Maryland Department of Natural Resources

Tidewater Ecosystem Assessment

New Germany Lake
SAV Survey
2013

Report of Survey Activity and Results

December 2013

Prepared For

Maryland Department of Natural Resources

Maryland Park Service

Prepared by

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SUMMARY AND RECOMMENDATIONS

The Maryland Department of Natural Resources (DNR) initiated a submerged aquatic vegetation (SAV) survey in New Germany Lake during summer 2011, and repeated this survey in summers 2012 and 2013. The goal of the SAV surveys was to define the distribution and relative abundance of SAV species present within the lake and monitor changes in species composition and distribution over time.

Several species of Naiads (*Najas* spp) and Pondweeds (*Potamogeton* spp) are present in New Germany Lake, as well as other vascular plants of the genera *Isoetes, Utricularia*, and *Myriophyllum.* Two species of macroalgae, *Chara* and *Nitella*, are also commonly observed. In 2011, biodiversity was high relative to the size of the lake, but high plant density was considered an impediment to recreation. During the 2011-2012 winter season, a near total drawdown of the lake water level was completed in an attempt to decrease the standing plant biomass the following summer. It appears this method of control was counter-productive. During the summer 2012 SAV surveys, it was observed that biodiversity decreased substantially while the invasive *Najas minor* (Brittle naiad) was observed in high densities throughout the lake at the detriment of native species. Water level drawdown did not take place again during the 2012-2013 winter season, and the summer 2013 SAV survey results indicate that in the absence of that control measure, the native plants were able to out-compete *N. minor*.

At this time, we are cautiously optimistic that *N. minor* abundance in New Germany Lake is being controlled by native plants. DNR recommends SAV surveys during summer 2014 to confirm that *N. minor* has not increased in abundance again, and will continue to be a non-threat to the native plants and overall biodiversity.

DNR recommends that throughout the summer 2014 season, all swimmers and boaters be alerted to the invasive nature of *N. minor* and other exotic species. Specific action to combat the spread of invasive species may include fact sheets for distribution throughout the park and informational signage at the boat ramp, beach/swim area, and in the clubhouse. DNR encourages park staff members to speak directly with visitors to alert them of the problem and provide information regarding the cleaning of any swim or boating gear before and after entering the lake. Further information about preventing the spread of invasive species should be made available on the park's website.

INTRODUCTION

In response to concerns regarding increased amounts of submerged aquatic vegetation (SAV) in New Germany Lake, the Maryland Department of Natural Resources, Resource Assessment Service (RAS) initiated an SAV survey in summer 2011, and repeated this survey in summers 2012 and 2013. The goal of the SAV surveys was to define the distribution and relative abundance of SAV species present within the lake and monitor changes in species composition and distribution over time.

Background

Located in New Germany State Park in western Maryland, New Germany Lake is a 13 acre lake surrounded by forests. Prior to 1837, it was a 9-15 foot channelized stream called Poplar Lick Run. In 1837 the Swauger Mill Dam was constructed, creating a 9 acre lake. Lake size increased to 13 acres in 1933 when the current dam was constructed two feet higher with a concrete spillway at the same site as Swauger Mill Dam.

Today the lake is the State Park's center of summertime activity. Non-motorized small boats are available to rent; fisherman enjoy the largemouth bass, catfish, bluegill, and trout; and swimming is available from the "east beach" within a guarded swimming area. Snorkelers are likely to get a glimpse of the many salamanders that hide within and among the SAV and submerged tree limbs, and possibly even a Hellbender, a species of giant salamander endemic to North America. Hellbenders are becoming exceedingly rare and although they normally inhabit areas with large rocks and swiftly moving water, one was seen several years ago in New Germany Lake.

Because the lake is stream-fed, it receives nutrient and sediment run-off from the surrounding watershed. Fueled by the incoming nutrients and increased water temperatures, SAV begins growing throughout the lake beginning in late spring. Similar to their terrestrial counterparts, SAV are underwater grasses which provide a myriad of important ecological functions. Through the process of photosynthesis, SAV produces oxygen which is vital to the survival of all lake organisms. It provides food, habitat and nursery grounds for many species of fish and invertebrates. It absorbs nutrients which decreases the likelihood of algal blooms and also improves water clarity by reducing turbulence which allows suspended solids to settle to the bottom and get incorporated into plant root systems. It reduces shoreline erosion by reducing the effects of waves and currents, and it is a major food source for waterfowl. Healthy native aquatic plant communities also help prevent the establishment of invasive plants like Eurasian watermilfoil (*Myriophyllum spicatum*) and Waterthyme (*Hydrilla verticillata*).

METHODS

Field

Submerged aquatic vegetation surveys took place on June 18, August 14, and September 26, 2013. Using SCUBA or snorkel gear, natural resource biologists sampled 30-35 0.25m^2 quadrats placed systematically but haphazardly throughout the lake. Exact quadrat locations (latitude and longitude) were recorded using a Garmin handheld GPS device. Within each quadrat, a total SAV percent cover was estimated, which included all macrophytes, both vascular plants and macroalgae, as well as the percent cover of each species present. In 2013, *Chara vulgaris* and

Nitella flexilis, the two species of macroalgae observed, were not differentiated as they had been in the past, but simply recorded as macroalgae due to the difficulty in accurately identifying them underwater.

Data Analysis

For each sampling event, average percent cover and frequency of occurrence values were calculated for total SAV, total Macroalgae, total *Najas spp.*, total *Potamogeton spp.*, total Other, and for each vascular plant species observed.

