A Survey of Bone Lake's Frogs and Toads in 2012

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Bone Lake Mapping Extension / Wildlife Report

Introduction

As our springtime waters warm, frogs of many species sing their mating songs with reckless abandon, especially through the night. In our neck of the woods, the hilarious gurgles of wood frogs and tinkling chimes of the chorus frogs begin early, soon joined by spring peepers and leopard frogs. As the warming continues into the Spring, American toads and tree frogs join in on the chorus. Green frogs step in with the sounds of plucked banjo strings just as the summer's breeding birds arrive and green leaves unfurl. Just as spring grows and changes around us with a new fragrance or a warm, moist wind, it also moves along in the songs of frogs.

Frog song signals the breeding season, a time when males risk life and limb to defend small territories and advertise their fitness to females. The female frog's "ear", a membrane much like the sensitive head of a snare drum, is capable of hearing the song with enough detail to fairly judge the strength of the singing male. Frogs congregate in the best available rearing habitats to fertilize eggs as they are laid in giant masses. Even though the eggs are fertilized outside of the body, a male frog's ability to defend a territory and maintain close proximity to a female greatly increases the chances that he will father more young. As the spring songs wrap up, thousands upon thousands of new frogs begin their lives.

Amphibians are important indicators of the health of our environment, both locally and in grand scale. Water quality, abundance and quality of breeding habitat, food web interactions and microbial ecology are all reflected in the well-being of frogs and salamanders. Amphibians breathe through their skin and have a very narrow range of tolerance to changes in their environment. Tadpole development is highly dependent upon clean water, and developmental deformities often result from aquatic fungi, parasitism, predation attempts, and a long list of aquatic pollutants entering the environment from human activities.

In Northwest Wisconsin, a richness of amphibian species is reflective of an abundance of natural woodland ephemeral pools, dense vegetation buffers along lakeshores, high quality waters, and natural, native weed beds and bulrush beds. Lake and water chemistry (including pH) in this region is fairly stubborn in the face of environmental change, and Northwest Wisconsin is experiencing vastly better survival of amphibian species than many of our neighboring ecological regions. Knowing how well our frogs are doing gives us a better idea of our own ecological health.

Spring frog choruses delight us and enhance that "Up North" feeling, contributing to our awareness of the changing seasons. While contributing to our aesthetic appreciation of a place along the lake, frogs also contribute greatly to a complex web of feeding interactions, lending to the long list of insect-pest controls and serving as food for game fish, otters, herons, and other animals that make a trip to the lake memorable.

While some important ecological factors, such as climate, may be beyond the scope of local habitat projects, there are many ways that we can enhance habitat and have a positive influence on amphibian communities. Maintaining a wide buffer of natural shoreline vegetation and protecting forested wetlands and small, temporary pools are very important to a conservation-minded community's efforts in keeping frogs (and all that frogs provide) around for future generations. As Wisconsin has recently rolled back the mandated protections on smaller wetlands, it now becomes increasingly important that we act locally to

protect and preserve those small wetlands, especially those within forested cover. These small wetlands, formerly protected by law, are the most important breeding locations for salamanders and many woodland frogs.

As you encounter frogs and toads in your excursions at home in the yard and around your Bone Lake community, remember their stories of survival, their dependence upon high quality lake and shoreline, woods and water. The frogs and toads of Bone Lake have important stories to sing on the evening air, and they need us all to listen.

For an introduction to frog sounds, be sure to check out the links to frog songs on the Bone Lake Management District web site at www.bonelakewi.com

Survey Methodology

We used the standardized Frog Survey methodology from the Wisconsin Department of Natural Resources Citizen-based Monitoring Network. In short, the surveys operate after sunset on days when wind is calm. Surveys are conducted in three distinct time frames when lake water temperatures are a minimum of 50 degrees F, 60 degrees F, and 70 degrees F, falling within three distinct spans of the calendar. We conducted our surveys in April, June and July. Usually this methodology is restricted to a single survey at each pond or lake, and we modified the survey protocol to include all 54 coordinates previously used for the Bone Lake bird surveys. By including so many points, we took great care to keep track of occurrence of frogs as either near "on point" or far "off point". In doing so, we were able to construct very informative maps showing areas important to frog breeding in 2012.

Since counting individual frogs as they call at night could be a near impossibility, frogs populations are instead described by an index and are ranked with a 1 (individual, distinct frogs), 2 (frogs overlapping and interrupting in song), and 3 (too many frogs to discern individuals).

We noted water temperature and air temperature at each point, noted whether frogs were "on point" or distant, and collected field notes on other species as we visited each point. Where relevant, we collected field recordings of frog songs. We used a small motor boat to access each site and logged each visit with a Garmin GPS.

Our methodologies are intended to produce a map that generalizes areas of importance to populations of frogs and allows for decisions to be made in areas of high conservation priority that will benefit these populations. These methods also provide some insight into peak breeding periods for different species of frogs using Bone Lake's habitats.

