

**COMMON
LOON**

Five-Year

MONITORING
SUMMARY REPORT



**2018-
2022**

Kezar Lake
Watershed

KEZAR LAKE WATERSHED

Common Loon Monitoring Summary Report

SUBMITTED TO:

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Loon Conservation Associates (LCA) is dedicated to the protection and welfare of loons through collaboration, education, and the implementation of successful conservation actions.

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1.0 INTRODUCTION

For the five-year period (2018-2022) the Kezar Lake Watershed Association (KLWA) and Loon Conservation Associates (LCA) conducted a comprehensive study of the common loon population within the Kezar Lake watershed. Reaching a five-year milestone in 2022 is significant, as it provides the first opportunity to accurately assess the overall health of the loon population over time, document and analyze stressors to the population, and examine the results of conservation efforts, like the introduction of artificial nest rafts.

The project was initially launched in 2018 in response to anecdotal evidence of poor reproductive success in the watershed in prior years. Field research efforts emphasized broad survey coverage through weekly comprehensive breeding surveys, which assured an accurate accounting of the current population status. Reproductive success results are presented both as a five-year average for the entire watershed, and individually by lake/territory.

Additionally, the project prioritized color-marking of individuals to enable tracking and confirmation of the survivorship and fidelity of adults, and return rates of adults banded as juveniles (ABJs).

This report summarizes the findings from the most recent five years of monitoring. More specific annual results can be found in annual reports published previously.

2.0 PRODUCTIVITY SUMMARY

Over the five-year period of 2018-2022, seven lakes in the watershed were surveyed each year. Based on well-defined criteria for an established loon territory, the number of observed territorial pairs fluctuated between 15-16 each year. During this five-year period a total of 56 chicks were hatched. Thirty-six of these chicks survived to > 6 weeks of age – an age used as a proxy for fledging for modeling purposes. Average productivity in the Kezar Lake watershed from 2018-2022 was 0.47 chicks surviving per territorial pair (CS/TP), which is just below the established threshold for maintaining a breeding population (0.48 CS/TP).

When comparing the productivity of Kezar Lake to the productivity of the small ponds during this same five-year period, a significant difference existed. The average productivity for Kezar Lake was 0.36 CS/TP, versus 0.74 CS/TP for the small ponds. Looking at it another way, five territorial pairs on the small ponds fledged 17 chicks (47%), of all the chicks between 2018-2022, while 11 territorial pairs on Kezar Lake fledged only 19 (53%).

3.0 OBJECTIVES

Collaborate with KLWA to:

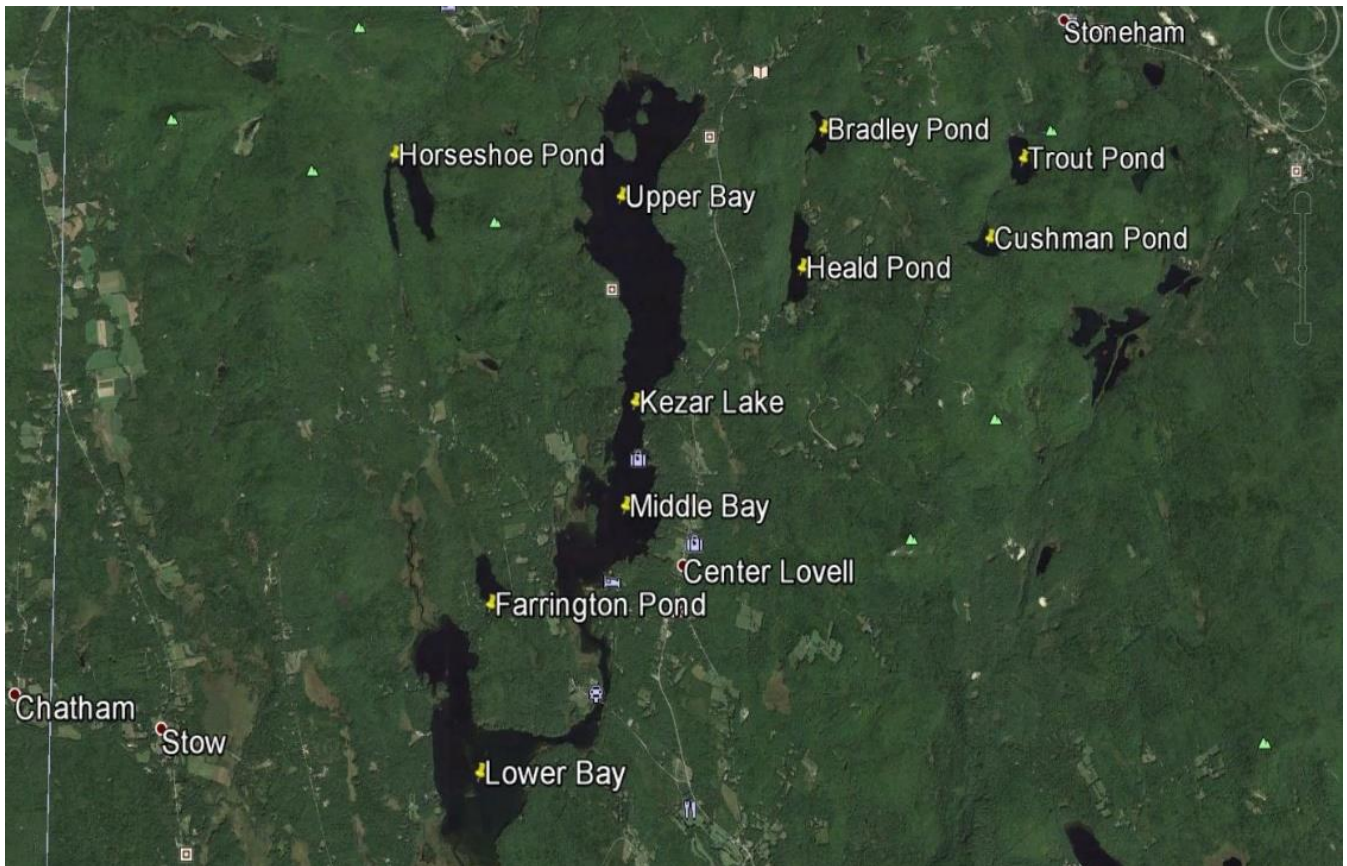
1. Conduct weekly, comprehensive productivity surveys to identify territorial pairs, nesting pairs, nest success/failure, number of chicks hatched, and number of chicks fledged;
2. Develop a color-banded population to determine demographic parameters of interest (individual reproductive performance, rate of return by adults to their breeding territory and mate fidelity) in breeding common loons in KLWA watershed;
3. Consult on deployment and placement of artificial nesting rafts, where appropriate, to increase nest success rates, and minimize nest loss due to flooding and predation;

4. Introduce the use of nest monitoring cameras to better assess nest disturbance, nesting behaviors, and potential causes of nest failure, and
5. Collect Hg and Pb levels in breeding loons to evaluate contaminant risk.

4.0 STUDY AREA

This study is limited to lakes of appropriate size and with suitable habitat for nesting loons in the Kezar Lake watershed in Oxford County, Maine. The specific lakes are: Kezar Lake, Horseshoe Pond, Farrington Pond, Cushman Pond, Heald Pond, Bradley Pond, and Trout Pond (Figure 1).

Figure 1. The Kezar Lake watershed study area. Courtesy of Google Earth Pro.



5.0 METHODS

5.1 GROUND SURVEYS

All known or potential loon territories and surrounding areas were surveyed by LCA and KLWA members, and volunteers, using binoculars and/or a spotting scope. Surveys were conducted by boat, or alternatively from shore. Surveys began in May and concluded in August. Lakes occupied by territorial pairs were prioritized and surveyed weekly at a minimum. To minimize impacts on the loons, surveys were conducted from the greatest distance possible. If nesting evidence was obscured by vegetation, it necessitated searching for nest evidence by foot. All known nesting sites were checked regularly for nesting evidence.

Loon territories were delineated according to observed territorial behavior by a loon pair such as close physical association, defensive posturing, and calling along borders. Territories are used by pairs for feeding, resting, breeding, nesting and chick rearing. They are also protected by resident pairs against incursion by other loons (and sometimes waterfowl) for a minimum of four weeks. Territories are used as a unit of reference in describing loon breeding activity and are recognized as being either established or transitional. Established territories have consistent occupancy for at least three seasons; transitional territories exhibit inconsistent occupation.

Nesting pairs were defined as those laying at least one egg; a nesting attempt was evidenced by a constructed nest dish or scrape with at least one egg present or fresh eggshell fragments. Successful nesting pairs hatched at least one chick. Causes of nest failure were attributed according to evidence observed.

