The Squam Lake Loon Initiative

2025 End-of-Season Report

Photo credit: Kittie Wilson

Tiffany Grade, Squam Lakes Biologist
Loon Preservation Committee

November 2025

The Squam Lake Loon Initiative

2025 End-of-Season Report

Executive Summary

Between 2005-2007, Squam Lake experienced an unprecedented decline of close to half of its adult loon population, followed by the near-complete reproductive failure of its remaining loons. The Loon Preservation Committee (LPC) launched its Squam Lake Loon Initiative to understand and address the causes of the declines in Squam's loon population in order to restore a healthy population of loons to the lake.

Squam's loons are facing multiple co-occurring stressors that are common to loons throughout the state, including climate change, increased recreational activities, increased predator populations, and other threats. Contaminant burdens that were higher on Squam than on other lakes and elevated rates of lead tackle mortality have, in concert with these other stressors, resulted in disruptions to loon social structure, survival, and breeding success on Squam.

In 2025 on Squam Lake, there were 15 territorial pairs, 15 nests among 11 nesting pairs, 7 chicks hatched, and 5 chicks fledged. Long-term average productivity on Squam remains well below historic levels, although there has been a welcome uptick in productivity parameters in recent years (pgs. 3-4). Three adult loon mortalities and 2 chick mortalities have been collected to date on Squam Lake in 2025 (pg. 12).

The identification of elevated contaminant levels in unhatched Squam loon eggs collected from failed nests has driven LPC's work to monitor contaminants in loon eggs and to identify sources of contaminants in the Squam watershed. LPC collected one inviable loon egg from the 2024 breeding season, which was sent in for contaminant testing. Overall contaminant levels are gradually declining since the spike in contaminant levels between 2005-2007 (pgs. 5-8). LPC is preparing a paper on egg contaminant results for submission to a peer-reviewed journal.

Mean PFAS levels on Squam Lake remain higher than mean levels on lakes statewide but well below those on lakes with particularly elevated levels, such as Lake Winnipesaukee. While average levels of PFOS (the most well-studied type of PFAS in wildlife) on Squam Lake are slightly below levels demonstrated to cause negative health and reproductive effects in other bird species, 46% of eggs are above this level (pg. 11).

Sediment sampling conducted by LPC as part of our efforts to identify sources of contaminants pinpointed three sites of contaminated sediments. Levels of contaminants at these locations were above levels identified as being possibly or likely harmful to aquatic life. LPC and the Squam Lakes Association are working together to obtain proposals from environmental consulting companies to investigate the extent of contamination around Squam Lake (pg. 10). The fish consumption advisory, issued by New Hampshire Department of Environmental Services after follow-up testing in response to LPC's findings in loon eggs, crayfish and sediments, remains in effect (pgs. 10-11).

LPC's work to understand and reverse the decline of loons on Squam has ensured that issues affecting the health of loons and other wildlife are addressed to safeguard Squam and all its inhabitants. LPC

will continue to work to recover Squam Lake's loon population through intensive research, monitoring, management, and outreach as part of its Squam Lake Loon Initiative. This work will continue to inform LPC's conservation efforts for loons on Squam and throughout the state.

Background

Between the fall of 2004 and the spring of 2005, Squam Lake lost seven of its loon pairs. The decline from 16 to 9 pairs represented 44% of Squam's loon population, a single-year drop unprecedented on Squam or any other large lake in LPC's 50-year history of monitoring loons throughout New Hampshire. It also brought Squam's loon population to its lowest level since LPC began to survey Squam Lake in 1975**.** This decline was followed by the near-complete reproductive failure of the remaining loon population. In 2007, only three chicks were hatched on Squam and only one survived to late August and was presumed to have fledged. Loons on Squam had not experienced a reproductive failure of this magnitude since 1978, the year LPC petitioned successfully to have loons added to the Threatened Species list in New Hampshire.

The Squam Lake Loon Initiative is LPC's response to the decline of Squam's loon population. The Initiative began in 2007 and includes an intensive monitoring, research, management, and outreach effort to:

1. Determine the overall survival and reproductive success of Squam's loon population

2. Rescue sick or injured loons to increase survival

3. Assess causes of nest failures and collect inviable eggs from failed nests for analysis of a wide range of contaminants

4. Find and collect loon carcasses and test dead loons for contaminants and pathogens (disease-causing organisms) to determine causes of death

5. Band loons to allow us to identify and track individual birds and collect blood and feather samples for analysis of contaminants, pathogens, and indicators of health

6. Determine survival and breeding success of previously banded and sampled loons, and relate survival and breeding success of individuals to their contaminant levels

7. Determine possible sources of contaminants and options for mitigation of these sources

8. Restore and maintain a healthy and stable population of loons on Squam Lake as a component of a healthy statewide population of loons.

Squam's Loon Population and LPC's Management Activities in 2025

Squam Lake's loon population in 2025 included 15 pairs of loons, one more pair than in 2024. In 2025, 11 loon pairs nested and, including re-nests after failed nesting attempts, there were 15 nesting attempts—the highest number since 1996. A total of 7 chicks hatched and 5 chicks fledged. By comparison, seven chicks hatched in 2024, and four of those chicks fledged (Figure 1). Fifteen inviable eggs from failed nests were collected in 2025, the highest number collected on Squam in a single year to date. Reasons for egg collection included: eggs did not hatch (7); eggs washed out of the nest, likely due to boat wakes (4); eggs abandoned for unknown reason (2); eggs in the water for unknown reason (1); egg kicked into the water, likely during predation event (1); and two other eggs were unable to be collected after being destroyed by mammalian predators.

Two chicks died this summer. One died after being excluded from the family due to sibling rivalry. The other was a newly-hatched chick that was separated from its parents during the 4th of July weekend, most likely by boat wakes given the boating activity on the lake that day and the distance the chick was swept away. Despite being reunified with its family, the chick subsequently died. Between the loss of this chick and the 4 eggs that were likely washed into the lake by boat wakes, the impact of boat wakes on the breeding success of Squam's loons this year is notable. Three deceased adult loons were also collected this summer (see pgs. 12-13 for details).

LPC carries out management activities to help increase the chances for successful loon nesting and chick survival. Loons nest along the shoreline, and loon nests can be negatively impacted by habitat loss through shoreline development, changing water levels, and shoreline predators. LPC floats artificial loon nesting platforms to help loons cope with these challenges. In 2025, LPC floated 9 nesting rafts on Squam Lake and loons used 7 of those rafts. Six of the 7 chicks hatched on Squam in 2025 came from LPC's rafts. LPC protected all 15 nests by placing signs and/or ropelines around the nesting areas. Chicks were protected by LPC's orange "Caution: Loon Chick" signs to alert boaters to the presence of loon chicks in an area of the lake.

The reproductive success of Squam's loon pairs in the decade before the 2005-2007 decline was far greater than after the decline, but productivity rates have improved in recent years (Figure 2). From 1995-2004, an average of 10.1 chicks hatched each year on Squam and an average of 6.6 chicks fledged. Between 2018-2025, an average of 6.9 chicks hatched each year and 4.1 fledged, an improvement over the previous ten years (Figure 2). Despite the improved hatch rate, the rate of 0.31 chicks surviving per territorial pair between 2018-2025 remains well below the long-term statewide average (0.50) and the rate (0.48) needed to maintain a viable loon population. The improvements in productivity parameters in recent years are a hopeful indication that LPC's efforts to protect nesting loons are having a positive effect on Squam's loon population.