1	Point	Lat	Long	Date	Time	Anthropo	Wind	Sky	Air Temp	Water Temp	Wood Frog	Chorus Frogs	Spring Peeper	Leopard Frog	Pickeral Frog	American Toad	Eastern Gray Treefrog	Cope's Gray Treefrog	Cricket Frog	Mink Frog	Green Frog	Bullfrog	Notes
29	28	45.56262	-92.40313	24-Apr-12	2135	0	0	1	12	13			1	1									Sora; Beaver, Mallard
30	29	45.56063	-92.40044	24-Apr-12	2143	0	0	1	11	12				1									Leopard within point, artesian spring
31	30	45.55804	-92.39915	24-Apr-12	2149	0	0	1	11	12													Nothing, BAOW SE side of lake
32	31	45.55527	-92.39931	24-Apr-12	2156	0	0	1	13	12		3	3				1						BAOW here, Distant pond, tree frog
33	32	45.55237	-92.39923	24-Apr-12	2204	0	0	1	13	12		3	2				1						Gray Tree frog here within 50,
34	33	45.55005	-92.39702	24-Apr-12	2211	0	0	2	14	12		3	2										Still distant chorus frogs, SW 250 +
35	34	45.54807	-92.39334	24-Apr-12	2217	1	0	2	13	12		2	3	1									Pooled with Point 35
36	35	45.54522	-92.39399	24-Apr-12	2225	0	0	2	14	12		2	3										Really Here!
37	36	45.54243	-92.39497	24-Apr-12	2232	0	2	2	13	11													Dead Zone
38	37	45.54025	-92.39797	30-Apr-12	2219	0	0	0	13	11			1										
39	38	45.53761	-92.39949	30-Apr-12	2211	0	0	0	13	11			2										Nicely Close;
40	39	45.53484	-92.40074	30-Apr-12	2204	0	0	0	13	11		1	2										Distant W-SW, Barred Owl
41	40	45.53185	-92.40107	30-Apr-12	2156	0	0	0	13	11		1	3										Muskies X 2
42	41	45.5292	-92.40019	30-Apr-12	2149	0	0	0	13	10			3										SW
43	42	45.52648	-92.39729	30-Apr-12	2141	0	0	0	13	10			3										Distant SW
44	43	45.52297	-92.39469	30-Apr-12	2133	0	0	0	13	10			3										
45	44	45.52062	-92.39261	30-Apr-12	2127	0	0	0	13	10			3										
46	45	45.52029	-92.38852	30-Apr-12	2122	0	0	0	13	10			3										off point, West; Bat,

Computers were used to capture real time data on site. Spreadsheets were populated with all possible species of Wisconsin frogs, even though final analysis reveals a total of 7 species using Bone Lake.

The Frogs of Bone Lake

Three Major Taxonomic Groups

Bone Lake is home to three major taxonomic groupings of frogs and toads and home to a total of seven frog and toad species. The "true frogs" are those frogs with short, stout forelimbs, thick toes, and a rigid, strong skeleton that does not allow for turning of the head. These frogs, often in the genus *Rana*, include the green frog, the leopard frog, and the wood frog. Bone Lake also hosts three species of tree frogs, nimble frogs that have sticky pads on the toes, flexible, gripping toes, and the ability to turn the head. These include the gray tree frog, the Spring peeper, and the Western chorus frog. Bone Lake is also home to the American Toad. A true toad, it is an amphibian known for its dry skin, poison glands, and strong, stocky build.

Frogs and toads are amphibians, starting life in an aquatic egg, developing into an aquatic tadpole, and ultimately maturing as an animal as equally at home on land as in water. Because of their amphibious lifestyle, frogs are highly dependent upon habitat conditions both aquatically and terrestrially. Broad habitat considerations are important in maintaining healthy frog communities, and each species of frog may require something a little different from its kin. While leopard frogs spend vast amounts of time in tall, grassy meadows, sometimes far from water, they hibernate submerged in oxygen-rich springs and lake margins. By contrast, the wood frog is dependent upon shallow woodland pools that warm quickly in the spring and spends most of its life in close proximity to such habitats. Unlike the leopard frog, the wood frog hibernates under the leaves and deadfallen branches of the forest. Continuous stretches of habitat may be very important to migrating frogs, and many species travel between breeding, growing, and hibernating locations. Ultimately, frogs must return to preferred waters to breed, and the vibrant sounds of frog song signal successful migrations, the return of spring, and the beginning of another year's life cycle.

Typical of animals that produce thousands of young in the hopes of a few successful survivors, little care is given to the tadpoles by the adults of most frog species. In a world of complex ecosystem interactions, tadpoles must escape large, predatory insects, fish, and birds. Some frog tadpoles prey upon other tadpoles, and they may even resort to cannibalism. With each female frog releasing thousands of eggs, odds are very good that a few of them will eventually grow to maturity. While American bull frogs may take up to two years to metamorphose, most frogs and toads go from egg to air-breathing frog much more rapidly and take on an adult-like appearance by the middle of summer. Many species of frogs still require a couple of years to reach sexual maturity, and many will continue to become prey for an abundance of predators, including mink, otters, and herons. A pond full of chorusing frogs represents a thousand survivors from millions of young. While the path to reproductive success is filled with peril, the frogs lost along the way represent a tremendous wealth to the Bone Lake's food webs.