Chicks hatched were recorded as those that hatched completely out of their eggs, not necessarily departing from the nest. For this report, the number of loon chicks to survive past six weeks of age, were assumed to have fledged.

It's important to note that this project did not include counting all the loons observed, and did not estimate the total number of loons in the population.

5.2 ARTIFICIAL NESTING ISLANDS

Rafts were floated in territories that met specific criteria for flotation; including knowledge of 1) wind and wave action patterns relative to each territory, 2) loon territorial boundaries and proximity to neighboring territories, 3) previous traditional and non-traditional nest site locations, 4) boat traffic patterns relative to the specific territory, and 5) shoreline activities.

5.3 LOON CAPTURE AND SAMPLE COLLECTION

Loons were captured using well-established night lighting and playback techniques. Adult and juvenile birds were leg banded with U.S. Geological Survey (USGS) aluminum bands, and a unique combination of plastic, colored bands, enabling identification of individual birds to be made from a distance in future observations. Chicks were banded after their legs were large enough (> 5 weeks old) to hold adult-size bands.

Captured loons were weighed, two second secondary feathers were collected by clipping at the base of the quill, and blood samples were taken from the metatarsal vein for contaminant analysis. All sampling was accomplished using non-lethal methods.

5.4 USE OF NEST CAMERAS

Battery powered and programmable trail cameras were used to monitor some active nests where circumstances allowed. Cameras were most often installed after nest building and incubation were confirmed, to avoid placing cameras in locations where pairs don't ultimately nest. Cameras were

mounted on metal poles, which were driven into the lake bottom, approximately 10-20 feet from the nest. To preserve battery life and memory, the cameras were most often programmed in motion detection mode, with a three-picture trigger and a two-minute delay between triggers. Camera technology and capability is always advancing. Best settings for individual cameras should be determined and adjusted as circumstances, and technology changes dictate.

5.5 DEFINING REPRODUCTIVE SUCCESS

Reproductive success was evaluated according to four parameters; 1) nesting frequency, 2) hatching success, 3) chick survivorship, and 4) overall productivity. Nesting frequency was defined as the number of nesting pairs per total territorial pairs. This measure indicates the percent of the total potential breeding population that attempts to reproduce each season. The rate of success by these pairs, or hatching success, was measured through the number of chicks hatched by these pairs. Chick survivorship was defined as the number of chicks surviving divided by the number of chicks hatched. Overall productivity is a combination of the prior three parameters and measured through fledged young per territorial pair (CS/TP).

5.6 RECRUITING AND TRAINING VOLUNTEERS

Recruiting and training citizen volunteers is a key component of the project. Citizen volunteers are required to staff and conduct weekly surveys, reduce costs, and ultimately make the project sustainable long-term. Training was conducted in the field both in small groups and one-on-one, with an experienced, professional loon expert.

6.0 RESULTS

6.1 OVERALL PRODUCTIVITY, KEZAR LAKE WATERSHED 2018-2022 (Table 1).

During the 2018-2022 field seasons, seven lakes were surveyed in the Kezar Lake watershed. During this five-year period a **cumulative*** total of 76 territorial pairs were confirmed. Sixty-four nesting pairs hatched 56 chicks, and 36 survived to fledge. This yielded a nesting frequency of 0.84, a hatching success of 0.88, and chick survival of 0.64. Overall productivity was 0.47 fledged young per territorial pair (CS/TP), (Table 1).

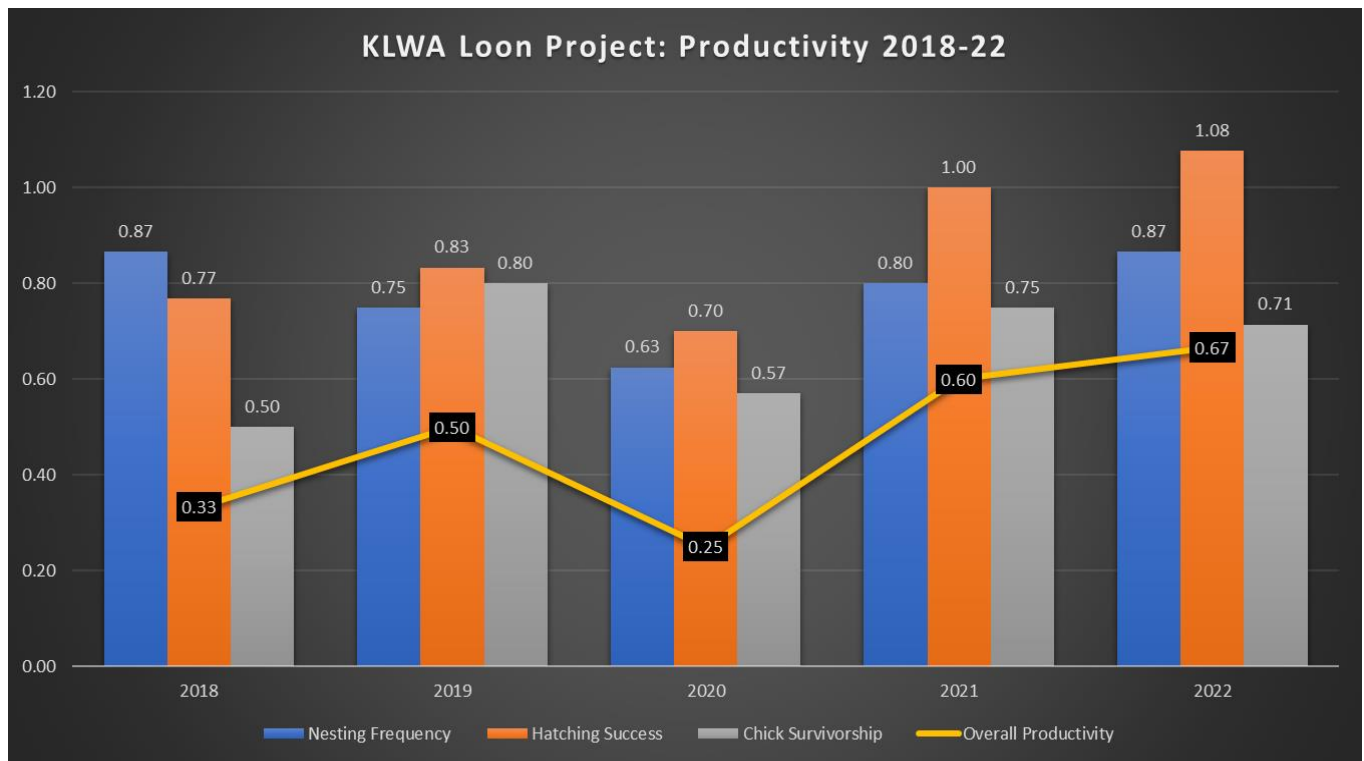
Table 1. Common Loon population and productivity, Kezar Lake watershed, **2018-2022**.

Population		Reproductive Success	
Territorial Pairs	76	Nesting Frequency	0.84
Nesting Pairs	64	Hatching Success	0.88
Chicks Hatched	56	Chick Survivorship	0.64
Chicks Surviving	36	Overall Productivity	0.47

* All the numbers presented are cumulative totals for all five years of the study. The annual productivity numbers can be found in the annual reports, which have already been published.

Annual reproductive success varied significantly from year-to-year, which is typical of loon productivity. Overall productivity was lowest in 2020 with 0.25 CS/TP, and it was the highest in 2022 with 0.67 CS/TP (Figure 2).

Figure 2.



6.2 OVERALL PRODUCTIVITY, KEZAR LAKE VS. SMALL PONDS, 2018-2022 (Table 2).

During the five-year period of 2018-2022 on **Kezar Lake** a **cumulative*** total of 53 territorial pairs were confirmed. Thirty-nine nesting pairs hatched 33 chicks, and 19 survived to fledge This yielded a nesting frequency of 0.74, a hatching success of 0.85, and chick survival of 0.58. Overall productivity was 0.36 fledged young per territorial pair (CS/TP), (Table 2).

During this five-year period of 2018-2022 on the **Small Ponds**, a **cumulative*** total of 23 territorial pairs were confirmed. Nineteen nesting pairs hatched 23 chicks, and 17 survived to fledge This yielded a nesting frequency of 0.83, a hatching success of 1.21, and chick survival of 0.74. Overall productivity was 0.74 fledged young per territorial pair (CS/TP), (Table 2).

* All the numbers presented are cumulative totals for all five years of the study. The annual productivity numbers can be found in the annual reports, which have already been published.

