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EFFECTS OF HUMAN ACTIVITY ON PRODUCTIVITY OF NESTING OSPREYS

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Osprey (*Pandion haliaetus*) population declines in many parts of North America are generally attributed to the effects of chlorinated hydrocarbon residues (Henny 1977, Henny et al. 1977). Direct human activity may be an additional factor negatively impacting reproductive success of ospreys (Reese 1977, Swenson 1979 and references therein, Van Daele and Van Daele 1982). French and Koplin (1977) indicated that logging activity might adversely affect nesting success; such activity generally began after nesting commenced, causing some pairs of ospreys to abandon their nests. In contrast, French and Koplin (1977) concluded that constant highway traffic and summer recreational activity had little or no impact on osprey productivity.

Melo (1975) described an osprey nest in the Usal Creek drainage (Mendocino County, Calif.) at which ospreys were incubating eggs by 20 April and which ultimately fledged two young. Logging operations near this nest commenced during the 1st week of May and continued at an intense level, to within 30–35 m of the nest, until mid-July. On the basis of this one nest, Melo (1975) concluded that careful timber harvesting would not adversely affect productivity of ospreys nesting near such operations. In this analysis, we investigated the effects of human activity on the productivity of ospreys nesting in northwestern California during the early 1970's.

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METHODS

Osprey nests were located and checked from the ground during the last week of April 1974. A nest was "occupied" if a pair of ospreys was present and exhibited "normal" reproductive behavior (e.g., courtship feeding, nest building). Nineteen occupied nests were observed, 5 near Humboldt Bay and 4 along the Eel River in Humboldt County, and 10 in the Usal Creek drainage in Mendocino County. Each occupied nest was rechecked during mid-May, the last week of June, and during the 1st week of August. Productivity, defined as the number of young fledged at an occupied nest, was measured during the 1st week of August. An occupied nest was termed "successful" if one or more young were fledged. Descriptions of the study area and climate are available elsewhere (French and Koplin 1977, Levenson 1979).

Human activity within 0.5 km of an occupied nest was qualitatively assessed during the 1974 season and assigned to one of three activity categories: (1) no disturbance or minimal disturbance (e.g., occasional hiking during entire study); (2) relatively constant disturbance, probably present before nesting commenced (includes normal county and state highway traffic, picnicking, hiking, and other nonmotorized recreational activities); and (3) no activity observed during initial check in late April when most ospreys on occupied nests were incubating eggs, but constant and intense activity (generally logging) present from mid-May until the end of the nesting season. French (1972) collected data on productivity of and human activity at occupied nests in Del Norte, Humboldt, Mendocino, and Trinity counties, California, during the 1971 and 1972

Table 1. Productivity of ospreys nesting in northwestern California in relation to human activity.

Reproductive parameter	Activity category one[a] 1971	1972	1974	Total	Activity category two[a] 1971	1972	1974	Total	Activity category three[a] 1971	1972	1974	Total
N occupied nests	6	24	3	33	1	24	9	34	0	8	7	15
N successful nests	5	17	2	24	1	11	8	20		3	1	4
Occupied nests producing fledglings,[b] %	83	71	67	73	100	46	89	59		37	14	27
N young fledged	10	28	4	42	2	19	8	29		5	1	6
N young fledged/occupied nest	1.67	1.17	1.33	1.27	2.00	0.79	0.89	0.85		0.63	0.14	0.40
N young fledged/successful nest	2.00	1.65	2.00	1.75	2.00	1.73	1.00	1.45		1.67	1.00	1.50

[a] Activity category one = no disturbance or minimal disturbance during entire study; activity category two = relatively constant disturbance during study; activity category three = no activity observed during early part of nesting season, but constant intense activity initiated during mid-May and continuing until the end of the nesting season.
[b] Number of successful nests ÷ number of nests occupied × 100.

breeding seasons. For comparison with data collected in 1974, French's categories two and three were combined and are equivalent to our category two. His categories one and four are equivalent to our categories one and three, respectively.

The effects of a particular type of human activity upon nesting productivity did not vary among years (category one: $F = 0.5803$, df = 2,30; category two: $F = 0.8843$, df = 2,31; category three: $F = 1.2874$, df = 1,13 [no category three nests in 1971]; $P > 0.25$ for all three tests). Therefore, data from all 3 years were combined to increase sample sizes for further statistical analyses. Variances of the sample means were homogeneous (Bartlett's test, Sokal and Rohlf 1969; all occupied nests: $B_c = 0.913$, df = 2, $P > 0.50$; successful nests only: $B_c = 0.836$, df = 2, $P > 0.50$). A single-factor analysis of variance was used to test differences among the sample means, and the Student-Newman-Keuls test (SNK) was used to specify which sample means differed from others in pairwise comparisons (Sokal and Rohlf 1969).

