Dimple Creek Watershed Water Chestnut Management Project
Final Report

Bucks County Conservation District

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Introduction

The objective of the Dimple Creek Watershed Water Chestnut Management Project was to improve habitat in the Dimple Creek watershed by implementing an integrated management regime (i.e., combining mechanical removal and chemical treatment), to address the infestation of the aquatic invasive plant, water chestnut (*Trapa natans*) on Lake Towhee. This integrated approach would mitigate the spread of this plant to Lake Nockamixon and the Tohickon Watershed overall.

The Dimple Creek (locally known as Kimples Creek) watershed is a 7.3 square mile subwatershed of the Tohickon Creek and is almost entirely contained within the boundaries of Haycock Township, Bucks County. Lake Towhee is a 50-acre county-owned impoundment at the center of this subwatershed and serves as the focal point of the 549-acre Lake Towhee County Park. The lake and its surrounding parkland are open year-round and provide park visitors with a variety of recreational opportunities including fishing, boating, picnicking, hiking and camping. Lake Towhee outlets to Dimple Creek, which drains to the Tohickon Creek 1.5 miles upstream of the inlet to Lake Nockamixon. At 1,450 acres, Lake Nockamixon is the largest lake in Bucks County and is the focal point of the 5,286-acre park which is utilized for picnicking, hiking, and biking. Lake Nockamixon was formed by the construction of a dam on the Tohickon Creek and has six public boat launch areas that are utilized by boaters and anglers.

Water chestnut is an aquatic invasive plant which threatens the diversity and abundance of native species, as well as the ecological stability of the waterways it infests. The plant's preferred habitat is shallow, slow-moving, nutrient-rich waters, which makes lakes and impoundments most susceptible to infestation. The spiky seed pods and tangled mats of plants on the water's surface pose a safety hazard to humans and impede recreational activities, potentially posing a great economic impact. This aggressive plant requires long-term management efforts, primarily due to the long viability of the seedpods, which can germinate up to 12 years after a dormancy period in the benthos. However, most seedpods are believed to germinate within the first 2-3 years after deposition.

The species' fast rate of reproduction through clonal and high annual seed production demands consistent management. Each rosette produces up to 20 seeds, and each seed can give rise to 10-15 rosettes; therefore, removal of a single plant prior to seed maturity can prevent germination and ultimate reproduction of 100-300 water chestnut plants. Consequently, for management efforts to be successful, all plants must be removed annually prior to reaching full maturity and contributing to the seed bank. In southeastern Pennsylvania, water chestnut emerges in mid-May and flowers around mid-July, providing a limited 2-month window to remove the plants.

Water chestnut was first documented in both Lake Towhee and Lake Nockamixon in July 2009 during a routine water quality assessment completed by

PADEP. A more extensive population was noted at Lake Towhee which had dense patches in the upper 25 acres as well as patches along the shoreline, adjacent to the public boat launch and near the outlet. Comparatively, Lake Nockamixon's population was more manageable, contained to the area near the Tohickon Creek inlet. Although Dimple Creek itself is listed as attaining its uses; in 2010, Lake Towhee was listed on Pennsylvania's Impaired Waters list as being impaired for aquatic life and recreational uses by exotic species and siltation attributed to various sources, including agriculture and small lot development.

While the land use in Dimple Creek watershed has been stable for over 20 years; water chestnut is a continuous growing threat to aquatic habitat in Dimple Creek watershed, and to Lake Nockamixon. Eradication of water chestnut through a consistent, multi-year management effort is the top priority for the health of the entire watershed and could remove one cause of impairment and demonstrate an incremental improvement at Lake Towhee.

Expected Results

The project is expected to produce ecological, recreational, and programmatic benefits to the watershed.

Ecological Benefits:

1) To reduce the annual nutrient load and anoxic conditions resulting from annual vegetation die off and decay.

2) To restore components of lake ecology by releasing native plants from light and nutrient competition with water chestnut.

Recreational Benefits:

1) To restore safe boating and fishing access by removing the impenetrable mats, an entanglement hazard.
2) To reduce the risk of injury to waders, anglers, and boaters from the sharp spiny nuts of water chestnut.

Programmatic Benefits:

1) To initiate consistent and integrated management water chestnut in the subwatershed combining mechanical removal and targeted herbicide application.

2) To implement a monitoring strategy allowing for early detection and control of emerging infestations.

3) To engage and reward volunteer monitoring and management effort as the highly visible return of open water habitats would result in positive feedback for the work.

4) To prevent high-impact infestations within the region using a network of educated stakeholders to encourage and initiate rapid responses to new infestations.

By sharing the story of Lake Towhee water chestnut management, we expect to prolong the project results as the public becomes further engaged in protecting local waterways from the spread of this and other invasive species. On site signage, brochures, and educational outreach via multiple platforms will educate and motivate some level of participation by different user groups. District outreach activities aim to reach at least 3,000 adults in the area. Ultimately, programmatic public participation could include taking precautions when transporting watercraft between water bodies, participating in monitoring or removal, or simply sharing the information with others.

Project Description

Deliverable 1. Mechanical and Chemical Control at Lake Towhee

There were a few changes from the expected scope of work related to this deliverable. First, the Growing Greener Grant agreement was fully executed too late in the season in 2018 to enable BCCD to select a contractor for herbicide treatments sufficiently to complete contractor selection prior to the 'Paddle with a Purpose' volunteer removal event. Second, the aquatic invasive plant *Hydrilla verticillata* was observed in Lake Towhee in 2017. In response, BCCD requested contractors to include in their proposals, treatment options that would avoid shifting the problem of aquatic invasives from one species to another. Most treatment options offered a benefit of additional impact on water chestnut. Third, 2018 summer monitoring of water chestnut coverage in Lake Towhee (described in the next section) revealed that the upper reaches of Lake Towhee, approximately 15 acres, averaged only 18 in. deep. This would preclude sufficient access for harvesting equipment/most powered boats. Further, an abundance of snags would create an additional hazard for the safe and efficient operation of harvesting equipment.

In 2019, the BCCD completed a Request for Proposals process for the herbicide treatment and received 3 proposals, ultimately awarding the contract for treatment to Aqua Link, Inc. in Doylestown. Aqua Link Inc. completed the permit application for herbicide treatment on the lake in coordination with BCCD and Bucks County Parks and Recreation and four (4) treatments were completed in the summer.

With permits in place, Aqua Link initiated a series of four herbicide treatments within the April to August growth and reproductive windows of both the 2020 and 2021 growing seasons. This timeframe ensured plants were killed prior to adding to the viable seedbank in the lake. Copies of annual reports from Aqua Link are included in Appendix A and include additional detail on chemicals used and permit for treatment.

Unfortunately, the scope of work required an adjustment because mechanical control via harvesters was deemed unfeasible due to combination of very shallow water and woody debris hazards in the most infested portions of the lake (see Deliverable 2 discussion). This change resulted in less plant biomass removed from the lake than initially planned and resulted in the overall project coming in under budget.

Plants harvested by volunteers were collected in heavy duty trash bags to facilitate transport and transported via BCCD pickup trucks to a location at Lake Towhee Park well away from the water. The estimated volume of biomass removed by year through mechanical means is shown in Table 1.

Table 1. Water chestnut volume removed from Lake Towhee mechanical removal

Year	Estimated Quantity Removed (cubic yards)
2018	48
2019	36
2020	12
2021	26

Deliverable 2. Annual Monitoring of Water Chestnut Coverage in Lake Towhee and the Dimple Creek Watershed

In 2018, BCCD worked with volunteers from the Paddle with a Purpose event and Master Watershed Steward volunteers to monitor Lake Towhee for the relative abundance of water chestnut in Lake Towhee and to assess depth in the upper lake area proposed for harvesting. Through the paddling survey completed over a series of 3 days, the group documented that 80-90% of the upper 30 acres of the lake were covered with water chestnut (*Trapa natans*) with a few smaller patches in coves downstream of the boat launch and isolated plants near the dam. Photos depicting the density of water chestnut at that time are included in Appendix B.

It was determined that the restoration of open water as a result of treatment would best be documented using overhead imagery. In 2020, BCCD received approval to utilize drones to capture surface vegetation conditions and the extent of open water habitat on Lake Towhee. Orthomosiac imagery for 2020 and 2021 are included (along the satellite imagery from 2018 as comparison) in Appendix C.

Watershed assessments were completed via combination of windshield survey and walking stream segments with the BCCD Watershed Specialist and BCCD intern

and/or Master Watershed Stewards through mostly slow-moving sections of the stream network in the upper watershed for any populations that would undermine management efforts at Lake Towhee. Fortunately, no populations upstream of Lake Towhee were identified within the watershed from 2018-2021, although a population was documented in a small pond in the nearby Cooks Creek watershed during this timeframe.

Additional monitoring efforts have been completed by PADCNR and Master Watershed Stewards of Bucks County at Lake Nockamixon. BCCD was able to assist with mechanical removal of water chestnut near the ThreeMile Run boat launch and a survey by PADCNR of the extent of water chestnut in the lake in 2019. Master Watershed Steward volunteers completed the monitoring and removal effort in 2020 and documented a new occurrence of water chestnut in Haycock Run inlet. Thanks to building community awareness and a rapid, dedicated response, the population is being kept in check at Lake Nockamixon.

Deliverable 3. Education and Outreach

BCCD collaborated with Bucks County Parks and Recreation, Nockamixon State Park, Delaware Canal State Park and Pennsylvania Department of Environmental Protection to coordinate volunteer pulling events in July 2018, 2019 and 2021. COVID-19 posed a disruption to the pre-established volunteer program; however, BCCD modified the format to a self-scheduled event and provided resources via mail, contactless delivery and online. Figure 1 shows the number of participants and hours contributed (or self-reported per 2020).

Participants were recruited for the mostly 3-day events via email blasts, social media, press release and coordination with NGOs (Friends of Lake Nockamixon and Philadelphia Canoe Club). Participant numbers included state employees (PADCNR and PADEP) but their hours were not included as match for this grant. PA DCNR provided kayaks, PFDs and paddles for use by volunteers which enabled those without access to a kayak to participate.

The volunteer events were kicked off with a presentation intended to help volunteers with proper identification of water chestnut (*Trapa natans*) and to underscore the importance of removing the plants to offer ecological, water quality and recreational benefits at Lake Towhee and downstream in Lake Nockamixon as well as boating safety.

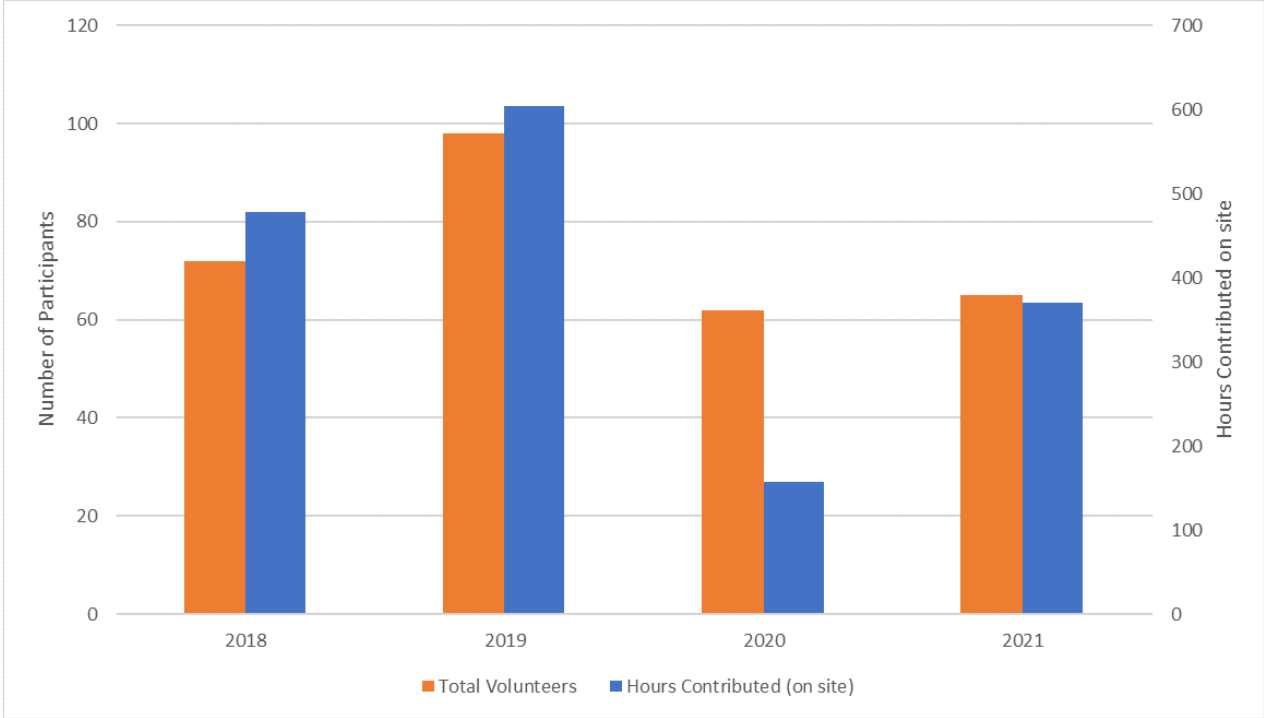


Figure 1. Lake Towhee Water Chestnut Volunteer Participation and Volunteer Hours Contributed 2018-2021

Additional outreach included a presentation at the May 2019 meeting of the Philadelphia Canoe Club and hosting an exhibit at the club's open house event in June 2019. The project was also highlighted in a Pennsylvania Invasive Species Council (PISC) Story Map in 2020 https://storymaps.arcgis.com/stories/7a0f6078503f48429658e75bb78e7d10 and featured on PADEP blog 'Our Common Wealth' https://www.dep.pa.gov/OurCommonWealth/pages/Article.aspx?post=61.

