Effects of Lead Fishing Tackle on Loons in New Hampshire, 1989-2011

Loon Preservation Committee
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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 graduate student 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). This report updates this study with loon mortality data collected in 2011—the most recent year for which results are available.

Loon Mortality from Lead Fishing Tackle in New Hampshire

We found that **49% of New Hampshire adult loon mortalities LPC collected from 1989-2011 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 total 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. 2000-2011) found that the rate of lead fishing tackle mortalities in New Hampshire loons fell subsequent to these restrictions (Figure 2); however, this reduction has not been large enough to protect our loon population, and recently (2006-2011) rates of lead tackle mortalities have begun to rise once again.

Loons can ingest lead fishing tackle by ingesting a fish with attached tackle or by striking at tackle or a fish being retrieved through the water. In a small number of cases, loons may also ingest a small sinker after mistaking it for the pebbles they ingest as grit. Although the typical prey of loons is yellow perch, loons can ingest larger fish (Figure 3; Evers *et al*. 2010), especially those impaired in some way, e.g., by attached 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 indicate 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 are strongly correlated with the peak of summer fishing and tourist season in July and August ($p=0.00005$; Figure 4). 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.

Ingested jigheads removed from dead loons are missing the hook, which breaks off in the gizzard soon after ingestion. When we added the average length of jig hooks to the length of the eroded jigheads removed from loons, we found that sizes of jigs ingested by New Hampshire loons exceeded one inch in total length and, therefore, were <u>legal</u> for sale and use in New Hampshire (Figure 5). **From 2000-2011, legal-sized jigs comprised 52% of the tackle found inside New Hampshire loons that died from lead tackle** (Figure 6). Therefore, recent (2000 to 2011) mortality of New Hampshire loons 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 jig<u>heads</u> removed from New Hampshire loons weigh less than 0.4 oz (Figure 7). However, these eroded jigheads are missing the hook and enough of the mass of lead to fatally poison the loon (Figure 8). 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 a loon's 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. The largest reported piece of lead fishing tackle removed from a Common Loon to date weighed 2.76 oz (a lead sinker swallowed by a loon in North Carolina; Franson *et al.* 2003). The weights of eroded tackle objects removed from loons in New Hampshire indicate that restricting the use and sale of lead sinkers and lead–headed jigs weighing 1 oz or less would be protective of most loons.

<u>Population-level Impacts of Lead Fishing Tackle on New Hampshire's Loons</u>

Lead tackle is the largest contributor to documented New Hampshire adult loon mortality in the state and is responsible for the deaths of 124 adult loons since 1989 (Figure 1). LPC collects 28% to 31% of total expected loon mortalities (Sidor *et al.* 2003; Grade 2011). 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. **Actual loon mortalities from ingested lead tackle are likely much higher than we report.**

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 9); therefore, limiting adult mortality is of prime importance to the continued viability of loon populations (Grear *et al.* 2009; Meyer 2006). 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 9) makes lead tackle the largest quantifiable factor limiting the recovery of New Hampshire's loon population (Figure 10).

Multiple analyses suggest that **lead fishing tackle is having a population-level impact on the New Hampshire loon population:** 1) An analysis using the loon population model published in Grear *et al.* (2009) indicates that New Hampshire's loon population is approximately 13-17% lower than the projected population had the loons that died from lead tackle survived; 2) Ingested lead fishing tackle is known to have caused the deaths of an average of 1.1% of the total adult loon population each year (Figure 11), which exceeds the maximum sustainable level for all human-caused mortalities for loons of 0.43% (see Dillingham and Fletcher 2008); 3) LPC's Loon Recovery Plan projects a long-term decline in New Hampshire's loon population, even at recent (2006-2010) levels of intensive management and outreach (LPC, 2011). Lead fishing tackle is the largest quantifiable factor causing this projected decline (Figure 10).

The loon population projection in LPC's Loon Recovery Plan is based on published loon life history parameters, quantified stressors, and current levels of management. It 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.

<u>Lead Fishing Tackle and the Challenge of Preserving Loons</u>

The growth of New Hampshire's loon population since 1975, despite high levels of human-caused mortalities, has been achieved 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 38 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 2006-2011 (a total of 276 rafts floated), the benefit to our loon population of our intensive raft program was entirely negated by 38 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 two of the past seven years (Figure 12). The loon population remains far below its estimated historical abundance and carrying capacity (Figure 13) 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 impacts to the number of paired adults would appear only after several years. LPC's statewide loon count in 2011 showed a drop in paired adults (Figure 13) after a high number of lead tackle mortalities from 2006-2010 and poor reproductive success of our loons over the same period.

Loons continue to face an uncertain future in New Hampshire, which makes it of prime importance to bolster our state'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. Limiting the sale and use of lead fishing tackle would also protect a host of other species in addition to loons. Lead fishing tackle ingestion has been documented in 28 other bird species, including bald eagles, great blue herons, and many species of waterfowl (Franson *et al.* 2003; Scheuhammer *et al.* 2002), and the Environmental Protection Agency considers 75 species to be susceptible to lead fishing tackle ingestion (US EPA 1994).

