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Decreases in the Southern Florida Osprey Population, a Possible Result of Food Stress

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Abstract: We estimate that the Osprey population nesting in extreme south and southwest Florida was 250 pairs in 1978-1980. More Ospreys nested in Florida Bay than along the southwest Gulf of Mexico coast, including Whitewater Bay. Nearly all nests were built on natural supports, especially mangrove trees. During 8 years, 1973 to 1980, a 58% decrease occurred in the numbers of Ospreys nesting in Florida Bay. The numbers of Ospreys present in the winter nesting season in Florida Bay decreased over the same period. Compared to other populations, productivity per nest was low and nestlings were food stressed. We suggest that the population decrease may have been caused by lowered food availability.

Osprey (*Pandion haliaetus*) populations in various parts of North America decreased during the 1950's and 1960's, primarily because of pesticide contamination (Henny and Ogden 1970) and destruction of habitat (Ogden 1978). Ospreys nest throughout Florida, along lakes, rivers, and coastal areas, and are particularly common along the St. John's River in Ocala Forest, and in extreme southern Florida. Unlike other populations (Zarn 1974), Ospreys in subtropical southern Florida are considered to be non-migratory (Ogden 1977) and nest in winter and spring. Between 1968 and 1974, Ogden (1975, 1977) used aerial surveys in Florida Bay to document a major segment of the southern Florida population and used ground visits to measure nesting effort and productivity on 3 Florida Bay islands near Flamingo. He concluded that the Florida Bay osprey population was stable (Henny and Ogden 1970), and that on the 3 study islands, the number of Ospreys and percentage of successful nests remained approximately constant over 5 years (Ogden 1977).

The stated purpose of the previous study was to provide a baseline for monitoring the status of the Osprey population in Florida Bay and by extension the ecological well-being of the Florida Bay ecosystem (Ogden 1977). Ten years after the initiation of that work, we began a 3 year study to deter-

mine whether the population had indeed been stable. Concurrently Poole (1982) restudied productivity on the same 3 islands on which Ogden did his work and found the birds nesting there to be food stressed. In this paper we analyze the nesting population of Ospreys in southern Florida during 3 breeding seasons and compare our findings to those of the previous study.

METHODS

The nesting population of Ospreys in extreme southern Florida was censused by air during the breeding seasons ending in 1978, 1979, and 1980. The census area was divided into 3 regions: Florida Bay, Whitewater Bay, and the Gulf of Mexico coast (Fig. 1). Florida Bay included all islands (called keys) and the adjoining coast; Whitewater Bay included surrounding rivers, bays and lakes; the Gulf coast included the 10,000 islands and inland bays and rivers north to Everglades City. Our censuses did not include the mainline Florida Keys or the lower Atlantic coast.

We used fixed-wing aircraft to locate nest sites in January 1978, February-March 1979, and February 1980. Flights were conducted at an altitude of 60 m in a Lake amphibious aircraft. The total survey time was 15-20 h per year. For each nest site, we recorded vegetative characteristics, the condition of the nest, and the number of eggs, young, and adults present. All potential nesting areas were searched thoroughly. In the first year, the location of each nest was determined exactly and recorded on detailed maps, which were then used to relocate previously used sites during subsequent surveys. Data and nest locating maps are available from a Park Service Management Report (Bass and Kushlan 1982). We attempted to observe previously occupied sites carefully and those not reoccupied in subsequent surveys were noted. We used a helicopter to determine the number of young/successful nest in Florida Bay. Flying at an altitude of 50 m, we recorded the number of young/nest for all nests in March-April 1978 and in April 1979 and 1980. Ospreys appeared to be little affected by either the fixed-wing aircraft or the helicopter, although a couple of individuals tended to attack the helicopter. These were avoided by aerial maneuvers.

We classified nests as being occupied if eggs or young were present, if adults were at or near the nest, or if the nest was clean, lined, or otherwise showed signs of being recently constructed or rehabilitated. These are the same criteria used by Ogden in his surveys and seem to include nests that were early failures. We did not note any second-nesting attempts. Nests were classified as being unoccupied if none of these criteria was met. Our census data, then, are the number of occupied nests. We express total counts as $\bar{x} + SD$. Henny and Van Velzen (1972) calculated that 6% of the population on the breeding grounds was nonbreeding. Thus, extrapolating the number of breeding pairs from the number of occupied nests counted, as we do, will include some birds that did not actually breed that year. This will not affect the comparability of censuses in different years.

