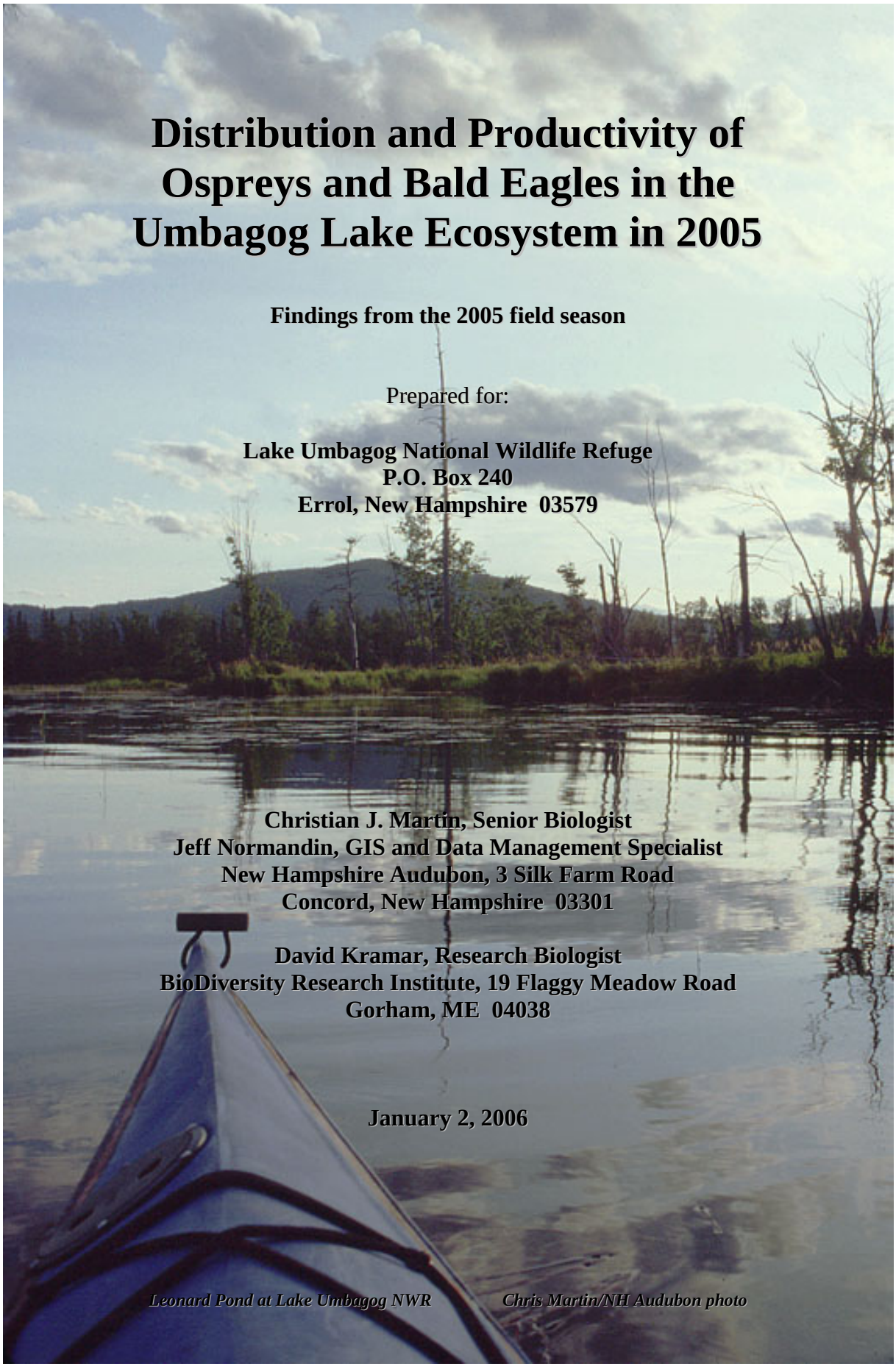


Distribution and Productivity of Ospreys and Bald Eagles in the Umbagog Lake Ecosystem in 2005

Findings from the 2005 field season

Prepared for:

Lake Umbagog National Wildlife Refuge
P.O. Box 240
Errol, New Hampshire 03579

Christian J. Martin, Senior Biologist
Jeff Normandin, GIS and Data Management Specialist
New Hampshire Audubon, 3 Silk Farm Road
Concord, New Hampshire 03301

David Kramar, Research Biologist
BioDiversity Research Institute, 19 Flaggy Meadow Road
Gorham, ME 04038

January 2, 2006

Leonard Pond at Lake Umbagog NWR *Chris Martin/NH Audubon photo*

Distribution and Productivity of Ospreys and Bald Eagles in the Umbagog Lake Ecosystem in 2005: Findings from the 2005 field season.

Christian J. Martin, Senior Biologist, and Jeff Normandin, GIS and Data Management Specialist, New Hampshire Audubon, 3 Silk Farm Road, Concord, NH 03301.

David Kramar, Research Biologist, BioDiversity Research Institute, 19 Flaggy Meadow Road, Gorham, ME 04038.

Introduction

Osprey (*Pandion haliaetus*) and bald eagle (*Haliaeetus leucocephalus*) populations in the northeastern United States have been closely monitored since widespread DDT-induced population declines were first detected for both species in the middle of the 20th century. Populations of both of these piscivorous raptors have rebounded significantly since the federal government banned the use of DDT (Buehler 2000, Poole et al. 2002). Mean rates of osprey population recovery have ranged from 6-15% across the North American continent over the past several decades (Ewins 1997, Houghton and Rymon 1997). Bald eagles populations in the continental U. S. have also increased recently, from less than 1,500 pairs estimated in 1982 to well over 6,000 pairs estimated today (Buehler 2000; M. Amaral, USFWS, personal communication). Ospreys are not currently listed as endangered or threatened by the federal government or in the State of Maine. They are listed as threatened in the State of New Hampshire. Bald eagles are currently classified as threatened on the federal level and as endangered in both Maine and New Hampshire.

In New Hampshire, breeding season monitoring and management of ospreys and bald eagles, and winter monitoring and management of bald eagles, have been coordinated since 1980 by New Hampshire Audubon (NHA) under contract with the New Hampshire Fish and Game Department (NHFGD). Population status and management strategies for both ospreys and bald eagles in New Hampshire are discussed in individual "species profiles" (Martin 2005a, 2005b) included in the state's provisional Wildlife Action Plan submitted to the U. S. Fish and Wildlife Service (USFWS) in October 2005. This plan is available for review at http://www.wildlife.state.nh.us/Wildlife/wildlife_plan.htm).

Data compiled during annual population monitoring conducted by NHA since the early 1980s has indicated a decline in the total number of osprey breeding pairs present in the Umbagog Lake area between 1996 and 2002. Recently, questions have been raised about the overall local population status and ecological health of ospreys and other piscivorous birds, including common loons (*Gavia immer*), whose numbers have also declined locally in recent year (Vogel and Taylor 2002). This field study of ospreys and bald eagles is one part of a broader ecological investigation currently being conducted to better understand the overall status of wildlife populations in the Umbagog Lake ecosystem.

Literature review

The Umbagog Lake region's pioneering ornithologist, William Brewster, characterized both ospreys and bald eagles as relatively common during the period from 1875 through 1910 (Brewster 1925). Except for Brewster's observations, few data exist regarding the local abundance of either of these raptors near Umbagog Lake during the first half of the 20th century (Evans 1994a), when significant region-wide population declines caused primarily by DDT contamination (Buehler 2000, Poole et al. 2002) were affecting both species.

