2000 Flagstaff Lake
Common Loon Population Survey
and Management Report

- FINAL DRAFT -
(REPORT BRI-2001-03)

(FERC Project No. 2612)

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INTRODUCTION

About the Study Site

Flagstaff Lake is a reservoir, managed by FPL Energy Maine Hydro. And located in the townships of Flagstaff, Eustis, Bigelow, Dead River, Carrying Place, and Spring Lake, Maine.
The Flagstaff Project, located on the Dead River in Somerset and Franklin Counties, Maine, is licensed by the Federal Energy Regulatory Commission (FERC) as Project No. 2612. The Flagstaff Project is comprised of a concrete dam, an earthen dike, and an approximately 17,950-acre (28 sq. mi.) reservoir. The Project dam (Long Falls dam) is located in Township 3 Range 4 BKP WKR (Spring Lake), Maine. The project is operated as a water storage facility to regulate flows in the Kennebec River for downstream hydroelectric generation, for the reduction of flood flows, and for other uses.

History and Purpose of Study

In 1950, a hydro storage dam was constructed at Long Falls on the Dead River and the Flagstaff Reservoir was created. Due to its susceptibility to the effects of water level fluctuations during the nesting season, the U.S. Fish and Wildlife Service (FWS) and other wildlife agencies have identified the Common Loon (*Gavia immer*) as a species to be evaluated in connection with FERC relicensing of certain reservoir projects. Rafts are the primary management tool used to increase productivity on the reservoir by mitigating for the impacts of water level fluctuations on nesting loons. This report documents the Common Loon population and productivity surveys and the active loon management project on Flagstaff Lake in 2000.

Flagstaff Lake was surveyed from 1993 to 1998 by Fairwinds Wildlife Services, after which point BioDiversity Research Institute (BRI) has assumed full responsibility for the loon surveys, management, and the preparation of this annual report. Jeff Fair (Fairwinds Wildlife Services, senior Biologist) and Bill Hanson (now senior biologist, FPL Energy Maine Hydro) have worked yearly with BRI biologists at Flagstaff to ensure thorough standardization of survey techniques and definitions to minimize observer bias during this transition.

OBJECTIVES

1.

a. To continue the existing 7-year loon-management and monitoring project on Flagstaff Lake in 2000. To monitor site-specific nesting activities and factors affecting the productivity of the current dynamic Common Loon population on Flagstaff. Emphasis is placed upon monitoring the effects of current water level management practices as well as monitoring and quantifying the impact of human and animal disturbances on loon productivity.

b. To implement and evaluate the effectiveness of rafts within loon territories. We will make recommendations on the improvement, addition, removal, and placements of artificial nesting islands according to guidelines formulated in the management plan.

2. To evaluate loon habitat quality on Flagstaff Lake using long-term territory reproductive success as an indicator.

3. To evaluate between-year territory fidelity, mate fidelity, and estimated minimum survivorship for all loon pairs on Flagstaff Lake.

4. To extend chick monitoring later into the fall to determine chick survivorship.

METHODS

* Terms used in this report are defined in Appendix 4.

POPULATION AND NESTING SURVEYS

We regularly surveyed Flagstaff Lake to confirm the presence/absence of Common Loons and document their nesting activity from May 4 to October 1, 2000 (Table 1). The bulk of the survey effort was concentrated on the Common Loon nesting onset and hatching period from May through July. Survey methods were consistent with those reported by Fair (1986) and Fair (1999), with a few changes to address objectives 2 through 4. We surveyed all known territories and surrounding areas on Flagstaff Lake from a 16' boat using 10X binoculars and occasionally a 15-45X spotting scope. Every effort was made to gather information from the greatest distance possible in order to minimize impacts on nesting activities. Since nesting evidence may be obscured by vegetation, it was often necessary to search for presence/absence of nest evidence by foot. We searched for evidence of natural nesting attempts by walking the perimeter of the available nesting habitat in loon territories. All known historical nesting sites previously reported by Jeff Fair (Fairwinds Wildlife Services and Bill Hanson FPL) were checked regularly for nesting evidence both above and below the waterline in response to fluctuating water levels.

TABLE 1: Lake Survey visit record for 2000 on Flagstaff Lake, Maine.

Month	Visit dates
May	4, 5, 12, 17, 24, 30
June	2, 3, 6, 13, 15, 20, 21
July	4, 11, 15, 23, 29
August	6, 15, 24
September	1
October	1

TOTAL: 23 'visits'

SURVEYING FOR MARKED INDIVIDUALS

We surveyed Flagstaff Lake for marked individuals to achieve objectives 2 and 3. From 1995-2000, a total of 19 adult and 13 juvenile Common Loons have been captured at Flagstaff, using a night-lighting technique developed by Evers (1993), and sampled for blood and feather mercury, and uniquely color marked. Each captured individual was custom fitted in the field with one or two bands on each leg (one USFWS band plus 1-3 color bands per bird). These color bands are visible both above and below the water with binoculars and/or a spotting scope. We opportunistically identified individual loon color band combinations to determine site and mate fidelity (Objective 3). We also recorded the location and general behavior of both banded and unbanded individuals at the time of observation.

LOON MANAGEMENT TOOLS: RAFTS, AVIAN GUARDS AND SIGNS

Raft Implementation

We floated new and old rafts constructed from cedar logs (nailed together using ~8 inch galvanized spikes) and plastic "mesh" fencing (attached using 1-1/2 inch galvanized fencing staples) similar to those described in Fair (1986) and Fair (1992a). We vegetated rafts using material found in the general nesting area (sphagnum moss, grasses, and other vegetation). Common Loons typically build their nests from materials gathered from the immediate vicinity of the nesting site (McIntyre 1988). Nesting materials were built up to levels at which the eggs would be dry and well above the water level. We monitored all rafts periodically for proper placement, buoyancy and sufficient nesting materials throughout the season. All rafts were pulled out of the water to a point that was above the highest possible waterline to dry for the winter (after all nesting activities ceased).

