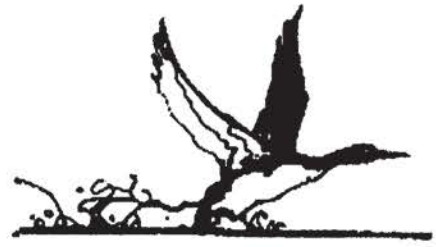
2003 Lake Umbagog
Loon Population and Management Report
Errol Dam Project – FERC No. 3133



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SUMMARY OF NEW HAMPSHIRE LOON PRESERVATION COMMITTEE FIELD ACTIVITIES ON LAKE UMBAGOG
2003

Report
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March 2004

The Mission

The Loon Preservation Committee exists to restore and maintain a healthy population of loons throughout New Hampshire; to monitor the health and productivity of loon populations as sentinels of environmental quality; and to promote a greater understanding of loons and the natural world.

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Introduction

Lake Umbagog, the source of the Androscoggin River, is located in Magalloway and Upton, Maine, and Errol and Cambridge, New Hampshire, with affected backwaters reaching into Wentworth Location, New Hampshire. Any mention of Lake Umbagog, or "the lake" refers to this area. Lake Umbagog's surface elevation is controlled by Errol Dam which is licensed as Federal Energy Regulatory Commission (FERC) Project No. 3133. The "open waters" of Lake Umbagog are public waters of the states of Maine and New Hampshire. Activities on these waters must comply with all Maine and New Hampshire state laws.

All hydro-related activities on Lake Umbagog, the lakeshore and the shoreline elevation 1247 MSL are the responsibility of FPL Energy Maine Hydro (FPLE) in compliance with its FERC license for the Errol Project. Water levels and shoreline management, public access and environmental monitoring within the FERC boundary is required by the licensee. Lands adjacent to the shore of Lake Umbagog above elevation 1247 are owned and managed by various private landowners and the Lake Umbagog National Wildlife Refuge. These owners control public use and land management activities on these lands.

Article 27 of FERC License No. 3133 contains a target management scheme for water level management on Lake Umbagog during waterfowl nesting seasons, primarily defined by Common Loon (*Gavia immer*) nesting chronology. The target management scheme is dynamic, depending upon amounts and timing of rainfall, downstream conditions, and the variable chronology of Common Loon nesting on any given year. FPLE works and communicates with the Loon Preservation Committee (LPC; the New Hampshire loon recovery program, headquartered in Moultonborough, NH), state wildlife agencies in Maine and New Hampshire, and the U.S. Fish and Wildlife Service (USFWS), in order to comply with Article 27. Biological information regarding chronology of Common Loon nesting each year dictates FPLE water level management within the target scheme.

Common Loons are formally listed as a Threatened Species in New Hampshire under NH RSA 212-A, the Endangered Species Conservation Act. Loon population and productivity on Lake Umbagog have been monitored annually since 1976 by LPC, a project of the Audubon Society of New Hampshire.

In 1992, the hydro licensee obtained the services of consulting biologist Jeff Fair and undertook its own survey and management program to provide direct information and documentation on Common Loon populations, productivity, and the effects of water level management on loon nesting on Lake Umbagog. It also ensured continuity of the survey and management programs currently active through volunteer cooperation. These efforts were continued annually through 1995. Since 1995, the hydro company biologists have partnered with LPC to conduct the Common Loon surveys.

This report summarizes results of loon population and productivity surveys in conjunction with efforts by LPC; evaluates the Lake Umbagog water level management regime during the 2003 Common Loon nesting season; and assesses the effects of lake level fluctuations on Lake Umbagog loon productivity in 2003. All FERC related loon management and water level management activities included in this report occur only on the public waters of Lake Umbagog and the shoreline and lake bottom areas within the FERC project boundary which is defined by elevation 1247.

Objectives

1a. To continue the existing 28-year loon management and monitoring project on Lake Umbagog. Nesting activities and factors affecting the productivity of the current loon population on the lake will be monitored. Emphasis will be placed upon monitoring the effects of current water level management practices, as well as monitoring and quantifying the impact of human and predatory disturbances on loon productivity.

b. To implement and evaluate the effectiveness of various management techniques within loon territories. Recommendations will be made on the placement, addition, and removal of artificial nesting islands and floating signs and/or ropes in loon territories.

2. To evaluate loon habitat quality on Lake Umbagog using long term productivity and individual performance as indicators.

3. To evaluate site fidelity, mate fidelity, and territorial persistence for all loon pairs on Lake Umbagog. Determination of factors affecting these parameters and their relationship to reproductive measures throughout the season will be made for territorial pairs, successful nesting pairs, and unsuccessful nesting pairs.

Methods

Population and Productivity Survey

A biological census was conducted on Lake Umbagog in 2003 to catalog individual loons and the breeding success of pairs. Observations commenced on 1 May and concluded on 8 September. Loon surveys on the lake were obtained from a 13' Boston Whaler with a 25HP engine. Observations were made using 10X binoculars and a 15-45X spotting scope, and lasted at least one hour/territory. All known historical nesting sites previously reported by Jeff Fair were checked for evidence of nesting. In some cases this necessitated search by foot: all other observations were made by boat.

Territorial pairs were defined as a pair of loons defending a territory for at least four weeks and having the potential to breed. A territory with occupancy by loons for at least three consecutive seasons was characterized as established. Territories experiencing occupancy for less than three consecutive seasons were considered transitional territories.

Nesting pairs were defined as those pairs laying at least one egg, and successful pairs hatched at least one chick. A nest categorized as a "fail" included evidence as to the cause of the failure if it could be reported with certainty. Causes of failure may include:

Avian predation: characterized by a small hole in the egg.
Mammalian predation: characterized by smashed eggs/eggshells, tracks around nest, and/or scat.
Water level rise: increase in lake level causing nest floods. Eggs washed off nests, or eggs still in nest, chilled in standing water.
Water level fall: decrease in lake level causing eggs to be stranded in unreachable nests.
Human disturbance: human intrusion, human related activities.
Loon disturbance: loon intrusion.
Inviable egg: loons remaining on nest past normal incubation times (27-30 days).
Unknown: cause unknown.

Location of nest sites were determined using hand-held GPS receivers, mapped by hand on 1:24,000 USGS topographical maps, or with the use of Maptech's TopoScout ® CD-ROM or DeLorme's TopoQuad ® for New Hampshire and Maine. All hatch dates were calculated using a 27-day count from the onset of incubation.

Adult loons not establishing a pair bond lasting at least four weeks were counted as unmated or non-territorial individuals. Sub-adults in alternate plumage were counted as immatures. Adult loons previously banded as juveniles were recorded as "ABJs". Collections were made of abandoned whole eggs, eggshells, and carcasses.

Management

Water Level Scheme: Lake-level changes known to negatively affect the nesting success of loons are generally those greater than or equal to 1.0 vertical feet (0.3 m) of lake-level recession and greater than or equal to 0.5 vertical feet (0.15 m) of lake-level increase (Fair 1998). The water scheme currently employed was proposed during the 17 March 1998 annual water level meeting and instituted that spring. It calls for waterlevels to be stabilized at 1246.0 MSL until 20 June, with a gradual drawdown afterwards, lowering the level to 1245.6 MSL and holding it there until 20 July.

Rafts: Artificial nesting islands, also called rafts, have not been used on Lake Umbagog since 2001. Rafts are an effective wildlife management tool used to mitigate human and/or predatory impacts to nesting loon pairs in those areas. LPC considers raft usage only for established pairs experiencing successive nest failure due to artificial water level fluctuations or shoreline predation, and on lakes having a suitable flotation site (LPC 1990) (Taylor and Vogel 1997, 1999). LPC strictly monitors the construction, placement, and use of all rafts under the authority of the State of New Hampshire and Maine Marine Patrol. Permission to use rafts falls under the authority of New Hampshire and Maine which regulate the publicly owned waters of the lake, FPLE which owns the flowage rights around the shore, and the USFWS as trustees under the Migratory Bird Treaty Act.

Nesting platforms are constructed by volunteers or by field biologists according to specifications provided by LPC. Raft locations are chosen in areas protected from prevailing winds and wave action. Care is given to avoid deploying rafts near submerged boulders or other objects that may become exposed with a decreasing water level and serve as a perch for predators. Rafts are floated with no more than half of the log framework submerged. Non-woody vegetation from the surrounding shoreline is used as nest-building material. Placement is approximately 50-100 m from shore at a water depth of >2 m. Anchors are fastened by wire at opposite corners of the raft, and dropped at 45 degree angles from the raft. Anchor lines are left with 0.5 m of slack in lines to allow for fluctuations in water level. Rafts are monitored frequently for buoyancy and adequate nesting material until the occurrence of nesting.

Signs and Floatlines: Protective signs and floatlines were placed in areas of high visibility or high traffic in order to minimize impacts of human activities on nesting loons. These were placed at the first sign of nesting or with the establishment of a brood site Used as a tool to allow a measure of privacy, signs and floatlines can also serve to attract attention. This potential effect was taken into consideration before deployment, as well were recommendations by local residents. LPC and FPLE have chosen not to use signs and floatlines on Umbagog. Refuge personnel have decided to use signs and floatlines at selected loon nests. Restricting boat traffic in the "open waters" of Lake Umbagog was done under the authority of New Hampshire and Maine Marine Patrol, and the Maine Department of Inland Fisheries and Wildlife Warden Service (MDIFW).

Educational Initiatives: LPC's educational initiatives are management efforts intended to educate the public on the status of loons and the human activities that can be detrimental to reproductive success. Formal and informal presentations were encouraged as productive avenues to disseminate information. Additionally, educational posters and literature produced by FLP and LPC were posted at public areas and boat ramps.

Banding and Surveying Marked Individuals

In recent years, LPC has participated in the banding of loons on Lake Umbagog in cooperation with BioDiversity Research Institute (BRI), Falmouth, ME, FPLE, and USFWS. LPC, BRI, and FPLE biologists

possess all the required state and federal permits and the experience required to band loons and collect samples.

Loon family units were targeted for night capture using a combination of spotlighting and playback recordings (Evers 1992, 2001). Short and long-term impacts from capture and banding do not have significant impacts on individual loons (Evers 2001). Captured birds were banded for individual identification using unique combinations of color-marked bands and numbered USFWS aluminum bands. Prior to release, each bird was weighed, two second secondary feathers were removed at the base of the quill, and blood samples were taken from the metatarsal vein for contaminant analysis.

LPC assists in the banding effort by finding bandable pairs, providing logistical support, notifying key residents, scouting loon movements prior to capture, and doing follow-up checks on newly banded birds. In territories where banding had occurred in previous years, data were collected on return chronology, adult return rates, mate fidelity, and territory faithfulness/switching.

Color bands of previously banded birds were observed opportunistically with binoculars and/or spotting scopes. Color combinations could be seen out of water during preening episodes, or just below the water surface on flat water, and/or on clear days. Color band observations were collected visually, then later verified against a band identification list to avoid bias.

Satellite Telemetry

Satellite implants were used as a mechanism to track long-distance movements and possibly gather information related to the recent adult loon loss which appeared to occur on the coastal wintering grounds. Subcutaneous implants were placed in the upper back of the bird. The satellite transmitter weighed approximately 18 grams. The battery was kept separate from the actual transmission unit to improve overall battery life.

The implant transmits a signal that is received by satellites every 48 hours initially to monitor migratory movements, tapering to weekly signals over winter. Approximately 140 transmissions will be made from this unit to satellites. These signals are georeferenced and tracked by United States Geological Survey (USGS) personnel. Mortality can also be discerned since the transmitter also monitoirs body temperature.

Eggs

Loon eggs were opportunistically collected from abandoned nests. Whole eggs were collected only when it was certain they had failed. Collection of eggs from nests occurred when birds were observed to be off-nest for over 24 hours. If an egg was cold or obviously addled, it was marked with an "X" in pencil. If the "X" was in the same position by the following day, indicating the egg had not been turned, the egg was collected.

Each egg was sealed in a small resealable plastic bag with collection tags in each bag noting collection date, territory, and remarks. Eggs were frozen and stored in LPC's sample freezer for later processing in the lab. Each egg was accompanied by a biological collection report with information regarding history of nest, number of eggs, reason for failure, and fate of other egg in the clutch.