The USFWS conducted aerial surveys in Coos County, New Hampshire in 1970 and 1971, locating seven and 12 osprey nests, respectively, however the osprey population around Umbagog was believed to number just three or four pairs by 1977 (Smith and Ricardi 1983). Prior to 1950, one bald eagle pair nested productively at "Leonard Pond," a backwater channel located on the northwestern shore of Umbagog Lake near the confluence of the Magalloway and Androscoggin rivers. Bald eagles continued to occur on the lake after 1950, but there was no documentation of the presence of a territorial pair or nest again until 1988 (Evans 1994b).

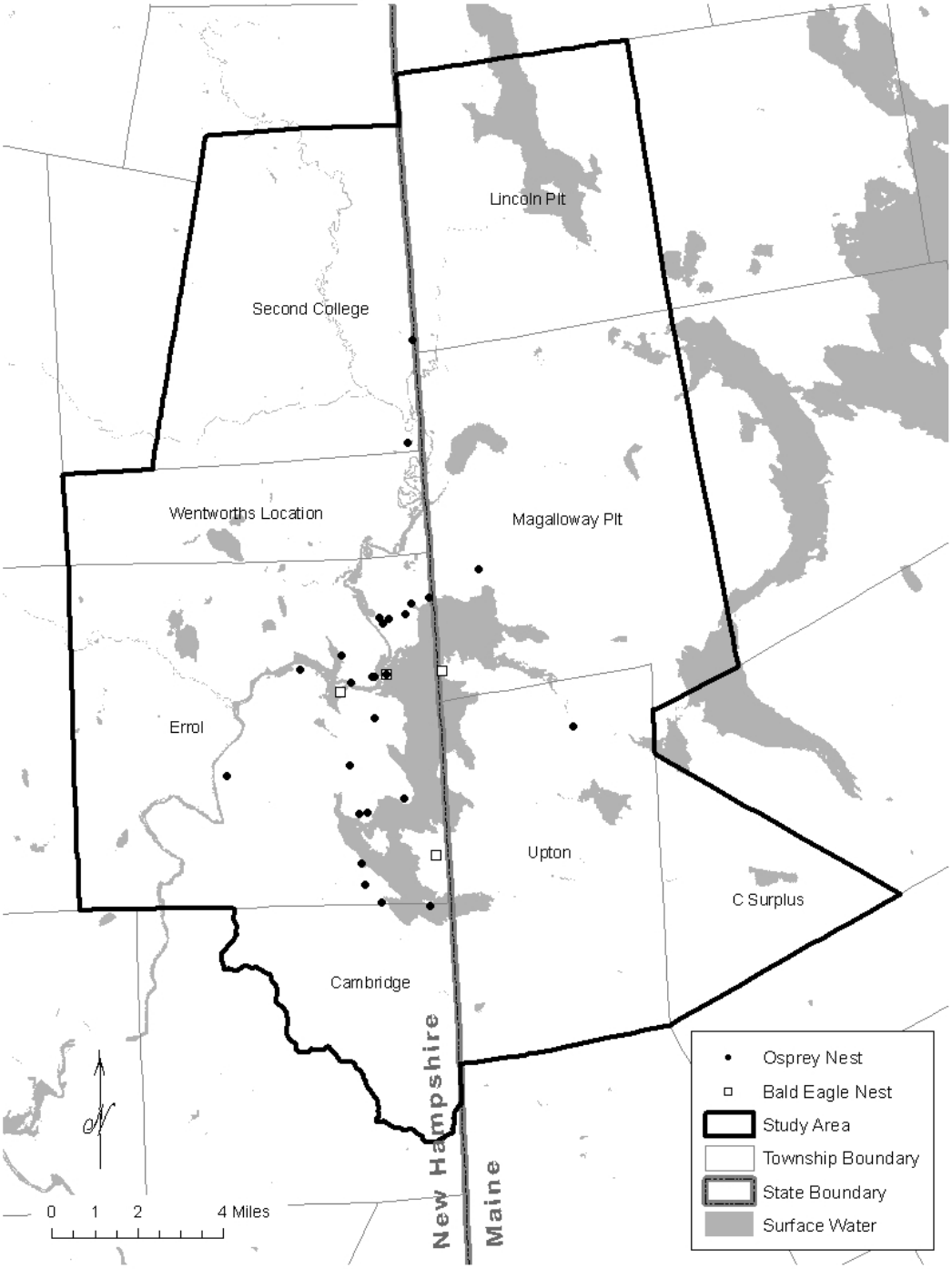
Ospreys and bald eagle populations have both experienced strong recoveries on the statewide scale since the early 1980s. Breeding ospreys in Maine have increased from an estimated 1,000 pairs to 2,000-2,400 pairs from 1981-2002 (Poole et al. 2002), and from three active nests to 43 active nests in New Hampshire from 1980-2005 (Martin 2005c). Breeding bald eagle populations in Maine have increased from 56 to 385 territorial pairs from 1980-2005 (C. Todd, Maine DIFW, personal communication), and from zero to 10 territorial pairs in New Hampshire from 1980-2005 (Martin 2005d).

Study area

Our field study during the 2005 raptor breeding season took place in a portion of Oxford County, Maine and Coos County, New Hampshire, an area known as the Rangeley Lakes region (Figure 1). Within this region, the area delineated as our Umbagog study area covers a total of approximately 780 km^2 (301 mi^2), or 77,950 ha (192,615 acres). Our study area includes four complete townships in Maine (C Surplus, Lincoln Plantation, Magalloway Plantation, Upton), three complete townships in New Hampshire (Errol, Second College Grant, and Wentworths Location), plus that portion of Cambridge, New Hampshire which is located in the Mollidgewock Brook watershed.

Several major surface water bodies occur within the study area. Umbagog Lake, a shallow 3,177 ha (7,850-acre) impounded lake straddling the Maine–New Hampshire state border, is located near its center. Umbagog Lake has three major direct inflows (Magalloway River, Rapid River, and Dead Cambridge River) and one major outflow (Androscoggin River). Other named streams within the study area include Clear Stream, Dead Diamond River, Mollidgewock Brook, and Swift Diamond River. Other large impoundments within the study area include Aziscohos Lake, and portions of Lower

Figure 1. Umbagog study area in the Rangeley Lakes region of Oxford Co., Maine and Coos Co., New Hampshire. Locations of all osprey and bald eagle nests known in 2005 are shown.



Richardson Lake, and Pond-in-the-River. Smaller lakes within the study area include Akers Pond, B Pond, C Pond, Greenough Pond, and Sturtevant Pond.

The Umbagog study area includes several large scale land ownerships or managers, including the federal government which manages approximately 6,880 ha (17,000 acres) as the Lake Umbagog National Wildlife Refuge (NWR). Additional land owners or managers of extensive tracts in the study area include Dartmouth College, the State of New Hampshire, several large timberland owners (e.g., Bayroot LLC, Plum Creek Timber, Pingree family), and at least one regional timberland management firm, Wagner Forest Management Ltd.

Study objectives and methods

Field studies of ospreys and bald eagles in the Umbagog study area in the 2005 field season had two primary objectives:

1) Monitor breeding season productivity and analyze reproductive parameters for both ospreys and bald eagles in the study area, and compare findings with local information for previous years any with similar data from other populations described in the literature.

2) Determine prey species composition and nest provisioning characteristics for ospreys in the study area, and compare finding with historical data from Umbagog (e.g., McWhorter 1983) and with similar data from other studies reported in the literature.

