LAKE HOPATCONG - 2025 AQUATIC PLANT SURVEY

MORRIS AND SUSSEX COUNTIES, NEW JERSEY

Grant funding provided by the New Jersey Highlands Council

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1.0 INTRODUCTION

Princeton Hydro, LLC was contracted by Jefferson Township to conduct a submerged aquatic vegetation (SAV) survey of select near-shore locations throughout Lake Hopatcong, Morris and Sussex Counties, NJ. Grant funding for this project was provided by the New Jersey Highlands Council. Aquatic macrophyte surveys and management have occurred in Lake Hopatcong for the past several decades, with efforts taken to reduce nuisance densities of macrophytes throughout the littoral zone. Management of these plants has largely consisted of the removal of plant biomass via mechanical harvesting, primarily through the Lake Hopatcong Commission with financial support through the New Jersey Department of Environmental Protection (NJDEP). Additionally, some local stakeholder groups have hired licensed applicators who file for permits to conduct chemical treatments with aquatic herbicides in select, nearshore areas of the lake. Concerns in the past have pertained to impacts to the lake's recreational and ecological value as a result of excessive growth of invasive plants, such as Eurasian watermilfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*), and native plants that grow to nuisance densities, such as tapegrass (*Vallisneria americana*).

Over the past few years, Princeton Hydro scientists have observed a decline in Secchi depth (a measurement of water clarity), hypothesized to be a product of recent increases in cyanobacteria densities. These trends have coincided with recent apparent declines in the lake's SAV densities. A survey conducted in 2023 in Landing Channel as part of a pre-dredging assessment found a notable lack of most species of macrophytes, despite previous surveys recording a diversity of species in this part of the lake. This was in part hypothesized to have been the product of a recent herbicide treatment in the area. In 2024, it was noted that the mechanical weed harvesting program harvested the lowest total annual macrophyte biomass of the past several full harvesting seasons.

The apparent decline in SAV densities in Lake Hopatcong is concerning, especially when viewed alongside the decreases in Secchi depths and increased cyanobacteria biomass, which can led to nuisance Harmful Algal Blooms (HABs). This suggests that the lake may be shifting from a vascular plant-dominated system to an algae-dominated system. Under these conditions, increased algal densities result in lower water clarity and a lower degree of light penetration to the bottom sediments, resulting in a reduction in macrophyte growth potential. While nuisance macrophyte densities can impede the use of the lake, macrophytes provide a series of important ecosystem services to a waterbody, such as fish habitat and potentially nutrient sequestration and sediment stabilization. Additionally, HABs can produce aesthetically displeasing surface scums and have the potential to produce cyanotoxins, which can negatively impact the health of people, pets, and wildlife. As such, a healthy population of macrophytes should be allowed to continue growing at reasonable densities in Lake Hopatcong to maintain these benefits.

During the 2025 survey, Princeton Hydro conducted a semi-quantitative aquatic macrophyte survey at the original 22 sampling points from the last two SAV surveys that were conducted in 2018 and 2021. Also, 15 additional sampling points were assessed, many of which are adjacent to boat launches and inlets, as these are areas by which newer invasive plant species, such as hydrilla (*Hydrilla verticillata)* may be introduced. The results from the 2025 SAV Survey will be compared with the data from 2018 and 2021 to assist in the assessment of the apparent decrease in macrophyte growth in recent years. This survey was also used to monitor for newer invasive plant species, as well as to assess populations of native species.

In addition to the SAV survey, Princeton Hydro also completed environmental DNA (eDNA) sampling at select locations. eDNA is an innovative and novel technique used in the early detection of invasive species. eDNA monitoring involves the amplification of DNA present in water samples. A significant advantage that eDNA sampling offers over traditional non-invasive DNA sampling, especially in an aquatic environment, is the lack of a need for biological material deposited by the organism of interest (feces, hair, scales, etc.). Thus, eDNA sampling is particularly effective for invasive species surveillance in aquatic ecosystems because it is more sensitive in detecting the presence of organisms. This monitoring was recommended in the newly developed Early Detection Aquatic Invasive Species Management (AIS) Plan (AIS Management Plan) for Lake Hopatcong, funded by the New Jersey Audubon Watershed Restoration and Community Empowerment Program, and developed by Princeton Hydro and the Lake Hopatcong Foundation.

2.0 METHODOLOGY

2.1 SAV METHODOLOGY

The SAV survey in Lake Hopatcong was conducted at 37 near-shore sampling locations around the lake on 2 September and 3 September 2025 (Appendix I). The 2025 survey was comprised of 22 "original" stations, and 15 "new" stations. The original stations, HC-1 through HC-22, were sampled during the 2018, 2021 and 2025 surveys. The new stations, HC-23 through HC-37, were only sampled during the 2025 survey.

Sampling stations were recorded using a hand-held GPS device. A 1 m² floating quadrat was placed over a stand of plants within the designated sampling areas. Two areas were between an island and the shoreline, in which case plots were sampled along both the main shore and island shore. The area inside the quadrat, defined on the bed of the lake by drop chains, was observed and surveyed using an Aquascope and/or rake grabs and all plants located within the quadrat were identified to species. Species identifications were made utilizing previous identification knowledge and various aquatic plant field guides (Borman, 1997, Hellquist, 1980). Species were semi-quantitatively ranked according to the following guidance:

- Abundant (greater than or equal to 50% of area)
- Common (between 10 and 50% of area)
- Present (less than or equal to 10% of area)

Select locations were also harvested for further biomass analysis (Appendix I). The above sediment plant material was placed into plastic bags and transported to Princeton Hydro's Biological Laboratory in a cooler with ice and weighed to the nearest gram (wet weight). The following section provides the results of this survey. This methodology followed the same protocol as the 2018 and 2021 SAV surveys to facilitate direct comparisons. Sampling locations and their associated station labels are listed below.

In addition to measuring the wet-weight of the community plant biomass, sub-samples of this harvested material were transported to a State-certified laboratory and analyzed for percent solids, total phosphorus, and total nitrogen. This data will be used to update and expand on the 2006 study that has been used for almost 20 years to quantify how much phosphorus is removed from Lake Hopatcong through mechanical weed harvesting. A total of 13 community-level plant samples were collected for this analysis.

Table 2.1: SAV sampling locations in Lake Hopatcong

Location	Station	Location	Station
Landing	HC-1	Flash Marina	HC-20
Landing Island	HC-2	Liffy Island Shore	HC-21
Near Silver Springs	HC-3	Liffy Main Shore	HC-22
King Cove	HC-4	Outlet/Dam	HC-23
Ingram Cove	HC-5	State Park Launch	HC-24
River Styx	HC-6	Shore Hills Marina	HC-25
Crescent Cove	HC-7	Opposite of State Park	HC-26
Crescent Cove	HC-8	Barnes Bros. Marina	HC-27
Crescent Cove	HC-9	Lee's Marina 1	HC-28
Crescent Cove	HC-10	Lee's Marina 2	HC-29
Van Every Cove	HC-11	Great Cove Marinas	HC-30
Great Cove	HC-12	Witten Park	HC-31
Davis Cove	HC-13	Mountain Brook	HC-32
Byram Cove	HC-14	Bridge Marina	HC-33
Henderson Cove	HC-15	Ashley Cove	HC-34
Halsey Island Shore	HC-16	Lake Forest Yacht Club	HC-35
Halsey Main Shore	HC-17	Woodport Bay	HC-36
N Cherry Rd Cove	HC-18	Liffy Island North	HC-37
Below Espanong Rd Bridge	HC-19		

2.2 EDNA METHODOLOGY

Princeton Hydro collected five samples from Lake Hopatcong during the SAV survey that were analyzed for eDNA by Jonah Ventures. Jonah Ventures is a Colorado based laboratory that specializes in eDNA analysis. Princeton Hydro identified the following ten invasive species of concern that should be prioritized for early detection in Lake Hopatcong:

- Hydrilla (*Hydrilla verticillata*)
- Carolina Fanwort (*Cabomba caroliniana*)
- Water Chestnut (*Trapa natans*)
- Zebra Mussels (*Dreissena polymorpha*)
- Quagga Mussels (*Dreissena bugensis*)
- Northern Snakehead (*Channa argus*)
- Flathead Catfish (*Pylodictis olivaris*)
- Round Goby (*Neogobius melanostomus*)
- Spiny Waterflea (*Bythotrephes longimanus*)
- Fishhook Waterflea (*Cercopagis pengoi*)

After discussions with Jonah Ventures, it was determined that a combination of metabarcoding and qPCR was required to monitor for most of these species; Jonah Ventures did not have assays available for spiny waterflea or fishhook waterflea, so those species were not included in the analysis. At each of the five stations, samples were analyzed via metabarcoding for fish and plant species, as well as qPCR analysis for zebra mussels and quagga mussels.

