Post-Restoration Vegetation and Water Level Monitoring Report

Post-Restoration, Year 1 (2025)

Hinckleys Pond – Herring River Headwaters Eco-Restoration Project

Jenkins Bog and Warner Bog

Harwich, Massachusetts

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Executive Summary

This Year 1 Post-Restoration Vegetation and Water Level Monitoring Report summarizes monitoring protocols, the establishment of and adherence to long-term monitoring plots, and results of the post-restoration vegetation monitoring for the ecological restoration project associated with the retired cranberry bogs adjacent to Hinckleys Pond in Harwich, Massachusetts. Jenkins Bog is located to the southeast of Hinckleys Pond in Harwich and was last harvested in the fall of 2020.Warner Bog is located to the west of Hinckleys Pond in Harwich and Brewster and was last harvested in the fall of 2021.

Inter-Fluve conducted post-restoration monitoring activities in August of 2025 at the retired Jenkins and Warner Bogs. Inter-Fluve conducted a baseline pre-restoration vegetation survey in August of 2024 following the same methodology. This report compares the pre- and post-restoration vegetation communities.

Pre- and post-restoration 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
- installation of groundwater and surface water wells for water level monitoring

Prior to restoration in August of 2024, we found 58 plant species across the two bogs. Of those 58, 50 species were native and 29 were wetland adapted. Jenkins Bog was more species rich than Warner Bog. Earthwork in the bogs began in late March 2025 and was completed by mid-June 2025, with trail and other infrastructure work completed by mid-September 2025. Following the restoration earthwork in the bogs, we found 91 plant species within the monitoring plots in August 2025, of which 73 were native and 44 were wetland adapted. Jenkins Bog remained more species rich than Warner Bog. At both bogs, there was no statistically significant difference in vegetation composition between areas of microtopography with sand removal and without sand removal. Groundwater and surface water levels remained similar for pre- and post-restoration monitoring.

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1 Introduction

The Jenkins and Warner Bogs were 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 2020 and Warner Bog last harvested around 2021. 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. Pre-restoration, 1.5 to 2 feet of sand placed by the farmers lay 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).

The Harwich Conservation Trust (HCT) retained Inter-Fluve, Inc. (Inter-Fluve) in 2021 to provide data collection including water level monitoring, 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. Construction began on the site in March 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). The Association to Preserve Cape Cod (APCC) retained Inter-Fluve in August of 2024 to provide pre-restoration vegetation monitoring and reporting services of the retired Jenkins and Warner Bogs. In June of 2025, APCC retained Inter-Fluve for year one of post-restoration monitoring. Inter-Fluve conducted its first year of post-restoration vegetation monitoring in August of 2025 and water level monitoring in September to December of 2025. This monitoring report summarizes the methods and results of this year's post-restoration vegetation and water level 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. The bogs were surveyed again in August of 2025 to assess the post-restoration vegetation. 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. Monitoring vegetation before and after restoration allows for analysis of changes in pre- and post-restoration conditions. Inter-Fluve also installed groundwater and surface water wells in August of 2025 to monitor water levels. Vegetation and water level monitoring provides 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. We will not compare data from Jenkins Bog with data from Warner Bog, rather we will compare 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

Monitoring Phase	Vegetation Survey	Photographic Survey	Water Level Monitoring Period	Monitoring Report Submitted
Pre-Restoration	08/08/2024, 08/12/2024, 08/13/2024	08/13/2024	01/21/2022 to 09/3/2022	December 2024
Post-Restoration	08/25/2025, 08/26/2025, 08/27/2025, 08/28/2025, 08/29/2025	10/22/2025	09/04/2025 to 12/15/2025	January 2026

2 Methodology

2.1 Vegetation Survey

To evaluate the state of the pre- and post-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.

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

**Plot 37 relocated 10 feet in the westerly direction due to conflict with constructed boardwalk, post-restoration*

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 (Appendix B).

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. All treatment comparisons of sand removal and no sand removal in both bogs that are based on species richness (total or wetland) were done using a Kruskal-Wallis non-parametric means comparison. Wetland cover in both bogs was compared using ANOVA. 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 and installed a wooden stake. 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; and Appendix D provides the photos.

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.

2.3 Water Level Loggers

Inter-Fluve deployed seven Onset Hobo U-20L data loggers at locations shown in Appendix C. The installation, maintenance, quality assurance and quality control (QA/QC) follow the protocols developed in the Quality Assurance Project Plan (QAPP, Inter-Fluve, 2022). The hobo loggers record pressure and temperature every 15 minutes and are used to monitor the water levels of the pond, surface water within the bog ditches, and groundwater within wells placed in the bogs. An eighth logger was deployed to log atmospheric pressure which was used to correct the water level data. Data was downloaded periodically throughout the monitoring period. Water surface elevations were collected at each download for calibration purposes. Table 4 provides the GPS coordinates of the loggers.

Table 4. Coordinates of water level loggers.

Logger	Bog	Northing (US Feet)	Easting (US Feet)
JGW1	Jenkins	2722471.151	1043522.657
JGW2	Jenkins	2722195.434	1044048.281
JS1	Jenkins	2722300.149	1043753.745
JP1	Jenkins	2722565.797	1042981.788
WGW1	Warner	2724349.453	1038909.331
WS1	Warner	2724562.912	1038827.051
WP1	Warner	2724385.814	1039268.33

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

3 Data Collection

3.1 Pre-Restoration Monitoring

3.1.1 Vegetation Survey (2024)

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 (2024)

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 Appendix A for maps of the photo station locations.

3.1.3 Water Level Monitoring (2022)

On January 21, 2022, Inter-Fluve installed seven Onset Hobo U-20L water level loggers at Jenkins and Warner Bogs in accordance with the QAPP (Inter-Fluve, 2022). Data were collected periodically until the loggers were removed

on September 3, 2022. Refer to section 4.2.1 for results of the water level monitoring and to Appendix C for maps of water level logger locations.

3.2 Post-Restoration Monitoring

3.2.1 Vegetation Survey (2025)

On August 25, 2025 through August 28, 2025, Inter-Fluve conducted the Post-Restoration vegetation survey at the monitoring plots in Jenkins Bog. Refer to Section 4.1.2 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 28, 2025 and August 29, 2025, Inter-Fluve conducted the Post-Restoration vegetation survey at the monitoring plots in Warner Bog. Refer to Section 4.1.2 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.

Inter-Fluve used the same plot locations as those surveyed in the 2024 Pre-Restoration vegetation survey. These plots were surveyed using RTK GPS and were marked with pin flags in their southeast corner. Refer to Appendix A for maps of the plot locations.

3.2.2 Photographic Survey (2025)

Following completion of restoration activities, Inter-Fluve collected photographs from the same photo station locations on October 22, 2025. Refer 4.2.3 for results of the photographic survey and to Appendix A for maps of the photo station locations.

3.2.3 Water Level Monitoring (2025)

On September 4, 2025, Inter-Fluve installed groundwater and surface water level loggers in the retired Jenkins and Warner Bogs. Logger data were retrieved on December 15, 2025. Refer to 4.2.2 for results of the water level monitoring and to Appendix C for maps of water level logger locations.

Inter-Fluve installed loggers in the same general locations as those used in 2022. The logger locations were surveyed using RTK GPS according to the QAPP protocols (Inter-Fluve, 2022).

4 Results

4.1 Vegetation Survey

4.1.1 Pre-Restoration (2024)

During pre-restoration monitoring, we recorded 57 total plant species between the two bogs, of which 50 were native. At Jenkins Bog, 48 of 53 species were native, and at Warner Bog 25 of 28 species were native. 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. 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 (± 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 (Figure 2).

4.1.2 Post-Restoration (2025)

This report summarizes the post-restoration vegetation monitoring. Between the two bog cells, we recorded 91 total plant species, of which 73 were native. At Jenkins Bog, 66 of 80 species were native, and at Warner Bog, 46 of 52 species were native (Table 5, Table 6). At both bogs, mean species richness per plot was between 21 and 23, and mean wetland species richness was between 12 and 13 (Table 7); these values are more than double what we observed in the pre-restoration monitoring (Figure 1). At both Jenkins and Warner, there was no significant difference between species richness or mean wetland species richness in the sand removal and no sand removal locations. At both Jenkins and Warner, mean bare ground % cover was higher in areas without sand removal (Table 8), which may reflect reduced ground disturbance and persistence of existing rooted vegetation. Drought conditions during the post-restoration monitoring period likely constrained vegetation establishment, and limited infilling was observed across treatments. Consequently, treatment-related differences may become more evident with additional monitoring over time.

Across all plots, wetland species, excluding cranberry, covered 42.83 % of the area (± 3.43 % standard error), a 20 % increase from the pre-restoration wetland species % cover. The percentage of species that are perennial decreased from 88 % to 71 % following restoration. Overall mean cranberry coverage decreased significantly from 50 % in the pre-restoration data to less than 2 % in the post-restoration data. Mean forb and graminoid coverage increased in the post-restoration survey at both Jenkins and Warner Bog while moss, shrub, tree, and vine % cover decreased. Graminoids had the highest mean % cover per plot of all life forms with 50 % at Jenkins and 29 % at Warner Bog (Table 8). At both sites, the mean % cover per plot of bare ground increased from less than 2 % to over 40 % (Figure 2).