Table 2. Common Loon population and productivity, Kezar Lake vs. Small Ponds, **2018-2022.**

Population	KL*	SP*	Reproductive Success	KL*	SP*
Territorial Pairs	53	23	Nesting Frequency	0.74	0.83
Nesting Pairs	39	19	Hatching Success	0.85	1.21
Chicks Hatched	33	23	Chick Survivorship	0.58	0.74
Chicks Surviving	19	17	Overall Productivity	0.36	0.74

* KL = Kezar Lake, SP =Small Ponds

6.3 PRODUCTIVITY AND NEST FAILURE, KEZAR LAKE, BY TERRITORY AND YEAR, 2018-2022 (Table 3).

Great Brook:

The Kezar Lake, Great Brook territory was occupied and defended by a pair of loons every year. They nested each year, including two nest attempts in 2019 and 2020, after initial nest attempts failed due to black fly disturbance. They were successful hatching a chick(s) every year, and fledging a chick(s) in all years except 2019. Over the five-year period of 2018-2022 this pair hatched a total of nine chicks and fledged five. This productivity made them the most successful breeding pair on Kezar Lake (Table 3a).

Table 3a. Productivity and nest failure Kezar Lake, Great Brook 2018-2022.

Year	TP*	NP*	DATE(S)	NATURAL/RAFT	CH*	CF*	NF*	Cause of Nest Failure
2018	Y	Y	6/12-17	Raft	2	1	0	
2019	Y	Y(2)	<5/23 & 6/11	Raft	1	0	1	Abandoned – black flies
2020	Y	Y(2)	<5/31 & 6/12	Raft	2	1	1	Abandoned – black flies & predated
2021	Y	Y	6/1	Raft	2	1	0	
2022	Y	Y	6/3-4	Raft	2	2	0	
Total	--	7**	--	--	9	5	2	

* TP = territorial pair, NP = nesting pair, CH = chick(s) hatched, CF = chicks fledged, NF = nest failure

** Total number of nest attempts

An artificial nest raft was placed in this territory prior to 2018. It was not used. In 2018 it was relocated, and loons used it for all nesting during the five-year period.

The adult male was banded in 2017, prior to the official start of the monitoring project. He returned and occupied the territory every year. In 2022 he died from lead poisoning after ingesting a lead sinker. The adult female was banded in 2021, and she returned and occupied the territory with the banded male in 2022.

Alaska Bay:

The Kezar Lake, Alaska Bay territory was occupied and defended by a pair of loons every year. They nested every year except 2021, including two nest attempts in 2020, after their initial nest attempt failed. Their nests failed every year except 2019. The cause of the nest failures was mammalian predation. In 2019 they hatched and fledged two chicks (Table 3b).

Table 3b. Productivity and nest failure Kezar Lake, Alaska Bay, 2018-2022.

Year	TP*	NP*	DATE(S)	NATURAL/RAFT	CH*	CF*	NF*	Cause of Nest Failure
2018	Y	Y	6/12-13	Natural	0	0	1	Mammalian predation
2019	Y	Y	6/11-12	Natural	2	2	0	--
2020	Y	Y(2)	6/7-8 & 6/25-26	Natural	0	0	2	Mammalian predation
2021	Y	N	--	--	0	0	0	--
2022	Y	Y	6/16-20	Natural	0	0	1	Mammalian predation/abandonment
Total	--	5**	--	--	2	2	4	

* TP = territorial pair, NP = nesting pair, CH = chick(s) hatched, CF = chicks fledged, NF = nest failure

** Total number of nest attempts

An artificial nest raft was placed in this territory prior to 2018. It was not used. In 2019 it was relocated. It remained unused, so it was removed in 2020.

Both the male and female were banded in 2019, along with one of the two chicks. The banded pair has returned each year and remained together in the territory.

Vinton's Cove:

The Kezar Lake, Vinton's Cove territory was occupied and defended by a pair of loons beginning in 2019, although casual observations by local camp owners indicated loon sightings there in prior years. This pair nested all four years (2019-2022), including two nest attempts in 2020 & 2022, after initial nest attempts failed. During this four-year period, they nested a total of six times and all the nests failed due to mammalian predation (Table 3c).

Table 3c. Productivity and nest failure Kezar Lake, Vinton's Cove, 2018-2022.

Year	TP*	NP*	DATE(S)	NATURAL/RAFT	CH*	CF*	NF*	Cause of Nest Failure
2019	Y	Y	UNK	Natural	0	0	1	Mammalian predation
2020	Y	Y(2)	6/11-12 & 6/25-26	Natural	0	0	2	Mammalian predation
2021	Y	Y	--	Natural	0	0	1	Mammalian predation
2022	Y	Y(2)	6/12 & 7/12	Raft	0	0	2	Mammalian predation
Total	--	6**	--	--	0	0	6	

* TP = territorial pair, NP = nesting pair, CH = chick(s) hatched, CF = chicks fledged, NF = nest failure

** Total number of nest attempts

With the hope of mitigating the threats from confirmed mammal activity in the area, chicken wire fencing was placed around the back and sides of the nest, post-nesting. While this seemed effective in extending the incubation period in some cases, mammals were still able to access the nest from the water side. Additionally, an artificial nest raft was placed in this territory beginning in 2020. Loons ignored it until 2022, when they nested on it twice. They failed both times. A nest monitoring camera confirmed a raccoon, most likely the same predator as prior years, swam to the raft and consumed the egg(s).

Severance West:

The Kezar Lake, Severance West territory was occupied and defended by a pair of loons every year. During the five-year period of 2018-2022 this pair nested a total of seven times, including two nest attempts in 2019, 2021 & 2022, after initial nest attempts failed. All nest attempts failed due to mammalian predation. Several different times a nest monitoring camera confirmed the predator was a raccoon (Table 3d).

Table 3d. Productivity and nest failure Kezar Lake, Severance West, 2018-2022.

Year	TP*	NP*	DATE(S)	NATURAL/RAFT	CH*	CF*	NF*	Cause of Nest Failure
2018	Y	N	--	--	--	--	--	--
2019	Y	Y(2)	6/13 & 6/26	Natural	0	0	2	Mammalian predation
2020	Y	Y	6/10	Natural	0	0	1	Mammalian predation
2021	Y	Y(2)	6/3-4 & 7/11	Natural	0	0	2	Mammalian predation
2022	Y	Y(2)	<6/21 & 6/22	Natural	0	0	2	Mammalian predation/abandonment
Total	--	7**	--	--	0	0	7	

* TP = territorial pair, NP = nesting pair, CH = chick(s) hatched, CF = chicks fledged, NF = nest failure

** Total number of nest attempts

With the hope of mitigating the threats from confirmed mammal predation, chicken wire fencing was placed around the back and sides of the nest, post-nesting. While this seemed affective in extending the incubation period in some cases, mammals were still able to access the nest from the water side.

Additionally, an artificial nest raft was placed in this territory beginning in 2021. It was not used that year or in subsequent years.

Fox Cove:

The Kezar Lake, Fox Cove territory was occupied and defended by a pair of loons every year. During the five-year period of 2018-2022, this pair nested a total of six times, including two nest attempts in 2020, after an initial nest attempt failed due to mammalian predation. They had successful nests in 2018, 2021 & 2022, hatching a total of five chicks. Three chicks survived to fledge (Table 3e).

Table 3e. Productivity and nest failure Kezar Lake, Fox Cove, 2018-2022.

Year	TP*	NP*	DATE(S)	NATURAL/RAFT	CH*	CF*	NF*	Cause of Nest Failure
2018	Y	Y	6/3	Natural	1	0	0	--
2019	Y	Y	7/4	Natural	0	0	1	Mammalian predation
2020	Y	Y(2)	6/7 & 7/3-4	Natural/Raft	0	0	2	Mammalian predation
2021	Y	Y	5/29-30	Natural	2	2	0	--
2022	Y	Y	6/20	Natural	2	1	0	--
Total	--	6**	--	--	5	3	3	

* TP = territorial pair, NP = nesting pair, CH = chick(s) hatched, CF = chicks fledged, NF = nest failure

** Total number of nest attempts

With the hope of mitigating the threats from confirmed mammal predation, chicken wire fencing was placed around the back and sides of the nest, post-nesting. While this seemed affective in extending the incubation period in some cases, mammals were still able to access the nest from the water side. Additionally, an artificial nest raft was placed in this territory beginning in 2018. It was used one time, for a second nest attempt in 2020. That nest attempt failed.

Both the male and female were banded in 2018, and they have returned each year and remained together in the territory. The two chicks they hatched and fledged in 2021 were banded, also. One of those two chicks was rescued from the lake in January 2022, after it was nearly iced in. That chick was examined at Avian Haven and found to be healthy. It was later released on the ocean in Maine.

