SUBMERSED AQUATIC PLANTS OF THE TIDAL POTOMAC RIVER

GEOLOGICAL SURVEY BULLETIN 1543

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By VIRGINIA CARTER, PATRICIA T. GAMMON, and NANCY C. BARTOW

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PREFACE

The tidal Potomac River and Estuary are complex environments inhabited by a variety of plants and animals. These living resources are greatly influenced by dynamic physical and chemical processes which modify their habitat. They, in turn, modify chemical and physical processes and change the habitat. Plants form the link in the food chain between the nutrients in the water column and the sediment and the animals – fish, invertebrates, birds, herptiles, and mammals. Hydrologists study submersed plants not only as indicators of water quality and health of aquatic ecosystems but also to understand the interrelation between plants and other ecosystem components.

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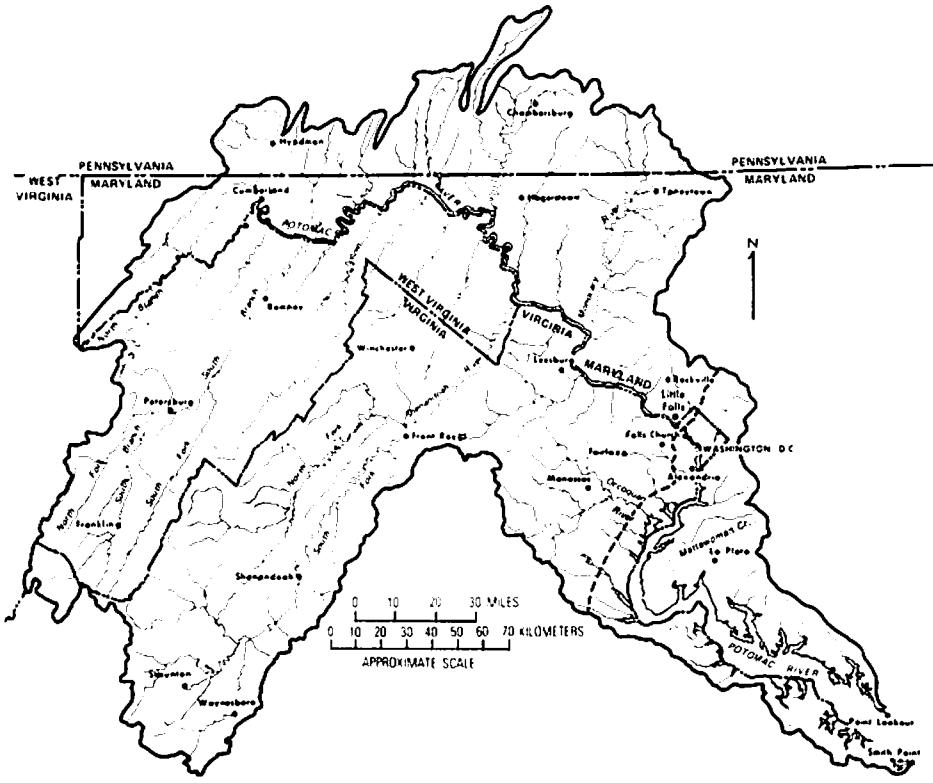
INTRODUCTION

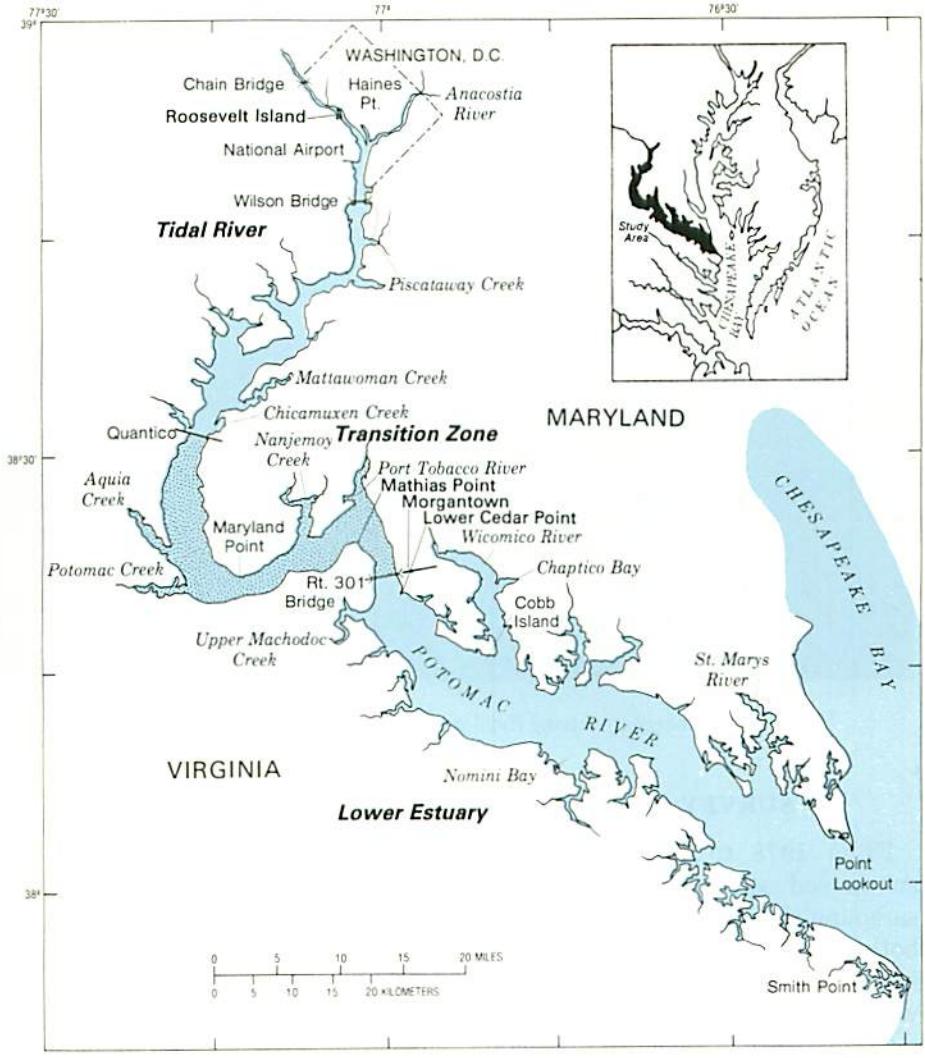
In terms of drainage area and volume of water, the Potomac River is the second largest tributary entering the Chesapeake Bay. The Potomac River rises in the Appalachian Mountains in West Virginia, flows eastward, and forms part of the Maryland–West Virginia border. As it flows eastward from Cumberland, Md., it receives the water from many small tributaries and several large rivers such as the South Branch of the Potomac, the Shenandoah, and the Monocacy. The volume is increased as the river flows eastward. At Little Falls, 300 miles (483 kilometers) from its source and just below the series of rapids which mark the fall line, the Potomac River comes under tidal influence. It is tidal from just below Little Falls, near Washington, D.C., to Point Lookout, Md., 114 mi (183 km) downstream, where it enters the Chesapeake Bay about 73 mi (117 km) from the Atlantic Ocean. The Potomac River watershed has a drainage area of 14,670 square miles (38,000 square kilometers) including the District of Columbia and parts of Maryland, Virginia, West Virginia, and Pennsylvania. It contributes about 18 percent of the total freshwater inflow to the Chesapeake Bay.

On the basis of salinity, the tidal Potomac River and Estuary can be subdivided into three zones. Between Little Falls and Quantico, Va., the Potomac is a relatively narrow freshwater tidal river. Downstream from Quantico lies the Potomac Estuary where freshwater and saltwater mix. In the upstream end of the estuary, between Quantico and the Route 301 bridge at Morgantown, Md., the saltwater-freshwater interface fluctuates in response to changes in river discharge. This zone is often termed the transition zone, or middle Potomac. The remainder, from the Route 301 bridge to Point Lookout, is called the lower estuary, or the lower Potomac. Some publications refer to the entire reach between Little Falls and Point Lookout, including the estuary and the tidal river, as the Potomac Estuary.



Potomac River Watershed.

The tidal Potomac River is relatively shallow and has an average overall depth of 19.7 feet (6 meters) The greatest depth, about 120 ft (36.5 m), is found near Mathias Point, Md. The tidal river and estuary generally have a deep channel flanked on one or both sides by wide shallow flats or shoals. Emergent wetlands (marshes) are found in most of the tributaries in narrow bands along the shore and more extensive areas where the tributary widens into a tidal embayment before entering the main river. There are few emergent wetlands along the shore of the main stem of the Potomac River. Those that do exist are generally separated from the river by a narrow sand berm, except during floods. In some places, there are narrow bands of threesquare (*Scirpus americanus*), a plant that can withstand wave action well, and, in the vicinity of Roosevelt Island, in Washington, D.C., large beds of spatterdock (*Nuphar luteum*) can be seen.



Map of tidal Potomac River.

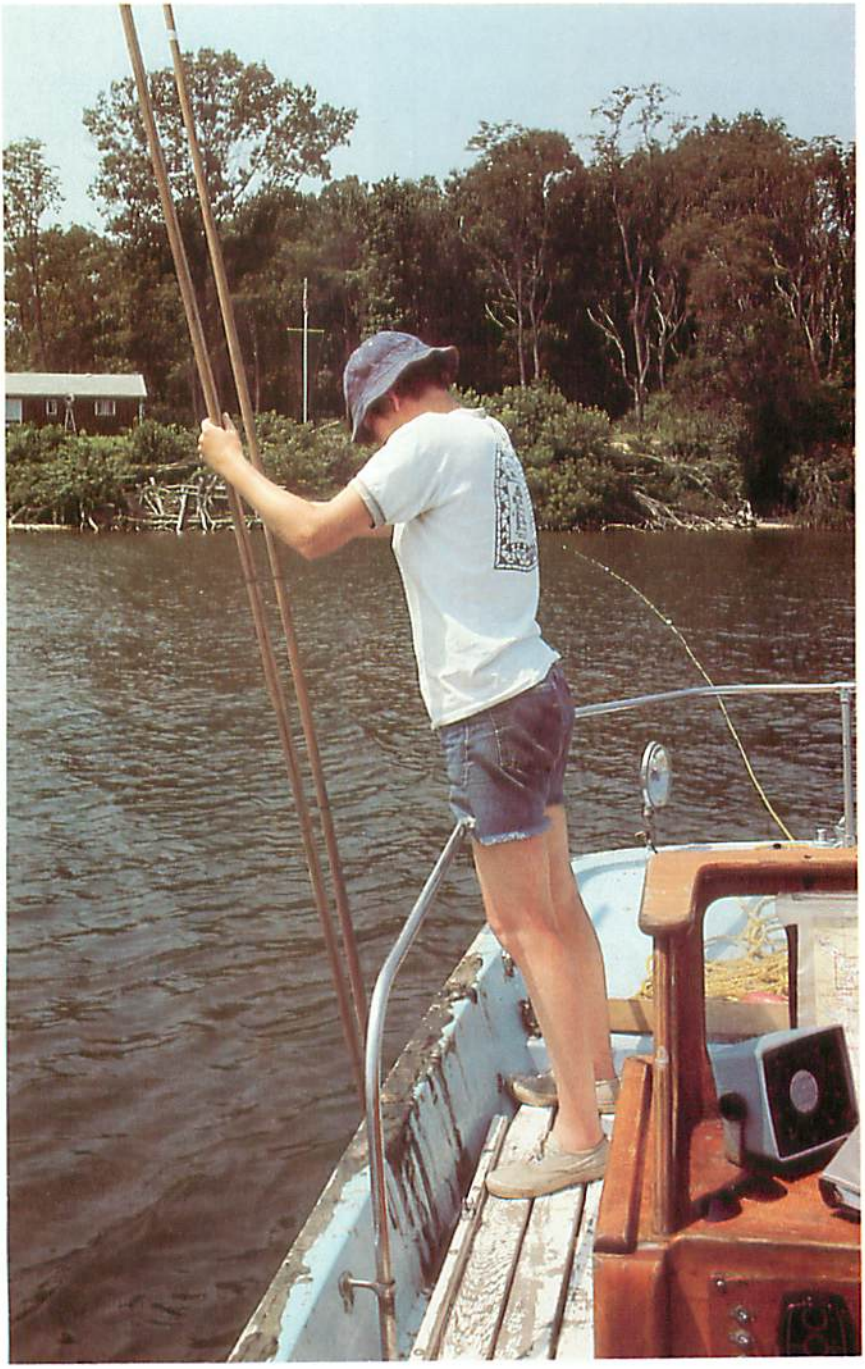
Beds of submersed aquatic plants are common in most estuaries and tidal rivers. Submersed aquatic plants are those which grow primarily below the water surface, their upper leaves and flowers sometimes extending above the surface. All of the flowering submersed aquatic plants mentioned in this publication are rooted, with the exception of coontail. These plant beds provide habitat, cover, and food for a variety of aquatic fauna, and they are also a source of food for migrating waterfowl. These plants are often referred to as baygrasses or grasses in other publications.

