

Minnesota Loon Monitoring Program 1994 - 2015

22nd Anniversary Report

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Photo by Carrol Henderson

The Minnesota Loon Monitoring Program (MLMP) is a long-term project of the Minnesota Department of Natural Resources' Nongame Wildlife Program. Since 1994, nearly 1000 volunteer observers have annually gathered information about common loons in six 100-lake regions, or "Index Areas" of the state. The data these generous citizens collect provide the Nongame Wildlife Program with an early warning system for detecting changes in the numbers of loons and the health of their lake habitats in Minnesota.

The 2015 survey season marked the 22nd year of the MLMP. The MLMP owes its ongoing success to its large base of citizen volunteers throughout the state. Without the interest and dedication of these volunteers, this project would not be possible. We want to thank you, and provide this report to demonstrate how your efforts are contributing information valuable in the management of Minnesota's natural resources.

The analysis of MLMP data presented in this report indicates that Minnesota's common loon population remains healthy overall with an average of two adults per 100 acres of lake across all six Index Areas. Loon occupancy, or the percent of MLMP lakes with loons present, has averaged 66% over the 22-year period. The abundance of loons varies greatly across the state, and is lowest in the southwestern (Kandiyohi) Index Area, and highest in the north central (Itasca) Index Area. The number of juveniles per two adults observed, a measure of reproductive success, also varies among Index Areas, but appears to be much lower in the northeastern (Cook/Lake) Index Area than the other five Index Areas.

The value of MLMP data is widely recognized by Minnesota's biologists and planners, and its results have been incorporated into several summaries of statewide ecological health, including the DNR's [Strategic Conservation Agenda](#) and [Minnesota Milestones](#). The Nongame Wildlife Program hopes to continue tracking the health of Minnesota's loon populations into the future.



Why Monitor Loons?

There are at least 3 good reasons....

- **Importance to Minnesotans**

The Common Loon (*Gavia immer*) is Minnesota's state bird, and a source of pleasure to the thousands of lake dwellers and visitors who enjoy its enchanting sights and sounds.

- **Stewardship Responsibilities**

A statewide survey conducted by the Nongame Wildlife Program in 1989 found that Minnesota is the summer home to roughly 12,000 adult loons, more than in all other states combined, excluding Alaska. As with the bald eagle and grey wolf, Minnesotans are responsible for the stewardship of one of the nation's largest loon populations. The DNR uses the MLMP to track the health of the state's loons and lakes, and to help ensure that this bird will grace Minnesota far into the future.

- **Environmental Indicators for Minnesota's lakes**

Loons have several characteristics that make them a valuable "indicator" of the health of the state's lakes:

- a) As diving birds that use sight to hunt prey, they thrive in clear lakes with healthy fish populations.
- b) Loons only nest on undisturbed shorelines or islands with plenty of natural vegetation.
- c) Like other animals that eat carnivorous fish, loons will accumulate health-threatening pollutants in their bodies if their habitat is contaminated. This can in turn reduce the birds' survival and reproductive success.



Methods

Because it would be far too difficult to collect loon data from all 12,000 of Minnesota's lakes each year, the MLMP is designed to measure the health of loon populations within six 100-lake "Index Areas" (Fig. 1). Annually surveying 600 lakes is beyond the capacity of the Nongame Wildlife Program; therefore, MLMP utilizes hundreds of volunteers who visit their assigned lakes on one morning during a ten-day period in late June or early July. Depending on the size of the lake, the volunteers' survey styles vary, with some using boats or canoes, and others surveying from the shore. Similarly, some use binoculars or spotting scopes, and others view with the naked eye. However, Nongame Wildlife Program staff standardize methods by providing survey guidelines to all volunteers. In addition to the numbers of loons seen, observers are asked to report on such things as weather and shoreline conditions. Once the survey is completed, data forms are returned to the Nongame Wildlife Program for compilation and analysis.

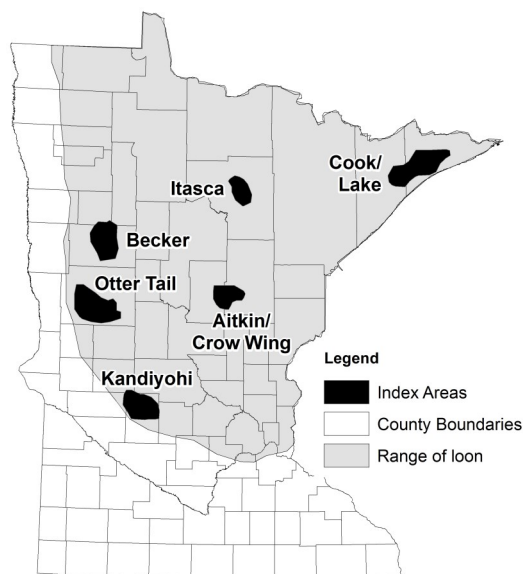


Figure 1. MLMP Index Area locations.

INDEX AREA SELECTION

The Index Areas have been selected because they are typical of larger portions of the state in ways that matter to loons. For example, we know that loons can be adversely affected by shoreline development. To help us detect problems that may stem from loss of shoreline habitat, the MLMP Index Areas are divided between those likely to experience rapid human population growth (e.g., Aitkin/Crow Wing and Kandiyohi) and those in which human populations and their impacts are likely to change more slowly in the near future (e.g., Becker, Cook/Lake, Itasca, and Otter Tail). The six Index Areas are similarly divided between those where acid rain sensitivity, public or private land ownership, or road density are expected to increase or to stay the same. The Index Areas are named for the counties in which they are located. The characteristics of each Index Area are detailed on pages 5 - 10 of this report.