As referenced above, the BCCD incorporated some modifications in 2020 due to COVID-19 gathering limitations and the need for limited close contact with this project while assisting volunteers and offered a self-scheduled option over 8 weeks. Participants were encouraged to post photos to social media and BCCD offered a $25 gift card raffle as an incentive. Overall, 62 participants registered for the removal event in 2020; however, despite repeated requests for documentation response rate was low on hours contributed to the project that season. To avoid redundancy for repeat volunteers, while preparing new volunteers, BCCD provided an alternative to the typical kickoff presentation. Volunteers were given access to video series on aquatic invasive species, water chestnut, native plants of Lake Towhee and the importance of cleaning gear to prevent the spread of aquatic invasive species (AIS).

For lasting effect, outreach materials were produced to present the impacts of unchecked water chestnut spread alongside the beneficial effects of integrated

management. 500 double-sided rack cards will be shared with established and potential watershed stakeholders, as well as residents of Bucks County. A sign was fabricated and installed at the Lake Towhee Boat Launch, advising recreational users of the lake to clean their gear and prevent the spread of aquatic invasive species. Additionally, 350 glossy brochures have been printed and will be available at an outdoor literature box at the park's information kiosk. Depictions of outreach materials are found in Appendix D.

Conclusion/Next Steps

Financial support and execution flexibility for necessary project adjustments provided by this Growing Greener grant allowed for the fulfillment of project objectives. Open water habitat has been restored as compared to initial conditions. This represents an incremental improvement to the recreational impairment of Lake Towhee. The project produced an opportunity for increasing awareness through storytelling of a local instance of the spread and management controls of invasive aquatic species.

Still, the remaining, viable seedbank requires future management and monitoring effort at Lake Towhee. In response to this future need, BCCD applied for and was granted a Pennsylvania Lake Management Society Mini-Grant to maintain treatment efforts for the 2022 season. Ideally with a minimum of five (5) consecutive years of treatment, these efforts can be scaled back gradually and maintained by vigilant monitoring and more limited hand removal efforts going forward.

Appendix A. Copy of Aqua Link, Inc. seasonal Technical Reports for 2019-20 and 2021

February 9, 2021

Bucks County Conservation
District 1456 Ferry Road, # 704
Doylestown, PA 18901

Re:Lake Towhee Aquatic Macrophyte Treatment Report
ALI Project No. 1005-24 & 1005-25

Dear District Board Members:

Aqua Link was retained by the Bucks County Conservation District (hereinafter referred to as the District) to control excessive amounts of aquatic vegetation in Lake Towhee during the 2019 and 2020 growing seasons. For this project, aquatic plant control was accomplished using aquatic herbicides (pesticides) that were applied by boat. The primary objective of these aquatic herbicide treatments was to target non-native, invasive aquatic vegetation which has invaded the lake. In addition, as part of this project, Aqua Link was hired to assess the overall effectives of the above aquatic herbicide treatments.

Funding for this project was made possible by a PA Department of Environmental Protection Growing Greener grant. Lake Towhee, owned by the Bucks County Department of Parks and Recreation, is a 50-acre impoundment located in Lake Towhee County Park of Haycock Township in Bucks County, Pennsylvania. The upper end of the lake (inlet) is quite shallow with water depths ranging from less than 1 foot up to about 4 feet in the old creek channel (Figure 1). This shallow section has numerous stumps, sunken timber and heavy aquatic vegetation plus both submerged and floating leaved aquatic vegetation. As a result, navigation in this area can be quite difficult. Middle and lower sections of the lake are deeper and more navigable with water depths up to 8 feet and averaging about 4 feet. In middle and lower sections of the lake, the heaviest aquatic plant growth was located along the perimeter of the lake as both submerged and floating leaved aquatic vegetation (Figure 1).

More specifically, the aquatic plant treatment program, as performed by Aqua Link

in 2019 and 2020, was designed to gain control over water chestnut (*Trapa natans*) and hydrilla (*Hydrilla verticillata*), which are both highly aggressive, non-native aquatic plant species. The majority of the water chestnut was located in the shallower, inlet end of the lake. However, water chestnut was observed at lower densities in the middle and lower sections of the lake as well - primarily along the lake perimeter. Hydrilla was located primarily in the shallower, inlet end of the lake and extending to the boat launch area (Figure 1). Smaller stands of hydrilla were observed in the middle and lower regions of the lake perimeter, mostly opposite the boat ramp.

Figure 1: Aerial Image of Lake Towhee (Spring 2020)

Other significant macrophytes identified in the lake were spatterdock (*Nuphar sp.*), water shield (*Brasenia schreberi*), white water lily (*Nymphaea sp.)*, coontail (*Ceratophyllum demersum*), and curlyleaf pondweed (*Potamogeton crispus*). Although other plants exist in Lake Towhee at high densities, the objective of this treatment program were to reduce the densities of both water chestnut and hydrilla. Both of these species are non-native, highly invasive plants that have multiple modes of reproduction and can quickly out-compete other plant species if left untreated. More information regarding all plants listed in this report can be found in Appendix B.

The final product of the Lake Towhee aquatic plant treatment program is this report. This

report describes the aquatic plant management strategy in both 2019 and 2020, the aquatic herbicides applied on each treatment date during 2019-20, and our professional evaluation of lake conditions and the overall effectiveness of the aquatic plant treatment program. More specifically, Section 1 of this report reviews permitting for the project and Section 2 discusses in detail the aquatic herbicide treatments performed in 2019 and 2020. Section 3 provides our field observations and assessment of the aquatic pesticide treatment programs performed in the 2019 and 2020 growing seasons. Section 4 discusses our conclusions and our recommendations to further control non-native, invasive aquatic vegetation , namely water chestnut and hydrilla.

1. Permitting

Aqua Link prepared an aquatic pesticide permit application for treating excessive amounts of aquatic vegetation in Lake Towhee on April 15, 2019. The applicant for this application was the Bucks County Department of Parks and Recreation. This application was subsequently signed by William M. Mitchell of the Bucks County Department of Parks and Recreation on April 17th and was sent out from the Aqua Link office that day to the Department of Environmental Protection South East Regional Office and the Pennsylvania Fish & Boat Commission. The application was reviewed by these two agencies and the jointly approved permit became valid on June 10, 2020, but was received by Aqua Link on June 17, 2020. This approved aquatic pesticide permit has no expiration date. A copy of this approved permit is presented in Attachment A of this report.

2. Aquatic Pesticide Treatments in 2019 & 2020

Aqua Link performed aquatic plant treatments during the 2019 and 2020 growing seasons. Treatments were performed using 14 foot modified V aluminum boat with a 7 HP Stump Jumper Mud Motor. The air cooled motor has a long shaft that extends off the back of the boat in a nearly horizontal fashion and is designed to run in extremely shallow water of only a few inches, where a significant amount of target species are located in Lake Towhee. Advantages over a standard propeller motor include that the motor is air cooled, preventing clogging from mud and other debris as well as the long shaft allowing the motor to push straight out as opposed to a 90 degree angle, allowing more thrust forward. This motor enables treatments, as those performed in Lake Towhee, of floating leaved plants to be more effective as opposed to other options like an air boat. This is because air boats, since driven by a large force of air, flip floating leaves over thereby washing the pesticide off the plant surface. This would have been a problem for treating water chestnut in Lake Towhee, which was primarily applied as a surface application.

Spray equipment included an electric powered 25 gallon pesticide spray tank equipped with a spray hand gun and spray boom with dropper hoses. A gas powered trash pump was used to fill the spray tank thereby rigorously mixing pesticides with lake water. Pesticides used were Rodeo, Habitat, Clipper, and Tribune. Surfactants used were Tactic for surface applications and Cide Kick II for subsurface applications.

Table 1 illustrates the treatments performed throughout the 2019 and 2020 treatment seasons at Lake Towhee. Due to high densities of vegetation, adjustments were necessary for the timing of treatments and the specific target species, water chestnut or hydrilla. Onsite decisions were based on what plants were most problematic at that particular treatment date. Furthermore, the timing of treatments was adjusted in an effort to maintain dissolved oxygen levels for the safety of fish and other aquatic life.

Table 1 2019 & 2020 Pesticide Treatment Summary

Target Species	*Pesticides Used*	*Date & Acreage Treated*
Water Chestnut	**Rodeo & Habitat.**	**7/2/19 | 10 acres**
Water Chestnut	**Rodeo & Habitat**	**7/29/19 | 10 acres**
Hydrilla	**Clipper & Tribune**	**8/29/19 | 10 acres**
Hydrilla	**Clipper & Tribune**	**9/25/19 | 10 acres**
Water Chestnut	**Rodeo & Habitat**	**4/14/20 | 10 acres**
Hydrilla	**Clipper & Tribune**	**5/22/20 | 10 acres**
Hydrilla	**Clipper & Tribune**	**7/7/20 | 10 acres**
Water Chestnut	**Rodeo & Habitat**	**8/28/20 | 10 acres**

3. Field Observations & Assessment of Aquatic Pesticide Treatments

As mentioned previously, the target species for the Lake Towhee project were water chestnut (*Trapa natans*) and hydrilla (*Hydrilla verticillata*), which are both highly aggressive, non-native aquatic plant species. Please refer to Attachment B for more information regarding these species. Both water chestnut and hydrilla were and continue to be most densely populated at the shallow, inlet end of the lake (northern section of lake). However, less densely populated stands continue to persist in the middle and lower perimeter regions of the lake.

Prior to our first scheduled treatment in 2019, Aqua Link determined that it would be necessary to reduce some non-target plant species, in particular spatterdock, to perform these treatments with any success. This was especially necessary in the upper inlet end of the lake, which was simply inundated with spatterdock making treatments nearly impossible. As a result, it was determined that some paths or channels would need to be creating through this dense foliage in order to access the water chestnut and hydrilla that was in this area. This was accomplished by use of aquatic pesticides. Similarly, in the middle and lower perimeter areas of the lake, spatterdock, in addition to water chestnut and hydrilla was treated. If this was not done, treatments for hydrilla and water chestnut would have clearly been less successful.

Aqua Link's management plan for water chestnut and hydrilla consisted of applying pesticides to Lake Towhee a total of four times per year. More specifically, the plan was to

treat two times for water chestnut and two times for hydrilla. Each treatment, regardless of species, targeted approximately 10 acres of the target species. Aqua Link was aware of the high density of numerous plant species within the lake. Therefore, in order to preserve safe dissolved oxygen levels for fish and other aquatic life, only 10 acres out of the 50 acre total surface acreage was targeted per treatment. In addition, the time duration between treatments was typically 4 weeks or more to ensure recovery of dissolved oxygen levels that likely dropped shortly after the treatments. As plants break down and decay, dissolved oxygen is consumed. For this reason, Aqua Link was very cautious not to treat too much area or too quickly between treatments.

