Aquatic Features

There are numerous ways to classify lakes and streams but no universal standard that will serve all purposes. The classification of waterbodies presented here was developed in the 1980s for use by the Scientific Areas Preservation Council (NAPC) and the State Scientific Areas program as a tool that would enable them to classify, identify, evaluate, and select representative waterbodies to ensure that all types of aquatic communities or assemblages found within the state could be evaluated and considered for representation within the Wisconsin DNR's State Natural Areas system.

Terms used by the State Natural Areas program to name, define, and classify the types of waterbodies tracked by Wisconsin DNR's Natural Heritage Inventory (NHI) (and used on the NHI program's Natural Community Working List as of 07/2016; Table 7.1) are defined below.

Lakes and Ponds: Lentic Systems (Standing Waters)

Water Source

- **Seepage Lake** – The sources of water are groundwater infiltration, overland flow, and precipitation. These are essentially landlocked waterbodies, usually lacking defined inlets and outlets.
- **Drainage Lake** – The primary source of water is via one or more inlet streams. Water exits the system by an outlet stream. Other water sources include one or more of those mentioned above under Seepage Lake.
- **Spring Lake** – Springs contribute substantially to lake volume. Features such as spring runs or spring ponds may discharge waters directly into a spring lake, or springs located beneath the lake discharge their waters directly into the lake from below.
- **Riverine Lake** – Riverine lakes and ponds (these are differentiated only by size, with "lakes exceeding 10 acres; ponds occupying less than 10 acres) occur within the floodplains of large rivers. They may be periodically connected to the main channels of rivers and streams and therefore behave as parts of a river when water levels are high and have direct connections to flowing waters and behave like seepage lakes when water levels in the rivers are low and they are temporarily isolated.
- **Impoundment** – Impoundments are defined by the state of Wisconsin as waterbodies for which over one-half of the maximum depth is due to the presence of a dam. As the hydrology of such modified systems is significantly altered by the dams, and they are typically managed to meet human needs and desires (e.g., for power production, to improve navigation potential, or for recreation purposes), waterbodies meeting the state definition of "impoundment" are treated as "Selected Habitats."

Impoundments for which dams are responsible for less than one-half of the maximum depth are hybrids, but the presence of a dam, even with a low head of water, will alter flow characteristics, thermal properties, and prevent the movement of fish and other aquatic organisms from one segment of an impounded stream to another.

The floodplain of the lower Black River features extensive bottomland hardwood forests, marshes, running sloughs, and scattered ponds. During periods of high water, this riverine lake is directly connected to the mainstem of the river. Van Loon State Wildlife Area, La Crosse and Trempealeau counties, Western Coulees and Ridges Ecological Landscape. Photo by Wisconsin DNR staff.

Lake Pepin is a huge natural drainage lake on the Mississippi River. Sandy alluvium deposited by the Chippewa River constricted the Mississippi's main channel, creating the lake. Pepin County, Western Coulees and Ridges Ecological Landscape. Photo by Eric Epstein, Wisconsin DNR.

Only a few photos in our archives were suitable for use as illustrating specific lake or stream types. Some of the key defining characteristics for these waterbodies (such as depth, temperature, and alkalinity) cannot be represented well by a photograph. Future iterations of this document will include additional graphics, including tabular data and schematics, that will contribute to conveying some of the differences used to separate aquatic types clearly.

- **Ephemeral Pond** – Ephemeral ponds possess attributes of both terrestrial and aquatic ecosystems. Early on, most of the material we had used to describe ephemeral ponds was based on the vascular flora, but some of this type's unique characteristics are related to the life histories of highly specialized animals, especially invertebrates. The description of Ephemeral Pond may be found on page 168.

