Condor 84:439–441

TIME AND ACTIVITY BUDGETS OF OSPREYS NESTING IN NORTHEASTERN NOVA SCOTIA

IAN JAMIESON

NORMAN SEYMOUR

AND

ROBERT P. BANCROFT

Green (1976) and Stinson (1978) studied time and activity budgets of Ospreys (*Pandion haliaetus*) in Scotland and Virginia, while Levenson (1979) conducted a similar study in northern California. Levenson also documented division of labor between members of a nesting pair.

Ospreys in northeastern Nova Scotia use the habitat in two different ways: (1) nesting near the coast and foraging in estuaries; and (2) nesting near lakes and streams where most of their foraging occurs (Jamieson, Seymour and Bancroft, unpubl. data). This paper details and compares time and activity budgets for Ospreys nesting near the coast and near lakes and streams from before egg-laying until the young fledged. We compare this Nova Scotia population with Osprey populations elsewhere and also examine the roles of the sexes.

STUDY AREA AND METHODS

Our investigation was conducted within the watersheds of Antigonish and Pomquet estuaries, which empty into the Gulf of St. Lawrence in northeastern Nova Scotia. The West and South rivers are the two major rivers and they flow into Antigonish estuary; shallow, eutrophic Gaspereaux Lake flows into the West River about 11 km from the estuary. Ospreys that nested close to the estuaries fished almost entirely in them, particularly Antigonish estuary, while the inland birds fished in the rivers and lakes.

Most of the pairs that foraged in the estuaries nested on power poles midway between the two estuary systems, approximately 3 km from each. Here we observed four pairs with nest sites, which were from 0.25 to 1.2 km apart.

Pairs inland nested on trees and power poles. Two intensively observed nests were on poles, approximately 250 m apart, between Gaspereaux Lake and the West River, approximately 10.8 km from Antigonish estuary, 0.8 km from Gaspereaux Lake, and 0.5 km from the West River. The third pair nested in a live white spruce (*Picea glauca*) 0.6 km from Gaspereaux Lake and 12 km from Antigonish estuary, while the fourth pair nested on a hilltop power pole 2.4 km from the South River and 9.0 km from Antigonish estuary. Additional information on the study area and the status of the population can be found in Prévost et al. (1978).

Nests were initially found and periodically surveyed by helicopter. Observations were made from elevated blinds which were 100 to 300 m from the nests. This allowed an unobstructed view of nests and nearby trees where the birds perched. Observation time totalled 487 h, from before egg-laying to until the young fledged (9 May to 22 August 1978). Daily observations were divided into three periods (06:00–11:00, 11:00–16:00, 16:00–21:00) encompassing most daylight hours. On one day the observation period would include the 06:00–11:00 and 16:00–21:00 periods, and the next day the period from 11:00–16:00. A different nest was watched during each observation period and each nest was usually watched at least once every four days.

We divided the reproductive season into three periods: pre-incubation (before egg-laying); incubation (from the onset of egg-laying to hatching of the first egg; and nestling (from the first appearance of young until the first young fledged). Sex of the adults was initially determined by their relative positions during copulation. However, each female of the eight intensively studied pairs had a darker breast patch than did her mate, so we were able to identify individuals at the nests by patterns of coloration.

We defined eight main activities: (1) sitting on nest; (2) incubation; (3) brooding; (4) fishing, which was considered to be from the time birds left the nest site until they returned with fish; (5) eating, which included fishing time for males since they ate at least part of their fish at foraging sites (see also Prévost 1977), whereas for females the time was precisely recorded and comprised the time females took to feed themselves and their young; (6) interaction, periods of more than 60 s spent flying near, or obviously chasing, other Ospreys or other species; (7) sitting-at-perch-near-nest; and (8) unknown.

Fishing time began with departure from the nest site and lasted until a bird returned with a fish. Although we could not be sure that males hunted during the entire period while they were away, we knew that males usually fish continuously while in these two estuaries and usually leave for nest sites whenever they catch fish; even when they eat part of the fish in the estuary, they usually take only a few minutes (Seymour, unpubl. data). In our study, males always returned to their nests from the direction of the estuaries. The duration of any absence by males who returned without a fish was scored in the "unknown time" category. Even duration of absence by birds who returned with nesting material was scored as unknown, since we could not determine precisely how much time the birds spent at that activity.