The first two treatments in 2019 focused primarily on water chestnut as well as carving paths through the extremely dense stands of spatterdock as mentioned previously. These treatments occurred on July 2, 2019 and July 29, 2019. The first two treatments targeted 10 acres each using tank mixes of Rodeo and Habitat in roughly a 2:1 ratio in addition to Tactic, which is a surfactant. These products were applied as a surface application using a hand spray gun. Both of these treatments focused on stands throughout the lake, creating channels in the upper end and reducing the perimeter in the middle and lower sections of the lake. The initial two surface treatments opened significant pathways in the lake that were necessary to gain access to stands of both water chestnut and hydrilla, which were previously inaccessible. In addition, a substantial amount of water chestnut was successfully treated in 2019, primarily located in the shallow, more densely populated inlet end of the lake (north end of lake – Figure 1).

Hydrilla was the primary target plant species for the last two treatments of 2019. These two initial treatments targeting hydrilla were performed on August 29, 2019 and September 25, 2019. Similar to the water chestnut, each treatment was for 10 acres, but this time using tank mixes of Clipper and Tribune using approximately a 1 pound to 1 gallon ratio, respectively. Cide Kick II was added to the tank mixes as a surfactant. These products were applied as a subsurface application using dropper hoses or sprayed in some cases depending on the access. Also similar to the water chestnut treatments, both of these subsurface treatments focused on stands throughout the lake, creating channels in the upper end and reducing the perimeter in the middle and lower regions. Both subsurface treatments were deemed highly successful as well in 2019, greatly reducing the hydrilla population through the lake. As added benefits from both subsurface applications, some problematic stands of water chestnut, curlyleaf pondweed, and coontail were also controlled.

Treatments performed during the 2019 season allowed Aqua Link to gain access to many difficult to reach areas, primarily in the upper, shallow regions of the lake. In addition to reducing populations of water chestnut and hydrilla, treating some of the spatterdock paved the paths for future treatments. All treatments in 2019 were highly successful and greatly improved the usability of the lake for boating and fishing. The success of the 2019 treatment program is visually presented in Photographs 1A through 2B in Appendix C.

A slightly different approach was used in 2020. The initial treatment took place on April 14,

2020, much earlier since our permit was already in place. This earlier treatment enabled Aqua Link to access areas further uplake than before in 2019. This treatment focused on treating water chestnut as well as creating more paths through the densely populated spatterdock that was not previously accessed in 2019. This was beneficial since the plants were smaller at this time of year, allowing easier boat travel through the shallow water. This treatment was deemed extremely successful allowing more access in hard to reach areas. Like previous surface applications performed in 2019, this initial treatment of 2020 focused on 10 acre treatment areas using tank mixes of Rodeo and Habitat in roughly a 2:1 ratio in addition to Tactic. As a result, more areas were made accessible than ever before in addition to a significant reduction of water chestnut after the first treatment of 2020.

The next two treatments, performed on May 22 and July 7 of 2020, focused on hydrilla. This plant was found to be more densely populated, especially in the shallow inlet end (norther end of lake – Figure 1) than previously observed. Hydrilla was more evident at this time since paths had been created through the spatterdock to gain further access in difficult to reach areas of the lake. Therefore, two submerged treatments were performed back to back in an effort to reduce the most problematic species at those times, hydrilla. Once again, as an added benefit, water chestnut was largely controlled by the tank mix used for hydrilla. The tank mixes were once again for 10 acres, using a combination of Clipper and Tribune using approximately a 1 pound to 1 gallon ratio, respectively. Cide Kick II was added to the tank mixes as a surfactant. These products were applied primarily as a subsurface application using dropper hoses, with minimal spraying. These treatments primarily targeted the upper shallow section of the lake, but about 1/3 of the application performed on July 7, 2020 was used on the middle and lower perimeters of the lake to keep populations of hydrilla in check. Both of these treatments reduced populations of hydrilla as well as water chestnut and were considered very successful.

The final surface application took place on August 28, 2020. By this time, access was greatly improved to reach existing stands of water chestnut. As a result, this treatment focused more on water chestnut and less on treating spatterdock to gain access. Similar to previous treatments, this treatment was deemed very successful in reducing the water chestnut population. Like previous surface applications performed in 2019 and 2020, this final treatment of 2020 focused on 10 acres of treatment area using tank mixes of Rodeo and Habitat in roughly a 2:1 ratio in addition to Tactic. As a result, some additional areas were made accessible in addition to substantial reduction of water chestnut population.

Overall, observations made on October 8, 2020 indicated a dramatic reduction in water chestnut and hydrilla populations in Lake Towhee since the initial visit in 2019. These changes have made the lake more user friendly for boating, fishing, as well as generally improving the overall aesthetics for years to come. The success of the 2020 treatment program is visually presented in Photographs 3A through 4B in Appendix C. In addition, Figure 2 shows aerial imagery on June 15, 2018 (prior to any treatments) and September 21, 2020 (after Aqua Link's 2-year treatment program). The results in this figure show the dramatic transformation of Lake Towhee and illustrate high levels of effectiveness of the aquatic plant treatment program from 2019-20.

Although these improvements have been significant, it is important to continue the management plan to further control these problematic invasive plant species. Chemical herbicides will be necessary for several years to come to keep the populations of both water chestnut and hydrilla at acceptable levels. There are many more chemical treatments to be performed at this point before water chestnut can be controlled by hand-pulling alone. The seed bank is incredibly large and the seeds remain viable for several years after they are formed. Similar to water chestnut, hydrilla will need to be controlled chemically for an undetermined amount of time. Hydrilla is a species that can grow and spread very quickly and can also reproduce by fragmentation, making hand-pulling generally ineffective and impractical for control.

4. Conclusions & Recommendations

Aquatic herbicide treatments performed in 2019 and 2020 were deemed highly successful in Lake Towhee in reducing dense populations of both water chestnut and hydrilla as shown in Figure 2. Paths through dense populations of spatterdock have been created in previously inaccessible areas to enable future treatments to be performed. In addition to Spatterdock, other problematic plant species such as curlyleaf pondweed and coontail have been greatly reduced as a supplementary benefit. Due to the densities and seed banks of both water chestnut and hydrilla in Lake Towhee, it is quite apparent that hand-pulling alone will not be an effective management strategy for several years to come. Since these seed banks are massive for both water chestnut and hydrilla in Lake Towhee, it is important to stay vigilant when treating these species. If left untreated, all will be lost, causing the end result to revert to the condition of the lake prior to treatments in 2018 and early 2019.

Additional benefits of herbicide treatments include improved aesthetics and accessibility of the lake encouraging more visitors to use the lake for fishing as well as boating. Furthermore, the overall improvement in lake ecology should not be underestimated. Both water chestnut and hydrilla have the ability to create large monocultures, reducing biodiversity and the health of a lake. In addition, a heavy monoculture with heavy biomass could lead to a fishkill when they plants die back for the season.

By treating these problematic, invasive species, the end result would be a more balanced ecosystem with several different plant species within the lake. Furthermore, large swings in dissolved oxygen levels can be prevented by not allowing the biomass of one of these invasive species to become too large, in turn creating a healthier environment for fish and other aquatic life. Lastly, treating water chestnut and hydrilla chemically reduces the risk of transporting these invasive species to other water bodies.

Figure 2: Before & After Aquatic Herbicide Treatments as Performed by Aqua Link (2019-20) www.aqualinkinc.com

Based upon the above, Aqua Link offers the following recommendations to the District to further improve the aquatic ecosystem of Lake Towhee:

1. It is strongly recommended to continue treating Lake Towhee for problematic stands of the invasive plants, water chestnut and hydrilla. At this point, significant improvements have been made in regard to the control of both species, but much more work is necessary to keep these plants at acceptable levels. After only two years of pesticide treatments, hand-pulling alone will not be an effective management strategy. Treatments have greatly improved the appearance, usability, and ecology of the lake. Continuing these treatments is expected to further improve and enhance Lake Towhee.

   A total of four treatments, approximately 4 weeks apart, of 10 acres in area per treatment should be the continued frequency and acreage targeted. Due to the nature of both water chestnut and hydrilla, these plants will continue to grow back for many years to come. Therefore it is imperative to be vigilant when treating these species. If treatments become too infrequent or reduced in treatment area, the results will likely be to revert to pretreatment status.

   Early initial treatment, mid- to late April, is again strongly recommended for water chestnut control in 2021. Follow-up treatment for water chestnut should occur likely in mid to late May, depending on the level of hydrilla growth. Ideally, hydrilla can be treated for the third and fourth treatment, likely occurring in mid to late June and mid to late July, respectfully. It may be necessary to adjust timing and order of treatments and chemicals used based on real-time site evaluations. It is recommended to use the same chemicals, Rodeo and Habitat, for surface applications targeting water chestnut and Clipper and Tribune for subsurface applications targeting hydrilla at this time, as they have proven to be quite effective in Lake Towhee. These overall earlier treatments are recommended for 2021 since much of the biomass of spatterdock, in particular, will only need to be minimally treated to gain further access. Therefore, dissolved oxygen levels are expected to remain more stable in 2021 as a result of less overall plant decomposition after treatment.

2. Many of the isolated stands of native macrophytes (rooted aquatic plants) found in Lake Towhee should be allowed to propagate and spread. Macrophytes provide habitat for aquatic organisms including fish and compete with phytoplankton (microscopic free-floating algae) for nutrients. Therefore, it is expected that increased quantities of native macrophytes will further improve the water quality and clarity of Lake Towhee.

3. Mechanical aquatic weed harvesting and the stocking of triploid grass carp are not recommended for Lake Towhee. These techniques have the potential for spreading the growth of aquatic plants via fragmentation. This includes all types of aquatic weed harvesting such as manual raking/cutting or the use of commercial weed harvesting equipment. In addition, grass carp are highly unpredictable when stocked in lakes greater than 10 acres in surface area. These fish may feed primarily on native plant species as opposed to the target plant species.

4. It is recommended to post multiple signs near the boat launch and parking lot regarding the dangers of invasive plant and animal species. Signage often encourages lake users to inspect and clean their fishing and boating gear. This awareness may lead to less transportation of invasive plants and animals from water body to water body.

5. Invasive species disposal areas should be designated to further prevent transportation of invasive species. These should be located at both the boat ramp and the parking area. The disposal areas can simply be small sand pits and a disposal can.

Some of the above recommendations will require a high level of technical expertise and, therefore, likely require the professional services of a qualified environmental consultant. Aqua Link is an environmental consulting firm, specializing in lake management and restoration, and is uniquely qualified to assist the District in implementing all of the recommendations offered in this report.

If you have any questions or need assistance in implementing any of the recommendations offered in this report, please call me. Thank you for allowing Aqua Link to assist you in properly managing your lake.

Sincerely,

Edward W. Molesky, Jr., CLM
President

EWM:kam
Attachments A – C
1005-24&25 Lake Towhee APM 2020 Report

ATTACHMENT A

Aquatic Pesticide Permit

/

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

June 5, 2019

William Mitchell
Bucks County Department of Parks & Recreation
901 E. Bridgetown Pike
Langhorne, PA 19047

Re: Joint Permit for Algicide, Herbicide or Fish Control Chemical
Lake Towhee Pesticides
Permit No. 0919812
Authorization ID No. 1274864
Haycock Township, Bucks County

Dear Mr. Mitchell:

Enclosed is your permit for the use of algicides, herbicides or fish control chemicals (" pesticides") in Bucks County. This permit is issued under the joint authority of the Pem1sylvania Department of Environmental Protection (DEP) and the Pem1sylvania Fish and Boat Commission (PFBC).

Your use of pesticides under this permit is subject to compliance with the conditions of the permit and any **Additional Requirements** noted in the permit. Inaddition, please note the following:

1. You should immediately cease your treatment(s) and contact the local Fish and Boat Commission Waterways Conservation Officer if you observe any unanticipated impacts to fish or other aquatic life as a result of your treatment(s).

2. You are required to use extreme caution and carefully follow the directions on the manufacturer's label when using an algicide, herbicide or fish control chemical.