Raft positioning and location was determined by 1) knowledge of wind and wave action patterns relative to each territory, 2) knowledge of loon territorial boundaries and proximity to other territories (the importance of this point is addressed in the Discussion) 3) knowledge of previous traditional and non-traditional nest site locations and 4) knowledge of boat traffic patterns relative to the specific territory (This is important relative to the orientation of the avian guard, which obscures the view to/from the nest on two sides of the raft).

Avian Guards

Before raft floatation, we continued the practice of attaching (using staple-nails) avian guards made of metal fencing to all rafts as was initiated by Jeff Fair in 1988 (Fair 1992a). Avian guards are effective in reducing raft visibility and nest exposure from aerial predators and lake users, which decreases flushing events and disturbances to nesting loons. Avian guards may therefore increase hatching success of raft nesting birds. Guards were covered with a camouflage mesh material, which was removed at the end of the season to avoid further degradation (Cabella's Order # HK22-0081-168).

Signs

Several pairs on Flagstaff have failed due to disturbance by humans. Many of these disturbances are unintentional and may be avoided by placing informational signs both at the launch sites and at some nesting/brooding areas where deemed necessary. FPL Energy Maine Hydro distributes signs ("Loon Nesting Area Please Keep Away") for use in protecting these areas from human disturbances. The decision of whether or not to place a sign in a territory is often a difficult one based on their variable effectiveness as management tools. The character of and type of lake users as well as the configuration of the territory and location of nest site will influence their efficacy. Sign placements are based on previous reports' recommendations, knowledge of typical lake use patterns and previous site-specific nest failure history. Signs were not implemented before nesting activity had been found (and were therefore not used for territorial pairs which did not attempt nesting), and should be taken down after nesting and/or brooding activities cease. They were also not implemented in cases where it was determined that their cost (potentially attracting attention to a nest site) outweighed the benefit (notifying unsuspecting lake users to stay away).

ABANDONED EGG COLLECTION AND ANALYSIS

We collected abandoned Common Loon eggs to determine 1) egg viability as indicated by developmental stage and 2) egg mercury concentration. Information gathered from these analyses provides insight into causes of nest failure.

Collection of Eggs

Loon eggs were not collected unless abandonment or failure could be confirmed beyond a reasonable doubt. We collected abandoned eggs before they were predated or destroyed. When uncertainty existed in the determination of the absolute abandonment of the eggs by the adults, we gently penciled an "X" on the "upside" surface of the egg(s) in question. Eggs were checked no less than 24 hours later and those that had not been rolled were considered inviable and were collected, and placed in a labeled plastic bag, and frozen until analysis.

Egg Sample Analysis

For each egg, we measured and recorded the length, width, volume (through water displacement), and weight. Evidence of external damage was noted. Eggs were then cut open, their contents were rated for embryological development (based on the scale below), and placed in sterile I-Chem® jars. (Territory-specific egg embryological development is presented in Appendix 1.) Egg contents were analyzed for mercury concentration using cold vapor atomic absorption, and eggshells were archived.

Embryological development scale used for Common Loon eggs

NA (not assessable): Developmental stage could not be determined. Contents were gray or yellowish-tan in color and typically had a foul smell. A darker color suggested some degree of development had occurred, whereas a yellow homogeneous liquid may be sifted through and if no dark spots or hardened areas were found we classified the egg as infertile (0).

0: No development was evident. Egg had a yellow/orange or yellow/tan yolk (intact or broken down into a liquid). A translucent jelly-like mass surrounded the yolk sac and showed no sign of embryonic development (e.g. mass not dark or hardened).

1: Embryo was viable (length was up to 1.5 cm). The jelly like mass (embryo) was dense and hardened. Small dark (red) eyespots may be visible at this stage.

2: Developing embryo (length was 1.5 – 2.0) has an apparent central nervous system. Cranial development and visible eyes are apparent. Feathers are absent.

3: The embryo shows advanced development (length was 2-3 cm). Bill was developed (e.g. egg tooth present but soft). Legs and wings were visible but not fully developed. Some feathers were present (first seen in tail).

4: The fully developed embryo was completely covered by feathers. Appendages were completely developed. Vent, preen gland was visible. A small portion of yolk sac remained attached to belly.

RESULTS AND DISCUSSION: Flagstaff Productivity Survey Summary

1. PRODUCTIVITY SUMMARY (2000)

We present productivity information for the Flagstaff loon population for the 2000 season only. Below, we summarize overall lakewide productivity, nest failures and renest, the development of new territorial pairs, and the development of new nesting pairs. Territory-specific productivity data is summarized in Appendix 1 and the Qualitative Territory Summary.

TABLE 2: Common Loon Productivity and Nesting Summary (2000).
Territory-specific productivity details are summarized in Appendix 1 and The Qualitative Territory Summary.

21 Territorial Pairs
18 Nesting Pairs
22 Nesting Attempts
4 Renests
11 Successful Pairs
19 Chicks Hatched from all territories
9 Chicks Fledged from all territories
11 Nest Failures
3 Nest Failures due to abandonment for unknown cause
1 Nest Failure due to mammalian predation
5 Nest Failures due to unknown causes
1 Nest Failure due to avian predation
1 Nest Failure due to egg rolling off raft

Overall Lakewide Productivity Summary

We observed 21 territorial pairs on Flagstaff Lake in 2000. Eighteen of the 21 pairs nested, nesting attempts totaled 22 times lakewide (Table 2). The 2000 nesting frequency was 86% (19 NP/21 TP). Eleven pairs were successful (North Branch, Stratton, Arnold Falls, Meyers, Bigelow, Becky Brook, Pond Marsh, Bridge Cove, Turner, Jerome, and Reed Brook), which produced 9 fledged chicks in 2000. This yielded a nesting success of 61%, and 47% chick survival. The 2000 hatch rates for both nesting pairs (H/NP) and territorial pairs (H/TP) were 1.10 (19/18) and 0.91 (19/21), while corresponding fledge rates (F/NP and F/TP) were 0.50 (9/18) and 0.43 (9/21).