Chi-square tests were performed to determine significant differences in proportion, and the *Z*-test was used when observations were made in minutes of time (Mendenhall 1975).

RESULTS

Females in both habitats remained at, or perched near, their nests throughout the breeding season (Table 1). Flight time was minimal, involving some interactions with other Ospreys and a few hunts just before their young fledged. Females spent an unknown amount of time in gathering nesting material but this was primarily a male activity; during the nestling period significantly ($\chi^2 = 6.3$, $P < 0.01$) more sticks were brought by females (29) than males (13); this activity occupied only a small amount of female time.

Females did most (70%) of the incubating in both habitats and virtually all brooding of young. They did not leave nests until males arrived at nests to relieve them; males frequently ceased incubating while their mates were away from nests and, when this occurred, females invariably flew immediately to nests. Females spent most (84% of 65 h) of their off-nest time perched within 100 m of their nests. They were relieved by males (mean of 0.36 times/h) when males delivered fish (45%) to them or when males voluntarily flew in from nearby perches. Males incubated significantly ($Z = -12.0$, $P < 0.005$) less than usual during periods of rain (15% of observation time) and females were on nests significantly ($\chi^2 = 4.0$, df = 1, $P < 0.005$) more (87%, $n = 30$) than males when we began observations at sunrise and terminated them at sunset.

Brooding lasted until young were five- to six-weeks old and involved females sitting in the nest and covering the

TABLE 1. Duration of time (in percent hours of observation) spent at different activities by male and female Ospreys throughout the nesting period in two areas in northeastern Nova Scotia.

Site and period	Duration of observations[a]	Sitting on nest		Incubating		Brooding		Sitting at perch near nest		Hunting		Eating[b]	Interaction near nest site		Unknown	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♀	♂	♀	♂	♀
Coastal nests (A–D)																
Pre-incubation	14.5 (2)	7	86	0	0	0	0	55	1	13	3	3	0	0	25	8
Incubation	116.0 (3)	<1	<1	26	74	0	0	45	21	16	0	3	1	0	12	1
Nestling	104.8 (4)	<1	<1	0	0	1	65	35	20	60	2	12	1	1	3	0
Inland nests (E–H)																
Pre-incubation	13.8 (1)	23	79	0	0	0	0	21	14	21	0	2	0	0	35	4
Incubation	99.0 (3)	<1	<1	31	66	0	0	34	28	22	0	3	3	0	9	3
Nestling	138.7 (3)	<1	<1	0	0	0	79	45	4	51	5	11	2	1	3	1
All nests (A–H)																
Pre-incubation	28.3 (3)	18	83	0	0	0	0	39	7	17	2	2	0	0	27	7
Incubation	215.0 (6)	<1	<1	29	70	0	0	40	25	19	0	3	2	0	11	2
Nestling	243.5 (7)	<1	<1	0	0	1	73	41	11	55	4	11	1	1	3	1

[a] Presented in hours. Number of nests studied given in parentheses.
[b] No information for males.

young, presumably to shade them from the sun, to keep them dry on rainy days, and generally to assist them in thermoregulation. Females usually ate at their nests and eating time increased markedly during the nestling period because eating time then included feeding the young; only one male fed his young and this occurred twice (in 110 bouts of feeding). Females either fed each of their nestlings in sequence or, sometimes, they fed several pieces in succession to one nestling. On 10 occasions (in three different nests each containing three young), one nestling was not fed during a bout of feeding. Females fed their young until they were seven- to eight-weeks old and nestlings fed unassisted by females on only 5 of 115 fish consumed.

Males brought either whole or partial (always without heads and sometimes without viscera) fish to nests; 3 of 5 and 22 of 32 fish were partially eaten during the pre-incubation and incubation periods, respectively. Most (71 of 96) fish delivered during the nestling period were whole. More white suckers (*Catostomus commersonei*; 14 of 20 fish), the largest species of fish caught, were delivered partially consumed than whole; this is nearly statistically significant ($\chi^2 = 3.2, 0.10 > P > 0.5$). Only four whole small yellow perch (*Perca flavescens*) were delivered but significantly ($\chi^2 = 35.0$, $P < 0.001$) more winter flounders (*Pseudopleuronectes americanus*; 50 of 56), another small fish, were delivered whole than partially eaten. The numbers of whole (9) and partial (13) herring (*Alosa* spp.) that males brought to nests did not differ significantly ($\chi^2 = 0.7$, $P > 0.10$).