MB Narrows:

The Kezar Lake, MB Narrows territory was occupied and defended by a pair of loons every year. During the five-year period of 2018-2022, this pair nested a total of seven times, including two nest attempts in 2018, 2020 & 2022, after initial nest attempts failed due to mammalian predation. They had successful nests in 2021 & 2022, hatching a total of three chicks. Two chicks survived to fledge (Table 3f).

Table 3f. Productivity and nest failure Kezar Lake, MB Narrows, 2018-2022.

Year	TP*	NP*	DATE(S)	NATURAL/RAFT	CH*	CF*	NF*	Cause of Nest Failure
2018	Y	Y(2)	6/5-10 & 6/22-27	Natural	0	0	2	Mammalian predation
2019	Y	N	--	--	--	--	--	--
2020	Y	Y(2)	6/17-21 & 7/5-8	Natural	0	0	2	Mammalian predation
2021	Y	Y	6/5-6	Natural	2	1	0	--
2022	Y	Y(2)	5/28-30 & 6/20-21	Natural	1	1	1	Mammalian predation
Total	--	7**	--	--	3	2	5	--

* TP = territorial pair, NP = nesting pair, CH = chick(s) hatched, CF = chicks fledged, NF = nest failure

** Total number of nest attempts

Artificial nest rafts have been placed in multiple spots in this territory. They have never been used. Evidence suggests this pair has nested in three different locations over the five-year period of 2018-2022; narrows marsh, Blueberry Island and Pleasant Point.

The adult male and female were banded in 2022. Future monitoring of this banded pair will determine if this one pair does occupy and nest in the large geographic area suspected.

SE Island

The Kezar Lake, SE Island territory was occupied and defended by a pair of loons every year, except 2020. During the five-year period of 2018-2022, this pair nested a total of three times. All nests failed after eggs were abandoned for unknown reasons. Intense black fly disturbance was observed during surveys, and is suspected as the most likely cause of nest abandonment in one or more cases (Table 3g).

Table 3g. Productivity and nest failure Kezar Lake, SE Island, 2018-2022.

Year	TP*	NP*	DATE(S)	NATURAL/ RAFT	CH*	CF*	NF*	Cause of Nest Failure
2018	Y	Y	UNK	Natural	0	0	1	Abandoned
2019	Y	N	--	--	--	--	--	--
2020	N	--	--	--	--	--	--	--
2021	Y	Y	6/6	Raft	0	0	1	Abandoned – black flies?
2022	Y	Y	5/15-18	Raft	0	0	1	Abandoned – black flies
Total	--	3**	--	--	0	0	3	--

* TP = territorial pair, NP = nesting pair, CH = chick(s) hatched, CF = chicks fledged, NF = nest failure

** Total number of nest attempts

Due to lack of productivity, an artificial nest raft was placed in this territory beginning in 2021. This pair used the raft immediately, and again in 2022.

Outlet River Marsh

The Kezar Lake, Outlet River Marsh territory was occupied and defended by a pair of loons every year. During the five-year period of 2018-2022, this pair nested a total of three times. In 2018 they hatched two chicks, but neither one survived to fledge. Two other nest attempts, one in 2019 and one in 2020 failed (Table 3h).

Table 3h. Productivity and nest failure Kezar Lake, Outlet River Marsh, 2018-2022.

Year	TP*	NP*	DATE(S)	NATURAL/ RAFT	CH*	CF*	NF*	Cause of Nest Failure
2018	Y	Y	6/26-27	Natural	2	0	0	--
2019	Y	Y	6/11-13	Natural	0	0	1	Abandoned
2020	Y	N	--	--	--	--	--	--
2021	Y	Y	UNK	Natural	0	0	1	Unknown
2022	Y	N	--	--	--	--	--	--
Total	--	3**	--	--	2	0	2	--

* TP = territorial pair, NP = nesting pair, CH = chick(s) hatched, CF = chicks fledged, NF = nest failure

** Total number of nest attempts

Due to lack of productivity, an artificial nest raft was placed in this territory every year. It was not used.

Rock Island

The Kezar Lake, Rock Island territory was occupied and defended by a pair of loons every year. They nested each year, including two nest attempts in 2019, after an initial nest attempt failed due to black fly disturbance. They were successful hatching a chick(s) every year, and fledging a chick(s) in all years except 2022. Over the five-year period of 2018-2022 this pair hatched a total of nine chicks and fledged four (Table 3i).

Table 3i. Productivity and nest failure Kezar Lake, Rock Island 2018-2022.

Year	TP*	NP*	DATE(S)	NATURAL/ RAFT	CH*	CF*	NF*	Cause of Nest Failure
2018	Y	Y	6/10	Raft	1	1	0	--
2019	Y	Y(2)	6/1 & 6/14-15	Raft/Natural	2	1	1	Abandoned – black flies
2020	Y	Y	6/5-6	Raft	2	1	0	--
2021	Y	Y	6/2-3	Raft	2	1	0	--
2022	Y	Y	6/2	Raft	2	0	0	--
Total	--	6**	--	--	9	4	1	--

* TP = territorial pair, NP = nesting pair, CH = chick(s) hatched, CF = chicks fledged, NF = nest failure

** Total number of nest attempts

An artificial nest raft was placed in this territory prior to 2018. It was not used. In 2018 the raft was relocated and loons used it immediately. All nests in subsequent years were on the raft except for the second nest in 2019.

The adult male and female were banded in 2018, and in 2019 the chick was banded. The banded pair of adults have returned and remained together in the territory every year.

In 2022, both chicks were killed by a rogue loon right after hatching and leaving the nest.

NW Cove

The Kezar Lake, NW Cove territory was occupied and defended by a pair of loons every year. Successful nests in 2018 and 2019 produced a total of three chicks, and all survived to fledge. A nest in 2022 failed (Table 3j).

Table 3j. Productivity and nest failure Kezar Lake, NW Cove 2018-2022.

Year	TP*	NP*	DATE(S)	NATURAL/ RAFT	CH*	CF*	NF*	Cause of Nest Failure
2018	Y	Y	6/5-6	Natural	1	1	0	--
2019	Y	Y	6/2-3	Natural	2	2	0	--
2020	Y	N	--	--	--	--	--	--
2021	Y	N	--	--	--	--	--	--
2022	Y	Y	UNK	Natural	0	0	1	Unknown – eggs (2) went missing
Total	--	3**	--	--	3	3	1	--

* TP = territorial pair, NP = nesting pair, CH = chick(s) hatched, CF = chicks fledged, NF = nest failure

** Total number of nest attempts

An artificial nest raft was placed in this territory prior to 2018, and it remained for 2018 & 2019. It was never used. It was removed after the 2019 season.

The adult male and female were banded in 2018, and they both returned and occupied the territory in 2019. In 2020 the banded male lost the territory to a new, unbanded male. The banded female has been with an unbanded male since. In 2019, both chicks were banded. The original banded male from 2018 was sighted in the lower bay with a large group of loons in 2022.

6.4 PRODUCTIVITY AND NEST FAILURE, SMALL PONDS, BY LAKE AND YEAR, 2018-2022 (Table 4).

Bradley Pond:

Bradley Pond was never occupied by a pair of loons for the five-year period of 2018-2022. Single individuals were observed on a number of days, usually foraging and moving around the pond. It is believed that the individuals sighted were most likely one of the adults occupying Heald Pond, but this couldn't be confirmed (Table 4a).

Table 4a. Productivity and nest failure Bradley Pond, 2018-2022.

Year	TP*	NP*	DATE(S)	NATURAL/ RAFT	CH*	CF*	NF*	Cause of Nest Failure
2018	N	N	--	--	--	--	--	--
2019	N	N	--	--	--	--	--	--
2020	N	N	--	--	--	--	--	--
2021	N	N	--	--	--	--	--	--
2022	N	N	--	--	--	--	--	--
Total	--	--	--	--	--	--	--	--

* TP = territorial pair, NP = nesting pair, CH = chick(s) hatched, CF = chicks fledged, NF = nest failure

A nest raft was placed on this pond prior to 2018. It was never used. It was removed in 2018 and moved to Cushman Pond.

Cushman Pond:

Cushman Pond was occupied and defended by a pair of loons every year. This pair nested every year except 2019, including two nest attempts in 2018, after an initial nest attempt failed. Over the five-year period of 2018-2022 this pair hatched a total of three chicks, and two survived to fledge (Table 4b).

Table 4b. Productivity and nest failure Cushman Pond, 2018-2022.

