FRESHWATER TIDAL WETLANDS

Contents

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Concept: Freshwater Tidal Wetlands are marshes and swamps that experience regular lunar tidal or irregular wind tidal flooding with water less salty than brackish. Salinity ranges from oligohaline to fully fresh, though saltier water may intrude along the bottom of adjacent estuaries and saltier water may flood them during storm tides.

Distinguishing Features: Freshwater Tidal Wetlands are distinguished from all other themes by the occurrence of tidal flooding along with vegetation indicative of freshwater or oligohaline conditions. The distinction of Tidal Swamps from riverine swamps can be especially subtle; canopies may be the same but often show a composition more intermediate between blackwater and brownwater swamps, marking a change from vegetation upstream. Lower strata are usually but not always more diverse.

Tidal Freshwater Marshes are distinguished by dominance by herbaceous or shrub or mixed vegetation, with trees present only as sparse canopies (occasionally up to 50% tree cover). Floating-leaf aquatic plants (*Nuphar* spp.) are also included. The Freshwater Marsh Pool community has submerged aquatic vegetation in small areas surrounded by other Tidal Freshwater Wetlands. More extensive submersed aquatic vegetation is not yet represented in this classification but might also be placed within this theme. Tidal Red Cedar Swamp is distinguished by an open canopy of *Juniperus silicicola* in a matrix of herbaceous vegetation, often associated with substantial fine-scale microtopography that allows the species to coexist. Tidal Swamps are dominated by trees in closed or open canopies.

Synonyms:

Sites: These communities occur on broad flats and intertidal bands along the shorelines of estuaries and tidally influenced rivers. They range from sea level to a few feet above, depending on the tidal range.

Soils: Soils range from alluvial soils to marsh soils. They are usually organic but may be mucky mineral soils.

Hydrology: Tidal flooding ranges from lunar to wind tidal. The distinction between these may create important differences in dynamics (Odum et al. 1984). In the southern part of the state, where barrier islands are short and tidal ranges the highest, semidiurnal lunar (astronomical) tidal fluctuations propagate up rivers and creeks upstream of where salt or brackish water floods the banks. Partially this is caused by water damming — the high tide downstream blocking the flow of the river's fresh water. Penetration of a salt wedge along the bottom of rivers may also push fresh or oligohaline surface water into adjacent wetlands without subjecting them to higher salinity. In the northern part of the state, continuous barrier islands and low tidal range in the ocean result in little lunar tidal influence. At the same time, the broader estuaries are more subject to effects of persistent winds, which can raise or lower water levels by one or two feet, in tidal fluctuations that can then penetrate upstream on tidal creeks and flood adjacent wetlands. Wind tidal fluctuations may be slow but can be observed to be rapid at times.

Water is fresh or oligohaline because of limited exchange with sea water, combined with dilution by fresh water from rainfall and river flow. Freshwater Tidal Wetlands that are closer to brackish or salt water may be penetrated by saltier water during unusual events such as storm surges, but saltier conditions do not persist.

Vegetation: Vegetation structure ranges from closed forests to dense tall herbaceous vegetation, short dense to sparse herbaceous vegetation, to floating or submersed aquatic plants. Swamps are dominated by combinations of *Nyssa biflora*, *Nyssa aquatica, Taxodium distichum, Acer rubrum*, and *Fraxinus pennsylvanica*. Marshes may be near monocultures of *Sporobolus* (*Spartina*) *cynosuroides, Cladium jamaicense*, *Typha* spp., *Zizaniopsis miliacea* or a few other species, by virtue of the large size and clonal growth excluding smaller plants. However, they more often are more diverse mixtures of other graminoid and broadleaf herbaceous species. Shrubs, especially *Morella cerifera*, but sometimes *Baccharis halimifolia*, *Persea palustris* or other species may also be prominent or dominant. Woody vines, especially *Toxicodendron radicans* may be abundant. Freshwater Tidal Wetlands usually contain more plant species than the saltier Estuarine Communities, and some subtypes of both Tidal Freshwater Marsh and Tidal Swamp are quite diverse.

Dynamics: Short term dynamics of Freshwater Tidal Wetlands are driven by tidal fluctuations, which bring nutrients into the ecosystem and make them more fertile and productive than most nontidal wetlands. An important natural disturbance is occasional penetration of brackish water into them, driven by hurricanes and other storms. Hackney (1990) noted that nor'easters may be more important because they are not accompanied by as heavy rains as hurricanes. Because these marshes contain many plant species not tolerant of brackish conditions, much of the vegetation is damaged by these events. The frequency and severity of brackish water intrusion likely is responsible for much of the zonation among these communities, which vary in the salt tolerance of their dominant species. Natural shifting of channels and artificial ditching can modify these patterns.

Other dynamics may be occurring among different subtypes due to the ability of several dominant plant species to spread vegetatively. These are not well known, but Frost (2000) suggested that fire may be important for maintaining some of the lower stature communities such as the Oligohaline Low Marsh Subtype from expansion by larger stature subtypes.

The long term dynamics of these communities are driven by the long-standing ongoing rise in sea level. Accumulation of organic or mineral sediment may partly offset these rises, especially in those with regular lunar tides and significant tidal currents to move sediment. Nevertheless, all Freshwater Tidal Wetlands should be regarded as in transition to wetter and saltier communities. Often this transition is slow, but it may happen abruptly in local areas. Vegetation that is under stress by increased wetness can be killed over sizeable areas by a single salt intrusion event and regenerate as a different community. Many Tidal Swamps can be seen to be under stress, with canopies thinning, individual trees showing reduced crowns, and shrub and herbaceous marsh vegetation establishing beneath them. Vast areas of recently dead swamp can be seen along the sounds.

This process can be exacerbated and accelerated by artificial alterations. A recent artificial transition from swamp to marsh can often be observed along ditches that are connected to estuarine waters. Hackney (1990) noted that the tidal range of the Cape Fear River estuary has increased with each dredging of the shipping channel, that all of the colonial era rice fields were in areas now too salty to grow rice, as well as that the sea level has risen by nearly a foot there. He also noted that some tidal swamps had trees growing on old stumps, but that nearby old rice fields that had no stumps had become marshes.

Comments: Tidal Freshwater Marsh has more subtypes than any other community type. Most occur as zones or as apparently random patches in a mosaic. Many are based on a single dominant species that spreads clonally, and it is not entirely clear that they represent anything other than the chance spread of clones. Other portions of marsh complexes have mixed vegetation that is intermediate between two or more of the subtypes. In particular, the Giant Cordgrass, Sawgrass, Threesquare, and Cattail subtypes tend to occur together. The Needlerush Subtype also is a major part of this mosaic in the Currituck Sound area. It is unclear if these represent stable mosaics or if the subtypes shift over time. With further study, it may be appropriate to lump these into a single subtype. However, the relative amounts of each vary, and some are absent from particular sites, suggesting some value in attempting to track each specifically. The other subtypes are more distinct and are associated with different kinds of sites.

Taxodium distichum / *Typha angustifolia* Woodland (CEGL004231) and several other tidal *Taxodium distichum* woodlands have been recognized in Virginia and attributed to North Carolina. These do not appear to be distinct enough to be appropriate as community elements. *Taxodium* groves may be present in most of the Tidal Freshwater Marsh subtypes.

References:

Frost, C.C., III. 2000. Studies in landscape fire ecology and presettlement vegetation of the southeastern United States. PhD. Dissertation, University of North Carolina, Chapel Hill.

Hackney, C.T. 1990. Effects of human activities and sea level rise on wetland ecosystems in the Cape Fear River estuary, North Carolina, USA. In: D.F. Whigham, et al. (eds) Wetland Ecology and Management: Case Studies pp 55-61.

Odum, W.E., T.J. Smith III, J.K. Hoover, and C. C. McIvor. 1984. The ecology of tidal freshwater marshes of the United States East Coast: a community profile. FWS/OBS 83/17.

KEY TO FRESHWATER TIDAL WETLANDS

1. Vegetation a forest or woodland; tree cover greater than 25% unless recently disturbed.
   2. Canopy dominated by *Nyssa biflora, Nyssa aquatica*, or *Taxodium distichum*, in some combination. **Tidal Swamp (Cypress—Gum Subtype)**
   2. Canopy dominated by *Fraxinus pennsylvanica, Pinus taeda, Ulmus americana, Fraxinus profunda* in some combination, or by *Juniperus silicicola*; if *Taxodium* or *Nyssa* are present, they are a minority of the canopy.
      3. Canopy dominated by *Juniperus silicicola*; undergrowth consists of herbaceous species of marshes, often larger graminoids or more salt-tolerant forbs ..... **Tidal Red Cedar Forest**
      3. Canopy dominated by combinations of *Fraxinus pennsylvanica, Pinus taeda, Ulmus americana,* and *Fraxinus profunda*, though *Juniperus silicola* may be abundant; undergrowth often shared with marshes, sometimes larger graminoids and more salt-tolerant forbs but generally with abundant species less tolerant of salt. ..... **Tidal Swamp (Mixed Subtype)**

