



# Pre-Restoration Vegetation Monitoring Report Pre-Restoration (2024)

Hinckleys Pond – Herring River Headwaters Eco-Restoration Project  
Jenkins Bog and Warner Bog  
Harwich, Massachusetts



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## Executive Summary

This Pre-Restoration Vegetation Monitoring Report summarizes monitoring protocols, the establishment of long-term monitoring plots, and results of the pre-restoration vegetation monitoring for the ecological restoration project associated with the retired cranberry bogs adjacent to Hinckleys Pond in Harwich, Massachusetts.

In August of 2024, Inter-Fluve conducted pre-restoration vegetation monitoring activities at the retired Jenkins and Warner Bogs. The retired Jenkins Bog is located to the southeast of Hinckleys Pond in Harwich. The retired Warner Bog is located to the west of Hinckleys Pond in Harwich and Brewster.

Pre-restoration vegetation monitoring activities included:

- vegetation survey within the retired Jenkins and Warner Bogs; monitoring plots were located within areas where the restoration designs proposed sand removal and microtopography as well as in areas with microtopography but no sand removal
- photographic survey within the proposed transitional and upland planting zones

Across the two bogs, we found 58 plant species of which 50 were native and 29 were wetland adapted. Jenkins Bog was more species rich than Warner Bog.

Vegetation monitoring is anticipated to continue in subsequent monitoring years following construction.

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# 1 Introduction

The Jenkins and Warner Bogs are retired cranberry bogs on the east and west ends of Hinckleys Pond, respectively, in Harwich, Massachusetts. While we do not know exactly when cultivation began on these bogs, some of the first commercial cranberry farms were initiated in this part of Harwich in the early 1800s. We suspect that these bogs were developed in the early to mid-1800s, with Jenkins Bog last harvested around 2021 and Warner Bog last harvested around 2023. As with other cranberry farms in the region, Jenkins and Warner Bogs were developed on former wetlands, which were ditched to maintain drainage and water control. Over the 150-200 years that the farms were developed, farmers placed sand on the bog surface to stimulate cranberry growth and reduce weed growth. Today, 1.5 to 2 feet of sand placed by the farmers lie on top of organic wetland soils and peat of varying depths across much of the former bogs. More information regarding the site history and site conditions can be found in the *Hinckleys Pond-Herring River Headwaters Restoration Project Harwich, MA Basis of Design Report – 100% Design* (Inter-Fluve, 2024).

In 2021, the Harwich Conservation Trust (HCT) retained Inter-Fluve, Inc. (Inter-Fluve) to provide data collection, ecological restoration design, and permitting services for the Hinckleys Pond-Herring River Headwaters Ecological Restoration Project. Since then, design plans and permitting were completed and a competitive bid process was completed in late 2024 to select a construction contractor. HCT anticipates construction beginning on the site in early 2025. More information regarding the restoration designs can be found in the *Hinckleys Pond-Herring River Headwaters Restoration Project Harwich, MA Basis of Design Report – 100% Design* (Inter-Fluve, 2024). In August of 2024, the Association to Preserve Cape Cod (APCC) retained Inter-Fluve to provide pre-restoration vegetation monitoring and reporting services of the retired Jenkins and Warner Bogs. This monitoring report summarizes the methods and results of this vegetation monitoring.

Inter-Fluve completed vegetation and photographic surveys to establish a baseline of vegetation at the retired Jenkins and Warner Bogs prior to construction implementation of the Hinckleys Pond-Herring River Headwaters Eco-Restoration Project. As described in the methods section below, monitoring plots were studied throughout the Jenkins and Warner Bogs. Because the restoration designs included two primary treatments to the bog surface, microtopography after some sand removal and microtopography with no sand removal, vegetation monitoring plots were placed in both treatment areas. We anticipate that the vegetation monitoring program will continue after restoration is complete. Monitoring vegetation before and after restoration will allow for analysis of changes in pre- and post-restoration conditions. Vegetation monitoring will provide data needed to measure progress of project goals and questions, including establishing native freshwater wetlands and vegetation and evaluating the impact of different restoration treatments (some sand removal versus no sand removal) on post-restoration plant communities. In our methods and results, we will not be comparing data from Jenkins Bog with data from Warner Bog, rather we will be comparing pre- and post-restoration data within the same plots and bogs as well as comparing impacts of the different treatments on the vegetation response within each bog.

Table 1 summarizes the monitoring activities completed to date.

*Table 1. Monitoring activities*

<b>Monitoring Phase</b>	<b>Vegetation Survey</b>	<b>Photographic Survey</b>	<b>Monitoring Report Submitted</b>
Pre-Restoration	08/08/2024, 08/12/2024, 08/13/2024	08/13/2024	December 2024

## 2 Methodology

### 2.1 Vegetation Survey

To evaluate the state of the pre-restoration vegetation at Jenkins and Warner Bogs, Inter-Fluve used an established vegetation survey method that is being used at many retired and restored cranberry bogs in southeastern Massachusetts (Neill et al. 2023, Klionsky et al. *in review*). We used ESRI ArcGIS Pro to randomly select points for survey plots in both the areas designated for sand removal and no sand removal during restoration. We surveyed 27 plots at Jenkins Bog and 18 plots at Warner Bog. At both bogs, nine of the study plots were in areas of no designed removal of sand and the remainder were in areas with planned sand removal. The random points were used as the southeast corner of each 3 x 3 m plot, and we used a Carlson BRx7 survey-grade RTK GPS to survey the location of each plot's southeast corner in the field. Appendix A illustrates the locations of the plots; Table 2 provides the GPS coordinates of the plots. Plots were delineated with a 3 x 3 m PVC quadrat frame with detachable sides. To establish plots, we used a compass to orient one quadrat side due north from the southeast corner and subsequently attached the three remaining sides.

