family.

South of the railroad track and east of the road (directly north of Parcel #4). DEEP already owns the property to the north and east of this piece.

DEEP is interested in the lot directly south of 207 Palmer Neck Road (personal communication, Mr. David Kozak of DEEP's Office of Long Island Sound Programs), a 6.2-acre parcel owned by the Pantani Trust (Parcel #4) and bordered by the WMA on three sides. The parcel was inspected from its perimeter only, since permission was not received to access the lot. The property is primarily forested, but has some dense thicket areas on the higher elevations near Palmer Neck Road. The rear of the property abuts the wetland landward of Impoundment 1. There is a relatively large, flat zone of black gum seepage swamp adjacent to the Impoundment that could allow tidal marsh encroachment with sea level rise. The upper areas could be managed to increase and enhance thicket habitat for species of concern. There is not currently a house on the site, but there are some boats on trailers and at least one shed.

An inholding called Middle Island (Parcel #14, Map S) is located south of the Davis marsh and east of Barn Island proper. It is owned by the Johnstone family and is surrounded by WMA property.

UConn Researchers Chris Elphick and Chris Fields have been working on a "decision support tool" for use in prioritizing land purchases specifically for the purpose of protecting populations of coastal birds by conserving upland adjacent to tidal marshes to allow migration of marshes and preservation of this habitat as sea levels rise. In their report (Field and Elphick 2012) they utilize the tool on property adjacent to the BIWMA and include a map that prioritizes parcels that they recommend be purchased for conservation purposes. These include many parcels west of Palmer Neck Road, the Davis Farm and unpreserved property along the Pawcatuck River.

In the processes of creating the BIWMA Vegetation Map, the "adjacent parcels of interest" were included. Table 8, which shows the area of each type of vegetation on each parcel, may be useful information for DEEP when making future land acquisition decisions.

Table 8. Area of vegetation types for parcels near Barn Island Wildlife Management Area, Stonington, CT (as described in Table 7). All vegetation type numbers are in acres.

Vegetation Type	**Parcel Number (from Table 7)**												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Developed	0	0.59	0	0	0	0	0	0	1.81	0	0	0	1.48
Open field	15.42	1.52	0.71	0.47	0	0	11.78	1.10	18.71	4.46	0	26.56	0
Tidal wetland	0.64	3.83	0	0.04	0.83	2.07	0	0	2.67	32.17	10.07	9.72	2.60
Shrub wetland	0	0	0	0	0	0	0	0	1.34	9.10	0	0	0
Young forested wetland	0	0	0	0	0	0	0	0	0	0	0	0	0
Moderate-aged forested wetland	0	0	0	0	0	0	0.37	0.38	0	0	0	0	0
Older forested wetland	0	0	0	0	0	0	37.63	2.73	0.72	18.80	0	0	0
Upland woodland	0	0	0.70	1.06	2.60	3.18	4.95	0	2.37	0	0	0.84	1.24
Young upland forest	0	0.36	2.23	3.29	1.37	1.55	2.66	4.03	3.36	8.08	0	5.57	17.11
Moderate-aged Upland forest	0	0	0	0	0	0	13.93	1.45	0	61.04	0	1.57	19.35
Older upland forest	0	0	0	1.33	0	0	46.26	12.82	8.37	13.65	0	0	4.13
Open freshwater	0	0	0	0	0	0	0	0	0	0.07	0	0.49	0
Total	**16.1**	**6.3**	**3.6**	**6.2**	**4.8**	**6.8**	**117.6**	**22.5**	**39.4**	**147.4**	**10.1**	**44.8**	**45.9**

Management Recommendations/Options

- If the Stonington Land Trust is not successful in purchasing an easement on the Davis properties, consider methods for acquiring or protecting these two parcels
- Acquire the Pantani Trust property if it becomes available

- Acquire Middle Island parcel if it becomes available
- Use the Field and Elphick decision support tool to help prioritize additional land purchases

Tidal Marshes/Coastal Habitats

Vegetation Change on the Natural Marsh

As detailed in the following section on Mosquito Control, ditching of the marshes in the early 1930's drained them, greatly diminishing the amount of panne habitat and rather quickly shifting the dominant vegetation to high marsh grasses, especially saltmeadow cordgrass (*Spartina patens)* and black-grass (*Juncus gerardii)*. By 1947, the dominant plants (exceeding 75% cover) were high marsh grasses. Since then various panne habitats have gradually increased and the high marsh grasses have decreased. The upland-to-bay vegetation sequence on Palmer Neck now resembles the Miller and Egler (1950) description of the pre-ditching marsh vegetation.

Various management activities have been suggested for the tidal wetlands at Barn Island. These include draining pannes and developing adaptive management strategies to address anticipated changes due to climate change – such as increasing high marsh meadow habitat critical to the salt marsh sharp-tailed sparrow (*Ammodramus caudacutus*). Despite the long-history of marsh research and monitoring, there are still changes that are poorly understood in the absence of vegetation monitoring on a more frequent schedule (approximately every 5 years). Management success will depend upon a better understanding of vegetation change and also wetland response to activities such as ditching or thin layer disposal techniques.

Impounded Marsh Restoration

Five impoundments were created at Barn Island to improve habitat for waterfowl and shorebirds, increase muskrat populations and control mosquito breeding. The history of these structures was summarized in the History section of this report in the Tidal Marsh Impoundments Construction sub-section.

Eventually, tidal flow was restored to the five Impoundments (Map C) with the restoration ages range from 22 to 36 years. Post restoration monitoring and research (Warren et. al 2002) identified key restoration elements and illustrated the progression of the return of ecological services. The restoration objectives, to restore the broad complexes of salt and brackish marsh habitat, were successfully achieved. No attempt was made to restore the precise pre-disturbance condition, which could not be easily replicated and was not the desired goal, particularly since the pre-disturbance habitats would have changed in response to sea level rise.

Management Recommendations/Options

- Continue to monitor restoration changes in the 5 impoundments.
- Manage the 5 impoundments as tidal marshes. The restoration efforts have greatly improved wildlife utilization and restored many of the original ecological services present in the natural tidal wetland (Warren et. al., 2002) and pre-ditching marsh. Low lying freshwater wetlands and sea level fens associated with the Impoundments will become tidal wetland as a result of marine transgression caused by sea level rise. A return to managing these areas as impoundments will jeopardize marsh migration.
- Remove the weir boards from Impoundment 5 as the existing boards cause low dissolved oxygen and perhaps anoxia that at least is stressful on forage fish.
- Evaluate the tidal restriction caused by the access road at the north end of Impoundment 1. Increasing tidal flow above this road could help to reduce *Phragmites* in this area including north of the railroad embankment. Typically, railroad structures were properly sized for tidal flow and stormwater discharge. A simple survey could measure the height difference in water level upstream and downstream of the culvert on a slack high tide. Also note the difference in timing of slack water at the dike versus the slack water at the access road. These observations can be used to gauge the severity of the restriction.
- *Phragmites* dominated borders such as found in Impoundment 5 appear to occupy the *Juncus* belt and adjacent sea level fen. Herbicide treatment might provide additional habitat for sea level fen and facilitate transgression of the *Juncus* belt.

Mosquito Control Activities

Ditching

Ditching in 1931-1932 drained the Barn Island marshes, decreasing panne habitat which in turn decreased use by wading and shorebirds. It is likely that the marshes contained meandering tidal creeks prior to ditching, but the ditching has largely erased any evidence of natural creeks except for the meander between Dikes 3 and 4. This was the creek that fed and drained Impoundment 4 but that function was eliminated with the construction of Dike 3.

Ditching favored an increase in the high marsh grasses. The ditches are spaced between 80 and 100 feet apart and were excavated by hand with special shovels and the peat was placed alongside the ditch. This practice contributed to the ponding of water on the marsh and the elevated soil was soon colonized by the shrub marsh-elder (*Iva frutescens*). This formed the "fence rows" described in Miller (1948). Stearns *et al.* (1940) described the loss of elevation following ditching in a Delaware brackish marsh. Little is known about the consequences of ditching on marsh elevation.

Maintenance ditching was sporadic and the marsh was last ditched in 1979 with the then new amphibious rotary ditching machine. Maintenance ditching was discontinued state wide in 1984

and replaced with the selective use of open marsh water management to control mosquito breeding. The 1979, ditching may have led to an increase in high marsh grasses but if it did, it was not as dramatic as the changes that followed from the initial ditching. Vegetation maps prepared by Blake-Coleman (1978) show a marsh where various panne communities had replaced high marsh grasses and marshes at Barn Island resembled the pre-ditching marsh as described by Miller and Egler (1950). Open water panne habitat has increased since Blake-Coleman mapped the vegetation of the natural marsh. Some of that is in response to the abandonment of maintenance ditching but some of the pannes have formed due the formation of microlevees along the ditches (Miller and Egler 1950).

Open Marsh Water Management

Open marsh water management (OMWM) is a method of saltmarsh mosquito control that advocates source reduction and biological control through the use of selective channel and pool creation in mosquito producing areas. This technique focuses on mosquito breeding sites and uses non-tidal ditches and ponds to create habitat for killifish (*Fundulus* spp.) which feed on mosquito larvae. The lack of maintenance ditching has favored the gradual increase in various panne habitats including open water pannes. Typically, the ditches accumulate sediment at their upstream terminus, and gradually fill in a downstream direction. Pannes typically form adjacent to the uplands. OMWM is considered a more ecologically sound alternative compared to indiscriminate parallel ditching or chemical pesticide use (Wolfe 2005).

To adapt OMWM to ditched marshes, the initial federal permit identified the types of OMWM practices that could be used and required the creation of a committee composed of resources specialists, scientists and regulatory staff to pool their knowledge base about retrofitting ditched marshes with OMWM. Mosquito control staff identified marshes with significant levels of mosquitoes and developed preliminary control plans. The committee reviewed each project on-site and at the end of each year reviewed all of the new proposals and finalize the design.

Three OMWM activities were implemented at Barn Island in 1987, in the early stages of OMWM implementation. These techniques successfully controlled mosquito populations for approximately 20 years. Due in part to sea level rise and to the “closed” nature of these initial systems (i.e., no direct tidal connection), in some cases the marsh areas surrounding these systems became saturated, retaining water in marsh vegetation or creating open areas that were conducive to producing mosquitoes. The initial OMWM systems continued to hold fish and control mosquitoes; however the surrounding areas now produced mosquitoes. These new mosquito-producing sites were regularly inspected (in addition to other known mosquito-producing sites) and treated for mosquito larvae using approved pesticides. In 2014, an OMWM plan approved in 2009 was implemented. Nearly 100% control of larval mosquitoes was achieved.

Management Recommendations/Options

- Avoid OMWM activities in:
    - Priority research areas including SET sites and micro-relief plots
    - Avoid OMWM activities including the use of tidal ditches in the panne complex between Dike 3 and Bloom's Point.
- Monitor the thick layer fills in the tidal marsh and sea level fen to determine what the consequences of using this new technique are. An assessment report should be presented to the OMWM site committee for review.
    - Disposal sediments on the west side of Impoundment 2 contain numerous *Phragmites* rhizomes. This area will likely require treatment and removal of *Phragmites*. Monitor and report findings to the OMWM site review committee.
- Consider the installation of a structure such as marine plywood in Impoundment 3a to re-flood the panne areas. If this action is implemented, assess the ecological services by the brackish water pannes in this location.
- Monitor areas where OMWM was implemented to ensure that an acceptable level (95-100%) of mosquito control was achieved.

Pannes & Pools

There are three commonly recognized panne types in Connecticut, forb pannes, stunted smooth cordgrass (*Spartina alterniflora* = Sas) pannes and open water pannes. By definition, pannes do not always have standing water while pools are permanently filled with water. Pools may contain aquatic vegetation such as widgeon grass (*Ruppia maritima*) and less commonly horned pondweed (*Zannichellia palustris*). Today, pannes are the dominant habitats on the high marsh.

Area of all three panne habitat types (forb, Sas and open water) have been increasing since 1947 at BIWMA, with open water pannes increasing particularly rapidly in the last 20 to 30 years. Pool habitat is also increasing. Open water panne is a natural and important habitat of the tidal marsh and the conversion of high marsh vegetation to open water panne should not be considered a form of marsh loss but of habitat change. Forb and Sas pannes are the dominant high marsh habitats today and open water pannes are increasing. The increase in this habitat type may reflect a return to pre-ditching dominance by pannes as described by Miller and Egler (1950).

There have been suggestions to drain additional panne habitat at Barn Island and elsewhere. The extent of panne habitat on the natural marsh is poorly known but various historic photographs (Figure 15) demonstrate that in portions of the tidal marsh, open water panne can be the dominant habitat. Miller and Egler (1950) make reference to the natural marsh containing 20% panne habitat. There are no data to indicate the current percentage of Barn Island tidal wetlands that support panne habitat.

Figure 15. Historic photographs showing the abundance of open water panne habitat in three tidal marshes in Connecticut prior to ditching. From left to right: Quinnipiac River marsh (1917), marsh near Morris Cove (~1915) and Westbrook (Nichols, 1920). The first two images are from DEEP archives.

Wetlands were acquired at Barn Island to help offset declines of waterfowl and shorebirds in the Atlantic Flyway. In the late 1940's, restoring panne and pool habitat through the cessation of ditching or plugging ditches may not have been a viable management option given that Stonington had paid to construct ditches in the early 1930's. Today, pannes and pools are returning to the Barn Island marshes and there has been an increase in shorebird and wading bird use of the marsh.

Sea Level Fen and Black Gum Forested Wetlands

Sea level fen is a rare coastal community dominated by shrubs and grasses that occurs on the seaward slope of uplands on freshwater peatland. Typically just a few meters wide, it is the habitat for the state endangered yellow thistle (*Cirsium horridulum*) and perhaps seacoast angelica (*Angelica lurida*). This community is continuously moving inland and uphill as the wetland substrate moves inland. When this wetland is colonized by the black gum tree (*Nyssa sylvatica*), the grass/shrub phase fen disappears. It appears to be the spread of the black gum forested wetland that is the main cause of the declining state of this habitat at Barn Island. The spread of *Phragmites* is also contributing to the decline of fen habitat.

Management Recommendations/Options

- Consider removal of shrub thickets to create habitat that fen can occupy in the future. For example, there is a low ridge of shrubs between Impoundment 5 and a *Cladium* fen to the east. This had been pasture in 1947. Assess the need to remove shrubs on the sandy ridge to the west of the Brucker Marsh Creek. Actions such as this may be necessary to provide critical habitat for the endangered yellow thistle.
- Implement *Phragmites* control in the marsh between Impoundments 4 and 5. The goal is to restore the previously diverse sea level fen and *Schoenoplectus* vegetation. Removal of *Phragmites* also facilitates future marine transgression of the salt marsh.

Marine Transgression

There has been a continuous but gradual marine transgression of the marsh vegetation and the *Panicum* fen at BIWMA since the first vegetation observations in 1947. Long-term studies of marsh vegetation enable the development of a conceptual model for marsh migration (transgression) into upland habitat as follows:

- The black-grass (*Juncus gerardii)* belt undergoes a form of erosion, the underlying peat is washed away by groundwater when the peat becomes aerobic.
- Black grass seeds wash into the lower slope of the switch grass (*Panicum virgatum*) belt directly inland, and gradually the black grass belt is reformed with a thin layer of black grass peat over switch grass peat.
- The *Panicum* belt (i.e., fen) gradually migrates to higher ground as sea level raises the ground water table.
- Salt marsh panne vegetation colonizes the eroded edge as it is low in elevation and soil water chemistry is polyhaline.
- These changes occur over the course of 20 years and the cycles repeat.

Historic practices of clear cutting and farming at Barn Island likely caused the loss of the black-gum forested wetland and its replacement by the *Panicum* fen. As these fields and pastures were abandoned, young black gum forests have reestablished and occupy the same habitat zone as the fens. The *Juncus* belt also migrates into the understory of black gum, and these trees at the lowest elevations are dying due to inundation (Figure 16).

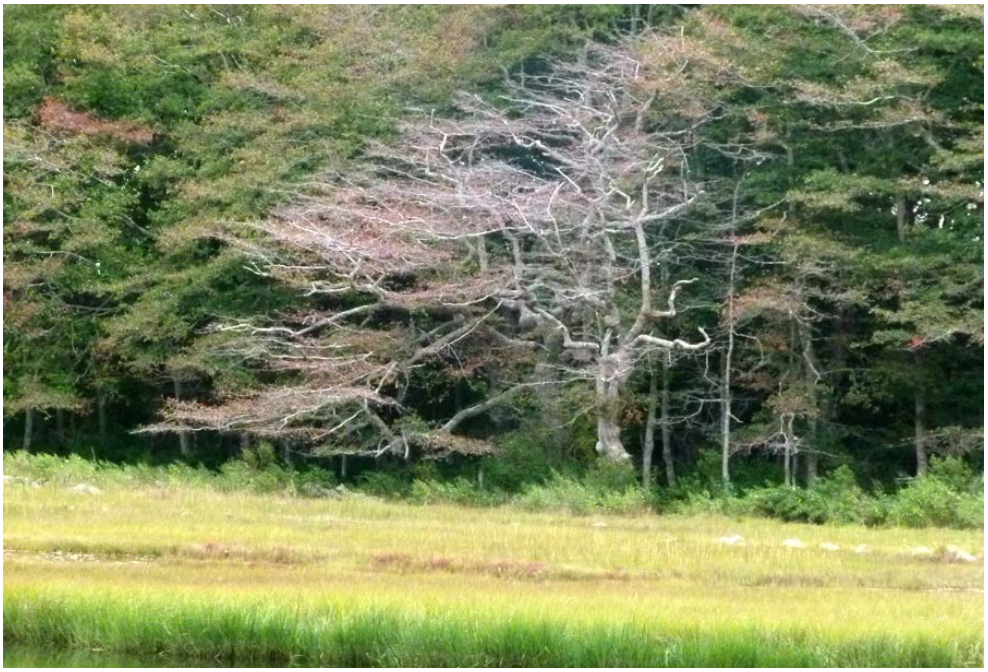

Figure 16. Evidence of marine transgression. A 2014 image of recently dead black gum on west side of the upland forest between Impoundment 2 and 3, Barn Island Wildlife Management Area, Stonington, CT. The stone wall crossing the marsh is believed to have been constructed at the edge of an upland field. Today salt marsh lies between the stone wall and the forest edge.

