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Stewardship in Action

Skunk Cabbage (*Symplocarpus foetidus*) Coverage Reduction in a Wetland that is Habitat for the Bog Turtle (*Glyptemys muhlenbergii*)

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ABSTRACT

In 2013 and 2014, several methods of managing dense skunk cabbage (*Symplocarpus foetidus*) using aquatic glyphosate were tested in a wetland in Carroll County, Maryland, as part of an adaptive management plan for enhancing bog turtle (*Glyptemys muhlenbergii*) habitat. Using a backpack sprayer with a 3–5% aquatic glyphosate solution and surfactant in late May to mid-June was found to be effective in reducing skunk cabbage coverage without reducing the vegetation species richness in the treated areas.

Index terms: aggressive native species; bog turtle; habitat management; skunk cabbage

INTRODUCTION

Since approximately 2004, the U.S. Fish and Wildlife Service (USFWS) and the Maryland Department of Natural Resources (DNR) have been working with the Maryland Department of Transportation State Highway Administration (SHA) to manage occupied bog turtle (*Glyptemys muhlenbergii* Schoepff, 1801) habitat on land owned by SHA. Bog turtles typically live in spring-fed wet meadows and are listed as threatened by both USFWS and DNR.

The habitat management at this wetland in Carroll County, Maryland, has included efforts to reduce the aerial cover of skunk cabbage (*Symplocarpus foetidus* L. Salisb. ex W.P.C. Barton), which is an aggressive native species. Prime bog turtle habitat is dominated by low grasses and sedges (Chase et al. 1989; Byer 2015; Macey 2015; Zappalorti et al. 2015); however, several areas of the wetland were dominated by skunk cabbage in the spring and broad-leaf cattail (*Typha latifolia* L.) the rest of the growing season. Basking is important to bog turtles for thermoregulation and reproduction (Zappalorti 2023), and nests need solar exposure to be successful (Zappalorti et al. 2015). The wetland had very few young bog turtles (poor recruitment), and the lack of basking and nesting habitat due to dense patches of skunk cabbage and broad-leaf cattail was considered a potential contributing factor. Broad-leaf cattail management is ongoing; however, the skunk cabbage management was successful and is the focus of this article.

METHODS

We first attempted grazing by a mixed herd of sheep and goats as a passive method to manage unwanted vegetation on the site. The grazing was effective in managing woody species, particularly in the uplands around the wetland, but had limited success with reducing the cattails and no success with the skunk cabbage. Therefore, we considered other methods for decreasing skunk cabbage aerial cover.

We conducted a literature search to determine what methods were possible for managing skunk cabbage, but very little information was found. However, skunk cabbage is considered poisonous to grazing livestock (Aganga et. al 2011) and has a very large, deep root system (Williams 1919). These characteristics make mechanical control difficult. Therefore, we considered herbicide to be the best option.

USFWS and DNR decided to test aquatic glyphosate applications. To determine what methods would work and to stay within the bounds of the applicable USFWS Biological Opinion (USFWS 2012), test management areas were established within areas of dense skunk cabbage. Six test management areas, each 49 m^2 in size, were randomly selected from within two areas of dense skunk cabbage. The four corners of these test management areas were marked by 5-foot tall, $\frac{3}{4}$-inch schedule 40 PVC pipes. Before treatment, two vegetation sampling plots, each 1 m^2 in size, were randomly located in each of the test management areas. Four additional 1 m^2 vegetation sampling plots were established in untreated areas to serve as control plots. These vegetation sampling plots

Table 1.—Skunk cabbage management methods tested in this trial.

Test Management Area (49 m^2)	Pre-treatment Activity	Aquatic Glyphosate Application Method	Aquatic Glyphosate Concentration	Time of Application
1	Cut skunk cabbage at base with knife	Hand spray bottle (spray directed at cut stump)	Full concentrate with surfactant	Mid-June (2013)
2	None	Hand spray bottle (one spray on each visible leaf)	Full concentrate with surfactant	Mid-June (2013)
3	None	Backpack sprayer	5% with surfactant	Mid-June (2013)
4	Cut skunk cabbage at base with machete	Backpack sprayer	5% with surfactant	Mid-June (2013)
5	None	Backpack sprayer	5% with surfactant	Early April (2014)
6	None	Hand spray bottle	Full concentrate with surfactant	Early April (2014)

were also marked with PVC poles, one in the center of each plot. Numerous times each year, a meter square was placed over the PVC pipe and centered on it. No attempt was made to orient the meter square the same way each time. Aerial cover of all plant species in the meter square was estimated visually and a photo of the plot was taken. This information was used to determine the success of the skunk cabbage management and the effect of the aquatic glyphosate on vegetation species richness.

