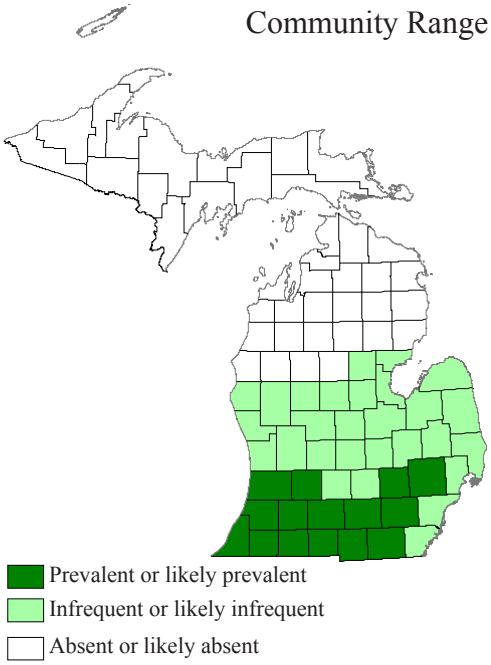
Inundated Shrub Swamp — Community Abstract

Photo by Joshua G. Cohen



Overview: Inundated shrub swamp is a shrub-dominated wetland occurring in small kettle depressions on ice-contact features, ground moraines, end moraines, outwash plains, and glacial lakeplains. Soils are saturated or inundated mucks of variable depth over silty or sandy clay. Substrate pH ranges from strongly acid to circumneutral. Water depth varies seasonally and from site to site. The community is dominated by buttonbush (*Cephalanthus occidentalis*) and is often surrounded by a shallow moat of open water ringed by a thin band of wetland trees. Herbaceous cover, which is sparse and includes numerous aquatic and semi-aquatic species, varies with degree of inundation. The community is also referred to as a buttonbush depression.

Global and State Rank: G4/S3

Range: Inundated shrub swamp is broadly distributed in glaciated regions of the Midwestern and northeastern United States and adjacent Canadian provinces, occurring in Iowa, Missouri, Illinois, Indiana, Michigan, Ohio, Ontario, Pennsylvania, Maryland, Virginia, Delaware, New Jersey, New York, Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and Maine (NatureServe 2009). Similar buttonbush-dominated wetland communities occur in unglaciated regions of the southeastern and south-central United States (NatureServe 2009). In Michigan, inundated shrub swamp occurs primarily south of the climatic tension zone in the southern Lower Peninsula, where it is prevalent in subsections VI.1 (Washtenaw) and VI.2 (Kalamazoo Interlobate), and also occurs or may occur in subsections VI.3 (Allegan), VI.4 (Ionia), VI.5 (Huron), and VI.6 (Saginaw Bay Lake Plain) (Albert et al. 2008). High quality occurrences of inundated shrub swamp have been documented from only subsections VI.1 and VI.2, and the community is among the least surveyed types in the state, despite its apparent prevalence in much of southern Lower Michigan. Buttonbush depressions may also occur locally in the northern Lower Peninsula in subsection VII.3 (Newaygo Outwash Plain). Inundated shrub swamp is apparently absent in the northeastern Lower Peninsula and in Upper Michigan, where cool mean summer temperatures and extreme minimum temperatures below -34° C (-29° F) may restrict the distribution of buttonbush (Eichenlaub et al. 1990, Voss 1996, Wennerberg 2004).

Rank Justification: Analysis of General Land Office (GLO) survey notes in Michigan reveals that shrub-dominated wetlands of all types covered a total of 170,000 ha (430,000 ac) circa 1800 (Comer et al. 1995). Included within this total are 7,300 ha (18,000 ac) of buttonbush- and willow-dominated wetlands, which were nearly restricted to southern Lower Michigan. The majority of buttonbush- and willow-dominated wetland acreage occurred in Ingham (1,300 ha or 3,300 ac), Ionia (1,300 ha or 3,300 ac), Eaton (1,100 ha or 2,800 ac), Kent (770 ha or 1,900 ac), Washtenaw (650