Thermal Stratification

- **Deep Lake** – In deep lakes, a thermocline develops during the summer and again in late fall or early winter. In the spring and fall, this zone of abrupt temperature difference breaks down, allowing for the mixing of bottom and surface waters and the redistribution of oxygen and nutrients.
- **Shallow Lake** – Shallow lakes do not stratify thermally. Water temperatures remain relatively constant from surface to bottom. These lakes may become oxygen depleted as the water warms and decomposition exceeds primary production. Oxygen depletion may also occur during the winter when ice and snow cover the lake surface, inhibiting photosynthesis. "Freezeout" conditions may then prevail with significant loss of aquatic life.
- **Meromictic Lake** – This is a very rare lake type in Wisconsin. Thermal and chemical stratification are permanent. Meromictic lakes usually have very small surface areas (only a few acres is typical) but great depth, sometimes exceeding 20 meters. The surface waters are somewhat protected from wind and other forces that could potentially contribute to the mixing of waters at different depths by size, local topography, and dense surrounding forest vegetation. (See Eggleton 1986, Fry 1986, Edinger et al. 2014.)

Chemical Attributes

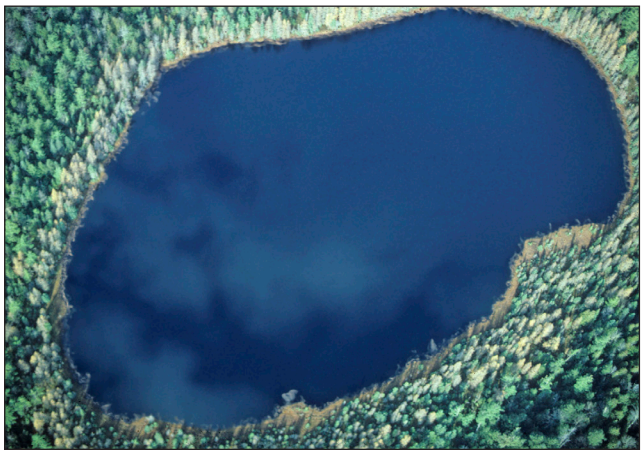
- **Hardness/Alkalinity**
  - **Hard water** – Total alkalinity is greater than 50 ppm. Hard water lakes are somewhat buffered from acidification by the presence of hydroxyl, carbonate, and/or bicarbonate ions.
  - **Soft water** – Total alkalinity is less than 50 ppm. Soft water lakes are vulnerable to acidification due to their low capacity to buffer acids.
- **Other chemical characteristics sometimes used as aids in lake classification:** pH, specific conductance, marl (calcium carbonate) deposition.

Miscellaneous Attributes

(These have been, and sometimes are, used to describe lakes but not necessarily to classify them.) The physical factors mentioned below may play major roles in the plant and animal life a given waterbody will support.

- Size
- Basin Morphology
- Shoreline Configuration
- Biotic Assemblages (e.g., fish, invertebrates)
- Proximity to other waterbodies or wetlands apart from classification as drainage versus seepage systems

Aerial view of Lake Alva, a deep, soft, seepage lake in collapsed glacial outwash that is the centerpiece of an outstanding natural features complex. Northern Highland-American Legion State Forest, Vilas County, Northern Highland Ecological Landscape. Photo by Eric Epstein, Wisconsin DNR.



Aerial view of a shallow, softwater, seepage lake (a bog pond) on the Winegar Moraine. Both the lake and the narrow fringe of open peatland vegetation support rare plants, and the older adjoining forest is inhabited by many rare animals. Catherine Lake, Iron County, North Central Forest Ecological Landscape. Photo by Eric Epstein, Wisconsin DNR.

Rivers and Streams: Lotic Systems (Flowing Waters)

Gradient (Correlates Roughly with Substrate Particle Size and Stream Velocity)

- **Fast** – Stream gradient exceeds 20 feet per mile.
- **Slow** – Stream gradient is less than 20 feet per mile.

Temperature

- **Warm** – Maximum summer water temperatures exceed 25 degrees Celsius.
- **Cold** – Maximum summer water temperatures are less than 22 degrees Celsius.
- **Cool** – Summer water temperatures are between 22 and 25 degrees Celsius, and this can affect the fish species present (both coldwater and warmwater species may be present in "cool" streams, but there is little or no overlap in the species composition between coldwater and warmwater streams. The aquatic macroinvertebrate specialists

The floodplain of the lower Wolf River supports large stands of bottomland hardwoods laced with running sloughs. Other key features of this complex ecosystem are riverine lakes, small ponds, and patches of marsh, sedge meadow, and shrub swamp. All of these habitats and the high diversity of associated species are ultimately dependent on the health and function of the Wolf's mainstem. Waupaca County, Southeast Glacial Plains and Central Lake Michigan Coastal ecological landscapes. Photo by Eric Epstein, Wisconsin DNR.

