# The New Hampshire Loon Recovery Plan:

## Concept Paper and Year Three Progress Report to the Blake-Nuttall Fund

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## Background

The Common Loon (*Gavia immer*) is an iconic symbol of New Hampshire's pristine lakes and ponds and an important part of New Hampshire's natural character and natural resource-based economy. The New Hampshire Business and Industry Association recognized the importance of loons when it cited our loon population as a key indicator of the quality of life in our state.

Loons are also recognized as sentinels of environmental quality because they are sensitive to contaminants in lakes and ponds. Declines in loon populations or breeding success like those recently observed in New Hampshire may indicate impairments to ecosystems, and could foretell declines of fisheries and other wildlife as well.

The Loon Preservation Committee (LPC) was created in 1975 because of concerns about dramatic declines in New Hampshire's loon population. The Committee consists of a network of dedicated individuals who work to further the organization's mission of restoring and maintaining a viable population of loons throughout New Hampshire; monitoring the health and productivity of loons and loon populations as sentinels of environmental quality; and promoting a greater understanding of loons and the natural world. Today, LPC houses the most comprehensive database of loon populations and productivity statistics in the world, and our management activities have more than tripled New Hampshire's loon population, despite dramatic increases in shoreline development and human use of lakes.

## Current Status and Threats

The Loon Preservation Committee has monitored loon populations and productivity throughout the state since 1975 to assess threats to loons and to measure our success in recovering New Hampshire's loon population. LPC's monitoring recorded five consecutive years of declines in the number of loon chicks on New Hampshire's lakes from 2004 to 2008, and significant population declines or mortality incidents on the state's three largest lakes in the past ten years. These declines threatened to undo the hard-won gains that LPC's research, management and educational efforts had achieved and were the impetus for the creation of the Loon Recovery Plan.

In 2011, Loon Preservation Committee staff and volunteers counted 271 pairs of loons on lakes in New Hampshire, four pairs fewer than in 2012. Despite an impressive increase in numbers since the inception of LPC, loons remain a threatened species in the state and face growing challenges. Lead fishing tackle continues to be the largest documented cause of death of adult loons in the state, and anthropogenic stressors including mercury, other contaminants, and human disturbance continue to affect loon breeding success. LPC's groundbreaking research on loon eggs collected from failed nests has revealed high levels of PBDE (flame retardants), PFOS (stain repellants) and a host of other contaminants in eggs that failed to hatch.

## The New Hampshire Loon Recovery Plan

The Loon Preservation Committee developed its Loon Recovery Plan to inform and direct LPC's work to promote a healthy and growing loon population throughout New Hampshire. The New Hampshire Loon Recovery Plan includes:

1. Analyses that estimate New Hampshire's state-wide carrying capacity for loons (to establish the number of loons New Hampshire's lakes can and should support);
2. Population models to measure the effects of man-made stressors on loon survival and breeding success (to target our limited resources toward mitigating the most problematic stressors;
3. An assessment of our ability to help loons cope with these challenges through research, management activities and outreach/education; and,
4. Strategies that will be implemented to increase loon populations to as close as possible to historical, pre-decline levels of an estimated 450 loon pairs (almost 200 pairs above current levels).

## Goals of the Loon Recovery Plan

**The goals of the New Hampshire Loon Recovery Plan are first, to recover, and then, to maintain, a viable population of loons in New Hampshire as a component of a healthy regional population and ecosystem.**

We anticipate that the achievement of these goals will require increased and sustained levels of monitoring, research, management and outreach activities in New Hampshire for the foreseeable future. LPC's progress in achieving these goals will be monitored on an annual basis, with the following two objectives to be realized by the end of Year Three (March of 2013). The Loon Recovery Plan will be continually revised and updated to reflect LPC's success in achieving these objectives and addressing new challenges facing loons in New Hampshire.

## Three-year Objectives

**Objective #1:** Decrease mortality of adult loons resulting from lead fishing tackle, boat collisions, and other human causes from approximately 8 yearly mortalities at present to an average of 5.5 mortalities annually (a 31% decrease in human-caused mortality).

> **Year Three Progress and Results:** New initiatives in 2012 to decrease human-caused mortalities of loons included a partnership with the New Hampshire Lakes Association (NH LAKES) to launch our "Lead-Free Lakes Initiative." This effort included a new "Get The Lead Out!" fact sheet; a pilot project to work with NH LAKES' Lake Hosts to distribute these fact sheets at boat launches; continuing to incorporate a strong message about the dangers of lead tackle into LPC's regular talks; and presenting LPC's newly-developed "Lead and Loons" presentation for interested groups. LPC prepared a report on the effects of lead fishing tackle for the NH Legislature and the NH Fish and Game Commission

(appended) to inform decision-makers of the continuing serious effects of lead fishing tackle on loons in New Hampshire, and is taking part in a NH House Interim Study Committee to assess the need for further measures to protect loons from lead fishing tackle. LPC is also preparing its research on causes of adult loon mortality for submission to a peer-reviewed journal to inform the broader scientific community of its findings on loon mortality resulting from ingested lead fishing tackle.

To date in 2012 LPC staff members have recovered 14 deceased adult loons. Causes of death of adult loons necropsied to date include suspected fungal infection (2), unknown (could not be determined) (3), and one case each for lead fishing tackle, blunt trauma, Bald Eagle predation, foreign object (a carpentry nail), and conspecific injury (i.e., attacked by another loon). Necropsies are still pending for the remaining three adult loons. Therefore, a minimum of three adult loons collected by LPC to date were killed as a direct result of human activity.

**Objective #2:** Increase reproductive success of loon pairs to a minimum of 0.48 chicks surviving to fledge per loon pair from the current 0.41 chicks surviving per loon pair (a 17% increase in reproductive success of loon pairs).

**Year Three Progress and Results:** In 2012 LPC continued and expanded its management activities (nesting rafts, signs and ropelines) to mitigate specific challenges to nesting loons; expanded its communications with dam owners to maintain stable water levels during critical nesting periods; and increased its outreach and recruitment of volunteers to educate lake users about the needs of nesting loons and loon families. Loon population data for 2012 have not yet been collated, error-checked and summarized. In 2011, 271 pairs of loons on New Hampshire's lakes hatched a total of 186 chicks; 149 of these chicks were surviving as of mid August and presumed to have fledged. This was a gain of 20 surviving chicks over 2010 and represented a breeding success of 55 surviving chicks per 100 loon pairs – the first time in six years that NH loons had exceeded the rate of 48 chicks/100 pairs needed to maintain a stable loon population.

**Strategies to Meet the Objectives**

The Loon Recovery Plan outlines specific, measurable strategies to achieve the two major objectives outlined above. These strategies and LPC's progress in carrying them out in year three of the Loon Recovery Plan are outlined below:

a. Increase the number of nesting loon pairs protected by floating signs and ropelines from 61 pairs (avg. 2005-2009) to 80 pairs by Year Three of the Recovery Plan. Signs and ropelines educate lake users and provide a barrier to the close approach to nesting loons, thus reducing nest abandonment. An average of three signs are floated around active loon nests; therefore, this strategy represents an additional 57 signs floated by the end of Year Three.