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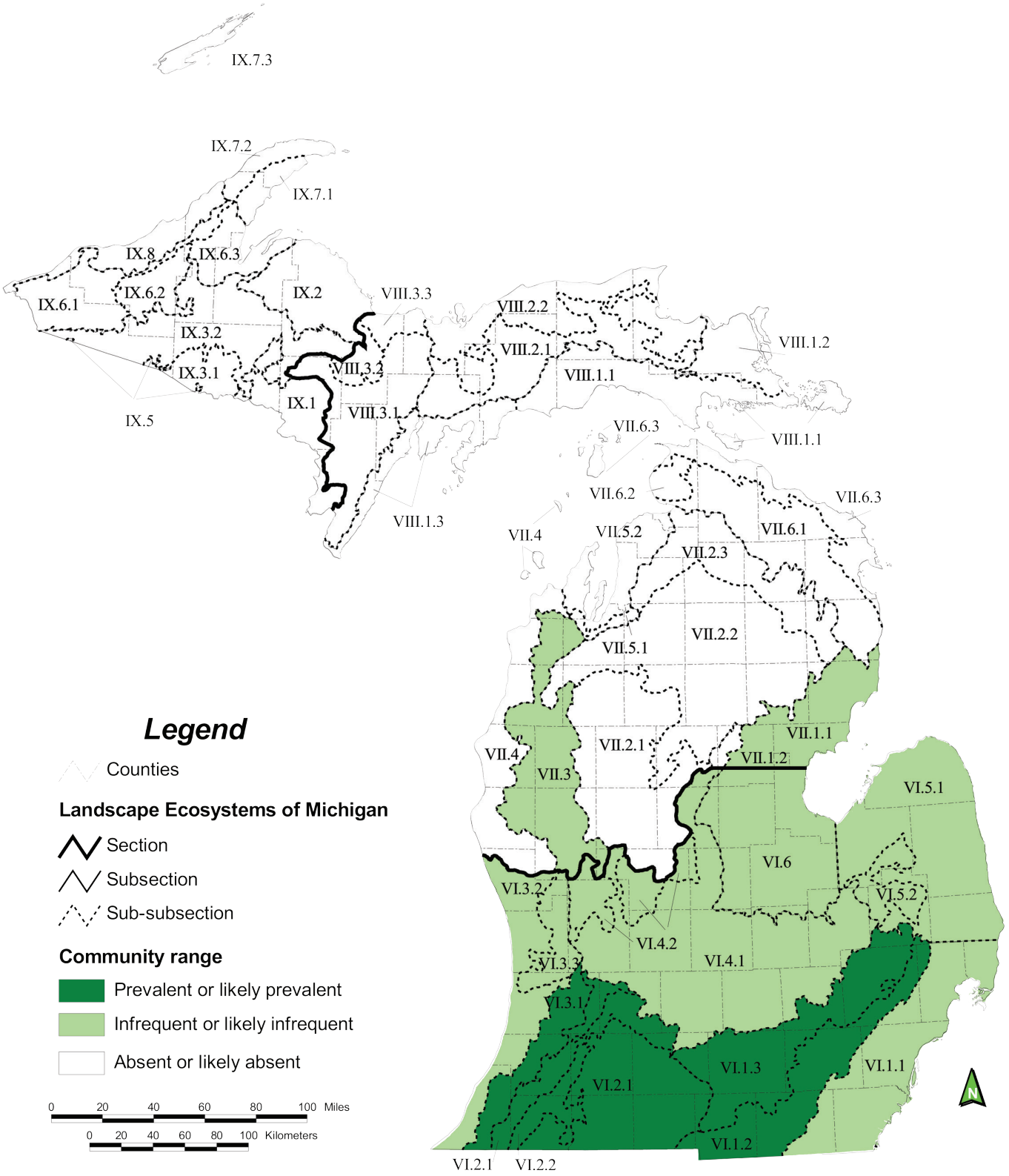


Ecoregional map of Michigan (Albert 1995) depicting distribution of inundated shrub swamp (Albert et al. 2008)

ha or 1,600 ac), Lenawee (650 ha or 1,600 ac), and Hillsdale (400 ha or 1,000 ac) counties (Comer et al. 1995). Most of the shrub-dominated wetland acreage in these counties and elsewhere in southern Lower Michigan was associated with streams, lakes, and large wetland complexes. These large wetland systems typically supported zones of southern shrub-carr, the most prevalent shrub-dominated wetland community in southern Lower Michigan, rather than inundated shrub swamp, which typically occurs in small, isolated depressions (Kost et al. 2007). Buttonbush depressions are likely underrepresented on the circa 1800 vegetation map because they are usually small and isolated, and because small vegetation patches that were not crossed by section lines were generally not mapped or described by the GLO surveyors (Comer et al. 1995). Due to these factors, the actual acreage of inundated shrub swamp circa 1800 is unknown.

A comparison of MIRIS cover type data (MDNR 1978) and circa 1800 vegetation (Comer et al. 1995) indicates that shrub-dominated wetland acreage increased from approximately 170,000 ha (420,000 ac) in 1800 to 490,000 ha (1,200,000 ac) circa 1978. The apparent increase in acreage between the two time periods is likely due to several factors. First, many forested wetlands converted to shrub-dominated systems as a result of ecological succession following logging and road construction (Comer 1996). Second, many previously open wetland community types such as southern wet meadows and prairie fens succeeded to shrub-dominated communities as a result of altered hydrology, fire suppression, and abandonment of the agricultural practice of mowing for marsh hay. Last, the methodology used to derive acreage figures for each time period differs substantially. MIRIS data are not sufficiently detailed to indicate acreage of inundated shrub swamp circa 1978, and the lack of historical and current data on the distribution and acreage of inundated shrub swamp prevents a more accurate analysis of its conservation status in Michigan. Currently, two occurrences of inundated shrub swamp are tracked in the MNFI statewide database (MNFI 2010). The community is under-surveyed due to the perception that it is common globally and within Michigan and that it supports relatively few rare species (but see Kost et al. 2006). Though aerial photo interpretation and survey data suggest inundated shrub swamp is widespread and locally frequent in southern Lower Michigan, the community is considered vulnerable in the state due to a variety of anthropogenic disturbances, including hydrologic alteration and incompatible land use in adjacent uplands (Kost et al. 2007). Road construction and landscape fragmentation pose significant threats to the associated animal species that disperse among several different wetlands (see **Conservation and Biodiversity Management** section).

