Department of Defense
Legacy Resource Management Program

NR-16-815

Evaluation of the Biology, Ecology, and Control of Aldrovanda within a Risk Analysis Framework
Cooperative Agreement #: HQ0034-16-2-0019

Rob Richardson / Final Report

10/12/2020

Final Report:

Evaluation of the Biology, Ecology, and Control of Aldrovanda within a Risk Analysis Framework

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I. Executive Summary

Aldrovanda vesiculosa L. is a submersed, rootless aquatic plant native to Europe, Asia and Africa. Following its discovery on Fort A.P. Hill property in 2013, a technical advisory committee (TAC) was formed to evaluate the scope of *Aldrovanda* on military and non-military sites and determine potential risks and implications for Department of Defense assets. This report details meetings of the TAC, an *Aldrovanda* literature review, TAC meeting priorities and a fact sheet on the known biology and ecology of the species.

II. Fort A.P. Hill Technical Group Site Visit and Discussion

Technical Advisory Committee (TAC), September 27th 2016

Attendance:

- In Person: Tim Stamps (Quantico), John Rohm (Quantico), Ben Fulton (Fort A.P. Hill Fish and Wildlife), Brian Josey (FAPH Environmental), Tom Olexa (US Navy Weapons Station), Scott Florence (Department of Defense Camp Peary), David Birdsall (DOD Camp Peary), Sara Reid (DOD Camp Peary), Drew Garey (Virginia Department Environmental Quality), Bryan Wilfong (FAPH Forestry), Tina MacIntyre (Virginia Department Agriculture and Consumer Services), Rob Richardson (North Carolina State University), Alejandro Reyes (NCSU), Jason Applegate (FAPH), Robert Floyd (FAPH).
- Call in: Melissa McCormick (Smithsonian Institute), Dorothy Keough (DOD Fort Belvoir), Wes Knapp (North Carolina National Heritage Program), Steve Young (New York State Department Environmenal Conservation), Nancy Rybicki (United States Geologic Survey), Chris Doyle (SOLitude Lake Management)

Meeting Start: 9:10am, Romenick Hall, Fort A.P. Hill, VA

Jason and Robert gave a brief introduction to the *Aldrovanda* infestation at Fort A.P. Hill detailing the history, site locations, and preliminary grass carp stockings. Rob Richardson explained North Carolina State University's involvement and gave background as to how the TAG was formed.

Two sites were visited on the property. The first pond, Madison Pond, had *Aldrovanda* matting throughout the pond whenever emergent vegetation (spatterdock, water lilies, rushes, etc.) were present. This included 100ft out from the pond edge, but also throughout the relatively shallow pond.

The second site (Lower Jordan's Crossing Pond) did not have *Aldrovanda* near the outlet, due to the depth at that particular point. There was a considerable amount of *Aldrovanda* intermixed with the spatterdock in the shallow parts of the pond (approximately 80% of the area we viewed).

Back at Romenick Hall, the group brainstormed potential risks/impacts from potential spread and priorities for identification or mitigation of risks. The contents of this brain storming session are contained within the document entitled "*Aldrovanda* Technical Advisory Group Meeting Priorities."

Lunch: 12:00 pm

After lunch, we were joined by six other members of the TAG via call in, who weighed in on the infestation. Rob Richardson led the discussion, Alejandro Reyes gave summary of the brainstorming session from earlier. Chris Doyle detailed his experience with *Aldrovanda* in New Jersey and New York.

Rob Richardson and Jason Applegate thanked everyone for participating in the meeting

Meeting adjourned at 2:30pm

III. *Aldrovanda vesiculosa* Literature Review

Aldrovanda vesiculosa L. is a submersed, rootless aquatic carnivorous plant native to Europe, Asia and Africa. Recently, a population of *Aldrovanda vesiculosa was* discovered on the US army base Fort A.P. Hill located in Bowling Green, VA in 2012 (Floyd et al. 2015). As of 2016, *Aldrovanda vesiculosa was* estimated in 161 acres of ponds and wetlands at Fort A.P. Hill. In order to assess potential impacts to DOD operations and infrastructure, a compilation and examination of all relevant scientific information concerning an *Aldrovanda vesiculosa invasion* is warranted.

