

PhD Dissertation
Department of Environmental Science and Policy
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Defense Date and Time: Thursday, June 24, 2:00-4:00 pm

Defense Location: Virtual via Zoom (RSVP to slister1@gmu.edu for link)

Title: Phenology and Water Quality Impacts of an invasive Water Chestnut (*Trapa bispinosa* Roxb. var *iinumai* Nakano) in Northern Virginia, USA, and evaluation of Early Detection/Rapid Response (EDRR) practices in its control

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ABSTRACT

Species of the genus *Trapa*, specifically *T. natans*, have plagued the northeastern US, including the tidal Potomac for over 100 years. Much has been learned about the ecology and management of *T. natans*, during this period. In 2014, a new species of *Trapa* identified as *T. bispinosa* Roxb. var *iinumai* Nakano was discovered in the tidal Potomac River and in subsequent years it has spread to nearby waterbodies. This species is different from *T. natans* as it has pink flowers instead of white flowers of *T. natans*; two horned fruits instead of four horned fruits; and reddish underside of leaves instead of green leaves of *T. natans*. *T. bispinosa* (hereafter referred as *Trapa*) has been identified at over 65 different locations in VA, since 1995.

The purpose of this study is to describe the vegetative and reproductive phenology of *T. bispinosa* in a group of Fairfax County ponds and to assess its impact on WQ variables such as temperature, dissolved oxygen (DO), pH, specific conductance (SPC) and turbidity (NTU). The final goal is to evaluate laws, regulations, incentives, knowledge gaps, and to assess the usefulness of Early Detection and Rapid Response (EDRR) as a policy option in its control. A total of 8 *Trapa* ponds were sampled over the two-year study (2019 and 2020). Some had a history of herbicide treatment while others did not. A total of 4 non-*Trapa* ponds were also sampled in 2020 and WQ was compared with *Trapa* ponds. In untreated ponds with dense and healthy *Trapa*, the beds rapidly developed in spring and remained robust until fall. Rosette diameters were bigger in July and August. *Trapa* flowers, fruit and reproductive phenology

were also higher in late summer and early fall. *Trapa* growth was highly impacted by herbicide applications in treated ponds resulting in more erratic plant development, with less flowers and fruits. Even though *Trapa* appeared later in treated ponds compared to untreated, the maximum flower and fruit phenology was during the similar months. Herbicide did not completely block the flowering and fruiting capacity of *Trapa*.

All phenological parameters were negatively correlated with DO (mg/L). WQ variables also varied according to the density of *Trapa* and were more consistent in untreated ponds compared to treated ponds except pH. DO (mg/L and %) was significantly depleted in untreated *Trapa* ponds compared to treated *Trapa* ponds and non-*Trapa* ponds. This indicated that the dense carpet of *Trapa* was obstructing reaeration and photosynthesis in the underlying layers. pH was low in fall and alkalinity was low in spring in *Trapa* ponds compared to non-*Trapa* ponds. In the most intensely studied untreated pond, VGA-VA, DO (mg/L) was mostly below 5 but above 2 in summer and DO % was above 25 in summer and above 40 in spring and rest of the fall months, where *Trapa* was healthy, dense and abundant. The short-term hydroponic experiment assessing the effect of low densities of *Trapa* found that *Trapa* could sustain higher DO levels in uncrowded conditions due to photosynthesis by underwater leaves. *Trapa* management is a multijurisdictional issue in VA. Counties, researchers, and volunteers have initiated some management options for its control. EDRR could help manage the distribution and spread of *Trapa* and efforts are being made to apply EDRR to this situation. This study by providing some basic ecological and phenological information on *Trapa* growth in both treated and untreated ponds will inform the EDRR process.

Keywords: *T. natans*, *T. bispinosa*, Phenology, Fairfax County, EDRR