Year	TP*	NP*	DATE(S)	NATURAL/ RAFT	CH*	CF*	NF*	Cause of Nest Failure
2018	Y	Y(2)	6/1-2 & 6/19	Natural	0	0	2	Mammalian predation & unknown
2019	Y	N	--	--	0	0	0	--
2020	Y	Y	6/8-11	Raft	0	0	1	Abandoned, 1 egg collected
2021	Y	Y	6/16	Raft	1	1	0	--
2022	Y	Y	6/4-5	Raft	2	1	0	--
Total	--	5**	--	--	3	2	3	--

* TP = territorial pair, NP = nesting pair, CH = chick(s) hatched, CF = chicks fledged, NF = nest failure

** Total number of nest attempts

Due to lack of productivity, an artificial nest raft was placed in this territory after the first nest failure in 2018. Although nesting did not occur in 2019, this pair was observed on and around the raft on numerous occasions.

The adult male and female were banded in 2021, and they both returned and occupied the lake in 2022.

Horseshoe Pond:

Horseshoe Pond was occupied and defended by a pair of loons every year, and they nested each year. They were successful hatching a chick(s) every year. Over the five-year period of 2018-2022 this pair hatched a total of eight chicks and all the chicks survived to fledge. This productivity made them the most successful breeding pair within the Kezar Lake watershed (Table 4c).

Table 4c. Productivity and nest failure Horseshoe Pond, 2018-2022.

Year	TP*	NP*	DATE(S)	NATURAL/RAFT	CH*	CF*	NF*	Cause of Nest Failure
2018	Y	Y	6/16-18	Raft	2	2	0	--
2019	Y	Y	6/14	Raft	1	1	0	--
2020	Y	Y	6/8-11	Raft	1	1	0	--
2021	Y	Y	6/5-6	Raft	2	2	0	--
2022	Y	Y	6/4-5	Raft	2	2	0	--
Total	--	5**	--	--	8	8	0	--

* TP = territorial pair, NP = nesting pair, CH = chick(s) hatched, CF = chicks fledged, NF = nest failure

** Total number of nest attempts

Due to lack of productivity, an artificial nest raft was placed in this territory prior to 2018, and it was never used. In 2018 it was relocated to an area immediately adjacent to known, historical, natural nesting activity. The pair used the raft the very first year and every year since.

The adult male and female were banded in 2018, and they both returned and occupied the lake every year. One chick was banded in 2022.

Heald Pond:

Heald Pond was occupied and defended by a pair of loons every year, and they nested each year. They were successful hatching a chick(s) every year. Over the five-year period of 2018-2022 this pair hatched a total of eight chicks and three chicks survived to fledge (Table 4d).

Table 4d. Productivity and nest failure Heald Pond, 2018-2022.

Year	TP*	NP*	DATE(S)	NATURAL/RAFT	CH*	CF*	NF*	Cause of Nest Failure
2018	Y	Y	5/26	Natural	2	0	0	--
2019	Y	Y	6/12	Natural	1	0	0	--
2020	Y	Y	5/28	Natural	2	1	0	--
2021	Y	Y	5/30	Natural	2	2	0	--
2022	Y	Y	5/29-30	Natural	1	0	0	--
Total	--	5**	--	--	8	3	0	--

* TP = territorial pair, NP = nesting pair, CH = chick(s) hatched, CF = chicks fledged, NF = nest failure

** Total number of nest attempts

Given the strong history of successful natural nesting, an artificial nest raft was not placed on this pond.

No loons were banded on this pond.

Trout Pond:

Trout Pond was occupied and defended by a pair of loons every year. They nested every year except 2020, and hatched chicks in 2019 & 2022. Over the five-year period of 2018-2022 this pair hatched a

total of four chicks and all the chicks survived to fledge. The nest failures documented in 2018 and 2021 were both caused by mammalian predation (Table 4f).

Table 4f. Productivity and nest failure Trout Pond, 2018-2022.

Year	TP*	NP*	DATE(S)	NATURAL/ RAFT	CH*	CF*	NF*	Cause of Nest Failure
2018	Y	Y	UNK	Natural	0	0	1	Mammalian predation
2019	Y	Y	6/12	Natural	2	2	0	--
2020	Y	N	--	--	--	--	0	--
2021	Y	Y	5/22-23	Natural	0	0	1	Mammalian predation
2022	Y	Y	6/4-5	Natural	2	2	0	--
Total	--	4**	--	--	4	4	2	--

* TP = territorial pair, NP = nesting pair, CH = chick(s) hatched, CF = chicks fledged, NF = nest failure

** Total number of nest attempts

Due to lack of productivity, an artificial nest raft was placed in this territory in 2019, in a location without known nesting activity. It was moved in 2020 to a new location immediately adjacent to their most recent natural nest. It has remained in this new location every year, but has never been used.

The adult male and female were banded in 2019. The banded male did not return in 2020. The banded female paired with an unbanded male that year, and has been with an unbanded male every year since.

Farrington Pond:

Farrington Pond was occupied by a pair of loons for the first three years, 2018 - 2020. They nested in 2019, but were unsuccessful. Over the five-year period of 2018-2022 this pair did not hatch any chicks. The cause of the nest failure in 2019 could not be confirmed, although mammalian predation is suspected, (Table 4g).

Table 4g. Productivity and nest failure Farrington Pond, 2018-2022.

Year	TP*	NP*	DATE(S)	NATURAL/ RAFT	CH*	CF*	NF*	Cause of Nest Failure
2018	Y	N	--	--	--	--	--	--
2019	Y	Y	6/18-26	Natural	0	0	1	Unknown, egg(1) went missing
2020	Y	N	--	--	--	--	--	--
2021	N	N	--	--	--	--	--	--
2022	N	N	--	--	--	--	--	--
Total	--	1**	--	--	0	0	1	--

* TP = territorial pair, NP = nesting pair, CH = chick(s) hatched, CF = chicks fledged, NF = nest failure

** Total number of nest attempts

Due to lack of productivity, an artificial nest raft was placed in this territory in 2020, immediately adjacent to the 2019 nest location. It was placed in the same location each year since. It was never used.

6.5 SUMMARY OF NEST FAILURE CAUSES KEZAR LAKE WATERSHED 2018-2022

During the five-year period of 2018-2022, loons in the Kezar Lake watershed attempted to nest a total of 73 times. Thirty-three of these nest attempts were successful (45%). There was a total of 40 nest failures (55%). Documented evidence confirmed that 32 (80%) of the failures were caused by mammals. This includes three instances (unknown) where eggs went missing, and mammal predation is highly suspected. There was a total of eight cases of egg abandonment (20%), mostly due to black fly disturbance (Table 5).

Table 5. Nest Failure Causes, 2018-2022.

Nest Attempts		Nest Failures		Cause	
Total Nest Attempts	73	Total Nest Attempts	73	Mammalian Predation	29
Successful Nest Attempts	33	Nest Failures	40	Abandoned	8
				Unknown	3
Success Rate	45%	Failure Rate	55%	Total Failures	40

4.6 USE OF ARTIFICIAL NESTING ISLANDS (RAFTS) 2018-2022.

During the five-year period of 2018-2022, loons nesting on artificial rafts were successful 77% of the time, compared to loons nesting naturally, who were successful 39% of the time. Twenty-two nest attempts on rafts produced the same number of chicks (28) as 49 natural nest attempts. A total of 20 chicks fledged from pairs nesting on rafts, and a total of 17 chicks fledged from pairs nesting naturally (Table 6).

Table 6. Comparative loon nesting summary: raft vs. natural nests, 2018-2022.

Raft Nests	2018-2022	Natural Nests	2018-2022
Number of Nest Attempts	22	Number of Nest Attempts	49
Number of Successful Nest Attempts	17	Number of Successful Nest Attempts	19
Success Rate	77%	Success Rate	39%
Chicks Hatched from Rafts	28	Chicks Hatched from Natural Sites	28
Total Chicks Fledged	20	Total Chicks Fledged	17
Contribution to Productivity*	54%	Contribution to Productivity*	46%

* Percentage of total chicks fledged

6.6 CAPTURE AND BANDING BY YEAR, 2018-2022.

In 2017, prior to the beginning of the project, two loons were banded on Kezar Lake; one male and one chick. During the five-year period of 2018-2022, a total of 27 loons were banded within the Kezar Lake watershed; eight males, nine females and 10 chicks (Table 7).

Table 7. Common loons captured and banded, Kezar Lake watershed by year, 2018-2022.