The goal of this literature review is to compile and summarize all relevant information concerning an *Aldrovanda vesiculosa invasion* and potential risks to DOD assets. The Technical Advisory Committee compiled a list of priorities for understanding both potential *Aldrovanda vesiculosa risks* and a structure to identify those risks (Appendix 1). To complement the list of priorities, we will give a brief introduction to *Aldrovanda vesiculosa morphology* and reproduction, then we will focus on aspects of *Aldrovanda vesiculosa* 's ecology relevant to potential risks to DOD assets. These aspects are as follows: growth, competition with native plants and predation on native fauna. Information gleaned from investigation into these aspects of *Aldrovanda vesiculosa will* help to identify all relevant risks to DOD assets.

Introduction

Non-native species can cause serious ecological and economic problems worldwide. Their presence in an ecosystem can lead to population declines of native species and in some cases, local extirpations. Non-native species introductions are the primary threat faced by forty-two percent of biota listed on the threatened and endangered species list in the US (Pimentel et al. 2005). They also can have profound economic effects, especially if the native populations they affect are of commercial value or if ecosystem services are detrimentally affected. Invasive species cost the United States approximately $120 billion annually, with $7.5 billion of these costs attributed to invasive aquatic plants, fish and invertebrates.

Non-native aquatic plants are very often the focus of aquatic plant management because of the wide variety of problems they cause. In high abundance, some invasive plants can create dense canopies that shade out native species and can potentially interfere with the ecology of the system (e.g. fish, native plants, and nutrients), in addition to human uses including boating, swimming, and angling.

Aldrovanda vesiculosa is a rootless, submersed carnivorous aquatic plant belonging to the same family as the venus fly trap (Droseraceae). Shoot length of *Aldrovanda vesiculosa varies* from 1.5 cm to 20 cm (Breckport 1997) with mean lengths from North American populations varying from 6 cm to 14 cm (Cross et al. 2015). Whorls are arranged around the stem in a wheel fashion, with 7-8 leaves per node). Each leaf is modified into a pair of oval lobes at the end of the petiole, which function as the trap. The trap closes in about 100 ms when hairs on the inside of the lobes come into contact with a foreign object (Poppinga and Joyeux 2011).

A. vesiculosa, like most submersed aquatic macrophytes has a reduced capacity for sexual reproduction. Flowering is considered to be rare and often unsuccessful in terms of producing fertile fruit (Cross 2012). Rapid asexual vegetative reproduction is the primary strategy of propagation of new plants along with formation of turions. *Aldrovanda vesiculosa turions* form at the apical tip in the fall, during cooler days (Adamec 1999b). Temperature, light and humic acids have all been speculated to play a role in turion formation (Adamec 1999b; Adamec 2003: Cross 2012). Once formed, turions fill with water and sink to the sediment-water interface to overwinter. During the spring, turions fill with carbon dioxide and float to the surface and start to grow (Adamec 1999b).

Distribution

Aldrovanda vesiculosa is distributed across all continents except for Antarctica and South America. Historical range for this species included most of Europe, sections of northern and equatorial Africa, coastal areas of Australia and several sites within China, India and Bangladesh (Breckport 1997; Cross 2012). Currently, the distribution of the species has declined over the last century, becoming extinct in at least 11 of the 43 counties which native populations have been recorded, with only 50 confirmed extant locations within these countries (Cross 2012). More than two-thirds of these locations are in Poland and the Ukraine (Cross 2012).

In North America, *Aldrovanda vesiculosa* is found in New York, New Jersey, and Virginia. Before documented introductions in the 1990's, trade of dormant turions between Japanese growers and American carnivorous plant enthusiasts was happening since the 1970's. The New York population was in Big Pond near Cuddebackville. A handful of the plant was introduced into the southeastern section of the pond in 1999. In 2006, the pond was visited again, with shoots growing in the same southeastern introduction site. By 2012, *Aldrovanda vesiculosa was* distributed around the entire shoreline of the pond. Rough estimations of population size put the number of individuals at 25 to 30 million (Lamont et al. 2013).

Assisted colonization of *Aldrovanda vesiculosa was* undertaken in northern New Jersey in 1999 at sites such as abandoned sand and gravel pits, small ditches under power lines, a rain water discharge basin and artificial koi ponds. Aldrovanda vesiculosa *was* only successful at the rainwater discharge site, and flourished only after management of an existing *Hydrocharis morsus-ranae* population. Once management ended, *Hydrocharis morsus-ranae* took over and *Aldrovanda vesiculosa* at the site is considered extirpated (Lamont et al. 2013). Lake Owassa in Sussex County, New Jersey has a population of *Aldrovanda vesiculosa present* both at the inlet and the outlet of the stream. Lamont et al. (2013) speculated that the Lake Owassa population was introduced via bird transport, citing a degree of desiccation resistance by vegetative fragments and a close proximity (approximately 50km) to the big pond population.

