REPRODUCTIVE SUCCESS, NEST SITE SELECTION AND MANAGEMENT OF OSPREYS AT LAKE ALMANOR, CALIFORNIA, 1969-1980

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ABSTRACT.

Reproductive success of ospreys at Lake Almanor, California during 1975-1980 was compared with results of previous surveys from 1969-1971. Nest site data were analyzed to determine factors important in nest site selection, and to determine the value of artificial platforms constructed during 1974-1978. Results showed that the number of known pairs increased, and reproduction increased from an average of 0.93 young fledged per occupied nest in 1969-1971 to 1.35 in 1975-1980. We suspect that the increase has resulted from a decrease in pesticide levels following the banning of DDT in 1972. Nest site analysis showed that osprey select tall, large diameter snags, or live trees with broken or dead tops. Platform occupancy for nesting averaged 32% of the available platform-years, indicating that platforms are a worthwhile management tool.

INTRODUCTION

Declines in osprey (pandion haliaetus) populations associated with increased pesticide levels in the environment were widely noted during the late 1950's and 1960's (Ames and Mersereau 1964, Ames 1966, Peterson 1969, Henny 1977). Most declines were documented in the eastern United States, where detailed early studies permitted comparisons of population sizes over time. In contrast, in the western U.S. little detailed historical information exists on population sizes and trends. Hence, population declines were evident only in areas where the species was completely or nearly eliminated (e.g., Southern California, Henny et al. 1978b). Less conclusive evidence of reproductive problems in many western populations has included low reproductive rates, the presence of DDT and other pesticide residues in eggs, thinning of eggshells and occurrence of addled eggs (Koplin 1971). Since the banning of DDT in the U.S. in 1972, recoveries of osprey populations have been documented in the northeastern U.S. (Spitzer and Poole 1980), Michigan (Henny 1977) and at Flathead Lake, Montana (McCarter and McCarter 1979).

The first reproductive data on ospreys at Lake Almanor was taken during 1969 to 1971 (Kahl 1971, Garber 1972). Reproductive rates were found to be at or slightly below the minimum rates determined necessary to maintain stable populations in eastern ospreys (Henny and Wight 1969). Although no pesticide analysis of birds, food or environment is available for Lake Almanor, DDT and its metabolites and eggshell thinning were found in addled eggs at nearby Eagle Lake (Garber 1972). This study also found that loss of nests and nest trees to wind had significant direct effects on osprey reproduction and may have reduced the population indirectly by decreasing the number of available nest sites. In response to these problems, Lassen National Forest began a program of artificial nest platform construction and other protective measures (Kahl 1971, 1972; Garber et al. 1974). In addition, annual monitoring of reproductive success was reinstituted in 1975.

The purposes of this paper are to: 1) report on recent reproductive success of ospreys at Lake Almanor and compare it with earlier productivity, 2) determine factors important in nest site selection and discuss their management implications, and 3) present results of the artificial platform construction program.

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STUDY AREA

Lake Almanor is a man-made reservoir located at the border of the Sierra Nevada and Cascade range in Plumas County, California at 1450 m elevation. The reservoir was created in 1914 by Pacific Gas and Electric Company, and since then has been enlarged various times. Its present size is about 11,000 ha. The lake supports an excellent fishery with a variety of game and non-game fishes (Garber 1972). The surrounding vegetation is mixed-conifer forest (Rundel et al. 1977) consisting of a mixture of (in decreasing order of abundance): white fir (Abies concolor), incense cedar (Calocedrus decurrens), ponderosa pine (Pinus ponderosa), sugar pine (P. lambertiana), Douglas-fir (Psuedotsuga menziesii) and lodgepole pine (Pinus contorta). Selective logging has occurred through most of the area, but a number of large old-growth trees and snags remain. Land ownership is divided between the U.S. Forest Service, private timber companies, Pacific Gas and Electric Co. and residential owners.