Mortality

All calls reporting dead or moribund loons were tracked by LPC staff. Live birds were brought to Plymouth Animal Hospital, Plymouth NH or other local veterinarians for examination and treatment/euthanasia. All

carcasses, accompanied with observation data, were sent to Tufts University Wildlife Clinic, Grafton, MA or the Madison Wildlife Health Lab, for necrospy. Post-mortem results were assigned to one of three categories: (1) "boat trauma;" evidenced by massive internal injury incurred from blunt trauma, (2) "loon trauma;" evidenced by punctures and lacerations on the head, neck or sternum indicative of loon attacks, and (3) "other;" including mortalities due to monofilament, lead, parasites or infection (Miconi 2000).

Results and Discussion

LPC has conducted summer-long surveys of Common Loon populations on Lake Umbagog since 1976. Previous reports have described the established territories and provide a foundation for this year's survey. In Evers (2000), established and transitional territories were separated from data summaries and interpretations. The same level of resolution was duplicated in this report to standardize interpretation of territories in 2001 and 2002. This year, Lower Thurston, traditionally a transitional territory, was included in data summaries due to shifts in territorial delineation as a result of the reduced adult population.

A qualitative survey of each territory is provided and includes breeding status, dates of nest initiation, hatching, failures and chick loss, presence of color-marked individuals, and other relevant information. Territories were separated into three areas: those on the Androscoggin River, Magalloway River, and on the lake itself, all within the FERC project boundary. Maps were created for territories with nesting pairs (Appendix 1). This report does not include Brown Owl Pond in Wentworth Location which lies outside the FERC boundary. Results from this loon territory are included in "North Country" comparisons. Accounts of territorial pairs that attempted nesting are found in their respective appendices. A summary of loon reproductive success follows with comparisons from other large lakes, the northern lakes, and lakes state-wide. Territory fidelity is discussed through summaries of the marked loon population, as well as the conservation implications of current water-level practices, raft management, predation, contaminants, conspecific interactions and human disturbance. Recommendations for the 2004 breeding season conclude the discussion.

Qualitative Summary by Territory

Androscoggin River (3 potential loon territories)

Androscoggin

A floater that was captured and banded in Harper's Meadow territory in late July of 2003 was seen here for a few days afterward. No reports of any activity by territorial loon pairs.

Harper's Meadow(Appendix 1, Map 1)

This year's pair consisted of the banded Harper's Meadow male and an unbanded female. A nest was established with one egg around 29 May in close proximity to last year's nest site. The egg hatched on 27 June and the shells of this egg were collected. The pair seemed to experience much less pressure from floater loons this year. The chick was brooded along the east end of Mile Pond and survived to the end of this season. Signs and floatlines were put out on 6 June and removed on 27 June in this territory.

The banded Harper's Meadow female was seen as a floater in Lower Magalloway, Chewonki, Yukon, B Brook and Magalloway territories.

Sweat Meadow (Appendix 1, Map 1)

The banded Sweat Meadow pair returned to territory this year. The pair established a nest with one egg on 27 May close to last year's nest site. The egg hatched by 23 June and the shells were collected. The female and chick were captured 24 June, and the chick was banded. The chick was brooded at the upper end of Androscoggin and survived to the end of the season. Signs and floatlines were put out on 6 June and removed on 27 June in this territory.

Both banded adults were seen on occasion in the Lower Magalloway territory.

Magalloway River (3 potential loon territories)

Magalloway
The banded Magalloway male returned and paired with an unbanded female. There was no evidence of any nesting activity. The male was occasionally seen in both the Yukon and Lower Magalloway territories as was the banded Magalloway female, who was a floater in this area.

Lower Magalloway (Appendix 1, Map 1)
This year's pair consisted of the banded Pierce Pond ABJ (ME) and an unbanded female. Pierce Pond is approximately 48 miles from Lake Umbagog. This loon was originally banded as a chick in 1998 by FPLE and BRI biologists. This male was part of the unsuccessful nesting pair in Leonard Pond last year. In 2003, the pair established a two-egg nest by 3 June. The eggs hatched on 1 July. A chick was seen on an adult's back on this date and a second chick was found dead in the nest bowl, significantly flattened with no other obvious injuries. The dead chick was collected and frozen at the Loon Center. The remaining chick did not survive.

Yukon
No pair on territory this year. Solo birds were seen on occasion.

Lake Umbagog (27 potential loon territories)

Absalom
No pair on territory this year. No loons were seen during most surveys.

B Brook Cove
No pair on territory this year.

Bear Island (Appendix 1, Map 2)
The pair on this territory consisted of the banded Potter Cove male and an unbanded female. A predated nest was found on 27 June. The shells of one egg were collected from behind the nest bowl and another egg was found whole, submerged in shallow water in front of the island. This egg was collected and stored at the Loon Center. This pair was later seen with a young chick in Potter Cove on 11 August. The renest that hatched this chick was not found and the chick did not survive.

Big Island North
No pair this year. No loons were seen during most surveys.

Big Island South (Appendix 1, Map 3)
An unbanded pair occupied this territory in 2003. A dry, disheveled nest site was discovered on 1 July, but the year of this nest was unknown and therefore nesting for this year could not be confirmed.

Black Island Cove (Appendix 1, Map 4)
This year's territorial pair consisted of the banded Gull Island male and an unbanded female. The pair established a nest site with one egg along the marsh grass at the back of the cove on 11 June. The nest had failed by 13 June. Eggshells were found a few meters behind the nest bowl, along a well-established wildlife trail and showed obvious signs of mammalian predation. A second nest site was discovered on 18 June on

the shoreline of the island in the cove. This nest bowl was poorly constructed and one egg was collected in the water outside the nest. Cause of this nest failure could not be discerned.

Chewonki Marsh
The pair on this territory originally consisted of the banded Chewonki male and the banded female from Three Island Cove. As with last year, the pair seemed to use the Three Island Cove territory for foraging activity but spent the majority of time in this territory. Later in the season, the Chewonki male switched mates and was seen paired with an unbanded female in this territory. There was no nesting activity observed from either pair.

After the mate switch, the banded Three Island Cove female remained in the Three Island Cove and Chewonki territories as a floater.

Dead Cambridge (Appendix 1, Map 5)
Both the banded male and female from Dead Cambridge were on territory this year. The pair established a nest with two eggs by 5 June. The eggs hatched on 2 July and the egg shells were collected. One dying chick was found at the state campground on 11 July and sent to the USGS National Wildlife Health Lab, Madison, WI. Necropsy results indicate that a bacterial infection of the umbilicus may have been a leading cause of death. It is assumed that this was the one of the chicks from Dead Cambridge as only one chick was seen with the pair after this date. The remaining chick survived to the end of the season.

The female of this pair was fitted with a satellite transmitter on 16 August 2003. Follow-up surveys by LPC and FPL staff reported reduced parental care by this female, with the male assuming the majority of chick-rearing duties. The male successfully raised the chick to fledge in November. The satellite loon exhibited no other post-surgical impacts and is currently being tracked on the wintering grounds near Lincolnville, ME.

Glassby Cove (Appendix 1, Map 6)
An unbanded pair was on territory this year. A nest site with one egg was discovered on 8 July. On 14 July, the shells of the egg were collected. The pair was never seen with a chick and therefore this nest was recorded as a failure.

The banded Glassby female was seen once, alone, in Spillman Cove in early May and again in late May in Magalloway territory by herself.

Gull Island
No pair on territory this year.

Lawrence
No pair on territory this year. The Leonard Marsh pair used this as well as their own territory for foraging and brooding later in the season.

Leonard Marsh (Appendix 1, Map 7)
An unbanded pair occupied the Leonard Marsh territory this season and established a nest by 3 June. One chick hatched on 8 July and the remaining egg shells were collected. The pair and chick were captured and banded on 28 July. The chick survived to the end of the season.

The newly banded female was fitted with a satellite transmitter on 16 August. Follow-up surveys by LPC and FPL staff reported reduced parental care by this female. Although she initially remained on territory, after several weeks the satellite telemetry located her as a loner in Spillman Cove. FPLE biologists confirmed this location with plane and boat surveys through October. The male assumed all chick-rearing

responsibilities in the female's absence and the chick successfully fledged in November. The satellite bird exhibited no other post-surgical impacts and is currently being tracked on the wintering grounds.

The banded Leonard Marsh female was first seen here in early June with another unbanded adult. She was not identified again until late season where she was located in a group of rafting loons at the north end of the lake.

Leonard Pond
No distinct pair was observed early in the season, but a pair was seen during a couple of surveys in early June. The Lower Magalloway pair likely used this and their own territory for foraging. A moose carcass was present in last year's nesting cove for the first few weeks of the season which may have deterred potential occupants.

Metallak
No pair on territory this year.

Pine Point (Appendix 1, Map 6)
This year's territorial pair consisted of the banded Rapid River male and the banded Pine Point female. The pair established a nest with two eggs by 18 June and hatched two chicks on 15 July. The remaining egg shells were collected. The pair used the unoccupied Rapid River territory as well as their own for foraging and brooding. The chicks were captured and banded on 27 August. Despite a significant difference in size between the chicks (1000 g), both chicks survived to season's end. FPLE biologists observed both chicks at Pine Point in late October.

Potter Cove
This territory was unoccupied throughout most of the season. On 11 August, the Bear Island Cove pair were seen with a young chick in the cove. The nest site could not be located and the chick did not survive.

Rapid River
No pair on territory. The pair that successfully nested at Pine Point was often seen foraging and brooding in this territory.

Sargent Cove
An unbanded pair occupied Sargent Cove this year. There was no evidence of nesting activity.

Southeast Arm
No pair on territory this year. The Dead Cambridge pair expanded into the traditional Southeast Arm territory. A single, unbanded loon was present on territory on several occasions.

Spillman Cove
No pair on territory this year. The banded Glassby female was identified here once in the beginning of the season. The satellite outfitted female from Leonard Marsh stayed tight in this territory from September to early November when it flew to the coast.

Stateline Cove
An unbanded pair occupied Stateline Cove but no nesting activity could be confirmed.

Sturtevant Cove
An unbanded pair occupied Sturtevent Cove but no nesting activity could be confirmed.

Sunday Cove (Appendix 1, Map 8)
An unbanded pair occupied Sunday Cove and established a nest with one egg by 6 June. The nest was found empty on 8 July.

Thibideau
No pair on territory this year.

Three Island Cove
The pair that occupied the Chewonki territory expanded into the traditional Three Island Cove territory.

Thurston Cove (Appendix 1, Map 3)
This year's pair consisted of the banded Thurston male and an unbanded female. The pair established a nest by 9 June and deserted it by 10 July.

The banded Thurston female was seen in early May in Thurston territory with an unidentified adult and then again mid-August as part of a raft of adults in Sargent Cove.

Thurston Cove, Lower (Appendix 1, Map 3)
An unbanded pair occupied this territory and put down two eggs by 18 June. The nest was found empty on 1 July. Signs and floatlines were used and removed by 10 July in this territory.

Other Significant Sightings
In addition to the non-breeders recorded in the Androscoggin, Chewonki, Southeast Arm and Magallowy territories, at least 8 other individuals were counted moving between several territories or in non-territorial portions of the lake throughout the season. Including in these were two ABJs on Umbagog, one from Potter Cove (banded in 1994) and the other likely the 1998 Potter Cove or 1996 Magalloway loon. The 1994 Potter Cove ABJ was seen in both Absalom and Potter Cove. An ABJ was seen once on 7 May with a group consisting of two unbanded adults and the banded Harper's Meadow female. Due to the similarity in band combinations, it could not be positively identified as either the 1996 Magalloway or the 1998 Potter Cove ABJ.

Lastly the ABJ from Cold Brook territory on Mooselookmeguntic Lake, Adamstown, ME seen last year in the Yukon territory was identified as part of a pair that successfully hatched in Brown Owl Pond located east of the Refuge building, across the Magalloway River.

Banded Loons Present in 2002 and Not Accounted For in 2003
Both the banded Leonard Marsh female and the Southeast Arm male, both present in 2002, were not observed on Lake Umbagog in 2003.

Shifts in Territorial Delineation
With the decrease in number of territorial pairs, shifts in established territory boundaries have altered traditional territory delineation (Appendix 2). In total, between 2000 and 2003, fourteen distinct territories have collapsed into seven, accounting for a reduction of 44% in available territories during that period. Last year, the first collapsing territories occurred in Black Island-Gull Island, Three Island Cove-Chewonki with instability in the Magalloway-L. Magalloway territories on the Magalloway River.

By 2003, these newly expanded territories retained their configuration, and further collapses occurred in Bear Island Cove-Potter Cove, Dead Cambridge-Southeast Arm, Leonard Marsh-Lawrence, and Pine Point-Rapid River. On the Magalloway River, Lower Magalloway merged with Leonard Pond for a second year of shifting occupancy.

