2020 Deep Creek Lake Hydrilla Management Plan and Report of Control Activity

Prepared by Julie Bortz

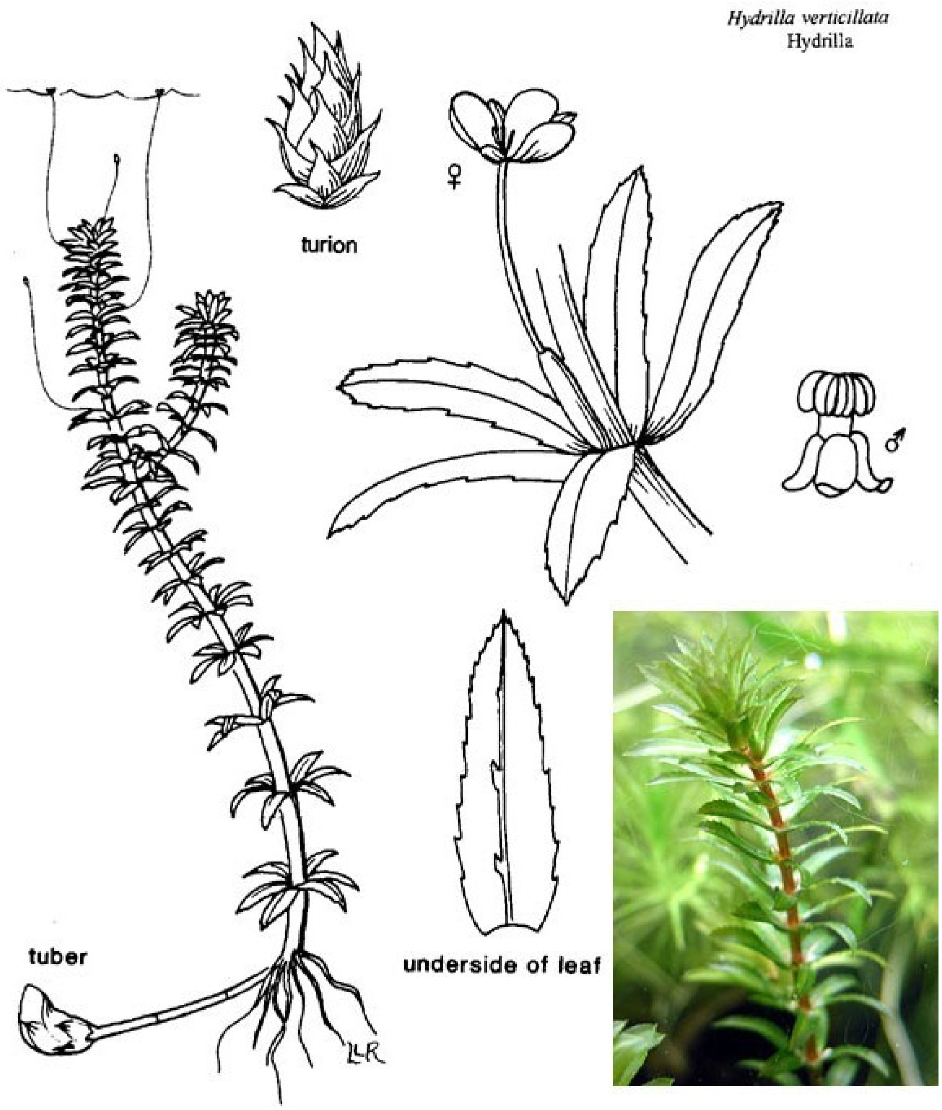

illustration provided by:
IFAS, Center for Aquatic Plants
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Acknowlegements

The development of this multi-year report would not have been possible without the substantial early contributions from Lee Karrh (formerly from the Maryland Department of Natural Resources), J. Brooke Landry (Maryland DNR) and Mark Lewandowski (Maryland DNR). Additionally, Dr. Mark Heilman (SePro), John Graveile, Jon Gosselin (both with SePro) and Bill Kirkpatrick (President-Aquatic Environment Consultants Inc.) were and continue to be instrumental in the development of the formula of herbicide dosage for each year's hydrilla management plan. Bill Kirkpatrick (Aquatic Environment Consultant Inc.) and his staff are additionally responsible for the application of herbicide and work with SePro staff and MDNR staff to monitor the results of the treatments and make adjustments as needed to the subsequent treatments. Special thanks to the Maryland Parks Service, especially the Deep Creek Lake Natural Resource Management Area (DCL NRMA) Lake Manager, Eric Null, for funding the majority of on the ground efforts including the bulk of costs associated with the herbicide chemicals and application. Additionally, DCL NRMA staff Seth Metheny and Jenna Sivic continue to be instrumental in all aspects of field work as well as contributing information regarding launch steward data and analysis. The Department of Natural Resources is also thankful to the MDNR Natural Resource Police, especially Lt. Harry Cage and Sgt. Mike Friend and his staff for their continued support during the herbicide application process. Additional appreciation to Mike Naylor, Mark Lewandowski and Bruce Michael from the Department of Natural Resources for their continued support and assistance with this on-going effort as well as for providing review and comments related to this report.

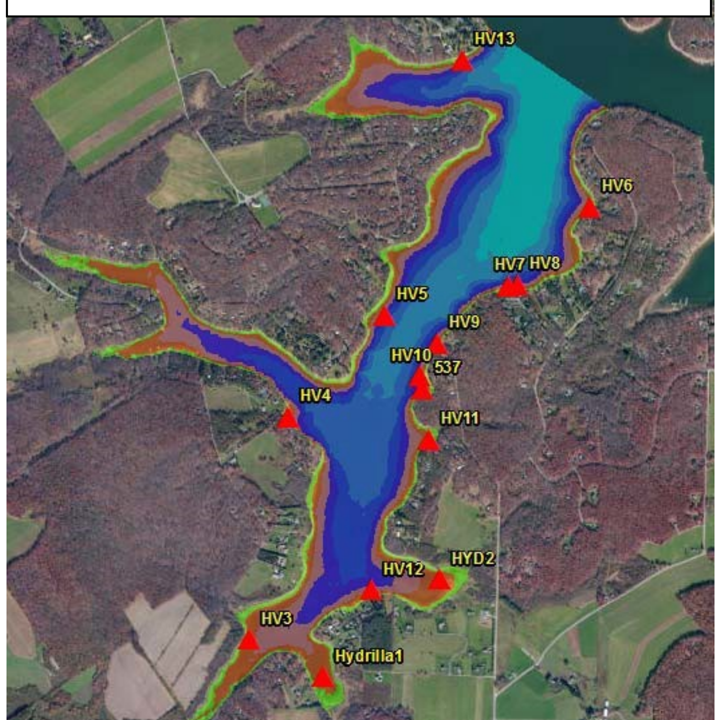
Background

Hydrilla verticillata is a listed noxious weed (Federal Noxious Weed Act -- Public Law 93-629 (7 U.S.C. 2801 et seq.; 88 Stat. 2148). A noxious weed is defined as any plant designated by a Federal, State, or county government as injurious to public health, agriculture, recreation, wildlife or property. Hydrilla is a rooted submersed perennial monocot, native to Asia (Haller, 2009). There is only one species of *Hydrilla verticillata* identified, but two biotypes have invaded the United States. The dioecious biotype (separate male and female plants) is found south of Virginia and was introduced in the 1950s. The monoecious biotype (male and female reproductive structures on the same plant), found in North Carolina and above, was introduced in the 1970s. North Carolina is the only known state where the two bio- types overlap in range.

Hydrilla is infamous for its rapid growth and ability to "top out" and form dense mats of vegetation at the water surface. For many years, it was believed that the species could grow as much as one inch per day. However, recent studies (Glomski and Netherland 2012) found that a single 5-inch long cutting of hydrilla rooted, grew and expanded three dimensionally by forming hundreds of new stems, lateral branches, and stolons over the course of a 5-week period. Collectively, new growth produced by the original cutting represented a lengthening of up to 191 inches per day (Glomski and Netherland 2012). Hydrilla thrives in lower light and deeper conditions than native plants, and the dense mats it forms can shade out native species of submerged aquatic vegetation (SAV). Hydrilla can spread rapidly via fragmentation and it has a very effective over- wintering strategy whereby prolific tubers or reproductive structures are produced allowing the plant to come back year after year. Due to how densely hydrilla grows, it can not only alter ecosystem functions in a body of water, but also make navigation and recreation difficult. There are economic concerns as well. For example, Florida spends nearly $15 million per year just on herbicides to control hydrilla (Waymer, 2015 and Haller, 2009). Aside from the cost of management and control, there is also the potential for lowered waterfront property values due to the reduced recreational opportunities and unsightly nature of a "topped out" hydrilla bed. Water-dependent industries, such as tourism, hydroelectric power, and businesses dependent on water withdrawal, are also affected.

During routine SAV transect monitoring on September 27, 2013, a Maryland Department of Natural Resources (DNR) Resource Assessment Service (RAS) biologist observed floating fragments of hydrilla near the Deep Creek Cove (DCC) submerged aquatic vegetation (SAV) transect site. This represented the first find of *Hydrilla verticillata* in Deep Creek Lake (DCL), Garrett County, Maryland. While hydrilla is common in other waters in Maryland, this was the first reported sighting in DCL by DNR staff. Following the discovery, the State of Maryland initiated a *Rapid Response Planning for Aquatic Invasive Species* plan (see Appendix A). A survey of the entire lake shoreline was undertaken over the several days and finished on October 22, 2013. During the survey, hydrilla was found and mapped in 13 locations; all of which were contained in the southern portion of the lake (see Figure 1). Patches ranged in size from 1m^2 to roughly 5 acres, totaling an estimated 6.5 acres. Specimen samples

Figure 1. Hydrilla patches identified by DNR biologists during lake surveys in September-October 2013.



were collected and taken to an outside expert (Nancy Rybicki, USGS) for positive identification and determination of the biotype (monoecious). In response to this discovery, RAS biologists conducted a thorough literature review of hydrilla biology and management/control options and convened an expert panel (see Table 1) to aid in development of the Deep Creek Lake Hydrilla Management Plan. In consultation with Lake Management staff, the defined goal of the management plan was to contain hydrilla populations, reduce the standing biomass as low as is technically and financially feasible, and prevent hydrilla from becoming a nuisance in the lake. Several management techniques were considered, including several forms of mechanical/physical control, biological control, and chemical control. Ultimately it was determined that chemical control using selective herbicides that have minimal impact to other SAV and/or aquatic resources offered the greatest chance of success.

Table 1. List of expert panel members and affiliations

Name	Affiliation
Dr. Mike Netherland	University of Florida/US Army Corps of Engineers
Dr. Lynn Gettys	University of Florida
Dr. John Madsen	Mississippi State University
Mr. James Balyszak	Cornell University Extension
Dr. Nancy Rybicki	United States Geological Survey
Mr. Mark Lewandowski	Maryland Department of Natural Resources
Dr. Robert Richardson	North Carolina State University

Herbicide control is the most common technique used to control or eliminate unwanted aquatic plant populations. Herbicides approved for aquatic use are some of the most intensively studied production chemicals, and have undergone extensive research and review before being registered by the United States Environmental Protection Agency as an aquatic herbicide. Additionally, the use of herbicides in aquatic systems has a long history of proven results.