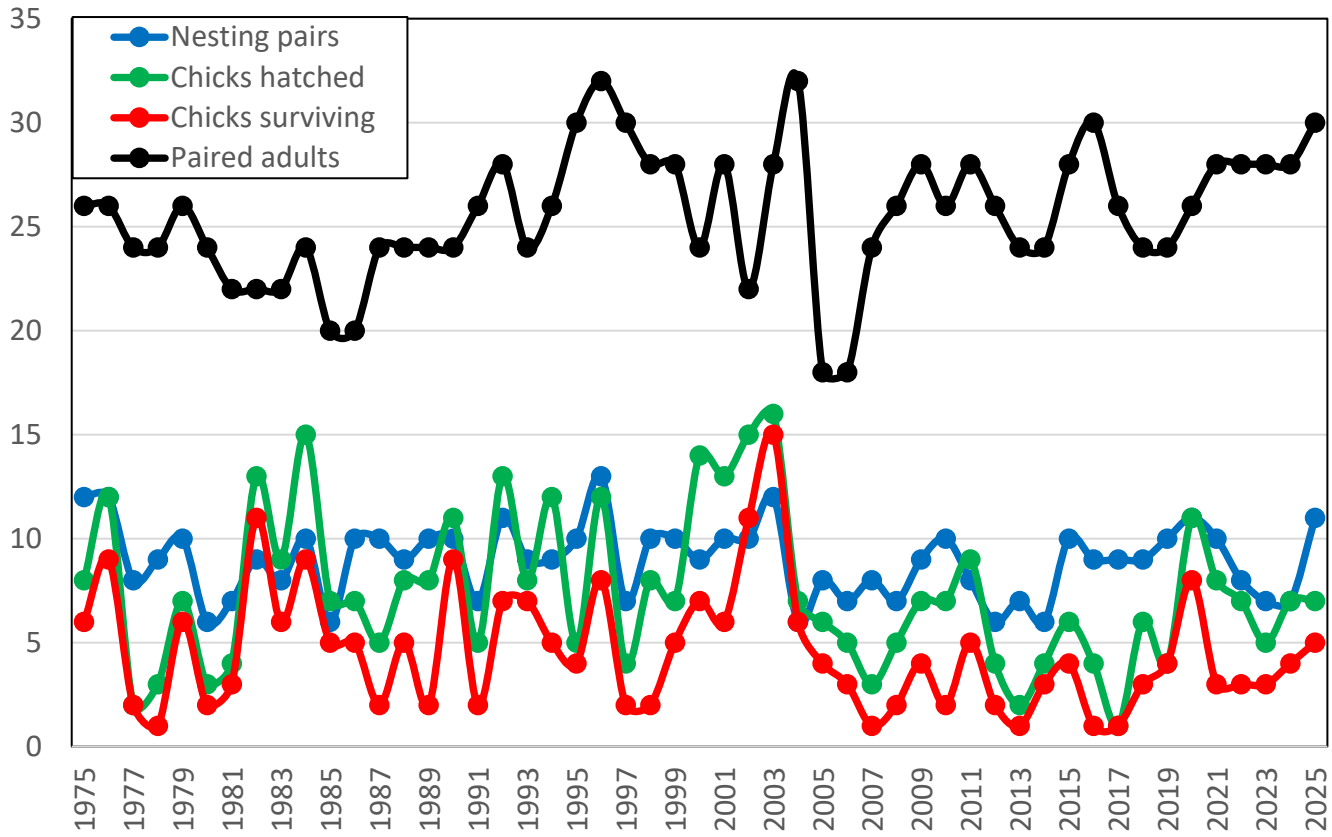


Figure 1: Squam's loon population and breeding success, 1975-2025.

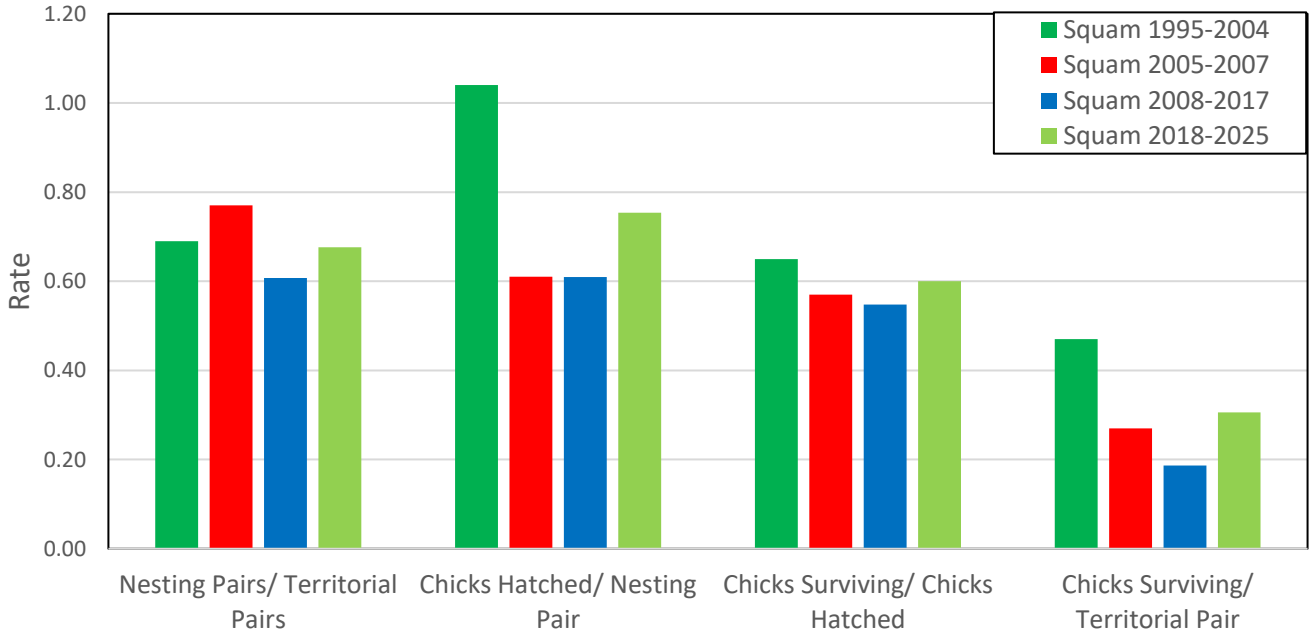


Figure 2: Productivity rates on Squam Lake before, during, and after the 2005-2007 period of decline. Time periods are divided into the ten years immediately before and after the 2005-2007 decline, as well as more recent years, which are showing improvement in productivity parameters.

Contaminants in Squam Lake Loon Eggs

Loons on Squam are facing multiple stressors, such as increased boating and recreational activities, increasing temperatures and storm events, increased populations of shoreline predators (raccoons, mink, etc.), and fluctuating water levels. All of these factors are common to loons on lakes throughout New Hampshire, yet declines on Squam have been more severe and protracted than those on other lakes. The factors that seem to set Squam Lake apart from other New Hampshire lakes are elevated levels of chemical contaminants and high rates of mortality from lead fishing tackle.

Inviable eggs collected from failed Squam nests between 2005 and 2007 revealed elevated levels of a number of contaminants, including BDEs (flame retardants); PFAS (stain guards, fire-fighting foam); PCBs (industrial insulating/cooling agents); DDT, its breakdown product DDE, and chlordane (pesticides); and dioxins and furans (PCDD/F's, byproducts of industrial processes). Levels of contaminants from Squam during 2005-2007 were **up to six times higher** than levels found in eggs collected from lakes throughout New Hampshire, Maine, and New York, as well as higher than the periods before and after these critical years on Squam. Although it is not known how these contaminants impact loons, some of the contaminants were present at levels that have been shown to affect the health and reproductive success of other bird species (Figure 4).

All of the contaminant classes tested by LPC in Squam's loon eggs may interact with each other within an organism and some may interact synergistically, i.e., the combinations of two or more contaminants may exceed the impacts of either contaminant in isolation. However, the combined effects of these contaminants in wildlife are not well understood.

LPC submitted the single inviable loon egg collected on Squam from the 2024 nesting season for contaminant testing. Contaminant results from this egg were consistent with recent years, which indicate stable or slightly decreasing trends across contaminant classes (Figures 5-7).

