Carolina Fanwort (*Cabomba caroliniana*)

A Technical Review of Distribution, Ecology, Impacts, and Management

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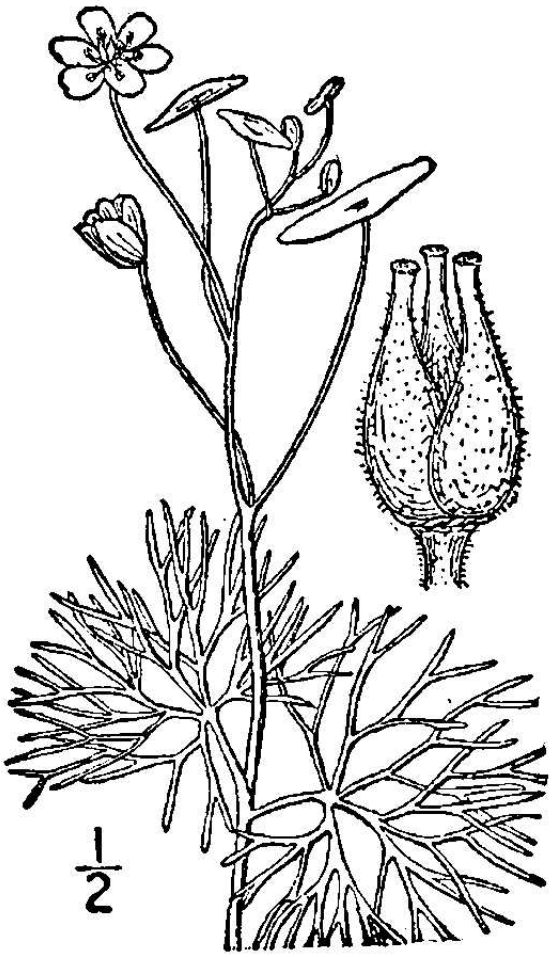

Cabomba caroliniana

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Carolina Fanwort (*Cabomba caroliniana*): A Technical Review of Distribution, Ecology, Impacts, and Management

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This literature review was commissioned by the nonprofit Centre for Agricultural Bioscience International (CAB International; http://www.cabi.org/index.asp) as part of a larger invasive species compendium. We completed eight literature reviews for the project, and due to the large number of requests for this information, we have decided to make the reviews available as DNR miscellaneous publications. Species reviewed include:

- Carolina fanwort (*Cabomba caroliniana*) – [PUB-SS-1047 2009]
- European frog-bit (*Hydrocharis morsus-ranae*) – [PUB-SS-1048 2009]
- Indian swampweed (*Hygrophila polysperma*) – [PUB-SS-1049 2009]
- African elodea (*Lagarosiphon major*) – [PUB-SS-1050 2009]
- Yellow floating heart (*Nymphoides peltata*) – [PUB-SS-1051 2009]
- Curly leaf pondweed (*Potamogeton crispus*) – [PUB-SS-1052 2009]
- Water spangles (*Salvinia minima*) – [PUB-SS-1053 2009]
- Water chestnut (*Trapa natans*) – [PUB-SS-1054 2009]

In completing the literature reviews, we preferentially consulted the peer-reviewed primary literature and supplemented the reviews with secondary sources where necessary. The outline for the reviews is identical for each species and was provided as part of the CAB International commissioning. This effort compliments work conducted during the development of the WDNR's proposed invasive species identification, classification and control rule; a more exhaustive list of species and accompanying literature review summaries can be found on the DNR website at: http://dnr.wi.gov/invasives/

