

Oregon Department of Agriculture
Plant Pest Risk Assessment for
European Water Chestnut, *Trapa natans* L.
2002 (Revised 2010)

Name: European water chestnut, *Trapa natans* L. a.k.a bullnut, singhara ling, water-caltrop, Jesuit nut
Family: Water chestnut, *Trapaceae*

Findings of This Review and Assessment: European water chestnut, *Trapa natans*, was evaluated and determined to be a category “**A**” rated noxious weed, as defined by the Oregon Department of Agriculture (ODA) Noxious Weed Policy and Classification System. This determination was based on a literature review and analysis using two ODA evaluation forms. Using the Noxious Qualitative Weed Risk Assessment v.3.8, European water chestnut scored **58** indicating a Risk Category of **A**; and a score of **21** with the Noxious Weed Rating System v.3.2, indicating an “**A**” rating. The introduction and spread of European water chestnut in the states’ waterways would present major challenges to both humans and the environment. Prevention of introduction and early detection is critical to control this species.

Introduction: The name *Trapa* is derived from the Latin word for “thistle,” *calcitrapa*, is named in reference to a caltrop (or caltrap), the name for a four-spined iron ball that was used in ancient warfare (Wikipedia). There are two species of *Trapa*, *T. calcitrapa* and *T. bicornis*. In Europe, *calcitrapa* seeds are four-spined, while those in Asia (*bicornis*) are two spined and resemble the horns of a bull. In the northern latitudes, *Trapa* is an annual- growing aquatic plant, rooted to the bottom in shallow to 15’ deep water and forming a dense canopy on the surface of ponds, lakes and slow moving streams. The plant was introduced into several Northeastern States in the 1800’s where it has spread by natural and human factors and is considered a serious aquatic weed in many eastern states. (US Fish and Wildlife 2010) The dense growth completely covers many lakes and rivers blocking sunlight and altering water chemistry. It also obstructs recreation and fishing. The seeds are edible containing starch as a source of carbohydrates. In Asia, the edible seeds are eaten by many people in various ways including raw, boiled, roasted or fried. In Europe, *Trapa* was widely available in markets until the 1880s, since that time, the species has suffered serious declines and has become the target of preservation and reestablishment in many countries (wikipedia).

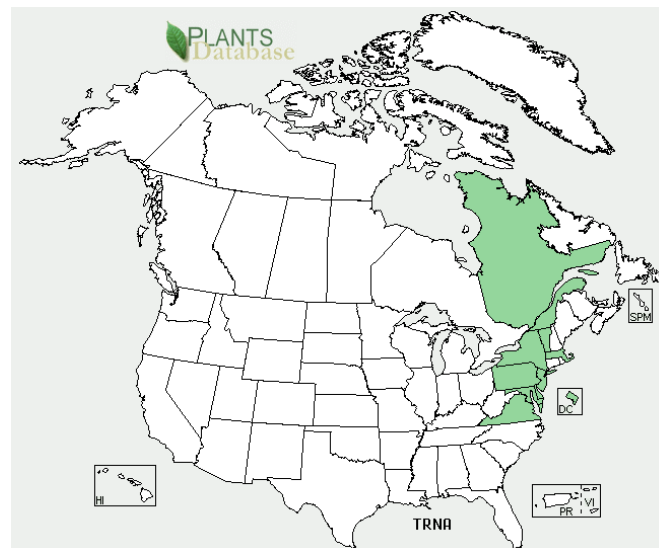


Images by Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Habitat: Lakes, ponds, slow moving streams, tidal influenced areas, mudflats.

World Distribution, History of Introduction and Spread: European water chestnut is native to Eurasia, being found in paleotropical and warm temperate regions. It has become naturalized and weedy in Australia and in northeastern North America. Because the fruits have been used as a source of food and for their medicinal and reputed magical properties, the plants became widely distributed throughout Europe. Plants were first introduced to North America around 1874 and were known to be cultured, in 1877, in the botanical garden of Asa Gray, an eminent botanist at Harvard University (Rhoads and Block 2002). By 1879, plants were already found in the local waters of the Charles River in Massachusetts.