Stations selected for eDNA analysis are presented below in Table 2.2.

Table 2.2: eDNA sampling locations

Location	Station
River Styx	HC-6
Below Espanong Rd Bridge	HC-19
Liffy Island Shore	HC-21
State Park Launch	HC-24
Lee's Marina 1	HC-28

3.0 RESULTS AND DISCUSSION

3.1 COMMUNITY COMPOSITION ANALYSIS

A table with the full results from the SAV survey are provided in Appendix II.

Community composition and abundance were highly variable throughout the lake. High densities of species were observed at HC-1, HC-12, HC-17, HC-23, HC-29, HC-30, HC-31, HC-32, and HC-34. These stations were all observed to feature two or more plant species in abundant densities. Overall richness in 2025 had notable variations, ranging from no species observed to seven distinct species (Figure 3.1).

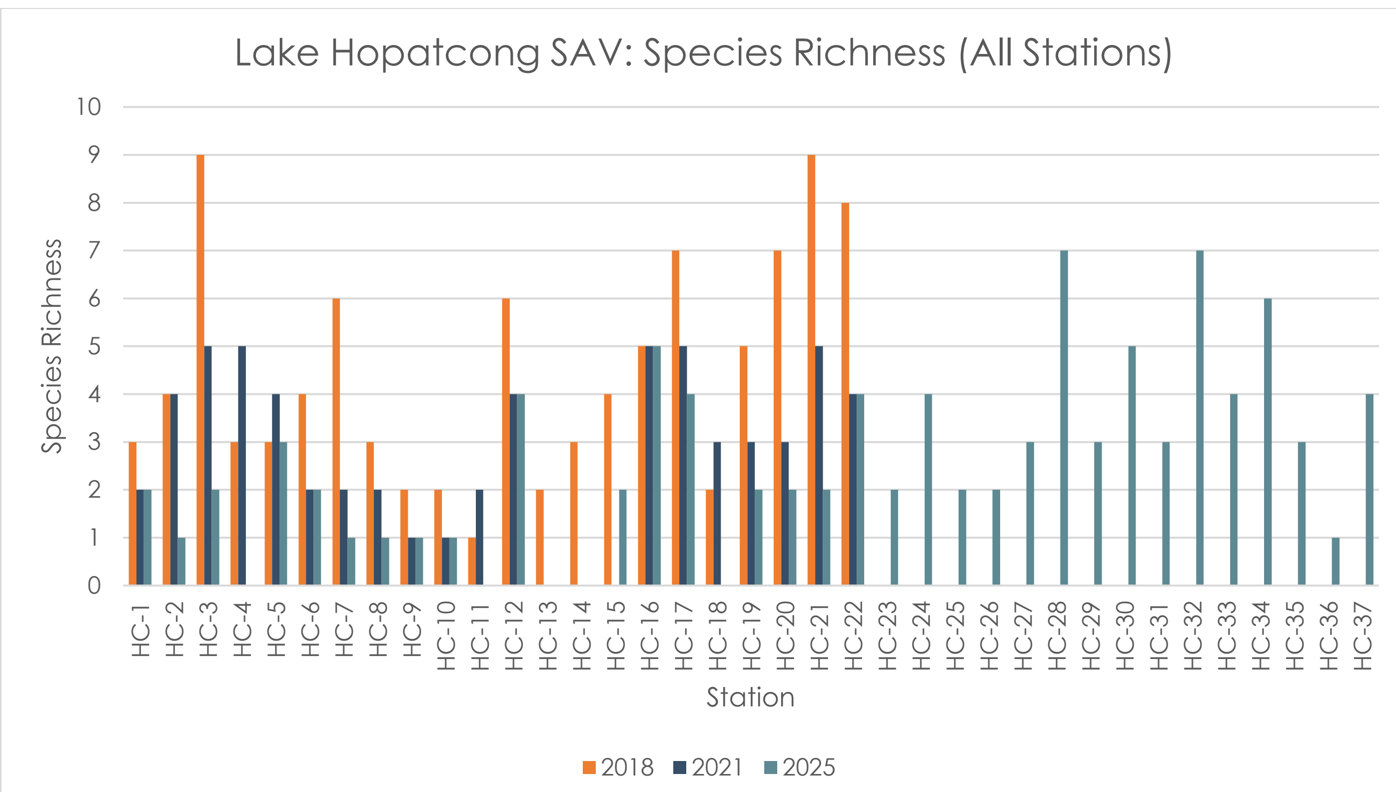


Figure 3.1: Interannual SAV species richness in Lake Hopatcong

Eurasian watermilfoil was observed as abundant at 14 stations in 2025, with the plant comprising more than 50% of the sampled area. The plant was observed in lesser densities at an additional 16 stations. Complete abundance observations of Eurasian watermilfoil in 2025 are presented below in Figure 3.2.

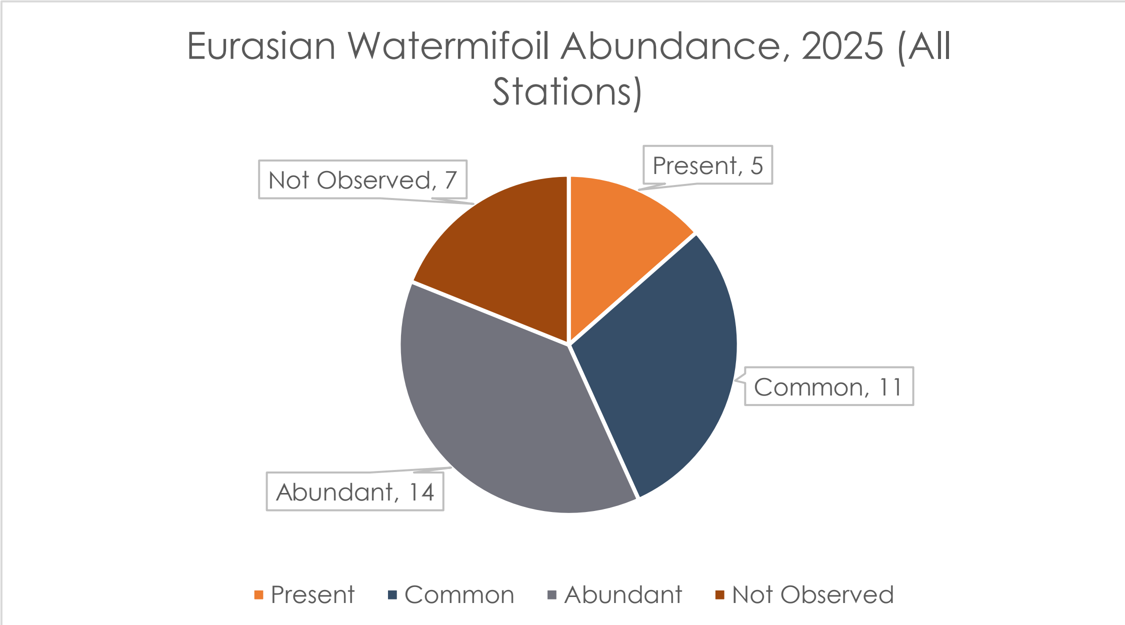


Figure 3.2: Abundance observations of Eurasian watermilfoil at all stations in 2025

Evidence indicates that densities of Eurasian watermilfoil in the lake have been increasing since 2018. In 2025, eight of the original stations sampled were observed to feature the plant at abundant densities. This demonstrates an increase from the 2021 survey, where only three stations were observed to feature abundant densities. During the 2018 survey, Eurasian watermilfoil was only observed in common or present densities. Abundance of Eurasian watermilfoil during each SAV survey are presented in Figures 3.3 through 3.5.

