4.4.1 Aquatic Group

4.4.1.1 Overview

Wisconsin has a large and diverse aquatic resource that supports numerous species, communities, ecological processes, and human uses. In addition, many terrestrial species and processes are dependent on neighboring aquatic systems. Table 4.4.1.1 provides the number of SGCNs estimated to have a high or moderate association with this community group. The aquatic communities of Wisconsin include two Great Lakes, 14,000 inland lakes, and 33,000 miles of perennial streams and rivers. On a landscape scale, aquatic systems are an integral piece of an ecological continuum that includes upland terrestrial systems and transitional wetland areas. Aquatic communities also often serve as important recharge or discharge areas for groundwater.

Wisconsin's Great Lakes shoreline on Lakes Superior and Michigan is approximately 1000 miles long. The Lake Michigan shoreline is also the site of Wisconsin's highest population density and the majority of its industrial base. State waters include 1.7 million acres of Lake Superior and 4.7 million acres of Lake Michigan including Green Bay. About a third of Wisconsin's 11 million land acres and a third of its river miles drain to these two lakes.

With Euro-American settlement in the early 1800s and continuing up to present times, aquatic resources have incurred numerous alterations and stressors. The physical attributes of our waterbodies have been altered through damming and channelization, dredging, replacement of shoreline vegetation with substrates or vegetation that suit human needs, and filling/draining of associated wetlands. Water quality has been diminished with inputs of sediment, nutrients, wastewater, and industrial pollutants. Aquatic biota has also been negatively impacted through overfishing, introduction of invasive species, and damage from recreational watercraft.

The Aquatic Group includes 23 natural community types. The former “Inland Lake” community type has been expanded to comprise 15 new types reflective of their hydrology, depth, alkalinity, and landscape position. The Great Lakes, streams and river community descriptions can be found online.1 Descriptions of the Inland Lake community types can be found in Appendix 4.1 at the end of this Section.

- Coldwater streams
- Coolwater streams
- Warmwater rivers
- Warmwater streams
- Lake Michigan
- Lake Superior
- Small Lake
  - Soft bog lake
  - Hard bog lake
  - Meromictic lake

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1 [http://dnr.wi.gov/topic/EndangeredResources/Communities.asp?mode=group&Type=Aquatic](http://dnr.wi.gov/topic/EndangeredResources/Communities.asp?mode=group&Type=Aquatic) [Search Terms: Aquatic Communities of Wisconsin DNR]
Wisconsin Wildlife Action Plan
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- Other
  - Large Lake
    - Shallow seepage lake – soft
    - Shallow seepage lake – hard
    - Shallow drainage lake – soft
    - Shallow drainage lake – hard and very hard (marl)
    - Deep seepage lake – Soft and very soft
    - Deep seepage lake - Hard
    - Deep drainage lake – Soft
    - Deep drainage lake – Hard
- Other Lake Types
  - Riverine impoundment
  - Riverine Lake/Pond
  - Spring pond/lake
- Spring and Spring Run (Hard)
- Spring and Spring Run (Soft)

In addition, there are several natural communities included in the Wetland Group that are closely related to the natural communities present in the Aquatic Group. Specifically, the submergent aquatic and emergent aquatic natural communities or their variants (i.e., emergent aquatic-wild rice and submergent aquatic-oligotrophic) as well as floating-leaved marsh could potentially be present in all of the aquatic communities included in this section. For that reason, the reader is encouraged to also review the information in the Wetland Group section of this document (Section 4.4.7) when working with any of the communities found in the Aquatic Group.

Table 4.4.1.2 at the end of this Section provides the Natural Community – Ecological Landscape (NC-EL) Opportunity scores for the Aquatic Community Group. The key to these scores is provided below.

**Key to NC-EL Opportunity Scores**

<table>
<thead>
<tr>
<th>Level of Opportunity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>A major opportunity for sustaining the natural community in the Ecological Landscape exists, either because many significant occurrences of the natural community have been recorded in the landscape or restoration activities in areas of historical occurrence are likely to be successful maintaining the community’s composition, structure, and ecological function over a long period of time.</td>
</tr>
<tr>
<td>Moderate</td>
<td>Although the natural community does not occur extensively or commonly in the Ecological Landscape, one to several significant occurrences do occur and are important in sustaining the community in the state. In some cases, important opportunities may exist because the natural community may be restricted to just one or a few Ecological Landscapes within the state and should be considered for management there because of limited geographic distribution and a lack of better opportunities elsewhere.</td>
</tr>
<tr>
<td>Low</td>
<td>The natural community occurs in the Ecological Landscape, but better management opportunities appear to exist in other parts of the state.</td>
</tr>
<tr>
<td>None</td>
<td>The natural community is not known to occur in this Ecological Landscape.</td>
</tr>
</tbody>
</table>
4.4.1.2 Issues and Associated Conservation Actions for the Aquatic Communities Group

This Section describes issues and conservation actions that are common to all or most of the community types in this group. As much as possible, the source of the threat is described as well as the stresses or effects that occur directly or indirectly as a result of the threat. Stresses are generally thought of as loss, conversion and/or degradation of the natural community.

**Issue.** Nonpoint source (NPS) pollution, also known as polluted runoff, is a leading cause of water quality problems in Wisconsin. Polluted runoff is caused by rainfall or snowmelt moving over and through the ground picking up natural and human-made pollutants, depositing them into rivers, lakes, wetlands and groundwater. Pollutants include fertilizers, nutrients, oil, grease, sediment and bacteria from agricultural, urban and residential areas. Runoff may be exacerbated by climate change-related events, including more frequent and intense storms, and winter precipitation falling in the form of rain on frozen ground.