Identity

Taxonomy and Nomenclature

Cabomba caroliniana A. Gray, common name fanwort, is a member of the water-shield family, Cabombaceae, a bi-generic family containing both *Cabomba* and *Brasenia*. The genus *Cabomba* Aublet was first described in 1775 and is characterized by submerged rhizomatous stems, floating peltate leaves, petiolate dissected leaves, and emergent hypogynous flowers (Mackey, 1996). The genus name *Cabomba* is thought to be an Aboriginal word for "aquatic plant" (Ørgaard, 1991). Five species within the genus are currently recognized: *C. aquatica, C. caroliniana, C. furcata, C. haynesii,* and *C. palaeformis* (Ørgaard, 1991; USDA-ARS, 2008; eFloras, 2009). With regards to the species *C. caroliniana,* there are three recognized varieties, distinguished primarily on the basis of flower color (Ørgaard, 1991; Wilson et al., 2007). *C. caroliniana* var. *caroliniana* is the most widespread variety, and the flowers are creamy white (Wilson et al., 2007). *C. caroliniana* var. *pulcherrima* has purplish flowers, and its range is restricted to parts of the southeastern United States. Some sources treat *C. caroliniana* var. *pulcherrima* as synonymous to *C. caroliniana* var. *caroliniana*, attributing the purple-colored flower to environmental, as opposed to genetic factors (USDA-ARS, 2008; eFloras, 2009). South American plants having pale yellow flowers are treated as variety *C.*

caroliniana var. *flavida* Ørgaard. Many synonyms exist for *C. caroliniana* var. *caroliniana,* including *C. australis* and *C. pulcherrima* (USDA-ARS, 2008). There are also many unique cultivars of *C. caroliniana* traded by aquarists (Wilson et al., 2007).

Summary of Invasiveness

C. caroliniana is a highly adaptable submersed aquatic macrophyte whose attractive flowers and finely dissected leaves have lead to widespread use and trade in the aquatic industry. It also has a high natural dispersal potential (Hogsden et al., 2007) due to its ability to readily fragment and spread both actively and passively. Fanwort can reach nuisance levels even in portions of its native range. *C. caroliniana* has been shown to clog a variety of waterbodies and drainage canals that are important for ecological, recreational, and/or economic reasons (ISSG, 2006). The plant is typically associated with habitats that have lower species diversity (Lyon and Eastman, 2006; Zhang et al., 2003).

Distribution, Introduction and Spread

Distribution

C. caroliniana is native to subtropical temperate areas of eastern North and South America (Ørgaard, 1991). *C. caroliniana* has three recognized varieties with different distributions. *C. caroliniana var. caroliniana* is fairly common from Texas to Florida, northward to Massachusetts, and westward to Kansas (Zhang et al., 2003). The purple-flowered variety *C. caroliniana* var. *pulcherrima* occurs in the southeastern U.S., restricted to North and South Carolina, Georgia, and Florida (Wilson et al., 2007). The yellow-flowered *C. caroliniana* var. *flavida* occurs in parts of South America, including southern Brazil, Paraguay, Uruguay, and northeastern Argentina (Ørgaard, 1991). Widespread trade in the aquarium industry has lead to introduction of *C. caroliniana* in areas outside of its native range. *C. caroliniana* is widely reported as problematic in Australia, Japan, China, and parts of the U.S. (Wilson et al., 2007; Hogsden et al., 2007). *C. caroliniana* is preferentially associated with low-energy, nutrient-rich systems and is commonly found in water of depths ranging 0.4 to 1.2 meters (Yu et al., 2004).

History of Introduction and Spread

Though native to the southeastern United States, the pre-settlement distribution of *C. caroliniana* along the eastern coast did not extend north of Virginia (Les & Mehrhoff, 1999). In 1920, *C. caroliniana* was first observed beyond its native range in Massachusetts, and from there, spread throughout much of New England. By 1991, *C. caroliniana* had spread northward to Ontario, Canada. In the northwestern United States, *C. caroliniana* has established localized populations in both Washington and Oregon, though the timing and pathway of introduction is unknown (Washington State Department of Ecology, 2009). In Australia, the earliest record is from 1967, though it was not recognized as naturalized until 1986 (Mackey, 1996). In China, it was introduced in the 1980s (Yu et al., 2004). It has been reported as introduced to India under the name *Cabomba aquatica*, although the plants are clearly referable to *C. caroliniana* (Wilson et al., 2007). In Europe, *C. caroliniana* has recently been reported from the Netherlands, Belgium, Hungary, and parts of England (Wilson et al., 2007).