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Table 2. Coordinates of vegetation monitoring plots

Vegetation Monitoring Plot	Bog Location	Northing (US Feet)	Easting (US Feet)
1	JSR	2722007.365	1043075.83
2	JSR	2722096.907	1044125.946
3	JSR	2722076.351	1043134.904
4	JSR	2722078.064	1044216.695
5	JSR	2722294.948	1043639.969
6	JSR	2721996.185	1043854.972
7	JSR	2722148.638	1043972.702
8	JSR	2722357.813	1043309.144
9	JSR	2721939.473	1044180.231
10	JSR	2722194.713	1044081.957
11	JSR	2722111.496	1043288.689
12	JSR	2722252.736	1044201.599
13	JSR	2722162.906	1043484.524
14	JSR	2722306.122	1042977.822
15	JSR	2722143.037	1043602.692
16	JSR	2722616.33	1043226.565
17	JSR	2721980.976	1044095.858
18	JSR	2722033.278	1043986.943
19	JNSR	2722491.817	1043705.75
20	JNSR	2722408.624	1043914.096
21	JNSR	2722489.807	1043525.194
22	JNSR	2722365.965	1043546.746
23	JNSR	2722593.788	1043428.154
24	JNSR	2722520.965	1043562.589
25	JNSR	2722568.587	1043459.328
26	JNSR	2722535.677	1043685.554
27	JNSR	2722398.7	1043692.209
28	WSR	2724575.713	1039055.111
29	WSR	2724646.821	1039015.309
30	WSR	2724063.452	1039028.888
31	WSR	2724397.021	1038898.583
32	WSR	2724700.738	1038907.048
33	WSR	2724465.317	1039099.152
34	WSR	2724667.691	1038816.466
35	WSR	2724804.661	1039008.737
36	WSR	2724674.306	1039214.227
37	WNSR	2724211.76	1038822.37
38	WNSR	2724361.12	1038611.805
39	WNSR	2724121.688	1038756.517
40	WNSR	2724112.664	1038938.533
41	WNSR	2724475.18	1038693.919
42	WNSR	2724304.336	1039092.088
43	WNSR	2724419.873	1039083.849
44	WNSR	2724224.717	1039049.336
45	WNSR	2724426.737	1039019.751

The horizontal coordinate system is the NAD 1983, Massachusetts State Plane, Mainland Zone, US Ft.

Acronym key: J=Jenkins, W=Warner, SR=sand removal, NSR=no sand removal

In each 3 x 3 m study plot, we recorded the percent cover of each plant species present as well as the coverage of bare ground, open water, leaf litter, and woody debris. We recorded percent cover in seven cover class bins (<1%, 1-2%, 3-5%, 6-15%, 26-50%, 51-75%, 76-100%). We classified species following *Flora Novae Angliae* (Haines 2011), and taxa were all classified to the species level except for moss, which was recorded as moss. We characterized the wetland indicator status for each plant species, using the Army Corps of Engineers Northcentral and Northeast Plant List (2020), native/non-native status, and physical form. At each study plot, we took a photograph from the southern edge of the plot facing north.

We used our vegetation survey data to determine the overall species richness and create a species list for each bog. We additionally calculated the mean species richness, mean wetland species richness, and mean wetland species percent cover per plot. Wetland species percent cover calculations excluded cranberry. While cranberry is a native, wetland obligate species, it was cultivated and would mask detection of recovery of other wetland species. We also found the mean percent cover of graminoids, forbs, vines, shrubs, and trees per plot. We used analysis of variance (ANOVA) means comparison tests to compare per plot species richness and per plot wetland species richness among plots in sand removal and no sand removal areas within each bog. At Jenkins Bog, the number of wetland species per plot was log-transformed to meet model assumptions. Within each bog, we also compared the percent cover of cranberry in sand removal and non-sand removal plots. At Jenkins Bog, the data did not meet parametric model assumptions, so we used a Kruskal-Wallis non-parametric means comparison test. We used ANOVA to compare treatments at Warner Bog. Similar analyses will be conducted post-restoration for within-bog comparisons. All data analysis was completed in R 4.4.0 (R Core Team 2024).

## 2.2 Photographic Survey

Inter-Fluve identified eight representative locations at Jenkins Bog and five locations at Warner Bog for transitional and upland zone photo monitoring. We recorded each point’s location with a RTK GPS. At each photo station, we took a photo facing each of the four cardinal directions. We also noted the presence or absence of invasive plant species as well as other common vegetation. Appendix A illustrates the locations of the photo stations; Table 3 provides the GPS coordinates of the photo stations.

Table 3. Coordinates of photo stations

Photo Station	Bog	Northing (US Feet)	Easting (US Feet)
1	Jenkins	2722675.115	1043942.524
2	Jenkins	2722420.566	1044059.315
3	Jenkins	2722177.125	1044345.266
4	Jenkins	2721878.102	1044067.538
5	Jenkins	2722446.091	1042953.834
6	Jenkins	2721856.625	1043219.176
7	Jenkins	2722122.59	1043782.644
8	Jenkins	2722640.822	1043299.606
9	Warner	2724939.572	1038773.38
10	Warner	2724641.527	1038692.653
11	Warner	2724678.344	1039256.562
12	Warner	2724107.001	1038773.62
14	Warner	2724155.845	1039144.936

The horizontal coordinate system is the NAD 1983, Massachusetts State Plane, Mainland Zone, US Ft.

## 3 Data Collection

### 3.1 Pre-Restoration Monitoring (2024)

#### 3.1.1 Vegetation Survey

On August 7, 2024, Inter-Fluve conducted the Pre-Restoration vegetation survey at the monitoring plots in Jenkins Bog. Refer to Section 4.1.1 for vegetation survey results. Inter-Fluve took photographs of each of the vegetation monitoring plots facing north. Refer to Appendix B for photographs of the plots.