The consensus of the expert panel was to use a two-pronged approach consisting of "block treatments" using a systemic herbicide intended to treat large areas infested with hydrilla, and "spot treatments" using a contact herbicide for treating newly discovered hydrilla beds or vegetation that appears resistant to the systemic herbicide. The block treatment is intended to treat large volumes of the infested area with a systemic herbicide as soon as hydrilla emerges from its over-wintering tubers in the spring/early summer. The application of the systemic herbicide allows for newly emerging plants to begin assimilating the herbicide via the roots and new growth, then moving throughout the plant's tissues, over time killing it and preventing establishment (Netherland, 2009). The spot treatments would be used, as needed, if new patches of hydrilla were discovered or plants appeared to be resistant to the systemic herbicide. The panel further suggested using Fluridone for the systemic block treatments, and Diquat and Flumioxazin for the spot treatments.

Fluridone (sold under the brand names Avast!, Sonar®, and Whitecap) is a systemic herbicide that has shown to impact hydrilla at low concentrations (5-10 ppb Fluridone), while native plants tend to be less affected. Fluridone acts to stop the plant from producing a protective pigment that keeps chlorophyll from breaking down in the sun. Treated plants will turn pinkish yellow before dying. The disadvantage with Fluridone is that it requires a long contact time, 45-90 days of treatment is necessary for adequate control (WDNR 2012). Consequently "bump" applications throughout the growing season are needed to keep concentrations at the required level to effectively treat hydrilla populations. The advantage of using a systemic herbicide like Fluridone is that it primarily targets invasive species like hydrilla and milfoil populations, with less effect on native species. Additionally, the plants die and decompose slowly, reducing the risk of dissolved oxygen sags that might cause fish kills (WDNR 2012).

Diquat (trade name Reward™) is a fast-acting, non-volatile contact herbicide that rapidly controls aquatic weeds by interfering with photosynthesis (Reward™ Herbicide label, 2010). It is non-selective meaning it impacts all plants rather than targeting one species. Additionally, as a contact herbicide it does not move through the plant like a systemic herbicide would, so it only impacts the parts of the plant it contacts. If the treated area is muddy or the sediments are disturbed during treatment, the efficacy of the herbicide is reduced, as it tends to bind to silts and clay particles in the water (WDNR 2012). Similar to Diquat, Flumioxazin (trade name Clipper™) is also a broad spectrum herbicide. It controls aquatic weeds by interfering with photosynthesis through the inhibition of protoporphyrinogen oxidase, an essential enzyme required by plants for chlorophyll biosynthesis. Flumioxazin is fast acting and can be applied subsurface. It is most effective when applied to young, emergent plants, especially in the spring (Clipper™ label, 2011). Flumioxazin should not be used in lakes with pH higher than 8.5 and should be applied early in the morning to increase efficacy (WDNR, 2012)

Site Description

Deep Creek Lake lies just west of the Allegheny Front on a large plateau known as the Tablelands or Allegany Highlands. It lies west of the Eastern Continental Divide and within the Mississippi River watershed. Deep Creek Lake was created in 1925 when the Deep Creek Lake project was constructed by the Youghiogheny Hydroelectric Company. At full pool, Deep Creek Lake sits at an elevation of 2462 ft and has 68 miles of shoreline, with a surface area of 3900 acres. Deep Creek Lake is Maryland's largest freshwater lake ecosystem. The state of Maryland bought the buffer strip and the ground beneath the lake in 2000. The Deep Creek Lake Natural Resource Management Area (DCL NRMA), part of the Maryland Park Service, manages the lake and the buffer strip. Data from the Department's monitoring effort shows that the trophic state or biological productivity of Deep Creek Lake is mesotrophic. These waters have moderate levels of nutrients (nitrogen, phosphorus), chlorophyll (a measure of the mass of algae in the lake) and water clarity all which results in a generally low level of biological productivity, but a diverse aquatic plant community. The moderate trophic level supports a wide range of recreational uses and diverse habitat for aquatic life. The trophic status along with the abundant and diverse fish habitat makes Deep Creek Lake one of the best public, recreational lakes in Maryland.

Map of Deep Creek Lake, Maryland

Methods

Pre-treatment study

Prior to the first treatment scheduled to begin in the summer of 2014, a hydrological tracer study was conducted between April 28th and May 3rd, 2014 with the purpose of determining lake energy and water flow characteristics in Deep Creek Lake. Rhodamine WT dye pellets were used to most closely mimic the pelletized Fluridone herbicide (trade name Sonar®) that would be used during block treatment, hydrilla control. Rhodamine pellets were placed in two coves in the southwestern leg of the lake and monitored for dissolution over the course of four days. Results of the dye study suggested that Deep Creek Lake is a very low energy environment with predominantly wind-driven, water flow and particularly long residence times in the coves. As such, little horizontal movement of the herbicide is anticipated meaning the impacts of the treatment are thought to be relatively confined to the treatment area.

Treatment Approach

The thirteen hydrilla patches observed in 2013 were divided into eight management zones that ranged in size from five to 29 acres (total of 93.5 acres) (Figure 2). Because of the long residence time observed in the pre-treatment study of a subset of the coves where hydrilla was observed, a series of 4-5 "block treatments" were planned to be conducted within the assigned management zones (see Figure 2) every 3-4 weeks throughout the hydrilla growing season (May-September). The first treatment would begin at or near the first sighting of hydrilla in the lake or if water temperatures reached a sustained temperature of (65°F or greater). A systemic herbicide (Fluridone-trade name Sonar®) would be used for the block treatments and applied in pellet form, via boat, throughout each management zone during the scheduled treatment. DNR Biologists would conduct weekly to bi-weekly visual underwater monitoring, using SCUBA, or mask and snorkel, in the treated locations during that time to assess efficacy of the treatments. Results of those monitoring efforts would be relayed to the appropriate personnel to make adjustments to the herbicide dosage as needed. Additionally, FasTEST® water quality samples would be collected within each management zone, just above the water/bottom sediment interface, every 2 weeks following the first treatment and continuing to the final treatment to ensure the proper dosage and concentration of herbicide is attained. Samples would be sent to the laboratory for analysis and results communicated to the herbicide applicator as well as persons responsible for determining herbicide dosage. At the same time water samples are collected, various water quality parameters would be recorded using a YSI multi-parameter meter at each location samples were collected to ensure no adverse impacts on water quality are observed in the treatment area due to the herbicide. Water quality parameters collected include water temperature, pH, conductivity, dissolved oxygen and secchi depth.

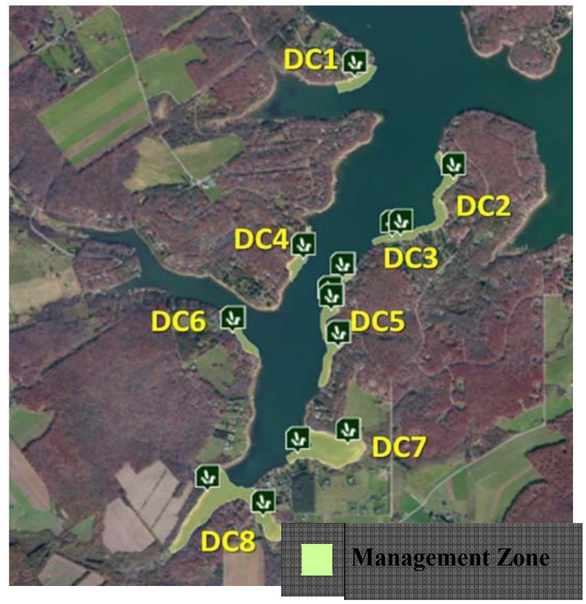


Figure 2: Original 8 hydrilla management zones delineated for "block treatments" using Fluridone during the first year of hydrilla control in 2014

Should any hydrilla observed in the treatment zones appear to be resistant to the systemic herbicide or any areas be found with newly discovered hydrilla, "spot treatments" using a contact herbicide would be considered. Regular scouting throughout the lake's coves and shallow water shorelines would also be conducted during the hydrilla growing season. Scouting would be done visually from the surface of a boat or underwater surveys using SCUBA or mask and snorkel would be conducted in targeted areas outside the treatment zones as resources allowed. If a new bed of hydrilla was found outside the treatment area or plants remained viable after the block treatment, a "spot treatment," would be planned for the area. Spot treatments would be done using a contact herbicide, and a tarp/PVC enclosure (see Figure 3) would be erected prior to treatment around the area, if conditions allowed. This enclosure would help to target the effects of the contact herbicide to the area enclosed as contact herbicides tend to be broad spectrum

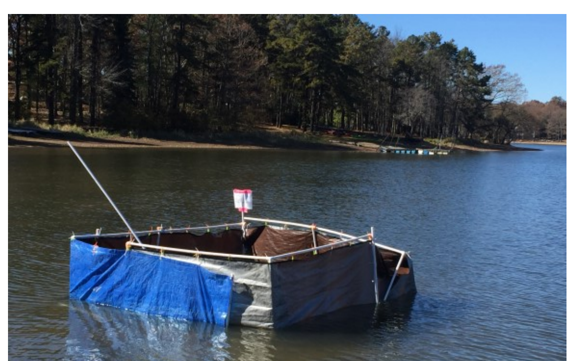


Figure 3: picture of tarp and PVC enclosure erected around newly discovered hydrilla bed

and only impact plants that come in direct contact with the compound (Netherland, 2009). The enclosure would be taken down as soon as plants were no longer viable at the location and/or lake conditions warranted the removal. Spot treatments would be conducted as soon as possible following the discovery of a new patch of hydrilla or if hydrilla within a treatment zone appeared to not be affected by the herbicide. If a new patch of hydrilla was discovered outside the treatment zone, it would be included in the following years "block treatment" plan.

Additional educational and outreach activities

The primary goal of the Hydrilla Management Plan was to control existing biomass and prevent the in-lake spread of hydrilla. However, it was equally important to prevent future invasions of hydrilla or other non-native aquatic species. During the panel discussion, experts, biologists and managers came to the consensus that any monetary investment in prevention activities would be best spent on simple vessel cleaning stations, outreach staff ("launch stewards"), and educational materials. As such, an extensive campaign to educate lake stakeholders on the risks associated with invasive species introductions and what they could do to minimize spread of these species was consequently implemented. Prior to the first herbicide treatment in 2014, DNR provided all of the residents impacted by the treatment, with information about the hydrilla infestation in Deep Creek Cove. Additionally, residents were provided with instructions for site specific closures related to the treatment application, any water use restrictions, and literature regarding the herbicides. Additionally, educational signs were posted at the state owned public boat launch (at Deep Creek Lake State Park) to educate boaters on the proper way to clean their vessels to avoid invasive species introductions. The Maryland Park Service (MPS) hired seasonal launch stewards to conduct voluntary vessel inspections at the State Park boat launch, during the 2014 summer months, and provide educational materials to incoming boaters. The DNR Communications Office also developed an instructional video on how to properly clean your vessel and avoid aquatic introductions, which was posted on DNR's website and linked to various stakeholder websites, including but not limited to The Friends of Deep Creek Lake (FoDCL) website.