DATA ANALYSES

For each Index Area, the following indices have been calculated through analysis of MLMP data:

- ◆ **LOON ABUNDANCE:** Within an index area, abundance measures such as *total number of loons seen* or *average number of loons seen per lake* can be compared from year to year. However, since average lake size varies among index areas, we have converted these to the *average number of adult loons seen per 100 acres of lake surface* so that we can also make comparisons among index areas.
- ◆ **LOON OCCUPANCY:** Occupancy can be thought of as the *likelihood of seeing a loon on a lake*.
- ◆ **LOON REPRODUCTIVE SUCCESS:** In this analysis, we calculated the *average number of juvenile loons seen for every two adult loons seen*. Since a healthy pair of loons typically produce a two-egg clutch each year, this ratio would equal 1 in the ideal world. However, rarely in any wildlife population do all young survive. To maintain a population, each pair of adults need to raise a total of two young to breeding age during the course of their lives. Because loons may nest for many years, they can afford to be less successful in any one year. Consequently, a low reproductive success in a single year is not necessarily a concern. For this analysis, all lakes with fewer than 2 loons were excluded.
- ◆ **LAKE CLARITY AND LOONS:** We used water clarity data measured via LandSat satellite imagery in 2008 from the Water Resources Center and Remote Sensing Laboratory at the University of Minnesota (<http://water.umn.edu>) to compare our MLMP data with lake clarity for all six of the MLMP Index Areas.

The following data were also tabulated for each Index Area: total adult loons observed, total juvenile loons observed, number of lakes with adult loons, number of lakes with juvenile loons, and total number of lakes surveyed. The number of lakes surveyed in a given year often varied from the goal of 100 lakes per Index Area due to volunteer participation.



Results

On the following pages, the results of data analyses are presented for each Index Area. Because of the way the MLMP is designed, the analyses must evaluate the data from each Index Area separately. Further, conclusions reached about populations within the six Index Areas do not precisely describe the status of the state's entire loon population. Taken together, however, conclusions regarding loon populations within the six Index Areas do provide an overall picture of the status of loons in Minnesota.

Data generated by the MLMP were analyzed in two ways:

- 1) Within each Index Area, we looked for trends that indicate population changes occurring over time.
- 2) Among the Index Areas, we compared data to learn how loons respond to different environmental conditions that exist in the various areas.

LOON ABUNDANCE: Adult Loons Seen per 100 Acres of Lake Surface within an Index Area

During the 22-year period studied, adult loon abundance has remained stable for four of the six Index Areas; slight differences between years (see Figures on pages 5-10) are likely due to normal fluctuations that occur in all natural populations. In the other two Index Areas, an increase was detected in the number of adults per 100 acres in the Otter Tail Index Area ($p \leq 0.01$), and a marginal decrease was detected in the Becker Index Area ($p \leq 0.05$).

LOON OCCUPANCY: Percent of Lakes in an Index Area with Any Adult Loons

A small, but statistically significant increase in loon occupancy was detected within the Kandiyohi and Otter Tail Index Areas (both $p \leq 0.05$). Occupancy in all other Index Areas remained stable between 1994-2015, though fluctuations up to 20% were observed over the study period.

LOON REPRODUCTIVE SUCCESS: Juvenile Loons for Every Two Adult Loons on a Lake

During the 22-year study period, no statistically significant changes in reproductive success were observed within four of the six Index Areas. However, significant declines in reproductive success were observed in the Becker and Itasca Index Areas ($p \leq 0.05$ and $p \leq 0.001$, respectively). This ratio fluctuates widely from year to year in all Index Areas; given the smaller sample size than was used for other measures (since lakes with fewer than 2 loons were dropped from the analysis) and the fact that juvenile loons are more likely than adults to be missed by observers, this measure may be less precise than those using only adult data.

LAKE CLARITY AND LOONS

In addition to evaluating the health of Minnesota's loon population, we have compared our MLMP loon data to water clarity in the six Index Areas. The results indicate that there is a significant relationship between water clarity and number of adult loons ($p \leq 0.01$), number of juvenile loons ($p \leq 0.01$), percent of lakes with loons ($p \leq 0.01$), and loons per acre ($p \leq 0.001$; Fig. 2). As water clarity increases, all of the above metrics also increase, demonstrating a link between loons and overall water quality.