On August 12, 2024, Inter-Fluve conducted the Pre-Restoration vegetation survey at the monitoring plots in Warner Bog. Refer to Section 4.1.1 for vegetation survey results. Inter-Fluve took photographs of each of the vegetation monitoring plots facing north. Refer to Appendix B for photographs of the plots.

On August 13, 2024, Inter-Fluve conducted an RTK GPS survey of the location of each plot's southeast corner in the field. Refer to Appendix A for maps of the plot locations.

#### 3.1.2 Photographic Survey

On August 13, 2024, Inter-Fluve established transitional and upland zone photo stations and conducted an RTK GPS survey of the location of each photo station. Refer to Section 4.1.2 for photographic survey results and Appendix A for maps of the photo station locations.

## 4 Results

### 4.1 Pre-Restoration Monitoring (2024)

#### 4.1.1 Vegetation Survey

This report summarizes the pre-restoration vegetation monitoring. Between the two bog cells, we recorded 57 total plant species, of which 50 were native. At Jenkins Bog, 48 of 53 species were native, and at Warner Bog 25 of 28 species were native (Table 4). At both bogs, mean species richness per plot was between 9 and 10 and mean wetland species richness was between 3 and 4 (Figure 1), though there was more variation at Jenkins than Warner (Table 5). At Jenkins, there was no difference between mean species richness or mean wetland species richness in the sand removal and no sand removal locations. At Warner, there were significantly more species per plot in the no sand removal area ( $p = 0.02$ ), and there were marginally more wetland species per plot in the no sand removal area ( $p = 0.08$ ).

Across all plots, wetland species, excluding cranberry, covered an average of 22.33 % of the area ( $\pm 3.65$  % standard error). The vegetation in the bogs is predominantly perennial (50 species) with five species of annuals and two species that can either be annual or short-lived perennial. Mean cranberry coverage ranged from 36.72% in the Warner no sand removal area to 59.94% in the Jenkins sand removal area. Although the areas slated for sand removal at both bogs had higher mean coverage of cranberry, the differences in cranberry coverage were not statistically significant at an alpha value of 0.05. Mean forb, graminoid, and tree coverage was low across all survey locations with cranberries and other vines, shrubs, and mosses covering more area (Table 6).

Table 4. List of species found in vegetation monitoring plots at Jenkins and Warner Bogs. Values indicate the number of plots in which the species was found, and species with an \* are non-native.

Species	Common Name	Life Form	# of Jenkins Plots (total 27)	Jenkins Mean % Cover	# of Warner Plots (total 18)	Warner Mean % Cover
<i>Acer rubrum</i>	Red maple	Tree	7	1.07	5	1.40
<i>Agrostis scabra</i>	Northern tickgrass	Graminoid	13	0.85	4	0.75
<i>Agrostis stolonifera</i> *	March bentgrass	Graminoid	0	0	1	0.50
<i>Andropogon glomeratus</i>	Bunched broom-sedge	Graminoid	8	5.75	15	1.83
<i>Andropogon virginicus</i>	Broom-sedge	Graminoid	9	0.89	0	0
<i>Apios americana</i>	Groundnut	Vine	0	0	1	0.50
<i>Aronia melanocarpa</i>	Black chokecherry	Shrub	5	0.50	18	33.56
<i>Bartonia virginica</i>	Screw-stem	Forb	3	0.50	8	0.50
<i>Bidens connata</i>	Swamp beggars-ticks	Forb	1	4.00	0	0
<i>Carex lurida</i>	Sallow sedge	Graminoid	1	1.50	0	0
<i>Carex scoparia</i>	Broom sedge	Graminoid	4	0.50	0	0
<i>Carex stricta</i>	Tussock-sedge	Graminoid	1	4.00	1	0.50
<i>Celastrus orbiculatus</i> *	Bittersweet	Vine	0	0	1	0.50
<i>Chamaedaphne calyculata</i>	Leatherleaf	Shrub	0	0	4	18.00
<i>Clethra alnifolia</i>	Sweet pepper-bush	Shrub	2	19.25	4	9.88
<i>Cuscuta gronovii</i>	Common dodder	Vine	2	0.50	0	0
<i>Cyperus dentatus</i>	Pondshore flatsedge	Graminoid	3	0.50	0	0
<i>Cyperus strigosus</i>	Straw-colored flatsedge	Graminoid	1	0.50	0	0
<i>Danthonia spicata</i>	Poverty oatgrass	Graminoid	1	0.50	0	0
<i>Dichanthelium acuminatum</i>	Pondshore panic-grass	Graminoid	7	0.64	2	0.50
<i>Dichanthelium clandestinum</i>	Deer-tongue	Graminoid	6	0.67	0	0
<i>Euthamia caroliniana</i>	Slender-leaved flat-topped goldenrod	Forb	5	0.70	6	0.50
<i>Euthamia graminifolia</i>	Grass-leaved flat-topped goldenrod	Forb	1	0.50	0	0
<i>Galium palustre</i>	Marsh-bedstraw	Forb	2	0.50	1	0.50
<i>Hieracium lachenalii</i> *	Common hawkweed	Forb	2	0.50	0	0
<i>Holcus lanatus</i> *	Velvet-grass	Graminoid	1	1.50	0	0
<i>Hypericum canadense</i>	Lesser St.-John's-wort	Forb	4	0.50	0	0
<i>Hypericum gentianoides</i>	Orange-grass St. John's wort	Forb	1	0.50	0	0
<i>Hypericum mutilum</i>	Dwarf St. John's-wort	Forb	2	0.50	0	0