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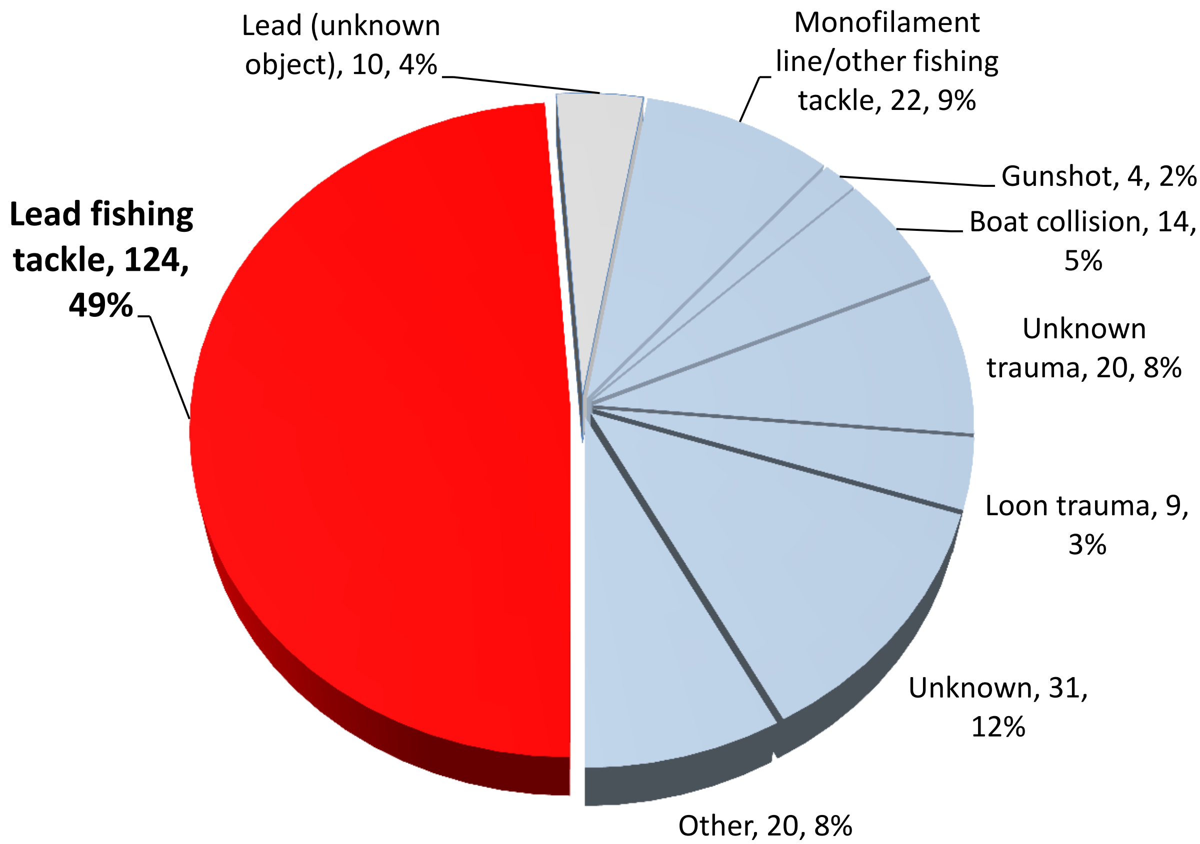

Figure 1. Lead fishing tackle is responsible for **49%** of documented New Hampshire adult loon mortalities from 1989-2011.

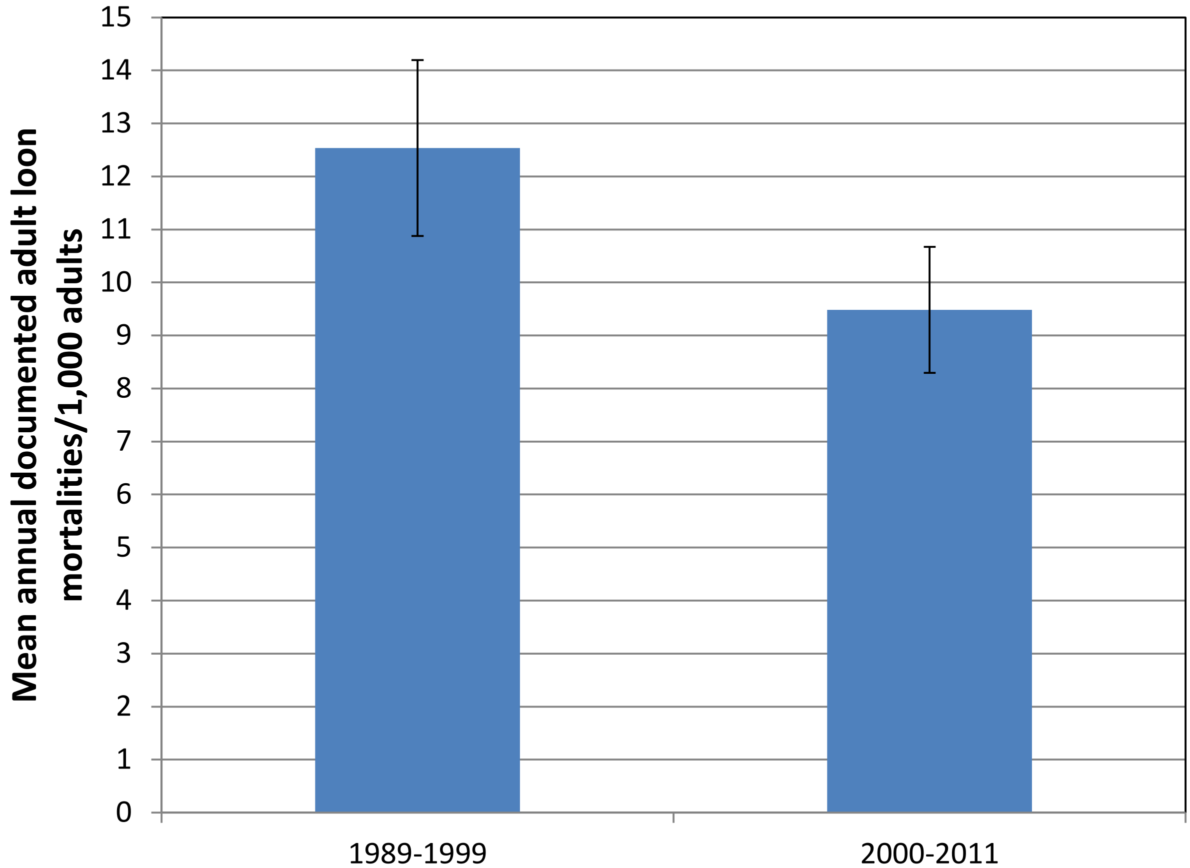

Figure 2. Mean documented mortality rates for pre-lead restriction period (1989-1999) and post-lead restriction period (2000-2011) show that mortalities from ingested lead fishing tackle have declined slightly since 2000; however, this reduction is not statistically significant (p=0.15). Error bars are standard errors.