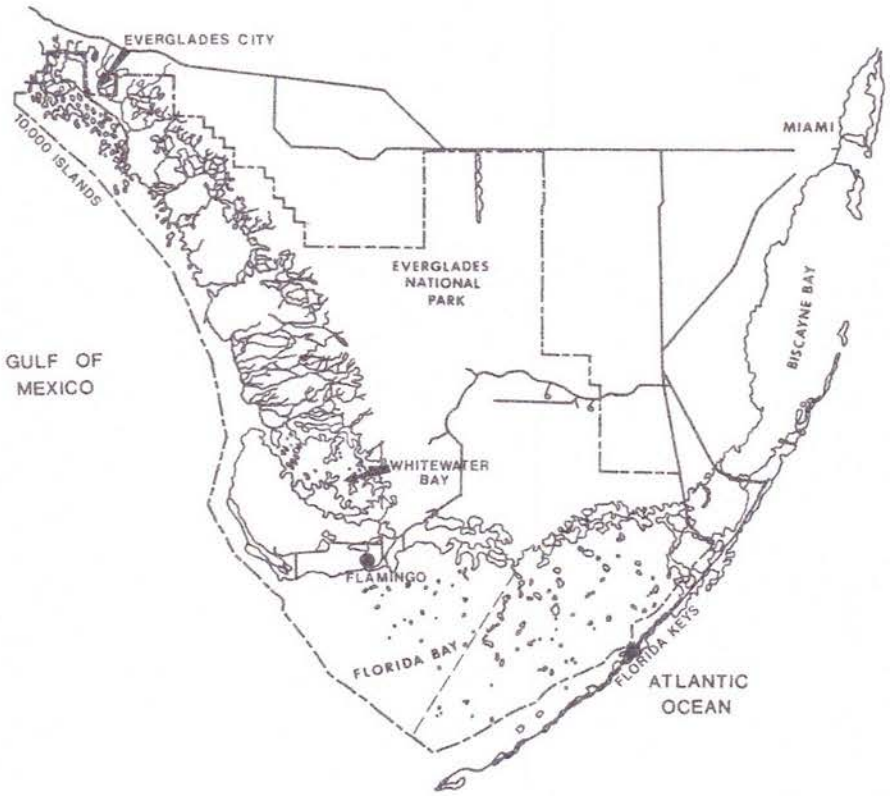

FIGURE 1. Map of south Florida. Solid circles represent Christmas Bird Count locations. Dotted line divides east and west Florida Bay.

For the 3 study islands near Flamingo, Alan Poole (pers. comm.) conducted an independent ground count of the number and location of nests in 1979. His data permitted calculation of a visibility factor for aerial censuses, which was used to adjust our aerial counts (Henny *et al.* 1974). In the present study, the visibility factor was 1.33. Although visibility factors may have varied in different parts of southern Florida or under different nest dispersal patterns, we are unable to evaluate any such differences and so report the total nesting population as our aerial census corrected by this factor.

We also analyzed population trends by making use of data obtained during Christmas counts near Flamingo (Coot Bay) and on the upper Florida Keys (Key Largo-Plantation Key). These data, published in *American Birds*, are expressed as the number of birds per party hour.

RESULTS

Nesting Population

In our 3 years of aerial censuses, we counted an average of 188 ± 16.0 osprey nests in southern Florida (Table 1). Applying the correction factor, we estimate the population to be 249 ± 21.5, or about 250 nesting pairs during 1978-1980.

More Ospreys nested in Florida Bay than in the other 2 areas censused (Table 1). During 1978-1980, we counted an average of 102 ± 7.3 nests per year in Florida Bay and estimated the population to be 136 ± 9.8 nesting pairs. Fewer nests occurred in Whitewater Bay and along the Gulf coast. Nests were more abundant and more islands were occupied in the eastern than in the western portions of Florida Bay in 1978-1980. Over the census period, 62% of the nests in Florida Bay were in the eastern part (Table 2).