METHODS

Reproductive success was monitored from 1969 to 1971 (Kahl 1971, Garber 1972) and from 1975 to 1980. Annual monitoring consisted of an early check in May to locate occupied nests, and a late check by helicopter in early July to determine nesting success. Success values reported here for the 1975-1980 period include only those nests that were determined to be active during the early check. We excluded nests discovered during late surveys from reproductive success calculations, since we were more likely to find successful nests than unsuccessful nests which may have been abondoned by that time.

Because we did not make aerial checks of pairs during the incubation period, we could not distinguish pairs that nested unsuccessfully from "housekeeping" birds that did not attempt to nest. Hence, nesting success calculations include housekeepers as non-successful breeders. Since non-nesting birds usually comprise only a small proportion of the pairs in stable populations, the effect on reproductive values is minimal (Henny 1977). The data for 1979 are reported, but are not used in calculations because of ambiguity in the reporting procedure used for many nests during that year.

Habitat data were taken on all located nest sites during 1980. Variables recorded include: nest and nest tree height (measured by clinometer) and nest tree diameter (dbh) and tree condition (intact-top live tree, dead or broken-top live tree, snag or platform). Distances from nests to the lake in 200 m classes were determined from USGS topographic maps.

RESULTS

Population Size--Table 1 shows the number of osprey pairs recorded at Lake Almanor in each year. These values do not necessarily reflect actual population sizes, since observer effort varied between years (Kahl 1971, Garber 1972, Camarena, pers. comm.). However, we believe that due to the intensive effort involved in monitoring during 1980, greater

than 90% of the nests were located in that year. While the increase in the number of pairs recorded between 1969-1971 and 1975-1980 may not indicate a population increase, the population almost certainly has not declined.

Table 1. Nesting success of ospreys at Lake Almanor, California during 1969-1971 and 1975-1980.

Year	No. occup. nests 1/	No. succ. nests 1/	No. young produced 1/	No. succ./ no. occup.	No. young/ succ. nest	No. young/ occ. nest
1969	13	6	10	.46	1.7	0.7
1970	17	9	15	.53	1.7	0.9
1971	15	8	17	.53	2.1	1.1
Average	15.0	7.7	14.0	.51	1.83	0.93
1975	14(1)	7	12	.50	1.7	0.9
1976	22(1)	13(1)	34(3)	.59	2.6	1.6
1977	24(5)	13(2)	31(4)	.54	2.4	1.3
1978	19(7)	13(4)	29(8)	.68	2.2	1.5
1979 2/	8(9)	6(8)	13(14)	.75	2.2	1.6
1980	20(2)	12(2)	28(3)	.60	2.3	1.4
Average 3/	19.8(3.2)	11.6(1.8)	26.8(3.6)	.59	2.31	1.35

1/ Values are for nests located during early nest checks. Values in parentheses are for additional nests found late in the nesting season which are not used in calculations (see text).

2/ Low numbers reflect inadequate monitoring during this year, not actual population.

3/ Average does not include 1979 data.

Reproductive success--We follow the majority of researchers in using three major statistics to describe osprey nesting success: 1) percent of nests successful, 2) number of young fledged per successful nest, and 3) number of young fledged per occupied nest (Postupalsky 1977).

The proportion of nests that were successful (produced 1 or more fledglings) gradually increased from 1969 to 1980 (Table 1). For example, the average success of 1969-1971 nests was 50%, while in 1975-1980 success averaged 59%.

The number of young produced per successful nest showed a general, but non-significant increase over the study period. Variation is considerable between years. In 3 of the last 4 years in which reliable data are available, a stable and relatively high rate has been observed.

The number of young produced per occupied nest is the most reliable indicator of population

reproductive success (Postupalsky 1977). Results from Lake Almanor show an increasing trend over the 12-year period. Values for 1969-1971 (Kahl 1971, Garber 1972) were at the lower end of the range of 0.95-1.30 young per occupied nest determined to be necessary to maintain stable populations in the eastern U.S. (Henny and Wight 1969). These rates and other factors prompted concerns that the osprey population in this area was suffering from pesticide contamination (Garber 1972). Recent data show that reproductive rates in 1975-1980 have been at the upper end of the range determined necessary for population maintenance. If this mortality schedule applies to western ospreys, recent data suggest that the Lake Almanor population is vigorous.