1. Vegetation not a forest or woodland; tree cover less than 25%, generally of relict trees that are not regenerating, or of young trees that are not expected to mature because of normal natural disturbances or salt exposure; vegetation herbaceous, shrub-dominated, or, occasionally, sparse or limited to aquatic plants.
   4. Vegetation limited to submerged or floating aquatic plants in deeper water, sparse plants on a mud flat, or small plants on a low fringe of a marsh complex; sites permanently flooded or exposed only during the lowest part of normal tidal ranges.
      5. Community largely aquatic, consisting of submersed or floating aquatic vegetation; always flooded.
         6. Community consisting of submersed plants in a deep pool surrounded by marsh. ..... **Freshwater Marsh Pool**
         6. Community consisting of floating-leaf or free-floating plants; occurring in permanent water within a stream or river channel.
            7. Community dominated by *Nuphar*.
               8. Community dominated by *Nuphar advena*..... **Tidal Freshwater Marsh (Broadleaf Pondlily Subtype)**
               8. Community dominated by *Nuphar sagittifolia* ..... **Tidal Freshwater Marsh (Narrowleaf Pondlily Subtype)**
            7. Community dominated by free-floating plants such as *Hydrocotyle ranunculoides* and *Alternanthera philoxeroides*; occurring in a river or stream channel; normally inland beyond tidal influence but sometimes extending into tidal reaches. ..... **Riverine Floating Mat**
      5. Community not largely aquatic, consisting of sparse to dense small plants such as *Eleocharis*, *Lilaeopsis*, *Isoetes, Eriocaulon*, or other smaller plants not characteristic of any Tidal Freshwater Marsh subtype.
         9. Vegetation sparse; site primarily bare mud; *Isoetes riparia* or other small plants predominate.. ..... **Tidal Mud Flat**
         9. Vegetation moderate to dense; *Lilaeopsis, Eleocharis, Eriocaulon* or similar species dominant; occurring as a fringe on the edge of marsh patches. ..... **Tidal Freshwater Marsh (Shoreline Lawn Subtype)**
   4. Vegetation dense, consisting of shrubs, large graminoids, or medium to large forbs.
      10. Vegetation dominated by *Morella cerifera*, often with *Persea palustris, Toxicodendron radicans*, relict trees, and sometimes abundant snags and logs of a former tree canopy. ..... **Tidal Freshwater Marsh (Shrub Subtype)**

10. Vegetation dominated by herbs; relict trees may occasionally be present in a sparse canopy but shrubs are absent or sparse.

11. Vegetation dominated by *Spartina cynosuroides*, sometimes but not always in nearly monospecific stands; usually occurring as a zone on the edges of oligohaline marsh complexes near the tidal channel or estuary ..... **Tidal Freshwater Marsh (Giant Cordgrass)**

11. Vegetation not dominated by *Spartina cynosuroides*; settings various

12. Vegetation dominated by *Cladium jamaicense*, sometimes but not always in dense monospecific stands; usually occurring as an interior zone in oligohaline marsh complexes, but sometimes on edges **..... Tidal Freshwater Marsh (Sawgrass Subtype)**

12. Vegetation not dominated by *Cladium jamaicense*; settings various.

13. Vegetation dominated by *Juncus roemerianus*; dense or moderate in cover (but mixed with species less tolerant of brackish water that distinguish it from Brackish Marsh); usually occurring as an interior zone in oligohaline marsh complexes..... ..... **Tidal Freshwater Marsh (Needlerush Subtype)**

13. Vegetation not dominated by *Juncus roemerianus*; settings various

14. Vegetation dominated by *Schoenoplectus (Scirpus) pungens*; sometimes but not always in dense monospecific stands; usually occurring as an interior zone in oligohaline marsh complexes, but sometimes on edges..... ..... **Tidal Freshwater Marsh (Threesquare Subtype)**

14. Vegetation not dominated by *Schoenoplectus pungens*; settings various

15. Vegetation dominated by *Typha latifolia, Typha angustifolia*, or *Typha domingensis*; sometimes but not always in dense monospecific stands; usually occurring as an interior zone in oligohaline marsh complexes, but sometimes on edges..... ..... **Tidal Freshwater Marsh (Cattail Subtype)**

15. Vegetation not dominated by *Typha* sp.; settings various.

16. Vegetation dominated by *Zizaniopsis miliacea*; most often occurring with no other marsh subtypes or only with the Broadleaf Pondlily or Narrowleaf Pondlily subtypes, but sometimes as a zone in the interior of oligohaline or fresher marsh complexes; usually in fresher water rather than oligohaline..... ..... **Tidal Freshwater Marsh (Southern Wild Rice Subtype)**

16. Vegetation not dominated by *Zizaniopsis miliacea*; vegetation generally a dense stand of medium size or small plants in a more diverse mix.

17. Vegetation generally dominated by forbs such as *Peltandra, Sagittaria, Pontederia*, or *Impatiens*, though smaller graminoids such as *Carex* may also be abundant; water fresher than oligohaline; many species intolerant of moderate salt levels present; *Juncus roemerianus, Cladium jamaicense, Spartina patens*, and *Schoenoplectus pungens* generally absent; usually occurring alone or only with the Broadleaf Pondlily, Narrowleaf Pondlily, or Southern Wild Rice subtypes..... ..... **Tidal Freshwater Marsh (Mixed Freshwater Subtype)**

17. Vegetation variable but generally with abundant *Eleocharis* sp., along with *Sagittaria lancifolia* var. *media* (*falcata*)*, Pontederia cordata*, and a wide variety of both graminoids and forbs; water oligohaline; species intolerant of moderate salt levels may be present but species more typical of oligohaline conditions such as *Cladium jamaicense, Schoenoplectus pungens*, *Juncus roemerianus*, and *Spartina cynosuroides* are generally present; occurring in the interior of oligohaline marsh complexes, associated with the Sawgrass, Threesquare, Needlerush, Giant Cordgrass, or Cattail Subtype..... ..... **Tidal Freshwater Marsh (Oligohaline Low Marsh Subtype)**

TIDAL FRESHWATER MARSH (GIANT CORDGRASS SUBTYPE)

Concept: Tidal Freshwater Marshes are very wet herbaceous wetlands, permanently saturated and regularly or irregularly flooded by lunar or wind tides with fully fresh or oligohaline water. The Giant Cordgrass Subtype covers the common, though often narrow, zones dominated by *Spartina cynosuroides*. This subtype has a broad range of salt tolerance and may occur from marginally brackish to fully fresh water.

Distinguishing Features: All Tidal Freshwater Marsh communities are distinguished from Brackish Marsh and Salt Marsh by occurring in oligohaline to fresh water and containing plants intolerant of brackish water. The Giant Cordgrass Subtype is distinguished from all other subtypes by the strong or weak dominance of *Spartina cynosuroides*.

Synonyms: *Spartina cynosuroides* Herbaceous Vegetation (CEGL004195). Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259).
Ecological Systems: Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Sites: The Giant Cordgrass Subtype community occurs on intertidal flats and shorelines along the sounds and tidal creeks and rivers. It is most often in zoned mosaics with other subtypes, usually forming a band on the edge of the open water.

Soils: Most occurrences in both lunar and wind tidal areas have organic soils, most often Currituck (Terric Haplosaprist) but often Lafitte, Hobonny, or Dorovan (Typic Haplosaprists). A few may be mineral soils such as Chowan (Thapto-histic Fluvaquent).

Hydrology: The Giant Cordgrass Subtype is regularly or irregularly flooded by lunar or wind tides in oligohaline waters, occasionally in areas that are nearly brackish in salinity. The salinity tolerance of this subtype slightly overlaps that of Brackish Marsh.

Vegetation: The Giant Cordgrass Subtype consists of dense tall herbaceous vegetation dominated by *Spartina cynosuroides*. This may be almost the only species in some areas, but it may be mixed with any of a number of other species and be only weakly dominant. Based on 32 CVS plots of this subtype in North Carolina, species that are sometimes codominant or abundant include *Juncus roemerianus, Cladium jamaicense, Typha angustifolia, Typha domingensis, Zizaniopsis miliacea, Schoenoplectus pungens, Bolboschoenus robustus, Spartina patens*, *Carex hyalinolepis, Thelypteris palustris* var. *pubescens, Morella cerifera, Baccharis halimifolia*, and, beneath the taller vegetation, *Eleocharis* spp. Other species frequently present include *Hibiscus moscheutos, Kosteletzkya pentacarpos, Rosa palustris, Amorpha fruticosa, Sagittaria lancifolia* var. *media*, *Persicaria sagittata, Iresine rhizomatosa, Ptilimnium capillaceum, Amaranthus cannabinus, Hydrocotyle verticillata, Persicaria punctata, Boehmeria cylindrica*, and *Osmunda spectabilis*.

Range and Abundance: Ranked G4. This community is abundant in the freshwater tidal zones of North Carolina. The equivalent association ranges from New Jersey southward to Georgia.
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Associations and Patterns: The Giant Cordgrass Subtype most often occurs in zoned mosaics with the Sawgrass, Needlerush, Cattail, Threesquare, and Shrub Subtype, sometimes with Southern Wild Rice, Oligohaline Low Marsh, or other subtypes or with Freshwater Marsh Pool. It often is primarily a narrow band along tidal channels and shorelines, with the other subtypes forming a mosaic in the interior. Occasionally it occurs alone in extensive dense patches. It may occasionally occur in association with Brackish Marsh, usually upstream of it along tidal creeks.

Variation: Two variants are recognized, based on flooding dynamics and presumed differences in animal and microbial components and in ecosystem processes, though these are not associated with known vegetation differences. Plot data show some differences in species composition, but most are in species with low constancy and do not reflect any known association with the regions. A possible exception is abundant *Schoenoplectus pungens* in northern wind tidal areas.
1. Wind Tidal Variant occurs in areas remote from tidal inlets, where tidal flooding is irregular and largely drive by wind.
2. Lunar Tidal Variant occurs in areas with closer connection to the ocean and with regular semidiurnal tidal flooding.

