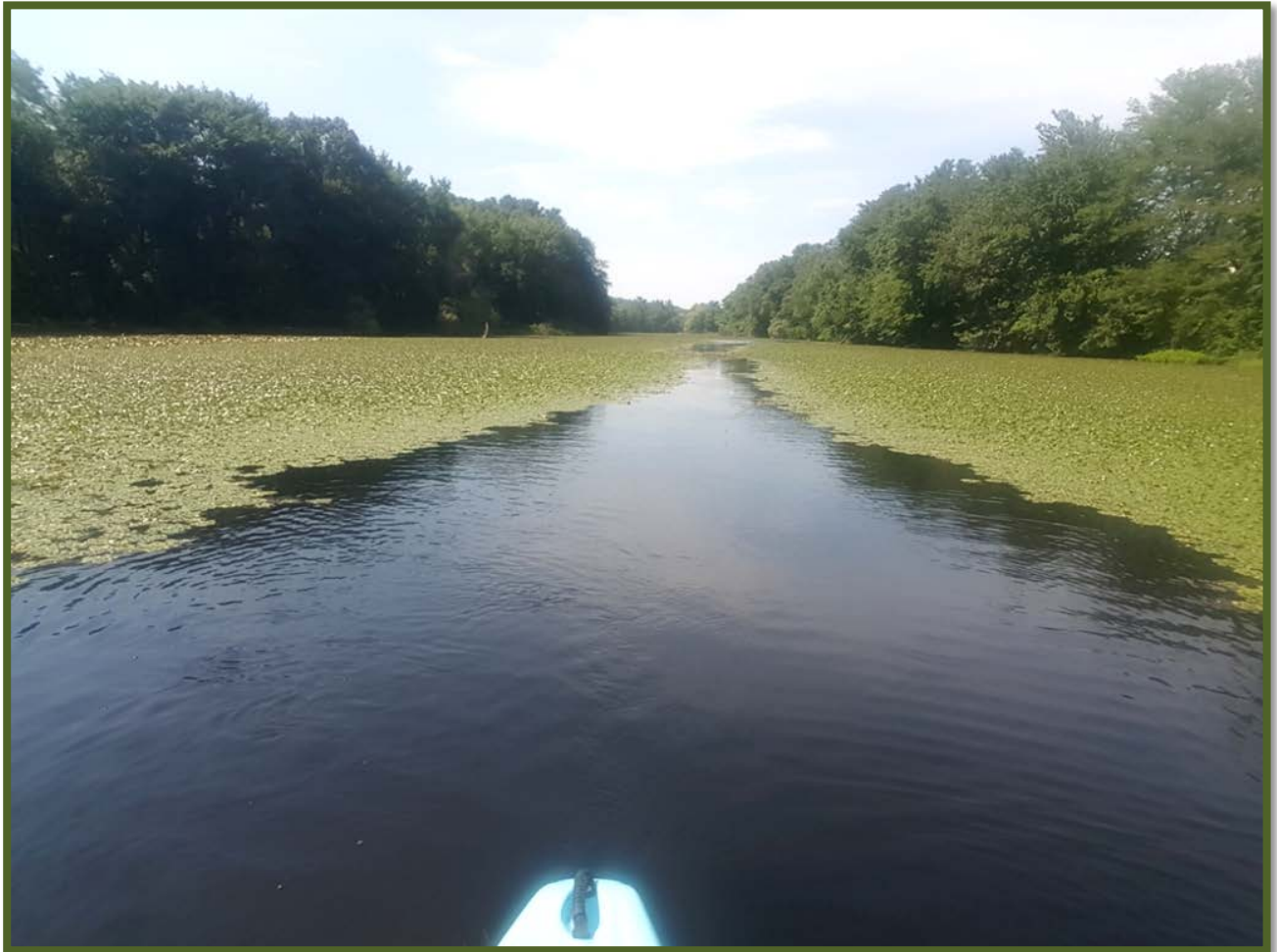


WATER CHESTNUT MANAGEMENT GUIDANCE & FIVE-YEAR MANAGEMENT PLAN FOR THE SUDBURY, ASSABET, AND CONCORD RIVER WATERSHED

FEBRUARY 2017



FOR THE ASSABET SUDBURY & CONCORD RIVERS

23 Bradford Street · Concord, MA 01742

978 · 369 · 3956

office@oars3rivers.org

www.oars3rivers.org

ACKNOWLEDGEMENTS

This Guidance document was produced by OARS through a project entitled “Planning and Guidance for Water Chestnut Management in the SuAsCo Watershed.” We would like to thank the members of the project’s Technical Advisory Committee who contributed their time and ideas to this document: Amber Carr (SuAsCo Cooperative Invasive Species Management Area), Jeff Castellani (Aquatic Control Technology/SOLitude, Inc.), Ron Chick (River Stewards Committee, Friends of Saxonville), Tom Flannery (Lakes and Ponds Program, Mass. Department of Conservation and Recreation), Michele Girard (Mass. Association of Conservation Commissions), Delia Kaye (Concord Natural Resources), Tom Largy (Wayland Surface Water Quality Committee), Lealdon Langley (Wetlands Program, Mass. Department of Environmental Protection), Frank Lyons (Hop Brook Protection Association), Eileen McGourty (Eastern Mass. National Wildlife Refuge Complex, U.S. Fish & Wildlife Service), Dave McKinnon (Lincoln Conservation Dept.), Judy Schmitz (Wetlands Circuit Rider, Central Region, Mass. Department of Environmental Protection), and Michael Stroman (Wetlands Program, Mass. Department of Environmental Protection). Special thanks also to Bettina Abe (Acton Natural Resources Department), Eugene Benson (Mass. Association of Conservation Commissions), and Kathy Sferra (Stow Conservation Commission).