3. You are required to conduct algicide, herbicide or fish control chemical treatments in an environmentally safe mam1er.

4. The labels for some algicide, herbicide and fish control chemicals prescribe restricted usage of treated water for such things as drinking, swimming, watering livestock, irrigating and the consumption of fish. You must adhere to those restrictions.

5. If you use algicide, herbicide or fish control chemicals in areas open to the public, you are required to take appropriate actions to ensure public safety.

6. You must use appropriate safety practices at all times while storing, transporting, handling and applying any chemicals.

7. The permitted party is responsible for any damages caused by chemical usage, as well as complying with all applicable laws and regulations administered by the DEP and PFBC.

Southeast Regional Office
2 E Main Street | Norristown, PA 19401 | 484.250.5970 | Fax 484.250.5971
www.dep.pa.gov

It is important that you understand the physical features of the water body, the various types of vegetation that are in and around the water, and the proper use of chemicals when using an algicide, herbicide or fish control chemical. If you do not have experience in aquatic pesticide control, DEP recommends that you utilize the services of a professional consultant.

Please note that this joint permit does not expire. However, in the event that any of the following changes are proposed, you must submit a new application to amend your joint permit:

- Changes to the water bodies being treated.
- Increases in the maximum dose or to the number of annual treatments for any water body.
- Changes in the pesticide(s) used for treatment, unless the new pesticide(s) contain the same active ingredient(s) and the same or lower percent composition of the ingredient in comparison to the pesticide(s) previously approved by DEP/PFBC.

Any person aggrieved by this action may appeal the action to the Environmental Hearing Board (Board), pursuant to Section 4 of the Environmental Hearing Board Act, 35 P.S. § 7514, and the Administrative Agency Law, 2 Pa.C.S. Chapter SA. The Board's address is:

Environmental Hearing Board
Rachel Carson State Office Building, Second Floor
400 Market Street
P.O. Box 8457
Harrisburg, PA 17105-8457

TDD users may contact the Environmental Hearing Board through the Pennsylvania Relay Service, 800-654-5984.

Appeals must be filed with the Board within 30 days of receipt of notice of this action unless the appropriate statute provides a different time. This paragraph does not, in and of itself, create any right of appeal beyond that permitted by applicable statutes and decisional law.

A Notice of Appeal form and the Board's rules of practice and procedure may be obtained online at http://ehb.courtapps.com or by contacting the Secretary to the Board at 717-787-3483. The Notice of Appeal form and the Board's rules are also available in braille and on audiotape from the Secretary to the Board.

IMPORTANT LEGAL RIGHTS ARE AT STAKE. YOU SHOULD SHOW THIS DOCUMENT TO A LAWYER AT ONCE. IF YOU CANNOT AFFORD A LAWYER, YOU MAY QUALIFY FOR FREE PRO BONO REPRESENTATION. CALL THE SECRETARY TO THE BOARD AT 717-787-3483 FOR MORE INFORMATION. YOU DO NOT NEED A LAWYER TO FILE A NOTICE OF APPEAL WITH THE BOARD.

IF YOU WANT TO CHALLENGE THIS ACTION, YOUR APPEAL MUST BE FILED WITH AND RECEIVED BY THE BOARD WITHIN 30 DAYS OF RECEIPT OF NOTICE OF THIS ACTION.

If you have any questions, please call Reza H. Chowdhury at 484.250.5197 or email at rchowdhury@pa.gov.

Sincerely,

Environmental Program Manager
Clean Water Program

Enclosures

cc: Aqua Link, Inc.
Mr. Russell
File

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

COMMONWEALTH OF PENNSYLVANIA ,
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF CLEAN WATER
FISH AND BOAT COMMISSION

JOINT PERMIT FOR USE OF AN ALGICIDE, HERBICIDE OR FISH CONTROL CHEMICAL IN WATERS OF THE COMMONWEALTH

PERMIT NO.: 0919812

In compliance with the provisions of Pennsylvania's Clean Streams Law, as amended, 35 P.S. §§ 691.1 *et seq.*, the regulations at 25 Pa. Code§ 91.38, and the Fish and Boat Code, 30 Pa. C.S. § 2504(a)(1),

Bucks County Department Of Parks & Recreation
901 E **Bridgetown Pike**
Langhorne, PA 19047

is authorized to use the algicide(s), herbicide(s) or fish control chemical(s) ("pesticides") specified below, in accordance with the conditions and requirements set forth herein.

THIS PERMIT SHALL BECOME EFFECTIVE ON JUNE 10, 2019

Municipality: Haycock Township
Water Body: Lake Towhee
Receiving Stream: UNT to Dimple Creek
County: Bucks
Total Area: 50 acres
Avg Depth: 4 feet

TREATMENT INFORMATION

Chemical	Maximum Dose	Treatment Area	Treatment Deoth	Amount Each Treatment	No. Annual Treatments
Rodeo	0.875 gal/acre	10 acres	0-4 feet	8.75 gal	2
Habitat	0.5 gal/acre	10 acres	0-4 feet	5.0 gal	2
Clipper	1.1 lbs./af	10 acres	0-4 feet	11 lbs.	2
Tribune	1.0 gal/acre	10 acres	0-4 feet	10 gal	2

THIS PERMIT IS ISSUED UNDER THE FOLLOWING CONDITIONS:

1. The permittee shall use pesticides strictly as described by the product label. Chemical applications shall be performed in accordance with the manufacturer's label directions, existing pesticide use laws, and any conditions imposed by local or state agencies.
2. The permittee may treat a standing body of water (i.e., pond, lake, reservoir, etc.) only when there is minimal or no outflow occurring or expected.
3. The permittee shall not treat Fish and Boat Commission approved stocked trout waters between March 1 and June 15.
4. The permittee shall not treat bass waters during the first week of the Commonwealth inland waters harvest season for bass (the first Saturday after June 11 through the following Saturday).
5. If copper sulfate will be used, the permittee shall not apply copper sulfate at a dose exceeding 0.5 mg/L Cu^{2+} or 1.36 lbs CuS04/acre-

foot where the total hardness of the water body is less than 50 mg/L CaC0 3. Where total hardness exceeds 50 mg/L CaCQ3, the permittee shall not exceed a dose of 1.0 mg/L cu^{2} or 2.27 lbs $CuSQ_4$/acre-foot.

6. The permittee shall not treat water bodies containing stocked or wild trout with copper in excess of 0.1 mg/L Cu^{2}.

7. The permittee shall treat water bodies containing very high plant densities separately, in sections, to prevent suffocation of fish. Monitoring of dissolved oxygenis recommended under these conditions.

8. The permittee is responsible for all damages to aquatic life and humafl health resulting from treatment.

- 1 -

9. Failure of the permittee or agents acting on behalf of the permittee to follow the approved specifications, conditions and requirements immediately renders this permit null and void.

10. If applicable, treatments must also comply with the terms and conditions of NPDES permit coverage.

11. The permittee shall comply with pesticide licensing requirements established by the Pennsylvania Department of Agriculture for the applications approved under this permit.

12. This permit is valid for the treatment information identified above. The permittee shall submit a new application to amend this permit if any of the following changes are proposed:

    a. Changes to the water bodies being treated.

    b. Increases in the maximum dose or to the number of annual treatments for any water body.

    c. Changes in the pesticide(s) used for treatment, unless the new pesticide(s) contain the same active ingredient(s) and the same or lower percent composition of the ingredient in comparison to the pesticide(s) previously approved by DEP/PFBC.

APPROVALS		
For the Pennsylvania Fish and Boat Commission:		
Heather Smiles	Division Chief	06/03/2019
Thomas L. Magge Thomas L. Magge	Title	Date 6/5/19
For the Department of Environmental Protection:		
	Environmental Program Manager	
	Title	Oate
Additional Requirements:		

ATTACHMENT B

Aquatic Plant Descriptions & Images

Water Chestnut
Trapa natans

Invasive in Pennsylvania

Alternate names— devil's hat, devil's sled, bull nut

Description— Water chestnut features a rosette of floating, toothed, triangular leaves. Feathery leaves are found along the submerged stem. The roots are fine, long, and profuse. The small, four-petal flower is white and most often hidden under the leaf rosettes. The fruit is a large nut with four sharp spines or barbs. The plant may have been released from a water garden.

The leaves or stems of water chestnut do not fragment or regenerate the plant; but the fruit is very viable and can remain so for up to ten or twelve years in bottom sediments before giving rise to a new plant. These spiky seeds are commonly found attached to the carpeted bunks of boat trailers, under feathers of waterfowl, and possibly in the fur of animals.

Special Control Considerations— Manual or mechanical control is a viable option if done before the plant flowers and goes to seed each season. The key to water chestnut control is early detection. It is vital to spot small populations while they are easy to remove by hand.

Hydrilla or Waterthyme

Hydrilla verticillata

Invasive in Pennsylvania; can reproduce by fragmentation

Alternate names— anachris, waterthyme

Description— Native to Africa, hydrilla is a submerged aquatic that resembles native elodea. It has finely toothed leaves coming off stems in whorls of three to eight. The plant roots in the bottoms of ponds, lakes, and canals. Stems grow to the surface up to twenty-five feet in length, where they can branch and extend horizontally. Plant fragments are capable of regenerating the plant.

This exotic plant is extremely prolific in the warmer southeastern United States, choking many waterways as it out-competes and replaces native pond plants. Hydrilla has spread up the East Coast and is found in the Lower Delaware and Susquehanna drainages, as well as in the Youghiogheny drainage and Bradford County. Since hydrilla is new to Pennsylvania, its identity should be confirmed by an expert before treatment measures are implemented. There is significant risk of introducing hydrilla accidentally from the potted stock of other plants coinhabited by hydrilla, particularly from the southeastern United States.

Value— The habitat hydrilla creates for invertebrates and fish is usually outweighed by its invasive nature. This is the most aggressive invasive submerged plant in the United States. It can grow up to a half-inch per day in favorable conditions. It frequently becomes thick enough that it inhibits the growth of other plants as well as the use of habitat by larger species of fish; it can even interfere with recreational uses of the water body.

Common look-alike – native elodea, Brazilian elodea

Yellow Water Lily or Spatterdock

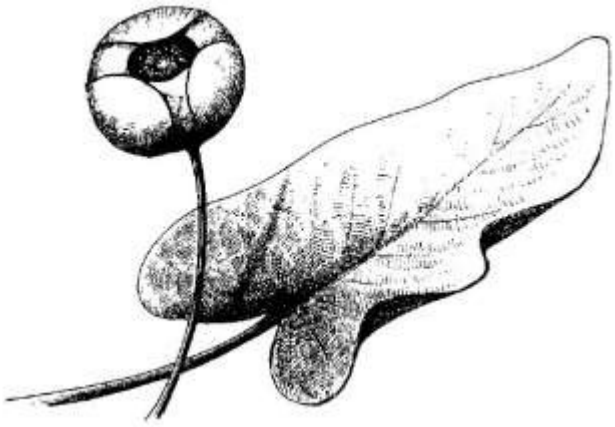
Nuphar sp.

Alternate names—yellow pond lily, cow lily, bullhead pond lily

Description—Spatterdock is common to Pennsylvania ponds, especially acidic, soft-water ponds in northern regions. It has large, twelve-inch leaves that are round to heart shaped, with a distinct midrib. Most leaves extend above the water. Flowers are large and yellowish outside and reddish inside. Spatterdock tolerates fluctuating water levels and reproduces by rootstocks and seeds.

Value—Spatterdock is an excellent plant from a wildlife and fisheries perspective. It supports a high density of fish and insect life below the water surface, providing good food and cover for fish. Large bass can often be found cruising through spatterdock looking for small fish and insects. Spatterdock is also a food source for many animals and plants.

Common look-alike—water lily



Watershield

Brasenia schreberi

Alternate names—dollar bonnet, dollar tag, water target

Description—Floating leaves are oval to elliptical (football shaped) and have an elastic stem that attaches at their centers. Leaves are green on top and purple underneath and grow two to five inches in length. A gelatinous coating on stems and the undersides of leaves protects them from herbivores. Flowers are dull red to purple. Plants prefer acidic and soft-water ponds and reproduce by rootstocks and seeds. Watershield can quickly take over a pond surface and severely limit recreational uses. Plants can grow in water up to six feet deep.