Results of 2003 Breeding Season

During the 2003 field season, 20 weeks were spent surveying Lake Umbagog. Eighteen territorial pairs were recorded, with four of these pairs occupying territories on the Androscoggin and Magalloway Rivers (Table 1, Appendix 3). This year, a total of 14 territories were unoccupied by loons. On average, a loss or gain of three territories can be expected between years on Lake Umbagog (LPC 28-year database). The magnitude of territory loss from 2000-2002 was unprecedented, and was not observed in other lakes in the Upper Androscoggin River watershed (LPC/BRI unpub. data) during that same time period.

Table 1. 2003 Population and Reproductive Success for Lake Umbagog, Errol, NH.

Population on Lake Umbagog		*Reproductive Success*	
Adults-paired	36	Nesting Pairs/Territorial Pairs (NP/TP)	0.67
Adults-unpaired	12	Chicks Hatched/Territorial Pair (CH/TP)	0.56
Total-adults	48	Chicks Surviving/Territorial Pair (CS/TP)	0.33
No. Nesting pairs	12	Chicks Hatched/Nesting Pair (CH/NP)	0.83
No. Chicks hatched	10	Chicks Surviving/Nesting Pair (CS/NP)	0.50
No. Chicks surviving	6	Chicks Surviving/Chicks Hatched (CS/CH)	0.60
Total population	55		

*This table includes Lower Thurston territory.

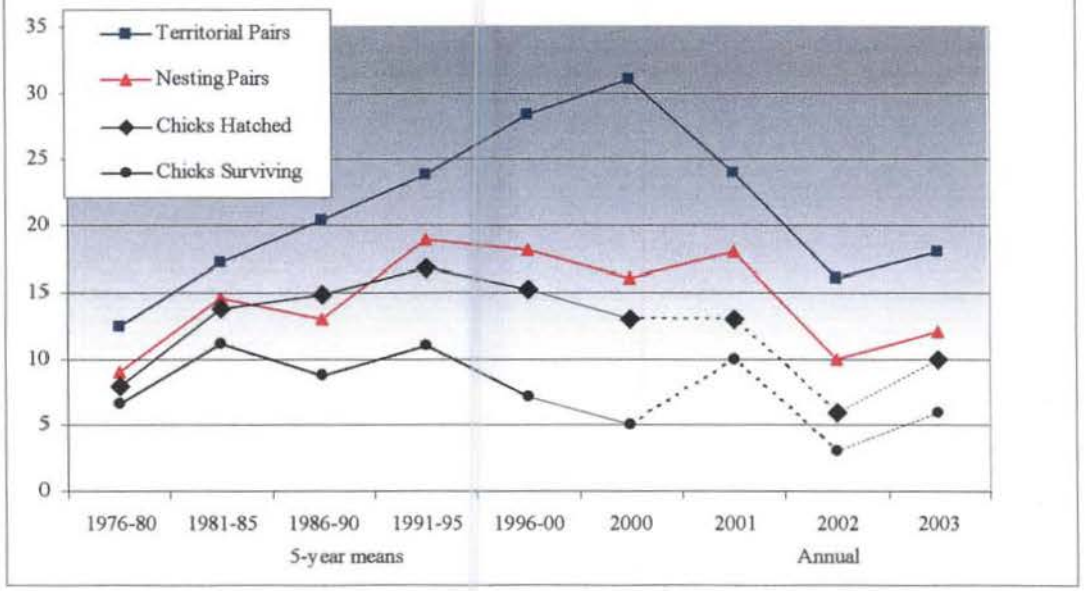
Sixty-seven percent of pairs (n=12) nested this season. Of these, over half (n=7) were successful in hatching at least one chick, and ten chicks were hatched in total. Seven attempted nests failed. Of the recorded nest failures, two were due to predation, and four nest abandonments could not be determined. No nest failures were attributed to water level fluctuations. Three abandoned eggs were collected with six chicks on Lake Umbagog survived to fledge.

Overall Perspective on Population Declines, 2000-2003

Nearly half of the territorial pairs present during the 2000 breeding season are now absent (Figure 1). In that year, thirty-two territories were occupied by loon pairs on Lake Umbagog. For the first time in three years however, re-occupancy occurred in two territories, Lower Thurston and Stateline Cove. Furthermore, the number of nesting pairs, chicks hatched and chicks surviving increased from the previous year (20%, 67% and 100% respectively).

While the total number of adults increased by 7% from the previous year, there remains a net loss of 26% of adults since the 2000 count. A total of 14 established loon territories were vacant this season. Despite these available territories, 25% of the adult population were non-territorial (we expect non-territorial adults to comprise 19% of the total adult population, and on Umbagog, these birds historically comprise 7% of the adult population – LPC unpubl. data). These individuals represent an influx of non-breeders that were first recorded in 2002.

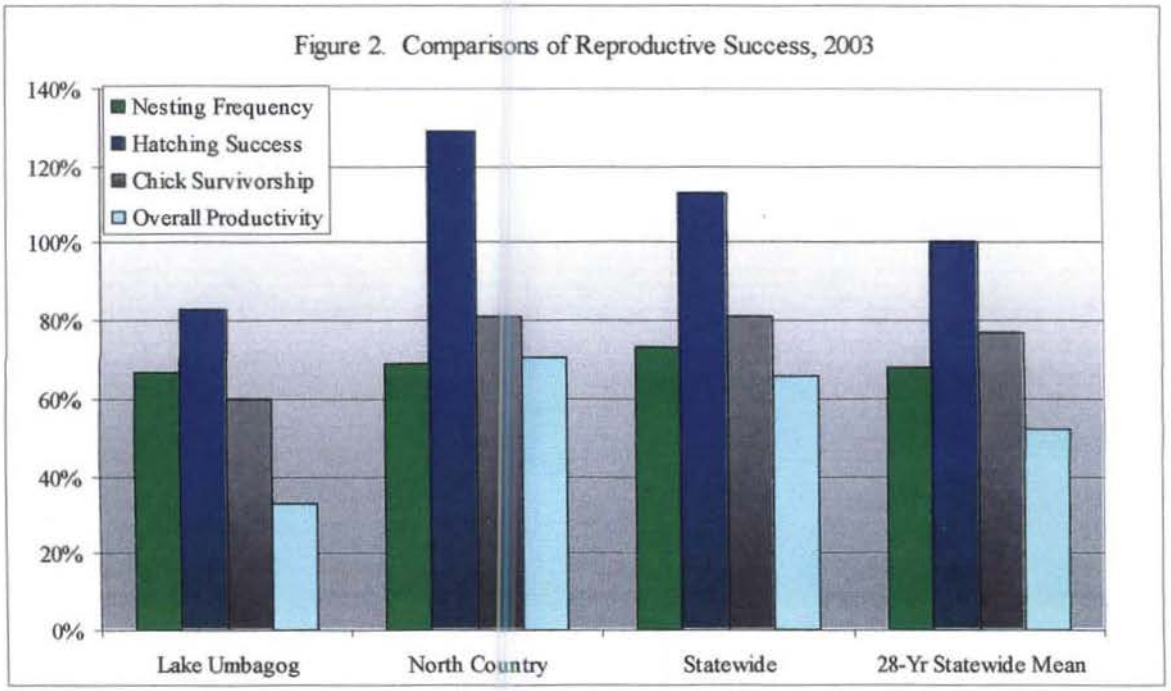
Figure 1. Loon Population on Lake Umbagog, 1976-2003



Regional and Statewide Perspective on Lake Umbagog Reproductive Success

In reviewing reproductive success both regionally (northern tier of New Hampshire) and statewide, nesting frequency and hatching success on Lake Umbagog are within expected ranges for the lake, however hatching success is quite low in comparison to other lakes statewide. Furthermore, Lake Umbagog continued to fall below other regional and statewide lakes in terms of chick survivorship and overall productivity in 2003, (Figure 2) and was also well below expected values for these parameters when compared with 28-year statewide means.

Figure 2. Comparisons of Reproductive Success, 2003



Productivity is measured through chicks surviving per territorial pair

Nesting Frequency: Sixty-seven percent (n=12/18) of the territorial pairs attempted nesting this season. The number of nesting birds was greater than in 2002 (n=10/16), with both years at the lower end of normal parameters for the lake (10-year NP/TP average is 0.72 +/- 0.13).

Hatching Success: Hatching success, defined as chicks hatched per nesting pair, is generally lower on Lake Umbagog in comparison with other lakes both regionally and statewide, however, this parameter in 2003 (0.83) is well within expected rates for the lake (10-year average hatching success is 0.79 +/- 0.12). This is an increase of 38% from the previous year.

Chick Survivorship: This year 60% of hatched chicks survived to fledge age. Historically, chick survivorship on Lake Umbagog (10-year CS/CH average is 0.55 +/-0.13) is low in comparison with other lakes surveyed in the northern tier of the state (a region bordered by the White Mountains to the south), as well as with lakes state-wide. Survivorship on Umbagog was again below both the state-wide average this year (81%) and survivorship on other lakes in northern New Hampshire (77%)

Overall Productivity: Productivity is measured through chicks surviving per territorial pair. According to LPC data and developing population models, approximately 0.48 chicks surviving per pair is needed for a self-sustaining population. Lake Umbagog continues to be well below this recommended value.

Banding and Surveying Marked Individuals

Summary of Banding Activities in 2003: A total of 103 loons have been captured and banded on Lake Umbagog since 1993 (Appendix 4), representing 20 loon territories. These banded individuals are essential for the accurate evaluation of population trends, recruitment, site fidelity, mate fidelity, and toxic levels of the Umbagog loons. In 2003, 13 loons were captured on the lake (8 adults including 4 recaputures and 5 chicks). During capture in the Harper's and Sweat Meadow territories on 24 July, it was noted that the adults had numerous small white leeches on their legs. In over 3,000 loons banded, no other reports of leeches on loons have been documented (D. Evers pers comm.)

Between-Year fidelity: On average, 81% of males and 78% of females return to territories on Lake Umbagog each year (Table 2). Combined, males and females average an 80% return rate (1993-2003). In 2003, 75% of banded males and 71% of banded females returned to territory, yielding a combined return rate of 73% for banded loons on Lake Umbagog. According to Evers (2001), between-year territory fidelity in New England's loon population is 80% for males and 84% for females on lakes with multiple territories. Therefore, territory fidelity for loons on Lake Umbagog is lower than that for New England loons.

Last year, only 53% of banded males returned and we speculated that this bias towards males being more impacted by the unknown stressor event on Umbagog may indicate a prey-related issue (i.e., larger males forage on larger prey that have greater concentration of biotoxins through biomagnification). This year, the return rates of the remaining banded males improved, while those for the banded females dropped by 13%.

Unlike Umbagog, return rates for other lakes in the upper Androscoggin River watershed are within normal standards (BRI unpubl. data) in 2003. Of the birds lost (> 30) these last three years, nine have been banded individuals.

Table 2. Between-Year Fidelity for Breeding Adult Loons on Lake Umbagog, 1993-2002.

Year	Potential Returning Adults			Actual Returning Adults			Between Year Territory Fidelity		
	Male	Females	Both	Male	Females	Both	Male	Females	Both
1994	0	2	2	0	2	2	0%	100%	100%
1995	7	7	14	6	6	12	86%	86%	86%
1996	11	8	19	10	7	17	91%	88%	89%
1997	13	8	21	11	6	17	85%	75%	81%
1998	13	7	20	10	5	15	77%	71%	75%
1999	10	11	21	9	10	19	90%	91%	90%
2000	14	10	24	14	8	22	100%	80%	92%
2001	17	14	31	13	9	22	76%	64%	71%
2002	15	11	26	8	9	17	53%	82%	65%
2003	4	7	11	3	5	8	75%	71%	73%
Total	104	83	187	84	65	149	81%	78%	80%

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). If a loon is found that was previously in either of these categories it is eligible at the beginning of the year (Evers et al. 1996).

Satellite Telemetry

On 16 August, in a joint, cooperative effort including FPL, BRI, LPC, USGS, and USFWS, satellite transmitters were implanted into two Lake Umbagog loons, the Dead Cambridge and the Leonard Marsh females. Post-operative observations (18 August – late October) indicated a reduction in parental interaction with the chicks in both territories, with brooding occurring primarily with the adult males. Both chicks survived to fledge.

The Leonard Marsh female was the first to move, being tracked about 159 km (99 miles) southeast of Lake Umbagog on 8 November. The highest quality location placed her roughly 6 miles off Cape Elizabeth, ME. On 15 November, she was located just south of this point, near Old Orchard Beach, Scarborough, ME. That same day, the Dead Cambridge female was located 169 km (105 miles) WNW of Lake Umbagog, just offshore of Lincolnville, ME in Penobscot Bay.