   **Year Three Activities:** LPC protected 78 nesting pairs of loons with signs and ropelines in 2012, a 28% increase in the number of pairs protected with these measures compared to pre-

Loon Recovery Plan levels. Loon pairs protected by signs and ropelines hatched 78 chicks, 47% of the total number of chicks hatched in New Hampshire.

b. Increase the total number of loon nesting rafts floated in New Hampshire each year from 54 rafts (avg. 2005-2009) to 75 rafts annually by Year Three of the Recovery Plan. These rafts will provide alternate nesting sites to loons displaced from traditional natural sites as a result of shoreline development, and help protect eggs from water level fluctuations and increased populations of opportunistic predators such as raccoons and foxes.

   **Year Three Activities:** LPC floated 76 loon nesting rafts in 2012, a 41% increase over the number of rafts floated before implementation of the Loon Recovery Plan. Loons nesting on these rafts hatched 41 chicks, 25% of the total number of chicks hatched in New Hampshire.

c. Increase the number of LPC exhibits and public presentations made by LPC staff from 58 (avg. 2005-2009) to 75 by Year Three of the Recovery Plan. These exhibits and presentations encourage a culture of respect and appreciation for loons; illustrate the challenges facing loons in New Hampshire from lead fishing tackle, irresponsible boating, and other human practices that directly and indirectly affect loons; and increase awareness and support for loons, and for LPC's efforts to preserve them.

   **Year Three Activities:** LPC staff and volunteers have given 86 presentations/exhibits to date since April 1 of 2012, and have another 10 presentations/exhibits scheduled before March 31st of 2013. This represents an 88% increase in the number of exhibits and presentations and exhibits given throughout the state compared to pre-Loon Recovery Plan levels.

d. Increase the awareness of legislators and decision-makers to challenges facing loons in order to encourage informed discussion and actions that protect loons and other wildlife in New Hampshire.

   **Year Three Activities:** LPC staff created and presented a comprehensive report to the New Hampshire Legislature and the NH Fish and Game Commission (appended) on the effects of lead fishing tackle on loons in New Hampshire; supported legislation to create an annual "Loon Appreciation Day" to focus attention on loons and their challenges (this bill was unfortunately tabled); and worked with the Environmental Policy Committee of New Hampshire Audubon to provide information on other issues affecting lakes and loons. LPC is participating in the New Hampshire House Interim Study Committee to investigate effects of lead fishing tackle on loons and will support new "Loon Appreciation Day" legislation when it is introduced in the fall.

e. Investigate new and increasing challenges to loon survival and reproductive success, including but not limited to contaminants in loon eggs and adult loons; increased weather and temperature extremes predicted in global and regional climate change models; and the direct and indirect effects of increasing human populations.

**Year Three Activities:** LPC is continuing its investigation of contaminants in loon eggs collected from failed nests in 2012; continued to band loons and sample blood from live loons to determine the effects of contaminants and pathogens on loon survival and breeding success; and in conjunction with Elizabeth Jackson, an LPC field biologist and University of Vermont student, carried out a pilot study to place motion-activated cameras near nesting loons to document causes of nest failure.

f. Investigate our ability to mitigate these challenges through new management and outreach activities, and enhancements to LPC's current management and outreach efforts.

   **Year Three Activities:** LPC monitored the effectiveness of its expanded site-specific management (rafts, signs, ropelines); furthered its efforts to work with dam owners to maintain stable water levels during critical loon nesting periods by contacting 72 dam owners operating dams on 127 lakes occupied by loons; dramatically increased its traditional and electronic communications through exhibits, presentations, press releases, Facebook and e-Newsletters to inform its members, volunteers and the public about loon life history, challenges, and actions that could help loons; and expanded its end-of-season volunteer appreciation events to thank volunteers, reinforce the value of their efforts, and foster a sense of community among LPC volunteers.

**Expenditures of Blake-Nuttall Grant Funds**

Funding for the Blake-Nuttall Fund was used to pay wages of the Senior Biologist/Executive Director to create and present a report on the effects of lead fishing tackle to the NH Legislature, the NH Fish and Game Commission, and the public ($2,121.16); wages of the Staff Biologist to coordinate expanded field monitoring efforts and carry out field monitoring, loon rescues, and collection of deceased loons ($1,284); and field staff mileage to carry out expanded monitoring, banding, loon rescues, and carcass retrievals ($1,594.84).

# Effects of Lead Fishing Tackle on Loons in New Hampshire, 1989-2010


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During the summer of 2010, Loon Preservation Committee (LPC) staff and volunteers collected 11 loons that died from ingested lead fishing tackle, the highest number LPC has recorded to date. As a result of this record number of lead tackle mortalities, the Loon Preservation Committee, University of Wisconsin-Madison Master of Science graduate Tiffany Grade and Dr. Mark Pokras at Tufts University School of Veterinary Medicine undertook a comprehensive investigation of collected loon mortalities from 1989-2010 to establish: 1) the number of New Hampshire loons that died from lead fishing tackle during that period; 2) the success of New Hampshire's legislation to protect loons from lead fishing tackle mortality; 3) the sizes and types of lead tackle ingested by New Hampshire loons; and 4) the population-level impacts of lead fishing tackle on loons in New Hampshire (Grade 2011).

We found that **50% of the New Hampshire adult loon mortalities LPC collected from 1989-2010 resulted from ingested lead fishing tackle** (Figure 1). In 2000, legislation took effect in New Hampshire to restrict the use *in lakes and ponds* of lead sinkers weighing one ounce or less, and lead-headed jigs measuring less than one inch in length (including the hook). Subsequent legislation to restrict the use of these tackle *in all freshwater* in New Hampshire took effect in 2005, and the *sale* of these tackle was restricted beginning in 2006. Our analysis comparing pre- and post-restriction periods (1989-1999 vs. 2000-2010) found that legislation had slightly reduced the rate of lead tackle mortalities in New Hampshire loons (Figure 2); however, this reduction has not been large enough to protect our loon population, and recently (2006-2010) rates of lead tackle mortalities have begun to rise once again. When we added the average length of jig hooks to the length of the eroded jigheads removed from loons, we found that the majority, and perhaps all, sizes of jigs ingested by New Hampshire loons exceeded current regulations (Figure 3). From 2000-2010, legal-sized jigs comprised 50% of the tackle found inside New Hampshire loons that died from lead tackle (Figure 4).

Loons could ingest lead fishing tackle by ingesting a fish with attached tackle or by striking at tackle or a fish being retrieved through the water. Loons may also mistake a small piece of lead for the pebbles they ingest as grit. Although the typical prey of loons is yellow perch, loons can ingest larger fish (Figure 5; Evers *et al*. 2010), especially those impaired in some way, e.g., by carrying lead tackle (Barr 1996). Dr. Mark Pokras of Tufts University and staff at USGS

National Wildlife Health Center have found fish with attached tackle in loons' digestive tracts (M. Pokras, pers. com., USGS National Wildlife Health Center, unpubl. data).

Our data indicates that **much of the ingested lead tackle in lead-poisoned loons results from current fishing activity**. If loons were ingesting tackle primarily from a reservoir of lead tackle on lake bottoms, we would expect an even distribution of mortalities throughout the time loons are on lakes (mid-April through October). However, lead tackle mortalities peak at a highly significant level in July and August, coincident with the peak of summer fishing and tourist season (Figure 6). We found associated tackle (hook, line, swivel, leader) in 66% of loons with ingested jigs and/or sinkers, also indicating ingestion from current fishing activity. Therefore, continued New Hampshire loon mortality from ingested lead tackle is a result of an inadequately protective standard for lead-headed jigs and inadequate compliance with New Hampshire's legislation restricting use of small lead sinkers.