Physiographic Context: The Michigan range of inundated shrub swamp is primarily in southern Lower Michigan, south of the climatic tension zone. This region has a warm, temperate, rainy to cool, snow-forest climate with hot summers and no dry season. The daily maximum temperature in July ranges from 29° to 32° C (85° to 90° F), the daily minimum temperature in January ranges from -9° to -4° C (15° to 25° F), and the annual average temperature ranges from 8.2° to 9.4° C (47° to 49° F) (Albert et al. 1986, Barnes 1991). The mean number of freeze-free days is between 146 and 163, and the average number of days per year with snow cover of 2.5 cm (1 in) or more is between 10 and 60. The mean annual total precipitation for the southern Lower Peninsula is 82 cm (32 in). Inundated shrub swamp occurs locally north of the climatic tension zone in northern Lower Michigan, where the number of freeze-free days ranges from 115 to 141, average annual temperature ranges from 6.2° to 7.8° C (43° to 46° F), average snowfall ranges from 100 to 360 cm (40 to 140 in), and mean annual precipitation ranges from 74 to 85 cm (29 to 33 in) (Albert et al. 1986, Barnes 1991, Albert 1995, Comer et al. 1995, Barnes and Wagner 2004).

Inundated shrub swamp develops in small ice-block depressions on a variety of landforms, including ice-contact features, ground moraines, end moraines, outwash plains, and glacial lakeplains. Most inundated shrub swamps occur in groundwater-fed depressions (Novitzki 1979, Brinson 1993). These depressions intercept the water table and receive groundwater inflow, in addition to surface runoff and precipitation (rain and snow) (Novitzki 1979, Brinson 1993). Groundwater inflow creates saturated conditions throughout the year, fostering the accumulation of muck (sapric peat). Muck soils are typically shallow, but sometimes deep (>1 m), and are underlain by silty or sandy clay. Soil pH of both organic and mineral layers ranges from strongly acid to circumneutral (Faber-Langendoen and Maycock 1989, Kost et al. 2006, Kost et al. 2007). The degree of groundwater seepage, size and shape of the depression, and permeability of the underlying substrate influence

the duration and depth of inundation. Inundated shrub swamp may also occur in surface water depressions that dry seasonally due to their presence above the water table (Novitzki 1979, Brinson 1993). These wetlands are fed by surface runoff and precipitation. Inundated shrub swamps in surface water depressions may lack surface peats due to frequent soil desiccation, which permits aerobic decomposition of organic compounds.

Inundated shrub swamps are typically geographically isolated and completely surrounded by upland communities (Tiner 2003). The primary matrix forest community types that support buttonbush depressions in southern Michigan are mesic southern forest and dry-mesic southern forest (Cohen et al. 2009). Buttonbush depressions also commonly occur in abandoned stream channels and oxbows of floodplain forests and as isolated depressions within lowland forest, including southern hardwood swamp and wet-mesic flatwoods (Faber-Langendoen and Maycock 1989, Goforth et al. 2002, Tepley et al. 2004, Kost et al. 2007). Inundated margins or "moats" surrounding sphagnum bogs are sometimes dominated by buttonbush. Inundated shrub swamp within all of these settings is characterized by relatively well-defined topographic and vegetative boundaries (Anderson 1982).

Photo by Joshua G. Cohen

Inundated shrub swamp typically occurs as small, isolated depressions surrounded by upland forest.

Natural Processes: Hydrology is the primary driver of inundated shrub swamp development and maintenance. Specifically, frequency and duration of flooding and variability of water depth influence successional pathways and species composition and structure (Faber-Langendoen and Maycock 1989). The community becomes established as shrubs tolerant of prolonged inundated conditions invade relatively steep-sized, small kettle depressions and abandoned stream oxbows. Frequent disturbances such as seasonal hydrologic cycling and prolonged flooding allow inundated shrub swamp to persist rather than succeed to swamp forest. Water often pools for prolonged periods due to the impermeable clay layer in the soil profile, which limits tree establishment and growth. While major flood events kill invading trees, contributing to the persistence of inundated shrub swamp, extended periods of drought or hydrologic changes that lower the water table foster tree establishment and conversion to swamp forest (Anderson 1982).

The hydrologic regime within inundated shrub swamps generates conditions suitable for the establishment and maintenance of the dominant shrub, buttonbush (*Cephalanthus occidentalis*). Buttonbush produces hydrochorous (water-dispersed) seeds that germinate during dry periods or on appropriate rooting surfaces within inundated areas such as decaying logs and stumps (Conner et al. 1981, Middleton 2000). Cold stratification is not required for seed germination (Snyder 1991). Buttonbush seedlings are highly tolerant of flooding, exhibiting several adaptations to inundation, rapid changes in water level, and low oxygen availability. In response to flooding, stomatal conductance decreases, stem height and diameter increase, and root biomass decreases (McCarron et al. 1998). The decrease in root biomass is thought to be an adaptation that reduces oxygen demand. Inundated buttonbush seedlings also produce adventitious roots, which may improve water-absorbing efficiency following flooding (Kozlowski and Pallardy 2002). Above-ground biomass of buttonbush is minimally impacted by a variety of flood regimes. However, frequent, single-season floods of long duration can cause reductions in leaf area and leaf biomass (Simmons et al. 2007). Adaptations to temporally and spatially variable hydrology give buttonbush broad ecological amplitude, allowing it to grow and compete in a variety of wetland habitats (Tyrrell 1987, Voss 1996). Buttonbush is also tolerant of nutrient inputs and water pollution, including low concentrations of salt (McCarron et al. 1998, Hubbard et al. 1999).