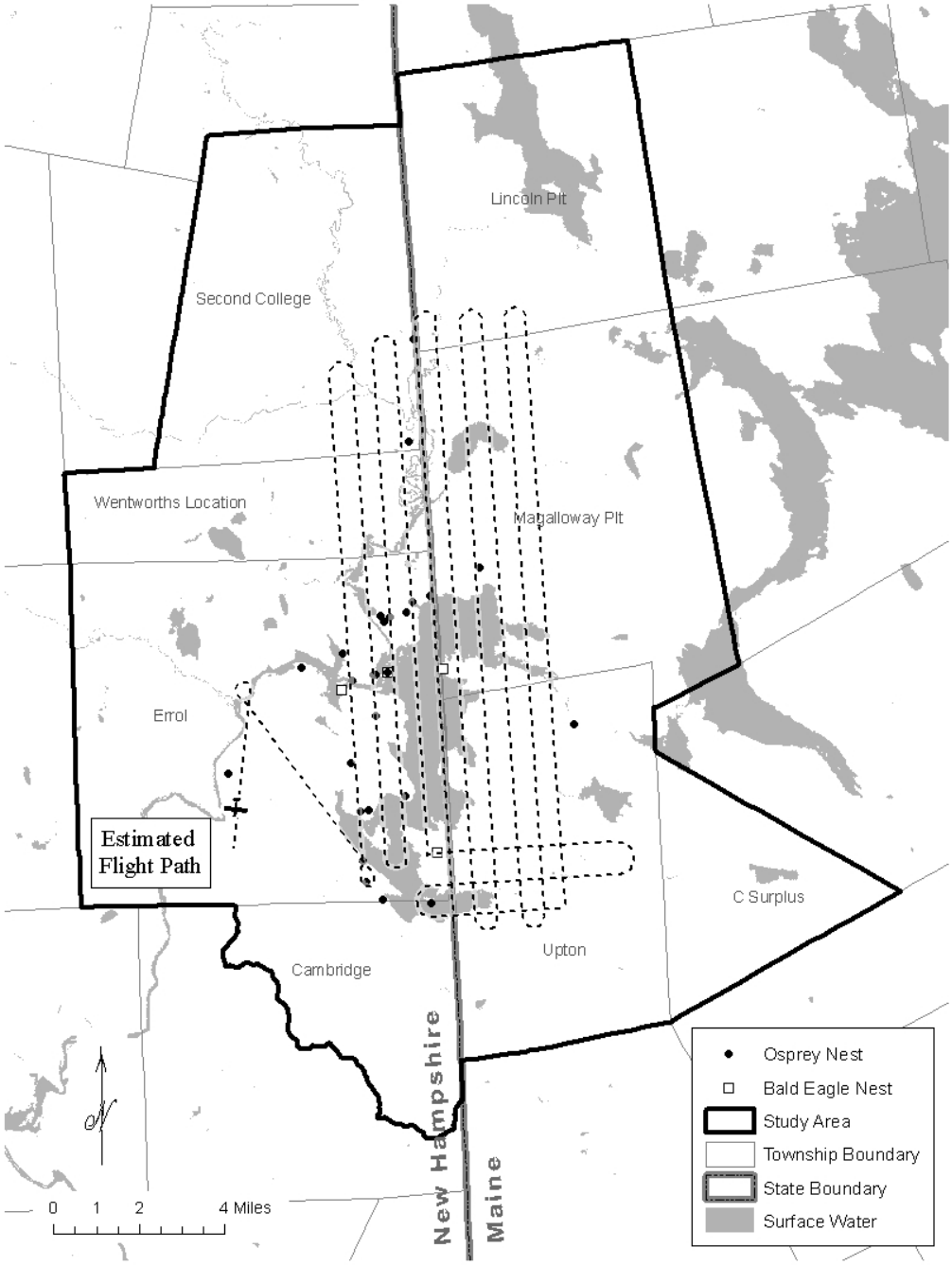
Methods, results, analysis, and discussion of osprey and bald eagle nest distribution and productivity in 2005 are contained in this document. Information about osprey prey species composition and nest provisioning in 2005 is available in a separate document (DeSorbo et al. 2005) produced by BioDiversity Research Institute (BRI).

During the course of our 2005 nest distribution and productivity field work, we employed a combination of two different survey methodologies (aerial survey, repeated ground-based observations) to detect osprey and bald eagle nests located within the study area, and to obtain data on nest site productivity and metrics. These two survey techniques are described in detail below.

Aerial survey

At the start of the 2005 breeding season, we conducted one systematic aerial survey flight (Figure 2) using a Cessna 206 fixed-wing aircraft contracted to the project through Folsom's Air Service of Greenville, Maine. Generally, we surveyed the study area using a north-south grid pattern at elevations ranging from 300-500 ft above the ground. Air speed was roughly 130-160km/hr (80-100 miles/hr). Flight lines were monitored using on-board GPS technology and flight lines were spaced ½ mi apart. We assumed that maximum lateral visibility on either side of the aircraft was approximately ¼ mile.

Figure 2. Flight path followed during aerial survey conducted on 3 May 2005 over the Umbagog study area. Locations of all osprey and bald eagle nests known in 2005 are shown.



Biologists positioned in the rear seats of the aircraft conducted continuous visual searches of the ground during the flight. Our search efforts were influenced to a significant degree both by knowledge of nest locations identified in previous years (NHA data) and by the distribution of open and forested wetlands and forested shoreline habitat across the landscape. During the flight, tight circling and backtracking occurred frequently whenever we detected a new nest, noted the presence of an osprey or a bald eagle, or when we were attempting to determine the activity status of a site. We used a hand-held voice recorder during the flight to note distinctive features of individual nest locations and other key information. The aircraft always resumed its grid pattern flight after backtracking or circling was completed.

Ground-based observations

BRI staff (wildlife biologist David Kramar, technician Cindy Lindstrand, and intern Jesse Fallon) conducted the land-based and water-based observations that we used to determine the reproductive outcomes at each nest. NHA wildlife biologist Chris Martin and BRI wildlife biologist Chris DeSorbo also assisted with collection of these field data. USFWS refuge biologist Laurie Wunder helped us with ½-day of field work. David Kramer coordinated daily logistics associated with field work, and developed a PDA-based data-logging methodology that streamlined data collection and manipulation. Chris Martin acted as overall coordinator for the study.

The ground-based field methods we used during the 2005 study at Umbagog are based upon monitoring protocols developed by NHA for the NHFGD (Martin 2005e, Martin 2005f) to document osprey and bald eagle population status throughout New Hampshire. We used standard raptor reproductive terminology, such as "territorial pair," "active nest," and "successful nest" (Postupalsky 1974), to categorize and describe breeding status and nest productivity. We visited favorable observation points for various nests at least once every two weeks, accessing these points by boat, by vehicle, by bicycle, or on foot. During our visits, we documented nest occupancy and determined the status of a territorial pairs' reproductive efforts. Observers generally remained present at an observation point only as long as was required to confirm whether a reproductive attempt was ongoing or if a nest failure had occurred. As the breeding season advanced, our nest site observational efforts shifted to focus more on documenting the number of chicks present.

We made ground-based observations using handheld 10x binoculars, as well as 20-60x Eagle Optics Raven model spotting scopes mounted on Manfrotto tripods. We documented nest locations and suitable observation sites using Garmin 12XL and Etrex Legend GPS receivers using 1983 datum. We obtained tree metric data using a Spencer Products diameter tape, a Forestry Suppliers 100-ft distance tape, and a Suunto clinometer. Collected field data were entered into a Compaq Ipaq 3700 series PDA with Windows CE version 2002, and we used SprintDB Pro to build customized forms and a PDA-based database. We mapped nest locations in ArcView using ArcGIS Version 8.3 software.