The majority of jigheads removed from New Hampshire loons weigh less than 0.4 oz. However, these eroded jigheads are missing the hook, broken off in the gizzard soon after ingestion, and enough of the mass of lead to fatally poison the loon (Figure 7). Cook and Trainer (1966) found that 66% of the volume of lead shot in the gizzard of Canada geese dissolved within three days of ingestion. Larger jigs would lose a lower percentage of total volume in the same period but are also resident in the gizzard for a much longer time (estimated 2-4 weeks) before death. Therefore, the mass of the entire jig at ingestion would be greater, perhaps by a substantial amount. Restricting use and sale of lead–headed jigs less than 2.5" long (equivalent to ¾ oz jigs) would be protective of most loons (Figure 8).

**Lead fishing tackle is having a population-level impact on New Hampshire's loons**. Lead tackle is the largest contributor to documented adult loon mortality in the state (Figure 1). Our data and methods have produced a conservative assessment of loon mortality from ingested lead tackle; therefore, the data we present should be regarded as minimum numbers.

The growth of New Hampshire's loon population since 1975, despite high levels of human-caused mortalities, has been accomplished through intensive management supported by the extensive contributions of a dedicated corps of volunteers. This exceptional effort has helped loons to overcome some of the negative consequences of human activities over the past 37 years. One of the most evident and successful of LPC's management activities is the provision of artificial nesting rafts to loon pairs. **Despite record numbers of nesting rafts floated by LPC staff and volunteers from 2006-2010 (a total of 359 rafts floated), the benefit to our loon population of our intensive raft program was entirely negated by 34 pieces of lead fishing tackle.**

New Hampshire's loon population is not self-sustaining and is dependent on LPC's intensive management for its persistence. Despite record levels of management and outreach, New Hampshire's loons have achieved the minimum reproductive success required to sustain their population in only one of the past six years (Figure 9). The population remains far below its estimated historical abundance and carrying capacity (Figure 10) and the challenges facing loons continue to grow in number and in scope. Population declines would initially result in decreased numbers of juveniles and unpaired loons—segments of the population difficult to monitor and quantify—and would eventually become evident in numbers of paired adults. LPC's statewide loon count in 2011 showed a drop in paired adults (Figure 10); this result is not surprising given the recent poor reproductive success of our loons, declining survival rates among adult loons (<0.915 since 2002), and the high number of lead tackle mortalities from 2006-2010.

Loon life history is characterized by low rates of natural adult mortality, delayed maturation (average age of first breeding is 6-7 years), and low productivity (an average of about ½ a chick per pair, per year in New Hampshire). Adult survival is by far the largest factor influencing the growth and viability of New Hampshire's loon population (Figure 11); therefore, limiting adult mortality is of prime importance to the continued viability of loon populations. The combination of lead tackle as the largest source of known adult mortality (Figure 1) and the critical importance of adult survival for loon population growth (Figure 11) makes lead tackle the largest quantifiable factor limiting the recovery of New Hampshire's loon population (Figure 12).

Multiple analyses suggest that lead fishing tackle is having a population-level impact on the New Hampshire loon population: 1) An analysis using the model published in Grear *et al.* (2009) indicates that the current population in the state is significantly ($p<0.01$) lower than the projected population had the loons that died from lead tackle survived; 2) Population simulations based on Grear *et al*.'s (2009) loon population model suggest that, at current (2006-2010) levels of lead tackle mortality and reproductive success, New Hampshire's loon population is already experiencing a decline that will in time become evident in numbers of paired adults; 3) Ingested lead fishing tackle caused the deaths of <u>at least</u> 1.1% of the total adult loon population each year over the period of our study (Figure 13), which exceeds the calculated annual maximum sustainable level for all human-caused mortalities for loons (0.41% of the New Hampshire population; see Dillingham and Fletcher 2008); 4) The population viability analysis in LPC's Loon Recovery Plan projects a declining population, even at current levels of intensive management and outreach.

The declining population projected in LPC's Loon Recovery Plan is based on published loon life history parameters, quantified stressors, and current levels of management. This projection should be considered optimistic given our limited knowledge and likely underestimation of the effects of present and future stressors and uncertainty about our ability to maintain and expand our research, management and outreach programs. This uncertain outlook makes it of prime importance to bolster New Hampshire's loon population against future stressors by addressing critical issues like lead fishing tackle that can be mitigated through relatively simple measures like material substitutions. Lead fishing tackle ingestion has been documented in 28 other bird species, including bald eagles, great blue herons, and many species of waterfowl; therefore, such measures would protect a host of other species as well.

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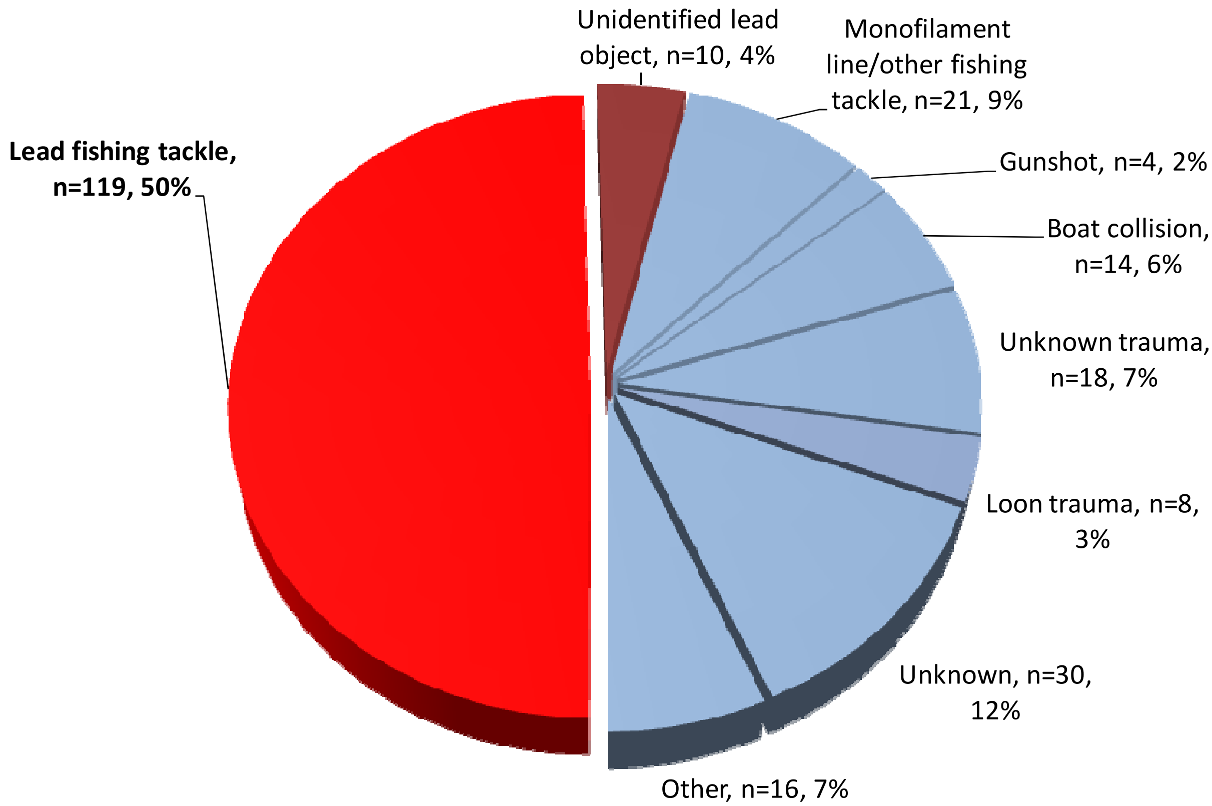


Figure 1. Lead fishing tackle is responsible for **50%** of documented New Hampshire adult loon mortalities from 1989-2010.