A different skunk cabbage management method was tested in each test management area. Replicates were not performed because the purpose of the study was to inform the adaptive management plan for this site rather than strict scientific research. The following management methods were randomly assigned to test areas (Table 1):

1. Full concentrate aquatic glyphosate with surfactant applied from a hand spray bottle to the cut stumps of the skunk cabbage leaves (cut with a knife) in mid-June.
2. Full concentrate aquatic glyphosate with surfactant applied from a hand spray bottle, one spray to each leaf, in mid-June.
3. Five percent aquatic glyphosate with surfactant applied from a backpack sprayer to the leaves in mid-June.
4. Five percent aquatic glyphosate with surfactant applied from a backpack sprayer to the cut stumps of the skunk cabbage leaves (cut with a machete) in mid-June.
5. Five percent aquatic glyphosate with surfactant applied from a backpack sprayer to the skunk cabbage plants in early April.
6. Full concentrate aquatic glyphosate with surfactant applied from a hand spray bottle to the cut stumps of the skunk cabbage plants in early April.

Data

Pre-treatment data was collected for test management areas 1 through 4 and two of the control vegetation sampling plots in late May 2013. Two additional control vegetation sampling plots were established in mid-June 2013, and pre-treatment data for them was collected at that time. Early in the spring of 2014, test management areas 5 and 6 were added. For these last two test management areas, the skunk cabbage was just starting to leaf out when pre-treatment data was taken; therefore, the pre-treatment aerial coverage data was much lower than and not comparable to the other management areas. To remedy this difference, for the purpose of estimating treatment effectiveness, the pre-treatment skunk cabbage cover from the other vegetation sampling plots was averaged and used as the pre-treatment aerial skunk cabbage coverage for test management areas 5 and 6.

For simplicity in comparison and display, data from the two 1 m^2 vegetation sampling plots in each test management area was averaged, and that average was used to represent the enclosing test management area. The data from the four controls was also averaged.

Post-treatment data was collected periodically through the growing season. The final post-treatment data was collected in late May 2015.

RESULTS

The treatment methods we used for test management areas 1 through 3 were all very effective, resulting in decreases of aerial skunk cabbage cover ranging from 84% to 100%. These treatments were June applications using full concentrate to the cut stumps (area 1) and leaves (area 2), as well as the June application of dilute glyphosate to the leaves from a backpack sprayer (area 3). The treatments we used in test management areas 4 through 6 were minimally effective, resulting in decreases of aerial skunk cabbage cover ranging from 16% to 27%. These treatments were the June application of dilute glyphosate to cut leaf stumps (area 4) and both early April treatments (areas 5 and 6). As can be seen in Table 2 and Figure 1, we found the most effective treatment was the use of the 5% aquatic glyphosate solution from a backpack sprayer in June.

In addition to recording the aerial cover of skunk cabbage in the vegetation sampling plots, we recorded the percent cover of other vegetation species within the plots. There was a decrease in total aerial cover of vegetation, not just skunk cabbage, in plots with effective skunk cabbage control (Figure 2). Although the vegetation sampling plots were not sampled after spring of 2015, we observed that other species filled the areas left open by skunk cabbage treatment in subsequent years. In addition, we were able to use the aerial coverage data to determine if the aquatic glyphosate use was impacting vegetation species richness (Figure 2). There was greater species richness after treatment (May 2015 sampling) than before treatment (May/June 2013) in the four test

Table 2.—Percent reduction in skunk cabbage by management method.

Test Management Area	Aerial % Cover by Skunk Cabbage: Pre-treatment Sampling (May/June 2013)	Post-treatment Sampling (June 2014)	% decrease in skunk cabbage
1	95.0	15.0	84.2
2	77.5	7.5	90.3
3	55.0	0.0	100.0
4	95.0	80.0	15.8
5	82.5	62.5	24.2
6	82.5	60.0	27.3
Control	90.0	88.8	1.4

management areas treated in June of 2013 (test management areas 1 through 4). In one of the test management areas treated in April of 2014, the species richness decreased following treatment. This area, test management area 5, was treated with 5% aquatic glyphosate from a backpack sprayer. The other test management area treated in April of 2014 showed equal species richness before and after treatment. The control plots showed a decrease in species richness from 2013 to 2015.

Continued Management

We considered the three treatments that showed the greatest decrease in skunk cabbage for expanded use in the wetland. Cutting the skunk cabbage with a knife prior to treatment was very time consuming and did not provide the best results. Using a hand spray bottle to treat each leaf was more time consuming than using the backpack sprayer, was not quite as effective, and resulted in releasing more aquatic glyphosate to the environment. Therefore, for this location, utilizing the backpack sprayer with a low percentage aquatic glyphosate solution, including surfactant, when the leaves were well grown was the method selected for continued skunk cabbage management.

After this decision was made, we ended the study and started full-scale management of the skunk cabbage in the portions of the bog turtle habitat that it dominated. We used backpack sprayers with an aquatic glyphosate solution and surfactant to treat skunk cabbage in late May 2015, early in June 2016, and early in June 2017. For the first of those treatments, the glyphosate was inadvertently mixed at 3% rather than 5%. We chose to use it at that percentage, and the treatment was successful. Therefore, we continued to use a 3% solution, with surfactant, for the 2016 and 2017 treatments. The area being treated was divided into three sections, and one section was sprayed each year. In 2016 and 2017, in addition to treating the section slated for that year, we walked through areas that had been treated previously and sprayed any surviving skunk cabbage.