Distribution in North American: The plants have become an aquatic nuisance species in North America because of their ability to reproduce rapidly and form extensive floating mats. Presently the species is found in northeastern North America in the states of Maryland, Massachusetts, New York, Pennsylvania and Vermont (USDA PLANTS database). In 1998, it was reported for the first time in Canada, in southwestern Quebec, along a 5 km stretch of the Rivière du Sud, just north of the US-Canada border. This would appear to be a natural expansion northward from the Lake Champlain watershed of New York and Vermont where it has been present for some time. The species is also known to occur at Sodus Bay, NY, on the south shore of Lake Ontario where annual control has been undertaken since the 1960s (Vermont 2010). Because the species is common throughout Asia and Europe, it has the potential to exist in both warm and cold climates in the United States. The Pacific Northwest with its moderate climate would serve as an excellent region for this plant to establish and achieve high densities. It thrives in 6-7 hardiness zones (See attachment A). There are no known populations that have escaped in the western United States.



US distribution of European water chestnut on USDA Plants Database

Biology: European water chestnut is an annual that grows most commonly as a rooted, floating aquatic herb. The plants are showy and distinct and were prized in aquatic gardens. *Trapa* can grow in any quiet stream, pond, lake, on the freshwater regions of estuaries and on exposed freshwater mud flats though it grows best in shallow, nutrient-rich lakes and rivers and is generally found in North American waters with a pH range of 6.7-8.2. Surface leaves are triangular-shaped with a hollow bulbous stem that helps float the rosette. Underwater leaves arising from a long stem are feather-like, much like a milfoil leaf.

Flowers are produced singly on stalks arising from the center of the floating rosette of leaves. Each flower is bisexual, and four-petaled. Four triangular sepals surround the flower and develop into barbed spines in the mature fruit. Flowering begins in the northeastern United States in July and fruits ripen in about a month. Plants flower until killed by frost (Rhoads and Block 2002). Each seed can give rise to 10-15 rosettes, and each rosette may produce as many as 20 seeds.

Reproduction and Spread: Seeds are the primary means of reproduction for this species. Seeds can remain viable for up to about 12 years (wikibugwood). The fruits may be dispersed when individual plants are uprooted and float downstream during control operations so barriers must be erected to capture seeds and plant fragments. One acre of plants can provide enough seed production to cover 100 acres the following year (Rhoads and Block 2002). Stem fragments can be introduced into new water bodies on recreational craft and waterfowl can move seeds through their feeding behavior.

Environmental Impacts: European water chestnut has become a significant nuisance aquatic weed in the northeastern United States, especially in the Hudson and Potomac Rivers, Lake Champlain and in the Connecticut River Valley. Due to its dense, clonal, mat-forming growths the species impedes navigation; its low food value for wildlife potentially can have a substantial impact on the use of the area by native species. The dense surface mats, like those produced by European frog-bit (*Hydrocharis morsus-ranae*) in southeastern Ontario, likely also reduce aquatic plant growth of other species beneath the shade of the floating canopy. Light extinction under *Trapa* canopies can reach 100% (Hummel and Finley 2006). The abundant detritus in the fall of each year and its decomposition could contribute towards lower oxygen levels in shallow waters and impact other aquatic organisms. The sharp spiny fruits can also be hazardous to bathers. Research on fish populations within large *Trapa* beds is extensive and documents steep declines in fish populations (Hummel and Finley 2006). Impacts on dissolved oxygen, nitrogen have been researched and found to be altered in the largest beds (Hummel and Finley 2006). Macro invertebrate fauna has also be researched in the Hudson River under large mats of *Trapa* and found not to be effected (Kornijow 2010).