The numbers of occupied nests differed among the 3 years of the study. Counted nests increased on the Gulf coast and Whitewater Bay from the first to the second year of the census, 1978 to 1979. This increase was due to more experience and time allocated in the second year. The numbers changed little between the second and third year, so no overall trend can be detected. In Florida Bay, we were well experienced with aerial censuses in the first year, and changes in numbers of nests counted were not due to differences in census technique. Our data show a decrease of 16% in the number of Osprey nests over the study period. In Florida Bay, ground censuses are available for the numbers of nests on 3 islands near Flamingo: Murray, Palm and Frank Keys (A. Poole, pers. comm.). The nesting population decreased on these islands during the 3 years study (Table 3).

Nest Sites

Osprey nests were closer together in Florida Bay than in other regions surveyed. There we found 1-7 nests per island, with some nests situated less than 50 m apart. We found nests in both dead and living trees, especially Black Mangrove (*Avicennia germinans*), Red Mangrove (*Rhizophora mangle*), and Buttonwood (*Conocarpus erectus*). Storm-killed Black Mangrove snags were also used. Ospreys often nest on man-made structures, and Henny *et al.* (1974) found 68% of the Osprey nests in Chesapeake Bay were built on artificial supports. Few suitable artificial structures were available in the study area and only 1 nest on such a site was found. Most nests were placed 1-7 m above ground and were most often on top of the supporting vegetation. We found 2 nests on the ground.

In the Whitewater Bay region, nests were located along rivers and bays, and on mangrove-covered islands. The largest concentrations of nests were near the mouth of Whitewater Bay on mangrove-lined islands, which contained over 60% of the nest sites in the region. In Whitewater Bay, nests were spaced farther apart than in Florida Bay, with the nearest nests being

TABLE 1. Number of Active Osprey Nests Counted in Aerial Censuses in Southern Florida in 3 Areas, and the Number of Nesting Pairs Estimated From These Censuses.

	Number of active nests counted				Estimated nesting pairs	
	Florida Bay	Whitewater Bay	Gulf Coast	Total	Florida Bay	Total
1968	195					
1973	222					
1978	111	16	44	171	148	227
1979	102	38	63	203	136	270
1980	93	33	63	189	124	251

TABLE 2. Comparison in the Numbers of Osprey Nests Counted, Occupied Islands, and Deserted Islands in Florida Bay During Surveys in 1968 and 1973 and During Comparable Surveys in 1978-80.

	1968	1973	Mean	1978	1979	1980	Mean
Number of nests - eastern bay	91	108	100	72	65	53	63
Number of nests - western bay	104	114	109	39	37	40	39
Number of nests counted	195	222	209	111	102	93	102
Occupied islands - eastern bay	32	34	33	33	31	28	31
Occupied islands - western bay	22	23	23	13	12	12	12
Occupied islands	54	57	56	45	44	40	43
Island deserted from previous census	–	5		17	1	5	

TABLE 3. Number of Osprey Nests and Their Productivity on Murray, Palm and Frank Keys, Florida Bay. Data for 1968-1974 are from Ogden (1975); from 1978-1980 are from A. Poole (pers. comm.).

	Active Nests				Young/Active Nest			
	Murray	Palm	Frank	Total	Murray	Palm	Frank	Total
1968	11	25	15	51	0.90	1.20	0.80	1.02
1969	10	24	15	49	1.30	0.83	0.80	0.92
1970	10	23	14	47	1.20	0.60	0.78	0.78
1971	11	25	19	55	1.18	0.76	0.57	0.78
1972	11	24	18	53	0.36	0.70	1.10	0.77
1973	9	21	13	43	0	0.09	0.46	0.16
1974	6	20	12	38	1.16	1.30	0.91	1.15
1978	7	12	5	24	0.28	0.58	0.80	0.54
1979	5	9	7	22	0.60	1.00	–	0.54
1980	4	9	4	17	0.50	0.55	1.00	0.65

more than 150 m apart. Black and Red Mangroves were the most frequently used living trees, but most (60%) of the nests in this region were in the tops of dead snags. Nests were 6-12 m above ground.