The project was supported through the Natural Resource Damage Assessment and Restoration Programs of the U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, and Massachusetts Department of Environmental Protection, using funding via the Nyanza Trustee Council, to restore natural resources that were injured by the release of mercury and other contaminants from or at the Nyanza Chemical Waste Dump Site in Ashland, Massachusetts. We are grateful to the Nyanza NRD Trustees for their support.

This work was prepared by OARS staff Suzanne Flint, Alison Field-Juma, and Jessica Furbeck and any errors or omissions are OARS’ responsibility. The Guidance is intended as a living document and we will endeavor to keep it up-to-date with the help of its readers and users.

EXECUTIVE SUMMARY

Lakes, ponds and rivers across the Commonwealth of Massachusetts are being choked by invasive water chestnut (*Trapa natans*). The result is degraded ecology and habitat value, loss of recreational value, and the high cost of control efforts. It can be challenging to figure out how to effectively manage water chestnut due to a lack of life-cycle information, diverse approaches to permitting, cost, and evolving control methods. This Guidance provides the latest research and management experience compiled for Conservation Commissions, communities, researchers and other stakeholders to use in developing effective management approaches and plans. The document reviews the control options and permitting needs for each option and provides model language for permitting under the Wetlands Protection Act for use by both applicants and Commissions. It includes a 5-year Water Chestnut Management Plan for the Sudbury, Assabet and Concord watershed, and extensive references. It is intended to be a living a document.

