PESTICIDES AND REPRODUCTIVE FAILURE IN THE OSPREY

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Abstract: Measurements of reproductive success of ospreys (*Pandion haliatus*) on Flathead Lake in western Montana were generally lower than comparable measurements taken by other investigators in Virginia and Florida. There is also evidence that the number of young fledged is declining approximately 30% annually, a rate similar to that found for ospreys in the northeastern United States. At this rate of decline, complete extirpation of the population is predicted by 1980 at the latest. Limited evidence suggests that pesticide contamination is responsible for the reproductive failure of these ospreys.

INTRODUCTION

There is increasing evidence that chlorinated hydrocarbon insecticides persist and cycle in our environment and, in the process of cycling, are systematically concentrated in the higher trophic levels of food chains (Hunt and Bischoff 1960; Hickey et al 1966; J. O. Keith 1966; Woodwell et al 1967). Associated with increased pesticide contamination in the higher trophic levels of aquatic eco-systems are dramatic declines in populations of fish-eating birds resulting from mortality (J. O. Keith 1966) or reproductive failure (Ames 1966; J. A. Keith 1966; Stickel et al 1966).

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Concern over earlier reports of this information as well as reports of sharply declining osprey populations in the northeastern United States (Ames and Mersereau 1964) prompted us in 1966 to begin a study on the reproductive performance of a population of ospreys in western Montana. This paper is a status report of our findings to this date.

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METHODS

Study area: The study is being conducted on Flathead Lake in Flathead and Lake Counties, Montana. The elevation of the lake is approximately 3,000 feet. The lake basin was produced by a southward extension of a continental glacier; consequently, the east and west shores are quite precipitous, and shallow areas, suitable for fishing by ospreys, exist mainly on the north and south ends of the lake.

A number of cherry orchards line the east shore of the lake. The less modified west shore is vegetated predominantly by yellow pine, *Pinus ponderosa*; Douglas fir, *Pseudotsuga menziesii*; and western larch, *Larix occidentalus*. The banks of inlet and outlet streams are vegetated primarily by black cottonwood, *Populus tricocarpa*.

Techniques: Nests were located by scanning trees along the shore while cruising 25 to 100 yards offshore in a motorboat. Occupied nests were checked for eggs and chicks by climbing the nest tree or adjacent trees and looking into the nest. Several nests were completely inaccessible during the Summer of 1968; these were checked by flying over them in an aircraft.

Samples for pesticide analysis were dried for 24 to 72 hours at 50° to 60°C, extracted with hexane, and cleaned by centrifuging in activated charcoal and filtering. Reading was on a Jarrell-Ash 27-600 electron gas chromatograph with a column 0.64 cm. by 1.2 m. on 70/80 chromasorb G DMCS. Carrier pressure was 88.5 kgm. per square cm. Temperatures were: column, 200°C; injector, 250°C; and detector, 205°C.

Eggshell thickness was measured with a Helios micrometer. Measurements were taken to the nearest 0.01 mm.

RESULTS AND DISCUSSION

All nests were found in the tops or upper branches of yellow pines and cottonwoods. Eighty-seven per cent of the nests were in dead trees.

Reproductive success

Nest utilization: The first summer (1966) was devoted to a reconnaissance of the lake. We located a total of 28 nests only 16 of which were utilized--contained adults exhibiting "normal" nesting behavior. During 1967 we resurveyed the lake and searched the mouth of Flathead River on the north end of the lake. We located an additonal eight nests for a total of 36 known nest sites. Only 16 of the 36 known nests were utilized in 1967. In 1968 we resurveyed the lake and the mouth of Flathead River, and explored the river for several miles further upstream from the lake and several miles downstream from the lake. We located an additional 10 nests for a total of 46 known nesting sites. Only 20 of the 46 known sites were utilized in 1968. Not only were proportionately fewer available nest sites being utilized during successive summers, but nest utilization on Flathead Lake was lower than nest utilization in Virginia (Tyrell 1937) or in Florida (Ogden pers. comm.) (Table 1).

Three indications, considered collectively, strongly suggest that the osprey population on Flathead Lake is declining. First, the Flathead Lake population was lower than the Virginia and Florida populations in all but one of the comparable measurements of nesting success. Secondly, the number of young fledged per utilized nest was 36% less in 1968 than in 1967 (Table 1). Finally, at the turn of the century, Siloway (1901:7) wrote that ospreys "...were common at Flathead Lake and very common at Swan Lake..." We do not consider ospreys to be 'common' at Flathead Lake, and we have no evidence at all of ospreys on nearby Swan Lake.