Results

2014 Results

Five low-dose Sonar® applications were planned for 2014 in an effort to maintain adequate concentrations of the systemic Fluridone herbicide throughout the SAV growing season. Herbicide application took place within each management zone every three weeks between June and September 2014 (specifically on June 11th, July 1, July 21, August 13 and September 3, 2014). This approach controlled for any late-germinating tubers and prevented any additional tuber development during the 2014 season. FasTEST® samples for herbicide monitoring were collected on a weekly or biweekly basis to document and adjust herbicide dosage as necessary. Routine surveys of each management zone were conducted on a weekly to monthly basis to confirm Sonar® efficacy and monitor conditions. At the conclusion of the 2014 summer season, no hydrilla was observed in any of the management zones. Starting in July, when SAV in DCL was nearing its peak biomass, broader scouting was conducted to detect possible new areas of infestation. Four new patches of hydrilla were detected: two in early August while scouting and two in mid-September during the comprehensive shoreline survey. One of these patches was within the southern arm of the lake in between treatment zone DC1 and DC4. The other three patches were found in the southeastern arm of the lake and included several small beds found along the shoreline just south of Poland Run Cove, a small patch in the back of Green Glade Cove, and a small patch in the back of Back Bay Cove (see Figure 4). Licensed applicators from DNR Fisheries Service treated these patches with the contact herbicides Reward® and Clipper® and the infected areas were monitored for the remaining summer months to ensure efficacy of the treatment. While the Fluridone herbicide treatments were effective at suppressing hydrilla growth, the contact herbicides appeared to be less effective at controlling hydrilla, likely due to the short window for successful treatment. Some hydrilla plant material was still observed in the four newer infestation areas at the end of the 2014 treatment season. These areas (DC9, DC10, DC11 and DC12 on Figure 4) were included in the hydrilla management plan for 2015, with positive control of these areas expected.

Educational outreach activities conducted in 2014 included the hiring of two launch stewards to conduct vessels inspections at the Deep Creek Lake State Park boat ramp from June-September. Launch stewards conducted voluntary vessel inspections from 6am-6pm, recording any SAV found on vessels as well as data regarding the type of boat entering the lake, the state where it was the boat was registered, where the vessel had last been launched and where it was most commonly used. From June 3rd to September 23rd, 2014, 1,066 vessels were inspected. Of the boats inspected, only 23 vessels (2.2%) were carrying potential AIS. The vegetation was mostly found on the hull, trailer bunks, and propellers. There was no correlation between the presence of vegetation and the type of vessel. The most common SAV species found were wild celery (*V. americana*) and several types of pondweeds (*Potamogeton* species).

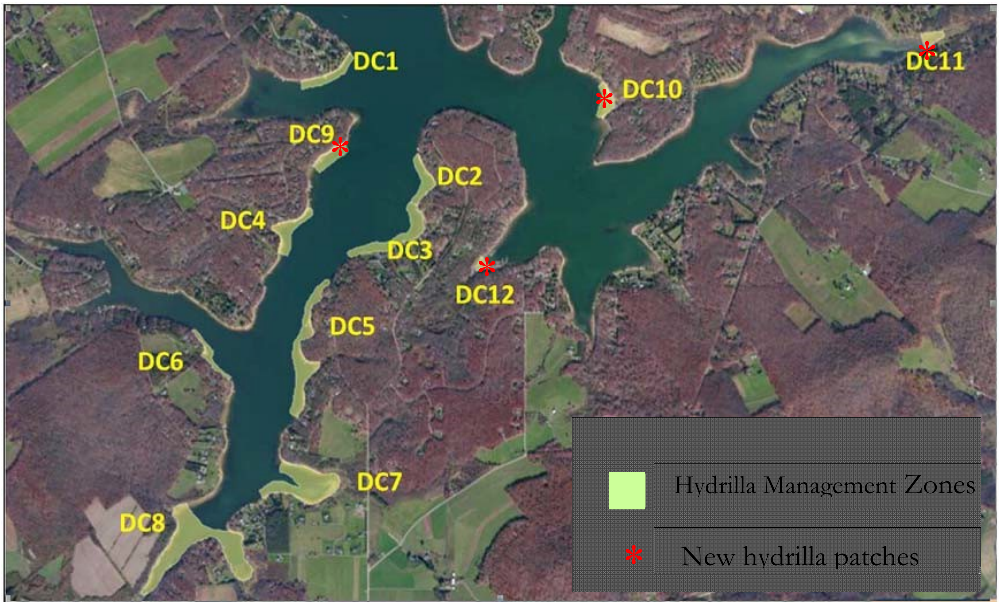


Figure 4: 2015 Hydrilla Management Zones with new hydrilla beds found in fall 2014 located in red

2015 Results

The DNR Resource Assessment Service and DCL Natural Resource Management Area (DCL NRMA) built on the success of the 2014 Management Plan and continued with the Fluridone (trade name Sonar®) block herbicidal treatments of hydrilla in DCL in 2015. Four new management zones (DC9, DC10, DC11, DC12) were delineated and included in the 2015 planned treatment zones (see Figure 4), to include the four new hydrilla patches found in 2014. A total of 12 management zones covering 104 acres were scheduled for treatment in 2015. Treatment began as soon as DNR biologists observed hydrilla emerging in most of the treatment areas. Five treatments were planned for the 2015 season however monitoring results allowed for adjustments to be made of the formulations of Sonar® keeping the dosage rate in the necessary range for the treatment period so the fifth and final treatment planned for September was determine to be unnecessary. Four treatments took place over the course of the 2015 summer months, specifically on June 10, July 1, July 27, August 31, 2015. By mid-July 2015, no remaining hydrilla was observed in any of the treatment areas. Shoreline surveys intended to scout nearby areas for any new hydrilla populations discovered one additional small patch (<$2m^2$) of hydrilla outside the treatment areas, specifically in Green Glade Club Cove (see Figure 5). The patch was discovered in late September 2015 and a small enclosure was erected around the bed prior to treatment with a contact herbicide, Flumioxian (trade name Clipper™) in early October 2015. Despite best efforts, the contact herbicide had little impact on the bed and the plants naturally senesced in late October 2015. The reason for the reduced efficacy of the contact herbicide is thought to be due to the higher pH values (pH ~8.5-9.0) observed in the cove near the time of treatment. Flumioxian (trade name Clipper™) is not effective in waters with pH values>8.5 (WDNR 2012).

Outreach and education efforts previously outlined in 2014 continued in 2015. Some notable additions to the outreach and educational effort, included outreach to the local marinas, boat rental business, and other stakeholder groups that have boat ramps to include the various yacht clubs and home owner organizations.

The goal of the outreach to these groups was to communicate the importance of aquatic invasive species (AIS) protection and how to properly clean and decontaminate any boats launching onto DCL. A meeting with representatives from these groups was held in April 2015 to discuss their collective approach to protecting DCL from AIS. DNR continued with voluntary vessel inspections at the State Park boat launch and collected an expanded suite of data from boaters, including the most recent body of water accessed and zipcode of origin. Slight changes to the 2015 launch steward program included formalizing the partnership between DNR's Park Service (specifically the DCL NRMA) and Garrett College's Natural Resource and Wildlife Technology (NRWT) Program. Garrett College hired 5 NRWT students to serve as boat launch stewards and conducted vessel inspections at the Deep Creek Lake State Park boat ramp from 6:00 AM to 7:00 PM from Memorial Day through Labor Day. Working 7 days a week, the 2015 launch stewards inspected 2,256 vessels, and found 41 vessels (1.8%) to have vegetation on the vessel or trailer. All of the vegetation or SAV was believed to be native species, but suggests less than 2% of incoming boats were found to be carrying organic matter. Again, there was no correlation between presence of vegetation and vessel type. Most of the vessels inspected in 2015 use Deep Creek Lake as well as other local lakes and rivers in Maryland, Pennsylvania, and West Virginia. Some vessels came from as far away as Utah, Florida, and Connecticut, highlighting how simple it is to transport invasive species over state lines and introduce them to new ecosystems if precautions aren't taken.

2016 Results

In 2016, DNR continued to treat the 13 locations identified to have *Hydrilla* growing at the location (see Figure 5) for a total of 104 acres treated. Five low-dose Sonar® application treatments were scheduled from June-September 2016, however no hydrilla was observed growing at any of the locations by late July 2016. As such the 5th treatment in September was determined to be unnecessary.

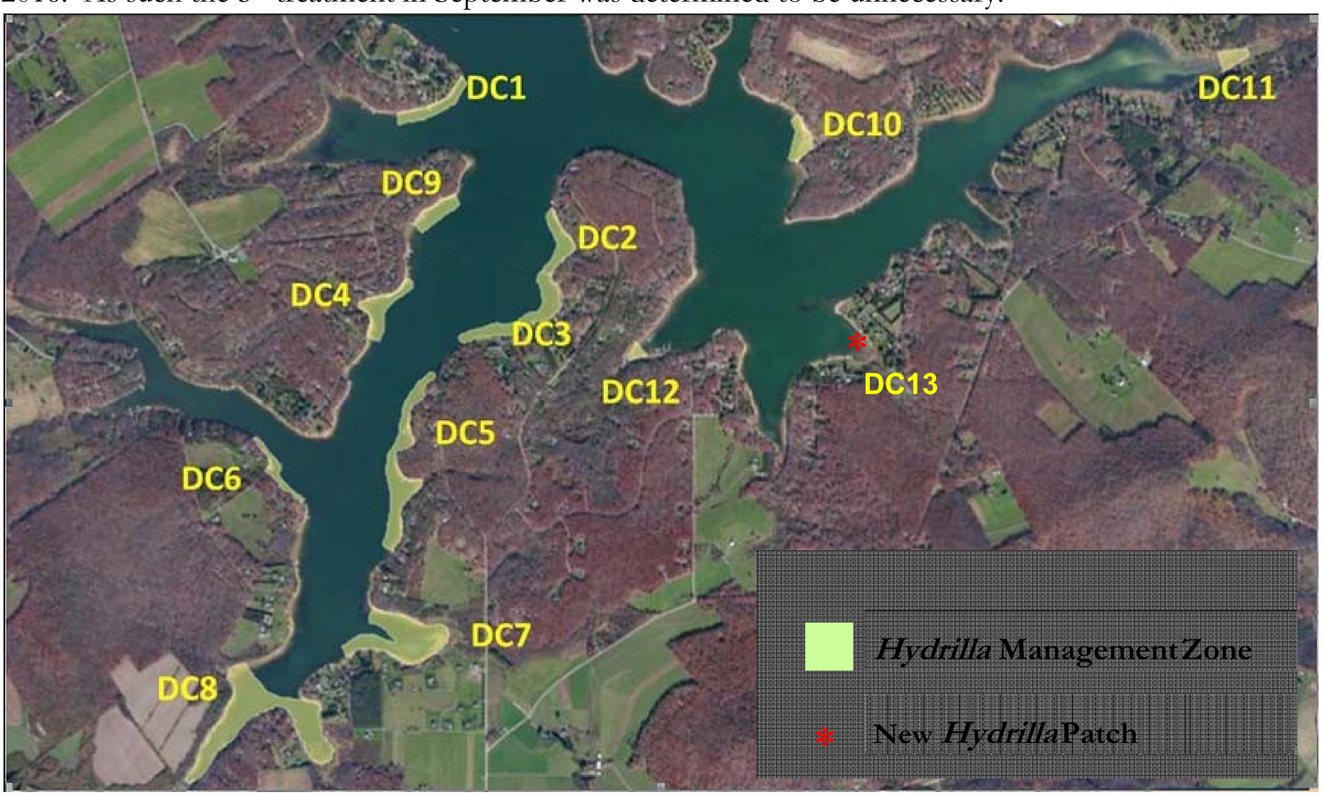


Figure 5. 2016 and 2017 hydrilla management zones. New hydrilla patch discovered in October 2015 and included in the 2016 and 2017 hydrilla management zones.