Dynamics: Dynamics are typical of the theme, but by occurring along channels and shorelines, this subtype likely is more subject to salt water intrusion and to erosion or disturbance by wave action.

Comments:
Spartina cynosuroides - *Panicum virgatum* - *Phyla lanceolata* Herbaceous Vegetation (CEGL007741) is another association in NVC, described from southeast Virginia and attributed to North Carolina. It appears to be a narrowly defined association that overlaps the more broadly defined *Spartina cynosuroides* association. *Panicum virgatum* is present in North Carolina's examples but without high constancy. It doesn't appear to make sense to try to distinguish two associations in North Carolina, though it may be appropriate to divide the more broadly defined association into several, of which the Virginia association is one.

Although recognized in the NVC, the Giant Cordgrass, Sawgrass, Cattail, and Needlerush subtype may be only marginally distinct. They usually occur in mosaics with each other, may share dominants with each other, and have substantial floristic overlap. Because it is associated with the shoreline, the Giant Cordgrass is the most distinct of the four.

Rare species:

References:

TIDAL FRESHWATER MARSH (SAWGRASS SUBTYPE)

Concept: Tidal Freshwater Marshes are very wet herbaceous wetlands, permanently saturated and regularly or irregularly flooded by lunar or wind tides with fully fresh or oligohaline water. The Sawgrass Subtype covers the common zones in oligohaline areas, dominated by *Cladium jamaicense*.

Distinguishing Features: All Tidal Freshwater Marsh communities are distinguished from Brackish Marsh and Salt Marsh by occurring in oligohaline to fresh water and containing plants intolerant of brackish water. The Sawgrass Subtype is distinguished from all other subtypes by the dominance of *Cladium jamaicense*. It is one of the most salt-tolerant subtypes and may extend into areas approaching brackish.

Synonyms: *Cladium mariscus ssp. jamaicense* Tidal Herbaceous Vegetation (CEGL004178). Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259).
Ecological Systems: Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Sites: The Sawgrass Subtype occurs on broad intertidal flats and shorelines, most often in zoned mosaics with other subtypes. Patches may be in either the marsh interior or on the edges adjacent to tidal channels.

Soils: Most occurrences in both lunar and wind tidal areas have organic soils, most often Currituck (Terric Haplosaprist) but often Lafitte, Hobonny, or Dorovan (Typic Haplosaprists). A few may be mineral soils such as Chowan (Thapto-histic Fluvaquent).

Hydrology: The Sawgrass Subtype is regularly or irregularly flooded by lunar or wind tides in oligohaline waters, occasionally in areas that are nearly brackish in salinity. The salinity tolerance of this subtype slightly overlaps that of Brackish Marsh.

Vegetation: The Sawgrass Subtype consists of dense tall herbaceous vegetation dominated by *Cladium jamaicense*. Dominant species of other subtypes may sometimes be abundant or even codominant, including *Spartina cynosuroides, Typha angustifolia*, *Typha domingensis,* or *Schoenoplectus pungens*. Exotic *Phragmites australis* may become established and displace nearly all native plants. The native *Phragmites americana* may also occur, though its distribution is not well known. While some patches may be nearly monospecific with *Cladium*, many are quite diverse. In 16 CVS plots of this subtype in North Carolina, other frequent species were *Osmunda spectabilis*, *Hibiscus moscheutos, Thelypteris palustris* var. *pubescens, Sagittaria lancifolia*, and *Mikania scandens*. Other species occasionally abundant to codominant were *Kosteletzkya pentacarpos, Juncus roemerianus, Centella erecta, Hydrocotyle bonariensis, Typha angustifolia*, and *Symphyotrichum* sp. Approximately 110 additional plant species were found in the 16 plots at low frequency. Woody species are often present at low density, most frequently *Morella cerifera*, *Toxicodendron radicans*, *Baccharis halimifolia*, and *Rosa palustris*, but sometimes *Persea palustris*, *Pinus taeda*, *Acer rubrum*, or *Taxodium distichum*.

Range and Abundance: Ranked G4? This community is abundant in the freshwater tidal zones of North Carolina, and usually is one of the most extensive subtypes. The equivalent association ranges from North Carolina southward and westward to Louisiana.

Associations and Patterns: The Sawgrass Subtype most often occurs in zoned mosaics with the Giant Cordgrass, Needlerush, Cattail, Threesquare, and Shrub Subtype, sometimes with Oligohaline Low Marsh or other subtypes or with Freshwater Marsh Pool. It usually occurs as extensive patches in the marsh mosaic, both along channels and in the marsh interior. It occasionally occurs in association with Brackish Marsh, usually upstream of it along tidal creeks or landward of it in marsh complexes.

Variation: Two variants are recognized, based on flooding dynamics and presumed differences in animal and microbial components and in ecosystem processes. Plot data show some differences in species, but these are not believed to be related to environmental or regional differences:
1. Wind Tidal Variant occurs in areas remote from tidal inlets, where tidal flooding is irregular and largely drive by wind.
2. Lunar Tidal Variant occurs in areas with closer connection to the ocean and with regular semidiurnal tidal flooding.

Dynamics: Dynamics are typical of the theme. This subtype usually occurs in association with other subtypes, and it is unclear if the patches are stable or shift over time. Patches could be a simple result of clonal growth and dominance by *Cladium*, part of a long term successional trajectory, or a reflection of microsite differences.

Comments: Although recognized in the NVC, the Giant Cordgrass, Sawgrass, Cattail, and Needlerush subtypes may be only marginally distinct. They usually occur in mosaics with each other, may share dominants with each other, and have substantial floristic overlap.

Rare species:

References:

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Rare species:

References:

TIDAL FRESHWATER MARSH (THREESQUARE SUBTYPE)

Concept: Tidal Freshwater Marshes are very wet herbaceous wetlands, permanently saturated and regularly or irregularly flooded by lunar or wind tides with fully fresh or oligohaline water. The Threesquare Subtype covers the uncommon zones dominated or codominated by *Schoenoplectus* (*Scirpus*) *pungens* in association with other salt-intolerant plants. These zones generally occur in the interior of oligohaline marshes.

Distinguishing Features: All Tidal Freshwater Marsh communities are distinguished from Brackish Marsh and Salt Marsh by occurring in oligohaline to fresh water and containing plants intolerant of brackish water. The Threesquare Subtype is distinguished from all other subtypes by the dominance of *Schoenoplectus pungens* or by the codominance of *Schoenoplectus* with species other than the dominants of other subtypes.

Synonyms: *Schoenoplectus pungens* - (*Osmunda regalis* var. *spectabilis*) Herbaceous Vegetation (CEGL004189).
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259). Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Sites: The Threesquare Subtype occurs on intertidal flats, usually in the interior of zoned mosaics with other subtypes.

Soils: Most occurrences in both lunar and wind tidal areas have organic soils, most often Currituck (Terric Haplosaprist) but often Lafitte, Hobonny, or Dorovan (Typic Haplosaprists). A few may be mineral soils such as Chowan (Thapto-histic Fluvaquent).

Hydrology: The Threesquare Subtype is regularly or irregularly flooded by lunar or wind tides in oligohaline waters. Though this is not clear, this subtype may be associated with interior areas where water pools, so that evaporation concentrates salt more than in the rest of the marsh.

Vegetation: The Threesquare Subtype consists of dense tall herbaceous vegetation dominated by *Schoenoplectus pungens*. Woody species may be sparsely present, as in other subtypes. In 6 CVS plots, other species that were frequently abundant were *Juncus roemerianus, Distichlis spicata, Spartina patens*, *Mikania scandens*, and *Pluchea odorata*. Other species occasionally abundant to codominant were *Sagittaria lancifolia* var. *media*, *Bacopa monnieri, Eleocharis vivipara, Eleocharis obtuse, Bolboschoenus robustus, Proserpinaca pectinata, Osmunda spectabilis, Hydrocotyle verticillata, Typha angustifolia*, and *Baccharis halimifolia*. At least in the plots, this subtype's species richness is lower than the associated subtypes, with only about 20 additional species found in the plots, and an average of only 8 plant species per 10x10 meter plot.

Range and Abundance: Ranked G2G3. As defined, this subtype is confined to North Carolina. It is known both from the wind tidal marshes of the Embayed Region and the lunar tidal freshwater marshes of southeastern North Carolina.

Associations and Patterns: The Threesquare Subtype often occurs in mosaics with the Giant Cordgrass, Sawgrass, Needlerush, Cattail, Oligohaline Low Marsh Subtype. It may grade

particularly gradually into the latter.

Variation: No variants are recognized. Examples vary with the transition to other subtypes.

Dynamics: Dynamics appears to be similar to those of associated subtypes. The hypothesis that ponding of water and concentration of salt by evaporation is uncertain, but the frequent presence of *Distichlis spicata*, more than in other subtypes, suggests it. Thus, this subtype may be in a more stressful environment and have lower productivity.

Comments: There has been confusion over the nomenclature and identity of the dominant species. Some site descriptions list *Scirpus americanus* or *Schoenoplectus americanus* as dominant, but presumably these are the same species now known as *Schoenoplectus pungens*.

Schoenoplectus pungens Tidal Herbaceous Vegetation (CEGL004188) is a more northern, but also more brackish, association in states to the north. The existence of this more northern association appears to be why this equivalent association is defined with so narrow a range.

Rare species:

References:

TIDAL FRESHWATER MARSH (CATTAIL SUBTYPE)

Concept: Tidal Freshwater Marshes are very wet herbaceous wetlands, permanently saturated and regularly or irregularly flooded by lunar or wind tides with fully fresh or oligohaline water. The Cattail Subtype covers Tidal Freshwater Marsh zones dominated or codominated by *Typha latifolia, Typha angustifolia*, or *Typha domingensis*. These generally occur in the interior of oligohaline marshes.