Although buttonbush has broad ecological amplitude, it is particularly characteristic of inundated shrub swamp due to the hydrologic dynamics that shape this natural

community. Inundated shrub swamp is characterized by an impermeable clay layer that results in seasonal to permanent inundation. Maintenance of buttonbush populations appears to require a minimum water depth of 0.5 m (19 in) (Faber-Langendoen and Maycock 1989). Prolonged inundation prevents establishment of tree seedlings and most other shrub species, and may cause mortality of mature individuals of flood-sensitive species (Keeley 1979, Conner et al. 1981, Faber-Langendoen and Maycock 1989, McCarron et al. 1998, Middleton 2000). Light gaps and decaying logs and stumps created by dying canopy trees provide conditions suitable for buttonbush colonization and expansion (Conner et al. 1981). Tree seedlings may establish on rotting stumps and logs and also throughout the wetland during seasonal or temporary dry periods, resulting in the presence of a scattered, open overstory in some inundated shrub swamps (Faber-Langendoen and Maycock 1989, Kost et al. 2006). Long-term drought may result in tree colonization and the conversion of inundated shrub swamp to closed-canopy southern hardwood swamp (Anderson 1982, Kost et al. 2007).

Photo by Michael A. Kost

Prolonged flooding due to an impermeable clay layer in the soil profile limits the colonization of inundated shrub swamp by trees and other flood-intolerant species.

Inundated shrub swamps associated with relatively large kettle depressions and continuously saturated conditions may accumulate peat, resulting in the development of unstable grounded and floating mats that support vegetation commonly associated with bog (see **Vegetation Description** section). These peats are sometimes colonized by sphagnum mosses (*Sphagnum* spp.), creating an acidic microlayer (Kost et al. 2006). Although inundated shrub swamp is consistently dominated by buttonbush, overall species composition varies significantly among sites, likely due to environmental differences among regions that support the community and variations within individual sites (Tyrrell 1987, Faber-Langendoen and Maycock 1989).

Beaver (*Castor canadensis*) have the potential to convert forested wetlands to graminoid- and shrub-dominated wetlands through dam-building activities that result in relatively long periods of inundation (Wright et al. 2002, Cunningham et al. 2006). Buttonbush depressions in small, isolated ice-block depressions are less susceptible to beaver activity than those sites associated with abandoned stream channels, oxbows, and kettle lakes. Site-specific impacts of beaver-associated flooding depend on the original species composition of the wetland, basin morphology, and proximity to wetland plant seed sources.

The impacts of fire in inundated shrub swamp are poorly known. The community is widely distributed within both fire-dependent communities (e.g., dry-mesic southern forest) and communities associated with low fire frequency (e.g., mesic southern forest) (Comer et al. 1995, Kost et al. 2007). Fires likely impacted inundated shrub swamps associated with fire-dependent systems, but the combination of saturated or inundated conditions and poor fuels provided by buttonbush may have precluded significant, structure-altering impacts (Epanchin et al. 2002). In larger wetlands associated with streams, lakes, or large depressions, buttonbush may increase in the absence of fire (Snyder 1991). Buttonbush may also increase in the presence of fire due to its capacity to resprout.

Vegetation Description: Inundated shrub swamp is dominated by buttonbush (*Cephalanthus occidentalis*) and is often surrounded by a shallow moat of open water ringed by a thin band of wetland trees. Herbaceous cover, which is sparse and includes numerous aquatic and semi-aquatic species, varies with degree of inundation. Species listed in this section are derived from MNFI site surveys, Tyrrell (1987), Kost et al. (2006), and NatureServe (2009).

Buttonbush is the most characteristic species of inundated shrub swamp, and dominates the temporarily or permanently flooded portions of the wetland basin. Where prolonged flooding occurs, buttonbush tends

to be the only woody species present, and can form an open to closed thicket of leaning, tangled trunks and branches averaging 1 to 3 m in height. In seasonally flooded areas, buttonbush is often associated with other shrub species such as whorled loosestrife (*Decodon verticillatus*), Michigan holly (*Ilex verticillata*), swamp rose (*Rosa palustris*), pussy willow (*Salix discolor*), and highbush blueberry (*Vaccinium corymbosum*). These shrub associates also establish on raised mounds (e.g., downed wood, bases of shrubs and trees) within otherwise inundated zones.

Photo by Michael A. Kost

Buttonbush (*Cephalanthus occidentalis*) is the dominant shrub characterizing inundated shrub swamp. Buttonbush often forms dense stands of leaning, twisted trunks and branches.

Herbaceous vegetation is generally sparse, with numerous aquatic and semi-aquatic plants occurring in inundated areas. Areas of open water are often dominated by small duckweed (*Lemna minor*), which may be especially prevalent in highly eutrophic or polluted sites (Crow and Hellquist 2000). Terrestrial wetland herbs establish on exposed mucks or on raised areas within the wetland, including downed wood and bases of shrubs and trees. Characteristic herbaceous species include nodding bur-marigold (*Bidens cernuus*), false nettle (*Boehmeria cylindrica*), blue-joint grass (*Calamagrostis canadensis*), fringed sedge (*Carex crinita*), lake sedge (*C. lacustris*), tussock sedge (*C. stricta*), spinulose woodfern (*Dryopteris carthusiana*), fowl manna grass (*Glyceria striata*), jewelweed (*Impatiens capensis*), southern blue flag (*Iris virginica*), wood nettle (*Laportea canadensis*), stalked water horehound (*Lycopus rubellus*), northern bugle weed (*L. uniflorus*), tufted loosestrife (*Lysimachia thyrsiflora*), Canada mayflower (*Maianthemum canadense*), sensitive fern (*Onoclea sensibilis*), royal fern (*Osmunda regalis*), clearweed (*Pilea pumila*), great water dock (*Rumex orbiculatus*), mad-dog skullcap (*Scutellaria lateriflora*), and water-parsnip (*Sium suave*).