The satellite telemetry has provided valuable information on the timing, routes and locations of these migrating loons. It will also provide information on winter movements, potential mortality and the return migration of Lake Umbagog or another lake.

Conservation Implications

Historically poor reproductive success in the southern end of Umbagog was offset by higher productivity in the northern end. If the source population in the northern end continues to be compromised and can no longer carry the southern sink, other stressors could further destabilize the loon population on Umbagog. These stressors include:

Water Level Fluctuations: (Table 3): The Lake Umbagog water level management plan instituted in 1998 continues to be effective, with only one nest failure documented from flooding and draw-downs in each of 1999, 2000, and 2002. No nest failures occurred from fluctuating water levels in 2001 and 2003 (Appendix 5).

Table 3. Summary of Nest Failures Related to Water Level Fluctuation on Lake Umbagog, 1998-2003

Year	Nesting Attempts	Nests Flooded	Nests Stranded	% Failure
1998	24	0	0	0%
1999	31	1	0	3%
2000	18	1	0	6%
2001	15	0	0	0%
2002	10	1	0	10%
2003	14	0	0	0%
Total	112	3	0	3%

Rafts: In previous years, Lake Umbagog loons had use of two rafts, one in the Pine Point territory, and the other in Glassby Cove with an avian guard. Based on the extremely poor reproductive output in the latter territory, we recommended the removal of this raft. As stated in the methods section, the purpose of rafts is to aid in reproductive success where natural attempts are impacted by water level fluctuations or predation. Although loons used the Glassby raft, the poor fledge rate indicated an ineffective management strategy for this territory. Both rafts were removed in 2001.

In 2003, nesting attempts were recorded in both Glassby and Pine Point territories. The Glassby nest failed with the cause of abandonment undetermined. The pair at Pine Point nested on a small island and hatched two chicks that survived to season's end.

LPC considered a raft in the Black Island Cove territory due to a history of heavy predation pressure, but a raft was not deployed in time and the pair began incubating on the shoreline. As expected, the nest failed again this year from mammalian predation.

Predation: Two nest failures were confirmed as nest depredations. These occurred in the Bear Island Cove and Black Island Cove territories. The remaining nest failures could not be determined. Mammalian predators might include: raccoons (*Procyon lotor*), mink (*Mustela vision*), and fisher (*Mustela pennafi*). Other predators include avian species such as: Herring (*Larus argentatus*) gulls, Bald eagles (*Haliaeetus leucocephalus*), Common ravens *(Corvus corax)*, and possibly Ring-Billed gulls (*Larus delawarensis*). Species-specific predation however, was not recorded.

Strikes by Bald Eagles (*Haliaeetus leucocephalus*) on loon chicks have been recorded on the Brown Owl Pond, located just east of the Refuge headquarters. With the addition of a second pair of nesting eagles located on the Maine side of the lake in 2000, a significant increase in eagle activity was observed. In 2002, eagles were sporadically present in both Glassby Cove and Leonard Pond territories. Both these territories had failed nesting attempts. In 2003, eagles regularly roosted behind the nest site in Glassby Cove. This nest failed and only egg shells were found on the nest.

Contaminants: According to Evers and Reaman (1997), water-level fluctuations (> 2m) are one of several confounding variables which can increase mercury availability to biota, and mercury inputs from watersheds and atmospheric deposition on the lake exacerbate this tendency. Water levels on Lake Umbagog are, however, artificially managed by FPLE to be even more stable than even natural waterbodies. Lake Umbagog does not have exaggerated mercury levels. Subsequent sampling of loon blood, feather and eggs indicates a moderate mercury risk lake-wide.

Management for Human Disturbance: Recreational activities likely play a role in loon hatching and fledging success. In response to this pressure, LPC has used professional judgment and instituted the use of ropes and floating signs to cordon off high-risk territories on high-use lakes such as Lakes Winnipesaukee and Squam in central New Hampshire. When used properly, these

management tools are effective. For example, in comparing managed versus non-managed loon territories on New Hampshire lakes, we found the number of chicks hatched per nesting pair was greater in territories managed with signs and/or floatlines. In 2003, loon pairs in New Hampshire supported with restrictions experienced a lower rate of nest failure (27%) in comparison with their counterparts in territories without the need for such intervention (43%). Chicks hatched from managed territories contributed 38% to total chicks hatched. In sum, although signs and/or floatlines can serve to draw attention to a nest site, it appears that creating an appreciable distance for nesting pairs can act as an effective buffer to minimize human impacts.

Unlike other large lakes with multiple loon pairs in New Hampshire, this type of management was not initially deemed necessary on Lake Umbagog in the early 1990s due to comparatively low recreational use. By the late 1990s, however, significant increases in recreational activity were reported by LPC field staff and lake residents, most notably in the southern end where a campground and a public launch is available. This grew to include loon territories on the Magalloway and Androscoggin River which serve as primary sites of entry for non-motorized craft. This increase in recreational activity necessitated the introduction of more formal and consistent management techniques. FPLE feels decisions involving the restrictions of public access on public waters should be handled by the appropriate state and federal authorities.

The use of management options such as signed enclosures, floatlines and closing campsites conspicuous to nest sites should be carefully evaluated. As listed under the Status Assessment and Conservation Plan for the Common Loon (*Gavia immer*) in North America (Evers 2004), several considerations need to be observed for this type of management to be effective and evaluated over time as a viable management tool:

1. The perception of lake users and residents: Lake Umbagog has long been considered a wilderness lake; as such any restrictions have the potential to reduce an appreciation for the presence of loons on the lake. The use of enclosures should only occur on territories that are highly impacted by human disturbance. Placement should be site-specific based on nest failure history and an understanding of typical lake use patterns. On other lakes with multiple loon pairs and high rates of recreational use, successful management is achieved only in cooperation with lake users.

2. The appearance of restrictions: Once a territory is identified as highly impacted by human disturbance, the first strategy is to achieve a reduction in disturbance with the least amount of restriction as possible. Floating signs can create the effect of a barrier without the need for further roping. Kelly (1991) recommends floating 3-6 signs, approximately 137 m from the nest site for optimal buffering capacity. According to LPC methods, placement distances are determined by observing the tolerance of the nesting pair. Once the minimum distance at which neck lowering is observed, a 10 foot (~3 m) buffer is added to this distance. Only if signs are not respected should roping occur in the territory.

It is not necessary to cordon-off large areas and excessive roping and signage should be avoided. Enclosures should be removed following hatch, or when the adults have moved young to another location. Prompt removal will maximize public acceptance and compliance with the signs.

3. Effective scheduling of campsite closures: In an effort to increase nesting potential, campsite closures were established near known loon nesting sites. We have found that compliance is more readily achieved when there is an understanding that restrictions only apply during actual incubation and not necessarily in anticipation of potential nesting. Since campsites are reserved in advance of the season, it is, however, difficult to avoid unnecessary closures in cases where no nesting attempts are recorded.

Campsite closures have occurred mid-May extending to 1 July. Considering that peak-of-hatch generally occurs in the first to second week in July, this schedule does not effectively protect birds in the latter half of incubation nor does it accommodate late-nesters or renests.

4. *The ability to provide consistent management*: Once a management strategy is designed for a territory, it should be in place for a minimum of three years and evaluated after this period for continuation or termination. It is difficult to evaluate the necessity and/or effectiveness of management practices without proper justification or consistency.

5. *The ability to provide dynamic management*: LPC is currently funded and authorized by NHF&G to conduct loon management on New Hampshire Lakes, including Lake Umbagog. Part of LPC's successful efforts in offsetting impacts to loons for nearly thirty years on Lake Umbagog is the ability to make in-field decisions based on professional judgment.

Density dependence: Reproductive success as related to density of adult loons is more readily observed during seasons of low or high total adult populations, as seen in recent years on Lake Umbagog. If a buffer population existed that could significantly interfere with fledging success, non-breeding individuals would have filled any territories made available. Territories unoccupied by loons this year (n=14) were equally distributed on the northern and southern ends of Umbagog indicating that density-dependent pressures are less of a predictive force than other factors.

Mortality

2003 loon recoveries: No new adult carcasses were collected from the lake, but two chicks were recovered. On chick was sent at the USGS National Wildlife Health Lab, Madison, WI. Necropsy results indicate that a bacterial infection of the umbilicus may have been a leading cause of death. The second chick was sent to Tufts University Wildlife Clinic, Grafton, MA. Necropsy results are not yet available on this chick.

As reported last year, one recovery was made prior to the breeding season. a 1997 ABJ from Pine Point. This bird was found frozen in the ice on Sebago Lake, Windham, ME on 22 February 2003. Cause of death was determined to be lead poisoning.

Adult loon mortality averages 3-5% annually (BRI unpubl. data). Currently there are over thirty adult loons unaccounted for, representing a 44% loss in the number of pairs since the 2000 counts. We found no other carcasses and/or displaced Umbagog loons in surveys conducted inside or outside of normal dispersal ranges (average 2-3 km, maximum 15 km).

Angling and the availability of lead to loons: In the 1980s, the first smallmouth bass were recorded in southern Umbagog and this illegally introduced species has now radically changed the preferred fishing practices on the lake (Noon 1999). The rise in popularity of bass fishing on Umbagog has grown with the increase in bass size and abundance on the lake. Accompanying these increases have been higher rates of lead mortality to loons as a result of ingesting lead fishing tackle.

Lead fishing weights and tackle are made available to loons through use and improper retrieval and disposal of these items. A total of 12 loon carcasses have been collected from Lake Umbagog since 1979. This includes 6 adults and 6 chicks. Of the adult mortalities, four (67%) have been attributed to lead poisoning, and all have occurred since 2000.

Lead poisoning from the ingestion of lead fishing tackle has been identified as a significant cause of Common Loon mortality throughout Eastern Canada and the United States (D. Campbell pers. comm.; K.

Chubb pers. comm.; P. Daoust pers. comm; Ensor et al. 1992; Evers et al. 1996; Franson et al. 1993; McIntyre 1988; McNicholl 1988; Perry 1994; Pokras and Chafel 1992; Pokras et al. 1993; Poppenga et al. 1993; Sam and Boates 1993; Scheuhammer and Norris 1995; Scheuhammer and Norris 1996; Tufts University School of Veterinary Medicine 1992; V. Thomas pers. comm.; Tufts University School of Veterinary Medicine and United States Fish and Wildlife Service 1994).

The loss of loons to lead poisoning has been recognized as a problem by MDIFW, USFWS, the New Hampshire Department of Environmental Services, Maine Department of Environmental Protection, and the United States Environmental Protection Agency. Lead sinkers have been banned in England, in national parks and wildlife preserves in Canada, in Yellowstone National Park and in three national wildlife refuges in the United States due to their impacts on loons and other waterbirds.

Without an effective outreach effort and enforceable regulations to mitigate the impact of this sportfishing, we can expect progressively higher rates of mortality from lead in Umbagog's loon population.

Management Guidelines

LPC and FPLE are developing a Standard Operating Procedure for active loon management activities on Lake Umbagog and FPLE's other FERC hydro projects in Maine. The "Protocol for Surveying and Managing Common Loons on Lake Umbagog" will follow the best management practices which LPC has developed in conjunction with partnering organizations such as BRI over the last 30 years. FPL will send this manual to New Hampshire Fish &Game, MDIFW and USFWS. Upon approval of this protocol, FPLE and LPC biologists will be responsible for management activities and all day-to-day decisions related to loon management within the boundary of the Errol Dam Project. The FERC No. 3133 annual report will be sent out for agency review and an annual follow-up agency meeting will be hosted by FPLE.

Conclusion

Most notable this year on Lake Umbagog was a 7% increase in the adult population, re-occupation of two territories previously abandoned, and subsequent increases in nesting pairs, chicks hatched and chicks surviving from the previous year. Despite these increases, overall occupancy by loon pairs continues to be a net loss from 2000. In that year, Lake Umbagog held the highest concentration of breeding loons in New Hampshire. Since then, nearly half of territorial pairs present are now absent, resulting in a total of 14 unoccupied loon territories this season.

A loss or gain of three territories between years can be expected, and is consistent with other partial lake territories, such as Lakes Winnipesaukee and Squam in central New Hampshire (LPC unpubl. data). The magnitude of territory loss experienced on Lake Umbagog from 2000 to 2003, however, is unprecedented. No other lake in New Hampshire, or those on nearby Aziscohos Lake and the entire Rangeley Lakes Region in Maine, experienced such drastic territory loss (BRI unpubl. data).