C. caroliniana is very commonly used as an aquarium plant due to its attractive flowers and finely-dissected leaves, likely contributing to its introduction and spread. Those involved in the trade of *C. caroliniana* as part of the water garden industry grow plants in Florida, Australia, and Asia for distribution and sale to Europe and other parts of the United States (ISSG, 2006). Humans are the main vectors of dispersal, likely introducing the plant by either intentional

water garden plantings or through inappropriate aquaria disposals. Additionally, since the plant reproduces via fragmentation, boating activity facilitates the spread of the plant; fragments are frequently observed in lakes with heavy motorboat activity (Les & Mehrhoff, 1999).

Risk of Introduction

C. caroliniana spreads largely through activities related to the aquarium trade. The species is widely available from aquarium plant distributors and has long been recommended for use in aquarium gardening. The repeated introductions observed in southern New England, as evident from herbarium collections, indicates that accidental or intentional release from cultivation likely explains the introduction of this species in its adventive range (Les & Mehrhoff, 1999). The plant spreads most often through vegetative means, primarily through stem fragments and rhizomes (Washington State Department of Ecology, 2009). The spread of the plant increases with boating activity; it has long trailing stems that become wrapped around boat propellers and consequently is transported within and among water bodies (Les & Mehrhoff, 1999).

Biology and Ecology

Description

C. caroliniana is an herbaceous, submersed, rooted aquatic species (ISSG, 2006) that often grows in water from 0.4-1.2 m, though can grow in water up to 10 m deep (Yu et al., 2004; Australian Department of the Environment and Heritage, 2003). The plant is fully submersed and occasionally produces floating leaves and emergent flowers. Submersed finely dissected leaves are oppositely arranged on petioles up to 4 cm long. The leaves are 1-3.5 x 1.5-5.5 cm and are divided into 3-200 terminal segments. These leaves often secrete a sticky mucous that covers the submersed portion of the plant (Australian Department of the Environment and Heritage, 2003). Floating leaves are blades 0.6-3 cm x 1-4 mm with margins either notched or entire at base. Flowers are 6-15 mm in diameter and are white, yellow, or pink to purple-violet, depending on the variety. Petals are obtuse or notched, with 3-6 stamens, 2-4 pistils and 3 ovules. Fruits are 4-7 mm, and the 1-3 seeds are 1.5-3 x 1-1.5 mm with tubercles in 4 rows (eFloras, 2009). The plant is rooted, but can survive in a free-floating state for six to eight weeks (Australian Department of the Environment and Heritage, 2003). *C. caroliniana* produces fragile rhizomes, and the erect shoots, which are merely upturned extensions of horizontal rhizomes, are green to olive green, though sometimes reddish brown (Washington State Department of Ecology, 2009).

Similarities to Other Species

Due to the petiolate finely dissected leaves, *C. caroliniana* can be readily confused with *Ranunculus aquatilis.* Such misidentification has been reported in the literature (Les & Mehrhoff, 1999). It is also easily confused with a number of other species by those who are not practiced in the identification of aquatic plants. The leaf morphology looks similar to that of *Ceratophyllum* spp*., Myriophyllum* spp. and *Megalodonta beckii.* However, *C. caroliniana* is differentiated from these species by its distinctly petiolate leaves, which are arranged oppositely along the stem, rather than alternately or whorled. Differentiation of the five *Cabomba* species is a bit more difficult, and must take into account seed size, shape and surface structure (Mackey, 1996).