Ospreys nesting along the Gulf coast were concentrated at the mouths of rivers, and in the 10,000 islands. Only 8 nests were found around the inland bays, where they were more than 1 km apart. On the Gulf coast, Ospreys nested most commonly on the tops of Black and Red Mangrove trees 3-12 m tall. Sixty-five percent of the nests were in dead mangrove snags.

Population Trends

To examine trends in the numbers of Ospreys present during the winter nesting season, we analyzed Christmas count data from 2 locations in Florida Bay (Fig.1). The counts were centered near Flamingo in western Florida Bay and on the upper Florida Keys. The longest record, 31 years, is from Flamingo, an area that includes the islands studied by Ogden and Poole. Numbers in both of these areas were higher in the late 1960's and early 1970's than before or after. The lower population levels of the 1950's may reflect less intensive coverage during that period. The high levels of the 1960's near Flamingo, might be attributed to information provided by Ogden's study. However, the high counts occurred before Ogden began his work. As a result of these considerations, we believe the relatively high counts of the 1960's are substantiated. Of particular interest are the consistent data of the past decade, which show a decreasing trend. We conclude that a decrease in Osprey numbers from the 1960's to the 1970's is suggested by these data. Also, the low levels in the late 1950's and late 1970's may be part of a population cycle, but too few years of consistent data are available to be sure. Osprey numbers in winter along the Florida Keys show a similar trend in fluctuation over the same period of time. These data indicate that losses of Ospreys in the western bay were not compensated by increases along the upper Florida Keys. Data from Christmas counts suggest an overall decrease in the number of Ospreys has occurred in winter throughout Florida Bay and the upper Florida Keys over the past decade. Because local Ospreys begin nesting in winter and northern Ospreys winter south of Florida (Henny and Van Velzen 1972), these data reflect, at least in part, the status of the resident population.

Nesting population trends

To determine the trend of the nesting population, we compared our data from 1978-1980 to those collected by Ogden in 1968-1973. To do this, we first considered the comparability of the data bases. Ogden conducted 3 aerial censuses, in 1968, 1969, and 1973, in Florida Bay. He (pers. comm.) has indicated that only 1968 and 1973 were complete, and therefore potentially comparable to our own. Several interpretations of these censused data are

available. One account (Ogden 1970) was preliminary, not meant to be published, and expressed the census results as number of nests with associated adults (J. Ogden, pers. comm.). Ogden (1975) reported his census results to be 203 nests in 1968 and 229 nests in 1973, based on the same criteria that we used. However, Ogden (pers. comm.) has supplied us with a definitive interpretation of these censuses; 195 nests counted in 1968, and 222 nests counted in 1973. He also provided the data for each island. We used these data in our comparisons. Ogden's data were not corrected for nest visibility. As a result, we analyzed the population trend by comparing counts from aerial censuses without correction, for Florida Bay.

If we assume that our counts for Florida Bay and those of Ogden are approximately correct and comparable, they indicate an increase in nesting pairs from 1968 to 1973 followed by a decrease by 1978, which appears to be continuing (Table 1). From 1973 to 1980, the number of nests fell from 222 to 93, a 58% decrease (Table 1). Alternatively, we can compare the average counts of the 2 censuses representing status in the early 1970's and the average for the last 3 censuses representing status in the early 1980's. According to this comparison, the average number of occupied nests decreased from 209 to 102, or 51%. By either analysis, these data indicate a drastic population decrease which may be in the order of 19 nests per year or 8.6% of the 1973 population per year since 1973.

We believe this comparison and the indicated decrease to be valid because the methods, coverage, and aircraft were similar between the 2 studies and because both sets of data were based on single late winter censuses. We also believe all observers were similarly skillful, as all had considerable experience in surveying the same area for nests of eagles and colonial water birds.

To determine the nature of the decrease we examined changes in nesting status on each island and island group supporting Osprey nests in Florida Bay. We compared the average number of nests on each island in 1968 and 1973 with similar information from 1978 to 1980. The average number of Osprey nests increased on 16 islands, remained the same on 4 islands, but decreased on 48 islands, indicating a widespread loss in the nesting population.