Herbicide application took place within each management zone on June 6, June 27, July 26 and August 22, 2016 in all 13 control areas. Biologists began surveying the areas for the presence of hydrilla, prior to the onset of the first treatment and continued to survey the affected areas through the end of August 2016. FasTEST® samples for herbicide monitoring were collected on a weekly or biweekly basis to document and adjust dosage if necessary. In addition to FasTEST water samples, biologists routinely surveyed the treated areas looking for the presence of hydrilla and documenting the effectiveness of the treatments on hydrilla growth and relaying results so that the dosage could be adjusted if needed.

Aquatic Invasive Species (AIS) outreach and education efforts continued in 2016 with presentations to the public at two Deep Creek Lake Property Owners Association (POA) General Meetings in June and August 2016. Additionally the local marinas and organizations that have public boat ramps attended a meeting in April 2016, similar to what was done in April 2015 to discuss how they can help the state prevent further AIS introductions. The Deep Creek Lake Natural Resource Management Area (DCL NRMA) partnered for the second consecutive year with Garrett College's Natural Resource and Wildlife Technology Program to hire college students that served as boat launch stewards at the Deep Creek Lake State Park boat ramp during the summer months. Five college students were employed from May-September 2016 and offered voluntary boat inspections at the DCL State Park boat ramp along with educating boaters about properly cleaning and decontaminating their boats and gear. Boat launch stewards inspected 3,824 vessels from May-September 2016 and found 22 vessels carrying some sort of organic material, so less than <1% (0.5%). Nine of those 22 vessels were found to be carrying some form of AIS for 0.2% of all vessels carrying AIS. The data students collected is used by managers to better target AIS educational efforts as well as better understand the efficacy of current AIS education efforts.

2017 Results

In 2017, DNR continued to treat the 13 locations identified to have hydrilla growing at the location for a total treatment area of 110 acres. Five low-dose Sonar® application treatments were scheduled from June-September 2017, however no hydrilla was observed growing at any of the locations by mid August 2017. As such the 5th treatment in September was determined to be unnecessary. Herbicide application took place within each management zone on June 6, June 27, July 25 and August 21, 2017 in all 13 control areas. Biologists began surveying the areas for the presence of hydrilla, prior to the onset of the first treatment and continued to survey the affected areas through the end of August 2017. FasTEST® samples for herbicide monitoring were collected on a weekly or biweekly basis from June-August to document and adjust dosage if necessary. In addition to FasTEST® water samples, biologists routinely surveyed the treated areas looking for the presence of hydrilla and documenting the effectiveness of the treatments on hydrilla growth and relaying results so that the dosage could be adjusted if needed. In 2017, biologists also began monitoring water quality parameters in several of the treatment zones, similar to what is done for lake wide baseline water quality monitoring. This additional water quality monitoring was done in an effort to document any effects of the hydrilla treatment process on water quality.

On August 4th, 2017 DNR staff found several small patches of hydrilla growing in Arrowhead Cove. The area was surveyed that day, mapping the visible beds of hydrilla (see Figure 6). That same area was treated 5 days later on August 9, 2017 with diquat and flumioxian, both are contact liquid herbicides, (tradename Komeen and Reward) by a certified herbicide applicator. The hydrilla beds in Arrowhead were surveyed in the days and weeks following treatment and it was determined an additional herbicide treatment would be needed to kill the remaining hydrilla. This treatment was done again on September 21st, 2017 and populations were monitored through late October 2017. Several very small (<1m^2) beds of hydrilla were found on an underwater survey of Arrowhead Cove in mid October 2017. Beds were again mapped using a handheld

GPS and plotted. As a result of the August-October surveys for hydrilla in Arrowhead Cove, the majority of the cove will be included in the planned 2018 hydrilla management area (see Figure 7).

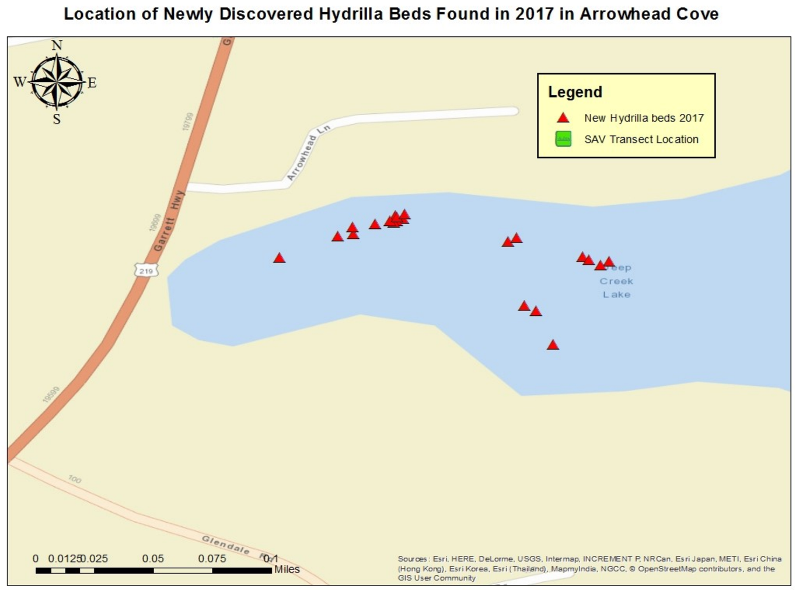


Figure 6. New hydrilla beds in Arrowhead Cove, Deep Creek Lake

Aquatic Invasive Species (AIS) outreach and education efforts continued in 2017 with presentations to the public at two Deep Creek Lake Property Owners Association (POA) General Meetings in June and August 2017. The June presentation again emphasized the need for proper boat decontamination and highlighted AIS educational efforts over the winter months to include the Department working with the POA to erect AIS educational road signs on highly traveled roads entering Deep Creek Lake. The August presentation focused on educating the public about the threat posed by one AIS in particular, zebra mussels (*Dressenia polymorpha*). The local marinas met again for the 3rd consecutive year in April 2017 to discuss how they can help the state prevent further AIS introductions. In addition to the AIS road sign project spearheaded by the POA, the Department worked with the POA and the Maryland Conservation Corps (MCC) crew to build AIS disposal stations and hang educational signage at participating local marinas and businesses that have public boat ramps. The AIS road signs and disposal stations were both done with the purpose of educating boaters and the general public about AIS and what they can do to stop the spread of AIS.

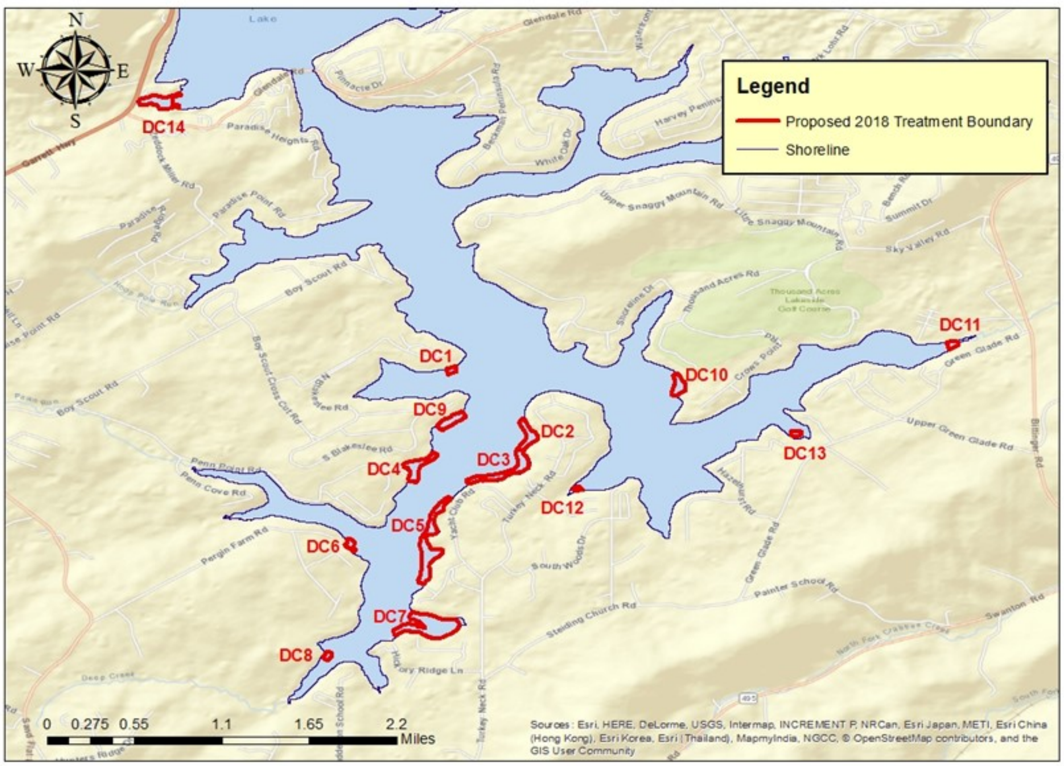
The Deep Creek Lake Natural Resource Management Area (DCL NRMA) partnered for the third consecutive year with Garrett College's Natural Resource and Wildlife Technology Program to hire college students that served as boat launch stewards at the Deep Creek Lake State Park boat ramp during the summer months. Four college students were employed from May-September 2017 and offered voluntary boat inspections at the DCL State Park boat ramp along with educating boaters about properly cleaning and decontaminating their boats and gear. For the second year in a row, boat launch stewards intercepted an incoming boat that was carrying zebra mussels again highlighting the need for continued AIS education and prevention. From May-September, boat launch stewards inspected 3,866 vessels at the Deep Creek Lake State Park boat ramp and found 127 vessels to have organic material on the boat and/or trailer (3.3%). Of those 127 vessels found with organic material, 13 were confirmed to be some form of AIS, representing <1% of all boats inspected to be carrying AIS. Ski and fishing vessels with outboard motors were the most common type of vessels inspected and along with personal watercrafts, represented the most common vessels being found with any organic material. All three types of vessels, fishing boat, ski boats and personal watercrafts were found to be carrying AIS during the 2017 season.

2018 Results

In 2018, DNR treated 14 locations (see Figure 7) identified to have hydrilla growing for a total treatment area of 74.5 acres; this represents 35 acre reduction in treatment area for 2018. Four low-dose Sonar® application treatments were scheduled from June-August 2018. Herbicide application took place within each management zone on June 4, June 26, July 26 and August 22, 2018 in all 14 control areas. Biologists began surveying the areas for the presence of hydrilla, prior to the onset of the first treatment and continued to survey the affected areas through the end September 2018. No viable hydrilla was found in any of the treatment zones beyond the end of August 2018.

FasTEST® samples for herbicide monitoring were collected on a weekly or biweekly basis from June-August to document and adjust dosage if necessary. In addition to FasTEST® water samples, biologists routinely surveyed the treated areas looking for the presence of hydrilla and documenting the effectiveness of the treatments on hydrilla growth and relaying results so that the dosage could be adjusted if needed. A mathematical error led to a reduction in the herbicide applied to treatment area DC5 during the July 26th treatment (40lbs of herbicide was used instead of the 400lbs prescribed). As such, biologists diligently surveyed the DC5 treatment zone to ensure any live hydrilla was being targeted with the available herbicide and responding accordingly. The error in treatment prescription was corrected for the 4th and final treatment, whereby 400lbs of herbicide was applied throughout the DC5 treatment area to account for the 3rd treatment error. Water quality monitoring continued at several of the treatment zones, similar to what is done in 2017 and for the lake wide baseline water quality monitoring effort. The additional water quality monitoring was done in an effort to document any effects of the hydrilla treatment process on water quality.