**Conservation Actions.** Depending on your overall objectives, the following conservation actions can address the source of polluted runoff as well as the effects that it has on aquatic communities:

- Improve habitat and water quality conditions in river basins, such as the Milwaukee River basin, by controlling non-point pollution through compliance with existing runoff and water quality laws.
- Work with NRCS Conservationist or follow NRCS guidelines (http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/fotg/) to develop a ‘cropland conservation management system’ for water quality and water quantity that holistically considers the effects of planting design, crop selection, discontinuous vegetative cover, tillage practices, nutrient management, pest management, and irrigation. Of particular concern is water degradation due to inputs of sediment (soil runoff), nutrients (fertilizers), and pesticides, as well as lowered water tables. Make specific reference to USDA NRCS National Agronomy Manual (2011). On WDNR lands leased for agricultural purposes, follow department policy as noted in the WDNR Wildlife Management Handbook.
- Work with local municipalities to reduce runoff from impervious surfaces and enhance infiltration through ordinances and development planning.
- Work with DNR, county, and municipal forests and other partners to refine and implement the strategy to “Slow the Flow” of runoff and sedimentation in the Superior Coastal Plain (in part by increasing the percentage of mature forests and conifer component in those forests and by decreasing the percentage of open land and very young forest in a given watershed). For recommendations, see WDNR publication entitled "Managing Woodlands on Lake Superior’s Red Clay Plain: Slowing the Flow of Runoff”.
- Work with state and local agencies to implement, comply with and enforce existing erosion control statues for construction, stormwater and runoff.
- Maintain or increase proportion of mature forests and other vegetation along riparian corridors and in upstream watersheds to help slow the flow of runoff during snowmelt and rain events.
• Fund staff level and time at both state and county levels to implement nonpoint source performance standards as described in Wisconsin’s Nonpoint Source Program Management Plan and as required by state law (NR 151 [Runoff Management] and NR 216 [Storm Water Discharge Permits]).

• Work with municipal planners, developers, businesses, and local zoning boards to increase groundwater infiltration practices and decrease stormwater input and nutrient enrichment of water from impervious surfaces (parking lots, etc.) through techniques such as the installation of bioswales, etc.

• Develop lake and waterway plans that consider conservation, management and restoration of aquatic habitats as part of assuring sustainable use and enjoyment. Consider management measures, methods and tools that provide multiple benefits for mixed uses and goals that include SGCN and their habitat.

• Educate, inform and guide property owners, organizations, lake and sanitary districts, businesses, interest groups and recreational users in aquatic habitat related issues.

• Encourage citizens, state and local decision-makers to take voluntary actions on behalf of maintaining and restoring water quality elements of aquatic habitats.

**Issue.** Eighty percent of the land bordering Wisconsin lakes and rivers is privately owned. Each year, thousands of shoreland parcels are developed. The cumulative effects of shoreline development projects of individual lakes and streams can harm water quality. Rain water and snow melt can become nutrient-laden as they run across lawns and gardens, picking up excess fertilizers that have been applied. These nutrients can cause excessive aquatic weed and algal growth that reduces the oxygen supply in lakes and rivers, incurring a cascade of aquatic ecosystem changes.

**Conservation Actions.** Depending on your overall objectives, the following conservation actions can address shoreline development/alteration as well as the effects that it has on aquatic communities:

• Learn about and restore shoreline habitat, assess the habitat on your shoreline property through technical assistance and information at: [http://dnr.wi.gov/topic/shorelandzoning/](http://dnr.wi.gov/topic/shorelandzoning/).

• Shoreline property owners become familiar with the WDNR publication series for shoreline protection and restoration. dnr.wi.gov; key words: “publications on shoreland management”. Seek additional guidance from the Shoreland Coordinator in the WDNR Watershed Management Program, UW-Extension, Wisconsin Association of Lakes, and River Alliance.

• Educate landowners on the uniqueness of the dune and shoreline plant community to minimize trails, erosion, beach grooming, etc.

• Work with DNR and local coastal zoning to develop stronger rules related to maintaining natural long-shore sand movement by minimizing new artificial shoreline structures (permanent piers, seawalls, rip-rap, jetties, etc.).

• Comply with ch. NR 115, describing minimum requirements for vegetated buffers around lakeshores to protect important traits of water chemistry, quality, and to prevent shoreline erosion.

• Restore wetland amphibian SGCN habitat adjacent to or within occupied areas. For example, riparian revegetation and groundwater flow areas, shoreline buffers
and exclude cattle from streams/streambanks and adjacent amphibian breeding wetlands.

- Continue to work with river and lake associations and other conservation organizations to promote shoreline protection and buffers for all aquatic SGCNs.
- Continue regulatory efforts to implement and comply with laws related to fish kills, water pollution, and shoreline protection, which are key issues for preserving aquatic SGCNs.
- Restore and maintain natural banks where shoreline and riparian areas are eroded by using natural and/or biodegradable materials such as coarse woody material, native wetland vegetation, regrading to a more shallow slope, bio-engineered erosion control as opposed to hard armoring such as rip-rap or sea walls to restore SGCN habitat and to buffer variations in water levels and wave action.