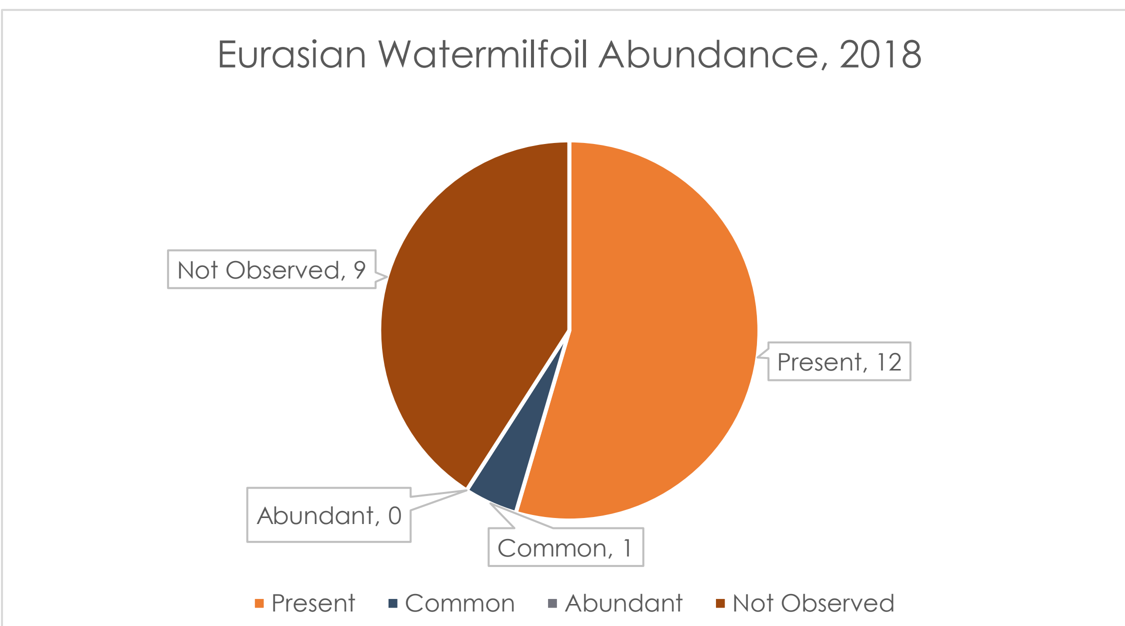


Figure 3.3: Abundance observations of Eurasian watermilfoil in 2018

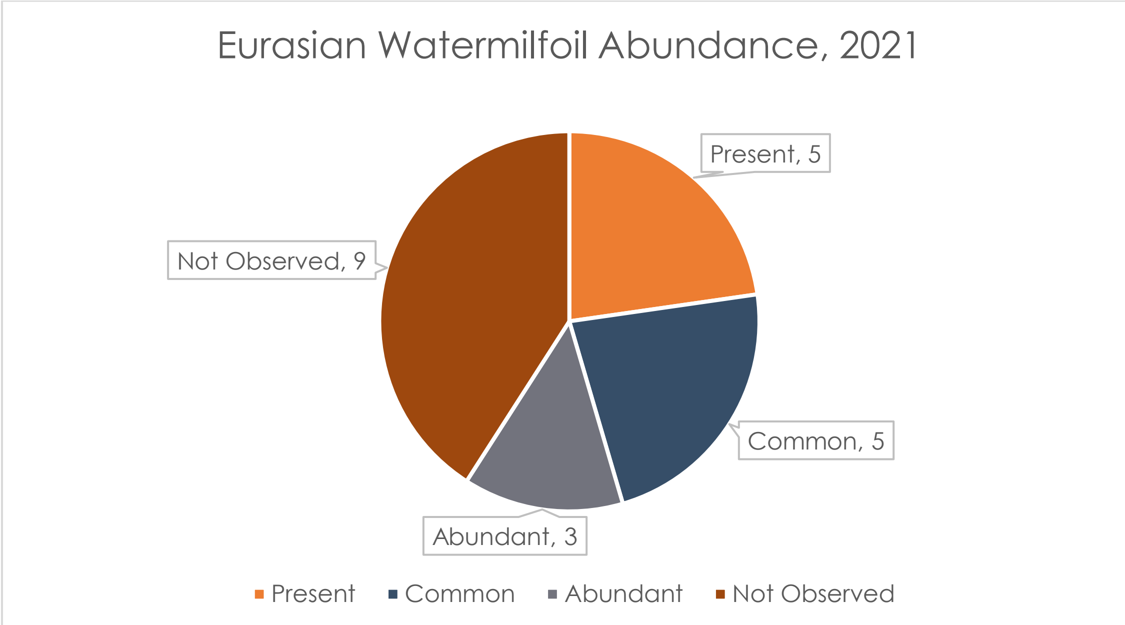


Figure 3.4: Abundance observations of Eurasian watermilfoil in 2021

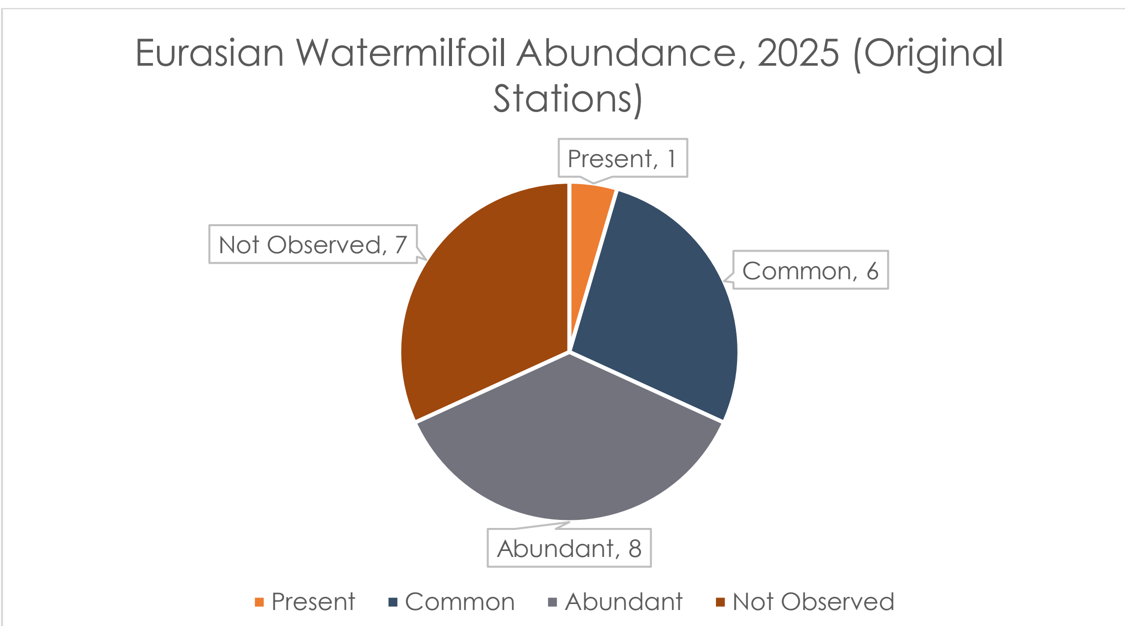


Figure 3.5: Abundance observations of Eurasian watermilfoil at original stations in 2025

In addition to increasing densities, evidence suggests that stations with abundant Eurasian watermilfoil display a lack of native species. In 2021, all stations that were observed to contain abundant densities of this plant also contained at least one other plant species. In 2025, 4 of the original stations with abundant Eurasian watermilfoil did not contain any other plant species. This trend is likely due to Eurasian watermilfoil's competitive advantages, which allows it to outcompete and shade out native plants.