Photo by Joshua G. Cohen

Small duckweed (*Lemna minor*) often covers the water surface in inundated shrub swamps, particularly in highly eutrophic or polluted sites.

A narrow band of lowland deciduous trees often occurs at the periphery of inundated shrub swamp. Characteristic species include red maple (*Acer rubrum*), silver maple (*A. saccharinum*), musclewood (*Carpinus caroliniana*), black ash (*Fraxinus nigra*), green ash (*F. pennsylvanica*), black gum (*Nyssa sylvatica*), cottonwood (*Populus deltoides*), swamp white oak (*Quercus bicolor*), pin oak (*Q. palustris*), black willow (*Salix nigra*), and American elm (*Ulmus americana*). Poison-ivy (*Toxicodendron radicans*) is a common vine growing on the trees that ring inundated shrub swamp. Occasionally, a scattered tree canopy occurs within the wetland basin itself (Kost et al. 2007). In addition to lowland hardwoods, species characteristic of adjacent upland forests may also be represented. Several shrubs that are tolerant of moist but not inundated conditions also occur in the forest edge. Among these are silky dogwood (*Cornus amomum*), gray dogwood (*C. foemina*), and red-osier dogwood (*C. stolonifera*).

The degree of water level fluctuation within an inundated shrub swamp impacts vegetative composition and structure (Faber-Langendoen and Maycock 1989). Species richness generally decreases with increasing water level (Faber-Langendoen and Maycock 1989, NatureServe 2009). Sites characterized by relatively stable hydrology provide suitable conditions for the

accumulation of peat, which can form floating mats or fill a portion of the kettle depression. These sites are often relatively large and/or irregularly shaped. Some of these peat mats, particularly in larger occurrences, are colonized by species characteristic of bog, including red maple, three-way sedge (*Dulichium arundinaceum*), tamarack (*Larix laricina*), wool-grass (*Scirpus cyperinus*), sphagnum mosses (*Sphagnum* spp.), poison sumac (*Toxicodendron vernix*), and Virginia chain-fern (*Woodwardia virginica*). The peat mats characteristic of inundated shrub swamp result from the accumulation and exposure of unconsolidated pond sediments (i.e., primary peats), which may be colonized by graminoids and/or sphagnum mosses (see Crum 1992 and Cohen and Kost 2008 for a discussion of peatland development). Sphagnum moss accumulation may lead to the development of bog over time. Buttonbush can also dominate the "moat" zone of kettle bogs, where groundwater seepage and water and nutrient run-off from adjacent uplands allows decomposition of plant matter and persistence of open-water conditions.

Photo by Michael A. Kost

Inundated shrub swamp is often characterized by an outer moat of open water.

Noteworthy Animal Species: Inundated shrub swamp provides important habitat for a variety of animal species. Standing water provides critical breeding habitat for invertebrates, a critical part of the food source for herptiles (amphibians and reptiles). Anurans (frogs and toads) and salamanders utilize inundated shrub swamps for breeding and foraging habitat. In addition to the state threatened Blanchard's cricket frog (*Acris blanchardi*) and state endangered smallmouth salamander (*Ambystoma texanum*), other amphibians that utilize inundated shrub swamp include, but are not limited to, American toad (*Bufo americanus*), bullfrog (*Rana catesbeiana*), gray treefrog (*Hyla versicolor*), green frog (*Rana clamitans melanota*), northern leopard frog (*Rana pipiens*), and wood frog (*Rana sylvatica*) (Roe et al. 2004). These amphibians are prey species for northern water snake (*Nerodia sipedon sipedon*) and the state endangered, federally threatened copperbelly water snake (*Nerodia erythrogaster neglecta*), both of which utilize inundated shrub swamp as an important habitat for hunting and basking (Roe et al. 2003, 2004, 2006, Kost et al. 2006). Inundated shrub swamp often occurs in association with a variety of ephemeral and permanent wetlands that provide, in concert with the upland matrix, home ranges for these snakes and other species that require the use of temporally and spatially variable prey resources (Roe et al. 2004; see **Conservation and Biodiversity Management** section). Other reptiles that utilize inundated shrub swamp include the state threatened spotted turtle (*Clemmys guttata*) and state special concern Blanding's turtle (*Emydoidea blandingii*) (Lee 1999, 2000, Hartwig and Kiviat 2007, Roe and Georges 2007). Mammalian mesopredators such as raccoons (*Procyon lotor*) utilize downed trees within inundated shrub swamps for travel and as hunting platforms. The flowers of buttonbush are an attractive nectar source for day-flying lepidopterans, including silver-spotted skipper (*Epargyreus clarus*), tawny-edged skipper (*Polites themistocles*), monarch (*Danaus plexippus*), bronze copper (*Lycaena hyllus*), pearl crescent (*Phyciodes tharos*), red admiral (*Vanessa atalanta*), and black swallowtail (*Papilio polyxenes*) (Tooker et al. 2002). Buttonbush nutlets, which persist through winter, are consumed by ducks and other water birds (Snyder 1991).