**Issue.** Non-native aquatic invasives are successful because they originate in other regions or continents, thus lacking natural checks and balances. Early and abundant growth of invasive aquatic plants not only overpowers native plants, it may disrupt aquatic predator-prey relationships by fencing out larger fish, and may limit important aquatic food plants for waterfowl. The die-off of plants such as curly-leaf pondweed in summer can cause oxygen depletion in waterbodies, and decaying plants can contribute to nutrient loading and algal blooms. Aquatic invasive animals similarly present overwhelming competition to their native counterparts (e.g., rusty crayfish versus native crayfish). The invasive common carp resuspends sediments and nutrients and destroys macrophyte beds, while non-native mussels feed on plants, animals and debris that are suspended in the water, leading to increased water clarity and light penetration (fostering overgrowth of rooted aquatic plants), and depleting the food supply for native aquatic organisms.

Aquatic invasive species spread to new waters by hitching a ride on watercraft and trailers, in the ballast water of Great Lakes ships, and on recreational equipment such as fishing gear. They can also be introduced via streams and rivers, and during flood events, which may be exacerbated with climate change-associated flooding. The milder winters and warmer temperatures projected with climate change may further enhance conditions for the proliferation and spread of invasives.

**Conservation Actions.** Depending on your overall objectives, the following conservation actions can address the direct threat of invasive plants and diseases as well as the effects that it has on aquatic communities:

- For any given waterbody, implement a multi-tiered approach to non-native invasive species: 1) careful planning; 2) prevention; 3) early detection and rapid response; 4) control; 5) slowing the spread; 6) monitoring; 7) restoration.
- Develop a plan by conducting surveys for invasives and creating maps showing their locations and densities. Set reasonable management objectives based on this information.
- Prevent invasions of non-native plants by limiting human vectors (e.g., boat launch inspections), maintaining healthy and diverse natural communities and conducting periodic inspections of high-risk areas (e.g., boat ramps).
4.4.1 Aquatic Group (Natural Community Summaries)

- Implement an Early Detection-Rapid Response approach by finding new populations of non-native invasives as early as possible when eradication and control are still feasible and less costly.
- Control non-native invasive species by manual, mechanical, and/or chemical means.
- In areas where eradication and control are not feasible, slow the spread of non-native invasives into adjoining areas by restricting activities during certain seasons, minimizing travel through areas, and inspecting watercraft.
- Conduct regular monitoring of sites to detect new invasions and to evaluate the success of pest management plans and control measures.
- Restore sites to confer resistance to infestation by non-native invasives. This may involve restoring system functions (e.g., hydrology), restoring natural community structure (e.g., native species)canopy, mid-story, shrub layer), and ameliorating invasive species.
- At a landscape or statewide level, support and strengthen regulatory mechanisms and voluntary BMPs that address the introduction and spread of non-native invasives.

Issue. Stream hydrology is altered with the installation of dams and other water control structures, or with channelization. Dams affect aquatic species and habitats by fragmenting them into disjunct segments, preventing the movements of some species between different stretches of the river. Water control structures and channelization may disrupt the natural hydrological fluctuations that are integral to aquatic ecosystems and associated riparian wetlands.

Long-term changes in the water levels of our waterbodies are projected to occur with climate change. Water levels may become lower due to the combined effect of summer heat, drought, diminished groundwater recharge due to less infiltration of precipitation in winter [if rain falls on frozen ground], and flashy spring/summer rains that run off rather than infiltrate. Or water levels may become higher due to overall increase in precipitation. Although the direction of change is hard to predict at a local level, some type of change is likely to occur, and with rapid onset.

Climate change-associated drought and extreme heat may lower groundwater resources, which may be further exacerbated by the necessity for increased agricultural irrigation. Even without climate change, humans may extract water for drinking/household usage or agriculture to the point where groundwater levels are severely lowered along with a commensurate lowering of associated streams and spring-fed lakes. Impervious surfaces also limit groundwater recharge by limiting infiltration of rainwater.

Conservation Actions. Depending on your overall objectives, the following conservation actions can address altered water levels and movement as well as the effects that these have on aquatic communities:

- Develop habitat management guidelines for Ephemeral Ponds to protect water quality, pond hydrology, and habitat for herptiles and invertebrates.
Identify priority groundwater recharge areas that supply fens, sedge meadows, springs, streams, and other wetlands.

Conduct groundwater quantity and/or quality monitoring, stream flow, and lake levels in areas where groundwater dependent species and communities are in close proximity to areas with high demand on groundwater resources.

Work with municipal planners, developers, businesses, and local zoning boards to increase groundwater infiltration practices and decrease stormwater input and nutrient enrichment of water from impervious surfaces (parking lots, etc.) through techniques such as the installation of bioswales, etc.

Work with NRCS and UW-Extension to develop incentives for practices that promote groundwater infiltration in groundwater recharge areas, particularly in agricultural and developed landscapes.

Encourage Dams and Floodplain Programs to incorporate the data and conservation actions from the WWAP to help guide decision regarding the best locations for dam removal, constructing fish passages, and where to target floodplain zoning ordinance reviews and workshops.

Continue to review and provide input to FERC (dam) projects during re-licensing to ensure protection of aquatic SGCNs and their habitats.