Nest Failures and Renests

There was a total of 11 nest failures on Flagstaff Lake in 2000 (Table 2). Fifty percent (11/22) of the attempted nests failed, which is approximately 0.61 nest failures per nesting pair. This year water levels did not influence nesting success (For territory-specific nest failure information, see the Qualitative Territory Summary and Appendix 1). Four of the 18 nesting pairs renested after the first nest failed. One of renests was successful (Bigelow) and three were unsuccessful (Blanchard Brook, Jim Eaton, and North End).

Development of New Territorial Pairs

We found one new territorial pair on Flagstaff Lake in 2000 that were previously unrecognized. In the 1999 report, we reported a pair was noted to be present in the Reed Brook area, but we thought it was the Bigelow pair. This year, a new territorial pair was present and nested in the Reed Brook area and the Bigelow pair was also territorial and nesting. Along with the new loon pair two new Bald Eagle nests were found on Flagstaff bringing the total to three nests lakewide.

Development of New Nesting Pairs

In 2000, we observed one new territorial pair that also nested. The birds nested on an island north of the mouth of Reed Brook. The Reed Brook pair could be the old Grasslands pair that has shifted their territory due to Bigelow's territory expansion. There is still room on Flagstaff for new nesting pairs.

Flagstaff Qualitative Territory Summary (2000)

Reporting productivity data in a quantitative summarized form often inadvertently overlooks some important details. We report territory-specific information here in a qualitative descriptive format to minimize this potential loss of information. All territories and other areas of interest are listed from north to south. Territories with a "(R)" represent those in which a Raft was *floated*; all others display "(nR)" meaning "no raft". Map numbers are also given, which display locations of nest sites and rafts within territories. Quantitative data about these territories is found in Appendixes 1-3. Embryological scale used for Common Loon eggs is found in the "Methods" section.

North Branch (R) Map 1
Both of the previously banded North Branch birds returned to the territory this year. The banded male and banded female nested on an island north of the bridge, between 5/17 and 5/24. Both eggs hatched between 6/6 and 6/15, but one chick disappeared between 6/20 and 7/4. Both banded adults and chick were last observed on 10/1.

Trout Brook (R) (no map)
A pair was first seen on 5/24 and occupied the territory in the throughout the season. We found no nesting evidence on this territory during the season. The pair was last observed on territory on 8/24.

Stratton (R) Map 2
Both of the previously banded Stratton birds returned to the territory this year. The birds nested on a the back side of Stratton island. They nested in a cove that was shallow, so the nest with the eggs was placed on a raft and moved to the waters edge. The loons returned to the moved nest on the raft and resumed incubation. Both eggs hatched between 6/13 and 6/21, but one chick disappeared between 6/21 and 7/4. Both banded adults and the chick were last observed on 10/1.

Arnold Falls (R) Map 2
An unbanded female and the banded male (Stratton/North Branch) occupied the territory this year. The birds nested on the island next to the raft between 6/13 and 7/12. Both eggs hatched between 7/12 and 7/15, but one chick disappeared between 7/15 and 7/23. Both banded adults and chick were last observed on 10/1.

Meyers (R) Map 3
The banded male and female returned to the territory for the third consecutive year, until an unbanded male usurped the banded male in the pre-nest period. The banded male was not observed again on the lake. The unbanded male and the banded female built a nest on the floating bog mats between 6/15 and 6/21. Both eggs hatched between 7/15 and 7/23, but one chick disappeared between 7/20 and 7/23. Both banded adults and chick were last observed on 10/1.

Grasslands (R) (no map)
A pair did not consistently occupy the territory this year. (See Bigelow).

Limestone (nR) (no map)
A pair did not consistently occupy the territory this year. A pair was seen once on 8/24. We occasionally observed loners.

Bigelow (R) (Map 4)
Both of the previously banded Bigelow birds returned to the territory this year. The banded male and female nested on the south side of Bigelow island between 5/30 and 6/3. The nest failed due to mammalian predation between 6/6 and 6/13. The birds then expanded their territory and nested in the adjacent territory, Grasslands. The banded birds renested and laid two eggs between 6/21 and 7/4. One egg hatched between 7/30 and 8/6 but the other egg disappeared. Both banded adults and the chick were last observed on 10/1.

Reed Brook (nR) Map 4
An unbanded pair occupied the territory this year. The birds nested on an island north of the mouth of Reed Brook between 5/17 and 5/23. Both eggs hatched between 6/15 and 6/21, and two chicks fledged from the territory. Both adults and the chicks were last observed on 10/1.

False Inlet (R) Map 5
Two unbanded birds occupied the territory this year. They nested on the raft, between 6/6 and 6/13. The nest was abandoned between 6/13 and 6/21. The pair was last observed 8/24.

Pond Marsh (R) Map 5
Two unbanded birds occupied the territory this year. The birds built a nest on the island west of the raft between 6/6 and 6/13. Both eggs hatched between 7/5 and 7/12. Both the chicks disappeared between 7/3 and 7/15. The pair was last observed on 8/6.