Average percent cover and frequency of occurrence for each species and genera were calculated using the following formulas:

Frequency of Occurrence = # of quadrats where observed /total # of quadrats surveyed

Average Percent Cover = sum of % cover values/ total # of quadrats surveyed

Average percent cover and frequency of occurrence graphs were created to show macrophyte density and "patchiness" change over time. To show trends in the distribution and density of each macrophyte group throughout the lake, maps were created in ArcGIS using the georeferenced percent cover data. Shapefiles for each sampling event were created, and from these, interpolated grid surfaces were created using the default settings of the Inverse Distance Weighted (IDW) function in the Spatial Analyst Extension. Total SAV, total Macroalgae, total *Najas*, total *Potamogeton*, and total Other were interpolated and mapped for each sampling event. Total Other includes *Utricularia vulgaris*, *Isoetes* sp., and both *Myriophyllum heterophyllum* and *M. sibiricum*.

Depth data were collected during the 2012 SAV surveys. These values were interpolated and mapped using the same method as the SAV interpolation. Depth data was not collected again in 2013. In general, New Germany Lake is relatively shallow (0.5 m to ~ 2.2 m) with the deepest area near the dam (Figure 1).

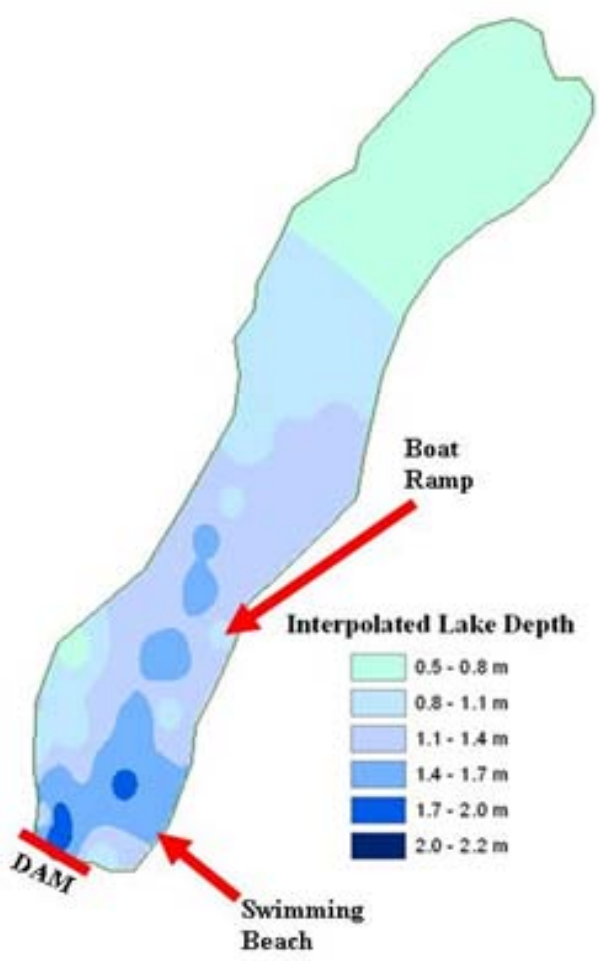


Figure 1. Interpolated water depth (meters) in New Germany Lake during summer 2012 SAV surveys.

RESULTS

During the summer 2013 New Germany Lake SAV surveys, three genera of submerged aquatic vegetation and two genera of macroalgae were observed. Present were *Najas*, *Potamogeton*, and *Myriophyllum*. Four species of *Najas* were observed, including *N. flexilis, N. gracillima, N. guadalupensis*, and *N. minor*, an exotic invasive. Three species of *Potamogeton* were observed. These include *P. pusillus, P. robbinsii*, and *P. diversifolius*. *Myriophyllum sibiricum* and *M. heterophyllum* were also observed, both native species of Watermilfoil. The macroalgae observed were *Chara vulgaris* and *Nitella flexilis.*

In 2012, we observed *Najas flexilis, N. guadalupensis, N. minor, Potamogeton pusillus, P. diversifolius, Heteranthera dubia* (a single shoot in a single quadrat, so not counted in analyses) and the macroalgae *Chara vulgaris* and *Nitella flexilis.* During summer 2011, four genera of vascular plants were observed, including four species of *Potamogeton*, four species of *Najas*, one species of *Utricularia*, and one species of *Isoetes*. See Table 1 for the list of species, their common names, and abbreviations used in figures. Descriptions of each species or genus are given in Appendix A.

Table 1. List of macrophytes observed in New Germany Lake during summers 2011, 2012, and 2013 SAV surveys.

Species	Abbreviation	Common name
Potamogeton pusillus	Pp	Slender pondweed
Potamogeton vasey	Pv	Vasey's pondweed
Potamogeton spirillus	Ps	Spiral pondweed
Potamogeton diversifolius	Pd	Waterthread pondweed
Potamogeton robbinsii	Pr	Robbin's pondweed
Najas flexilis	Nf	Nodding naiad
Najas gracillima	Ng	Slender naiad
Najas guadalupensis	Ngp	Southern naiad
Najas minor	Nm	Brittle naiad (spiny)
Utricularia vulgaris	Uv	Common bladderwort
Isoetes spp.	Iso	Quillwort
Myriophyllum sibiricum	Ms	Northern watermilfoil
Myriophyllum heterophyllum	Mh	Two-leafed watermilfoil
Chara vulgaris	Cv	Chara
Nitella flexilis	Nit	Nitella

Average percent cover values are given in Table 2 and graphed in Figure 2. Frequencies of occurrence are given in Table 3 and graphed in Figure 3. Total SAV cover was 53% on June 18, 2013, down from the previous June's 60%. Total SAV frequency of occurrence was 94%, meaning that SAV was found throughout the lake. *Najas* dominated at this time, and of the species of *Najas* present, the non-native *N. minor* dominated those. Very sparse *P. pusillus* was observed, as well as *M. sibiricum*. Macroalgae was also very sparse at this time.