**Issue.** Climate change is projected to significantly influence Wisconsin’s aquatic communities. While the nature of this change and its impacts remain uncertain, scientists anticipate that the changes will occur rapidly, and may not allow sufficient time for natural adaptation. There are many other factors apart from climate change that can influence changes in aquatic communities, particularly land cover types, land use, soils, and hydrology within a given watershed, as well as shoreline development/alteration. Climate change may interact with these other factors to amplify their impacts, or synergistically create novel impacts. The major considerations relating to climate change and aquatic communities are summarized below.

More winter precipitation is projected to fall in the form of rain and freezing rain, especially at the tail ends of winter. If the ground is frozen, rain won’t infiltrate, but instead will run off, limiting groundwater recharge. If, however, warmer winter temperatures prevent the ground from freezing, then groundwater recharge could increase; soil types, vegetation cover, and frost are all critical factors. Warmer summer temperatures, drought (and associated increase in irrigation demand), and a longer growing season can result in lower groundwater levels due to increasing evapotranspiration and plant uptake of water. This could all be offset, however, by increasing annual precipitation. A decrease in groundwater recharge can lead to lower lake levels, lower stream baseflow, and wetland loss or alteration. Slow-draining lakes and seepage lakes will be the most vulnerable to declining water levels (Walker et al., 2013). Lower lake levels may impact lake temperature, chemistry, and amount of available habitat for aquatic plants and animals. Cool- and cold-water streams may warm due to increasing temperatures and lower base flow, resulting in limited reproduction of species such as trout and aquatic invertebrates. Conversely, an increase in groundwater recharge can cause flooding and wetland loss/alteration.

If heavy rainfalls intensify, moderately deep lakes may no longer stratify, but instead mix continually, causing phosphorus loading and a change in trophic status ([WICCI] 2010).
Lake ice depth and longevity may decrease as a result of milder winters. Prolonged warm weather and decreased ice depth/duration may lengthen the period of thermal stratification and promote more extensive oxygen depletion throughout bottom waters and eventual die-off of fish that need cooler water ([WICCI] 2010).

Flooding can connect formerly disjointed water bodies, allowing invasion of non-native invasive species (plants and animals). Nutrient and sediment runoff may increase with higher intensity and more frequent storms, especially if they occur in winter or spring when there is little to no vegetative cover to limit erosion and runoff. Increasing temperatures combined with increased runoff and sedimentation may thus further stimulate the growth of non-native invasive plants. Flooding may also overwhelm stormwater and sewage management systems, resulting in dispersion of pollutants and contaminants into aquatic communities. Decreased water quality can also be associated with lower groundwater levels, as there is less water to dilute pollutants. Phosphorus loading can boost algal growth, while sediment can limit photosynthesis of submerged aquatic plants. Drainage lakes and impoundments may experience greater impacts than seepage lakes. Also, deeper, larger lakes may be more resistant to nutrient loading due to dilution.

Conservation actions. Depending on your overall objectives, the following conservation actions can be considered to help aquatic communities adapt to large-scale environmental and other changes:

- Work with local municipalities to reduce runoff from impervious surfaces and enhance infiltration through ordinances and development planning.
- At the site level, employ an eight-part approach to non-native invasive species: 1) careful planning; 2) prevention; 3) early detection and rapid response; 4) control; 5) slowing the spread; 6) reducing impacts; 7) monitoring; 8) restoration.
- Identify priority groundwater recharge areas that supply fens, sedge meadows, springs, streams, and other wetlands.
- Conduct groundwater quantity and/or quality monitoring in areas where groundwater dependent species and communities are in close proximity to areas with high demand on groundwater resources.
- See other conservation actions under the following issue sections above that can be adapted to consider the effects of changing climate:
  - Polluted runoff
  - Invasive plants and diseases
  - Altered water levels and movements


4.4.1.3 References


Table 4.4.1.1 Number of Species of Greatest Conservation Need Highly or Moderately Associated with Aquatic Communities

<table>
<thead>
<tr>
<th>SGCN Species Group</th>
<th>Aquatic (lakes-rivers) Community Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birds</td>
<td>10</td>
</tr>
<tr>
<td>Fish</td>
<td>24</td>
</tr>
<tr>
<td>Herps</td>
<td>11</td>
</tr>
<tr>
<td>Mammals</td>
<td>6</td>
</tr>
<tr>
<td>Insects - Aquatic</td>
<td>93</td>
</tr>
<tr>
<td>Insects - Terrestrial</td>
<td>5</td>
</tr>
<tr>
<td>Invertebrates - Crustacea</td>
<td>24</td>
</tr>
<tr>
<td>Invertebrates - Mussels</td>
<td></td>
</tr>
<tr>
<td>Invertebrates - Terrestrial Snails</td>
<td></td>
</tr>
<tr>
<td><strong>Total SGCN (High/Moderate Association)</strong></td>
<td><strong>173</strong></td>
</tr>
</tbody>
</table>
Table 4.4.1.2 Natural Community – Ecological Landscape Opportunity Scores for the Aquatic Community Group