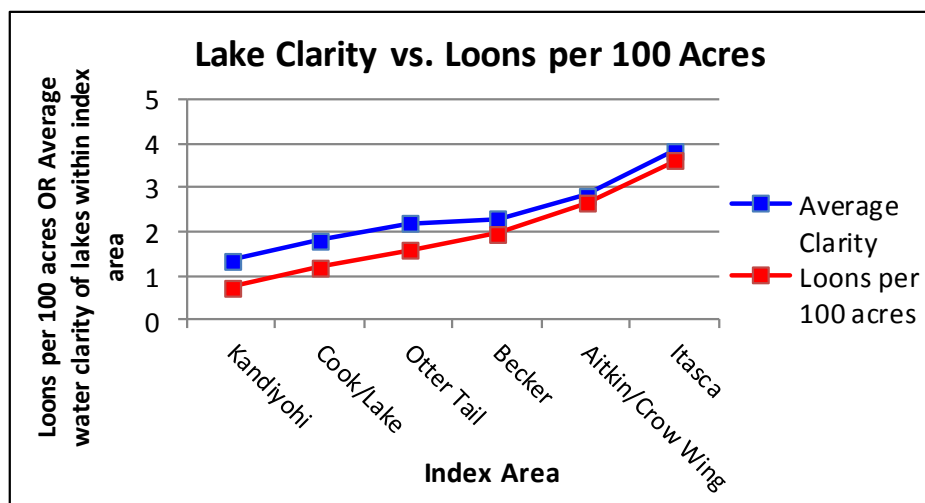


Figure 2. LAKE CLARITY AND LOONS PER 100 ACRES OF LAKE— Average water clarity of lakes within an index area compared to loons per 100 acres within the index area. As water clarity increases, the number of loons per 100 acres generally increases.

Since loons use their eyesight to pursue prey, lakes with higher water clarity are more beneficial to loons. However, water clarity is not the only factor affecting loon distribution in Minnesota. Obviously there are many other ecological factors not accounted for in this study including nesting habitat, prey availability, predation, and competition levels, to name a few. Water clarity likely interacts with these other ecological factors that, in combination, influence our state's loon population. For more information on water clarity in Minnesota, see <http://water.umn.edu>.

Aitkin/Crow Wing Index Area

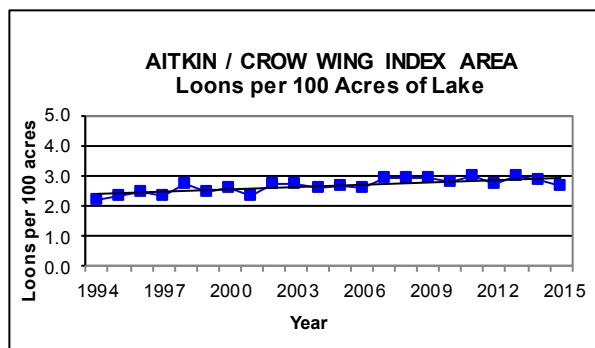


Figure 3. LOON ABUNDANCE—Adult loons seen per 100 acres of lake surface within the Aitkin/Crow Wing Index Area.

INDEX AREA CHARACTERISTICS

- ◇ Low acid rain sensitivity
- ◇ High density of humans and roads
- ◇ Rapid human population growth
- ◇ Predominantly private lands
- ◇ Average lake size = 195 acres

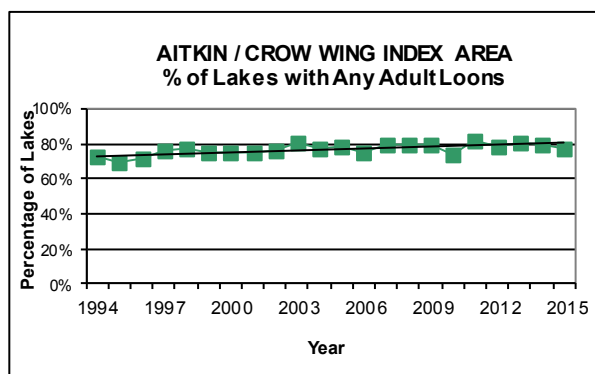


Figure 4. LOON OCCUPANCY – Percent of lakes in the Aitkin/Crow Wing Index Area with any adult loons.

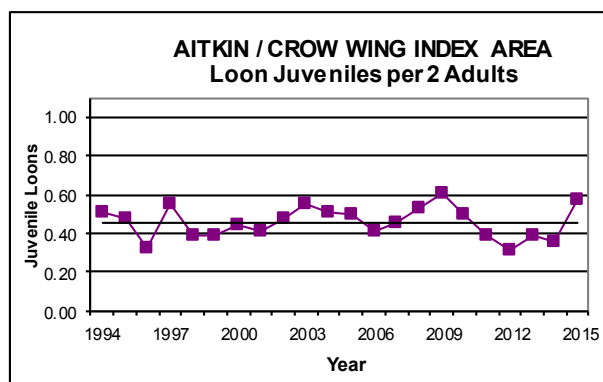


Figure 5. LOON REPRODUCTIVE SUCCESS— Juvenile loons for every two adult loons on a lake within the Aitkin/Crow Wing Index Area.

In summary:

- Loon abundance in the Aitkin/Crow Wing Index Area is stable and ranged from 2.2 – 3.0 adult loons per 100 acres of lake between 1994-2015 (Fig. 3).
- There has been no statistically significant change in loon occupancy in the Aitkin/Crow Wing Index Area. Occupancy (*likelihood of seeing a loon on a lake*) fluctuated between 69% - 82% (Fig. 4), averaging the 3rd highest amongst the Index Areas after Itasca and Becker (see Fig. 22).
- Reproductive success in the Aitkin/Crow Wing index area is stable and ranged from 0.31 - 0.61 juveniles per 2 adult loons over the 22 years of the loon monitoring program (Fig. 5).