Bone Lake's True Frogs, Family Ranidae

Wood Frog ***Rana sylvatica***

The wood frog is the earliest breeding frog in Northwest Wisconsin. Shortly after ice-out, wood frogs congregate in small woodland ponds, wooded marshes and ephemeral pools to attract mates and spawn. To complete its life cycle, the wood frog requires a complex and often damp forest in close proximity to wetlands. Leaf litter, dead and downed trees, woodland ponds, and closed canopy are important features to this species. The wood frog is recognized by its rusty-red body and black mask. It is also commonly seen in woodland ponds and hopping along the leaf litter in mid Summer.

Wood frogs are famous for their hibernation feats. As autumn temperatures cool and winter sets in, wood frog circulates metabolites of sugar, often sugar alcohols, to each and every cell of the body. These molecules are, effectively, antifreeze, and they prevent the formation of ice crystals in the cells thereby preventing the cell membranes from rupturing in the mid-winter freeze. Wood frogs will attempt to get below the frost line, burrowing into holes and beneath logs and leaf litter. Many will experience some degree of freeze, and a hibernating frog's water volume may be as much as 70% ice. In the spring, as conditions warm, the wood frog "thaws out" and resumes its life. Survival in these instances is an equation of cell survival. If enough cells survive the winter, the frog is able to recover from the hibernation, but a period of dormant healing is often required before the frog is able to breed.

While wood frogs completed their spawning before our surveys began, mostly due to an usual winter and spring, we did detect wood frogs crossing roads late at night throughout the survey periods. We do not have location data for wood frog spawning yet, but their presence is known and certain.

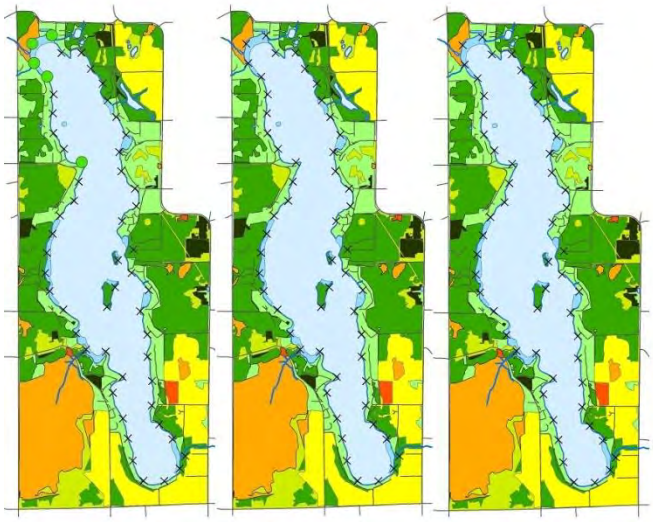
Wood frogs are easily recognized by their black mask and reddish coloration and are often observed in forested areas.

Northern Leopard Frog ***Rana pipiens***

The Northern leopard frog (*Rana pipiens*) breeds in ponds, shallow lake margins, and permanently inundated wetlands. Foraging habitat for this species is generally the tall, grassy margins of wetlands and lakes, but they are also able to withstand dry conditions and may range very far from water to pursue grasshoppers and other insects living in tall grass. Leopard frogs are sometimes seen swimming below the ice in winter, and they tend to hibernate under water, near oxygen rich sources, and with a reduced metabolic function.

While it could be argued that leopard frogs are more durable in that they can range more than a mile from water, leopard frogs have suffered from loss of tall grass lake margins and similar weedy habitats. Indeed, leopard frogs may be more susceptible to habitat alterations as they require such vast expanses of land to include wetlands, grassy fields, lake margins, and cold, oxygen rich streams to successfully complete their life cycles. Further, Northern leopard frogs are famous for deformities attributed to accumulations of toxins in surface water and trematode parasite infestation.

The Northern leopard frog ranges in color from bronze to green and is usually covered with large, black, oblong spots. The breeding song is a quiet, low snore followed by a mechanical chuckle.



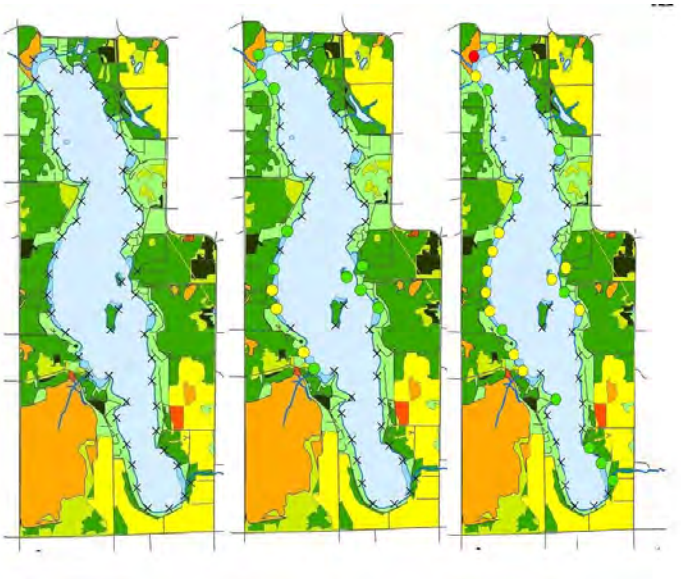
We detected just a few leopard frogs in the northern third of Bone Lake, with all individuals occurring along the North and West shores. Leopard frogs were closely associated with shallow, high-quality habitats in the littoral zone. The shallow northwest bay's sedge/wild rice wetland and neighboring bulrush beds were used by a few breeding leopard frogs during the first survey period. As this species has suffered widespread decline, continued conservation efforts to protect Wisconsin DNR sensitive areas should remain a priority.