RESULTS AND DISCUSSION

The average percent of occupied nests producing fledglings and the average number of young fledged per occupied nest declined with increasing activity levels (i.e., from category one through category three; Table 1). Differences among the mean numbers of young produced per occupied nest were significant ($F = 4.784$, df = 2,79, $P < 0.05$). Mean productivity of occupied nests in category one differed from mean productivity of occupied nests in category three ($q = 3.390$, df = 2,79, $P < 0.05$); mean productivity did not differ between categories one and two ($q = 2.221$, df = 2,79, $0.10 < P < 0.20$) or between categories two and three ($q = 2.612$, df = 2,79, $0.05 < P < 0.10$). The number of young fledged per successful nest ranged from 1.45 to 1.75 (Table 1: total), but differences among categories were not significant ($F = 0.947$, df = 2,45, $0.25 < P < 0.50$). Mean productivity of occupied nests in category one averaged 1.27 fledglings, but in category three was only 0.40 fledglings. These results indicate that after ospreys begin nesting, a substantial increase in human activity (e.g., category three activity) has a significant adverse effect upon productivity.

The mean number of young fledged per successful nest did not differ among categories ($P > 0.25$). Therefore the decline in productivity is attributable to the decline in the percent of occupied nests successfully producing fledglings; 73% of occupied nests in category one were successful, but only 27% in category three were successful (Table 1). The proximate reason for the decline is probably decreased egg hatching success, although we speculate that nest desertion may be occurring in some cases. Swenson (1979) and Van Daele and Van Daele (1982) speculated that human disturbance during incubation would keep ospreys off their nest, leading to overheating of eggs and subsequent embryonic death. Moreover, the timing of such disturbance appears to be critical. Ospreys nesting near human habitation, or initiating nesting while human activity is already ongoing, may be more tolerant of human activity (Swenson 1979, Van Daele and Van Daele 1982). In this study, ospreys responded variably to constant levels of activity begun before nesting started (category two); some pairs remained on their nests and produced fledglings, whereas others were unsuccessful. At extremely high levels of activity begun after incubation started (category three), most pairs of ospreys were unsuccessful, thereby greatly reducing total productivity.

Henny and Wight (1969) analyzed mortality rates of ospreys in eastern North America and concluded that a population of nesting ospreys should fledge 0.95–1.30 young/breeding pair/year to maintain a stable population. If these estimated requirements are applicable to osprey populations in the western United States, then any population experiencing high, prolonged levels of human activity (category three) will probably exhibit severe declines in productivity and population size.

The major form of intense human activity near osprey nests in northwestern California (and especially at Usal Creek) is logging. Productivity at Usal Creek was 0.50 in 1972 (French and Koplin 1977) and 0.60 in 1974. These rates are much lower than Henny and Wight's (1969) minimum estimate required for stability. Contrary to Melo (1975), we believe that logging initiated after nesting commences has a significant negative impact on productivity of osprey populations.

Most nests in northwestern California, outside of Usal Creek, are subject to minimal or moderate human activity (Table 1, categories one and two), primarily associated with recreation, and thus should exhibit normal or near-normal levels of productivity. The productivity in these areas ranged from 0.78 in 1974 (N = nine nests, two of which were category three nests) to 1.23 in 1971 (French and Koplin 1977). Overall productivity for 1971, 1972, and 1974 in all parts of northwestern California except for Usal Creek was 0.99 young/occupied nest. The population of ospreys nesting in northwestern California thus was relatively stable during the early 1970's, except at Usal Creek.

We concur with Henny et al. (1978) that the Usal Creek population should be monitored to further investigate the effects of logging on osprey nesting productivity. Where possible, human activity near nesting ospreys should be minimized and not initiated after ospreys have commenced nesting. Logging operations should be designed to minimize disruption of nesting ospreys, possibly by delaying operations in the area until young have fledged.

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ROOSTING HABITAT OF MERRIAM'S TURKEYS IN SOUTH-CENTRAL WASHINGTON

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Other studies indicate that roosting sites are an important component of Merriam's turkey (*Meleagris gallopavo merriami*) habitat. Boeker and Scott (1969) believed a scarcity of roost trees may be a factor limiting distribution, and Bryant and Nish (1975) partially attributed low use of one vegetative community to a lack of roost trees. In one case, disturbance of roosting sites may have caused turkey population declines (Scott and Boeker 1977).

Several authors (Hoffman 1962, 1968; Jonas 1966; Boeker and Scott 1969; Scott and Boeker 1975; Phillips 1980) have described Merriam's turkey roost sites; however, statistical analyses of roosting habitat use by Merriam's turkeys and data concerning roosting habitat in Washington are not available. Whitmore (1981) considered quantitative analysis of vegetation structure an important component of avian habitat studies. The objective of this study was to statistically evaluate roosting habitat of Merriam's turkeys in south-central Washington.

STUDY AREA

The 4,290-ha study area was located in southern Klickitat County, Washington, approximately 6 km northeast of the Klickitat River mouth. The area was characterized by gently undulating terrain dissected by steep canyons. Seventy-four percent of the study area was forested. Forest types were described as Garry oak (*Quercus garryana*), ponderosa pine (*Pi-*

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