Value—Watershield offers good cover and habitat for fish, but the stems make fishing difficult. The leaves make a great landing spot for insects.

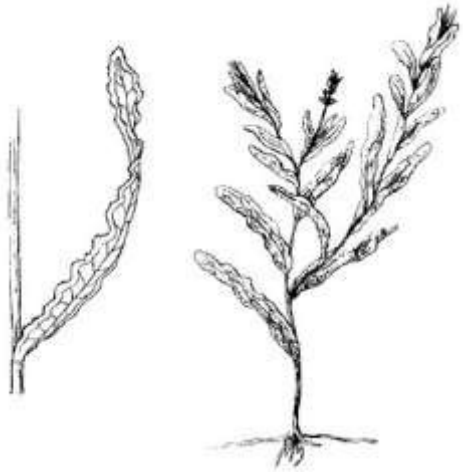
Pondweed, Curly-Leaf

Potamogeton crispus

Invasive in Pennsylvania; can reproduce by fragmentation

Description— Introduced from Europe, curly-leaf pondweed has a very distinctive appearance. The curlyedged leaves are alternate and finely toothed. Their wavy or rippled appearance has been likened to the edges of a lasagna noodle. These plants are most often found in ponds with nutrient-rich hard water. The flower spikes often stick up above the water during spring. Curly-leaf pondweed grows aggressively, can tolerate low light, and may grow in deep water. It often persists throughout the winter but most frequently dies back in late summer.

Value— Curly-leaf pondweed is of unique value to a pond because it grows through the winter and spring when most plants are absent from the pond. Thus, it provides food and habitat during these times. Curly-leaf pondweed does tend to crowd out native submerged plant species. Also, its invasive nature may outweigh any values.



Coontail

Ceratophyllum sp.

Can reproduce by fragmentation

Alternate name -hornwort

This plant can become more of a nuisance when you are trying to control it physically or mechanically because it reproduces quickly through fragmentation.

Description - The dark olive-green leaves of coontail are whorled around the stem. Each leaflet is forked with toothed edges. The leaflets are more densely crowded around the tip of the stem, giving the appearance of a raccoon tail. The purplish green flowers form where the leaf attaches to the stem and remain submerged. The plant may be anchored to the bottom or, more likely, free-floating beneath the surface. Coontail prefers ponds with hard water, although one species can be found more commonly in softer, acidic waters. Coontail can tolerate low light conditions in deep water. Plants have been described as having a very coarse or "plastic" feeling. Coontail spreads by seeds and by fragmentation.

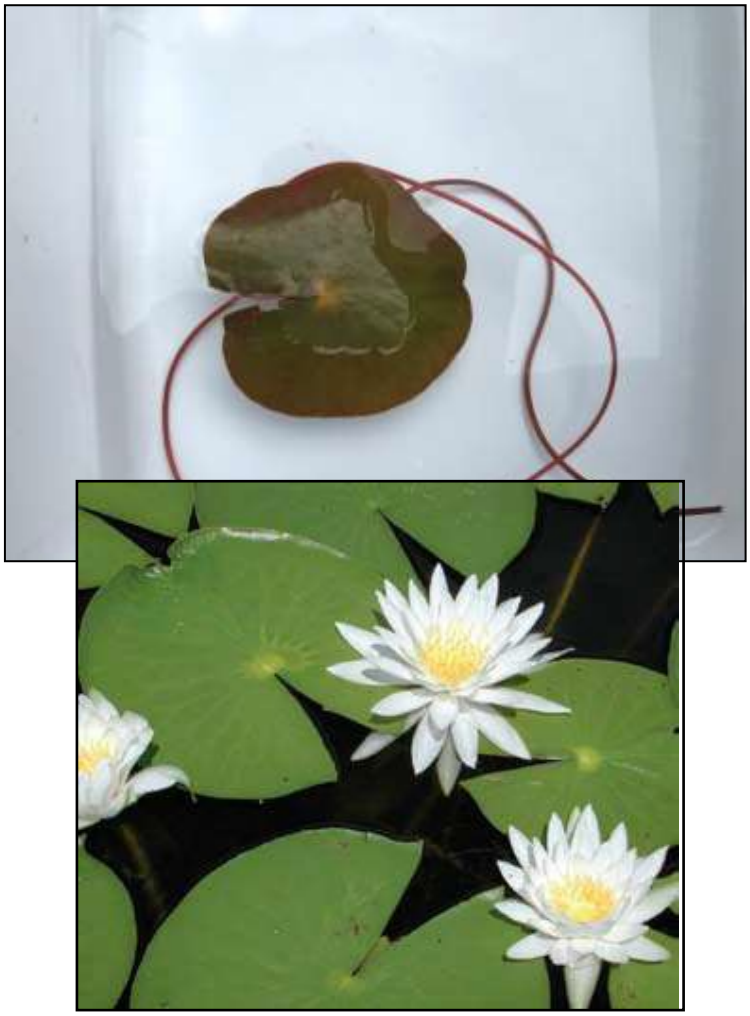
Value - Coontail foliage is a favorite of many species of waterfowl and muskrats in Pennsylvania. It is also home to many invertebrates such as snails, crustaceans, and insect larvae, thus providing a great source of food for fish. Coontail inhibits the growth of blue-green algae on its stems by secreting sulfur-based toxins.

Nymphaea sp.

Alternate name - fragrant water lily

Description -Floating round leaves grow up to twelve inches across, are split to the stem in a V shape at the center, and are often purple underneath. Flowers of native water lilies are large, showy, and white, and have a sweet smell. Water lilies bearing other colored flowers are nonnative, tropical plants often sold for backyard water gardens. Flowers remain open from morning until shortly after midday.
Commonly planted as an ornamental, this plant reproduces by rootstocks and seeds. It prefers to grow in quiet water less than six feet deep.

Value - This plant's beautiful appearance and its flowers make it a commonly used item in aquascapes. In addition, water lily creates excellent habitat for fish as it attracts small and large fish and their prey (insects, frogs, etc.). Despite this benefit, however, water lily's tangled stems make fishing very difficult. Waterfowl eat parts of the plant, as do a variety of wildlife, including deer. Water lily is also a favorite of honeybees.



Literature Cited

Penn State University. 2009. A Field Guide to Common Aquatic Plants of Pennsylvania. Penn State's College of Agricultural Sciences.

ATTACHMENT C

Lake Towhee Photo Documentation

Photo 1A - Upper End of Lake - Early Summer 2019 (Date: 7/2/19)

Photo 1B - Upper End of Lake – Early Fall 2019 (Date: 9/25/19)

Photo 2A - Lower End of Lake – Early Summer 2019 (Date: 7/2/19)

Photo 2B - Lower End of Lake – Early Fall 2019 (Date: 9/25/19)

Photo 3A - Upper End of Lake – Late Spring 2020 (Date: 5/22/20)

Photo 3B - Upper End of Lake – Fall 2020 (Date: 10/8/20)

Photo 4A - Lower End of Lake – Late Spring 2020 (Date: 7/7/20)

Photo 4B - Lower End of Lake – Late Summer 2020 (Date: 8/28/20)

October 29, 2021

Bucks County Conservation District
1456 Ferry Road, Suite 704
Doylestown, PA 18901

Re: Lake Towhee
Aquatic Macrophyte Treatment Report
ALI Project No. 1005-26

Dear District Board Members:

Aqua Link was retained by the Bucks County Conservation District (hereinafter referred to as the District) to control excessive amounts of aquatic vegetation in Lake Towhee during the 2019 through 2021 growing seasons. This report focuses on treatments and observations from 2021. For this project, aquatic plant control was accomplished using aquatic herbicides (pesticides) that were applied by boat. The primary objective of these aquatic herbicide treatments was to target non-native, invasive aquatic vegetation which have invaded the lake. In addition, as part of this project, Aqua Link was hired to assess the overall effectives of the above aquatic herbicide treatments.

Funding for this project was made possible by a PA Department of Environmental Protection Growing Greener grant. Lake Towhee, owned by the Bucks County Department of Parks and Recreation, is a 50-acre impoundment located in Lake Towhee County Park of Haycock Township in Bucks County, Pennsylvania. The upper end of the lake (inlet) is quite shallow with water depths ranging from less than 1 foot up to about 4 feet in the old creek channel (Figure 1). This shallow section has numerous stumps, sunken timber and heavy aquatic vegetation plus both submerged and floating leaved aquatic vegetation. As a result, navigation in this area can be quite difficult. Middle and lower sections of the lake are deeper and more navigable with water depths up to 8 feet and averaging about 4 feet. In middle and lower sections of the lake, the heaviest aquatic plant growth was located along the perimeter of the lake as both submerged and floating leaved aquatic vegetation (Figure 1).

More specifically, the aquatic plant treatment program, as performed by Aqua Link in 2021, was designed to gain further control over water chestnut (*Trapa natans*) and hydrilla (*Hydrilla verticillata*), which are both highly aggressive, non-native aquatic plant species. In 2021, the majority of the water chestnut continued to be located in the shallower, inlet end of the lake. However, water chestnut was observed at lower densities in the middle and lower sections of the lake as well - primarily along the lake perimeter. In 2021, Hydrilla was again located primarily in the shallower, inlet end of the lake and extending to the boat launch area (Figure 1). Smaller stands of hydrilla were observed in the middle and lower regions of the lake perimeter, mostly

opposite the boat ramp.

Figure 1: Aerial Image of Lake Towhee (June 2018)

Other significant macrophytes identified in the lake were spatterdock (*Nuphar sp.*), water shield (*Brasenia schreberi*), white water lily (*Nymphaea sp.)*, coontail (*Ceratophyllum demersum*), and curlyleaf pondweed (*Potamogeton crispus*). Although other plants exist in Lake Towhee at high densities, the objectives of this treatment program were to reduce the densities of both water chestnut and hydrilla. Both of these species are non-native, highly invasive plants that have multiple modes of reproduction and can quickly out-compete other plant species if left untreated. More information regarding all plants listed in this report can be found in Appendix B.

The final product of the Lake Towhee aquatic plant treatment program is this report. This report describes the aquatic plant management strategy for 2021, the aquatic herbicides applied on each treatment date during 2021, and our professional evaluation of lake conditions and the overall effectiveness of the aquatic plant treatment program. More specifically, Section 1 of this report reviews permitting for the project and Section 2 discusses in detail the aquatic herbicide treatments performed in 2021. Section 3 provides our field observations and assessment of the aquatic pesticide treatment programs performed in the 2021 growing season. Section 4 discusses our conclusions and our recommendations to further control non-native, invasive aquatic vegetation, namely water chestnut and hydrilla.

1. Permitting

Aqua Link prepared an aquatic pesticide permit application for treating excessive amounts of aquatic vegetation in Lake Towhee on April 15, 2019. The applicant for this application was the Bucks County Department of Parks and Recreation. This application was subsequently signed by William M. Mitchell of the Bucks County Department of Parks and Recreation on April 17th and was sent out from the Aqua Link office that day to the Department of Environmental Protection South East Regional Office and the Pennsylvania Fish & Boat Commission. The application was reviewed by these two agencies and the jointly approved permit became valid on June 10, 2019 but was received by Aqua Link on June 17, 2019. This approved aquatic pesticide permit has no expiration date. A copy of this approved permit is presented in Attachment A of this report.

2. Aquatic Pesticide Treatments in 2021

Aqua Link performed aquatic plant treatments during the 2021 growing season. This is the third straight year Aqua Link performed treatments at Lake Towhee. Treatments were performed using 14 foot modified V aluminum boat with a 7 HP longtail air-cooled mud motor. The air cooled motor has a long shaft that extends off the back of the boat in a nearly horizontal fashion and is designed to run in extremely shallow water of only a few inches, where a significant amount of target species are located in Lake Towhee. Advantages over a standard propeller motor include that the motor is air cooled, preventing clogging from mud and other debris as well as the long shaft allowing the motor to push straight out as opposed to a 90 degree angle, allowing more thrust forward. This motor enables treatments, as those performed in Lake Towhee, of floating leaved plants to be more effective as opposed to other options like an air boat. This is because air boats, since driven by a large force of air, flip floating leaves over thereby washing the pesticide off the plant surface. This would have been a problem for treating water chestnut in Lake Towhee, which was primarily applied as a surface application.