*Table 5. List of species found in vegetation monitoring plots at Jenkins Bog pre- and post-restoration. Values indicate the number of plots in which the species was found, and species with an * are non-native. Species are ordered by the number of plots in which they occurred post-restoration. Mean % cover is averaged across the plots where the species was found.*

Species	Common Name	Life Form	# of Jenkins Plots Pre-Restoration (total 27)	Jenkins Mean % Cover Pre-Restoration	# of Jenkins Plots Year 1 Post-Restoration (total 27)	Jenkins Mean % Cover Year 1 Post-Restoration
Cyperus dentatus	Pondshore flatsedge	Graminoid	3	0.5	27	16.69
Juncus canadensis	Canada rush	Graminoid	1	0.5	26	7.79
Hypericum mutilum	Dwarf St. John's-wort	Forb	2	0.5	24	0.58
Vaccinium macrocarpon	Large cranberry	Shrub	27	55.54	24	0.81
Viola lanceolata	Lance-leaved violet	Forb	12	0.5	24	1.42
Panicum virgatum	Switchgrass	Graminoid	0	0	21	6.92
Cyperus strigosus	Straw-colored flatsedge	Graminoid	1	0.5	20	1.25
Ludwigia palustris	Water purslane	Forb	2	2.25	18	2.47
Panicum dichotomuflanium	Fall Panic-grass	Graminoid	0	0	18	7.33
Hypericum canadense	Lesser St.-John's-wort	Forb	4	0.5	17	0.5
Rubus hispidus	Bristly dewberry	Vine	21	19.19	17	3.36
Dichanthelium acuminatum	Pondshore panic-grass	Graminoid	7	0.64	16	0.84
Juncus tenuis	Path rush	Graminoid	5	0.7	16	0.56
Agrostis scabra	Northern tickgrass	Graminoid	13	0.85	15	1.2
Toxicodendron radicans	Poison-ivy	Shrub	15	5.07	15	1.57
Acer rubrum	Red maple	Tree	7	1.07	14	0.5
*Salix cinerea ssp. Cinerea**	Gray Willow	Tree	0	0	13	0.77
Carex scoparia	Broom sedge	Graminoid	4	0.5	12	0.83
Nuttallanthus canadensis	Blue toadflax	Forb	1	0.5	12	0.79
Rubus flagellaris	Northern dewberry	Vine	15	13.8	12	3.45
Hypericum gentianoides	Orange-grass St. John's wort	Forb	1	0.5	11	0.5
Scirpus cyperinus	Wool-grass	Graminoid	3	0.83	11	1.09
Dichanthelium clandestinum	Deer-tongue	Graminoid	6	0.67	10	1.05
*Echinochloa crus-galli**	Common barnyard grass	Graminoid	0	0	10	16.1

Species	Common Name	Life Form	# of Jenkins Plots Pre-Restoration (total 27)	Jenkins Mean % Cover Pre-Restoration	# of Jenkins Plots Year 1 Post-Restoration (total 27)	Jenkins Mean % Cover Year 1 Post-Restoration
Eleocharis obtusa	Soft-stemmed Spike-rush	Graminoid	0	0	10	4.9
Euthamia caroliniana	Slender-leaved flat-topped goldenrod	Forb	5	0.7	10	0.8
Moss		Moss	15	13.37	9	0.61
Andropogon glomeratus	Bunched broom-sedge	Graminoid	8	5.75	8	1.753
Galium palustre	Marsh-bedstraw	Forb	2	0.5	8	0.5
Lysimachia terrestris	Swamp-candles	Forb	5	0.7	8	0.75
Persicaria hydropiperoides	False water-pepper smartweed	Forb	3	10.83	8	3
Leersia oryzoides	Rice cut-grass	Graminoid	4	0.5	7	0.64
*Persicaria maculosa**	Lady's thumb	Forb	0	0	7	0.93
Sagittaria latifolia	Common arrowhead	Forb	0	0	6	1.25
Lindernia dubia	False Pimpernel	Forb	0	0	5	0.9
Smilax rotundifolia	Common greenbrier	Vine	5	2.1	5	0.5
Ambrosia artemisiifolia	Ragweed	Forb	0	0	4	1
Bidens connata	Swamp beggars-ticks	Forb	1	4	4	0.75
Lycopus virginicus	Virginia water-horehound	Forb	0	0	4	0.75
*Rumex acetosella **	Sheep sorrel	Forb	1	0.5	4	2.25
Sparganium americanum	Common Bur-reed	Forb	0	0	4	0.75
Symphyotrichum novi-belgii	New York aster	Forb	3	0.5	4	0.5
Triadenum virginicum	Marsh St. John's-wort	Forb	0	0	4	0.5
Aronia melanocarpa	Black chokecherry	Shrub	5	0.5	3	0.5
Chamaecyparis thyoides	Atlantic White Cedar	Tree	0	0	3	0.5
Cuscuta gronovii	Common dodder	Vine	2	0.5	3	0.83
Eleocharis acicularis	Little Spike-rush	Graminoid	0	0	3	22.5

Species	Common Name	Life Form	# of Jenkins Plots Pre-Restoration (total 27)	Jenkins Mean % Cover Pre-Restoration	# of Jenkins Plots Year 1 Post-Restoration (total 27)	Jenkins Mean % Cover Year 1 Post-Restoration
Erechtites hieraciifolius	American Burnweed, Pilewort	Forb	0	0	3	0.5
*Leontodon spp.**	Hawkbit	Graminoid	0	0	3	0.5
*Lolium perenne**	Perennial rye grass	Graminoid	0	0	3	0.83
Smilax glauca	Glaucous-leaved greenbrier	Vine	2	10.5	3	1.66
Apios americana	Groundnut	Vine	0	0	2	0.5
Carex stricta	Tussock-sedge	Graminoid	1	4	2	2.25
*Celastrus orbiculatus **	Bittersweet	Vine	0	0	2	0.5
Danthonia spicata	Poverty oatgrass	Graminoid	1	0.5	2	0.5
*Digitaria sanguinalis**	Large Crab-grass	Graminoid	0	0	2	1
Euthamia graminifolia	Grass-leaved flat-topped goldenrod	Forb	1	0.5	2	0.5
Gratiola aurea	Golden pert	Forb	0	0	2	0.5
Juncus greenei	Greene's Rush	Graminoid	0	0	2	0.5
Juncus spp.	Rush	Graminoid	0	0	2	2.75
Muhlenbergia schreberia	Nimblewill Muhly	Graminoid	0	0	2	0.5
Persicaria hydropiper	Water-pepper	Forb	0	0	2	12.25
Persicaria pensylvanica	Pennsylvania Smartweed	Forb	0	0	2	7.25
Phytolacca americana	Pokeweed	Forb	0	0	2	0.5
Bartonia virginica	Screw-stem	Forb	3	0.5	1	37
Callitriche spp.	Starwort Species	Forb	0	0	1	1.5
Carex lurida	Sallow sedge	Graminoid	1	1.5	1	0.5
Clethra alnifolia	Sweet pepper-bush	Shrub	2	19.25	1	0.5
Cuscata spp.	Dodder Species	Vine	0	0	1	0.5
Cyperus lupulinus	Great Plains Flatsedge	Graminoid	0	0	1	4
Drosera intermedia	Spatulate-leaved Sundew	Forb	0	0	1	1.5
*Erigeron canadensis**	Canada horseweed	Forb	0	0	1	0.5
Eutrochium dubium	Atlantic Joe-Pye-weed	Forb	0	0	1	0.5

Species	Common Name	Life Form	# of Jenkins Plots Pre-Restoration (total 27)	Jenkins Mean % Cover Pre-Restoration	# of Jenkins Plots Year 1 Post-Restoration (total 27)	Jenkins Mean % Cover Year 1 Post-Restoration
*Fallopia scandens**	Climbing False Buckwheat	Vine	0	0	1	0.5
Lycopus uniflorus	Northern water-horehound	Forb	2	1	1	0.5
*Mollugo verticillata**	Green carpetweed	Graminoid	0	0	1	0.5
Nyssa sylvatica	Black tupelo	Tree	1	0.5	1	0.5
Parthenocissus quinquefolia	Virginia creeper	Vine	0	0	1	0.5
*Phalaris arundinaceae **	Reed canary-grass	Graminoid	1	10.5	1	1.5
Smilax spp.	Greenbrier	Vine	0	0	1	0.5
Andropogon virginicus	Broom-sedge	Graminoid	9	0.89	0	0
*Hieracium lachenalii **	Common hawkweed	Forb	2	0.5	0	0
*Holcus lanatus **	Velvet-grass	Graminoid	1	1.5	0	0
Impatiens capensis	Orange jewelweed	Forb	1	0.5	0	0
Juncus effusus	Soft rush	Graminoid	3	7.17	0	0
Lemna minor	Duckweed	Forb	2	2.75	0	0
Onoclea sensibilis	Sensitive fern	Forb	1	0.5	0	0
Pinus rigida	Pitch pine	Tree	9	4.78	0	0
Rubus allegheniensis	Common blackberry	Vine	2	10.5	0	0
Viburnum dentatum	Northern arrow-wood	Shrub	1	0.5	0	0

* Denotes non-native species

*Table 6. List of species found in vegetation monitoring plots at Warner Bogs pre- and post-restoration. Values indicate the number of plots in which the species was found, and species with an * are non-native. Species are ordered by the number of plots in which they occurred post-restoration. Mean % cover is averaged across the plots where the species was found.*

Species	Common Name	Life Form	# of Warner Plots Pre-Restoration (total 18)	Warner Mean % Cover Pre-Restoration	# of Warner Plots Year 1 Post-Restoration (total 18)	Warner Mean % Cover Year 1 Post-Restoration
Cyperus dentatus	Pondshore flatsedge	Graminoid	0	0	18	16.5
Aronia melanocarpa	Black chokecherry	Shrub	18	33.56	17	10.56
Juncus tenuis	Path rush	Graminoid	0	0	17	0.62
Juncus canadensis	Canada rush	Graminoid	0	0	16	3.34
Viola lanceolata	Lance-leaved violet	Forb	3		16	2.59
Euthamia caroliniana	Slender-leaved flat-topped goldenrod	Forb	6	0.5	15	0.73
Cyperus strigosus	Straw-colored flatsedge	Graminoid	0	0	14	2.64
Hypericum canadense	Lesser St.-John's-wort	Forb	0	0	14	0.64
Ludwigia palustris	Water purslane	Forb	0	0	14	0.64
Rubus hispidus	Bristly dewberry	Vine	6	39.92	14	2.18
Andropogon glomeratus	Bunched broom-sedge	Graminoid	15	1.83	13	0.73
Carex scoparia	Broom sedge	Graminoid	0	0	13	0.92
Dichanthelium acuminatum	Pondshore panic-grass	Graminoid	2	0.5	13	1.19
Hypericum mutilum	Dwarf St. John's-wort	Forb	0	0	13	0.58
Persicaria hydropiperoides	False water-pepper smartweed	Forb	0	0	13	2.92
Vaccinium macrocarpon	Large cranberry	Shrub	17	43.47	13	3.88
Agrostis scabra	Northern tickgrass	Graminoid	4	0.75	12	0.58
Moss		Moss	14	31.75	11	5.54
Smilax glauca	Glaucous-leaved greenbrier	Vine	12	6.79	11	4.72
*Echinochloa crus-galli**	Common barnyard grass	Grass	0	0	10	2.55
Panicum dichotomuflanium	Fall Panic-grass	Graminoid	0	0	10	2.85
Toxicodendron radicans	Poison-ivy	Shrub	15	10.73	10	8.5
Rubus flagellaris	Northern dewberry	Vine	7	45.64	8	5.87