Station HC-3 was observed to feature a moderate population of Eurasian watermilfoil and lesser densities of tapegrass in 2025. A reduction in species richness was noted at this station compared to previous surveys. In 2021, this station featured slender naiad (*Najas flexilis*), Robbins pondweed (*Potomogeton robbinsii*), coontail (*Ceratophyllum demersum*), and the macroalgae *Nitella* (*Nitella flexilus*). This was also a reduction in species richness from the 2018 survey, where 9 species were identified at this station.

Stations HC-7, HC-8, HC-9, and HC-10 (all located in Crescent Cove) were all observed to feature only abundant Eurasian watermilfoil during the 2025 survey. In 2021, several of these stations were also observed to feature other plant species. It is likely that Eurasian watermilfoil's competitive advantages in the lake allowed it to shade out other plants and become dominant in these areas as populations establish themselves.

Several stations were devoid of plants during the 2025 SAV survey. HC-11, HC-13, and HC-14 were all observed to feature no aquatic vegetation at the time of sampling. Species richness at these stations has been declining since the 2018 survey. In 2018, all three of these stations contained at least one plant species. During the 2021 survey, HC-13 and HC-14 had no observed plant populations. This may be attributed to localized treatments of aquatic herbicides.

Station HC-16, Halsey Island Shore, has maintained a diverse plant community during each SAV survey. In 2025, this station yielded moderate densities of tapegrass, Eurasian watermilfoil, and the macroalgae *Chara* (*Chara sp*.). Lesser densities of Southern naiad (*Najas guadalupensis*) and *Elodea* (*Elodea canadensis*) were also present. This is remarkably similar to the 2021 SAV survey, where this station was observed to feature similar densities of tapegrass, Eurasian watermilfoil and *Elodea*. Similar plants were also observed at this station in 2018.

Station HC-19, Below Espanong Rd Bridge, was observed to feature an unknown milfoil species (*Myriophyllum sp.*). Field identification of this plant suggest it is variable-leaf watermilfoil (*Myriophyllum heterophyllum*); however, this plant can look similar to other native species of *Myriophyllum* when not producing inflorescence (flowering spikes). *Myriophyllum heterophyllum* is presently listed as "Untiered" under the NJ Aquatic Invasive Species Management Plan. According to the USGS Nonindigenous Aquatic Species Database, *M. heterophyllum* features a native range that includes the southern $2/3^{rds}$ of NJ. Lake Hopatcong is not in this plant's historic native range, however it is native to a neighboring watershed, according to the USGS.

Two stations, HC-21 and HC-22, were observed to feature abundant densities of invasive brittle naiad (*Najas minor*) and common densities of Eurasian watermilfoil. In previous surveys, these stations had a higher richness of species present, including several native species. In 2021, HC-21 featured a significant population of white water lily (*Nymphaea odorata*), as well as lesser densities of both common bladderwort (*Utricularia vulgaris)* and humped/creeping bladderwort (*Utricularia gibb*a). In 2018, HC-21 and HC-22 were some of the most diverse stations observed in Lake Hopatcong, with 9 and 8 species, respectively.

HC-28 was observed to be one of the most species-rich stations in 2025, with a total of seven species. Tapegrass was observed in abundant densities, followed by elodea and Robins pondweed, both observed in common densities. Coontail, big leaf pondweed *(Potomogeton ampifolious*) and Eurasian watermilfoil were also present at this station.

HC-32 was also a particularly rich species station, with seven species observed. White water lily and Eurasian watermilfoil were both observed in abundant densities at this station. Tapegrass and common bladderwort were noted as slightly less prevalent at this station (common densities). Coontail, humped/creeping bladderwort, and brittle naiad were also present at this station. Additional species were also noted nearby but were not collected in the sample. These species included leafy pondweed (*Potomogeton foliosus*), ribbonleaf pondweed (*Potomogeton epihydrus*) and yellow pond lily (*Nuphar variegata*). Abundant patches of brittle naiad were also observed in the water near this station.

Mean species richness in Lake Hopatcong has been decreasing since 2018. In 2018, there were an average of 4.5 species per station. In 2021, the average had decreased to 2.8 species per station (Figure 3.6). In 2025, the average continued to decrease to 2.6 species per station at the original 22 stations.

The presence of various invasive species is a concern for the health of the lake and often outcompete the more desirable native plants. If these plants are left unchecked, they can take over entire areas of the lake, outcompeting natives and eliminating valuable habitat for fish and other aquatic organisms. This can cause a shift in the ecosystem and ultimately the health of the waterbody. The main species of concern are Eurasian watermilfoil, curly-leaf pondweed, brittle naiad, and tapegrass. While tapegrass is a native to this region and does have a value relative to aquatic habitats, it often attains nuisance densities within Lake Hopatcong. Brittle naiad and curly-leaf pondweed have also been observed in the lake and appear to be growing in increasing densities. Water chestnut (*Trapa natans*) is also an invasive species that has been identified in Lake Hopatcong over the last eight to ten years but has been closely monitored and hand pulled. Water chestnut was not observed at any of the stations during the 2025 survey, but it was identified by Princeton Hydro staff near the entrance to the Jefferson Canals.

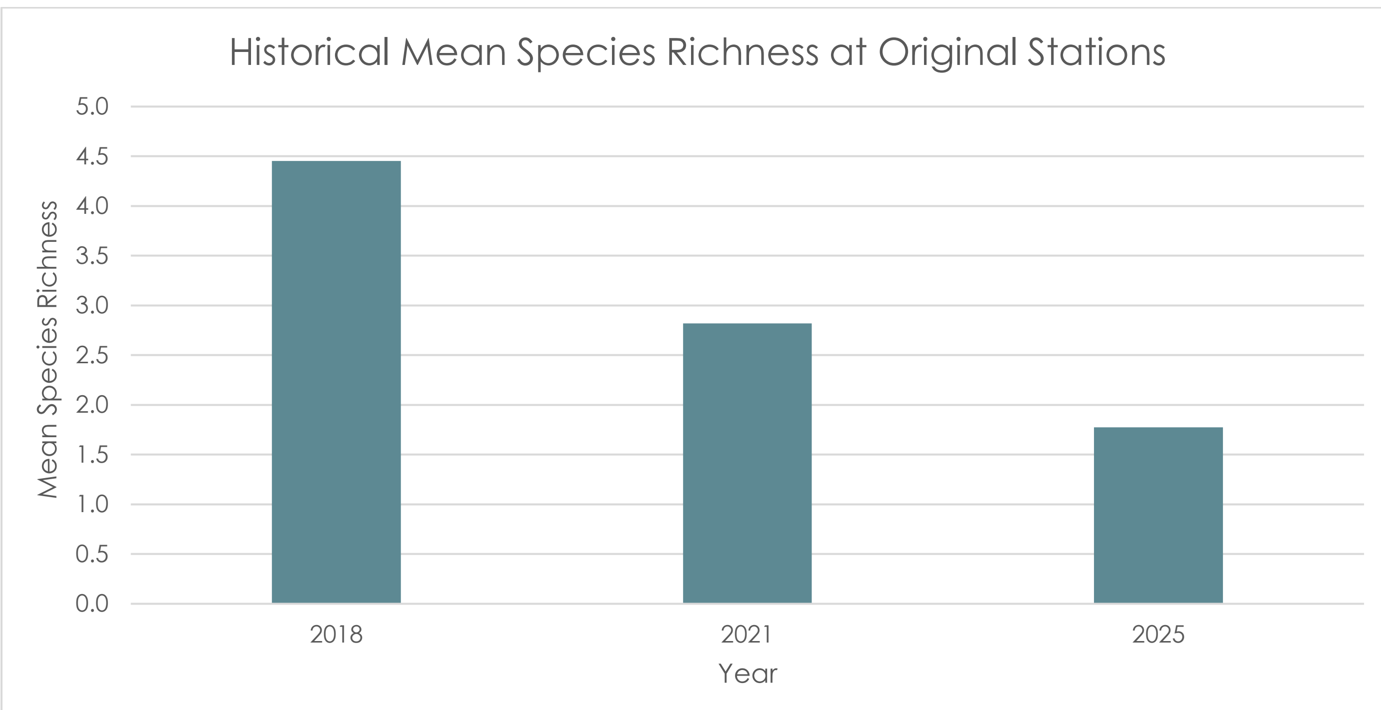


Figure 3.6: Mean species richness over time in Lake Hopatcong at original stations