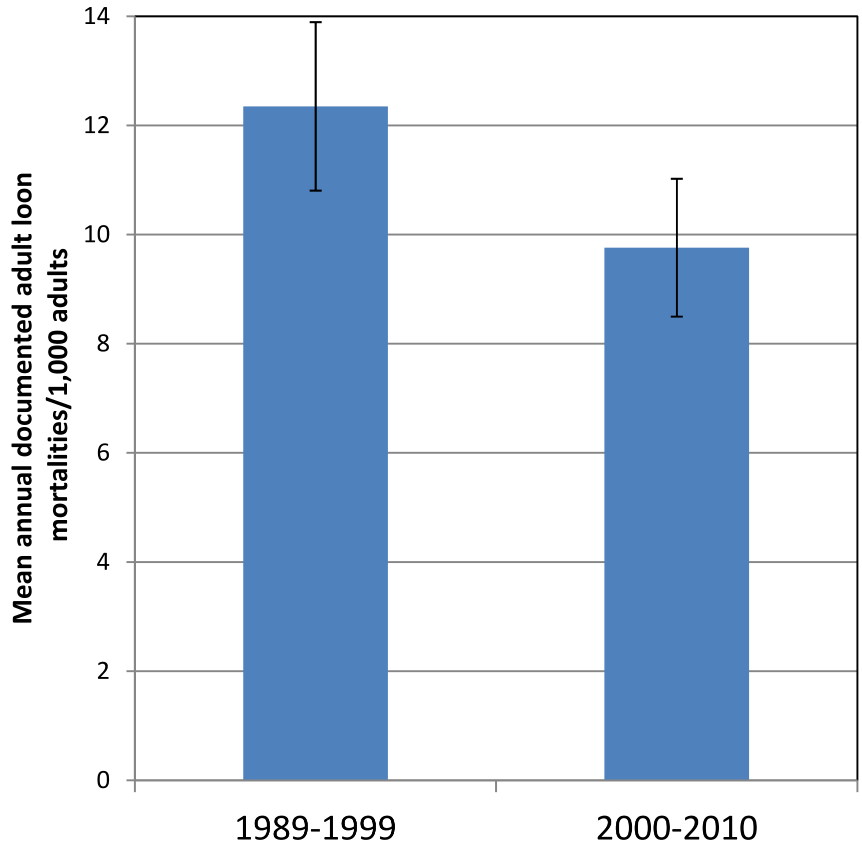


Figure 2. Mean documented mortality rates for pre-lead restriction period (1989-1999) and post-lead restriction period (2000-2010) show that New Hampshire's legislation has not significantly (P=0.37) reduced mortalities from ingested lead fishing tackle. Error bars are standard errors.

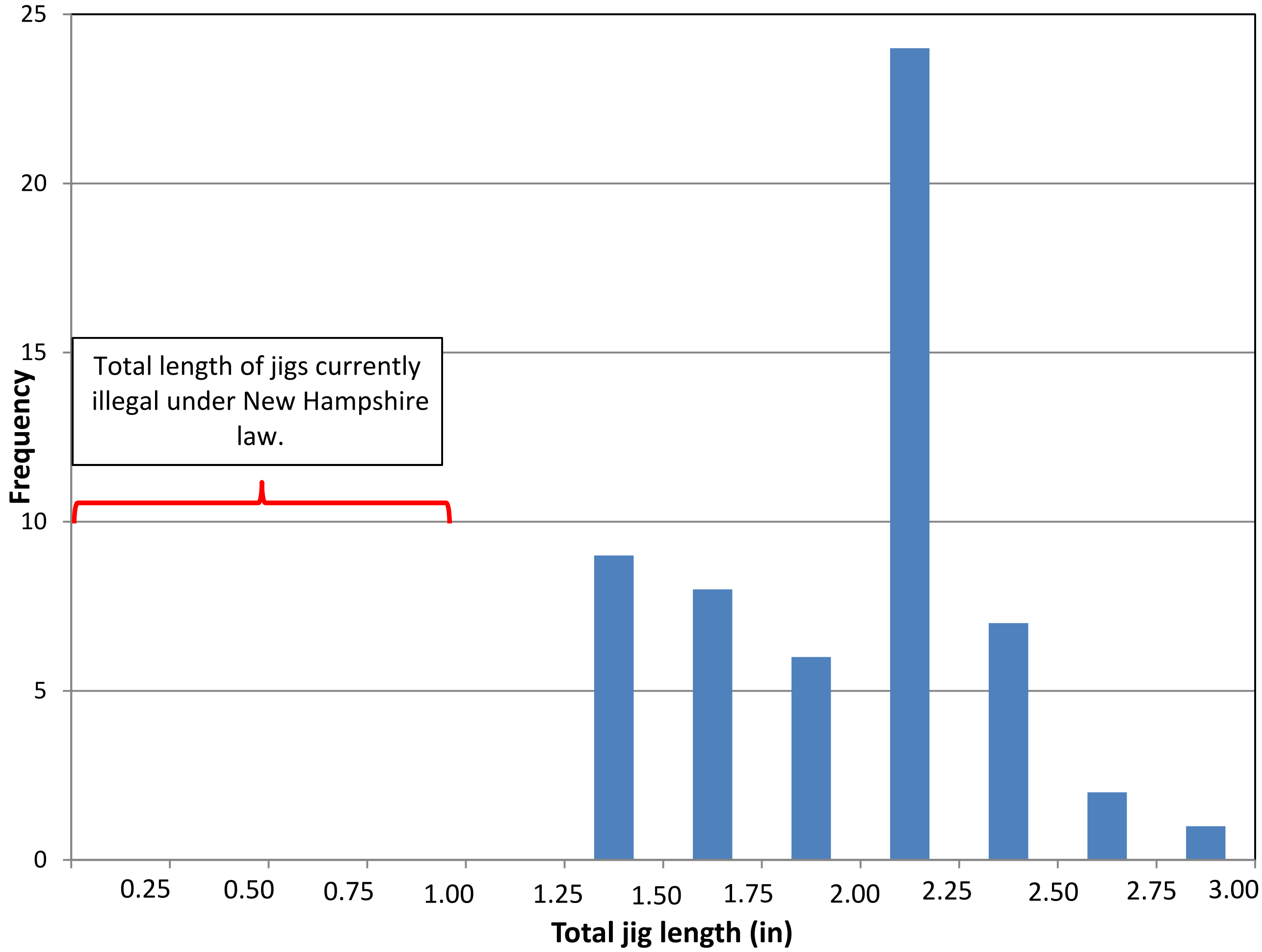


Figure 3: The total length of jigs ingested by New Hampshire loons from 1989-2010 exceeds the current standards. Extrapolated length of original jig=length of eroded jighead removed from each loon + average length of hook of purchased jigs from each size category.  Total N of purchased jigs=45.