Figure 7: 2018 Proposed Hydrilla Treatment Zones

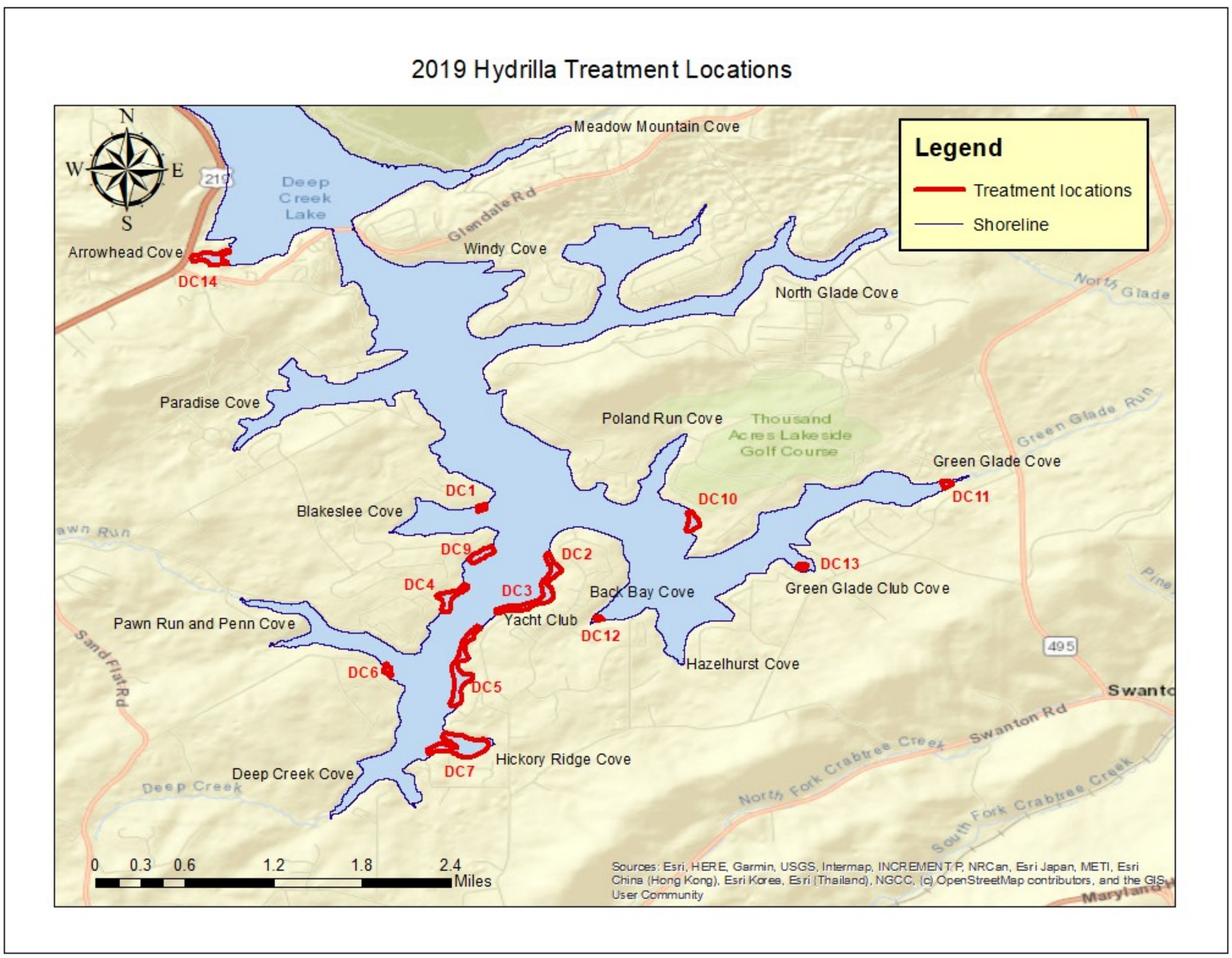


Notable changes to the treatment plan from the previous year includes the new addition of DC14 treatment zone, which treated the new hydrilla beds found in Arrowhead Cove during 2017. Other changes included reducing the size of DC8 to include just the immediate area around the original GPS coordinate recorded in 2013. This was due to no findings of hydrilla in the DC8 zone after 2013. Additional reductions in treatment zone size at DC1, DC6, DC11 and DC12 were also made due to biologist observations in those areas over the past 4 years. In most cases these reductions are the result of no hydrilla being found at the site in at least 1-2 years or only finding hydrilla at a very small location at the site. The reduction in area of the lake treated is a sign that the current treatment efforts are effective. The reductions not only reduce any potential negative impacts of the treatment on native SAV species in the area but also save money and allow for the natural recovery of native SAV habitat in the area impacted. These areas were monitored closely throughout the 2018 summer months and will be in subsequent years so that should any hydrilla be found, adjustments to the treatment plan can be made as needed.

Aquatic Invasive Species (AIS) outreach and education efforts continued in 2018 but focused on the development of an AIS trifold pamphlet and revising the AIS self-certification form that is used with the fishing tournaments at Deep Creek Lake. The self certification form was revised in 2018 but accepted in 2019. Additionally, the AIS pamphlet was developed in 2018 but approved for dissemination in 2019. Copies of the trifold will be put in the AIS disposal stations at Deep Creek Lake and throughout the state at the state lakes. The Deep Creek Lake Natural Resource Management Area (DCL NRMA) partnered for the fourth consecutive year with Garrett College's Natural Resource and Wildlife Technology Program to hire college students that served as boat launch stewards at the Deep Creek Lake State Park boat ramp during the summer months. Four college students were employed from May-September 2018 and offered voluntary boat inspections at the DCL State Park boat ramp along with educating boaters about properly cleaning and decontaminating their boats and gear. From May-September, boat launch stewards inspected 3,682 vessels at the Deep Creek Lake State Park boat ramp and found 115 vessels to have organic material on the boat and/or trailer (3.1%). Of those 115 vessels found with organic material, 4 were confirmed to be some form of AIS, representing <1% of all boats inspected to be carrying AIS.

2019 Results

The 2019 treatment approach was similar to the 2018 approach. The only notable change was that in 2019, treatment zone DC8 was removed altogether from the treatment due to no finding of hydrilla at that site since 2013. Monitoring was increased in frequency and coverage at DC8 to ensure that no hydrilla existed at that site. Total treatment cost were slightly lower than 2018 costs with a total cost of $209,400.00 to treat



a total of 73.5 acres within 13 treatment zones. FasTEST water quality monitoring and underwater plant monitoring took place throughout the summer months similar to years past. However, due to the reduced size of some of the treatment areas, FasTEST sampling was deemed not feasible nor necessary at sites DC8, DC11, DC12 and DC13. Based on monitoring results in 2018, underwater monitoring along the deeper edge of sites DC5, DC3, and DC2 occurred to ensure no viable hydrilla exists outside the treatment zones throughout Deep Creek Lake.

Voluntary boat inspections continued at the DCL state park boat ramp for the 6th year in a row, collecting valuable data from boaters regarding recent waterbody use, and point of origin, and educating boaters of the importance of properly cleaning, draining and drying their boats and gear. A total of four launch stewards were hired to work the State Park Boat Ramp Monday-Thursday 7am-7pm and Friday-Sunday 7am-9pm from Memorial Day thru Labor Day weekend. They continued to also staff the Rocky Gap State Park boat ramp on Saturday and Sundays throughout the summer months as well. Aquatic invasive species education and prevention continued at the Deep Creek Lake State Park boat ramp with the 6th year of Boat Launch Stewards offering voluntary boat inspections from Memorial Day to Labor Day during 2019. The stewards continue to be the Departments most visible line of defense against new introductions of AIS with an additional interception of a boat hailing from the Monogahelia River in West Virginia that had viable zebra mussels attached to the hull and motor. The stewards intercepted the boat on Labor Day weekend 2019, removed the mussels, notified appropriate personnel including the Natural Resource Police, and gave the boat owner information where they could get their boat properly cleaned. Since the inception of the program, the launch stewards have intercepted at least 4 of zebra mussels on boats attempting to launch onto Deep Creek Lake along with multiple finds each year of invasive plants attached to boats. While successful, their findings underscore the need for continued AIS education, monitoring and prevention efforts.

Additionally an AIS educational trifold was finalized in late spring 2019. Four thousand copies of the trifold were printed and disseminated with funds received from a federal Aquatic Nuisance Species Grant awarded in 2017. Copies were disseminated throughout Deep Creek Lake, targeting local marinas, business, visitor centers, in addition to being placed in AIS disposal stations located at the various boat ramps around Deep Creek Lake. Copies were also provided to the various other state owned lakes managed by the Maryland Park Service. It is hoped that additional copies of the trifold can be printed in subsequent years to be disseminated throughout the state of Maryland to communicate the CLEAN, DRAIN and DRY message.