Kezar Lake Watershed | Common Loon Monitoring Summary Report

Lake Name	Territory	Band #	Year	Sex	Age*	Left Leg Top	Left Leg Bottom	Right Leg Top	Right Leg Bottom
Kezar	Great Brook	0938-03351	2017	M	ATY	Yellow	R Stripe	Silver	O Dot
Kezar	Alaska Bay	0938-61715	2017	UNK	HY	W Stripe	Silver	R Dot	Orange
Kezar	NW Cove	0938-78850	2018	F	ATY	Y Stripe	Green	G Dot	Silver
Kezar	NW Cove	0649-08855	2018	M	ATY	R Stripe	White	G Dot	Silver
Kezar	Fox Cove	0649-08853	2018	F	ATY	Green	Red	Silver	G Dot
Kezar	Fox Cove	0938-78831	2018	M**	ATY	Y Stripe	White	G Dot	Silver
Kezar	Rock Island	1118-15849	2018	F	ATY	Y Dot	Red	G Dot	Silver
Kezar	Rock Island	1118-15844	2018	M	ATY	R Stripe	White	Red	Silver
Horseshoe	Horseshoe	1118-15842	2018	M	ATY	O Stripe	Green	Red	Silver
Horseshoe	Horseshoe	0938-78836	2018	F	ATY	Y Stripe	Green	Silver	Red
Kezar	NW Cove	1118-16202	2019	UNK	HY	Silver	Green	Red	Green
Kezar	NW Cove	0689-09415	2019	UNK	HY	Green	Silver	R Dot	Yellow
Kezar	Alaska Bay	0689-09401	2019	UNK	HY	Silver	Green	Yellow	Blue
Kezar	Alaska Bay	0938-78831	2019	M	ATY	Y Stripe	White	G Dot	Silver
Kezar	Alaska Bay	1118-15849	2019	F**	ATY	Y Dot	Red	G Dot	Silver
Kezar	Rock Isl.	0689-09452	2019	UNK	HY	Y Stripe	Silver	Blue	Yellow
Trout	Trout	1118-15842	2019	M	ATY	O Stripe	Green	Red	Silver
Trout	Trout	0938-78836	2019	F	ATY	Y Stripe	Green	Silver	Red
Kezar	G. Brook	0689-09499	2020	F	HY	Silver	Orange	Yellow	Green
Kezar	Rock Isl.	0649-09454	2020	F	HY	Orange	Silver	Green	Orange
Kezar	G. Brook	0689-15625	2021	F	ATY	Orange	G Stripe	Yellow	Silver
Kezar	G Brook	0689-15646	2021	UNK	HY	Yellow	Silver	Orange	Blue
Kezar	Fox Cove	0689-15636	2021	UNK	HY	Silver	R Dot	Yellow	O Dot
Kezar	Fox Cove	0689-15627	2021	UNK	HY	Silver	R Dot	Orange	Green
Cushman	Cushman	0689-15628	2021	F	ATY	Orange	B Stripe	Yellow	Silver
Cushman	Cushman	0689-15637	2021	M	ATY	O Stripe	Green	Silver	R Dot
Kezar	MB Narrows	0689-15904	2022	M	ATY	O Dot	White	B Stripe	Silver
Kezar	MB Narrows	0689-15903	2022	F	ATY	B Stripe	Orange	R Dot	Silver
Horseshoe	Horseshoe	1238-25628	2022	U	HY	Y Dot	Silver	Y Stripe	Red

* HY = hatch year, ATY = adult

** The Fox Cove banded male has lost the White band on his left leg, and the Alaska Bay banded female has lost the Green Dot band on her right leg.

6.7 BANDED LOON RE-OBSERVATIONS AND RECOVERIES, 2022.

In year five of the project, 2022, 15 of 16 adult loons previously banded returned. Fourteen of the 16 banded loons occupied the same territory or lake. The Kezar Lake, NW Cove male, originally banded in 2018 was observed in the lower bay, unpaired. The Trout Pond male, originally banded in 2019 did not return. Two ABJs (adults banded as juveniles), originally banded on Kezar Lake in 2019 returned (see yellow highlights). In the five-year history of the project this is the first confirmation of offspring returning to their natal lake (Table 8).

Table 8. Banded loon re-observations and recoveries, Kezar Lake watershed, 2022.

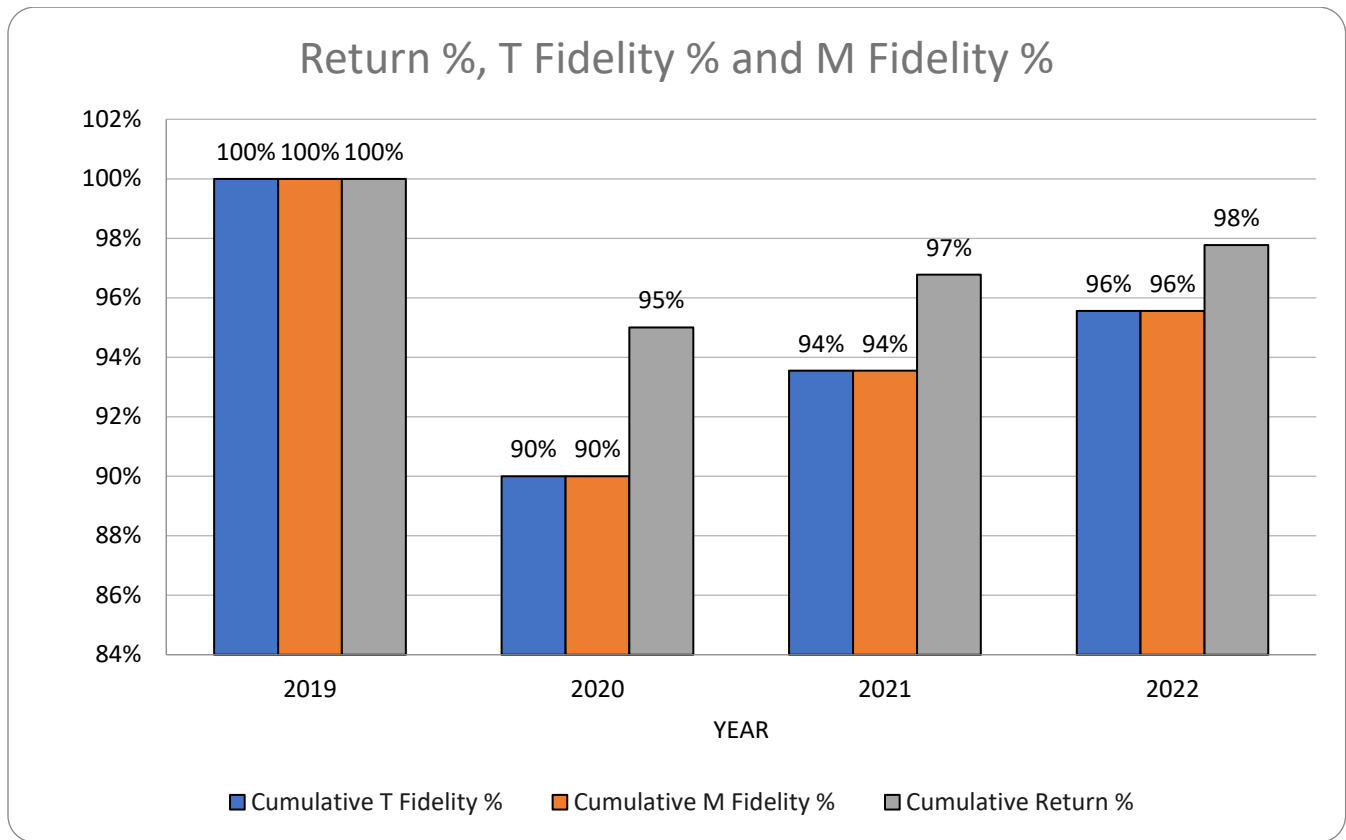
Lake Name	Band #	Year	Sex	Age*	2022 Return	Original Territory	2022 Territory
Kezar	0938-03351	2017	M	ATY	Y	Great Brook	Great Brook
Kezar	0938-61715	2017	U	HY	N	Alaska Bay	NA
Kezar	0649-08855	2018	M	ATY	Y	NW Cove	Not paired - Lower Bay
Kezar	0938-78850	2018	F	ATY	Y	NW Cove	NW Cove
Kezar	1118-15844	2018	M	ATY	Y	Rock Island	Rock Island
Kezar	1118-15849	2018	F	ATY	Y	Rock Island	Rock Island
Kezar	0938-78831	2018	M	ATY	Y	Fox Cove	Fox Cove
Kezar	1118-15849	2018	F	ATY	Y	Fox Cove	Fox Cove
Horseshoe	1118-15842	2018	M	ATY	Y	Horseshoe	Horseshoe
Horseshoe	0938-78836	2018	F	ATY	Y	Horseshoe	Horseshoe
Kezar	0938-78831	2019	M	ATY	Y	Alaska Bay	Alaska Bay
Kezar	1118-15849	2019	F	ATY	Y	Alaska Bay	Alaska Bay
Kezar	0689-09401	2019	U	HY	N	Alaska Bay	NA
Kezar	0689-09415	2019	U	HY	N	NW Cove	NA
Kezar	1118-16202	2019	U	HY	Y	NW Cove	Not paired – lower bay
Kezar	0689-09452	2019	U	HY	Y	Rock Island	Not paired – upper lake
Trout	1118-15842	2019	M	ATY	N	Trout	NA
Trout	0938-78836	2019	F	ATY	Y	Trout	Trout
Kezar	0689-09499	2020	F	HY	N	Great Brook	NA
Kezar	0689-09454	2020	F	HY	N	Rock Island	NA
Kezar	0689-15625	2021	F	ATY	Y	Great Brook	Great Brook
Kezar	0689-15646	2021	U	HY	N	Great Brook	NA
Kezar	0689-15636	2021	U	HY	N	Fox Cove	NA
Kezar	0689-15627	2021	U	HY	N	Fox Cove	NA
Cushman	0689-15628	2021	F	ATY	Y	Cushman	Cushman
Cushman	0689-15637	2021	F	ATY	Y	Cushman	Cushman
Kezar	0689-15904	2022	M	ATY	NA	MB Narrows	MB Narrows
Kezar	0689-15903	2022	F	ATY	NA	MB Narrows	MB Narrows
Horseshoe	1238-25628	2022	U	HY	NA	Horseshoe	Horseshoe