European water chestnut infestation, photo by Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Economic Impacts: *Trapa nutans* impact can be great on water recreational sports such as swimming, fishing, and boating. Impacted lakes such as Lake Champlain in Vermont experience large control costs. In 2009, \$412,000 was expended in Lake Champlain and other Vermont lakes to keep boating channels open and to maintain recreational facilities (Vermont 2010). Coupled with the loss of tourism dollars and losses in fishing resources, the dollar cost to Vermont is much higher.

Control Measures: Early detection is key to controlling this species. Plant morphology is unique and unlike any native aquatic plant which could aid in rapid identification. Active surveys of waterbodies in the state can significantly reduce the time between introduction and identification. Humans will be the only dispersal factor for this plant primarily due to illegal horticultural importation from Asia or from the northeastern United States. Wildlife cannot be counted on to introduce this species. Control has primarily consisted of manual or mechanical harvesting of the floating mats by means of weed harvesters used to unblock waterways. Repetitive harvesting over a number of years is effective in eradicating this aquatic weed in enclosed bodies of water. However, such mechanical harvesting likely will only serve to control or eliminate major infestations that hamper navigation in waterways on an interim basis and will not provide a long term solution to control in heavily infested areas of large lakes or streams (Rhoads and Block 2002). The use of aquatic herbicides has been effective in controlling *Trapa* where allowed.

Biocontrol: Attempts have been made to find suitable biocontrol insects through searches conducted in 1992 and 1993 in China, Japan, South Korea and the Russian Far East but no appropriate candidates were found. A similar attempt was made in 1995 in Europe, including France, Germany, Italy, and Poland without success. Potential natural enemies have been reported from warmer climates such as in India. Such species may not be suitable for the cooler regions of the northeastern United States but may become suitable subjects for study as biocontrol agents if European water chestnut extends its range further southward into warmer areas of the United States. Efforts now are focused on finding a suitable host-specific *Galerucella* beetle as well as a seed weevil, leafhoppers and a *pyralid* moth (Bugwood wiki 2010).

Noxious Weed Qualitative Risk Assessment Oregon Department of Agriculture

Common name: European water chestnut, a.k.a bullnut, singhara ling, water-caltrop, Jesuit nut

Scientific Name: *Trapa natans* L.

Family: Water chestnut, *Trapaceae*

For use with plant species that occur or may occur in Oregon to determine their potential to become serious noxious weeds. For each of the following categories, select the number that best applies. Numerical values are weighted to increase priority categories over less important ones. Choose the best number that applies, intermediate scores can be used.

Total Score: 58

Risk Category: A

GEOGRAPHICAL INFORMATION

1) 6 Invasive in Other Areas

- 0 Low- not know to be invasive elsewhere.
- 2 Known to be invasive in climates dissimilar to Oregon's current climates.
- 6 Known to be invasive in geographically similar areas.

Comments: North American populations as well as Australian populations have been documented to be weedy.

2) 6 Habitat Availability: Are there susceptible habitats for this species and how common or widespread are they in Oregon?

- 1 *Low* – Habitat is very limited, usually restricted to a small watershed or part of a watershed (e.g., tree fern in southern Curry County).
- 3 *Medium* – Habitat encompasses 1/4 or less of Oregon (e.g., oak woodlands, coastal dunes, eastern Oregon wetlands, Columbia Gorge).
- 6 *High* – Habitat covers large regions or multiple counties, or is limited to a few locations of high economic or ecological value (e.g., threatened and endangered species habitat).

Comments: Oregon has many acres of lakes and streams that are at risk.

3) 1 Proximity to Oregon: What is the current distribution of the species?

- 0 *Present* – Occurs within Oregon.
- 1 *Distant* – Occurs only in distant US regions or foreign countries.
- 3 *Regional* – Occurs in Western regions of US but not adjacent to Oregon border.
- 6 *Adjacent* – Weedy populations occur adjacent (<50 miles) to Oregon border.

Comments: No report of weedy in western states populations.

4) 0 Current Distribution: What is the current distribution of escaped populations in Oregon?