REFERENCES

- Abe, B. (2016). Town of Acton Natural Resources Department, Acton, Mass. Pers. comm., Nov, 2106.
- AECOM (2009). Use of Aquatic Herbicide Imazamox Clearcast® in the State of New York Supplemental Environmental Impact Statement. Final AECOM, Inc. September 2009 Document No.: 00760-245-310. Retrieved from www.dec.ny.gov/docs/materials_minerals_pdf/imazamoxseis.pdf on October 25, 2016.
- Allen, J. and D. Strain (2013). Aquatic invasive species water chestnut in the Chesapeake Bay. Maryland Sea Grant Brief. Retrieved from www.mdsg.umd.edu/sites/default/files/files/Water%20chestnut_AIS%20brief_PI-2013-05.pdf
- Aquamarine (n.d.). Aquatic Weed Harvesters. Retrieved from www.aquamarine.ca/aquatic-weed-harvesters/
- Aquatic Control Technology (2005). Warner's Pond Management Plan Summary. Retrieved from www.concordma.gov/pages/ConcordMA_NaturalResources/WarnersPond2004ReportACT.pdf
- Aquatic Control Technology (2015a). 2015 Baseline Assessment Sudbury River Survey Findings and Management Recommendations. Prepared for Town of Framingham.
- Aquatic Control Technology (2015b). 2015 Summary Report Water Chestnut Harvesting, Heard Pond, Wayland, MA.
- Brinton, W. F. (2000). Compost Quality Standards & Guidelines: Final Report. Prepared for: New York State Association of Recyclers. Retrieved from compost.css.cornell.edu/Brinton.pdf
- Caraco, N. F., and J. J. Cole (2002). Contrasting Impacts of a Native and Alien Macrophyte on Dissolved Oxygen in a Large River. *Ecological Applications*, 12 (5), 1496–1509
- Charles River Watershed Association (n.d.). Retrieved from www.crwa.org/canoeing-for-clean-water
- Commonwealth of Massachusetts (2016). General Laws. Part I, Title XIX, Ch 128, Section 20A. Retrieved from <https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXIX/Chapter128/Section20A>
- Connecticut River Watershed Council (n.d.). Retrieved from www.criver.org/get-involved/stopping-an-invasive-species-water-chestnut/
- Coote, T.W., R.E. Schmidt and N. Caraco (2001). Use of a Periodically Anoxic *Trapa natans* (water-chestnut) Bed by Fishes in the Hudson River. Section IV: 20pp. In: J.R. Wladmand & W.C. Nieder (Eds.), Final Reports of the Tibor T. Polgar Fellowship Program, 2000. Hudson River Foundation, NY.
- Cornell Chronicle (2016). Herbicides can't stop invasive plants. Can bugs? August. Retrieved from news.cornell.edu/stories/2016/08/herbicides-cant-stop-invasive-plants-can-bugs

Countryman, W.D. (1978). Nuisance Aquatic Plants in Lake Champlain. Prepared by Aquatec, Inc. for the Eutrophication Task Force. Lake Champlain Basin Study. New England River Basins Commission, Burlington, Vermont.

Countryman, W.D. (1970). The History, Spread and Present Distribution of Some Immigrant Aquatic Weeds in New England. *Hyacinth Control J.* 8: 50–52. Retrieved from www.apms.org/japm/vol08b/v8p50.pdf

Crow, G.E. and C.B. Hellquist (2000). *Aquatic and Wetland Plants of Northeastern North America: Volume One Pteridophytes, Gymnosperms, and Angiosperms: Dicotyledons*. The University of Wisconsin Press. Pp. 206–207.

Crow, G.E., and C.B. Hellquist (1983). Aquatic Vascular Plants of New England: Part 6. *Trapaceae, Haloragaceae, Hippuridaceae*. *Station Bulletin 524*. New Hampshire Agricultural Experiment Station University of New Hampshire, Durham, NH. Retrieved from www.library.unh.edu/digital/object/agbulletin:0485

Davenport, G. E. (1879). *Trapa natans*. *Bulletin of the Torrey Botanical Club*, 6 (58): 352. Stable URL: www.jstor.org/stable/2476842

DeHollander, J. (2016). Oswego County Soil and Water Conservation District, Fulton, NY. Pers. comm.

DeHollander, J. (2015). 2014 Oswego County Water Chestnut Control Program. Report of Oswego County Soil and Water Conservation District, Fulton, NY. Retrieved from www.sleloinvasives.org/wp-content/uploads/2014/04/Oswego-County-Special-Project-Report-2014-PDF.pdf

Des Jardin, K. (2015). Water Chestnut: Field Observations, Competition, and Seed Germination and Viability in Lake Ontario Coastal Wetlands. *Environmental Science and Biology Theses*. Paper #98.