Results

Results from the 2005 field season for both ospreys and bald eagles are described below. First, we describe the specific results from aerial survey and ground-based observations, and then we describe overall summary results for each species' 2005 breeding season.

Aerial survey results

We conducted a single aerial survey of the Umbagog study area on 3 May 2005. On board the aircraft during this flight were Sarah Folsom (pilot), Max Folsom (co-pilot), and wildlife biologists Chris Martin, Chris DeSorbo, and David Kramar. The flight originated and ended at the Berlin Municipal Airport located in Milan, New Hampshire about 16 km (10 mi) southwest of the study area. We spent a total of 120 minutes over the study area conducting our aerial survey. We calculate that the total linear flight path within the study area was 263 km (163.5 mi), not including frequent circling and backtracking. Assuming a nest detectability distance of ¼ mile on either side of the aircraft, we calculate that we visually searched an area of 200 km^2 (77.5 mi^2). Our flight path (Figure 2) covered the Dead Cambridge River valley as far east as C Pond, all of the Umbagog Lake basin from Hampshire Hills on the south to Diamond Peaks and Sturtevant Pond on the north, and the Androscoggin River valley and the Mollidgewock Brook valley from Errol village south to near the Errol-Cambridge town line. It is important to recognize that the available flight time permitted us to systematically surveyed only about 25% of the entire 780 km^2 (301 mi^2) study area.

Ospreys:

Results from our aerial survey are summarized in Table 1 below. During our flight, we located a total of 18 osprey nests (16 in New Hampshire, two in Maine), of which seven (five in New Hampshire, two in Maine) were not known prior to the 2005 field season. From the air, observers confirmed that 15 out of these 18 nests were occupied by at least one adult osprey (13 in New Hampshire, two in Maine), and that nine of these nests (seven in New Hampshire, two in Maine) contained ospreys in incubating posture. In just two hours of flight time, we documented 36% more occupied osprey nests (15 in 2005 versus 11 in 2004) than were detected during all ground-based field work conducted in the same area during the entire 2004 field season. See analysis and discussion section below for additional comments regarding the relative efficiency of aerial versus ground-based surveys.

Bald eagles:

We located a total of three bald eagle nests (all in New Hampshire) during the aerial survey, of which one was not known prior to the 2005 field season. Observers confirmed from the air that two out of three nests observed were occupied by at least one bald eagle, and that one of these nests contained an incubating/brooding adult eagle at the time of our flight.

Table 1. Osprey nests documented during aerial survey conducted 3 May 2005.

Nest activity category/status	NH	ME	Study area total
# osprey nests detected	16	2	18
# osprey nests occupied	13	2	15
% detected that were occupied	81%	100%	83%
# osprey nests w/ incubation	7	2	9
% occupied osprey nest incubating	54%	100%	60%

Ground-based observation results

Ospreys:

We conducted a grand total of 128 water-based and land-based field observations of 26 osprey nests located in the Umbagog study area on 31 separate dates from early May through early August 2005. Time intervals of individual observations among nests and among visit dates varied widely, depending upon the activity status of each nest. For example, inactive nests received brief checks while lengthy checks were sometimes required to determine the number of chicks present in active nests. In addition to the total number of observations listed above, we also walked to the base of eight nest trees in mid-August to gather site metric data and look for shed feathers and prey remains (for more details, see DeSorbo et al. 2006). During the course of our ground-based field work, we located one additional osprey nest with an incubating bird, two additional nests that were occupied by osprey pairs, and yet another nest where we found an incubating or brooding great horned owl (*Bubo virginianus*) occupying a former osprey nest that we had previously discovered from the air.

Bald eagles:

We conducted water-based and land-based field observations of bald eagle nests located in the Umbagog study area on 12 separate dates from early May through late July 2005. Observations of varying time intervals occurred on nine days at the Umbagog North nest (eight times at Leonard Pond nest and once at Dubose nest), on four days at the Umbagog South nest (including a climb to band chicks), and on eight days at the Umbagog West nest (including a climb to assess cause of nest failure).

2005 breeding seasons summaries for ospreys and bald eagles

Distribution and productivity status for all osprey and bald eagle nests known to be present within the Umbagog study area during the 2005 breeding season are described below and shown in Figure 3.
Ospreys:

In the Umbagog study area in 2005, we documented a total of 26 osprey nest structures, and estimated a total of 17 territorial pairs of ospreys. Four territorial pairs appeared to maintain two nest structures each, while five additional nests appeared to be unused throughout the 2005 breeding season. By the end of the 2005 breeding season, newly discovered nests represented 42% (11 of 26) of all known osprey nest sites within the study area. At least 14 territorial pairs engaged in active nesting attempts (egg-laying and/or incubation), while three pairs displayed no firm evidence of active nesting. Successful reproductive attempts occurred at 12 out of 14 active nests (86% of active nests), with a total of 18 fledglings produced (1.06 young/pair; 1.29 young/active nest; 1.50 young/successful nest). We estimate that the overall osprey population present in the study area at the conclusion of the 2005 breeding season was at least 52 birds (34 adults, 18 juveniles).

Detailed nest-by-nest results from the 2005 osprey breeding season are shown in Table 2, as are standard reproductive parameters. These may be used to compare 2005 breeding season results with results from the Umbagog study area in prior years, and with other closely-monitored local osprey populations.

Bald eagles:

In the Umbagog study area in 2005, we documented a total of four bald eagle nest structures (Figure 3 and Table 3), and a total of three territorial pairs of eagles. One territorial pair (Umbagog North) maintain two nest structures over the course of the breeding season (Leonard Pond nest, Dubose nest), while each of the other pairs (Umbagog South, Umbagog West) maintained only one nest each. Newly discovered nests represented 50% (two of four) of all known bald eagle nest sites within the study area in 2005. Two territorial pairs (Umbagog South, Umbagog West) engaged in active nesting attempts (egg-laying and/or incubation), while one pair (Umbagog North) displayed no firm evidence of active nesting. Successful reproduction occurred at only one active nest (50% of active nests), with a total of two fledglings produced (0.66 young/pair; 1.00 young/active nest; 2.00 young/successful nest). We estimate that the overall bald eagle population present in the study area at the conclusion of the 2005 breeding season was at least eight birds (six adults, two juveniles). In addition to individuals associated with these breeding territories and nests, there were also at least four other individual eagles (one sub-adult, one banded white-bellied immature, one banded dark immature, and one unbanded dark immature) confirmed present in the study area for varying lengths of time during the 2005 breeding season.

Figure 3. Distribution and productivity status for all osprey and bald eagle nests located in the Umbagog study area in 2005. "Known" nests defined as presence of nest structure during breeding season; "active" nests had confirmed incubation; "productive" nests fledged ≥1 young.

Table 2. Osprey nest productivity summary for the Umbagog study area in 2005.