Emergent wetland (tidal marsh) in Mattawoman Creek, Md.

SURVEY OF SUBMERSED AQUATIC PLANTS

From 1978 to 1981, the U.S. Geological Survey surveyed the submersed aquatic plants of the tidal Potomac River and Estuary, sampling the shallow flats on the main river and selected tributaries on both sides of the river. The U.S. Fish and Wildlife Service cooperated in this survey during 1978 and 1979. This formal sampling program was conducted using modified oyster tongs to sample the vegetation and the substrate on which the plants were growing. In addition to this formal sampling program, many field observations were made of plant distribution, time of flowering, and seed production. In the tidal Potomac River and Estuary, 15 species of submersed aquatic plants occur—two are algae with stemlike and leaflike structures, and the remainder are flowering plants.

Pictures of all the plants are shown on the following pages, along with a description and a map showing the actual (in red) and potential (in yellow) distribution. The actual distribution is based upon the results of the 4-year survey. The maps may not show the location of all existing beds of vegetation because every mile of river was not surveyed. Potential distribution is a best guess based upon the salinity of the water which generally determines the range of a species in an estuary.



Oyster tongs were used to sample the plants and bottom sediments.

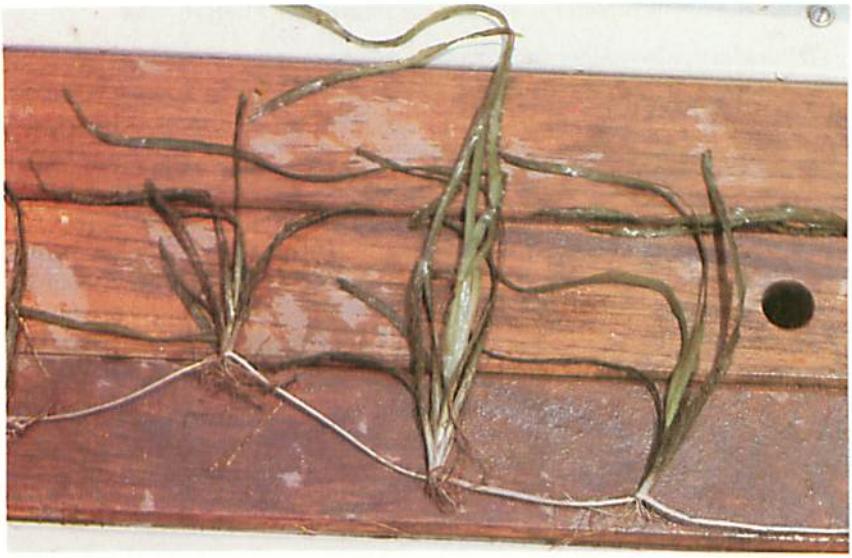
Redhead-grass.
(Photograph by G. M. Haramis,
U.S. Fish and Wildlife Service.)

Horned pondweed growing in a sandy substrate. (Photograph by G. M. Haramis, U.S. Fish and Wildlife Service.)

Wildcelery: *Vallisneria americana* Michx.

Wildcelery, also called tapegrass or eelgrass, has long slender ribbon-like leaves which grow from white underground stems and rhizomes. The leaves, often more than 3 ft (1 m) in length, are finely veined and may have a slightly lighter green central stripe. The rhizomes produce vegetative runners, a new plant springing from each node. A small tuber, or winter bud, is sometimes found attached to the bottom of the stem by a long runner, both of which are deeply buried in the substrate. Wildcelery flowers in late July through September in the tidal Potomac River. The male flowers are borne on short-stalked spathes at the base of the plant. The spathe breaks, allowing the flowers to float to the water surface. The female flowers are borne on long stems which reach

Wildcelery: *Vallisneria americana* Michx.



Wildcelery: Note the white underground rhizomes with individual plants arising from each node. (Photograph by G. M. Haramis, U.S. Fish and Wildlife Service.)

A single wildcelery plant showing winter bud or tuber.

Bed of wildcelery with flowers and seed pods. (Photograph by G. M. Haramis, U.S. Fish and Wildlife Service.)

Male flowers of wildcelery.

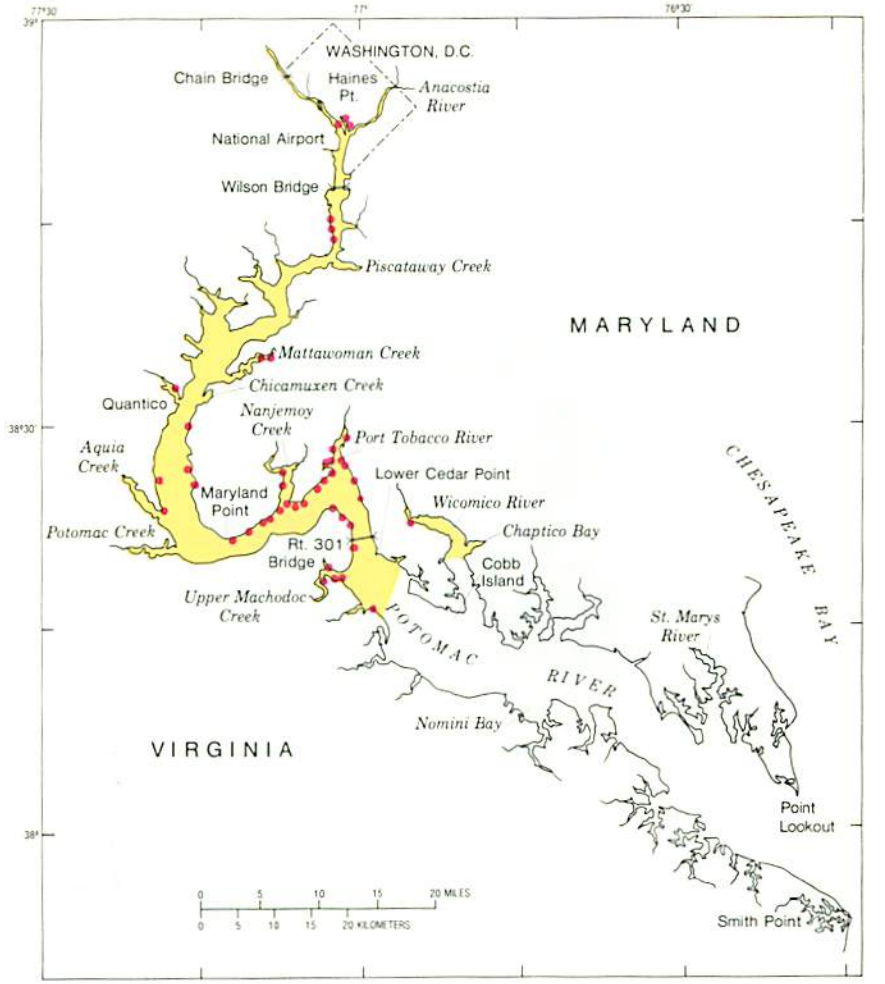
Immature seed pods.

Bed of wildcelery in Port Tobacco River, Md.

the water surface. After fertilization, these stems become coiled, pulling the flowers beneath the surface where the long cylindrical seed pods mature.

This plant is an excellent food for waterfowl, especially canvasbacks and redheads. All parts of the plant are eaten, including roots and tuberlike winter buds. The canvasback's fondness for wildcelery prompted the duck's scientific name, *Athya valisneria*. Wildcelery harbors insects and other invertebrate organisms and attracts marsh birds, shore birds, and muskrats. Its dense beds provide good shelter for fish.

Wildcelery is one of the most abundant submersed aquatic plants found in the tidal Potomac River. It is adapted to a narrow range of salinity and occurs only in fresh and slightly brackish (salty) water. Eelgrass (*Zostera marina*), which looks similar, thrives in saltier water and is not presently found in the tidal Potomac River. Wildcelery grows best in silty sand from just north of Maryland Point to the Wicomico River, growing in narrow zones along the shoreline and in tributaries such as Upper Machodoc Creek, Nanjemoy Creek, and Port Tobacco River. The most extensive growth occurs in the Port Tobacco River where beds may cover several thousand square feet (several hundred square meters).



Potential (yellow) and actual (red) distribution of wildcelery.

Redhead-grass: *Potamogeton perfoliatus* (Fern.) Farw.

Redhead-grass is a large vigorously growing plant with broad [0.75–1.5 inches (2–4 centimeters)] oval- to lance-shaped leaves occurring alternately along the white or reddish stem. The base of the leaf wraps partly around the stem, thus helping to distinguish this pondweed from the curly-leafed pondweed with which it might be confused. It has a dense, tangled, and extensive mass of rhizomes which anchors it on exposed sites.

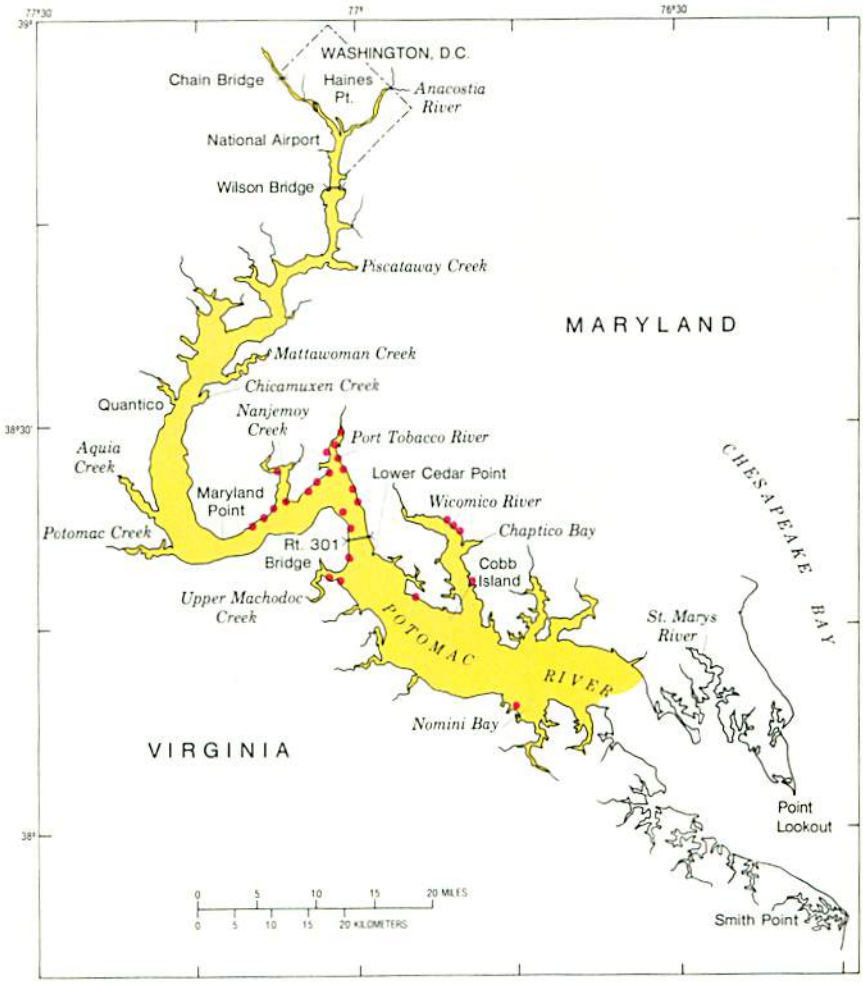
Redhead-grass is common in the shallow fresh to moderately brackish water of the tidal Potomac River and Estuary. It occurs abundantly from Maryland Point to the Wicomico River along the shore and

Redhead-grass.