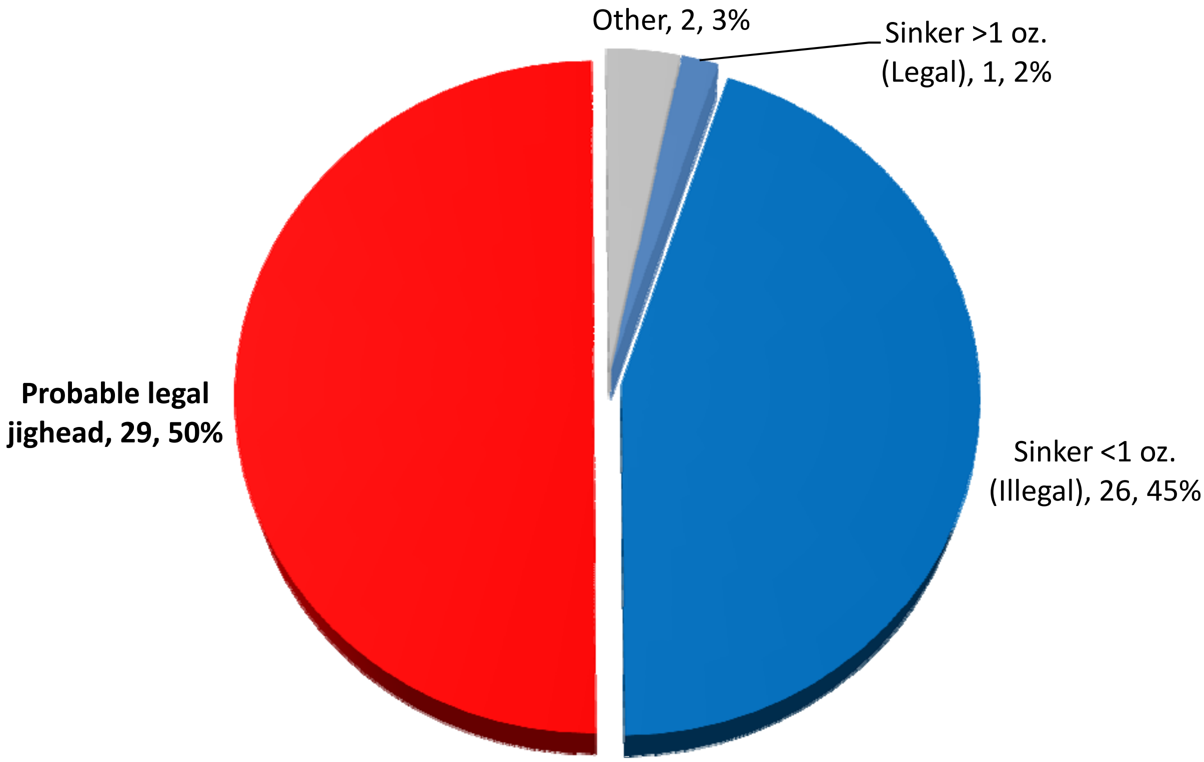


Figure 4. Recent (2000-2010) mortality of New Hampshire loons from ingested lead tackle is a result of an inadequate standard for lead-headed jigs (large red slice) and poor compliance with lead sinker legislation (large blue slice).

Figure 5. Loons will ingest fish larger than 12”, providing a clear mechanism for the ingestion of large-sized jigs and sinkers that may be attached to these fish.

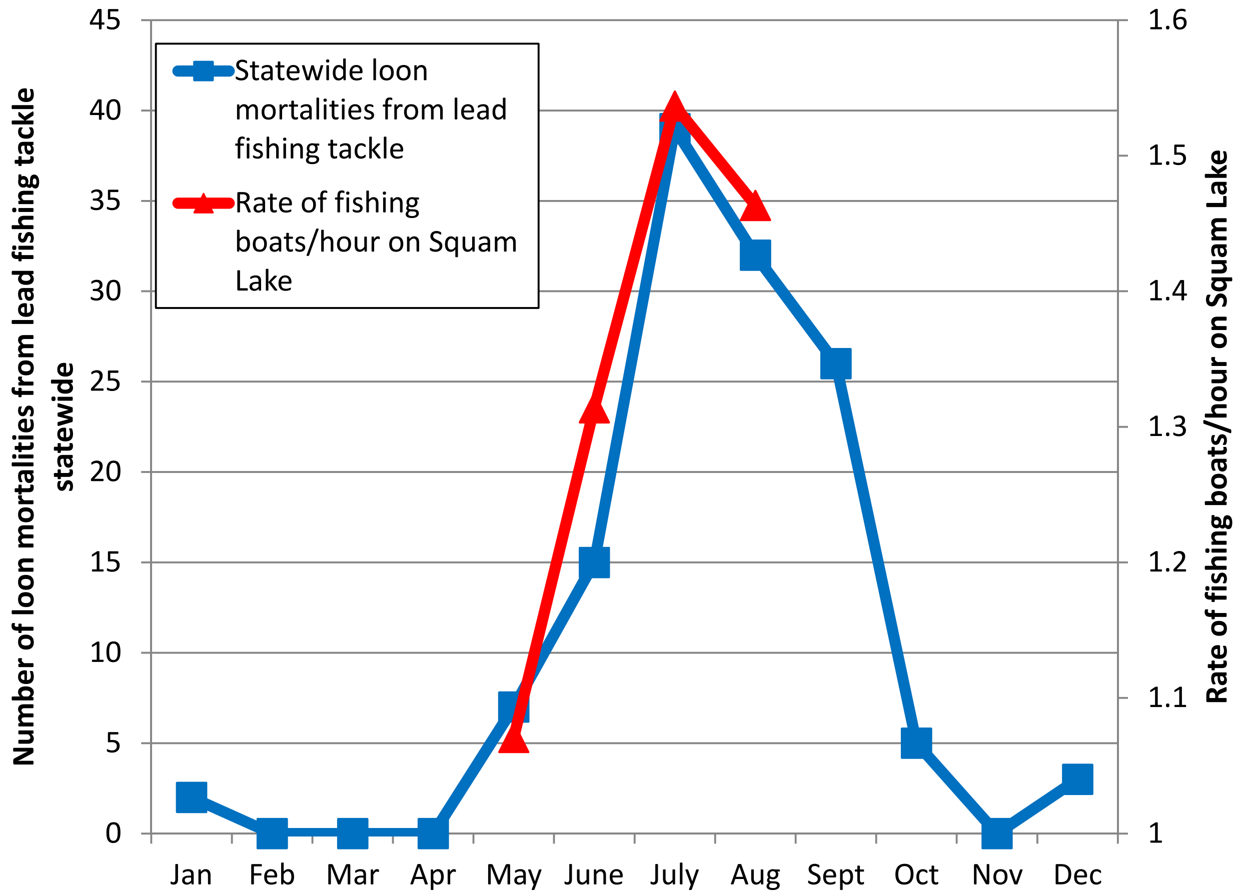


Figure 6. The timing of loon mortalities from ingested lead fishing tackle and of fishing activity indicates that mortalities result from current use rather than a reservoir of tackle on lake bottoms. The boating survey shown here, using Squam Lake as a metric for statewide fishing activity, is the most extensive survey of fishing activity undertaken in New Hampshire.

