WINTER MANAGEMENT OF Salvinia Weevils FOR BIOLOGICAL CONTROL OF GIANT SALVINIA

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Background

Giant salvinia, *Salvinia molesta*, is a floating aquatic fern that has become one of the most aggressive weeds in freshwater habitats (McFarland et al., 2004; Figure 1). Since its discovery in Louisiana in 1998, giant salvinia has spread throughout the state and is now found in almost every parish (Figure 2). Giant salvinia can double its coverage in as few as 36 hours under favorable environmental conditions (Johnson et al., 2010). Dense mats of giant salvinia block access to water bodies and prevent sunlight from penetrating the water column, which results in the loss of submersed aquatic plants (McFarland et al., 2004). In Louisiana, waterfowl hunting and fishing have been impacted by the invasion of giant salvinia.

Figure 1. Giant salvinia mats cover waterways and infest areas with limited accessibility, such as cypress domes.

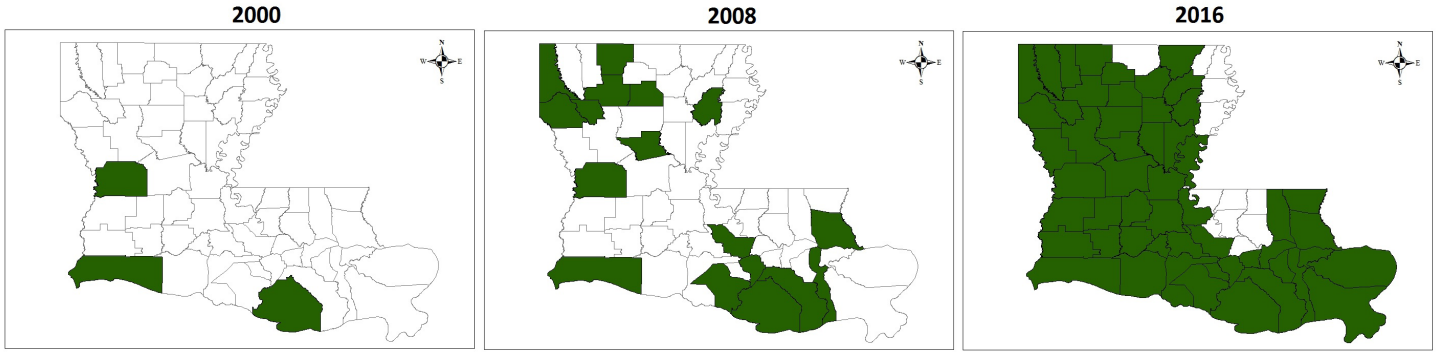


Figure 2. Current distribution of giant salvinia in Louisiana. The weed has spread to nearly every parish since its introduction in the late 1990s.

The salvinia weevil, *Cyrtobagous salviniae*, is native to Brazil and feeds exclusively on species of the Salviniaceae family. Because of its impact on the plant, the salvinia weevil has been used as a biological control agent of giant salvinia in several countries (Sullivan and Postle, 2012). Salvinia weevil adults are shiny, black and eight hundredths of an inch long, approximately the size of a kiwi seed (Figure 3). Under warm conditions, adults can be seen walking or mating on top of the salvinia fronds (i.e., leaves).