Ding, J., and B. Blossey (2005). Impact of the Native Water Lily Leaf Beetle, *Galerucella nymphaeae* (Coleoptera: *Chrysomelidae*), Attacking Introduced Water Chestnut, *Trapa natans*, in the Northeastern United States. *Environmental Entomology*, 34 (3): 683–689. DOI: 10.1603/0046-225X-34.3.683

Ding, J., B. Blossey, Y. Du, and F. Zheng (2006a). *Galerucella birmanica* (Coleoptera: *Chrysomelidae*), a promising potential biological control agent of water chestnut, *Trapa natans*. *Biological Control* 36(1):80–90.

Ding, J., B. Blossey, Y. Du, and F. Zheng (2006b). Impact of *Galerucella birmanica* (Coleoptera: *Chrysomelidae*) on growth and seed production of *Trapa natans*, *Biological Control*, 37 (3): 338–345. Retrieved from www.sciencedirect.com/science/article/pii/S1049964405003373

Eaton, R. J. (1947). *Lemna minor* as an Aggressive Weed in the Sudbury River. *Rhodora*, 49 (583): 165–171. New England Botanical Club, Inc. DOI: <http://www.jstor.org/stable/23303808>

ENSR (2005). Rapid Response Plan for Fanwort (*Cabomba caroliniana*) in Massachusetts. Retrieved from www.mass.gov/eea/docs/dcr/watersupply/lakepond/downloads/rrp/fanwort.pdf

ESS Group (2012). Warner's Pond Watershed Management Plan. Prepared for Town of Concord Division of Natural Resources. Concord, Mass.

Feldman, R. (2001). Taxonomic and Size Structures of Phytophilous Macroinvertebrate Communities in *Vallisneria* and *Trapa* Beds of the Hudson River, New York. *Hydrobiologia* 452 (1): 233–245. DOI: 10.1023/A:1011903315998 (Abstract only).

Gettys, L.A., W.T. Haller, and D.G. Petty, Eds. (2014). *Biology and Control of Aquatic Plants*. Aquatic Ecosystem Restoration Foundation, Marietta, Georgia. Retrieved from www.aquatics.org/bmp%203rd%20edition.pdf

Gleason, H. A., and A. Cronquist (1963). *Manual of Vascular Plants of Northeastern United States and Adjacent Canada*. Willard Grant Press. Boston, Mass. P. 496.

Groth, A. T., L. Lovett Doust, and J. Lovett-Doust (1996). Population Density and Module Demography in *Trapa natans* (*Trapaceae*), an Annual, Clonal Aquatic Macrophyte. *American Journal of Botany*, 83 (11): 1406–1415. Retrieved from www.jstor.org/stable/2446095

Haller, W.T. (2014). Appendix B: Aquatic Herbicide Application Methods. In: Gettys, L.A., W.T. Haller, and D. G. Petty (Eds.). 2014. *Biology and Control of Aquatic Plants*. Aquatic Ecosystem Restoration Foundation, Marietta, Georgia. Retrieved from www.aquatics.org/bmp%203rd%20edition.pdf

Hop Brook Protection Association (2004). 2004 Harvesting Report. Retrieved from www.hopbrook.org/id36.htm

Hummel, M. and E. Kiviat (2004). Review of World Literature on Water Chestnut with Implications for Management in North America. *J. Aquat. Plant Manage*, 42: 17–28. Retrieved from www.apms.org/japm/vol42/v42p17.pdf

Integrated Taxonomic Information System (2016). Online Database: *Trapa* L. Retrieved from www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=27169

Kadono, Y. and E.L. Schneider (1986). Floral biology of *Trapa natans* var. *japonica*. *Bot. Mag. Tokyo* 99: 435. DOI:10.1007/BF02488722

Karg, S. (2006). The Water Chestnut (*Trapa natans* L.) as a Food Resource During the 4th to 1st Millennia BC at Lake Federsee, Bad Buchau (Southern Germany). *Environmental Archaeology* 11(1): 125–130. DOI: 10.1179/174963106x97106.