3.2 PLANT BIOMASS AND NUTRIENT CONCENTRATIONS

The biomass and nutrient data collected from Lake Hopatcong during the 2025 survey is presented below in Table 3.1. Several stations with abundant plant densities, HC-7, HC-8, HC-10, and HC-25, had some of the highest TN and TP concentrations. HC-7 was observed to feature abundant densities of Eurasian watermilfoil, with respective TN and TP concentrations of 30,000 mg/kg and 13,000 mg/kg.

Overall biomass data collected had a significant range. The lowest biomass was observed at HC-2, where only 3.0 g/m^2 of plant mass was collected. The highest biomass was observed at HC-34, with 1,140.0 g/m^2 of plant material collected. The mean biomass for the entire 2025 survey was 328.3 g/m^2.

The mean TN and TP concentrations for the entire 2025 survey were 19,161.5 mg/kg and 5,623.1 mg/kg, respectively. These high values support the need for smart plant management, with an emphasis on mechanical harvesting that removes the biomass and nutrients from the system.

TN concentrations in plant biomass was not measured in the 2006 survey. However, TP was measured during the 2006 survey and overall concentrations were lower relative to the 2025 survey. For example, during the 2006 survey community-based TP concentrations varied between 1,140 and 3,930 mg/kg with a mean value of 2,285 mg/kg (n=8). In contrast, during the 2025 survey community-based TP concentrations varied between 2,100 and 13,000 mg/kg with a mean value of 5,623 mg/kg. Thus, TP concentrations in the plant biomass more than doubled from 2006 to 2025 (n=13). There may be one or a number of factors responsible for this increase in TP plant biomass, which may include, but not be limited to, changes within the composition of the aquatic plant community, an increase in the amount of epiphytic algae (attached to the plants), the creation of micro-habitats within the collected plant samples favoring the growth of planktonic algae and an increase in the mobilization of nutrients from the sediments to the plants. The same sampling methodology was utilized by Princeton Hydro and the same laboratory was used in the analysis of the samples so sampling and laboratory protocol were consistent between 2006 and 2025.

Table 3.1: Biomass and nutrient data for select sites in 2025.

Nutrient Analysis Data 2025				
Station	Wet Biomass g/m^2	Total Nitrogen mg/kg	Total Phosphate mg/kg	Percent Solids %
HC-1	436.0	15,000	4,000	9.3
HC-2	3.0	16,000	3,600	9.2
HC-6	116.0	15,000	2,100	10.0
HC-7	249.0	30,000	13,000	7.0
HC-8	219.0	29,000	8,400	6.8
HC-9	526.0	22,000	3,400	8.5
HC-10	126.3	9,100	11,000	6.6
HC-24	357.5	19,000	3,100	7.5
HC-25	279.0	32,000	6,000	7.5
HC-28	146.0	7,000	2,500	19.0
HC-32	597.0	14,000	6,500	8.5
HC-34	1,140.0	20,000	2,600	9.4
HC-35	72.5	21,000	6,900	6.4
Mean	328.3	19,161.5	5,623.1	8.9

3.3 RIVER STYX AND CRECENT COVE ANALYSIS

SAV community structure at the River Styx and Crecent Cove sampling stations for the September 2025 event are present below in Table 3.2.

Table 3.2: Community composition in River Styx and Crescent Cove in 2025

Location	Station	Eurasian watermilfoil *Myriophyllum spicatum*	Aquatic Moss *Fontinalis sp.*	Total Mass (g/m^2)
River Styx	HC-6	A	C	116
Crescent Cove	HC-7	A		249
Crescent Cove	HC-8	A		219
Crescent Cove	HC-9	A		526
Crescent Cove	HC-10	A		126

Overall, macrophyte densities were abundant in 2025 and were generally higher than those measured in 2021. Species richness was poor, with all stations being dominated by Eurasian watermilfoil. The lowest biomass values were identified at HC-6 and HC-10, with 116 g/m^2 and 126 g/m^2, respectively. The highest biomass value was observed at HC-9, reaching 526 g/m^2.

Comparisons of total biomass among the 2018, 2021 and 2025 SAV surveys are provided below in Tables 3.3 through 3.5.

Table 3.3: Changes in biomass from 2018 to 2021 in River Styx/Crescent Cove

Lake Hopatcong - River Styx/Crescent Cove Biomass

	HC-6 (g/m2)	HC-7 (g/m2)	HC-8 (g/m2)	HC-9 (g/m2)	HC-10 (g/m2)
2018	417.5	117	3.5	0.5	4
2021	72	402	298	13	9
Change	-345.5	285	294.5	12.5	5
% Change	-83%	244%	8414%	2500%	125%

Changes in biomass between 2018 and 2021 are shown above in Table 3.3. With the exception of HC-6, all stations were observed to feature an increase in biomass. HC-10 had the smallest increase at 125%, while HC-8 had an increase of 8,414%.

Table 3.4: Changes in biomass from 2021 to 2025 in River Styx/Crescent Cove

Lake Hopatcong - River Styx/Crescent Cove Biomass

	HC-6 (g/m2)	HC-7 (g/m2)	HC-8 (g/m2)	HC-9 (g/m2)	HC-10 (g/m2)
2021	72	402	298	13	9
2025	116	249	219	526	126
Change	44	-153	-79	513	117
% Change	61%	-38%	-27%	3946%	1303%

As shown above, biomass was significantly higher in 2025 compared to 2021 at HC-9 and HC-10. HC-9 had the most significant increase in biomass observed, with a 3,846% increase. HC-10 also had a significant increase in biomass, increasing by 1,303% from 2021 to 2025. HC-7 and HC-8 both had net decreases in biomass, between -27% and -38%.

Table 3.5: Changes in biomass from 2018 to 2025 in River Styx/Crescent Cove

Lake Hopatcong - River Styx/Crescent Cove Biomass

	HC-6 (g/m2)	HC-7 (g/m2)	HC-8 (g/m2)	HC-9 (g/m2)	HC-10 (g/m2)
2018	417.5	117	3.5	0.5	4
2025	116	249	219	526	126
Change	-301.5	132	215.5	525.5	122
% Change	-72%	113%	6157%	105100%	3056%

Long term changes in biomass from 2018 to 2025 are shown above in Table 3.5. HC-6 was the only station observed to feature a decrease in biomass, with a reduction of 72%. HC-9 had the most significant change in biomass, revealing a 105,100% increase. Stations HC-8 and HC-10 also had large increases of 6,157% and 3,056%, respectively.

It is interesting to note that from prior to the massive HAB event experienced in 2019 to 2025 SAV biomass declined by 72% (Table 3.5) in the River Styx section (HC-6), which is located adjacent to the main basin of Lake Hopatcong. In contrast, within the Crescent Cove section of the lake there has been a substantial increase in plant biomass from 2018 to 2025 (Table 3.5) at all four stations (HC-7 through HC-10). As shown in Table 3.2, these increases in biomass were exclusively due to Eurasian watermilfoil and three of these four stations (HC-7, HC-8, and HC-10) had the three highest community-wide TP concentrations.