Figure 7.  A plume of eroded lead leaching from a jig ingested by a loon.  Lead eroded from ingested tackle enters the loon's system and causes lead poisoning and death.

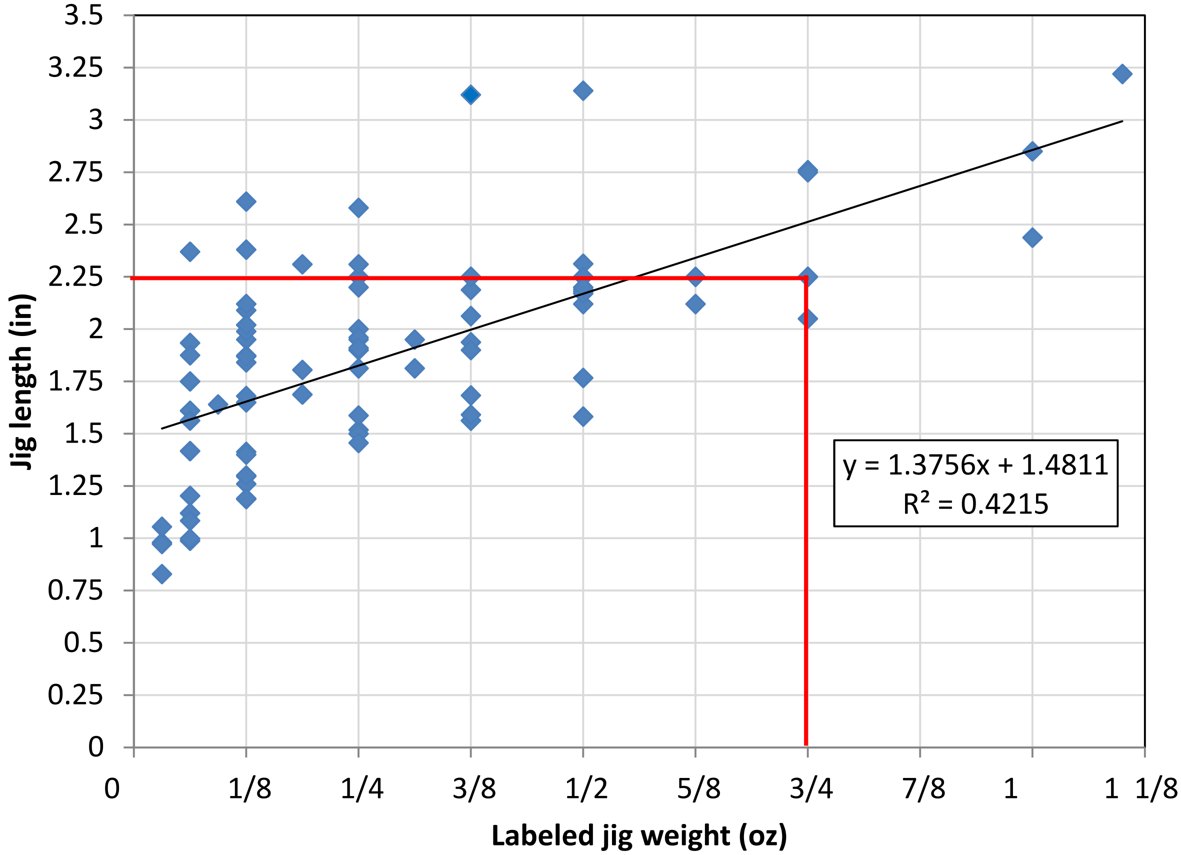


Figure 8. Regression of weight and length of purchased fishing jigs indicates that restricting use and sale of lead–headed jigs of ¾ ounce or less and less than 2.5” long would be protective of most (not all) loons.

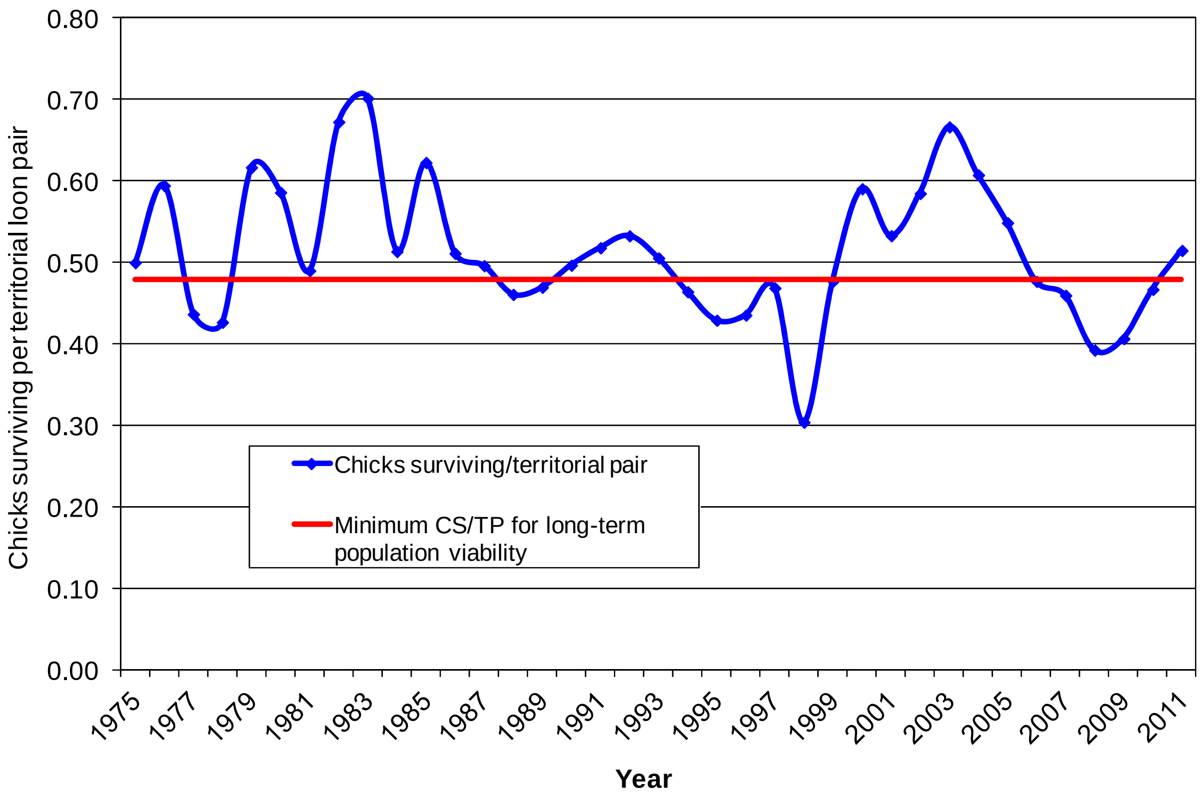


Figure 9. Loon breeding success has been below rates needed to maintain a stable population for five of the past six years, despite record levels of management and outreach in New Hampshire.