Nest Habitat--All natural nests were placed on or near the top of tall trees. For 27 nests measured, nest height averaged 41 m (s.d. = 7.8 m, range = 27-56 m). Only 5 nests were placed below the top of the tree, but these were close to the top, ranging only 2-6 m lower.

Diameters of natural nest trees averaged 172 cm (s.d. = 24.8 cm; range = 76-203 cm). The majority of trees used were larger than the typical rotation size and age for timber in this area.

Nesting occurred in trees of various condition categories (Table 2). Broken and dead-top live trees were most frequently used, followed by platforms, snags and intact-top live trees. Although no data exist on availability of tree types present in the study area, our field experience indicates that large, intact-top live trees are definitely underused relative to their availability. The tops of fully live trees seldom have branch configurations that permit stable placement of a nest structure.

Table 2. Use of different tree condition types for nesting by ospreys at Lake Almanor, California during 1975-1980.

Nest tree type	No. of nests	%
Broken or dead-top live	15	38
Snag	10	25
Live	2	15
Platform	13	32
TOTAL	40	

To derive an indication of the length of time that trees in various condition classes remain suitable for osprey nesting, we attempted to locate all nest trees used during the 1969-1971 seasons. Because Kahl (1971) and Garber (1972) did not distinguish between dead-top and live-top trees within their live tree category, the following discussion only compares snags to live trees, regardless of top condition. Of 23 nest trees of known fates, 7 (30%) were still suitable for nesting, 13 (57%) were not usable due to natural conditions (either the tree fell, the top broke so that a nest could not be supported or foliage grew to obstruct the nest site) and 3 (13%) had been cut down on private land either during clearing for residential construction or as boating hazards. Notably, all 5 snags were lost over the 12 year period, while only 11 of 18 live trees were no longer suitable.

As expected, most nests were located close to the lakeshore. Of 39 nests for which distance was known, 25 (64%) were within 400 m of the shore. Only 15% were located at distances greater than 1400 m. The farthest nest from the lake was 3900 m away. No relationship was found between nest site productivity and nest distance from the lake.

Use and Success of Artificial Nesting Platforms--Nesting platforms were constructed at Lake

Almanor by the U.S. Forest Service, Pacific Gas and Electric Company and private land developers. Platform construction resulted from concern over the loss of the older snags that had been created by flooding when the surface level of the reservoir was raised. It was believed that nest site availability had declined, and this may have caused a decrease in the osprey population (Kahl 1971). Platforms were constructed by topping a large live tree at a diameter greater than 35 cm, and constructing a platform at the cut with 5 x 10 cm redwood lumber (see Yoakum et al. 1980).

Of a total of 113 available platform-years at 35 different platforms in which reproduction was monitored, 36 (32%) showed occupancy by nesting pairs. Eighteen of these attempts were successful, producing 40 fledged young. The proportion of available platforms used at Lake Almanor is similar to the 27% found at Crane Prairie Reservoir in 1974-1977 (Henny et al. 1978a).

Platforms were found to have lower productivity than natural nests (1.1 vs 1.5 young per occupied nest). However, the differences were not statistically significant and probably result from consistently poor reproductive performance by a few pairs at particular platform nest sites.

We compared used to unused platforms for a variety of variables in an attempt to determine factors important in platform selection. None of the following showed a difference between used and unused platforms that would indicate importance in selection: tree species, tree diameter and distance to water. Used platforms averaged 7 m taller than unused ones (41 vs 34 m), but this difference was not statistically significant ($t = 1.22$, $p < .15$, $n = 11$ and 23 for used and unused, respectively). Interestingly, for platforms of known ages, those built in 1974-1976 showed high occupancy (32 of 85 available platform-years) while none of the platforms built in 1978 have been occupied (20 available platforms-years). However, one late season "frustration nest" (Postupalsky 1977) did appear on a 1978 platform in 1980.