Males in both habitats flew much more than females during each period. The males did all of the hunting except early in the pre-incubation period and just before young fledged (Table 1); during the latter period females accounted for only 7 of 115 fish brought to nestlings. Hunting time increased sharply in both habitats during the nestling period, accounting for almost all time spent away from the nest site; mean yields increased to 0.44 fish/h (8 fish in 243.5 h) from 0.18 fish/h (38 fish in 215 h) during incubation and 0.18 fish/h (5 fish in 28.2 h) during pre-incubation. Nests were constructed and maintained primarily by males. We could not precisely determine the amount of time birds spent gathering nesting material but males brought significantly more sticks than females during both the pre-incubation ($\chi^2 = 23.1$, $P < 0.001$) and incubation ($\chi^2 = 24.1$, $P < 0.001$) periods; 26 of 27 by males during the former period and 41 of 48 during the latter. We never saw birds pick up sticks from an abundant supply on the ground. On seven occasions birds landed on the outer part of small branches and used their weight to break the branch. Similar behavior was reported by Stinson (1976). Males either placed sticks on nests or left them near nests; females invariably picked them up and arranged them on nests.

Males spent most of their non-flight time perched near their nests; perches were usually one or two specific trees that protruded above the canopy. Perching time differed little between habitats and most inter- and intraspecific interactions involved males initiating chases from perches.

Birds visited nest sites within a week of arrival on the breeding grounds and began building or restoring nests; we saw little obvious courtship activity between paired males and females. We observed copulations from 9 May (first day of observation) until 2 June; 11 copulations occurred before egg-laying began and 7 during the incubation period. Except once when a pair copulated at a regularly used perch, all copulations were on nests. Four instances of pre-copulatory behavior followed the same pattern: males sat on the rims of their nests facing away from females who were inside nests. Males partly extended their wings and lowered their heads for 5 to 7 s. They then flew, immediately turned, and then hovered over their females. Males then landed on the backs of females and remained there for 7 to 10 s.

The male and the female of one pair copulated, gathered sticks and built a large nest on a power pole, but the female did not lay eggs. Unlike pairs that did have eggs, this male rarely (3% of 73 h of observation) visited the nest and did not sit in the nest cup like an incubating bird. Similarly, this female was off her nest for much longer than other females. However, she did assume an incubating posture when in the nest cup. Neither the male nor female chased conspecifics from their nest site. Other Ospreys landed near the nest seven times but were not chased, and once an intruding Osprey landed 1 m away from the female who was eating a fish. Neither the female, who was near the nest, nor her mate, who was at the nest, reacted to the intruder.

Henny and van Velzen (1972) estimated that 5 to 10% of a healthy Osprey population should consist of non-breeding two-year old (subadult) "housekeepers" who live in close association with nests but do not lay eggs. They reported that nest building for housekeepers began at the same time as for breeding pairs, but that nests of non-breeding pairs were judged poor to average and there was no incubation behavior. The nest of the non-breeding pair

in our study was very large and well constructed, and the female spent much time in the nest cup in an incubating position. These birds may have been two-year-olds since the male had a slight cinnamon tinge on the nape, which Ospreys are said to lose at about 18 months of age (Bent 1937).

DISCUSSION

We found no significant difference in the pattern or duration of activities of birds using the two habitats during any period of the reproductive cycle. Furthermore, we noted little variation among pairs for each activity in both habitats. The time/activity budget determined in our study for adults up to the time the young leave the nest is similar to those of populations studied by Green (1976), Stinson (1978) and Levenson (1979) in widely different habitats and geographic areas.

Division of labor between the sexes was the same in birds using both habitats. A similar close parallel, with respect to roles, exists with the other studies. The major task of the male is to provide fish to the female and young. If males must conserve energy for foraging, this might explain, in part, why they spend so much time perching when not foraging.

This study was supported by the Natural Sciences and Engineering Research Council of Canada (grant No. A6217) and St. Francis Xavier University. The Nova Scotia Department of Lands and Forests provided manpower, transportation and aircraft time. Thanks are extended to Dave Longard, Dan McKenna, Murray Workman, P. C. Smith and Richard Lewis.