Figure 3. Loons will ingest fish larger than 12" (Evers *et al*. 2010), providing a clear mechanism for the ingestion of large-sized jigs and sinkers that may be attached to these fish.

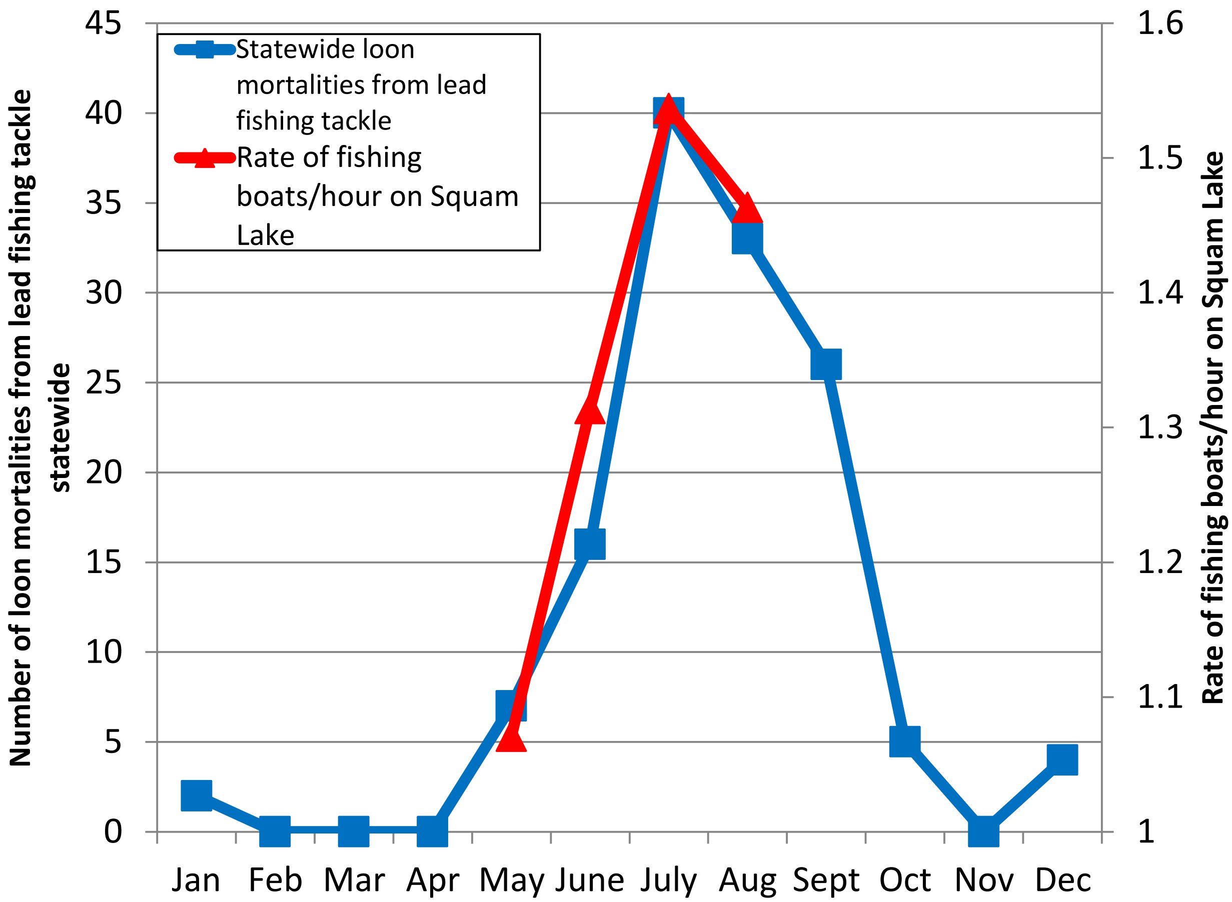

Figure 4. The timing of loon mortalities from ingested lead fishing tackle and of fishing activity indicates that mortalities result from current use rather than a reservoir of tackle on lake bottoms. The boating survey shown here, using Squam Lake as a metric for statewide fishing activity, is the most extensive survey of fishing activity undertaken in New Hampshire.

