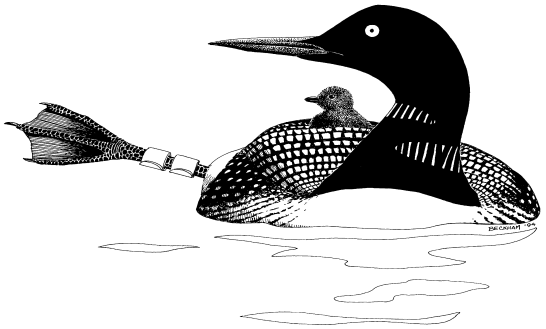
North American Loon Biomonitoring Program: Alaska

1996 Progress Report



Submitted to:

The Alaska Loon Working Group

Alaska Department of Fish and Game • Anchorage Audubon Society • Anchorage Bird TLC • Arco Alaska, Inc. • BioDiversity, Inc. • E-Pro • Fairwinds • Kenai NWR • National Biological Service • Tetlin NWR • Yukon Delta NWR • U.S. Fish and Wildlife Service, Office of Migratory Bird Management

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Introduction

Alaska is home to the world's five loon species. Loon distribution and abundance varies greatly throughout the state. Pacific Loons (*Gavia pacifica*) are abundant and widespread, Common Loons (*G. immer*) are common in the boreal forest while Red-throated Loons (*G. stellata*) are primarily inhabitants of the tundra and coastal wetlands. The Yellow-billed Loon (*G. adamsii*) is confined to interior lake habitats along the Arctic Coastal Plain and breeding populations of the Arctic Loon (*G. arctica*) are limited to the Seward Peninsula. Statewide mean population estimates from 1971-93 are approximately 69,500 +/- 5,600 Pacifics, 15,400 +/- 2,200 Red-throateds, 8,900 +/-800 Commons, 2,600 +/- 600 Yellow-billeds (Groves et al. 1996), and around 100 Arctics. Ten areas were surveyed by airplane with known concentrations of waterbirds. The Arctic Coast Plain was surveyed from 1986-93 and included the Yellow-billed Loon's breeding range. Population indices developed from these surveys show a significant population decline (53%) for the Red-throated Loon, the breeding population of the other three more common species did not show a significant change (Groves et al. 1996). However, the small and vulnerable breeding and wintering population of Yellow-billed Loons demands high resolution monitoring. Reasons for the substantial Red-throated Loon decline are unknown. Its statewide population in 1993 was estimated at 9,800 +/- 2,400 (Groves et al. 1996).

In 1995, BioDiversity, Inc. initiated a joint project with the U.S. Fish and Wildlife Service (USFWS) and the Alaska Department of Fish and Game (ADF&G) to develop biomonitoring programs for Alaska's loon species. Our first year's efforts concentrated on Common and Pacific Loons at three study areas: Kenai National Wildlife Refuge (NWR), Mat-Su Valley, and the Anchorage Area. In 1996 we expanded our efforts to include capture and contaminant analysis on Pacific Loons in Tetlin National Wildlife Refuge and continued sampling on the Kenai NWR. Due to extremely low productivity and logistical constraints in 1996, we did not sample loons in Anchorage or the Mat-Su Valley.

Background of Biomonitoring Study:

A time efficient nightlighting capture technique was established in the early 1990s for adult Common Loons accompanied by young less than 7 weeks of age (Evers 1993). Since its inception, over 1,100 loons (60% adults) have been captured and leg banded with a unique color-marking scheme including a USFWS numbered band. An associated toxicology study began in 1991 analyzing blood and secondary feather tissue. After an initial screening process of heavy metals, organochlorines, and PCBs to determine the most harmful toxins, mercury (Hg) levels were determined elevated in many individuals. Since 1993, blood has been sampled for basic hematological parameters, genetic relatedness and diversity and parasite loads.