- 0 *Not present* – Not known to occur in Oregon.
- 1 *Widespread* – Throughout much of Oregon (e.g., cheatgrass).
- 5 *Regional* – Abundant (i.e., occurs in eastern, western, central, coastal, areas of Oregon) (e.g., gorse, tansy ragwort).

10 *Limited* – Limited to one or a few infestations in state (e.g., kudzu).

Comments: Not known to occur.

BIOLOGICAL INFORMATION

- 5) 4 **Environmental Factors:** Do abiotic (non-living) factors in the environment effect establishment and spread of the species? (e.g., precipitation, drought, temperature, nutrient availability, soil type, slope, aspect, soil moisture, standing or moving water).
- 1 *Low* – Severely confined by abiotic factors.
 - 2 *Medium* – Moderately confined by environmental factors
 - 4 *High* – Highly adapted to a variety of environmental conditions (e.g., tansy ragwort, Scotch broom).

Comments: Occurs in both tropical and temperate zones.

- 6) 6 **Reproductive Traits:** How does this species reproduce? Traits that may allow rapid population increase both on and off site.
- 0 *Negligible* – Not self-fertile, or is dioecious and opposite sex not present.
 - 1 *Low* – Reproduction is only by seed, produces few seeds, or seed viability and longevity are low.
 - 3 *Medium* – Reproduction is vegetative (e.g., by root fragments, rhizomes, bulbs, stolons).
 - 3 *Medium* – Produces many seeds, and/or seeds of short longevity (< 5 years).
 - 5 *High* – Produces many seeds and/or seeds of moderate longevity (5-10 years) (e.g., tansy ragwort).
 - 6 *Very high* – Has two or more reproductive traits (e.g., seeds are long-lived >10 years and spreads by rhizomes).

Comments: Spreads by both seeds and plant fragments.

- 7) 4 **Biological Factors:** Do biotic (living) factors restrict or aid establishment and spread of the species? (What is the interaction of plant competition, natural enemies, native herbivores, pollinators, and pathogens with species?)
- 0 *Negligible* – Host plant not present for parasitic species.
 - 1 *Low* – Biotic factors highly suppress reproduction or heavily damage plant for an extended period (e.g., biocontrol agent on tansy ragwort).
 - 2 *Medium* – Biotic factors partially restrict or moderately impact growth and reproduction, impacts sporadic or short-lived.
 - 4 *High* – Few biotic interactions restrict growth and reproduction. Species expresses full growth and reproductive potential.

Comments: Plant expresses full reproductive growth in North America.

- 8) 3 **Reproductive Potential and Spread After Establishment - Non-human Factors:** How well can the species spread by natural means?
- 0 *Negligible* – No potential for natural spread in Oregon (e.g., ornamental plants outside of climate zone).
 - 1 *Low* – Low potential for local spread within a year, has moderate reproductive potential or some mobility of propagules (e.g., propagules transported locally by animals, water movement in lakes or ponds, not wind blown).
 - 3 *Medium* – Moderate potential for natural spread with either high reproductive potential or highly mobile propagules (e.g., propagules spread by moving water, or dispersed over longer distances by animals) (e.g., perennial pepperweed).

- 5 *High* – Potential for rapid natural spread throughout the susceptible range, high reproductive capacity and highly mobile propagules. Seeds are wind dispersed over large areas (e.g., rush skeletonweed).

Comments: Water, animals, and humans can spread the plant.

- 9) 3 **Potential of Species to be Spread by Humans.** What human activities contribute to spread of species? Examples include: interstate or international commerce; contaminated commodities; packing materials or products; vehicles, boats, or equipment movement; logging or farming; road maintenance; intentional introductions of ornamental and horticultural species, or biofuel production.