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<i>Impatiens capensis</i>	Orange jewelweed	Forb	1	0.50	0	0
<i>Juncus canadensis</i>	Canada rush	Graminoid	1	0.50	0	0
<i>Juncus effusus</i>	Soft rush	Graminoid	3	7.17	1	0.50
<i>Juncus tenuis</i>	Path rush	Graminoid	5	0.70	0	0
<i>Leersia oryzoides</i>	Rice cut- grass	Graminoid	4	0.50	0	0
<i>Lemna minor</i>	Duckweed	Forb	2	2.75	0	0
<i>Ludwigia palustris</i>	Water purslane	Forb	2	2.25	0	0
<i>Lycopus uniflorus</i>	Northern water-horehound	Forb	2	1.00	0	0
<i>Lysimachia terrestris</i>	Swamp-candles	Forb	5	0.70	5	0.50
Moss		Moss	15	13.37	14	31.75
<i>Nuttallanthus canadensis</i>	Blue toadflax	Forb	1	0.50	0	0
<i>Nyssa sylvatica</i>	Black tupelo	Tree	1	0.50	2	0.50
<i>Onoclea sensibilis</i>	Sensitive fern	Forb	1	0.50	0	0
<i>Persicaria hydropiperoides</i>	False water-pepper smartweed	Forb	3	10.83	0	0
<i>Phalaris arundinaceae</i> *	Reed canary-grass	Graminoid	1	10.50	0	0
<i>Pinus rigida</i>	Pitch pine	Tree	9	4.78	6	1.42
<i>Rubus allegheniensis</i>	Common blackberry	Vine	2	10.50	0	0
<i>Rubus flagellaris</i>	Northern dewberry	Vine	15	13.80	7	45.64
<i>Rubus hispidus</i>	Bristly dewberry	Vine	21	19.19	6	39.92
<i>Rumex acetosella</i> *	Sheep sorrel	Forb	1	0.50	0	0
<i>Scirpus cyperinus</i>	Wool-grass	Graminoid	3	0.83	0	0
<i>Smilax glauca</i>	Glaucous-leaved greenbrier	Vine	2	10.50	12	6.79
<i>Smilax rotundifolia</i>	Common greenbrier	Vine	5	2.10	9	2.50
<i>Symphotrichum novi-belgii</i>	New York aster	Forb	3	0.50	8	4.38
<i>Toxicodendron radicans</i>	Poison-ivy	Shrub	15	5.07	15	10.73
<i>Vaccinium macrocarpon</i>	Large cranberry	Shrub	27	55.54	17	43.47
<i>Viburnum dentatum</i>	Northern arrow-wood	Shrub	1	0.50	2	0.50
<i>Viola lanceolata</i>	Lance-leaved violet	Forb	12	0.50	3	

