2.6 Fanwort and Cabomba

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Cabomba caroliniana A. Gray; submersed plant in the Cabombaceae (watershield) family. Derived from *Cabomba* (an aboriginal name per botanist Asa Gray in 1848) and *caroliniana* (having a range that includes North and South Carolina in the US)

Native to the southern US, although some “populations” appear introduced from the aquarium industry. Found in the southeast, northeast, midwest and Pacific northwest US, Australia and New Zealand

Introduction and spread

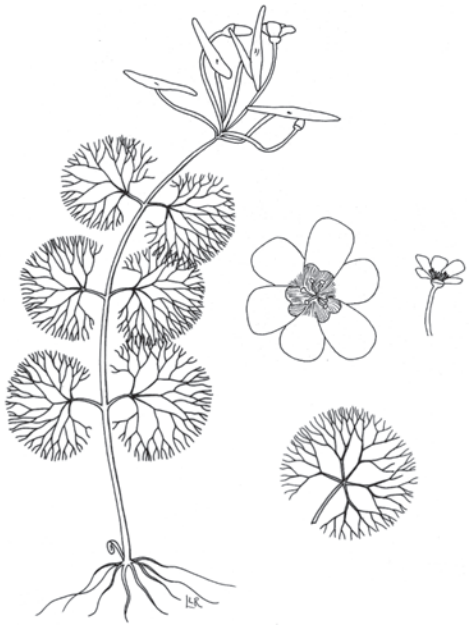
Fanwort (*Cabomba caroliniana*) is one of five species of the genus *Cabomba* and the only one broadly distributed in the United States (although *C. haynesii* and *C. palaeformis*, both known by the common name fishgrass, reportedly occur in Miami-Dade County in extreme southern Florida). There are three varieties of fanwort, but only two (*C. caroliniana* var. *caroliniana* and var. *pulcherrima*) are considered native to the US. In addition to native populations of

fanwort found throughout most of the eastern US, there is also a new type of fanwort that was likely introduced via the aquarium trade. Members of the genus *Cabomba* appear very similar to one another and are difficult to identify with certainty; even plant taxonomists are currently unable to clearly define species and subspecies of *Cabomba*. However,

it is clear that many of the new populations of *Cabomba* found throughout the midwestern US and Canada are invasive and have other characteristics that distinguish them from native populations. These invasive types will hereafter be referred to as "green cabomba"; the term "fanwort" will refer to members of the species *C. caroliniana*.

There is little information outlining the introduction of green cabomba, but research in the early 1980s revealed that the aquarium trade had discovered or developed a variety of fanwort that was solid (or nearly solid) green. Populations of green cabomba began to appear and rapidly expand in the midwestern and northwestern US, Canada and Australia in the early 1990s. Because these populations are similar in appearance and invasiveness, it seems likely that they were introduced from a common source – probably the aquarium trade. In addition to these new invasions of green cabomba, invasive behavior has also increased in native populations of fanwort in the southeastern and northeastern US. Cabomba populations in Australia and New Zealand are considered invasive and attempts are being made to eradicate the species.

Description of the species



Fanwort is a perennial dicotyledonous plant that roots in the sediment and grows entirely submersed in the water column. It colonizes new areas through prolific root growth or through shoot fragments that become rooted in the sediment. The species typically grows in shallow waters, but can be found at depths of up to 30 feet if the water is clear. Abundant branching occurs at the root crowns and base of the plant. Shoots grow to the surface of the water and continue to elongate, producing thick mat-forming canopies. Stems are round to slightly compressed and range in color from green to red (although stems are always green in green cabomba). Submersed leaves are opposite, fan-shaped, finely divided with as many as 200 terminal points on a single leaf and range from green to red. Leaves can vary greatly in size, but leaves near the tip of the plant are usually smaller and closer together than lower leaves.

Flowering occurs on the surface of the water on branches with floating leaves. Floating leaves look very different from submersed leaves and are alternate, smooth and linear-elliptic to ovate. Flowering stems bear single bisexual white flowers with 3 petal-like sepals and 3 petals; some flowers have yellow spots or purplish margins. Populations of native fanwort flower profusely, but green cabomba produces few flowers.

Fanwort prefers to grow in acidic water with a pH of 4 to 6 and growth is inhibited when water pH is above 7. Green cabomba, however, can survive in water with a higher pH and growth is not affected unless pH is 8 or higher. Fanwort is considered a more tropical species and proliferates in the southeastern US, whereas invasive green cabomba has colonized the much colder climates of the midwestern US and Canada and has adapted to overwinter there. During late fall when temperatures begin to drop, green cabomba stems break off and turion-like structures form at the apical tip. When warmer temperatures return in early spring, these fragments will begin to elongate and form adventitious roots.