We then asked whether particular islands were being deserted by Ospreys. Ospreys deserted 5 individual islands (9%) from 1968 to 1973 (2.3%/year), however 7 islands used in 1973 were not used in 1968, for a net gain of 2 islands occupied. Over the next 5 years, 17 islands were deserted, or 3.4%/year, and 3 were added for a net loss of 14 islands. In one year, from 1979 to 1980, Ospreys deserted 5 islands (12.5%/year), 3 in eastern Florida Bay and 2 in western Florida Bay and colonized only 1. The total number of occupied islands decreased from 57 to 40 from 1973 to 1980 and showed a continued downward trend through the 3 years of the recent study (Table 2).

To examine broad geographical change, we divided Florida Bay into east-

ern and western sections. Eastern Florida Bay is characterized by poor circulation and seasonally high salinities affected by upland runoff. Western Florida Bay experiences oceanic influences. The decrease in the number of islands occupied between the 2 studies was primarily in the western bay (23 to 12 in the west vs. 33 to 31 in the east). Similarly, the reduction in number of nests counted is not nearly as drastic in the eastern bay as in the western bay (70 nests lost vs. 37, 64% decrease vs. 37%) (Table 2). Thus, by both measures the reduction of nesting effort appears greater in the western part of the bay.

Florida Bay islands generally support 1 to 3 Osprey nests, but it is instructive to examine particular islands on which nesting effort has been more concentrated. We examined the years during the 2 survey periods having the most nests, in order to compare the most favorable seasons. We tallied islands that held more than 5 nests in 1973, the year with the largest nesting effort. Ten islands met these criteria accounting for 110 nests, nearly half (110/222) of the nests reported that year. These same islands held 36 nests in 1980. This 67% reduction is greater than the 58% decrease in the population as a whole, indicating that the reduction was to some extent concentrated on densely occupied islands. Most of the loss on densely occupied islands occurred on the 4 heavily populated islands in the western bay, near Flamingo, which lost 43 nests.

These particularly dramatic reductions included nests on the 3 heavily populated Flamingo keys of Murray, Frank, and Palm. For these islands, we are able to compare the actual number of occupied nests as published by Ogden (1975) and provided by Poole (pers. comm.) (Table 3). Over 1968-1974 an average of 48 ± 5.5 occupied nests were located on these islands. Over 1978-1980, 21 ± 2.9 nests were located there. A 56% reduction occurred in the interim. A comparison of 1973 with 1980 shows a 60% reduction. Whereas the aerial census data may be subject to survey error, these data should not, as they are based on both aerial and ground censuses.

Nesting Success

Unlike the northern, more migratory Osprey populations that nest in spring and summer, Ospreys in Everglades National Park breed in winter and spring. In Florida Bay, egg laying occurs between late November and March with most young fledging in April and May. Ogden (1978) reported that clutch sizes for Ospreys in Florida Bay were from 1 to 4 eggs. Although sizes of final clutches could not be determined from our infrequent census data, we found a similar range, 1 to 3 eggs, in the nests ($n = 105$) we censused. The mean clutch size of the Florida Bay population is lower than those further north (Poole 1982).

Where possible, we attempted to use a helicopter to count large young in nests to determine the number of young fledged/successful nest. We found

from 1-3 young fledged/successful nest, averaging 1.5 (n = 75) over 3 years in Florida Bay (1.7 (n = 29) in 1978; 1.4 (n = 32) in 1979; 1.4 (n = 14) in 1980). This average is similar to the 1.6 young/successful nest found by Ogden in 1968-1971. However, Poole (1982) found 1.1 ± 0.3 and 1.2 ± 0.4 young fledged/successful nest on Frank, Murray, and Palm Keys in 1979 and 1980. His data are more comparable to Ogden's because they are based on ground work. These data fail to account for active but unsuccessful nests. Ogden (Table 3) found an overall productivity of 0.80 Osprey/active nest during 1968-74. Poole's (pers. comm.) data were 0.54-0.65 Osprey/active nest during 1978-1980. By either measure of production, it appears that productivity was lower during the late 1970's than during the late 1960's.