Species	Common Name	Life Form	# of Warner Plots Pre-Restoration (total 18)	Warner Mean % Cover Pre-Restoration	# of Warner Plots Year 1 Post-Restoration (total 18)	Warner Mean % Cover Year 1 Post-Restoration
Triadenum virginicum	Marsh St. John's-wort	Forb	0	0	8	0.63
Acer rubrum	Red maple	Tree	5	1.4	7	0.5
Juncus greenei	Greene's Rush	Graminoid	0	0	6	0.5
Panicum virgatum	Switchgrass	Graminoid	0	0	6	1.41
Phytolacca americana	Pokeweed	Forb	0	0	6	0.83
Eleocharis acicularis	Little Spike-rush	Graminoid	0	0	5	0.9
Smilax rotundifolia	Common greenbrier	Vine	9	2.5	5	0.9
Eupatorium Perfoliatum	Boneset thoroughwort	Forb	0	0	4	0.5
Euthamia graminifolia	Grass-leaved flat-topped goldenrod	Forb	0	0	4	1.38
Lysimachia terrestris	Swamp-candles	Forb	5	0.5	4	0.75
Nuttallanthus canadensis	Blue toadflax	Forb	0	0	4	0.5
*Salix cinerea ssp. Cinerea**	Gray Willow	Tree	0	0	4	0.5
Carex stricta	Tussock-sedge	Graminoid	1	0.5	3	0.83
Chamaedaphne calyculata	Leatherleaf	Shrub	4	18	3	2.83
*Leontodon spp.**	Hawkbit	Graminoid	0	0	3	0.5
Persicaria hydropiper	Water-pepper	Forb	0	0	3	8.33
Symphyotrichum novi-belgii	New York aster	Forb	8	4.38	3	0.5
Bidens connata	Swamp beggars-ticks	Forb	0	0	2	0.5
Cuscuta gronovii	Common dodder	Vine	0	0	2	0.5
Eleocharis obtusa	Soft-stemmed Spike-rush	Graminoid	0	0	2	1
Erechtites hieraciifolius	American Burnweed, Pilewort	Forb	0	0	2	0.5
Hypericum gentianoides	Orange-grass St. John's wort	Forb	0	0	2	0.5
Kalmia angustifolia	Sheep-laurel	Shrub	0	0	2	1
Mollugo verticillata	Green carpetweed	Graminoid	0	0	2	0.5
*Persicaria maculosa**	Lady's thumb	Forb	0	0	2	1
Persicaria pensylvanica	Pennsylvania Smartweed	Forb	0	0	2	0.5

Species	Common Name	Life Form	# of Warner Plots Pre-Restoration (total 18)	Warner Mean % Cover Pre-Restoration	# of Warner Plots Year 1 Post-Restoration (total 18)	Warner Mean % Cover Year 1 Post-Restoration
Rhexia virginica	Northern Meadow-beauty	Forb	0	0	2	0.5
Scirpus cyperinus	Wool-grass	Graminoid	0	0	2	1
Sparganium americanum	Common Bur-reed	Forb	0	0	2	0.5
Chamaecyparis thyoides	Atlantic White Cedar	Tree	0	0	1	0.5
Clethra alnifolia	Sweet pepper-bush	Shrub	4	9.88	1	0.5
*Digitaria sanguinalis**	Large Crab-grass	Grass	0	0	1	4
Diodia teres	Buttonweed	Forb	0	0	1	4
Drosera intermedia	Spatulate-leaved Sundew	Forb	0	0	1	0.5
*Euphorbia maculata**	Spotted sandmat	Forb	0	0	1	0.5
*Festuca ovina**	Sheep fescue	Graminoid	0	0	1	0.5
Linum spp.	Flax species	Forb	0	0	1	0.5
*Lolium perenne**	Perennial rye grass	Graminoid	0	0	1	0.5
*Portulaca oleracea**	Common purslane	Forb	0	0	1	0.5
Solidago rugosa	Rough Goldenrod	Forb	0	0	1	0.5
Trichostema dichotomum	Blue curls	Forb	0	0	1	0.5
*Agrostis stolonifera **	March bentgrass	Graminoid	1	0.5	0	0
Apios americana	Groundnut	Vine	1	0.5	0	0
Bartonia virginica	Screw-stem	Forb	8	0.5	0	0
*Celastrus orbiculatus **	Bittersweet	Vine	1	0.5	0	0
Galium palustre	Marsh-bedstraw	Forb	1	0.5	0	0
Juncus effusus	Soft rush	Graminoid	1	0.5	0	0
Nyssa sylvatica	Black tupelo	Tree	2	0.5	0	0
Pinus rigida	Pitch pine	Tree	6	1.42	0	0
Viburnum dentatum	Northern arrow-wood	Shrub	2	0.5	0	0

* Denotes non-native species

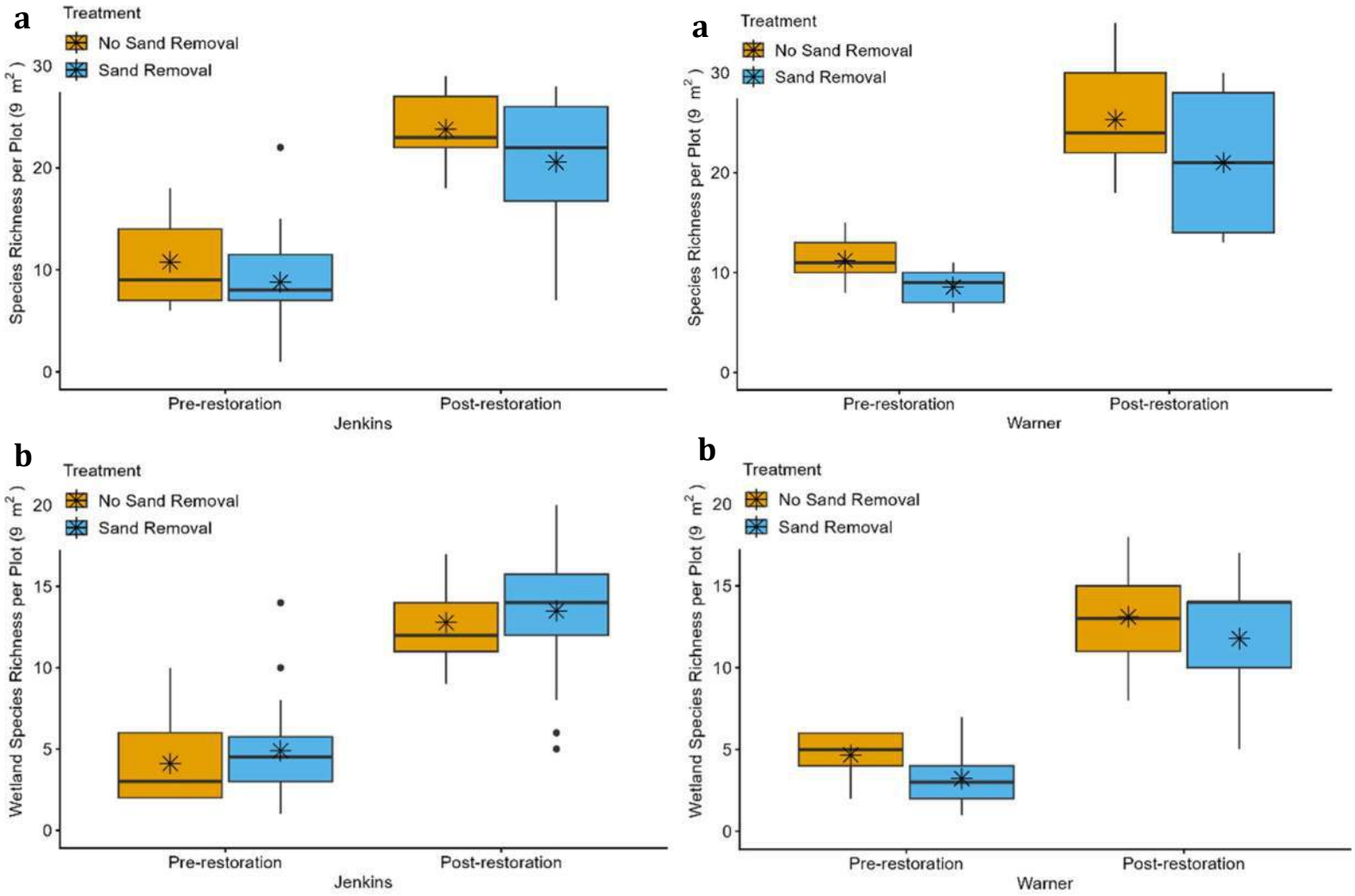

Figure 1. Per plot species richness (a) and wetland species richness (b) in areas slated for sand removal (blue) and no sand removal (yellow) during restoration at Jenkins and Warner Bogs for pre- and post-restoration. Boxes show the middle 50% of the data. Horizontal black lines indicate the median value and black 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.