Spray equipment included an electric powered 25 gallon pesticide spray tank equipped with a spray hand gun and spray boom with dropper hoses. A gas powered trash pump was used to fill the spray tank thereby rigorously mixing pesticides with lake water. Pesticides used were Rodeo, Habitat, Clipper, and Tribune. Surfactants used were Tactic for surface applications and Cide Kick II for subsurface applications.

Table 1 illustrates the treatments performed throughout the 2021 treatment seasons at Lake Towhee. Due to the observed growth of water chestnut and hydrilla while onsite, adjustments were made for the method of treatment on some specific treatment dates. Onsite decisions were made based on what plants were most problematic at that particular treatment date.

Table 1 2021 Pesticide Treatment Summary

Target Species	*Pesticides Used*	*Date & Acreage Treated*
Water Chestnut	**Rodeo & Habitat**	**4/20/21 | 10 acres**
Hydrilla	**Clipper & Tribune**	**5/20/21 | 10 acres**
Hydrilla	**Clipper & Tribune**	**6/29/21 | 10 acres**
Water Chestnut	**Rodeo & Habitat**	**8/2/21 | 10 acres**

3. Field Observations & Assessment of Aquatic Pesticide Treatments

As mentioned previously, the target species for the Lake Towhee project were water chestnut (*Trapa natans*) and hydrilla (*Hydrilla verticillata*), which are both highly aggressive, non-native aquatic plant species. Please refer to Attachment B for more information regarding these species. Both water chestnut and hydrilla were and continue to be most densely populated at the shallow, inlet end of the lake (northern section of lake). However, less densely populated stands continue to persist in the middle and lower perimeter regions of the lake.

Prior to our first scheduled treatment in 2021, Aqua Link once again determined that it would be necessary to reduce some non-target plant species, in particular spatterdock, to perform these treatments with better results. This was especially necessary in the upper inlet end of the lake, which continued to be densely covered in some locations with spatterdock making treatments difficult. As a result, it was determined that some additional paths or channels would need to be created through this dense foliage in order to gain access to more of the water chestnut and hydrilla that was in this area. This was accomplished by use of aquatic pesticides. Similarly, in the middle and lower perimeter areas of the lake, spatterdock, in addition to water chestnut and hydrilla was treated. If this was not done, treatments for hydrilla and water chestnut would have clearly been less successful.

Aqua Link's management plan for water chestnut and hydrilla control consisted of applying pesticides to Lake Towhee a total of four times in 2021. More specifically, the plan was to treat two times for water chestnut and two times for hydrilla. Each treatment, regardless of species, targeted approximately 10 acres of the target species. Aqua Link was aware of the high density of numerous plant species within the lake. Therefore, in order to preserve safe dissolved oxygen levels for fish and other aquatic life, only 10 acres out of the 50 acre total surface acreage was targeted per treatment. In addition, the time duration between treatments was typically 4 weeks or more to ensure recovery of dissolved oxygen levels that likely dropped shortly after the treatments. As plants break down and decay, dissolved oxygen is consumed. For this reason, Aqua Link was very cautious not to treat too much area or too quickly between treatments.

In 2021, the initial treatment took place on April 20, 2021. This early season treatment enabled Aqua Link to access areas further uplake beyond what was accessed in both 2019 and 2020. This treatment focused on treating water chestnut as well as creating more paths through the densely populated spatterdock that was not previously treated in 2019 and 2020. This was beneficial since the plants were smaller at this time of year, allowing easier boat travel through the shallow water. This treatment was deemed extremely successful allowing more access in hard to reach areas. Like previous surface applications performed in 2019 and 2020, this initial treatment of 2021 focused on a 10 acre treatment area using tank mixes of Rodeo and Habitat in roughly a 2:1 ratio in addition to the surfactant, Tactic. These products were applied as a surface application using a hand spray gun. As a result, more areas were made accessible than ever before in addition to a significant reduction of water chestnut after the first treatment of 2021. The first treatment was primarily targeting plants in the shallow, more densely populated inlet end of the lake (north end of lake – Figure 1).

The next two treatments, performed on May 20th and June 29th, focused on hydrilla. This plant was found to be moderately less dense, especially in the shallow inlet end (northern end of lake – Figure 1), than previously observed in 2019 and 2020. However, hydrilla was still fairly dense and problematic. Therefore, two submerged treatments for hydrilla were performed back to back in an effort to further reduce the most problematic species at those times. The submerged treatments were once again targeting roughly 10 acres, using a tank mixed combination of Clipper and Tribune using approximately a 1 pound to 1 gallon ratio, respectively. Cide Kick II was added to the tank mixes as a surfactant. These products were applied primarily as a subsurface application using dropper hoses, with minimal spraying depending on the access. The majority of these treatments focused on the upper shallow section of the lake, but about 1/3 of the applications performed on May 20th and June 29th of 2021 was used on the middle and lower perimeters of the lake to keep populations of hydrilla in check. Both of these treatments reduced populations of hydrilla as well as water chestnut and were considered very successful. Once again in 2021, as observed in 2019 and 2020, as an added benefit, water chestnut was largely controlled by the tank mix used for hydrilla. Previously problematic stands of curlyleaf pondweed and coontail were also controlled as well in 2021.

The final surface application took place on August 2, 2021. By this time, access was greatly improved to reach existing stands of water chestnut. As a result, this treatment focused more on water chestnut and less on treating spatterdock to gain access. Similar to previous treatments, this treatment was deemed very successful in reducing the water chestnut population. Like previous surface applications performed in 2019 and 2020, this final treatment of 2021 focused on 10 acres of treatment area using tank mixes of Rodeo and Habitat in roughly a 2:1 ratio in addition to Tactic. As a result, some other areas were made accessible in addition to substantial reduction of water chestnut population.

Overall, observations made on October 6, 2021 indicated a dramatic reduction in water chestnut and hydrilla populations in Lake Towhee since earlier treatment dates in 2021. These changes have made the lake more user friendly for boating, fishing, as well as generally improving the overall aesthetics for years to come. The success of the 2021 treatment program is visually

presented in Photographs 1A through 4B in Appendix C. Photographs 1A through 2B (Photoset 1) depict spring and fall comparisons during 2021. Photographs 3A through 4B (Photoset 2) illustrate changes prior to treatment in 2019 to the fall of 2021. In addition, Figure 2 shows aerial imagery on June 15, 2018 (prior to any treatments) and September 21, 2020 (after Aqua Link's 2 year treatment program). The results in this figure show the dramatic transformation of Lake Towhee and illustrate high levels of effectiveness of the aquatic plant treatment program from 2019-20. Unfortunately, aerial imagery was not updated for this report to illustrate changes observed in 2021.

Although these improvements have been significant, it is important to continue the management plan to further control these problematic invasive plant species. Chemical herbicides will be necessary for several years to come to keep the populations of both water chestnut and hydrilla at acceptable levels. There are many more chemical treatments to be performed at this point before water chestnut can be controlled by hand-pulling alone. The seed bank is incredibly large and the seeds remain viable for several years after they are formed.

Similar to water chestnut, hydrilla will need to be controlled chemically for an undetermined amount of time. Hydrilla is a species that can grow and spread very quickly and can also reproduce by fragmentation, making hand-pulling generally ineffective and impractical for control.

4. Conclusions & Recommendations

Similarly to aquatic herbicide treatments performed in 2019 and 2020, treatments performed in 2021 were deemed highly successful in Lake Towhee in reducing dense populations of both water chestnut and hydrilla. Figure 2 illustrates changes in plant density as a result of the herbicide applications from after treatments performed in 2019 and 2020. Unfortunately, no new imagery was available as an update for this report. In 2021 more new paths through dense populations of spatterdock have been created in previously inaccessible areas to enable future treatments to be performed. In addition to Spatterdock, other problematic plant species such as curlyleaf pondweed and coontail have been greatly reduced as a supplementary benefit. Due to the densities and seed banks of both water chestnut and hydrilla in Lake Towhee, it is quite apparent that hand-pulling alone will not be an effective management strategy for several years to come. Since these seed banks are massive for both water chestnut and hydrilla in Lake Towhee, it is important to stay vigilant when treating these species. If left untreated, all will be lost, causing the end result to revert to the condition of the lake prior to treatments in 2018 and early 2019.

Additional benefits of herbicide treatments include improved aesthetics and accessibility of the lake encouraging more visitors to use the lake for fishing as well as boating. Furthermore, the overall improvement in lake ecology should not be underestimated. Both water chestnut and hydrilla have the ability to create large monocultures, reducing biodiversity and the health of a

lake. In addition, a heavy monoculture with heavy biomass could lead to a fishkill when these plants die back for the season.

By treating these problematic, invasive species, the end result would be a more balanced ecosystem with several different plant species within the lake. Furthermore, large swings in dissolved oxygen levels can be prevented by not allowing the biomass of one of these invasive species to become too large, in turn creating a healthier environment for fish and other aquatic life. Lastly, treating water chestnut and hydrilla chemically reduces the risk of transporting these invasive species to other water bodies.

Based upon the above, Aqua Link offers the following recommendations to the District to further improve the aquatic ecosystem of Lake Towhee:

1. It is strongly recommended to continue treating Lake Towhee for problematic stands of the invasive plants, water chestnut and hydrilla. At this point, significant improvements have been made in regard to the control of both species, but much more work is necessary to keep these plants at acceptable levels. After only three years of pesticide treatments, hand-pulling alone will not be an effective management strategy. Treatments have greatly improved the appearance, usability, and ecology of the lake. Continuing these treatments is expected to further improve and enhance Lake Towhee.

   A total of four treatments, approximately 4 weeks apart, of 10 acres in area per treatment should be the continued frequency and acreage targeted. Due to the nature of both water chestnut and hydrilla, these plants will continue to grow back for many years to come. Therefore it is imperative to be vigilant when treating these species. If treatments become too infrequent or reduced in treatment area, the results will likely be to revert to pretreatment status.

   Early initial treatment, mid- to late April, is again strongly recommended for water chestnut control in 2021. Follow-up treatment for water chestnut can occur likely in mid to late July or early August. Since treatments applied targeting hydrilla have also further suppressed water chestnut growth, the follow-up surface application treatment for water chestnut does not need to be very early in the season. Depending on the level of hydrilla growth, hydrilla can be treated on the second and third treatment, likely occurring in mid to late May and mid to late June, respectfully.

Figure 2: Before & After Aquatic Herbicide Treatments as Performed by Aqua Link (2019-20) www.aqualinkinc.com

It may be necessary to adjust timing and order of treatments and chemicals used based on real-time site evaluations. It is recommended to use the same chemicals, Rodeo and Habitat, for surface applications targeting water chestnut and Clipper and Tribune for subsurface applications targeting hydrilla at this time, as they have proven to be quite effective in Lake Towhee. The early season surface treatment is again recommended for 2022 since moderate amounts of spatterdock will need to be treated to gain further access. Since a lower biomass of spatterdock is anticipated to be treated in 2022 compared to 2019- 2021, dissolved oxygen levels are expected to remain more stable in 2022 as a result of less overall plant decomposition after treatment.

2. Many of the isolated stands of native macrophytes (rooted aquatic plants) found in Lake Towhee should be allowed to propagate and spread. Macrophytes provide habitat for aquatic organisms including fish and compete with phytoplankton (microscopic free-floating algae) for nutrients. Therefore, it is expected that increased quantities of native macrophytes will further improve the water quality and clarity of Lake Towhee.

3. Mechanical aquatic weed harvesting and the stocking of triploid grass carp are not recommended for Lake Towhee. These techniques have the potential for spreading the growth of aquatic plants via fragmentation. This includes all types of aquatic weed harvesting such as manual raking/cutting or the use of commercial weed harvesting equipment. In addition, grass carp are highly unpredictable when stocked in lakes greater than 10 acres in surface area. These fish may feed primarily on native plant species as opposed to the target plant species.

4. It is recommended to post multiple signs near the boat launch and parking lot regarding the dangers of invasive plant and animal species. Signage often encourages lake users to inspect and clean their fishing and boating gear. This awareness may lead to less transportation of invasive plants and animals from water body to water body.