* HY = hatch year, ATY = adult

6.8 ADULT BANDED LOON SURVIVAL, AND TERRITORY AND MATE FIDELITY, 2018-2022.

Analysis of cumulative band returns and tracking data confirmed extremely high territory and mate fidelity of banded individuals between 2019-2022, when return data was available. During this four-year period only one banded adult did not return (Trout Pond male), and only one banded adult pairing changed (Kezar Lake, NW Cove). In 2022, return rates were 98%, and territory and mate fidelity were both 96% (Figure 3).

Figure 3.



6.9 CONTAMINANT ANALYSIS 2017 – 2022, (Tables 9 - 11).

Sampling of loons for mercury and lead contamination actually began in 2017, the year before the current project began. Data shown in this section includes the results of individuals sampled in 2017.

All blood and feather samples collected were processed and analyzed at Biodiversity Research Institute’s (BRI) laboratory in Portland, Maine. BRI ceased lead testing of blood samples after 2018, as historical records region wide and initial results from the Kezar Lake watershed were below detectable limits. Therefore, only mercury results are included in this report.

To assess the potential impacts of mercury (Hg) on loons, known baseline effects levels can be separated into risk categories based on studies from BRI and their collaborators.

Low risk indicates background Hg concentrations that have no known impact on wildlife. Loons that fall within the moderate risk category have elevated Hg concentrations but their impact levels on individuals remain undetermined. Loons that are in the high-risk category are exposed to toxic levels of environmental Hg that statistically show physiological, behavioral, and reproductive impacts. The extremely high Hg category is based on in-field observable impacts on loons and other birds (Evers et al. 2008). The high and extremely high categories therefore have Hg at levels of concern (Table 9).

Table 9. Risk categories for assessing Hg and Pb impacts, reported as parts per million (ppm) in wet weight (ww) for blood and egg, and fresh weight (fw) for feathers, for the common loon.

Contaminant and Matrix	Low	Moderate	High	X High	Endpoint	Reference
Mercury (Hg)						
Adult (blood)	0-1.0	1.0 to 3.0	3.0-4.0	>4.0	40% fewer fledged young	Burgess and Meyer 2008; Evers et al. 2008
Adult (feather)	0- 9.0	9.0-20.0	20.0-35.0	>35.0	Significant asymmetry	Evers et al. 2008
Juvenile (blood)	0-0.1	0.1-0.3	0.3-0.4	>0.4	Lower survival	Evers et al. 2010; unpubl. data
Egg	0-0.5	0.5-1.3	1.3-2.0	>2.0	Significantly smaller egg and reduced hatchability	Evers et al. 2003
Lead (Pb)						
Blood	0-0.12	0.12-0.24	> 0.24		Probable death	Franson et al. 2003; BRI unpubl. data

6.9.1 BLOOD

Blood Hg results are reported in parts per million (ppm) wet weight (ww). Banding and sampling efforts began in 2017. With the exception of loons sampled in the Kezar Lake, Great Brook and Alaska Bay territories, loons sampled in the Kezar Lake watershed between 2017-2022 had low or moderate levels of mercury in their blood. The Great Brook male was sampled three times, and his blood mercury levels were borderline high to extra high (2.962-4.071). The Great Brook female's blood mercury levels were borderline high (2.993). The mercury level in the blood of the Kezar Lake, Alaska Bay male was also high (3.947), (Table 10).

Table 10. Results of individual loons with high Hg in blood (ppm, ww), **2017-2022.**

Date Collected	Lake	Territory	Sex	Age*	Blood Hg (ppm, ww)
7/19/2017	Kezar	Great Brook	M	ATY	2.962
8/19/2020	Kezar	Great Brook	M	ATY	4.071 X high
7/19/2022	Kezar	Great Brook	M	ATY	3.916 high
8/8/2021	Kezar	Great Brook	F	ATY	2.993
8/1/2019	Kezar	Alaska Bay	M	ATY	3.947 high

*ATY = adult

6.9.2 FEATHER

Feather Hg results are reported in parts per million (ppm), fresh weight (fw). The mercury level in the feathers of these three adult loons varied from 16.930 – 19.771. These elevated, moderate to borderline high levels were the highest feather mercury levels found in the watershed. These results reflect the high blood mercury found in these individuals (Table 11).

Table 11. Results of Hg in feathers (ppm, fw), **2017-2022.**

Date Collected	Lake	Territory	Sex	Age*	Feather Hg (ppm, fw)
7/19/2017	Kezar	Great Brook	M	ATY	19.110
8/19/2020	Kezar	Great Brook	M	ATY	18.716
7/19/2022	Kezar	Great Brook	M	ATY	19.771
8/8/2021	Kezar	Great Brook	F	ATY	17.753
8/1/2019	Kezar	Alaska Bay	M	ATY	16.930

* ATY = adult

7.0 DISCUSSION

The findings presented in this report indicate that during the five-year period of 2018-2022 the common loon population in the Kezar Lake watershed was borderline stable and relatively healthy, with expected year-to-year fluctuations in reproductive success, which is common for the species. Much of the reproductive success during this period is attributed to project conservation measures, which were introduced in response to anecdotal evidence of poor reproductive success prior to 2018.

Productivity is calculated by dividing the number of chicks surviving by the number of territorial pairs (CS/TP) observed in a population or study area. Analysis of long-term data across different populations (Evers 2007; Mitro et al. 2008) showed a stable loon population requires pairs to fledge approximately one chick every other year (0.48 CS/TP). The five-year average productivity in the Kezar Lake watershed of 0.47 CS/TP compares favorably. This reproductive success rate was aided greatly by the excellent reproductive success in 2021 (0.60 CS/TP), and 2022 (0.67 CS/TP).

It is important to recognize that five years is a relatively short period of time to study a small population (n = 35-45). Given the documented annual fluctuations in reproductive success, average reproductive success over a relatively brief period of time remains subject to significant fluctuation.

Analysis of the data uncovers several factors which appear to be key contributors to the success of the population over the previous five years, 2018-2022:

- **Strong survivorship and fidelity** – the banded population had survivorship of 98%, and mate and territory fidelity of 96%. High survivorship allows for strong fidelity. When both are realized, odds for good reproductive success increase. These extremely high rates indicate a stable population, capable of maintaining strong reproductive success.
- **Favorable weather** - nesting conditions were favorable during most of the five-year period, with very few documented threats to active nests from rising water levels during the nesting period. This is highly unusual, and unlikely to continue with a warming climate and predictions for more frequent and more powerful storm events.
- **Successful raft nesting** – the success rate for loon pairs who nested on rafts was nearly double the success rate of loons nesting naturally; 77% vs. 39%. Twenty-two raft nest attempts produced 28 chicks, the same number as 49 natural nest attempts.
- **No observed impacts from mercury** – despite documented levels of high mercury (Hg) in several adult loons in the watershed, which was persistent throughout the five-year period, there were no documented adverse effects on reproductive success. The Kezar Lake, Great Brook male, who actually had the highest recorded levels (4.071 blood Hg, 2020) was the most successful breeder on Kezar Lake between 2018-2022.

Further, weekly monitoring surveys confirmed very consistent lake and territory occupancy by breeding pairs, with insignificant fluctuation. On Kezar Lake, the highest value habitat was fully occupied by breeding pairs during all five years. Some marginal habitat remains for potential occupancy and expansion of the number of breeding territories, but it is estimated that this habitat would be marginally productive if occupied in the future. Four of six small ponds in the watershed are consistently occupied by breeding pairs. The occupancy of Farrington Pond is inconsistent and non-committal. Bradley Pond remains unoccupied. Both of these ponds are capable of supporting breeding pairs, with abundant natural shoreline nesting habitat.