State	Nest_site_name	ID	Occupied	Active	Success	# Young	Guarded	New_site
NH	Dartmouth Grant	DAGR	yes	Yes	yes	2	Yes	no
NH	Dike Site Road	DISR	yes	Yes	yes	1	No	no
NH	Eames Camp 4	EAC4	yes	Yes	yes	1	No	no
NH	F&G Platform N	FGPN	yes	Yes	no	0	Yes	no
NH	F&G Platform S	FGPS	no	No	no	0	Yes	no
NH	Harpers Meadow 4	HAM4	yes	No	no	0	Yes	yes
NH	Harpers Meadow 5	HAM5	yes	Yes	yes	2	No	yes
NH	Horseshoe Camp	HOCA	yes	Yes	yes	2	Yes	no
NH	Leonard Marsh 1	LEM1	no	No	no	0	Yes	no
NH	Leonard Marsh 6	LEM6	no	No	no	0	Yes	no
NH	Leonard Marsh 8	LEM8	no	No	no	0	No	no
NH	Leonard Marsh Esker	LEME	yes	Yes	no	0	Yes	no
NH	Leonard Pond Eagle	LEPE	yes	No	no	0	Yes	yes
NH	Mollidgewock CG North	MCGN	yes	Yes	yes	1	No	yes
NH	Mt Pond Drainage	MTBD	yes	No	no	0	No	yes
NH	Potter Cove East	POCE	yes	Yes	yes	1	No	no
NH	Refuge Garage Road	REGR	no	No	no	0	No	yes
NH	Rte 16 Boat Launch	R16B	no	No	no	0	Yes	no
NH	Rte 26 Moose Wallow	R26M	yes	Yes	yes	2	No	yes
NH	Sargent Cove	SACO	yes	yes	yes	1	No	no
NH	Stagg Camp	STCA	yes	no	no	0	Yes	yes
NH	Thurston Cove	THCO	yes	no	no	0	Yes	no
NH	Thurston Cove 2	THC2	yes	no	no	0	No	yes
NH	Townline Island 3	TOI3	yes	yes	yes	2	Yes	no
ME	zSmooth Ledge	zSML	yes	yes	yes	1	No	yes
ME	zSturtevant Bog	zSTB	yes	yes	yes	2	No	yes

Totals:	Nest_sites	Occupied	Active	Success	# Young	Guarded	New_site
NH	24 sites known in 2005	18	12	10	15	13	9
ME	2 sites known in 2005	2	2	2	3	0	2
All	26 sites known in 2005	20	14	12	18	13	11

Productivity summary:

17 breeding pairs (1.06 young/pair), additional nests were unoccupied or alternate sites for a pair
14 active nests (1.29 young/active nest), 3 pairs showed no evidence of egg-laying or incubation
12 successful nests (1.50 young/successful nest), 86% (12 of 14) active nests were successful
Newly discovered nest sites comprised 46% (11 of 26) of all known sites at end of 2005 season

Definitions:

Occupied nest - routine presence of $\geq$ one potentially breeding bird at a partial/complete nest during breeding season.
Active nest - presence of an adult pair at a nest where physical evidence (presence of eggs, shell fragments, or young) or behavioral evidence (incubation) indicates that eggs were laid.
Successful nest - an active nest producing $\geq$ one young that reaches fledging age.
Young fledged - number of nestlings observed, or believed capable of, making flights from the nest.
Guarded - sheet metal predator guard installed on tree prior to breeding attempt.
New site - discovery/verification of presence of nest occurred after the previous (2004) breeding season.

Table 3. Known bald eagle nests in Umbagog study area during 2005 breeding season.

Nest name	Township	Guarded	N_deg	N_min	W_deg	W_min	Datum	Tree species
Leonard Pond	ERROL	1990	44	47.258	71	3.839	NAD83	P. strobus
Dubose	MAGALLOWAY PLANTATION	0	44	47.304	71	2.265	NAD83	P. strobus
Tidswell Deer	ERROL	1986	44	43.569	71	2.446	NAD83	P. strobus
Sweat Meadow	ERROL	0	44	46.898	71	5.139	NAD83	P. strobus

Detailed nest-by-nest results from the 2005 bald eagle breeding season are described below:

Umbagog Lake North territory – adult pair present; no evidence of incubation at Leonard Pond nest tree, which was eventually controlled by ospreys later in the summer; alternate nest built during the summer on Dubose property on Pine Point; Dubose nest tree located just east of site of former McElwaine nest tree, which was last actively used in 1994, but has since fallen; Dubose nest tree is live white pine, 108.7 cm (42.8 in) dbh, tree height is 26.2 m (86 ft), nest height is 22.3 m (73 ft); banding status of both adults uncertain; water-based closure signs installed and land-based closure signs in place throughout the breeding season at Leonard Pond, no closure signs posted at Dubose.

Umbagog Lake South territory – adult pair present; incubated and hatched young in Tidswell Deer nest tree; two chicks banded and blood and feather samples obtained by NHA and BRI staff; fledged two chicks; adult female banded status uncertain, adult male not banded; no closure signs posted.

Umbagog Lake West territory – new territorial pair constructed new nest in Sweat Meadow tree this spring; Sweat Meadow nest tree is live white pine, 99.8 cm (39.3 in) dbh, tree height is 30.8 m (101 ft), nest height is 29.9 m (98 ft); incubated and hatched young; failed after hatch; recovered the highly decomposed remains of one chick (<2-wks old) at base of nest tree after confirmation of nest failure; adult female banded status uncertain, sub-adult male not banded; no closure signs posted.

In addition to the remains of the Umbagog West nestling, we recovered, or know of the recovery by others, of the remains of two additional dead bald eagles from the Umbagog study area during the 2005 calendar year. Results of necropsies conducted on these dead birds are not yet available. In addition, we know of three banded birds that were last seen alive since the end of the 2004 breeding season (Table 4).

Table 4. Bald eagle "recoveries" from Umbagog study area since 2004 breeding season.

Individual bird ID	Date	Location	Reporter/collector	Outcome
unbanded adult, released as silver 629-50022 (right), black 5/M (left)	Oct-Dec 2004	Sunday Cove to Potter Farm	Steven Allaire, Maine DIF&W, Paul Casey, Lake Umbagog NWR	Alive, rehabbed, banded, and released
unbanded adult	Jan 30, 2005	Spellman Cove	Ian Drew, Lake Umbagog NWR	found dead, to Maine, necropsy pending (?) (see Figure 4)
9-month old, silver 629-50011 (right), black 5/R (left)	Feb 12, 2005	Mongaup River, Sullivan Co., NY	Gene Weinstein, NYSDEC	alive and well in southeast New York (see Figure 5)
Massachusetts "WN" series HY2004 immature	July 28, 2005	Magalloway River	Chris Martin, NHA	alive and well
unbanded immature	July 28, 2005	Se of Brown Owl Pond	Laura Farrell and Oliver Hatch, U. VT/ Chris Martin, NHA	Found dead, to Tufts Univ., necropsy pending

Figure 4. Ian Drew of Lake Umbagog NWR holding remains of unbanded adult bald eagle found dead on ice at Spellman Cove on Umbagog Lake in late January 2005 (USFWS photo).

Figure 5. 9-mo old HY2004 Umbagog South fledgling "5/R" at wintering area in southeastern New York State in February 2005 (Gene Weinstein/NYSDEC photo).

Analysis and discussion

Ospreys

The 2005 osprey breeding season in the Umbagog study area was characterized by the following three statistics:

The population experienced a record high in frequency of successful outcomes. Twelve out of 14 (86%) active nests were successful in fledging at least one young in 2005. This compares with a long-term average of 54% (160 of 302 active nests) successful outcomes in the study area from 1980-2004, and exceeds the previous maximum success rate of 83% (5 of 6 active nests) recently established in 2004.

Productivity at active nests was relatively high. A total of 18 young fledged from 14 active nests (1.29 young/active nest) in 2005. This compares with a long-term average of 1.01 young/active nest (302 young from 299 nests) in the study area from 1980-2004. The past three-year interval (2003-2005) has had the highest average productivity of any three-year interval from 1980-2005.

Although numerous, successful nests had extremely low average per nest productivity. A total of only 18 young fledged from the 12 successful nests (1.50 young/active nest) in 2005. This compares with a long-term average of 1.89 young/successful nest (160 of 299) in the study area from 1980-2004. This season's average annual productivity rate was the lowest since 1992, and was the third lowest on record since 1980, equaling the low average productivity documented in 1989 and 1992, and exceeded in futility only by the 1981 (0.00 young/nest) and 1983 (1.29 young/nest) breeding seasons.