Submerged Aquatic Vegetation

The once productive beds of eelgrass (*Zostera marina*) in Little Narragansett Bay have since been replaced by a massive bloom of the drifting algae *Cladophora* sp. (Figure 17). This has caused a loss of ecological services on the bay and algae flotsam is smothering the low marsh vegetation and decreasing the productivity of the low marsh.

Historically, eelgrass was so abundant it was harvested from the bay, dried and used to create insulation for homes. In the 1970's, upland border wracklines were largely composed of eelgrass, a testament to the presence of eelgrass beds in the bay. However, by 2002, the beds were absent in the bay. Additional observations are presented in case study for Little Narragansett Bay (http://www.lisrc.uconn.edu/eelgrass/index.html). The cause of the shift from eelgrass to *Cladophora* is nitrogen enrichment from two sewage treatment plant discharges to the Pawcatuck River (Dostie and Vaudrey 2014).

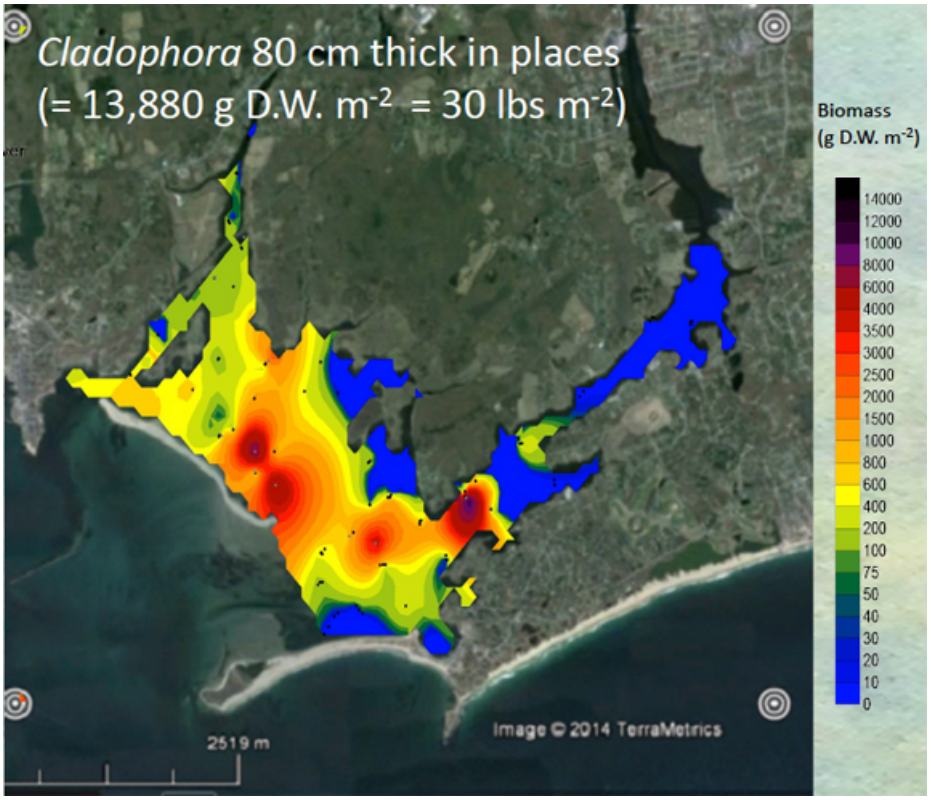

Figure 17. Biomass of *Cladophora* in Little Narragansett Bay (Dostie and Vaudrey 2014).

The ecological literature describes the impacts of the shift from eelgrass to algae on ecological services of the shallow water systems like the bay. However, for this report, the physical impacts of these algae upon the tidal marshes of BIWMA are emphasized. Figure 18 shows summer *Cladophora* algae on the bayward edge of the Headquarters Marsh. Bare areas of peat are locations where the flotsam has caused the loss of smooth cordgrass. The loss of smooth cordgrass rhizomes might weaken the peat and make the wetland edge more prone to erosion by wave action.

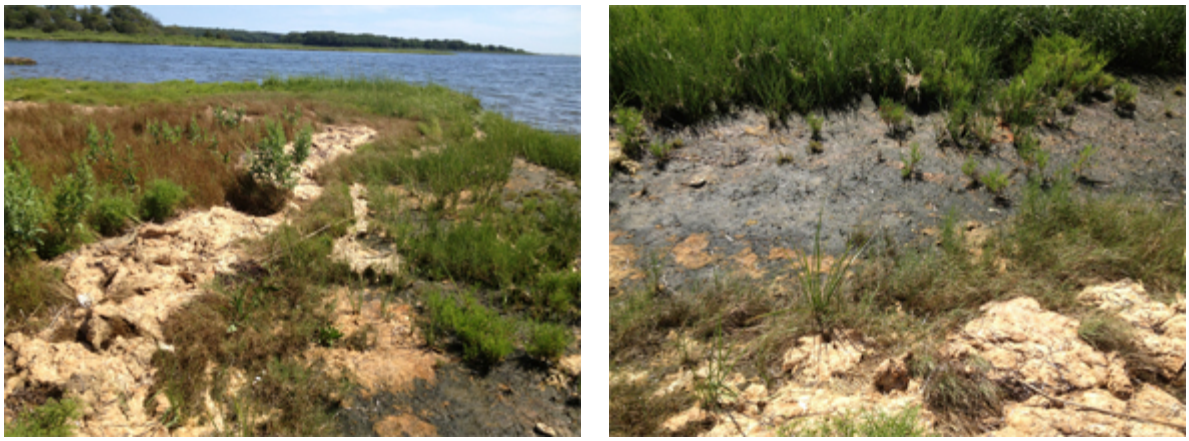

Figure 18. Bayward edge of Headquarters Marsh showing *Cladophora* flotsam on the low marsh and bare areas of peat at Barn Island Wildlife Management Area, Stonington, CT. (Photos: Rozsa 2013)

This same type of ecosystem shift has been documented in Mumford Cove, Groton. In 1993, the sewage treatment outfall pipe to the cove was removed and macroalgae disappeared within a year or two. It took 15 years for the recovery of the eelgrass beds. There is a bi-state plan (Dillingham 1992) for the Pawcatuck River that endeavored to identify management issues and establish management priorities. However the plan was drafted before the ecosystem shift from a bay dominated by eelgrass to one dominated by algae occurred.

Management Recommendations/Options
The states should consider reviewing this plan, identifying the accomplishments and emerging issues. It will require the cooperation of the two states to develop and implement a nitrogen reduction plan for Little Narragansett Bay.

Recreation

Hunting, trapping, fishing and wildlife observation are priority public uses of Wildlife Management Areas. Hunters are required to wear fluorescent orange and all other visitors to BIWMA are encouraged to do the same during hunting season. Hunting continues to be an important activity at BIWMA, occurring during the following seasons:

- Spring Turkey (April/May)
- Small Game (Jan/Feb, Sept, Oct – Dec)
- Waterfowl (Sept – Mar)
- Fall Archery – Deer (Sept – Nov, Dec) and Turkey (Sept – Nov, Dec)
- Fall Shotgun – Deer (Mid [A season] or Late Nov – Dec [B season]) and Turkey (Oct)
- Muzzleloader – Deer (Dec)

Pheasants have historically been stocked for hunting at Barn Island. For the years 2000- 2012 between 368 and 600 birds were released annually, with an average of 485 pheasant per year. According to the DEEP website, in 2014, 365 birds were scheduled for release at BIWMA. A

map of BIWMA on the website shows that pheasant (release) areas are in the coastal marshes on both sides of the dikes and in one of the eastern, upland fields of the former Stewart Farm.

Data provided by the Wildlife Division indicates fewer than 10 deer were taken annually by bow hunters during the past decade. Numbers for muzzleloader and shotgun hunting were not available.

Based on information supplied by DEEP, there has been little or no trapping at Barn Island during the past ten years. This may be due to the relatively small area of freshwater wetlands, which is the preferred habitat for the furbearing animals targeted by trappers. Trapping season runs from November thru March.

The Wildlife Division has conducted waterfowl breeding season surveys at Barn Island for the past 20 years. Raw data of waterfowl observations were received, but no summary or interpretation of the results. Data on number of waterfowl taken by hunters available. Barn Island is located in the State's South Zone which allows waterfowl hunting in the 2014-15 season beginning September 15 for Canada Geese and ending March 10 for Snow Geese.

The Connecticut Hunting and Trapping Guide, Migratory Waterfowl Hunting Guide and Connecticut Angler's Guide, published annually by the DEEP, provide detailed information on season dates, licensing and permit requirements, bag limits, hunting hours and other rules and regulations. These guides are available annually at town halls or on the DEEP's website (http://www.ct.gov/deep).

Other activities that occur at BIWMA include: shell fishing, swimming, boating, horseback riding, walking, research, trail construction, and game management and stocking.

The three principal report authors and two student summer research assistants spent a total of over 650 hours on site at BIWMA during 2013 and 2014. During that time we observed a large variety of recreational uses. As a start on quantifying these activities, the number of users were counted for 8 hours (8am - 4pm) on a weekday and weekend day with good weather during July 2014 (Table 9).

The Stewart Road entrance is used much less than the approach from Palmer Neck Road. On about half of the times BIWMA was visited by the report authors and student researchers, there were no cars at the trailhead. Most of the other times there was one car and on one occasion there were two cars.

In addition to the above uses horseback riders and hunters were observed on the trails at different times of year. A few mountain bikers were seen on the trails, but considerable evidence of trail modifications to enable passage for mountain bikes over obstacles was observed. Evidence of conflict among different types of users was not observed, nor did we see users off of the trails.

Table 9. Number of visitors and observed activities entering the main trail from Palmer Neck Road at Barn Island Wildlife Management Area, Stonington, CT on two days during July 2014 (8am-4pm).

Activity	Sunday, July 13	Thursday, July 17
Walking	39	9
Dog walking	25	14
Jogging	3	3
Birding	3	
Biking	6	6
Fishing	4	2
Research		10
Swimming		2
Picnicking		2

DEEP's Boating Division does not collect statistics on usage and types of boaters at this location, however it is known as a very popular facility that can fill to capacity on weekends and holidays. The majority of those using the boat launch facility do not stay in the waters near BIWMA. However, the parking lot is also used by visitors without boats for hunting and other recreational activities on site.

Summer student research assistants monitored also the number and types of boats transported into the boat launch area at end of Palmer Neck Road. Many of the vehicles without boats simply used the boat launch area to turn around.

Table 10. Visitation to boat launch at Barn Island Wildlife Management Area, Stonington, CT.

Type of vehicle	Sunday, July 13, 2014	Thursday, July 17, 2014
Power boats	44	37
Kayaks	20	6
Wind surfers	1	0
Canoes	5	1
Jet ski	1	3
Sailboats	2	0
No boats	60	26

Management Recommendations/Options

A detailed and systematic evaluation of public use of the BIWMA should be conducted. Techniques should include observation of activities during all times of the year, throughout the WMA, and creation of a survey instrument to be administered to visitors.

Research

BIWMA has a rich and lengthy history of research, especially in the tidal marshes. Subject matter has included a wide variety of topics including wildlife (waterfowl management, other birds, mosquitoes, mammals, fish, invertebrates) marsh restoration, sedimentation, effects of sea level rise, invasive species, plant community ecology, biogeochemistry, and metal pollution. A complete list of research reports and publications is contained in the research bibliography (Appendix F). Map T shows locations of some of the known research projects and additional information about research locations is found in Appendix G. Below is a summary of some of the key research reports and publications.

William Miller 1948

As a step toward reversing waterfowl declines in the first half of the twentieth century, in 1947 the Connecticut Board of Fisheries and Game provided financial support and on-site housing to William Miller, graduate student at the Department of Forestry and Wildlife Management, University of Connecticut. Simultaneously Miller had an opportunity to work with plant ecologist Dr. Frank E. Egler. Connecticut had acquired nearly all of the tidal wetlands and adjacent uplands at BIWMA from 1944 to 1946. In the years 1945 to 1947, the State created four waterfowl Impoundments. Highlights of Miller's thesis are:

- Provided a description and history of the area including land use, wildlife utilization and gun clubs,
- Summarized recent management practices including mosquito control, Impoundment construction, and game management policy,
- Described the vegetation with emphasis on tidal wetlands, mapping the vegetation in the four Impoundments, and a quadrat study of the headquarters marsh (which would form the foundation of the classic paper by Miller and Egler, 1950),
- Described the wildlife of the area,
- Described waterfowl food and cover, and
- Made suggestions for management.

Miller's research was conducted 14 to 15 years after the tidal marshes had been ditched. The Miller and Egler classic paper describes the vegetation of a recently ditched marsh. In 1974, Dr. Egler joined Dr. William Niering (Connecticut College) on a field trip and Egler memorialized his observations in a field trip report. In that report Egler noted that 90-95% of the vegetation had changed, that it was completely different than the 1947 vegetation!

Alfred Gross (1966)

Gross was a student of Dr. William Niering, Connecticut College, and he completed a Master's Thesis on the vegetation of the Brucker Marsh and the temporary Natural Area Preserve (Barn

Island proper and marshes north to the boat canal) just prior to the CT Board of Fisheries & Game creating the 5th Impoundment in 1968. Highlights of this thesis are:

- Described the major plant communities
- Established a series of vegetation transects
- Measured peat depths

Wendy Blake-Coleman (1978)

Blake-Coleman was a graduate student at Smith College, North Hampton, MA, and her study area was portions of the natural marshes (Palmer Neck, Headquarters, Brucker and Davis). The Brucker Marsh is actually on land that formerly belonged to Ida Barber, and so was not in Gross's study area. The highlights of this thesis are:

- Identified the major tidal marsh plant communities
- Mapped the vegetation
- Replicated the Miller and Egler hoop toss method of vegetation survey on the Headquarters Marsh

Gross and Miller's work were 18 years apart, and both had observed a *Juncus* belt and an unvegetatated eroded edge at the tidal marsh upper borders. Blake-Coleman's field work occurred 11 years after Gross, and by then no *Juncus* belt existed along the upland border. It appears that the eroded edge may be caused by the metonic or lunar nodal cycle (18.6 years). Blake-Coleman's thesis catches a snapshot of the vegetation during a different portion of the metonic cycle.

Connecticut College Scientists

Dr. William Niering arrived at Connecticut College in 1953 and in the same year he visited Barn Island with Dr. Frank Egler. Dr. Niering's photographs (35mm color slides) starting that year provides a valuable visual historic record of the vegetation at Barn Island. In the late 1960s, Dr. Scott Warren and Dr. Paul Fell joined the faculty of Connecticut College and began to contribute to the understanding of tidal marsh plants and animals. These scientists also had a variety of students that conducted research at Barn Island and contributed to our understanding of the tidal wetlands. Highlights of their research contributions include:

- Permanent transects (vegetation and elevation)
- Repeated the hoop toss on the Headquarters marsh in 1988
- Quantified changes in vegetation in the restoring marshes, and compared restoring marshes to reference marsh to understand rates of recovery for various ecological services (trajectories).
- Created a micro-relief plot at the Headquarters Marsh and Wequetequock Point marshes in 1998 (Bellet 2000).

University of Connecticut Scientists

BIWMA is one of a number of tidal marshes where Dr. Chris Elphick and students are surveying salt marsh and seaside sparrows as part of a regional study. The sparrow research is being supported with a recent grant from the Long Island Sound Study, and as a pilot for sentinel monitoring. In 2013 Chris Elphick and Chris Field established 46 marine transgression plots at BIWMA wetland/forest margins to quantify existing forest vegetation composition that will serve as the basis for quantifying and describing future changes in light of accelerating sea level rise. Min Huang with the CT Department of Energy and Environmental Protection – Wildlife Division is a collaborator on this grant.

DEEP

Since 2007, DEEP personnel have been participating in a regional mast survey. This entails estimating the percent of the crown of oak and beech trees with nuts present. At BIWMA only red and white oak trees have been surveyed. The trees included in the study have red or white dots painted on their trunks, and some of these may be seen along the main trail connecting the dikes.

U.S. Fish and Wildlife Service

In October 2014, Ralph Tiner, Regional Wetland Coordinator, USFWS, established a series of permanent plots marked with wooden stakes on the east side of the creek that leads to Impoundment 5. This is intended to capture information about the transgression of wetland and sea level fen habitat. Two forested plots were established in a *Nyssa* forested basin just north of the culvert under the Headquarters Road that connects Impoundment 1 and 2.

Research Questions and Recommendations

<u>Greatest Conservation Need Species</u>

- Continue to monitor GCN and State listed species at Barn Island. A comprehensive survey of the brackish vegetation in Impoundment 3 has not been conducted, and there is the high likelihood that populations of bayonet grass (*Bolboshoenus maritmus*) and, in the associated upland fens, yellow thistle (*Cirsium horridulum*) occur here. Look for populations of Canada sand-spurrey (*Spergularia canadensis*) and seacoast angelica (*Angelica lucida*).
- The critical habitat of yellow thistle is a dynamic and declining habitat. Monitor changes to the *Panicum* sea level fen to determine if management intervention is required to maintain viable populations of the thistle at Barn Island. This could include the removal of shrubs and young forest vegetation, such as on the sandy ridges around the Brucker marsh.

Tidal Marshes, General

- Continue to monitor the plant community changes in the tidal marshes.
- Continue to monitor surface elevation changes at the Surface Elevation Table (SET) locations and evaluate the need for shorter term observations to understanding seasonal elevation changes. For example, do the major elevation changes coincide with the springtime production of roots?
- Use SET locations in the near term to evaluate SLAMM outputs.

Sea Level Fens and the *Juncus* belt

- Refine the vegetation descriptions for the *Juncus* belt and the *Panicum* sea level fen. Survey for State listed species. Capture the transitioning of the lower slope of the fen to the *Juncus* belt through a time series of vegetation descriptions. Are there mesic and wet components of the *Panicum* fen vegetation? If possible, engage the NRCS to assist in describing the soil properties the fen habitat. If the soil is a mucky peat, how does it form?
- Attempt to capture the transition of the *Juncus* belt to the eroded edge particularly at the Brucker Marsh where the soils are sandy and the edge can be several meters wide. Determine the role of groundwater and precipitation in the creation of the eroded edge. Can intense rainfall alone contribute to the erosion of the peat? As the edge forms what is the condition of the lower slope of the *Panicum* fen – when does *Juncus* colonize the lower slope above the eroded edge?
- Enlist the aid of the USGS to determine the best ways to evaluate the role of groundwater in the marine transgression process. Examine groundwater conditions and properties in the *Juncus* and *Panicum* belts and black gum forested wetlands.