\* Denotes non-native species

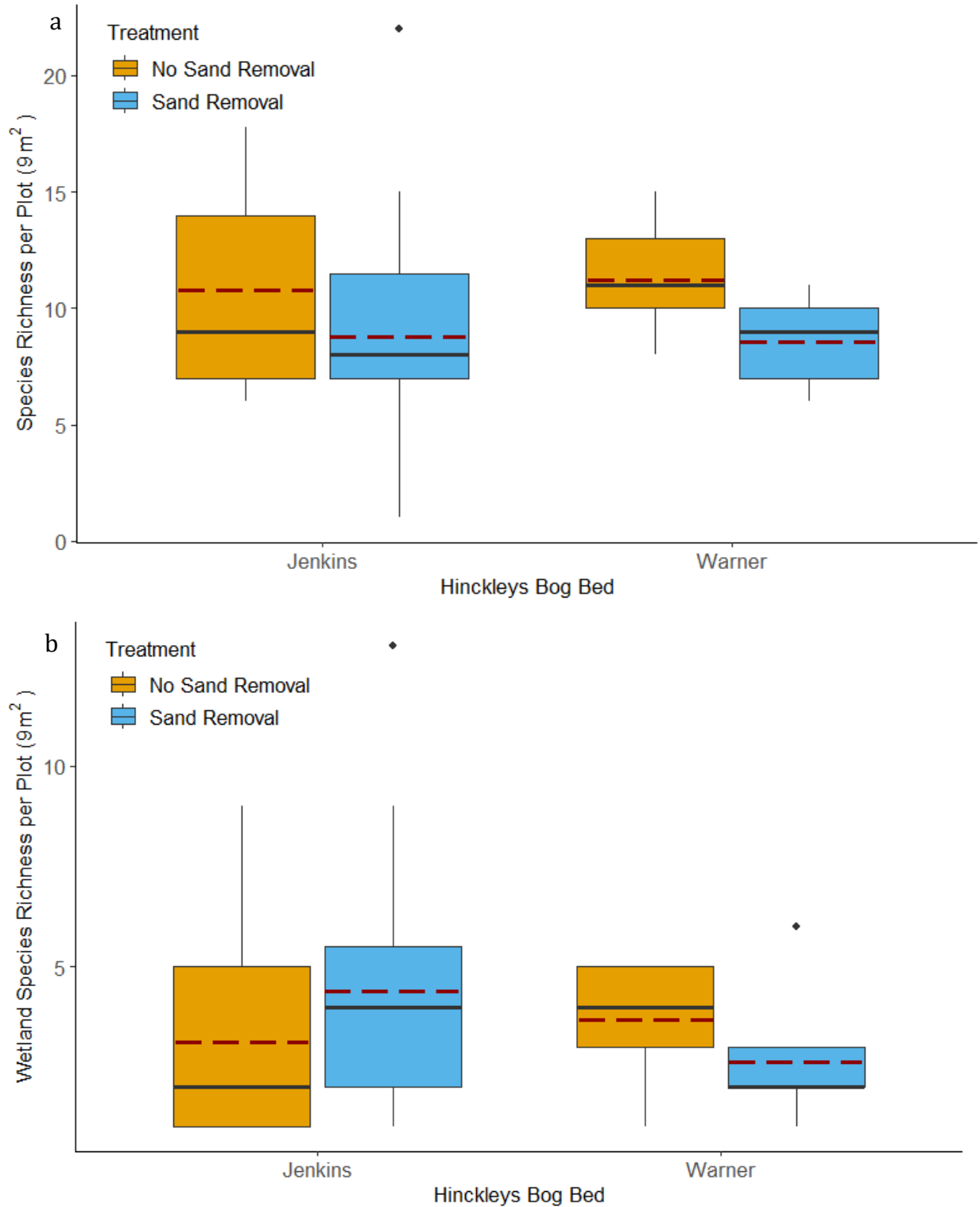


Figure 1. Per plot species richness (a) and wetland species richness (b) in areas slated for sand removal and no sand removal during restoration at Jenkins and Warner Bogs. Boxes show the middle 50% of the data. Horizontal black lines indicate the median value and dashed red lines indicate mean value within each box. Vertical black lines encompass additional data points up to 1.5 times the interquartile range. Outliers are indicated with individual points.

Table 5. Species richness, native species richness, wetland species richness, and percent cover across all vegetation survey plots at Jenkins and Warner Bogs. Mean ( $\pm$  standard error) species richness, wetland species richness, and wetland species cover from plots. Wetland species percent cover does not include cranberry.

	Species richness (native species richness)	% perennials	Mean species richness	Wetland species richness	Mean wetland species richness	Mean wetland species % cover
Overall	57 (50)	88	9.62 $\pm$ 0.6	29	4.36 $\pm$ 0.4	22.33 $\pm$ 3.65
Jenkins	53 (48)	87	9.44 $\pm$ 0.93	26	3.92 $\pm$ 0.62	22.14 $\pm$ 4.42
Jenkins sand removal	47 (43)	87	8.78 $\pm$ 1.19	25	4.38 $\pm$ 0.81	23.53 $\pm$ 5.64
Jenkins no sand removal	35 (32)	94	10.78 $\pm$ 1.43	13	3.11 $\pm$ 0.92	22.33 $\pm$ 7.44
Warner	28 (25)	96	9.89 $\pm$ 0.58	12	3.18 $\pm$ 0.38	26.47 $\pm$ 6.42
Warner sand removal	20 (19)	90	8.56 $\pm$ 0.63	8	2.63 $\pm$ 0.53	31.44 $\pm$ 11.12
Warner no sand removal	27 (23)	93	11.22 $\pm$ 0.78	11	3.67 $\pm$ 0.5	22.29 $\pm$ 7.43

Table 6. Mean percent cover ( $\pm$  standard error) of plant life forms in vegetation survey plots

	Mean cranberry % cover	Mean forb % cover	Mean graminoid % cover	Mean moss % cover	Mean shrub % cover	Mean tree % cover	Mean vine % cover
Overall				22.24 $\pm$	28.43 $\pm$		32.38 $\pm$
Jenkins	50.88 $\pm$ 3.2	3.4 $\pm$ 1.11	4.22 $\pm$ 1.71	4.83	4.69	2.7 $\pm$ 1.45	3.92
Jenkins sand removal	55.53 $\pm$	3.82 $\pm$ 1.69	5.95 $\pm$ 2.99	4.88	6.91 $\pm$ 2.87	3.64 $\pm$ 2.57	27.65 $\pm$ 4.1
Jenkins no sand removal	59.94 $\pm$	3.35 $\pm$ 1.97	7.83 $\pm$ 4.96	12.91 $\pm$	10 $\pm$ 4.63	4.6 $\pm$ 3.61	26.9 $\pm$ 4.98
Warner	46.72 $\pm$	4.83 $\pm$ 3.46	3.13 $\pm$ 0.99	8.82	2.5 $\pm$ 1.43	1.25 $\pm$ 0.32	7.49
Warner sand removal	43.47 $\pm$	2.91 $\pm$ 1.41	2.06 $\pm$ 0.73	31.75 $\pm$	48.75 $\pm$	1.5 $\pm$ 0.42	39.06 $\pm$
Warner no sand removal	51.06 $\pm$	3.86 $\pm$ 2.95	1.57 $\pm$ 0.53	7.96	5.29	0.75 $\pm$ 0.25	7.34
	7.70			45.42 $\pm$	48.17 $\pm$		37.63 $\pm$
	36.72 $\pm$	2.17 $\pm$ 1.18	2.44 $\pm$ 1.25	10.88	6.69		9.95
	8.65			21.5 $\pm$	49.33 $\pm$		40.33 $\pm$
				10.35	8.62	1.93 $\pm$ 0.59	11.22