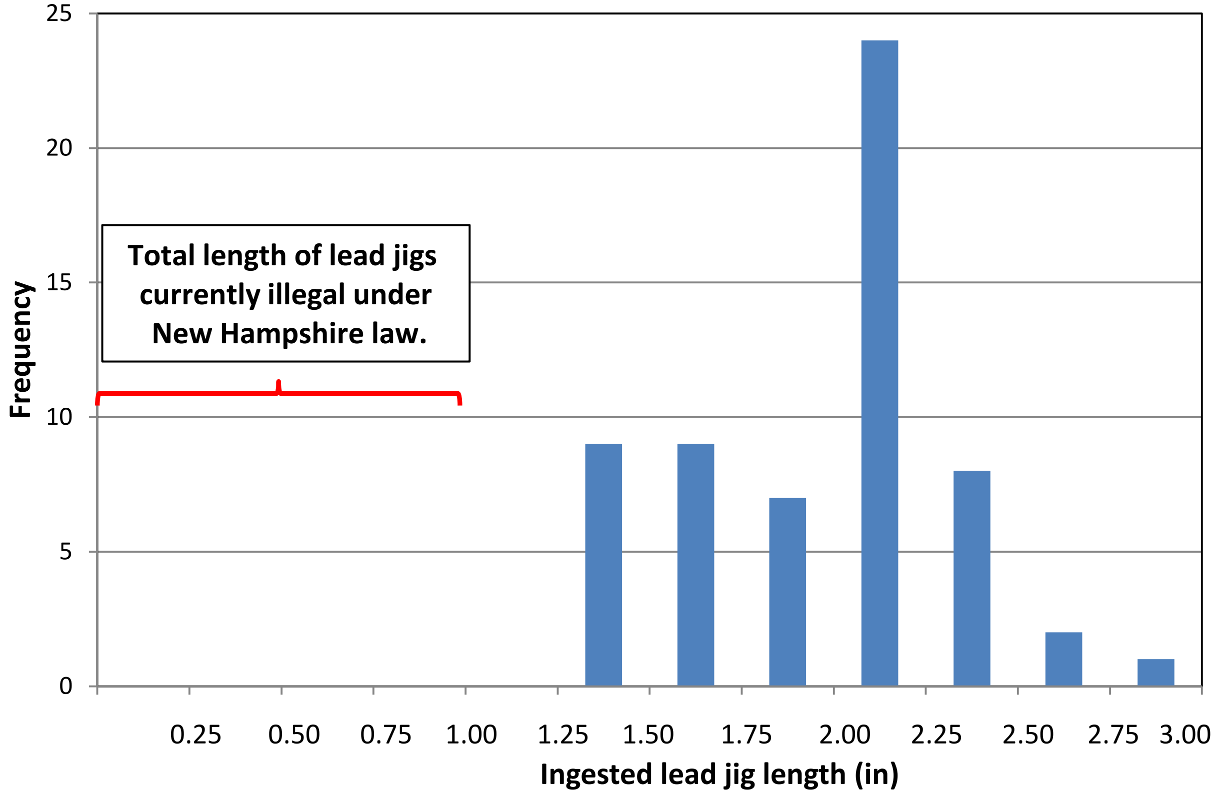

Figure 5. The sizes of jigs ingested by New Hampshire loons from 1989-2011 exceed the sizes currently banned in New Hampshire. Length of ingested jig length=length of eroded jighead removed from each loon + average length of hook of purchased jigs from each size category. Total number of purchased jigs=57.

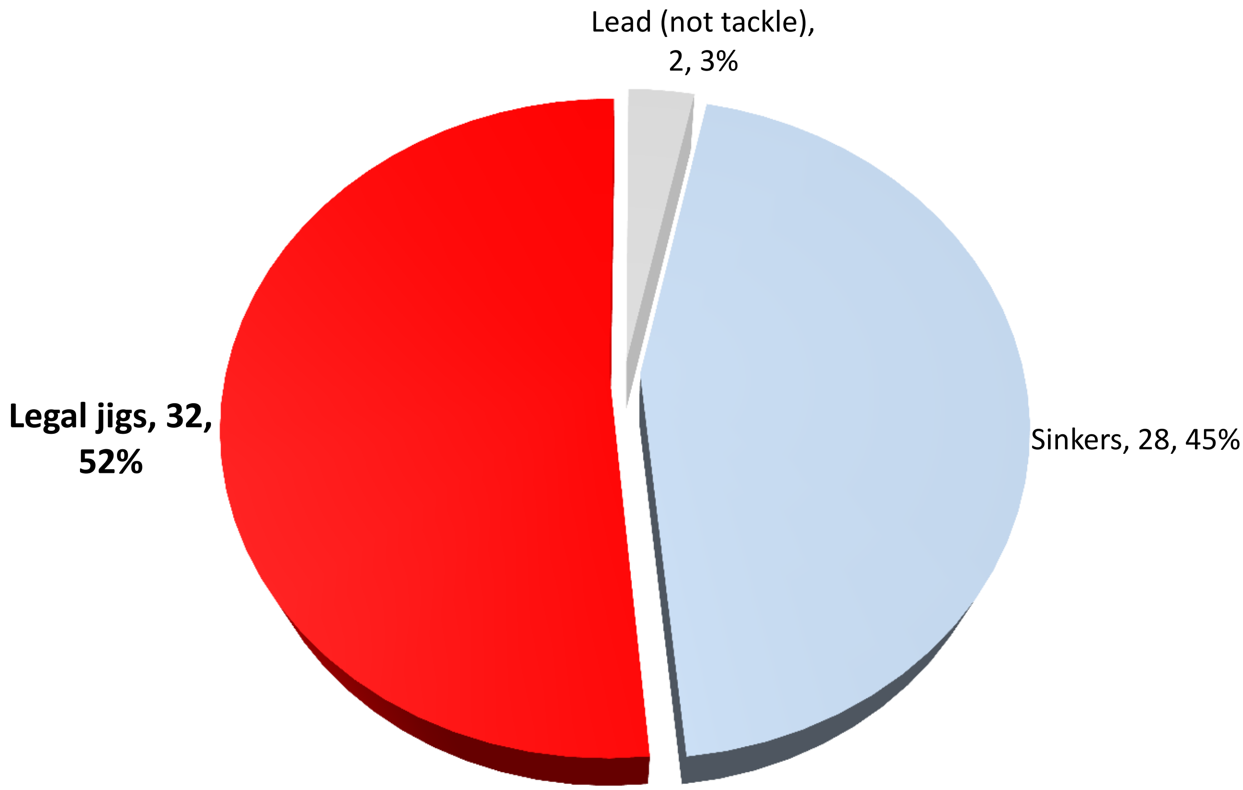

Figure 6. Recent (2000-2011) mortality of New Hampshire loons from ingested lead tackle is a result of an inadequate standard for lead-headed jigs (red slice) and poor compliance with lead sinker legislation (blue slice).