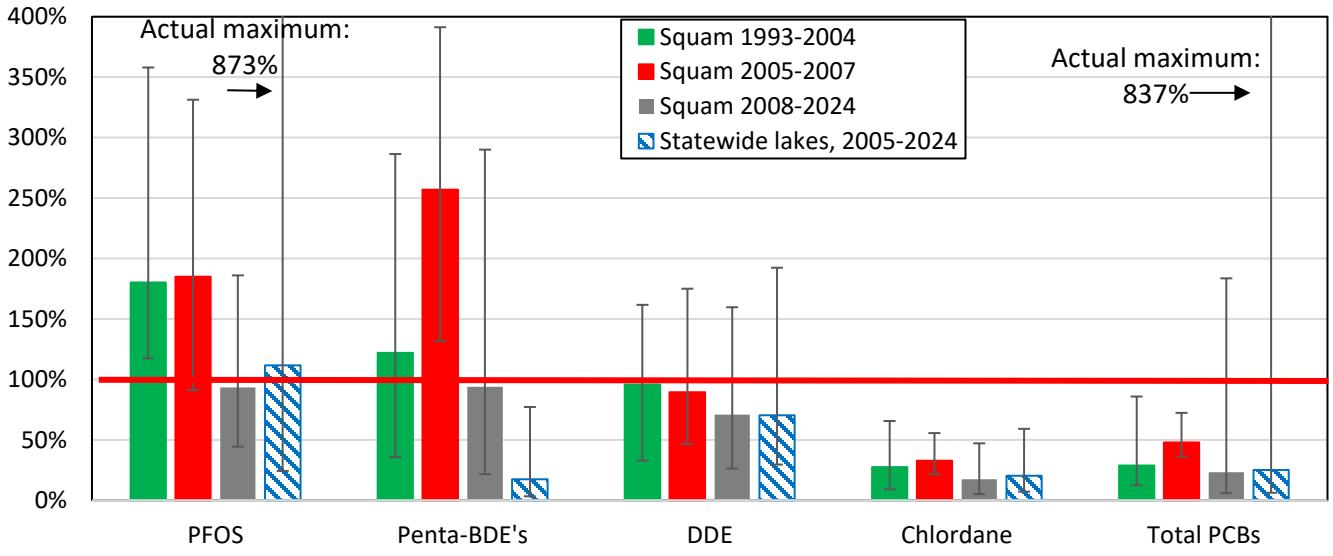
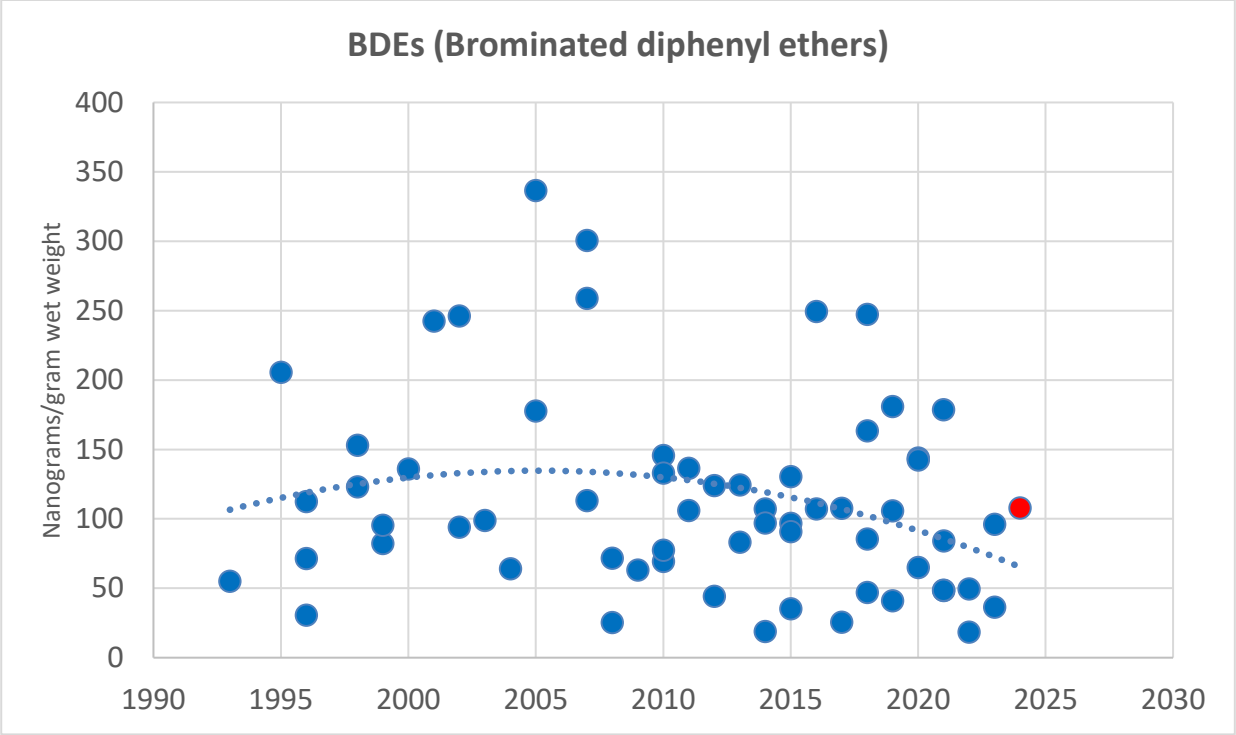


Figure 4: Contaminant levels in Squam eggs as a percentage of lowest levels causing health or reproductive effects in other bird species, as indicated by the red line. The error bars indicate the range of contaminant levels in tested eggs.



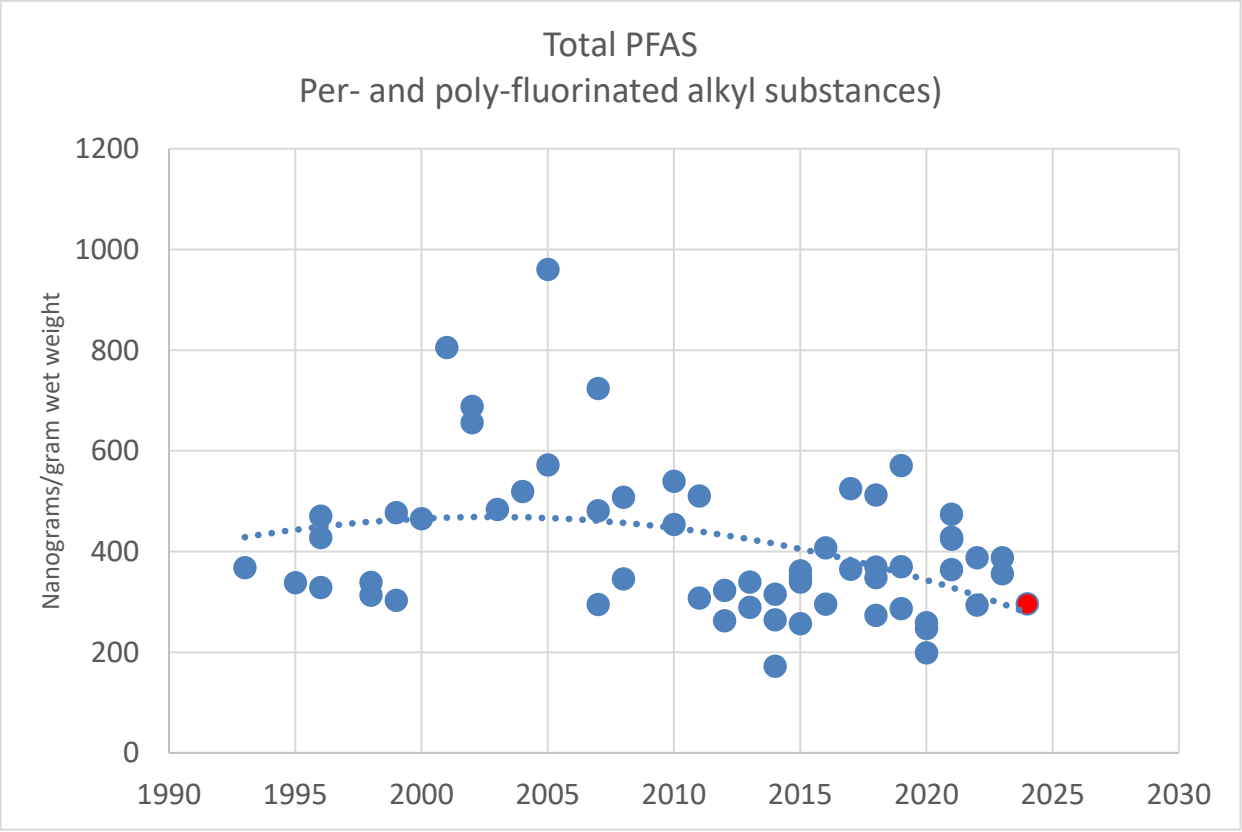
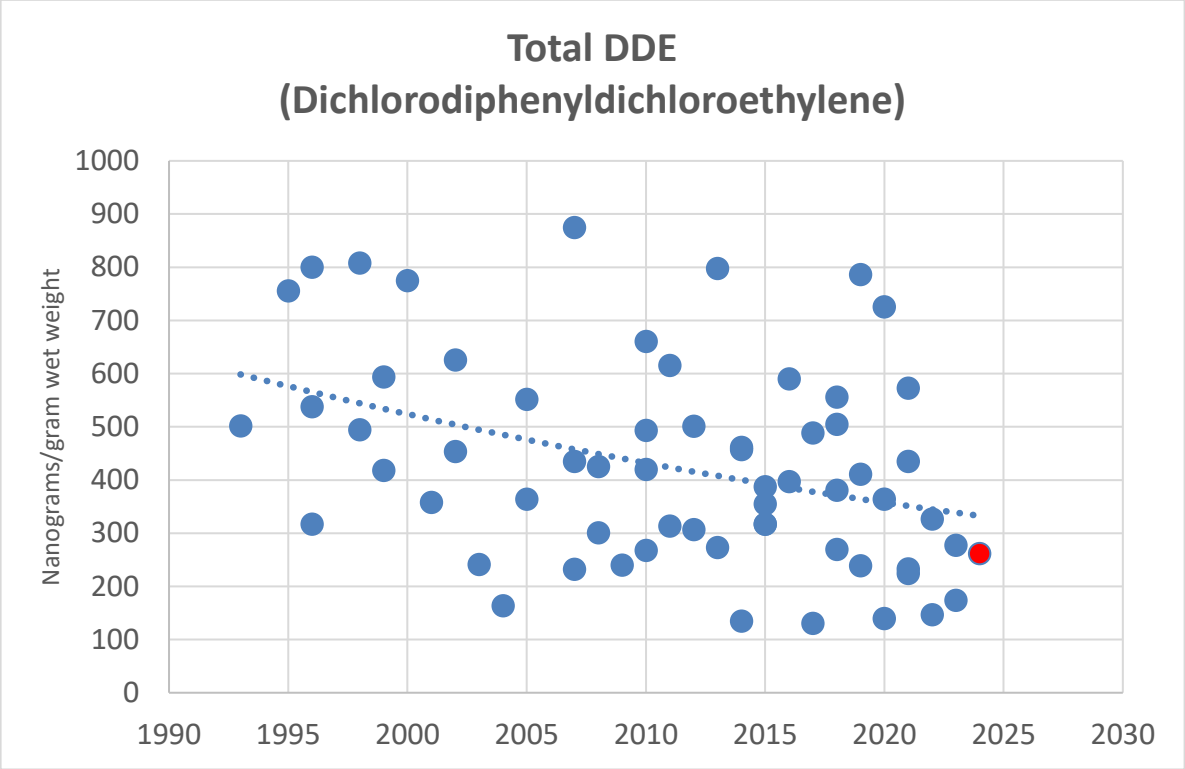