Green Frog ***Rana clamitans***

The plucked banjo string "glug" of the green frog (*Rana clamitans*) is unmistakable. This member of the true frogs is readily identified by its lime green moustache. The green frog is Bone Lake's largest frog, and it is second in Wisconsin only to the bullfrog (*Rana catesbeiana*). Green frogs mature slowly, reaching maximum size after four years. Adult females are the largest of the population, and a female may lay more than one clutch of eggs, depositing as many as 9000 eggs in two breeding cycles. Some tadpoles overwinter before undergoing metamorphosis, sometimes taking as many as 22 months to attain adult form.

While most of Bone Lake's frogs breed in woodland ponds and ephemeral pools, the green frog spawns within the littoral zone of Bone Lake, preferring shallow habitats with hardstem bulrush. This species is, therefore, the most dependent upon direct lake management and lakeshore activities. While studies have shown this species to be somewhat of a generalist, the frogs within Bone Lake's basin paint a vivid picture of habitat dependence.

More aquatic in nature than any other frog species in Bone Lake, the green frog remains within the littoral zone of the lake, in woodland ponds, or in close proximity to water throughout the year with some individuals visiting nearby terrestrial habitats during rainy weather. In many instances, green frogs are extremely faithful to a single location, occupying a very small home range of only a few meters. In winter, open-water seeps and streams with high oxygen and fine silt are preferred for hibernation.



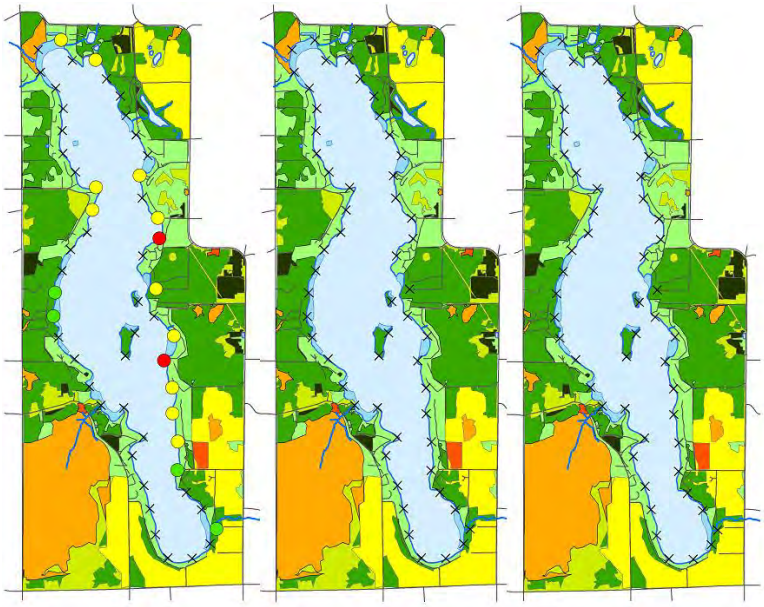
The green frog is a late Spring and summer breeding frog, and they were common to abundant in good habitat throughout the June and July survey period. Green frogs were most abundant in secluded bays with bulrush beds, wild rice, and intact, native habitats. Many of these areas were listed as DNR sensitive areas on the lake. Conservation priorities for this species include maintaining the high quality of Bone Lake's littoral zone, including protection of these areas with healthy levels of verge vegetation along the shoreline and abstaining from extensive use of fertilizers.

Bone Lake's Tree Frogs, Family Hylidae

Western Chorus Frog ***Pseudacris triseriata***

The Western chorus frog (*Psuedacris triseriata*) is the least often seen of all of our frogs, but their songs are abundant and easily recognized. As March warms and ice thaws, our small ponds, marshes and sedge meadows fill with a sound that is much like dragging a thumbnail across the brittle bristles of a plastic comb. Chorus frogs are highly dependent upon boggy sedge meadows, shallow marshes, and woodland potholes for their breeding in Northwest Wisconsin. Once the breeding season is over, chorus frogs head into damp forest environments, often spending time beneath leaf litter.

Varying in color from rusty red to olive green, the chorus frog is most easily recognized by its diminutive size, barely bigger than your thumbnail, and dark black streak running from in front of the eye to the hind legs along the frog's side. This frog is most closely related to the Spring peeper and is in the same taxonomic family, Hylidae, the tree frogs.