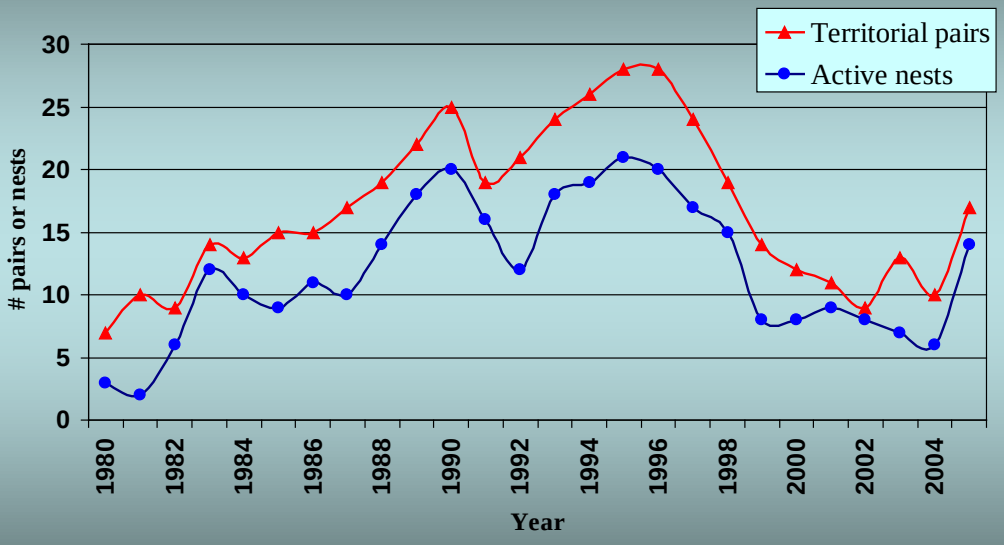
To better understand the dynamics of the osprey breeding population in the Umbagog study area, we compared data on territorial pairs, active nest attempts, and young fledged for the 26-year period from 1980-2005 (see Figures 6 and 7).

We found a 19% annual rate of increase in the estimated number of territorial pairs from 1980-1996 (from seven pairs in 1980 to 28 pairs in 1996), followed by an 11% annual decline from 1996-2002. Most recently, the estimated number of territorial pairs has increased again by 30% annually (from nine pairs in 2002 to 17 pairs in 2005).

We found a 40% annual rate of increase in the number of active nesting attempts from 1980-1995 (from three nests in 1980 to 21 nests in 1995), followed by an 8% annual decline from 1995-2004. Most recently, the number of active nests has more than doubled (from six nests in 2004 to 14 nests in 2005).

We found a 100% annual rate of increase in the number of successful nests (data not shown in Figures 6 and 7) from 1980-1994 (from one nest in 1980 to 15 nests in 1996), followed by a 17% annual decline from 1996-2001. Most recently, the number of successful nests has increased by 125% annually (from two nests in 2001 to 12 nests in 2005).

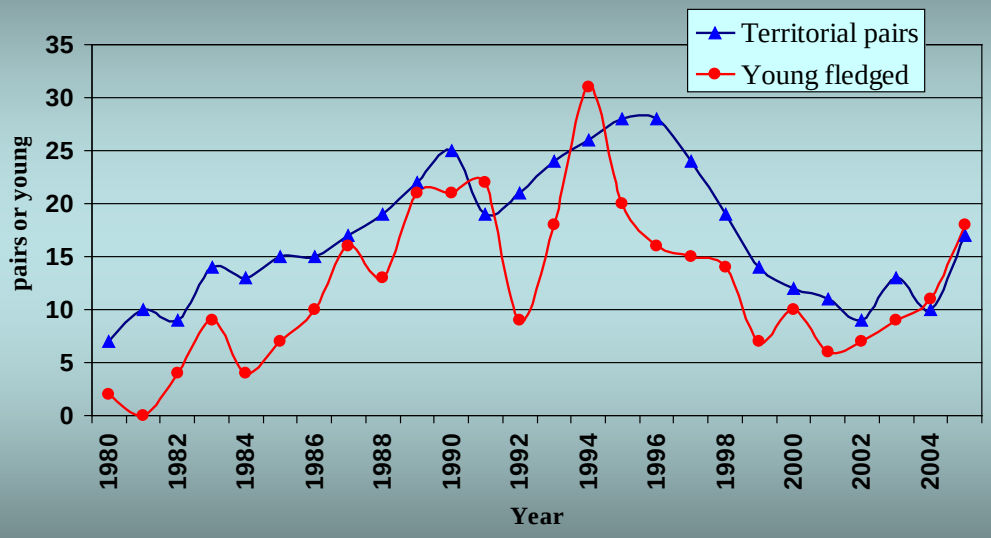
Figure 6. Territorial pairs (estimated) vs. active nests (documented) for ospreys in the Umbagog study area, 1980-2005.



Finally, we found a 91% annual rate of increase in the number of fledged young from 1980-1996 (from two in 1980 to 31 in 1994), followed by a 12% annual decline from 1994-2001. Most recently, the number of fledged young has increased by 50% annually (from six in 2001 to 18 in 2005).

It is interesting to note that data from a few selected local or regional osprey breeding populations in eastern North America also suggest that moderate declines have occurred within the past decade. For example, raptor biologists working in Ontario recently reported results from a study they conducted on ospreys breeding in the Kawartha Lakes region (roughly the same latitude as our study area) during a 23-year period from 1978-2001 (De Solla et al. 2003). They reported a 29% average annual increase (from 18 to 89 occupied nests) during a 15-year period from 1978-1992 (augmented substantially by nest platform installation), but a subsequent decline to 78 and then 66 occupied nests, respectively, by 1996 and 2000, off 12% and 26% from the population high set in 1992. Osprey populations monitored in the Upper and Lower peninsulas of Michigan also declined by 22% and 9%, respectively, during the latter half of the 1990s (Postupalsky, personal communication, reported in De Solla et al. 2003). The cause(s) of these observed declines are not clear to the biologists involved with these studies.

Figure 7. Territorial pairs (estimated) vs. young fledged (documented) for ospreys in the Umbagog study area, 1980-2005.



We also compared data from the Umbagog study area with a statewide data set for New Hampshire (Martin 2005c) for the 26-year period from 1980-2005 (see Figures 8, 9, and 10). Note that nearly all of New Hampshire's known osprey nest sites were located within the Umbagog study area during the interval from 1980-1988, after which other local populations in the state became established. Also note that a small fraction of the Umbagog study area nests (those located in Maine) are not added into the New Hampshire statewide totals.

Figure 8 compares active nesting attempts in the Umbagog study area with New Hampshire statewide data. The study area's share of the state's active nests was approximately 67% in 1994, but had declined to only a 16% share by 2004. Increasing numbers of active nests in other areas in New Hampshire enabled the statewide number of active nests to remain relatively constant from 1994-2003, when the Umbagog population was in decline. With the recent increase in the number of active nests in the study area, statewide numbers are up sharply.

Figure 8. Active osprey nests in Umbagog study area (NH+ME) vs. NH statewide totals, 1980-2005.