5. Invasive species disposal areas should be designated to further prevent transportation of invasive species. These should be located at both the boat ramp and the parking area. The disposal areas can simply be small sand pits and a disposal can.

Some of the above recommendations will require a high level of technical expertise and, therefore, likely require the professional services of a qualified environmental consultant. Aqua Link is an environmental consulting firm, specializing in lake

management and restoration, and is uniquely qualified to assist the District in implementing all of the recommendations offered in this report.

If you have any questions or need assistance in implementing any of the recommendations offered in this report, please call me. Thank you for allowing Aqua Link to assist you in properly managing your lake.

Sincerely,

Edward W. Molesky, Jr., CL
President

EWM:ka
Attachme
nts A - C

1005-26 Lake Towhee APM 2021 Report.docx

ATTACHMENT A

Aquatic Pesticide Permit

/

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

June 5, 2019

William Mitchell
Bucks County Department of Parks & Recreation
901 E. Bridgetown Pike
Langhorne, PA 19047

Re: Joint Permit for Algicide, Herbicide or Fish Control Chemical
Lake Towhee Pesticides
Permit No. 0919812
Authorization ID No. 1274864
Haycock Township, Bucks County

Dear Mr. Mitchell:

Enclosed is your permit for the use of algicides, herbicides or fish control chemicals (" pesticides") in Bucks County. This permit is issued under the joint authority of the Pem1sylvania Department of Environmental Protection (DEP) and the Pem1sylvania Fish and Boat Commission (PFBC).

Your use of pesticides under this permit is subject to compliance with the conditions of the permit and any **Additional Requirements** noted in the permit. Inaddition, please note the following:

1. You should immediately cease your treatment(s) and contact the local Fish and Boat Commission Waterways Conservation Officer if you observe any unanticipated impacts to fish or other aquatic life as a result of your treatment(s).

2. You are required to use extreme caution and carefully follow the directions on the manufacturer's label when using an algicide, herbicide or fish control chemical.

3. You are required to conduct algicide, herbicide or fish control chemical treatments in an environmentally safe mam1er.

4. The labels for some algicide, herbicide and fish control chemicals prescribe restricted usage of treated water for such things as drinking, swimming, watering livestock, irrigating and the consumption of fish. You must adhere to those restrictions.

5. If you use algicide, herbicide or fish control chemicals in areas open to the public, you are required to take appropriate actions to ensure public safety.

6. You must use appropriate safety practices at all times while storing, transporting, handling and applying any chemicals.

7. The permitted party is responsible for any damages caused by chemical usage, as well as complying with all applicable laws and regulations administered by the DEP and PFBC.

Southeast Regional Office
2 E Main Street | Norristown, PA 19401 | 484.250.5970 | Fax 484.250.5971
www.dep.pa.gov

It is important that you understand the physical features of the water body, the various types of vegetation that are in and around the water, and the proper use of chemicals when using an algicide, herbicide or fish control chemical. If you do not have experience in aquatic pesticide control, DEP recommends that you utilize the services of a professional consultant.

Please note that this joint permit does not expire. However, in the event that any of the following changes are proposed, you must submit a new application to amend your joint permit:

- Changes to the water bodies being treated.
- Increases in the maximum dose or to the number of annual treatments for any water body.
- Changes in the pesticide(s) used for treatment, unless the new pesticide(s) contain the same active ingredient(s) and the same or lower percent composition of the ingredient in comparison to the pesticide(s) previously approved by DEP/PFBC.

Any person aggrieved by this action may appeal the action to the Environmental Hearing Board (Board), pursuant to Section 4 of the Environmental Hearing Board Act, 35 P.S. § 7514, and the Administrative Agency Law, 2 Pa.C.S. Chapter SA. The Board's address is:

Environmental Hearing Board
Rachel Carson State Office Building, Second Floor
400 Market Street
P.O. Box 8457
Harrisburg, PA 17105-8457

TDD users may contact the Environmental Hearing Board through the Pennsylvania Relay Service, 800-654-5984.

Appeals must be filed with the Board within 30 days of receipt of notice of this action unless the appropriate statute provides a different time. This paragraph does not, in and of itself, create any right of appeal beyond that permitted by applicable statutes and decisional law.

A Notice of Appeal form and the Board's rules of practice and procedure may be obtained online at http://ehb.courtapps.com or by contacting the Secretary to the Board at 717-787-3483. The Notice of Appeal form and the Board's rules are also available in braille and on audiotape from the Secretary to the Board.

IMPORTANT LEGAL RIGHTS ARE AT STAKE. YOU SHOULD SHOW THIS DOCUMENT TO A LAWYER AT ONCE. IF YOU CANNOT AFFORD A LAWYER, YOU MAY QUALIFY FOR FREE PRO BONO REPRESENTATION. CALL THE SECRETARY TO THE BOARD AT 717-787-3483 FOR MORE INFORMATION. YOU DO NOT NEED A LAWYER TO FILE A NOTICE OF APPEAL WITH THE BOARD.

IF YOU WANT TO CHALLENGE THIS ACTION, YOUR APPEAL MUST BE FILED WITH AND RECEIVED BY THE BOARD WITHIN 30 DAYS OF RECEIPT OF NOTICE OF THIS ACTION.

If you have any questions, please call Reza H. Chowdhury at 484.250.5197 or email at rchowdhury@pa.gov.

Sincerely,

Environmental Program Manager
Clean Water Program

Enclosures

cc: Aqua Link, Inc.
Mr. Russell
File

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

COMMONWEALTH OF PENNSYLVANIA ,
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF CLEAN WATER
FISH AND BOAT COMMISSION

JOINT PERMIT FOR USE OF AN ALGICIDE, HERBICIDE OR FISH CONTROL CHEMICAL IN WATERS OF THE COMMONWEALTH

PERMIT NO.: 0919812

In compliance with the provisions of Pennsylvania's Clean Streams Law, as amended, 35 P.S. §§ 691.1 *et seq.,* the regulations at 25 Pa. Code§ 91.38, and the Fish and Boat Code, 30 Pa. C.S. § 2504(a)(1),

Bucks County Department Of Parks & Recreation
901 E **Bridgetown Pike**
Langhorne, PA 19047

is authorized to use the algicide(s), herbicide(s) or fish control chemical(s) ("pesticides") specified below, in accordance with the conditions and requirements set forth herein.

THIS PERMIT SHALL BECOME EFFECTIVE ON JUNE 10, 2019

Municipality: Haycock Township
Water Body: Lake Towhee
Receiving Stream: UNT to Dimple Creek

County: Bucks 50 acres
Total Area: 4 feet
Avg Depth:

TREATMENT INFORMATION

Chemical	Maximum Dose	Treatment Area	Treatment Deoth	Amount Each Treatment	No. Annual Treatments
Rodeo	0.875 gal/acre	10 acres	0-4 feet	8.75 gal	2
Habitat	0.5 gal/acre	10 acres	0-4 feet	5.0 gal	2
Clipper	1.1 lbs./af	10 acres	0-4 feet	11 lbs.	2
Tribune	1.0 gal/acre	10 acres	0-4 feet	10 gal	2

THIS PERMIT IS ISSUED UNDER THE FOLLOWING CONDITIONS:

1. The permittee shall use pesticides strictly as described by the product label. Chemical applications shall be performed in accordance with the manufacturer's label directions, existing pesticide use laws, and any conditions imposed by local or state agencies.
2. The permittee may treat a standing body of water (i.e., pond, lake, reservoir, etc.) only when there is minimal or no outflow occurring or expected.
3. The permittee shall not treat Fish and Boat Commission approved stocked trout waters between March 1 and June 15.
4. The permittee shall not treat bass waters during the first week of the Commonwealth inland waters harvest season for bass (the first Saturday after June 11 through the following Saturday).
5. If copper sulfate will be used, the permittee shall not apply copper sulfate at a dose exceeding 0.5 mg/L Cu^{2+} or 1.36 lbs $CuSO_4$/acre-foot where the total hardness of the water body is less than 50 mg/L $CaCO_3$. Where total hardness exceeds 50 mg/L $CaCO_3$, the permittee shall not exceed a dose of 1.0 mg/L Cu^{2+} or 2.27 lbs $CuSO_4$/acre-foot.
6. The permittee shall not treat water bodies containing stocked or wild trout with copper in excess of 0.1 mg/L Cu^{2+}.

7. The permittee shall treat water bodies containing very high plant densities separately, in sections, to prevent suffocation of fish. Monitoring of dissolved oxygenis recommended under these conditions.

8. The permittee is responsible for all damages to aquatic life and humafl health resulting from treatment.

9. Failure of the permittee or agents acting on behalf of the permittee to follow the approved specifications, conditions and requirements immediately renders this permit null and void.

10. If applicable, treatments must also comply with the terms and conditions of NPDES permit coverage.

11. The permittee shall comply with pesticide licensing requirements established by the Pennsylvania Department of Agriculture for the applications approved under this permit.

12. This permit is valid for the treatment information identified above. The permittee shall submit a new application to amend this permit if any of the following changes are proposed:

    a. Changes to the water bodies being treated.

    b. Increases in the maximum dose or to the number of annual treatments for any water body.

    c. Changes in the pesticide(s) used for treatment, unless the new pesticide(s) contain the same active ingredient(s) and the same or lower percent composition of the ingredient in comparison to the pesticide(s) previously approved by DEP/PFBC.

APPROVALS		
For the Pennsylvania Fish and Boat Commission:		
Heather Smiles Thomas L. Magge Thomas L. Magge	Division Chief Title	06/03/2019 6/5/19 Date
For the Department of Environmental Protection:		
	Environmental Program Manager Title	Oate
Additional Requirements:		

ATTACHMENT B

Aquatic Plant Descriptions & Images

Water Chestnut

Trapa natans

Invasive in Pennsylvania

Alternate names— devil's hat, devil's sled, bull nut

Description— Water chestnut features a rosette of floating, toothed, triangular leaves. Feathery leaves are found along the submerged stem. The roots are fine, long, and profuse. The small, four-petal flower is white and most often hidden under the leaf rosettes. The fruit is a large nut with four sharp spines or barbs. The plant may have been released from a water garden.

The leaves or stems of water chestnut do not fragment or regenerate the plant; but the fruit is very viable and can remain so for up to ten or twelve years in bottom sediments before giving rise to a new plant. These spiky seeds are commonly found attached to the carpeted bunks of boat trailers, under feathers of waterfowl, and possibly in the fur of animals.

Special Control Considerations— Manual or mechanical control is a viable option if done before the plant flowers and goes to seed each season. The key to water chestnut control is early detection. It is vital to spot small populations while they are easy to remove by hand.

Hydrilla or Waterthyme

Hydrilla verticillata

Invasive in Pennsylvania; can reproduce by fragmentation

Alternate names— anachris, waterthyme

Description— Native to Africa, hydrilla is a submerged aquatic that resembles native elodea. It has finely toothed leaves coming off stems in whorls of three to eight. The plant roots in the bottoms of ponds, lakes, and canals. Stems grow to the surface up to twenty-five feet in length, where they can branch and extend horizontally. Plant fragments are capable of regenerating the plant.

This exotic plant is extremely prolific in the warmer southeastern United States, choking many waterways as it out-competes and replaces native pond plants. Hydrilla has spread up the East Coast and is found in the Lower Delaware and Susquehanna drainages, as well as in the Youghiogheny drainage and Bradford County. Since hydrilla is new to Pennsylvania, its identity should be confirmed by an expert before treatment measures are implemented. There is significant risk of introducing hydrilla accidentally from the potted stock of other plants coinhabited by hydrilla, particularly from the southeastern United States.

Value— The habitat hydrilla creates for invertebrates and fish is usually outweighed by its invasive nature. This is the most aggressive invasive submerged plant in the United States. It can grow up to a half-inch per day in favorable conditions. It frequently becomes thick enough that it inhibits the growth of other plants as well as the use of habitat by larger species of fish; it can even interfere with recreational uses of the water body.