Table 2. Average percent cover values for total SAV, total Macroalgae, total *Najas spp.*, total *Potamogeton spp.*, and total Other, as well as individual species, observed during 2011, 2012, and 2013 SAV surveys in New Germany Lake.

Average Percent Cover (%)

Date	SAV	MA	Nf	Ng	Ngp	Nm	Total *Najas*	Pp	Pv	Pr	Ps	Pd	Total *Pot*	Uv	Iso	Myr	Other
June '11	62	53	0.6	0	0	0	0.6	1	0	0	2	0	4	0	6	0	6
Aug '11	76	23	24	15	0	0	15	0	0.1	0	11	2	13	0	0	0	0
Sept '11	81	20	13	32	8	0.8	54	2	0.2	0	0	2	4	2	0	0	2
June '12	60	51	5	0	0	2	7	2	0	0	0	0	2	0	0	0	0
Aug '12	71	6	9	0	3	52	64	0	0	0	0	0	0	0	0	0	0
Sept '12	89	0	3	0	8	76	87	0	0.3	0	0	0.1	0.4	0	0	0	0
June '13	53	4	0.6	3	8	36	48	2	0	0	0	0	2	0	0	0.2	0.2
Aug '13	95	20	17	25	23	2	67	0.2	0	0	0	6	7	0	0	2	2
Sept '13	80	2	37	32	0	5	74	2	0	0.8	0	0.6	4	0	0	0	0

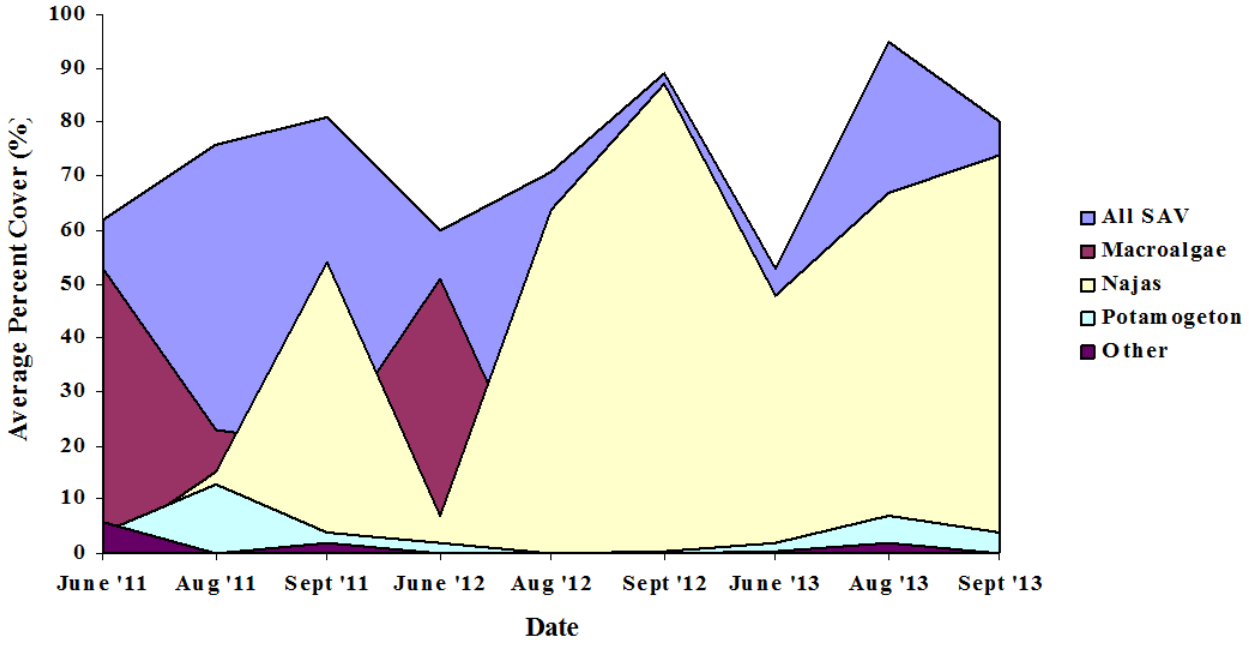


Figure 2. Average percent cover graph for 'All SAV' and other major macrophyte groups.

By August, average total SAV cover increased to 95% with 100% frequency of occurrence. Total macroalgae increased to 20% average cover and 40% frequency, but *Najas* continued to be the dominant genus observed at 67% mean cover and 90% frequency of occurrence. Interestingly, *N. minor* decreased to 2% average cover with low occurrence, while *N. flexilis*, *N. gracillima*, and *N. guadalupensis* were about even at 17%, 25%, and 23% mean cover, respectively. *Potamogeton pusillus* and *P. diversifolius* were sparse, as was *M. heterophyllum*.

Table 3. Frequencies of Occurrence values for total SAV, total Macroalgae, total *Najas spp.*, total *Potamogeton spp.*, and total Other, as well as individual species, observed during 2011, 2012, and 2013 SAV surveys in New Germany Lake.