Figure 5: Trends of BDEs and PFAS in unhatched Squam loon eggs from failed nests, 1993-2024. The red dot indicates the egg tested from the 2024 breeding season.



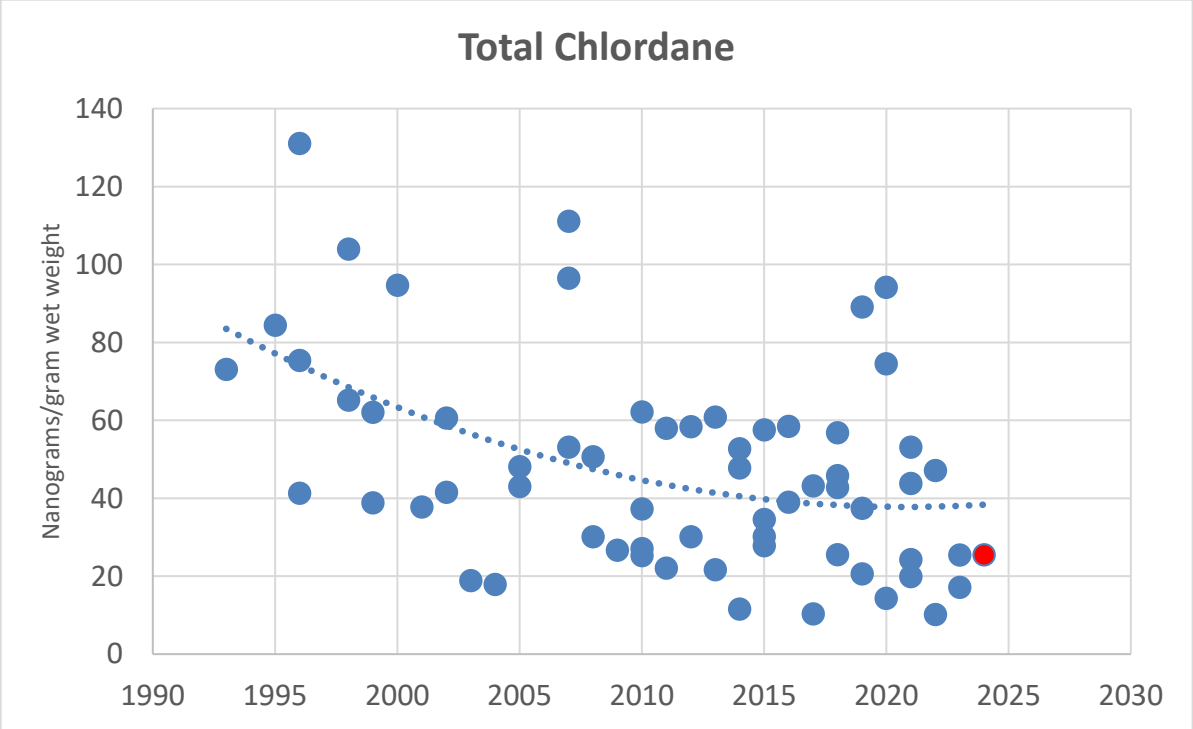
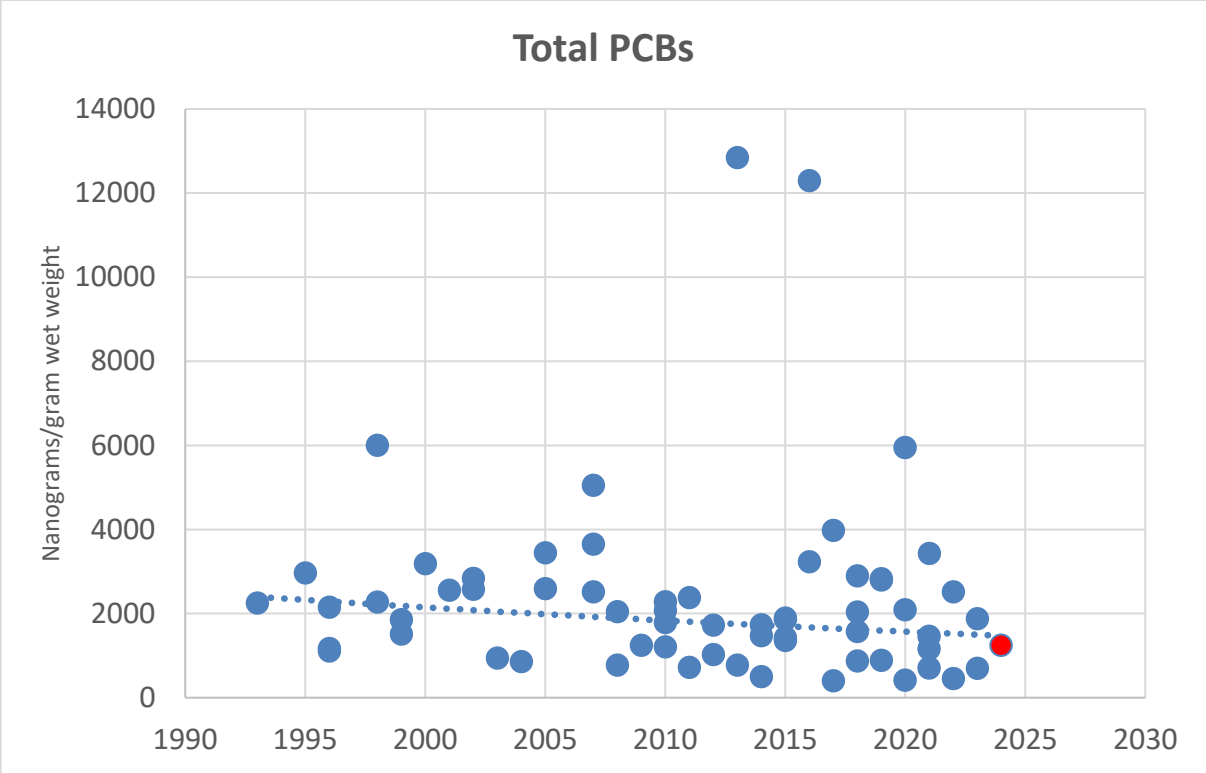


Figure 6: Trends of DDE and chlordane in unhatched Squam loon eggs from failed nests, 1993-2024. The red dot indicates the egg tested from the 2024 breeding season.