Table 1. Total number of adult and juvenile loons observed over the past 10 survey years in the Aitkin/Crow Wing Index

Year	Total Adult Loons	Total Juvenile Loons	Lakes with Adult Loons	Lakes with Juvenile Loons	Total # of Lakes Surveyed
2006	337	63	82	30	109
2007	330	71	87	37	110
2008	349	82	86	41	108
2009	349	85	82	43	103
2010	346	78	80	38	108
2011	334	55	84	33	103
2012	289	39	78	27	100
2013	284	45	71	29	88
2014	237	47	67	20	84
2015	299	67	76	39	98

Becker Index Area

INDEX AREA CHARACTERISTICS

- ◇ Low acid rain sensitivity
- ◇ Low density of humans and roads
- ◇ Slow human population growth
- ◇ Predominantly public lands
- ◇ Average lake size = 356 acres

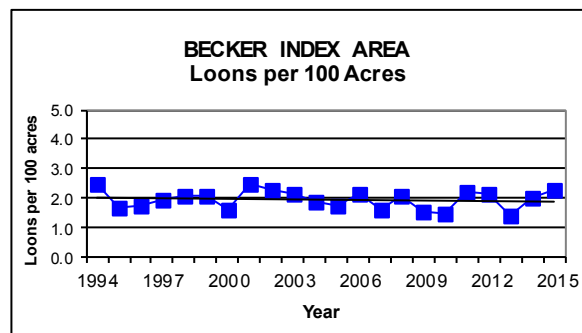


Figure 6. LOON ABUNDANCE—Adult loons seen per 100 acres of lake surface within the Becker Index Area.

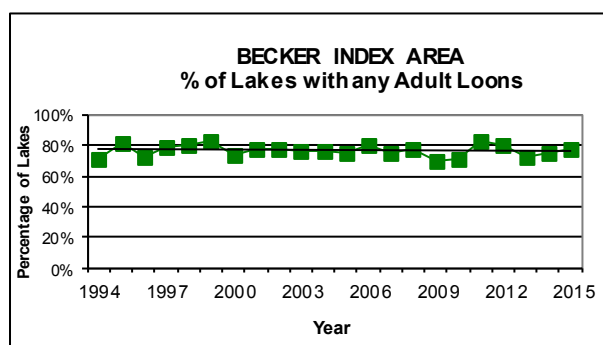


Figure 7. LOON OCCUPANCY – Percent of lakes in the Becker Index Area with any adult loons.

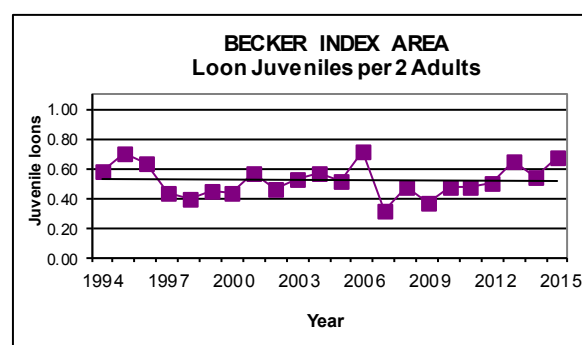


Figure 8. LOON REPRODUCTIVE SUCCESS— Juvenile loons for every two adult loons on a lake within the Becker Index Area.

In summary:

- There has been a marginal but significant decline in the number of adult loons within the Becker Index Area over the past 22 years of the loon monitoring program. Loon abundance ranged from 1.4 – 2.5 adult loons per 100 acres of lake (Fig. 6).
- Loon occupancy (*likelihood of seeing a loon on a lake*) is stable in the Becker Index Area, ranging from 70% – 83% between 1994-2015 (Fig. 7). This Index Area has the 2nd highest average occupancy amongst the six Index Areas in the monitoring program (see Fig. 22).
- Reproductive success was calculated as 0.32 to 0.72 juveniles per 2 adult loons in the Becker Index Area. While this Index Area holds the 2nd highest average reproductive success of the six areas in the program, it also has shown a marginal but significant decline in this ratio across the 22-year survey period (Fig 8).

Table 2. Total number of adult and juvenile loons observed over the past 10 survey years in the Becker Index Area.

Year	Total Adult Loons	Total Juvenile Loons	Lakes with Adult Loons	Lakes with Juvenile Loons	Total # of Lakes Surveyed
2006	280	86	74	41	93
2007	252	37	66	20	89
2008	214	44	64	25	83
2009	292	52	67	27	97
2010	309	64	62	26	88
2011	329	54	67	28	82
2012	325	65	72	32	90
2013	312	78	70	30	96
2014	320	74	71	32	95
2015	359	97	78	52	100

Cook/Lake Index Area

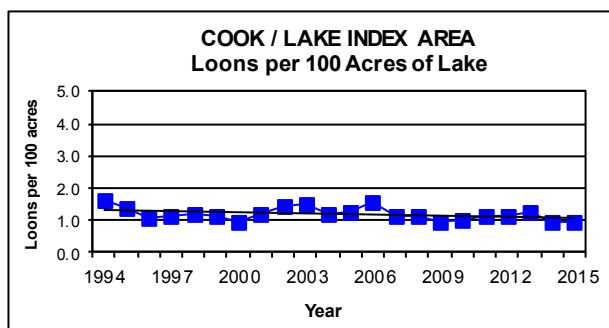


Figure 9. LOON ABUNDANCE—Adult loons seen per 100 acres of lake surface within the Cook/Lake Index Area.