Black Gum Forest

- Are the groundwater conditions in the black gum forested wetlands the same as conditions in the *Panicum* fen? At the boundary with the Oak-Hickory forest, what is the depth to the water table in relationship to the roots of these trees? How does this relationship change as sea level rises?
- Resurvey of the forest plots established by Dr. Elphick will be useful to identify the rate of loss of forest edge. Tree loss is lagging behind the actual marine transgression of marsh grasses, which now occupy the understory for edge forest. The surveys should record the landward boundary of tidal wetland plants, particularly *Juncus gerardii,* and also attempt to locate the boundary between the black gum forested wetland and upland plant communities. These observations would confirm the changing position of the groundwater table.
- Resurvey US Fish and Wildlife Service transects on a 5-year cycle. The forest transgression transects will also help to quantify the conversion of the black gum forest to emergent tidal marsh vegetation.

Impoundment 3 Vegetation

- Describe and remap the plant communities at this location and search for rare plants such as *Bulboshoenus maritimus*. Does the reed marsh transgress into sea level fen, and is the process similar to that of the salt marsh? It is remarkable that the brackish reed marsh did not convert to cat-tail or common reed during the many decades of impounding. The brackish reed vegetation is one of the best examples of this habitat outside the Connecticut River.

Photostations

- Continue to collect photographs at the Miller and Egler stations on a five year cycle. The stations in the impounded marshes need to be relocated.
- Review the Niering digital photos to determine if any of those should be part of the photostation network.
- Digitize the Blake-Coleman slides and identify slides that might be useful for the photostation network.
- Digitize the Rozsa slides, the majority of which were used to record vegetation change in the Impoundments following tidal flow restoration.

Marsh Change

- Remap vegetation in the Impoundments and natural marsh areas. Do this at a frequency to determine if there are vegetation changes that may be driven by the metonic cycle. These observations can be used to compare to the SLAMM model projections.
    - Update vegetation change monitoring procedures:
        - Digitize and georeference the vegetation maps of Blake-Coleman (1978). The ideal goal would be to remap these areas in their entirety.
        - A less intensive approach is to select strategic marsh panels bounded by mosquito ditches and delineate vegetation with GPS. This could be a companion dataset at photostations.
        - Resurvey the microrelief plot at the Headquarters Marsh and Wequetequock Point Marsh.
        - Resurvey the Headquarters Marsh using the hoop protocol of Miller and Egler (1950). Review the protocol to determine if there are ways to simplify the methodology and/or the diameter of the hoops (3 meter).
- Resurvey the two marine transgression plots every 5 years.

Pannes and Pools

- Conduct a study of pannes at Barn Island, including the variety of pannes and pools present (e.g., pools formed in associated with ditch filling versus pannes resulting from ditch microlevees; pannes in both salt and brackish marshes). Adamowich and Roman (2005) may have used BIWMA in the New England study of panne. If so their data could provide an

important baseline to expand the study of panne habitat at Barn Island. The unditched marsh at Barn Island (proper) might be an important reference site.

- Establish criteria regarding the types of field survey and ecological assessments that would be required prior to altering panne habitat.
- What are the wildlife food resources in salt and brackish pannes and how do they vary seasonally? Does seasonal variation in food resources among panne types influence foraging behavior by shorebirds? Little is known about the ecological services of salt and especially brackish marsh pannes. The no maintenance ditching policy has evidently led to restoration of pannes, but there has been no documentation of this recovery or studies to show how restoration pannes/pools compare to these habitats as control sites (e.g., unditched tidal marshes).

Submerged Aquatic Vegetation

- Review the degradation of Little Narragansett Bay with the coastal programs of Connecticut and Rhode Island (under the bi-state plan) and determine how, if at all, the plan should be revised in order to reduce nitrogen loadings to the Pawcatuck River. Another approach is to review the trend of bay degradation with the DEEP Water Bureau under the requirements of the 305(b) of the Federal Clean Water Act

Uplands

One of the main recommendations from the 2014 Education and Research Meeting was that research on the uplands at Barn Island should be a priority because so much emphasis has already gone into research in the tidal wetlands.

- Continue analysis and interpretation of upland vegetation samples from 2014.
- Further characterize the composition, structure, and function of the coastal black gum forest and locate extent of occurrences of this community throughout the Connecticut and Rhode Island coastline.
- The field system at the former Stewart Farm would be a suitable location for experimenting and monitoring various management techniques, such as mowing, chemical treatment and controlled burning, utilized to maintain an early successional stage of growth.

Wildlife

- Set objectives for the management of marsh birds including the role of pannes in the management scheme. That scheme should also consider other factors that lead to disturbances that disrupt bird use such as recreational activity and unleashed dogs that have been observed chasing birds in the marsh.
- Establish a regular breeding bird survey that includes all major habitats at BIWMA.
- Encourage visitors to engage in “citizen science” programs like eBird. eBird users have recorded 248 species at BIWMA as of March 18, 2015.

Unauthorized and Illegal Activities

BIWMA is closed to the public from ½ hour after sunset until ½ hour before sunrise except for fishing, certain types of hunting, and other activities authorized by the DEEP. By regulation, dogs must be kept on a leash no longer than 7 feet and under the control of their owner, except while in the act of hunting or being trained for hunting.

During the two years we visited Barn Island and discussed the area with DEEP personnel we were made aware of the following unauthorized or illegal activities.

- Numerous dogs off leash, and occasionally chasing marsh birds.
- Numerous ad hoc trails being formed, many leading from contiguous residential property.
- Occasional motor bike activity.
- Youth drinking parties, particularly at the parking area near Stewart Road, were mentioned by a number of DEEP personnel familiar with the site.
- A rather elaborate “fort” or encampment was found on Sassafras Island, near Barn Island proper.

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Barn Island Wildlife Management Area Management Assessment Report Appendices

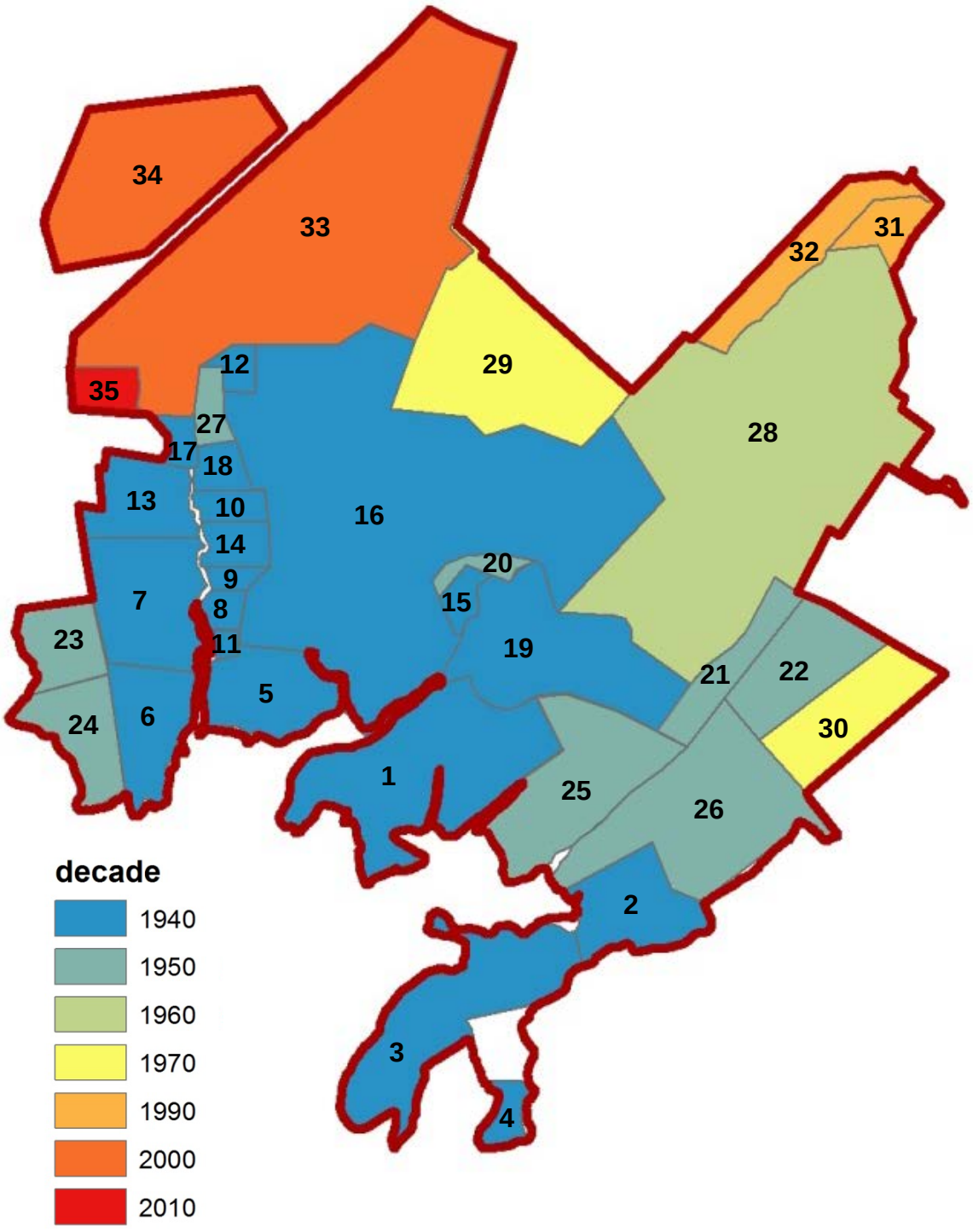
CONTENTS

APPENDIX A. Maps

A. Named Features

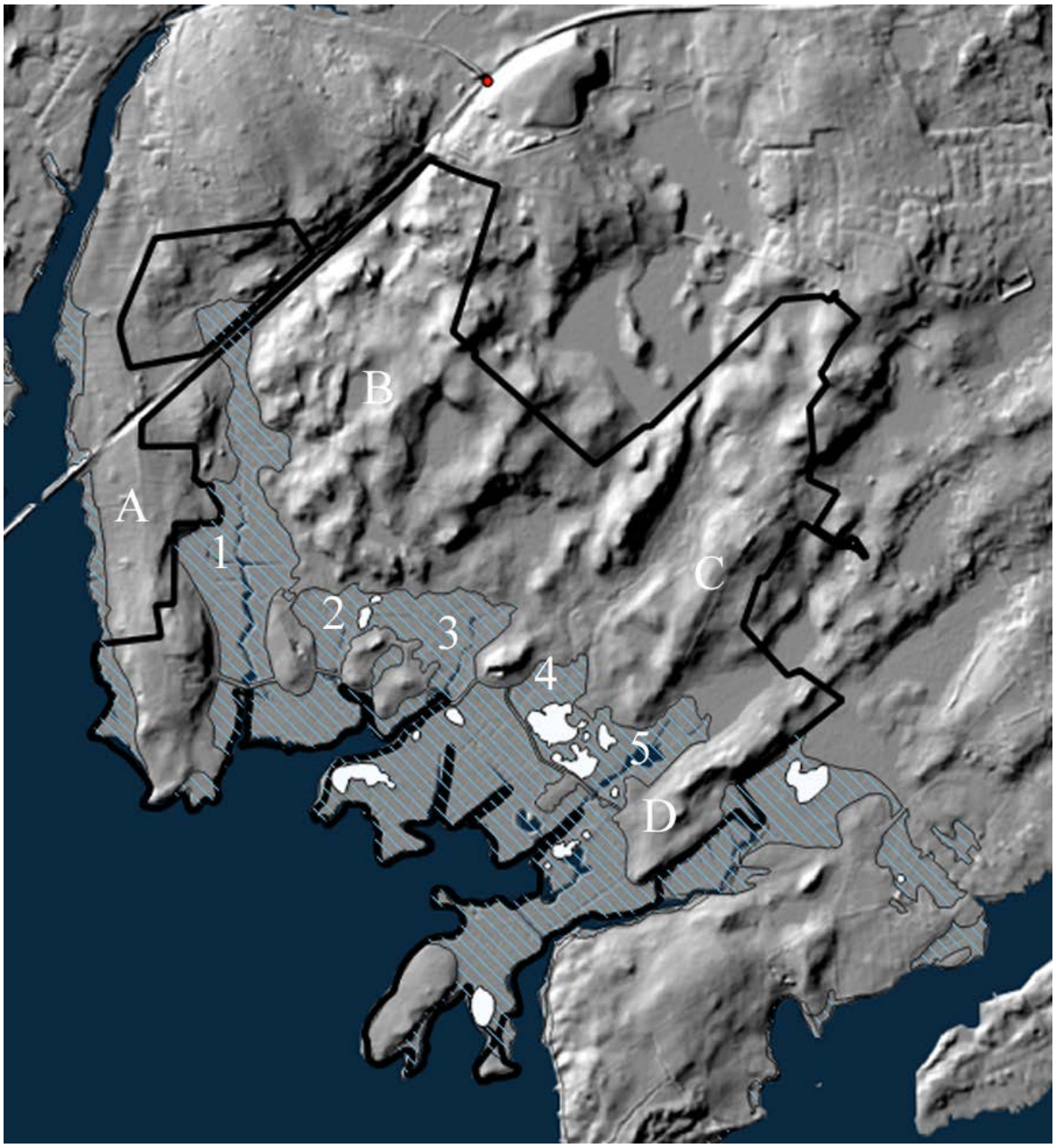
Map A: Named features in and around Barn Island Wildlife Management Area, Stonington, CT. Red line indicates boundary of the wildlife management area, blue lines indicate major roads.

B. Parcel Acquisition History by Decade



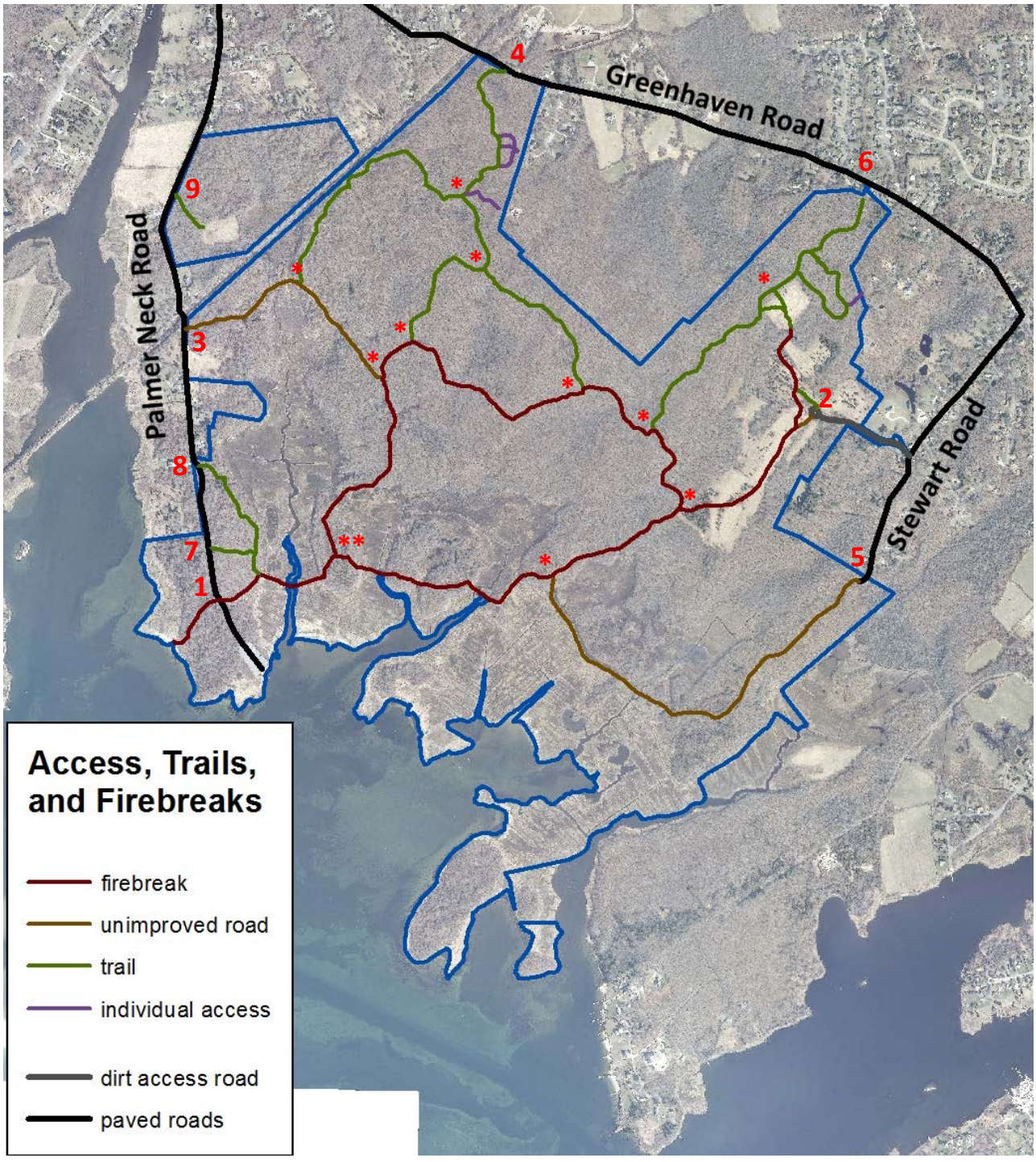
Map B: History of Acquisition, Barn Island Wildlife Management Area, Stonington, CT. Numbers indicate parcels in Table 1. Land area acquired by decade – 1940s: 428.2 acres (41.9%), 1950s: 145.0 acres (14.2%), 1960s: 152.3 acres (14.9%), 1970s: 72.8 acres (7.1%), 1990s: 23.8 acres (2.3%), 2000s: 194.0 acres (19.0%), 2010s: 5.8 acres (0.6%).