Distinguishing Features: All Tidal Freshwater Marsh communities are distinguished from Brackish Marsh and Salt Marsh by occurring in oligohaline to fresh water and containing plants intolerant of brackish water. The Cattail Subtype is distinguished from all other Tidal Freshwater Marsh subtypes by the dominance of some species of *Typha,* or by the codominance of *Typha* with species other than the dominants of other subtypes. It is distinguished from other communities which may be dominated by *Typha*, such as Interdune Marsh and Coastal Plain Semipermanent Impoundment, by occurring in tidal wetlands and being associated with species typical of those communities. Brackish Marsh (Transitional Subtype) may have local patches of *Typha*, which might dominate a small vegetation plot but are unlikely to cover a larger area.

Synonyms: *Typha angustifolia* - *Hibiscus moscheutos* Herbaceous Vegetation (CEGL004201) (only a very partial match). Unnamed *Typha latifolia* tidal association.
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259). Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Sites: The Cattail Subtype occurs on intertidal flats and shorelines, in zoned mosaics with other subtypes. Patches are usually in the marsh interior.

Soils: Most occurrences in both lunar and wind tidal areas have organic soils, most often Currituck (Terric Haplosaprist) but often Hobonny or Dorovan (Typic Haplosaprists). A few may be mineral soils such as Chowan (Thapto-histic Fluvaquent).

Hydrology: The Cattail Subtype is regularly or irregularly flooded by lunar or wind tides in oligohaline waters.

Vegetation: The Cattail Subtype is dominated by *Typha angustifolia, Typha domingensis*, or *Typha latifolia*, most often by *T. angustifolia*. The dominants of other subtypes, particularly *Juncus roemerianus, Sporobolus cynosuroides, Schoenoplectus pungens*, and *Cladium jamaicense,* may be abundant or occasionally codominant. In 11 CVS plots, frequent species include *Sagittaria lancifolia* var. *media*, *Ptilimnium capillaceum, Hydrocotyle verticillata, Hydrocotyle umbellata, Mikania scandens, Pontederia cordata, Osmunda spectabilis, Galium obtusum, Solidago sempervirens, Solidago mexicana, Eleocharis fallax, Pluchea* spp., *Hibiscus moscheutos*, and *Kosteltzkya pentacarpos*. Other fairly frequent species include several *Persicaria* species, *Bolboschoenus robustus, Carex hyalinolepis, Apios americana, Thelypteris palustris, Spartina patens*, *Lythrum lineare, Amaranthus cannabinus, Hypericum virginianum, Hypericum walteri, Sium suave, Cicuta maculata,* and *Toxicodendron radicans*. Woody species may be present at low density, including remnant *Taxodium distichum*, young *Acer rubrum*, *Morella cerifera, Baccharis halimifolia*, and less frequently, *Persea palustris* and other species of Tidal Swamps. Some

examples are nearly monospecific stands, but many are very diverse. A large number of additional freshwater wetland species may be present.

Range and Abundance: Ranked G4G5. This subtype is widespread in North Carolina, occurring throughout the tidal regions of the state. It may range into South Carolina. The NVC association, which is only partially synonymous, is defined as widespread, ranging north to Maine. This large span of climate suggests the association may warrant splitting.

Associations and Patterns: The Cattail Subtype most often occurs in zoned mosaics with the Giant Cordgrass, Needlerush, Sawgrass, Threesquare, and Shrub Subtype, sometimes with Oligohaline Low Marsh or other subtypes or with Freshwater Marsh Pool. It usually occurs as extensive patches in the marsh mosaic, both along channels and in the marsh interior. It occasionally occurs in association with Brackish Marsh, usually upstream of it along tidal creeks.

Variation: Examples are extremely variable, but variation is not well understood. Variants could be recognized based on either flooding dynamics or dominant species. The *Typha* species are likely to reflect differences in salinity tolerance or biogeography. In cases with multiple species present, the variant can be named by the predominant species.

1. Narrowleaf Cattail Variant is dominated by *Typha angustifolia*
2. Broadleaf Cattail Variant is dominated by *Typha latifolia.*
3. Southern Cattail Variant is dominated by *Typha domingensis*.

Dynamics: Dynamics are typical of the theme. This subtype usually occurs in association with other subtypes, and it is unclear if the patches are stable or shift over time. Patches could be a simple result of clonal growth and dominance by *Typha*, part of a long term successional trajectory, or a reflection of microsite differences.

Comments: The relationship to the NVC association is only partial. That association is described as being a brackish marsh, but it occurs in North Carolina in oligohaline marshes. The NVC at present has no tidal *Typha latifolia* association, so oligohaline marshes dominated by it are included in this subtype.

The vegetation description here is drawn from a combination of CVS plot data and NHP site descriptions. Both kinds of data are fairly abundant, but in both kinds of data there is uncertainty about the identity of the community in some examples. Some plots may be in marsh ecotones rather than this subtype, and many site descriptions do not distinguish this subtype from others. Both sources of information show substantial variability among examples. The different species of *Typha* have different levels of salt tolerance, and it may be inappropriate to lump them into a single subtype.

Although recognized in the NVC, the Giant Cordgrass, Sawgrass, Cattail, and Needlerush subtypes may be only marginally distinct. They usually occur in mosaics with each other, may share dominants with each other, and have substantial floristic overlap.

Rare species:

References:

TIDAL FRESHWATER MARSH (SOUTHERN WILD RICE SUBTYPE)

Concept: Tidal Freshwater Marshes are very wet herbaceous wetlands, permanently saturated and regularly or irregularly flooded by lunar or wind tides with fully fresh or oligohaline water. The Southern Wild Rice Subtype covers fringing marshes and marsh zones dominated by *Zizaniopsis miliacea*.

Distinguishing Features: All Tidal Freshwater Marsh communities are distinguished from Brackish Marsh and Salt Marsh by occurring in oligohaline to fresh water and containing plants intolerant of brackish water. The Southern Wild Rice Subtype is distinguished from all other subtypes by the dominance by *Zizaniopsis miliacea* or by the codominance of *Zizaniopsis* with species other than the dominants of other subtypes. It is distinguished from Interdune Ponds and other areas where *Zizaniopsis* may dominate by occurrence of lunar or wind tidal flooding or occurrence in association with other Tidal Freshwater Marsh or Tidal Swamp subtypes.

Synonyms: *Zizaniopsis miliacea* Tidal Herbaceous Vegetation (CEGL004705).
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259). Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Sites: The Southern Wild Rice Subtype sometimes occurs in marsh mosaics in intertidal flats with either lunar or wind tidal flooding. It also occurs along banks of tidal rivers and streams upstream of other Tidal Freshwater Marsh subtypes, adjacent to Tidal Swamp communities.

Soils: Most examples have organic soils, generally mapped as Dorovan (Typic Haplosaprist). A few may occur on mineral soils such as Muckalee (Typic Fluvaquent). Small patches bordering rivers are not distinguished in soil mapping; they generally are included in organic soil map units.

Hydrology: The Southern Wild Rice Subtype is regularly or irregularly flooded by lunar or wind tides, most often in fully fresh waters but sometimes in oligohaline waters.

Vegetation: The Southern Wild Rice Subtype consists of tall herbaceous vegetation dominated by *Zizaniopsis miliacea*, which may be moderate to very dense. Many occurrences are nearly monospecific, others are fairly diverse. Associated species typically are those less tolerant of salt, including *Boehmeria cylindrica, Elymus virginicus, Hypericum walteri, Peltandra virginica, Persicaria arifolia, Saururus cernuus, Persicaria punctata,* and *Mikania scandens*. Some examples have woody plants at low density, and those on river banks may have cover from plants rooted on adjacent higher areas. Frequent woody species include *Taxodium distichum, Acer rubrum, Alnus serrulata*, and *Rosa palustris*.

Range and Abundance: Ranked G3G5. It remains somewhat unclear how extensive this subtype is in North Carolina, but it appears to be abundant enough that G3 is inappropriate as a rank. The related association ranges from Virginia to Louisiana.

Associations and Patterns: The Southern Wild River Subtype often occurs as small patches along the banks of tidal rivers, where it may extend upstream nearly to the beginning of tidal influence. There it is bordered by Tidal Swamp and may be associated with the Broadleaf Pondlily,

Narrowleaf Pondlily, or Mixed Freshwater Subtype. It may also occur in oligohaline marsh mosaics with the Threesquare, Sawgrass, Cattail, Giant Cordgrass, and other subtypes.

Variation: The two distinct settings where this subtype occurs are recognized as variants:
1. Riverbank Variant occurs in upstream settings in small patches on the banks of tidal rivers, alone or with subtypes dominated by floating-leaf plants or forbs. This variant usually is very low in species richness, sometimes containing no other species other than overhanging woody plants.
2. Mosaic Variant occurs in downstream settings in small to large patches in mosaics with other subtypes dominated by large graminoid plants, such as the Giant Cordgrass, Threesquare, and Cattail Subtype.

Dynamics: Dynamics of the Mosaic variant are similar to those of most other subtypes. The dynamics of the Riverbank Variant may be somewhat different but are very poorly known. Its patchy distribution along the shoreline of tidal rivers suggests establishment on bars or lower areas than the adjacent Tidal Swamps. Along with the Broadleaf and Narrowleaf Pondlily Subtypes, it is the first to become established as the reach of a river becomes tidally influenced. Presumably those patches can be expected to expand, both upstream and in width, as rising sea level increases stress on the adjacent Tidal Swamps. However, as they get wider, they also begin to evolve into other Tidal Freshwater Marsh subtypes.