Frequency of Occurrence (%)

Date	SAV	MA	Nf	Ng	Ngp	Nm	Total *Najas*	Pp	Pv	Pr	Ps	Pd	Total *Pot*	Uv	Iso	Myr	Other
June '11	96	76	2	0	0	0	2	10	2	0	24	0	36	0	18	0	18
Aug '11	92	38	41	51	0	0	51	0	3	0	44	5	51	0	0	0	0
Sept '11	98	36	31	51	11	4	67	9	4	0	0	11	24	2	0	0	2
June '12	94	84	23	0	0	13	29	6	0	0	0	0	6	0	0	0	0
Aug '12	97	7	23	0	3	70	90	0	0	0	0	0	0	0	0	0	0
Sept '12	100	0	8	0	17	92	100	0	3	0	0	8	11	0	0	0	0
June '13	94	32	3	13	23	81	90	6	0	0	0	0	6	0	0	3	3
Aug '13	100	40	60	50	47	10	90	3	0	0	0	23	27	0	0	3	3
Sept '13	94	3	70	70	0	15	94	18	0	9	0	6	30	0	0	0	0

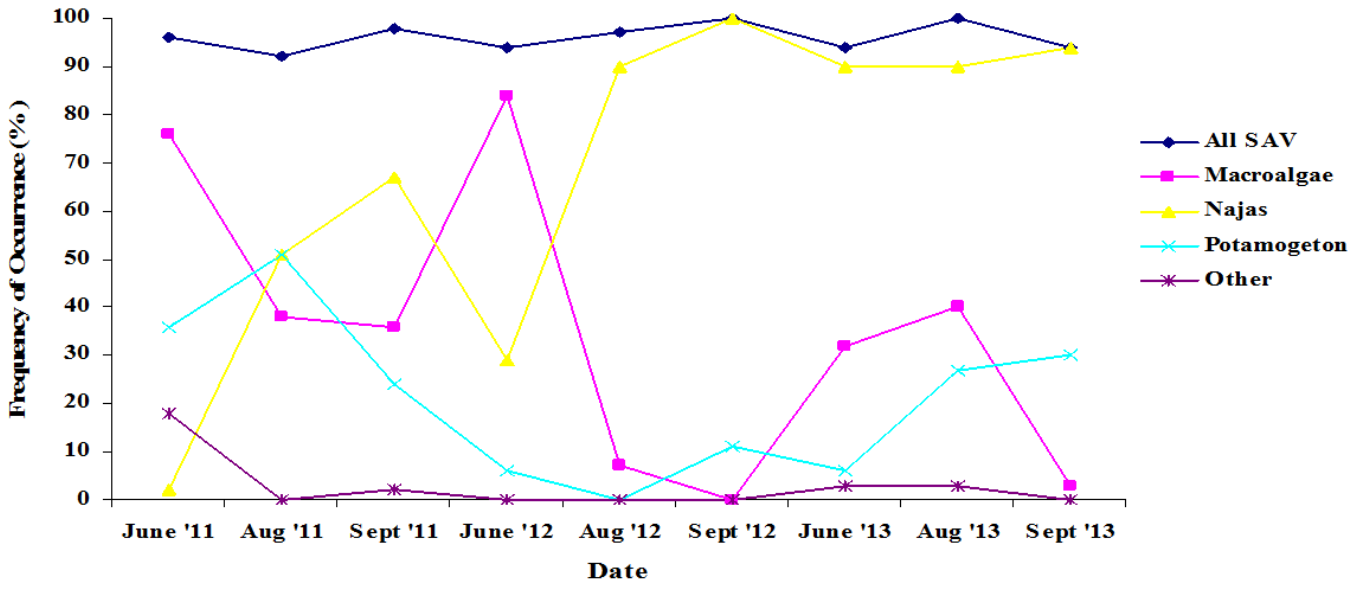


Figure 3. Frequency of Occurrence graph for 'All SAV' and other major macrophyte groups.

During the early fall survey on September 26th, average total SAV cover had fallen back to 80% cover and a 94% frequency of occurrence, with macroalgae composing only 2% of that. *Najas* remained dominant at 74% mean cover with *N. flexilis* and *N. gracillima* at 37% and 32%, respectively. *Najas minor* made up only 5% of the *Najas* total (Figure 4). *Potamogeton pusillus*, *P. robbinsii*, and P. *diversifolius* put total *Potamogeton* at 4% mean cover. No *Myriophyllum* was observed during this sampling event.

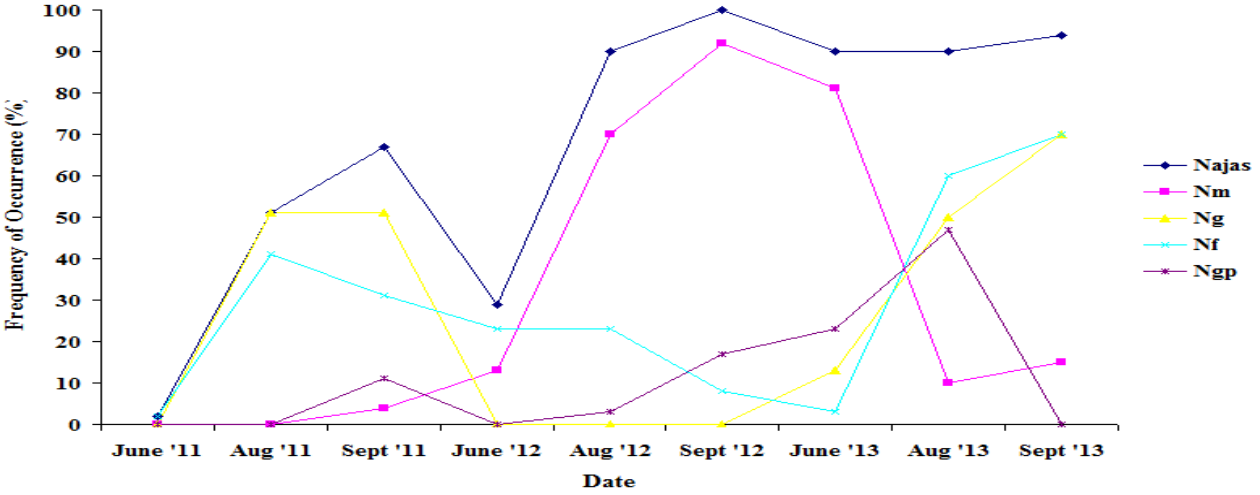


Figure 4. Frequency of Occurrence graph for *Najas spp*.