C. Topography



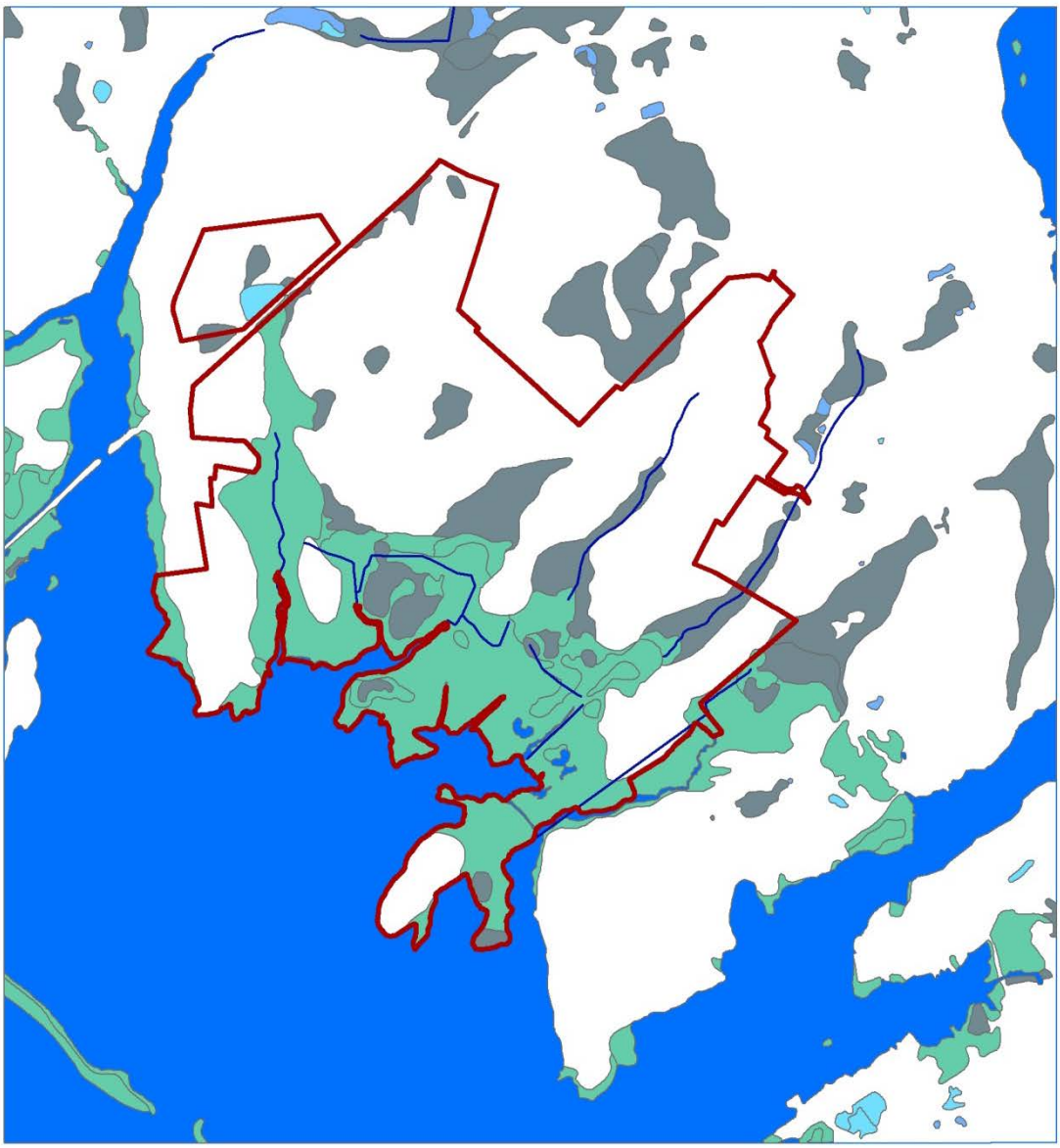
Map C. The boundary of Barn Island Wildlife Management Area, Stonington, CT parcels are shown in black. Tidal wetlands are shown with diagonal hatch (white polygons are upland within tidal wetland). Numbers 1 – 5 identify the five former impounded marshes. A = Palmer Neck, B = central uplands, C = Stewart Farm site and D = Burdick peninsula. Elevation ranges from 0-94 ft. 12.5% of area is >1 ft elevation, 47.7% between 1 and 20 ft, 26.3% between 20 and 50 ft, and 13.5% >50 ft.

D. Access, Trails and Firebreaks



Map D. Access and major trails at Barn Island Wildlife Management Area, Stonington, CT. Numbers 1-2 indicate major access points, 3-9 minor or potential access points. Stars indicate potential locations for signs with trail maps. Double stars indicated current location of trail map sign. Minor trails that do not lead to access points are not shown.

E. Wetlands and Streams



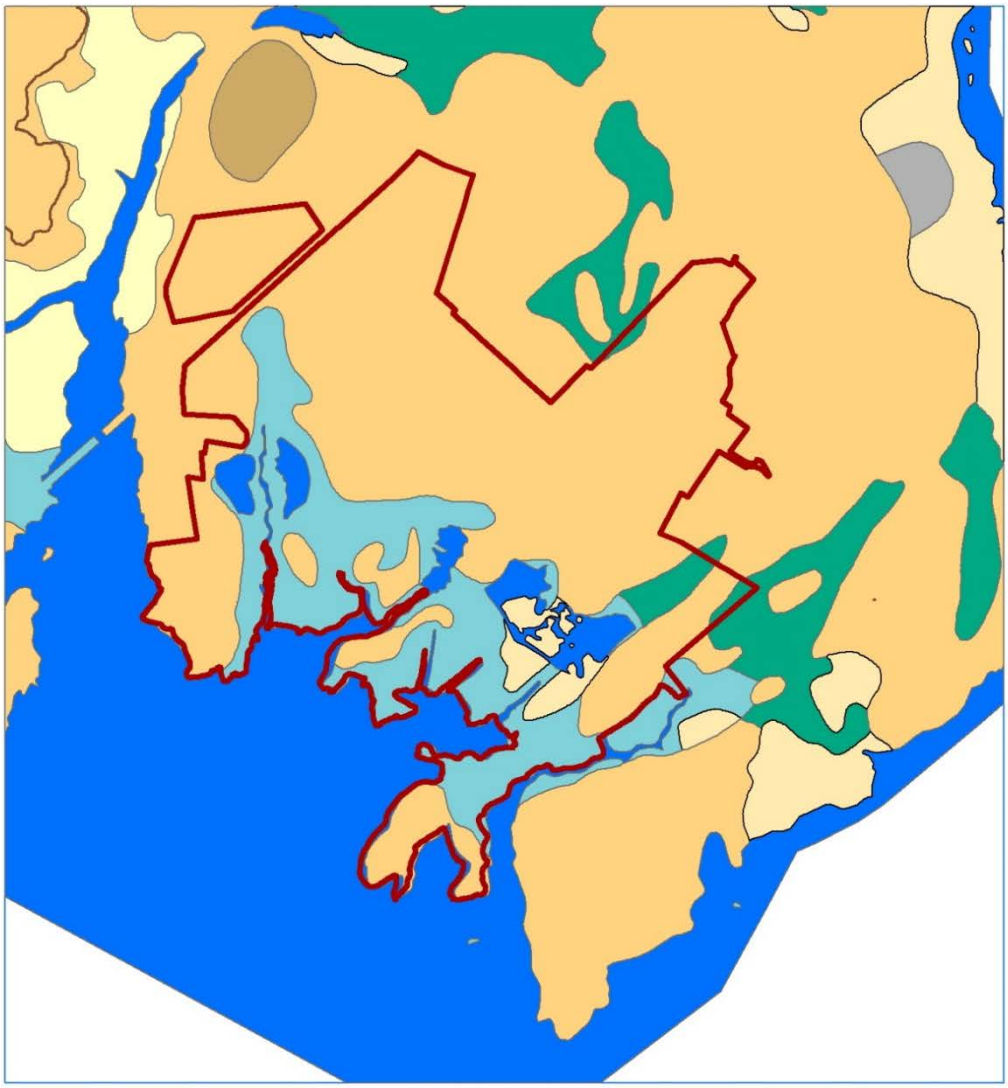
Streams

Wetland Type (Area within BIWMA)

- Estuarine and Marine Deepwater (10.0 acres)
- Estuarine and Marine Wetland (298.7 acres)
- Freshwater Emergent Wetland (4.0 acres)
- Freshwater Forested/Shrub Wetland (103.6 acres)
- Freshwater Pond (Outside WMA)

Map E. Wetlands and streams at Barn Island Wildlife Management Area, Stonington, CT.

F. Surficial Materials

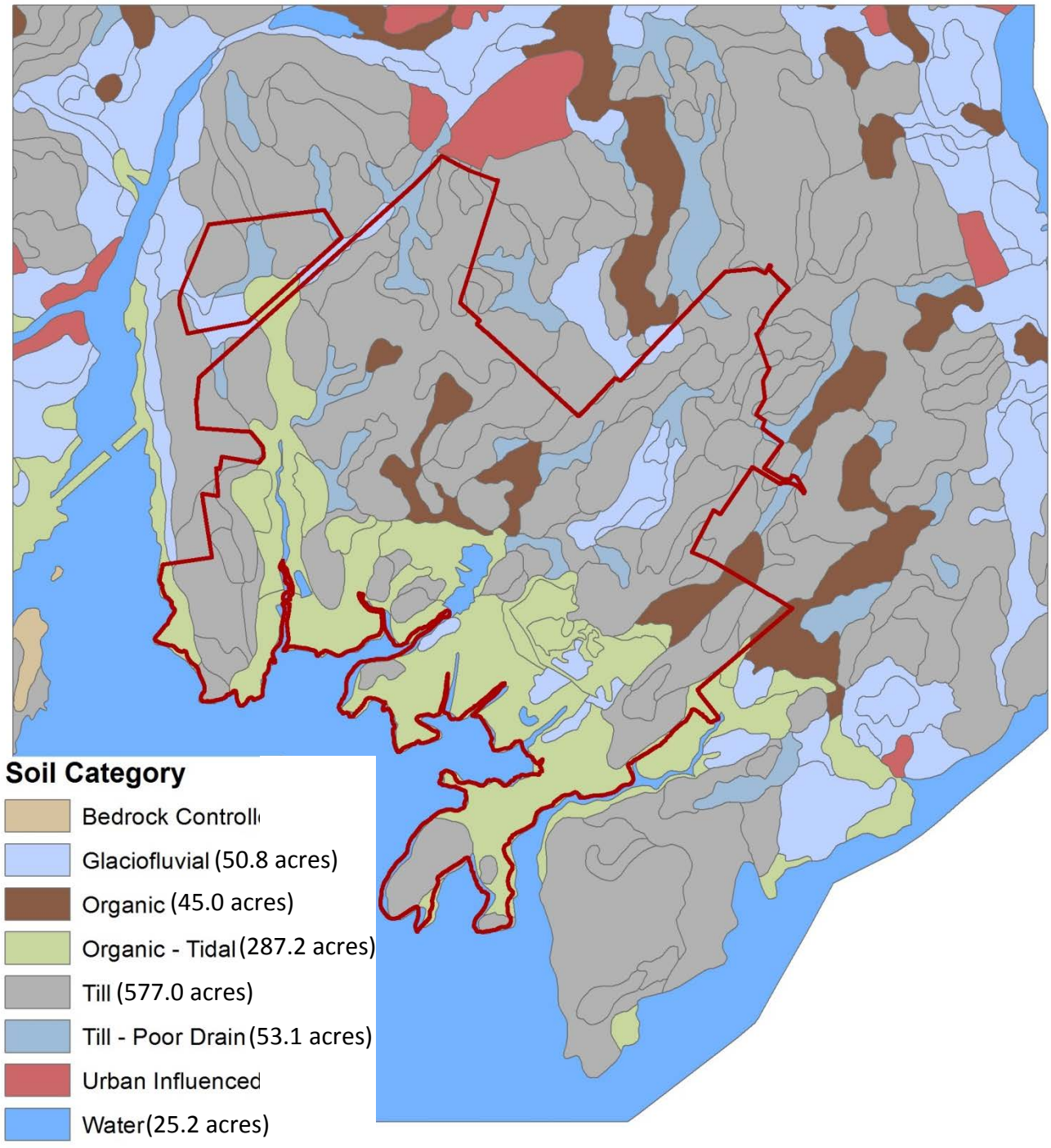


Surficial Materials (Area within BIWMA)

- Gravel
- Salt Marsh and Estuarine Deposits (229.7 acres)
- Sand and Gravel (25.6 acres)
- Sand and Gravel overlying Sand
- Swamp (18.4 acres)
- Thick Till
- Till (702.6 acres)
- Water (62.0 acres)

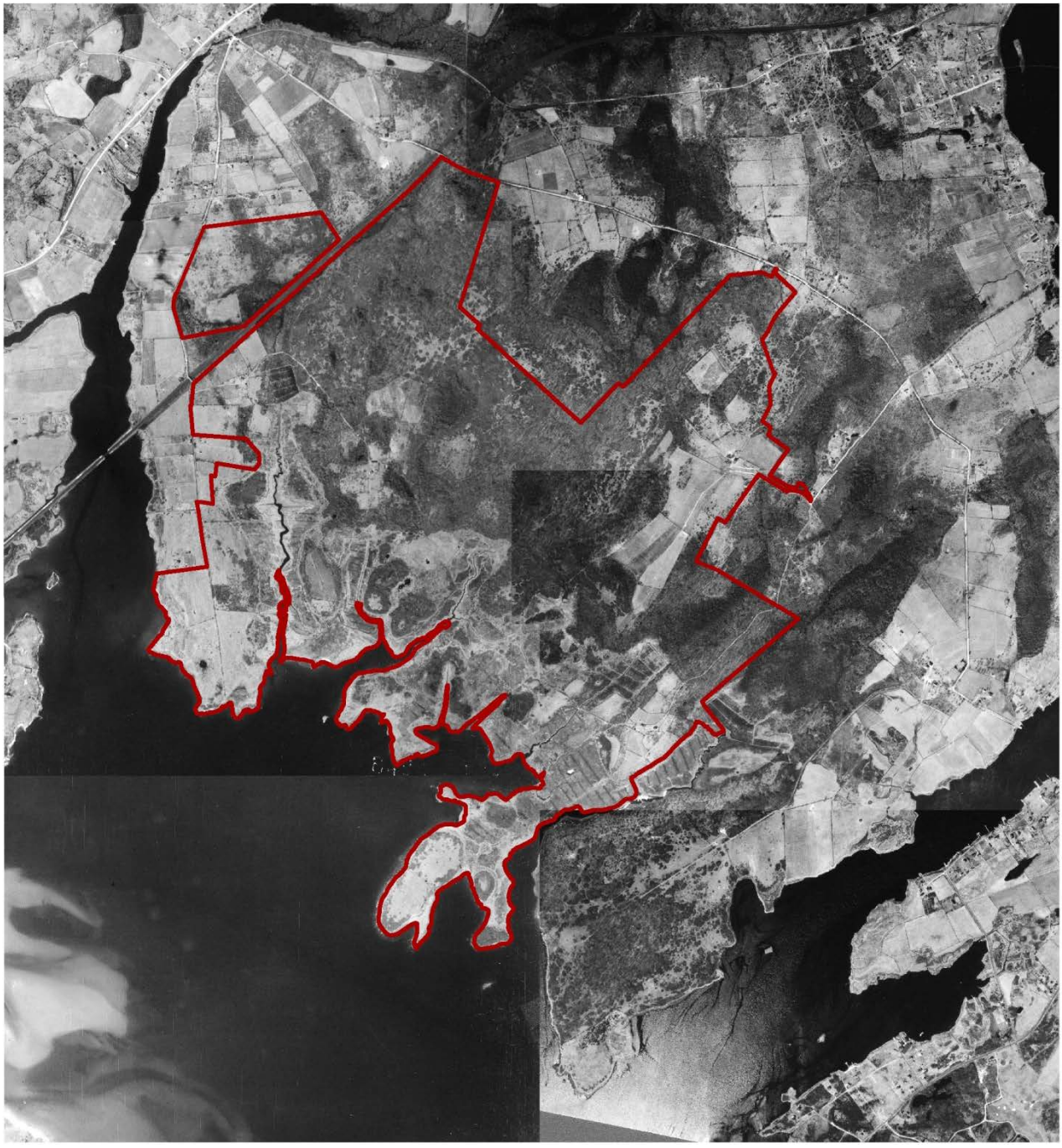
Map F. Surface material composition within Barn Island Wildlife Management Area, Stonington, CT.

G. Soils



Map G. Area of each soil category within Barn Island Wildlife Management Area, Stonington, CT is listed in parentheses. If no number is listed category does not occur within the WMA.

H. Aerial Photograph - 1934

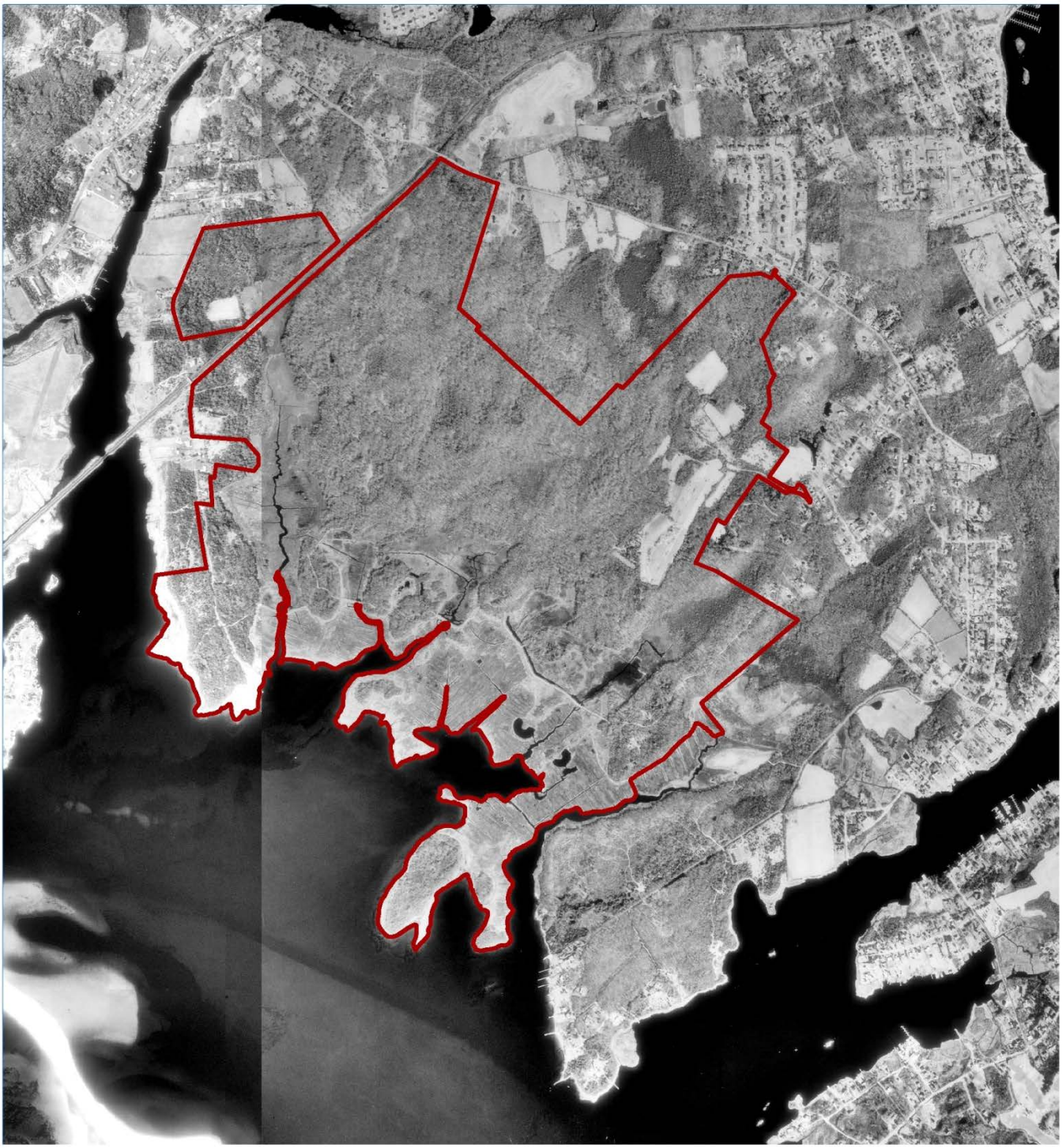


Map H. Aerial photograph of Barn Island Wildlife Management Area, Stonington, CT, 1934.