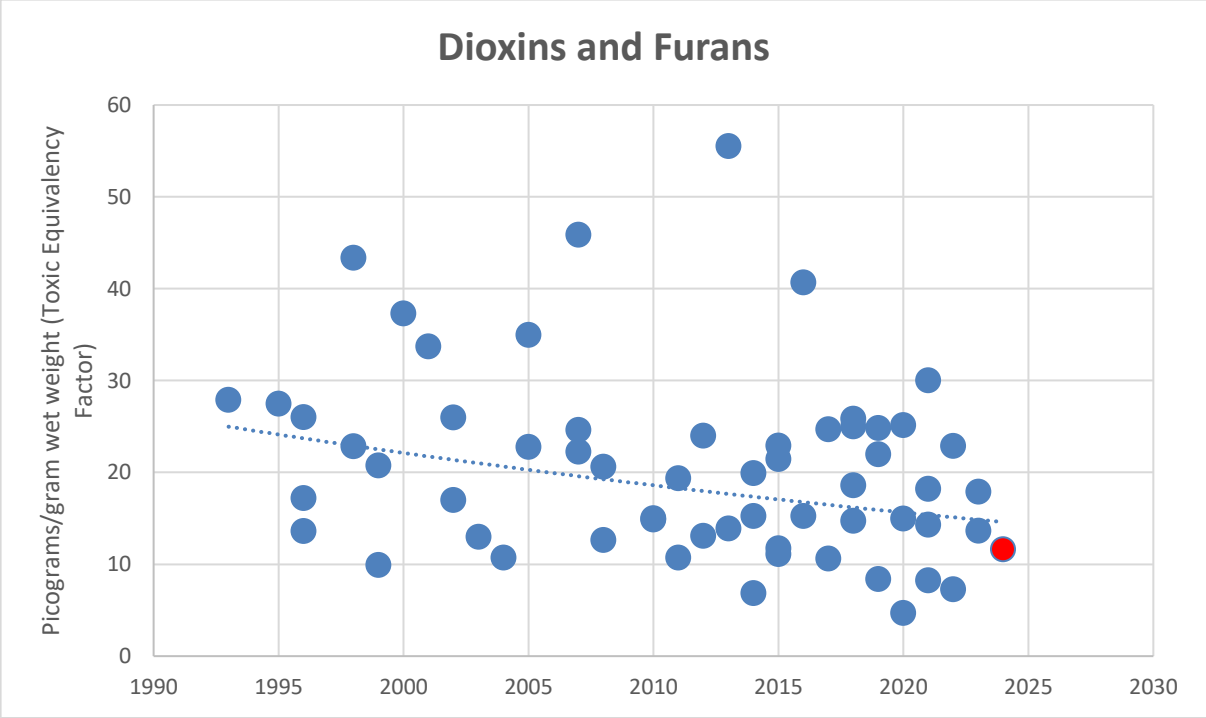


Figure 7: Trends of PCBs, dioxins, and furans in unhatched Squam loon eggs from failed nests, 1993-2024. The red dot indicates the egg tested from the 2024 breeding season.

In an effort to better understand the potential impact of contaminants on Squam's loons, LPC is investigating loon eggshell thickness and egg size in relation to contaminant levels and productivity. Initial analyses indicate that some of these contaminants may cause eggshell thinning and reduce the size of loon eggs, among other impacts, and these data are being further analyzed to understand if and how these contaminants may impact loon productivity. LPC is finalizing a paper to submit to a peer-reviewed journal reporting on contaminant levels in loon eggs and potential impacts on egg integrity and productivity.

The discovery of these contaminants in Squam's loon eggs raised two important questions for LPC: 1) What are the sources of the high levels of contaminants found in Squam's loon eggs? and 2) What impacts are these contaminants having on Squam's loon population?

Hypotheses as to the Sources of Contaminants

LPC has investigated six hypotheses to explain the high levels of contaminants present in Squam's loon eggs. These hypotheses and the evidence for or against them are listed below:

1) *Loons from Squam Lake acquired the contaminants while on their ocean wintering grounds.* Loon biology indicates that this would not likely be the case, and stable isotope testing confirmed that the nutrients (and, consequently, the contaminants) in the loon eggs came primarily from a freshwater source, not from the ocean.

2) *There was a change in the food web in Squam Lake, which forced loons to feed on fish at higher levels of the food web, thus exposing them to higher levels of contaminants.* Stable isotope testing of carbon and nitrogen did not reveal any change in the levels of the food web at which Squam's loons are feeding.

3) *The age structure of Squam's loon population (i.e., old loons that had accumulated contaminants over their lifetimes) contributed to elevated contaminant levels in the loons.* Banding evidence does not suggest the existence of a cohort of old loons on Squam.

4) *Squam has a unique hydrology, holding water longer than other lakes, which allowed for the retention and build-up of contaminants.* Limited data available do not suggest that Squam's hydrology has contributed to a build-up of contaminants, but detailed analyses by hydrological experts would be needed to definitively rule out this hypothesis.

5) *Pollution from a diffuse source accounts for the elevated contaminant levels found in Squam loon eggs.* Data collected by LPC working collaboratively with Jeff Schloss and Bob Craycraft of University of New Hampshire Cooperative Extension does not support the hypothesis that the contaminants found in Squam's loon eggs came from a diffuse source.

6) *Pollution from one or more isolated sources accounts for the elevated contaminant levels found in Squam loon eggs.* An isolated source posits a single large input of a contaminant into a system. Illegal dumping, accidental spill, or a leaking container of chemicals are examples of possible isolated sources. The evidence suggests that at least some of the contaminants in Squam loon eggs came from multiple isolated sources in the Squam watershed.

Sources of Contaminants and Sediment Sampling

In an effort to identify sources of the contaminants in Squam's loon eggs, LPC undertook sediment sampling from tributaries in the Squam watershed. LPC's sampling revealed three key locations of elevated contaminant levels in sediments. Contaminants at these sites exceeded levels identified by various agencies and researchers as being possibly or likely harmful to aquatic life. For further details of LPC's sediment testing and results, please see LPC's report to New Hampshire Department of Environmental Services at http://www.loon.org/squam-lake-study.php.

Since the discovery of these sites of contaminated sediments, LPC has been working with sediment contaminant experts to identify the extent of the contamination in these areas as a necessary first step to identify options for remediation. LPC had extensive discussions with environmental consulting companies, and we are currently working with the Squam Lakes Association to obtain final proposals for this work.

NHDES' PCB Fish Consumption Advisory

As a follow-up to LPC's data on PCB levels in loon eggs, crayfish, and sediments in the Squam watershed, New Hampshire Department of Environmental Services (NHDES) launched a study of PCB levels in fish from Squam Lake. The goals were to investigate another level on the food web between the contaminated sediments LPC found and the loons and to explore potential human health risks to people eating fish from Squam Lake. Loons are a key indicator species, being primarily fish eaters, and PCBs are known to biomagnify through the food web (i.e., increase successively in bacteria, invertebrates, and fish), so loons are accumulating the contaminants from the fish they eat. It is known that the nutrients (and, thus, contaminants) deposited in eggs come primarily from what the loon has been eating in the few weeks immediately prior to egg-laying. Isotope tests conducted by LPC confirmed that the material in loon eggs is primarily from freshwater sources rather than the ocean. Loons are present in their territories and defending them for 4-6 weeks prior to egg-laying, so the contaminants in the eggs primarily came from what they were eating within their territories on Squam. Thus, there is a potential risk to humans eating fish from Squam as well.

