

Fanwort (*Cabomba caroliniana*)



Cabomba caroliniana A. Gray, also known as fanwort, is a submersed aquatic plant that has greatly expanded its distribution in the last 100 years. Its northern spread is largely due to anthropogenic activities and has been found within the Adirondack Park in Saratoga County, NY. Outside of its native regions it is considered invasive in which fanwort's pestiferous, vegetative growth can alter native aquatic communities and hinder associated economies (Hogsden, Sager, & Hutchinson, 2007; Lyon & Eastman, 2006; Sheldon, 1994; Wilson, Darbyshire, & Jones, 2007). Managing fanwort is costly and difficult while having serious impacts on the environment (Wilson et al., 2007). The most effective means to eliminate fanwort's nuisance characteristics and establishment is through monitoring and spread prevention (Jacobs & Macisaac, 2009).

Cabomba caroliniana is considered native to southeastern United States, southern Brazil, Paraguay, Uruguay, and northeastern Argentina (Orgaard, 1991). Since all other species of the genus *Cabomba* are only found in Central and South America, it is thought that *C. caroliniana* is originally native to South America and has been naturalized in the southeastern United States for hundreds of years (Mackey & Swarbrick, 1997; Orgaard, 1991). Records of fanwort's pre-settlement distribution have not extended northward of Virginia (reviewed in Les & Mehroff, 1999), but since the 1930s its attractive foliage and flowers have facilitated its primary, long distance spread through the aquarium trade in the northeastern United States, Washington, and Oregon (Cohen, Mirotnick, & Leung, 2007; Mills, Leach, Carlton, & Secor, 1993; Wilson et al., 2007). After being first collected in New York in the Hudson Basin in 1955, its local dispersal within the state and other parts of southern New England has been attributed to boats, trailers and other aquatic equipment carrying fragments to surrounding water

bodies (Jacobs & Macisaac, 2009; Les & Mehroff, 1999; Mills et al., 1993). Recently, Fanwort has naturalized in its northern distribution and is commonly found in the Catskills and Long Island of New York (Lyon & Eastman, 2006). It has already been identified in the Adirondacks in Saratoga County which has created a concern for its spread further into the Park.

This submersed aquatic plant is generally considered sessile, attached to the sediments, but free-floating fragments can be present and viable. It has rhizomatous-like stems in which 1-10 adventitious roots can sprout at its nodes (Mackey & Swarbrick, 1997). These stems can reach up to 10m in vertical length and have horizontal root growth in the substrate. Fanwort's name is largely derived from its foliage's appearance, and thus its green to sometimes reddish, submersed vegetation has fan shaped leaves. The oppositely arranged leaves are usually 1-3.5cm by 1.5-6cm with 5-7 main blades that are palmately divided (Wilson et al., 2007). Also *C. caroliniana* can display dark green, floating leaves that are 1-4mm by 5-30mm, alternatively arranged, and oval in shape (Wilson et al., 2007). Fanwort displays small (1.75cm) white /cream, occasionally pink/purplish colored, solitary flowers blooming throughout the summer (Schneider & Jeter, 1982).



Fanwort is considered a perennial and grows to the water surface at the beginning of the growing season (April). Soon after, it quickly occupies the water column, and the floating leaves and



flowers then emerged around late June or early July (reviewed in Mackey & Swarbrick, 2007; Tarver & Sanders, 1977; Wilson et al., 2007). Later in the season when biomass is the greatest the plant begins to form turion like appendages at its shoot tips (Wilson et al., 2007). Around October the stems become brittle, begin to fragment, and take on a prostrate habit on the sediments. At this time the turions either remain attached or break free while fragments form adventitious roots (Wilson et al., 2007). In regions as north as Canada these turion

like buds and stem fragments can remain green and overwinter under ice (Hodsgen et al., 2007; Riemer & Ilnicki, 1968; Wilson et al., 2007). Immediately following ice breakup in the spring, healthy rooted plants and green stem fragments are already present, and these then give rise to the next season's vegetative growth (Wilson et al., 2007).

In Fanwort's native habitats reproduction by seed often occurs (Schneider & Jeter, 1982), while in its northern, nonindigenous regions there is little evidence of seed germination (Hodsgen et al., 2007; Riemer & Ilnicki, 1968; Wilson et al., 2007). Therefore, in its non-native distribution, fanwort reproduces vegetatively though auto-fragmentation, rhizomes, and the turion like structures (Robinson, 2002; Wilson et al., 2007). A stem fragment can be free-floating, form adventitious roots, remain viable, and

be capable of re-establishment in sediments provided there is a least one node and intact leaf (Mackey & Swarbrick, 1997; Orgaard, 1991). Additionally a single root mass (rhizome-like structure) can grow up to 40 leafy stems (Mackey & Swarbrick, 1997; Ogaard, 1991). Vegetative reproduction has enabled this aquatic plant to spread rapidly within a waterway and cause invasive growths in the northern United States as well as Canada.