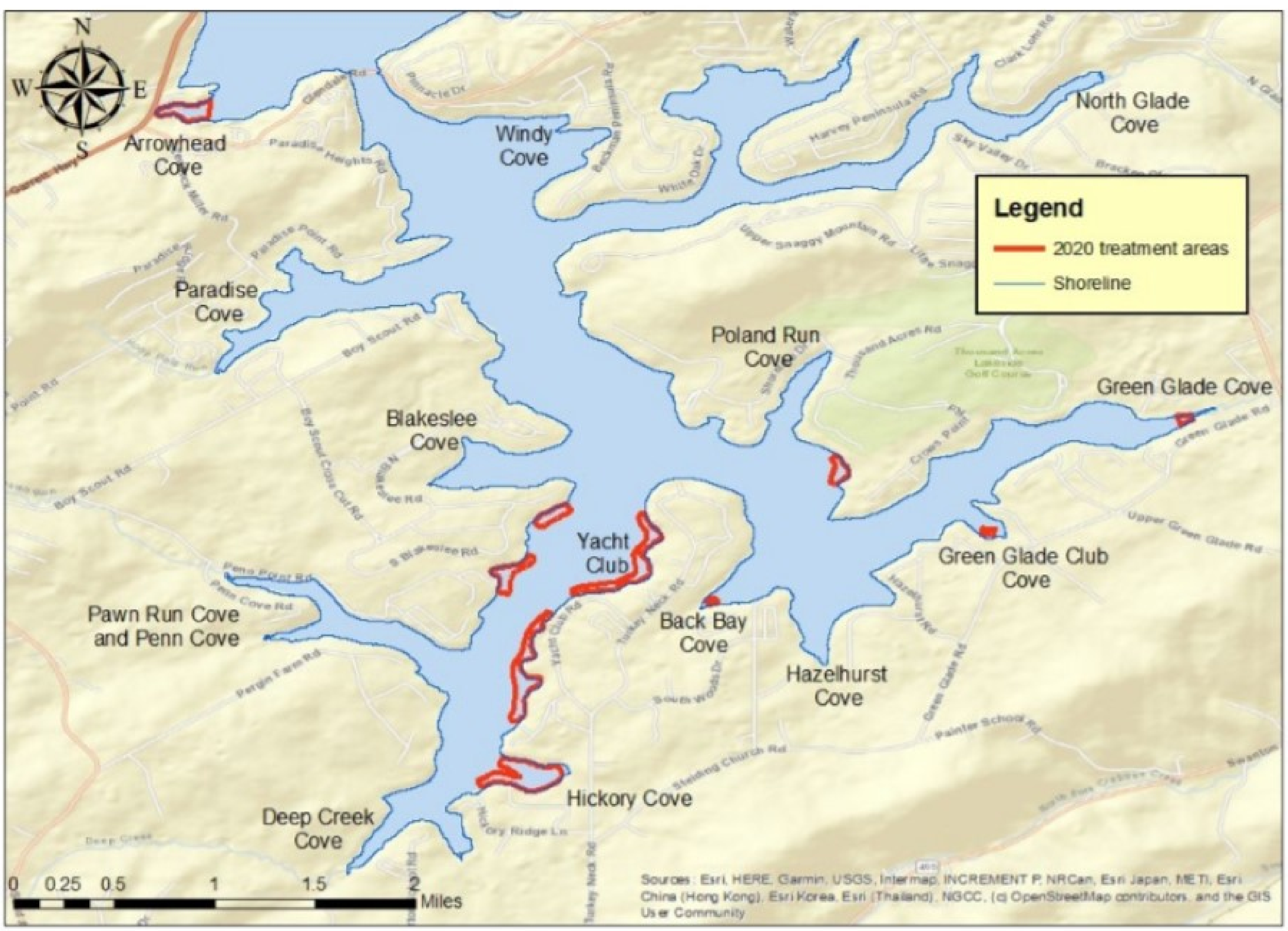
2020 Results

The 2020 treatment effort built upon the 2019 progress, as two additional treatment locations (DC1 and DC6) were removed from the 2020 treatment due to no finding of hydrilla at those locations within the past 3+ years. This reduced the total number of treatment locations from 13 in 2019 to 11 for the 2020 treatment. Additionally, three treatment zones (DC9, DC10 and DC11) were only treated during the first two scheduled treatments rather than all 4 treatments. Again, the reduction in number of treatments scheduled for these locations was due to no finding of hydrilla at these locations in the past 3+ years. The four scheduled 'block' herbicide treatments using Sonar occurred on Monday June 8, Tuesday June 30, Tuesday July 21 and Tuesday August 18, 2020. FasTEST water quality monitoring along with underwater monitoring found no live hydrilla at any of the 11 locations during the treatment period (June-August).

Staff from the DCL NRMA found a new bed of hydrilla in Windy Cove on September 4, 2020. Biologists confirmed the discovery of hydrilla and worked with DCL NRMA staff to document the location and size of hydrilla beds at the location. The herbicide contractor was contacted and on site one week later to treat all new beds of hydrilla in the area on September 11, 2020 with two broad spectrum herbicides (Reward and Clipper). While only 3 small beds of hydrilla were found at the location (totally <10 sq. meters) close to 1 acre of water was treated in attempt to neutralize any possible hydrilla at the location. Follow up surveys found that the September 11th treatment was effective at killing the new hydrilla beds. Additional plants (some native and others non-native) were also observed to be impacted by the September 11th herbicide treatment with most expected to recover the following year. These plants in the area of Windy Cove included *Elodea* species, *Myriophyllum* species, *Potamogeton* species, *Sagittaria* species and a large 30X100m bed of *Vallisneria americana*.

The 2020 growing season marked the 7th year of hydrilla treatment at Deep Creek Lake, Maryland. A total of 73 acres were treated in 2020 with Sonar and an additional 1 acre treated with Reward and Clipper bringing a treatment total of 74 acres treated in 2020 at a cost of roughly $170,000. It should be noted that in situ monitoring was not as frequent, nor thorough as was done in past years, in part due to restrictions associated with the Covid19 virus. None the less, the findings of no live hydrilla in any of the 11 treatment zones could be in fact accurate, as hydrilla was only found in 3 of the 13 sites during 2019. Treatment is nearing the estimated 8-10 years that was estimated to be needed to completely control hydrilla.

2020 DNR Hydrilla Herbicide Treatment Locations
at Deep Creek Lake, Maryland



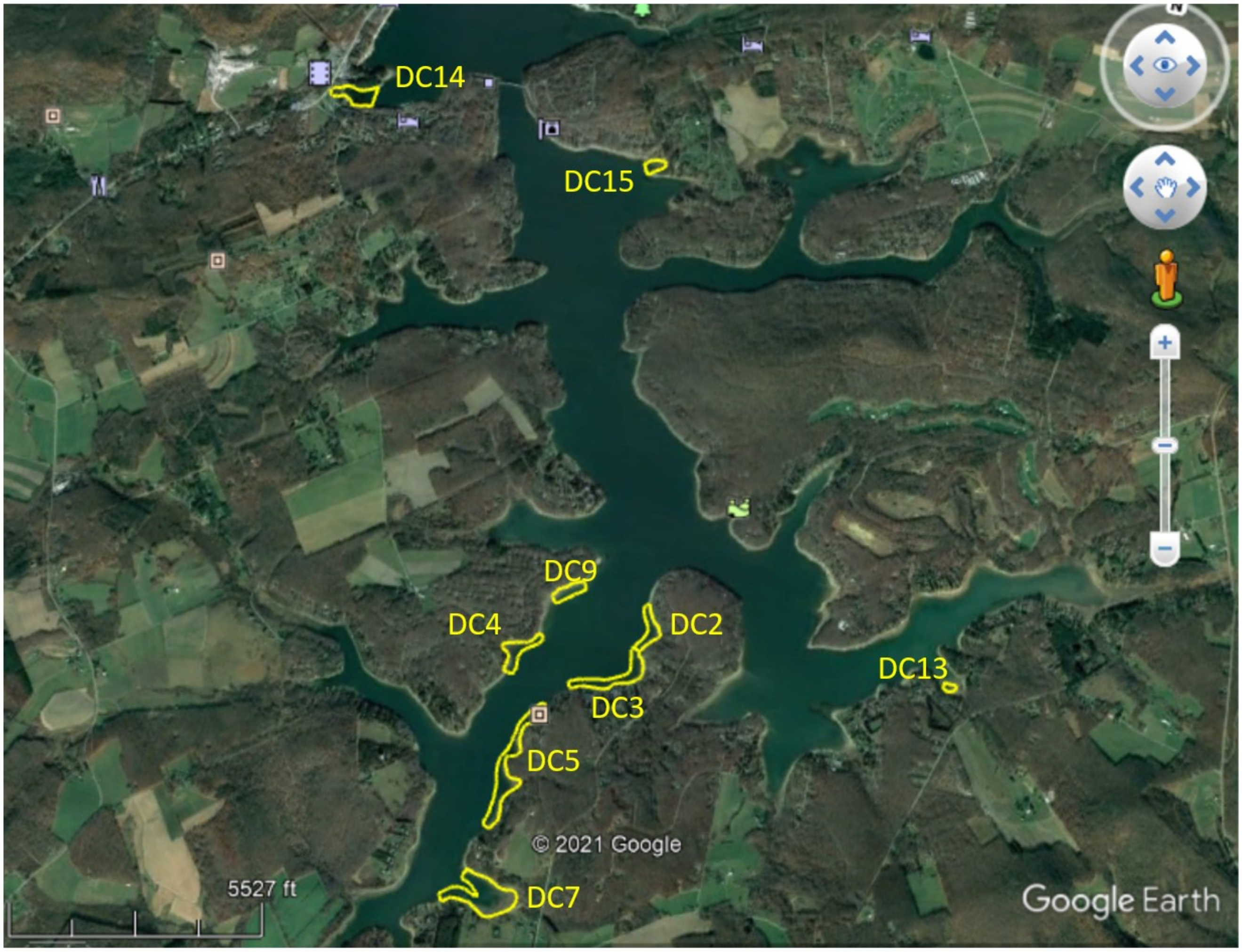
Voluntary boat inspections continued at the DCL state park boat ramp for the 7th year in a row, collecting valuable data from boaters regarding recent waterbody use, and point of origin, and educating boaters of the importance of properly cleaning, draining and drying their boats and gear. A total of four launch stewards were hired thru Garrett College to work the State Park Boat Ramp Monday-Thursday 7am-7pm and Friday-Sunday 7am-9pm from Memorial Day thru Labor Day weekend. They continued to also staff the Rocky Gap State Park boat ramp on Saturday and Sundays throughout the summer months as well. Aquatic invasive species education and prevention continued at the Deep Creek Lake State Park boat ramp with the launch stewards continuing to be the Department's most visible line of defense against new introductions of AIS. The 2020 boating season was among the busiest in recent history with a record number of steward inspections conducted (5814 which is nearly 2000 more than a typical year), as well as record number of AIS interceptions (29 boats found with AIS) including 9 boats founds with zebra mussels attached to either the hull and/or motor and 20 boats found with hydrilla.

Boats found with zebra mussels came from as far away as the Ohio River (in Ohio) and Indiana. However, the majority of boats with zebra mussels attached appeared to be originating from the Ohio River (near Pittsburg, PA) and could be a result of more frequent travel locally, due to travel and related restrictions associated with the Covid19 pandemic. A steady pulse of infected boats began arriving the July 4th holiday weekend and continued to be observed through the Labor Day 2020 weekend. Additional AIS interceptions of various species of invasive plants were also intercepted throughout the summer months by launch stewards. Launch stewards inspecting 5814 number of boats during the 2020 season at Deep Creek Lake, with 0.5 % being found with AIS present. The launch stewards should be strongly commended for their efforts during 2020, catching both juvenile and adult zebra mussels as well as attached invasive plants. Their findings suggest growing pressure of AIS potentially being introduced into Deep Creek Lake and underscore the need for continued AIS education, monitoring and prevention efforts.

Additionally, an unbiased review of the AIS educational efforts at Deep Creek Lake was conducted on behalf of the Deep Creek Lake Administrative Council. The review was completed during the 2020 summer semester by a group of graduate students through the University of Maryland Global Campus. Their findings can be found on Garrett County's website under the Deep Creek Lake Watershed resources webpage . The students reviewed other AIS educational efforts around the country and world and among their suggestion was to create a comprehensive AIS website specific to Deep Creek Lake and ensure that the link is shared with all stakeholders in the region. Additional suggestions included exploring social media opportunities to share the website link as well as contacting house rental companies in the region and ensure they provide links to the website and/or additional information to renters. In addition to the student report, DNR staff was able to secure Federal Aquatic Nuisance Species funding to explore the use of environmental DNA for early detection of AIS, supplement launch steward efforts at DCL and elsewhere in the state, produce additional AIS trifolds and signage, conduct a genetic study of the milfoil populations in the region and conduct an AIS decontamination and inspection training for staff and marinas in the region.

2021 Projections

The 2021 treatment season will mark the 8th consecutive year of herbicide treatment to control the growth of hydrilla in Deep Creek Lake. Due to recent year's monitoring results, 6 of the original sites (DC1, DC6, DC8, DC10, DC11, DC12) have been removed from the 2021 planned treatment. This represents 3 additional sites removed from the 2020 treatment. However, one new site, DC15 will be added to the 2021 treatment due to the discovery of a new hydrilla bed in Windy Cove. The below map shows the 2021 treatment polygons for 2021.



In addition to removing some sites from the treatment altogether DC9 and DC13 will only be treated the first 2 of 4 scheduled treatments. Treatment at DC2 and DC5 will focus efforts a bit more in the deeper sections of those polygons as hydrilla had been found in past years, lingering a little longer in to the growing season in the deeper depth portions of the treatment polygon. Monitoring efforts will focus on the deeper portions of sites DC2, DC3, DC5 and DC14 as well as trying to get out in the water in the early season (so late June, early July). Additional focus will be on getting in the water to monitor DC9 and DC13 early as only 2 treatments are planned for these locations. Monitoring all summer long is scheduled for DC15 as this was a new discovery in 2020 and fragments from this bed may have colonized other locations in the treatment polygon or in adjacent nearby areas.

