NOTE

Waterchestnut Seed Production and Management in Watervliet Reservoir, New York[1]

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INTRODUCTION

Waterchestnut (*Trapa natans* L.) is an annual exotic plant that 8overwinters completely by seeds. Growth from seed is rapid, with the plant establishing a floating rosette of leaves by early summer. The rosettes can form several flowers in succession by mid-summer, with the first fruits ripening in late summer. Flowering and seed production continue into the fall, until a hard frost kills the floating rosette. Waterchestnut was first introduced to Collins Lake in Schenectady County, New York in 1884 (Wibbe 1886, Smith 1955). It spread from there to the nearby Mohawk and Hudson Rivers and the Champlain Barge canal. Additional sites of waterchestnut in North America include Vermont, Maryland, Virginia, and Massachusetts (Steenis and Stotts 1963, Burk et al. 1976). Vigorous control programs were largely successful in the Potomac River, but nuisance problems still exist on the Hudson-Mohawk River and Lake Champlain (Steenis and Stotts 1963, Elser 1966).

Waterchestnut is an annual; a key point of the life cycle for effective plant control is the formation of fertile seeds. Cutting, harvesting, or applying herbicides is only useful if it reduces or prevents seed production.

Previous studies have indicated that up to twenty seeds may be produced per rosette (Elser 1966), and that individual seeds may remain viable up to twelve years (Winne 1935). Newly formed seeds are negatively buoyant, and sink rapidly to the bottom. Although they may be transported by water, transport before germination and formation of the early rosette is limited. The seed coat (or nut shell) is resistant to decomposition, and persists for many years after germination; giving the appearance of many more viable seeds present in the waterbody than actually occur.

Most waterchestnut control programs have found that traditional plant harvesting was largely unsuccessful (Elser 1966), although the states of New York and Vermont have maintained a long-term harvesting program on Lake Champlain (Countryman 1977). Recent efforts at the Watervliet Reservoir employed a high-speed cutting technique using an airboat. This study reports on the effectiveness of these cutting efforts to reduce the seed bank of the waterchestnut population in Watervliet Reservoir.

METHODS

Sampling was performed at the Watervliet Reservoir located in the Town of Guilderland, Albany County, New York. Watervliet Reservoir is a drinking water reservoir for the City of Watervliet and Town of Guilderland. Cores were taken at two locations in the reservoir: 1) at a control (or reference) area in which cutting was not performed, and 2) a treatment area in which cutting of waterchestnut was performed. Sediment seed bank in both locations was sampled by collecting 20 core samples by SCUBA divers using a 7.6 cm i.d. plexiglass tube approximately 60 cm in length which could be closed at both ends using rubber stoppers or plastic caps. All seeds were recovered from the cores by washing the core contents through a coarse mesh screen. The seeds were then counted, dried, and weighed. The first sampling was done on 27 June 1989 after seed germination, to sample for dormant seeds, and the second on 8 November 1989 after the senescence of waterchestnut rosettes, to count seed production for that year. Seeds were considered viable if they contained an intact endosperm. Laboratory studies of seed germination indicated that up to 93% of seeds with an intact endosperm germinated under ideal conditions[4]. Seeds without an endosperm were typically the empty shells of seeds germinated in previous years. The annual production of seeds was also examined by directly measuring seed fall under the canopy of waterchestnut rosettes. Seed fall collectors were constructed out of wire mesh with dimensions of 30 cm by 60 cm, and placed in the control area, with surface floats marking their location. Twenty seed fall collectors were placed on June 27, 1989 in the control area. Sixteen of the twenty control collectors were successfully retrieved on 8 November 1989. Seeds were counted, dried and weighed as with those from seed core samples. Seed fall collectors were also placed in the treatment area, but none of these were recovered since cutting activity and other boat traffic eliminated subsurface markers, and visibility was poor.

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[4]Madsen, J. D. 1990. Waterchestnut (*Trapa natans* L.) seed germination: Effects of temperature and daylength. Rensselaer Fresh Water Institute Report #90-16, Rensselaer Polytechnic Institute, Troy, NY. November 1990. 12pp.

RESULTS AND DISCUSSION

Analyses of samples from the June 27 sampling showed that 12 seeds m^{-2} were present in the control and 7 seeds m^{-2} occurred in the treatment area (Figure 1). Note that these estimates are after the given years' cohort had germinated, so these values represent the number of dormant seeds available for germination in subsequent years. Dissection of seed husks was an important step in determining the number of viable seeds, since over 90% of seed husks recovered were empty and, hence, nonviable.