Being on the shoreline of narrower rivers, the Southern Wild River Subtype is less subject to natural wave action than those along wider estuaries; however, patches may be subject to disturbance by wakes created by motorboats.

Comments: There is very little literature on this subtype, and very few CVS plots in North Carolina. The riverbank variant has been overlooked or not described even in many qualitative site reports, and many patches are narrower than standard plot sizes. Much of the description comes from recent observations by the author.

Earlier versions of the 4th Approximation had a Wild Rice Subtype, dominated by *Zizania aquatica*, based on attribution of an association of that species to North Carolina. Although *Zizania* occurs in Tidal Freshwater Marsh communities in North Carolina, and may dominate in Interdune Marsh communities, there appear to be no *Zizania*-dominated Tidal Freshwater Marsh communities in North Carolina.

Alnus serrulata / (Zizania aquatica, Zizaniopsis miliacea) Shrubland (CEGL004627) is a shrubby tidal marsh association known from as near as the lower Waccamaw River in South Carolina and might occur in North Carolina. It is unclear how distinct it is from this subtype. *Alnus serrulata* is common banks of tidal rivers, where it may lean over some patches of Tidal Freshwater Marsh.

Rare species:
Vascular plants: *Oenothera riparia.*
Vertebrate Animals: *Alligator mississippiensis*.

References:

TIDAL FRESHWATER MARSH (OLIGOHALINE LOW MARSH SUBTYPE)

Concept: Tidal Freshwater Marshes are very wet herbaceous wetlands, permanently saturated and regularly or irregularly flooded by lunar or wind tides with fully fresh or oligohaline water. The Oligohaline Low Marsh Subtype covers the interior zones of oligohaline marshes that are dominated by often-diverse mixtures of shorter herbs such as *Eleocharis fallax*, *Eleocharis rostellata*, *Sagittaria lancifolia* var. *media*, or *Pontederia cordata*. As defined, it is a diverse and highly variable association.

Distinguishing Features: All Tidal Freshwater Marsh communities are distinguished from Brackish Marsh and Salt Marsh by occurring in oligohaline to fresh water and containing plants intolerant of brackish water. The Oligohaline Low Marsh Subtype is distinguished from almost all other subtypes by the dominance of *Eleocharis fallax*, *Eleocharis rostellata*, *Sagittaria lancifolia* var. *media*, or *Pontederia cordata* or by a mixture of similar small-stature herbs with no clear dominants. The Estuarine Shoreline Lawn Subtype, also dominated by small-stature herbs, occurs on the edges of open water and is generally dominated by *Eriocaulon parkeri*, *Lilaeopsis chinensis*, or *Lilaeopsis carolinensis*.

Synonyms: *Eleocharis fallax - Eleocharis rostellata - Schoenoplectus americanus - Sagittaria lancifolia* Herbaceous Vegetation (CEGL004628).
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259). Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376)?

Sites: The Oligohaline Low Marsh Subtype occurs on intertidal flats in the interior of marsh complexes.

Soils: All known examples are on organic soils, most on Currituck (Terric Haplosaprist), a few on Hobonny (Typic Medisaprist) or other series.

Hydrology: The Oligohaline Low Marsh Subtype is known only in wind tidal areas with oligohaline water. The occurrence of most patches in the interior of marshes, away from channels, presumably indicates reduced tidal exchange of water. Interior areas that trap water may have salt concentrated by evaporation, but interior areas that shed water may alternatively have salinity and nutrients diluted by rainfall. However, some patches apparently may also be present on marsh edges as well.

Vegetation: The Oligohaline Low Marsh Subtype is dominated by dense herbaceous vegetation that is shorter than most of the associated subtypes. It may be dominated by beds of *Eleocharis fallax*, *Eleocharis rostellata*, or other species of *Eleocharis*, or by forbs such as *Sagittaria lancifolia* var. *media*, *Pontederia cordata*, *Peltandra virginica*, or *Osmunda spectabilis.* Often it has a diverse mix with no strong dominant. Large herbs typical of other subtypes, such as *Juncus roemerianus*, *Typha domingensis,* or *Scirpus pungens,* may be present but are not dominant. Other abundant species may include *Panicum virgatum, Spartina patens*, *Galium obtusum, Mikania scandens, Centella erecta,* and *Hibiscus moscheutos*. Other frequent species include *Hydrocotyle verticillata, Hydrocotyle umbellata, Iris virginica, Lythrum lineare, Juncus acuminatus, Persicaria punctata*, *Persicaria hydropiperoides, Persicaria arifolia, Ptilimnium capillaceum,*

Phyla lanceolata, Proserpinaca palustris, Cladium mariscoides, Lycopus rubellus, Pluchea foetida, Hypericum walteri, Oenothera fruticosa, and *Ludwigia alata*.

Range and Abundance: Ranked G1. In North Carolina, this subtype occurs only in the northeastern corner of the state, with most occurrences in the Northwest River-North Landing River area and only one occurrence outside of Currituck County. The related association ranges from North Carolina north to Delaware, but it is questionable if it is comparable to the North Carolina subtype throughout this range. Similar communities occur in adjacent Virginia and are somewhat more abundant there.

Associations and Patterns: The Oligohaline Low Marsh Subtype often occurs in the central part of mosaics with the Giant Cordgrass, Sawgrass, Needlerush, and Cattail, and Threesquare Subtype, and often grades particularly gradually into the latter.

Variation: Examples are extremely variable in dominants, but no pattern has been discerned to the variation and no variants have been identified.

Dynamics: The dynamics of this subtype, as distinct from other subtypes, are obscure. Cecil Frost, in multiple 1989 site reports to the Natural Heritage Program, suggested that fire may be important for maintaining it against invasion by larger herbs that would suppress its distinctive flora and turn it into one of the other subtypes. Many of the good examples of this subtype have been burned in recent years to improve conditions for waterfowl hunting. Fire is a likely natural occurrence in some extensive freshwater marsh complexes, where they are contiguous with flammable vegetation on adjacent areas. However, Frost also described other areas where it was associated with low wet basins and might be being drowned by rising sea level, suggesting a successional trajectory toward Freshwater Marsh Pool.

Where patches occur in the interior of large marsh patches, the distinctive hydrology and nutrient dynamics in this setting may be crucial for maintaining the distinctive character of these communities. As in the Threesquare Subtype, it is conceivable that concentration of salt by evaporation keeps this subtype in shorter vegetation and free of larger plants. However, the higher diversity of plants, including many not tolerant of higher salt levels, suggests lower fertility associated with greater rainwater dominance is a more likely cause.

Comments: Five CVS plots and a large number of plots in adjacent Virginia have been sampled in in the Oligohaline Low Marsh Subtype. The concept of this subtype was initially reported by Cecil Frost in the course of Natural Heritage Program inventories around Currituck Sound. As defined, this subtype is broad and includes complex variation from site to site and within sites. It is the most diverse of the subtypes, often with a high species richness, and may harbor rare species. *Aeschynomene virginica* has been found in similar communities in Virginia and could occur in this subtype in North Carolina.

Rare species:
Vascular plants: *Cladium mariscoides, Eleocharis rostellata,* and *Ludwigia alata.*

References:

TIDAL FRESHWATER MARSH (MIXED FRESHWATER SUBTYPE)

Concept: Tidal Freshwater Marshes are very wet herbaceous wetlands, permanently saturated and regularly or irregularly flooded by lunar or wind tides with fully fresh or oligohaline water. The Mixed Freshwater Subtype covers tidal marshes of more inland locations, where water is completely fresh, species less tolerant of salt are present, and vegetation is dominated by broadleaf herbs or graminoids not characteristic of other subtypes.

Distinguishing Features: All Tidal Freshwater Marsh communities are distinguished from Brackish Marsh and Salt Marsh by occurring in oligohaline to fresh water and containing plants intolerant of brackish water. The Mixed Freshwater Subtype is distinguished from other Tidal Freshwater Marshes by occurrence on more inland, freshwater tidal sites, and by the presence of species intolerant of oligohaline conditions. These typically include abundant *Peltandra virginica* and *Sagittaria* spp. and may include *Carex stricta*, *Spartina pectinata*, *Impatiens capensis, Apios americana*, *Zizania aquatica*, *Lilium superbum*, and *Bidens frondosa*, as well as small numbers of *Cornus foemina* or *Cephalanthus occidentalis.* They lack *Juncus roemerianus*, *Cladium jamaicense*, *Schoenoplectus pungens*, *Eleocharis fallax*, and *Eleocharis rostellata*, The Southern Wild Rice Subtype, Broadleaf Pondlily Subtype, and Narrowleaf Pondlily Subtype also occur in freshwater rather than oligohaline situations but are low-diversity communities dominated by the nominal species.

Synonyms: *Carex stricta - Peltandra virginica - Sagittaria (lancifolia* ssp. *media, latifolia)* Tidal Herbaceous Vegetation (CEGL004314).
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259). Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Sites: The Mixed Freshwater Subtype occurs on shoreline bars and medium size intertidal flats on edges of freshwater tidal rivers. Many of the occurrences are near the mouths of tributary streams at larger tidal rivers or estuaries.

Soils: Most examples have organic soils, generally mapped as Dorovan (Typic Haplosaprist). A few are mapped as mineral soils such as Muckalee (Typic Fluvaquent). Small patches bordering rivers are not distinguished in soil mapping; they generally are included in organic soil map units.