Redhead-grass in flower.
(Photograph by G. M. Haramis,
U.S. Fish and Wildlife Service.)

in the tributaries. Extensive beds of redhead-grass lie on the Virginia side of the transition zone just above the Route 301 bridge and along the littoral zone on the Maryland side from the Route 301 bridge to Maryland Point.

Spikes of flowers are located in the leaf axils or at the end of the stems. These spikes rise above the water surface for wind pollination; they sink below the water as the fruits mature in early to midsummer. The blunt-backed pointed-tipped seeds are about 0.1 in (3 mm) long. They detach from the plant and eventually sink to the bottom. New plants may either grow from the rhizomes of existing plants or germinate from seed.



Potential (yellow) and actual (red) distribution of redhead-grass.

Redhead-grass flowers and maturing seeds.

Redhead-grass takes its name from the species of duck that favors it as food source: the redhead duck. This species of waterfowl has declined sharply in the Chesapeake Bay recently, and this decline is a result of the loss of abundant growth of redhead-grass and other baygrasses. Many waterfowl still feed heavily on redhead-grass and the invertebrates it harbors during fall migration and the wintering period.

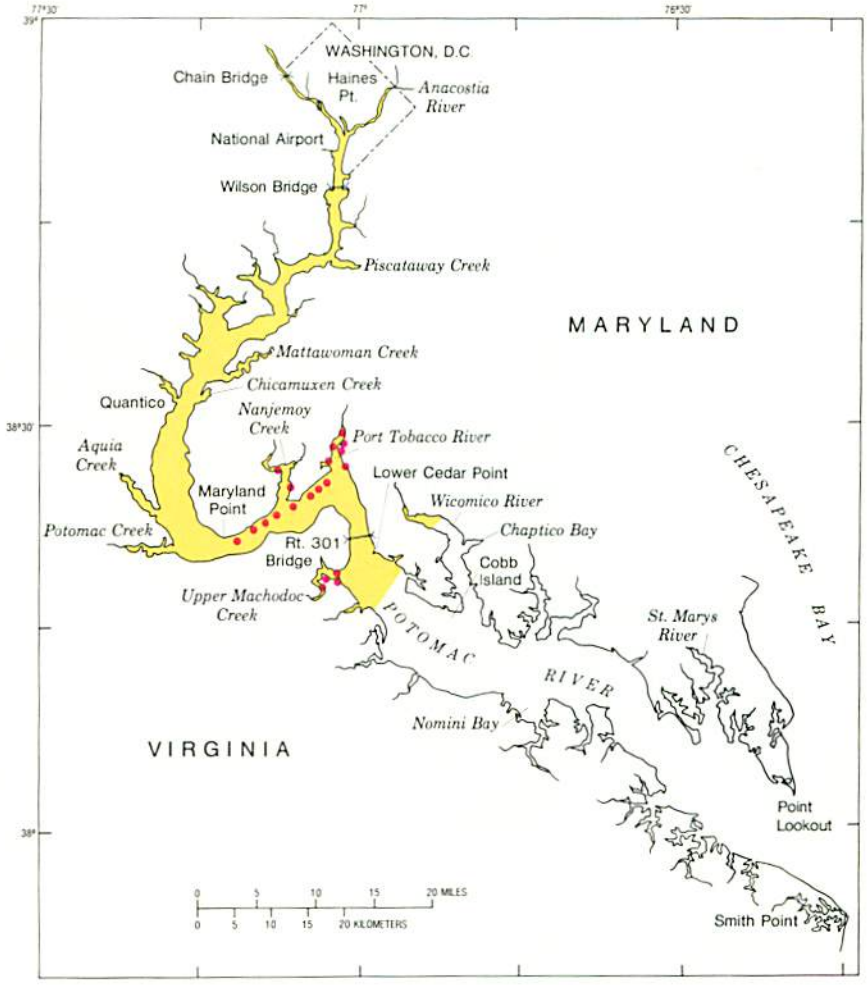
Redhead-grass seeds.

Curly pondweed: *Potamogeton crispus* L.

Curly pondweed was introduced into North America from Europe at least 150 years ago. It resembles redhead-grass but has a slightly flattened stem and elongated flat opposite leaves with toothed wavy margins which give its name. The root or rhizome mass is not as large as that of redhead-grass.

Curly pondweed is found in small populations in the fresh and slightly brackish waters of the tidal Potomac River and transition zone. It forms isolated patches in Nanjemoy Creek and Port Tobacco River, growing in sheltered spots that have a silty-clay substrate. Large beds are uncommon.

Curly pondweed.

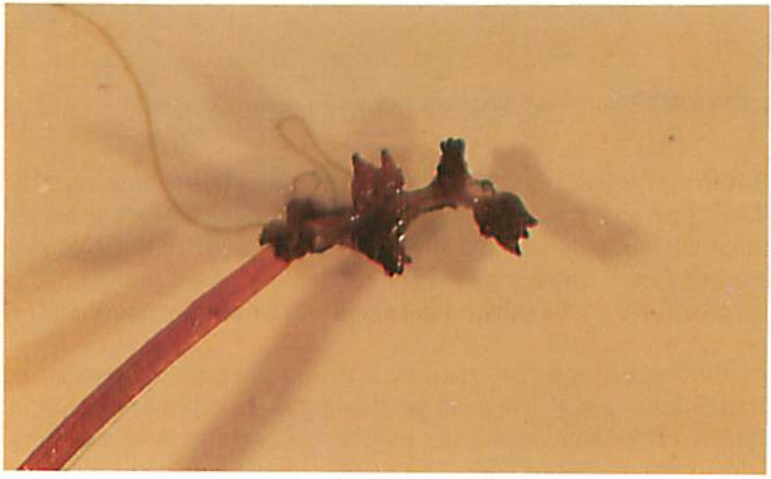


Potential (yellow) and actual (red) distribution of curly pondweed.

The flowers of curly pondweed are borne on spikes at or slightly above the water surface in late July or August. The flowering heads and fruit of curly pondweed are smaller than those of redhead-grass, and there are fewer flowers and seeds on a spike. Hard winter buds, called turions, form in the fall and germinate to form new plants in the spring.

Curly pondweed is considered to be a pollution-resistant species in the United States and Europe. It provides good shelter for fish and other aquatic organisms, especially during the early part of the summer; it dies back in September. It has only marginal food value for waterfowl.

Flower of curly pondweed.



Seeds of curly pondweed.

Tips of curly pondweed bearing winter buds.

Germinated winter bud of curly pondweed.

Coontail.

Coontail showing leaf detail.

Coontail: *Ceratophyllum demersum* L.

Coontail, also called hornwort, is an entirely submersed aquatic plant that has no true roots, although the basal ends are often buried in mud. The forked leaves occur in whorls and have marginal teeth that make them rough to the touch. Dense whorls of leaves near stem tips give the bushy coontaillike appearance. The leaves and stems may be stiff with encrusted lime. The flowers and nutlike seeds of coontail are found singly in the leaf axils.

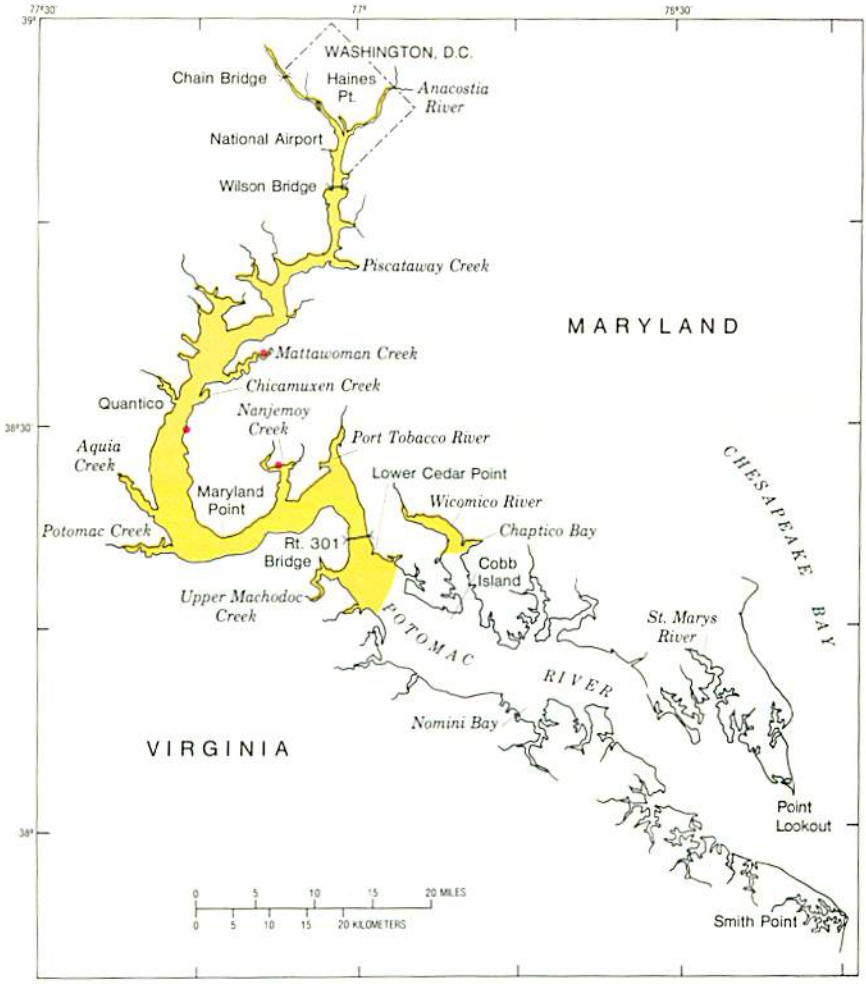
Coontail has a very localized distribution in the fresh to slightly brackish water of the transition zone and its tributaries. Small populations are found in the Aquia-Potomac Creek area, and a large bed of

Coontail bed in Nanjemoy Creek.

coontail, Eurasian watermilfoil, and curly pondweed is located in Nanjemoy Creek. Coontail can also be found in small open pockets in the marshes in Mattawoman Creek. Coontail is not an important food for waterfowl. It rarely flowers or produces seeds and may shade other plants more preferred by waterfowl.

Widgeongrass: *Ruppia maritima* L.

Widgeongrass, also called ditch-grass, has narrow threadlike alternate leaves that grow from short zigzag rootstocks or rhizomes that lack tubers. When not in seed, widgeongrass resembles sago pondweed and horned pondweed, but its leaves are arranged in less bushy clusters, and the sheathing base of the leaves has a firm rounded tip. Widgeongrass bears its flowers on umbels at the water surface, usually in late summer and early fall. Widgeongrass flowers are initially enclosed in sheaths at the leaf base; the flower stalks elongate during

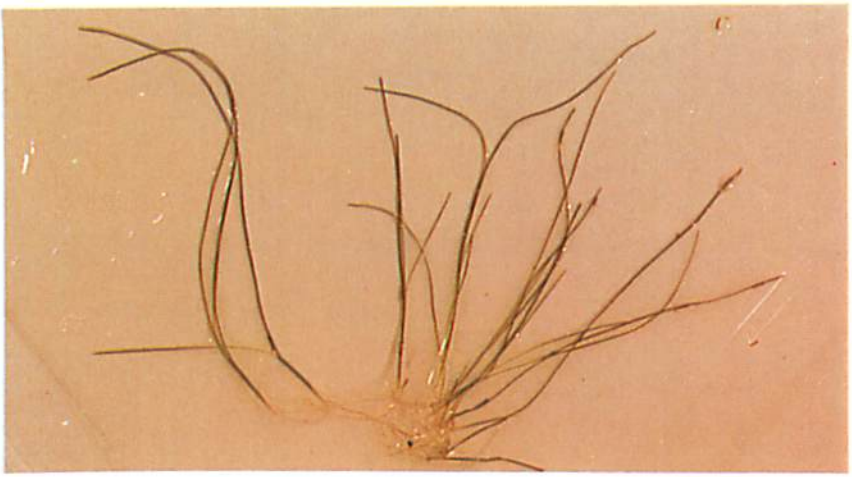


Potential (yellow) and actual (red) distribution of coontail.

maturation. The oval black fruits are 0.05 to 0.1 in (1.5–3 mm) long with a pointed tip. They are widely distributed by the water.