*Table 7. Species richness, native species richness, wetland species richness, and percent cover across all vegetation survey plots at Jenkins and Warner Bogs for pre- and post-restoration data. Slashes separate pre- and post-restoration data with **post-restoration values are bolded**. Mean (± 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) / **91 (73)**	88 / **71**	9.62 ± 0.6 / **22.24 ± 0.9**	29 / **44**	4.36 ± 0.4 / **12.93 ± 0.53**	22.33 ± 3.65 / **42.83 ± 3.43**
Jenkins	53 (48) / **80 (66)**	87 / **74**	9.44 ± 0.93 / **21.62 ± 1.11**	26 / **41**	4.62 ± 0.60/ **13.26 ± 0.71**	22.14 ± 4.42 / **48.02 ± 4.21**
Jenkins sand removal	47 (43) / **76 (62)**	87 / **72**	8.78 ± 1.19 / **20.56 ± 1.51**	25 / **41**	4.88 ± 0.79 / **13.50 ± 0.97**	23.53 ± 5.64 / **54.25 ± 5.28**
Jenkins no sand removal	35 (32) / **52 (46)**	94 / **71**	10.78 ± 1.43 / **23.78 ± 1.22**	13 / **28**	4.11 ± 0.92 / **12.78 ± 0.97**	22.33 ± 7.44 / **35.56 ± 5.00**
Warner	28 (25) / **64 (51)**	96 / **67**	9.89 ± 0.58 / **23.17 ± 1.53**	12 / **29**	3.94 ± 0.40/ **12.44 ± 0.78**	26.47 ± 6.42 / **35.06 ± 5.46**
Warner sand removal	20 (19) / **53 (45)**	90 / **70**	8.56 ± 0.63 / **21.00 ± 2.35**	8 / **26**	3.22 ± 0.57 / **11.78 ± 1.26**	31.44 ± 11.12 / **46.50 ± 8.77**
Warner no sand removal	27 (23) / **52 (44)**	93 / **73**	11.22 ± 0.78 / **25.33 ± 1.80**	11 / **25**	4.66 ± 0.50 / **13.11 ± 0.96**	22.29 ± 7.43 / **23.61 ± 4.14**

*Table 8. Mean percent cover (± standard error) of plant life forms in vegetation survey plots during pre- and post-restoration monitoring**.** Post-restoration values are bolded and highlighted in grey.*

	Mean cranberry % cover	**Mean forb % cover**	**Mean graminoid % cover**	**Mean moss % cover**	**Mean shrub % cover**	**Mean tree % cover**	**Mean vine % cover**	**Mean bare ground % cover**
Overall (Pre)	50.88 ± 3.2	3.4 ± 1.11	4.22 ± 1.71	22.24 ± 4.83	28.43 ± 4.69	2.7 ± 1.45	32.38 ± 3.92	0.54 ± 0.03
Overall (Post)	**1.89 ± 0.61**	**10.39 ± 0.61**	**41.69 ± 4.34**	**3.33 ± 1.41**	**9.41 ± 2.45**	**0.78 ± 0.11**	**6.35 ± 1.13**	**43.45 ± 4.18**
Jenkins (Pre)	55.53 ± 3.43	3.82 ± 1.69	5.95 ± 2.99	13.37 ± 4.88	6.91 ± 2.87	3.64 ± 2.57	27.65 ± 4.1	0.57 ± 0.05
Jenkins (Post)	**0.81 ± 0.16**	**10.65 ± 2.17**	**50.00 ± 5.99**	**0.61 ± 0.11**	**1.70 ± 0.28**	**0.86 ± 0.16**	**5.11 ± 1.36**	**33.15 ± 4.86**
Jenkins sand removal (Pre)	59.94 ± 4.08	3.35 ± 1.97	7.83 ± 4.96	12.91 ± 6.08	10 ± 4.63	4.6 ± 3.61	26.9 ± 4.98	0.61 ± 0.07
Jenkins sand removal (Post)	**0.63 ± 0.09**	**11.28 ± 3.15**	**58.75 ± 7.90**	**0.61 ± 0.11**	**1.63 ± 0.39**	**0.97 ± 0.21**	**1.81 ± 0.36**	**25.47 ± 5.54**
Jenkins no sand removal (Pre)	46.72 ± 5.43	4.83 ± 3.46	3.13 ± 0.99	14.63 ± 8.82	2.5 ± 1.43	1.25 ± 0.32	28.89 ± 7.49	0.50
Jenkins no sand removal (Post)	**1.11 ± 0.39**	**9.39 ± 1.94**	**32.50 ± 5.30**	**0**	**1.79 ± 0.42**	**0.58 ± 0.08**	**9.89 ± 2.60**	**47.66 ± 7.59**
Warner (Pre)	43.47 ± 5.93	2.91 ± 1.41	2.06 ± 0.73	31.75 ± 7.96	48.75 ± 5.29	1.5 ± 0.42	39.06 ± 7.34	0.50
Warner (Post)	**3.88 ± 1.60**	**10.00 ± 1.911**	**29.22 ± 4.94**	**5.55 ± 2.40**	**16.21 ± 3.95**	**0.60 ± 0.07**	**7.94 ± 1.86**	**58.33 ± 5.98**
Warner sand removal (Pre)	51.06 ± 7.70	3.86 ± 2.95	1.57 ± 0.53	45.42 ± 10.88	48.17 ± 6.69	0.75 ± 0.25	37.63 ± 9.95	0.50
Warner sand removal (Post)	**5.50 ± 3.42**	**10.78 ± 2.15**	**40.67 ± 7.83**	**8.00 ± 4.79**	**4.94 ± 2.94**	**0.60 ± 0.10**	**5.94 ± 2.69**	**51.11 ± 9.74**
Warner no sand removal (Pre)	36.72 ± 8.65	2.17 ± 1.18	2.44 ± 1.25	21.5 ± 10.35	49.33 ± 8.62	1.93 ± 0.59	40.33 ± 11.22	0.50
Warner no sand removal (Post)	**2.50 ± 0.71**	**9.22 ± 3.28**	**17.78 ± 3.11**	**4.14 ± 2.77**	**26.22 ± 5.05**	**0.60 ± 0.10**	**9.72 ± 2.58**	**65.55 ± 6.63**

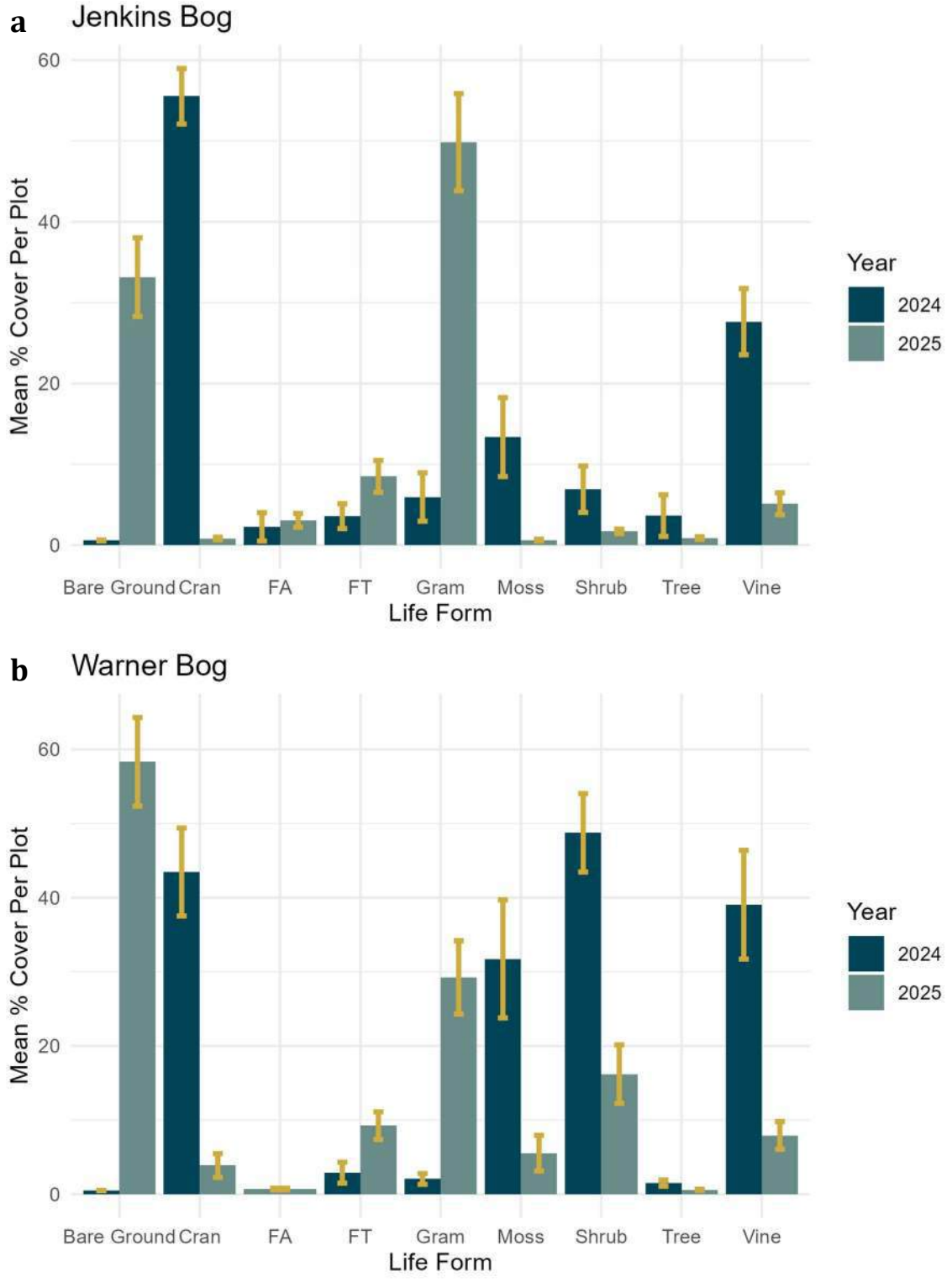

Figure 2. Mean per plot percent cover of plant life forms at (a) Jenkins and (b) Warner Bogs separated into years 2024 and 2025 for pre- and post-restoration. Gold bars show ± the standard error. 'Cran' = cranberry; 'gram' = graminoid, 'FT' = forb terrestrial, 'FA' = forb aquatic.