NHDES tests on yellow perch and smallmouth bass on Squam sampled in the fall of 2018 indicated elevated levels of PCBs in fish on Squam. In 2020, NHDES issued a fish consumption guideline for the Squam Lakes that was considerably more restrictive than the standard mercury guidelines in place throughout the state. The new guidelines for the Squam Lakes recommended limiting consumption to: for adults and children >7 years old, 1 meal per month of yellow perch and 1 meal every 4 months of smallmouth bass and other fish; for women of child-bearing age, 1 meal every 2 months of yellow perch and 1 meal every 6 months of smallmouth bass and other fish; and for children <7 years old, 1 meal every 3 months of yellow perch and 1 meal per year of smallmouth bass and other fish. Details of the guidelines can be found at: https://www.des.nh.gov/news-and-media/nhdes-issues-new-fish-consumption-advisory-squam-lake-high-levels-polychlorinated.

It was the decline of loons on Squam that led LPC to test unhatched loon eggs from failed nests. From there, follow-up research by LPC and its collaborators on contaminants in crayfish, sediments, and fish indicated implications for human health. LPC will continue to test unhatched loon eggs from failed nests on Squam and around the state to monitor contaminant levels. LPC's work to monitor

contaminants in loons will provide the ultimate measure of the success of any efforts to mitigate the issue of contaminants on Squam.

PFAS in Squam Lake Loon Eggs

In November 2021, LPC submitted a report to New Hampshire Department of Environmental Services (NHDES) and New Hampshire Department of Fish and Game detailing results of our contaminant testing of loon eggs throughout the state (available at www.loon.org/eggreport). As a result of this report, NHDES funded LPC to test PFAS in 144 archived inviable loon eggs from failed nests over the past 6 years. This contract represented recognition by NHDES of the importance of loon eggs as indicators of contaminant levels in aquatic ecosystems.

PFAS levels in Squam Lake loon eggs tested by LPC from 2019-2021 (n = 9) and eggs included in the LPC/NHDES study (n = 4) were 60.9% higher than mean statewide levels but were well below levels seen on Lake Winnipesaukee (Fig. 8), as well as other lakes with particularly elevated PFAS levels such as Canobie Lake and Arlington Mill Reservoir. The overall mean of PFOS (perfluorooctane sulfonic acid, the best-studied type of PFAS in wildlife) on Squam Lake was slightly below the level shown to impact the health and reproductive success of other bird species, although 46% of eggs exceeded this level. While mean PFOS levels on Squam were 33% higher than the statewide mean, mean levels of PFCAs (perfluoroalkyl carboxylates, a subgroup of PFAS) exceeded statewide levels by 126%. PFCAs accounted for an average of 68% of the overall composition of PFAS in Squam eggs vs. 48% in statewide eggs. This greater preponderance of PFCAs in Squam eggs had been noted in LPC's 2021 egg report as well and is in keeping with trends seen in other studies of birds. The effects of PFCAs on the health and reproductive success of birds are poorly understood. LPC's full report on the PFAS study is available at www.loon.org/PFAS-report.

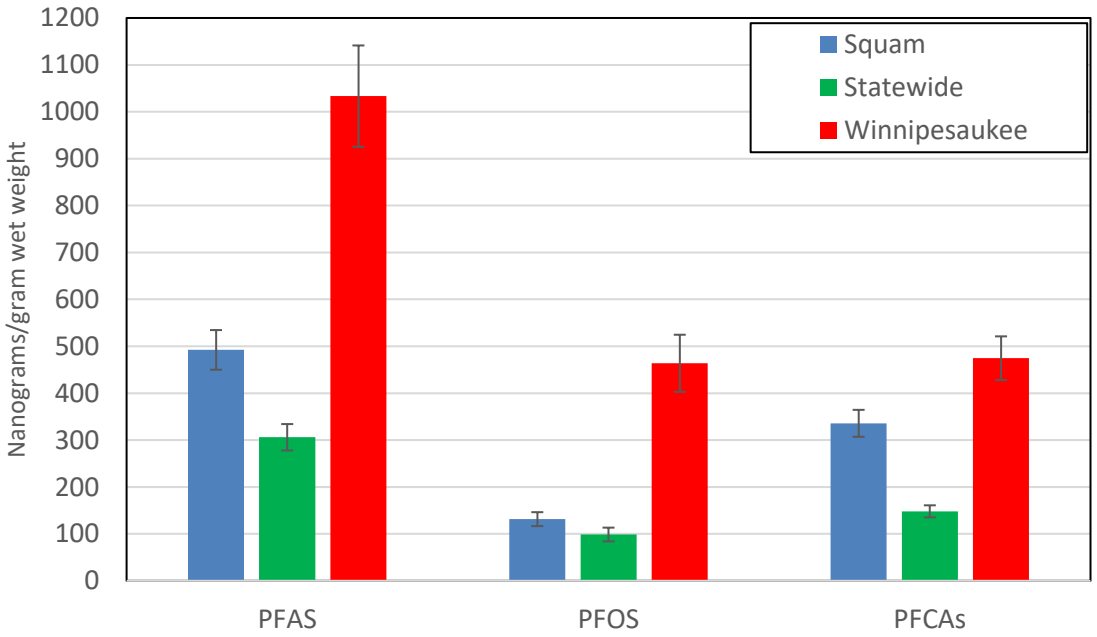


Figure 8: Levels of PFAS in loon eggs from Squam Lake, Lake Winnipesaukee, and across New Hampshire.

Mortality of Squam Lake's Adult Loons

Three adult loon mortalities were collected on Squam Lake in 2025. One loon died as a result of injuries sustained in a fight with another loon and was found in a territory where the resident pair had chicks. It had likely intruded into the territory and was injured as the pair defended their chicks and territory. The second loon was too decomposed to determine a cause of death. The third loon died after ingesting a lead fishing jig (Figure 9).

Figure 9: X-ray of adult loon found on Great Island in September of 2025 that died of lead poisoning after ingesting a lead fishing jig. The jighead is circled in red on the x-ray.

Staff from Tufts University School of Veterinary Medicine, the University of New Hampshire Veterinary Diagnostic Laboratory, and Loon Preservation Committee performed necropsies on 33 adult loons from Squam Lake that were found dead between 2001 and 2025. Over half of these loons died as a result of human causes: 10 loons died as a result of ingested lead fishing tackle; 5 loons were killed by boat strikes; and 2 loons died from avian malaria. Many more Squam Lake loons missing during this time period remain unaccounted for and are presumed to have died on their ocean wintering grounds, possibly as a result of poor body condition resulting from exposure to contaminants and other stressors on Squam.

Since the opening of the reconstructed public boat launch in 2001, the rate of mortality from lead fishing tackle on Squam Lake has increased by 67% (Figure 10) and is twice the overall statewide rate

of lead mortality during the same period. Loon populations may be negatively impacted by the loss of even 0.4% of their population annually from human causes (LPC, unpubl. data; Dillingham and Fletcher 2008); and, between 2001 and 2025, Squam lost on average 1.5% of its adult loon population annually due to lead fishing tackle alone. Although it is not possible to demonstrate causation, it is worth noting that, since 2001, the number of boats counted in the Squam Lakes Association boat census, the number of fishing tournaments, and the number of boats participating in fishing tournaments have all increased.