Habitat

C. caroliniana has broad environmental requirements. It often is rooted in the mud in low-energy streams and rivers as well as in ponds, sloughs, lakes, ditches, canals, and reservoirs

(Washington State Department of Ecology, 2009). *C. caroliniana* is highly tolerant of anaerobic conditions, and can survive in high alkalinity and acidic water (USDA-NRCS, 2009). USDA-NRCS (2009) reports that it can survive in water with pH from 5.7-9.2, though several sources report an optimum pH for growth at 4-6, and that at pH above 8, the stem becomes defoliated and growth is inhibited (Tarver and Sanders, 1977; Mackey, 1996; Wilson et al., 2007). Vegetative growth and adventitious root production is highest at medium turbidities, but the plant can also thrive in high turbidity water (Mackey, 1996). The plant prefers warm, humid, sub-tropical climates with temperatures from 13-27 °C (Australian Department of the Environment and Heritage, 2003), although it can tolerate below freezing temperatures in cold temperate regions (Mackey, 1996; Schooler et al., 2006). In China, the plant is particularly aggressive and problematic in nutrient-rich waters.

Genetics

The family Cabombaceae is one of the basal-most lineages of angiosperms (Aoki et al., 2004). Randomly amplified polymorphic DNA studies show the genetic variation within the genus to be low (Xiaofeng et al., 2005). In 1991, the genus *Cabomba* was revised by Ørgaard (1991), who recognized five species: *C. aquatica, C. palaeformis, C. furcata, C. haynesii* and *C. caroliniana;* and three varieties: *C. caroliniana* var. *caroliniana*, var. *pulcherrima,* and var. *flavida*. Ørgaard also suggests a basic chromosome number of x = 13.

Reproductive Biology

C. caroliniana is a perennial species that produces solitary hypogenous flowers with three sepals, three petals, and six stamens. The flowers are 1-2 cm across and are white, yellow, or pink to purple-violet, depending on the variety. The flowers are pollinated by small, nectar-seeking flies and bees (Tarver and Sanders, 1977; Schneider et al., 2003). The flowers are bisexual and can self-pollinate (Ørgaard, 1991; Washington State Department of Ecology, 2009), though this may be a rare event (Hanlon, 1990). Vegetative reproduction is likely the most important means of spread. The plant produces rhizomes which can easily break into fragments. Fragments can be transported both actively and passively to new areas, and can regenerate into a full plant as long as they have at least one pair of leaves (Peconic Estuary Program, 2006).

Physiology and Phenology

C. caroliniana flowers during the summer months of May to September in the southeastern U.S., though field germination rates are low (Washington State Department of Ecology, 2009). In the northern parts of its range, the plant doesn't produce seeds, but multiplies clonally and spreads quickly by stem fragmentation. At the end of the growing season, the stems become defoliated, brittle and hard (Mackey, 1996). These turion-like stems can break free and remain green at the sediment surface, helping the plant overwinter under adverse conditions (Wilson et al., 2007). Defoliated stem fragments can remain buried in mud under ice, and will regrow starting in April (Mackey, 1996).

In northern Queensland, Australia, *C. caroliniana* flowers throughout the year, while in southern Queensland, the plant may overwinter and sexual reproduction has not been documented (Mackey, 1996). During the summer in southeastern Queensland, buoyant stems up to 6 meters long can grow at 5 cm per day. In July and August, the stems loose buoyancy and fragment on the soil surface. After the winter months, these fragments will re-root and grow into new plants. In mild winters, dieback may not be observed (Mackey, 1996).

Associations
C. caroliniana is highly adaptable, and will likely be found growing in habitats along with many other aquatic plant species. In Texas, associated plants include *Nymphaea odorata* and *Brasenia schreberi* (Ørgaard, 1991). Co-dominant plants observed in *C. caroliniana* communities in China include *Ceratophyllum demersum, Hydrilla verticillata, Vallisneria natans, Potamogeton crispus,* and *Myriophyllum spicatum* (Yu et al., 2004). Lyon and Eastman (2006) found that *C. caroliniana* was more commonly found in areas with significantly lower biodiversity.