4.2 Water Level Monitoring

4.2.1 Pre-Restoration

Results of the pre-restoration water level monitoring from January to September of 2022 can be found in Figure 3 and Figure 4. The pre-restoration water level monitoring reveals the range of water levels at the site as well as the responsiveness to precipitation, as the period of observation coincided with an unusually wet winter followed by a relatively dry spring that progressed into a severe drought during the summer. Surface water levels, the loggers placed in ditches (JS1 and WS1) and in Hinckleys Pond (JP1 and WP1), remain relatively consistent, fluctuating less than 0.5 feet due to precipitation events during the observation period. Groundwater (WGW1, JGW1, JGW2), on the other hand, fluctuates by as much as a foot in response to large precipitation events.

Even during a period of extreme precipitation variation, water levels at the site remained in a fairly tight band with water levels at Jenkins Bog ranging 1.5 to 2.0 feet and water levels in Warner Bog ranging 1.3 to 1.9 feet (Table 9).

The results and QA/QC follow the protocols developed in the QAPP (Inter-Fluve, 2022).

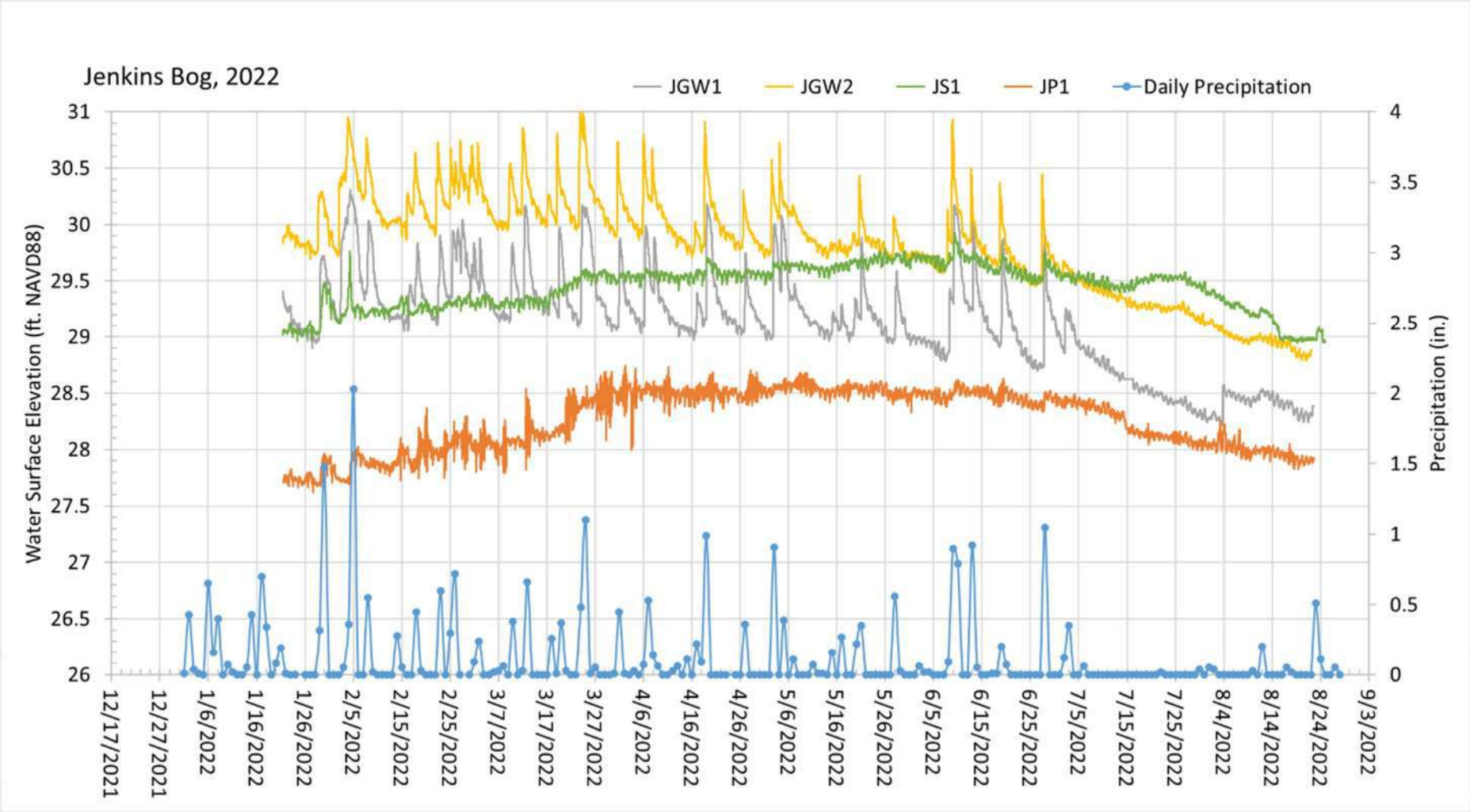

Figure 3. Water level data from Jenkins Bog, January-September 2022.

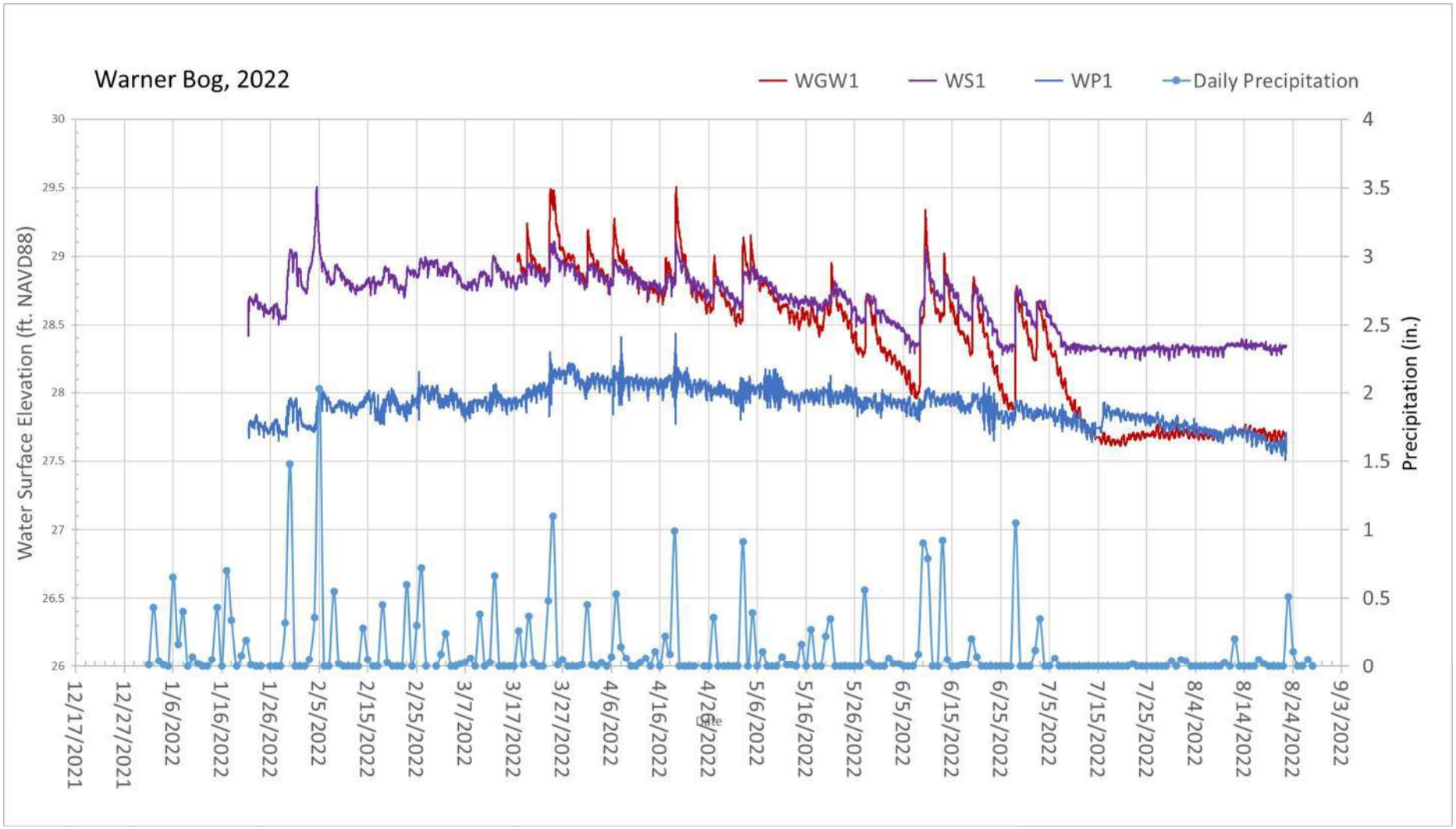

Figure 4. Water level data from Warner Bog, January-September 2022.

4.2.2 Post-Restoration (2025)

Results of the post-restoration water level monitoring from September to December of 2025 can be found in Figure 5 and Figure 6. Summary statistics for each monitoring location during pre- and post-restoration monitoring can be found in Table 9.

Across both monitoring periods, groundwater elevations exhibited greater overall variability than surface water elevations; the ranges and standard deviations of groundwater levels generally exceeded those observed in surface water loggers across the site (Table 9). Comparison of pre- and post- restoration summary statistics shows no consistent shift in mean or median elevation for either groundwater or surface water wells. Groundwater wells (WGW1, JGW1, JGW2) remained highly responsive to precipitation events during both monitoring periods, and surface water wells (JS1 and WS1) also showed responses to precipitation, though with smaller absolute ranges of fluctuation than groundwater wells. Pond water level (JP1 and WP1) at Jenkins bog was more variable than Warner, which may be due to greater wind and wave activity on the Jenkins side (Figure 5 and Figure 6). Additional years of water level monitoring during the same time of year are required to provide meaningful insight into post-restoration hydrologic conditions.