North End (R) Map 6
Two unbanded birds occupied the territory this year. They laid two eggs, in a scrape, between 6/6 and 6/13 on an island south of the cove. The nest failed due to unknown causes, between 6/13 and 6/21, both eggs disappeared. The pair then re-nested on the same island between 7/4 and 7/15. The nest failed again due to unknown causes, between 7/23 and 8/6, both eggs disappeared. The pair was not observed after 8/6.

Becky Brook (R) Map 6
The banded male returned with an unbanded female this year. The banded male and unbanded female nested on the raft, between 5/30 and 6/3. Two chicks hatched on 6/21, but one chick disappeared between 7/4 and 7/15. The pair and the chick were last observed on 10/1.

Entrance (R) Map 7
Two unbanded birds occupied the territory this year. They nested on an island north of Schoolhouse Island, between 5/30 and 6/3, and laid two eggs. We moved the nest closer to the lake as water levels were falling. The nest failed due to unknown causes, between 6/6 and 6/13, both eggs disappeared. The pair was last observed 8/6.

Jim Eaton (R) Map 8
Two unbanded birds occupied the territory this year. They built two nests on the island on the southern end of the territory. The first nest contained one egg which was laid between 5/23 and 5/30. This nest failed due to avian predation between 6/1 and 6/6. The birds re-nested on the same island but at the opposite end. The nest contained one egg and was laid between 6/22 and 7/4. This nest failed again between 7/29 and 8/6, due to unknown causes, the eggs disappeared The pair was last observed on 8/15.

Bley Cove (R) (no map)
A pair did not consistently occupy the territory this year. We occasionally observed loners.

Hurricane (R) Map 9
Two unbanded birds occupied the territory this year. A nest was built between 7/4 and 7/11 on a rocky island on the east side of the cove. The nest contained two eggs but failed, between 7/11 and 7/15, due to unknown causes the eggs disappeared. The pair was last observed on 8/6.

Bridge Cove (R) Map 10
Two unbanded birds occupied this territory this year. They built a nest on a raft between 5/30 and 6/6. Two chicks hatched between 6/22 and 7/4, one chick disappeared between 7/1 and 7/4. When the raft was pulled at the end of the season a third egg was discovered. The probability of this nest being a three egg clutch is extremely low. The pair and the chick was last observed on 10/1.

Jerome (R) Map 11
Two unbanded birds occupied the territory this year. They built one nest on the raft and laid one egg between 5/23 and 5/30. The egg hatched between 6/22 and 7/4 but the chick disappeared between 6/22 and 7/3. The pair was last observed on 8/6.

Blanchard Brook (R) Map 12
Two unbanded birds occupied this territory this year. They built two nests on the raft. The first nest laid between 5/23 and 5/30 and contained two eggs. The nest failed between 6/1 and 6/6 due to abandonment (probably eagles). The second nest

laid between 7/29 and ? contained two eggs and was abandoned. Both eggs were collected when the raft was pulled. A pair was last observed on 8/15.

Dam (R) Map 13
The banded male returned with an unbanded female this year. They nested on the raft and laid one egg between 6/21 and 7/4. The egg rolled off the raft and was abandoned between 7/4 and 7/15. The pair was last observed on 8/6.

Turner (R) Map 14
Two unbanded birds occupied this territory this year. The birds built a nest on the raft, between 5/23 and 5/30. The nest contained two eggs. One egg hatched on 6/24 and the pair abandoned the nest after the chick hatched. The chick disappeared two days later. The birds then returned to the raft and tried to incubate the remaining egg. The egg was collected a two weeks later (it was rotten) and the bird was still incubating the egg. The pair and was last observed on 8/15.

Pond Brook (R) (no map)
A pair did not consistently occupy the territory this year. A pair was seen on 6/21and 7/29. We occasionally observed loners.

Butterfly (nR) (no map)
A pair was first seen on 5/30 and occupied the territory in the throughout the season. The pair never nested but was observed there throughout the season. The pair was last observed on 7/29.

Beaver Cove (R) (no map)
A pair was first seen on 6/6 and occupied the territory in the throughout the season. The pair never nested but was seen there throughout the season. The pair was last observed on 7/23.

2. PRODUCTIVITY SUMMARY (2000) IN COMPARISON TO LONG TERM MEANS (1993-2000)

Results

Of the 25 potential territorial pairs (TPs) observed on Flagstaff Lake over the period of this study, 21 remained on territory in 2000 and were designated as TPs. The number of TPs on Flagstaff has fluctuated throughout the period of this study (Figure 3), the 2000 count is 11% higher than the 1993-2000 mean (Table 3). The 18 NPs of 2000 is tied with the highest number of NPs observed over the course of this study. The NP count in 2000 is 38% higher than the 1993-2000 mean (Table 3). The NP:TP ratio yields an 86% nesting frequency, which is a 29% increase relative to the 1993-2000 mean.

TABLE 3: Common Loon Productivity on Flagstaff Lake from 1993 – 2000, with comparisons to calculated long-term means[1].

Parameter	1993	1994	1995	1996	1997	1998	1999	2000	93-00	% Change
Territorial Pairs (TP)	19	18	14	*	18	21	21	21	19	11%
Nesting Pairs (NP)	9	11	9	*	10	16	18	18	13	38%
Nesting Frequency	47%	61%	64%	*	56%	76%	86%	86%	68%	29%
Successfully NP	4	6	4	*	6	1	5	11	5	120%
% Nesting Success	44%	55%	44%	*	60%	6%	26%	61%	42%	45%
No. Chicks Hatched (H)	7	7	5	*	10	1	12	19	9	111%
No. Chicks Fledged (F)	6	3	5	*	10	1	5	9	6	50%
% Chick Survival (F/H)	86%	43%	100%	*	100%	100%	42%	47%	74%	-36%
Hatch Rate (H/NP)	0.77	0.64	0.56	*	1.00	0.06	0.63	1.00	0.66	52%
Fledge Rate (F/NP)	0.67	0.27	0.56	*	1.00	0.06	0.26	0.47	0.47	0%
Hatch Rate (H/TP)	0.37	0.39	0.36	*	0.56	0.05	0.57	0.86	0.45	91%
Productivity (F/TP)	0.32	0.17	0.36	*	0.56	0.05	0.24	0.41	0.30	37%

[1]Explanations for all Parameters are listed in the Definition of Terms section (Appendix 4). Data for Table 3 used from Fair 1994, 1995a, 1995b, 1997, 1998, 1999, and Yates et al. 2000. * Data unreliable due to infrequent visits.