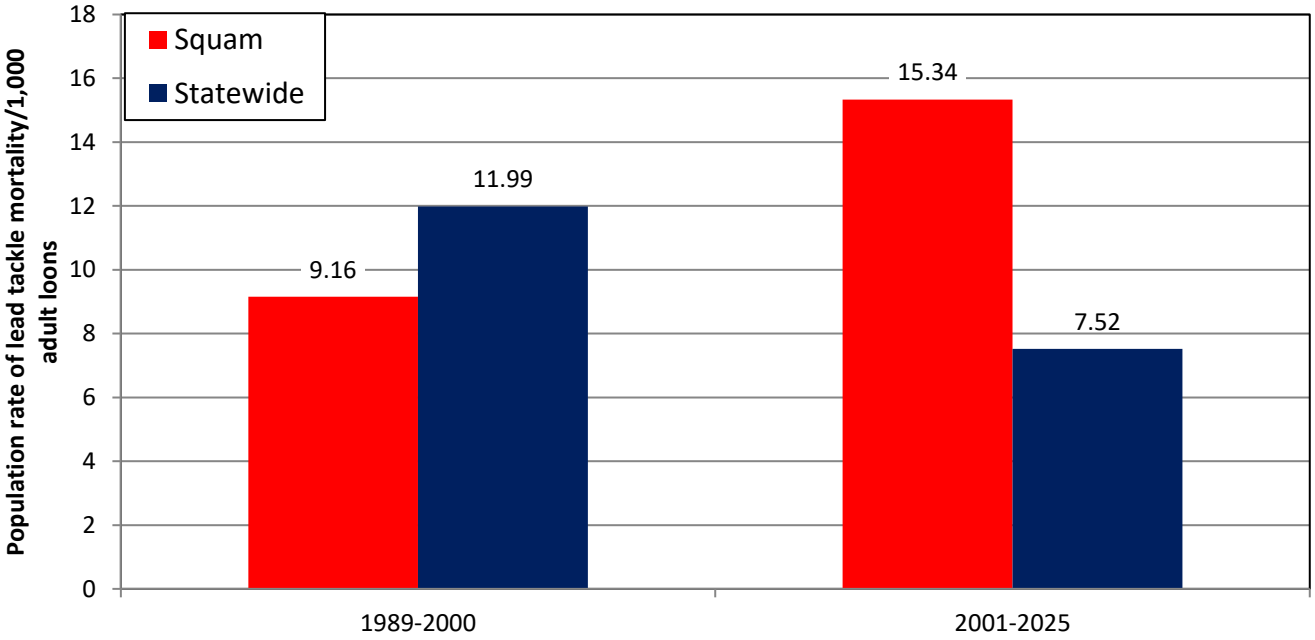


Figure 10: Population rates of lead mortality on Squam Lake vs. statewide population rates of lead mortality.

Working Hypothesis to Explain the Impacts of Stressors on Squam's Loon Population

The discovery of high levels of contaminants in Squam's loon eggs raised the question of what impact these contaminants had on the loon population in concert with the many other stressors facing Squam's loon population. LPC has a working hypothesis to understand the impacts of combined stressors on Squam's loon population. This hypothesis is subject to change as new evidence becomes available.

Like loons throughout New Hampshire, Squam's loons have been experiencing increasing stressors over time, from increased recreational pressure to increasingly hot summers and more intense precipitation events. On Squam, recreational and fishing pressure became more intense in the years following 2001, coincident with the reconstruction of the public boat launch in the same year, and mortality from lead fishing tackle increased in the same period (Figure 7). In approximately 2002, evidence suggests that there may have been an influx of contaminants into the lake from sources on tributaries flowing into Sandwich Bay and Bennett Cove, likely as a result of increased runoff. By 2004, these contaminants had worked their way up the food chain to loons. The classes of contaminants found in Squam loons concentrate in fat reserves and may become mobilized as fat reserves are used. These contaminants, in combination with other stressors, may have contributed to poor body condition and the deaths of many of Squam's loons during the winter of 2004/2005 as their

fat reserves were metabolized for the fall feather molt and migration, both energy-intensive processes. The loons that survived to reproduce in subsequent years deposited elevated levels of contaminants into their eggs, possibly contributing to poor productivity. An independent assessment by consultant Lori Siegel using a systems dynamics model with data from LPC and other sources likewise identified contaminants as likely factors in the declines in loon survival and breeding success.

By 2008, some of the contaminants seem to have flushed though the Squam system, as evidenced by a decline in levels of some contaminants in Squam's loon eggs in subsequent years. However, evidence suggests that factors including ongoing high levels of adult mortality from lead fishing tackle and other anthropogenic causes continue to undermine the recovery of Squam's loon population. The loss of so many established, experienced adult loons led to the immigration of new loons to fill vacant territories. These loons are intruding into territories, driving remaining established loons out of their territories, disrupting nesting, and, in some cases, killing chicks. While these behaviors are typical for territorial disputes, the effects on Squam are amplified due to ***high human-caused adult mortality*** and the resultant territorial vacancies. Loons have evolved to thrive in a stable environment and stable social structure, and Squam's loons have had neither since 2001.

Continued monitoring of contaminant levels in loon eggs is warranted, given the discovery of contaminated sediments in the watershed. The continuing presence of contaminants in Squam loon eggs suggests the ongoing availability of contaminants to the Squam food web. LPC will continue to monitor contaminant levels in inviable loon eggs from failed nests on Squam.

The critical factor to restore a healthy population of loons to Squam Lake seems to be ***keeping adult loons alive*** to stabilize the social structure. The stability of loon social structure can have a major impact on loon reproductive success. Increasing the use of non-lead fishing tackle and educating lake users about the dangers of lead and the need to boat carefully around loons will help reduce the threat of human-caused mortalities to loons. If adult mortality can be reduced and the social structure can stabilize, there is reason to hope that productivity on the lake will improve, as the disruptions Squam loons are currently facing during nesting and chick-rearing may abate.

The high number of nests in 2025 was a welcome increase over the past three years, although the hatch rate was lower this year compared with the previous 5 years. There was not one common cause in the loss of the nests this year (see pg. 3), although the loss of 4 eggs to boat wakes was very unfortunate. The other possible factor in nest outcomes this year was weather: there were 3 nests that were due to hatch around the 4th of July, and none of those eggs hatched. There was a period of high heat and humidity in the lead-up to the 4th of July, and it is unclear if these extremes played a role in those nest outcomes. Similar patterns of a high rate of nesting followed by poor overall productivity for the summer were seen on some other lakes this summer.

The evidence from the decline of loons on Squam Lake and an earlier decline on Lake Umbagog suggests that recovery will take time. LPC has learned from both of these events that perturbations to the system cast a long shadow over a loon population, which would be expected in a long-lived bird like a loon. While the causes of the declines of the loon population on Umbagog remain unknown and the adult population there has not recovered, productivity of the remaining pairs of loons on Umbagog has finally begun to improve in recent years, with this past summer being a notable exception. As would be expected in a complex biological system, the experience of loons on Umbagog and Squam are not directly comparable, but the example of Umbagog suggests that, with time and supportive

management, Squam's loons can recover. And on Squam, we understand much better the impacts of human activities on the decline of the loon population and how we can work together to restore the loon population.

Remediation

LPC is working to address the challenges loons are facing on Squam and restore a healthy population of loons to the lake in the following ways:

1) *Limiting mortality from lead fishing tackle:* LPC's data was the impetus for legislation to increase protections of loons from lead fishing tackle. Mortality from lead fishing tackle has likely contributed to the social chaos and resultant low productivity on the lake. LPC published a ground-breaking paper detailing our lead tackle mortality data and the population-level effects of lead tackle mortality on New Hampshire's loon population in the peer-reviewed *Journal of Wildlife Management* (Grade et al. 2018). This publication was an important step to buttress New Hampshire's lead legislation against efforts to repeal the bill, as well as to communicate our findings to the scientific community.

   Educating the public about the dangers of lead to loons forms a major part of all of LPC's outreach activities on and around Squam Lake. The evidence suggests that the most important thing we can do to restore a healthy population of loons on Squam is to ***keep adult loons alive***. Protecting loons from lead fishing tackle is a critical component of that effort. LPC's Lead Tackle Buyback Program, in partnership with the New Hampshire Department of Fish and Game, has expanded to 14 retail shops throughout New Hampshire, including Squam Boat Livery. Squam Lakes Association also serves as a lead tackle collection point. To date, the Lead Tackle Buyback Program has removed over 85,000 pieces of lead tackle as a potential threat to loons and other wildlife. For more information on the program, please visit www.loonsafe.org.