Hydrology: The Mixed Freshwater Subtype is flooded by regular or irregular lunar or wind tides in fully fresh waters. These conditions occur in the estuaries most remote from seawater inlets, such as the Chowan River and Albemarle Sound, and in large rivers with substantial flow, such as the Cape Fear.

Vegetation: The Mixed Freshwater Subtype consists of dense herbaceous vegetation of medium height, generally a diverse mix of forbs and graminoids. Weakly dominant or codominant species may include *Carex stricta, Persicaria arifolia, Persicaria punctata, Pontederia cordata, Carex hyalinolepis, Carex alata*, and, though less strongly dominant than in other subtypes, *Typha latifolia* or *Spartina cynosuroides*. *Spartina pectinata* is occasionally abundant. Other frequent species include *Cicuta maculata/mexicana, Sagittaria lancifolia* var. *media, Peltandra virginica, Osmunda spectabilis, Hibiscus moscheutos, Thelypteris palustris, Zizaniopsis miliacea, Zizania*

aquatica, Boehmeria cylindrica, and *Physostegia leptophylla*. These communities often are quite diverse, with several dozen species in an occurrence and with a large species pool occurring at low frequency.

Range and Abundance: Ranked G2? This subtype may be scattered throughout the tidewater region, but the specialized conditions that produce it are limited, and the community is rare throughout the state. The equivalent association is attributed only to North Carolina. Virginia has wind-tidal oligohaline marshes but lacks fully freshwater ones. However, several lunar-tidal freshwater marsh associations occurring farther north in Virginia are related to this subtype fairly closely.

Associations and Patterns: The Mixed Freshwater Subtype usually occur in fairly small patches. It often occurs adjacent to Tidal Swamps, without other marsh subtypes, but it may occur in association with the Narrowleaf Pondlily, Broadleaf Pondlily, Southern Wild Rice Subtype, or Shrub Subtype.

Variation: This subtype is very variable in vegetation, but no distinct variants or subdivisions have been identified. It may warrant subdivision with further study and more data.

Dynamics: The origin and dynamics of this subtype may be different from other subtypes, but they are particularly poorly known. It likely is less susceptible to natural disturbance by salt intrusion. The lack of salt makes their environment similar to that of Tidal Swamps, and it would appear capable of supporting trees. Indeed, many examples appear to have shrubs or young trees invading them. Cecil Frost suggested they might be primary successional communities on recent deposits and noted the presence of young forest behind some examples. The sites near the mouths of tributary streams or rivers may be associated with areas of new deposition, though given the limited currents in the wind tidal areas, it is unclear what would produce such deposits.

Comments: This subtype is virtually unrepresented by plots. Cecil Frost provided early support for recognition of this subtype, with descriptions of occurrences near the Chowan River, and listed a number of species not associated with oligohaline marshes nearby. Many of those species have since been found occasionally in oligohaline marshes elsewhere, but the pattern of salt-intolerant plants and weak dominance appears to be valid.

Earlier drafts of the 4th approximation included a Wild Rice Subtype, dominated by *Zizania aquatica*, based on an NVC association. It appears that there are no Tidal Freshwater Marshes dominated by *Zizania* in North Carolina. *Zizania* is sometimes present in the Mixed Freshwater Subtype.

Aeschynomene virginica has been found in similar habitats in Virginia and could occur.

Rare species:
Vascular plants: *Spartina pectinata.*

References:

TIDAL FRESHWATER MARSH (SHORELINE LAWN SUBTYPE)

Concept: Tidal Freshwater Marshes are very wet herbaceous wetlands, permanently saturated and regularly or irregularly flooded by lunar or wind tides with fully fresh or oligohaline water. The Shoreline Lawn Subtype includes distinctive short, regularly flooded to semipermanently flooded graminoid or phyllodial vegetation along the shores of estuaries and tidal channels. As defined, it is a diverse and highly variable association that is not well understood. It usually occurs as narrow fringes or small patches. This may be a rare community, as most marsh edges are barren mud flats or are scarped and have abrupt edges to other subtypes rather than a distinctive vegetated edge zone.

Distinguishing Features: The Shoreline Lawn Subtype may be distinguished from other subtypes by occurrence in lower, wetter areas on the edges of patches, along with dominance by *Eriocaulon parkeri*, *Lilaeopsis chinensis*, *Lilaeopsis carolinensis*, *Eleocharis* spp., or similar plants. Only larger patches should be recorded as occurrences of this subtype. Estuarine Beach Forest would be distinguished by being higher in elevation and on higher energy shorelines with sparse vegetation or plants adapted to high energy.

Synonyms: *Eriocaulon parkeri - Polygonum punctatum* Herbaceous Vegetation (CEGL006352). Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259). Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Sites: Shoreline Lawns occur along estuaries and tidal channels where a surface within a few centimeters of sea level is present. Sites generally border marsh patches of other subtypes but could occur as narrow fringes adjacent to higher areas.

Soils: This community tends to be smaller than the minimum map unit for soil mapping and is not distinguished. Soils may potentially be either organic or mineral soils.

Hydrology: The few examples described are in oligohaline wind tidal areas, and this community may be confined to them.

Vegetation: Vegetation is dominated by *Lilaeopsis chinensis, Lilaeopsis caroliniensis, Eleocharis flavescens*, or potentially by other *Eleocharis* species or by *Eriocaulon parkeri*. Other species may include *Samolus parviflorus*, *Sabatia calycina*, or *Ludwigia* spp.

Range and Abundance: Ranked G2. It is unclear how abundant this community is in North Carolina. It is seldom reported but likely is overlooked. The NVC association is described as ranging from North Carolina northward into Canada. However, the relationship of this community in North Carolina to that association is weak and may not be warranted. Also, given the range of climate and tidal conditions, that association must be extremely heterogeneous and likely warrants splitting.

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Associations and Patterns: The Shoreline Lawn Subtype might potentially occur adjacent to most other subtypes of Tidal Freshwater Marsh, and potentially adjacent to Tidal Swamp or even to non-tidal wetlands or uplands.

Variation: Nothing is known of variation.

Dynamics: Nothing is known of the dynamics of this community, beyond the very frequent to constant flooding. It likely is subject to occasional wave disturbance as well as potentially to intrusion by salt water.

Comments: This community needs much more investigation, and this subtype is defined largely as a place holder. It is one of the most poorly known communities, as it often is overlooked and unreported. There are no plots for it. It may be invisible at times of high water. It is not entirely clear if it is extensive enough to be recognized as a distinct community. The synonymized association is only a partial match, and possibly a very poor one. This subtype was formerly synonymized with CEGL004303 *Eriocaulon parkeri.* That association was merged into the one named above.

Rare species:
Vascular plants: *Lilaeopsis carolinensis*.

References:

TIDAL FRESHWATER MARSH (BROADLEAF PONDLILY SUBTYPE)

Concept: The Broadleaf Pondlily Subtype is a tidally influenced community dominated by *Nuphar advena* or, occasionally, *Nymphaea odorata*, occurring along tidal rivers and in pools in marsh complexes. It is permanently flooded or exposed only at very low tides. The water is generally fully fresh.

Distinguishing Features: The Broadleaf Pondlily Subtype is distinguished from all other communities by the dominance of *Nuphar advena* or *Nymphaea odorata* in tidally influenced water. It is distinguished from Coastal Plain Semipermanent Impoundment, Small Depression Pond, and other communities with floating-leaved plants by occurring in areas flooded by wind or lunar tides. Comparable communities dominated by *Nuphar sagittifolia* are treated as the Narrowleaf Pondlily Subtype. No *Nuphar advena* community is known along upstream non-tidal rivers in North Carolina, but the occurrence of such a community is possible.

Synonyms: *Nuphar advena* Tidal Herbaceous Vegetation (CEGL004472).
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259). Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Sites: The Broadleaf Pondlily Subtype usually occurs in shallow water along the banks of tidal rivers or in backwater channels of them. It less frequently occurs along the shorelines of freshwater estuaries or in pools within marsh complexes.

Soils: Soils are generally not mapped, but examples are associated with organic soils such as Dorovan (Typic Haplosaprist).

Hydrology: This subtype is permanently flooded, at least shallowly, with standing water absent only at unusually low tides. Tides may be either lunar or wind-driven, though most examples are in wind tidal parts of the state. Water is usually fully fresh but apparently may be oligohaline.

Vegetation: The Broadleaf Pondlily Subtype is dominated by dense to fairly sparse floating beds of *Nuphar advena* or occasionally *Nymphaea odorata*. Usually, no emergent plants are rooted in the community, though *Taxodium distichum, Nyssa biflora, Alnus serrulata*, or other large plants on the bank may partially shade it. Submersed aquatic plants such as *Ceratophyllum demersum, Utricularia gibba, Elodea nuttallii*, or free-floating plants such as *Spirodela polyrhiza* may be present or abundant. Floating *Alternanthera philoxeroides* may become established.

Range and Abundance: Ranked G4G5. The abundance of this community in North Carolina is poorly known, because it was not recognized as a community before the 4th approximation and was seldom reported. It probably is frequent, at least in northeastern North Carolina. The synonymized NVC association is widespread, ranging northward to Maine, with North Carolina at the southern end of its range. It may warrant further splitting, given the extremely broad range of climate represented.

Associations and Patterns: The Broadleaf Pondlily Subtype sometimes occurs with the Southern Wild Rice or Mixed Freshwater Subtype, occupying deeper water than those subtypes. It is often

adjacent to Tidal Swamps. It extends farther upstream than most other subtypes. Where it occurs in larger marsh complexes, it may be associated with any of the subtypes.