Widgeongrass tolerates ocean-strength salinity but is most productive in slightly to moderately brackish estuarine waters. It may be found throughout the Potomac Estuary below Maryland Point. Despite its wide distribution, widgeongrass currently is not very abundant in the estuary; the largest beds are found in the Wicomico River.

Because of its broad distribution in the estuary, widgeongrass is one of the most important submersed plants in the Potomac Estuary and in the Chesapeake Bay. In the past, widgeongrass was an extremely important waterfowl food, particularly to the American widgeon, or baldplate, after which it was named.



Widgeongrass.

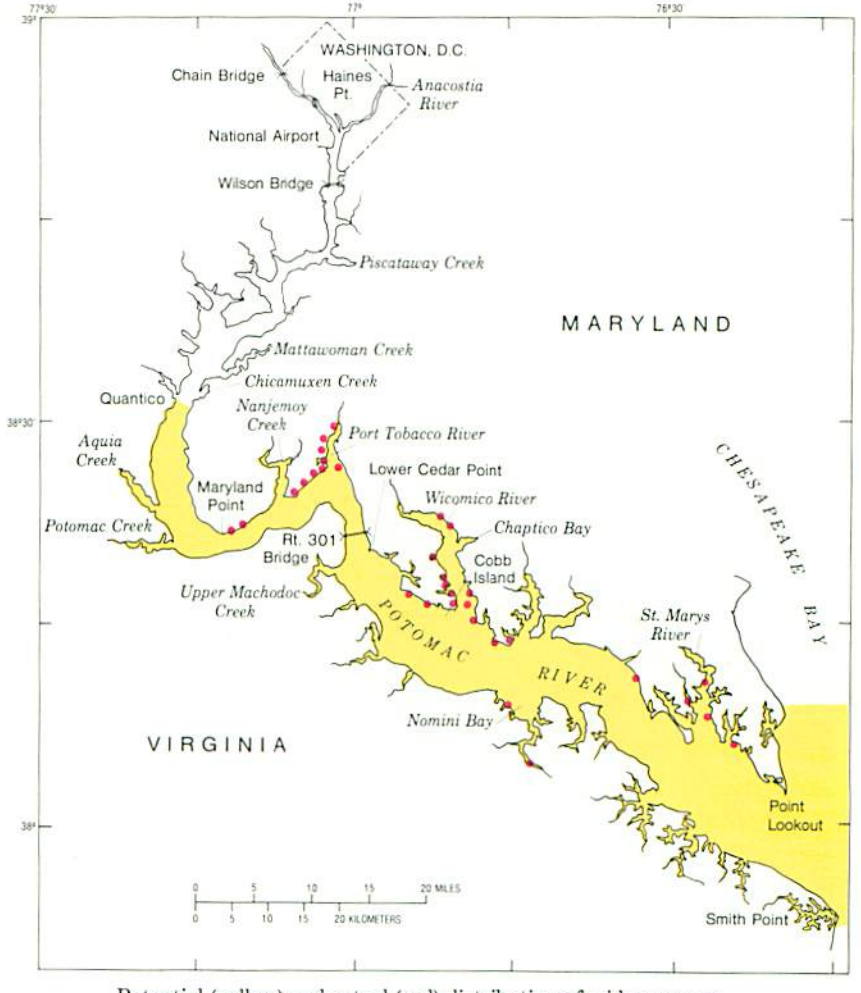
Widgeongrass (bottom) and horned pondweed (top).

Widgeongrass plant with male and female flowers.

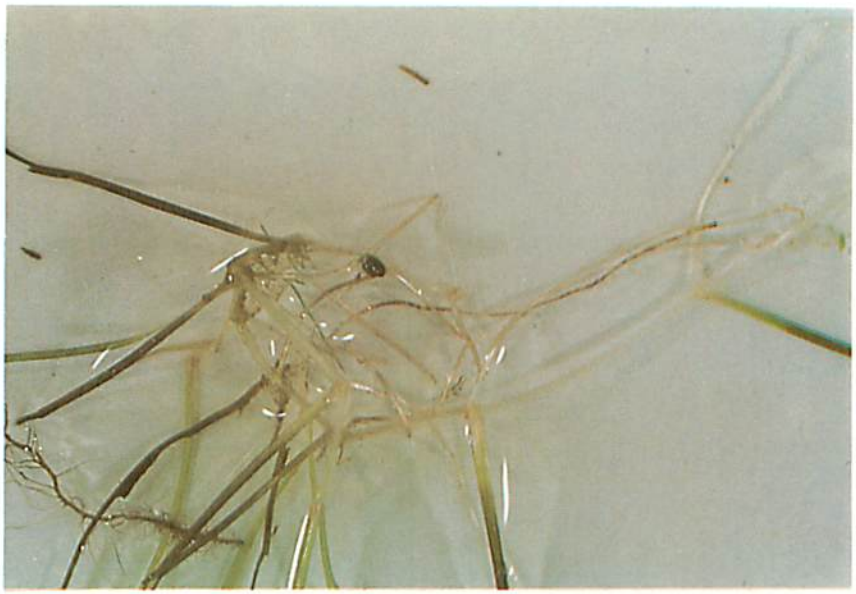
Male flower.

Widgeongrass seeds.

Female flower.



Potential (yellow) and actual (red) distribution of widgeongrass.



Widgeongrass growing from seed.

Sago pondweed: *Potamogeton pectinatus* L.

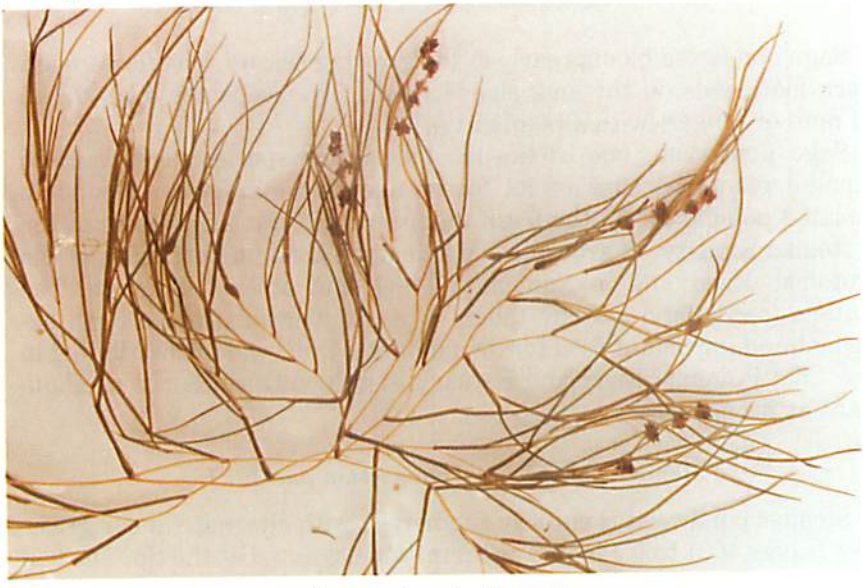
Sago pondweed is a vigorous plant with much branched stems and numerous threadlike leaves spreading out in fanlike fashion. The leaf tips have long tapering points; the length and thickness of the leaves is

Sago pondweed.

Bushy specimen of sago pondweed in flower.

Sago pondweed showing bean-shaped tuber.

quite variable. When not in bloom or in seed, it resembles widgeongrass, but its leaves are in bushier clusters, and the rootstocks are long and straight and often have tubers. Sago pondweed has a pointed tip (or "bayonet") attached to its stipules which also distinguishes it from widgeongrass.



Sago pondweed with seeds.

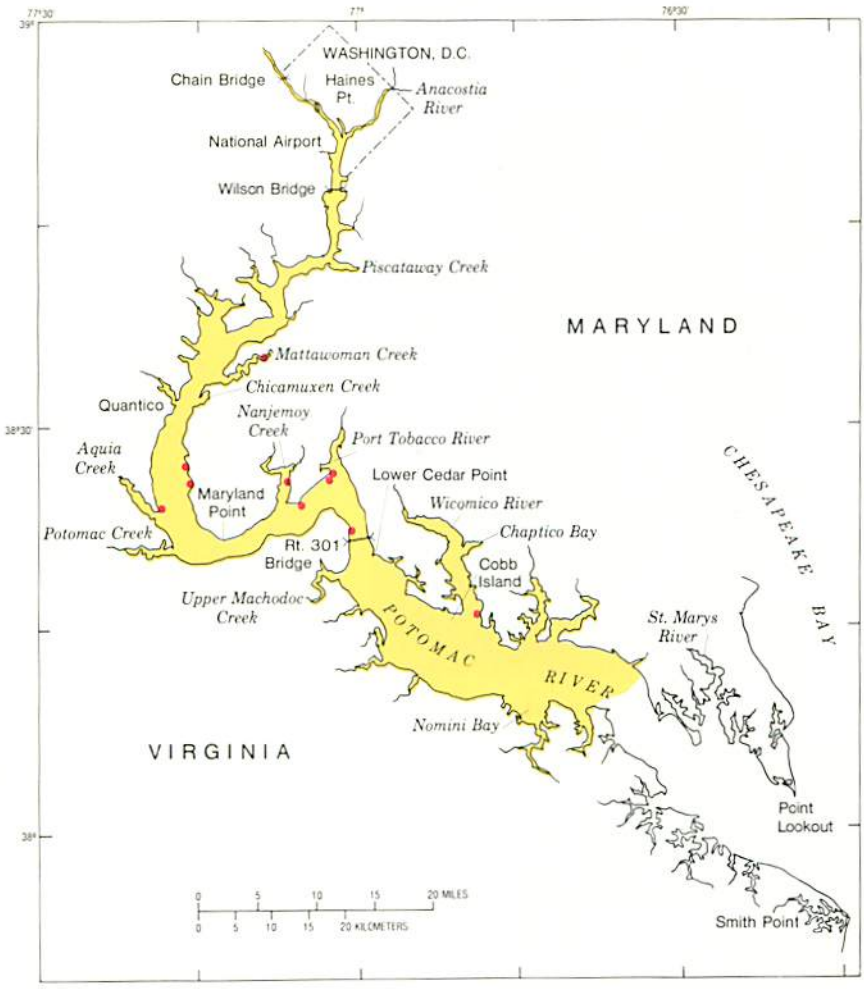
Close-up showing flowers (right) and seeds (left).

Sago pondweed blooms early in the growing season. The flowers are born like beads on the long slender stalk. The seeds are oval, 0.1 in (3 mm) or longer, with a pointed tip.

Sago pondweed, one of the most desirable species of submersed aquatic plants because of its food value to waterfowl, is found in isolated populations in the fresh to moderately brackish waters of the Potomac Estuary. It grows in the transition zone on both sides of the Potomac River and in Nanjemoy Creek and other tributaries. The nutlets (seeds) and starchy tubers of sago pondweed make it an excellent and important food for diving ducks. Once widely distributed in the tidal Potomac River and Estuary, sago pondweed is not as abundant as it once was.

Slender pondweed: *Potamogeton pusillus* L.

Slender pondweed is entirely submersed with alternate linear grass-like leaves, 0.01 to 0.1 in (0.3–2.4 mm) wide, pointed at the tip. The leaf blades are entire rather than toothed, and there are generally small glands at the unsheathed base of the leaves.



Potential (yellow) and actual (red) distribution of sago pondweed.