Loon pairs breeding on the small ponds had double the overall productivity of loons breeding on Kezar lake; 0.74 CS/TP small ponds vs. 0.36 CS/TP on Kezar Lake. Breeding loons on the small ponds outperformed their counterparts on Kezar Lake in all the statistical categories; nesting frequency, nesting success, chicks hatched and chicks surviving. Further analysis points to several primary reasons for this disparity; many more nest failures on Kezar Lake, leading to far fewer chicks being hatched per territorial pair, and small ponds reproductive success being heavily influenced by the exceptional breeding success by the Horseshoe Pond pair, who hatched and fledged eight chicks during the five-year study period.

Given the relatively small population, and their vulnerability to known threats and stressors, it is unknown if this level of reproductive success is sustainable. A weakness of the current population is illuminated when you look at the lack of diversity within the successful breeding pairs. Three pairs; Kezar Lake, Great Brook and Three Rock Island, and Horseshoe Pond (15% of all pairs) hatched a total of 26 chicks (46%), and fledged 17 (47%). Future reproductive success is heavily weighted to the success of these three breeding pairs. Should the productivity of one or more of these pairs drop off, the overall reproductive success of the population is at risk.

Additionally, significant threats and stressors to the population going forward, which could negatively impact the health and reproductive success of the population include:

- **Wintering mortality event(s)** – common loons from Maine winter off the coast. There have been recorded cases of large mortality events tied to oil spills, and other marine environmental hazards. Such events in the future pose a threat to the long-term survival and overall health of the population.
- **Human disturbance and recreation** – human disturbance was documented in a number of cases, and recreational use of the lakes by humans is on the rise, which can lead to an increase in disturbance issues in the future. Recreational boating, and particularly the recent presence of wake boats is concerning. Loon nests and adults with young chicks are vulnerable to the large wakes these boats create.
- **Climate change** – current documentation of a warming climate and the impacts include stronger and more frequent storm events, which can threaten loon nests. Further, degradation of lake water quality is a likely impact of climate change, which could negatively impact loons.
- **Contamination** – lead poisoning from fishing tackle remains a significant threat to loons, as documented in 2022 with the death of the Kezar Lake, Great Brook male, who was the most successful breeder on the lake. High mercury levels have been persistent, and although no adverse effects have been documented, studies have shown negative impacts to breeding loons are possible.
- **Bald eagle encounters** – there is one known bald eagle nest in the lower bay of Kezar Lake. Eagle activity has been observed throughout the entire lake, and on the small ponds in the watershed, which are being monitored. Many eagle/loon encounters have been documented, with at least two resulting in the death of a loon. As the eagle population continues to increase, it is reasonable to assume more encounters and more loon deaths are likely.

- **Population density** – the common loon population in New England has been recovering from historically low numbers for many decades. Researchers do not know what the carrying capacity is for a given lake(s), or how a populations' dynamics could shift as a result of overpopulation. Territorial disputes and aggression amongst loons are always present. Monitoring these behaviors and impacts will help project leaders better understand these population dynamics over time.

There were 40 nest failures documented during the five-year period of 2018-2022. Mammalian predation accounted for 29 of the nest failures (80%), and most of these occurred along the western shore of the middle and upper bays of Kezar Lake. Nest monitoring cameras helped determine that a raccoon(s) was the primary predator, swimming both to islands and artificial nest rafts from the mainland to depredate nests. Abandonment from suspected black fly disturbance was the second leading cause of nest failure (8 total). This occurred when loon pairs nested in May during the height of the black fly activity. Most nesting pairs delayed nesting until early June when the black fly population was in decline, and were minimally disturbed by black flies.

Ten artificial nest platforms (rafts) were initially introduced in the watershed in 2014, with the hope of increasing nest productivity. Between 2014 – 2017 none of the rafts were used. In 2018, after professional analysis and repositioning of several rafts, three of the ten rafts were used, and all three pairs were successful. Continued strategic use of nest rafts throughout the project proved to be a leading factor in nest success rates as described above. Over the five-year period of 2018-2022, additional nest rafts were deployed, bringing the total number of rafts in 2022 to 15. Five were used for nesting in 2022 (33%). Despite this low usage rate, four of the five pairs hatched chicks in 2022. This clearly demonstrates the value of utilizing rafts in the watershed to significantly aid breeding success.

Banding and sampling loons were key components of the project, enabling researchers to examine the stability of the population during the five-year period of 2018-2022. A total of 29 individuals were banded (18 adults and 11 chicks), which includes two individuals who were banded in 2017. In all but one case (Kezar Lake, Great Brook territory), adult loon banding efforts were successful in color-marking both the male and female at the same time. This capture/banding success rate provided ideal tracking circumstances to determine individual survival, and both mate and territory fidelity. Banding of chicks allowed for future identification, if/when any of these individuals return to the watershed and perhaps even their natal lake, and if any who return eventually become successful breeders. This occurred in 2022, when researchers conducting surveys on Kezar Lake confirmed the return of two three-year old adults who were banded as juveniles (ABJs) in 2019. This confirms two banded individuals returning to their natal lake. They did not occupy a territory, but they did interact with other adults, and were observed in the same general region of the lake on multiple occasions. Tracking these two individuals in the future will allow researchers to determine if they survive and eventually breed on their natal lake.

Inexpensive trail cameras have proven to be a valuable tool to document the events and behaviors during the incubation period of nesting loons. Depending on individual circumstances, they are usually installed after incubation has begun, and they are tolerated without any negative impacts or recorded cases of abandonment. These cameras helped researchers determine causes and timing of nest failures, they documented other threats to nests, and they recorded general nest behaviors of nesting loons. They remain the only tool available to reliably and accurately attain this information, which could lead to future conservation actions designed to reduce the number of nest failures.

Volunteers play a vital role in the success of the project. Since the outset of the project in 2018, there has been a core group of three volunteers, and several other volunteers who have reliably filled in key coverage gaps for surveys. A designated volunteer leader each year who serves on the KLWA Board of Directors serves as both coordinator and project liaison to the science leader. It's very encouraging for the long-term sustainability of the project that volunteer numbers have increased steadily. In 2022 there were a total of 12 volunteers who were actively involved in monitoring loons

in the watershed. The time and physical nature of the effort required to launch, maintain and remove the artificial nest rafts each season is a difficult task, made even more challenging by a very limited number of volunteers being available. Many volunteers are seasonal residents and are unavailable. There is risk of this task becoming unmanageable at some point in the future if additional local manpower is not recruited and maintained.

Over its five-year history, this project demonstrated the effectiveness of collaboration between trained professional researchers and volunteer citizen scientists. With training and guidance of dedicated volunteers, following successful models in other regions, this unique partnership allows for the development of sustainable conservation efforts, which in turn provides valuable information to local communities and scientists concerned about the health of loon populations.

8.0 RECOMMENDATIONS

Common loons have responded well to dedicated human conservation measures designed to either stabilize a population, or help a population rebound. However, these actions were implemented after years of research needed to accurately verify the status of the population and identify past and present stressors, which may have led to population declines.

LCA recommends the following actions for the future:

- Continue to use standardized survey methods to collect data on the number of territorial pairs, nesting pairs, location of nests, chicks hatched, and those surviving >six weeks of age.
- Focus on band return identification to verify color-marked individuals have returned, the status of territory fidelity, and individual productivity.
- Expand the use of nest monitoring cameras, as circumstances allow, and upgrade equipment to newer cellular technology, which allows accessing photo files remotely without disturbance to active nests.
- Further develop the engagement and skills of citizen science volunteers and seek to expand the volunteer base, especially related to more help for artificial nest rafts.
- Continue to capture and band loons through traditional night capture of pairs with chicks.
- Maintain ongoing monitoring of contaminants (Hg), and expand research into Hg levels in fish and potentially other food sources in the Upper Bay of Kezar Lake. Additionally, look into possible impacts of PFAS chemicals.
- Increase outreach and education efforts to communicate and reduce threats from fishing line entanglement, boat wakes, etc. Steps could include signage at boat launches and installation of containers for disposing of fishing line.
- Continue to engage and inform the local community about loons in the watershed through all available media.
- Continue strategic use and monitoring of artificial nesting platforms (rafts). Focus on locations where territorial pairs have been confirmed for multiple years, where a raft has a likelihood of enticing successful nesting. Review nesting platform locations annually, and make strategic relocations as circumstances dictate.
- Develop volunteer capacity to monitor chick survival until migration to better calculate true productivity.

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