Eradication was never our goal, and there is dense skunk cabbage on adjacent private land. However, within 3 y, we considered the skunk cabbage sufficiently reduced in cover to cease this focused management effort. In 2024, 7 y after the end of management, the skunk cabbage density has increased but is still low enough that we have not initiated additional control.

DNR and volunteers conducting Phase 2 bog turtle surveys (USFWS 2001) at the wetland in years following the skunk cabbage management have found an increasing number of juvenile bog turtles hatched after the skunk cabbage management occurred. As previously mentioned, broad-leaf cattail management is continuing at the site. In addition, predator management was undertaken by USFWS from 2013 to 2017. We credit these combined habitat management techniques with the increase in nesting success resulting in more juvenile bog turtles at this site.

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Anna McAninch is a Senior Environmental Scientist at Wallace Montgomery. She became involved in the bog turtle habitat management work when she was an on-site consultant for SHA in their Environmental Programs Division working under William Buettner. She has continued to assist with the habitat management as a volunteer for DNR.

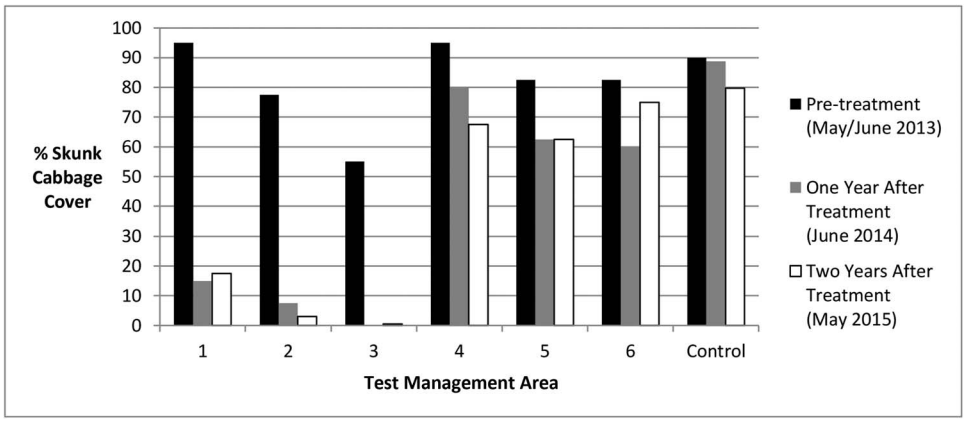

Figure 1.—Graphic of reduction in skunk cabbage by management method.

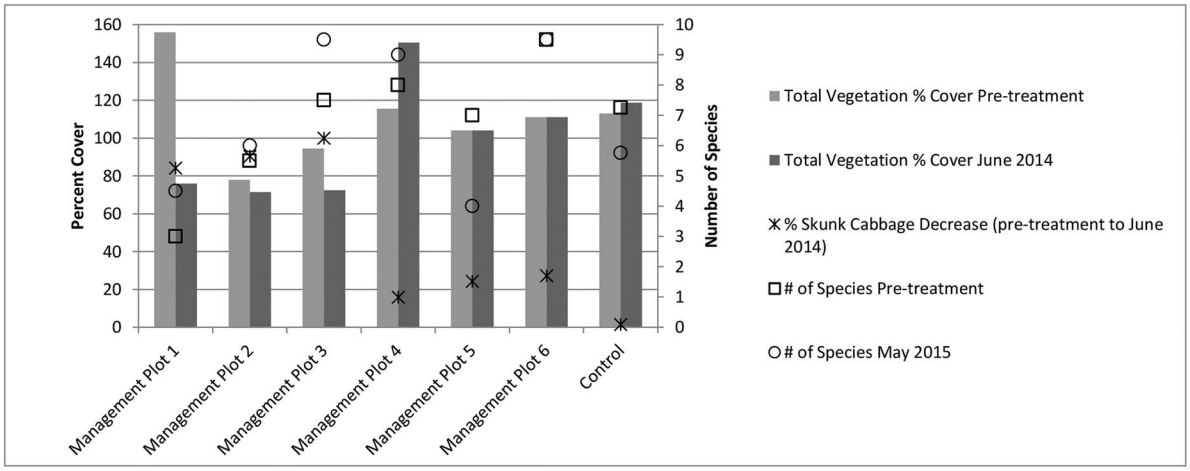

Figure 2.—Pre- and post-treatment data on total aerial vegetation cover and vegetation species richness. Percent decrease in skunk cabbage is also included.

Scott Smith is a retired Wildlife Ecologist for the Maryland Department of Natural Resources. He continues to work on conserving rare, threatened, and endangered animals and habitats, with a focus on reptiles and amphibians.

Julie Thompson Slacum is the Division Chief of Strategic Resource Conservation in the Chesapeake Bay Ecological Services Field Office of the U.S. Fish and Wildlife Service. She works to establish partnerships with states, private landowners, and nonprofit and academic institutions to achieve recovery for listed species and to try to preclude the need to list for at-risk species.

William Buettner retired from the Maryland State Highway Administration (SHA) after having served as the Mitigation Program Manager there. He is now a Senior Project Scientist for RK&K.

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