Photo by Joshua G. Cohen

Photo by Joshua G. Cohen

The small flowers of buttonbush are clustered in distinctive spherical heads that attract a diversity of nectar- and pollen-seeking insects (left). The persistent nutlets (right) provide a food source for ducks and other water birds.

Rare Species: Inundated shrub swamp provides potential habitat for five rare plant species and 11 rare animal species.

Rare Plants Associated with Inundated Shrub Swamp (E, Endangered; T, Threatened; X, presumed extirpated from Michigan).

Scientific Name	Common Name	State Status
Carex crus-corvi	raven's-foot sedge	E
Carex decomposita	log sedge	X
Carex seorsa	sedge	T
Populus heterophylla	swamp or black cottonwood	E
Wolffia papulifera	water-meal	T

Rare Animals Associated with Inundated Shrub Swamp (E, Endangered; T, Threatened; SC, species of special concern; LT, Federally Threatened).

Scientific Name	Common Name	State Status
Acris blanchardi	Blanchard's cricket frog	T
Ambystoma texanum	smallmouth salamander	E
Clemmys guttata	spotted turtle	T
Emydoidea blandingii	Blanding's turtle	SC
Euphyes dukesi	Dukes' skipper	T
Heteropacha rileyana	Riley's lappet moth	SC
Heterocampa subrotata	small heterocampa	SC
Nerodia erythrogaster neglecta	copperbelly water snake	E; LT*
Nycticorax nycticorax	black-crowned night-heron	SC
Papaipema speciosissima	regal fern borer	SC
Terrapene c. carolina	eastern box turtle	SC

*Populations of this species in the Great Lakes region (Michigan, northern Indiana, and northern Ohio) are federally listed; populations in Illinois, southern Indiana, Kentucky, and Tennessee are not federally listed (NatureServe 2009).

Photo by Glenn Fox

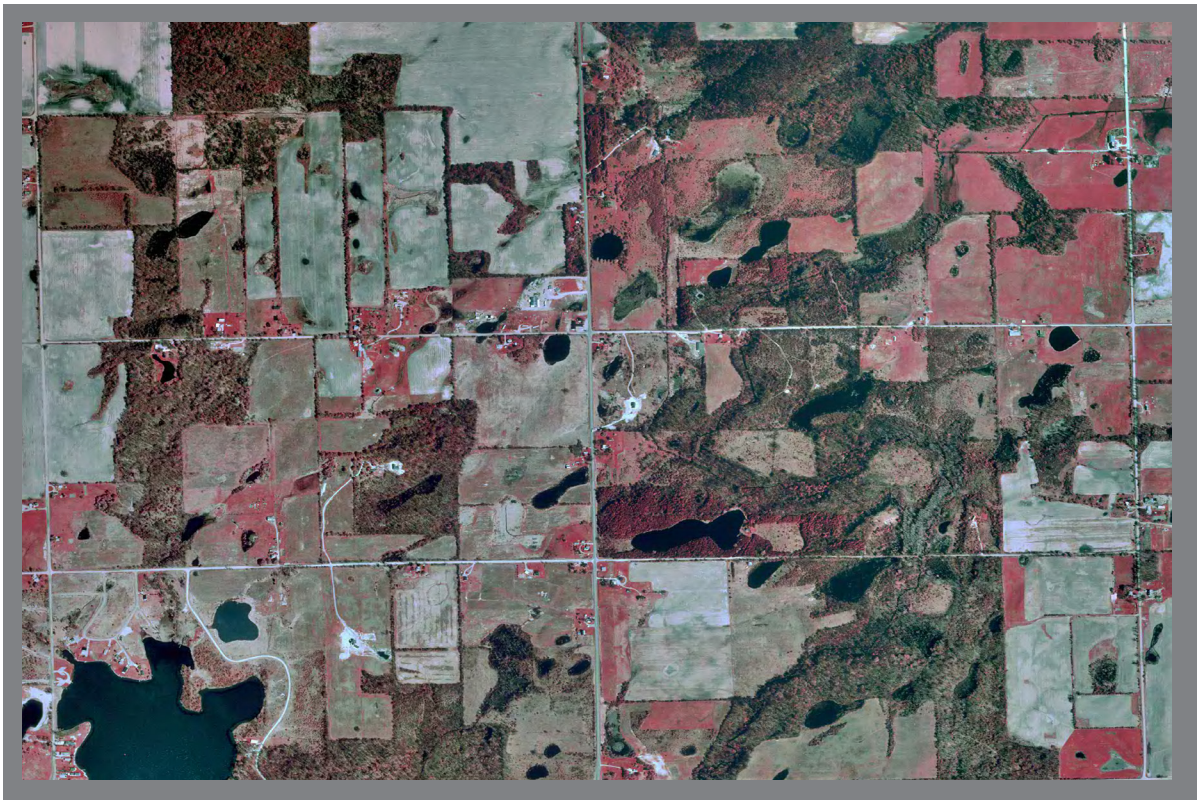
The state endangered, federally threatened copperbelly water snake (*Nerodia erythrogaster neglecta*) utilizes inundated shrub swamps for hunting and basking.

Conservation and Biodiversity Management: Conservation and management of inundated shrub swamp should focus on the following key areas: protection of groundwater and surface hydrology, reduction of landscape fragmentation, restoration or creation of new wetlands in modified landscapes, use of prescribed fire in associated fire-dependent upland habitats (e.g., dry-mesic southern forest), and the detection, monitoring, and removal of invasive plants, animals, and pathogens.

Inundated shrub swamp hydrology should be maintained by establishing a relatively wide upland buffer zone to prevent surface water run-off from inappropriate sources and protect groundwater seepage zones. Hydrologic disturbances, including increased or decreased flood cycles, sediment and/or nutrient loading, and changes to water chemistry, may alter vegetative composition and structure of wetland communities. For example, lowland grasslands often exhibit a shift in dominance from native perennials to annuals and non-native perennials following hydrologic disturbances (Galatowitsch et al. 2000, Kercher and Zedler 2004a, 2004b, Kercher et al. 2007). Buttonbush is tolerant of a variety of hydrologic disturbances, including short- and long-term flooding, deposition of salts in low concentrations, and effluent accumulation (McCarron et al. 1998, Hubbard et al. 1999, Simmons et al. 2007), but impacts of hydrologic disturbance on the inundated shrub swamp community as a whole are less well understood. Lowering of the local water table is likely to increase periods of seasonal drying in occurrences strongly influenced by groundwater inputs and result in tree establishment and conversion to southern hardwood swamp. Alteration or conversion of adjacent forest may result in increased or decreased surface water runoff. Decreased surface water runoff to inundated shrub swamps that are primarily fed by precipitation may result in longer periods of drying and the establishment of a forest overstory and subsequent conversion to southern hardwood swamp. Increased runoff from adjacent agricultural fields, roads, and developments may lead to excessive inputs of nutrients, sediments, and chemicals, which may lead to the establishment and eventual dominance of invasive plants such as narrow-leaved cat-tail (*Typha angustifolia*), common reed (*Phragmites australis*), and purple loosestrife (*Lythrum salicaria*). In addition, changes in hydrology that raise water levels for prolonged periods can result in mortality of species intolerant of long-term flooding, thereby reducing overall floristic diversity.

In addition to direct modification or destruction of inundated shrub swamps, conversion of adjacent

upland habitat to agricultural or urban infrastructure can diminish the value of these wetlands to a variety of animals, particularly those that disperse among several different wetlands in search of spatially and temporally variable resources. For example, the state-endangered and federally-threatened copperbelly water snake utilizes a variety of spatially isolated wetlands in search of prey (Roe et al. 2003, 2004, 2006). Many of these wetlands experience temporary dry periods that result in a reduction of prey populations. When prey populations decline or disappear, snakes must migrate to other wetlands. This overland migration among wetlands can lead to significant mortality in fragmented landscapes, particularly where snakes cross roads (Roe et al. 2006). Migration among different wetlands appears to be common among many reptile species, including the state-threatened spotted turtle and state special concern Blanding's turtle (Hartwig and Kiviat 2007, Roe and Georges 2007). All three species (copperbelly water snake, spotted turtle, and Blanding's turtle) utilize inundated shrub swamp, among other wetland communities (Lee 1999, 2000, Roe et al. 2003, 2004, Lacki et al. 2005, Kost et al. 2006, Hartwig and Kiviat 2007). Effective conservation of vagile reptile populations that utilize inundated shrub swamp requires protection of all wetland types within occupied territories, protection and creation of habitat corridors that promote safe dispersal among wetlands, protection and restoration of matrix habitat, reduction of landscape fragmentation, and the creation of new wetlands where suitable habitat is a limiting factor in the persistence of reptile populations (Roe et al. 2004, Kost et al. 2006, Roe and Georges 2007). In addition, management of open wetland habitats through the use of shrub cutting, herbicide application, and/or prescribed fire is suggested where these specific conditions are critical to conservation objectives (Kost et al. 2006). Land managers applying prescribed fire to fire-dependent uplands (e.g., dry-mesic southern forest, oak barrens, etc.) associated with inundated shrub swamp should allow these fires to spread into the wetland areas, but should not force fires into buttonbush depressions that are resistant to burning due to inundation and/or poor fuels.



Landscape fragmentation threatens the migration of reptile species that move from wetland to wetland in search of prey. In this aerial photo, many of the small inundated shrub swamps (dark areas) are surrounded by agriculture and separated by roads. Conservation of vagile reptile species requires protection of intact matrix forest and habitat corridors. Photo source: MNFI 1998 Digital Orthophoto County Mosaics.

Invasive vascular plant species documented in inundated shrub swamps include garlic mustard (*Alliaria petiolata*), Canada thistle (*Cirsium arvense*), autumn olive (*Elaeagnus umbellata*), moneywort (*Lysimachia nummularia*), reed canary grass (*Phalaris arundinacea*), glossy buckthorn (*Rhamnus frangula*), multiflora rose (*Rosa multiflora*), curly dock (*Rumex crispus*), horse nettle (*Solanum caroliniense*), and bittersweet nightshade (*S. dulcamara*) (Kost et al. 2006, Kost et al. 2007). Additional invasive plants capable of invading inundated shrub swamp in Michigan include narrow-leaved cat-tail, common reed, purple loosestrife, and hybrid cat-tail (*T.* x*glauca*). Efforts to detect, monitor, and control invasive species should be implemented to prevent these plants from outcompeting native species and altering community structure and function.

Research Needs: Inundated shrub swamp has not been systematically inventoried in Michigan, and few occurrences have been entered into the MNFI Biotics database (2010). Additional surveys are necessary to determine the conservation status of the community. Comparisons among buttonbush-dominated small kettle depressions, bog moats, and abandoned stream channels and river oxbows will improve classification of wetland natural community types. Studies of the relative contributions of precipitation versus groundwater inputs will improve our understanding of the hydrologic dynamics that shape the development and succession of inundated shrub swamp.

Additional research on the utilization of inundated shrub swamp by copperbelly water snake, spotted turtle, Blanding's turtle, and other species of conservation concern are suggested. One particular focus should be the development and monitoring of artificial wetlands as a restoration tool for the conservation of vagile reptile populations. The impacts of landscape fragmentation and road construction on inundated shrub swamp biodiversity warrant additional research.

Further study of buttonbush autoecology and its utility for wetland restoration in natural and anthropogenic settings will aid land managers and conservation planners working to improve or recreate wetland functions in a variety of landscapes. Buttonbush is tolerant of a wide range of hydrologic conditions and is adapted to flood events characteristic of disturbed ecosystems (Conner et al. 1981, McCarron et al. 1998). Buttonbush is one of the few woody species that persists in the seed bank in agricultural lands, providing a vital resource for the restoration of abandoned farmland to wetlands (Middleton 2003). In addition, buttonbush increases its biomass in response to nutrient inputs, making the species desirable for use in urban and disturbed wetland systems for its flood tolerance and ability to assimilate nutrients, including wastewater (Hubbard et al. 1999). Duckweed, another important plant species, is also desirable for use in polluted wetland systems for its ability to absorb and remove toxic metals from wastewater (Zayed et al. 1998). Continued research on the use of buttonbush and duckweed for phytoremediation is recommended. Recent research suggests buttonbush is sensitive to ozone pollution, making the species a candidate for use as a bioindicator (Kline et al. 2008). Buttonbush ecology and physiology and the importance of buttonbush-dominated inundated shrub swamp for several rare and declining animals provide several avenues of potential research.

Similar Communities: *Bog* is a sphagnum moss- and shrub-dominated acidic peatland that may contain a buttonbush-dominated moat zone (Cohen and Kost 2008). *Emergent marsh* is a shallow-water wetland dominated by emergent and floating herbaceous vegetation (Kost et al. 2007). *Floodplain forest* is a lowland forest associated with streams of third order or greater that may contain abandoned oxbows or channels supporting buttonbush (Goforth et al. 2002, Tepley et al. 2004). *Northern shrub thicket* is an alder-dominated wetland located north of the climatic tension zone that occurs in stream floodplains and other depressions with little or no perceptible slope (Cohen and Kost 2007). *Southern shrub-carr* is a willow- and dogwood-dominated wetland that occurs in stream floodplains and other depressions with little or no perceptible slope (Kost et al. 2007). *Southern hardwood swamp* is a hardwood-dominated lowland forest of shallow depressions and high-order stream drainages located south of the climatic tension zone (Slaughter 2009).

Other Classifications:

Michigan Natural Features Inventory Land Cover Mapping Code: 6123 (Buttonbush Swamp [Inundated Shrub Swamp])

MNFI circa 1800 Vegetation: Shrub Swamp

Michigan Resource Information Systems (MIRIS) (MDNR 1978)**:** 612 (Shrub/Scrub Wetland)

Michigan Department of Natural Resources (MDNR): L – Lowland Brush; V – Bog or Muskeg

MDNR IFMAP (MDNR 2001): Lowland Shrub

NatureServe U.S. National Vegetation Classification and International Classification of Ecological Communities (Faber-Langendoen 2001, NatureServe 2009):

CODE; ALLIANCE; ASSOCIATION; COMMON NAME

III.B.2.N.f; *Cephalanthus occidentalis* Semipermanently Flooded Shrubland Alliance; *Cephalanthus occidentalis* / *Carex* spp. Northern Shrubland; Northern Buttonbush Swamp

Michigan Resource Information Systems (MIRIS): 612 (shrub/scrub wetland): 6123 (buttonbush swamp)

Other states and Canadian provinces (natural community types with strongest similarity to Michigan inundated shrub swamp indicated in *italics*):

IL: *Shrub swamp* (White and Madany 1978)
IN: *Shrub swamp* (Jacquart et al. 2002)
ON: *Buttonbush mineral thicket swamp type; buttonbush organic thicket swamp type* (Lee et al. 1998)
OH: *Buttonbush shrub swamp* (Anderson 1982)
PA: *Buttonbush wetland* (Fike 1999)
NY: *Shrub swamp* (Edinger et al. 2002)
MA: *Shrub swamp* (Swain and Kearsley 2001)
VT: *Buttonbush swamp* (Thompson and Sorenson 2000)
NH: Oxbow buttonbush swamp; *buttonbush basin swamp* (Sperduto and Nichols 2004)
ME: Mixed graminoid – shrub marsh (Gawler and Cutko 2004)

Related Abstracts: bog, floodplain forest, northern shrub thicket, southern hardwood swamp, wet-mesic flatwoods, Blanchard's cricket frog, spotted turtle, Blanding's turtle, black-crowned night-heron, regal fern borer, eastern box turtle, water-meal.

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Photo by Joshua G. Cohen

Inundated shrub swamp provides habitat for a diversity of amphibians, including this gray tree frog (*Hyla versicolor*).

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