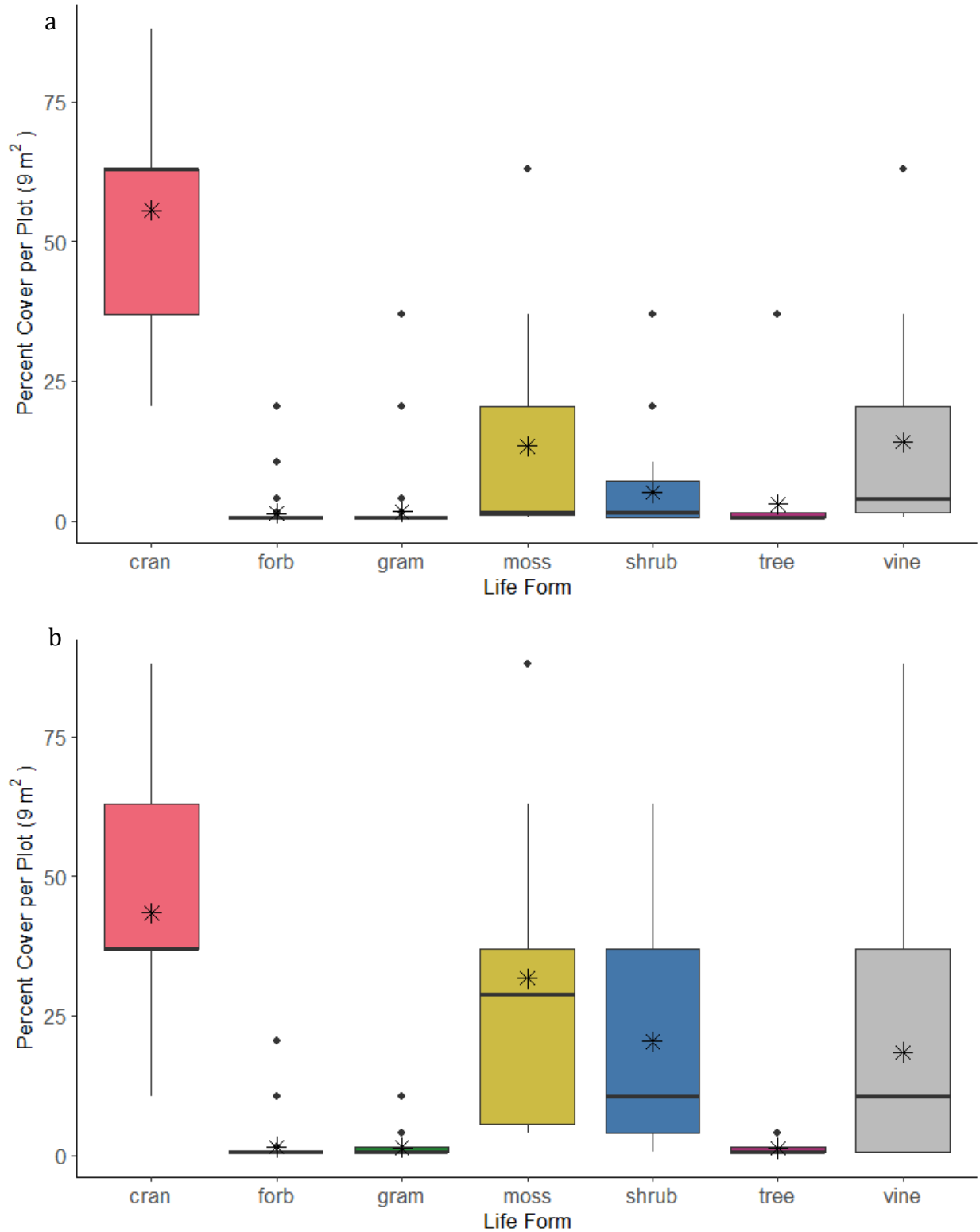


Figure 2. Per plot percent cover of plant life forms at (a) Jenkins and (b) Warner Bogs. Boxes show the middle 50% of the data. Horizontal black lines indicate the median value and stars indicate mean value within each box. Vertical black lines encompass additional data points up to 1.5 times the interquartile range. Outliers are indicated with individual points. 'Cran' = cranberry; 'gram' = graminoid.

#### 4.1.2 Photographic Survey

This section provides a comparative record of photographs and notes taken as part of this monitoring program. At present, the results of the pre-restoration photographic survey are provided. The presence or absence of invasive plant species as well as other common vegetation are provided in Table 7. Refer to Tables 8 to 20 for photographs taken at each photo monitoring station.

Table 7. Invasive plant species and other vegetation present at transitional and upland zone photo stations

Photo Station	Bog	Invasive Species Present	Non-invasive Species Present
1	Jenkins	No	<i>Cichorium intybus</i> (non-native), <i>Toxicodendron radicans</i> , <i>Agrostis scabra</i> , <i>Solidago rugosa</i> , <i>Rosa virginiana</i>
2	Jenkins	Yes ( <i>Celastrus orbiculatus</i> )	<i>Smilax rotundifolia</i> , <i>Clethra alnifolia</i> , <i>Euthamia caroliniana</i> , <i>Toxicodendron radicans</i> , <i>Rubus flagellaris</i> , <i>Pteridium aquilinum</i> , <i>Quercus velutina</i> , <i>Pinus rigida</i> , <i>Acer rubrum</i> , <i>Prunus serotina</i>
3	Jenkins	Yes ( <i>Phalaris arundinaceae</i> )	<i>Toxicodendron radicans</i> , <i>Agrostis scabra</i> , <i>Juncus effusus</i> , <i>Symphotrichum novi-belgii</i>
4	Jenkins	No	Low maintained vegetation, <i>Egarostis spectabilis</i> , <i>Agrostis sp.</i>
5	Jenkins	No	<i>Prunus serotina</i> , <i>Agrostis scabra</i> , <i>Alnus sp.</i>
6	Jenkins	No	<i>Toxicodendron radicans</i> , <i>Rubus flagellaris</i> , <i>Smilax glauca</i> , <i>Agrostis scabra</i>
7	Jenkins	No	<i>Erigeron canadense</i> , <i>Agrostis scabra</i> , <i>Smilax glauca</i> , <i>Rubus flagellaris</i>
8	Jenkins	No	<i>Agrostis stolonifera</i> , <i>Toxicodendron radicans</i> , <i>Euthamia graminifolia</i> , <i>Rubus flagellaris</i>
9	Warner	No	<i>Pinus rigida</i> , <i>Andropogon virginicus</i> , <i>Quercus velutina</i> , <i>Erigeron canadense</i>
10	Warner	No	Mowed, <i>Smilax rotundifolia</i> , <i>Rubus flagellaris</i> , <i>Hieracium caespitosum</i> (non-native), <i>Andropogon virginicus</i>
11	Warner	No	<i>Rubus flagellaris</i> , <i>Sympyotrichum novi-belgii</i> , <i>Glyceria canadensis</i> , <i>Smilax glauca</i>
12	Warner	Yes ( <i>Phalaris arundinaceae</i> )	<i>Agrostis scabra</i> , <i>Andropogon virginicus</i> , <i>Panicum dichotomiflorum</i>
13	Warner	No	<i>Toxicodendron radicans</i> , <i>Agrostis stolonifera</i> , <i>Rosa virginiana</i> , <i>Parthenocissus quinquefolia</i>