Finally, there are some complex interrelationships that should be cited between Eurasian watermilfoil and cyanobacteria (the group of algae responsible for HABs). In laboratory studies, Eurasian watermilfoil is known to produce various molecules that can have an allelopathic impact on algae and cyanobacteria. In these studies, high concentrations of these molecules can negatively impact algae / cyanobacteria. However, in the field such impacts have not been documented. This is primarily due to the in-the-field concentrations of these molecules being substantially lower than those used in laboratory studies (Bergeron, et al., 2025). However, this does not mean that such allelopathic impacts do not exist in nature for specific cyanobacteria. In addition, Eurasian watermilfoil is known to be typically better adapted to growing in turbid, more eutrophic (nutrient-enriched) waters, particularly when compared to native plants (Padgett, 2024). Thus, conditions in the Crescent Cove section of the lake, particularly after the 2019 HAB event, may have contributed toward the proliferation of Eurasian watermilfoil. Algal blooms, increasing the turbidity, as well as high nutrient concentrations in the water and the sediments, may collectively favor the growth of Eurasian watermilfoil in Crescent Cove.

3.4 EDNA ANALYSIS

Water samples collected in Lake Hopatcong were analyzed via metabarcoding for fish and plant species, as well as qPCR analysis for zebra mussels and quagga mussels.

Both invertebrate species of concern, zebra mussels and quagga mussels returned negative results. This does not definitively mean they are not present in the lake, but there have been no observations of either species, and these results further support that.

None of the three invasive plant species of concern (Hydrilla, Carolina fanwort and water chestnut) were detected in Lake Hopatcong using eDNA techniques. However, a small population of water chestnut was observed in the lake in 2025. Carolina fanwort and hydrilla were not observed. eDNA analysis is a novel technique and has limitations on its use at this time. Aquatic plants give off very little eDNA compared to other organisms, so continued visual monitoring is crucial for the early detection of these plants.

In addition, none of the fish species of concern (Northern snakehead, flathead catfish, and round goby) were detected in the lake through eDNA analysis.

Tables with full metabarcoding results from each station are provided in Appendix III. These tables contain the species and/or taxonomic groups found at or above a 90% match in each sample. The "% Match" column represents the percentage of base-pairs in the assessed sample that match to known base-pairs in a known data base of species and higher taxonomic groups. The "frequency of occurrence" column refers to the number of times one of these base pairs was detected in the sample. It should be noted that this may not directly correlate to overall density of that species or group of species.

Of interesting note is the detection of base pairs for *Vallisneria denseserrulata* x *Vallisneria spiralis.* This would be an invasive hybrid species of tapegrass. The lake is known to contain a large population of the American species of tape grass *Vallisneria americana.* It is likely that *V. americana* is simply not present in the library of available base pairs and is closely related enough to the invasive hybrid that it triggers a base-pair match for the invasive hybrid. An ecological risk screening summary by the U.S. Fish and Wildlife Service for the invasive parent species *V. spiralis* cites Gorham et al. (2021)'s findings of this hybrid only in Florida and Alabama.

4.0 SUMMARY AND RECOMMENDATIONS

Princeton Hydro conducted a late-summer SAV survey at 37 near-shore stations at Lake Hopatcong on 2 and 3 September 2025. This survey followed the same methodology as surveys conducted in 2018 and 2021, building on the valuable database. Monitoring the SAV community over time allows for a better understanding of the state of invasive and native plants and facilitates the design and implementation management practices to manage the SAV community.

The most common species observed during this survey was Eurasian watermilfoil, followed by tapegrass. Historically, these have been the most dominant plant species found in Lake Hopatcong. Although Eurasian watermilfoil has been the most dominant species in the lake for years, the data collected in 2025 shows that the species has become increasingly dominant over the past 7 years which has coincided with a decrease in species richness. An increase in turbidity, particularly associated with the large HAB event of 2019, may have contributed toward this increase in Eurasian watermilfoil. Additionally, elevated nutrient concentrations in the water and sediments in the Crescent Cove section of the lake may have also contributed toward this dominance of Eurasian watermilfoil.

Following Eurasian watermilfoil and tapegrass, the next most frequently occurring species were southern naiad and coontail. Coontail is a native species that lacks true roots and has the ability to absorb nutrients directly from the water column, as opposed to obtaining nutrients solely through the sediment. This species may be beneficial in Lake Hopatcong as it can act as a nutrient sequestering plant. However, it also has the ability to grow to nuisance densities and can form dense mats that inhibit all types of recreation.

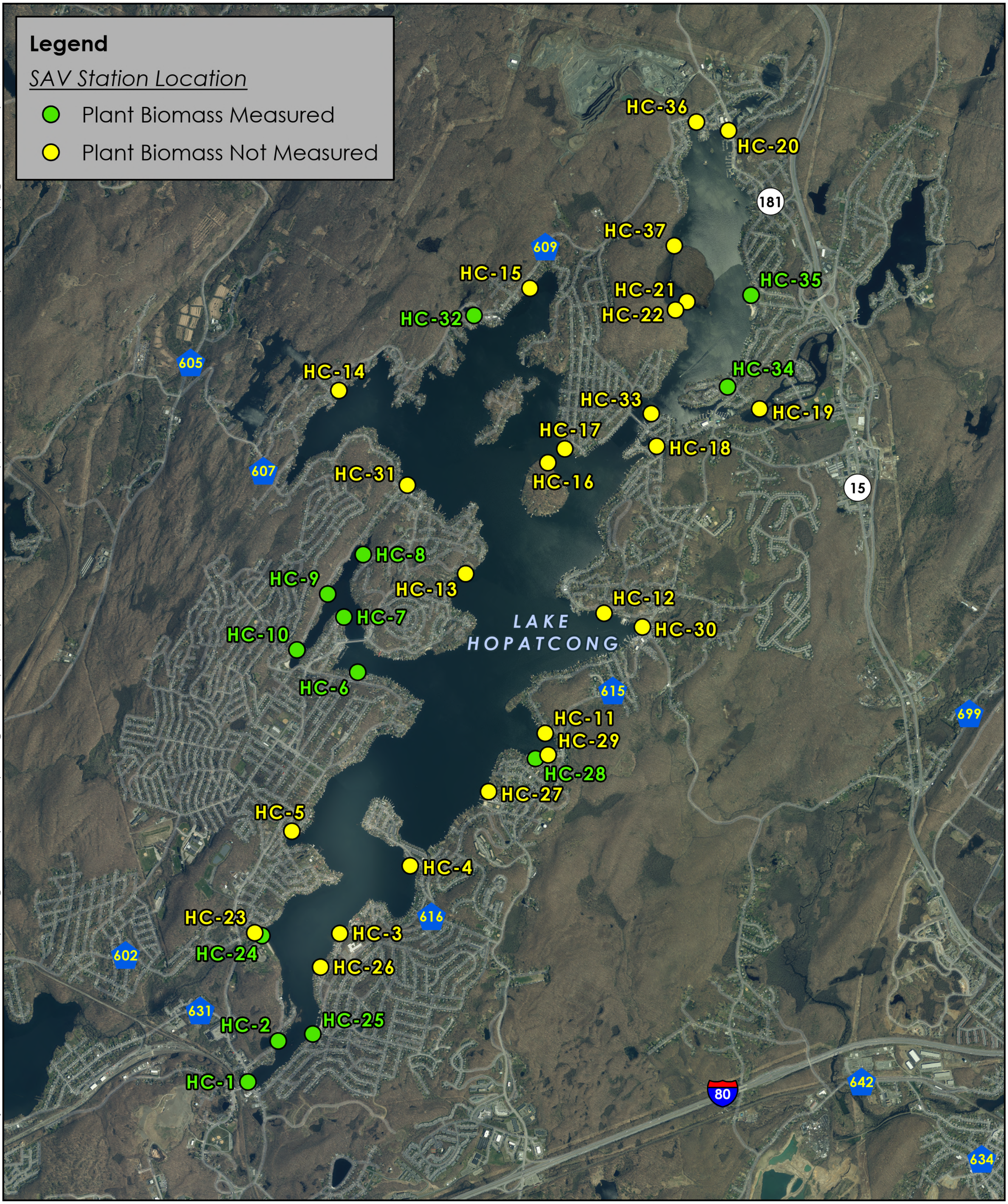
Since the 2018 survey, a decrease in overall plant richness has been observed. This is likely due to invasive species, like Eurasian watermilfoil, outcompeting native plants for habitat. In addition, increasing densities of invasive plants have been observed throughout the lake since 2018. Curly-leaf pondweed and brittle naiad were both observed as abundant for the first time during the 2025 survey. These plants have been observed in the lake since the 2018 survey, where they were observed as present. In 2021, their density did not appear to increase, as both species were also only observed in present densities.