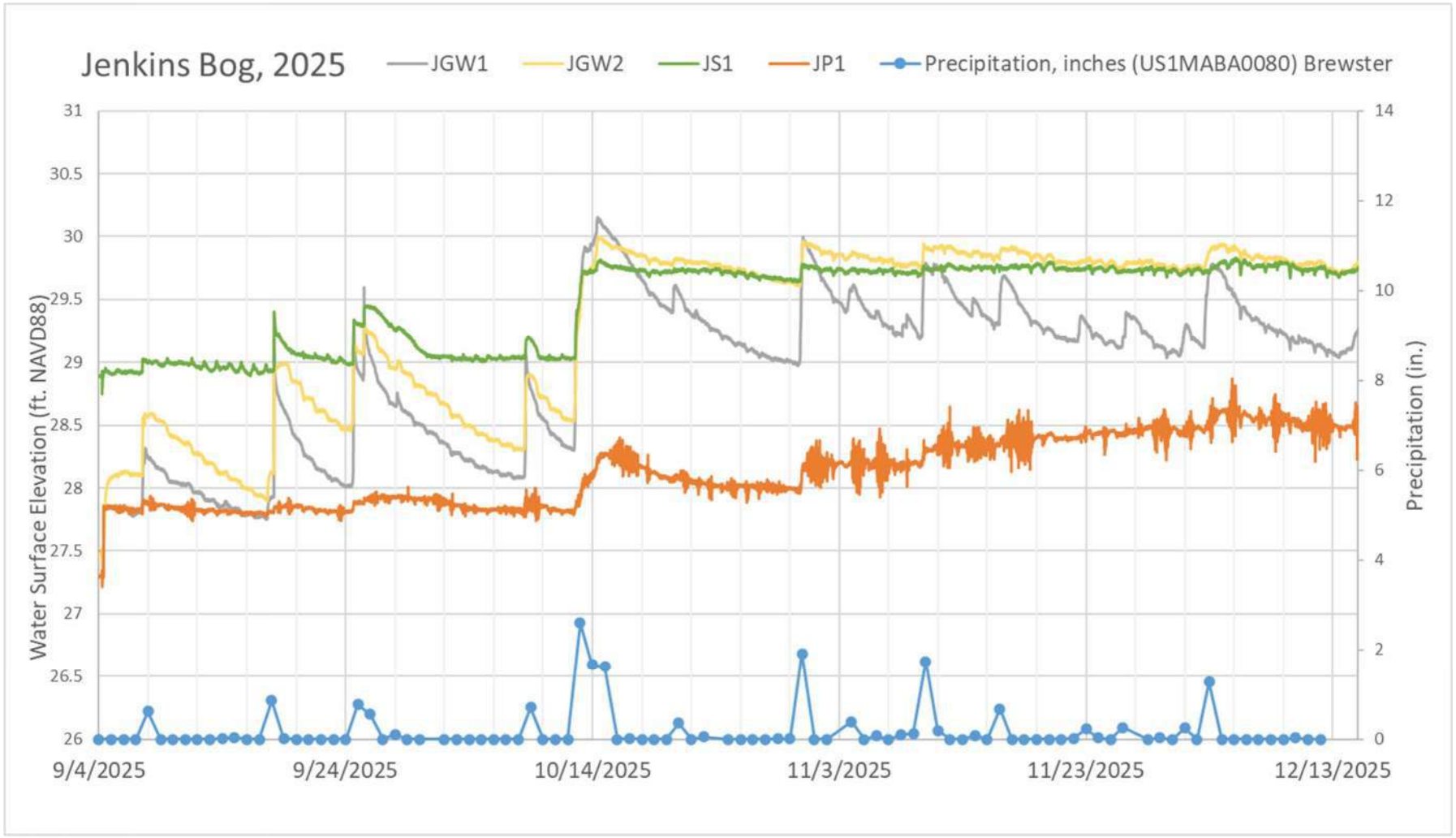

Figure 5. Water level data from Jenkins Bog, September-December 2025.

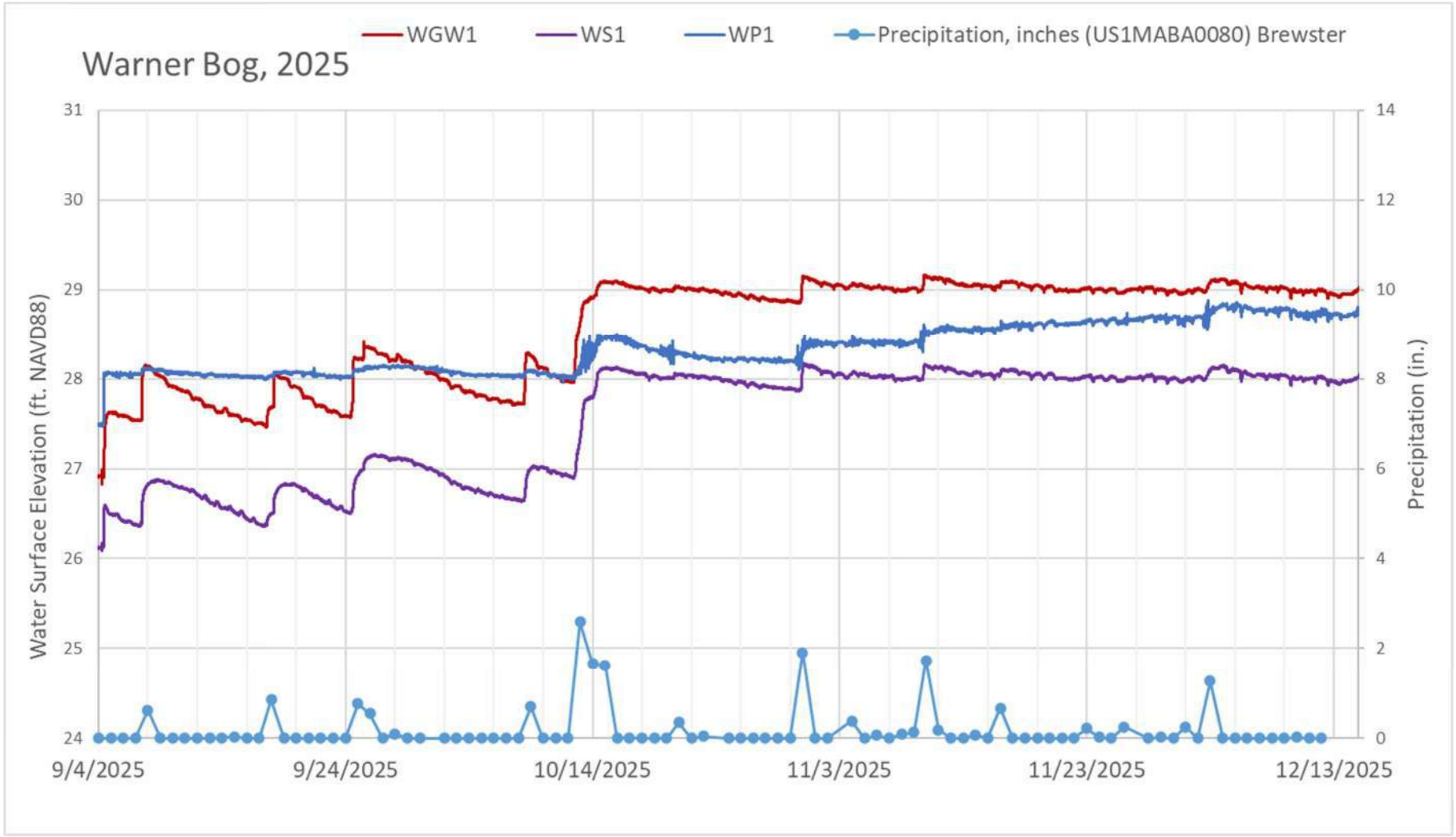

Figure 6. Water level data from Warner Bog, September-December 2025.

Table 9. Summary statistics (mean, median, standard deviation, min, max) of water surface elevations in feet recorded at each logger in 2022 (1/21/2022 to 9/3/2022) and 2025 (9/4/2025 to 12/15/2025). 2022 data is shaded.

	JGW1 (2022)	JGW1 (2025)	JGW2 (2022)	JGW2 (2025)	JP1 (2022)	JP1 (2025)	JS1 (2022)	JS1 (2025)	WGW1 (2022)	WGW1 (2025)	WP1 (2022)	WP1 (2025)	WS1 (2022)	WS1 (2025)
Average	29.08	28.93	29.78	29.30	28.243	28.12	29.43	29.47	28.33	28.55	27.90	28.33	28.65	27.53
Median	29.14	29.15	29.84	29.75	28.335	28.08	29.51	29.71	28.48	28.97	27.92	28.30	28.70	27.98
Std Deviation	0.46	0.64	0.48	0.69	0.2720	0.29	0.22	0.34	0.51	0.61	0.14	0.29	0.23	0.64
Min	28.22	27.38	28.73	27.37	27.621	27.16	28.47	28.75	27.61	26.70	27.51	27.42	28.24	25.82
Max	30.31	30.15	31.02	30.00	28.743	28.87	29.93	29.83	29.51	29.17	28.44	28.88	29.51	28.18
Range	2.10	2.78	2.30	2.64	1.122	1.71	1.46	1.08	1.90	2.47	0.93	1.47	1.27	2.35

4.3 Photographic Survey

4.3.1 Pre- and Post-Restoration (2024 & 2025)

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 and Year 1 post-restoration photographic survey are provided. The presence or absence of invasive plant species as well as other common vegetation are provided in Table 10, though this list is not as comprehensive as the plot-level overview above in section 4.1. Refer to Appendix D for photographs taken at each photo monitoring station.

Table 10. Invasive plant species and other vegetation present at transitional and upland zone photo stations. No invasive plants were identified in 2025 as they were treated and managed during construction.