## 5 Discussion

This monitoring report describes the methods and results of a vegetation survey completed prior to ecological restoration activities expected to occur in 2025. The site and plot level species richness are within the same range as many other recently retired cranberry bogs (Neill et al. 2023, Klionsky et al. *in review*), but many factors influence species richness, including location in the landscape, soil moisture, propagule pressure, and disturbance. Farm ditches are likely refugia for species that cannot survive on the farmed bed (Klionsky et al. *in review*, Neill, *pers. comm.*), so vegetation plots that are located closer to ditches may have higher species richness and account for some of the variability we see in the data. Here, the goal of the monitoring is to compare the vegetation within sites before restoration and then after restoration, so there will be no effect of inter-site variation. Additionally, monitoring will evaluate the impact of two different restoration treatments on the growth of vegetation: microtopography following some sand removal and microtopography with no sand removal. Once the post-restoration vegetation monitoring has been completed, those data will be analyzed in a revised monitoring report. In the revised monitoring report, we will use this Discussion section to evaluate the trends observed in the pre- and post-restoration data for each bog as well as for the areas of different restoration treatments.

Table 8. Jenkins Bog, Photo Station 1

ID	Pre-Restoration (2024)
1	

Table 9. Jenkins Bog, Photo Station 2

ID	Pre-Restoration (2024)
2	
North	
East	
South	
West	

Table 10. Jenkins Bog, Photo Station 3

ID	Pre-Restoration (2024)
3	
North	
East	
South	
West	

Table 11. Jenkins Bog, Photo Station 4






ID	Pre-Restoration (2024)
4	
North	
East	
South	
West	

Table 12. Jenkins Bog, Photo Station 5

ID	Pre-Restoration (2024)
5	

Table 13. Jenkins Bog, Photo Station 6


ID	Pre-Restoration (2024)
6	
North	
East	
South	
West	

Table 14. Jenkins Bog, Photo Station 7




ID	Pre-Restoration (2024)
7	
North	
East	
South	
West	

Table 15. Jenkins Bog, Photo Station 8

ID	Pre-Restoration (2024)
8	
North	
East	
South	
West	

Table 16. Warner Bog, Photo Station 9

ID	Pre-Restoration (2024)
9	
North	
East	
South	
West	

Table 17. Warner Bog, Photo Station 10

ID	Pre-Restoration (2024)
10	

Table 18. Warner Bog, Photo Station 11

ID	Pre-Restoration (2024)
11	
North	
East	
South	
West	

Table 19. Warner Bog, Photo Station 12






ID	Pre-Restoration (2024)
12	
North	
East	
South	
West	

Table 20. Warner Bog, Photo Station 13

ID	Pre-Restoration (2024)
13	
	<p><i>*Stake in photo is incorrectly labeled. The correct Photo Station ID is PS13.</i></p>
North	
East	
South	
West	

## 6 Works Cited

Haines, A. (2011) *New England Wild Flower Society's Flora Novae Angliae: a manual for the identification of native and naturalized higher vascular plants of New England*. Yale University Press.

Klionsky, S.M, Neill, C., Pulak, A.M, and B. Lawrence. Hydrologic restoration of retired cranberry farms leads to species rich wetlands. *In Review*.

Neill, C., Pulak A.M., Miller, H.J., Hoekstra, B.R., and S.M. Klionsky. (2023). Trajectories of plant communities in Massachusetts, USA cranberry farms discontinued from agriculture. *Wetlands Ecology and Management* 31. 697-713.

R Core Team (2024) 'R: A Language and Environment for Statistical Computing'. Vienna, Austria: R Foundation for Statistical Computing. Available at: <https://www.r-project.org/>.

U.S. Army Corps of Engineers 2020. National Wetland Plant List, version 3.5. Available at: <http://wetland-plants.usace.army.mil/>