INDEX AREA CHARACTERISTICS

- ◇ High acid rain sensitivity
- ◇ Low density of humans and roads
- ◇ Slow human population growth
- ◇ Predominantly public lands
- ◇ Average lake size = 198 acres

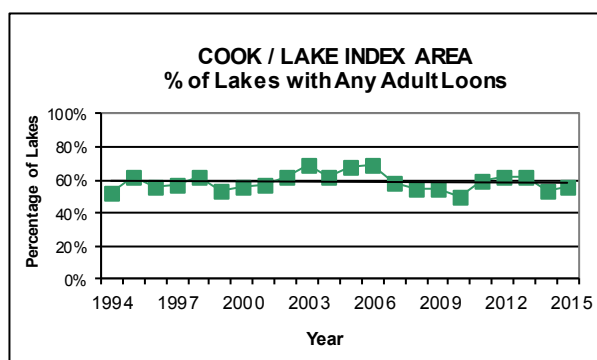


Figure 10. LOON OCCUPANCY – Percent of lakes in the Cook/Lake Index Area with any adult loons.

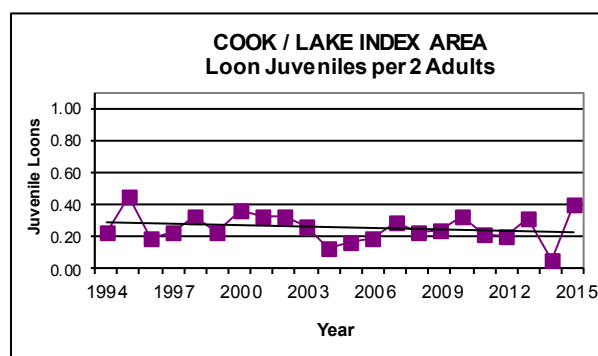


Figure 11. LOON REPRODUCTIVE SUCCESS— Juvenile loons for every two adult loons on a lake within the Cook/Lake Index Area.

In summary:

- Loon abundance is stable in the Cook/Lake Index Area, ranging from 0.9 – 1.6 adult loons per 100 acres of lake surface over the 22-year survey period (Fig. 9).
- There has been no statistically significant change in loon occupancy in the Cook/Lake Index Area between 1994-2015. Occupancy (*likelihood of seeing a loon on a lake*) fluctuated between 50% - 69% (Fig. 10), ranking 5th out of 6 Index Areas, with only the Kandiyohi Index Area demonstrating lower occupancy (see Fig. 22).
- Reproductive success is stable in the Cook/Lake Index Area. Reproductive success was calculated between 0.06 - 0.45 juveniles per 2 adult loons during the 22-year period (Fig. 11), resulting in the lowest average ratio of the six Index Areas.

Table 3. Total number of adult and juvenile loons observed over the past 10 survey years in the Cook/Lake Index Area.

Year	Total Adult Loons	Total Juvenile Loons	Lakes with Adult Loons	Lakes with Juvenile Loons	Total # of Lakes Surveyed
2006	179	14	67	8	98
2007	140	17	56	12	97
2008	88	8	40	7	74
2009	124	10	52	7	96
2010	143	21	49	13	100
2011	126	11	52	7	87
2012	138	15	61	9	98
2013	115	16	57	10	93
2014	115	5	52	5	98
2015	121	22	53	14	95

Itasca Index Area

INDEX AREA CHARACTERISTICS

- ◇ High acid rain sensitivity
- ◇ Low density of humans and roads
- ◇ Slow human population growth
- ◇ Predominantly public lands
- ◇ Average lake size = 169 acres

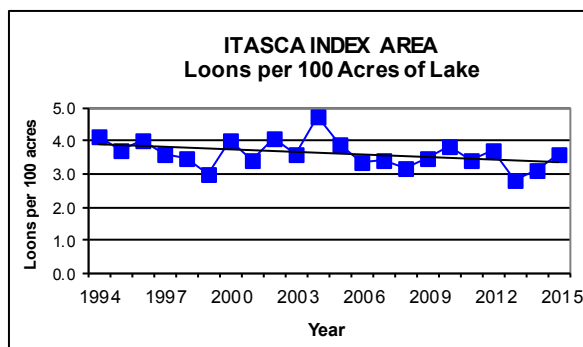


Figure 12. LOON ABUNDANCE—Adult loons seen per 100 acres of lake surface within the Itasca Index Area.

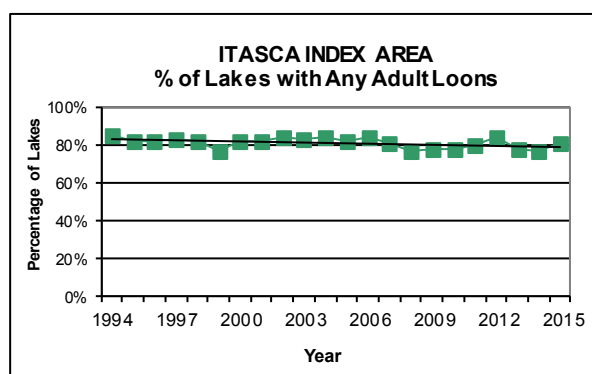


Figure 13. LOON OCCUPANCY – Percent of lakes in the Itasca Index Area with any adult loons.

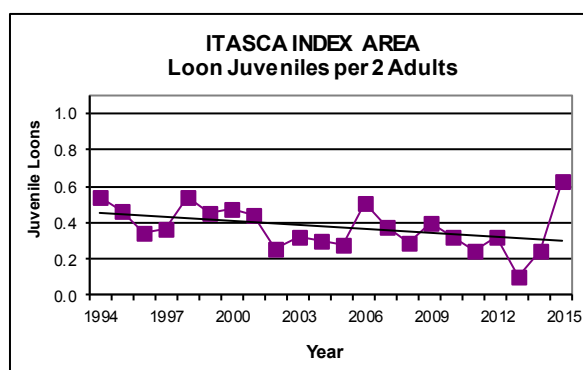


Figure 14. LOON REPRODUCTIVE SUCCESS— Juvenile loons for every two adults on a lake within the Itasca Index Area.