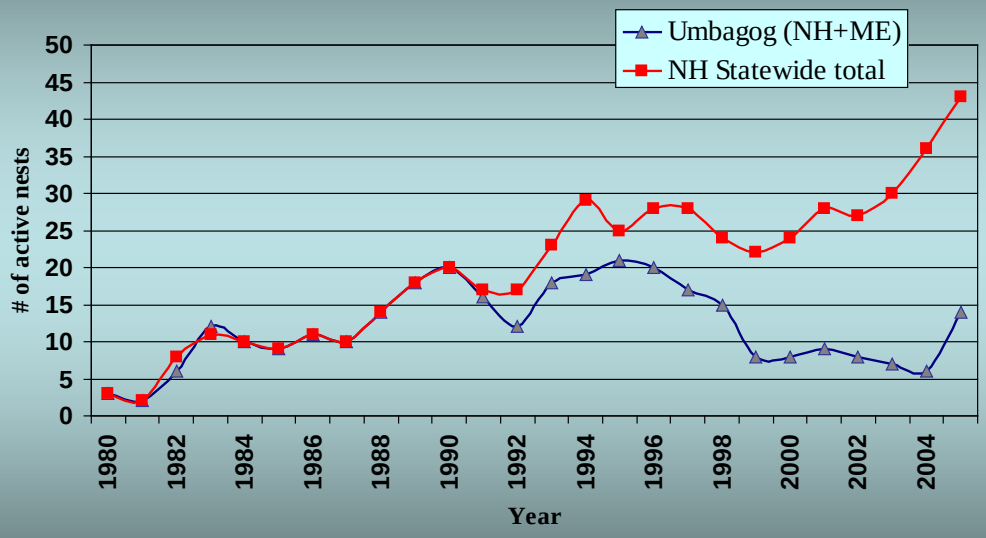


Figure 9 compares the number of fledged young in the Umbagog study area with New Hampshire statewide data. Prior to about 1996, trends in the number of fledged young between the two areas were very similar, however after 1996 they gradually diverged, with statewide numbers rising substantially even while Umbagog numbers declined.

Finally, Figure 10 compares the mean productivity (number of fledged young/active nest) in the Umbagog study area and for New Hampshire statewide. Most notable is the fact that after tracking similar courses from 1980-1994, the annual productivity rate for Umbagog nests has lagged behind that of New Hampshire nests statewide since about 1995, with only one exception in 2004.

Figure 9. Young ospreys fledged in Umbagog study area (NH+ME) vs. NH statewide totals, 1980-2005.

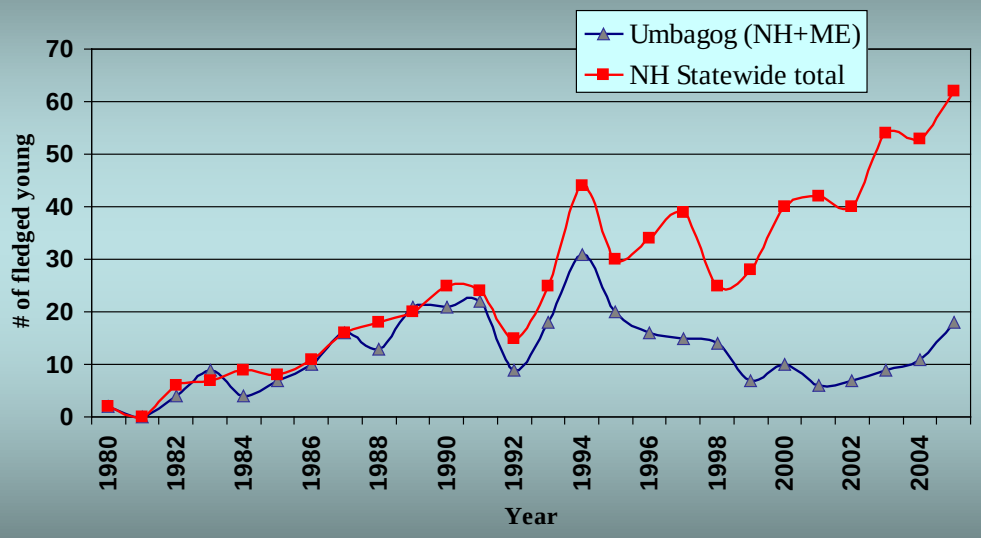
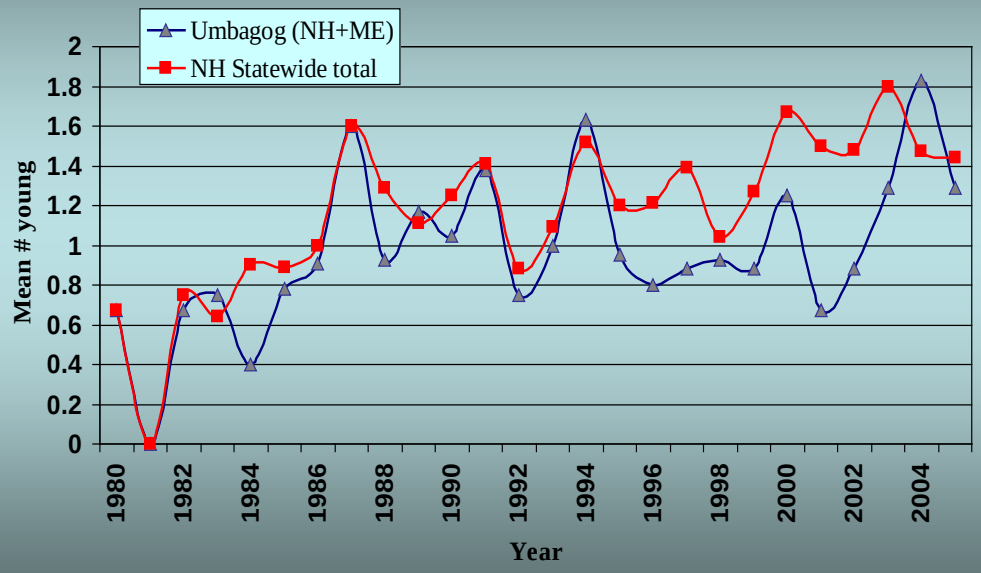


Figure 10. Mean number of young ospreys fledged per active nest in the Umbagog study area (NH+ME) vs. NH statewide, 1980-2005.



What is most clear from analyses conducted so far is that the growing osprey breeding population around Umbagog Lake experienced a substantial negative change in their productivity beginning around 1994-1996. This negative growth persisted for a period of 5-10 years until about 2001-2004 and ran counter to trends in the New Hampshire statewide population as a whole. Subsequently, local conditions in the Umbagog study area have changed once again, now favoring renewed osprey breeding population growth.

Bald eagles

The 2005 bald eagle breeding season in the Umbagog study area was characterized by a 50% increase in the number of territorial pairs (from two pairs in 2004 to three pairs in 2005) and moderate productivity (2 active nests, 1 successful nest, 2 fledge young). There are now three territorial pairs of bald eagles whose nests are located within an 11 km^2 (5.6 mi^2) polygon centered on Umbagog Lake. This is the highest concentration of territorial pairs anywhere in New Hampshire. Another territorial pair nests at Pontook Reservoir just to the southwest of the study area, and three additional territorial pairs maintain nests just to the east of the study area at Pond-in-the-River, at Upper Dam on Upper Richardson Lake, and at Rangeley Lake's South Bay Bog (Bill Hanson, Florida Power & Light, personal communication).

Bald eagle population recovery will likely result in some displacement of osprey pairs to less optimal nesting areas or to locations that are further from preferred foraging areas (Ewins 1997). Bald eagles are widely known to attack or kleptoparasitize adult ospreys (MacDonald and Seymour 1994, Prevost 1979) and unfledged nestlings (Fleming and Bancroft 1990, Liston 1997), and to exhibit interspecific territoriality (Ogden 1975). We did not observe any cases of predation by eagles on ospreys during our 2005 field work. There are two additional predators that may actually be equally important to osprey population distribution and productivity. Raccoons (*Procyon lotor*) are widely documented as predators on osprey eggs and on younger nestlings (Poole et al. 2002). Great horned owls have also been documented to kill an adult osprey at its nest (Cold 1993).