Launch Stewards are planned for the Deep Creek Lake State Park boat ramp starting Memorial Day and running through Labor Day with occasional weekends before and after those dates. Several other AIS related research and monitoring efforts are also planned for the 2021 season to include an eDNA study to determine if this technology can be used for the early detection of hydrilla, a milfoil genetic study to determine which of the milfoil species found in DCL are native and which are not native and if the species are hybridizing, as well as working to get some additional AIS signage at the DCL State Park boat ramp and possibly a traffic counter and/or camera to help ensure boats are cleaned, drained and dry before launching onto DCL.

Summary and Future Recommendations

Based on the results of the hydrilla management plan and control efforts at Deep Creek Lake over the 2014-2020 time period, it is recommended that Fluridone block treatments continue in a fashion similar to what has been done since 2014 as this appears to be largely successful. Due to the biology of hydrilla and its ability to produce over-wintering tubers (reproductive structures) that can remain viable in the sediment for several years, it is anticipated that areas once infected with hydrilla will need to be treated for several consecutive years before the area can be effectively "cleared" of any hydrilla. That said, once an area can be found to be clear of hydrilla for at least 3 consecutive years, treatment of the area many be able to be scaled back (either in size and/or number of treatments needed per season) in an effort to increase the efficient use of resources (time and money) required by the control efforts. Such is the case with DC8, DC1 and DC6 which have been removed from current treatment. Additionally, some of the smaller 2013 and 2014 beds of hydrilla (<5m^2 total area), that were relatively solitary in nature and located in a protected cove or sheltered area, appear to be more effectively treated using a localized approach rather than treating the larger cove area. This is a more efficient use of resources (time and money associated with herbicide costs and monitoring activities) and could limit any adverse affects of the herbicide treatment on native plants and water quality in the surrounding areas. This type of localized approach was used from finding onset at DC13 (see Figure 5) in 2016, and since has been successful at suppressing hydrilla growth while not adversely affecting water quality or other SAV populations in the cove. While not used initially at DC1, DC6, DC12, DC13 and DC11 (Figure 5), treatment of these locations shifted towards a more localized approach in 2016 and has been successful since. A localized approach for treatment of small, isolated beds is recommended in subsequent years until no hydrilla can be found for at least 3 consecutive years. These modifications to the hydrilla management plan and control efforts are anticipated to reduce overall costs of the hydrilla treatments, reduce the area treated or affected by the herbicide, all the while not sacrificing in the effectiveness of the overall effort.

Should any new beds of hydrilla be found in the future, it is recommended that spot treatments using a contact herbicide be used to treat and hopefully suppress these hydrilla beds until they can be included in a larger, systemic block treatment approach using Fluridone. That said, previous spot treatments with contact herbicide have ranged in their efficacy, with some appearing to be highly successful and others not as effective. This could be due in part to environmental variables at the site that affect efficacy, such as silts covering the plants, higher than normal pH values depending on location or time of year or time of day, or even hydrilla bed size and/or density of plants limiting the effectiveness of contact herbicides. Based on these wide ranging observations in effectiveness, newly found beds should be monitored weekly following any contact treatment to assess efficacy of the treatment and determine if any additional spread of the beds may have taken placed due to fragmentation. Additionally, the erection of enclosures prior to treatment and maintenance post treatment until the hydrilla dies, is recommended when possible to further limit the spread or fragmentation of hydrilla as well as keep the herbicide targeted on the species of concern. It should be noted that these guidelines were followed during the September 11, 2020 treatment of hydrilla in Windy Cove. Water quality measurements were made in the area prior to treatment and pH values were observed above 8.5 during the day and conveyed to the herbicide applicator so that he could make necessary adjustments to the treatment timing and concentration. The location was monitored weekly post treatment and no hydrilla was visible by the end of September 2020. Due to the finding of multiple small beds in the area, an exclosure was not deemed appropriate and larger area was treated so that should any fragments of hydrilla be outside the mapped locations, these fragments could be neutralized by the herbicide.

The following chart summarizes the herbicide treatment efforts to date.

	2014	2015	2016	2017	2018	2019	2020
Acres Treated	93.5	104	104	110	74.5	73	73
Number of Treatment Zones	8	12	13	13	14	13	11
Systemic Herbicide (Block Treatment)	Sonar®	Sonar®	Sonar®	Sonar®	Sonar®	Sonar®	Sonar®
New Hydrilla beds found	4	1	0	1	0	0	1
Contact Herbicide (Spot treatment)	Reward® & Clipper®	Reward® & Clipper®	NA	Reward® & Clipper®	NA	NA	Reward® & Clipper®

Other suggestions arise from the location of the 2017 and 2020 findings and characteristic of those areas of new hydrilla beds. At both locations, the densest hydrilla was found in very shallow water (<1m water depth) with the largest of the beds found on the shallow, shoreline side of the docks. Additionally, both the 2017 and 2020 locations were in the central portion of the lake, far from the locations on the original locations on southern end of the lake. This suggests possible new introductions of hydrilla rather than floating fragments of hydrilla from other locations within the lake. Possible mechanisms of introduction introduction from land or boat, possibly via soft launching contaminated kayaks/paddleboards, or the release of contaminated water/bait fish. Waterfowl could also be introducing new hydrilla in this fashion. The fact that these two locations are closer to the State Park boat ramp and further from the 2013-2014 original hydrilla beds in the southern end of the lake also suggest the 2017 and 2020 hydrilla beds were likely a result of new introductions of hydrilla into the lake, rather than fragments moving from other parts of the lake. While biologists and Department staff routinely survey the shoreline of the lake each year looking for evidence of new hydrilla beds, based on where these beds were found, it is unlikely they would have been discovered during the routine shoreline survey. Both locations were discovered more accidentally as staff were at the location, and walking along the dock, for alternative reasons. This suggests that a new approach may need to be added to the early detection process. Drone surveys could prove useful for identifying 'suspicious beds' of hydrilla in the very shallow parts of the lake, up against docks and in waters too shallow for boat access. Exploring the use of drone piloted shoreline surveys may prove more efficient, thorough and expeditious than the historic boat operated shoreline survey.

And finally, the hydrilla beds found in Arrowhead Cove in 2017and Windy Cove in 2020, combined with an increasing number of boats coming into DCL with zebra mussels attached are a continual reminder of the persistent threat all waterbodies face of new invasions of AIS. They additionally emphasize the need to continue and expand on AIS education and outreach efforts and encourage boaters to properly clean, drain and dry their boats and gear prior to launching and leaving Deep Creek Lake, or any water body for that matter. Furthermore, early detection monitoring should continue, in all parts of Deep Creek Lake throughout the boating season in an effort to identify any potential newly found AIS plants or animals. Monitoring should correspond to the species of interest and reflect the species' biology and habitat. Visual surveys should continue as an early detection monitoring effort, but environmental DNA (eDNA) may be an effective tool in early detection AIS monitoring and should be considered when developing any additional monitoring efforts. AIS continues to present a very real and serious threat to the ecological integrity of aquatic ecosystems as well as the economic costs of sustaining these systems. Prevention is the best approach to limit long term costs and adverse changes to Deep Creek Lake and other water body.

The continued success of this control effort will rest on AIS education and prevention, early detection monitoring, and the continued effectiveness of subsequent hydrilla herbicide treatments. The DCL Boat Launch Steward Program should continue with possible additions of cameras and/or counters to get an idea of how many boats are launching when stewards are not available. The 2020 student generated report suggested the use of solar powered, internet connected cameras that can be used to help deter the launching of dirty or contaminated boats outside of hours the DCL State Park boat ramp is staffed by launch stewards. Additionally launch steward data suggests a rise in the number of 'dirty' boats or boats arriving with organic matter. Therefore it's evident that additional AIS education and outreach efforts to communicate the CLEAN, DRAIN, and DRY message are needed. Local marinas, house rental agencies and other DCL stakeholders should continue to be brought into the AIS educational message. Protection of DCL from AIS requires a community wide effort and buy in from all stakeholders locally and beyond. The Department has taken the lead on this AIS educational effort but success will rely on this being a broader, more collaborative effort across the DCL community.

Year	Number of Launch Stewards	Number of Vessels Inspected	Number of vessels with organic matter	Number of vessels carrying AIS	% of total vessels inspected carrying organic matter
2013	NA	NA	NA	NA	NA
2014	2	1066	23	not specified	2.20%
2015	5	2256	41	not specified	1.80%
2016	6	3824	22	9	0.50%
2017	5	3866	127	13	3.30%
2018	4	3682	115	4	3.10%
2019	4	3841	185	5	4.80%
2020	4	5814	409	29	6.90%

In summary, the management of hydrilla in Deep Creek Lake continues to require a long term, multi-faceted approach with significant investment of time, money and effort to remain successful. It is reasonable to expect that control efforts will be underway for several additional years. However, should the herbicide treatments continue to suppress hydrilla growth and AIS education and prevention efforts thwart future introductions of hydrilla, it is feasible that eradication of current hydrilla populations in DCL is plausible. The Department remains committed to managing existing populations of hydrilla, preventing further introductions, and reducing the threat it poses to the lake's ecosystem and the region's economy.

References

Cornell Cooperative Extension. May 2015. "Fluridone" and "Fluridone FAQ" http://ccetompkins.org/environment/invasive-species/fluridone-herbide-treatment-faq). Retrieved January 2018.

Glomski, L. M., and M. D. Netherland. 2012. "Does hydrilla grow an inch per day? Measuring short-term changes in shoot length to describe invasive potential." *Journal of Aquatic Plant Management* 50: 54–57.

Haller, W.T. 2009. Biology and control of aquatic plants: Chapter 13.1: Hydrilla. Aquatic Ecosystem Restoration Foundation. 89-93.