Kato, Y., J. Nishihiro, and T. Yoshida (2016). Floating-Leaved Macrophyte (*Trapa japonica*) Drastically Changes Seasonal Dynamics of a Temperate Lake Ecosystem. *Ecol. Res.*, 31: 695. DOI:10.1007/s11284-016-1378-3 (Abstract only).

Kaye, D. (2016). Concord Natural Resources, Concord, Mass. Pers. comm., November.

- Kishbaugh, S.A. (2014). Chapter 15.6: Waterchestnut. In: Gettys, L.A., W.T. Haller, and D. G. Petty (Eds.). *Biology and Control of Aquatic Plants*. Aquatic Ecosystem Restoration Foundation, Marietta, Georgia. Retrieved from www.aquatics.org/bmp%203rd%20edition.pdf
- Kornijów, R., D. L. Strayer, and N. F. Caraco (2010). Macroinvertebrate Communities of Hypoxic Habitats Created by an Invasive Plant (*Trapa natans*) in the Freshwater Tidal Hudson River. *Fundam. Appl. Limnol., Arch. Hydrobiol.*, 176 (3): 199–207. Retrieved from www.caryinstitute.org/sites/default/files/public/reprints/Kornijow_2010_FAL.pdf
- Kundu, M. and R. Joshi (2012). Production technology of water chestnut (*Trapa natans* L.) Indian Agricultural Research Institute, Division of Fruits and Horticultural Technology, New Delhi. Retrieved from www.krishisewa.com/articles/production-technology/142-chestnut.html
- Kurihara, M., and I. Ikusima (1991). The Ecology of the Seed in *Trapa natans* Var. Japonica in a Eutrophic Lake. *Vegetatio*, 97 (2): 117–124. Retrieved from www.jstor.org/stable/20046091
- Langley, L., L. Rhodes, and M. Stroman (2004). Guidance for Aquatic Plant Management in Lakes and Ponds as it Relates to the Wetlands Protection Act. Department of Environmental Protection, Bureau of Resource Protection, Wetlands/Waterways Program. Retrieved from www.mass.gov/eea/docs/dep/water/laws/a-thru-h/alkguide.pdf
- Largy, T. (2016). Wayland Surface Water Quality Committee. Pers. comm., October.
- Les, D. H. and L. J. Mehrhoff (1999). Introduction of nonindigenous aquatic vascular plants in southern New England: a historical perspective. *Biological Invasions*, 1: 281–300.
- Mass. DCR (2007). Standard Operating Procedures: Using Hand Pulling and Benthic Barriers to Control Pioneer Populations of Non-Native Aquatic Species, A Guide for Volunteers. Mass. Department of Conservation and Recreation, Lakes and Ponds Program. Retrieved from www.mass.gov/eea/docs/dcr/watersupply/lakepond/downloads/sop2007.pdf
- Mass. DCR (2010). Aquatic Invasive Species Assessment and Management Plan. Mass. Department of Conservation and Recreation, Office of Watershed Management. Retrieved from www.mass.gov/eea/docs/dcr/watersupply/watershed/2010aismgplan.pdf
- Mass. DAR (2016a). Aquatic Vegetation Management. Mass. Department of Agriculture. Retrieved from www.mass.gov/eea/agencies/agr/pesticides/aquatic-vegetation-management.html
- Mass. DAR (2016b). Mass. Department of Agriculture, Pesticide Product Registration Information. Retrieved from www.kellysolutions.com/ma/showproductsbypest.asp?Pest_ID=PCGABBA01
- Mass. EOE (2004). Eutrophication and Aquatic Plant Management in Massachusetts Final Generic Environmental Impact Report. Massachusetts Executive Office of Environmental Affairs. Retrieved from www.mass.gov/eea/docs/dcr/watersupply/lakepond/downloads/main-geir.pdf

Mass. EOEAA (2016). Massachusetts Prohibited Plant List. Executive Office of Energy and Environmental Affairs. Retrieved from www.mass.gov/eea/agencies/agr/farm-products/plants/massachusetts-prohibited-plant-list.html

MACC (2015). Protecting Wetlands and Open Space: MACC's Environmental Handbook (First On-Line Edition). Massachusetts Association of Conservation Commissions, Belmont, Mass. Available through maccweb.org/ehandbook.html.