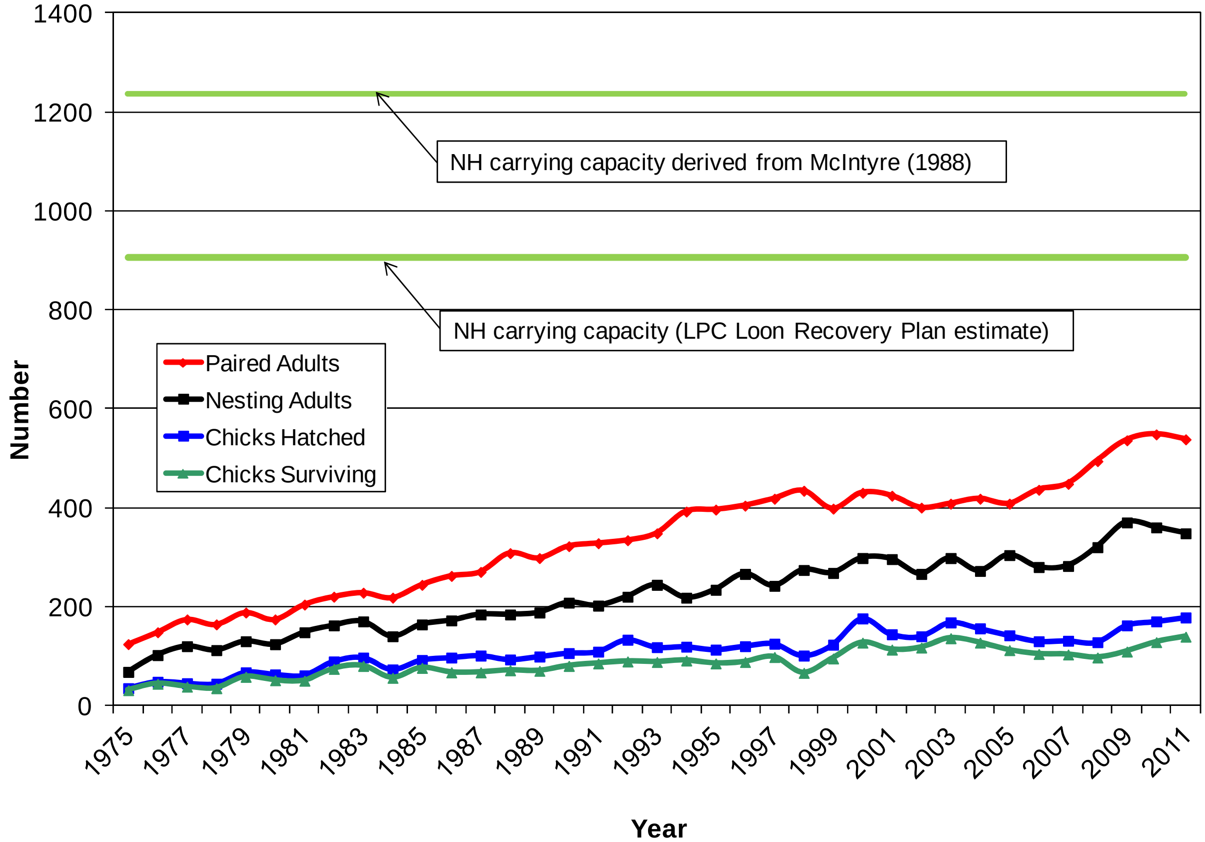


Figure 10. Paired adult loons are far below estimates of New Hampshire's carrying capacity and declined in 2011 after recent declines in productivity (chicks surviving per territorial pair) and high adult mortality from ingested lead tackle. These declines occurred despite record levels of management and outreach to increase productivity and decrease adult mortality.

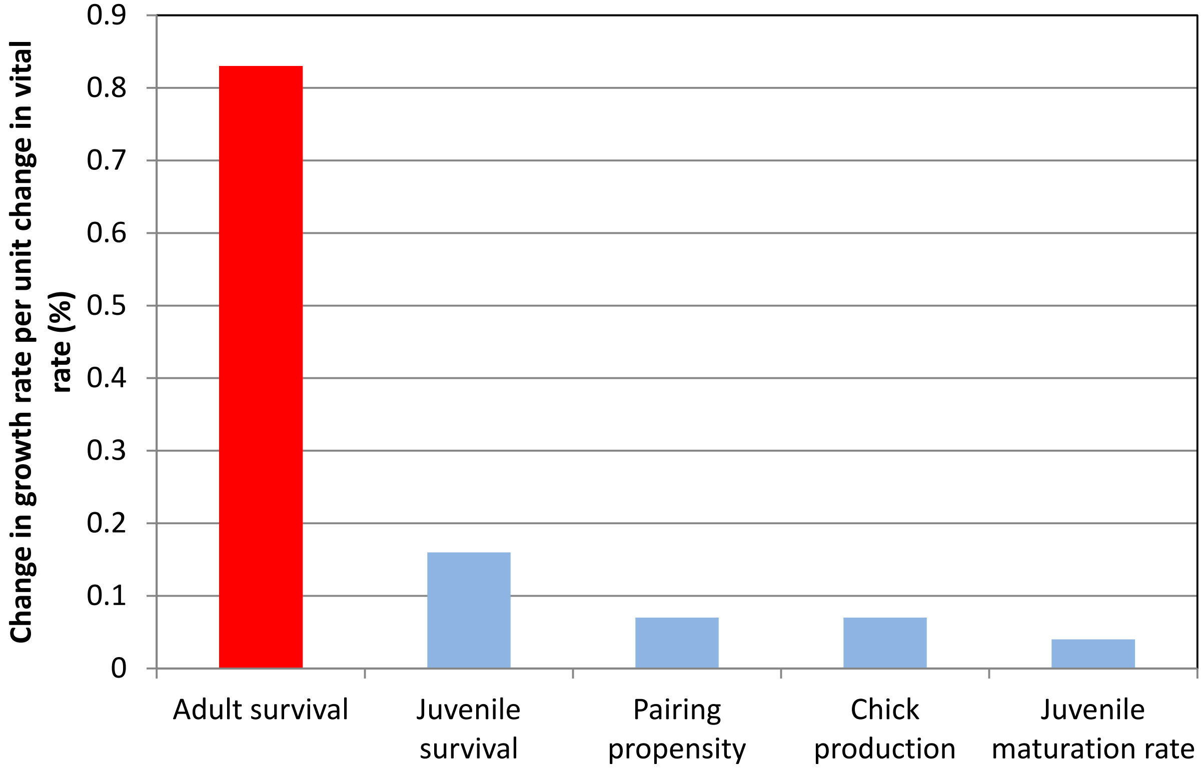


Figure 11. The impact of different Common Loon vital rates on the growth rate of New Hampshire's loon population. This graph demonstrates the overwhelming importance of adult survival in maintaining a viable loon population (Grear *et al*. 2009).