I. Aerial Photograph - 1965

Map I. Aerial photograph of Barn Island Wildlife Management Area, Stonington, CT, 1965.

J. Aerial Photograph - 1990

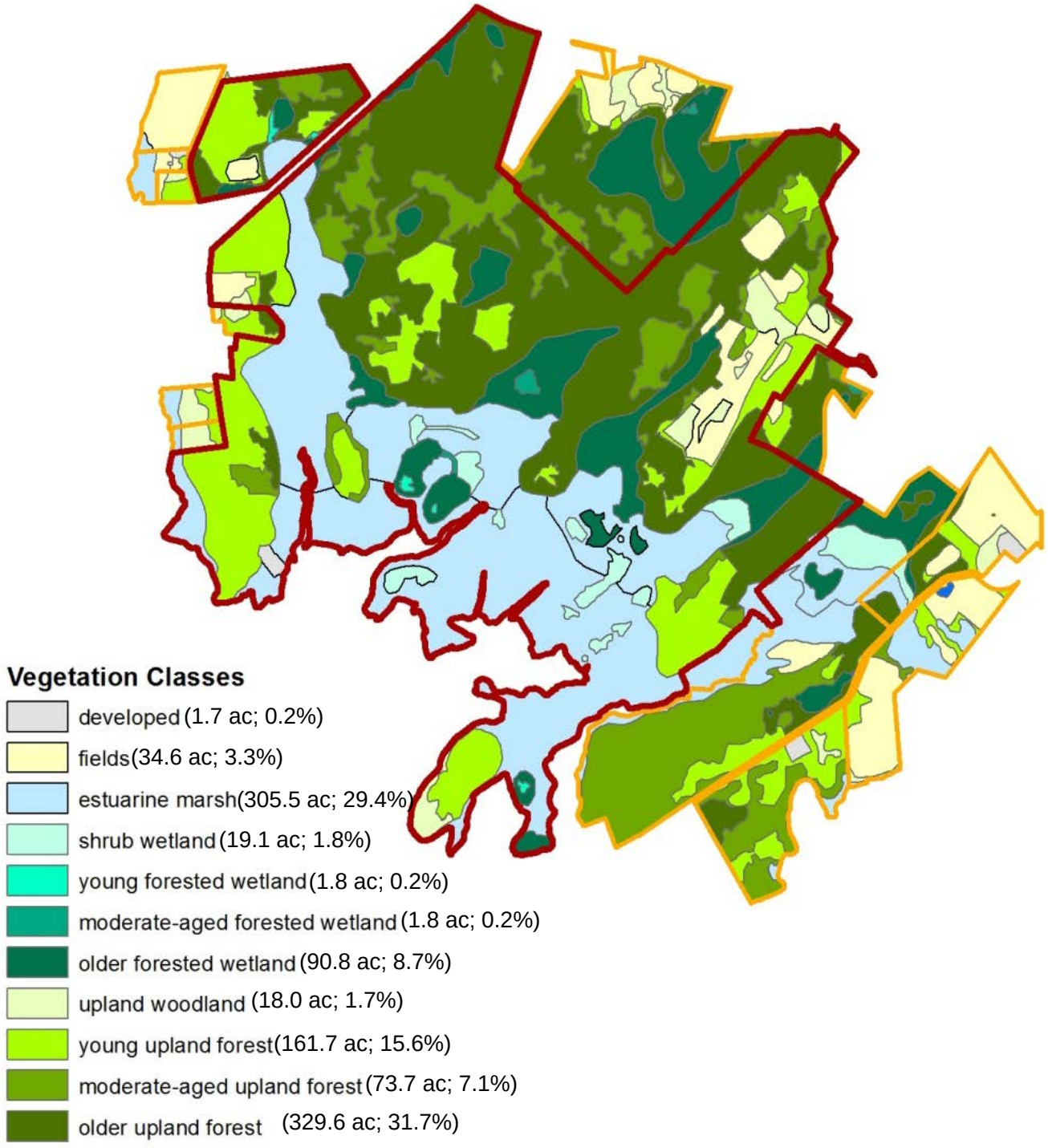


Map J. Aerial photograph of Barn Island Wildlife Management Area, Stonington, CT, 1990.

K. Aerial Photograph - 2012

Map K. Aerial photograph of Barn Island Wildlife Management Area, Stonington, CT, 2012.

L. Current Vegetation



Map L. This layer was created using aerial photographs from 1934 and 2012 and the wetland layer from the National Wetlands inventory. Map includes adjacent parcels of potential interest (outlined in orange) at Barn Island Wildlife Management Area, Stonington, CT.

Definitions of Vegetation Classes

Developed – human dominated areas such as parking lots, buildings, driveways.

Fields – areas of open vegetation in 2012 that is not within wetland boundaries

Estuarine marsh – open vegetation with tidal influence

Shrub wetland – areas dominated by shrubs or sparse trees (from the 2012 aerial photo) that are within wetland boundaries

Young forested wetland – wetland areas that are currently forested (2012 aerial) but were open fields in the 1934 aerial

Moderate-aged forested wetland – wetland areas that are currently forested (2012 aerial) but were open forest or shrub lands in the 1934 aerial

Older forested wetland – wetland areas forested both currently and in 1934

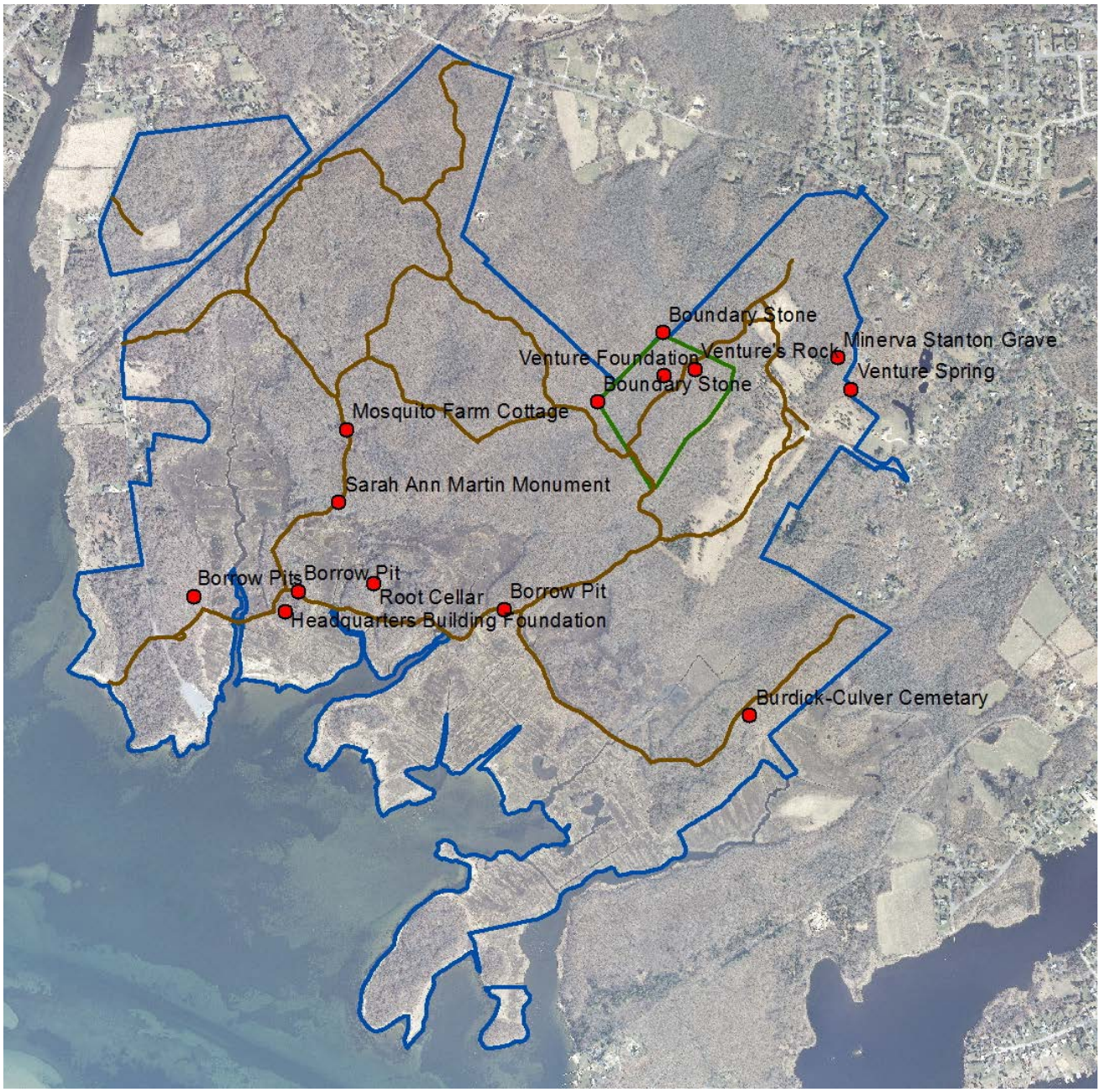
Upland woodland – areas dominated by shrubs or sparse trees (from the 2012 aerial photo) that are outside wetland boundaries

Young upland forest – upland areas that are currently forested (2012 aerial) but were open fields in the 1934 aerial

Moderate-aged upland forest – upland areas that are currently forested (2012 aerial) but were open forest or shrub lands in the 1934 aerial

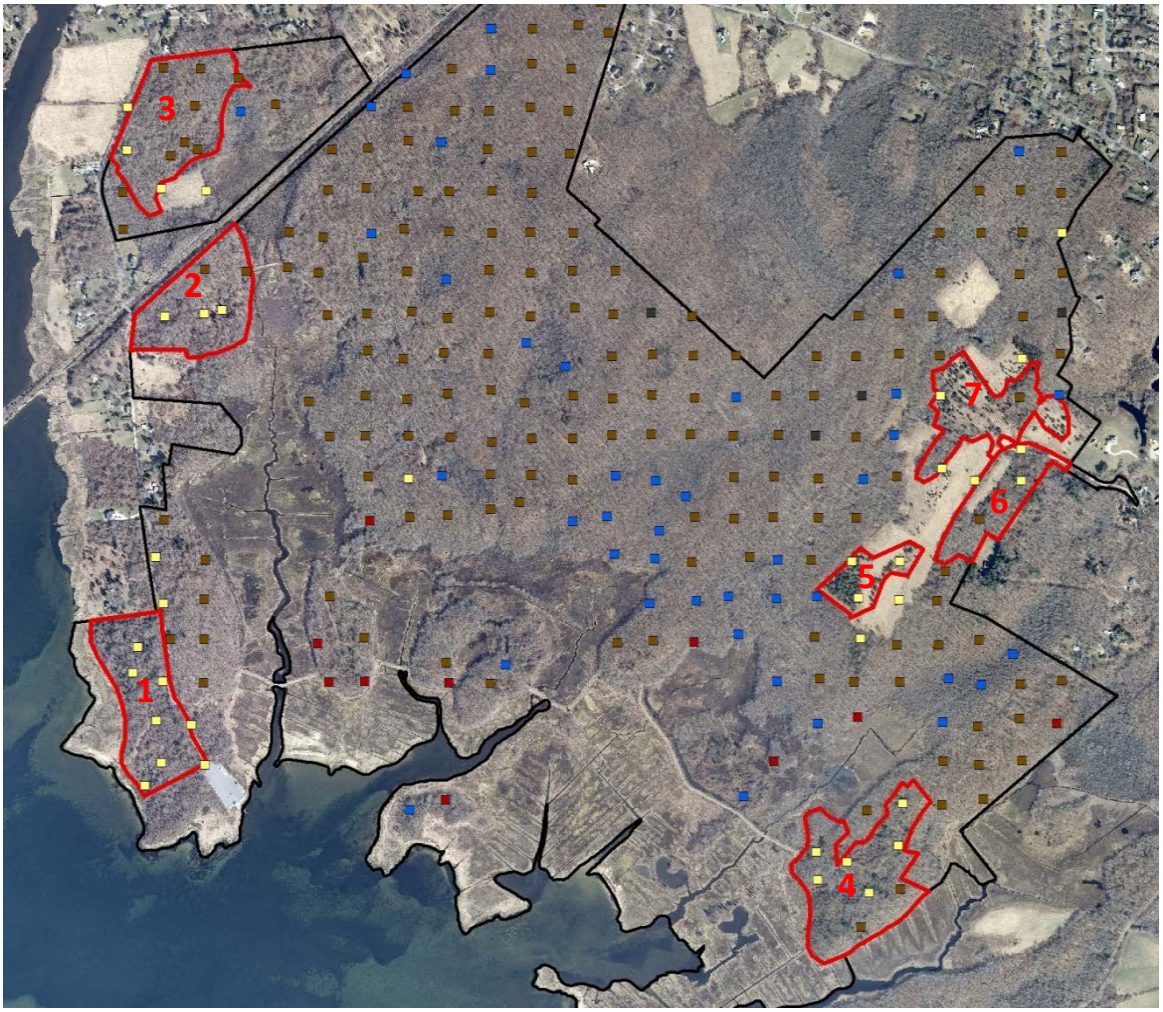
Older upland forest – upland areas forested both currently and in 1934

M. Cultural Sites



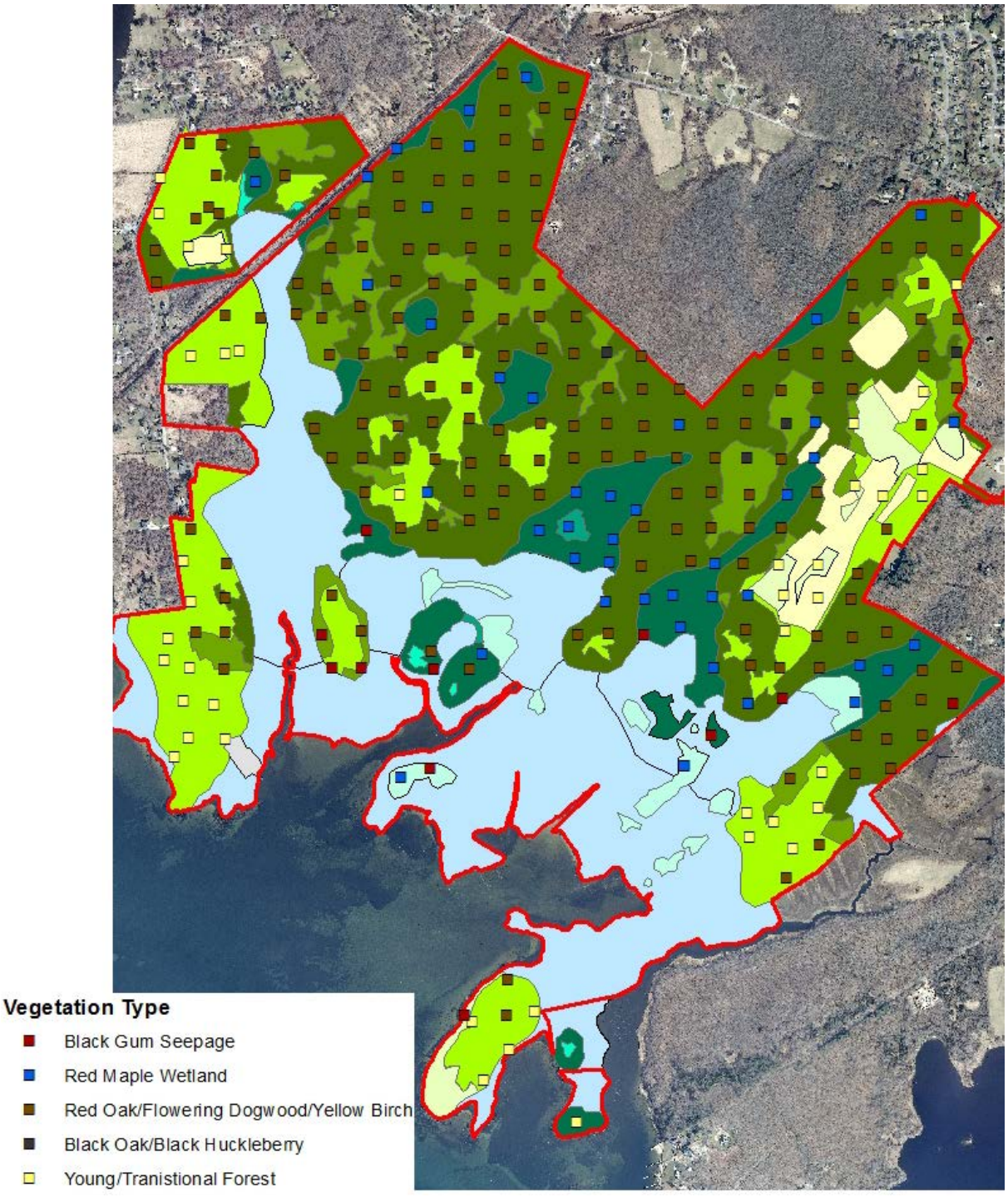
Map M. Culturally significant sites at Barn Island Wildlife Management Area, Stonington, CT.