McGouty, E. (2016). Eastern Mass. National Wildlife Refuge Complex , US Fish & Wildlife Service, pers. comm., Nov. 2016.

Methe, B.A., R. J. Soracco, J. D. Madsen, and C.W. Boylen (1993). Seed Production and Growth of Waterchestnut as Influenced by Cutting. *J. Aquat. Plant Manage.*, 31: 154–157. Retrieved from www.apms.org/japm/vol31/v31p154.pdf

MIPAG (2011). Massachusetts Invasive Plant Species: Early Detection Priorities. Massachusetts Invasive Plants Advisory Group. Retrieved from www.massnrc.org/mipag/docs/EarlyDetectionMIPAG.pdf

Muenschler, W. C. (1944). *Aquatic Plants of the United States*. Comstock Publishing Company, Inc. Cornell University, Ithaca, New York. Pp. 274–276.

Mystic River Watershed Association (n.d.) mysticriver.org/water-chestnut

Nashoba Valley Voice (2016). August 30. Ayer, Mass. Retrieved from www.nashobavalleyvoice.com/pepperell_news/ci_30307299/whats-that-smell-pepperell

Nashua River Watershed Association (n.d.). Retrieved from www.nashuariverwatershed.org/what-we-do/protect-water-and-land/invasive-species-overview/plants-water-chestnut.html

Nemecek, R. and J. DeHollander (2014). Chemically Treating Water Chestnut (*Trapa natans*) in a River System. Presented at Eastern Lake Ontario Invasive Species Symposium, June 11, 2014.

Netherland, M. D. (2014). Chapter 11: Chemical Control of Aquatic Weeds. In: Gettys, L.A., W.T. Haller and D. G. Petty, Eds. *Biology and Control of Aquatic Plants. A Best Management Practices Handbook*. Third Edition. Aquatic Ecosystem Restoration Foundation, Marietta, Georgia. Retrieved from www.aquatics.org/bmp%203rd%20edition.pdf

OARS (2013). Report to CISMA: Mapping Water Chestnut in the Sudbury, Assabet, and Concord River System. October 31. OARS, Concord, Mass. Retrieved from cisma-suasco.org/sites/default/files/uploads/OARS-report-to-CISMA%20final.pdf

Pelczarski, K. (1990). Evaluation of a Pop Net for Sampling Fishes from Water-Chestnut Beds in the Tidal Hudson River. A Report of the 1990 Tibor T. Polgar Fellowship Program. Hudson River Foundation, NY.