Netherland, M.D. 2009. Chapter 11, "Chemical Control of Aquatic Weeds." Pp. 65-77 in Biology and Control of Aquatic Plants: A Best Management Handbook, L.A. Gettys, W.T. Haller, & M. Bellaud (eds.) Aquatic Ecosystem Restoration Foundation, Marietta, GA. 210 pp

Wisconsin Department of Natural Resources. January 2012. Diquat Chemical Fact Sheet. Wisconsin DNR. Madison, Wisconsin. DNR PUB-WT-969

Wisconsin Department of Natural Resources. January 2012. Flumioxazin Chemical Fact Sheet. Wisconsin DNR. Madison, Wisconsin. DNR PUB-WT-971

Wisconsin Department of Natural Resources. January 2012. Fluridone Chemical Fact Sheet. Wisconsin DNR. Madison, Wisconsin. DNR PUB-WT-972

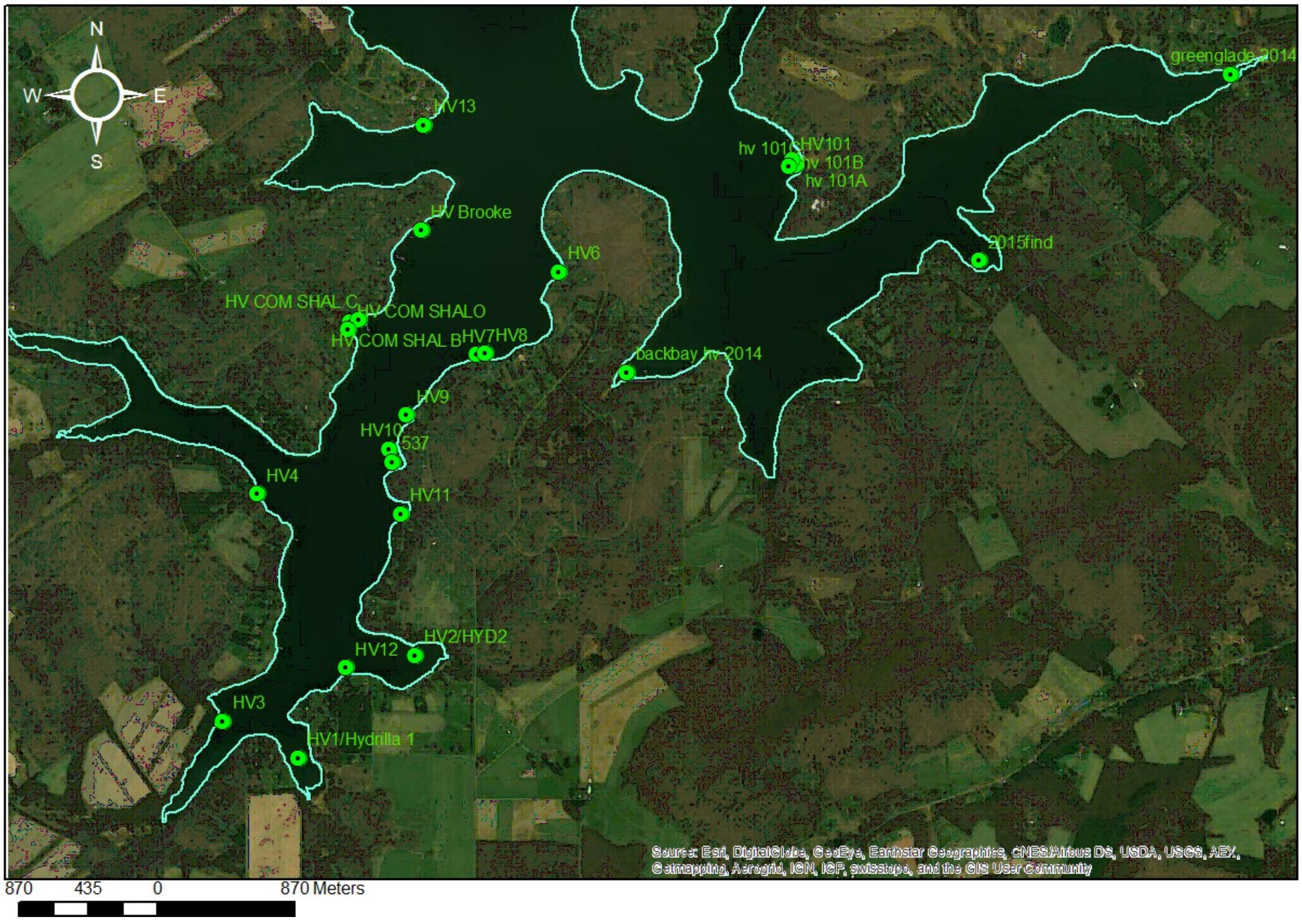
Wymer, Jim. March 5, 2015. "Florida water managers struggle with invasive hydrilla." Florida Today.

Appendix A:

GPS Coordinates and Map of
Hydrilla Locations in Deep Creek Lake
Original locations (2013-2015)

Treatment Polygon	Site Description	Waypoint # or name	Date found	Lattitude ('N)	Longitude ('W)
DC1	Blakeslee/Holy Cross	HV13	Oct-13	39.47856	-79.29732
DC2	small cove N. of Yacht Club	HV6	Oct-13	39.47215	-79.28974
DC3	Yacht Club	HV7	Oct-13	39.46853	-79.29437
	Yacht Club	HV8	Oct-13	39.4686	-79.29384
DC4	Commons Dock	HV COM SHAL B	Oct-13	39.469953	-79.301484
DC4	Commons Dock	HV COM SHAL C	Oct-13	39.470043	-79.301022
DC4	Commons Dock	HV COM SHALO	Oct-13	39.46964	-79.30163
DC5	Boat lift S. of Yacht Club	HV9	Oct-13	39.46589	-79.29831
DC5	S. of Yacht Club	HV10	Oct-13	39.46442	-79.29929
DC5	S. of Yacht Club	HV11	Oct-13	39.46159	-79.29863
DC5	S. of Yacht Club	537	Oct-13	39.46385	-79.29912
DC6	Pawn/Penn Cove	HV4	Oct-13	39.46246	-79.30679
DC7	Hickory Ridge Cove (Back)	HV2/HYD2	Oct-13	39.4554	-79.29784
	Hickory Ridge Cove (point)	HV12	Oct-13	39.45485	-79.30176
DC8	Chadderton Cove	HV1/Hydrilla 1	Oct-13	39.45091	-79.30442
DC8	Deep Creek Cove	HV3	Oct-13	39.45251	-79.3087
DC9	Shoreline across from Yacht Club	HV Brooke	Sep-14	39.47397	-79.29747
DC10	Swan Boat	HV101	Sep-14	39.47694	-79.27654
DC10	Swan Boat	hv 101A	Sep-14	39.4768	79.27631
DC10	Swan Boat	hv 101B	Sep-14	39.47703	79.27653
DC10	Swan Boat	hv 101C	Sep-14	39.47675	79.27671
DC11	Green Glade Cove (way back)	greenglade hv 2014	Aug-14	39.48078	-79.25169
DC12	Back Bay Cove	backbay hv 2014	Aug-14	39.467758	-79.285872
DC13	Green Glade Club Cove	2015find	Sep-15	39.47264	-79.26594

Original Locations of Hydrilla found in
Deep Creek Lake, Maryland (2013-2015)



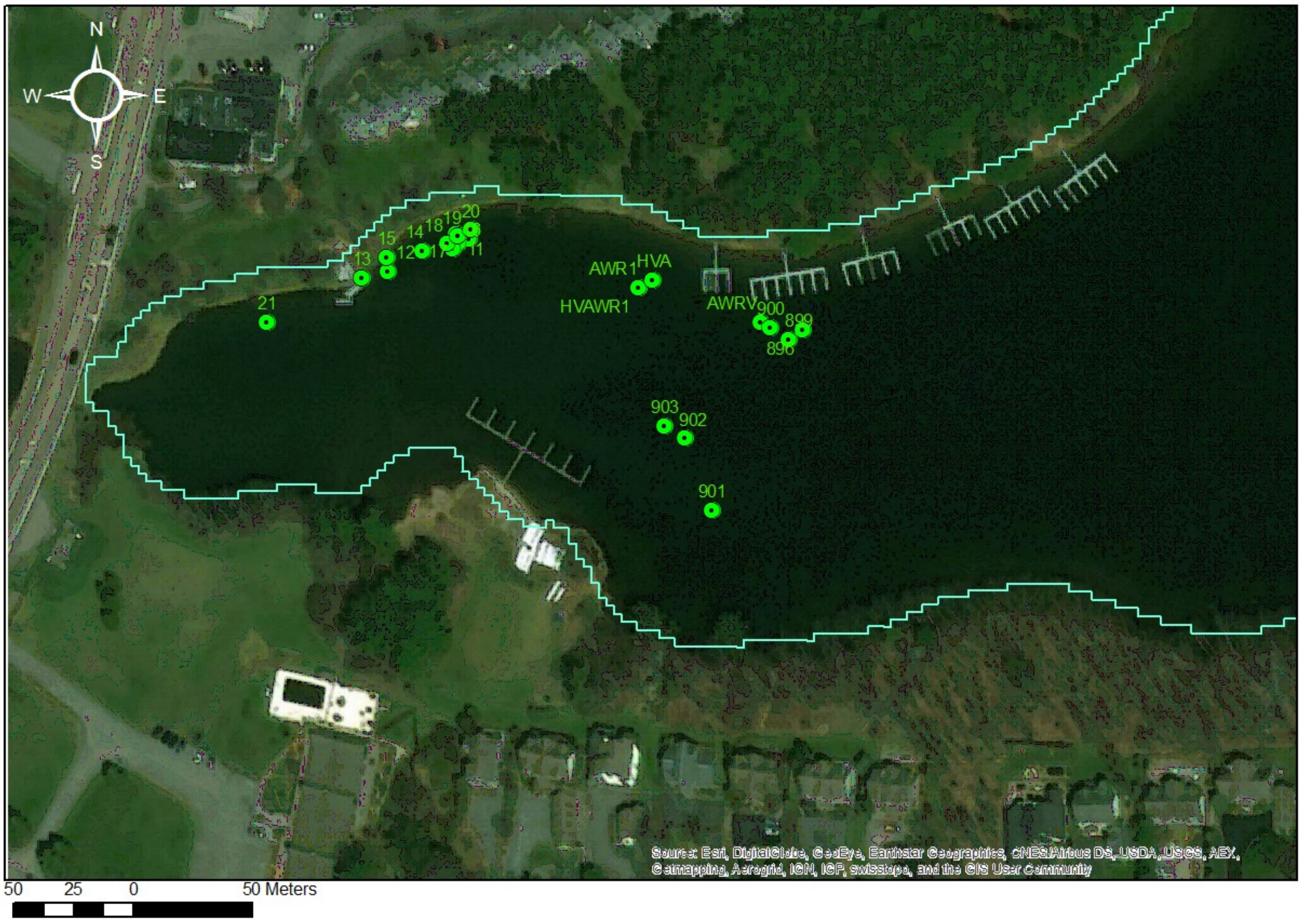
Appendix A:

GPS Coordinates and Map of Hydrilla Locations in Deep Creek Lake

Arrowhead locations (2017)

Treatment Polygon	Site/Size Description	Waypoint # or name	Date found	Lattitude ('N)	Longitude ('W)
DC14	Arrowhead Cove	AWR1	8/4/2017	39.50318	-79.32387
DC14	2m	HV2M	8/4/2017	39.50332	-79.324511
DC14	no data	11	8/4/2017	39.503307	-79.324551
DC14	no data	12	8/4/2017	39.503226	-79.324817
DC14	no data	13	8/4/2017	39.503208	-79.324915
DC14	no data	14	8/4/2017	39.503286	-79.324686
DC14	no data	15	8/4/2017	39.503267	-79.324821
DC14	no data	16	8/4/2017	39.503293	-79.32457
DC14	no data	17	8/4/2017	39.503337	-79.32456
DC14	no data	18	8/4/2017	39.503306	-79.324593
DC14	no data	19	8/4/2017	39.503329	-79.32455
DC14	no data	20	8/4/2017	39.503347	-79.324503
DC14	0.5m	21	8/9/2017	39.503078	-79.325271
DC14	1m	HVAWR1	10/4/2017	39.503177	-79.323871
DC14	1m	HVA	10/4/2017	39.503201	-79.323815
DC14	1.5m	AWRV	10/5/2017	39.503079	-79.32341
DC14	few plants	896	10/5/2017	39.503054	-79.323251
DC14	few plants	899	10/5/2017	39.503028	-79.323304
DC14	1m	900	10/5/2017	39.503062	-79.323372
DC14	few plants	901	10/5/2017	39.502531	-79.323594
DC14	0.5m	902	10/5/2017	39.502741	-79.323697
DC14	0.5m	903	10/5/2017	39.502776	-79.323772

Locations of Hydrilla found in Arrowhead Cove
Deep Creek Lake, Maryland



Appendix B:

Flow chart showing
Rapid Response Effort