2) *Increasing reproductive success:*

   - **Management:** LPC is continuing intensive management on Squam Lake to increase the reproductive success of loons, including the provision of 9 artificial nesting rafts, roping and/or signing all 15 loon nesting areas, and the placement of "Caution: Loon Chick" signs in successful territories to alert boaters to the presence of loon chicks.

   - **Investigating causes of nest failures:** Cameras placed at loon nests help us understand the causes of nest failures to guide future management. In 2025, LPC placed two cameras at nest sites on Squam.

   - **Outreach:** Educating the public about the needs of loons and the importance of maintaining a respectful distance from loons and loon nests forms an important part of LPC's outreach activities. The Squam Lake Loon Initiative has resulted in dramatically increased outreach to the Squam Lake community and visitors through weekly presentations at the Rockywold-Deephaven Camps on Squam Lake and twice-weekly loon cruises on the lake in partnership with the Squam Lakes Natural Science Center (SLNSC), as well as giving other presentations in the Squam area. In 2025, LPC and SLNSC

partnered for a special "Loon Day," featuring additional loon cruises and loon educational displays at the Science Center. Squam Lakes Loon News e-newsletters provide updates on Squam's loons to over 450 people during the summer, and LPC responds to inquiries about loons and our work through individual communications throughout the year.

- **Protecting loon families:** LPC biologists are a near-constant presence on the lake during the loon breeding season, and LPC continues to collaborate with the Squam Lakes Association (SLA) to protect loon families. LPC trains the Lakes Region Conservation Corps (LRCC) interns working for the SLA each year on how to practice and promote responsible behavior around loons and loon families, and LRCC interns assist with placing signs around loon nesting and brooding areas.

- **Mitigating effects of climate change:** Covers on loon nesting rafts help protect loons from avian predators and provide shade for incubating loons, which can easily overheat. In addition, LPC has deployed shade fabric on raft covers to help loons cope with a warmer climate. LPC's nest cameras also help us understand the impacts of climate change on nesting loons by allowing LPC to assess nest attendance during heat waves and observe behavioral signs of heat stress in incubating loons.

3) *Identifying levels and sources of contaminants:* LPC continues to investigate contaminants as one of many possible contributors to both reduced survival and reduced breeding success of Squam's loons and to identify solutions to the complex issue of contaminated sediments in the Squam watershed. LPC is collaborating with the SLA to evaluate proposals from consultants to measure the extent of the contamination at known sites and assess other possible sources of contaminants. This will establish the extent of the contamination problem in these areas and guide plans for mitigation efforts. These collaborative efforts between LPC and SLA to address this issue dovetail with SLA's runoff mitigation efforts as part of its watershed management plan.

LPC is working to ensure that the issues facing loons are addressed to safeguard the health of Squam and all its inhabitants. As indicators of the health of the aquatic environment, Squam's loons originally alerted us to the problem of contamination on Squam Lake, and they will continue to serve as sensitive barometers of contamination in the watershed. As funding permits, LPC will continue to test inviable loon eggs from failed nests on Squam for contaminants. Results of these tests will provide the ultimate measure of our success to address the issue of contaminants on Squam Lake. LPC will continue to work with the SLA and others in this collaborative effort to ensure the health of the Squam ecosystem and the wildlife and people that call Squam home.

Next Steps

The Squam Lake Loon Initiative has already provided critical baseline data on contaminants and other environmental stressors on loons, which will be invaluable to assess changes in, and effects of, contaminants and pathogens in the future. The collaboration of researchers formed as a result of the decline of loons on Squam Lake is unprecedented, and the testing being done on loon samples is the most comprehensive undertaken anywhere to date. The contaminants for which LPC is testing biomagnify and bioaccumulate in the food web, and LPC's research is the only systematic testing in the state for contaminants in wildlife at or near the top of aquatic food webs. Contaminant levels in

loons are important indicators of the health of aquatic ecosystems. LPC's testing of inviable Squam Lake loon eggs has shown that Squam's loons are carrying a contaminant body burden that includes not just DDT and PCBs but flame retardants (BDEs) and stain repellants (PFAS), among other chemicals (Figure 4), and LPC remains concerned about the overall contaminant body burden of Squam's loons. LPC's sediment testing identified potential sources for DDT, PCB's, and dioxins/furans; but, to date, we have not identified specific sources for other contaminants. LPC continues to advocate for testing that covers the full scope of contaminants of concern revealed by our efforts, including dioxins/furans, dioxin-like PCBs, BDEs, and PFAS.

The SLLI has resulted in a detailed record of loon populations and productivity on Squam Lake, including causes of nest failures; the quick response to sick or injured loons to increase chances of survival of these loons; an increased number of banded and sampled loons on Squam to increase our knowledge of the survival and breeding success of known individuals, and the relationship of survival and breeding success with contaminant burdens; a model to elucidate the effects of multiple co-occurring stressors on the survival and breeding success of loons; and protection, management, and outreach to recover and maintain the Squam Lake loon population. This initiative will continue to investigate the much larger, more systemic problem on Squam indicated by the decline of loons; inform other initiatives such as LPC's New Hampshire Loon Recovery Plan and SLA's Squam watershed plan; and help LPC and others make informed decisions to protect Squam's loons, other wildlife, and the ecological integrity of Squam Lake, as well as lakes throughout New Hampshire.

Objectives for the Squam Lake Loon Initiative in 2026-2027 include:

1. Testing inviable loon eggs from failed Squam nests in 2025 to monitor current contaminant levels and trends;
2. Submitting a paper to a peer-reviewed journal to report results and negative effects of contaminants on Squam and statewide eggs and to focus scientific attention on this issue;
3. Inspecting data from nest cameras to investigate disturbances at nests and causes of nest failures;
4. Advocating for comprehensive testing of samples while working with New Hampshire Department of Environmental Services, US Environmental Protection Agency, and Squam Lakes Association to determine the extent of contaminated sediments and facilitate remediation of potential sources;
5. Continuing intensive monitoring, management, and outreach to support Squam's loons.

Squam Lake plays a leading role in advancing our understanding of loons and their challenges in New Hampshire, and the groundbreaking research being conducted on Squam Lake will continue to inform LPC's efforts to preserve loons throughout New Hampshire.

Acknowledgements

LPC would like to thank Victoria Nassikas for serving as a volunteer intern on Squam Lake in 2025. We also thank our many collaborators and partners who have contributed technical expertise, opportunities for outreach, and financial support to the Squam Lake Loon Initiative over the past year:

- LPC's Technical Committee: Brian Reilly (Chair; LPC Board Trustee), Gil Barth, Kristen Begor (LPC Board), Sean Flint (US Fish and Wildlife Service), Dave Govatski (LPC Board), Sandi Houghton (NH Fish and Game), Ralph Kirshner (LPC Board, retired), Anne Kuhn (US Environmental Protection Agency), Chris Martin (NH Audubon), Brenda Stowe (LPC Board), Bob Varney (LPC Board)

- New Hampshire Department of Environmental Services: Ted Diers, Ken Edwardson, David Neils, Tracie Sales
- New Hampshire Veterinary Diagnostic Laboratory
- Rockywold-Deephaven Camps and Squam Environmental Preservation Fund
- Squam Lakes Association and Lakes Region Conservation Corps
- Squam Lakes Natural Science Center
- Tufts University Cummings School of Veterinary Medicine: Mark Pokras
- The many people, private and family foundations, and efforts that have made our work to understand and reverse the declines of loons on Squam Lake possible.

The Loon Preservation Committee is a not-for-profit 501(c)3 and donations to fund our work to protect loons are tax deductible as allowed by law. To donate to the Squam Lake Loon Initiative, please visit https://loon.org/donate/. Thank you for your support of our work to help the loons of Squam Lake!

Literature cited

Dillingham, P.W. and D. Fletcher. 2008. Estimating the ability of birds to sustain additional human-caused mortalities using a simple decision rule and allometric relationships. Biological Conservation 141:1783-1792.

Grade, T.J., M.A. Pokras, E.M. LaFlamme, and H.S. Vogel. 2018. Population-level effects of lead fishing tackle on Common Loons. *Journal of Wildlife Management* 82:155-164. https://doi.org/10.1002/jwmg.21348.