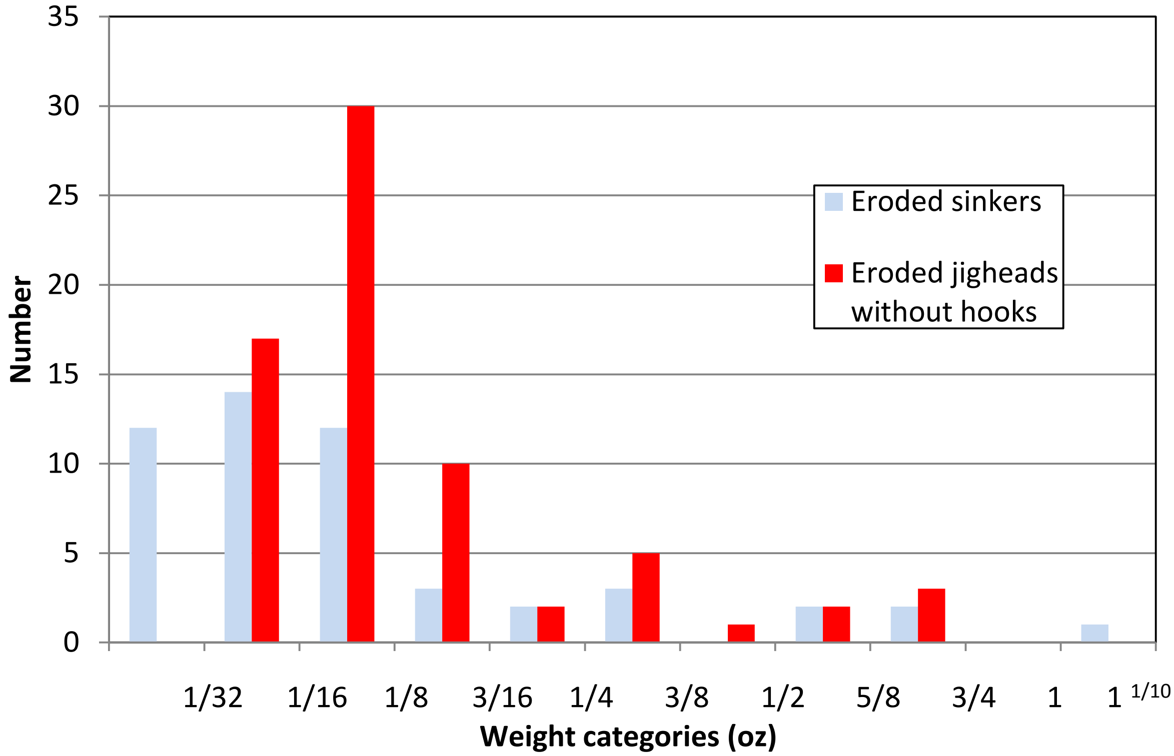

Figure 7. Weights of eroded lead sinkers and lead jigheads (without hooks) removed from loons in New Hampshire. Eroded tackle removed from loons indicates that restricting use and sale of lead sinkers and lead–headed jigs weighing 1 ounce or less would be protective of most (not all) loons.

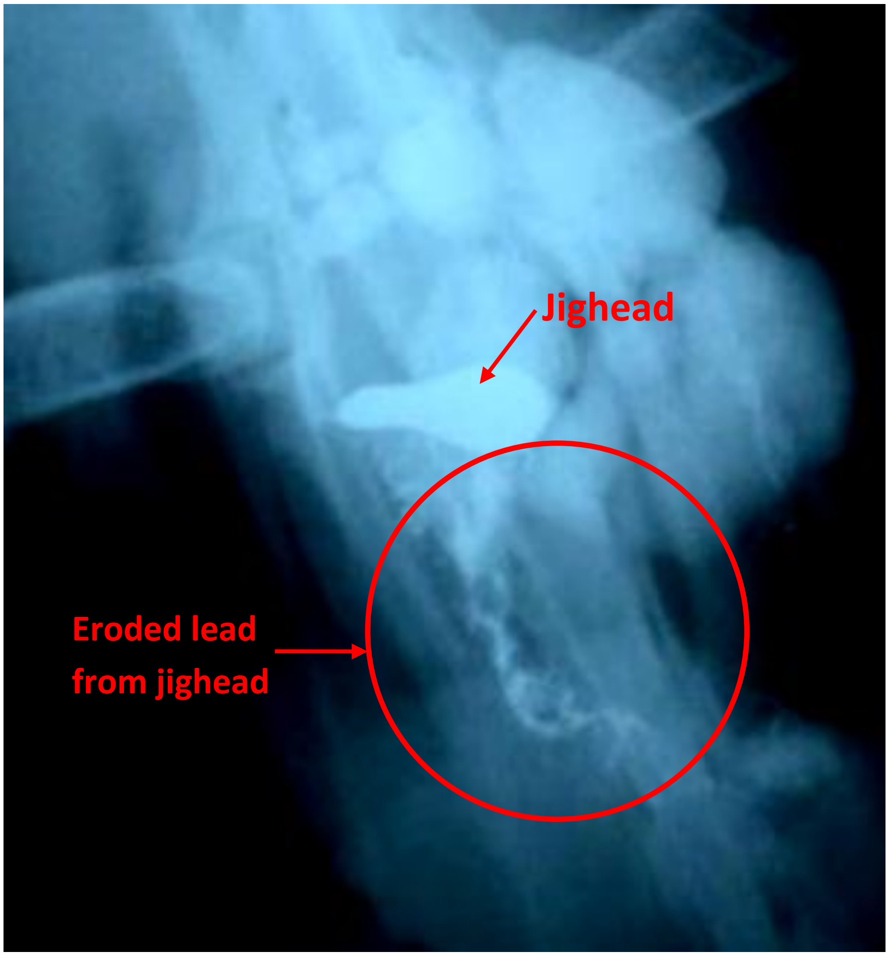

Figure 8. A plume of eroded lead leaching from a jig ingested by a loon. Lead eroded from ingested tackle enters the loon's system and causes lead poisoning and death.