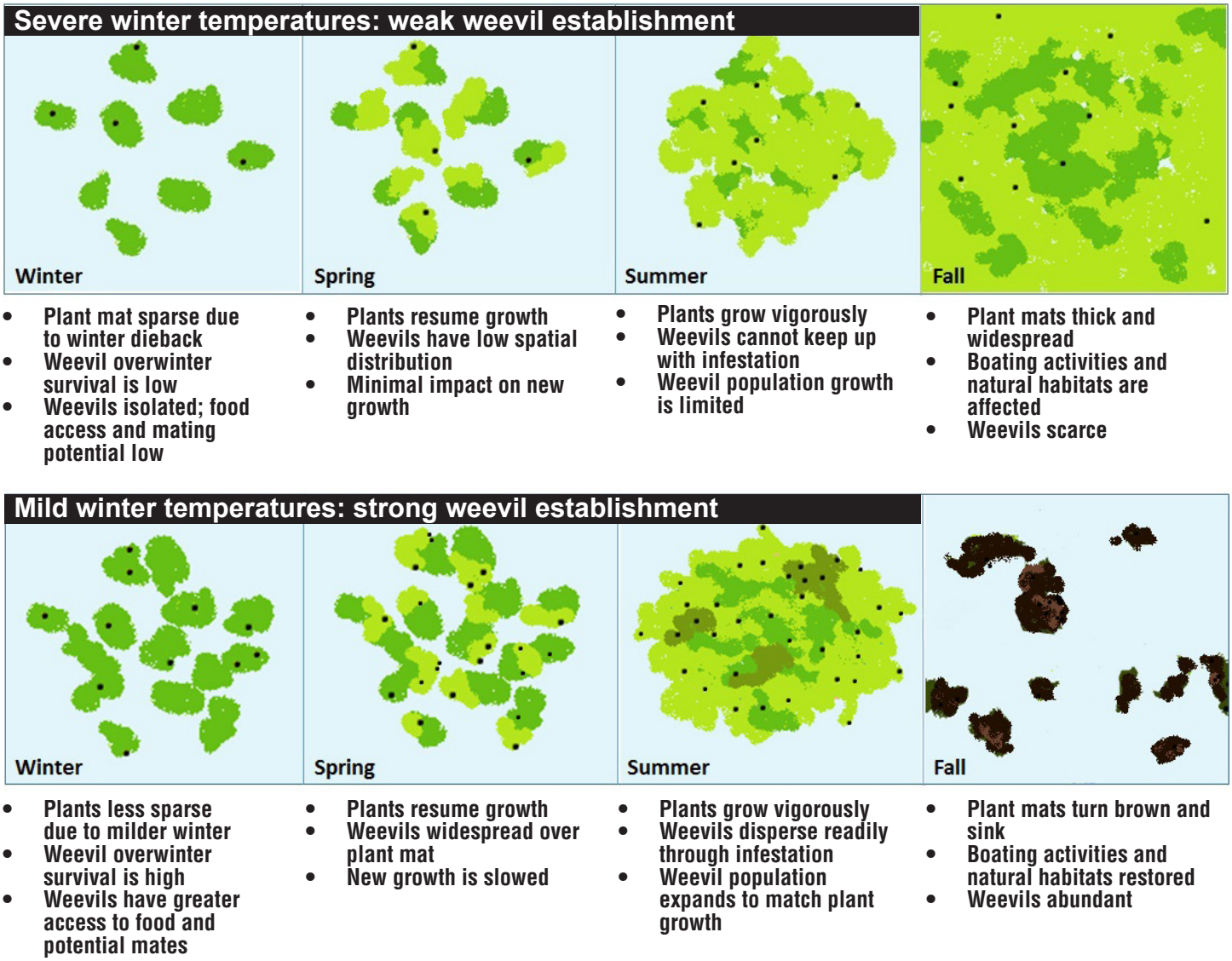
Figure 3. Adult salvinia weevil on giant salvinia leaf.

Damage by the weevil can be recognized by yellowing of the leaves, and as the damage progresses, the salvinia mat will turn dark brown and eventually sink (Figure 4). Field observations suggest that giant salvinia infestations can be controlled using salvinia weevils in south Louisiana. However, in central and north Louisiana, the impact of the weevil is limited in part by cold temperatures lower than 40 degrees (Obeysekara et al., 2015). Low survival and limited spatial distribution of overwintering weevils has led to slower population growth compared to giant salvinia (Figure 5). Therefore, land managers must time releases carefully and monitor release sites to prevent winter losses.

Winter management of giant salvinia mats is another approach that can be used to maximize survival and establishment of salvinia weevils during cold fronts. The purpose of this publication is to provide land managers with practical information on winter management techniques to increase salvinia weevil establishment and reduce overwinter mortality.

Figure 4. Weevil feeding causes giant salvinia mats to turn brown and eventually sink.

Figure 5. Possible scenarios demonstrating how winter conditions affect the population growth of salvinia weevils (black dots) and giant salvinia.