Forested habitats along the east shore appeared more important to Western Chorus Frog than other areas of Bone Lake. Western Chorus Frogs were detected along Bone Lake's shores but were mostly present in forested wetlands set back away from the shore. An early singer, Western chorus frogs were not detected after the first survey.

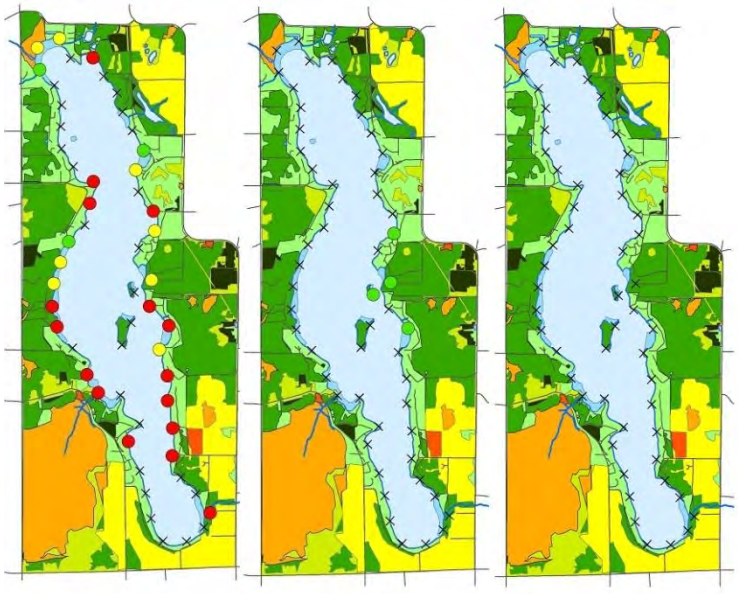
Spring Peeper ***Pseudacris crucifer***

The Spring peeper (*Pseudacris crucifer*) is famous for its loud, rich singing that has been equated to sleigh bells ringing from a midnight marsh. The loud, single syllable "peep" songs are the most easily recognized, though other vocalizations including a hesitant "scrape" call are also common. In Northern Wisconsin, Spring peepers signal warmer water and reach their singing peak in early May with remarkably loud breeding congregations that have been described as "deafening." Their iconic sounds are often equated with a wild, undisturbed North Woods experience and have been used for countless generations to know the time of the annual walleye spawning run.

Like their close relatives, the chorus frogs and gray tree frogs, Spring peepers require small, marshy lakes, marshes, bogs, woodland potholes, and ephemeral pools for breeding. Protecting small wetlands is important to the future of the Spring peeper. Spring peepers are very sensitive to habitat degradation and tend to avoid wetlands that have been heavily disturbed by humans.

In late summer and throughout early autumn, Spring peepers are commonly encountered within forested habitats. Often, they are on the move, engaged in mini-migrations to favorable habitat. Though Spring peepers are another species of tree frog in the family Hylidae, they seldom climb high into the trees and are usually seen among the carpets of forest leaf litter.

This tiny, bronze-colored frog is most easily recognized by the thin "X" running across the back. The Latin "*crucifer*" refers to this cross.



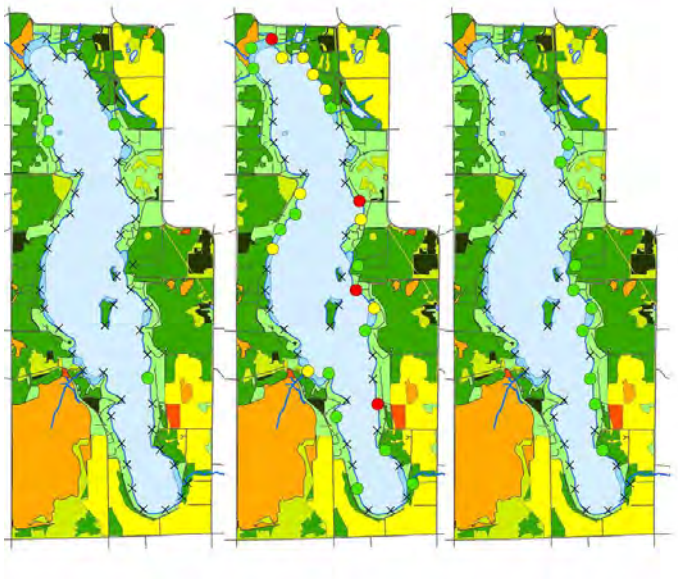
An early singer, most Spring peepers were detected in the first survey period and were often associated with habitats settled back away from the lake shore. Some Spring peepers persisted into early June along the east shore of Bone Lake, nearer to areas of rich, contiguous woodlands with small, pooled wetlands interspersed.

Gray Treefrog ***Hyla versicolor***

Many people mistake the calls of a gray treefrog for the calls of a bird high in the branches. At the peak of breeding season, gray treefrogs may gather in deafening groups and may share small breeding pond habitats with spring peepers and American toads. Gray treefrogs defend small breeding spaces near shallow water. When fertilized, the eggs attach to vegetation and other structures in the water.