In 2000 there were eleven successful nesting pairs, which is 120% higher than the 1993-2000 mean (Table 3). In 2000 we found a 61% nesting success rate, which represents a 45% increase compared to the 1993-2000 mean. We also found that the number of chicks hatched and chicks fledged in 2000 had

increased, in comparison to the 1993-2000 mean, 111% and 50% respectively (Figure 4). However, there was a 32% decline in chick survival in comparison to the mean. The number of chicks hatched and hatch rate (H/NP & H/TP) were also higher than their respective means for the period (Figure 5). This figure is also noticeably higher than the overall NH average of 68%, which is based on 23 years of loon data (Taylor and Vogel 2000). The number of chicks hatched, fledged, and both measures of hatch rate (H/NP & H/TP) were all lower than their respective means for the period. The 19 chicks hatched in 2000 represents a 111% increase in comparison with the mean; nine chicks fledged on Flagstaff in 2000, which represents a 50% increase from the mean. Hatch rates for both nesting pairs (0.66) and territorial pairs (0.45) represent 52% and 91% increases compared to their respective means for the period. In comparison to the 23-year NH averages (H/NP = 0.99 & H/TP = 0.67), Flagstaff measures of hatch rate are 1% and 22% higher. The productivity indices of fledging (F/NP & F/TP) on Flagstaff were 0.47 and 0.41, representing an increase in productivity and fledge rate remained the same relative to their respective long-term Flagstaff means, and were 48% and 88% lower than measures fledging for the overall NH loon population (F/NP = 0.70 & F/TP = 0.77). Percent chick survival (CH/CF) was 47% in 2000, the lowest it has been over the course of this study (three of the eight chicks lost on Flagstaff this season were likely lost within the first few days of life). This chick survival rate is 64% lower than the NH average of 77%.

Discussion

The 2000 season is a remarkable year in comparison to long-term means with respect to many different productivity parameters. In the 2000 season, Flagstaff had the highest values of TPs, NPs, nesting frequency, successful nesting pairs, percent nesting success, chicks hatched, and hatch rate (for both NPs and TPs) seen over the course of this study. Total number of chicks fledged and fledge rate (F/NP) were also notable. Conversely, percent chick survival was 47%, 36% lower than the long- term mean. These data indicate that loons on Flagstaff were able to successfully nest and hatch young in 2000, but were not as able to successfully raise them to fledge.

One explanation for the increase in many of the productivity parameters is related to successful management efforts. Specifically, these increases reflect: 1) Increased efforts with rafts (75% [6/8] of nesting attempts on rafts were successful [Table 4]); 2) the effect of a slow water level drawdown over the course of the nesting season (Figure 3). We cannot fully explain the decline in chick survival relative to the long-term mean using current management and survey methods. This impact on fledging may reflect pressures exerted on the population by avian predators (e.g. Herring Gull [*Larus argentatus*], Common Raven [*Corvus corax*], Bald Eagle [*Haliaeetus leucocephalus*]), mammalian predators (e.g. raccoon [*Procyon* lotor], river otter [*Lutra Canadensis*]), contaminants (e.g. Hg), variables related to habitat quality (e.g. prey abundance, turbidity) and/or density dependence. Although we know many nests were lost to predation in the 2000 season, impacts of these other pressures are more difficult to confirm and require further study. Whether or not fluctuating water levels negatively affect chick survival on Flagstaff is not fully understood.

3. LOON MANAGEMENT TOOLS: RAFTS, AVIAN GUARDS AND SIGNS

Raft Implementation

We[1] reinforced, floated, vegetated, positioned and maintained 21 rafts in 21 loon territories (See Appendix 2 and territory maps for territory-specific information) on May 8th and 9th, 2000 (water level gauge reading at dam = 1145.2 ft.). Recommendations for raft placements and movements were consistent with 1999 recommendations with minor logistical adjustments.
Avian guards were either repaired/reused or installed on all rafts. All rafts were pulled out of the water above the highest possible water level to dry over the winter.

Raft Maintenance

At least two cases of eggs rolling off the rafts were documented. Old rafts on which the plastic mesh was nailed on the "underside of the raft, created the need for much more nesting material, which often became more wet than newer rafts with the mesh nailed on the "top" surface. These nests contained adequate nesting material that was then pulled into the nest dish, creating reservoirs of water within the raft next to the nest dish. Although the resultant nest is very similar to natural nest configurations such as hummocks, we feel that eggs are more likely to roll off the nest and/or get wet, especially in cases where the raft is already waterlogged. Fair (1990) improved the buoyancy of waterlogged rafts by attaching additional cedar logs beneath them. We have recommended modifying all remaining rafts of this type and having floatation materials on site to apply to waterlogged rafts.

Avian Guards

Avian Guards were used on 15 of the rafts in the 2000 season, and are recommended for all rafts in future seasons

Signs

Signs were implemented in 2000 in accordance to guidelines discussed in the "Methods" section. Because of nesting activities in 2000, the resultant sign usage was minimal. Signs were placed on the Bigelow Island. Human activity evident on the nesting island early in the season (e.g. campfire) may warrant use of a sign on this island *before* nesting activity is found on this site in the future.