## Appendix A: Vegetation Monitoring Maps



**Vegetation Monitoring Plots**

- sand removal
- no sand removal

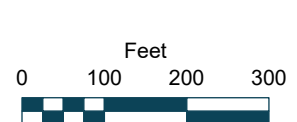
★ Photo Stations

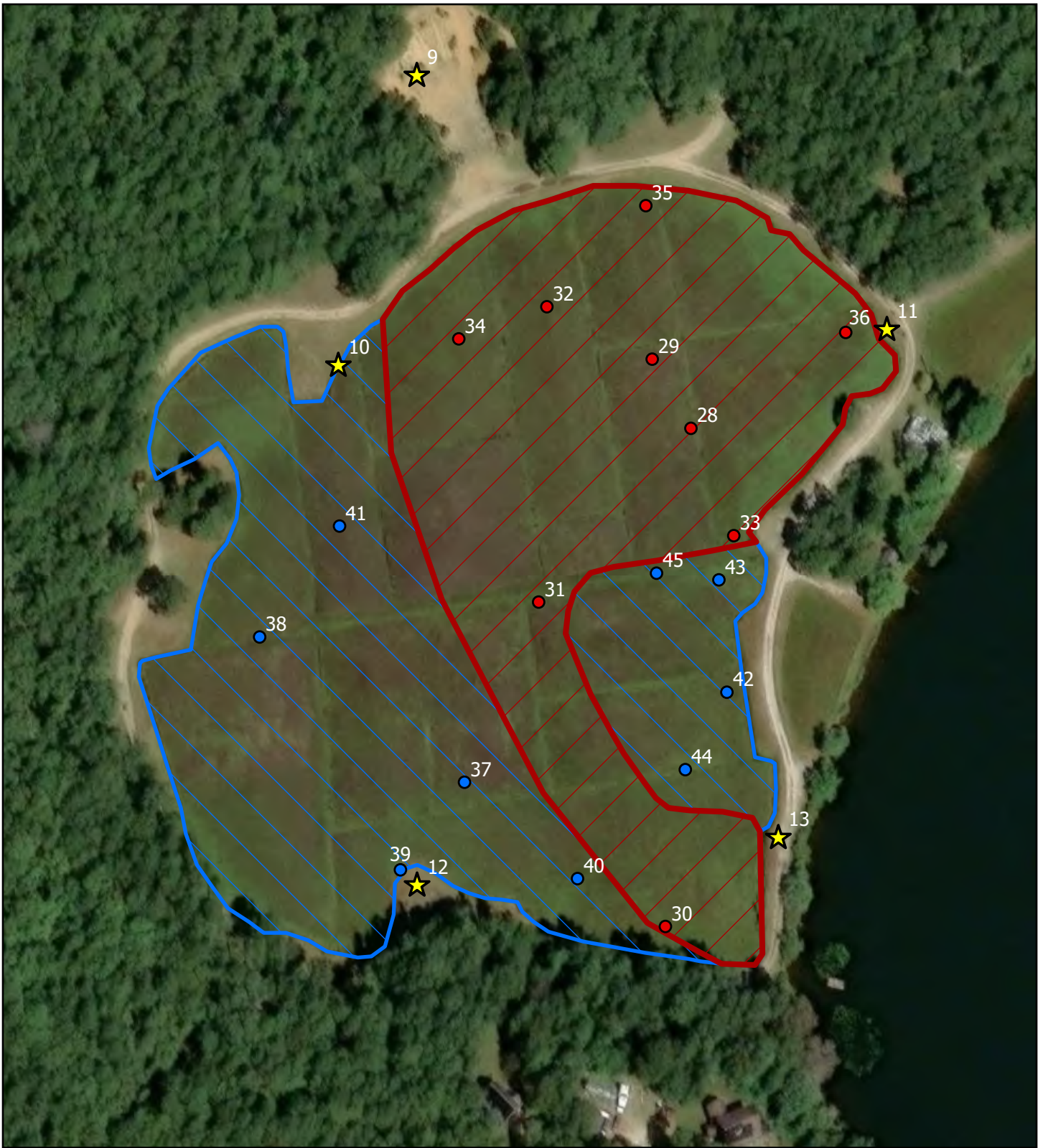
- sand removal
- no sand removal

Coordinate System: NAD 1983  
State Plane Massachusetts

**Vegetation Monitoring Map**

Jenkins Bog  
Harwich, MA





**Vegetation Monitoring Plots**

- sand removal
- no sand removal

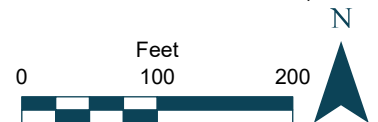
★ Photo Stations

- sand removal
- no sand removal

Coordinate System: NAD 1983  
State Plane Massachusetts

**Vegetation Monitoring Map**

Warner Bog  
Brewster & Harwich, MA



## Appendix B: Vegetation Monitoring Plot Photographs

VEGETATION MONITORING PLOT PHOTOGRAPHS

Table 1. Jenkins Bog, Sand Removal

Plot	Pre-Restoration (2024)
1	
2	
3	
4	
5	
6	

VEGETATION MONITORING PLOT PHOTOGRAPHS

7



8



9



10



11



12



VEGETATION MONITORING PLOT PHOTOGRAPHS

13



14



15



16



17









18



VEGETATION MONITORING PLOT PHOTOGRAPHS

Table 2. Jenkins Bog, No Sand Removal

Plot	Pre-Restoration (2024)
19	
20	
21	
22	
23	
24	

VEGETATION MONITORING PLOT PHOTOGRAPHS

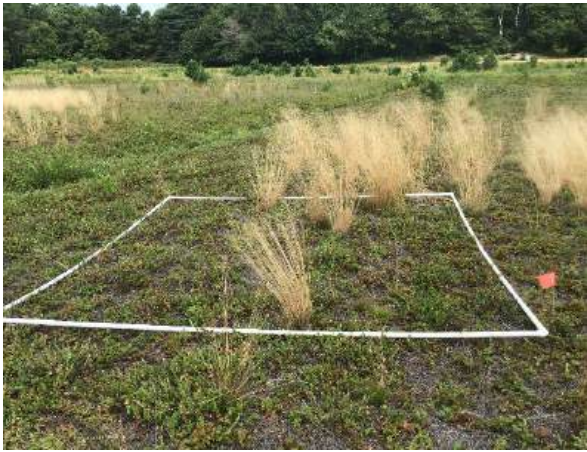
25



26



27



VEGETATION MONITORING PLOT PHOTOGRAPHS

Table 3. Warner Bog, Sand Removal

Plot	Pre-Restoration (2024)
28	
29	
30	
31	
32	
33	

VEGETATION MONITORING PLOT PHOTOGRAPHS

34



35









36



VEGETATION MONITORING PLOT PHOTOGRAPHS

Table 4. Warner Bog, No Sand Removal

Plot	Pre-Restoration (2024)
37	
38	
39	
40	
41	
42	

VEGETATION MONITORING PLOT PHOTOGRAPHS

43



44



45