Information on the loon's population ecology including site faithfulness, mate fidelity, social structure and interaction, and inter- and intra-seasonal movements is being gathered through annual monitoring during the breeding season. We now know, for example, that mean adult survivorship across our North American study sites is upwards of 95% or more and their return to the previous year's territories is approximately 80% (Evers et al. 1996). Mate switching is frequent and commonly triggered by nest failures. At least 20% of the breeding population under study switches mates within

the year (defined as one banded bird remaining in a territory and the other being replaced). Typically, females remain in the territory and the male is replaced. Recent observations indicate that territory switching takes place at a rate higher than formerly believed – around 10-15% per breeding season. These switches may occur up to 7 miles from the territory of the previous year.

Individual reproductive performance is being monitored on marked loons. To date some individuals seem to be more established than others, and therefore more likely to successfully fledge young. Loons originally banded as juveniles are returning. Based on a small sample of these returns, first year breeding of Common Loons varies from 5-9 years. Natal site faithfulness has been observed but it is unclear whether this is the dominant return strategy. Subadult loons, those in alternate plumage but have not bred, typically develop flexible territories and form pair bonds as they age. Recruitment rates may be hard to determine due to dispersal, although confirmed dispersal distances in the Great Lakes Region do not exceed 15 miles.

The comprehensive biological data we have generated through the capture, marking, and subsequent observations of Common Loons are providing valuable answers for current and future management plans. We believe these proven techniques can now be employed toward other species.

Description of Alaska study sites:

The Alaska Working Group is currently monitoring Common and Pacific Loons on two National Wildlife Refuges and in the Anchorage and Mat-Su Valley (Appendix 1). The Kenai NWR road system provides access to lakes with breeding Common Loons and Tetlin NWR has high concentrations of Pacific Loons. In 1997 we will expand into two new areas 1.) Yukon Delta NWR to monitor Red-throated Loons and 2.) the Colville River Delta to monitor Yellow-billed Loons.

In 1996, Tetlin NWR was added to the "North American Loon Biomonitoring Program" as a site that offered an abundance of breeding Pacific Loons and access to a number of lakes. At 700,000 acres (283,000 ha), Tetlin NWR is Alaska's second smallest refuge, but still one of the largest in the nation's refuge system. Thousands of lakes and ponds are interspersed with rolling hills and boreal forest that produce an abundance of nesting habitat for waterbirds. Data from 45 lakes on the refuge in 1986 indicate that all the lakes surveyed were of circumneutral pH or alkaline, however, hydrological characteristics in the refuge vary considerably. Pacific Loon population estimates gathered from 1989-95 waterfowl surveys on 11 clusters of lakes, found an average of 2,709 adults inhabit the refuge producing 377 broods (1-2 chicks/brood) and 467 chicks. A steady decrease in the number of chicks produced from 608 in 1989 to 295 in 1995 is disconcerting. Reasons for these declines are unknown. Detailed demographic and productivity data (e.g. average chicks/pair, number of second nesting attempt, etc.) have not been collected for this population of Pacific Loons. Very few Common and Red-throated Loons nest in the refuge.

The nearly 2 million acre (810,000 ha) Kenai NWR has an abundance of small lakes with forested shorelines that provide breeding habitat for Common Loons and a few pairs of Pacific Loons. Total alkalinity, pH, and apparent color were measured in late August, 1996 in Engineer, Lower Ohmer, Pack, and Peterson lakes. Pack Lake had the poorest buffering capacity with a pH of 6.6 and total alkalinity of 2.9 mg/L while Peterson lake was the most alkaline (pH=8.3, alkalinity was 58.9 mg/L). Engineer and Lower Ohmer had water chemistry similar to Peterson. Apparent color, a qualitative measure of dissolved organic matter, was low and ranged from 14-21 PCU.