Growers of carnivorous plants in north central Virginia introduced turions to their backyard ponds at some point between the late 1980's and early 1990's. By the late 1990's, populations of *Aldrovanda vesiculosa were* naturalized in sites within 5 counties (Lamont et al. 2013). In 2013, *Aldrovanda vesiculosa was* found in Meadow Creek pond, a 9 ha waterbody located just north of Fort AP Hill. The source of this introduction is believed to be from a cultivated population adjacent to the pond (Floyd et al. 2015). *Aldrovanda vesiculosa has* been present on Fort AP hill since 2013, expanding in estimated acreage every year up to 2016 (Robert Floyd personal communication).

Growth

Dense stands of *Aldrovanda vesiculosa have* been observed in multiple populations in North America (Lamont et al. 2015; Cross et al. 2015; Floyd et al. 2015). Timing of growth in North America is still a relative unknown; with Cross et al. (2015) only examining densities during July. In Europe, *Aldrovanda vesiculosa starts* apical growth once turions rise to the water surface in spring, where temperatures start to climb above 15-16°C (Cross 2012). Lamont et al. (2013) noted that Virginia populations had dense stands by the end of the year, indicating that *Aldrovanda vesiculosa may* follow a typical pattern of high biomass accumulation later in the summer. Cross (2012) noted that optimal growth occurs when water temperatures reach 22-36 °C, which is typically achieved during the latter part of the summer in temperate climates.

Aldrovanda vesiculosa typically inhabits slow moving, slightly acidic, dystrophic waterbodies typical of bogs and fens (Kaminski 1987a; Adamec 1995a; Cross 2012). Typically, 20-60 cm in depth is considered optimal for growth (Cross 2012), with a minimum depth of 3-5 cm being reported (Adamec 1999). An adequate amount of free CO2, moderate humic acid concentration, and appropriate mineral composition (potassium and magnesium) all have been reported to be requirements for optimal *Aldrovanda vesiculosa growth* (Kaminski 1987a; Adamec 1995a; Cross 2012). Nutrient concentrations in these habitats are typically low, but *Aldrovanda vesiculosa has* been found in areas with nutrient levels typical of eutrophic conditions (Cross 2012). Adamec (1995) suggested that eutrophication may slightly increase growth rate of *Aldrovanda vesiculosa*, however also postulated that high algal growth in eutrophic waterbodies may have a negative impact on *Aldrovanda vesiculosa reproduction*.

Cross et al. (2015) examined four microhabitats in Meadow Creek, VA that contained *Aldrovanda vesiculosa.* All microhabitats examined ranged from 23-47 cm in depth, pH ranged from 5.7 to 6.2, and nutrient concentrations were typical of meso-eutrophic conditions and were rich in organic carbon. The greatest growth characteristics of *Aldrovanda vesiculosa in* this study were observed in shallow waters (10-50 cm). Due to the close proximity of this study site and Fort A.P. Hill, we can infer that site conditions present in this study may be representative of site conditions on the military base.

Competition

Most authors note that *Aldrovanda vesiculosa has* a poor competitive ability (Adamec 1995a; Breckport 1997; Adamec and Lev 1999; Cross et al. 2015), however these claims are based on observations of co-occurrence data rather than direct studies of competition. Admaec and Lev (1999) found no evidence of negative impacts of co-occurrence with emergent macrophytes such as *Carex spp.*, *Phragmites australis* and *Typha angustifolia*. Other studies have noted a positive relationship with emergent macrophytes (Kaminski 1987b; Adamec 2005; Cross 2012; Lamont et al. 2013; Cross et al. 2015). Kaminski (1987b) observed higher growth rates for *Aldrovanda vesiculosa when* mixed with emergent macrophytes compared to grown alone or with *Hydrocharis morsus- ranae*. The author speculated that there is a positive allopathic effect that is providing *Aldrovanda vesiculosa with* an organic substance that is essential to metabolism.

Another explanation for the positive relationship of *Aldrovanda vesiculosa and* emergent macrophytes is refuge from excessive amounts of irradiance. *Aldrovanda vesiculosa seems* to prefer a moderate amount of irradiance (20-60%) with higher levels leading to increased senescence, apical reduction and decrease of size and fitness of individuals (Cross 2012). Shading by emergent macrophytes may provide enough refuge from irradiance to offset any deleterious effects to *Aldrovanda vesiculosa populations*.