[1] (Chris De Sorbo, Lucas Savoy, David Yates (BRI) and Shearon Clarke, Kyle Murphy (E-Pro).

Raft vs. Natural Nest Site Summary

This section is intended to provide managers with the information necessary to evaluate the effectiveness of rafts as a management tool. We will compare productivity, renests, and nest failures between loon pairs choosing raft and natural nest sites in 2000.

TABLE 4: Common Loon Comparative Nesting Summary: Rafts vs. Natural Nests (2000)

Raft Sites: 21 rafts floated in 21 territories
- 7 of 21 (32%) rafts used for nesting by loons
- 8 of 21 (38%) nesting attempts in raft-containing territories were on rafts
- 13 of 21 (62%) natural nesting attempts were made on natural sites in territories with rafts

8 of 22 (36%) lakewide nesting attempts were on rafts
- 6 of 8 (75%) nesting attempts on rafts were successful
- 7 of 8 (88%) nesting attempts on rafts were 1st attempts
- 1 of 8 (12%) nesting attempts were 2nd attempts

3 Renests on raft sites
- 1 of 1 (100%) renests were on sites that differed from the first nest site.
- 0 Renests switched from a natural nest site to a raft site
- 6 of 19 (32%) chicks hatched (H) lakewide from raft nests

2 of 9 (22%) chicks fledged (F) lakewide from raft nests

Nest Failures: 4 nest failures on rafts
3 of 4 (75%) nest failures on rafts was due to abandonment for unknown causes
1 of 4 (25%) nest failure on rafts was due to egg rolling off raft

Natural Sites:

14 of 22 (64%) lakewide nesting attempts were on natural sites
- 9 of 22 (41%) nesting attempts on natural sites were successful
- 12 of 14 (86%) nesting attempts were 1st attempts
- 2 of 14 (14%) nesting attempts were 2nd attempts

3 Renests on natural nest sites
- 3 of 3 (100%) renests were on sites that differed from the first nest site.
- 0 Renests switched from a natural nest site to a raft site

13 of 19 (68%) chicks hatched (H) lakewide from natural nests
7 of 9 (78%) chicks fledged (F) lakewide from natural nests

Natural Nest Failures: 7 nest failures on natural Sites
1 of 7 (14%) nest failures on natural sites were due to avian predation
1 of 7 (14%) nest failures on natural sites were due to mammalian predation
5 of 7 (72%) nest failures on natural sites were due to unknown causes

Raft vs. Natural Nest Site Productivity

Rafts were an instrumental management tool in increasing productivity on Flagstaff Lake in 2000. As demonstrated in the past (Fair and Poirier 1992, Merrie 1996) Common Loon productivity can be substantially enhanced on reservoirs with significant fluctuations in water levels by using rafts. Water level fluctuations do not appear to impact nesting activities of raft-nesting loons. Even though there were close to twice the number of nests built on natural sites than raft sites in 2000, 36% of the successfully nesting pairs on Flagstaff Lake nested on rafts (Table 4 & Appendix 2). These pairs were responsible for producing 22% of the fledged young from Flagstaff in 2000. In comparison of natural and raft nesting attempts, we have found that raft selection seems to be either individual or site influenced, and we have not found a method that is successful in influencing a pair's choice of a nest site. Nonetheless, in the 21 territories where rafts were floated, 7 of them were used, accounting for 38% of the nesting attempts in raft-containing territories. Lakewide, 36% of the nesting attempts were on rafts, which seems to be increasing every year.

In a long-term context, we compared territory-specific productivity (i.e., hatching) relative nest site selection – while accounting for territory age (Appendix 2). We divided data into two categories: territories where the pairs nested on natural sites, and those that selected raft sites (See comments in Appendix 2 for specific criteria involved in data categorization). The cumulative (1993-2000) total of chicks hatched on each territory was divided by the territory age to yield a territory-specific measure of productivity in both raft and natural nest site-selecting pairs that is not biased by territory age. This comparison indicates that the long-term productivity of raft-selecting pairs is higher than pairs choosing natural sites. Raft-selecting territorial pairs yielded an H/territory years value of 1.018, while the value for natural nest-selecting pairs was 0.350. These data indicate that under the current water level management practices, rafts are three times more productive than naturally- nesting loons on Flagstaff Lake.

Rafts vs. Natural Nest Sites: Failures

Nest failures are relatively predictable when comparing natural and raft sites. On a reservoir like Flagstaff Lake where the water levels fluctuate, most natural nests are likely to fail, while nests on rafts will likely be unaffected. Rafts also seem to be quite effective in reducing mammalian and avian predation (due to the avian guards). There are cases of human disturbance, unexplained abandonment and unknown causes of nest failure in both raft and natural nesting situations (one often-overlooked cause for nest abandonment may be inviable eggs). Although we collect and analyze abandoned eggs, we have not yet attempted to explain this variable.

As discussed in the Productivity section, nest failures were reasonably abundant in 2000. There were 7 nest failures on natural sites (64% of all failures) and 4 failures on rafts (36%). A total of 72% of the nest failures on natural sites were due to unknown causes, 14% were due to mammalian predation, 14% were due to avian predation of the four raft nest failures (75%) were due to abandonment for unknown causes and one (25%) was due to the egg rolling off the raft.

Rafts vs. Natural Nest Sites: Renests

Individuals on both raft and natural sites showed no difference in their efforts to renest after a failure. The proportion of first and second nesting attempts was almost identical when comparing raft and natural sites. For both sites, first attempts accounted for approximately 82% of the total number of attempts, while second attempts accounted for approximately 18% of the attempts. This suggests that the presence or absence of raft is not necessarily influencing individuals' choice to renest after nest failure.