On 9-10 August, 1995, aerial surveys of 60 lakes within 0.5 miles of a road access found 33 lakes (or 57% occupancy) with Common Loons (one lake had Pacific Loons). Of the 22 territorial

Common Loon pairs located, 8 produced young - five one-chick broods and three two-chick broods. The number of chicks hatched per territorial pair was 0.50. This rate is relatively low compared to our other sites but is consistent with Smith's (1981) findings of 0.30 to 0.67 chicks/pair on Kenai NWR.

The Matanuska-Susitna Valley (Mat-Su) is a large area in south-central Alaska that contains over 450 lakes. It contains prime habitat for the Common Loon but also supports a healthy Pacific Loon breeding population. Ruggles (1994) found minimum nesting lake sizes in the area to be 12 ha (30 acres) for Common Loons, 4 ha (10 acres) for Pacific Loons, and even smaller ponds for Red-throated Loons. The 1987-89 mean Common Loon reproductive rate was 0.91 chicks per monitored breeding pair (n=39 pairs) and 0.84 (n=11 pairs) for Pacific Loons (Tankersley 1990). An average of 153 lakes was surveyed for those three years and 25% were occupied by Common Loon territorial pairs and 7% by Pacific Loons.

There are 45 lakes in the greater Anchorage area (2,000 mi^2 or 5,200 km^2) and 31 lakes have a history of use by loons. Although several of these lakes commonly harbor nonbreeding individuals or groups, only 3-4 territorial Common Loon pairs and 7-8 Pacific Loon pairs are regularly present (from 1985-89 surveys, Tankersley 1990). The mean number of Common Loon chicks produced per pair is 0.68 and for Pacific Loons is 0.56 chicks/pair. Recent surveys indicate a relatively stable population although the distribution of territorial Common and Pacific Loon pairs changes annually. Some lakes have a long history of successful Common Loon pairs (e.g., Lower and Upper Sixmile and Otter) and Pacific Loon pairs (e.g., DeLong, Goose, Green, Little Campbell, and Psalm). Protection of these territories is critical for the long-term maintenance of the Anchorage area's breeding population.

Results of Color Marking:

A total of 39 Common Loons and 24 Pacific Loons have been color-marked in Alaska since 1995 (Table 1). Of the Common Loons, 25 were banded in Kenai NWR and 14 in the Anchorage/Mat-Su Valley area. Three Pacific Loons were marked in Kenai NWR (the only nesting pair identified on the refuge near a road access), 13 in Tetlin NWR and 8 in the Anchorage/Mat-Su Valley. Two Red-necked Grebes (Engineer Lake, Kenai NWR) and one Red-throated Loon (Big Lake, Mat-Su Valley) were also captured and will provide comparative toxicological data of related piscivorous species.

A total of 9 males and 14 female Common Loons have been marked since 1996. Because Pacific Loons show no dimorphism in plumage characteristics and weight ranges for males and females are yet to be determined. Confirmation of sex is possible through 1) chromosomal analysis in blood and 2) observation of mating and vocal cues of color marked individuals. Individual sex confirmation by weight is likely a reliable sexing technique in the future.

Table 1. Summary of piscivores banded in Alaska, 1995-1996.

Site/Species	# of Adults	# of Juveniles	TOTAL (new)	# Adult M	# Adult F	# Adult Unk	# Recaps
KENAI NWR							
Common Loon							
1995	5	2	7	2	3	0	-
1996	9	9	18	3	6	0	1
Subtotal	*14*	*11*	*25*	*5*	*9*	*0*	*1*
Pacific Loon							
1996	2	1	3	-	-	2	-
Red-necked Grebe							
1996	1	1	2	-	-	1	-
TETLIN NWR (1996)							
Pacific Loon	9	4	13	-	-	9	-
ANCHORAGE / MAT-SU VALLEY (1995)							
Common Loon	9	5	14	4	5	0	-
Pacific Loon	4	4	8	-	-	4	-
Red-throated Loon	0	1	1	-	-	-	-
Subtotal	*13*	*10*	*23*	*4*	*5*	*4*	-
Common Loon							
1995	14	7	21	6	8	0	-
1996	9	9	18	3	6	0	1
subtotal	***23***	***16***	***39***	***9***	***14***	***0***	***1***
Pacific Loon							
1995	4	4	8	-	-	4	-
1996	11	5	16	-	-	11	-
subtotal	***15***	***9***	***24***	***-***	***-***	***15***	***-***
Red-throated Loon	0	1	1	-	-	-	-
Red-necked Grebe	1	1	2	-	-	1	-
Total	**39**	**27**	**66**	**9**	**14**	**16**	**1**