Common look-alike – native elodea, Brazilian elodea

Yellow Water Lily or Spatterdock

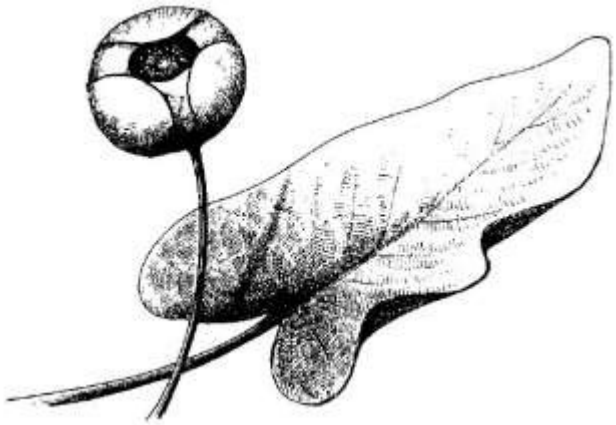
Nuphar sp.

Alternate names—yellow pond lily, cow lily, bullhead pond lily

Description—Spatterdock is common to Pennsylvania ponds, especially acidic, soft-water ponds in northern regions. It has large, twelve-inch leaves that are round to heart shaped, with a distinct midrib. Most leaves extend above the water. Flowers are large and yellowish outside and reddish inside. Spatterdock tolerates fluctuating water levels and reproduces by rootstocks and seeds.

Value—Spatterdock is an excellent plant from a wildlife and fisheries perspective. It supports a high density of fish and insect life below the water surface, providing good food and cover for fish. Large bass can often be found cruising through spatterdock looking for small fish and insects. Spatterdock is also a food source for many animals and plants.

Common look-alike—water lily



Pondweed, Curly-Leaf

Brasenia schreberi

Alternate names—dollar bonnet, dollar tag, water target

Description—Floating leaves are oval to elliptical (football shaped) and have an elastic stem that attaches at their centers. Leaves are green on top and purple underneath and grow two to five inches in length. A gelatinous coating on stems and the undersides of leaves protects them from herbivores.
Flowers are dull red to purple. Plants prefer acidic and soft-water ponds and reproduce by rootstocks and seeds. Watershield can quickly take over a pond surface and severely limit recreational uses. Plants can grow in water up to six feet deep.

Value—Watershield offers good cover and habitat for fish, but the stems make fishing difficult. The leaves make a great landing spot for insects.

Pondweed, Curly-Leaf

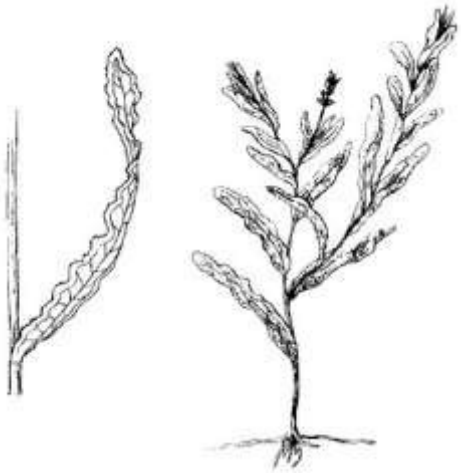
Potamogeton crispus

Invasive in Pennsylvania; can reproduce by fragmentation

Description— Introduced from Europe, curly-leaf pondweed has a very distinctive appearance. The curlyedged leaves are alternate and finely toothed. Their wavy or rippled appearance has been likened to the edges of a lasagna noodle. These plants are most often found in ponds with nutrient-rich hard water. The flower spikes often stick up above the water during spring. Curly-leaf pondweed grows aggressively, can tolerate low light, and may grow in deep water. It often persists throughout the winter but most frequently dies back in late summer.

Value— Curly-leaf pondweed is of unique value to a pond because it grows through the winter and spring when most plants are absent from the pond. Thus, it provides food and habitat during these times. Curly-leaf pondweed does tend to crowd out native submerged plant species. Also, its invasive nature may outweigh any values.

Pondweed, Curly-Leaf



Coontail

Ceratophyllum sp.

Can reproduce by fragmentation

Alternate name -hornwort

This plant can become more of a nuisance when you are trying to control it physically or mechanically because it reproduces quickly through fragmentation.

Description - The dark olive-green leaves of coontail are whorled around the stem. Each leaflet is forked with toothed edges. The leaflets are more densely crowded around the tip of the stem, giving the appearance of a raccoon tail. The purplish green flowers form where the leaf attaches to the stem and remain submerged. The plant may be anchored to the bottom or, more likely, free-floating beneath the surface. Coontail prefers ponds with hard water, although one species can be found more commonly in softer, acidic waters. Coontail can tolerate low light conditions in deep water. Plants have been described as having a very coarse or "plastic" feeling. Coontail spreads by seeds and by fragmentation.

Value - Coontail foliage is a favorite of many species of waterfowl and muskrats in Pennsylvania. It is also home to many invertebrates such as snails, crustaceans, and insect larvae, thus providing a great source of food for fish. Coontail inhibits the growth of blue-green algae on its stems by secreting sulfur-based toxins.

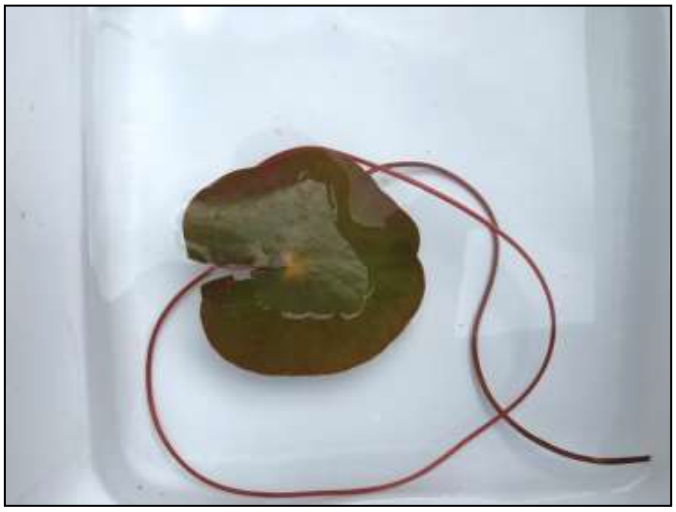
Water Lily, White

Nymphaea sp.

Alternate name - fragrant water lily

Description -Floating round leaves grow up to twelve inches across, are split to the stem in a V shape at the center, and are often purple underneath. Flowers of native water lilies are large, showy, and white, and have a sweet smell. Water lilies bearing other colored flowers are nonnative, tropical plants often sold for backyard water gardens. Flowers remain open from morning until shortly after midday. Commonly planted as an ornamental, this plant reproduces by rootstocks and seeds. It prefers to grow in quiet water less than six feet deep.

Value - This plant's beautiful appearance and its flowers make it a commonly used item in aquascapes. In addition, water lily creates excellent habitat for fish as it attracts small and large fish and their prey (insects, frogs, etc.). Despite this benefit, however, water lily's tangled stems make fishing very difficult. Waterfowl eat parts of the plant, as do a variety of wildlife, including deer. Water lily is also a favorite of honeybees.



Literature Cited

Penn State University. 2009. A Field Guide to Common Aquatic Plants of Pennsylvania. Penn State's College of Agricultural Sciences.

Attachment C

Lake Towhee Photo Documentation

Photo Set 1: Lake Condition Comparisons – Before & After Treatments

Photo 1A - Upper End of Lake – Spring of 2021 (Date: 5/20/21)

Photo 1B - Upper End of Lake – Fall of 2021 (Date: 10/6/21)

Photo 2A - Lower End of Lake – Spring of 2021 (Date: 5/20/21)

Photo 2B - Lower End of Lake – Fall of 2021 (Date: 10/6/21)

Photo 3A - Upper End of Lake - Early Summer 2019 (Date: 7/2/19)

Photo 3B - Upper End of Lake – Fall of 2021 (Date: 10/6/21)

Photo 4A - Lower End of Lake – Early Summer 2019 (Date: 7/2/19)

Photo 4B - Lower End of Lake – Fall of 2021 (Date: 10/6/21)

Photset 2 : Volunteer Vegetation Removal and Monitoring

Photo 1: Volunteer boats transport material for disposal (2018) Credit: Amy Jewitt

Photo 2: Volunteers remove water chestnut amid stands of native spadderdock (2019). Credit: Ashlin Brooks

Photo 3: BCCD employee, Jason Maurer and intern, Ashlin Brooks display the volume of vegetation removed. Credit: Susan Seykot

Photo 4. 'Sign of the Times' offers park users information for the 2020 growing season. Credit: Tim Cherry

Photo 5. DEP employee, Jim Brabusky, with his haul of water chestnut (2020). Credit: Tim Cherry

Photo 1. A 2021 volunteer pauses for a photo opp.

Photo 2. A 2018 volunteer, Joyse Wobensmith assesses a dense stand of water chestnut in upper reach of Lake Towhee

Photo 3. 2018 volunteer, Mike McCann assesses another dense stand of water chestnut in upper reach of Lake Towhee in 2018.

Photo 4. Tohickon Creek during stream monitoring summer 2019.

Photo 5. Dimple Creek stream monitoring summer 2020.

Photo 6. BCCD Watershed Specialist, Meghan Rogalus and BCCD intern, Ashlin Brooks assist PADCNR with Lake Nockamixon *Trapa natans* monitoring in 2019.

Appendix C

Satellite and Drone Imagery

Image 1: Lake Towhee NearMap Satellite and Orthomosaic Imagery Comparison

Image 2: Satellite imagery of Lake Towhee dated June 15, 2018

Image 3: Lake Towhee Orthomosaic Imagery
September 8, 2020

Image 4: Lake Towhee Orthomosaic Imagery
September 13, 2021

Appendix D

Education and Outreach Materials

Image 1: Informational sign for recreational and watercraft users

Image 2: Glossy brochures available at park information kiosk. (1 of 3)

Image 2: Glossy brochures available at park information kiosk. (2 of 3)

Image 2: (3 of 3)

THE HISTORY OF WATER CHESTNUTS
Introduced to the United States in the late 1800's from its native regions of Eurasia and Africa as an ornamental plant, the Water Chestnut Trapa natans L., is now considered an invasive species. Locally, Water Chestnut was first documented in both Lake Towhee and Lake Nockamixon in July 2009 during a routine water quality assessment by the PA DEP. The plant flourishes in lakes and impoundments, but since 2009, local Water Chestnut populations have fluctuated in response to local management efforts.
LOCAL IMPACTS OF WATER CHESTNUT
fig. 1
Water Chestnut is an aquatic invasive plant which threatens the diversity and abundance of native species and ecological stability of local waterways. The Water Chestnut can form dense vegetative mats across the water's surface that crowd out native plants. As native plants are lost, so are the species that depend on them, making the ecosystem susceptible to negative consequences such as fish kills. The spiky seed pods (fig 1) and tangled mats of plants also pose a safety hazard to humans and impede recreational activities, potentially posing a great economic impact.
WHAT CAN WE DO?
In Southeastern Pennsylvania, Water Chestnut emerges in mid-May and flowers around mid-July, providing a 2-month window to remove the plants before maturity. Plants can be removed by hand and should be placed far from waterways. Each rosette produces up to 20 seeds, and each seed can give rise to 10-15 rosettes; meaning one plant removed today can prevent up to 300 next season! To avoid the spread of this and all aquatic invasive species, clean, drain and dry all equipment after leaving one waterway to enter another.
CLEAN
DRAIN
DRY

Image 3: Double-sided rack cards for distribution

Growing our Economy
Growing our Communities
Growing Greener

BUCKS COUNTY CONSERVATION DISTRICT

Water Chestnut Identification

Seed

- Aquatic vegetation: Rooted, floating-leaved plant
- Root: Submerged stem 12-15 feet long
- Leaf: Vascular, diamond-shaped floating leaves with sawtooth edge
- Stem: hollow, air-filled
- Flower: Small 4-petaled white flowers bloom in June
- Seed: Pyramid-shaped with sharp points

Impacts

- Shade out native plants that support diverse fish and wildlife
- Decrease ecosystem resilience to environmental changes
- Tangled mats and spikey seeds create safety concerns, and limit recreation opportunities

Management

- Physically remove plant before maturity (Mid-May to Mid-July)
- Clean, drain, and dry all equipment before entering a new waterway to avoid spreading the seed or plant
- Educate others on the importance of aquatic invasive species management

BCCD
2021