Information about direct competition between *Aldrovanda vesiculosa and* submersed macrophytes is limited. There is typically low submersed macrophyte diversity in dystrophic habitats (Roberts et al. 1985; Rørslett 1991; Weiher and Boylen 1994; Murphy 2002; Adamec 2012), with carnivorous aquatic plants tending to dominate (Ellison and Adamec 2011). Adamec (2012) compared relative abundances of rootless aquatic carnivorous plants (ACP's) with rooted non- carnivorous aquatic plants (N-ACP's) at 110 dystrophic sites across six countries. The author found that the relative abundance of N-ACPs found at these sites was much lower than

ACPs. ACPs have specific adaptations to deal with dystrophic conditions such as lack of roots, rapid apical growth, surface sprouting turions, high nutrient uptake affinity and carnivory (Adamec 2012). The absence of these adaptations within many N-ACPs most likely limits competitive interactions with aquatic carnivorous plants. In dystrophic habitats, *Aldrovanda vesiculosa should* have a strong competitive advantage against any N-ACPs present.

The Bladderworts (*Utricularia* spp.) may be the submersed macrophyte most impacted by the presence of *Aldrovanda vesiculosa. Utricularia* spp. are rootless, carnivorous and commonly inhabit the same dystrophic waters as *Aldrovanda vesiculosa (*Kaminski 1987b; Lamont et al. 2013; Cross et al. 2015). No studies to our knowledge have followed an *Aldrovanda vesiculosa and Utricularia* spp. community through time or examined possible overlap in diet, therefore only inferences can be made about potential outcomes of competition. These inferences are based on a few published studies that have looked at competition either indirectly and or under a limited time frame (Kaminski 1987b; Adamec and Koravora 2006; Cross et al. 2015)

Adamec and Korarova (2006) compared growth rates at two sites in the Czech Republic and found that *Aldrovanda vesiculosa can* grow faster during the peak season than *Utricularia australis*. This rapid growth was in form of frequent branching and separation of daughter shoots, which may be important for vegetative propagation. Since this study did not have any plots where either

Aldrovanda vesiculosa or Utricularia australis were grown alone, we cannot discern if differences in growth rates were influenced by competition or some other factor. Cross et al. (2015) compared percent cover of *Aldrovanda vesiculosa to* native macrophytes at several transects in a braided creek system in Virginia, USA. Several species of *Utricularia* were present within most transects, however percent cover data was presented as an aggregate of native macrophytes present. No percent cover data was given for individual taxa, preventing a direct comparison.

Without peer reviewed studies comparing competing populations of *Aldrovanda vesiculosa and* other submersed aquatic macrophytes, it is difficult to speculate on any potential impacts of competition. *Aldrovanda vesiculosa can* become locally dominant (Adamec and Koravova 2006; Lamont et al. 2013; Cross 2015; Floyd et al. 2015), however we cannot discern if this dominance was due to a superior competitive ability or colonization of a novel habitat. More information is needed on the potential outcomes of direct competition between *Aldrovanda vesiculosa and* submersed aquatic vegetation.

Predation

While it is known that carnivory in *Aldrovanda vesiculosa is* an important for physiological processes (Adamec 2000; Adamec 2008b; Cross 2010; Adamec 2012), information regarding prey selection and impacts to prey populations is scarce. *Aldrovanda vesiculosa does* feed on a variety of invertebrates such as ostracods, branchiopods, copepods, chironomid larvae and mosquito larvae (Akeret 1993; Cross 2012). There have been some instances where larger prey was caught such as *Gammarus* spp., fish fry and young tadpoles (Cross 2012). Despite trap size being relatively small (1.9 -5.6 mm in Virginia populations [Cross et al. 2015]) there has been anecdotal evidence that larger prey can get caught within the traps partially (Cross 2012); with any part of the prey item within the trap being fully digested. This partial capture may lead to either increased direct or indirect mortality for larger prey species.

Prey selection for *Aldrovanda vesiculosa is* still a relative unknown, however there is evidence that epiphytic invertebrates may represent a large amount of the prey items captured (Schell 2003). Similar observations have been made for *Utricularia spp*. (Sanabria-aranda et al. 2006). Schell (2003) observed a larger proportion of ostracods within traps despite an even community of invertebrates present in cultivation containers. The author hypothesizes that the trigger hairs on traps mimicked filamentous algae and attracted the ostracods to the plant.