Environmental Requirements
C. caroliniana grows rooted in the mud in low energy streams, rivers, pools, ponds, reservoirs, impoundments, and lakes. The species is not at all drought tolerant (USDA-NRCS, 2009), and grows in water at least 0.4 m deep (Yu et al., 2004). In China, Yu et al. (2004) report finding *C. caroliniana* typically in waters with pH 6.19-7.51, total nitrogen 0.14-3.27 mg/L, total phosphorus 0.044-0.838 mg/L, and dissolved oxygen from 1.23-7.32 mg/L. *C. caroliniana* prefers soft, silty substrate and grows with decreased success on harder media such as cobble or sand (ISSG, 2006; Wilson et al., 2007). It also grows optimally at very low calcium ion concentrations (4 ppm), as higher levels of calcium inhibit growth (Mackey, 1996).

Movement and Dispersal

Natural Dispersal
C. caroliniana disperses mainly vegetatively by rhizomes and fragments. Passive spread of fragments and seeds by water movement allows the plant to expand its population locally. Clonal multiplication happens quickly (Wilson et al., 2007), with growth rates of up to 5 cm per day (Mackey, 1996).

Vector Transmission
In parts of its range where sexual reproduction has been recorded, seeds are likely dispersed by water birds, which allows for spread among waterbodies (Ørgaard, 1991; Mackey, 1996). Plant fragments may also travel as hitchhikers on waterfowl or wildlife.

Accidental Introduction
C. caroliniana has long been used by aquarium enthusiasts. It is one of the most popular aquarium plants available from distributors. Therefore, improper disposal of aquarium specimens likely leads to a number of accidental introductions. Long fragments can also easily be wrapped on boat motors or become entangled in boating equipment, and since the plant is highly capable of reproducing via fragmentation, boating activity has facilitated population expansion (Les & Mehrhoff, 1999).

Intentional Introduction
Because of its value to the aquarium industry, the plant is often intentionally cultivated both in its native and adventive range, where it is harvested for sale and distribution worldwide. It is suspected that at least some of the invasive populations in Queensland, Australia were intentional introductions related to the aquarium trade (Mackey, 1996). Additionally, the same qualities that make this plant attractive as an aquarium plant may also lead people to plant it in outdoor water gardens, posing a risk for release and population expansion.

Natural Enemies
C. caroliniana does serve as a source of food for some wildlife (Mackey, 1996). In an attempt

to identify a suitable biological control agent for the species, several natural enemies were discovered in South America. Of the several insects, snails, and limpets evaluated, the most promising biological agents were the stem boring weevil *Hydrotimetes natans* and the aquatic moth *Paracles* spp. (Schooler et al., 2006). The bulk of the existing biocontrol research centers on *H. natans*, the adults of which feed on foliage and the larvae that mine the stems. The larvae are divers that can live under water for hours by means of an air bubble held around the abdominal sternites. Field and lab studies indicate that this species is specific to fanwort (Walsh and Mattioli, 2007). The plant has been reported to be a source of food to waterfowl. In addition, the freshwater turtle commonly known as the Texas river cooter (*Pseudemys texana*), feeds preferentially on *C. caroliniana.*

Impacts

Economic Impact
C. caroliniana is an economic asset given its heavy trade in the aquarium industry. In Queensland, Australia, even despite its noxious status, the plant is still traded by northern growers, although its economic value is estimated at less than $10,000 annually (Mackey, 1996). The Australian Department of the Environment and Heritage (2003) give a much higher estimate, with trade representing a $300,000 industry, despite being restricted in most states. In relation to the economic asset this species may present in the aquarium trade, the economic costs that this species can exhibit is quite substantial. A conservative 1999 estimate places the national cost of *C. caroliniana* control at more that $500,000 (The Australian Department of the Environment and Heritage, 2003). Infestations alter the color of potable water, thus increasing the cost of treatment up to $50 per megalitre (Mackey, 1996). Dense populations can interfere with recreational activities and matted vegetation can decrease aesthetic value, resulting in a decrease in tourist dollars. For example, both commercial fishing camps and private camp owners in the U.S. have been forced to close or have had incomes severely impacted due to heavy infestations (Mackey, 1996). Economic losses may be less severe in Australia where natural lakes are fewer, although decreased amenity values, increased health risks, and additional safety issues still threaten significant economic impacts (Mackey, 1996).