Gray treefrog song peaks when Spring air temperature is approximately 60 degrees, and these choruses are strongly associated with breeding. Individuals may sing throughout the summer and fall, though summer song is not related to breeding. In areas with good forested habitat, gray treefrogs are often attracted to yard lights, porches, and windows where artificial illumination attracts insect prey.

Forest habitats are important for this species during much of the year, and, like other forest frogs, the gray treefrog hibernates beneath pulpy wood and leaf litter, freezing and avoiding cell rupture by circulating glycerol as temperatures sink below 40 degrees F in the late autumn.



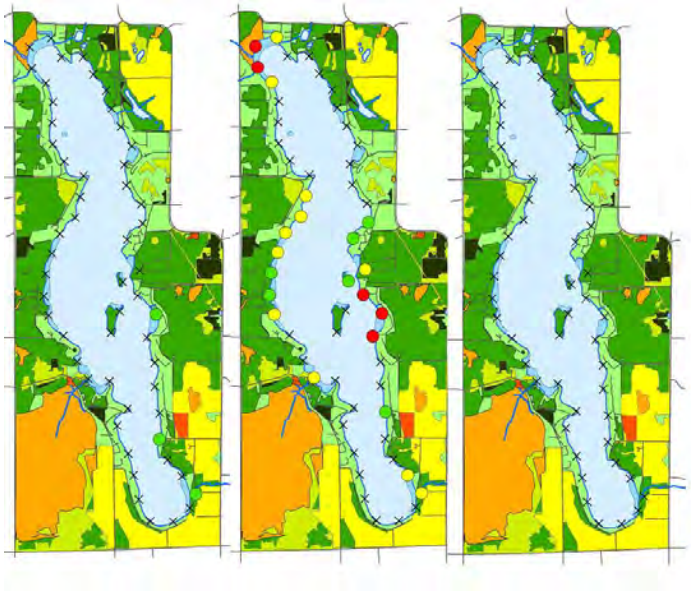
Gray treefrogs were present in all three surveys, though they were clearly the most abundant in the middle survey period. Areas of low-lying residential woodlots were the most important habitats and would seem to show a connection between high quality natural habitats intersecting artificial lighting of lake homes that attract the frogs' insect prey. Areas along the east shore of Bone Lake seemed consistently important, and ephemeral pools and small pond wetlands are an important habitat consideration.

Bone Lake's American Toad, Family Bufonidae

American Toad ***Bufo americanus***

The tadpoles of the American Toad are abundant, small, black, and often found in small ponds, and ephemeral pools. Breeding occurs in any semi-permanent or permanent waters, with males defending small territories and females laying as many as 8000 eggs. Toad tadpoles develop quickly in as little as 40 days and are herbivores. As they develop, they switch to insect prey and are soon hopping around as tiny versions of the adults by mid-summer. Tough and adaptable, American toads are found wherever aquatic habitats meet with dense vegetation.

American toads are nocturnal insect hunters, and they are often considered to be a friend to the garden. While some species of snakes are able to eat toads, milky glandular poisons protect the American toad from most predators. American toad tadpoles, also somewhat toxic, seek refuge from predators by swimming in shallow water, forming large schools.



American toads were detected in abundance during the second survey period. While some toads were detected in the early survey period in April, all toad activity had ceased by the July surveys. American toads were widespread, with their peak abundance being highly reflective of the quality of habitat in areas described by the Wisconsin DNR as sensitive areas. While the literature indicates that the American toad is an adaptable generalist, survey data indicates that Bone Lake's populations of American toads are more abundant in habitats of high quality.

Habitat Connections

Ephemeral Woodland Ponds

Ephemeral woodland ponds are critically important to successful breeding by almost all of Wisconsin's amphibian species. While these ponds are usually temporarily full, recharged by snowmelt and early rains, many woodland ephemeral pools provide enough water and habitat to provide the right ingredients for a successful crop of eggs and developing tadpoles, complete with an aquatic insect prey base. The timing of amphibian breeding in early spring corresponds to the development of these woodland wetlands, and, in many instances, young frogs are ready to migrate by the time the wetlands are less suitable. Recognizing and preserving ephemeral woodland pools is a high conservation priority and somewhat challenging for land managers to recognize, as basins may be dry through much of the late summer and autumn.