In summary:

- Loon abundance is stable but showing a non-significant negative trend in the Itasca Index Area. Abundance ranged from 2.8 – 4.7 adult loons per 100 acres of lake between 1994-2015 (Fig. 12), the highest of the six Index Areas.
- Loon occupancy (*likelihood of seeing a loon on a lake*) is stable in the Itasca Index Area, ranging from 76% – 86% over the 22-year survey period (Fig. 13). This Index Area has the highest average occupancy amongst all six areas in the monitoring program (see Fig. 22).
- Reproductive success was calculated as 0.10 - 0.63 juveniles per 2 adult loons in the Itasca Index Area (Fig. 14). This area is showing a highly significant decline in reproductive success between 1994-2015; juvenile counts rebounded in 2015, so additional years of data will help to shed light on a long-term pattern.

Table 4. Total number of adult and juvenile loons observed over the past 10 survey years in the Itasca Index Area.

Year	Total Adult Loons	Total Juvenile Loons	Lakes with Adult Loons	Lakes with Juvenile Loons	Total # of Lakes Surveyed
2006	348	72	88	38	105
2007	369	62	83	33	102
2008	263	25	72	18	94
2009	361	57	81	28	104
2010	422	64	81	30	104
2011	326	35	68	17	85
2012	365	54	85	29	101
2013	307	22	80	9	102
2014	288	29	81	20	105
2015	371	80	83	37	103

Kandiyohi Index Area

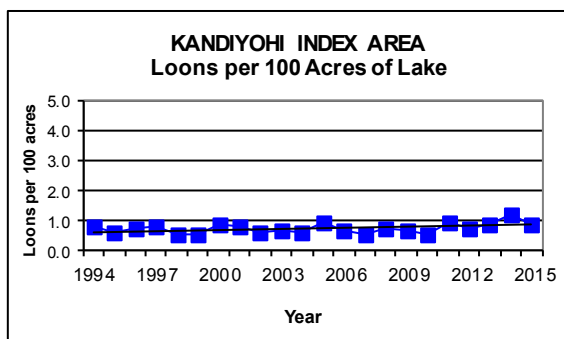


Figure 15. LOON ABUNDANCE—Adult loons seen per 100 acres of lake surface within the Kandiyohi Index Area.

INDEX AREA CHARACTERISTICS

- ◇ High acid rain sensitivity
- ◇ Low density of humans and roads
- ◇ Slow human population growth
- ◇ Predominantly public lands
- ◇ Average lake size = 327 acres

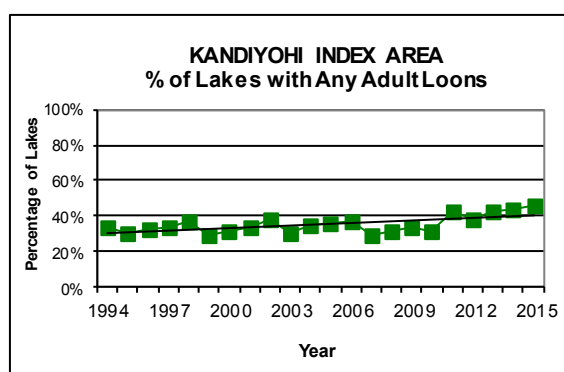


Figure 16. LOON OCCUPANCY – Percent of lakes in the Kandiyohi Index Area with any adult loons.

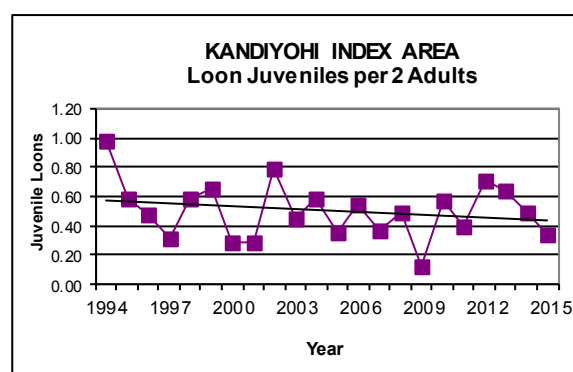


Figure 17. LOON REPRODUCTIVE SUCCESS— Juvenile loons for every two adult loons on a lake within the Kandiyohi Index Area.

In summary:

- Loon abundance is low, but stable in the Kandiyohi Index Area, ranging from 0.5 – 1.2 adult loons per 100 acres of lake between 1994-2015 (Fig. 15).
- Loon occupancy increased between 1994-2015 in the Kandiyohi Index Area. Occupancy (*likelihood of seeing a loon on a lake*) was calculated as 29% - 47% (Fig. 16), with the lowest average amongst the Index Areas (see Fig. 22).
- Reproductive success is stable but highly variable in the Kandiyohi Index Area. Reproductive success ranged from 0.12 - 0.98 juveniles per 2 adult loons over the 22 year period (Fig. 17), with the second-highest average rate amongst the Index Areas.

Table 5. Total number of adult and juvenile loons observed over the past 10 survey years in the Kandiyohi Index Area.