Variation: Too little is known to define variants. It may be appropriate to recognize variants for wind tidal and lunar tidal occurrences in the future. The inclusion of the single known *Nymphaea odorata* tidal marsh in this subtype is based on limited knowledge and is mainly for convenience. It may warrant recognition as a distinct subtype, or at least a variant, with further study.

Dynamics: Little is known of the dynamics of this subtype, which may be different from most other subtypes. Flooding is essentially permanent, perhaps making the environment more stable and less stressful than in other subtypes. The disturbing effect of infrequent saltwater penetration presumably occurs as it does in other subtypes but may be rare because this subtype is usually farther upstream on tidal rivers. Disturbance by motorboat wakes and propellor damage may be common.

Where it occurs, the Broadleaf Pondlily Subtype is a series of patches, generally in narrow bands along the bank. It is unclear what determines where patches occur. They may occupy submerged bars, but they may merely be shallower parts of the channel bed. They generally do not extend out into the center of the channel, suggesting a need for still water or at least weak current, but their occurrence may be tied more simply to water depth. The vegetation presumably traps sediment as well as producing organic matter, and this may help aggrade the bottom as sea level rises.

Comments: This subtype is very poorly known. No plot data are known for it, and it is rarely described in site reports. The reported *Nymphaea odorata*-dominated marsh pools are included here but need much more investigation. They may be more closely related to the Marsh Pool community. Like it, they may be increasing due to rising sea level and possibly represent deterioration of the marsh.

This community has some of the simplest vegetation in North Carolina, often consisting of only one vascular plant species.

Rare species:

References:

TIDAL FRESHWATER MARSH (NARROWLEAF PONDLILY SUBTYPE)

Concept: The Narrowleaf Pondlily Subtype is a tidally influenced community dominated by *Nuphar sagittifolia* (*lutea ssp. sagittifolia*), occurring along tidal rivers. The water is fully fresh.

Distinguishing Features: The Narrowleaf Pondlily Subtype is distinguished from all other communities by the dominance of *Nuphar sagittifolia* in tidally influenced water. It is distinguished from Coastal Plain Semipermanent Impoundment, Small Depression Pond, Sand and Mud Bar, Natural Lake Shoreline Marsh, and other communities with *Nuphar sagittifolia* by occurring in areas flooded by wind or lunar tides.

Synonyms: *Nuphar sagittifolia* Tidal Herbaceous Vegetation (CEGL006094).
Ecological Systems: Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Sites: The Narrowleaf Pondlily Subtype usually occurs in shallow water along the banks of tidal rivers or in backwater channels of them.

Soils: Soils are not generally mapped. Occurrences may be associated with organic soils, such as Dorovan (Typic Haplosaprist) or flooded mineral soils such as Muckalee (Typic Fluvaquent).

Hydrology: This subtype is essentially permanently flooded, at least shallowly, with standing water absent only at the lowest tides. All examples are in the lunar tidal portions of the state, and regular tidal fluctuations may be as much as 3 feet.

Vegetation: The Narrowleaf Pondlily Subtype is dominated by dense to fairly sparse floating beds of *Nuphar sagittifolia (advena* var. s*agittifolia*). Usually no other emergent plants are rooted in the community, though *Taxodium distichum, Nyssa biflora, Alnus serrulata*, or other large plants on the bank may partially shade it. Submersed aquatic plants or free floating aquatic plants may be present, but these have not been documented. Unlikely *Nuphar advena*, *Nuphar sagittifolia* often has extensive underwater leaves, which likely reduce the amount of associated submersed vegetation.

Range and Abundance: Ranked G1G2. The abundance of this community in North Carolina is poorly known, because it was not recognized as a community before the 4th approximation and was seldom reported. The dominant species is rare enough to be on the NHP watch list and was studied for potential federal listing. The dominant species has a narrow, but odd, global range. It is largely centered in southeastern North Carolina, barely ranging into adjacent South Carolina, but with a small disjunct area on the Chickahominy River of east-central Virginia.

Associations and Patterns: The Narrowleaf Pondlily Subtype sometimes occurs with the Southern Wild Rice or Mixed Freshwater Subtype, occupying deeper water than those subtypes. It is often adjacent to Tidal Swamps. It may extend farther upstream than most other subtypes.

Variation: Too little is known to define variants.

Dynamics: Little is known of the dynamics of this subtype. As with the Broadleaf Pondlily Subtype, flooding is essentially permanent, perhaps making the environment more stable and less stressful than in other subtypes. Because tidal ranges are greater and tidal currents stronger, the Narrowleaf Pondlily Subtype may have more mechanical stress than the Broadleaf Pondlily Subtype. The disturbing effect of infrequent saltwater penetration presumably occurs as it does in other subtypes but may be rare because this subtype is usually farther upstream on tidal rivers. Disturbance by motorboat wakes and propellor damage may be common.

As with the Broadleaf Pondlily Subtype, the Narrowleaf Pondlily Subtype occurs as a series of patches, generally in narrow bands along the bank, and it is unclear why patches occur where they to. The vegetation presumably traps sediment as well as producing organic matter, and this may help aggrade the bottom as sea level rises.

Comments: This subtype is very poorly known. No plot data are known for it, and it is rarely described in site reports.

This community has some of the simplest vegetation in North Carolina, often consisting of only one vascular plant species. The idea that a different subtype is warranted for dominance by a different species in the same genus is somewhat speculative and needs more data for support. However, the different habit of *Nuphar sagittifolia*, with more extensive submersed cover, as well as the different tidal dynamics, suggests reasons for separation.

Rare species:

References:

TIDAL FRESHWATER MARSH (SHRUB SUBTYPE)

Concept: Tidal Freshwater Marshes are very wet herbaceous wetlands, permanently saturated and regularly or irregularly flooded by lunar or wind tides with fully fresh or oligohaline water. The Shrub Subtype covers transitional zones between Tidal Freshwater Marsh and Tidal Swamp or other forests, where the vegetation is naturally dominated by shrubs, though herbs typical of other Tidal Freshwater Marsh subtypes generally are abundant. Relict or young trees may be present in areas that have recently developed into Tidal Freshwater Marsh in response to rising sea level.

Distinguishing Features: All Tidal Freshwater Marsh communities are distinguished from Brackish Marsh and Salt Marsh by occurring in oligohaline to fresh water and containing plants intolerant of brackish water. The Shrub Subtype is distinguished from other Tidal Freshwater Marshes by dominance or codominance of shrubs along with herbaceous plants in a freshwater or oligohaline tidal setting. Its boundary with Tidal Swamp and Estuarine Fringe Pine Forest is placed where trees no longer form a substantial canopy; relict trees may be present but with 30% cover or less.

Synonyms: *Morella cerifera* - *Rosa palustris* / *Thelypteris palustris* var. *pubescens* Shrubland (CEGL004656).
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259).

Sites: The Shrub Subtype occurs on intertidal flats and shorelines, most often in zoned mosaics with other subtypes. Patches are most often on the inland edge of the marsh complex, but may occur on shoreline berms or on local rises.

Soils: Most occurrences in both lunar and wind tidal areas have organic soils, most often Currituck (Terric Haplosaprist) but often Lafitte, Hobonny, or Dorovan (Typic Haplosaprists). A few may be mineral soils such as Chowan (Thapto-histic Fluvaquent).

Hydrology: The Shrub Subtype may occur with lunar or wind tides in oligohaline waters and may occasionally be adjacent to areas that are nearly brackish in salinity.

Vegetation: The Shrub Subtype vegetation is an open shrubland dominated by *Morella cerifera*. *Rosa palustris* may also be abundant, as may young *Acer rubrum* or *Pinus taeda*. Remnant larger trees, particularly *Taxodium distichum, Nyssa biflora*, or *Fraxinus* spp., may be present. Other frequent woody species include *Toxicodendron radicans, Muscadinia rotundifolia, Smilax walteri, Smilax laurifolia, Smilax rotundifolia, Salix nigra, Baccharis halimifolia*, *Persea palustris*, and *Liquidambar styraciflua*. Large herbs are dense between the shrubs and often beneath them. Frequently species with high cover in CVS plots include *Thelypteris palustris, Osmunda spectabilis, Cladium jamaicense, Peltandra virginica*, and *Carex* spp. Less frequently, *Typha* spp., *Pontederia cordata*, *Iris virginica, Eleocharis fallax*, or *Hydrocotyle verticillata* may be dominate patches. Other frequent species include *Mikania scandens, Hibiscus moscheutos, Saururus cernuus, Sagittaria lancifolia* var. *media, Persicaria sagittata, Apios americana, Ptilimnium capillaceum, Hypericum walteri, Cicuta maculata, Boehmeria cylindrica, Persicaria arifolia, Persicaria hydropiperoides, Centella erecta, Pluchea foetida*, and *Bidens* spp. Any other species

of Tidal Freshwater Marshes may also be present. *Phragmites australis* may invade and come to dominate patches.

Range and Abundance: Ranked G4. The Shrub Subtype is frequent and often extensive in oligohaline marsh complexes throughout North Carolina. The association ranges from North Carolina to Delaware and Maryland.

Associations and Patterns: The Shrub Subtype often grades into the Sawgrass, Cattail, Threesquare, Needlerush, or Estuarine Low Marsh Subtype. Inland, it usually gives way to Tidal Swamp or Estuarine Fringe Pine Forest, but it may also border other wetland or upland communities. The transitions may be particularly gradual in either direction, reflecting the gradual succession that occurs with rising sea level.