Mapping of each genus or group (Figure 5) showed that SAV was present throughout the small lake. No genus exhibited striking spatial patterns favoring one area over another, but *Najas* did tend towards the center of the lake.

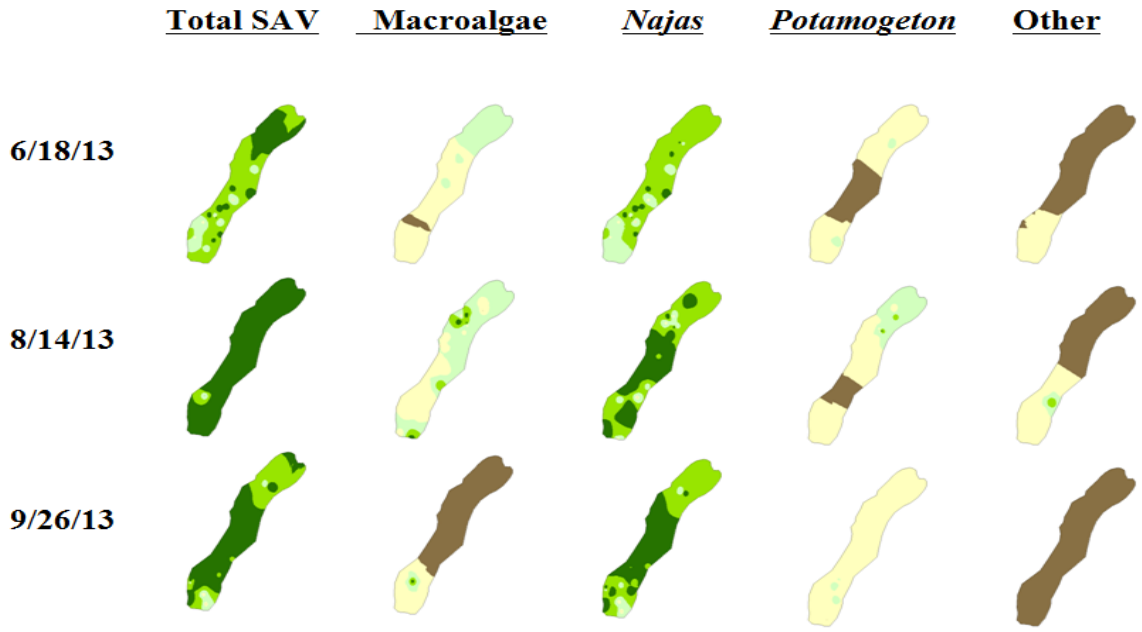


Figure 5. Interpolated percent cover maps of the macrophytes observed in New Germany Lake during summer 2013 surveys.

DISCUSSION

The goal of the SAV survey was to define the distribution and abundance of the SAV community throughout New Germany Lake. As such, the results of the survey provide a comprehensive view of the Lake's SAV community as a whole and how this community changes in space and time. The survey methodology is a globally accepted method to identify changes in an SAV community; it does not focus on any one species over another.

In 2011, our results indicated that New Germany Lake supported a healthy and somewhat diverse population of SAV relative to its size, including four genera of vascular plants and two species of macroalgae. Of the four vascular plants, the Naiads (*Najas spp*.) and the Pondweeds (*Potamogeton spp*.) were the most abundant. Pondweeds are perennial flowering plants with creeping rhizomes and leafy branches. Their leaf blades may either be floating or submersed and it can be difficult to differentiate one species from another. Naiads are annual plants that grow in small freshwater streams or ponds. Naiads vary in size from inch-high tufts to highly branched plants two or three feet high. They are considered an excellent food source for waterfowl. *Chara vulgaris* is a macroalgae that superficially resembles the vascular plants in the lake because of its stem-like and leaf-like structures. *Chara* plants are rough to the touch because of deposited calcium salts on the cell wall. *Nitella flexilis* is another robust freshwater macroalgae that grows up to a meter long with axes up to 1mm wide.

With the exception the *Isoetes* and *Utricularia*, the same genera of plants were present in the lake in 2012, and again in 2013. Results from our 2012 SAV surveys indicated that a major community shift took place over the summer. Macroalgae made up the majority of the plant biomass in the June survey, but it was only observed in trace amounts in August and then was completely absent in September. Vascular plant diversity decreased as well. Where *Potamogeton spp*. were commonly observed in 2011, there were only two observation of *P. pusillus* in June 2012, and only trace amounts of *P. diversifolius* were detected in September. *Utricularia* and *Isoetes* were absent in 2012. *Najas flexilis* and *N. guadalupensis* were observed, but in small amounts. *Najas minor*, however, an exotic plant from eastern Europe and Asia, was observed in high densities in practically every quadrat sampled in August and September and was by far the dominant species present.