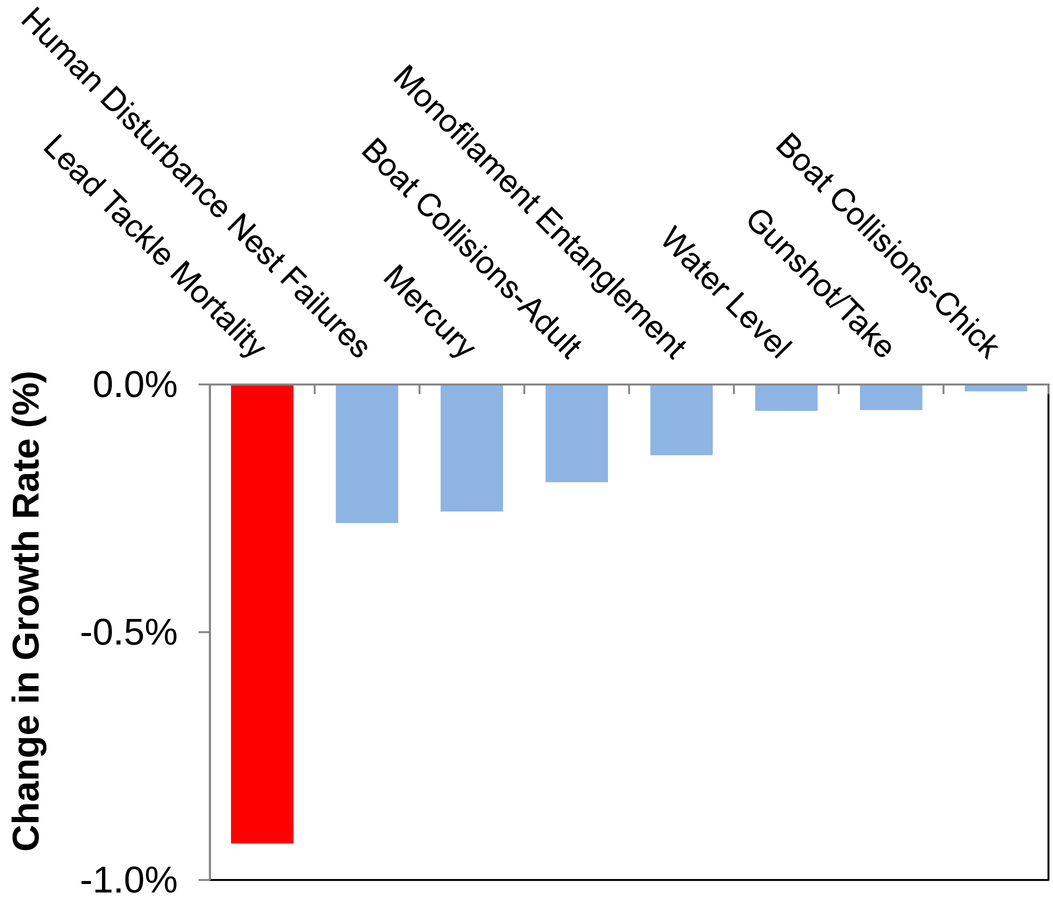


Figure 12. Lead is by far the largest quantifiable factor decreasing the growth rate of New Hampshire's loon population.*

*This figure provides estimates of stressor impacts on the New Hampshire loon population growth rate. Values reflect the difference between current conditions and a baseline unimpaired state, (the absence or complete mitigation of the stressor). Impacts were derived by applying the observed extent and unit impact of individual stressors to demographic vital rates in a population model developed for loons (Grear *et al.* 2009). For mortality stressors like lead poisoning, the observed mortality rate from the stressor (e.g., 11.1 loons per thousand loons per year (1989-2010) for lead tackle) was reduced by the observed background mortality rate (8%) before deriving the population growth rate impact. This offers a conservative estimate by allowing for natural mortalities—loons that might have died from other causes if they had not been killed by the stressor in question.

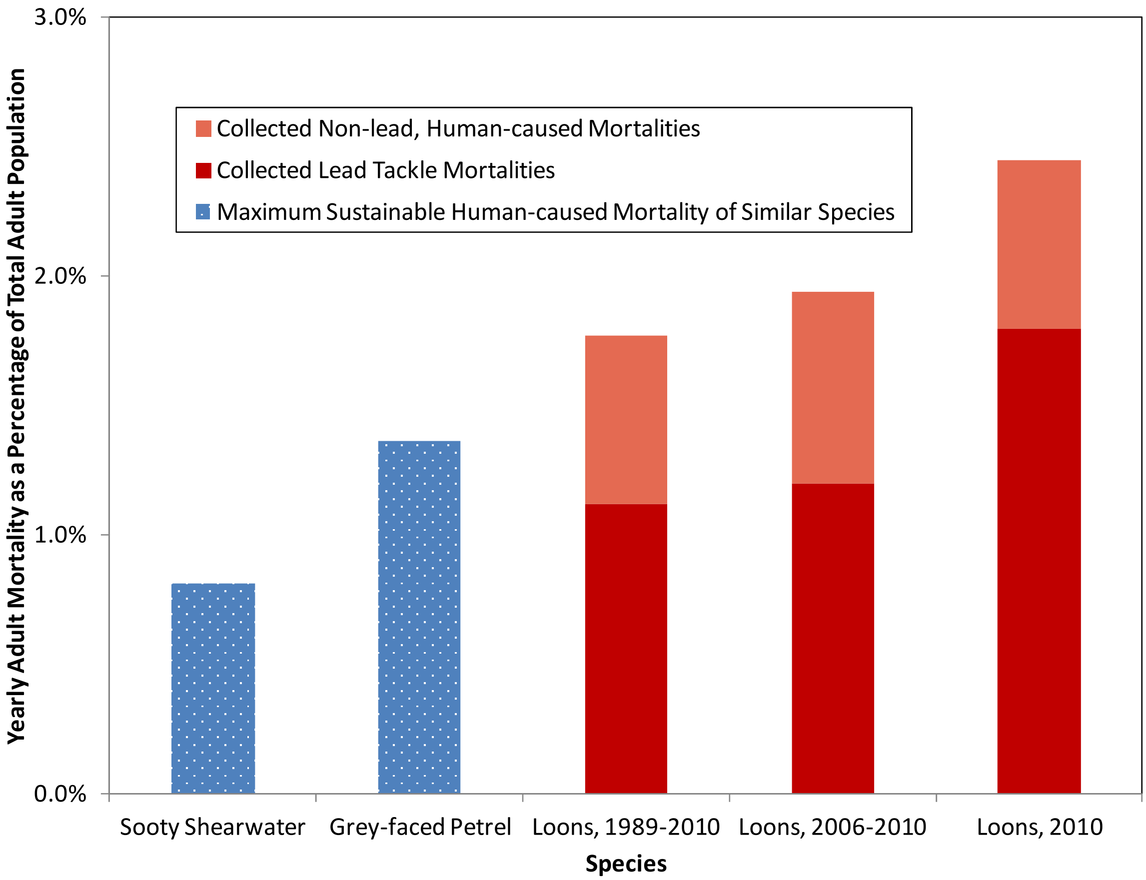


Figure 13. Lead has a population-level impact on loons in New Hampshire. Collected adult loon mortalties as a percent of total adult population indicate that yearly collected lead mortalties are approaching or exceeding sustainable levels for New Hampshire's loon population. These are conservative estimates of actual adult loon mortality.