Social Impact
While *C. caroliniana* has high social value as an aquarium plant, in natural systems the plant can cause substantial nuisance to recreational users by impeding navigation, tangling fishing line, and wrapping motor propellers. Thick vegetation, leading to unsightly mats of vegetation and foul smelling water, can also decrease aesthetic value (Australian Department of the Environment and Heritage, 2003). *C. caroliniana* can also reduce swimming access and potentially cause human health safety issues such as drowning (Mackey, 1996).

Impact on Crops and Other Plants
C. caroliniana is an aggressive plant, and in many instances has seriously impacted biodiversity. *C. caroliniana* has a broader niche than, and may pose a threat to, native species such as *Ceratophyllum demersum, Vallisneria* spp*.,* and *Utricularia* spp. (Cao et al., 2006). Zhang et al. (2003) report that *C. caroliniana* presents a significant threat to *Ottelia alismoides*, a once common species that is seldom seen after the introduction of *C. caroliniana*.

Impact on Habitat
C. caroliniana is extremely productive, and can be a nuisance even in its native range (Hanlon et al., 2000). In Queensland, *C. caroliniana* has been shown to negatively impact water quality. The winter dieback that occurs in harsher areas of its range can cause substantial nutrient

release, especially of manganese. This sudden manganese release can impact the nutrient cycle and water quality (Mackey, 1996). Additionally, dense stands can cause water loss through seepage and overflow, thus impacting hydrological regimes (Mackey, 1996). Compared to native macrophyte beds, light is significantly attenuated under *C. caroliniana* beds (Hogsden et al., 2007). Extracts of *C. caroliniana* have also been shown to have allelopathic effects at medium and high concentrations, and may play a role in the invasion of new habitats and the exclusion of native species (Elakovich and Wooten, 1989; Nakai et al., 1999).

Impact on Biodiversity
The impacts of *C. caroliniana* on biodiversity have been widely reported in the literature. *C. caroliniana* populations are often associated with areas of decreased species diversity (Cao et al., 2006). Ding et al. (2007) found that plant species composition and richness were lower in sites with *C. caroliniana.* Hogsden et al. (2007) showed that while native macrophytes could be found in *C. caroliniana* beds, their abundance was low and unevenly distributed. Hogsden et al. also found that epiphytic algae was more commonly present on *C. caroliniana* plants. Although the community composition of macroinvertebrates was not different from native plants, *C. caroliniana* plants supported higher abundances of macroinvertebrates. Nakai et al. (1999) found that *C. caroliniana* inhibited the growth of blue-green algae. In Australia, platypus and water rat populations are lower in creeks invaded by *C. caroliniana* (Australian Department of the Environment and Heritage, 2003).

Management

Economic Value
C. caroliniana has been grown and distributed worldwide as part of the aquarium business. In Australia, trade represents a $300,000 per year business, despite being restricted by legislation in most states (Australian Department of the Environment and Heritage, 2003). *C. caroliniana* is also used in reclamation activities, primarily to remove lead from contaminated water supplies. Lead removal by *C. caroliniana* was 80-90% efficient at lead concentrations of 1 mg/L and 10 mg/L after 12-15 days of exposure (Yaowakhan et al., 2005).

Social Benefit
Many people value *C. caroliniana* for its use as an aquarium plant due to its attractive flowers and feather-like foliage. Its tolerance of a wide range of environmental conditions means it is relatively easy to grow in home aquariums.

Environmental Services
C. caroliniana is a productive aquatic macrophyte which can cause nuisance problems. However, in highly degraded systems it does sequester nutrients, which can be useful in the revegetation of impacted ecosystems. It might be helpful in shifting a waterbody away from an algal-dominated state towards a plant-dominated one. *C. caroliniana* can also provide environmental benefits typical of similar submersed plants, such as providing oxygen to the surrounding water, habitat to macroinvertebrates and young fish, and food for waterfowl and wildlife (Mackey, 1996).