Population Ecology and Selected Marked-Loon Interactions

Because of the recent addition of this study region, little can be extrapolated from the current adult survivorship of Alaska's loon populations. Of 11 Common Loons monitored and eligible for return, only the Big Lake - Petrovich female (in the Mat-Su Valley) did not return to her original territory (Table 2). In Kenai NWR all of the marked adults returned. Three territories with marked loons were not surveyed in 1996 and their return rates are not known. The national cumulative adult return rate for all of our North American sites is 79.5%. Several years of data are necessary before we

can determine how Alaska Common Loon populations compare. Only one of the four adult Pacific Loons banded in 1995 returned in 1996 (Psalm Lake, Mat-Su Valley).

Table 2. Cumulative site return rate of adult Common Loons for Alaska, 1996.

Year	Total # of marked			Total	Total # of returning			Percent Return		
	M	F	Both	Mortality	M	F	Both	M	F	Both
Kenai NWR	2	3	5	0	2	3	5	100%	100%	100%
Anchorage/ Mat-Su Valley	3	3	6	0	3	2	5	100%	67%	83%
TOTAL	5	6	11	0	5	5	10	100%	83%	91%

* Beginning-of-the-year eligibility in calculating return percentages for marked loons does not include individuals (1) found off their original territory or outside of other territories with banded loons and (2) that were "gone" the previous year (either known dead or missing). Should a loon be found that was previously in either of these categories it is eligible at the beginning of the year.

Detailed behavioral observations of Common Loons, based on time-activity budgets, have provided ample insight into behaviors of marked individuals that had not been previously described. However, in Alaska, we presently rely on incidental and cursory observations of Common and Pacific Loons.

Notable behaviors relevant to management strategies are territory and lake switching. Multiple lake territories and territory switches in Common Loons are frequent throughout their range. For example, on Pack Lake in Kenai NWR we observed the color-marked male flying around the lake while the female and chick remained stationary. He later landed on the lake and joined his family. These adults likely raise chicks on Pack lake and feed on nearby lakes during the day, a behavior not uncommon on small, kettle lakes. These behaviors have yet to be quantified for marked Pacific Loons, although there is evidence. The DeLong Lake pair did not return in 1996. An unmarked pair replaced them indicating either the loss of a breeding pair of Pacific Loons from the limited Anchorage population or that the pair defends multiple lakes in their territory (there are two neighboring lakes). The Goose Lake pair (both banded in 1995) did not return in 1996. Unlike the DeLong Lake territory an unmarked pair replaced them. Even though this territory was newly claimed the pair attempted to nest (although it was unsuccessful). The marked Goose Lake Pacific Loon pair was not observed in 1996.

We have a unique opportunity to better understand the population and behavioral ecology of Pacific Loons and significantly contribute to the handful of North American studies on this species (e.g., Petersen 1979, 1989). In 1997, we plan to expand our banding and observational efforts at all sites.

Results of Mercury Sampling

We collected blood and feather samples from adult and juvenile loons for the second consecutive year. Blood Hg levels indicate dietary uptake for the past 2-3 months, while feather levels are a measure of chronic exposure. Adult and juvenile blood Hg levels are excellent indicators of breeding lake methylmercury (MeHg) availability. Interpretation of tissue Hg concentrations can be complex because of many confounding variables. For example, we have consistently found significant

gender differences in adults (male Hg levels are higher than females) (Evers et al. Summitted) and there is increasing evidence that MeHg bound in muscle tissue can become available during stress (Scheuhammer et al. In Press). Our efforts across the North American study sites indicate significant feather Hg accumulation rates of over 6% per year. These and other confounding variables demand further study and a multi-media sampling strategy for deciphering Hg concentrations.