5. USING COLOR-MARKED LOONS: BETWEEN-YEAR TERRITORY FIDELITY, MATE FIDELITY, TERRITORIAL PERSISTENCE AND SURVIVORSHIP

We confirmed the identity of uniquely color-marked individuals throughout the season to gain insight into observed nesting activities, movements, and behaviors witnessed in the field on specific TP and NPs. Band confirmations provide insights into territory boundaries, as well as into nesting activities and productivity of specific territorial pairs. This information allows us to better understand the dynamics and movements of the loon population, and to more accurately quantify productivity parameters.

Between-Year Territory Fidelity

Between year territory fidelity is a reflection on various complex factors, such as territory quality, frequency of nest failures, individual fitness, and population pressures such as intrusions. We monitored between-year territory fidelity for all territories on Flagstaff Lake in 2000.

Table 5: Common Loon Between-Year Territory Fidelity to Flagstaff Territories. Site Fidelity of color-marked Common Loons on Flagstaff Lake from 1996 – 2000[2].

	Total No. Marked			Total No. Returning			Percent Return		
Year	M	F	Both	M	F	Both	M	F	Both
1996	1	1	2	1	1	2	100%	100%	100%
1997	2	3	5	2	1	3	100%	33%	60%
1998	5	4	9	3	4	7	60%	100%	78%
1999	3	4	7	3	4	7	100%	100%	100%
2000	7	4	11	5	4	9	71%	100%	82%
Totals	**15**	**19**	**34**	**13**	**15**	**28**	**87%**	**79%**	**82%**
NE Avg*	227	192	419	182	162	344	80%	84%	82%

Table 5 presents information regarding the yearly proportions of color-marked individuals returning to their original territories after wintering on the ocean. Eighty two percent of marked individuals

[1] Values given represent loon return-years. 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 then eligible at the beginning of the year. 3) Individuals that did not return for two consecutive years were assumed to be elsewhere or dead, in which case they were not included for subsequent years' total of marked individuals.

returned to their respective original territories in 2000, which yielded a 87% and 79% return rates for males and females, respectively.

The overall return rate for both sexes from 1996-2000 is 82%. This number is the same as other breeding populations with monitored partial lake territories in New England (82%) (Evers et al. 2000, Evers 2001).

Return rate information is biased towards successfully nesting pairs due to limitations of the capture technique to capture non-breeders. More information is needed to determine site fidelity of unsuccessfully nesting loons and non-breeders. One useful technique is "Vocal Tagging", in which portable recorders are used to record the "vocal fingerprint" (the yodel) of male individuals.

Mate-Switching Activities

The monitoring of mate switching among individuals offers insights into loon population pressures, social interactions, and their effects on nesting activities. We monitored mate switching for all banded territorial pairs in 2000.

We observed one case (Arnold Falls) of mate switching out of the twenty one territorial pairs in which one adult was banded (we cannot detect a mate switch in pairs with unbanded individuals). In this case, the a banded male replaced the unbanded male in a territory adjacent to the birds previous territory.

Mate switching activities are likely to affect productivity parameters. Current studies indicate that loons are more likely to switch mates subsequent to a nest failure. Studies indicate that males are 40% less likely to breed immediately after a mate switch, and females are 83% less likely to breed after a mate switch (BRI unpub. data) Gathering information on this parameter provides helpful insights on nesting activities and overall productivity of the population in comparison with other populations. An increase in the number of switches on Flagstaff Lake may also be indicative of pressures exerted by an increasing population. Activities that increase incidence of nest failures (i.e. water level fluctuations, human disturbance) are likely to also increase the incidence of mate switching among those individuals that failed. This would likely result in lower productivity. Therefore it is valuable to monitor mate switching among marked surveyed pairs.

Estimated Minimum Survivorship

Confirmations of the annual return of individuals to a lake are our best indication of loon survivorship. It is intrinsically linked to between-year territory fidelity given that most individuals confirmed to the lake are confirmed on territory. If a catastrophic event on Maine loon wintering habitat caused mortality of much of the current Flagstaff Lake population, it would be detected the subsequent year when those banded individuals did not return to the lake. Such an event would likely affect loon productivity in the short term. Monitoring between-year territory fidelity can be a helpful management tool in understanding and explaining changes in productivity.

Of the 18 adult Common Loons that have been banded on Flagstaff Lake since 1995, mean annual survivorship was 96%. Males and females had estimated minimum survivorships of 97.5% and 94%, respectively.

Other Marking Techniques: "Vocal Tagging"

A technique has been devised that allows us to consistent identification of the yodel call, or the territorial song of the male loon (Walcott et al. 1999, Walcott and Evers 2000). This method offers one clear advantage over the capture method in that it is possible to vocal tag non-breeding (but territory-holding) individuals. This information helps us understand the consistently low productivity of traditionally unsuccessful or non-breeding individuals (such as the False Inlet) on Flagstaff Lake. We have vocal tagged 5 of the 21 TPs on Flagstaff through other funding projects since 1998. Of the 5 vocally marked males, 2 are unbanded. This has increased the percentage of individuals "marked" lakewide.

6. EVALUATION OF HABITAT QUALITY

Long-term Territory Productivity as an indicator of Habitat Quality

We have evaluated habitat quality on Flagstaff Lake by analyzing territory-specific productivity over time (# chicks fledged/ # years surveyed). Territories were placed into the following six categories for habitat quality developed for a similar study of Lake Umbagog (Evers 2000): extra low (0 - .10), low (0.11 – 0.31), moderate-low (0.32 – 0.52) moderate-high (0.53 – 0.73), high (0.74 – 0.93), and extra-high (>0.93). Territory quality based on these categories of mean chick survival is displayed in Figure 4. Territories in which rafts were used are denoted with an R, naturally nesting loon pairs are denoted by N, and those that have used both natural and raft sites for nesting are denoted by n/a.