Evers (2001) found that displaced adults have a tendency to remain within 8 km of their former territory. Males are generally found within 2 km of their former territory. We did not find displaced Umbagog loons in standardized surveys conducted inside or outside of this range (up to a 50 km distance). In addition to loons, other anecdotal information from lake residents substantiates the loss of other piscivorous birds utilizing Lake Umbagog. Active local osprey nests have declined from eighteen in 1996 to nine in 2002 (C. Martin, NH Audubon pers. comm.).

Satellite transmitters were implanted in two adult females in August of 2003. Understanding migratory routes and winter locations of Lake Umbagog's loon population may provide insight into the loss of adults on

that lake over the last several years. Stressors on the wintering grounds may include incidents such as red tides, oil spills, contaminants and localized commercial fishing pressure.

Three working hypotheses to explain the loss of territorial pairs are under consideration: (1) Lake-specific disease, parasites and/or biotoxins that become acute during stress events such as migration or feather molt, (2), a water-based point source releasing contaminants not mobilized (and therefore not available) until the occurrence of a biological stress event, or (3) site specific loss caused by some event occurring on the wintering grounds.

The extremely high loss of adult loons and accompanying declines in reproductive output on Lake Umbagog is of serious concern. Despite some increases in these parameters in 2003, we have not seen the number of territorial pairs this low since the early 1980s, and that drastic loss has occurred within a three year period. Further confounding an understanding of this loss is a sharp increase in lead mortality that has accompanied the popularity of sportfishing on the lake.

It is imperative that all efforts be made to investigate causes of this unprecedented decline and measures be in place to offset further destabilization of this important loon population.

Recommendations

Monitoring

Continue monitoring of all established pairs, transitional pairs, and non-breeding adults. Based on the increasing eagle population on Lake Umbagog, we recommend documenting the presence of eagles in loon territories and increasing observation times in those areas during incubation and when chicks are present. At a minimum, observations in Glassby Cove should be increased. This territory historically has a high rate of undetermined nest failure. In both 2002 and 2003, activity was noted in this territory.

Management

Water Level Scheme: The current water level plan for Lake Umbagog optimizes the needs of nesting loons on the lake. We recommend this same management strategy for the 2004 loon nesting season.

Rafts: The decision to re-introduce rafts on Lake Umbagog is based on a two level approach. The first level is responding to established management methods for Common Loons. LPC's criteria for raft flotation calls for consideration in territories where nest failure has occurred (minimum 3 successive seasons) due to artificial water level fluctuation or shoreline predation. For the past 6 years, we have documented persistent predatory pressure on nesting loons in Black Island Cove.

A secondary approach for the use of rafts on Umbagog is to stabilize the impacts of the recent decline in the adult loon population. Rafts significantly improve hatching success on systems with fluctuating water levels as well as those with stable levels (DeSorbo In Prep). To offset poor chick production we feel that short-term use of rafts (at least 3 years) should be considered in the Big Island South, Sunday Cove and Thurston Cove territories. These sites represent established territories (those with historic occupancy or occupancy for a minimum of 3 successive breeding seasons) and have suitable flotation sites.

Human Disturbance: We recommend an assessment of disturbance due to human activity in territories in the southern end and a comparison with territories in the northern end. This can be accomplished with well-established observation techniques (i.e., time-activity budgets). Results will be compared to summarized data already collected on northern Lake Umbagog and nearby Aziscohos Lake (BRI, unpubl.data). Furthermore, a thorough review of previously signed and roped territories should be conducted to determine necessity, continuation or termination of these actions. Currently, other than qualitative observations of

recreational use in Lower Thurston and Dead Cambridge territories, LPC has no consistent data to support restrictions in any other territories at this time.

In regards to campsite closures, an optimal strategy for campsite closures would be the creation of a dynamic policy that calls for designated closures to occur from 1 May through the end of July. If no pair is determined to be occupying the territory or nesting has not occurred by 1 July, these sites can be reviewed for early opening.

Banding and Sample Collection

Since 1993, LPC has participated in the banding of loons on Lake Umbagog in cooperation with BioDiversity Research Institute, FPL Maine Hydro, and USFWS. The banding project on Lake Umbagog is part of a long-term effort to understand loon demographics. It also serves to provide specific information on population dynamics on Umbagog's loon population. Lastly, banding provides a mechanism for acquiring samples in support of the current loss of adults on Lake Umbagog, and these samples serve as a reference in understanding other impacts. Capture and banding of additional loon pairs and chicks should occur in 2004.

Investigation into the Adult Loon Loss on Lake Umbagog

We propose and have already begun to implement the following steps to investigate the causes of the observed declines:

1. Continue banding of adults and chicks. We recommend the capture of adult loons occur in the spring and fall as possible, in addition to normal capture periods. Continue health checks on captured loons and collection of blood samples for West Nile Virus should be included.

2. Arrangements should be made with the USGS National Wildlife Health Lab, Madison, Wisconsin to test for the West Nile virus and conduct a full organic pesticide and PCB scan of Umbagog loon eggs archived by LPC. We would like to analyze 5 eggs from the mid-1970s, 1980s, 1990s, and 2001, 2002 and 2003.

3. LPC and FPLE biologists should conduct late-season surveys to determine any mortality (shoreline searches), abnormal behaviors, and location of spring and fall flock areas on the lake.

4. We recommend sampling fish at the three primary inlets into the lake.

5. Identify and measure disease, parasites and biotoxins though blood, feather and egg samples as described by Tufts University methods.

Satellite Transmitters

The effort will be made to remove the satellite hardware should either the Dead Cambridge or Leonard Marsh females return to Lake Umbagog or any other lake in 2004. All future transmitter implants in other loons will follow U.S. Geological Survey methodologies.

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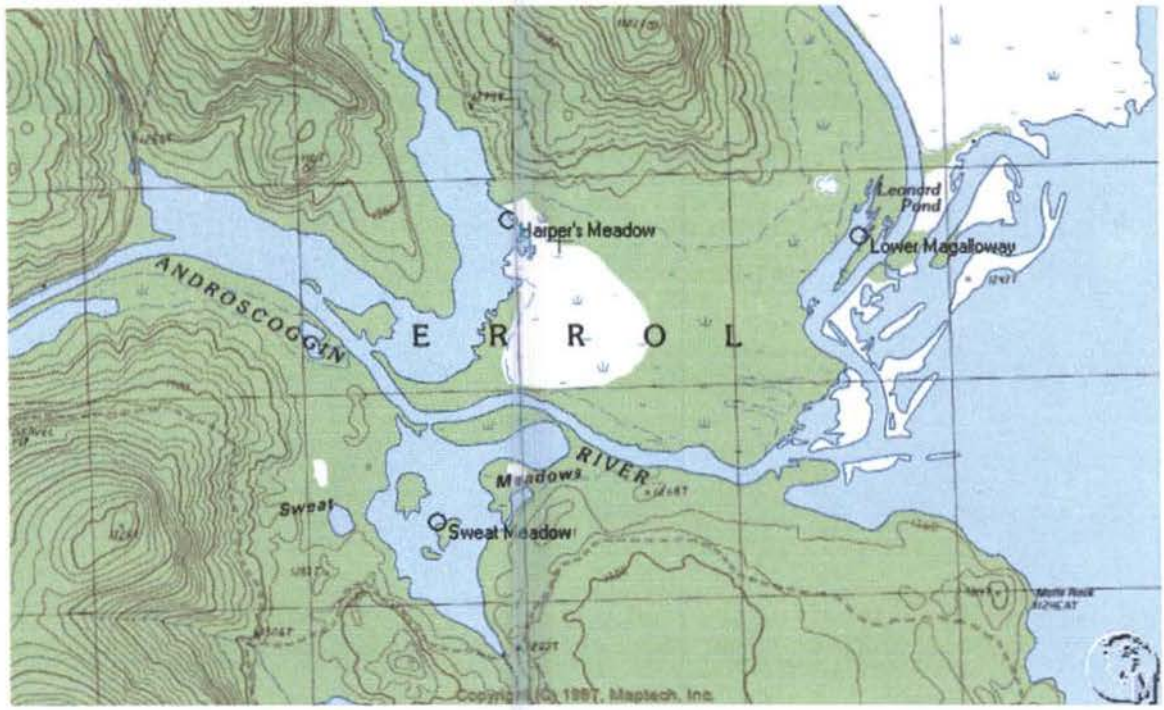
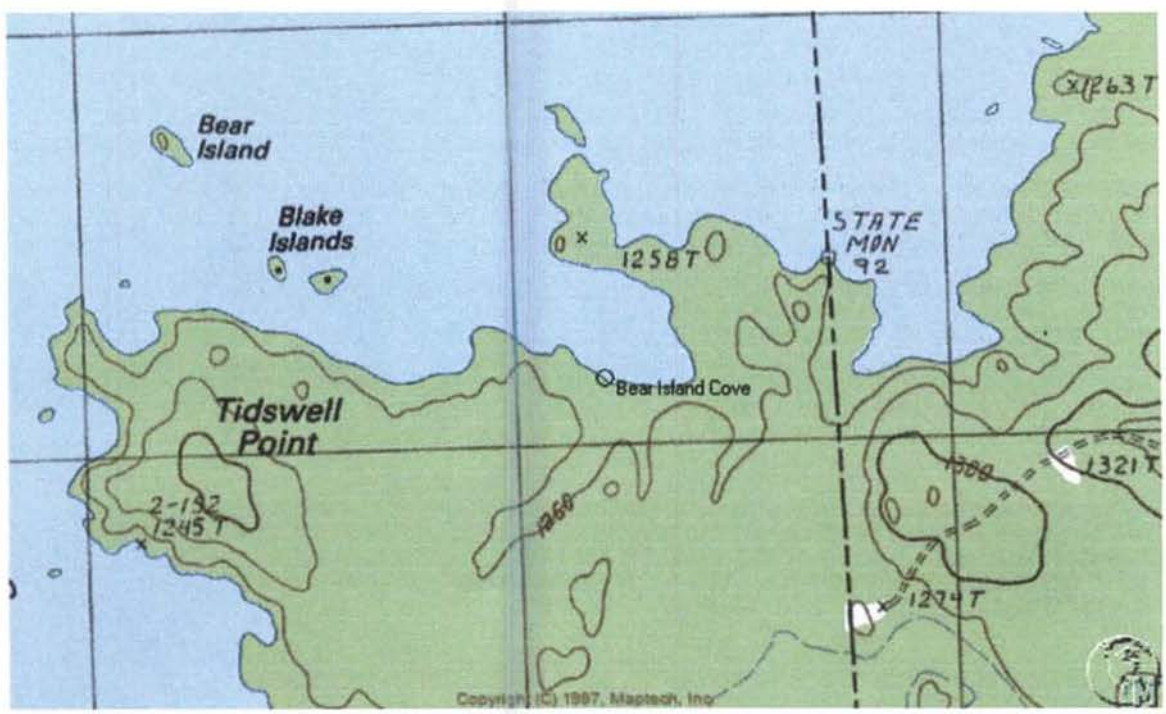
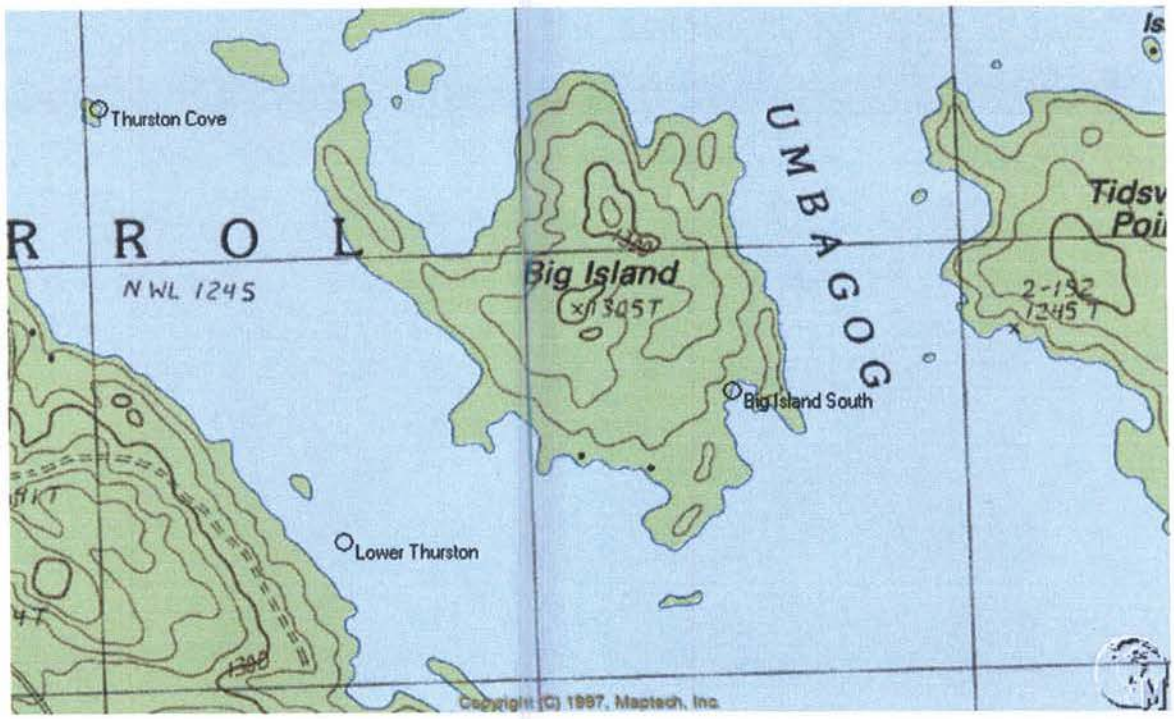
Appendix 1, Map 1: Harper's Meadow, Sweat Meadow and Lower Magalloway