- 1 *Low* – Potential for introduction or movement minimal (e.g., species not traded or sold, or species not found in agricultural commodities, gravel or other commercial products).
- 3 *Medium* – Potential for introduction or off-site movement moderate (e.g., not widely propagated, not highly popular, with limited market potential; may be a localized contaminant of gravel, landscape products, or other commercial products) (e.g., lesser celandine, Canada thistle).
- 5 *High* – Potential to be introduced or moved within state high (e.g., species widely propagated and sold; propagules common contaminant of agricultural commodities or commercial products; high potential for movement by contaminated vehicles and equipment, or by recreational activities) (e.g., butterfly bush, spotted knapweed, Eurasian watermilfoil).

Comments: Quarantines exist to prevent interstate sale of this species. Some movement possible among homeowners and gardeners.

IMPACT INFORMATION

- 10) 7 **Economic Impact:** What impact does/can the species have on Oregon’s agriculture and economy?

- 0 *Negligible* – Causes few, if any, economic impacts.
- 1 *Low* - Potential to, or causes low economic impact to agriculture; may impact urban areas (e.g., puncture vine, pokeweed).
- 5 *Medium* – Potential to, or causes moderate impacts to urban areas, right-of-way maintenance, property values, recreational activities, reduces rangeland productivity (e.g., English ivy, Himalayan blackberry, cheatgrass).
- 10 *High* – Potential to, or causes high impacts in agricultural, livestock, fisheries, or timber production by reducing yield, commodity value, or increasing production costs (e.g., gorse, rush skeleton weed, leafy spurge).

Comments: Causes impacts to water recreation, tourism, and fishing.

- 11) 6 **Environmental Impact:** What risks or harm to the environment does this species pose? Plant may cause negative impacts on ecosystem function, structure, and biodiversity of plant or fish and wildlife habitat; may put desired species at risk.

- 0 *Negligible* – None of the above impacts probable.
- 1 *Low* – Can or does cause few or minor environmental impacts, or impacts occur in degraded or highly disturbed habitats.
- 4 *Medium* – Species can or does cause moderate impacts in less critical habitats (e.g., urban areas, sagebrush/ juniper stands).

- 6 *High* – Species can or does cause significant impacts in several of the above categories. Plant causes severe impacts to limited or priority habitats (e.g., aquatic, riparian zones, salt marsh; or T&E species sites).

Comments: Causes significant impacts to aquatic habitats.

- 12) 1 Impact on Health:** What is the impact of this species on human, animal, and livestock health? (e.g., poisonous if ingested, contact dermatitis, acute and chronic toxicity to livestock, toxic sap, injurious spines or prickles, causes allergy symptoms.
- 0 *Negligible* – Has no impact on human or animal health.
 - 2 *Low* – May cause minor health problems of short duration, minor allergy symptoms (e.g., leafy spurge).
 - 4 *Medium* – May cause severe allergy problems, death or severe health problems through chronic toxicity, spines or toxic sap may cause significant injury. (e.g., giant hogweed, tansy ragwort).
 - 6 *High* – Causes death from ingestion of small amounts, acute toxicity (e.g. poison hemlock).

Comments: In Asia, the plant serves as an alternate host for larval flukes that cause the disease fasciolopsiasis.

CONTROL INFORMATION

- 13) 5 Probability of Detection at Point of Introduction:** How likely is detection of species after introduction and naturalization in Oregon?
- 1 *Low* – Grows where probability of early detection is high, showy and easily recognized by public; access to habitat not restricted (e.g., giant hogweed).
 - 5 *Medium* – Easily identified by weed professionals, ranchers, botanists; some survey and detection infrastructure in place. General public may not recognize or report species (e.g., leafy spurge).
 - 10 *High* – Probability of initial detection by weed professionals low. Plant shape and form obscure, not showy for much of growing season, introduction probable at remote locations with limited access (e.g., weedy grasses, hawkweeds, skeletonweed).

Comments: Plant easy to recognize by botanists and other professionals.