In Alaska mean blood-Hg concentrations for adult Common Loons was 0.66 µg/g and, as we have found in other areas, gender differences were significant (Table 3). The Hg concentrations in Alaskan adults are low and probably not at concentrations that pose health, survival, or productivity threats to individuals or populations. Both males and females in Kenai NWR had a higher mean Hg concentration than loons in Anchorage; however, sample sizes are low and geographic differences in atmospheric Hg deposition or point source releases (natural or anthropogenic) are yet to be determined.

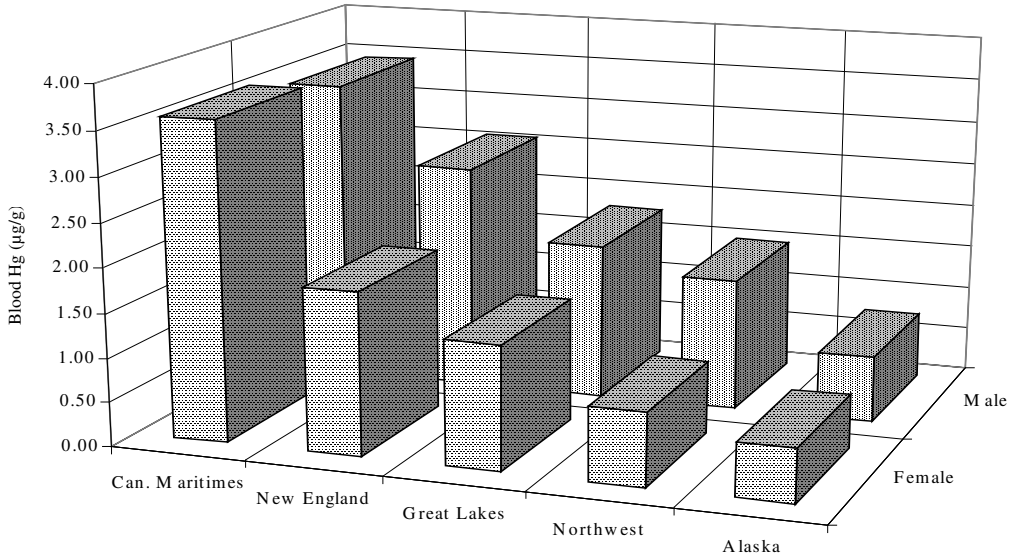
Table 3. Mean mercury concentrations in adult Common Loon blood and feathers in Alaska, 1995-96

	Blood Hg Values (µg/g, ww)					Feather Hg Values (µg/g, fw)†				
Location	n	Male	n	Female	Combined	n	Male	n	Female	Combined
Anchorage/Mat-su Valley	4	0.62	5	0.51	0.56	4	4.9	5	6.9	6.0
Kenai NWR	5	0.85	9	0.65	0.72	5	6.2	9	4.3	5.0
ALL SITES	**9**	**0.75**	**14**	**0.60**	**0.66**	**9**	**5.6**	**14**	**5.2**	**5.4**

†As measured in a composite of 2 second secondaries from each individual

Compared to our other four North American study regions, Alaska ranked the lowest in blood Hg concentrations (Figure 1). We consider Alaska a reference region because atmospheric deposition of Hg is likely low compared with the contiguous United States.