Other carnivorous plants use attractants to lure prey (Moran 1966; Kreuzwieser et al. 2014); despite methods of attraction not being described from *Aldrovanda vesiculosa.*

While there is no peer reviewed studies investigating changes in invertebrate populations in response to *Aldrovanda vesiculosa predation*, impacts of *Utricularia* spp. predation have been explored. *Utricularia* spp. has been implicated in reducing invertebrate population densities in laboratory and enclosure experiments (Baumgartner 1987; Harms 2002). Havens (1991) investigated littoral zooplankton populations in a humic lake (pH = 4.9) in Ohio and speculated that *Utricularia spp.* predation was a significant factor influencing zooplankton densities. The author noticed a rapid increase of zooplankton density corresponding with *Utricularia spp*. senescence in September indicating a release from predation.

Based on high observed densities of *Aldrovanda vesiculosa observed* in Fort A.P. Hill (Floyd et al. 2015), there is most likely localized predation on invertebrates within these waterbodies. Predation on which taxa and to what extent the population as a whole would be affected is still unknown. Macroinvertebrates contribute positively to the ecology of ponds and wetlands such as aiding in decomposition (McQueen et al. 1996) and providing a food source for fish and waterfowl (Keast 1985; Batzer et al. 1993). Further research should be conducted to improve our understanding of potential predation impacts.

Conclusions

Due to the high densities observed both at Fort A.P. Hill and other populations in North America, DOD operations involving movement within wetlands and ponds may be impacted. Recreational use of ponds may also be impacted as shoreline fishing may be limited by dense surface coverage fouling gears. In our literature search, we did not come across instances where *A. vesiculosa* was recreationally impeding. Bogs and fens are not usually areas that are subject to high amounts of boating and fishing which may explain why recreational impediment was not reported before. Our understanding of *Aldrovanda vesiculosa growth* habits in North America comes from one study; which only examined populations during one part of the year. We still have little understanding of seasonal trends in *Aldrovanda vesiculosa density*, which hinders the ability to predict when *Aldrovanda vesiculosa may* become an issue for operations and recreation. Furthermore, impacts to native flora and fauna are similarly unclear. Due to the presence of dense stands of *Aldrovanda vesiculosa,* it can be inferred that there may be some impact, however, the magnitude of these potential impacts is not known.

Literature Cited

*note that this list represents all of the literature we examined for this report. Some of the literature below was not represented in the above text, but is related to *Aldrovanda vesiculosa*.

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IV. *Aldrovanda* Technical Advisory Committee WebEx meeting

February 23rd, 2017

Attendance: Rob Richardson (NCSU), Steve Young (NYSDEC), Alejandro Reyes (NCSU), Chris Doyle (SOLitude), Willow Eyres (NYSDEC), Jason Applegate (Fort A.P. Hill), Spencer Blisset (VCU), Ray Fernald (VDGIF), Tina MacIntyre (VDACS), Kevin Heffernan (VDCR), John Thompson (CRISP), Dorothy Keough (USAG Fort Belvoir).

Alejandro Reyes called the meeting to order at 1:10pm

Introduction:

- Jason Applegate gave a brief review of the history of the *Aldrovanda* infestation at Fort A.P. Hill.
- Alejandro Reyes gave a brief overview of the site visit and the formation of the *Aldrovanda* Technical Advisory Committee Meeting Priorities.

Preliminary Literature Review (Alejandro Reyes gave an overview of the preliminary literature review of information relevant to the *Aldrovanda* invasion).

- Only three peer reviewed manuscripts concerning *Aldrovanda* in North America.
  - Only one of these papers was an ecological study.
- Potential impacts to recreation
  - Growth is restricted to shallow (10-50 cm) wind protected sections of dystrophic habitats
  - Localized, dense growth has occurred in other areas in North America, including a pond adjacent to fort A.P. Hill.
  - No literature on nuisance populations of *Aldrovanda* in Europe or Asia
  - No literature on development, implementation and/or evaluation of management techniques for *Aldrovanda* control.
- Potential impacts to native vegetation
  - Positive relationship with emergent macrophytes
  - Limited competitive interactions with many other native submersed aquatic plants due to limited diversity in dystrophic habitat.
  - Bladderworts may be impacted the most by an *Aldrovanda* invasion, however few studies have explored their interaction.
- Potential impacts to native fauna
  - Information concerning prey selection and impacts to prey populations is scarce
  - There is anecdotal evidence that larger prey items can be caught within the traps
  - No studies have investigated any change in invertebrate abundance or community assemblage in response to an *Aldrovanda* invasion.