Causitive factors

Food resources: There are at least two indications that the present nesting population is not being influenced to any significant extent by limited food supplies. First, all broods of three and four were successfully reared; observations at these nests suggested that the parents had no apparent difficulty in providing food for the broods. Furthermore, 97% (31/32) of all nestlings found in 1967 and 1968 were successfully reared to the age of fledgings. The one nestling lost was a normally developing chick that apparently fell from its nest and drowned in water surrounding the base of the nest tree. Secondly, observations in areas where ospreys regularly fish show that a high proportion of fish are

Table 1. Measurements of nesting success of ospreys on Flathead Lake.

Location & Year	Nest Utilization	Nesting Activity	Nesting Productivity	
	% of Available Nests Utilized	% of Utilized Nests With Eggs and/or Chicks	Ave. No. Young Fledged per Utilized Nest	Ave. No. Young Fledged per Active Nest
Flathead L.:				
1966	57	--	---	---
1967	45	75	1.1	1.4
1968	44	55	0.7	1.3*
Virginia (1934)	95	87	---	---
Florida (1968)	76	89	1.2	1.4

*One normally developing egg was accidentally collected; had it hatched and fledged, the average number of young fledged per active nest would have been 1.4 also.

captured for the number of dives attempted, again indicating no shortage of food.

While we have no evidence suggesting food supply as a factor limiting the present breeding population of ospreys on Flathead Lake, we cannot rule out the possibility that it may have been contributory to the decline noticed by Saunders (1921:67) between 1900 and 1921.

Human disturbance: There are at least three conceivable ways in which humans could directly decrease nesting populations of ospreys: interference with nesting activity, shooting, and destruction of nesting sites.

We have no evidence indicating that the presence of humans interferes with nesting success. In fact, the most productive nests were those in the immediate proximity of lakeside cottages inhabited throughout much of the nesting season by very active groups of people. Many days of observation in the field turned up little evidence of shooting, and the large number of unutilized nests certainly rules out the possibility of a limited supply of nesting sites. However, cutting of snags has eliminated ospreys from portions of the lake where, according to older residents, they once nested regularly.

Pesticide contamination: At the present time we have four indications that pesticides are responsible, in part at least, for the relatively low breeding success of ospreys on Flathead Lake. First, the decrease in fledging success between 1967 and 1968 was approximately 30 per cent, a rate very similar to that found by Ames and Mersereau (1964) in the northeastern United States where Ames (1966) has presented evidence strongly implicating DDT contamination as the causitive factor. Secondly, we have detected from 37 to 59 ppm (dry-weight basis) DDT residues in three addled eggs, all containing well-developed but dead embryos. Thirdly, measurements of eggshell thickness of the three addled eggs and one developing but contaminated egg correlate inversely with content level of DDT residues (Table 2), suggesting that DDT influences shell thickness in osprey eggs

Table 2. Variation in shell thickness and levels of DDT residues in osprey eggs.

Level of contamination (dry weight-basis) DDT + DDD + DDE	Shell thickness* (in mm.)
25 ppm	0.53 ± 0.01
49 ppm	0.45 ± 0.01
59 ppm	0.42 ± 0.02
37 ppm	0.40 ± 0.01

* Measurements were of the shell and dried egg membranes. Values shown are averages of 20 measurements with 95% confident estimates of the means.

in much the same way as it influences shell thickness in peregrine falcon and gull eggs (Ratcliffe 1958, 1963, 1967; Hickey and Anderson 1968). Finally, no factor other than DDT contamination, experimentally demonstrated to delay ovulation (Jeffries 1967), can be suggested to account for the large number of utilized but inactive nests (Table 1).

Source of contamination: We have detected the same contaminants in several samples of water and fish from the lake as those found in the osprey eggs, suggesting the source of contamination is Flathead Lake. It is conceivable that adult ospreys could be contaminating their eggs with pesticides picked up from their wintering grounds. If this was the case, then it is reasonable to expect, on the basis of the large number of different pesticides now in general use, that we would have detected organochlorides in at least some of the contaminated eggs different from or in addition to those found in water and fish from Flathead Lake.

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