LITERATURE CITED

BENT, A. C. 1937. Life histories of North American birds of prey. Part 1. U.S. Natl. Mus. Bull. 167.

GREEN, R. 1976. Breeding behaviour of Ospreys *Pandion haliaetus* in Scotland. Ibis 118:475–490.

HENNY, C. J., AND W. T. VAN VELZEN. 1972. Migration patterns and wintering localities of American Ospreys. J. Wildl. Manage. 36:1133–1141.

LEVENSON, H. 1979. Time and activity budgets of Ospreys nesting in northern California. Condor 81:364–369.

MENDENHALL, W. 1975. Introduction to probability and statistics. Duxbury Press, North Scituate, MA.

PRÉVOST, Y. A. 1977. Feeding ecology of Ospreys in Antigonish County, Nova Scotia. M. Sci. thesis, Macdonald Coll. of McGill Univ., Montreal, Quebec.

PRÉVOST, Y. A., N. R. Seymour, and R. P. Bancroft. 1978. Status of the Osprey in Antigonish County, Nova Scotia. Can. Field-Nat. 92:294–297.

STINSON, C. H. 1976. The gathering of nesting material by Ospreys. Raptor Res. 19:73.

STINSON, C. H. 1978. The influence of environmental conditions on aspects of the time budgets of breeding Ospreys. Oecologia 36:127–139.

Department of Biology, Acadia University, Wolfville, Nova Scotia. Present address of first author: Department of Zoology, University of Alberta, Edmonton, Alberta. Address of second author: Department of Biology, St. Francis Xavier University, Antigonish, Nova Scotia. Address of third author: Nova Scotia Department of Lands and Forests, Antigonish, Nova Scotia. Received 29 May 1981. Final acceptance 7 May 1982.

Condor 84:441–443

THE THERMAL NEST ENVIRONMENT AND PARENTAL BEHAVIOR OF A BURROWING BIRD, THE BANK SWALLOW

JANET H. ELLIS

Avian embryos can develop only in a relatively warm and stable environment (White and Kinney 1974). Adult birds must therefore modify the environment around the egg to promote its proper development. The amount of time and energy that parent birds must devote to this activity strongly depends upon ambient temperatures around the nest. The burrow environment is thermally more stable than most nesting habitats, protecting birds from temperature extremes (White et al. 1978). However, burrow temperatures are continuously lower than the "relatively warm" environment required for avian embryonic development. Parental nest attentiveness of burrowing birds hence must reflect the low temperatures of the nesting cavity. I examine here the thermal nest environment and incubation habits used by one burrowing species, the Bank Swallow (*Riparia riparia*).

Bank Swallows are the smallest North American swallows (15 g). They nest in burrows dug in sand or gravel banks, extending 0.3–1.0 m or more into the soil (Bent 1942). Nests are constructed of loosely woven grasses and feathers. The species is circumpolar in distribution, breeding throughout the Northern Hemisphere.

METHODS

I excavated an observation pit (Beyer 1938) behind a swallow colony on a cliff that faced west-southwest near Missoula, Montana (46°52'N, 114°01'W). A cardboard cone with a small window was then placed against the nesting chamber of four burrows. Care was taken to seal the spaces around the cone to prevent drafts between the observation pit and the burrow. I kept the pit dark to minimize disturbance of the birds. Temperatures of incubation, the burrow and the outside air were measured using a portable tele-thermometer. A thermistor probe inserted into a silicone-filled Bank Swallow egg monitored incubation temperatures (Calder 1971). Each thermistor egg was substituted for one egg in each nest to keep clutch size constant. A second probe suspended above the nest in each nesting chamber measured burrow temperature. Outside air temperatures were measured by a probe located near the cliff face. All probes were calibrated with a National Bureau of Standards thermometer before and after field experiments. Temperatures were read to the nearest 0.1°C.

I began recording data 20 min after entering the observation pit, which allowed displaced birds to return to their nests. Temperatures were recorded at 5-min intervals during observation periods. It took me approximately 3.5 days to gather one 24-h day of observations. I watched birds a total of 67 h between 23 June and 7 July 1979. All temperatures used in analysis as incubation temperatures are those recorded at least 5 min after a parent bird began sitting on the nest.

RESULTS AND DISCUSSION

The number of observation hours per nest varied from 3.0 h for nest 3 to 65.3 h for nest 2 (Table 1). Eggs hatched