It is possible that the decrease in water clarity throughout Lake Hopatcong over the past few years is favoring invasive plants that are generally more tolerable of less favorable conditions. Some invasive species, like Eurasian watermilfoil, are able thrive in low light conditions where other plants may not be able to grow. This species has the unique ability to form dense canopies along the surface where light is plentiful.

The eDNA analysis for invertebrate, plant and fish species of concern all returned negative results, indicating a lack of their presence in the lake. While this is a positive indication that these species have not established themselves in the lake, eDNA analysis is a novel technique with challenges and limitations to its utility. Combining traditional and novel sampling methods is recommended to ensure a comprehensive analysis and assessment of invasive species in the lake.

It is recommended that similar SAV plant surveys occur at least every three years to support the continuous development of the database that can be used to inform management decisions. Continued eDNA analysis is also recommended, as it serves as a cost-effective technique to detect new invasive species. It is also recommended that biomass samples continue to be collected from the River Styx / Crescent Cove areas. The data collected in 2025 also highlights the need to reduce nutrient concentrations and improve water clarity to restore the balance to the macrophyte community. Mechanical harvesting is recommended as the primary management technique, as this is the only strategy that will remove the plant biomass and nutrients from the lake. Herbicides should be used sparingly, and preference should be given to selective herbicides that can target Eurasian watermilfoil.

APPENDIX I: SAMPLING FIGURE



Notes:
1. SAV station locations are approximate.
2. 2020 orthoimagery and roads obtained from the NJ Geographic Information Network (NJGIN) Open Data portal: https://njgin.nj.gov/

0 2,000 4,000 Feet

Spatial Reference: NAD 1983 2011 StatePlane New Jersey FIPS 2900 Ft US

SAV STATION LOCATION MAP

2025 LAKE HOPATCONG SAV SURVEY
MORRIS AND SUSSEX COUNTIES
NEW JERSEY

PRINCETON HYDRO
SCIENCE DESIGN ENGINEERING
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APPENDIX II: SAV RESULTS

Lake Hopatcong 2025 SAV

Location	Station	White Waterlily	Southern Naiad	Tape Grass	Large Leaf Pondweed	Eurasian watermilfoil	Robbin's Pondweed	Elodea	Coontail	Nitella	Chara	Curly Leaf Pondweed	Leafy Pondweed	Yellow Pond Lily	Common Bladderwort	Humped/ Creeping Bladderwort	Brittle naiad	Bur-Reed	Common duck-meal	Aquatic Moss
		Nymphaea odorata	*Najas guadalupensis*	*Vallisneria americana*	*Potamogeton amplifolius*	*Myriophyllum spicatum*	*Potamogeton robbinsii*	*Elodea canadensis*	*Ceratophyllum demersum*	*Nitella Flexilis*	*Chara sp.*	*Potamogeton crispus*	*Potamogeton foliosus*	*Nuphar variegata*	*Utricularia vulgaris*	*Utricalaria gibba*	*Najas minor*	*Sparganium sp.*	*Spirodela polyrrhiza*	*Fontinalis sp.*
Landing	HC-1	A				A														
Landing Island	HC-2					P														
Near Silver Springs	HC-3			P		C														
King Cove	HC-4																			
Ingram Cove	HC-5		P	P		C														
River Styx	HC-6					A														C
Crescent Cove	HC-7					A														
Crescent Cove	HC-8					A														
Crescent Cove	HC-9					A														
Crescent Cove	HC-10					A														
Van Every Cove	HC-11																			
Great Cove	HC-12		A	A		C			P											
Davis Cove	HC-13																			
Byram Cove	HC-14																			
Henderson Cove	HC-15					A						P								
Halsey Island Shore	HC-16		P	C		C		P			C									
Halsey Main Shore	HC-17		A	P						P	A									
N Cherry Rd Cove	HC-18																			
Below Espanong Rd Bridge	HC-19				A													P		
Flash Marina	HC-20			C		A														
Liffy Island Shore	HC-21					C											A			
Liffy Main Shore	HC-22			C		C				P							A			
Outlet/Dam	HC-23			A		A														
State Park Launch	HC-24		C	A		C					C									
Shore Hills Marina	HC-25	C				A														
Opposite of State Park	HC-26		P			A														
Barnes Bros. Marina	HC-27			A		P			P											
Lee's Marina 1	HC-28			A	P	P	C	C	P				P							
Lee's Marina 2	HC-29			A		C						A								
Great Cove Marinas	HC-30		P	A		C		A	P											
Witten Park	HC-31			A		P							A							
Mountain Brook	HC-32	A		C		A			P						C	P	P			
Bridge Marina	HC-33	A		C		P									C					
Ashley Cove	HC-34			C	A	C			A						P				P	
Lake Forest Yacht Club	HC-35			A		C						P								
Woodport Bay	HC-36					A														
Liffy Island North	HC-37			P		A			P					C						

APPENDIX III: METABARCODING RESULTS

Plant eDNA results for Southern River Styx (HC-6)

Order	Family	Genus	Species	Common Name	% Match	Frequency of Occurrence
Desmidiales	Desmidiaceae	Teilingia	Teilingia granulata	Teilingia	93.1	787
Desmidiales	Desmidiaceae	Cosmarium		Cosmarium	90.3	95
Saxifragales	Haloragaceae	Myriophyllum		Milfoils	100	9233
Desmidiales	Desmidiaceae			Desmids	91.9	944
Alismatales	Araceae			Arum Family	100	833

Fish eDNA results for Southern River Styx (HC-6)

Family	Genus	Species	Common Name	% Match	Frequency of Occurrence
Clupeidae	Alosa	Alosa pseudoharengus	Alewife	100.0	2023
Centrarchidae	Ambloplites	Ambloplites rupestris	Rockbass	100.0	103
Ictaluridae	Ameiurus	Ameiurus natalis	Yellow Bullhead	100.0	14
Leuciscidae	Cyprinella	Cyprinella analostana	Satinfin Shiner	100.0	380
Esocidae	Esox	Esox masquinongy	Muskellunge	100.0	115
Centrarchidae	Lepomis	Lepomis auritus	Redbreast Sunfish	100.0	527
Centrarchidae	Lepomis	Lepomis macrochirus	Bluegill	100.0	5610
Moronidae	Morone	Morone americana	White Perch	100.0	777
Leuciscidae	Notemigonus	Notemigonus crysoleucas	Golden Shiner	100.0	9864
Percidae	Perca	Perca flavescens	Yellow Perch	100.0	2190
Percidae	Sander	Sander vitreus	Walleye	100.0	107
Centrarchidae	Micropterus		Black Bass Genus	100.0	1207
Ictaluridae	Ameiurus		Bullhead genus	100.0	117
Cyprinidae	Cyprinus		Carp genus	100.0	106
Centrarchidae	Pomoxis		Crappie genus	100.0	814
Cyprinidae			Minnow/Carp Family	97.7	15
Esocidae	Esox		Pike genus	100.0	375
Centrarchidae			Sunfish Family	94.7	76
Centrarchidae	Lepomis		Sunfish Genus	100.0	8806