Photo Station	Bog	Invasive Species Present (2024)	Non-invasive Species Present
1	Jenkins	No	2024: *Cichorium intybus* (non-native), *Toxicodendron radicans, Agrostis scabra, Solidago rugosa, Rosa virginiana.* 2025: New trail was built further into the bog than the dirt road prior to construction. Only the cover crop from the seed mix installed adjacent to the trail is emerging at this time as well as the potted trees and shrubs that were installed following construction.
2	Jenkins	Yes (*Celastrus orbiculatus*)	2024: *Smilax rotundifolia, Clethra alnifolia, Euthamia caroliniana, Toxicodendron radicans, Rubus flagellaris, Pteridium aquilinum, Quercus velutina, Pinus rigida, Acer rubrum, Prunus serotina.* 2025: Sand reuse area where multiple trees were removed and other vegetation covered with fill material. Some trees remain along with typical native groundcover and forbs. *Pinus rigida, Acer rubrum, Rubus flagellaris, Panicum dichotomiflorum*
3	Jenkins	Yes (*Phalaris arundinaceae*)	2024: *Toxicodendron radicans, Agrostis scabra, Juncus effusus, Symphyotrichum novi-belgii.* 2025: This is an area of fill during construction to build a more gradual slope and extend the trail into the bog and away from the road. The slope is re-growing with primarily cover crop from the seed mix installed during construction as well as the potted trees and shrubs installed.
4	Jenkins	No	2024: Low maintained vegetation, *Egarostis spectabilis, Agrostis sp.* 2025: This area was part of the staging area during construction. Some of the same vegetation is still growing as well as the cover crop emerging from the seed mix installed along the slope.
5	Jenkins	No	2024: *Prunus serotina, Agrostis scabra, Alnus sp.* 2025: The slope going to the pond was regraded and a switchback trail was constructed. The trees and saplings noted in 2024 were removed. A seed mix was placed under the erosion control fabric during construction and the cover crop is emerging.
6	Jenkins	No	2024: *Toxicodendron radicans, Rubus flagellaris, Smilax glauca, Agrostis scabra*. 2025: Limited disturbance at the photo point during construction; similar species present. Trail constructed where the dirt road was prior to construction. Seed mix with cover crop beginning to emerge along the side slopes to the bog and on either side of the trail.
7	Jenkins	No	2024: *Erigeron canadense, Agrostis scabra, Smilax glauca, Rubus flagellaris.* 2025: This area was disturbed and graded during construction with new trails constructed. Mostly cover crop beginning to emerge with some *Rubus flagellaris* growing as well.

8	Jenkins	No	2024: *Agrostis stolonifera, Toxicodendron radicans, Euthamia graminifolia, Rubus flagellaris.* 2025: New trail constructed where the dirt road was located. The vegetation along the slope to the bogs has begun to regrow with similar species as 2024 along with the cover crop from the seed mix installed along the edge slopes of the bogs.
9	Warner	No	2024: *Pinus rigida, Andropogon virginicus, Quercus velutina, Erigeron canadense.* 2025: Sand reuse area was regraded recently to complete construction, so no new vegetation was growing and all previous vegetation was removed with the grading area. *Pinus rigida* along the margins of the grading.
10	Warner	No	2024: Mowed, *Smilax rotundifolia, Rubus flagellaris, Hieracium caespitosum* (non-native), *Andropogon virginicus.* 2025: Limited disturbance at the photo point during construction; similar species present.
11	Warner	No	2024: *Rubus flagellaris, Sympyotrichum novi-belgii, Glyceria canadensis, Smilax glauca.* 2025: Limited disturbance at the photo point during construction; similar species present.
12	Warner	Yes (*Phalaris arundinaceae*)	2024: *Agrostis scabra, Andropogon virginicus, Panicum dichotomiflorum.* 2025: Limited disturbance at the photo point during construction; similar species present.
13	Warner	No	2024: *Toxicodendron radicans, Agrostis stolonifera, Rosa virginiana, Parthenocissus quinquefolia.* 2025: Portions of the berm and vegetation were removed during construction but most of the groundcover remains in the portions of the berm that were not removed: *Toxicodendron radicans, Agrostis stolonifera, Parthenocissus quinquefolia*

5 Discussion

This report describes the methods and results of the water level monitoring and vegetation survey completed after ecological restoration activities which occurred in 2025 at Jenkins and Warner Bog. At both sites, we saw an increase in overall species richness and wetland species richness in the post-restoration survey, suggesting that restoration efforts successfully created more diverse and hydrologically favorable conditions for wetland plants. Although perennial species increased in number in the post-restoration survey, they represent a smaller proportion of the total community, which may reflect an influx of short-lived annuals typical of early restoration stages. There was no statistically significant difference in vegetation composition and richness between areas of microtopography with sand removal and microtopography with no sand removal. This finding may suggest that sand removal had a limited influence on immediate post-restoration plant development; however, continued monitoring is necessary to track any emerging trends in areas with and without sand removal. Overall, we observed positive trends of increased species richness, wetland species richness, and mean per plot % cover in the early stages of restoration at Warner and Jenkins Bog. At other sites, total species richness and wetland species richness declined during post-restoration years 3–5 following an initial increase after restoration. Tree and shrub cover is expected to increase over time as woody species establish and mature. Subsequent monitoring years will continue to track post-restoration vegetation in order to evaluate revegetation trends.

Water level logger data indicate that site hydrology remains dynamic and responsive to precipitation, similar to pre-restoration trends, which contextualizes emerging wetland plant growth.

6 Works Cited

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Appendix A: Vegetation Monitoring Maps

inter·fluve

Vegetation Monitoring Plots

- sand removal
- no sand removal

Photo Stations

- sand removal
- no sand removal

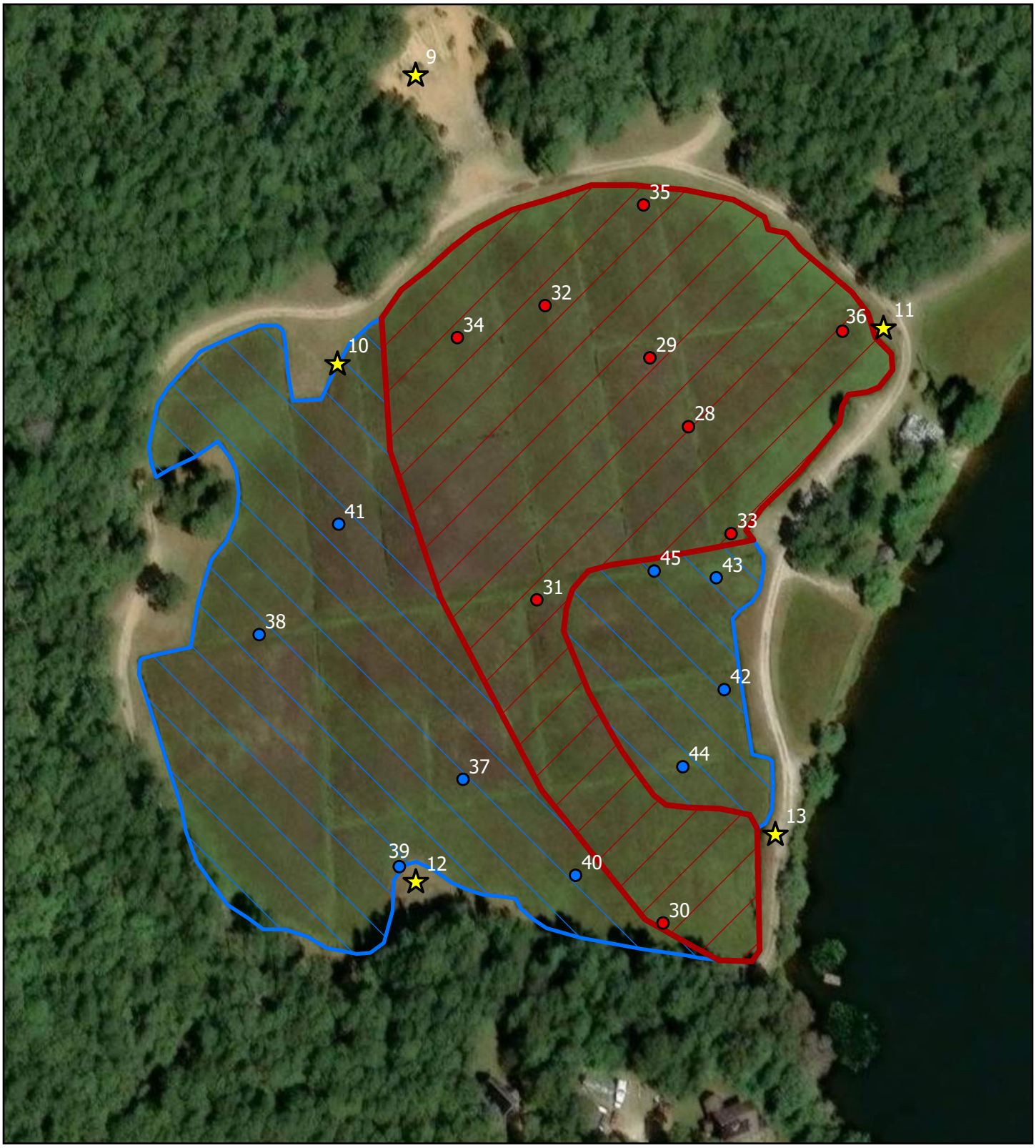
Coordinate System: NAD 1983
State Plane Massachusetts