Variation: Examples are extremely variable, with herbs varying with the transition to neighboring subtypes. Variants are recognized based on tidal dynamics. It is not clear if there are obvious vegetational differences associated with them. Other variations that could be recognized as subtypes or variants include the presence or absence of *Taxodium*, which might persist as a sparse savanna for many years.
1. Wind Tidal Variant occurs in areas remote from tidal inlets, where tidal flooding is irregular and largely drive by wind.
2. Lunar Tidal Variant occurs in areas with closer connection to the ocean and with regular semidiurnal tidal flooding.

Dynamics: The Shrub Subtype usually represents an obvious transitional stage between forested wetlands and open marshes, though one that may persist for many years. As Tidal Swamps and Estuarine Fringe Pine Forests are increasingly stressed by rising sea level, trees stop regenerating and the shrubs and herbs of this community establish beneath the thinning canopy. The transition to the Shrub Subtype may occur gradually or quickly, as enough trees die to allow the lower strata to dominate. If *Taxodium* is present in the swamp, it may persist as an open stand for many years due to its tolerance of water and salt, while pine forests and swamps with only *Nyssa* and other hardwoods lose the relict trees more quickly. If the canopy trees were killed by a storm surge or other transient event, young trees, especially *Acer rubrum* or *Pinus taeda,* may appear and persist with the shrubs. Rarely do they survive to form a true forest again.

With continued sea level rise, the shrubs become sparser, and the community develops into one of the other subtypes. Fire may accelerate either transition by killing individuals of woody species that are unable to regenerate. The recent development and transitional nature of this subtype is often apparent in the presence of numerous standing or fallen dead trees. A few examples of the Shrub Subtype may be successional in the opposite direction, representing a transition from a herbaceous marsh to a forest as trees establish in areas that were disturbed or that are newly established on new sediment deposits.

The Shrub Subtype appears to represent less wet settings than other subtypes and presumably is flooded less often and less deeply.

Comments: The common abundance of fallen logs, along with the shrubs and vines, makes this one of the most difficult communities to explore, while standing snags can make it dangerous. There is a moderate number of plots representing it, but all are in the wind tidal area.

Morella cerifera - *Toxicodendron radicans / Spartina bakeri* Shrubland (CEGL004789) is a more southern equivalent from South Carolina to Florida. *Morella cerifera* - *Baccharis halimifolia / Eleocharis fallax* Shrub land (CEGL006846) is a more northerly equivalent from Virginia, Maryland, and Delaware.

Rare species:

References:

TIDAL MUD FLAT

Concept: Tidal Mud Flats are communities of soft, fine-textured sediments that are regularly or irregularly flooded by tides. This is presently a conceptual community that is poorly studied in North Carolina. The range and vegetation of this type are not well known. It covers all intertidal areas of fresh to brackish estuaries that have vegetation sparser or of smaller stature than the recognized marsh communities. Most patches may be too small to map, but larger patches are possible.

Distinguishing Features: The Tidal Mud Flat type is distinguished from other tidal communities by predominance of small plants other than the characteristic dominants of the various marsh types. Vegetation is usually sparse. While *Isoetes riparia* may dominate, other sparsely vegetated tidal mud flat vegetation should be placed here as well.

Synonyms: *Isoetes riparia* Tidal Herbaceous Vegetation (CEGL006058)
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259). Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Sites: Intertidal Mud Flats occur in marsh complexes and around estuaries, generally in still waters such as bays or along tidal channels. They may be either on barrier islands or on the mainland.

Soils: Soils are newly deposited clay, silt, or loamy sediments without developed soil horizons. They are not generally distinguished in soil mapping.

Hydrology: Tidal Mud Flats are flooded regularly or irregularly by either astronomical or wind tides. The water is brackish or saltier.

Vegetation: The range of vegetation in North Carolina's Tidal Mud Flats is unknown. *Isoetes riparia, Sagittaria subulata, Sagittaria calycina, Eriocaulon parkeri, Eleocharis obtusa, Heteranthera reniformis*, or other species may occur.

Range and Abundance: Ranked GNR. This community presumably is scattered through the freshwater estuaries in the northern part of the state and may occur on tidal rivers in the southern part as well. Examples are not well tracked, and its abundance is not known. Patches are small, and the overall acreage is very limited. The NVC association ranges northward to Massachusetts, but it may be heterogeneous and call for subdivision.

Associations and Patterns: Tidal Mud Flats occur in association with Tidal Freshwater Marsh or Brackish Marsh, potentially with other Freshwater Tidal Wetlands.

Variation: Nothing is known of variation in these communities.

Dynamics: The dynamics of this community are particularly poorly known. They probably generally represent primary successional communities, where further colonization by plants and deposition of sediment will eventually allow them to develop to marsh communities. Some may be chronically disturbed areas, where reworking of sediment prevents development of more

substantial vegetation. All are affected by rising sea level, which may lead to their submergence and disappearance.

Comments: This community is very poorly understood in North Carolina and is included only provisionally. The Tidal Mud Flat community is recognized in states to the north and appears to occur here, but it is generally not described in site reports and no CVS plots exist. Clontz (1994) noted a zone of fine muck with abundant fiddler crab burrows in what may be this community but noted no plants.

There has been confusion about its salinity characteristics, which appear to range between the salinity levels of Tidal Freshwater Marsh and Brackish Marsh, but this is difficult to tell. In the 4th Approximation Guide in 2012, it was treated as an Estuarine Community, believed to occur primarily in brackish waters. However, following the current NVC description that suggests it is primarily in fresher water, it has been moved to the Freshwater Tidal Wetlands theme. It may be that a salt version needs to be created in addition. Several subtypes are likely to be distinguished with further study.

Sagittaria subulata - *Limosella australis* Tidal Herbaceous Vegetation (CEGL004473) is a northern equivalent of this type that ranges southward into Virginia.

Rare species: No rare species are known to be associated with this community.

References:

Clontz, R.B. 1994. An ecological assessment of a *Juncus roemerianus*-dominated tidal marsh within the Sealevel Tract, Sealevel, North Carolina. M.S. Thesis, Duke University.

FRESHWATER MARSH POOL

Concept: Freshwater Marsh Pools are vegetated permanently flooded portions of Tidal Freshwater Marsh complexes, with floating or submersed aquatic vegetation.

Distinguishing Features: Freshwater Marsh Pools may be distinguished from most Tidal Freshwater Marsh subtypes by dominance by submersed aquatic vegetation or detached floating plants in enclosed waters. Tidal channels and adjacent large estuaries are not included; they would be treated as submersed aquatic vegetation that is not yet defined. The Broadleaf Pondlily and Narrowleaf Pondlily Subtypes also occur in permanent flooded area and may have floating or submerged vegetation but are dominated by the rooted floating-leaf *Nuphar* or *Nymphaea* species.

Synonyms: *Ceratophyllum demersum* - *Utricularia macrorhiza* - *Nymphaea odorata* Herbaceous Vegetation (CEGL004661).
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259). Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Sites: Freshwater Marsh Pools occur in shallow permanently flooded areas on intertidal flats. Pools may be isolated in marsh complexes or may be connected by tidal channels.

Soils: Freshwater Marsh Pools are generally associated with organic soils, such as Currituck (Terric Haplosaprist) or less likely Hobonny (Typic Medisaprist) or other series.

Hydrology: The known Freshwater Marsh Pools are in wind tidal areas with oligohaline water. Pools may be connected by tidal channels, so that they are quickly subject to all tidal fluctuations, or may be isolated so that tidal flooding occurs only when the tide overflows the adjacent marshes.

Vegetation: Freshwater Marsh Pool vegetation may include any of the submersed or floating aquatic plants tolerant of oligohaline water. The few examples that are well described have *Nymphaea odorata* and *Spirodela polyrhiza*. Submersed plants include *Ceratophyllum demersum, Utricularia gibba, Utricularia biflora, Najas guadalupensis*, and *Ruppia maritima*. Algae and the liverwort *Riccia fluitans* may also be prominent. *Eleocharis* sp. and *Juncus* sp. also may be present, and there may be a more diverse zone of emergent marsh plants around the edge. The NVC description, based on Virginia data, also includes *Utricularia macrorhiza, Utricularia purpurea, Elodea nuttallii, Wolffiella gladiata*, and *Lemna* spp.

Range and Abundance: Ranked G3?. Only a handful of examples are documented, but more may occur in northeast North Carolina. The NVC association is attributed to Virginia as well as North Carolina. The synonymized association may not be completely parallel and may be more broadly defined.

Associations and Patterns: Freshwater Marsh Pools occur in Tidal Freshwater Marsh complexes, associated with the Sawgrass, Needlerush, Threesquare, Cattail, Giant Cordgrass, and Estuarine Low Marsh subtypes.

Variation: Examples appear to be very variable, but patterns have not been elucidated.

Dynamics: Dynamics of Freshwater Marsh Pools are particularly poorly known. There is concern that pools in marshes are associated with marsh deterioration. If sediment accumulation does not keep pace with rising sea level, productivity will decline first in the lowest areas, vegetation will eventually drown, and open water pools will form. Once formed, they can expand by shoreline erosion, as well as proliferate as additional areas drown. It is not clear that the vegetated Freshwater Marsh Pools represented by this community are the same phenomenon. Stable vegetated pools should be regarded as natural communities, though they, like marshes, are at risk of being replaced by deep water as sea level continues to rise. The wind tidal areas where the known examples occur are in the Embayed Region, where geological subsidence exacerbates global sea level rise. There is very little mineral sediment movement in this area, and marshes have kept pace with past sea level rise largely by accumulation of organic matter.

Comments:

Rare species:

References: