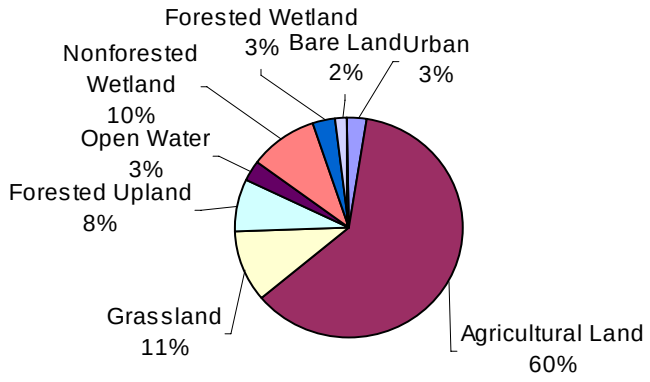
Forested Wetlands

Lake Koshkonong lies within the Ecological Subsection known as the Southern Green Bay Lobe Subsection. Its landforms are glacial till plains, drumlins, moraines, and localized outwash and lake plains. Soil conditions in the Southern Green Bay Lobe Subsection have been summarized as follows (David Hvizdak, NRCS, personal communication):

> Most moraine uplands and drumlins have soils formed in brown calcareous sandy loam to loam till (Udalfs and Udolls). They range from well drained to somewhat poorly drained and generally have silt loam surface textures, moderate to very slow permeability, and moderate to high available water capacity. The outwash plains have upland soils formed in loamy alluvium or loess over calcareous outwash sand and gravel (Udalfs and Udolls). They range from well drained to somewhat poorly drained and generally have silt loam to loam surface textures, moderately rapid to moderate permeability, and moderate available water capacity. The lake plains have soils formed in calcareous loamy to silty lacustrine (Udalfs and Udolls). They range from well drained to somewhat poorly drained and generally have silty loam surface textures, moderate to slow permeability, and moderate to very high available water capacity. Most lowland soils are very poorly drained non-acid muck (Saprists), but includes silty and clayey lacustrine (Aquolls) and loamy till (Aquolls). The major river valleys have soils formed in loamy to silty alluvium (Fluvents, Aquolls, Aqualfs, and Udepts) or non-acid muck (Saprists), range from moderately well drained to very poorly drained, and have areas subjected to periodic flooding. A modern soil survey is available for the area.

The WISCLAND consortium developed broad-scale data on land use/land cover based on satellite imagery collected in 1992. Land use of the Southern Green Bay Lobe Subsection is dominantly agricultural (Figure 35). Forests make up a total of 11% of the area, and forested wetlands represent 3%. This shows that lowland forest is a relatively scarce feature in the landscape. For further discussion of the Southern Green Bay Lobe Subsection and Ecological Land Classification as related to Lake Koshkonong refer to Attachment 9.

Figure 35 Land Use within the Southern Green Bay Lobe Subsection



The lowland forest along Lake Koshkonong is classed as a Floodplain Forest according to the Wisconsin Natural Heritage Inventory Program classification, Wisconsin Department of Natural Resources. The classification replaces in part the Southern Wet and Southern Wet-Mesic Forests of Curtis (1959). This lowland forest community occurs along large rivers that flood periodically. The best development occurs along large rivers in southern Wisconsin.

In the floodplain forest along Lake Koshkonong, the dominant tree species are silver maple (*Acer saccharinum)* and

green ash (*Fraxinus pennsylvanica).* Other important tree species include swamp white oak (*Quercus bicolor),* black ash (*Fraxinus nigra),* American elm (*Ulmus americana),* red elm (*Ulmus rubra),* basswood (*Tilia americana*). Box elder (*Acer negundo*), willow (*Salix* spp.), hackberry *(Celtis occidentalis),* and cottonwood (*Populus deltiodes)* are present as minor components. This information is supported through forest survey data of properties within the forested floodplain areas around Lake Koshkonong in Jefferson and Rock Counties.

Common understory plants of lowland hardwood forests often occur in patchy distribution. They include wood nettle (*Laportea canadensis*), sedges *(Carex spp.),* grasses, touch-me-not (*Impatiens biflora*), cardinal flower (*Lobelia cardinalis*), green dragon (*Arisaema dracontium*), green-headed coneflower (*Rudbeckia laciniata*), and button brush (*Cephalanthus occidentalis*). Vines are often prominent in floodplain forests, particularly wild grape (*Vitis riparia*), woodbine (*Parthenocissus vitacea*), poison ivy (*Rhus radicans*), moonseed ((*Menispermum canadense*), and wild cucumber (*Echinocystis lobata*) (Curtis 1959).

Floodplain forests are subject to periodic episodes of flooding of various lengths both during the dormant season and growing season. These floodplain forests are subject to scouring effects (water, ice, and debris), sediment deposition, and periods of saturation or inundation interspersed with very dry conditions. Vegetative composition, including successional patterns, can vary depending on the timing and severity of flooding.

Numerous studies have been conducted to understand the impact of flooding on trees. A state-of-the-art method has not developed sufficiently to warrant a precise statement on the adaptability of a species to a specific flooding condition. Tolerance to flooding depends on many different environmental conditions and tree species. A brief review of soil, tree, and flood characteristics indicates the complexity of these interactions (Attachment 10).

The following soil-related points are important in understanding flooding effects on trees.

Soil Aeration- Flooding results in poor soil aeration because the supply of oxygen to flooded soil is severely limited. Oxygen deficiency is likely the most important environmental factor that triggers growth inhibition and injury in flooded plants.

pH- Flooding of soil increases the pH of acid soils and decreases the pH of alkaline soils.

Texture- Clay and silt soils remain waterlogged for a longer period of time after flooding, because the surface tension of water restricts its movement out of the smaller soil pore spaces. Sandy soils drain more rapidly.

Organic Matter- The rate of decomposition of organic matter in flooded soil tends to be only half that in an unflooded soil. The major end products of decomposition of organic matter in flooded soils are carbon dioxide, methane, and humic materials. In addition, high concentrations of methanol and hydrogen sulfide are produced in waterlogged soils, which can be damaging to root systems.

Sedimentation- Deposits of silt, or sand as shallow as three inches may seal over and smother tree roots by limiting the supply of oxygen. Species vary in tolerance to sedimentation, but all seedlings are susceptible to root injury.

Scouring- Strong currents, waves, or suspended particulates may cause soil around the base of the tree to be washed away, exposing tree roots. Exposed roots can lead to not only tree stress but can make the tree more vulnerable to windthrow.

Various characteristics of a tree affect its flood tolerance with the most prominent presented below.

Height- Tree injury increases in proportion to the percent of crown covered by water. Species that can survive standing in several feet of water for months may die in less than one month when their foliage is completely covered. Few species can tolerate more than one month of complete submersion during the growing season.

Crown Class- Trees in the dominant crown class survive flooding much better than trees in lower crown

classes.

Age- Adult trees tolerate flooding better than over mature trees or seedlings of the same species. Therefore, some species rated as flood tolerant may be quite sensitive in the seedling stage. Seedlings often die because they are pushed over, buried in the mud, or uprooted.

Vigor- Tree vigor at the time of flooding influences tolerance. Healthy trees with adequate starch reserves in their roots that are not already under stress, can withstand flooding better than less vigorous trees. Tree vigor may be irrelevant, however, if the tree is totally submersed in water.

Roots- Long-term flooding leads to death and decay of large portions of a tree's root system. During flooding, some species can maintain normal roots in an active or dormant condition; others rely upon new secondary and adventitous roots that may form from the root collar or on the trunk near the water surface. Species unable to either maintain normal roots or grow new ones can quickly die.

Species Variations- Flood tolerance variations within a species are not well understood. Flood tolerance may be an inherited trait and this may explain some of the discrepancies in reports on survival. It is generally accepted that some species have a greater tolerance for flooding than others.

The following points are important in understanding flooding effects on trees

Season- Flooding during the growing season is usually more harmful to woody plants than flooding during the dormant season. Specifically trees are most susceptible to flooding in late spring just after the first flush of growth. The timing of a spring flood influences species differentiation. For example, since silver maple flushes earlier than green ash, an early flood might be more damaging to silver maple while a later flood more injurious to green ash.

Duration-The longer trees are exposed to flooding, the greater the potential for injury. Most trees can stand only 1-4 months with water being continuously over the soil surface. Most trees can tolerate short periods of flooding during the growing season. However, if flooding is recurrent and keeps the soil saturated or prevents recovery from previous flooding, injuries will accumulate and serious damage may occur.

Water Level- The depth of water influences flood tolerance. The mortality rate is less for trees in saturated soil than for trees with water covering the soil. After water covers the soil, the depth may have little significance until the lower foliage is covered; research results, however, differ on this point. Tolerance to complete submersion is much lower than tolerance to shallower depths of water.

Temperature and Oxygen- Cold water is less injurious than warm water due to cold water's capacity to hold more dissolved oxygen. Rapidly flowing water (with higher oxygen content) is less harmful than stagnant water.

Mechanical Injuries- An often overlooked aspect of flood damage is mechanical injury caused by current, wave action, ice, and floating debris. Young trees may be especially damaged by current and wave action. Floating debris can injure both small and large trees. Because the proposed increase in water level will lead to year round flooding, damage due to ice movement will also be significant.

Stress- Permanent and prolonged flooding subject trees to stress. Flood stressed trees exhibit a range of symptoms including leaf chlorosis, defoliation, reduced leaf size and shoot growth, sprouting, and crown dieback. Early fall coloration and leaf drop often occur. It is also common for stressed trees to produce large seed crops in the years following the stressing event. Flood stressed trees are also prime targets for attack by secondary organisms. Secondary organisms include a wide variety of opportunistic fungi and insects that selectively invade hosts after they are weakened or predisposed by stress. Certain root and collar rot diseases are favored by waterlogged, oxygen deficient soil conditions, most notably those caused by the water mold fungi, *Phytophthora* spp. and *Pythium* spp. Flooded soil conditions not only promote reproduction and dispersal of these fungi, but also promote the susceptibility of plant roots to infection.

Table 8 and much of the above information comes directly from the publication Flooding and its Effect on Trees, USDA Forest Service, State and Private Forestry, Northeastern Area, State and Private Forestry, St. Paul, Minnesota, authored by Stephen Bratkovich, Lisa Burban, Steven Katovich, Craig Locey, Jill Pokorny, and Richard Wiest, September 1993 and Wisconsin Ecological Landscapes Handbook (HB 18051), Wisconsin Department of Natural Resources.

Table 8

Relative tolerance of Illinois trees to flooding during the growing season. (Source: Bell and Johnson 1974). **NOTE**: *Flood tolerance categories in Table 2 differ from Table 1 in both name and definition.*

Species	Common Name	Tolerant[1]	Somewhat Tolerant[2]	Slightly Tolerant[3]	Intolerant[4]
Acer negundo	Boxelder	■			
Acer saccharinum	Silver maple	■			
Carya ovata	Shagbark hickory		■		
Carya tomentosa	Mockernut hickory			■	
Celtis occidentalis	Hackberry		■		
Cercis canadensis	Redbud		■		
Crataegus mollis	Downy hawthorn	■			
Diospyros virginiana	Persimmon	■			
Juglans nigra	Black walnut		■		
Fraxinus pennsylvanica	Green ash		■		
Gleditsia triacanthos	Honeylocust	■			
Platanus occidentalis	Sycamore	■			
Populus deltoides	Eastern cottonwood	■			
Prunus serotina	Black cherry				■
Quercus alba	White oak			■	
Quercus bicolor	Swamp white oak	■			
Quercus imbricaria	Shingle oak		■		
Quercus macrocarpa	Bur oak	■			
Quercus palustris	Pin oak	■			
Quercus rubra	Red oak			■	
Quercus velutina	Black oak				■
Salix nigra	Black willow	■			
Sassafras albidum	Sassafras				■
Ulmus americana	American elm		■		

[1] Tolerant: most individuals survived more than 150 days of flooding during the growing season.

[2] Somewhat Tolerant: some individuals killed by less than 90 days of flooding and some individuals survived greater than 150 days of flooding.

[3] Slightly Tolerant: most individuals survived more than 50 days but less than 100 days of flooding.

[4] Intolerant: severe effects with less than 50 days of flooding.

Importance of Wetlands

The federal Clean Water Act requires that wetlands be protected from degradation because of their multiple, important ecological roles including maintenance of high water quality and provision of habitat for fish and wildlife.

Since 1980, this protection has slowed the precipitous decline in wetland acreage observed in the United States since European settlement.

Restoration of riparian functions is a goal. Over the last several decades, federal and state programs have increasingly focused on the need for maintaining or improving water quality, ensuring the sustainability of fish and wildlife species, protecting wetlands, and reducing the impacts of flood events. Because riparian areas perform a disproportionate number of biological and physical functions on a unit area basis, their restoration can have a major influence on achieving the goals of the Clean Water Act, the Endangered Species Act, and flood damage control programs.

Protection should be the goal for riparian areas in the best ecological condition, while restoration is needed for degraded riparian areas. Management of riparian areas should give first priority to protecting those areas in natural or nearly natural condition from future alterations. The restoration of altered or degraded areas could then be prioritized in terms of their relative potential value for providing environmental services and/or the cost effectiveness and likelihood that restoration efforts would succeed. Where degradation has occurred—as it has in many riparian areas throughout the United States—there are vast opportunities for restoring functioning to these areas.

Patience and persistence in riparian management is needed. The current degraded status of many riparian areas throughout the country represents the cumulative, long-term effects of numerous, persistent, and often incremental impacts from a wide variety of land uses and human alterations. Substantial time (years to decades) will be required for improving and restoring the functions of many degraded riparian areas. Commensurate with restoration must be efforts to improve society's understanding of what riparian functions have been lost and what can be recovered.

General Physical Description of Wetlands

The wetlands of Lake Koshkonong are riverine/lake fringe wetlands associated with several navigable bodies of water: Lake Koshkonong, the Rock River and several tributary streams. Many of the tributaries in the upper watershed are ditched to facilitate drainage in agricultural areas. The natural hydroperiod of the Lake Koshkonong wetlands vary from seasonally and permanently flooded to groundwater springs and seeps and saturated soils. Since dam installation, the natural hydroperiod has been modified, resulting in increased water levels and more permanently flooded wetlands.

Before the dam was constructed, the shallow and deep marshes were known as a "sea of green" because of the extensive wild rice beds and other emergent vegetation. Increased water levels have resulted in much greater areas of open water. The wetlands currently present around Lake Koshkonong include aquatic beds, deep marsh, shallow marsh, wet meadow, shrub carr and southern lowland forest. Extensive wetlands underlain by mucks and hydric mineral soils exist around the lake. Surrounding land uses include agriculture, urban development and open space/wetland.

Wetland Observations

A list of plant observations made during field investigations is shown in Table 9. Wetland plant communities observed included southern lowland forest (floodplain forest), emergent marsh, wet meadow and aquatic bed types (Figure 36). The forested wetlands were dominated by silver maple and green ash trees. Other species observed included black willow and swamp white oaks. Herbaceous vegetation was particularly scarce due to both timing of field investigations and long-duration flooding which drowned out these plants.

Shrub carr communities occupied drier areas of marsh and are dominated by sandbar willow. Emergent marsh is dominated by cattail, soft-stem bulrush and river bulrush with some invasion by non-native narrow-leaved and hybrid cattails, tall reed grass and purple loosestrife. Wild rice and chair-makers rush are occasionally seen growing in marsh areas. Wet meadows observed along the lake shore were dominated by reed canary grass. White water-lily, yellow pond-lily and water smartweed were the main species observed in aquatic bed wetlands. In addition to these wetlands, many areas of submergent wetlands, mainly occupied by sago pondweed were observed.

The wetlands observed were not unimpacted. Stresses on wetlands included impacts from raised water levels, decreased water quality, human uses and disturbance from carp and non-native plant introductions. High water levels were noted by the lack of herbaceous layers in much of the lakeside wetlands, the presence of adventitious roots, shallow roots, dead and dying trees and the absence of groundwater-dependent plants and plant communities. High water levels have increased erosion and loss of wetlands. Water quality conditions are poor as a result of nutrient and sediment-laden surface water coming into the wetlands from upstream agricultural and urban areas. Wetland filling has occurred along the shoreline and urban uses within the watershed contribute additional pollutants. Recreational boating stirs up sediments in the shallow basin, increasing turbidity levels. Carp, an introduced species, also stir up sediments, which in turn increases turbidity levels and reduces light penetration and submergent plant growth. Non-native plant species present which are invasive include reed canary grass, giant reed grass, narrow-leaved and hybrid cattails and purple loosestrife.

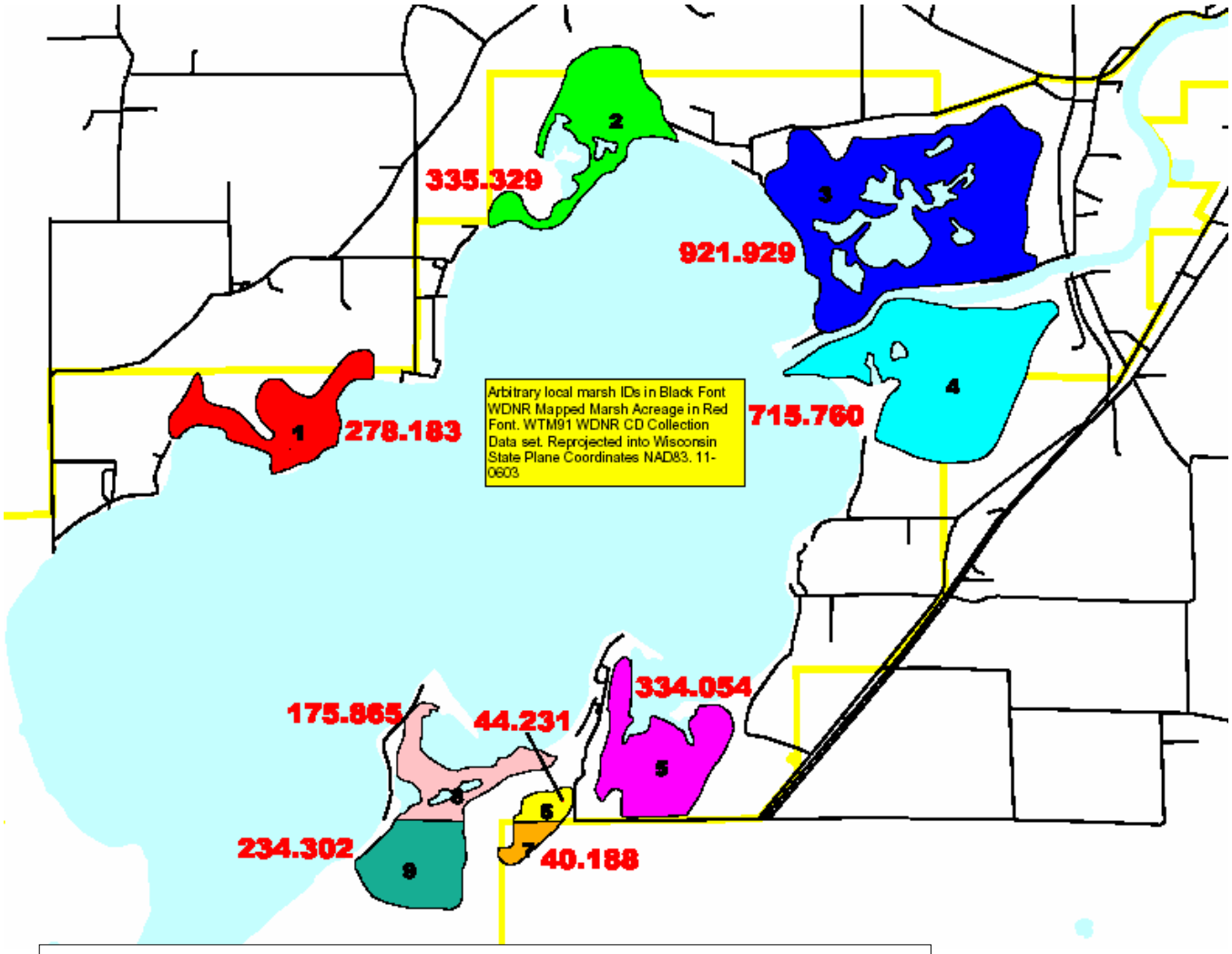
Table 9. Lake Koshkonong Wetland Plant Species Observed

Acer negundo	Box elder
Acer saccharinum	Silver maple
Asclepias incarnata	Marsh milkweed
Bidens cernuus	Nodding beggar-ticks
Bidens sp.	Beggar-ticks
Bolboschoenus fluviatilis	River bulrush
Ceratophyllum demersum	Coon's-tail
Crataegus sp.	Hawthorn
Echinochloa walteri	Water-millet
Eleocharis sp.	Spike-rush
Fraxinus pennsylvanica	Green ash
Glechoma hederacea	Creeping-charlie
Leersia oryzoides	Rice cut-grass
Lemna minor	Common duckweed
Lysimachia nummularia	Moneywort
Lythrum salicaria	Purple loosestrife
Nuphar advena	Yellow pond-lily
Nymphaea sp.	White water lily
Phalaris arundinacea	Reed canary grass
Phragmites australis	Tall reed
Polygonum amphibium	Water smartweed
Quercus bicolor	Swamp white oak
Sagittaria latifolia	Arrowhead
Salix exigua	Sandbar willow
Salix nigra	Black willow
Salix sp.	Willow
Schoenoplectus pungens	Chair-maker's rush
Schoenoplectus tabernaemontani	Soft-stem bulrush
Scutellaria galericulata	Marsh skullcap
Sium suave	Water-parsnip
Solanum dulcamara	Nightshade
Sparganium sp.	Burreed
Spartina pectinata	Prairie cordgrass
Spirodela polyrrhiza	Giant duckweed
Stuckenia pectinata	Sago pondweed
Typha angustifolia	Narrow-leaved cattail
T. latifolia	Broad-leaved cattail
Ulmus americana	American elm
Vitis riparia	Riverbank grape
Zizania aquatica	Wild rice

Wetland Functional Values

Despite the significant stresses to these wetlands, they still provide important functional values. The wetlands support a diverse native plant assemblage. The wetland complexes support aquatic bed, wet meadow, deep and shallow marsh, shrub carr and lowland hardwood forest wetland types. These plant communities support critically important fish and wildlife habitat. The area has been historically noted as one of the most important waterfowl hunting marshes before the dam was installed. It still provides significant migratory waterfowl habitat. Wetlands also support migrating shorebirds and neotropical birds, nesting and year-round resident songbirds, raptors and other bird species and important reptile, amphibian and mammal habitat, particularly for muskrats, mink, white-tail deer and small mammals. During one day's field investigation, we observed over 100 American White Pelicans,

Figure 36. List of riparian wetlands to Lake Koshkonong using Jefferson County GIS data. The green wetland polygons represent shallow marsh areas with the exception of select areas of floodplain forests located along tributaries and the mainstem Rock River at Blackhawk Island.



Wetland Name & Number Acreage Wetland Type

1. Koshkonong Creek 278.183 Shallow Marsh, Floodplain Forest
2. Krump Creek 335.329 Shallow Marsh
3. Mud Lake 921.929 Shallow Marsh
4. State-owned Blackhawk Island 715.760 Shallow Marsh, Shrub/Carr, Wet Meadow
5. Otter Creek 334.054 Shallow Marsh, Floodplain Forest

6,7,8,9. Thiebeau Marsh 494.586 Shallow Marsh, Shrub/Carr, Wet Meadow

Total 3,079.841 Acres

numerous shorebirds, state endangered, threatened and special concern species (Forster's Tern, Great Egret and Black Tern) and large flocks of waterfowl. These wetlands provide habitat for species of aquatic life, which support the Lake Koshkonong fisheries. Although carp have had a major impact upon the fishery of the lake, other native species such as northern pike are present and use adjacent wetlands for most stages of their life cycles.

Wetlands along Lake Koshkonong provide important flood and stormwater attenuation. Evidence of high water levels is observable as high water marks on trees, erosion marks and lack of herbaceous vegetation from long-duration flooding. Long-duration flooding allows settling of sediment, nutrient and pollutant-laden surface water. This water quality protection function is evidenced by historical documentation of alga blooms. Urban development, wastewater discharges and agriculture in the watershed have added additional pollutants to the system over the years. Wetlands can store nutrients, sediments and toxic substances and in some cases remove them, such as through denitrification. Seasonal high water levels, long wind fetch and boat traffic results in shoreline erosion, which can be reduced by shoreline wetlands. Wetland vegetation located along the shore decrease wave energy, hold soil particles and thereby reduce erosion. Although wetland vegetation slows the erosion of shoreline property, wetland erosion and loss has intensified since the dam was installed and continues to be a major problem.

Groundwater functions are not well documented in Lake Koshkonong wetlands, however, springs within the basin feed the lake. Marly soil within the lake basin may be an indication of groundwater seepage. Areas of groundwater springs and seeps may have been drowned by surface water since the dam raised water levels.