Table 7.1. *Wisconsin Natural Heritage Working List of Aquatic Types.*

ELCODE	Scientific Name	Global Rank	State Rank
LAKES AND PONDS			
CLEPH390WI	Ephemeral Pond	GNRQ	SU
CLDRA340WI	Lake—Deep, Hard, Drainage	GNR	S3
CLSEE342WI	Lake—Deep, Hard, Seepage	GNR	S2
CLDRA344WI	Lake—Deep, Soft, Drainage	GNR	S1
CLSEE346WI	Lake—Deep, Soft, Seepage	GNR	S3
CLSEE347WI	Lake—Deep, Very Soft, Seepage	GNR	S3
CLBOG360WI	Lake—Hard Bog	GNR	S2
CLMER376WI	Lake—Meromictic	GNR	S1
CLDRA348WI	Lake—Shallow, Hard, Drainage	GNR	SU
CLSEE350WI	Lake—Shallow, Hard, Seepage	GNR	SU
CLDRA352WI	Lake—Shallow, Soft, Drainage	GNR	S3
CLSEE354WI	Lake—Shallow, Soft, Seepage	GNR	S4
CLDRA349WI	Lake—Shallow, Very Hard, Drainage (Marl)	GNR	S2
CLBOG362WI	Lake—Soft Bog	GNR	S4
CLSPR375WI	Lake—Spring	GNR	S3
CLUNI380WI	Lake—Unique	GNR	SU
CLRIV374WI	Riverine Lake/Pond	GNR	SU
CLSPR370WI	Spring Pond	GNR	S3
SPRINGS AND STREAMS			
CRSPR302WI	Springs and Spring Runs, Hard	GNR	S4
CRSPR304WI	Springs and Spring Runs, Soft	GNR	SU
CRSTR310WI	Stream—Fast, Hard, Cold	GNR	S4
CRSTR312WI	Stream—Fast, Hard, Warm	GNR	SU
CRSTR314WI	Stream—Fast, Soft, Cold	GNR	SU
CRSTR316WI	Stream—Fast, Soft, Warm	GNR	SU
CRSTR320WI	Stream—Slow, Hard, Cold	GNR	SU
CRSTR322WI	Stream—Slow, Hard, Warm	GNR	SU
CRSTR324WI	Stream—Slow, Soft, Cold	GNR	SU
CRSTR326WI	Stream—Slow, Soft, Warm	GNR	SU

See Appendix 7.A for global and state ranking definitions.

working with the Natural Heritage Inventory program said that definitions of "coolwater" systems as used by Wisconsin DNR fisheries researchers would also work for aquatic invertebrates (Bill Smith, Wisconsin DNR, personal communication).

Note that "cool" is not yet used in the NHI aquatic features classification, but we are recommending that it be added.

Hardness/Alkalinity

- **Soft** – Total alkalinity is less than 50 ppm.
- **Hard** – Total alkalinity is greater than 50 ppm.

Additional Terms Needing Definition

Large River: Large River is not currently recognized as a distinct entity in the NHI Aquatic Features classification, but it should be considered for addition to the Aquatic Features Working List (WDNR 2016c) as these waterbodies are of the

Lower reaches of Perry Creek, a spring-fed coldwater stream tributary to the Black River, flows over sandstone bedrock south of Black River Falls. An unusual assemblage of aquatic invertebrates is associated with the moss-covered rock in this gorge, which also provides nesting sites for rare birds. Black River State Forest, Jackson County, Central Sand Plains Ecological Landscape. Photo by William A. Smith.

This spring-fed coldwater stream supports native brook trout (Salvelinus fontinalis) *and other organisms requiring clean, cold, highly oxygenated water. Clear Creek, Fort McCoy Military Reservation, Monroe County, Western Coulees and Ridges Ecological Landscape. Photo by Eric Epstein, Wisconsin DNR.*

A prized recreational resource, this segment of the Mukwonago River is classified as a Slow, Hard, Warmwater Stream that supports extremely high aquatic diversity. It is one of the most important and irreplaceable streams in heavily developed southeastern Wisconsin. Southeast Glacial Plains Ecological Landscape. Photo by Thomas Meyer, Wisconsin DNR.

highest significance for the exceptional ecological diversity they support as well as for the ecosystem services, economic benefits, and recreational resources they provide.