Vegetation Monitoring Map

Jenkins Bog
Harwich, MA

N

Feet
0 100 200 300



inter·fluve

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

N

Feet
0 100 200

Appendix B: Vegetation Monitoring Plot Photographs

VEGETATION MONITORING PLOT PHOTOGRAPHS

Table 1. Jenkins Bog, Sand Removal

Plot	Pre-Restoration (2024)	1 Year Post-Restoration (2025)
1		
2		
3		
4		
5		
6		

VEGETATION MONITORING PLOT PHOTOGRAPHS

7

8

9

10

11

12

VEGETATION MONITORING PLOT PHOTOGRAPHS

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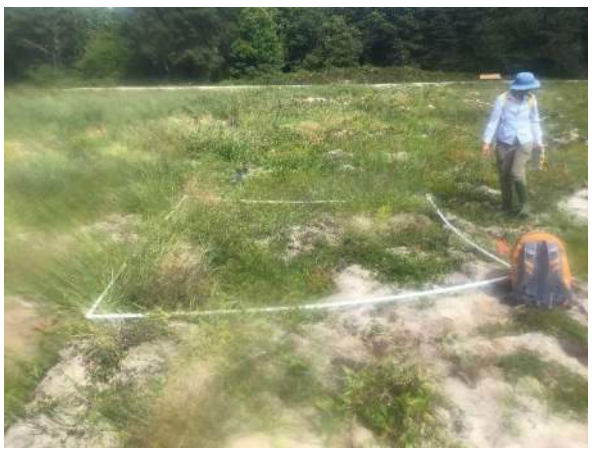
VEGETATION MONITORING PLOT PHOTOGRAPHS

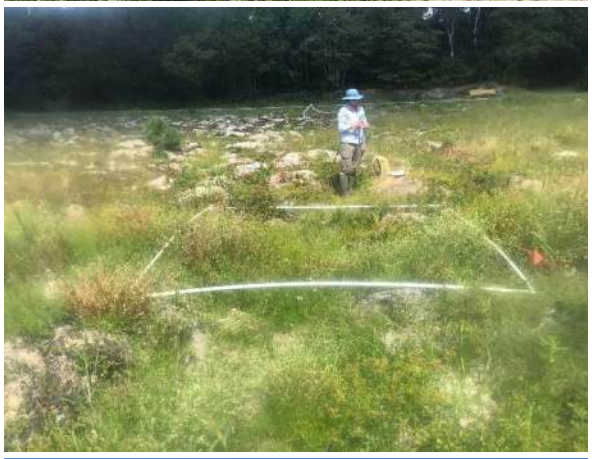
Table 2. Jenkins Bog, No Sand Removal

Plot	Pre-Restoration (2024)	1 Year Post-Restoration (2025)
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)	1 Year Post-Restoration (2025)
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)	1 Year Post-Restoration (2025)
37		
38		
39		
40		
41		
42		

VEGETATION MONITORING PLOT PHOTOGRAPHS

43

44

45

Appendix C: Water Level Logger Maps

inter·fluve

Water Level Loggers

Coordinate System: NAD 1983
State Plane Massachusetts

Vegetation Monitoring Plots

Jenkins Bog
Harwich, MA

N

Feet
0 100 200 300

inter·fluve

Water Level Loggers

Coordinate System: NAD 1983
State Plane Massachusetts

Vegetation Monitoring Plots

Warner Bog
Harwich, MA

N

Feet
0 100 200 300

Appendix D: Photo Station Photos

PHOTO STATION PHOTOS

Jenkins Bog, Photo Station 1

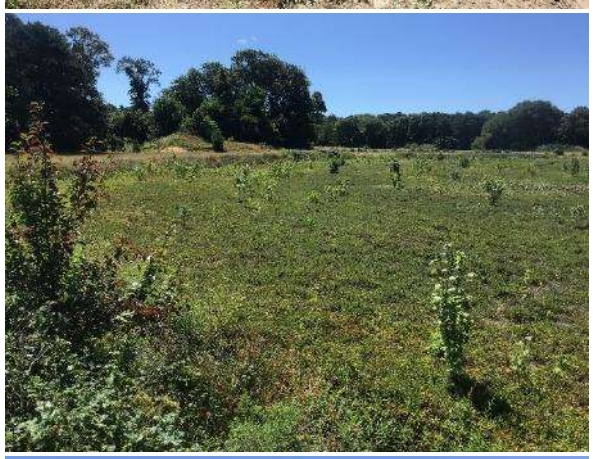
ID	Pre-Restoration (2024)	Year 1, Post-Restoration (2025)
1		
North		
East		
South		
West		

PHOTO STATION PHOTOS

Jenkins Bog, Photo Station 2

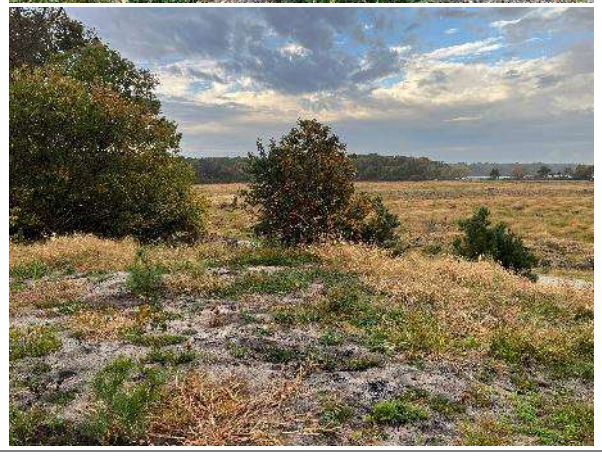
ID	Pre-Restoration (2024)	Year 1, Post-Restoration (2025)
2		
North		
East		
South		
West		

PHOTO STATION PHOTOS

Jenkins Bog, Photo Station 3

ID	Pre-Restoration (2024)	Year 1, Post-Restoration (2025)
3		
North		
East		
South		
West		

PHOTO STATION PHOTOS

Jenkins Bog, Photo Station 4

ID	Pre-Restoration (2024)	Year 1, Post-Restoration (2025)
4		
North		
East		
South		
West		

PHOTO STATION PHOTOS

Jenkins Bog, Photo Station 5

ID	Pre-Restoration (2024)	Year 1, Post-Restoration (2025)
5		
North		
East		
South		
West		

PHOTO STATION PHOTOS

Jenkins Bog, Photo Station 6

ID	Pre-Restoration (2024)	Year 1, Post-Restoration (2025)
6		
North		
East		
South		
West		

PHOTO STATION PHOTOS

Jenkins Bog, Photo Station 7

ID	Pre-Restoration (2024)	Year 1, Post-Restoration (2025)
7		
North		
East		
South		
West		

PHOTO STATION PHOTOS

Jenkins Bog, Photo Station 8

ID	Pre-Restoration (2024)	Year 1, Post-Restoration (2025)
8		
North		
East		
South		
West		

PHOTO STATION PHOTOS

Warner Bog, Photo Station 9

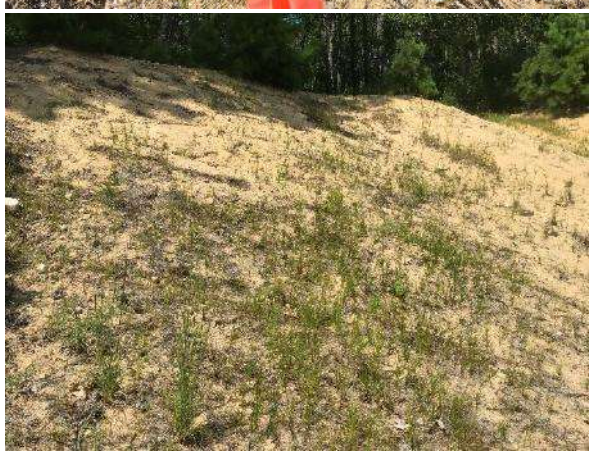
ID	Pre-Restoration (2024)	Year 1, Post-Restoration (2025)
9		
North		
East		
South		
West		

PHOTO STATION PHOTOS

Warner Bog, Photo Station 10

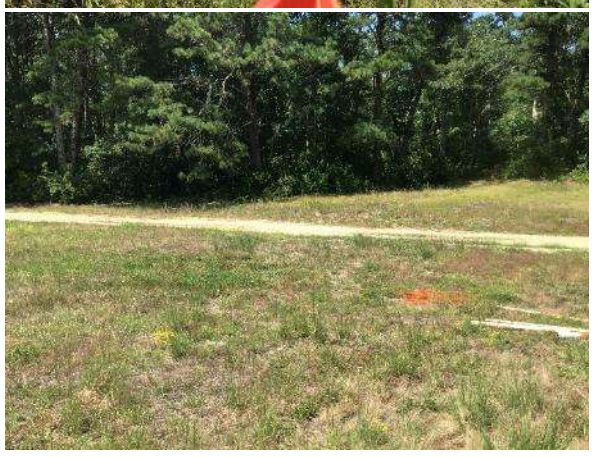
ID	Pre-Restoration (2024)	Year 1, Post-Restoration (2025)
10		
North		
East		
South		
West		

PHOTO STATION PHOTOS

Warner Bog, Photo Station 11

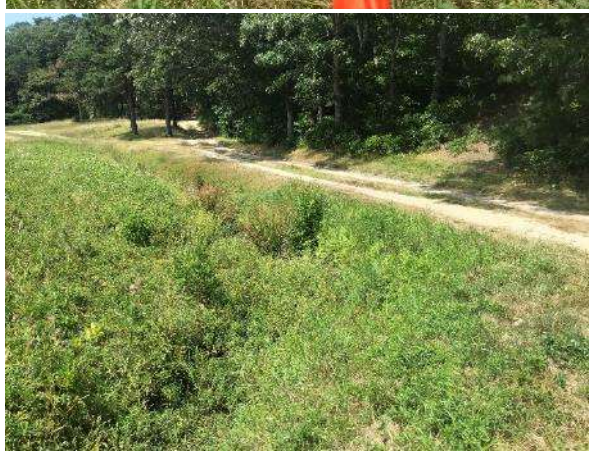
ID	Pre-Restoration (2024)	Year 1, Post-Restoration (2025)
11		
North		
East		
South		
West		

PHOTO STATION PHOTOS

Warner Bog, Photo Station 12

ID	Pre-Restoration (2024)	Year 1, Post-Restoration (2025)
12		
North		
East		
South		
West		

PHOTO STATION PHOTOS

Warner Bog, Photo Station 13

ID	Pre-Restoration (2024)	Year 1, Post-Restoration (2025)
13	 **Stake in photo is incorrectly labeled. The correct Photo Station ID is PS13.*	
North		
East		
South		
West