Permanent Wetlands Near Bone Lake

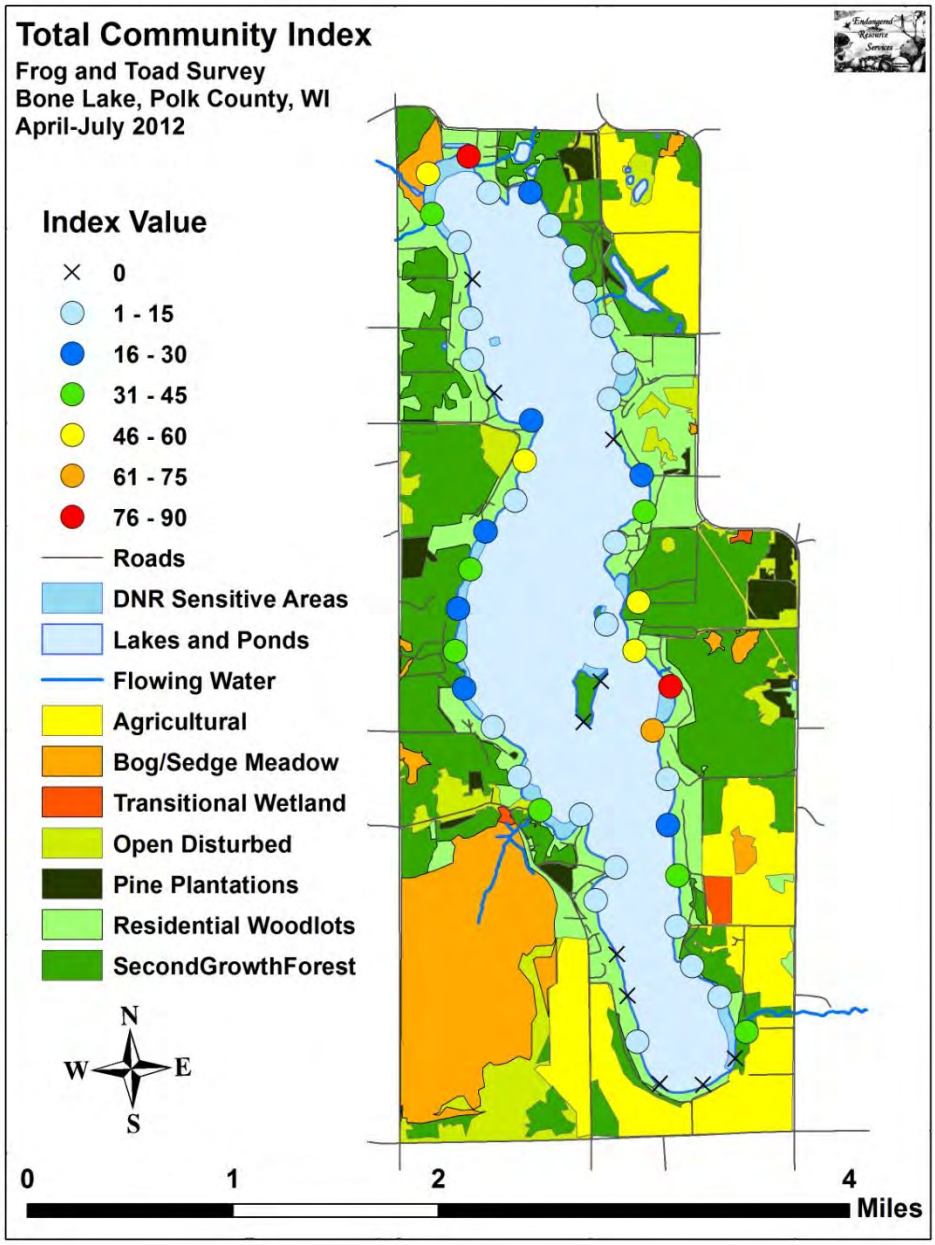
The permanent wetlands set back from the shores of Bone Lake are critically important in maintaining healthy breeding populations of all of the lake's frog species. While Green Frog may have been primarily detected within the littoral zone of the Bone Lake, this species commonly breeds in larger, deeper and more permanent woodland ponds. Permanent wetlands offer the rich variety of microhabitats that allow many frog species to grow, mature, hibernate and complete all aspects of their life cycle.

Important Habitats Within Bone Lake's Littoral Zone

Northern Leopard Frog and Green Frog are both dependent upon high quality habitats within the shallow littoral zone of Bone Lake for breeding. Both species are strongly associated with hardstem bulrush (*Schoenoplectus acutus*) and wild rice (*Zizania palustris*) in wetland lake margins and shallow, firm, sand and gravel substrates. Both species correlated strongly to DNR sensitive areas identified within Bone Lake, though Green Frog was much more abundant and widespread than its leopard frog associate. Maintaining buffers of natural vegetation along these sensitive littoral zones is important in protecting these frog species throughout their life cycles. Much work could be done to improve the quality of frog habitats buffering these portions of the lake.

Areas of Importance for Bone Lake's Frogs and Toads

Combining data for number of frog species present and data for calling indices over all three survey periods resulted in a rank score between 0 and 88 for each of the 54 standardized survey points. Many areas were important to multiple frog species. The wetland managed by the Wisconsin DNR was exceptionally diverse. A large tract of contiguous forest with many small, pooled wetlands and lowland forest along the east shore of Bone Lake also scored exceptionally high. These two areas produced the highest index scores for the most species over the three survey periods. While species richness may have been lower, the bulrush beds are very important in maintaining Bone Lake's green frog population, a population that contributes greatly to the food web of Bone Lake as both a predator and prey.



Areas of consistently important frog habitat were identified by multiplying the number of frogs occurring in one area over three survey periods by the total of all index scores for that area. The resulting data give a snapshot of frog use from April into July.