Year	Total Adult Loons	Total Juvenile Loons	Lakes with Adult Loons	Lakes with Juvenile Loons	Total # of Lakes Surveyed
2006	107	32	37	16	100
2007	90	24	30	10	102
2008	135	29	32	12	100
2009	102	13	31	9	90
2010	103	27	31	12	95
2011	126	27	39	16	91
2012	89	29	36	16	94
2013	96	23	42	17	98
2014	120	30	42	15	95
2015	126	18	47	10	100

Otter Tail Index Area

INDEX AREA CHARACTERISTICS

- ◇ Low acid rain sensitivity
- ◇ Moderate density of humans and roads
- ◇ Slow human population growth
- ◇ Predominantly private lands
- ◇ Average lake size = 515 acres

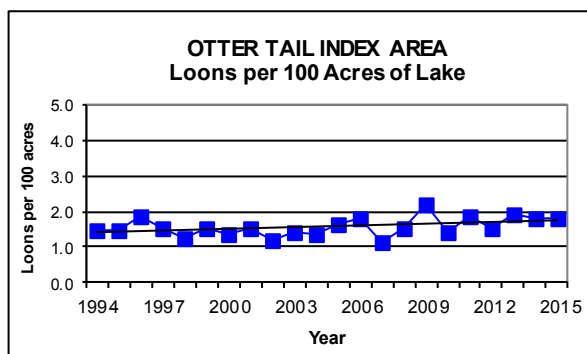


Figure 18. LOON ABUNDANCE—Adult loons seen per 100 acres of lake surface within the Otter Tail Index Area.

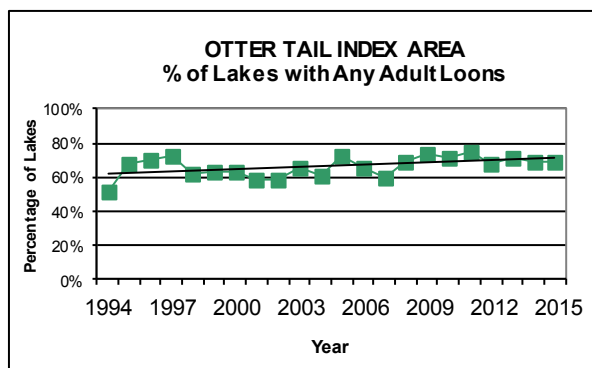


Figure 19. LOON OCCUPANCY – Percent of lakes in the Otter Tail Index Area with any adult loons.

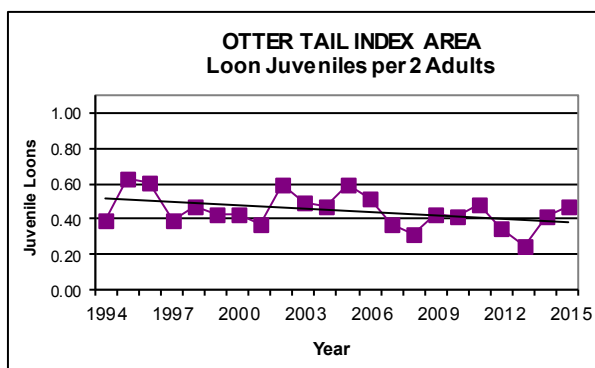


Figure 20. LOON REPRODUCTIVE SUCCESS— Juvenile loons for every two adult loons on a lake within the Otter Tail Index Area.

In summary:

- Loon abundance has significantly increased between 1994-2015 in the Otter Tail Index Area, ranging from 1.2 – 2.2 adult loons per 100 acres of lake over this time period (Fig. 18).
- Loon occupancy has increased between 1994-2015 in the Otter Tail Index Area. Occupancy (*likelihood of seeing a loon on a lake*) fluctuated between 51% - 75% (Fig. 19), ranking the 4th highest out of the Index Areas, after Itasca, Becker, and Aitkin/Crow Wing (see Fig. 22).
- Reproductive success was calculated as 0.25 - 0.63 juveniles per 2 adults in the Otter Tail Index Area (Fig. 20). While highly variable, there has been no significant change in reproductive success in this Index Area.

Table 6. Total number of adult and juvenile loons observed over the past 10 survey years in the Otter Tail Index Area.

Year	Total Adult Loons	Total Juvenile Loons	Lakes with Adult Loons	Lakes with Juvenile Loons	Total # of Lakes Surveyed
2006	372	75	72	35	110
2007	307	52	68	29	116
2008	382	56	71	26	104
2009	333	55	81	31	111
2010	387	57	75	33	106
2011	386	67	74	31	98
2012	417	50	66	20	99
2013	376	50	80	24	112
2014	322	53	76	29	111
2015	384	62	79	36	114