Samples taken after the growing season ended (8 November 1989) contained 31 seeds m^{-2} in the control area, and 5.6 seeds m^{-2} in the treatment area. These values were significantly different ($p=0.05$) as calculated by a t-test. Calculated seed production rates were 19 seeds m^{-2} y^{-1} for the control area, and -1.4 seeds m^{-2} y^{-1}, or a loss of 1.4 seeds m^{-2} y^{-1} from the seed bank in the treatment area (Figure 1). The results of this experiment are significant in two ways. First, the coring method predicts that the waterchestnut population is producing on average of 19 seeds m^{-2} y^{-1} directly below the canopy for continued propagation (e.g., recruitment). Second, treatment by cutting proved to be very effective in reducing seed production, with no additional seeds recruited to the seed bank in a given year. Continued sampling of this type may be adequate to both quantify impacts and effectiveness of cutting, and monitor the seed bank in given areas of the reservoir.

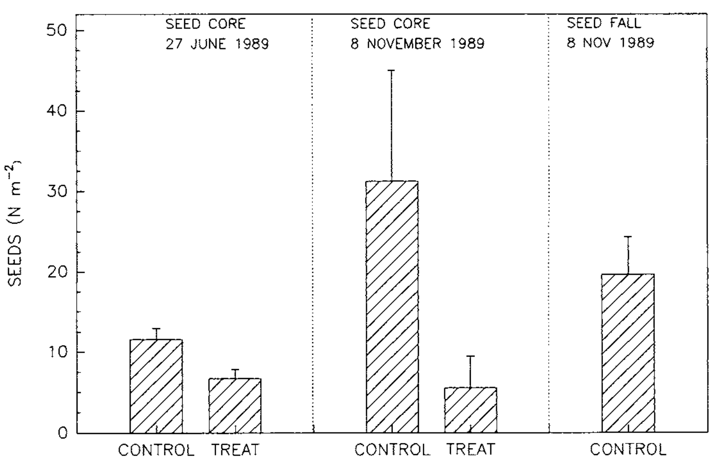

Figure 1. Number of viable seeds per square meter from cores and seed fall collectors taken after seed germination in the spring (June 27, 1989) and after plant senescence in the fall (November 8, 1989).

Seed fall data is only available for the control area, as indicated in the Methods section. The 19.7 viable seeds m^{-2} y^{-1} found for seed production at the control site from seed fall collectors coincides almost exactly with the number of seeds produced in this area as calculated from seed cores (19.0 seed m^{-2} y^{-1}, Figure 1), corroborating the validity of both sampling methods.

Seed fall collectors are an appropriate method to estimate seed production by waterchestnut in control or nontreated areas, but were not successful in the treatment area. Cutting operations disturb the collectors and make it difficult to mark them for postseason retrieval.

Seed bank recruitment is the single most important factor to monitor in a waterchestnut management program. Although SCUBA collection techniques were used in this study, surface coring samplers could be employed. Information gathered from seed bank monitoring would provide the best predictive indicators of the success of waterchestnut management programs.

ACKNOWLEDGMENTS

This research was supported by a grant from the City of Watervliet to the Rensselaer Fresh Water Institute (RFWI). Kimberly Clash, Chris Hartleb, Leslie Taggett, Bob Bombard, Dr. Reginald Soracco, and Evan Weiher provided field assistance. Comments on this manuscript were provided by Dr. David Smith and Dr. Reginald Soracco. Contribution Number 570 of the Rensselaer Fresh Water Institute.

LITERATURE CITED

Burk, C. J., S. D. Lauermann and A. L. Mesrobian. 1976. The spread of several introduced or recently invading aquatics in western Massachusetts. Rhodora 78:767-772.

Countryman, W. C. 1977. Waterchestnut (*Trapa natans* L.) in Lake Champlain. pp. 3-10. In: Proc. Fourth Annual Lake Champlain Basin Environmental Conference, Aug. 9-10, 1977. J. C. Dawson, Ed. Miner Center, Chazy, NY.

Elser, H. J. 1966. Control of waterchestnut by machine in Maryland, 1964-1965. Proc. Northeastern Weed Control Conf. 23:682-687.

Smith, R. H. 1955. Experimental control of waterchestnut (*Trapa natans*) in New York State. N.Y. Fish Game J. 2:73-93.

Steenis, J. H. and V. D. Stotts. 1963. Recent tests on waterchestnut control. Proc. Northeastern Weed Control Conf. 20:476-479.

Wibbe, J. 1886. Notes from Schenectady. Bull. Torrey Bot. Club 13:39.

Winne, W. 1935. A Study of the Water Chestnut, *Trapa natans*, With a View to its Control in the Mohawk River. M.S. Thesis, Cornell University, Ithaca, NY. 122pp.