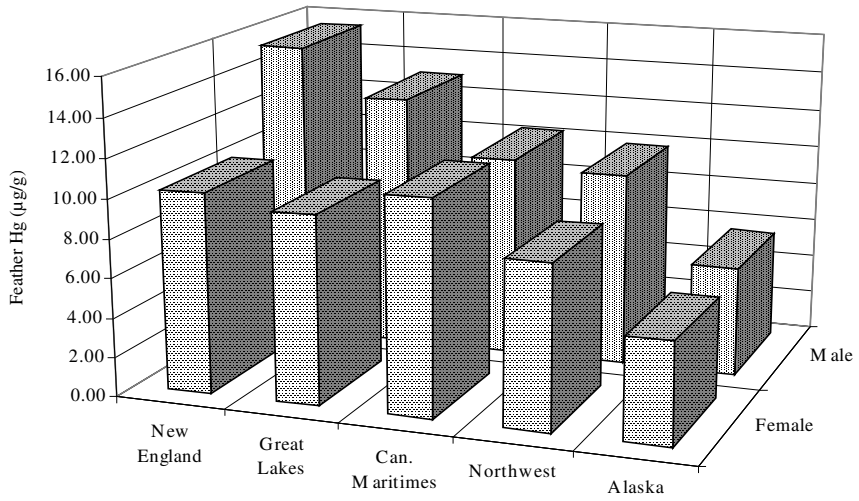
Figure 1. Mean mercury concentrations in Common Loon blood at selected sites in North America, 1992-96



Adult Common Loon feather Hg concentrations were 5.4 µg/g; males were higher than females (Table 3). Like blood Hg concentrations, these levels are significantly lower than those found in eastern North America, particularly New England (Figure 2). Loons from Kenai NWR had lower adult mean feather concentrations than the Anchorage/Mat-su valley, which contrasts with our findings of blood-Hg concentrations. Wintering loons are probably site faithful and breeding populations of adults may aggregate in the same general area. Therefore, feather-Hg concentrations are a potentially useful measurement of Hg bioavailablity in marine environments. Perhaps differences in adult feather-Hg between study sites reflect geographic Hg availability on the wintering areas. This variation may be due to point source mercury input, local atmospheric deposition rates, Hg availability in prey items and the existing body burden of Hg, particularly in highly exposed individuals. We will be able to address these questions only when we know the distribution of breeding populations in the winter.

It is likely that areas of the Pacific Coast, where loons from Alaska reside, are less contaminated than Atlantic and Gulf Coast areas because feather-Hg concentrations are higher in eastern loon populations (Figure 2). We must first understand the physiokinetics of Hg (i.e., how Hg is distributed and mobilized throughout the body) before making conclusions. Loons with elevated Hg concentrations from the breeding season likely retain this Hg into the winter and sequester it in feathers during the flight feather molt. We have found that blood and feather-Hg levels in the same individuals from Alaska correlate weakly (r^2=0.04), while the relationship is much stronger in individuals from the Canadian Maritimes (r^2=0.48). The Maritime adults have a mean summer blood-Hg concentration that is 6x higher than Alaska and thus probably have a higher body burden of Hg at the time of feather growth. In contrast, we believe loons from Alaska carry feather-Hg concentrations that primarily reflect winter dietary uptake of Hg. Interpreting feather-Hg is further complicated by gender, age, lake chemistry, etc., but feather-Hg concentrations serve as an excellent barometer of chronic Hg exposure to individuals and populations.

Figure 2. Mean mercury concentrations in adult Common Loon feathers at selected sites in North America, 1992-96.