DISCUSSION

Five major factors have potential to affect population size and reproductive success of ospreys: 1) weather conditions, 2) human disturbance, 3) nest site availability, 4) food availability, and 5) pesticide levels. The likelihood of each of these factors in affecting recent increases in reproductive success of ospreys at Lake Almanor is discussed below.

Although destruction of active nests by wind was a significant source of reproductive failure at nearby Eagle Lake, wind loss occurred in only 2 of 46 nesting attempts at Lake Almanor during 1969-1970 (Kahl 1971). We found no obvious evidence of reproductive failure due to wind or other weather factors during 1975-1980. However, losses of nest trees during the non-breeding season have occurred regularly.

Hypothesized changes in human disturbance during the study period are not correlated with changes in reproductive success. Disturbance by boaters, other recreationists and housing developments has probably increased at Lake Almanor, but apparently this has not been highly detrimental to the population as a whole. Management practices such as restricting development on public land, timber sale modifications, provision of artificial platforms and public education (Kahl 1971, Garber et al. 1974), appear to be maintaining disturbance below a critical level. The possibility that birds are becoming accustomed to increased human contact needs further study.

Nest site availability was probably increased by the provision of artificial platforms. Although the availability of platforms coincides with an increase in the known number of nesting pairs, the relationship between these may be spurious. The increase in the number of young per occupied nest cannot be attributed to the availability of platforms, since the higher production has occurred at both natural nests and platforms.

Few data exist on the availability of various fish species and their use by ospreys at Lake Almanor, although some changes in relative abundances of game fish have occurred

over the study period (R. DeCoto, pers. comm.). Thus, we cannot determine whether changes in the abundance of preferred food fishes may have allowed ospreys to successfully raise more young.

No data are available on former or present pesticide levels in the local environment. Thus, we cannot evaluate the hypothesis that increased reproductive success has resulted from reductions in pesticide loadings following banning of DDT in 1972. Still, it remains the most likely explanation to us, in light of similar increases in reproductive rates in a number of areas in the U.S. (Henny 1977, McCarter and McCarter 1979, Spitzer and Poole 1980).

Regardless of the factor responsible, monitoring has shown a marked increase in reproductive success between 1969-1971 and 1975-1980. The reproductive rates of these 2 periods fall at the extremes of the Henry and Wight (1969) values, suggesting a change in population status from one on the edge of declining to one on the verge of expanding.

Analysis of natural nest trees shows that the birds prefer tall, large diameter snags or live trees with broken or dead tops. Since these trees tend to be eliminated through typical timber management practices, special prescriptions are required to maintain them in managed stands. This has been accomplished through continued implementation of the Osprey Habitat Management Plan (Kahl 1971).

One point that has emerged from nest tree condition and longevity analysis is the importance of live trees with dead and broken tops. Nesting sites in these trees are as suitable as those provided by the more widely recognized snags. However, the increased longevity of live trees makes them more dependable than snags as a nest resource.

Identification of factors important in determining osprey use of artificial platforms should help managers to choose better sites for future platform construction. While we did not completely sort out the array of factors that may have influenced platform selection, the data and our experience indicate a few obvious recommendations. First, platforms should be constructed close to (and probably within view of) the water body providing food. Also, they should be placed in a dominant tree that is easily accessible to the birds from the air. Optimal platform height for accessibility depends on the height of the surrounding vegetation. At Lake Almanor and other densely forested areas, very tall emergent trees are required. In more open habitats or areas where lower vegetation predominates, shorter nest trees are readily used (e.g., Ames 1966, Spitzer and Poole 1980).