We used seven years of chick survival data on 25 recognized territories. One territory rated in the extra-high category (4% Reed Brook (N)) and one rated in the high category (4% Becky Brook (R)). Only three territories (12%), Bridge Cove (R), Jerome Brook (R), Meyers (N), were placed in the moderate-high category. Three territories (12%) were rated moderate-low: Stratton (N), North Branch (N), Arnold Falls (N), and nine (36%) were low (Entrance (N), Bigelow (N), False Inlet (N), Jim Eaton (N), Turner (R), Hurricane (N), Blanchard (N), Dam (R), Grasslands (N)). Eight territories (32%) were rated extra low (Pond Marsh, North End, Limestone, Butterfly, Pond Brook, Trout Brook, Beaver Cove, and Bley Cove).

The lake average productivity is 0.292. Ten territories (40%) were above this lakewide average and are carrying the reproductive load for Flagstaff. Loon territory quality is likely to change over time. Water level fluctuations (by affecting the amount of available nesting habitat), human activities, presence/absence of rafts, abundance of predators, vegetative features, and loon social dynamics influence loon habitat quality over time.

One tendency apparent in Figure 4 is for the more productive territories to be located in protected coves – where a greater percentage of the boundary of their territory is land instead of water. A similar tendency was reported by Evers (2000) for Umbagog Lake territories in the Magalloway River. Territories with a higher percentage of water boundary are likely to experience more intrusions by neighboring and non-breeding loons. This may result in a greater threat to the survival of the young, and a higher energy expenditure by the adults. The extra-low categorization of the territory is likely to be related to the open configuration of the territory. Intruders and predators are often observed in these

territories. More data and physical measurements need to be collected in each territory to further address this factor.

Due to the success of management using rafts on Flagstaff, productivity data are confounded by differential use of rafts by nesting loons. Raft-nesting loons appear to have significant reproductive advantage over naturally nesting loons. Therefore, chick productivity data are directly linked to raft implementation and use by nesting loons. The use and presence/absence of rafts within territories must be taken into consideration when comparing and/or evaluating habitat quality of loon territories on Flagstaff.

Individual performance can be a useful indicator of habitat quality. By tracking the reproductive success of an individual over time, we can eliminate mate-switching as a factor that can potentially affect productivity. We were currently not able to adequately estimate habitat quality using individual performance due to a low sample size.

7. LATE-SEASON CHICK MONITORING AND OVERALL CHICK SURVIVAL

Since breeding activities are typically concluded by the early fall, survey efforts are usually not carried out past this point in the season. Typically, the productivity parameters for the population can be accurately collected using this survey schedule. The one exception, however, is the number of chicks fledged (F). Once a loon chick reaches six weeks of age, it's chances of survival increase dramatically. Typically, loon surveys calculate the number of chicks fledged as the number of chicks surviving past eight weeks of age. We extended our loon monitoring into September to: 1) confirm juvenile survival past the six-week period.

As juvenile loons get older, they become more mobile and difficult to observe. We did observe the survival of nine 2000 juveniles well into the fall. All chicks were confirmed on 10/1. Territory-specific chick survival and confirmation dates are listed by territory in the Qualitative Territory Summary. Nine of the 19 chicks are assumed to have fledged from Flagstaff Lake in 2000. The absence of a chick during these surveys late in the season does not necessarily indicate it's mortality, especially given that juvenile loons should be able to fly at about 70 days of age (10 weeks). All juveniles were observed in the general vicinity of the territory where they hatched, but varied in their movements.

8. YEAR 2000 RECOMMENDATIONS

Nest Predation and Chick Survival

Flagstaff productivity is severely limited by two factors that are not quantifiable using current survey methods: nest predation and chick survival. We recommend further studies that can: 1) Document the actual causes of nest predations that currently go unexplained; 2) determine the causes for the current low chick survival on Flagstaff.

Raft Management and Placement

As mentioned in the management implications discussion, raft use should be approached with considerable discretion. Improper use within lake and/or territory may have adverse impacts on nesting loons. The recommendations made incorporate knowledge of Flagstaff loon social dynamics, previous and historical nest sites, territory boundaries, and six years of territory-specific history. We recommend keeping the current rafts in the same territories and in the same locations on Flagstaff. This management would result in a total of 21 rafts floated out of the current 25 territories on Flagstaff Lake.

Use of Signs on Flagstaff

There are several pairs on Flagstaff that have failed due to disturbance by humans. Many of these human disturbances are unintentional and would likely be avoided by placing informational signs both at the launch sites and at some nesting/brooding areas where deemed necessary. The decision of whether or not to place a sign in a territory is often a difficult one based on the fact that it's effectiveness is often variable depending on the lake users and situation. Our recommendations are based on knowledge of typical lake use patterns and previous site-specific nest failure history. FPL Energy distributes informational signs at boat ramps and campgrounds. Additional site-specific signs should be placed on sensitive islands if needed.

Color Marking Individuals

Color-marking the loons gives us insights into the nesting activities and performance of specific individuals as well as information on loon social dynamics that would otherwise be impossible to collect. Individual performance is the best indicator of habitat quality, we found a relationship between mate switching and productivity. We cannot, however, evaluate individual performance and mate switching without color-marking individuals. Understanding these variables helps us to determine the causes of differential productivity on various sites, which is likely to affect management decisions in those areas.

The Old Lake and Eastern Lake areas: We have very few birds banded in much of Flagstaff, making it relatively impossible to distinguish between pairs, as well as mate and territory switches.

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