Overwintering Refugia

Salvinia weevil establishment can be affected by severe cold and declining plant quality following winter cold fronts. Overwintering refugia made from "floating weevil nurseries" can increase giant salvinia mat temperatures and reduce frost damage to plants. These nurseries have been shown to increase weevil survival in south Louisiana (Moshman, 2017). However, they may not be sufficient on their own to reduce overwinter mortality in areas that are more prone to severe winter cold fronts, such as north and central Louisiana. In these areas, greenhouses or winter cold frames may be necessary to ensure the success of salvinia weevil rearing operations (Nachtrieb, 2012). Winter management methods should ideally be established prior to the first major cold front of the winter, which tends to be in November or December.

Weevil nurseries keep plants in a specific location where they can be monitored and accessed for potential weevil redistribution to other locations. Floating nurseries can be constructed using plastic wading pools and pool noodles (Figure 6), which are available seasonally at a low cost. A basic floating nursery is constructed by removing the pool's bottom and attaching two pool noodles to the outside of the pool using zip ties. Alternative materials, such as PVC pipe and nylon rope, can be substituted. In large water bodies, floating containment booms can be used to designate the nursery area.

Figure 6. Floating nursery design using a bottomless plastic pool with two polystyrene pool noodles for support.

Fabric Covers

Just like row covers are used to protect cold-sensitive row or horticultural crops, insulating fabrics can be utilized to protect giant salvinia mats during cold fronts. Short-term use of row covers during the winter can extend periods of weevil activity by creating a favorable environment that is protected from wind and frost. Row covers are available in several weights that allow for varying levels of frost protection. In south Louisiana, heavy covers (sometimes called frost blankets) are sufficient and cost about $1 per square yard. Row covers are safe to use throughout the winter or may be applied just before a predicted cold front. They should be removed in spring once the danger of frost has passed. A structural base is required to prevent fabric covers from sagging. Ideally, the fabric maintains an insulated air space above the plant surface. The floating nurseries themselves can serve as a structural support (Figure 7). In north and central Louisiana, additional insulating materials, such as greenhouse plastics or pine straw mulch, could be beneficial. For maximum protection nurseries should be located in areas with stable water depth and minimal disturbance from wind and strong currents.

Figure 7. Floating weevil nurseries covered with heavy row cover fabric. For best results, the fabric must be stretched tightly over the plant mat without touching the plants or the water. Excess fabric can be tucked into the pool noodles for greater support.

Plant Crowding

Crowding giant salvinia to increase plant density is another way to create overwintering refugia. Winter die-offs of giant salvinia can result in reduced tertiary growth (the dense, mat-forming stage) and decreased biomass and quality of plants, which create patches of open water and thins the plant mat to a single layer. This can impact weevil activity by reducing temperature buffering and increasing exposure to severe environmental conditions. Crowding plants reduces areas of open water, thus allowing for greater heat retention within the salvinia mat. Crowded conditions encourage the plants to remain in the tightly clustered tertiary form rather than the flat-leafed secondary or colonizing form. This provides greater microhabitat for the weevils and gives them more plant layers in which to hide from adverse weather conditions. Crowding can be achieved by stocking floating nurseries with a sufficient amount of giant salvinia to create a mat that is 2-3 inches thick (Figure 8).

Containment booms can also be used to create nurseries on a larger scale (Figure 9). Ideal locations to set booms include large ponds, cypress domes and boat launches. Booms can prevent plants from drifting via water currents, and they maintain the physical structure of the plant mat. Additionally, booms facilitate accessibility to weevil release sites for purposes of monitoring and application of aquatic herbicides if necessary.

Figure 8. Crowding plants inside a floating nursery maintains tertiary growth and prevents the mat from thinning

For information on how to monitor weevil population density using Berlese funnels, see the LSU AgCenter publication titled How to Release and Monitor Salvinia Weevils for Biological Control of Giant Salvinia in Louisiana (Moshman et al. 2017).

Figure 9. Tertiary-stage giant salvinia crowded into a small section of a pond with a boom.

Conclusion

It is important to continue monitoring giant salvinia infestations after salvinia weevils are released. Monitoring after release will let land managers know if a weevil population has successfully overwintered and will provide guidance for future management decisions, especially if additional spring releases are needed. A variety of management approaches may be used to control giant salvinia infestations throughout the year as part of an integrated management program. Winter management of giant salvinia mats is another tool that we can use to maximize biological control efforts and raise public awareness about giant salvinia.

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