Data Summary and Results

Survey Period 1

Our first survey was initiated on April 24, 2012, after an unusual ice-out and belabored warm-up. Specifically, a historically warm March accelerated ice out and allowed for an early woodland frog spawning period, while lake ice remained and lake temperatures continued to be very cold. An abrupt cooling period further delayed lake temperature warm up, delaying the initiation of surveys. The result was that we missed the spawning period for wood frog and were not able to collect any meaningful data regarding their presence or abundance.

Wood frogs, among the earliest singing frogs in Wisconsin, responded quickly to the unusually warm spring. The unusual spring may have been disastrous to some local populations as many came out of hibernation early, only to be frozen again before having time to circulate sugars and glycerols to their cells. Some people reported finding large collections of dead wood frogs at the edges of woodland pools in various parts of Wisconsin. Wood frogs also spawned very early, long before lake temperatures reached 50 degrees and before the first protocol window for the surveys. While many survey protocols may need to be re-tooled in the face of climate change, we were not able to adapt our methodologies quickly enough and missed the wood frogs' spawning this year.

Species present in the first survey period included Spring Peeper (abundant, sum of indicies = 67), Western Chorus Frog (common, sum of indices=32), leopard frog (uncommon, sum of indices = 5), gray treefrog (uncommon, sum of indices= 4) and American toad (uncommon, sum of indices = 3).

Survey Period 2

We initiated our second survey on June 3, 2012. Weather patterns had stabilized, and frog patterns were similar to what is expected in a normal spring. Conditions were perfect.

Species present in the second survey period included Spring peeper (uncommon, sum of indices = 4), American toad (common, sum of indices = 43), Eastern gray treefrog (common, sum of indices = 42), and green frog (uncommon, sum of indices = 18).

Survey Period 3

We initiated our third survey period on July 2, 2012. Conditions were perfect, though some increases in human activity on the lake accompanied Independence Day festivities. From our observations, frog behavior was not significantly altered by human activity.

Species present in the third survey period included gray treefrog (uncommon, sum of indices =9) and green frog (common, sum of indices =36).

Overall results

Different species of frogs do not utilize the same time frames for breeding, and estimation of habitat use and relative contribution to the animal community is complicated by the fact that species may actually avoid competition with one another by staggering their breeding patterns. To capture an overall picture of the breeding frog community, relative abundance was calculated as a function of the sums of indices for each species in all three survey periods.

SPECIES	PERCENT of COMMUNITY
Spring Peeper	27.0%
Gray Treefrog	20.9%
Green Frog	20.5%
American Toad	17.5%
Western Chorus Frog	12.2%
Leopard Frog	2%
Wood Frog	Not Detected, but present

Relative abundance can be readily used to gain some insight into available habitat niches. The Bone Lake frog and toad community shows a very even abundance distribution of species. These results paint a picture of Bone Lake's frog habitats being a rich and even mosaic of high quality woodland wetlands and some areas of diverse and natural foliage in the lake's littoral zone.

Conclusions

Areas previously identified as sensitive areas within the littoral zone of Bone Lake correlate well with high quality spawning areas for fish and also with the presence of breeding populations of green frog, leopard frog, and American toad. Hardstem bulrush beds, complete with sand and gravel substrate, are the areas favored by green frogs and leopard frogs on Bone Lake, and protecting these areas will protect healthy populations of frogs and fish alike.

The presence of woodland frog species points to the importance of high quality forested habitats, including off-shore woodland pools, ephemeral wetlands, and large wetland ponds. Near-shore bogs and wetlands will continue to be important spawning areas for all of these frog species, and other, less common species may be detected with further surveying. Protection of small wetlands and high-quality stands of forest remains a high priority. Such conservation efforts will continue to benefit spring peeper, gray treefrog, western chorus frog, wood frog, and American toad.

Because so many frogs require complex woodland structure, including leaf litter, dead and downed logs, and pitted, mounded root mats, especially for winter hibernation, maintaining a vital and somewhat chaotic, natural woodland presence on the lake is critically important for woodland frogs. Maintaining shallow forested pools within the landscape is also beneficial to these frogs for both hibernation and migration needs.

Leopard frogs tend to migrate vast distances, crossing many property boundaries and requiring grassy fields, thickets, dense areas of lakeside vegetation, and rich, natural areas of aquatic emergent vegetation.

Unfortunately, leopard frogs have experienced a sharp decline in many areas locally. Such a diverse habitat mosaic is best served by the cooperation of many landowners and a larger landscape planning initiative.

Leopard frogs and green frogs both benefit greatly from oxygen-rich streams that flow into the Bone Lake basin. Maintaining the high quality of all feeder streams and tributaries should maintain or increase overwinter survival of aquatic hibernating frogs. Management activities that promote oxygenated water and avoid winter kill are important to healthy frog populations.

Frogs are strong indicators of environmental health. Maintaining frog populations requires attention to all aspects of the life cycles of a diverse group of sensitive animals. Lakeside buffers of natural vegetation, clean and healthy streams, intact and large tracts of forest, protected and secluded wetlands, and management of forests to protect lowland areas and woodland pools are all very important to protecting the frogs and keeping the spring choruses rich and strong.

Enjoy the beauty of Bone Lake's amazing and musical frogs!