Under certain circumstances, ospreys may also act quite aggressively toward bald eagles (Ogden 1975, Poole et al. 2002), although we could find no evidence in the literature to support the claim that such behavior would result in serious injury or mortality to eagles. For the first time ever documented in New Hampshire, ospreys successfully took control of an existing bald eagle nest. This "takeover" of the Leonard Pond nest may have been due as much to nest site neglect by eagles as to aggressive territoriality by ospreys, since the Umbagog North eagle pair was constructing a new nest roughly one mile to the east on the opposite shore of the lake during the breeding season.

Field techniques

One highlight of the 2005 field season in the Umbagog study area was the exceptionally high rate of discovery/detection of "new" osprey nest sites. Eleven of 26 nests (42%) known by the conclusion of the 2005 breeding season were newly identified this year. In terms of absolute numbers, this is the highest number of nest nests discovered in any one year since 1980. By percentage, it is the second highest annual rate of new nests, trailing only the 11 of 23 nests (48%) found in 1983.

Aerial surveys for osprey nests were routinely conducted in the Umbagog study area from the mid-1980s through 1996, but these flights were discontinued due to lack of aircraft and qualified pilots available at an affordable cost. Aerial survey was resumed in 2005, and in just two short hours of flight time on May 3, we documented 36% more occupied osprey nests (15 in 2005 versus 11 in 2004) than were detected during all ground-based field work conducted in the same area during the entire 2004 field season.

It is probable that the resumption in use of aerial survey has contributed substantially to the high nest discovery/detection rate documented in 2005. But given the limited scope of our resources, we have not yet conducted a detailed analysis to determine to what extent observed differences in the total number of nest sites in 2005 compared to 2004 or prior years is due to survey method versus actual changes in the local population.

Literature cited

Brewster, W. 1925. The birds of Lake Umbagog region of Maine, Pt. 2. Bull. Comp. Zool. 66. Harvard College, Cambridge, Mass.

Buehler, D. A. 2000. Bald eagle (*Haliaeetus leucocephalus*). *In* The Birds of North America, No. 683 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Cold, C. W. 1993. Adult male osprey killed at nest by great horned owl. Passenger Pigeon 55:269-270.

De Solla, S. R., P.A. Martin, P. J. Ewins, and M. E. Barker. 2003. Productivity and population trends of ospreys in the Kawartha Lakes region, Ontario, 1978-2001. Journal of Raptor Research 37:307-314.

DeSorbo, C. R., D. C. Evers, and D. Kramar. 2005. Characterizing food habits and time budgets of ospreys within the Lake Umbagog ecosystem. Report BRI 2005-14. BioDiversity Research Institute, Gorham, Maine. 21pp.

Evans, D. 1994a. Osprey. Pp. 42-43 *in* Atlas of breeding birds in New Hampshire. C. R. Foss (ed.). Arcadia Press. Dover, NH.

——— . 1994b. Bald eagle. Pp. 373-374 *in* Atlas of breeding birds in New Hampshire. C. R. Foss (ed.). Arcadia Press. Dover, NH.

Ewins, P. J. 1997. Osprey (*Pandion haliaetus*) populations in forested areas of North America: changes, their causes and management recommendations. Journal of Raptor Research 31:138-150.

Fleming, S. P. and R. P. Bancroft. Bald eagle attacks osprey nestling. Journal of Raptor Research 24:26-27.

Houghton, L. M. and L. M. Rymon. 1997. Nesting distribution and population status of U.S. ospreys 1994. Journal of Raptor Research 31:44-53.

Liston, T. M. 1997. Bald eagle attacks osprey nestling. Loon 68:238-239.

MacDonald, J. and N. R. Seymour. 1994. Bald eagle attacks adult osprey. Journal of Raptor Research 28:122.

Martin, C. J. 2005a. Species profile: Osprey *Pandion haliaetus*. Pp. A481-A497, *in* New Hampshire wildlife action plan. (New Hampshire Fish and Game Department, ed.). New Hampshire Fish and Game Department, Concord, NH.

——— . 2005b. Species profile: Bald Eagle *Haliaeetus leucocephalus*. Pp. A353-A367, *in* New Hampshire wildlife action plan. (New Hampshire Fish and Game Department, ed.). New Hampshire Fish and Game Department, Concord, NH.

——— . 2005c. Breeding status of ospreys in New Hampshire in 2005. Report submitted to New Hampshire Fish and Game Department. New Hampshire Audubon, Concord, NH. 11 pp.

——— . 2005d. Status of bald eagles in New Hampshire in 2005. Report submitted to New Hampshire Fish and Game Department. New Hampshire Audubon, Concord, NH. 17 pp.

——— . 2005e. Osprey breeding season monitoring protocol for New Hampshire. Report submitted to New Hampshire Fish and Game Department. New Hampshire Audubon, Concord, NH. 10 pp.

——— . 2005f. Bald eagle breeding season monitoring protocol for New Hampshire. Report submitted to New Hampshire Fish and Game Department. New Hampshire Audubon, Concord, NH. 11 pp.

McWhorter, M. 1983. Osprey nesting study Umbagog Lake region, New Hampshire, 1983. Report submitted to New Hampshire Fish and Game Department. New Hampshire Audubon, Concord, NH. 35 pp.

Ogden, J. C. 1975. Effects of bald eagle territoriality on nesting ospreys. Wilson Bulletin 87:496-505.

Poole, A. F., R. O. Bierregaard, and M. S. Martell. 2002. Osprey (*Pandion haliaetus*). *In* The Birds of North America, No. 683 (A. Poole and F. Gill, eds.). The Birds of North America, Inc. Philadelphia, PA.

Postupalsky, S. 1974. Raptor reproductive success: some problems with methods, criteria, and terminology. Raptor Research Report 2:21-31.

Prevost, Y. 1979. Osprey-bald eagle interactions at a common foraging site. Auk 96:413-414.

Smith, C. F. and C. Ricardi. 1983. Ospreys and bald eagles in New Hampshire: status, habitat and nest site characteristics. Pp. 149-156, *in* Biology and management of bald eagles and ospreys. (D. M. Bird, ed.). Harpell Press. Ste. Anne de Bellevue, PQ. 325 pp.

Vogel, H. and K. Taylor. 2002. Summary of New Hampshire Loon Preservation Committee field activities in 2001. Final report. Loon Preservation Committee, Moultonborough, NH. 20 pp., plus 2 app.

Acknowledgements

Funding for this study of ospreys and bald eagles in the Umbagog Lake ecosystem was provided by the U. S. Department of the Interior, Fish and Wildlife Service as part of a multi-year investigation of wildlife populations, public use, and overall ecosystem function in the Umbagog Lake watershed. We are particularly grateful to New Hampshire Senator Judd Gregg for his assistance in securing funding to conduct this work.

We wish to acknowledge the professional staff of the Lake Umbagog NWR for their assistance throughout the 2005 field season. Housing for field personnel was generously provided by the NWR, as was boat transportation on those occasions when multiple boats were required. Additional field equipment was supplied by NHFGD and by H. P. "Flip" Nevers. Thanks also to Max Folsom and Sarah Folsom from Folsom's Air Service, who provided invaluable aerial survey expertise.

Chris DeSorbo of BRI offered many helpful comments and suggestions at all stages of this study, from conception, through implementation, to report submission. Significant contributions to the initial study proposal and design were made by David C. Evers, Ph.D., from BRI. Additional constructive suggestions during field season and report writing phases were offered by Carol R. Foss, Ph.D., from NHA.