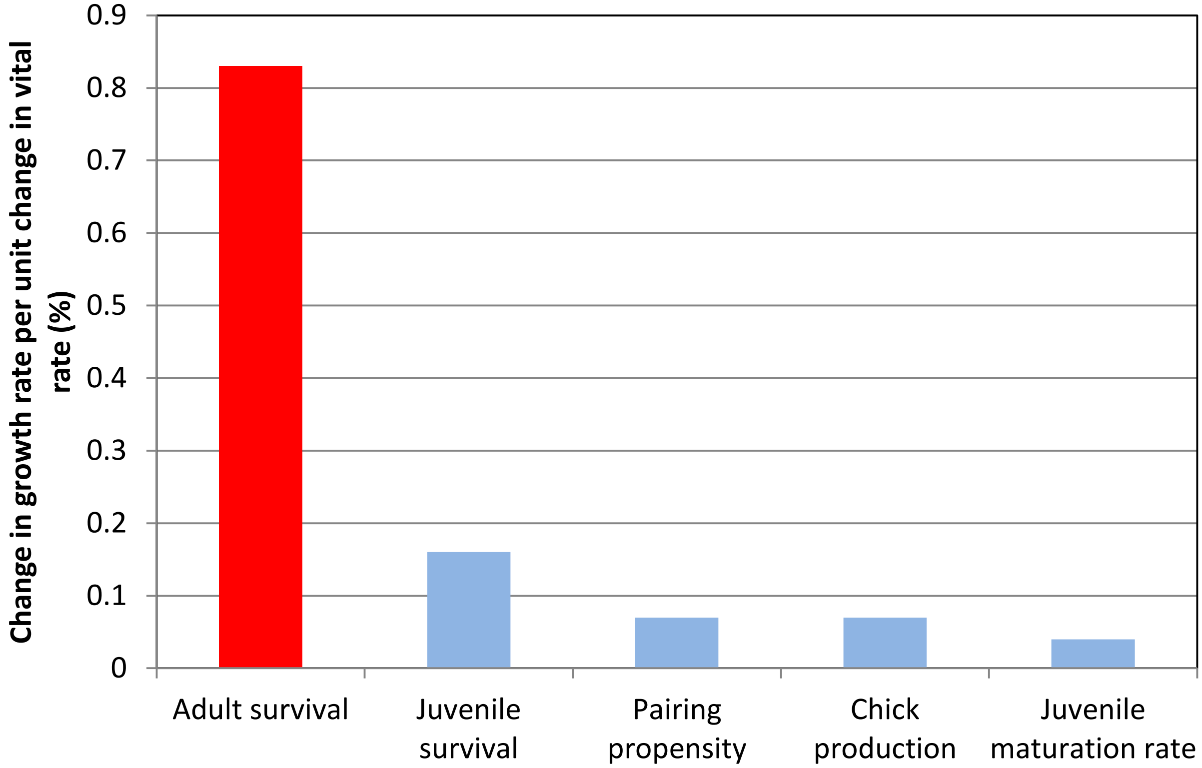

Figure 9. The impact of different Common Loon vital rates on the growth rate of New Hampshire's loon population. This graph demonstrates the overwhelming importance of adult survival in maintaining a viable loon population (Grear *et al*. 2009).

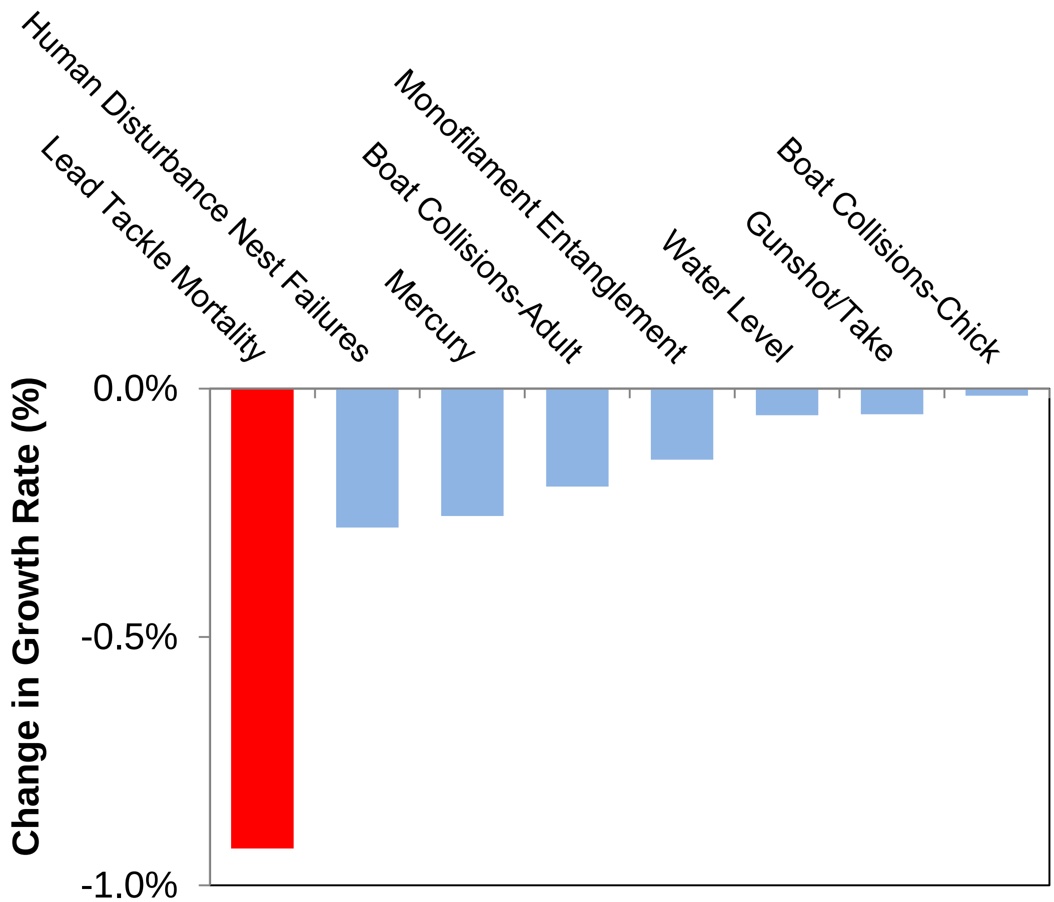

Figure 10. Lead is by far the largest quantifiable factor decreasing the growth rate of New Hampshire's loon population.*

*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., 10.9 loons per thousand loons per year (1989-2011) 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.