N. Potential New England Cottontail Habitat



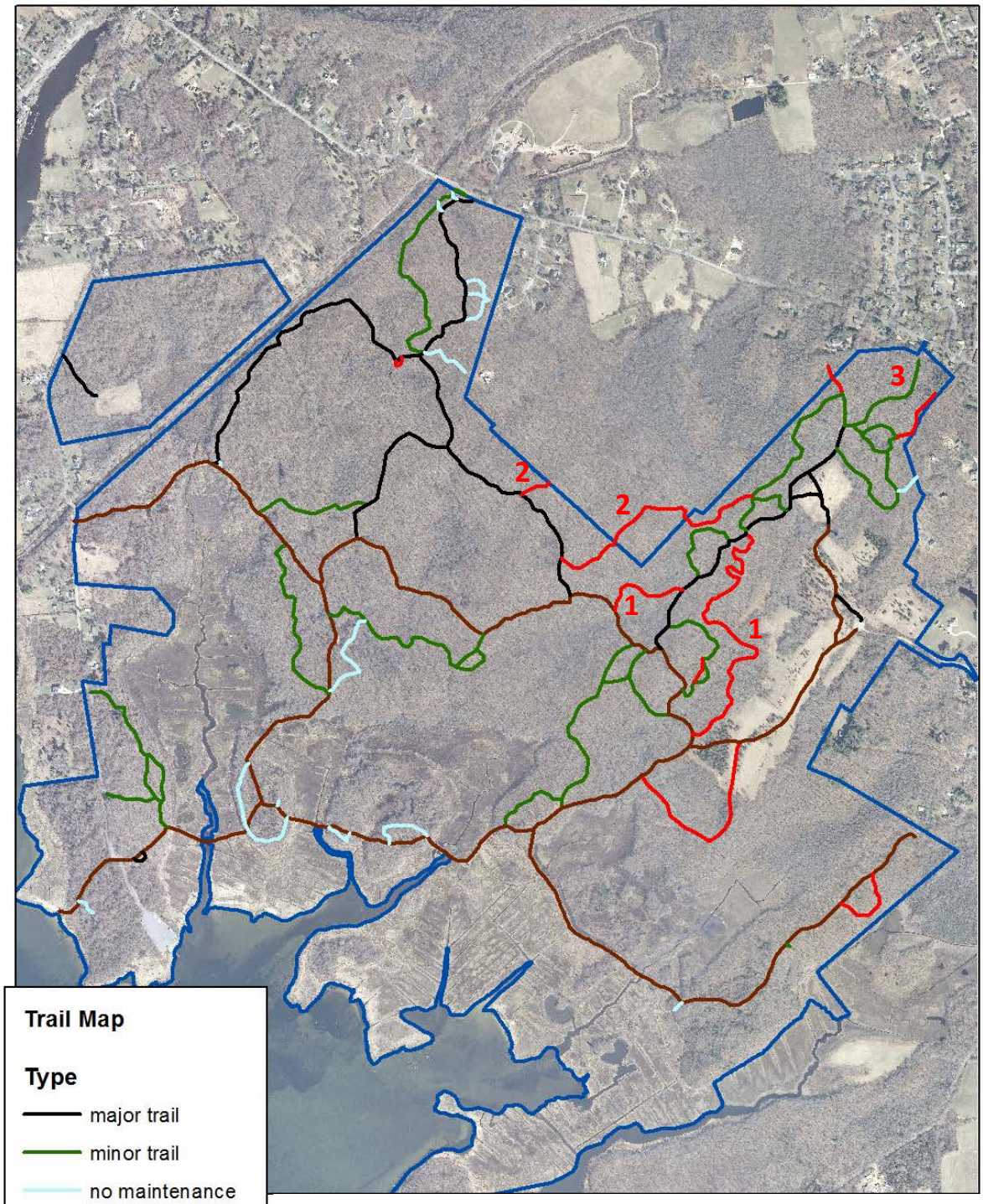
Map N. Potential areas for managing vegetation for New England Cottontail habitat at Barn Island Wildlife Management Area, Stonington, CT. Red outlines indicate potential areas. Colored squares indicate vegetation types (yellow = young forest, brown = red oak forest, see Figure X for additional details. Area of potential management sites are 1 = 16.6 ac, 2 = 4.6 ac, 3 = 17.9 ac, 4 = 20.3 ac, 5 = 5.3 ac, 6 = 9.4 ac, 7 = 12.7

O. Vegetation Composition



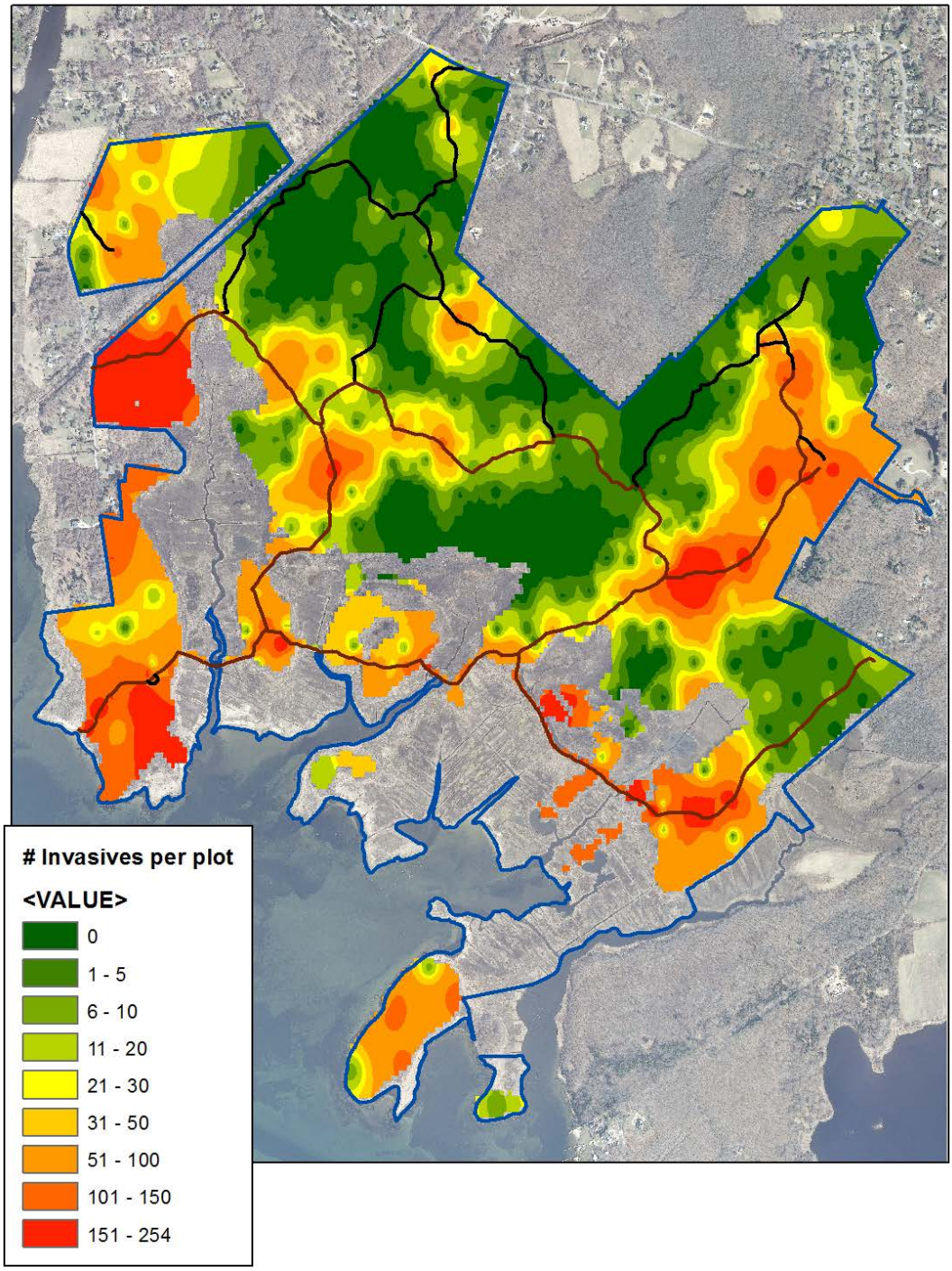
Map O. Vegetation composition in Forests at Barn Island Wildlife Management Area, Stonington, CT. Colored squares indicate forest type at 276 plots sampled in summer 2014. Background colors indicate habitat types based on aerial photographs and wetland layers and follow Map L.

P. Existing Trails with Recommendations



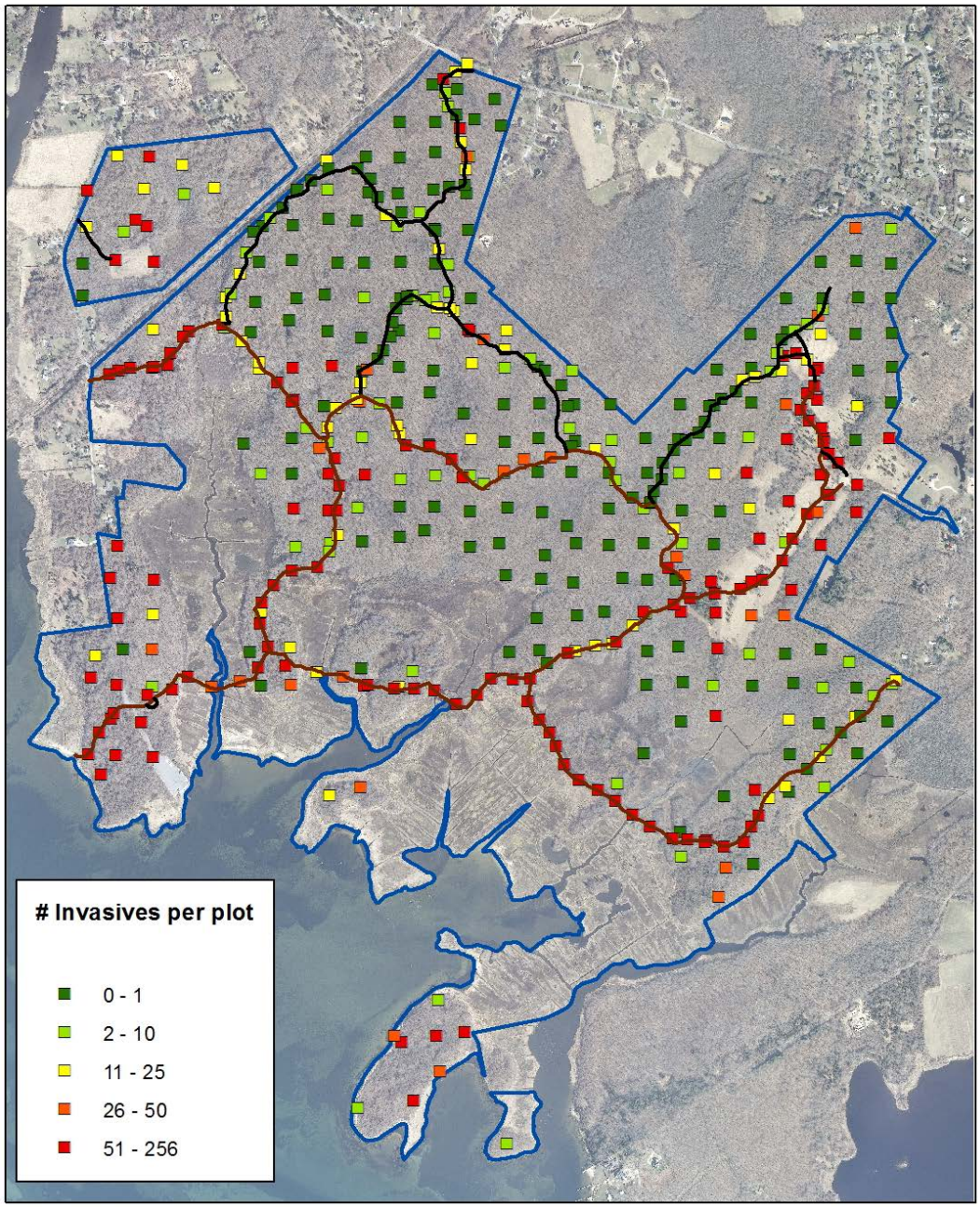
Map P. All existing trails at Barn Island Wildlife Management Area, Stonington, CT. Unimproved roads include the firebreaks. Trails labeled #1 have impact on wetland areas. Those labeled #2 lead onto the adjacent Davis property. The trail labeled #3 leads to a potential access point on Greenhaven Road.

Q. Invasive Plants



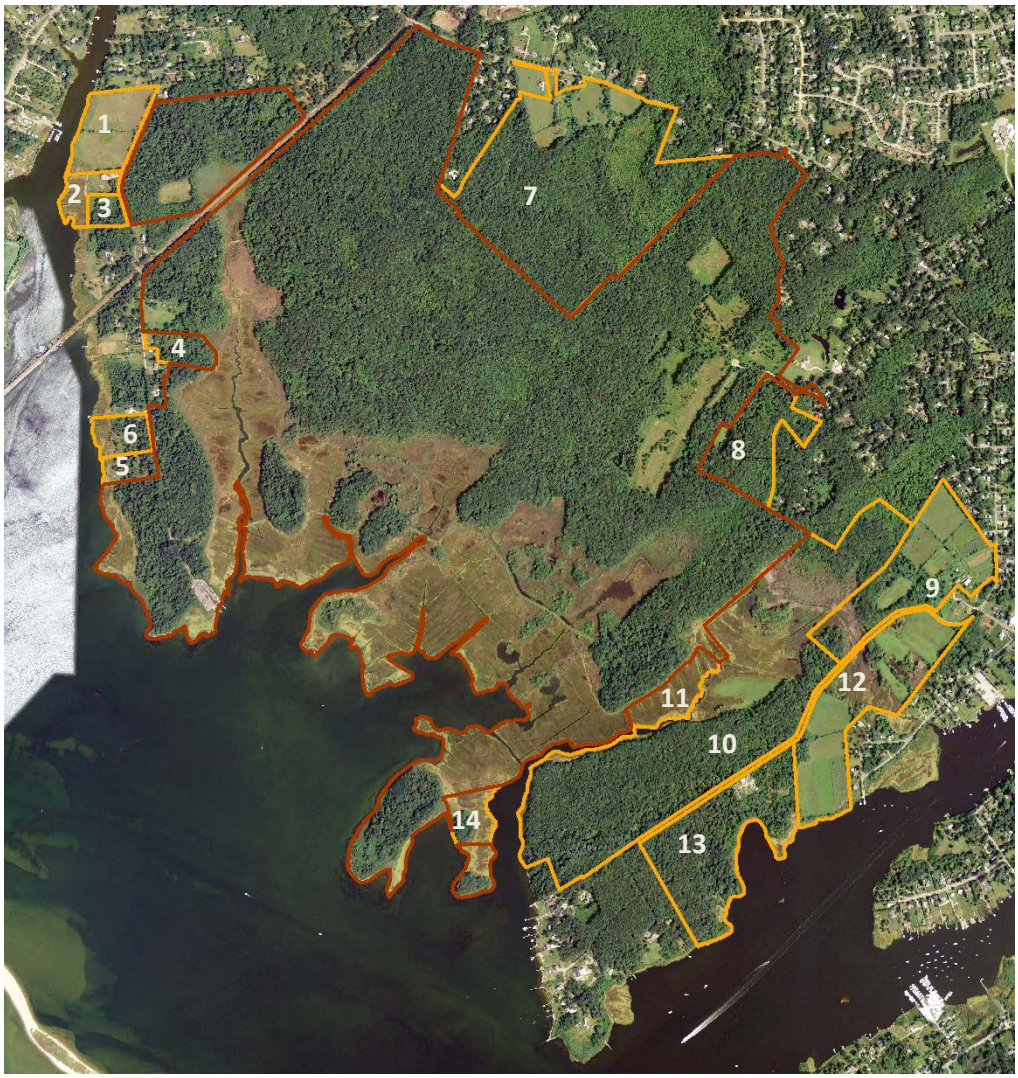
Map Q. Predicted abundance of invasive species at Barn Island Wildlife Management Area, Stonington, CT. Colors indicate predicted numbers of individual of all invasive species combined per plot. Values are predicted based on interpolation from 276 vegetation plots and 192 additional plots to measure invasive species along trails. Lines indicate major trails.

R. Invasive Plant Sampling Points



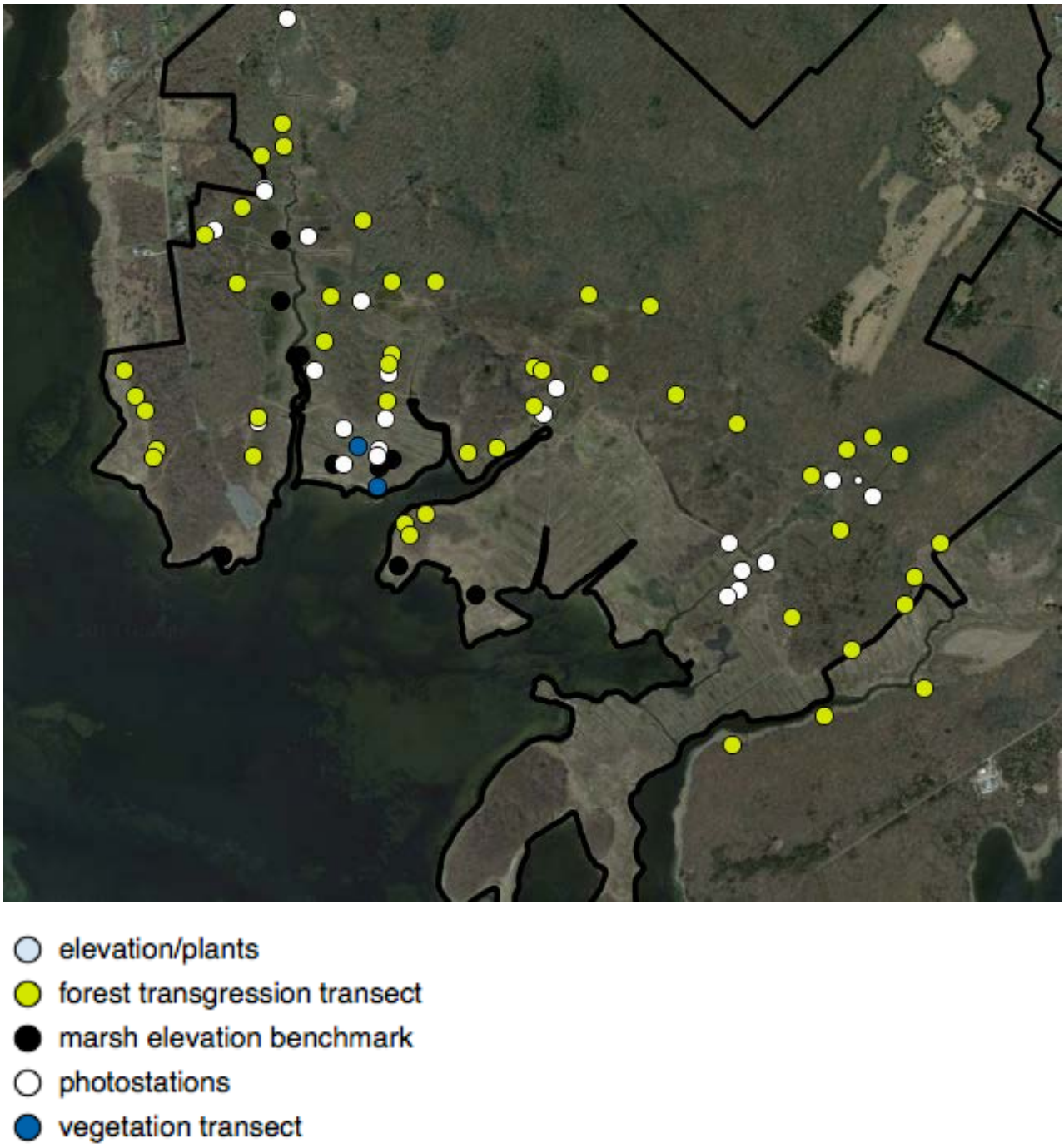
Map R. Location of invasive species plots (squares) at Barn Island Wildlife Management Area, Stonington, CT. Colors indicate total numbers of invasive plants per plot. Lines indicate major trails.