General discussion:

Steve Young noted that risk to the food web structure should be added to the list of potential risks.

Dennis Whigham noted that available information concerning effects of macrophytes such as water chestnut on the invertebrate community should be used in our assessment.

Alejandro Reyes asked if there was any information concerning recreational impediment for the fisherman at Fort A.P. Hill.

Jason Applegate noted that 245 grass carp went into 4 ponds on the property in 2016. Chris Doyle suggested developing a monitoring protocol to assess the effectiveness of the carp.

The group agreed to rank the potential risks by severity via an online survey and then move forward from there.

Alejandro Reyes adjourned the meeting at 2:30pm.

V. *Aldrovanda* Technical Advisory Committee Meeting Priorities

At the conclusion of the Fort A. P. Hill site visit, The TAC Came up with a list of potential risks/impacts and the way ahead for identification and mitigation of risks:

What are the potential risks/impacts from potential spread?

1) Compromising biodiversity (species and habitats).
2) Changes to water chemistry.
    A) Downstream effects if surface water bodies are used for human use.
3) Changes to predation patterns (e.g. increasing escape).
4) Indirect mission impacts if the species compromises endangered species.
5) Co-occurrence with rare *Utricularia* (Virginia S2).
6) State rare insects (e.g., dragonflies).
7) Increased administrative requirements when control is warranted and federal/state species co-occur.
8) Predation upon fish larvae and/or amphibian larvae?
9) Impacts to recreation
    A) Engagement with recreator regarding boat contamination/spread.
    B) Awareness campaign at the installation.
    C) Decreased user satisfaction; shift in use/pressure on other impoundments.
10) Public Relations for recreators and land managers for control.
11) Counter mobility for waterborne operations (small craft).
12) Impacts to ROWPU ops.
13) Impacts to food web structure
14) Practical hindrance to monitoring communities/biology.
15) Impacts to federally permitted restoration/mitigation projects
16) Increases culvert maintenance frequency/level of effort (where cages/bars exist at inlet)

What would the way-ahead look like for identification or mitigation of risks?

1) Research on changes to water chemistry/dissolved oxygen
2) Research on prey selection
3) Research on chemical control
4) Monitoring for grass carp herbivory as a control measure
    A) Enclosure cages
5) Monitoring protocol to discern degree of infestation
6) Awareness campaign (local/regional)
7) Waterwheel environmental thresholds

Follow on work:

At this moment, it is unknown if any of the potential impacts of an *Aldrovanda* infestation are realized at Fort A.P. Hill. Negative impacts, if present should be documented before any control measures are undertaken. To document potential negative impacts to flora, fauna and water quality, an ecological monitoring program should be implemented. In addition to an ecological monitoring program, a survey of recreational users of the Fort A.P. Hill should be conducted to gauge what impact the infestation has had on fishing and boating. Results from both the ecological monitoring and recreational survey should be reviewed by the TAC and recommendations for potential management actions should be developed.

VI. *Aldrovanda* Fact Sheet

Aldrovanda vesiculosa L. (Waterwheel) is a submersed, rootless aquatic carnivorous plant native to Europe, Asia and Africa. In its native range, *Aldrovanda vesiculosa* is on the decline however, several large populations have established in North America. Recently, waterwheel has been increasing in abundance in wetlands and ponds on the US army base Fort A.P. Hill, VA.

Biology: Typically, waterwheel is green to brown in color, with shoot length ranging from 1.5 cm to 20 cm. Whorls are arranged around the stem in a wheel fashion, hence the name waterwheel with 7-8 leaves per node. Each leaf is modified into a pair of oval lobes at the end of the petiole, which function as the trap to capture insects. Waterwheel feeds on a variety of insects such as snails, mosquito larvae and zooplankton.

Habitat: Waterwheel typically inhabits slow moving, slightly acidic, dystrophic waterbodies typical of bogs and fens. Most often, you can find waterwheel in shallow, stagnant areas among emergent vegetation such as rushes and cattails. Since waterwheel does not have roots, it is most often found at the water’s surface. When conditions are right, waterwheel can form dense stands numbering in the millions of individuals.

Reproduction: primarily, waterwheel reproduces via fragmentation (breaking off of a section of a shoot, which can grow into a new plant). Flowers are rarely observed an often unsuccessful in producing viable seeds. At the end of the growing season, waterwheel produces an overwintering structure called a turion. The turions sinks to the bottom of the water during winter and rises to the water’s surface during the spring time to sprout.