<table>
<thead>
<tr>
<th>Community</th>
<th>Central Lake Michigan Coastal</th>
<th>Central Sand Hills</th>
<th>Central Sand Plains</th>
<th>Forest Transition</th>
<th>North Central Forest</th>
<th>Northeast Sands</th>
<th>Northern Highland</th>
<th>Northern Lake Michigan Coastal</th>
<th>Northwest Lowlands</th>
<th>Northeast Sands</th>
<th>Southeast Glacial Plains</th>
<th>Southern Lake Michigan Coastal</th>
<th>Southwest Savanna</th>
<th>Superior Coastal Plain</th>
<th>Western Coulee and Ridges</th>
<th>Western Prairie</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Michigan</td>
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<td>Lake Superior</td>
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<tr>
<td>Large Lake--deep, hard, drainage</td>
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<tr>
<td>Large Lake--deep, hard, seepage</td>
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<td>Large Lake--deep, soft and very soft, seepage</td>
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<td>Large Lake--deep, soft, drainage</td>
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<tr>
<td>Large Lake--shallow, hard and very hard (marl), drainage</td>
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<td>Large Lake--shallow, hard, seepage</td>
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<td>Large Lake--shallow, soft, drainage</td>
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<tr>
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<tr>
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### 4. Aquatic Group (Natural Community Summaries)

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Appendix 4.1  
Aquatic Community Descriptions New to the WWAP and Currently Not Presented Online

Inland Lakes:
Small Lakes (typically less than 10 acres):
- Hard Bog Lake
- Soft Bog Lake
- Meromictic Lake

Large Lakes (typically greater than 10 acres):
- Shallow Drainage Lake – Soft
- Shallow Drainage Lake - Hard & Very Hard (marl)
- Deep Drainage Lake - Soft
- Deep Drainage Lake - Hard
- Deep Seepage Lake - Hard
- Deep Seepage Lake - Soft and Very Soft
- Shallow Seepage Lake - Hard
- Shallow Seepage Lake - Soft

Other Lakes:
- Riverine impoundment
- Riverine Lake/Pond
- Spring pond/lake

Springs:
- Spring and Spring Run (Hard)
- Spring and Spring Run (Soft)
Appendix 4.1
Aquatic Community Descriptions New to the WWAP and Currently Not Presented Online

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- Deep Drainage Lake - Hard
- Deep Seepage Lake - Hard
- Deep Seepage Lake - Soft and Very Soft
- Shallow Seepage Lake - Hard
- Shallow Seepage Lake - Soft

Other Lakes:
- Riverine impoundment
- Riverine Lake/Pond
- Spring pond/lake

Springs:
- Spring and Spring Run (Hard)
- Spring and Spring Run (Soft)

A4.1.1 General Description

Inland lakes are naturally occurring bodies of standing water with a huge diversity in size, configuration, water chemistry, and biota. Glaciation, post-glacial water flow, soil characteristics, topography, bedrock composition, land cover, land use and other factors can all combine to determine the physical and chemical characteristics of any given lake.

In Wisconsin's Wildlife Action Plan, we divide lakes first by size: "Small Lakes" are typically less than 10 acres and "Large Lakes" are more than 10 acres. Large Lakes are further subdivided by their depth (shallow or deep), alkalinity (hard or soft) and water source (drainage or seepage). These descriptors are defined below. Table A.4.4.1 illustrates the relationship between this classification and other classifications used within the state.
Water Depth. Depth is just one of several lake characteristics that influence stratification; others include surface area, water source, and water clarity. Stratification refers to variations in temperature at different depths of a lake throughout the seasons. In stratified lakes (typically deeper lakes), a thermocline develops during the summer and winter. In the spring and fall, this zone of marked temperature difference breaks down, allowing for the mixing of bottom and surface waters and a redistribution of oxygen and nutrients. Lakes that do not stratify thermally (typically shallow lakes) can become oxygen depleted as the water warms and decomposition exceeds primary production. This can also occur during the winter when ice and snow cover the surface, inhibiting photosynthesis – “freezout” conditions may then prevail.

For the purposes of this classification, associated plant and fish species are correlated with deep (> 18 feet) and shallow (< 18 feet) water.

Alkalinity. Hard – Total alkalinity equals or exceeds 50 ppm. Hard water lakes are less susceptible to acidification because they have a high concentration of hydroxyl, carbonate, and/or bicarbonate ions, which buffer acids. Soft – Total alkalinity is less than 50 ppm. Soft water lakes have low capacity to buffer acids.

Water Source. Drainage Lakes - These lakes have both an inlet and outlet, and the main water source is from streams. Most major rivers in Wisconsin have drainage lakes along their course. Drainage lakes owing one-half of their maximum depth to a dam are considered to be artificial lakes or impoundments.

Seepage Lakes - These lakes do not have an inlet or an outlet, and only occasionally overflow. As landlocked waterbodies, the principal source of water is precipitation or runoff, supplemented by groundwater from the immediate drainage area. Since seepage lakes commonly reflect groundwater levels and rainfall patterns, water levels may fluctuate seasonally. Seepage lakes are the most common lake type in Wisconsin. Several types of lakes don’t fit consistently into the “Small Lake” or “Large Lake” classes, and are treated separately. These include Riverine Impoundment, Riverine Lake/Pond, Spring Pond, and Spring Lake. Table 4.4.1 shows the different types of lakes as presented in the Wildlife Action Plan and how they relate to two other classification systems commonly used in Wisconsin.