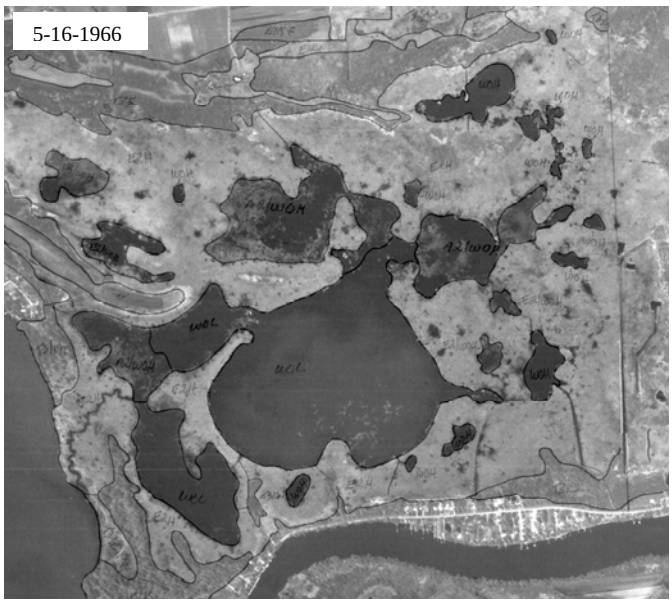
Human use values include aesthetics, recreation, education and science. While the aesthetics of the marsh once known as a "sea of green" are significantly reduced by the large expanses of open water, high turbidity levels and algae blooms, the remaining vegetated wetlands provide natural scenic beauty. Wetlands support habitat for important wildlife species that are fished, hunted, trapped and watched. These wetlands were once one of the most significant waterfowl hunting areas in the country and although reduced, they are still locally significant for waterfowl hunters. Also significant is the presence of less common species of birds, which are sought out by bird watchers from throughout the state and surrounding areas. Examples of these species are large flocks of American White Pelicans, state endangered Forster's Terns, waterfowl and shorebirds which have been observed in Mud Lake.

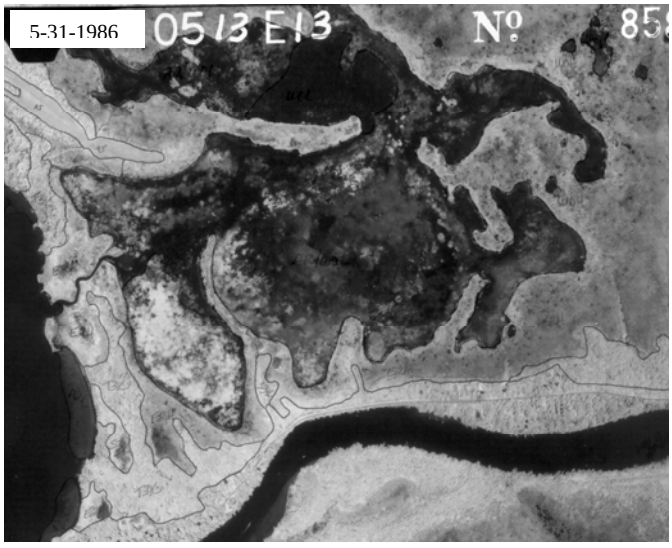
Wetland Recession
Historic aerial photography was interpreted for two wetland complexes of Lake Koshkonong to determine change in wetlands over time.

Mud Lake (Figure 37) Aerial photo dated 7-19-1937: Very little open water is present. The majority of the wetland vegetation consists of persistent emergent vegetation that is classified as E2H or E2/WØH. There is an area of aquatics mixed with open water that is classified as A2/WØH (mix of aquatic vegetation and open water). There are several stands of deciduous trees that are classified as T3K. **Aerial photo dated 5-16-1966:** There is a significant amount of open water (WØL) and aquatic vegetation mixed with open water (A2/WØH) as compared to the 1937 aerial photo. A channel is also visible that connects Lake Koshkonong to Mud Lake. Large areas of persistent emergent vegetation (E2H) are also present. **Aerial photo dated 6-25-1979**: More open water is present as compared to the 1966 aerial photo. Areas are classified as A2/WØL and A2L where more dense stands of aquatic vegetation are present. The channel that connects Koshkonong Lake to Mud Lake is visible. **Aerial photo dated 5-31-1986:** The vegetation, open water and channel appear to be very similar to what was present in 1979. **Aerial photo dated 5-6-1992**: More open water (WØL) is present than in 1986. It appears that a berm or similar structure was built through a wetland and across the mouth of the channel. Other wetland vegetation present includes E2H and T3K.

Carcajou (Figure 38) **Aerial photo dated 7-19-1937**: A large floodplain forest (T3Kw) is present. Large areas of persistent emergent vegetation are also present (E2H). The E2H wetlands buffer the floodplain forest complex from Lake Koshkonong.**Aerial photo dated 5-16-1966**: The E2H wetlands that buffer the floodplain forest complex have decreased in area. They no longer exist at the southern edge of the floodplain forest surrounding Koshkonong Creek and have decreased in size in the bay to the east. **Aerial photo dated 6-25-1979**: The E2H wetlands in the bay have decreased further. **Aerial photo dated 5-31-1986:** The E2H wetlands appear similar in size as to what was present in 1979.**Aerial photo dated 4-28-1992**: The E2H wetlands appear similar in size as to what was present in 1979.