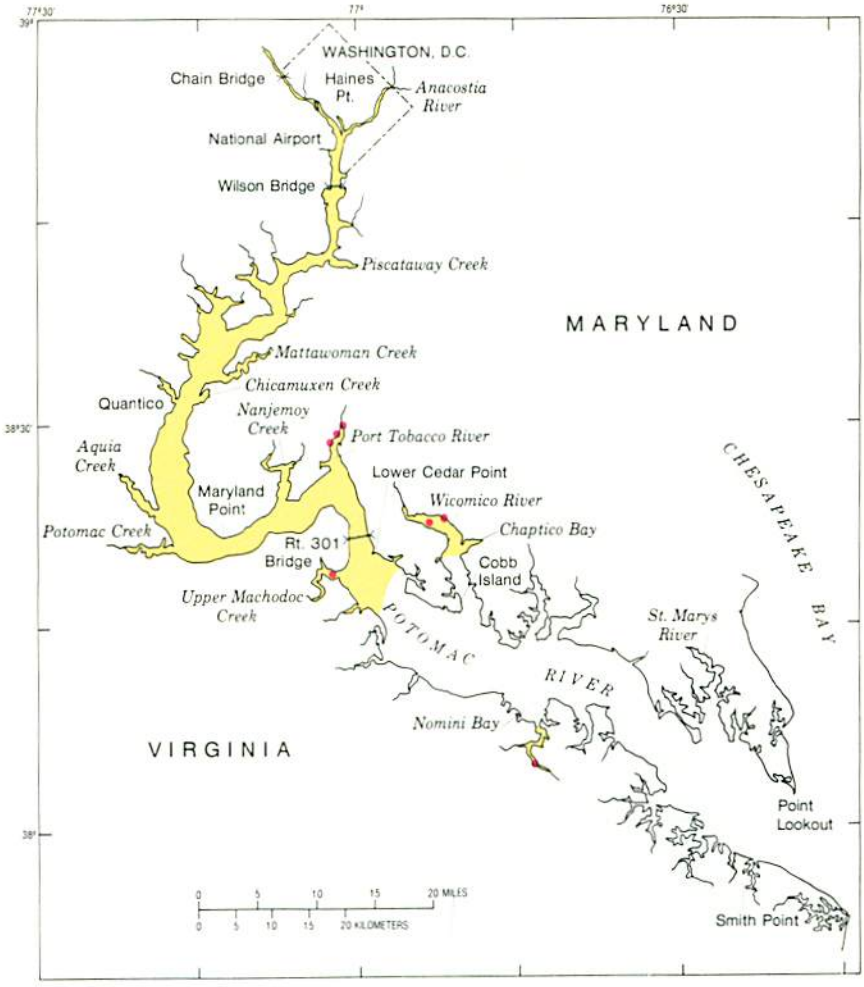
Slender pondweed has a relatively spotty distribution in the tidal Potomac River; it is seldom very abundant. It is found in fresh and slightly brackish water in the transition zone and tributaries – Nanjemoy Creek and Port Tobacco River on the Maryland side and Nomini Bay on the Virginia side. It is a good food for waterfowl when found in sufficiently large concentrations.

The flowers are born in whorls in terminal or axillary spikes. The seeds are small and rounded on the back. Winter buds are also produced. Slender pondweed can be confused with leafy pondweed (*Potamogeton foliosus*) which is found in small tributaries emptying into the Piscataway Creek. Leafy pondweed lacks the small glands at the base of the leaves, and its seeds have an undulate ridge along the back.

Slender pondweed.

Slender pondweed.

Slender pondweed showing seeds.



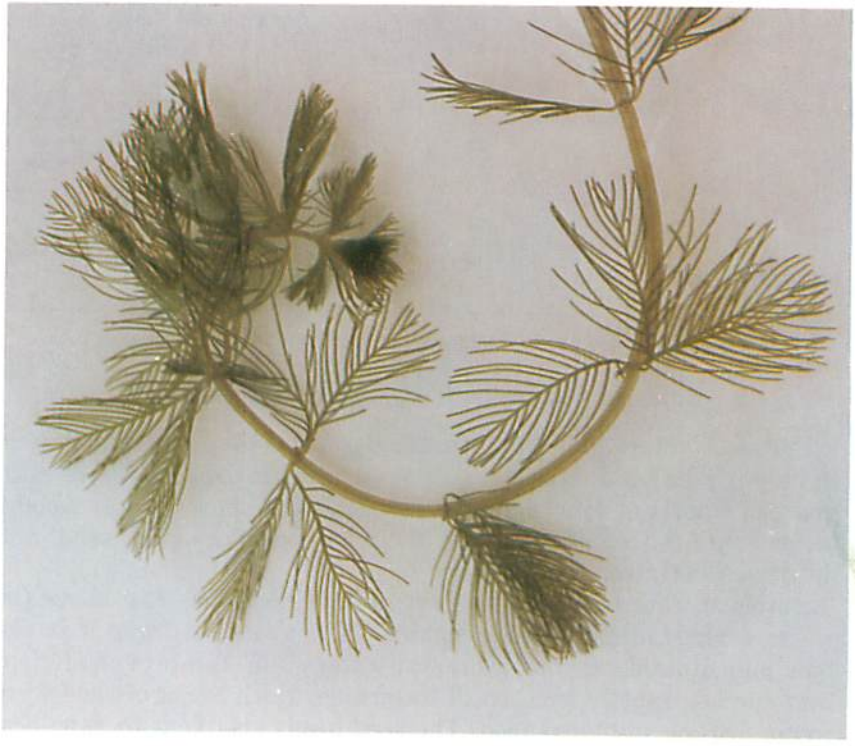
Potential (yellow) and actual (red) distribution of slender pondweed.

Eurasian watermilfoil: *Myriophyllum spicatum* L.

Eurasian watermilfoil was introduced to the United States from Asia in the early 1900's. It is easily recognized by its featherlike leaves which grow in whorls of four along the stems. It has short, almost woody, lower stems with numerous long roots and colonizes mud, sand, and detritus substrates.

Eurasian watermilfoil bears flowers in spikes which rise above the water surface in mid- to late summer. The abundant fruits look like four joined nutlike bodies. Eurasian watermilfoil is a perennial plant that spreads rapidly from small fragments which break off and form roots, drifting until stranded. The seed beads also float to new locations, or seeds are eaten and later excreted by waterfowl.

Eurasian watermilfoil.

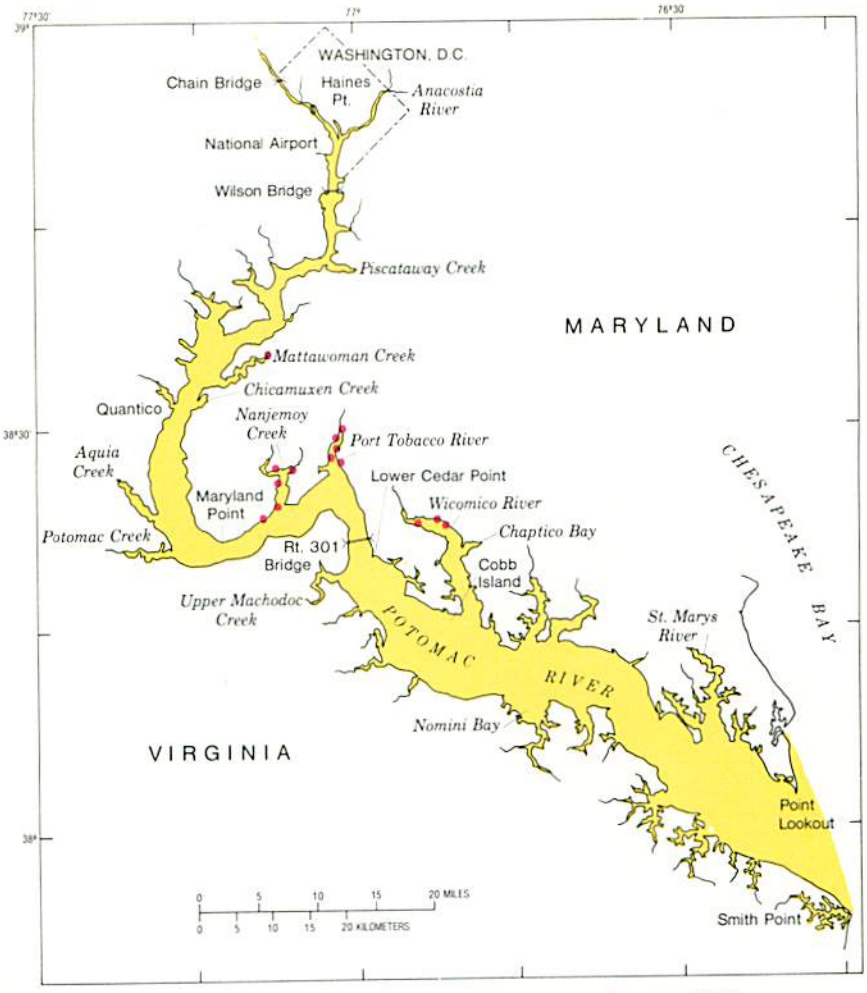


Eurasian watermilfoil showing leaf detail.

Eurasian watermilfoil flowering in Nanjemoy Creek. (Photograph by G. M. Haramis, U.S. Fish and Wildlife Service.)

At present, Eurasian watermilfoil occurs in widely scattered beds in the transition zone and tributaries including the Wicomico River. However, in the early 1960's, it enjoyed a brief population explosion in the tidal Potomac River and its tributaries, blocking many channels and backwater areas. It declined naturally and reached an apparently stable population level in the late 1960's. The plant provides excellent cover for fish fry and crabs, and its seeds may be locally important waterfowl food. In some areas, watermilfoil may outcompete more desirable waterfowl food plants.

Eurasian watermilfoil bed in Nanjemoy Creek. (Photograph by G. M. Haramis, U.S. Fish and Wildlife Service.)



Potential (yellow) and actual (red) distribution of watermilfoil.

Horned pondweed: *Zannichellia palustris* L.

Horned pondweed is a slender branching plant growing from extensive creeping rootstocks or rhizomes. It has numerous slender vertical stems with opposite or nearly opposite narrow threadlike leaves by which it may be distinguished from widgeongrass or sago pondweed. The base of the leaf is covered by a membraneous sheath or stipule. When exposed to wave action, it often forms mats of grasslike prostrate growth.

Horned pondweed flowers early in the growing season and develops conspicuous cresent-shaped horn-like fruits which aid in distinguishing it from widgeongrass. It dies back in late July and August in the tidal Potomac River. At this time, plants disintegrate, and vegetation and

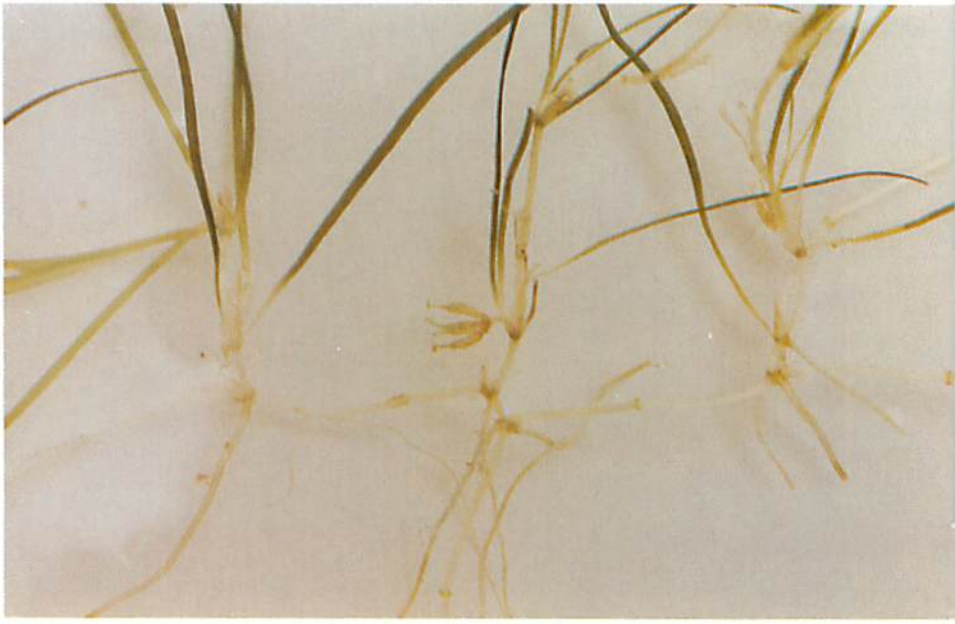
Horned pondweed, prostrate form. (Photograph by G. M. Haramis, U.S. Fish and Wildlife Service.)

seeds are dispersed throughout the estuary. New plants may be found during late September and October.