- 14) 6 Control Efficacy:** What level of control of this species can be expected with proper timing, herbicides, equipment, and biological control agents?
- 1 *Negligible* – Easily controlled by common non-chemical control measures (e.g., mowing, tillage, pulling, and cutting; biocontrol is very effective at reducing seed production and plant density) (e.g., tansy ragwort).
 - 2 *Low* – Somewhat difficult to control, generally requires herbicide treatment (e.g., mechanical control measures effective at preventing flowering and but not reducing plant density; herbicide applications provide a high rate of control in a single application; biocontrol provides partial control).
 - 4 *Medium* – Treatment options marginally effective or costly. Tillage and mowing increase plant density (e.g., causes tillering, rapid regrowth, spread from root fragments). Chemical control is marginally effective. Crop damage occurs or significant non-target impacts result from maximum control rates. Biocontrol agents ineffective.
 - 6 *High* – No effective treatments known or control costs very expensive. Species may occur in large water bodies or river systems where containment and complete control are not achievable. Political or legal issues may prevent effective control.

Comments: Treatment options costly and can involve herbicide applications to water.

Category Scores:

13 Geographic score (Add scores 1-4)

20 Biological Score (Add lines 5-9)

14 Impact Score (Add lines 10-12)

11 Control Score (Add Lines 13-14)

58 Total Score (Add scores 1-14 and list on front of form)

Risk Category: 55-89+ = **A** 24-54 = **B** < 24 = unlisted.

This Risk Assessment was modified by ODA from the USDA-APHIS Risk Assessment for the introduction of new plant species.

1/15/2013 v.3.8

Oregon Department of Agriculture
Noxious Weed Rating System

Common name: European water chestnut
Scientific name: *Trapa natans*

Point Total: 21

Rating: A

- 1) **2 Detrimental Effects:** Circle all that apply, enter number of circles.
1. *Health:* causes poisoning or injury to humans or animals
 2. *Competition:* strongly competitive with crops, forage, or native flora
 3. *Host:* host of pathogens and/or pests of crops or forage
 4. *Contamination:* causes economic loss as a contaminate in seeds and/or feeds
 5. *Interference:* interferes with recreation, transportation, harvest, land value, or wildlife and livestock movement
- 2) **4 Reproduction & Capacity for Spread:** Circle the number that best describes, enter that number.
1. Few seeds, not wind blown, spreads slowly
 2. Many seeds, slow spread
 3. Many seeds, spreads quickly by vehicles or animals
 4. Windblown seed, or spreading rhizomes, or water borne
 5. Many wind-blown seeds, high seed longevity, spreading rhizomes, perennials
- 3) **3 Difficulty to Control:** Circle the number that best describes, enter that number.
1. Easily controlled with tillage or by competitive plants
 2. Requires moderate control, tillage, competition or herbicides
 3. Herbicides generally required, or intensive management practices
 4. Intensive management generally gives marginal control
 5. No management works well, spreading out of control
- 4) **6 Distribution:** Circle the number that best describes, enter that number.
1. Widely distributed throughout the state in susceptible habitat
 2. Regionally abundant, 5 or more counties, more than 1/2 of a county
 3. Abundant throughout 1- 4 counties, or 1/4 of a county, or several watersheds
 4. Contained in only 1 watershed, or less than 5 square miles gross infestation
 5. Isolated infestation less than 640 acres, more than 10 acres
 6. Occurs in less than 10 acres, or not present, but imminent from adjacent state
- 5) **6 Ecological Impact:** Circle the number that best describes, enter that number.
1. Occurs in most disturbed habitats with little competition
 2. Occurs in disturbed habitats with competition
 3. Invades undisturbed habitats and crowds out native species
 4. Invades restricted habitats (i.e. riparian) and crowds out native species

21 TOTAL POINTS

Note: Noxious weeds are non-native plants with scores of 11 points or higher. Any plants in 4.1, 4.2, and 4.3 should not be classified as “A” rated weeds. Ratings: 16 + = A, 15 – 11 = B
ODA Weed Rating System 1/15/2013 v.3.8

RA produced by Glenn Miller, ODA, 2010

References:

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Attachment A