While Naiads are an excellent food source for waterfowl, decreased biodiversity is not the favored state-change and this substantial shift in community structure to a non-native species was of concern. *Najas minor*, also known as minor, brittle, spiny, or bushy naiad, is an introduced species that was first reported in North America in 1932 when it was collected from Ashtabula County, OH, and then reported from the tidal Hudson River in New York in 1934. Sediment seed records indicate a simultaneous appearance in the northern portion of Chesapeake Bay.

Najas minor prefers calm waters such as ponds, lakes, and reservoirs, and is capable of growing in depths up to 4 meters. It has been observed to tolerate brackish water, and it is more tolerant of turbidity and eutrophic conditions than some native species of *Najas.* Consequently, it has replaced native species in many instances. Although its growth is usually compact and relatively bushy, as it is observed in New Germany Lake, the highly branched stems can grow up to 4 ft. in

length. The visibly serrated leaves of the plant are opposite, unbranched, strap-shaped, are around 4.5 centimeters in length and only 1 mm wide, and tend to curl back on themselves. *Najas minor* is one of the more distinctive species of *Najas*, however, young sterile individuals resemble *N. gracillima*.

Although *Najas minor* can easily and rapidly reproduce by fragmentation, the primary means of reproduction is by seeds, which grow along its stem. Its reproductive season starts from August, peaks in September, and ends in October. It has small flowers located in clusters along the leaf axils.

Najas minor can form dense, monospecific stands in shallow water that inhibit the growth of native species of aquatic macrophytes. This appears to be what happened in New Germany Lake in 2012. Introduction into New Germany could have been by small boat, by bird, or even on swimming gear. *Najas minor* was observed only twice in 2011, in two quadrats at moderate densities during the September SAV survey, at which time *N. flexilis* and *N. guadalupensis* were the dominant vascular plants in the lake. Cause for the dramatic expansion of the plant in 2012 is unclear, although it may have been associated with the near complete drawdown of the lake water level during the 2011-2012 winter season. The water in the lake was drawn down specifically to control aquatic macrophytes. It is possible that the drawdown killed the majority of other vascular plants but left the small amounts of *N. minor* unscathed and able to reproduce rapidly and outcompete the macroalgae by August 2012. Water level drawdown has been known to increase the density of some species of *Najas*, but prior evidence for the effect on this species was not found.

During the June 2013 survey, our observations showed that several species of *Najas* were present, as well as two species of macroalgae and small amounts of *Potamogeton pusillus*. The majority of the *Najas* cover (which made up the majority of total SAV cover) was what we believed at the time to be immature *Najas minor*, with small amounts of *N. flexilis, N. gracillima,* and *N. guadalupensis.*

In August, we realized that we had mis-identified *N. gracillima* as immature *N. minor* in our June survey. These two species are almost identical in appearance before they mature. While the blades of mature *N. minor* are brittle and curl back upon themselves, immature *N. minor* blades stand straight up and are more flexible, much like *N. gracillima*. By August, the plants should have been completely mature with brittle, curled leaves and nearing reproduction, but the majority of what we observed looked just like it did in June, meaning that it was most likely *N. gracillima* in the first place. Our average cover values for the *Najas* species in August were: *N. flexilis* = 17%, *N. gracillima* = 25%, *N. guadalupensis* = 23%, and *N. minor* = 2%. Also in August, there was a large amount of both *Potamogeton diversifolius* and *P. pusillus*. Average macroalgae cover was 20% and was composed of both *Nitella* and *Chara*.

By September, almost all of the macroalgae had disappeared and total SAV percent cover and frequency of occurrence had decreased slightly, responding to the cooler temperatures and decreasing daylight. *Najas* values remained high however, with *N. flexilis* and *N. gracillima* almost equal in distribution and abundance. Only a small amount of *N. minor* was observed in September, and *Potamogetons* were relatively uncommon also.

It is our opinion that the lack of water drawdown during the 2012-2013 winter allowed for the native species of *Najas* to recuperate and outcompete the invasive *N. minor*. Biodiversity is returning to normal, and the native SAV community appears to be recovering.

RECOMMENDATIONS

At this time, we are cautiously optimistic that *Najas minor* in New Germany Lake is under control. While the plant is still present, and will likely remain so, it appears that the native species are able to outcompete this invasive as long as winter water drawdown does not occur. With regards to future monitoring in New Germany Lake, RAS recommends SAV surveys during summer 2014 to confirm that *N. minor* has not increased in abundance again, and will continue to be a non-threat to the native plants and overall biodiversity. As we have seen, management efforts are often more harmful to the ecosystem as a whole than the plant itself, so due diligence is required before future action is taken. Should removal efforts be deemed eventually necessary, a thorough evaluation of available control measures and their benefits and cost to New Germany Lake will take place and an action plan created.

Throughout the summer 2014 season, it will be vitally important that all swimmers and boaters, particularly those that launch their own small boat, are alerted to the invasive nature of *Najas minor* and other exotic species. Action should be taken to ensure that new invaders do not enter New Germany Lake and that *N. minor* not be transported from the Park to other lakes or water bodies in the area via swim gear or boats, and staff at New Germany Lake should take action to ensure that no seeds or fragments are released over the dam.

Specific action to combat the spread of invasive species may include fact sheets for distribution throughout the park and informational signage at the boat ramp, beach/swim area, and in the clubhouse. Park staff members are encouraged to speak directly with visitors to alert them of the problem and provide information regarding the cleaning of any swim or boating gear before and after entering the lake. Not only might visitors take *Najas minor* out of the lake, but they may bring other invasive species in. Further information about preventing the spread of invasive species should be made available on the park's website.