S. Surrounding Parcels of Potential Interest



Map S. Parcels of potential interest near at Barn Island Wildlife Management Area, Stonington, CT. Numbers refer to parcels in Table 7.

T. Research Activities



Map T. Locations of various research activities at Barn Island Wildlife Management Area, Stonington, CT

APPENDIX B. Plant Species

Plant species observed at Barn Island Wildlife Management Area, Stonington, CT by the report team during 2013 and 2014.

Acer rubrum
Agrostis gigantea
Ailanthus altissima
Amelanchier canadensis
Andropgon gerardii
Andropogon virginicus
Asclepias syriaca
Asclepias tuberosa
Baccharis halmifolia
Baptisia tinctoria
Berberis japonica
Betula alleghaniensis
Betula lenta
Betula papyrifera
Betula populifolia
Carex intumescens
Carya sp.
Celastrus orbiculatus
Chichorum intybus
Chimaphyla maculata
Clethra alnifoiia
Cynanchum rossicum
Dactylis glomerata
Dennstaedtia punctilobula
Desmondium canadensis
Dichanthelium clandestinum
Dioscorea villosa
Distichilis spicata
Eleagnus umbellata
Eragrostis spectabilis
Euonymus alatus
Eurybia divaricata
Euthamia graminifolia
Fagus grandifolia
Frangula alnus
Fraxinus americana
Gaulussacia baccata
Ghaphalium uliginosum
Hamamelis virginiana

Hypericum sp.
Hypochaeris radicata
Ilex opaca
Iva frutescens
Juncus gerardii
Juncus tenuis
Juniperus virginiana
Leersia oryzoides
Leersia virginica
Lilium superbum
Lindera benzoin
Lonicera japonica
Lonicera maackii
Microstegium vimineum
Morella caroliniensis
Nyssa sylvatica
Oclemena acuminata
Osmunda regalis
Osmundastrum cinnamomeum
Panicum virgatum
Parathelypteris novaboracensis
Parthenocissus quinquefolia
Paspalum sp.
Phragmites australis
Picea sp.
Pinus strobus
Plantago sp.
Pyrola americana
Quercus alba
Quercus alba
Quercus coccinea
Quercus rubra
Quercus veluntina
Rhododentron sp.
Rhus coppilina
Robinia psuedoacacia
Rosa multiflora
Rubus allegheniensis
Rubus flagellaris
Rubus sp.
Rudbeckia hirta
Sassafras albidum
Schizachyrium scoparius
Scutellaria lateriflora
Smilax rotundifolia
Solidago altissima?

Solidago juncea
Solidago rugosa
Sonchus arvensis ?
Spartina alterniflora
Spartina patens
Spartina pectinata
Spiranthes vernalis
Symplocarpus foetidus
Thalictrum pubescens
Trifolium aureum
Trifolium repens
Tsuga canadensis
Vaccinium corymbosum
Viburnum dentatum var. *lucidum*
Vitis labrusca

APPENDIX C. Researcher and Educator Meeting

October 8, 2014

The Barn Island Wildlife Management Area (BIWMA) is actively used for research and environmental education. In order to more fully understand how BIWMA is used for these purposes an online survey (see appendix A) was developed and distributed to 27 individuals (see appendix D) known to have been involved in research and/or education at BIWMA. Seven individuals responded to the survey (see appendix B and C). Nine individuals attended a meeting convened at Connecticut College on the morning of August 4, 2014 to further discuss needs and issues.

Attendees: Lisa Gilbert, Mystic-Williams Maritime Studies; Chuck Mulligan, New London Science Magnet HS; Chris Elphick, University of Connecticut; Bob Askins, Connecticut College; Frank Bolen, University of Connecticut; Kelly Matis, Mystic Marinelife Aquarium, Corrie Folsom-O'Keefe, National Audubon, Connecticut; Rich Orson, Consulting Researcher; Chris Field, University of Connecticut. [Note, while Scott Warren is part of the planning team, he also has several decades of experience conducting research and instructing college students about the ecology of tidal marshes at Barn Island.]

Planning Team: Glenn Dreyer, Ron Rozsa, Chad Jones, Scott Warren

Ron Rozsa opened the meeting with introductions around the room, followed by a 30-minute powerpoint presentation that served as an orientation on named places, acquisition history, the purpose of management areas and summarized the research. Chad Jones provided a powerpoint presentation about his vegetation surveys of the upland vegetation. He described the vegetation survey techniques used at each point (about 300 points, one per hectare). He showed a new trail map, some historic aerial photos and an invasive hotspot map.

Ron then reviewed the survey questions and responses. Additional suggestions and comments were requested from the attendees. The responses and recommendations have been organized by topics covered. We list the recommendations that emerged from the discussions. There are not the recommendations of the planning team.

Conflict between hunting and educational groups

Kelly Matis expressed concern about bringing out educational/ family groups who were frightened by the sound of firearms. Rich Orson suggested striving for a balance between hunting and education.

Bob Askins provided an explanation of how hunters supplied much of the conservation impetus and funding for BI. Much of the early land acquisition was possible using fees for hunting

equipment and licenses. The system of wildlife refuges and management areas set up in the past century along the migratory flyways helped to reduce long-term bird population declines.

Many of the attendees were not aware of the contribution of sportsman to land acquisition and management.

Recommendations:

1. Provide information about the contribution of sportsmen to wildlife conservation efforts at Barn Island. Use interpretive panels, website and QR codes (using smartphones the codes locate a website containing information).

2. Post a calendar at the entrances to inform about the public about when and where hunting may be occurring.

Volunteers

There was discussion about how volunteers could be organized to help with education, communication and maintenance. It was also suggested that a coordinator should be identified that could help to organize volunteers for priority projects. There are various sources of funding that might be available for projects. There is a current trend for corporations and others to offer volunteer days with lots of people for a number of hours to do a particular project. A list of BI projects could be developed for that purpose. Consider the creation of the "Friends of BI."

Recommendations:

1. Identify projects and activities that could lend themselves to volunteers and identify groups that are interested in conducting volunteer actions. It may be possible to secure some level of funding for a volunteer coordinator from the Long Island Sound Study or LIS Futures Fund, especially once the management plan is in place.

Bird Viewing

Ron inquired about ways to improve viewing shorebirds (as identified in the online survey). Chris Elphick suggested that BI is a good location to set up blinds near pools of water, with access trails placed so birds are not scared off as people enter the blind. These are common in Europe, not available in CT. Possible locations include Impoundment 1 – accessed from the Headquarters Road and the "elbow" of dike 3 where there is a small forested island that could be used as viewing area.

Recommendations:

1. Identify strategic locations to improve viewing of marsh birds.

Research Priorities It was noted that BI is the largest location with a large salt marsh system adjacent to intact, contiguous, undeveloped upland from NYC to somewhere in Maine. This makes the site extremely significant for research and wildlife management. Rich Orson advocated (multiple times) for more study of inland vegetation and wildlife (both terrestrial and freshwater wetland), since there is already so much known about the tidal wetlands. Once more is known about the habitats and uses, the site can be better managed and utilized. Chris Elphick discussed his marsh migration experiments in relation to endangered salt marsh sparrow species. Barn Island is the perfect location for work to understand where and how to allow a complete suite of marsh species to move inland with rising sea level.

Recommendations:

1. Identify historic and on-going research/monitoring. Create and update a GIS coverage, which would be used to assure that management, research and education activities do not degrade these critical areas.
2. Identify research and monitoring priorities. Review and update these priorities on an annual basis.
3. Identify how Barn Island as a LIS Stewardship Site can contribute to the LIS Sentinel Monitoring Program.
4. All research and monitoring must secure permission from DEEP. This should not be confused with collectors permits. Key technical staff throughout the agency should review proposals.

Funding The Aquarium is a Coastal American Learning Center, which could be the source of funding for projects. Audubon CT is starting to administer a fund generated by mitigation payments. The Long Island Sound Futures Fund might supply funding for recommendations in the management plan report.

Recommendations:

1. Identify education, research and monitoring priorities and identify sources of funding.

Permits and Permissions

This addresses the use of Barn Island for research and education. The 1974 management plan was reviewed which had established the Palmer Neck Marsh as the tidal wetland area for education for classes below college level. It was suggested that the more ideal location for this type of education is the trail that leads to Wequetequock Cove. The trail terminates at a small sandy barrier beach which provides easy access to the shallow cove for activities such as seining or searching for marine organisms. There is also a typical tidal marsh available at this location. Some educators noted that this area is being used for education. No concerns were raised with regard to concentrating education at this location.

The 1974 plan recommended that all tidal wetlands be available for research and college level education.

Recommendations:

1. Create an online form that would allow educators to register planned activities. DEEP can monitor the registrations to make certain that educators are complying with all requirements contained in the management plan.
2. Signage explaining education and research procedures needs to be posted. This can appear on the website, but should also be physically posted on site. A letter explaining procedures could also be sent to the Southern New England Marine Educators Association, which could be forwarded to association members. DEEP might also enlist the aid of the State Department of Education to contact schools regarding the rules for Barn Island.

Online Survey Questions.

1. Please tell us a bit about yourself.

2. Please describe the activities you conduct. For example: lead field trips staying on trails; view the marshes and forests; high school field trips venturing into the marshes to identify plants; use a seine in creeks to examine marine life; conduct research.

3. What habitats do you visit? For example forests, fields, tidal wetlands, and freshwater wetlands. If you visit specific areas, please identify them by referring to the map attached to the e-mail invitation to this survey.

4. How many individuals are usually in the groups participating on your visits to Barn Island?

5. Do you have any suggestions for enhancements that would improve your visits to Barn Island?

6. Are you aware of any user conflicts or any issues at Barn Island that you think should be addressed by a management plan?

7. A bibliography of Barn Island research was attached to the survey invitation e-mail that you received. Please review the bibliography and suggest any relevant additions in the space below.

8. Are there individuals or organizations not on the list attached to the e-mail invitation to this survey who are using Barn Island that we should contact for input?

Barn Island Wildlife Management Area – Summary of survey of researchers and educators.

2. Please describe the activities you conduct. For example: lead field trips staying on trails; view the marshes and forests; high school field trips venturing into the marshes to identify plants; use a seine in creeks to examine marine life; conduct research.

Researcher Responses:

Conduct research.

field trips for ornithology class - We always stay on the trails.

lead field trips (graduate courses), conduct research

Educator Responses:

Conducted one educational workshop in conjunction with students and staff of Bennie Dover Middle in New London.

Led family focused programs to identify birds and marsh inhabitants while staying on trails, lead family focused and student groups to coastline to seine for marine life

identification, student field trips into the marsh to conduct ecological assessment.

Conduct research and lead college field trips venturing into marsh

Have led field trips, but none planned at this time, visit the site occasionally, birding from tails. Very interested in any efforts to protect additional lands at site.

We use Barn Island for school field trips, summer camp, home-school and also adult programs - on birding, hiking, salt marsh ecology, coastal studies, explorations etc. Over the years DPNC has co-hosted walks and programs there with TNC, local land trusts and others. I recently led a group of adults on a walk there to look at the Venture Smith homestead site, so there's the whole cultural piece as well. It's a regular place for our full moon hikes and we use the boat launch for kayak trips in and around Little Narragansett Bay, including going across to Sandy Point for horseshoe crab surveys (part of a citizen science project through Sacred Heart U).

3. What habitats do you visit? For example forests, fields, tidal wetlands, freshwater wetlands If you visit specific areas, please identify them by referring to the map attached to the e-mail invitation to this survey.

Researcher responses:

Tidal wetlands and forest edge throughout the WMA

The main goal of the field trips is to visit salt marshes, but we also search for birds in fields, woodlands and thickets.

tidal marshes

Educator responses:

Woodlands, marshes, and coastal rivers

Wequetequock Cove Marsh and forest and fields on walking path

tidal wetlands: HQ marsh and Wequetequock Point marsh

use existing trails

4. How many individuals are usually in the groups participating on your visits to Barn Island?

Researchers responses:

3-5, but occasionally more

15

10-15

Educator responses:

5-18 participants

3-20

10-20

5. Do you have any suggestions for enhancements that would improve your visits to Barn Island?

Researcher responses:

No. The salt marshes are already accessible, so I don't think boardwalks or observation platforms are needed to see birds. A narrow boardwalk into the marsh might be useful

for other types of field trips that focus on plants or invertebrates, however, particularly if this would help protect the marsh from excessive foot traffic.

Actually, I think it is very good the way it is now

Educator responses:

Educational events

Additional signage to identify points of interests for individuals and groups visiting area.

Improved shorebird viewing opportunities through creation of shorebird foraging habitat, but realize that these may be opposed to overall goals for salt marsh management.

6. Are you aware of any user conflicts or any issues at Barn Island that you think should be addressed by a management plan?

Researcher responses:

There are many dogs off leash on the dikes during the breeding season. I don't think this is an issue because the dogs seem to stay with their owners on the dikes, but this may warrant further study. I don't think I've ever seen dogs in the marsh, and even leashed dogs would cause disturbance from a distance.

sea level rise and wetland loss

Educator responses:

None currently

It is difficult to utilize the area during hunting season due, even with colored vests, families still find the sounds concerning.

Some conflicts with off-leash dog walkers, but I generally don't encounter any conflicts when I have visited (generally mornings before or after peak season).

The original survey responses.

Initial Report

Last Modified: 07/30/2014

1. Please tell us a bit about yourself.

Your name	Your affiliation/organization
Chris Elphick	UCOnn
Robert Askins	Dept. of Biology, Connecticut College
Dr. Richard Orson	OEC
Chuck Mulligan	Science and Technology Magnet HS
MaryEllen Mateleska	Mystic Aquarium
Lisa Gilbert	Williams College / Williams-Mystic
Patrick Comins	Audubon Connecticut

Statistic	Value
Total Responses	7

2. Please describe the activities you conduct. For example: lead field trips staying on trails; view the marshes and forests; high school field trips venturing into the marshes to

identify plants; use a seine in creeks to examine marine life; conduct research.

Text Response
Conduct research.
field trips for ornithology class - We always stay on the trails.
lead field trips (graduate courses), conduct research
Field Trips to explore woodlands, marshes, and the coastal rivers. We have also started using our SeaPerch units to view and log submerged aquatic vegetation off Bluff Point. We did do one educational workshop with all of the above in conjunction with students and staff of Bennie Dover Middle in New London.
Lead family focused programs to identify birds and marsh inhabitants while staying on trails, lead family focused and student groups to coastline to seine for marine life identification, student field trips into the marsh to conduct ecological assessment.
conduct research; lead college field trips venturing into marsh
Have led field trips, but none planned at this time. I visit the site occasionally, birding from tails. Very interested in any efforts to protect additional lands at site.

Statistic	Value
Total Responses	7

3. What habitats do you visit? For example forests, fields, tidal wetlands, freshwater wetlands If you visit specific

areas, please identify them by referring to the map attached to the e-mail invitation to this survey.

Text Response
Tidal wetlands and forest edge throughout the WMA
The main goal of the field trips is to visit salt marshes, but we also search for birds in fields, woodlands and thickets.
tidal marshes
Woodlands, marshes, and coastal rivers
Visit Wequetequock Cove Marsh and forest and fields on walking path
tidal wetlands: HQ marsh and Weq Pt marsh
All of the above that can be viewed from public trails.

Statistic	Value
Total Responses	7

4. How many individuals are usually in the groups participating on your visits to Barn Island?

Text Response
3-5, but occasionally more
15
10-15
They have not been to Barn Island
5-18 participants
3-20
10-20

Statistic	Value
Total Responses	7

5. Do you have any suggestions for enhancements that would improve your visits to Barn Island?

Text Response
No. The salt marshes are already accessible, so I don't think boardwalks or observation platforms are needed to see birds. A narrow boardwalk into the marsh might be useful for other types of field trips that focus on plants or invertebrates, however, particularly if this would help protect the marsh from excessive foot traffic.
Actually, I think it is very good the way it is now
Educational events
Additional signage to identify points of interests for individuals and groups visiting area.
No
I would like to see improved shorebird viewing opportunities through creation of shorebird foraging habitat, but realize that these may be opposed to overall goals for salt marsh management.

Statistic	Value
Total Responses	6

6. Are you aware of any user conflicts or any issues at Barn Island that you think should be addressed by a management plan?

Text Response
There are many dogs off leash on the dikes during the breeding season. I don't think this is an issue because the dogs seem to stay with their owners on the dikes, but this may warrant further study. I don't think I've ever seen dogs in the marsh, and even leashed dogs would cause disturbance from a distance.
sea level rise and wetland loss
None currently
It is difficult to utilize the area during hunting season due, even with colored vests families still find the sounds concerning.
No
Some conflicts with off-leash dog walkers, but I generally don't encounter any conflicts when I have visited (generally mornings before or after peak season).