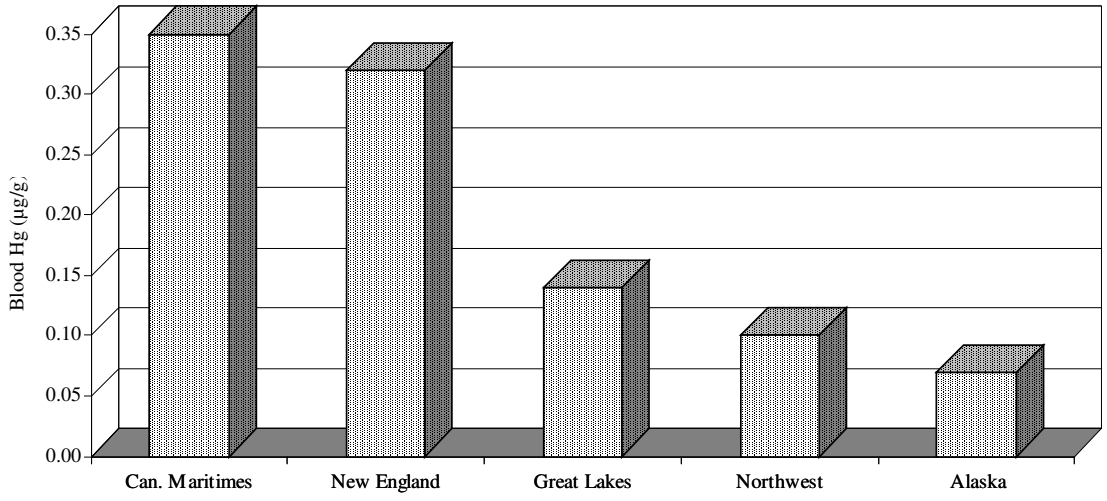
Juvenile blood-Hg concentrations are also good indicators of lake MeHg bioavailability, although the bioaccumulation and biomagnification of Hg is better represented in adults. Compared to our North American results juvenile Common Loon Hg levels were the lowest (Figure 3), ranging from 0.025-0.27 (Table 4). Anchorage/Mat-Su juveniles were higher than the Kenai NWR, but sample sizes are low and the mean skewed due to a high level outlier from Cornelius Lake (Mat-Su Valley).

Table 4. Total mercury concentrations in juvenile Common Loon blood in Alaska, 1995-96

Location	n	mean Hg (µg/g)	SD	Range
Anchorage/Mat-Su Valley	5	0.10	0.10	0.025-0.27
Kenai NWR	11	0.05	0.03	0.027-0.1
ALL SITES	**14†**	**0.07**	**0.06**	**0.025-0.27**

†Combined site blood mercury represents only one sibling / territorial pair in cases where both chicks were sampled

Figure 3. Mean mercury concentrations in juvenile Common Loon blood at selected sites in North America, 1992-96.



Adult Pacific Loon blood-Hg concentrations from this study are the first known recorded for this species. We still are unable to confidently determine gender in adults, although sexual dimorphism is apparent. The mean adult blood-Hg concentration is 0.39µg/g, slightly more than half the mean concentration found in adult Common Loons. These results were expected because Pacific Loons have a forage base comprised of smaller prey and we know avian piscivores foraging on lower trophic levels have lower blood-Hg concentrations than Common Loons (Derr 1995). Higher Hg concentrations in

adult Pacific Loons from 1995 were most likely due to sample size or geographic bias instead of annual Hg availability changes. In contrast to adult blood-Hg differences found between Common and Pacific Loons, blood levels in juvenile Pacific Loons (Table 5) were more than double the concentrations found in juvenile Common Loons (Table 4). These differences may indicate actual site differences in Hg availability due to water chemistry, trophic structure, geochemical processes, and hydrology. Increased sample sizes and prey sampling at different sites will enhance interpretation.

Mean Feather-Hg concentration in adult Pacific Loons in 1995-96 was 1.3µg/g compared to 5.4µg/g in adult Common Loons. These values are well below the North American average for adult Common Loons (11.1 +/- 4.6 µg/g). All Pacific Loon juveniles were adult-sized at the time of capture. Since feathers are a natural mechanism for depurating Hg (73 to 90% of the body burden), those from full-grown juveniles provide an indication of the amount of Hg passing through loons for the 7-8 week period prior to complete flight feather growth (Table 5).