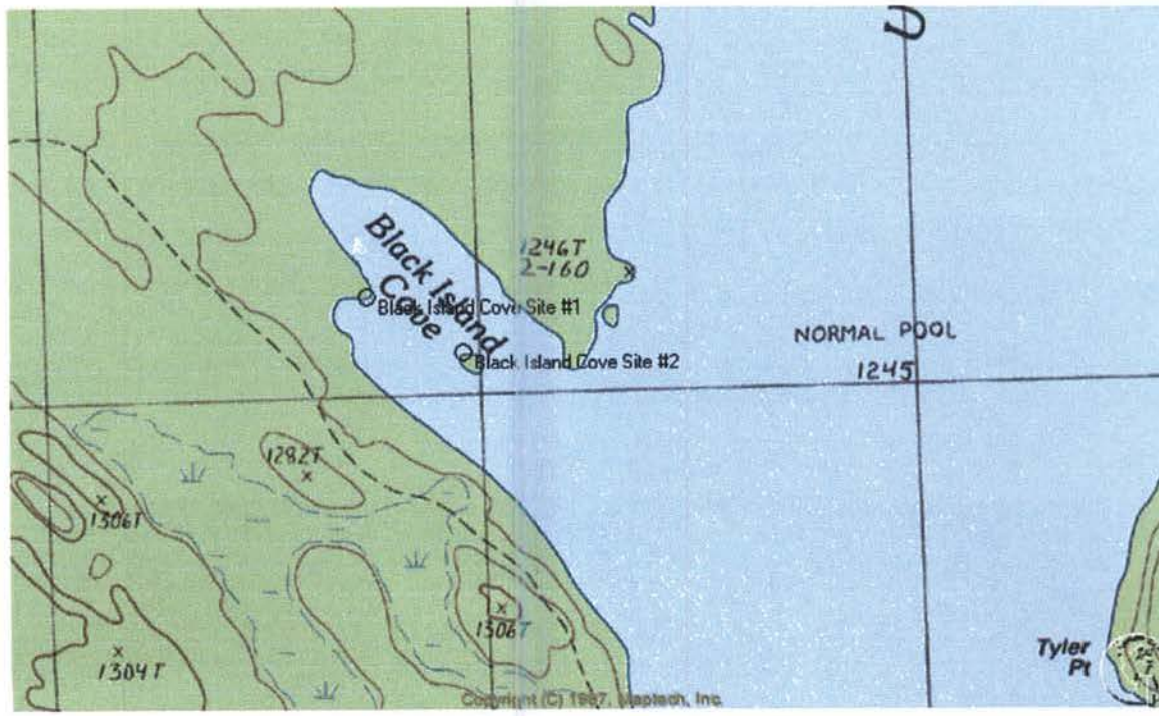
Appendix 1, Map 2: Bear Island Cove



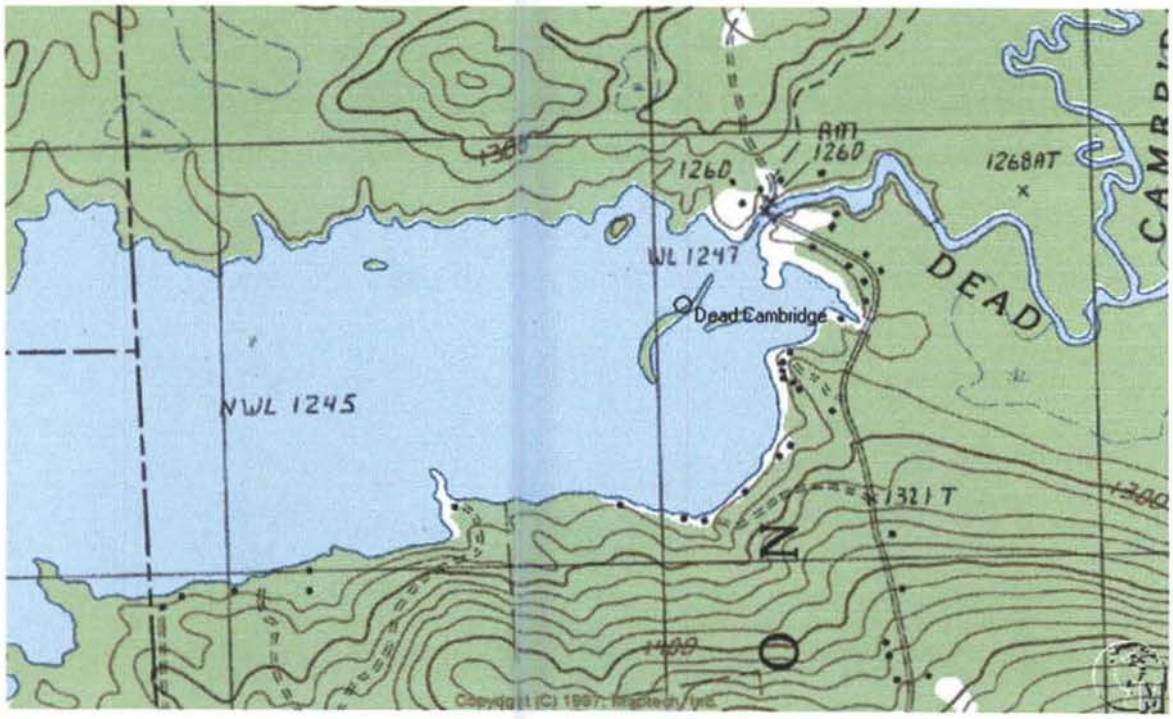
Appendix 1, Map 3. Big Island South, Thurston Cove and Lower Thurston



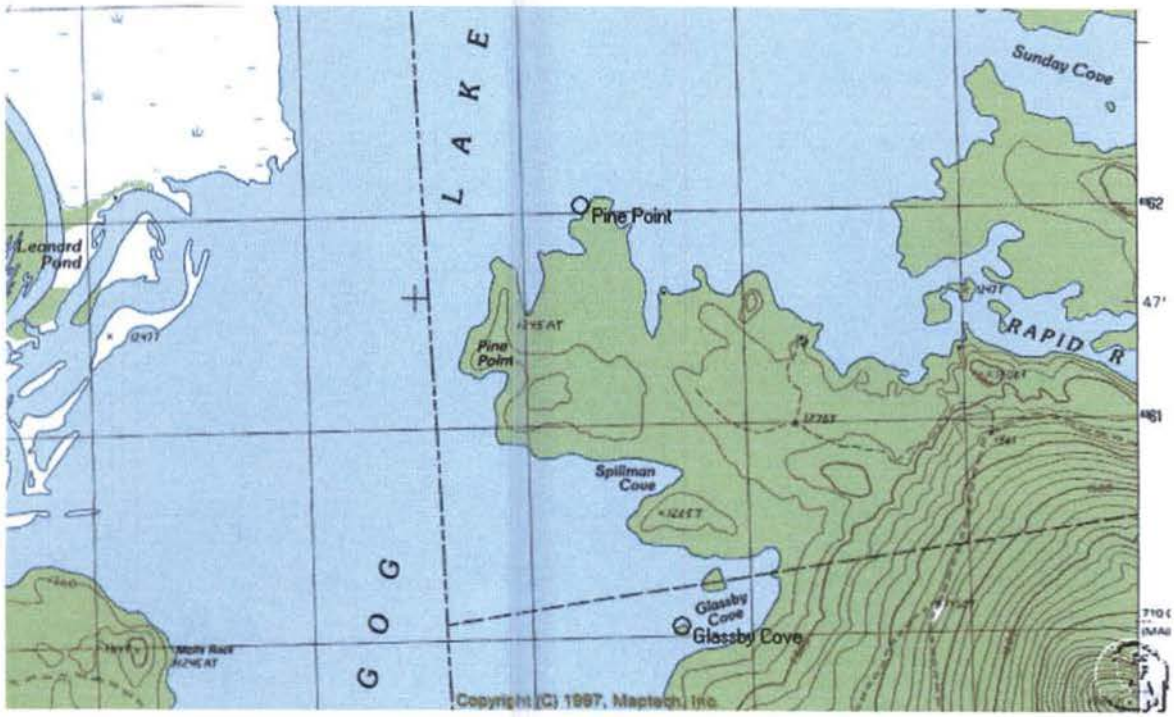
Appendix 1, Map 4. Black Island Cove, nest sites 1 and 2.