- Pemberton, R.W. (1999). Natural Enemies of *Trapa* spp. in Northeast Asia and Europe. *Biological Control* 14: 168–180.
- Pemberton, R.W. (2002). Chapter 3: Water Chestnut. In: Van Driesche, R., B. Blossey, M. Hoddle, S. Lyon, & R. Reardon. *Biological Control of Invasive Plants in the Eastern United States*. USDA Forest Service Publication, FHTET-2002-04. Retrieved from www.invasive.org/weedcd/pdfs/biocontrol.pdf
- Poovey, A.G. and K.D. Getsinger (2007). Subsurface Applications of Triclopyr and 2,4-D Amine for Control of Water Chestnut (*Trapa natans* L.). *J. Aquat. Plant Manage.*, 45: 63–66. Retrieved from www.apms.org/japm/vol45/v45p63.pdf
- Rector, P.R., P. J. Nitzsche, and S.S. Mangiafico (2015). Temperature and Herbicide Impacts on Germination of Water Chestnut Seeds. *J. Aquat. Plant Manage.*, 53: 105–112.
- Robinson, M. (2002). Water Chestnut: An Exotic Invasive Aquatic Plant *Trapa natans*. Massachusetts Department of Conservation and Recreation, Lakes and Ponds Program. Retrieved from: www.mass.gov/eea/docs/dcr/watersupply/lakepond/factsheet/water-chestnut.pdf
- Schmidt, K. (1986). The Life History of the Chrysomelid Beetle *Pyrrhalta nymphaeae* (Galerucienae) on Water Chestnut, *Trapa natans* (Hydrocharitaceae), in Tivoli South Bay, Hudson River, NY. In J. C. Cooper (Ed.) Polgar Fellowship Reports of the Hudson River National Estuarine Sanctuary Program. Hudson River Foundation, NY.
- Schultz, R. and E. Dibble (2012). Effects of Invasive Macrophytes on Freshwater Fish and Macroinvertebrate Communities: the Role of Invasive Plant Trails. *Hydrobiologia*, 684: 1–14.
- SePRO Corporation (2015). Safety Data Sheet: Clearcast. Retrieved from www.sepro.com/documents/Clearcast_MSDS.pdf
- SOLitude Lake Management (2016). Case study: Water Chestnut Controlled with Clearcast & Renovate Max G; Fairfax, Virginia. Retrieved from www.solitudelakemanagement.com/lake-and-pond-management-success-stories-and-case-studies
- Strayer, D. L., C. Lutz, H. M. Malcom, K Munger, and W.H. Shaw (2003). Invertebrate Communities Associated with a Native (*Vallisneria americana*) and an Alien (*Trapa natans*) Macrophyte in a Large River. *Freshwater Biology*, 48 (1): 1938–1949. DOI: 10.1046/j.1365-2427.2003.01142.x/abstract (Abstract only).
- Sweta, K. Baudhb, R. Singha, and R. P. Singha (2015). The Suitability of *Trapa natans* for Phytoremediation of Inorganic Contaminants from the Aquatic Ecosystems. *Ecological Engineering*, 83: 39–42. Retrieved from DOI:10.1016/j.ecoleng.2015.06.003
- Takamura, N., Y. Kadono, M. Fukushima, M. Nakagawa, and B. O. Kim (2003). Effects of aquatic macrophytes on water quality and phytoplankton communities in shallow lakes. *Ecol Res.*, 18, 381. doi:10.1046/j.1440-1703.2003.00563.x (Abstract only).

Teixeira, M.C., M. P. Budd, and D. L. Strayer (2014). Responses of Epiphytic Aquatic Macroinvertebrates to Hypoxia. *Inland Waters* 5: 75–80. DOI: 10.5268/IW-5.1.764

The Nature Conservancy (2012). SLELO-PRISM Special Project. Oswego County 2012 Water Chestnut Control Program. Retrieved from www.sleloinvasives.org/wp-content/uploads/2012/09/Oswego-County-Special-Project-Water-Chestnut-Control-Report-PDF.pdf

US Army Corps of Engineers (2012). Aquatic Herbicides. Retrieved from glmris.anl.gov/documents/docs/anscontrol/AquaticHerbicides.pdf

USDA (2016a). Federal and State Noxious Weed List. US Department of Agriculture, Natural Resources Conservation Service. Retrieved from plants.usda.gov/java/noxComposite

USDA (2016b). The PLANTS Database. National Plant Data Team, Greensboro, NC. Retrieved from plants.usda.gov/core/profile?symbol=TRNA

Wagner, K. (2004). The Practical Guide to Lake Management in Massachusetts, A Companion to the Final Generic Environmental Impact Report on Eutrophication and Aquatic Plant Management in Massachusetts. Mass. Executive Office of Environmental Affairs. Retrieved from: www.mass.gov/eea/docs/dcr/watersupply/lakepond/downloads/practical-guide.pdf

Zheng, F., Y. Du, A. Wang, and J. Xu (2008). Effect of temperature on the demography of *Galerucella birmanica* (Coleopter: Chrysomelidae). *Insect Science* 15: 375–380. DOI: 10.1111/j.1744-7917.2008.0024.x (Abstract only)