Index Area Comparison

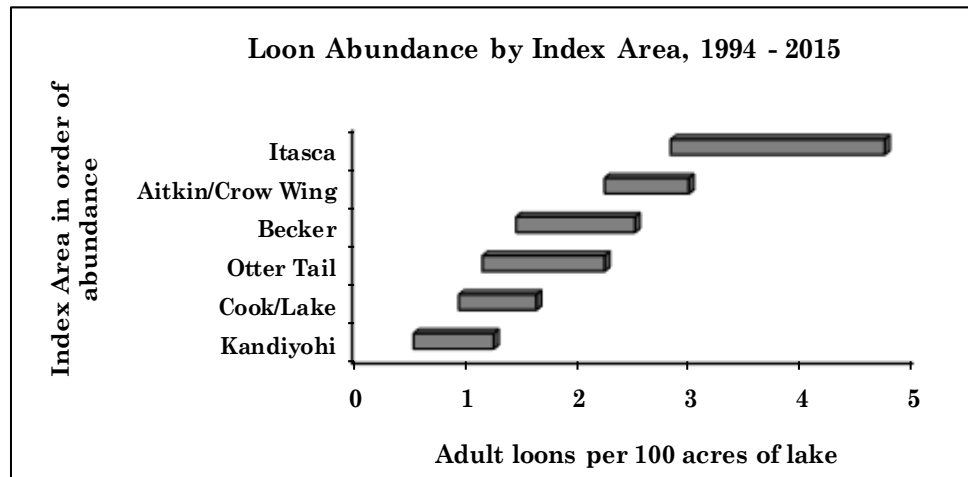


Figure 21. LOON ABUNDANCE comparison amongst Index Areas. The bars represent the span between highest and lowest values observed during the 22 years of the loon monitoring program.

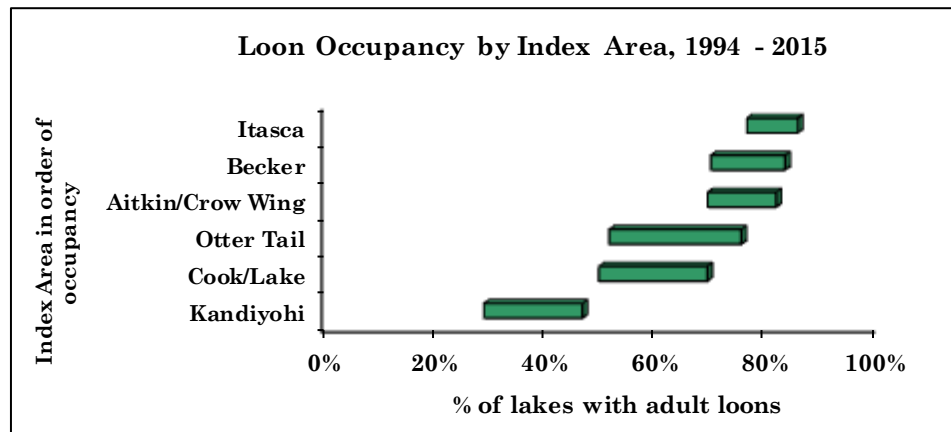


Figure 22. LOON OCCUPANCY comparison amongst Index Areas. The bars represent the span between highest and lowest values observed during the 22 years of the loon monitoring program (1994—2015).

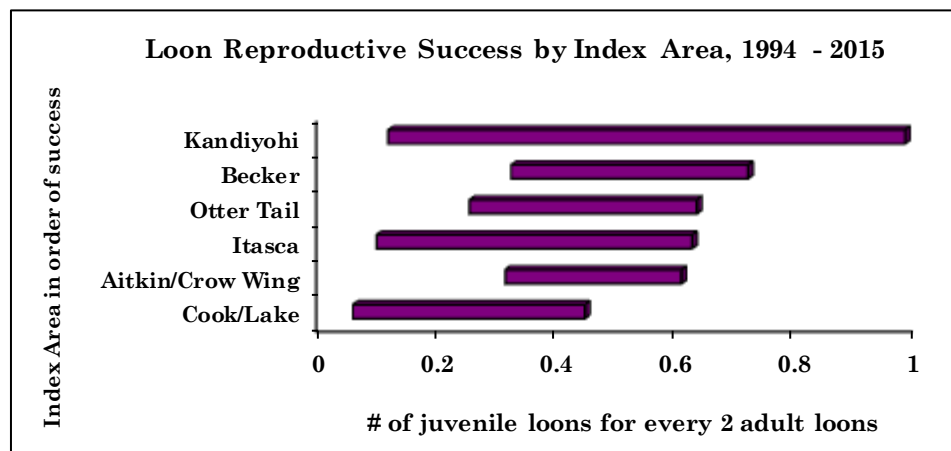


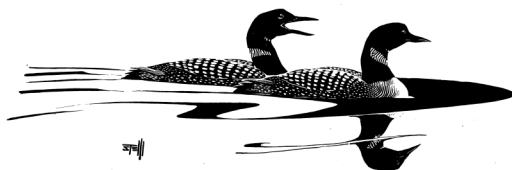
Figure 23. LOON REPRODUCTIVE SUCCESS comparison amongst Index Areas. The bars represent the span between highest and lowest values observed during the 22 years of the loon monitoring program (1994—2015).



Conclusions

Overall, loon populations within the six Index Areas of the MLMP have remained relatively stable for the past 22 years. This is good news for Minnesotans, who appreciate the charm and appeal of loons on our beloved lakes. Because the loon is an indicator of the quality of our lakes and a significant portion of the nation's loons nest here, the DNR's Nongame Wildlife Program plans to continue monitoring loons through the MLMP.

The results of this study also indicate that there is a link between water clarity and loon populations in Minnesota. Conservation management efforts to enhance water clarity should benefit loons. Managers, homeowners, and educators can use this insight when formulating landscape management plans, and when addressing water quality issues on lakeshore property. Minnesotans are stewards of over 15,000 lakes, and only through careful management will these lakes provide both recreational and esthetic benefits far into the future.



For more information on the MLMP, and to download this report, visit our website:
http://www.dnr.state.mn.us/eco/nongame/projects/mlmp_state.html

Acknowledgements:

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