Variations in color are the most significant barrier to separating members of the genus *Cabomba*. Most descriptions of fanwort list color as ranging from green to red, with red coloration most common in warmer temperatures and green in cooler temperatures. True fanworts – for our purposes, *Cabomba caroliniana* – do often have green leaves close to the base of the plant and red to purple leaves near the tip of the plant, but this is highly variable. Some populations may be entirely red to purple with no green (these plants are most likely *C. caroliniana* var. *pulcherrima*); however, other plants may appear red to purple but have green leaves in deeper water. In contrast, green cabomba is always entirely green and

water temperature has no effect on color. These color differences provide evidence to support the theory that green cabomba is unique from native fanworts and there are differences in physiological responses as well. For example, research has shown that green cabomba grows more quickly, tolerates cold temperatures, survives under a wider range of water pHs and may be more tolerant of some herbicides than native fanworts.

Reproduction

Fanwort and green cabomba reproduce using multiple strategies. Both spread via vegetative fragmentation; a single leaf node can produce roots and grow into a new plant. As such, contaminated watercrafts, trailers and live wells can transfer these species to new areas. Also, both species grow in slow flowing canals and rivers, so plant fragments can travel long distances on currents until they settle in a suitable habitat. Fanwort spreads primarily through vegetative fragmentation, but sexual reproduction does occur. Flowers are usually pollinated by insects, although self-pollination can occur as a result of wave action. Flowering is a two-day event; flowers emerge and can be pollinated on the first day and are closed and pulled below the surface of the water for seed formation on the second day. Seed viability is very low in fanwort and whether viable seed production occurs in green cabomba is unknown.

Problems associated with fanwort and cabomba

Species of *Cabomba* produce mat-forming canopies that can become quite dense, particularly when these mats are produced by green cabomba. Dense canopies decrease light penetration through the water column, which can displace or eliminate other desirable or native plant species (Section 1.1), thus creating a monoculture of fanwort or green cabomba. This lack of diversity can impact fisheries (Section 1.2) and waterfowl (Section 1.3), especially when coupled with the reduced dissolved oxygen levels that result from poor penetration of oxygen through dense vegetation. These thick mats can also impede navigation and recreational use of the water body and can have negative economic impacts on the industries that utilize these resources. Plant fragments may also clog drainage pipes, canals, intakes, pumps and other structures, which can impede irrigation, drainage and flood control efforts.

Management options

Mechanical control (Section 3.5) is unlikely to be successful in eradicating fanwort and green cabomba from an aquatic system, since harvesting can produce fragments that can root, form new plants and quickly recolonize the water body. Also, extensive root systems are often undisturbed by harvesting and new plant growth from these roots can quickly re-infest an area after harvesting operations are concluded. Drawdowns (Section 3.4) can be used to control fanwort and green cabomba, but are not practical in areas where the waters are heavily utilized for recreational activities and elimination of the resource is not an option. Because fanwort grows best in low-pH water and growth is inhibited at higher pH, it may be possible to use lime to increase pH as a control strategy. Fisheries biologists have added agricultural lime to farm ponds and noted control of fanwort and improved fish production due to the resulting increased pH. There are no known biological control agents (Section 3.6) for fanwort, although the generalist herbivore grass carp (Section 3.6.2) will provide some control of the species. Because green cabomba was probably created by the aquarium industry, it is unlikely that biocontrol agents will be identified for green cabomba, since these agents would also likely feed on native fanworts.

Chemical control (Section 3.7.1) of fanwort is possible with several herbicides, but control of green cabomba is much more challenging. Contact herbicides such as diquat, endothall (amine salt) and flumioxazin, along with the systemic herbicide fluridone, can be used to control fanwort. However, diquat and fluridone have little effect on green cabomba.

Flumioxazin is reportedly effective on green cabomba and high rates of the amine salt of endothall can also reduce biomass, but toxicity to fish is a concern when using high rates of endothall amine. Thus, options for chemical control of *Cabomba* species – particularly green cabomba – is limited at this time.

Summary

Although fanwort is a native species, populations of green cabomba behave like – and have impacts similar to – an invasive species. Native populations of fanwort are prevalent in the southeastern US, whereas green cabomba is more common in Canada and in the midwestern, northeastern and northwestern US. Identifying species in the genus *Cabomba* is challenging, which makes it difficult to characterize invasions by green cabomba; however, it is clear that its rapid spread to new areas of the US over the last few decades is troubling. Furthermore, the rapid spread of green cabomba through fragmentation and a lack of available management tools is cause for concern since it may be difficult to limit the further spread and impact of this plant throughout the US.

Photo and illustration credits:

Page 47: Cabomba infestation; Brett Bultemeier, University of Florida
Page 48 upper: Line drawing; University of Florida Center for Aquatic and Invasive Plants
Page 48 lower: Color variation in cabomba/fanwort; Brett Bultemeier, University of Florida
Page 49: Cabomba flower; Lyn Gettys, University of Florida
Page 50: Cabomba population; Lyn Gettys, University of Florida