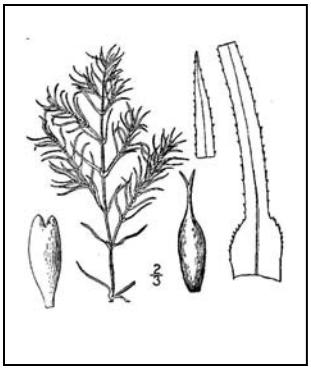
APPENDIX A

This appendix provides drawings, pictures, distribution maps, and a brief description of each species of submerged aquatic vegetation observed in New Germany Lake during the summers 2011, 2012, and 2013 SAV surveys.

Najas flexilis (Slender or nodding naiad)

Monocot. Annual. Native to the continental US, Alaska, and Canada. Found in most northern states and Canada.

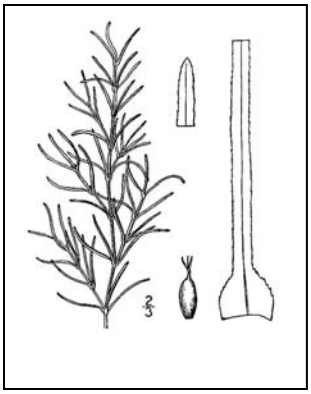
Naiads grow in small freshwater streams. They prefer sandy substrates and tolerate relatively low light. Naiads vary in size from inch-high tufts on sandy bottoms to highly branched plants two or three feet high. *Najas flexilis* is considered to be excellent food sources for waterfowl.



Najas guadalupensis (Southern naiad)

Monocot. Annual. Native to the continental US, Puerto Rico, and Canada. Invasive to Hawaii. Distributed throughout US.

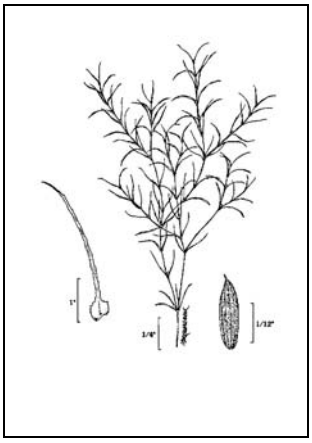
This plant grows in ponds, ditches, and streams. It produces a slender, branching stem up to 60 to 90 centimeters in maximum length. The thin, somewhat transparent, flexible leaves are up to 3 cm long and just 1-2 mm wide. They are edged with minute, unicellular teeth. Tiny flowers occur in the leaf axils; staminate flowers grow toward the end of the plant and pistillate closer to the base



Najas minor (Brittle naiad)

Monocot. Annual. Invasive and established throughout eastern US and part of Canada. Native to North Africa, Japan, Turkey, India, as well as central and eastern Europe.

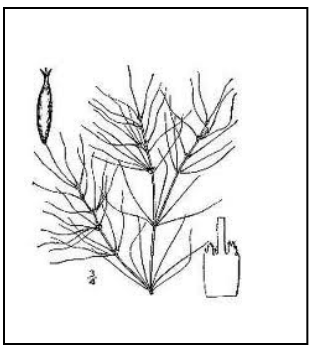
This plant prefers calm waters, such as lakes and ponds. It may grow in depths up to 4 m. It grows in dense clusters and has highly branched stems. Propagation from stem fragments or from small seeds which grow along its stem. Small flowers are located in clusters along the leaf axils. Leaves are opposite, unbranched, strap-shaped, and are around 4.5 centimeters in length. The leaves have serrations which are visible to the naked eye.



Najas gracillima (Thread-leaf naiad)

Monocot. Annual. Native to the continental US, Alaska, and Canada. Found in the eastern states and California. Rare in some.

This plant prefers clear, healthy lakes. Stems are branched on the distal portion. The margins of leaf blades are minutely serrulate with 13-17 teeth per side, and the mid vein has no prickles. 1-3 flowers in each leaf axil. It propagates via seed and fragmentation. Seed surfaces are dull and pitted.



***Potamogeton pusillus* (Slender pondweed)**
Monocot. Perennial. Native to the continental US, Alaska, and Canada. Distributed throughout native range.

Slender pondweed grows in soft, fertile mud substrates and quiet to gently flowing water. Leaf blades of slender pondweed are entire and have pointed tips and can have a purplish tint. Like all other pondweeds, slender pondweed is considered an important food for waterfowl.

***Potamogeton diversifolius* (Waterthread pondweed)**
Monocot. Perennial. Native to the continental US and distributed throughout with the exception of far northeast.

This pondweed produces a very narrow, compressed stem branching to around 35 cm. It has thin, pointed linear leaves a few cm long spirally arranged about the thin stem. Flowers emerge from the water surface.

Pota*mogeton vaseyi* (Vasey's pondweed)
Monocot. Perennial. Native to the continental US and Canada. Distribution limited to the northeastern US and eastern Canada.

Not previously documented in Maryland, Vasey's pondweed is considered threatened, endangered, or of special concern where found in northeastern US states. It grows in quiet waters and has dimorphic leaves: very narrow, flaccid, submersed leaves and wider, thicker floating leaves.

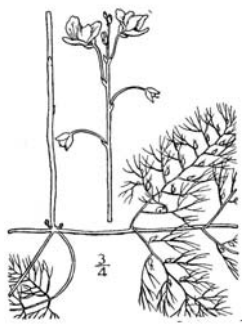
***Potamogeton spirillus* (Spiral pondweed)**
Monocot. Perennial. Native to the continental US and Canada, but distributed only throughout the northeast US and northern mid-west, and eastern Canada.