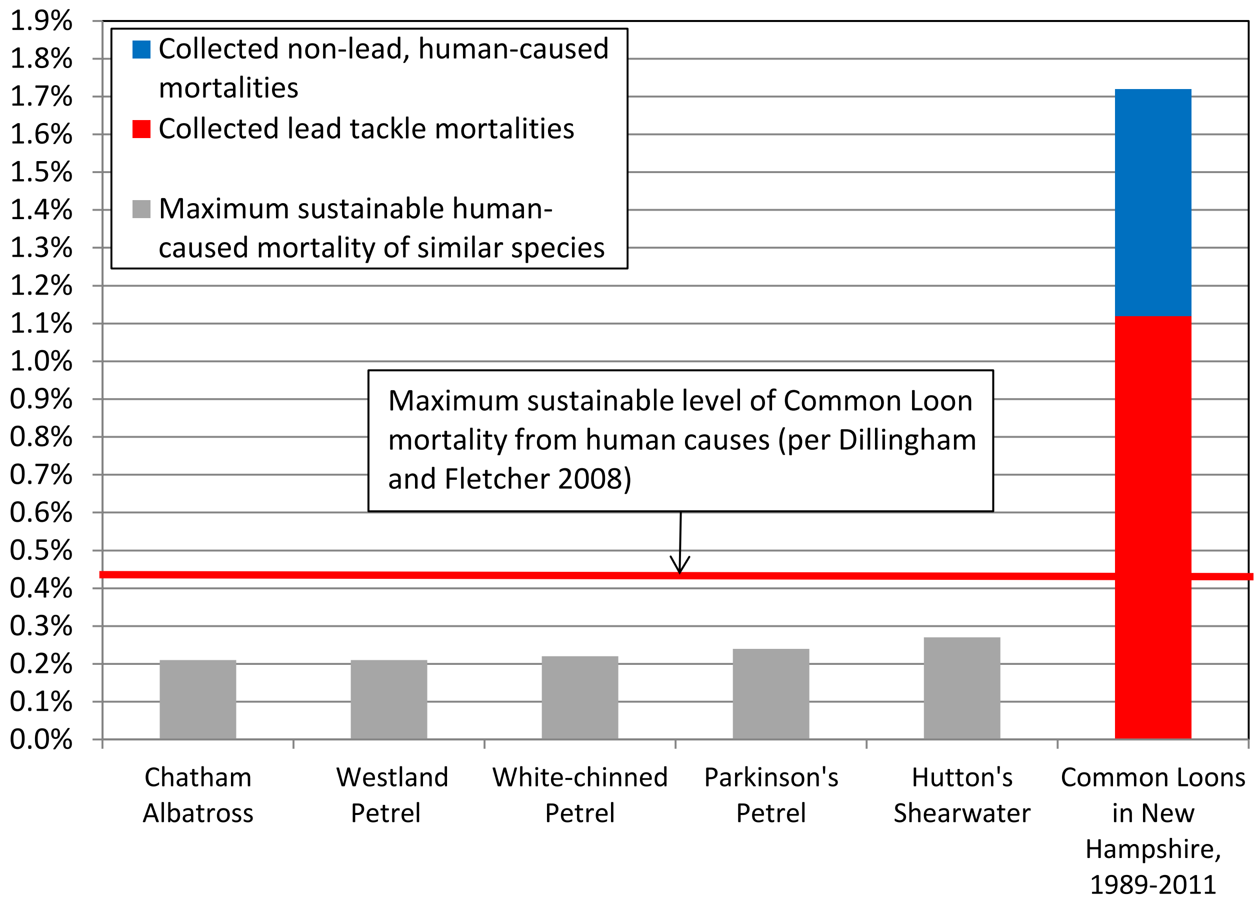

Figure 11. Lead has a population-level impact on loons in New Hampshire. Collected adult loon mortalties as a percent of total adult population indicate that yearly collected lead mortalties are approaching or exceeding sustainable levels for New Hampshire's loon population. These are conservative estimates of actual adult loon mortality. The gray bars show the maximum sustainable levels of human-caused mortality for closely related species with similar life history characteristics* (Dillingham and Fletcher 2011).

* All species have an annual breeding cycle, a lifespan of 15-30 years, a breeding success rate of 0.2-0.62 chicks/year, and begin breeding between 4-8 years of age (BirdLife International 2013; Agreement on the Conservation of Albatrosses and Petrels 2010; Agreement on the Conservation of Albatrosses and Petrels 2009; del Hoyo *et al.* 1992).