Statistic	Value
Total Responses	6

7. A bibliography of Barn Island research was attached to the survey invitation e-mail that you received. Please review the bibliography and suggest any relevant additions in the space below.

Text Response
Didn't get such a bibliography
I didn't receive the bibliography. There were only three attached files.
Please see: http://www.tidalmarshbirds.org/?page_id=383

Statistic	Value
Total Responses	3

8. Are there individuals or organizations not on the list attached to the e-mail invitation to this survey who are using Barn Island that we should contact for input?

Text Response
All of the people I thought of are already on the list.
I didn't see Scott Warren's name on the list
Not at this time.
Corrie Folsom-O'Keefe (Audubon), Scott Warren (Conn College, perhaps retired), Glenn Dryer, Suzanne Paton (USFWS), Min Huang (CT DEEP), Chris Loscalzo (New Haven Bird Club, closcalz@optonline.net), Maggie Jones (Dennison Pequotsepos Nature Center), Avalonia Land Conservancy.

Statistic	Value
Total Responses	4

Barn Island Wildlife Management Area – Research & Education Workshop Invitees.

Name	Organization
Frank Bohlen	UConn Avery Point Marine Sciences
Chris Elphick	UConn Ecol & Evol. Bio
Nels Barrett	NRCS Ecologist
Melinda Smith	Yale Ecol & Evol. Bio
Rich Orson	Consulting Ecologist
Robert Askins	Conn Coll biology
Johann Varekapmp	Wesleyan Earth Sciences
Ellen Thomas	Wesleyan Earth Sciences
Jamie Vaudrey	Uconn Avery Point Marine Sciences
Roman Zajac	U New Haven, Bio & Env. Sci.
Bob Whitlatch	UConn Avery Point Marine Sciences
Jeff Ward	CT Ag. Experiment Station, Forestry
David Wagner	UConn Ecol & Evol. Bio.
Jeffrey P. Donnelly	Woods Hole Oceano. Inst.
Maggie Jones	Dennison Pequotsepos Nature Center
Juliana Barrett	CT SeaGrant
Lauren Rader	Project Oceanology, Chief Instructor
Chuck Mulligan	NL Science & Tech HS teacher
Amy Ferland	Groton Marine Magnet HS rep
Amy Ferland	SE New England Marine Educators
Patrick Comins	Audubon CT
Milan Bull	CT Audubon
Mistral Dodson	New England Science and Sailing
Bob Dewire	Naturescapes
Diba Kahn-Burea	Three Rivers, Envir. Engineering
Lisa Gilbert	Mystic-Williams Maritime Studies
Dr. Kelly Matis	Mystic Aquarium

APPENDIX D. Bird Species

Birds Seen or Heard on Barn Island 2014

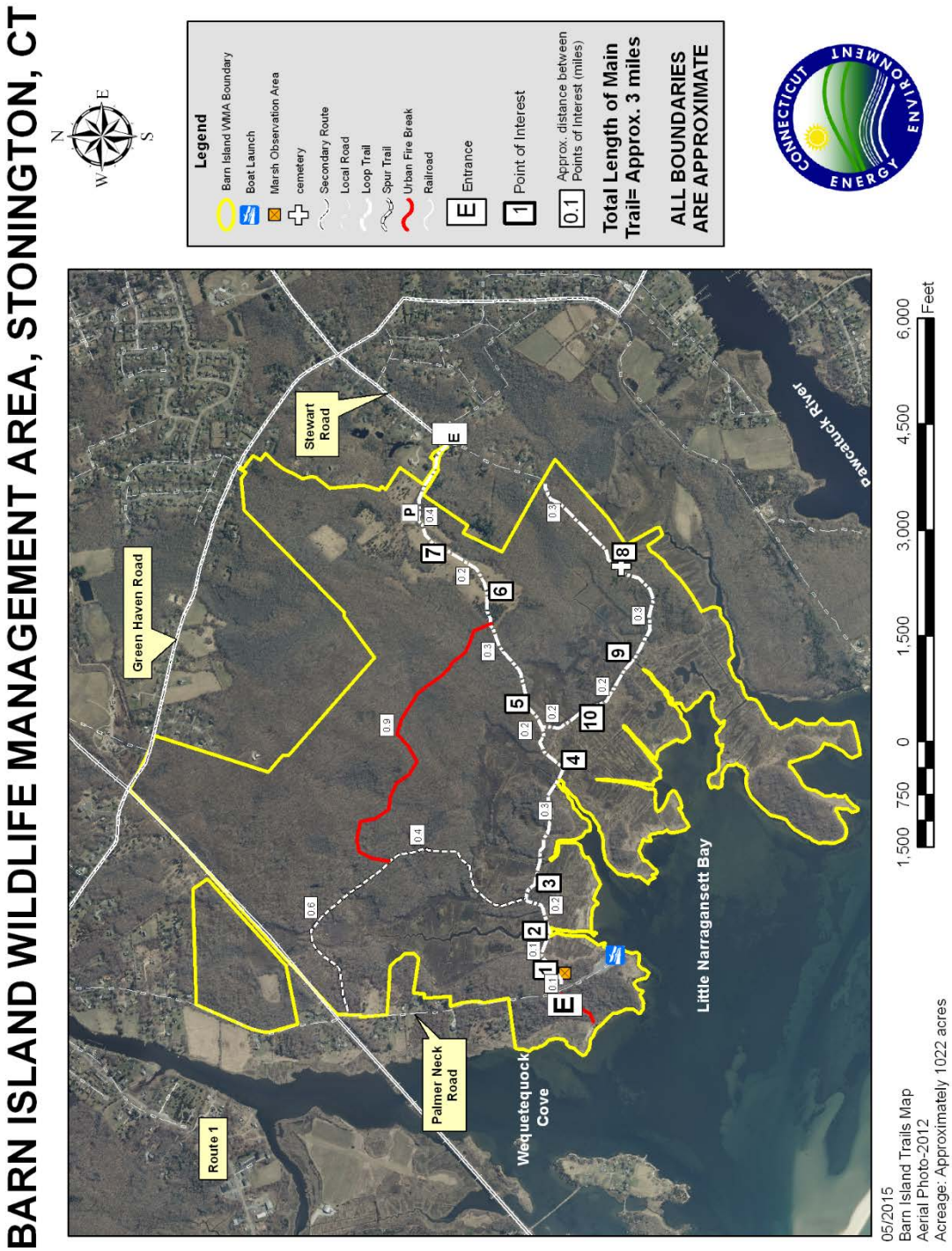
Rarely Observed (1-3 times): 1
Occasionally Observed (4-6 times): 2
Commonly Observed (7-10 times): 3
Frequently Observed (>10 times): 4

This list was compiled by Mary Buchanan, Connecticut College ’14, who spent June and July 2014 as a summer research assistant with the Barn Island assessment group. Most of her time was spent in the uplands, so the frequency of the marsh or coast birds wasn’t noted. Also these numbers are likely an underestimate since most work was vegetation surveys conducted during the day rather than early in the morning, so the birds were probably not very active.

Acadian Flycatcher (?) (1)
American Black Duck (marsh)
American Goldfinch (edge of forest) (2)
American Redstart (edge of the forest) (2)
American Robin (forest) (4)
Baltimore Oriole (marsh, meadow) (2)
Barn Swallow (marsh)
Black-and-white Warbler (forest) (3)
Blue Jay (forest) (2)
Blue-gray Gnatcatcher (forest) (2)
Blue-winged Warbler (meadow) (3)
Brown-headed Cowbird (meadow) (3)
Carolina Wren (meadow) (2)
Cedar Waxwing (meadow) (2)
Chipping Sparrow (meadow) (2)
Common Grackle (forest) (3)
Common Yellowthroat (forest, meadow) (4)
Double-crested Cormorant (marsh)
Downy Woodpecker (forest) (3)
Eastern Bluebird (meadow) (2)
Eastern Kingbird (marsh)
Eastern Towhee (meadow/edge) (4)
Eastern Phoebe (forest) (2)
Eastern Wood-Pewee (forest) (4)
Field Sparrow (meadow) (2)
Fish Crow (near road) (1)

Glossy Ibis (marsh)
Gray Catbird (edge) (4)
Great Black-backed Gull (coast)
Great Blue Heron (marsh)
Great Crested Flycatcher (forest) (4)
Great Egret (marsh)
Green Heron (marsh)
Hairy Woodpecker (forest) (1)
Herring Gull (coast)
House Wren (meadow) (3)
Mallard (marsh)
Marsh Wren (marsh)
Mourning Dove (edge) (3)
Northern Cardinal (forest, meadow) (3)
Osprey (marsh)
Ovenbird (forest) (4)
Red-bellied Woodpecker (edge of meadow/forest) (3)
Red-eyed Vireo (forest) (4)
Red-tailed Hawk (near edge of meadow/forest) (1)
Red-winged Blackbird (marsh, meadow) (4)
Rose-breasted Grosbeak (edge of meadow/forest) (2)
Scarlet Tanager (forest) (3)
Semipalmated Sandpiper (marsh)
Snowy Egret (marsh)
Song Sparrow (meadow) (3)
Tree Swallow (meadow) (4)
Tricolored Heron
Tufted Titmouse (forest, meadow) (4)
Turkey Vulture (meadow, near parking lot) (2)
Veery (forest) (4)
Warbling Vireo (edge of meadow/forest) (2)
White-eyed Vireo (edge of marsh) (4)
White-breasted Nuthatch (forest) (2)
Willet (marsh)
Willow Flycatcher (along marsh)
Wood Thrush (edge of forest) (2)
Yellow Warbler (edge of meadow, edge of marsh) (4)
Yellow-billed Cuckoo (edge of marsh) (1)
Yellow-throated Vireo (forest, along trail) (3)

APPENDIX E. Trail Brochure by Eagle Scout Phillip Banker



Points of Interest

1. *Estuary*: Mixing of inland fresh water and salt water from the ocean. In the distance are Little Narragansett Bay and Watch Hill, RI.
2. *Culvert:* Installed in the late 1970s to allow free movement of tidal water. The increased tidal flushing allows native plants to thrive.
3. *Common Reed Grass*: An invasive species that grows in elevated marsh areas. The growth of this plant is managed by allowing salt water into the marsh.
4. *Salt Panne*: A shallow depression on the marsh surface. The plants that live here are uniquely adapted to high levels of salinity and extreme temperatures. Salt pannes provide feeding habitat for shorebirds, wading birds and waterfowl.
5. *Upland Hardwood Forest*: Farther away from the salt water, larger hardwood trees are able to grow.
6. *Fields*: These field openings are maintained to provide food and cover for wildlife such as eastern bluebirds, blue-winged warblers, cottontail rabbits, and bobwhite quail. Controlling non-native, invasive plants is the primary management objective at this site.
7. *Barn Owl Nest Box*: This box was built by a local boy scout for an Eagle Scout project. The barn owl is a state-endangered species.
8. *Cemetery*: This colonial-era cemetery dates back to the 1600s.
9. *Osprey Nesting Platform*: Once threatened with extinction, the osprey has made a dramatic comeback with help from protective laws (most importantly, the ban on the use of the pesticide DDT) and the installation of nesting platforms.
10. *Mosquito Ditches*: These ditches were dug in the early 1900s to drain water from the marsh surface in an attempt to eliminate mosquito-breeding habitat.

7/03

Historical Information

Barn Island Wildlife Management Area is a 900+-acre state-owned property bordering Little Narragansett Bay. State acquisition of this land began in 1944 and is an ongoing process. A major portion of this area was purchased with funds derived from an excise tax on sporting arms and ammunition through the Federal Aid in Wildlife Restoration Act. The management goals for Barn Island are to maintain and enhance the biological values of the area while providing a variety of wildlife-based outdoor recreation opportunities such as hunting, fishing, boating, birdwatching, nature photography and hiking.

Saltwater and freshwater marshes, mixed hardwood forest, and open fields are all part of Barn Island's ecology. This makes Barn Island home to a wide variety of plants and animals such as waterfowl, shorebirds, wading birds, songbirds, hawks, owls, deer, turkeys, amphibians and reptiles.

In the early 1900s, mosquito ditches were dug to drain water from the marsh surface for the purpose of eliminating mosquito-breeding habitat. These ditches, however, drained so much water that the ecology of the marsh was significantly altered. A new, more ecologically sound method, known as Open Marsh Water Management, is now being used to restore saltmarsh habitat and control mosquito breeding. Using this method, a network of shallow ponds with inter-connecting channels is created to hold water on the marsh surface. These open water areas provide habitat for minnows, which feed on mosquito larvae.

Most hunters are required to wear fluorescent orange. As a safety precaution, you are encouraged to do the same during the hunting season. For hunting season dates, refer to the Connecticut Hunting & Trapping Guide, available from town clerks or at website www.dep.state.ct.us/burnatr.

Barn Island Wildlife Management Area

Stonington, CT

Trail Map

Brochure courtesy of Philip Banker
Boy Scout Troop 17-G
Groton, CT

For additional information, contact the State of Connecticut, Department of Environmental Protection - Bureau of Natural Resources, Wildlife Division at (860) 295-9523.

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APPENDIX G. Research Locations – Additional Information

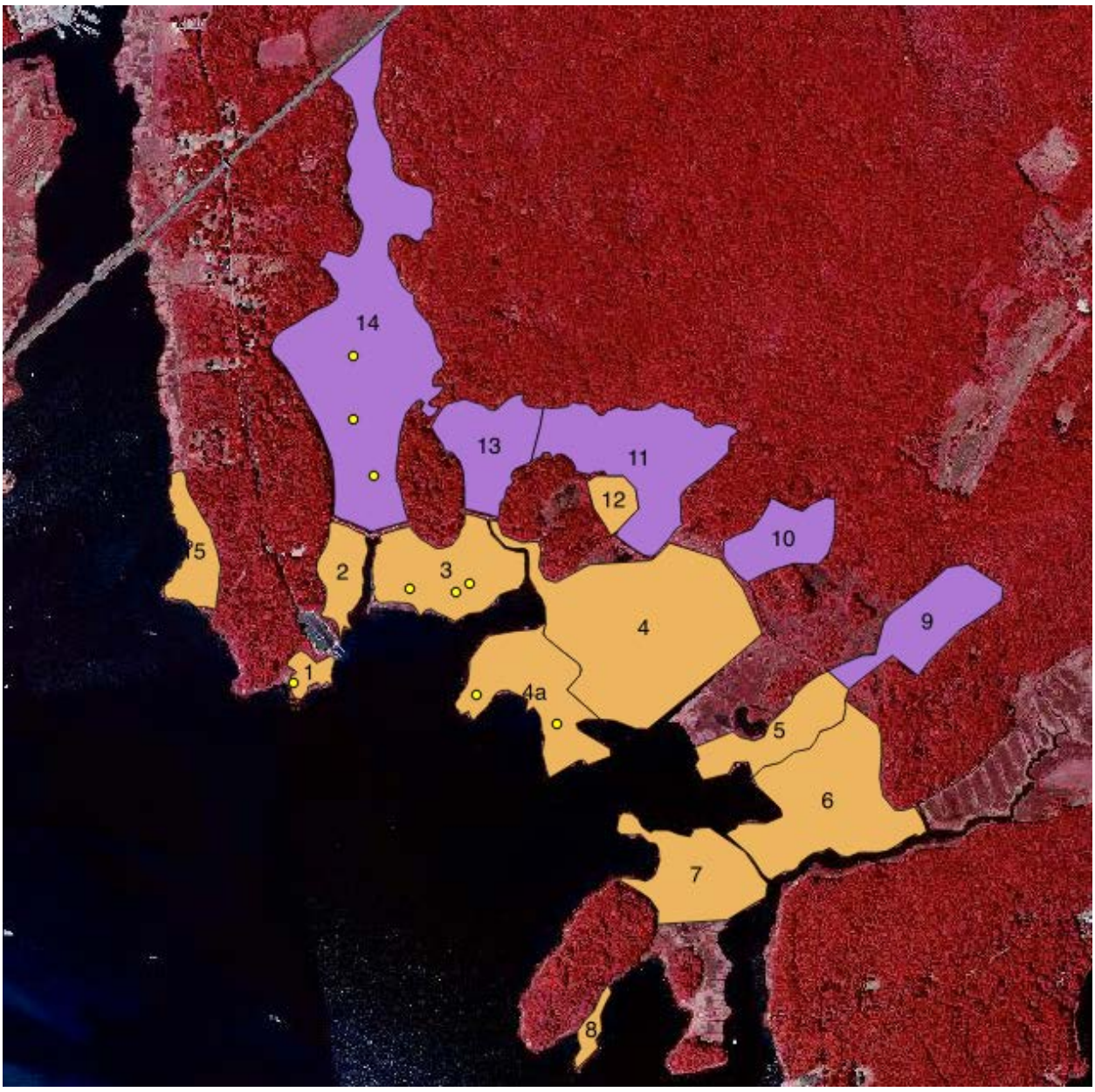

Figure A. Salt Marsh Zones for research locations at Barn Island Wildlife Management Area, Stonington, CT.

Table A. Research Activities at Barn Island Wildlife Management Area, Stonington, CT, by Location. Location # refer to Figure A. Numbers in parentheses represent times sampled. G – Gross, H – Hebard, ME – Miller & Egler 10' diameter circular plots, S – SHARP (Saltmarsh Habitat and Avian Research Program)

Location	SET	Vegetation Map	Photo station	Forest transgression	Veg transect	Peat Depth Transect	Microrelief Plot	Marsh Birds	Nitrogen Enrichment	Vegetation Plots	New England Cottontail	Acorn Mast
Wequetequock Cove (15)				X								
Wequetequock Point (1)	X						X					
Palmer Neck Marsh (2)		X (1)	X	X	X							
Headquarters Marsh (3)	X	X (1)	X	X	X		X	X		ME(3), S(2)		
Barber Marsh (west) (4)			X	X				X	X	S(2)		
Barber Marsh (4a)	X											
Brucker Marsh (5)			X		X					X		
Barber Marsh (east) (6)		X (1)		X								
Barber Marsh (south) (7)					X							
Impoundment 1 (14)	X	X (3)	X	X	H	X						
Impoundment 2 (13)		X (2)	X	X	H	X						
Impoundment 3 (11)		X (2)	X	X	H	X				S(2)		
Impoundment 4 (10)		X (2)	X	X	H	X						
Impoundment 5 (9)			X	X	G, H	X				X		
Uplands											X	X