Large Rivers are defined by Wisconsin DNR as those segments of rivers with a mean annual flow of at least 40 cubic meters per second and include the Mississippi and certain segments of the Wisconsin, Chippewa, Black, St. Croix, Wolf, Menominee, Rock, Red Cedar, Flambeau, and Fox rivers.

Marl, Marl Lake: Marl is basically an unconsolidated rock composed of calcium carbonate, clay, and silt. "Marl Lakes" occur in parts of Wisconsin (e.g., east central and northeast) where groundwater provides abundant quantities of calcium carbonate, which may be precipitated from the water column, accumulating on the lake bottom and sometimes encrusting the aquatic vegetation. In Marl Lakes, the aquatic vegetation is composed in large part of members of the Characeae (*Chara*, *Nitella*) and Potamogetonaceae (Wiik et al. 2013). Additional data are needed on the potentially unique biota associated with the unusual conditions associated with Marl Lakes. Recent work has found that Marl Lakes are vulnerable to eutrophication (Wiik et al. 2015) and that it is therefore important to reduce external inputs of nutrients and sediments as early as possible.

Additional Information

For additional information on and approaches to Aquatic Ecosystem Classification, also see:

Cowardin et al. (1979)
Frissell et al. (1986)
Lammert et al. (1997)
Lyons (2005)
Lyons (2006)
Lyons et al. (2009)
Maxwell et al. (1995)
Rosgen (1994)
Weitzel et al. (2003)
Wetzel (2001)
Wisconsin Wildlife Action Plan (2015): http://dnr.wi.gov/topic/wildlifehabitat/actionplan.html or http://dnr.wi.gov/, keywords "wildlife action plan." For information from the updated Wildlife Action Plan (WAP) specifically dealing with aquatic ecosystems, see http://dnr.wi.gov/files/pdf/pubs/nh/nh0983_4_4_1.pdf or Section 4.4.1 in the 2015 WAP.

Sources used to provide additional information on aquatic ecosystems include the following (the full citations may be found in the "Literature Cited"):

Amoros and Bornette (2002)
Angermeier and Schlosser (1995)
Baker and Barnes (1998)
Bayley (1995)
Belk (1998)
Broch (1965)
Burne and Griffin (2005)
Calhoun and deMaynadier (2008)
Center for Watershed Protection (2003)
Colburn (2004)
Comer et al. (2005)
Crow and Hellquist (2000a)
Crow and Hellquist (2000b)
DiMauro and Hunter (2002)
Drever (1982)
Eggleton (1986)
Engel (1985)
Fassett (1930)
Fry (1986)
Gibbs (1998)
Higgins et al. (1998)
Jass and Klausmeier (2006)
Jennings et al. (1999a)
Jennings et al. (1999b)
Jennings et al. (2009b)
Kahl (1993)
Kershner (1997)
Lillie (2003)
Lyons (1992)
Lyons (1996)
Lyons et al. (1996)
Miller et al. (2014)
Nichols (1999)
Nichols and Vennie (1991)
Nilsson and Berggren (2000)
Richter et al. (2003)
Sapper (2008)
Scheffer (2001)
Schmude (2012)
Skawinski (2010)
Skawinski (2014)
Sparks (1995)
Stewart et al. (2001)
Strayer and Findlay (2010)
Swindale and Curtis (1957)
The Nature Conservancy (1997)
Walker et al. (2013)
Wang et al. (1997)
Wang et al. (2001)
Ward (1998)
WDNR (2016c)
Weigel (2003)
Weitzel et al. (2003)
Wilcox (1995)
Wiik et al. (2013)
Wiik et al. (2015)
WGNHS (2013)
Wisconsin Initiative on Climate Change (2010)

FROM: Epstein, E.E.. Natural communities, aquatic features, and selected habitats of Wisconsin. Chapter 7 *in The ecological landscapes of Wisconsin: An assessment of ecological resources and a guide to planning sustainable management.* Wisconsin Department of Natural Resources, PUB-SS-1131H 2017, Madison.