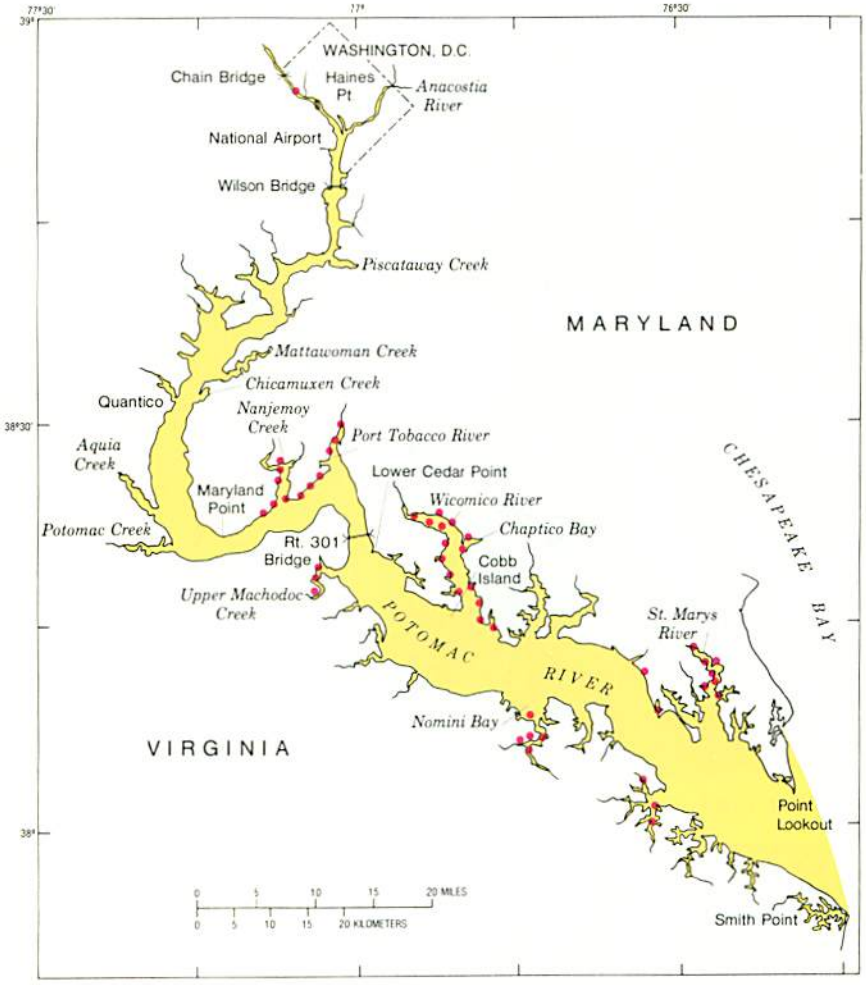
Horned pondweed is one of the most widely distributed submersed aquatic plants in the tidal Potomac River, growing in fresh to moderately saline water along the shore. It can be found up the river as far as National Airport in Washington, D.C., and as far down the river as the St. Mary's River. It grows in many of the tributaries, including the Wicomico River.

Horned pondweed, upright plant. (Photograph by G. M. Haramis, U.S. Fish and Wildlife Service.)

Mass of horned pondweed found floating in Wicomico River. (Photograph by G. M. Haramis, U.S. Fish and Wildlife Service.)



Seeds of horned pondweed.



Potential (yellow) and actual (red) distribution of horned pondweed.

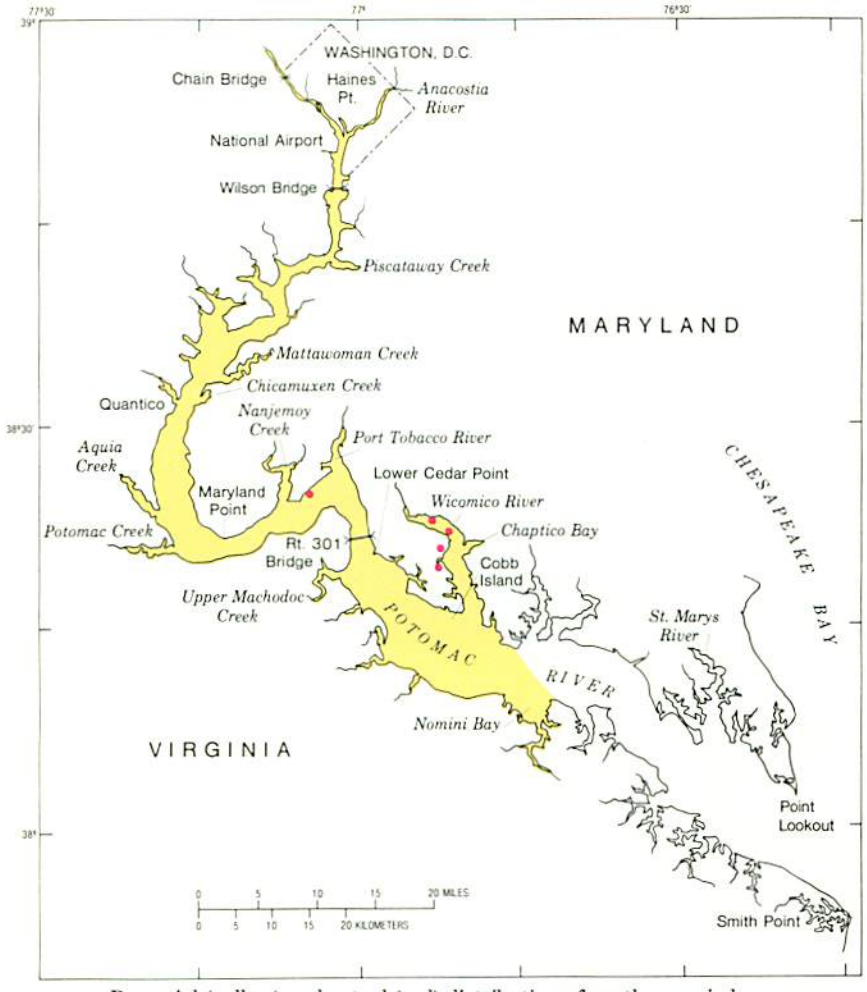
Southern naiad: *Najas guadalupensis* (Spreng.) Magnus

Southern naiad has coarse roots and slender much branched stems with opposite narrow toothed ribbonlike leaves enlarged at the base. The flowers and fruits are born singly in the leaf axils with papery walls tapered to a short style. Seeds are 0.08 to 0.2 in (2–5 mm) long, round in cross section, and tapered at each end. The seeds are coarsely and deeply pitted.

Southern naiad is found in very small populations in the tidal Potomac River. It occurs with other species in the fresh to slightly brackish water of the Wicomico River. Its stems, foliage, and nutlets are eaten by waterfowl.

Southern naiad.

Leaf detail of southern naiad.



Potential (yellow) and actual (red) distribution of southern naiad.

Naiad: *Najas gracillima* Magnus

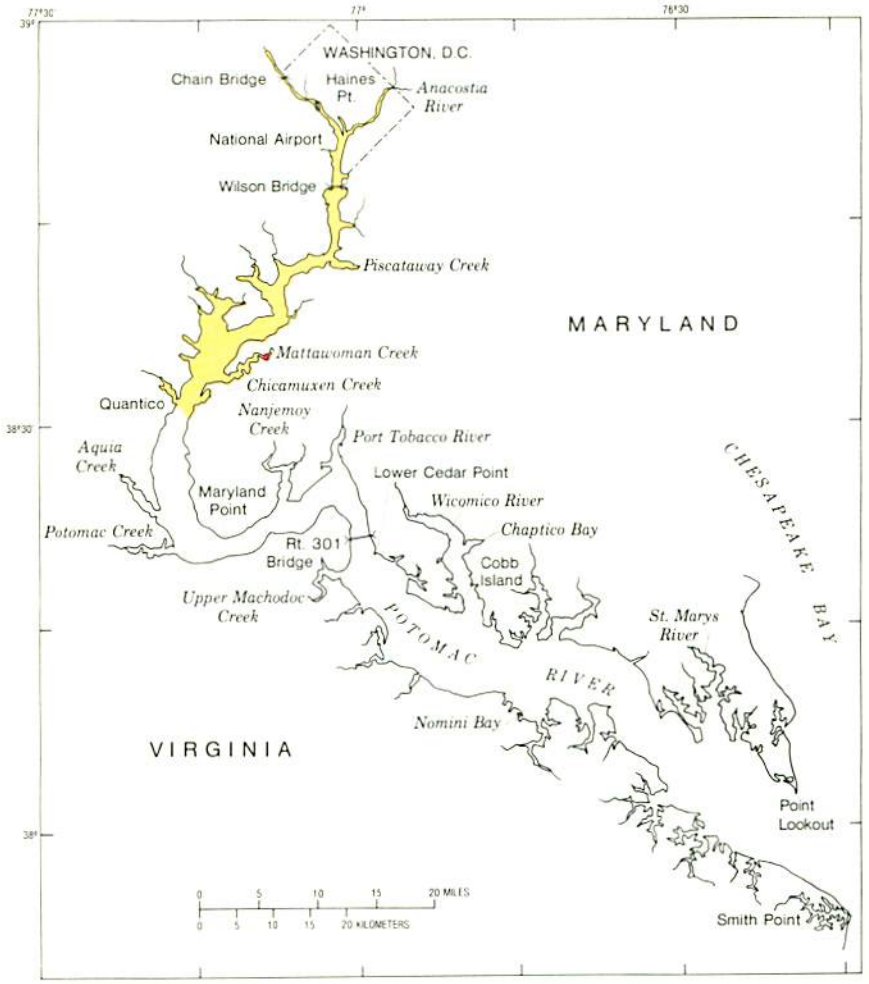
This naiad is a very slender and delicate plant. It has much branched stems and long straight linear leaves with a sheathing base. The enlarged base has relatively long spiny teeth. The seeds are linear and slightly cresent shaped with rows of small pits. Naiad has only been found in freshwater in the upper reaches of the Mattawoman Creek.

Naiad.

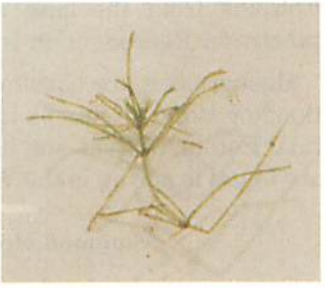
Naiad showing seed.

Muskgrass: *Chara* spp.

Muskgrasses, sometimes called stoneworts, are actually algae. The plant body or stem has alternating short nodes and long internodes with whorls of simple undivided branchlets occurring at the nodes.