Prevention
The vegetative propagules of this species are very easy to spread. Therefore, educational programs are necessary to decrease human-mediated spread. Teaching users how to clean equipment in a way that decreases the chance of transmission is one way to lessen the impact

of the human vector. *C. caroliniana* has been declared noxious in several states and countries.

Detection and Inspection
Aquatic plant surveys by qualified aquatic botanists are generally necessary to detect this species.

Rapid Response
Because *C. caroliniana* reproduces vegetatively quite quickly, rapid response to decrease the population spread is integral to successful management. This species has been shown to be relatively resistant to physical and chemical management techniques, therefore an integrated management plan should focus on early detection and rapid response (Wilson et al., 2007).

Public Awareness
Numerous educational campaigns have been directed at informing the public about the danger of aquatic invasive species. Areas where *C. caroliniana* is particularly problematic commonly distribute informational materials about its identity as well as how to report new invasions. Other educational campaigns have been directed toward informing the public about how to clean equipment in order to prevent the movement of invasive species.

Eradication
No reports of eradication exist in the literature. Eradication of *C. caroliniana* is considered unlikely, or often prohibitively expensive once it is established in a water system.

Cultural Control and Sanitary Measures
Fragments are easily transportable, thus it is extremely important to decrease the instances of accidental introduction by addressing humans as a vector. By establishing guidelines on how to properly clean equipment, dispose of aquarium water, and identify target plants, it is likely that instances of accidental transportation and release will decrease.

Physical and Mechanical Control
Mechanical harvesting has been used to control *C. caroliniana*, but since the plant spreads via fragmentation, mechanical control cannot be expected to provide any benefit beyond temporary nuisance relief (Wilson et al., 2007). A mechanical harvester on Lake MacDonald in Australia effectively halved the standing population, but within three weeks the population had grown back to pre-cut levels (Mackey, 1996). Draining and drying are viable means of physical control (Wilson, 1997). Benthic barriers, drawdown, sediment removal, rotovation, and shading are additional techniques that have been used with some success (USACE-ERDC, 2005). Since *C. caroliniana* needs direct sunlight for growth, shading may be a good control method for small populations or early infestation (Peconic Estuary Program, 2006).

Movement Control
Since plants can spread via fragments, much attention has been given to decrease human-mediated dispersal. The plant has been officially listed as a noxious weed in the United States and Australia. Some states have put in place legislation to regulate the sale, transportation and introduction of *C. caroliniana.*

Biological Control
Schooler et al. (2006) found no existing biocontrol measures to manage *C. caroliniana* populations. Therefore, surveys to identify biological control agents have been conducted in the plants native range of South America. The most promising agents are the stem boring

weevil *Hydrotimetes natans* and the aquatic moth *Paracles* spp. (Schooler et al., 2006). The stem boring weevils were predicted to have a larger impact on deep water *C. caroliniana* populations, while the moth larvae were expected to control shallow water populations (Schooler et al., 2006). Additionally, triploid grass carp have been used as biological control agents in Florida and Arkansas (Hanlon et al., 2000; Wilson et al., 2007); however, there remains some concern with incomplete sterilization and release of this non-selective grazer.

Chemical Control
In general, it is reported that *C. caroliniana* is very difficult to chemically control and results are very inconsistent. *C. caroliniana* is sensitive to 2,4-D (Wilson, 1997). Fluridone has been shown to give good control as well (Mackey, 1996). In all treatments tested, significant reduction of shoot dry weight was achieved. However, the rates that gave >80% control had undesirable effects on non-target water marigold species (Nelson et al., 2002).

Research Needs
More research is necessary to evaluate potential control techniques, as well as the plant's impact on the ecosystem and native plant species.

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Cabomba caroliniana
Flower, emersed leaves

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