Blood Hg values in both adult and juvenile Pacific Loons was highest in the Anchorage and Mat-Su Valley birds and lowest in Kenai NWR. Feather Hg values in adults were highest in Tetlin and lowest in Kenai NWR. Sample size is currently too small to make statistical evaluations.

Table 5. Mean mercury concentrations in adult and juvenile Pacific Loon blood and feathers in Alaska, 1995-96

	Blood Hg Values (µg/g, ww)						Feather Hg Values (µg/g, fw)†					
Location	n	Adult	SD	n	Juvenile	SD	n	Adult	SD	n	Juvenile	SD
Anchorage/Mat-su Valley	3	0.63	0.22	4	0.27	0.12	4	1.9	0.3	4	1.6	0.3
Kenai NWR	2	0.22	0.04	1	0.03		2	1.7	0.1			
Tetlin NWR	6	0.32	0.16	1	0.08		9	2.4	1.6			
ALL SITES	**11**	**0.39**	**0.22**	**6**	**0.20**	**0.15**	**15**	**1.3**	**1.3**	**4**	**1.6**	**0.3**

†As measured in a composite of 2 second secondaries from each individual

1997 Research Outline:

1. We will continue our standard biomonitoring protocol. This includes data collection on the survival and productivity of adults and the capture and blood/feather sampling of adults and juveniles. Feather and blood samples will be used for a wide variety of tests. Capture efforts will focus on Common Loons at the Kenai NWR, Pacific Loons at Tetlin NWR, Yellow-billed Loons on the North Slope and Red-throated Loons in the Yukon Delta NWR in an effort to have each regularly breeding Alaskan species represented by our standard protocol. We will attempt to sample the ubiquitous Pacific Loon at each site to compare heavy metal exposure in the state. The potential for sampling breeding adult Pacific Loons making foraging flights to marine waters (Andres 1993) will be evaluated at each coastal study site. Water chemistry sampling will be emphasized for better interpretation of heavy metal concentrations. Other piscivorous (e.g., grebes) and omnivorous species (e.g., sea ducks) will be sampled opportunistically at some sites for comparative purposes and to further investigate recent findings by Henny et al. (1995) of heavy metal contamination in Alaska's sea ducks.

2. Studies on the North Slope will be in cooperation with Dr. Susan Earnst of the National Biological Service, ARCO Alaska, Inc., and Fairwinds. We will begin a contaminant and population ecology

study on the Colville River Delta on loons and sea ducks. Capture, color-marking, and tissue sampling will focus on the Yellow-billed Loon. The Colville River Delta is one of two Alaskan areas with concentrations of breeding Yellow-billed Loons (North and Ryan 1989). Because this species is sparsely distributed throughout its range, has relatively low population densities in Alaska, and may be affected by oil development the U.S. Fish and Wildlife Service has expressed an interest in initiating a biomonitoring study. Like the Pacific Loon, no studies of marked populations of Yellow-billed Loons have been conducted. Integrating ecological information on this species and the intensively studied Common Loon will aid in conservation strategies.

3. Studies on the Yukon Delta NWR is in cooperation with the refuge and partially funded through the USFWS Cost-Share Program. The target species is the Red-throated loon that has experienced significant population declines in recent years (53% from 1977 to 1993), particularly in the Yukon Delta (Groves et al. 1996). Methodology and techniques will mirror current Common and Pacific Loon studies in Alaska.

4. Normal avian blood parameters will be analyzed by Bird Treatment and Learning Center to establish healthy loon target levels. In cooperation with Tufts University School of Veterinary Medicine (TUSVM), we have compiled baseline clinical health parameters for breeding Common Loons in New England and the Canadian Maritimes. The goal is a better understanding of the normal physiological status of the Common Loon, and eventually applying these reference ranges to aid in the clinical assessment of loons in captivity or rehabilitation. In addition, subtle effects of contaminants on birds may affect normal functioning of immunosupression and behavior. Measuring these health parameters in captured individuals will provide evidence of toxic effects of contaminants.

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