We cannot satisfactorily explain the great difference in occupancy rates of 1974-1976 and 1978 platforms. Two hypotheses are: 1) 1978 platforms are superfluous because the population is at a carrying capacity determined by food availability, and use continues at traditional nest sites, or 2) some subtle, unknown differences in construction design or location made later platforms less suitable. Future monitoring and study may clarify the causes for this differential use.

Although we cannot be sure that they resulted in a population increase, we believe that platforms are a worthwhile management tool. Perhaps the best evidence for their value is that ospreys use a substantial number of them; they must be perceiving these as superior to natural nest tree alternatives. In addition, birds are using platforms in some areas where no other suitable nest trees exist. We recommend that for future platform construction at Lake Almanor and other areas priority be given to sites where suitable trees (or future nest trees) are lacking.

LITERATURE CITED

Ames, P.L. 1966. DDT residues in the eggs of the osprey in the northeastern United States and their relation to nesting success. J. Applied Ecol 3:87-97.

____ and G.S. Mersereau 1964. Some factors in the decline of the osprey in Connecticut. Auk 81:173-185.

Garber, D.P. 1972. Osprey nesting ecology in Lassen and Plumas Counties, California. M.S. Thesis. Calif. State Univ., Humboldt. 59 p.

_____, J.R. Koplin and J.R. Kahl 1974. Osprey management on the Lassen National Forest, California. p. 119-122 in: F.N. Hammerstrom, Jr., et al. (ed.). Proceedings of the Conference on Raptor Conservation, Rapt. Res. Rep. 2.

Henny, C.J. 1977. Research, management and status of the osprey in North America. p. 199-221 in: R.D. Chancellor (ed.). Proc. World Conf. of Birds of Prey, Int. Counc. Bird Preservation, Vienna. 442 p.

_____, J.A. Collins and W.J. Deibert 1978a. Osprey distribution, abundance and status in Western North America: II. The Oregon population. Murrelet 59:14-25.

_____, D.J. Dunaway, R.D. Mallette and J.R. Koplin 1978b. Osprey distribution, abundance and status in western North America: I. The Northern California population. Northwest Science 52:261-271.

_____ and H.M. Wight 1969. An endangered osprey population: estimates of mortality and production. Auk 86:188-198.

Kahl, J.R. 1971. Osprey habitat management plan, Lassen National Forest. USDA Forest Service, San Francisco. 38p.

____ 1972. Osprey management on the Lassen National Forest. Cal-Neva Wildlife 1972: 7-13.

Koplin, J.R. (ed.). 1971. Osprey workshop: summary of research findings and management recommendations. Cal-Neva Wildlife 1971:114-122.

McCarter, D.L. and D.S. McCarter 1979. Ten-year nesting status of ospreys at Flathead Lake, Montana. Murrelet 60:42-49.

Peterson, R.T. 1969. Population trends of Ospreys in the northeastern United States. p. 333-337 in: J.J. Hickey (ed.). Peregrine falcon populations: Their biology and decline. Univ. Wisconsin Press, Madison. 596 p.

Postupalsky, S. 1977. A critical review of problems in calculating osprey reproductive success. p. 1-12 in: J.C. Ogden (ed.). Trans. N. Amer. Osprey Res. Conf. U.S. Nat. Park Service.

Rundel, P.W., D.J. Parsons and D.T. Gordon 1977. Montane and subalpine vegetation of the Sierra Nevada and Cascade ranges. p. 559-599 in: M.G. Barbour and J. Major (eds.). Terrestrial Vegetation of California. John Wiley and Sons, Inc., New York.

Spitzer, P. and A. Poole 1980. Coastal ospreys between New York City and Boston: a decade of reproductive recovery 1969-1979. Amer. Birds 34:234-241.

Yoakum, J., W.P. Dasmann, H.R. Sanderson, C.M. Nixon and H.S. Crawford 1980. Wildlife habitat improvement techniques. p. 329-403 in: S.O. Schemnitz (ed.). Wildlife Techniques Manual, 4th Edition. Wildl. Soc. Wash., D.C.