Figure 37. Aerial Photos of the Mud Lake Wetland Complex.





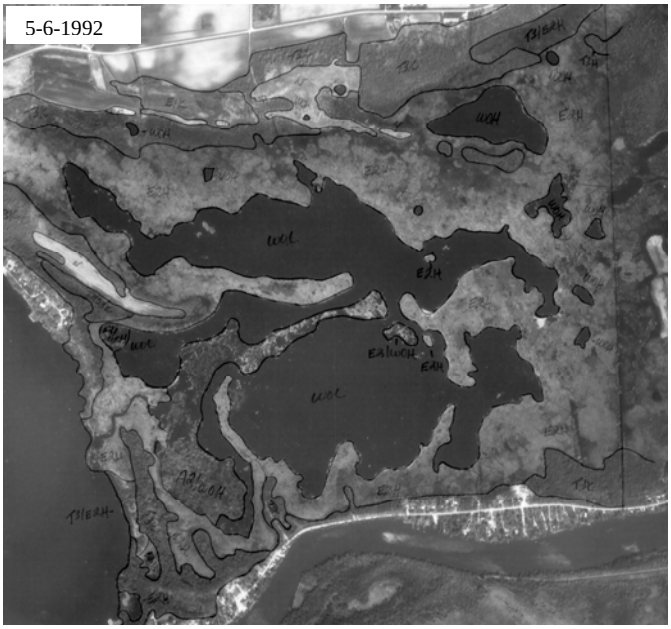
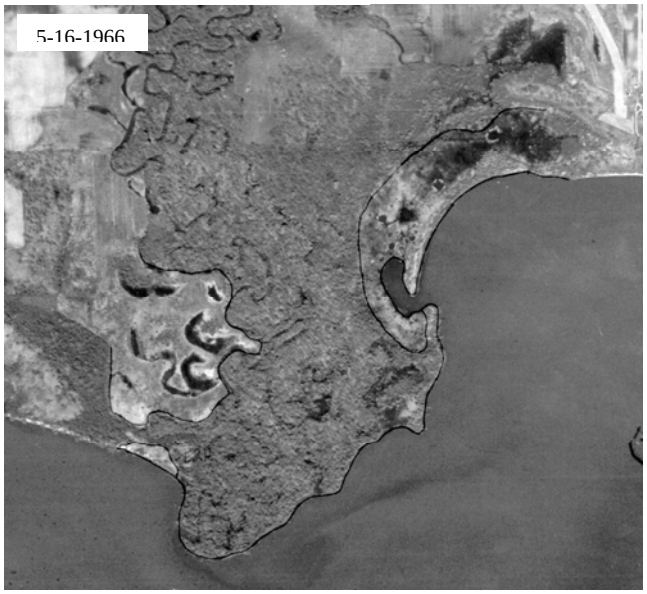
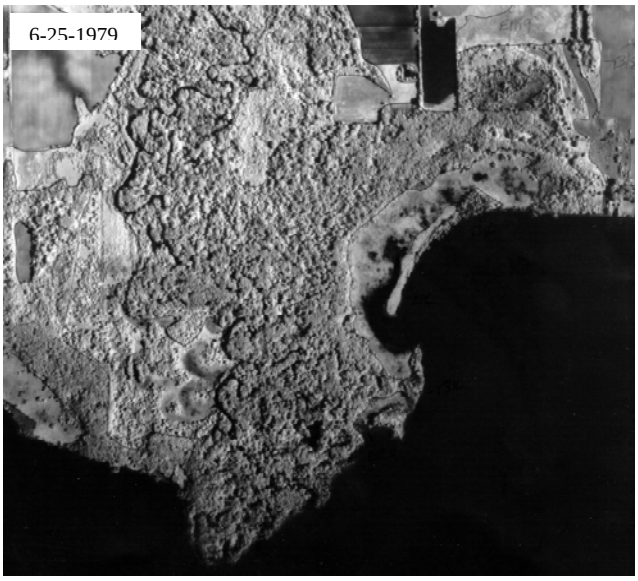



Figure 38. Aerial photos of the Carcajou Wetland Complex