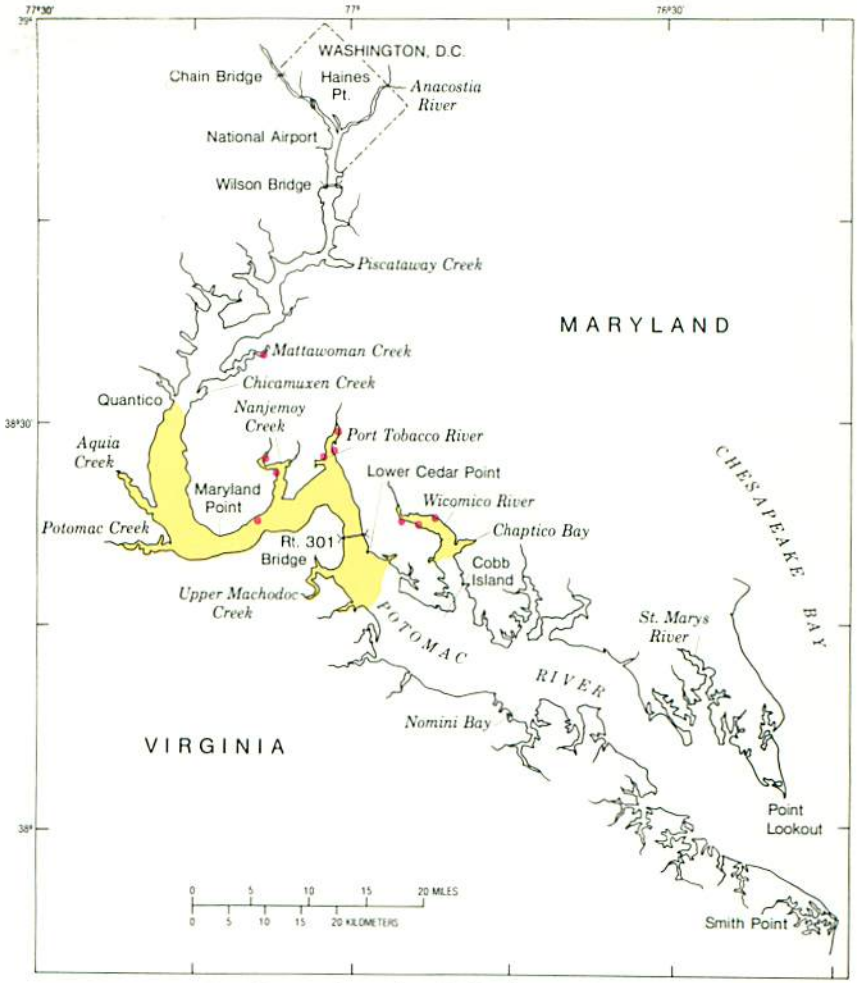


Potential (yellow) and actual (red) distribution of naiad.



Muskgrass.

Muskgrass with filamentous algae covering stems and leaves.



Potential (yellow) and actual (red) distribution of muskgrass.

Rhizoids from the base of the stem hold the plant firmly on the substrate. Reproduction is by spores rather than flowers and seeds.

Muskgrasses are bottom-dwelling plants that grow in small populations or isolated clumps in the fresh to slighly brackish water of the tidal Potomac River and its tributaries. Significant numbers of plants are found in spring in the Wicomico River but disappear in midsummer.

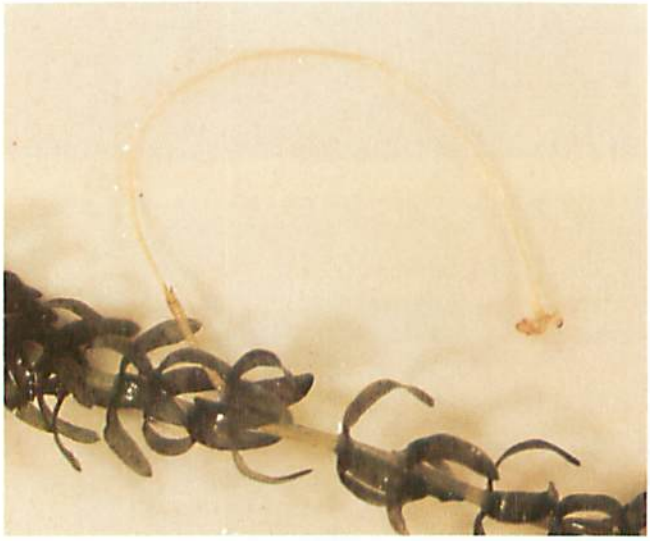
Common elodea: *Elodea canadensis* Michx.

Common elodea is often found in home aquariums; it is only locally abundant in the tidal Potomac River. It has branching stems with leaves in whorls of two or three at the nodes, and the leaves are closely

Common elodea.

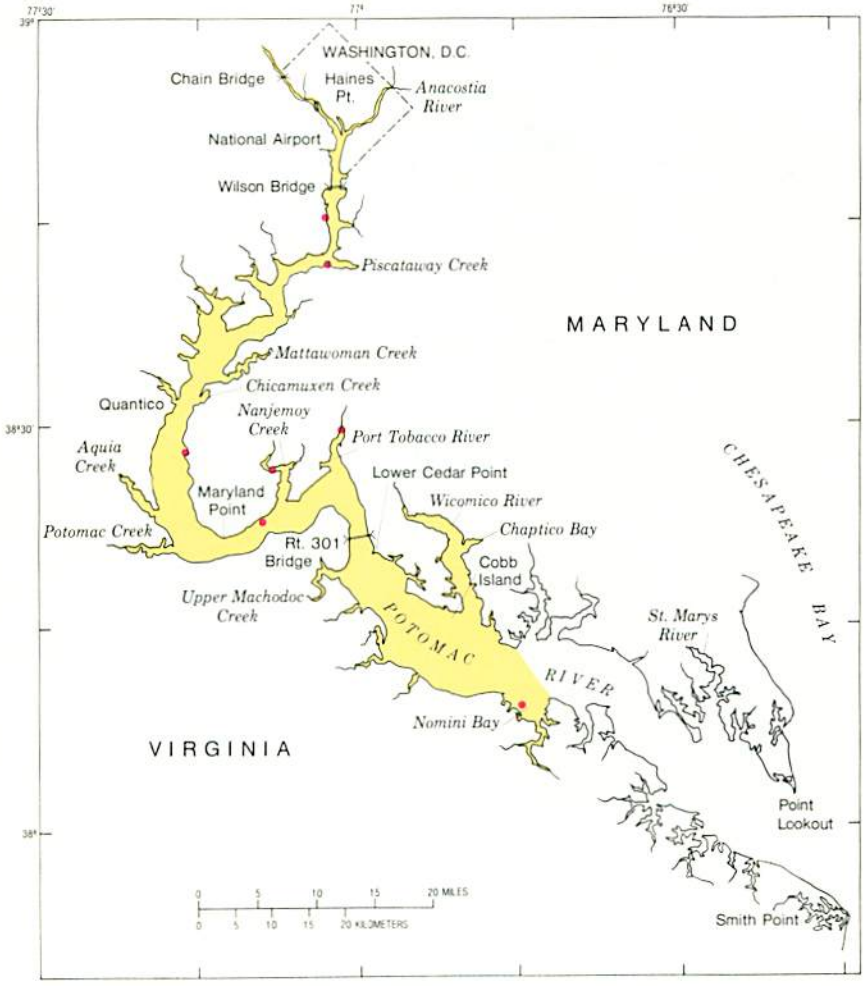
Common elodea, leaf detail.

Bed of common elodea in Nomini Bay. (Photograph by G. M. Haramis, U.S. Fish and Wildlife Service.)



Elodea in flower.

crowded near the tip of the stem. The leaves are veinless and one-ribbed, linear, or narrowly oval with blunt tips and no leafstalk, varying in width and size at different locations. The leaves have microscopic teeth along the margins.



Potential (yellow) and actual (red) distribution of common elodea.

Common elodea seldom blooms in our area, reproduces vegetatively, and is often found broken loose and free-floating. When it blooms, male flowers are on a spathe 0.4 to 0.5 in (11–13 mm) long, and female flowers have a long threadlike tube that reaches the surface for pollination.

Common elodea is found only occasionally growing in the tributaries of the tidal Potomac River in fresh to moderately brackish water and generally in association with other plants. Large populations are only found in extremely sheltered areas with clear water as in Nomini Bay or the tiny subtributaries, such as those entering Piscataway Creek. It is generally a poor food for ducks because it produces little or no seed in this area. Elodea can achieve extremely dense growth which provides excellent refuge to an abundance of aquatic life.

Water-weed.

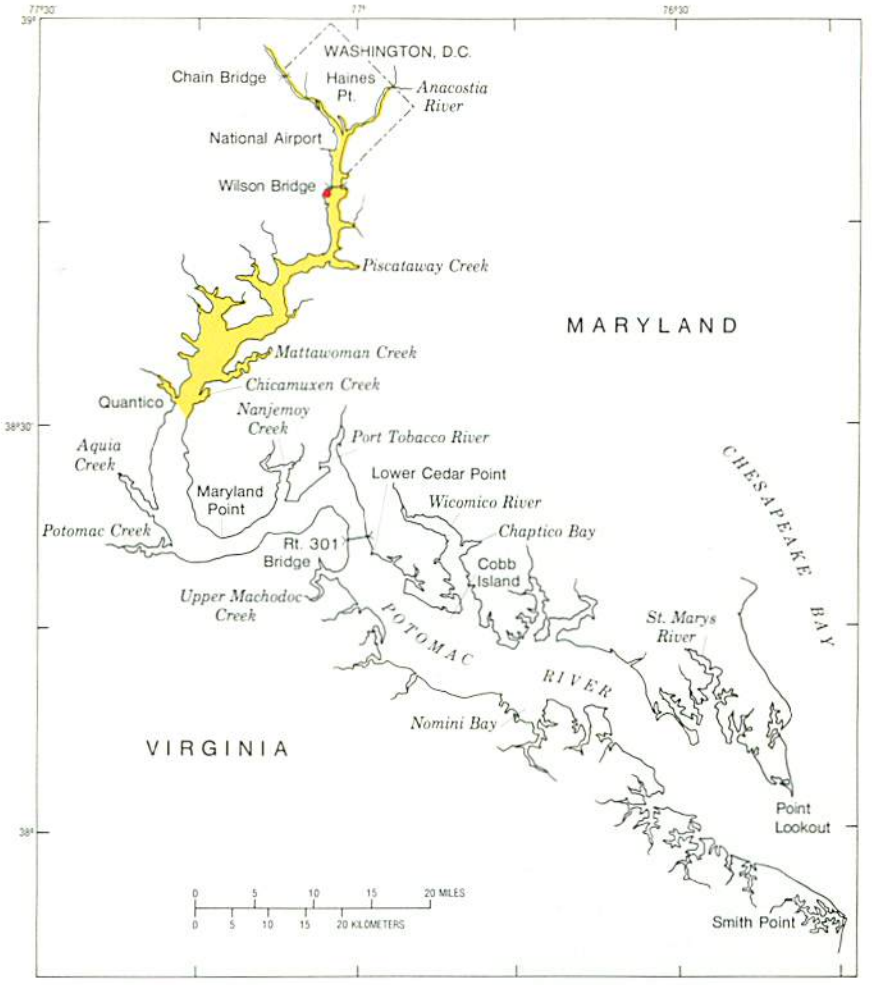
Water-weed: *Egeria densa* Planch.

Water-weed, also know as Anacharis, was introduced to this country from South America. It is similar to common elodea but is a larger coarser plant. It has branching stems with leaves in whorls of four or more at the nodes, closely crowded near the tip of the stems. The leaves are linear to narrowly lance shaped with microscopic teeth along the margins. Flowers have not been observed in our area.

Water-weed has been found only in the freshwater tributaries to the tidal river, growing in extremely clear flowing water under tidal influence.

IMPORTANCE OF SUBMERSED AQUATIC VEGETATION

Submersed aquatic plants are an important component of the aquatic environment. In the Chesapeake Bay and the Potomac River, aquatic plant communities have many functional values. Growing in beds along the shallow flats and margins, the plants create a habitat that provides



Potential (yellow) and actual (red) distribution of waterweed.

food and cover for large numbers of invertebrate species – insect larvae, mollusks, crustaceans, and others – which are eaten by fish, waterfowl, and larger invertebrates. The plants themselves (seeds, leaves, stems, tubers, and attached epiphyte populations) are consumed by such diverse herbivores as ducks, muskrats, snails, turtles, and fish. The vegetation provides valuable spawning sites for some fish and refuge for fish fry, many invertebrate species, and juvenile and molting crabs. Plant beds also improve water quality by absorbing nutrients from the water column, by providing a source of oxygen as a byproduct of photosynthesis, and by settling particulate matter. The stems and leaves retard current flow, and the roots stabilize the bottom, thus slowing erosion and encouraging the accumulation of sediment. In

Aquatic plants growing on the shallow margins of the Port Tobacco River, Md. (Photograph by G. M. Haramis, U.S. Fish and Wildlife Service.)