Spiral pondweed usually grows in shallow water: lakes, ponds, wet swales, and rarely quiet river borders. The submersed leaves are often curved, giving the whole bushy plant the aspect of a broad-leaved *Najas*

***Potamogeton robbinsii* (Robbin's pondweed)**
Monocot. Perennial. Native to the continental US, Alaska, and Canada. Distribution limited to ~ half US states and most of Canada.
This pondweed is found in deep to shallow, often muddy waters of lakes, ponds, and rivers. It is the only *Potamogeton* that has branching inflorescences, though it rarely flowers. This plant is believed extirpated from Maryland and is threatened or endangered in several of its native states.

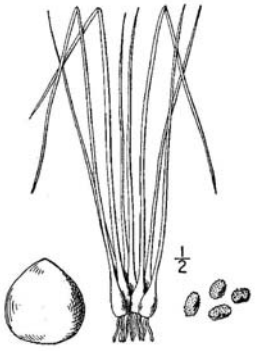
***Utricularia vulgaris* (Common bladderwort)**
Dicot. Perennial. Native to the continental US, Alaska, and Canada.

Several species of bladderwort occur in the Chesapeake Bay region, primarily in the quiet freshwater of ponds and ditches. They can also be found on moist soils associated with wetlands. Bladderworts are considered carnivorous because minute animals can be trapped and digested in the bladders that occur on the underwater leaves.



***Isoetes spp.* (Quillwort)**
Lycopod. Perennial. Native to the continental US, Alaska, and Canada. Distributed throughout.

Quillwort leaves are hollow. Each leaf is narrow (2–20 cm long and 0.5–3 mm wide). They broaden to a swollen base up to 5 mm wide where they attach in clusters to a bulb-like, underground rhizome. This base also contains male and female sporangia, protected by a thin velum. Quillwort species are very difficult to distinguish by general appearance.

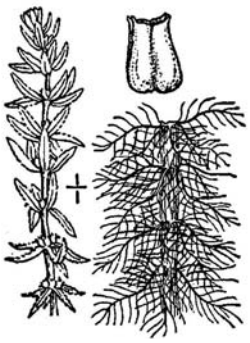


Myriophyllum sibiricum (Northern water milfoil)
Dicot, Perennial. Native to the continental US, Alaska, Canada, and elsewhere. Distribution throughout Canada and the US with the exception of southeastern states from TX east to FL.

This plant is distinguished from the Eurasian water milfoil by its less finely divided leaves and larger floral bracts. It typically has 5-10 thread-like segments on each side of the midrib whereas Eurasian water milfoil has 12-24 segments. It is found in shallow to deep water of lakes, ponds, marshes, where its presence significantly increases the abundance of macroinvertebrates, although the value of milfoil is likely due more to its value as habitat than as food.

Myriophyllum heterophyllum (Two-leafed water milfoil)
Dicot, Perennial. Native to the continental US and Canada with distribution throughout the eastern US and Canada.

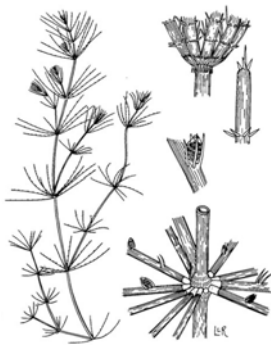
Two-leafed water milfoil has fine densely packed, featherlike leaves whorled around a main stem. It can grow up to 15 feet and may exhibit a three to six inch green spike-like flower above the waterline in late June or in July. A cross-section of the stem will reveal “pie-shaped” air chambers.

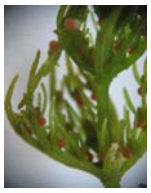


Macroalgae

Chara vulgaris (Chara, Common stonewort)

Chara is a green alga belonging to the Charales, a lineage that may have given rise to all land plants. The stoneworts are a very distinctive group of green algae that are sometimes treated as a separate division (the Charophyta). These algae can occur in fresh or brackish waters, and they have cell walls that contain large concentrations of calcium carbonate. Charophytes have relatively complex growth forms, with whorls of "branches" developing at their tissue nodes. Charophytes are also the only algae that develop multicellular sex organs.





Nitella flexilis (Nitella, Smooth stonewort)

Nitella flexilis is closely related to *Chara vulgaris* in the Stonewort family, a group of complex algae that superficially resemble vascular plants more than they do other groups of algae. *Nitella* is a green, freshwater algae; a robust species growing up to a meter long with axes up to 1mm wide. Branches in whorls once or twice divided.

Vascular plant drawings were obtained from Britton and Brown (1913) via the USDA Plant Database.
USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913. *An illustrated flora of the northern United States, Canada and the British Possessions. 3 vols.* Charles Scribner's Sons, New York.

Distribution maps were obtained from the USDA Plant Database.
USDA, NRCS. 2011. The PLANTS Database (http://plants.usda.gov, 10 November 2011). National Plant Data Team, Greensboro, NC 27401-4901 USA.

Images were obtained from the following:
Najas flexilis: www.vilaslandandwater.org
Najas guadalupensis: www.aquahobby.com
Najas minor: www.outdooralabama.com
Najas gracillima: www.wisplants.uwsp.edu
Potamogeton pusillus: http://flora.nhm-wien.ac.at
Potamogeton diversifolius: www.dcnr.state.al.us
Potamogeton vaseyi: www.botany.wisc.edu
Potamogeton spirillus: www.uwgb.edu/
Potamogeton robbinsii: www.yankee-lake.org
Utricularia vulgaris: www.dnr.state.md.us/bay/sav/key
Isoetes spp.: www.nybg.org
Myriophyllum sibiricum: www.mainevolunteerlakemonitors.org
Myriophyllum heterophyllum: www.missouriplants.com
Chara vulgaris: www.biolib.cz
Nitella flexilis: www.diszhal.info