Plant communities associated with inland lakes can fall into two general categories: submergent marsh and floating-leaved aquatic, and both communities can be found within a single lake. Submergent aquatic macrophytes tend to occur in deeper water than beds of floating-leaved or emergent species, but there is considerable overlap. Where the two communities do co-occur, the large-leaved pond lilies, when dominant, can inhibit the development of submergent or emergent plants by casting heavy shade over the plants below. The water clarity, chemistry, substrate, and stratification at a given lake affect these two plant communities. The water chemistry, perhaps more so than other ecological factors, greatly affects the types and abundance of aquatic plants present.
Aquatic plants, including both emergent and submergent aquatic vegetation, form the foundation of healthy and flourishing aquatic ecosystems - both within lakes and on the shores and wetlands surrounding them. They not only protect water quality, but also produce life-giving oxygen. Aquatic plants are a lake's own filtering system, helping to clarify the water by absorbing nutrients like phosphorus and nitrogen that could stimulate algal blooms. Plant beds stabilize soft lake bottoms and reduce shoreline erosion by reducing the effect of waves and current. Aquatic plants also serve as spawning habitat for fish and amphibians, and support populations of aquatic insects that serve as a food base for other species.

Inland lakes are different than other natural communities described in the NHC webpages in that they describe a system rather than a discrete plant community. In the description of each inland lake type we have attempted to paint a picture of the typical plants one is most likely to observe. Aquatic plant communities, however, do not align as precisely with specific geological features and local/regional conditions as their terrestrial counterparts. Distribution of aquatic plants is most consistently determined by alkalinity and light regime, two factors that can vary across all lake types regardless of depth or water source. Water depth and source may, however, be very important for other organisms of this aquatic system, including fishes.

A4.1.2 Inland Lake Community Descriptions

**Small lakes (typically less than 10 acres).** There are thousands of small lakes across the state. They can exhibit diverse hydrological regimes, depths, substrates, alkalinity, and associated species. Below are three types that have been recognized as important conservation targets. Other types of small lakes may appear in the Wisconsin Wildlife Action Plan in the future if sufficient data is gathered to accurately describe and categorize them (e.g., small seepage lakes in central Wisconsin). Spring Ponds are typically under 10 acres, but are listed under "Spring Ponds/Lakes" in the "Other Types" section below.

**Hard Bog Lake.** The pH of this lake type is at or slightly above neutral, due to groundwater influence. This mineral-rich environment commonly supports a genera of macroalgae called muskgrass (Chara spp.), which in turn supports diverse aquatic invertebrates. As the muskgrasses extract carbon dioxide from calcium bicarbonate, they produce calcium carbonate which precipitates on the lake bottom in the form of marl. Observers may notice many muskgrass populations have a hard or crunchy texture due to the crusty layer of marl that often precipitates on the plant’s surface. If nutrient levels get very high, eutrophication may occur, resulting in a muddy false bottom as the remains of poorly decomposed microscopic plants and animals accumulate.

A quaking sedge mat (often Carex lasiocarpa) typically occupies the margins of the lake, providing a substrate for pioneering Sphagnum. If conditions allow (e.g., low lake levels during dry years), this sedge mat may advance into the lake, and eventually transition to Poor Fen. Observers may key in to indicators of groundwater influence in the vegetation surrounding the lake, even during later successional stages of the bog mat. These include distinctive species such as white beak-rush (Rhynchospora alba),
bogbean (Menyanthes trifoliata), pink-flowered orchids (grass pink (Calopogon tuberosus), rose pogonia (Pogonia ophioglossoides), dragon’s-mouth (Arethusa bulbosa), and tamarack (Larix laricina).

Associated fish species include central mudminnow, yellow perch, golden shiner, fathead minnow, northern redbelly dace, fine-scale dace, and brook stickleback.

**Soft Bog Lake.** The pH of this mineral-poor lake type is below neutral due to a lack of groundwater influence. It typically has clear water and a firm substrate, and supports an oligotrophic submergent community sparsely populated by short aquatic macrophytes called isoetids. Dwarf watermilfoil (Myriophyllum tenellum), pipewort (Eriocaulon aquaticum) and submersed brown-fruiting rush (Juncus pelocarpus) are all examples of this plant group commonly found in high quality soft bog lakes.

Bladderworts (Utricularia spp.) may be associated with shallow mineral pockets. Floating lilies (Nymphaea odorata and Nuphar variegata) can usually be found along lake margins, which transition to a narrow sphagnum lawn and fringe of sedges. This, in turn, often transitions to an Open Bog dominated by leather-leaf (Chamaedaphne calyculata), Labrador-tea (Ledum groenlandicum), black spruce (Picea mariana), and tamarack (Larix laricina). Because these lakes are nutrient poor, they are particularly vulnerable to eutrophication. High nutrient levels can lead to dense beds of duckweeds (Lemna spp.), and water-meals (Wolfia spp.) as well as larger aquatic macrophytes like coontail (Ceratophyllum demersum) and common waterweed (Elodea canadensis), which can, in turn, displace the smaller isoetids. Associated fish species include central mudminnow and yellow perch.

**Meromictic Lake.** This lake type is typified by extreme relative depth in relation to surface area. These factors in addition to watershed soils and its protection from surrounding uplands result in meromictic lakes never “turning over” as the water temperature changes in the spring and fall as is typical of most other Wisconsin lakes. Instead, these lakes stay stratified, creating unusual chemical and biological layers. There are very few known examples of this lake type in Wisconsin, making them difficult to characterize in terms of vegetation associates. Meromictic lakes do not support fish.

**Large Lakes (typically greater than 10 acres).** Large lakes are divided by their depth (shallow or deep), hydrology (drainage or seepage), and alkalinity.