Like many invasive species, *C. caroliniana* can inhabit a wide range of habitats. This submersed aquatic plant favors slow moving lakes and rivers but can colonize in briskly flowing waters (Jacobs & Macisaac, 2009; Robinson, 2002). It commonly inhabits 1-3m of water and has been found at depths exceeding 10m (Mackey & Swarbrick, 1997; Robinson, 2002; Wilson et al., 2007). In oligotrophic to eutrophic waters, optimal growing conditions for fanwort are slightly acidic (pH 4-5), and growth has been shown to be inhibited in waters with high calcium concentrations (>4ppm) and pH 7-8 (reviewed in Mackey & Swarbrick, 1997; Robinson, 2002; Wilson et al., 2007). It can withstand colder temperatures (0°C) as it overwinters under ice in its northern most regions, but prime growing temperatures are between 13 to 27°C (Riemer & Ilnicki, 1968; Wilson et al., 2007). Additionally fanwort prefers loose silty substrates and is not usually found growing vigorously on cobble, sand, or rock ledges (Mackey & Swarbrick, 1997; Sheldon, 1994; Wilson et al., 2007). These varying habitat requirements help support the success of fanwort's northern invasion and distribution.

Fanwort is considered an invasive species outside of its indigenous regions and can cause disruption to aquatic environments and economies (Mackey & Swarbrick, 1997; Wilson et al., 2007). Most of fanwort's negative impacts are due to its dense foliage. When the plant bed's cover exceeds 40%, fish density can be reduced which has caused commercial fishing camps to close as a result of fanwort's infestation (reviewed in Wilson et al., 2007). Additionally recreational activities can be greatly hindered while real estate values have been diminished by fanwort's noxious characteristics (Mackey & Swarbrick, 1997; Robinson, 2002). The competitive, vegetative growth also reduces light for benthic organisms and native plants (Hogsden et al., 2007; Lyon & Eastman, 2006). As a result, monocultures of *C. caroliniana* can form with more than 200 plants/m²; a reduction in aquatic macrophyte species richness can occur with native species displacement (Mackey & Swarbrick, 1997; Lyon & Eastman, 2006; Sheldon, 1994; Wilson et al., 2007); and increases in epiphytic algae and macroinvertebrate abundances have been documented (Hogsden et al., 2007). Furthermore, when die back takes place in autumn alterations in nutrient cycling and depleted dissolved oxygen in water can follow (Mackey & Swarbrick, 1997)

As a result of fanwort's negative environmental and economic impacts, management has been implemented. The modeling of propagule pressures to identify areas most vulnerable to fanwort's invasion is important for monitoring and resource allocation (Jacobs & Macisaac, 2009). Once this invasive species becomes established its management comes at high fiscal and ecological costs. Some management practices include:

- Chemical treatment
 - Fluridone and endothal → estimated to costs of \$200-600/ha (reviewed in Mackey & Swarbrick, 1997)
- Mechanical and manual harvesting

- Plants do not root deeply and are easily uprooted but viable fragments can remain in waterway (Mackey & Swarbrick, 1997)
- Benthic barriers
 - Effective, low cost options for small scale management (reviewed in Mackey & Swarbrick, 1997; reviewed in Wilson et al., 2007).

Fanwort, *C. caroliniana*, is a submersed aquatic plant with decorative leaves and attractive, emergent flowers. It can withstand a wide range of habitats, but flourishes in slightly acidic, low calcium concentration waters like those of the Adirondacks. Its high vegetative and propagule production by fragmentation, adventitious roots, and turion like buds allows fanwort to form large, dense plant beds throughout a waterway (Wilson et al., 2007). These growths can alter the aquatic ecology and decrease economies by eliminating recreational use and lowering real estate values (Mackey & Swarbrick, 1997). Fanwort has been naturalized in the southern United States for hundreds of years, but through the aquarium trade it has greatly expanded its distribution since the 1930's in North America. With fanwort naturalizing closer and closer to the Adirondack Park and its high affinity for waters that have similar chemistry to those within the Park, this aquatic invasive needs to be kept high on the radar.

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