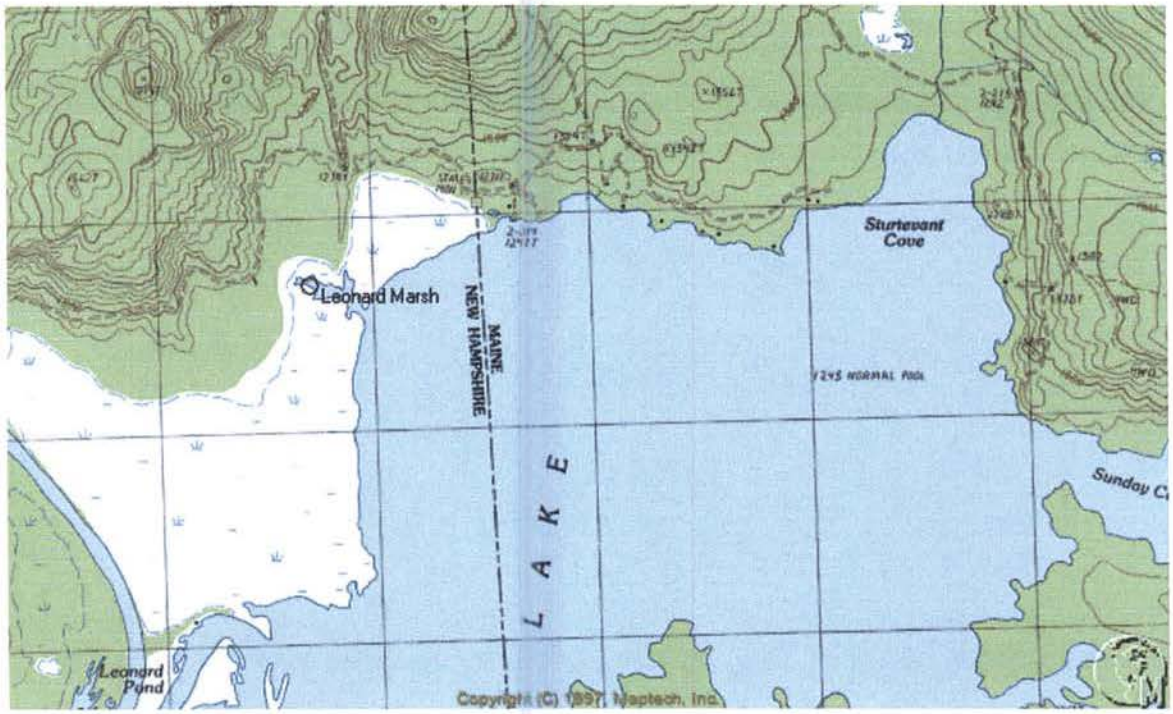
Appendix 1, Map 5. Dead Cambridge



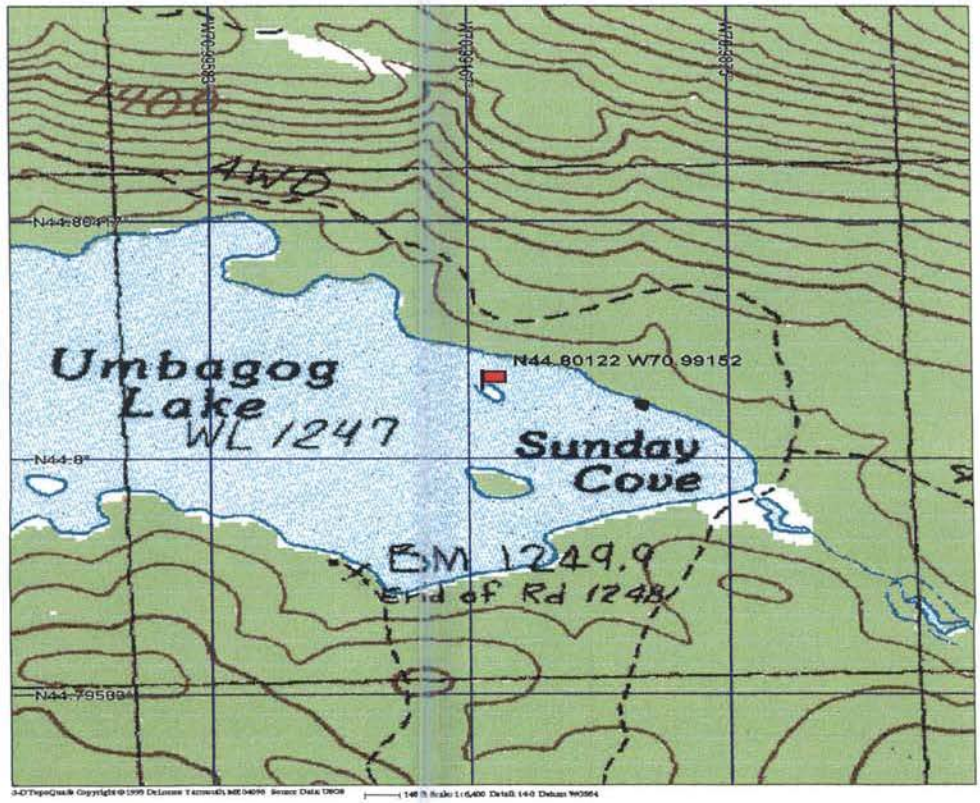
Appendix 1, Map 6. Glassby Cove and Pine Point



Appendix 1, Map 7. Leonard Marsh



Appendix 1, Map 8. Sunday Cove



Appendix 3. Lake Umbagog Common Loon Summary by Territory, 2003

Lk ID	NHT-	Lake	Territory	Paired Adults	Unpaired Adults	Immatures	Nesting Pairs	Successful Pairs	Nest Failures	Renests	No. Chicks Hatched	Hatch Date	No. Chicks Surviving	No. Rafts Floated	No. Rafts Used	No. Chicks Hatched from Rafts	No. Chicks Surviving from Rafts	Lakes with Paired Adults	Lakes with Nesting Pairs	Lakes with Successful Pairs	Adult Mortalities Submitted	Chick Mortalities Submitted	No. Eggs Collected	Total Pop (Adults+Chicks+Immatures	Signs/Floats	comments
987		Androscoggin River	Androscoggin	0	1	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	1	0	
987	0114	Androscoggin River	Harper's Meadow	2	0	0	1	1	0	0	1	6/27	1	0	0	0	0	1	1	1	0	0	0	3	1	
987	0110	Androscoggin River	Sweat's Meadow	2	0	0	1	1	0	0	1	6/23	1	0	0	0	0	0	0	0	0	0	0	3	1	
997	0291	Magalloway River	L. Magalloway	2	0	0	1	1	0	0	2	7/1	0	0	0	0	0	1	1	1	0	1	0	2	0	Used Leonard Pond territory in addition to own.
997	0112	Magalloway River	Magalloway	2	1	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	3	0	
997	0292	Magalloway River	Yukon	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	
188	0121	Umbagog	Absalom Island	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	
188	0192	Umbagog	B Brook Cove	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	
188	0119	Umbagog	Bear Island Cove	2	0	0	1	1	1	1	1		0	0	0	0	0	1	1	1	0	0	1	2	0	
188	0128	Umbagog	Big Island North	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	
188	0125	Umbagog	Big Island South	2	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	2	0	Old nest found, couldn't confirm NP
188	0108	Umbagog	Black Island Cove	2	0	0	1	0	2	1	0		0	0	0	0	0	0	0	0	0	0	2	2	0	1st fail = mamm. Pred., 2nd fail = unknown
188	0111	Umbagog	Chewonki Marsh	2	1	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	3	0	Foraged in 3-Island, banded 3-Island female was floater
188	0194	Umbagog	Dead Cambridge	2	0	0	1	1	0	0	2	7/2	1	0	0	0	0	0	0	0	0	1	0	3	0	Female outfitted with satellite transmitter
188	0106	Umbagog	Glassby Cove	2	0	0	1	0	1	0	0		0	0	0	0	0	0	0	0	0	0	0	2	0	Eagle roosted in snags behind nest
188	0107	Umbagog	Gull Island	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	
188	0117	Umbagog	Lawrence	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	Leonard Marsh used this territory in addition to own
188	0103	Umbagog	Leonard Marsh	2	0	0	1	1	0	0	1	7/8	1	0	0	0	0	0	0	0	0	0	0	3	0	Female outfitted with satellite transmitter
188	0113	Umbagog	Leonard Pond	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	L. Magalloway used this territory in addition to own
188	0118	Umbagog	Metallak	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	
188	0105	Umbagog	Pine Point	2	0	0	1	1	0	0	2	7/15	2	0	0	0	0	0	0	0	0	0	0	4	0	
188	0129	Umbagog	Potter Cove	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	See Bear Island Cove (nest site)
188	0104	Umbagog	Rapid River	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	Pine Pt used this territory in addition to own.
188	0123	Umbagog	Sargent Cove	2	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	2	0	
188	0122	Umbagog	Southeast Arm	0	1	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	1	0	Dead Cambridge used this territory in addition to own.
188	0293	Umbagog	Spillman	0	0	0	0	0	0	0	0		0	0	1/0	0	0	0	0	0	0	0	0	0	0	
188	0120	Umbagog	Stateline Cove	2	0	0	0	0	0	0	0		0	0	1/0	0	0	0	0	0	0	0	0	2	0	
188	0102	Umbagog	Sturtevant Cove	2	0	0	0	0	0	0	0		0	0	1/0	0	0	0	0	0	0	0	0	2	0	
188	0191	Umbagog	Sunday Cove	2	0	0	1	0	1	0	0		0	0	0	0	0	0	0	0	0	0	0	2	0	
188	0190	Umbagog	Thibideau	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	
188	0109	Umbagog	Three Island Cove	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	Chewonki used this territory in addition to own.
188	0127	Umbagog	Thurston Cove	2	0	0	1	0	1	0	0		0	0	0	0	0	0	0	0	0	0	0	2	0	
188	0124	Umbagog	L. Thurston Cove	2	0	0	1	0	1	0	0		0	0	0	0	0	0	0	0	0	0	0	2	1	
188			Not on designated territories	0	8	1	0	0	0	0	0		0	0	0	0	0	0	0	0	1	0	0	9	0	ABJ frozen on Sebago Lk, ME 2/22/03
			Totals	36	12	1	12	7	7	2	10		6	0	0	0	0	3	3	3	1	2	3	55	3	

Appendix 2. Changes in Traditional Territorial Occupation on Lake Umbagog through 2003 (includes L. Thurston)

Traditional Territories Pre-2001

Waterbody	Territory
Androscoggin River	Harper's Meadow
Androscoggin River	Sweat's Meadow
Magalloway River	L. Magalloway
Magalloway River	Magalloway
Magalloway River	Yukon
Umbagog	Absalom Island
Umbagog	B Brook Cove
Umbagog	Bear Island Cove
Umbagog	Big Island North
Umbagog	Big Island South
Umbagog	Black Island Cove
Umbagog	Chewonki Marsh
Umbagog	Dead Cambridge
Umbagog	Glassby Cove
Umbagog	Gull Island
Umbagog	Lawrence
Umbagog	Leonard Marsh
Umbagog	Leonard Pond
Umbagog	Metallak
Umbagog	Pine Point
Umbagog	Potter Cove
Umbagog	Rapid River
Umbagog	Sargent Cove
Umbagog	Southeast Arm
Umbagog	Spillman
Umbagog	Stateline Cove
Umbagog	Sturtevant Cove
Umbagog	Sunday Cove
Umbagog	Thibideau
Umbagog	Three Island Cove
Umbagog	Thurston Cove
Umbagog	L. Thurston Cove

Summary: In total, 32 loon territories available
No territories are vacant.

Territories 2001

Waterbody	Territory
Androscoggin River	Harper's Meadow
Androscoggin River	Sweat's Meadow
Magalloway River	L. Magalloway
Magalloway River	Magalloway
Magalloway River	Yukon
Umbagog	Absalom Island
Umbagog	B Brook Cove
Umbagog	Big Island South
Umbagog	Black Island Cove
Umbagog	Chewonki Marsh
Umbagog	Dead Cambridge
Umbagog	Glassby Cove
Umbagog	Gull Island
Umbagog	Lawrence
Umbagog	Leonard Marsh
Umbagog	Leonard Pond
Umbagog	Pine Point
Umbagog	Rapid River
Umbagog	Sargent Cove
Umbagog	Southeast Arm
Umbagog	Sturtevant Cove
Umbagog	Sunday Cove
Umbagog	Three Island Cove
Umbagog	Thurston Cove

Summary: In total, 24 loon territories are occupied.
Eight territories are vacant:
Bear Island Cove
Big Island North
Metallak
Potter Cove
Spillman Cove
Stateline Cove
Thibideau
L.Thurston Cove

Territories 2002

Waterbody	Territory
Androscoggin River	Harper's Meadow
Androscoggin River	Sweat's Meadow
Magalloway River	*Magalloway/L. Magalloway***
Umbagog	*Black Island Cove/Gull Island*
Umbagog	Dead Cambridge
Umbagog	Glassby Cove
Umbagog	Leonard Marsh
Umbagog	Leonard Pond
Umbagog	Pine Point
Umbagog	Rapid River
Umbagog	Sargent Cove
Umbagog	Southeast Arm
Umbagog	Sturtevant Cove
Umbagog	Sunday Cove
Umbagog	*Three Island Cove/Chewonki Marsh*
Umbagog	Thurston Cove

Summary: Six distinct territories collapsed into 3 for a total of 16 loon territories occupied. Sixteen territories are vacant:
Lower Magalloway
Yukon
Absalom
B Brook Cove
Bear Island Cove
Big Island North
Big Island South
Gull Island
Lawrence
Metallak
Potter Cove
Spillman
Stateline Cove
Thibideau
Chewonki
L. Thurston Cove

Territories 2003

Waterbody	Territory
Androscoggin River	Harper's Meadow
Androscoggin River	Sweat's Meadow
Magalloway River	*L. Magalloway/Leonard Pond*
Magalloway River	Magalloway
Umbagog	*Bear Island Cove/Potter Cove*
Umbagog	Big Island South
Umbagog	*Black Island Cove/Gull Island*
Umbagog	*Chewonki Marsh/Three Island Cove*
Umbagog	*Dead Cambridge/Southeast Arm*
Umbagog	Glassby Cove
Umbagog	*Leonard Marsh/Lawrence*
Umbagog	*Pine Point/Rapid River*
Umbagog	Sargent Cove
Umbagog	Stateline Cove
Umbagog	Sturtevant Cove
Umbagog	Sunday Cove
Umbagog	Thurston Cove
Umbagog	L. Thurston Cove

Summary: Fourteen distinct territories collapsed into 7, for a total of 18 loon territories occupied. Fourteen territories are vacant:
Leonard Pond
Yukon
Absalom Island
B Brook Cove
Potter Cove
Big Island North
Gull
Three Island Cove
Southeast Arm
Lawrence
Metallak
Rapid River
Spillman
Thibideau