**Shallow Drainage Lake – Soft.** The submergent community of this lake type is often dominated by cosmopolitan species like coontail (Ceratophyllum demersum), water milfoils (Myriophyllum spp.), common waterweed (Elodea canadensis), fern-leaf pondweed (Potamogeton robbinsii) and wild celery (Vallisneria americana), even in high quality examples. While less abundant, other submersed species, including large-leaf pondweed (P. amplifolius), and slender naiad (Najas flexilis) provide excellent fish habitat. Floating lilies (Nymphaea odorata and Nuphar variegata) are common along lake margins, especially in shallow sheltered bays. Headwater drainage lakes within this type have the following associated fish species: golden shiner, black bullhead, yellow bullhead, bluegill, largemouth bass. Lowland drainage lakes within this type have the following fish associates: northern pike, black bullhead, yellow bullhead, bluegill, largemouth bass, and black crappie.
4. Aquatic Group (Natural Community Summaries)

**Shallow Drainage Lake - Hard and Very Hard (marl).** Similar to soft water shallow drainage lakes, the submergent community of this lake type is often dominated by coontail (Ceratophyllum demersum), watermilfoils (Myriophyllum spp), common waterweed (Elodea canadensis) and naiads (Najas spp.). However, muskgrasses (Chara spp.) that thrive in hard water are some of the most abundant species of aquatic plant in this particular lake type. Floating lilies (Nymphaea odorata and Nuphar variegata) occur near the shoreline in most examples. Headwater drainage lakes within this type have the following associated fish species: northern pike, golden shiner, blacknose shiner, blackchin shiner, black bullhead, yellow bullhead, Bluegill, largemouth bass, black crappie, and johnny darter. Lowland drainage lakes within this type have the same fish associates, plus brook silverside, though the johnny darter does not favor lakes that are very hard.

**Deep Drainage Lake - Soft.** The submergent communities in soft water deep drainage lakes are quite diverse and plants are abundant. Coontail (Ceratophyllum demersum), common waterweed (Elodea canadensis) and fern-leaf pondweed (Potamogeton robbinsii) occur abundantly, and a number of other pondweeds such as large-leaf pondweed (P. amplifolius), variable-leaf pondweed (P. gramineus) and small pondweed (P. pusillus) can be found in high quality examples where water clarity is moderate to high. These diverse assemblages of aquatic macrophytes provide excellent habitat for fish, macro invertebrates, and other wildlife. Associated fish species include northern pike, rock bass, smallmouth bass and yellow perch, with cisco appearing in very deep lakes.

**Deep Drainage Lake - Hard.** Muskgrasses (Chara spp.) are well-adapted to live in hard water drainage lakes and can often be found growing in dense mats along the lake bottom. These macroalgae play a valuable role in the lake’s ecological community by preventing sediment re-suspension and helping to maintain clear water. Other common members of the submergent community at these lakes include cosmopolitan species such as coontail (Ceratophyllum demersum), common waterweed (Elodea canadensis), naiads (Najas spp.) and water celery (Vallisneria americana). Floating lilies (Nymphaea odorata and Nuphar variegata) are also common. Associated fish species vary depending on water depth and hydrology:

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<td>Johnny darter</td>
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### Shallow Seepage Lake – Soft.
Similar to their deep counterparts, the submergent community of soft water shallow seepage lakes is characterized by a group of slow-growing, mostly rosette-forming aquatic plants called isoetids. These plants cannot utilize bicarbonate as a source of carbon, and instead assimilate inorganic carbon from the sediment via an extensive root system. Typical species include pipewort (Eriocaulon aquaticum), quillworts (Isoetes spp.), and dwarf watermilfoil (Myriophyllum tenellum). However, their short stature makes them vulnerable to shading, and as a community, they are extremely sensitive to nutrient pollution that favors faster-growing submerged and/or floating-leaf species. The floating-leaved community consists largely of watershield (Brasenia schreberi), but also includes floating lilies (Nymphaea odorata and Nuphar variegata). Associated fish species include bluegill, pumpkinseed, and largemouth bass.

### Shallow Seepage Lake - Hard.
The macroalgae muskgrass (Chara spp.) dominates the submergent community of this lake type, along with a variety of pondweeds (Potamogeton spp.) and naiads (Najas spp.). Where nutrient levels are particularly high, more cosmopolitan species like coontail (Ceratophyllum demersum) can occur at moderate to high abundance. White and yellow water lilies (Nymphaea odorata and Nuphar variegata) are also often present in shallow waters. Associated fish species include golden shiner, black bullhead, yellow bullhead, bluegill, pumpkinseed, and largemouth bass.

### Deep Seepage Lake - Soft and Very Soft.
The submergent community of this lake type is characterized by a group of slow-growing, mostly rosette-forming aquatic plants called isoetids. Because these plants cannot utilize bicarbonate as a source of carbon, they have substantial root systems that allow them to assimilate inorganic carbon from the sediment. Typical species include water lobelia (Lobelia dortmanna), quillworts (Isoetes spp.), and dwarf watermilfoil (Myriophyllum tenellum). However, their short stature makes them vulnerable to shading, and as a community they are extremely sensitive to nutrient pollution that favors faster-growing submerged and/or floating-leaf species. In deeper water, stoneworts (Nitella spp.), a genera of macroalgae can be found with high abundance. The floating-leaved community consists largely of watershield (Brasenia schreberi), but also includes floating lilies (Nymphaea odorata and Nuphar variegata). Associated fish species include bluegill, pumpkinseed, largemouth bass,
and yellow perch, with rock bass appearing in soft (as opposed to very soft) waters, and cisco appearing in very deep, soft waters.