Plant eDNA results for Jefferson Canals (HC-19)

Order	Family	Genus	Species	Common Name	% Match	Frequency of Occurrence
NO MATCHES DETECTED						

Fish eDNA results for Jefferson Canals (HC-19)

Family	Genus	Species	Common Name	% Match	Frequency of Occurrence
Centrarchidae	Ambloplites	Ambloplites rupestris	Rockbass	100.0	100
Catostomidae	Erimyzon	Erimyzon oblongus	Creek Chubsucker	100.0	567
Percidae	Etheostoma	Etheostoma olmstedi	Tessellated Darter	100.0	78
Centrarchidae	Lepomis	Lepomis auritus	Redbreast Sunfish	100.0	73
Centrarchidae	Lepomis	Lepomis macrochirus	Bluegill	100.0	10403
Leuciscidae	Notemigonus	Notemigonus crysoleucas	Golden Shiner	100.0	4168
Percidae	Perca	Perca flavescens	Yellow Perch	100.0	5780
Percidae	Sander	Sander vitreus	Walleye	100.0	42
Centrarchidae	Lepomis		Sunfish Genus	100.0	11342
Centrarchidae	Pomoxis		Crappie genus	100.0	1628
Esocidae	Esox		Pike genus	100.0	880
Centrarchidae	Micropterus		Black Bass Genus	100.0	877
Centrarchidae	Lepomis		Sunfish Genus	96.4	481
Centrarchidae	Enneacanthus		Enneachanthus Sunfish genus	100.0	331
Centrarchidae	Lepomis		Sunfish Genus	100.0	306
Cyprinidae	Cyprinus		Carp genus	100.0	208
Centrarchidae			Sunfish Family	95.9	89
Ictaluridae	Ameiurus		Bullhead genus	100.0	32

Plants eDNA results for Liffy Island South (HC-21)

Order	Family	Genus	Species	Common Name	% Match	Frequency of Occurrence
Zygnematales	Zygnemataceae	Spirogyra	Spirogyra maxima	Spirogyra algae	93.3	9
Alismatales	Hydrocharitaceae	Vallisneria	Vallisneria denseserrulata x Vallisneria spiralis	Tapegrass	100.0	631
Saxifragales	Haloragaceae	Myriophyllum		Milfoils	100.0	4876
Nymphaeales	Nymphaeaceae	Nuphar		Yellow Pond Lilies	100.0	8130
Nymphaeales				Water Lily Order	100.0	8069
Nymphaeales	Nymphaeaceae			Waterlily Family	96.0	251

Fish eDNA results for Liffy Island South (HC-21)

Family	Genus	Species	Common Name	% Match	Frequency of Occurrence
Centrarchidae	Lepomis	Lepomis auritus	Redbreast Sunfish	100.0	25
Centrarchidae	Lepomis	Lepomis macrochirus	Bluegill	100.0	6291
Centrarchidae	Micropterus	Micropterus salmoides	Largemouth Bass	100.0	184
Leuciscidae	Notemigonus	Notemigonus crysoleucas	Golden Shiner	100.0	396
Percidae	Perca	Perca flavescens	Yellow Perch	100.0	806
Ictaluridae	Ameiurus		Bullhead genus	100.0	19
Cyprinidae	Cyprinus		Carp genus	100.0	24469
Centrarchidae	Enneacanthus		Enneachanthus sunfish genus	100.0	72
Esocidae	Esox		Pike genus	100.0	103
Centrarchidae	Lepomis		Sunfish Genus	100.0	6238
Centrarchidae	Micropterus		Black Bass Genus	100.0	690
Centrarchidae	Pomoxis		Crappie genus	100.0	543
Cyprinidae			Minnow/Carp Family	95.4	137

Plant eDNA results for the State Park Boat Launch (HC-24)

Order	Family	Genus	Species	Common Name	% Match	Frequency of Occurrence
Alismatales	Potamogetonaceae	Potamogeton	Potamogeton crispus	Curlyleaf Pondweed	100.0	326
Alismatales	Hydrocharitaceae	Vallisneria	Vallisneria denseserrulata x Vallisneria spiralis	Tapegrass	100.0	21839
Desmidiales	Desmidiaceae	Cosmarium		Cosmarium	94.4	50
Saxifragales	Haloragaceae	Myriophyllum		Milfoils	100.0	7997
Alismatales				Flowering Plant order (contains some aquatics)	96.3	84

Fish eDNA results for the State Park Boat Launch (HC-24)

Family	Genus	Species	Common Name	% Match	Frequency of Occurrence
Clupeidae	Alosa	Alosa pseudoharengus	Alewife	100.0	107
Centrarchidae	Ambloplites	Ambloplites rupestris	Rockbass	100.0	23
Leuciscidae	Cyprinella	Cyprinella analostana	Satinfin Shiner	100.0	543
Percidae	Etheostoma	Etheostoma olmstedi	Tessellated Darter	99.4	43
Centrarchidae	Lepomis	Lepomis auritus	Redbreast Sunfish	100.0	28
Centrarchidae	Lepomis	Lepomis macrochirus	Bluegill	100.0	1022
Moronidae	Morone	Morone americana	White Perch	100.0	49
Leuciscidae	Notemigonus	Notemigonus crysoleucas	Golden Shiner	100.0	168
Percidae	Perca	Perca flavescens	Yellow Perch	100.0	477
Percidae	Sander	Sander vitreus	Walleye	100.0	18
Centrarchidae	Micropterus		Black Bass Genus	100.0	172
Cyprinidae	Cyprinus		Carp genus	100.0	83
Centrarchidae	Pomoxis		Crappie genus	100.0	140
Esocidae	Esox		Pike genus	100.0	68
Centrarchidae	Lepomis		Sunfish Genus	100.0	27298

Plant eDNA results for Lee's Marina 1 (HC-28)

Order	Family	Genus	Species	Common Name	% Match	Frequency of Occurrence
Alismatales	Hydrocharitaceae	Vallisneria	Vallisneria denseserrulata x Vallisneria spiralis	Tapegrass	100.0	6153
Saxifragales	Haloragaceae	Myriophyllum		Milfoils	100.0	1924
Desmidiales	Desmidiaceae	Cosmarium		Cosmarium	90.3	529

Fish eDNA results for Lee's Marina 1 (HC-28)

Family	Genus	Species	Common Name	% Match	Frequency of Occurrence
Ictaluridae	Ameiurus	Ameiurus natalis	Yellow Bullhead	100.0	115
Percidae	Etheostoma	Etheostoma olmstedi	Tessellated Darter	100.0	494
Centrarchidae	Lepomis	Lepomis auritus	Redbreast Sunfish	100.0	139
Centrarchidae	Lepomis	Lepomis macrochirus	Bluegill	100.0	12877
Centrarchidae	Micropterus	Micropterus salmoides	Largemouth Bass	100.0	299
Leuciscidae	Notemigonus	Notemigonus crysoleucas	Golden Shiner	100.0	2728
Percidae	Perca	Perca flavescens	Yellow Perch	100.0	2767
Percidae	Sander	Sander vitreus	Walleye	100.0	184
Centrarchidae	Lepomis		Sunfish Genus	100.0	5904
Centrarchidae	Micropterus		Black Bass Genus	100.0	1144
Centrarchidae	Lepomis		Sunfish Genus	98.2	384
Centrarchidae	Pomoxis		Crappie genus	100.0	197
Cyprinidae	Cyprinus		Carp genus	100.0	70
Cyprinidae			Minnow/Carp Family	98.9	6