L.Thurston and Stateline Cove are re-occupied

** "/" between territories indicates two territories collapsing into one

Appendix 4. Summary of Banded Loons on Lake Umbagog, 1993-2003*

Date	Territory	Band #	Age	Sex	State	Recap	Left Leg	Right Leg	Year
8/22/1993	Sweat Meadow	838-149-02	Adult	Female	NH	n	yellow / white	orange / silver	1993
8/22/1993	Sweat Meadow	838-149-01	Juvenile	Unknown	NH	n	orange / silver	green / green	1993
8/22/1993	Three Island Cove	838-148-96	Adult	Female	NH	n	green / green	orange / silver	1993
8/10/1994	Black Island Cove	848-047-07	Adult	Male	NH	n	white / blue	orange / silver	1994
8/10/1994	Black Island Cove	848-047-08	Adult	Female	NH	n	blue / yellow	orange / silver	1994
8/11/1994	Harper's Meadow	559-617-80	Adult	Male	NH	y	blue / green	orange / silver	1994
8/11/1994	Harper's Meadow	848-047-15	Adult	Female	NH	n	blue / orange	orange / silver	1994
8/11/1994	Harper's Meadow	848-047-14	Juvenile	Unknown	NH	n	orange / silver	blue / green	1994
8/17/1994	Lawrence	848-047-29	Adult	Male	NH	n	green / yellow	orange / silver	1994
8/17/1994	Lawrence	848-047-31	Adult	Female	NH	n	white / red	orange / silver	1994
8/13/1994	Magalloway	848-047-19	Adult	Male	NH	n	green / red	orange / silver	1994
8/11/1994	Magalloway	848-047-16	Juvenile	Unknown	NH	n	orange / silver	red / yellow	1994
8/11/1994	Magalloway	848-047-17	Adult	Female	NH	n	green / white	orange / silver	1994
8/10/1994	Metallak Cove	848-047-09	Adult	Male	NH	n	blue	orange / silver	1994
8/10/1994	Metallak Cove	848-047-10	Adult	Female	NH	n	blue / white	orange / silver	1994
8/10/1994	Potter Cove	848-047-11	Adult	Male	NH	n	blue / red	orange / silver	1994
8/10/1994	Potter Cove	848-047-12	Juvenile	Unknown	NH	n	orange / silver	blue	1994
8/12/1994	Rapid River	848-047-18	Adult	Male	NH	n	white / blue	silver / orange	1994
8/13/1994	Three Island Cove	838-148-96	Adult	Female	NH	y	green / green	orange / silver	1994
7/29/1995	(wanderer)	559-617-23	Adult	Male	NH	n	red / red	silver / orange	1995
7/20/1995	Harper's Meadow	559-617-80	Adult	Male	NH	y	blue / green	orange / silver	1995
7/20/1995	Harper's Meadow	848-047-15	Adult	Female	NH	y	blue / orange	orange / silver	1995
7/31/1995	Harper's Meadow	848-047-69	Juvenile	Unknown	NH	n	silver / orange	red / red	1995
7/19/1995	Leonard Marsh	559-617-16	Adult	Male	NH	y	red	silver / orange	1995
7/17/1995	Magalloway	848-047-60	Juvenile	Unknown	NH	n	orange / silver	orange	1995
7/17/1995	Magalloway	848-047-59	Juvenile	Unknown	NH	n	orange / silver	red	1995
7/19/1995	Pine Point	559-617-18	Adult	Male	ME	n	white / green	orange / silver	1995
7/24/1995	Pine Point	848-047-64	Adult	Female	NH	n	yellow / yellow	orange / silver	1995
7/19/1995	Sunday Pond	559-617-17	Adult	Male	NH	n	white	orange / silver	1995
7/24/1995	Sunday Pond	848-047-73	Adult	Female	NH	n	yellow / red	orange / silver	1995
7/17/1995	Sweat Meadow	838-149-02	Adult	Female	NH	y	yellow / white	orange / silver	1995
7/20/1995	Sweat Meadow	559-617-19	Adult	Male	NH	n	orange / red	orange / silver	1995
7/31/1995	Sweat Meadow	848-047-68	Juvenile	Unknown	NH	n	silver / orange	white / white	1995
7/26/1996	Gull Island	898-053-15	Adult	Male	NH	n	Green / Blue	Orange / Silver	1996
7/26/1996	Gull Island	848-048-96	Adult	Female	NH	n	Orange / Yellow	Orange / Silver	1996
7/25/1996	Harper's Meadow	848-047-15	Adult	Female	NH	y	Blue / Orange	Orange / Silver	1996

Date	Territory	Band #	Age	Sex	State	Recap	Left Leg	Right Leg	Year
7/25/1996	Harper's Meadow	559-617-80	Adult	Male	NH	y	blue / green	orange / silver	1996
7/26/1996	Leonard Pond	898-053-17	Adult	Male	NH	n	Yellow / Orange	Orange / Silver	1996
9/16/1996	Lower Magalloway	898-053-63	Juvenile	Unknown	NH	n	Orange / Silver	Yellow "J"	1996
7/25/1996	Lower Magalloway	898-053-14	Adult	Male	NH	n	red / blue	Orange / Silver	1996
8/1/1996	Magalloway	898-053-31	Juvenile	Unknown	NH	n	Silver / Orange	Red st.	1996
8/1/1996	Magalloway	848-047-19	Adult	Male	NH	y	Green / Red	Orange / Silver	1996
7/25/1996	Magalloway	848-047-17	Adult	Female	NH	y	Green / White	Orange / Silver	1996
7/26/1996	Three Island Cove	898-053-16	Adult	Male	NH	n	White / Orange	orange / Silver	1996
7/26/1996	Three Island Cove	838-148-96	Adult	Female	NH	y	Green / Green	Orange / Silver	1996
7/28/1997	Chewonki	898-090-07	Adult	Female	NH	n	orange / white	yellow dot / silver	1997
9/11/1997	Chewonki	898-090-77	Juvenile	Unknown	NH	n	silver	red dot	1997
7/21/1997	Chewonki	898-090-27	Adult	Male	NH	n	green	yellow dot / silver	1997
9/10/1997	Harper's Meadow	559-617-80	Adult	Male	NH	n	blue / green	orange / silver	1997
9/11/1997	Harper's Meadow	559-617-85	Juvenile	Unknown	NH	n	silver	white L	1997
7/21/1997	Magalloway	848-047-19	Adult	Male	NH	y	green / red	orange / silver	1997
7/21/1997	Magalloway	898-090-26	Juvenile	Unknown	NH	n	silver	blue V	1997
7/29/1997	Pine Point	898-090-13	Juvenile	Unknown	NH	n	silver	yellow H	1997
7/21/1997	Sweat Meadow	898-090-28	Adult	Male	NH	n	red stripe	orange / silver	1997
7/21/1997	Sweat Meadow	838-149-02	Adult	Female	NH	y	yellow / white	orange / silver	1997
7/1/1998	Glassby	838-145-82	Adult	Female	NH	n	yellow / orange	yellow dot / silver	1998
7/1/1998	Leonard Marsh	898-091-60	Adult	Female	NH	n	yellow / blue	yellow / silver	1998
8/20/1998	Leonard Pond	898-091-03	Adult	Female	NH	y	red / white	silver / yellow dot	1998
6/24/1998	Leonard Pond	898-091-03	Adult	Female	NH	n	red / white	silver / yellow dot	1998
6/24/1998	Leonard Pond	898-053-17	Adult	Male	NH	y	yellow / orange	orange / silver	1998
8/18/1998	Pine Point	898-090-63	Juvenile	Unknown	ME	n	blue / silver	blue stripe	1998
8/18/1998	Pine Point	898-090-69	Adult	Female	ME	n	red / blue	silver / yellow	1998
8/18/1998	Potter Cove	848-047-11	Adult	Male	NH	y	orange / silver	blue / red	1998
8/18/1998	Potter Cove	898-099-12	Juvenile	Unknown	NH	n	silver / orange	red stripe	1998
6/24/1998	Rapid River	898-091-59	Adult	Female	ME	n	red / green	yellow dot / silver	1998
8/20/1998	Three Island Cove	559-618-58	Adult	Male	NH	n	yellow	blue / silver	1998
8/11/1999	Harper's Meadow	559-617-53	Adult	Male	NH	n	Yellow	Red / Silver	1999
8/11/1999	Harper's Meadow	848-047-15	Adult	Female	NH	y	Blue / Orange	Orange / Silver	1999
8/11/1999	Harper's Meadow	938-033-03	Juvenile	Unknown	NH	n	Silver	Yellow Dot	1999
8/11/1999	Harper's Meadow	559-617-59	Juvenile	Unknown	NH	n	Silver	Red stripe	1999
7/16/1999	Magalloway	848-047-19	Adult	Male	NH	y	Green / Red	Orange / Silver	1999
7/16/1999	Magalloway	898-098-16	Adult	Female	NH	n	Blue / Yellow	Silver / Yellow	1999
7/16/1999	Sweat Meadow	838-149-02	Adult	Female	NH	y	Yellow / White	Orange / Silver	1999

Date	Territory	Band #	Age	Sex	State	Recap	Left Leg	Right Leg	Year
7/16/1999	Sweat Meadow	898-098-41	Adult	Male	NH	n	Blue / Red stripe	Silver / Yellow	1999
7/10/2000	Dead Cambridge	938-064-74	Adult	Female	NH	n	orange / blue	white stripe / silver	2000
7/10/2000	Dead Cambridge	938-064-70	Adult	Male	NH	n	yellow / blue	green dot / silver	2000
7/6/2000	Leonard Marsh	898-091-60	Adult	Female	NH	y	yellow / blue	yellow / silver	2000
7/6/2000	Leonard Marsh	559-617-16	Adult	Male	NH	n	red	orange / silver	2000
7/6/2000	Leonard Pond	938-064-62	Adult	Female	NH	n	red / red	green dot / silver	2000
7/6/2000	Pine Point	898-090-69	Adult	Female	NH	y	red / blue	silver / yellow	2000
7/6/2000	Rapid River	898-099-79	Adult	Male	NH	n	yellow dot / yellow	silver / green dot	2000
7/6/2000	Rapid River	898-091-59	Adult	Female	NH	y	red / green	yellow dot / silver	2000
7/20/2000	Southeast Arm	898-099-72	Adult	Male	NH	n	red	silver / white stripe	2000
7/20/2000	Southeast Arm	938-064-72	Adult	Female	NH	n	orange / white	silver / blue dot	2000
7/10/2000	Thurston Cove	938-064-69	Adult	Female	NH	n	orange / yellow	silver / blue dot	2000
7/10/2000	Thurston Cove	559-617-46	Adult	Male	NH	n	yellow	white stripe / silver	2000
8/14/2002	Pine Point	559-617-18	Adult	Male	ME	y	white / green	orange / silver	2002
7/3/2002	Sweat Meadow	898-098-41	Adult	Male	NH	y	blue / red stripe	silver / yellow	2002
7/3/2002	Sweat Meadow	838-149-02	Adult	Female	NH	y	yellow / white	orange / silver	2002
8/14/2002	Three Island Cove	898-090-27	Adult	Male	ME	y	green	yellow / silver	2002
8/16/2003	Dead Cambridge	938-064-74	Adult	Female	ME	y	orange / blue	white stripe / silver	2003
7/29/2003	Harper's Meadow	938-062-33	Adult	Female	NH	n	yellow / green	silver / red dot	2003
7/24/2003	Harper's Meadow	938-063-63	Juvenile	Unknown	NH	n	silver / green stripe	orange / white	2003
7/24/2003	Harper's Meadow	938-151-40	Adult	Female	NH	n	white / green	green stripe / silver	2003
7/24/2003	Harper's Meadow	559-617-53	Adult	Male	NH	y	yellow	red / silver	2003
7/28/2003	Leonard Marsh	938-153-70	Adult	Female	NH	n	green / orange	silver / green stripe	2003
7/28/2003	Leonard Marsh	938-151-32	Adult	Male	NH	n	white / green	red dot / silver	2003
7/28/2003	Leonard Marsh	938-151-87	Juvenile	Unknown	NH	n	silver / red dot	green	2003
8/16/2003	Leonard Marsh	938-153-70	Adult	Female	NH	y	green / orange	silver / green stripe	2003
8/27/2003	Pine Point	938-033-95	Juvenile	Unknown	ME	n	silver / yellow stripe	yellow	2003
8/27/2003	Pine Point	938-151-30	Juvenile	Unknown	ME	n	silver / blue stripe	red / green	2003
7/24/2003	Sweat Meadow	838-149-02	Adult	Female	NH	y	yellow / white	orange / silver	2003
7/24/2003	Sweat Meadow	938-151-93	Juvenile	Unknown	NH	n	silver / red dot	blue / yellow	2003

*Data from BioDiversity Research Institute, Falmouth, ME

Appendix 5. Lake Umbagog Water Levels, May - August 2003