**Deep Seepage Lake - Hard.** The macroalgae muskgrass (Chara spp.) and stonewort (Nitella spp.) are frequent members of the submergent community of this lake type, with stoneworts often preferring deeper waters. Common aquatic vascular plants in undisturbed deep seepage lakes include naiads (Najas spp.), and a variety of pondweeds, including large-leaf pondweed (Potamogeton amplifolius), variable-leaf pondweed (P. gramineus) and flat-stem pondweed (P. zosteriformis). Where nutrient levels are high watermilfoil (Myriophyllum spp.), coontail (Ceratophyllum demersum) and common waterweed (Elodea canadensis) are more abundant. Floating lilies (Nymphaea odorata and Nuphar variegata) occur often in shallow waters. Associated fish species include mimic shiner, bluntnose minnow, rock bass, bluegill, pumpkinseed, smallmouth bass, largemouth bass, black crappie, yellow perch, with cisco and mottled sculpin appearing in very deep lakes.

**Other Lake Types (any size).**

**Riverine Impoundment.** Impoundments (also known as reservoirs) are artificially created standing water bodies, produced by dams on streams or rivers. Because of the diverse nature of streams, rivers, and dams, these waterbodies can vary greatly in size, configuration, flow patterns, water chemistry, and biota. Impoundments are nearly as numerous and diverse in characteristics as natural lakes, with larger and more southerly waters having the richest fish faunas. Fish species associated with impoundments on large rivers include Gizzard shad, emerald shiner, bluegill, largemouth bass, walleye and freshwater drum. Fish species that are associated with mill ponds on streams or small rivers include bluegill and largemouth bass.

**Riverine Lake/Pond.** Riverine lakes occur naturally within the floodplains of large rivers. They are periodically connected to rivers and streams, and therefore behave as drainage systems when water levels are high and have direct connections to flowing waters, and behave like lakes when water levels are low and they are temporarily isolated. Oxbow Lakes are a special type of Floodplain Lake that forms when a wide meander from the main stem of a river is cut off, creating a free-standing body of water. Common plants include American white water-lily (Nymphaea odorata), bullhead pond-lily (Nuphar variegata), and various Potamogeton (pondweed) species, with more pristine oxbows harboring bladderwort (Utricularia) species and water star-grass (Heteranthera dubia). Highly eutrophic systems can become choked with free-floating plants such as duckweeds (Lemma spp), water-meal (Wolffia spp.) and filamentous algae. While bluegill and largemouth bass are common associates at most Riverine Lakes/Ponds, some fish associates reflect the amount of groundwater input: grass pickerel is associated with significant groundwater input, whereas central mudminnow and golden shiner are associated with lakes where there is little groundwater influence.

**Spring Pond/Lake.** The primary source for these waterbodies is groundwater from both inside and outside the immediate surface drainage area. The groundwater is often mineral rich, resulting in above neutral pH and alkalinity greater than 50 ppm. Spring
Ponds are usually less than 10 acres, and have no inlet, but may have an outlet, occasionally joining with Spring Runs to feed into larger Spring Lakes. Spring Lakes are often greater than 10 acres, and have no inlet, but typically do have an outlet, often forming the headwaters of streams particularly in northern Wisconsin. Due to their smaller size, Spring Ponds are cooler than Spring Lakes. The submerged community of both Spring Ponds and Spring Lakes is often dominated by muskgrasses (Charaspp.), which thrive in alkaline water. Coontail (Ceratophyllum demersum), naiads (Najas spp.), common waterweed (Elodea canadensis), and wild celery (Vallisneria americana) are also common. The non-native invasive watercress (Nasturtium officinalis) is often found growing in shallower areas, and may completely cover the water's surface. These lake types are often surrounded by white cedar dominated Northern Wet-mesic Forests. Fish species associated with Spring Ponds include brook trout, creek chub, common shiner, white sucker, and mottled sculpin.

A4.1.3 Natural Community Descriptions for Springs

**Springs and Spring Runs (Hard).** A "spring" is a defined point at which groundwater reaches the surface (a spring seepage is less easily localized or defined). The "spring run" is a defined flowing channel (these can be braided) fed by the spring. Usually these are short, and either join other spring runs, a stream, a spring pond, or a spring lake. Total alkalinity is > 50 ppm. Alkalinity can play a role in determining invertebrate composition of a site (e.g., those that make shells are mostly associated with "hard" water springs).

**Springs and Spring Runs (Soft).** A "spring" is a defined point at which groundwater reaches the surface (a spring seepage is less easily localized or defined). The "spring run" is a defined flowing channel (these can be braided) fed by the spring. Usually these are short, and either join other spring runs, a stream, a spring pond, or a spring lake. Total alkalinity is < 50 ppm. Alkalinity can play a role in determining invertebrate composition of a site (e.g., those that make shells are mostly associated with "hard" water springs).
Table A4.1.1 Comparison of Inland Lake Types Presented in the WWAP with Classification Systems Commonly Used in Wisconsin

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<td>Wisconsin's Wildlife Action Plan</td>
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<td></td>
<td>Stratification</td>
<td>Hydrology</td>
</tr>
<tr>
<td>Impounded flowing waters</td>
<td>variable</td>
<td>Headwater/lowland drainage</td>
</tr>
<tr>
<td></td>
<td>lowland drainage</td>
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</tr>
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|                             | seepage          |                                | Spring pond/lake             | Spring Pond, Lake - Spring}