Patches of curly pondweed growing in a shallow bay in Nanjemoy Creek, Md. (Photograph by G. M. Haramis, U.S. Fish and Wildlife Service.)

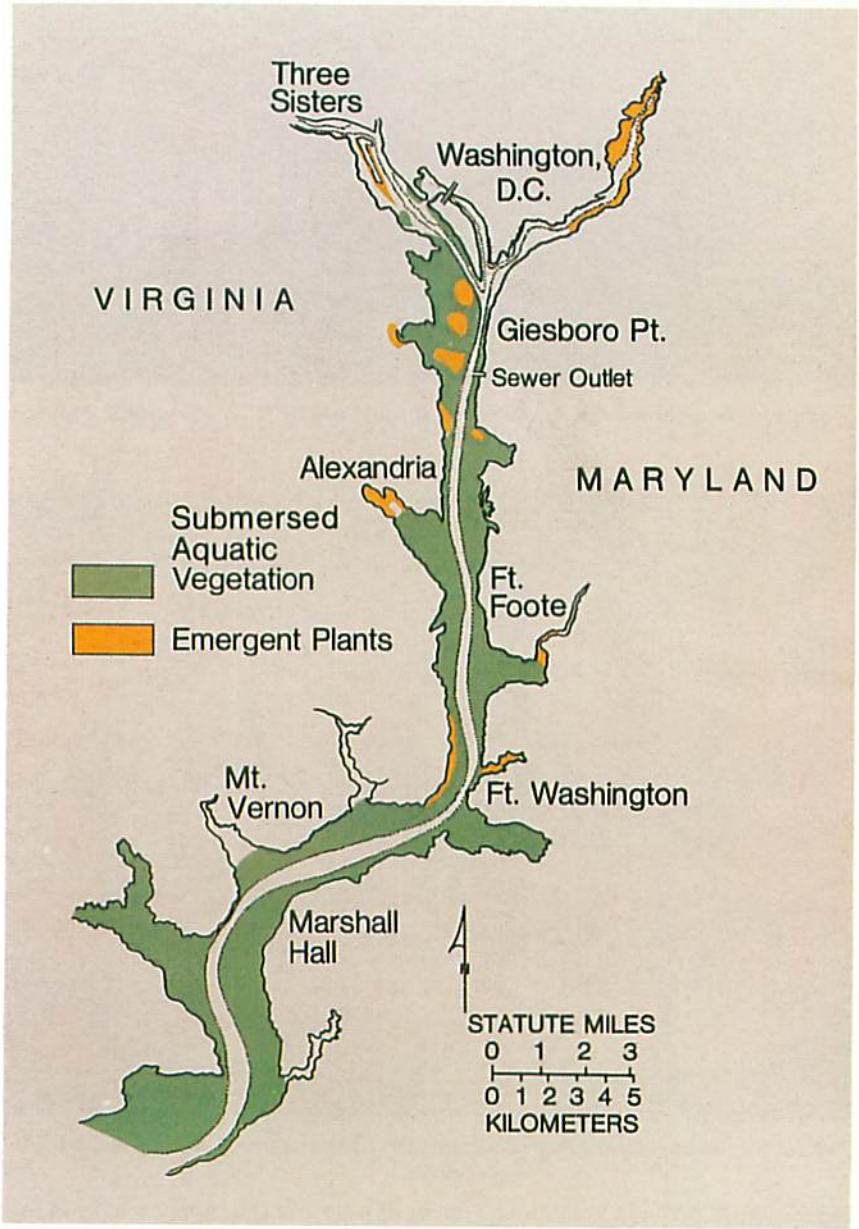
Wildcelery plant parts eaten by waterfowl. (Photograph by M. C. Perry, U.S. Fish and Wildlife Service.)

Canvasbacks on Chesapeake Bay. (Photograph by G. M. Haramis, U.S. Fish and Wildlife Service.)

turn, plants provide a valuable source of detritus that serves as food for numerous organisms in the detritus-based food chain of the estuary and coastal zone.

HISTORIC AND PRESENT DISTRIBUTION

Historically, the Potomac Estuary and tidal river contained an abundance of submersed aquatic vegetation. A map of the river at low tide,



Upper part of the tidal Potomac River at low water showing distribution of aquatic vegetation (reproduced from Cumming and others, 1916).

published in 1916, shows a narrow channel and wide shallow vegetated margins and flats containing curly pondweed, coontail, and wildcelery. The transition zone and lower estuary were also well vegetated; eelgrass (*Zostera marina*) beds were found in shoal zones as far up the river as Cobb Island at the mouth of the Wicomico River.

Today, large beds of submerged aquatic plants occur primarily in the transition zone. There is almost no submersed vegetation in the freshwater tidal river, except for one large bed of wildcelery in the ship channel behind Haines Point in Washington, D.C., and a bed of wildcelery, slender pondweed, and naiad in Mattawoman Creek 5 km upstream of the tributary mouth. There are small healthy beds of elodea, water-weed, and curly pondweed in tiny tributaries emptying into the Potomac River, and there is a large stand of horned pondweed in the tidal pond behind National Airport. Broad expanses of the lower estuary are completely unvegetated, and eelgrass no longer occurs in the Potomac River.

FACTORS AFFECTING DISTRIBUTION AND ABUNDANCE

Submersed aquatic plants occur where the physical and biological environment is favorable to their growth and reproduction. Each species has its own requirements for and tolerances to salinity, temperature, light, substrate type, water velocity, and other factors. In addition, submersed aquatic plants must compete for light, space, and nutrients in the aquatic system. Plant populations in the Potomac River and the Chesapeake Bay vary in size naturally from year to year, depending upon the water temperature, the salinity, the amount of seed set the previous year, and the successful germination of seeds. Distribution of annual plants, such as horned pondweed, may fluctuate greatly if storms scour the bottom and wash away the seeds. Large beds of perennial plants such as wildcelery and sago pondweed growing from rhizomes and tubers may reappear in the same location year after year.

A general decline in populations of submersed aquatic plants in the Chesapeake Bay has been noticeable in recent years. However, the plants in much of the tidal Potomac River and Estuary disappeared in the 1920's and 1930's and have not reappeared. By 1939, the loss of plants from the tidal river and the lack of eelgrass in the lower estuary had been noticed and documented by scientists interested in waterfowl food. Various theories have been suggested to account for the disappearance of submersed aquatic plants in the tidal river and lower estuary and for the decline throughout the Chesapeake Bay, but sound scientific support for these theories has been generally lacking. The factors which caused the disappearance of these plants from the tidal river may or may not be operating today. Natural stresses such as

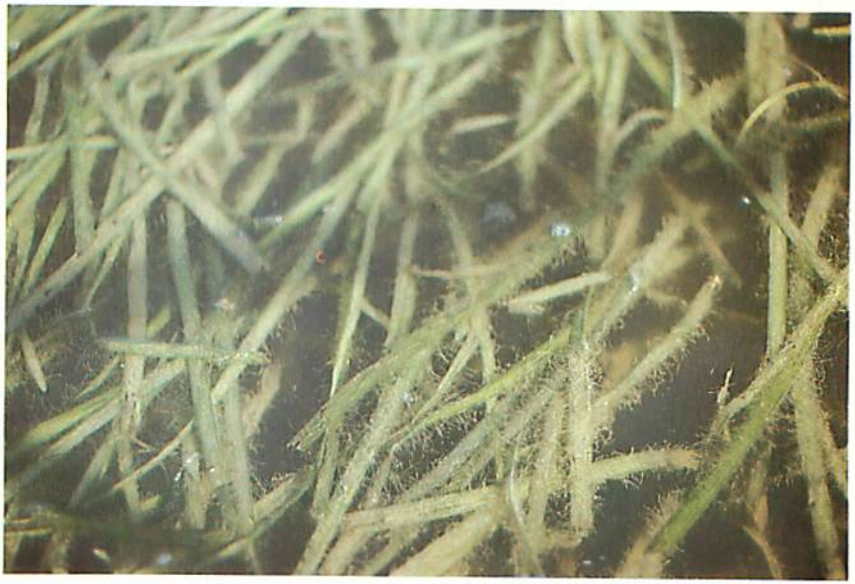
overgrazing by animals or climatic changes and manmade stresses, such as pollution, could act together or separately to affect plant survival.

NATURAL CLIMATE EFFECTS

Severe storms, such as Hurricane Agnes in 1972 and the March storm of 1936, caused by early snowmelt and heavy precipitation may have scoured the sediment from some parts of the river or deposited large quantities of sediment over the vegetation beds, as happened in the Susquehanna Flats area of the Chesapeake Bay after Hurricane Agnes. However, plant populations are generally fairly resilient, and recolonization, although it might take several years, should be expected to occur. Warming trends and disease have been suggested as possible causes for the eelgrass disappearance in the Potomac River during the 1930's.

EXCESSIVE NUTRIENTS

Decline in submersed aquatic vegetation may be associated with the long-term increase in nutrient enrichment from metropolitan wastes, agricultural runoff, and other sources. The introduction of nutrients may have changed the balance between phytoplankton and aquatic plant growth and favored a major ecological shift in primary productivity. Scientists have shown that increased nutrient loads cause heavy epiphyte and filamentous algae growths that shade out aquatic plants. An initial decline in plant abundance followed by continued shading



Epiphytes growing on submersed aquatic plants in the tidal Potomac River. (Photograph by G. M. Haramis, U.S. Fish and Wildlife Service.)

from phytoplankton may greatly suppress or eliminate the aquatic plant populations. Fluctuations of salinity in the transition zone may limit the growth of epiphytes and algae and allow the submersed aquatic plants to survive, even if nutrient concentrations are high.

TURBIDITY

Increasing turbidity from suspended sediment or algae causes a reduction in the light available for photosynthesis and generally acts to confine plant growth to shallower water. Many scientists believe that turbidity has been a factor suppressing plant growth in the tidal Potomac River. At present, there is no evidence that turbidity is higher today than in the early 1900's or that turbidity was responsible for the disappearance of plants from the tidal river. Turbidities in the transition zone where plants are abundant are very similar to those in the tidal river. Observations have shown that plants presently existing in the Potomac River are those that grow to or near the water surface, thus avoiding the effects of turbidity.

POLLUTION

Submersed aquatic plants may be sensitive to increased loads of pollutants such as chlorine, herbicides, or such natural substances as sediment. It has been suggested that chlorine from sewage and water-treatment facilities and powerplants could have an adverse affect upon aquatic plants. The Ecological Services Laboratory of the National Park Service has found that elodea, wildcelery, and other species are adversely affected by chlorine concentrations at levels near those presently found in the tidal river. It is not clear, however, that chlorine caused the original disappearance of the submersed vegetation, nor is there sufficient evidence to state that its presence prevents the reestablishment of the plants. Herbicide usage has increased in the entire Chesapeake Bay area, and herbicides may adhere to silt particles and be washed into adjacent streams. Laboratory and field studies would be needed to establish whether concentrations of herbicides in bottom sediments or water are sufficient to affect the aquatic vegetation. The same is true for heavy metals and chemicals which are both present in the sediment and water of the Potomac River. The impact of oil and oil-contaminated sediments on submersed aquatic vegetation is not known, and the concentrations of heavy metals in water seem to be lower than those found to affect the growth of aquatic plants.

OVERGRAZING

Carp, cownose rays, waterfowl, and muskrat have all been accused of destroying or damaging aquatic plant beds. Plants transplanted to the

tidal river in Washington, D.C., and Maryland survive if wire cages or exclosures are placed around them; they are cut off or uprooted when unprotected. It is possible that predation or overgrazing is preventing the recolonization of the shallow flats in the reach from Chain Bridge to Quantico.

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