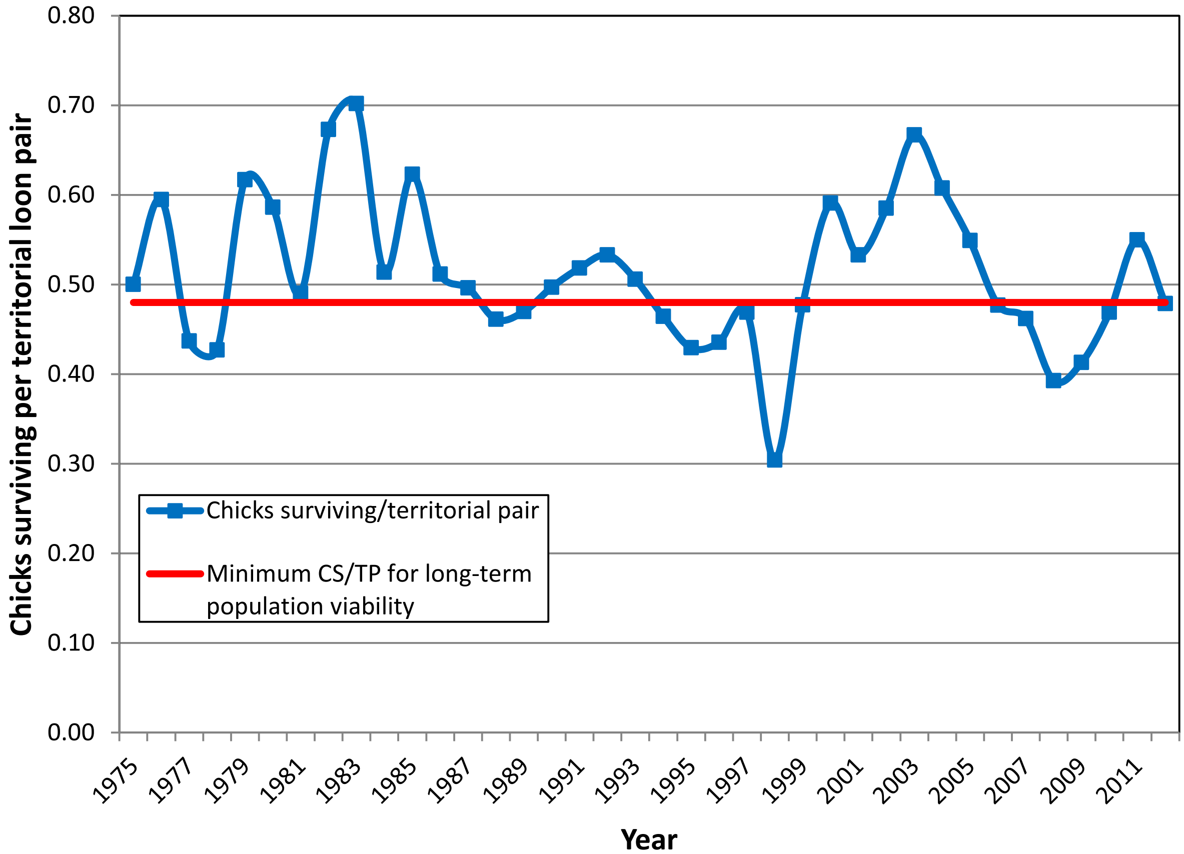

Figure 12. Loons have achieved the minimum reproductive success required to sustain their population in only two of the past seven years, despite record levels of management and outreach.

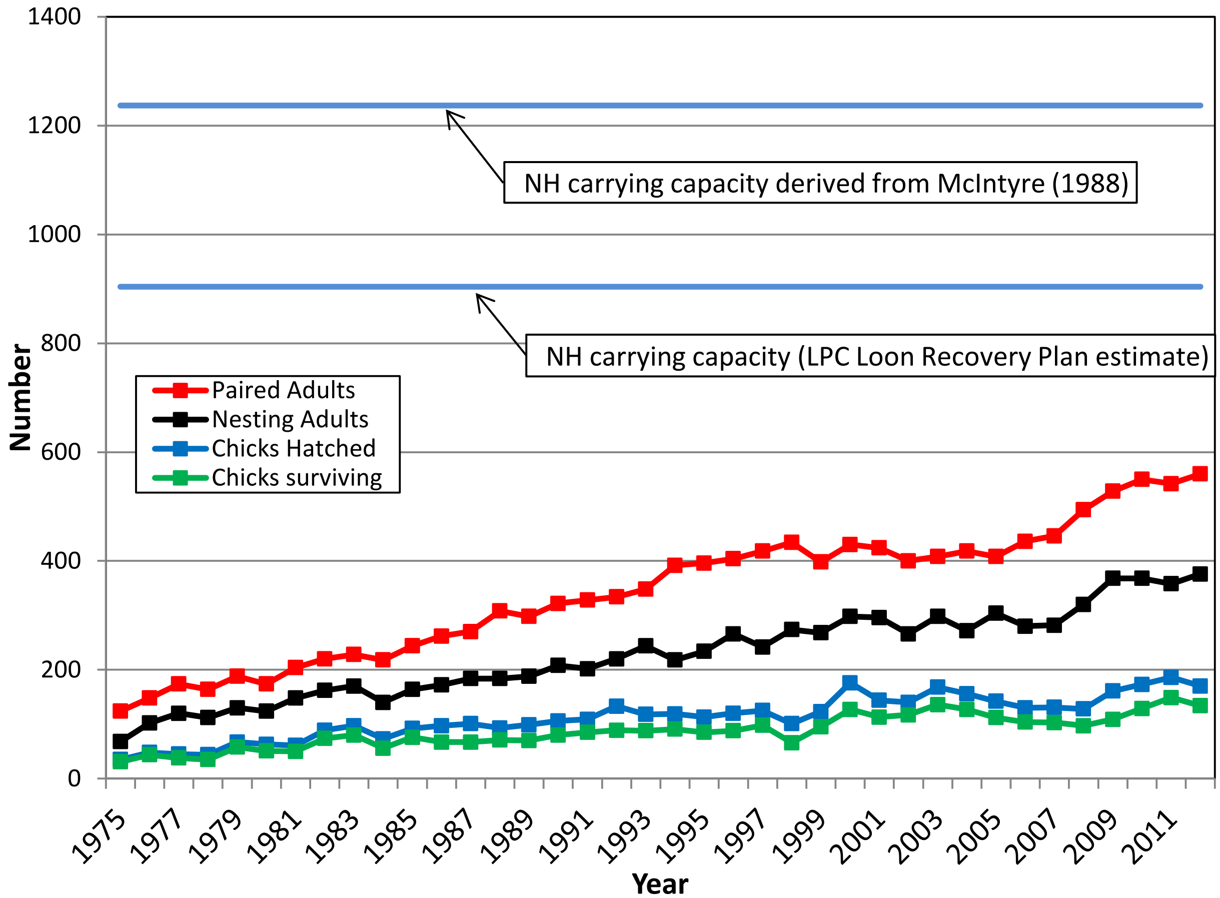

Figure 13. Paired adult loons are far below estimates of New Hampshire's carrying capacity and declined in 2011 after high adult mortality from ingested lead tackle and recent reductions in productivity (chicks surviving per territorial pair). These declines occurred despite record levels of management and outreach to increase productivity and decrease adult mortality.