Pesticides

Certain Osprey populations, beginning in the 1950's, suffered decreases because of the effects of pesticide accumulation (Ames 1966, Wiemeyer *et al.* 1975, Spitzer *et al.* 1978). These decreases were later reversed (Spitzer and Poole 1980). The most recent analysis of pesticides in Ospreys in southern Florida was conducted on eggs collected in 1971. Of organochloride pesticides tested, concentrations were found to be low (Ogden 1977).

DISCUSSION

By our best estimate, the nesting population of Ospreys in southern Florida (Florida Bay and southwest Gulf coast) was 250 pairs in the early 1980's. The population in Florida Bay was 136 pairs. Based on his study of Ospreys in Florida Bay in the late 1960's and early 1970's, Odgen had concluded that the population was stable (Henny and Ogden 1970, Ogden 1977). This does not seem to be the case. We estimate that a 58% reduction has occurred in the number of Osprey nesting in Florida Bay in the 8 years between 1973 and 1980.

To examine the cause of this population decrease, we need to consider factors that may affect Osprey numbers and productivity. These include: 1) long-term low productivity; 2) interactions with Bald Eagles (*Haliaeetus leucocephalus*); 3) shifting of nest sites; 4) pesticides; 5) disturbance; and 6) food stress. We examine each of these aspects of Osprey population biology.

Productivity in Florida Bay Ospreys is low relative to other populations. Ogden's (1975) data (Table 3) indicate an annual average productivity of 0.80 young/active nest (n = 7 yrs) in the early 1970's; Poole (pers. comm.) found 0.54-0.65 young/active nest in the late 1970's (n = 3 yrs). Although the latter data may be biased by not locating nests early in the season, correction for such early failures would reduce Poole's productivity estimate further. This comparison suggests that productivity may have decreased during the period between studies.

Based on his first 5 years of data during which he found production of 0.84

young/active nest, Ogden (1977) concluded that Ospreys were "maintaining stable numbers in spite of the fact that productivity...is less than the 0.95-1.30 young per active nest calculated by Henny and Wight (1969)" to be required for population stability. Spitzer (Spitzer and Poole 1980) has calculated that 0.79 young/active nest were required to balance mortality and maintain populations in the northeastern United States. In that area productivity from 1975 to 1979 averaged 1.86 young/successful nest and 1.08 young/active nest, much higher than either set of Florida Bay data. Thus, productivity in Florida Bay has been close to or less than that theoretically required for stability of northeastern Osprey populations. Both Ogden (1977) and Poole (pers. comm.) believed such production is adequate for stabilizing the Florida Bay population because if the birds do not migrate they would sustain lower post-fledging mortality than northern birds. However, no analysis of survivorship or migratory status has been made to quantify the exact productivity required for population stability in Florida Bay. It would seem that the productivity found by Ogden and Poole has not in itself resulted in population stability in Florida Bay, as the population has decreased in recent years.

Ogden (1975) concluded that low productivity in Florida Bay Ospreys can be caused by the interference from Bald Eagles. He found that establishment of an eagle nest caused a reduction in nesting success and nest site relocation in neighboring Ospreys on 1 island (Murray Key) in 1 year (1972). To show this, he contrasted nesting success on this island with its average and with that on other nearby islands but did not analyze his data statistically. As a result, it is necessary to reanalyze Ogden's (1975) data. To do so, we take the "average" production of young/active nest to be the mean of all years of the study other than the one compared. Ogden (pers. comm.) prefers also to eliminate data from 1973, during which he believes production was low from local food shortages caused by weather conditions. Following these criteria, we find that production for the five years, 1968-1971 and 1974, was 1.1 ± 0.13 for Murray, 0.9 ± 0.27 for Palm, and 0.8 ± 0.11 for Frank Keys. The 1972 production was below average for Murray and Palm Keys and above average for Frank Key. Statistically this analysis confirms Ogden's conclusion that Murray Key had lower production ($t = 5.41$, $p < .05$, one tail) in 1972 than in other years ($n = 5$). Frank Key ($t = 2.70$, $p > .05$, two tail) and Palm Key ($t = 0.68$, $p > 0.05$), two tail) were not different than average ($n = 5$). Thus a statistical analysis of Ogden's data, if 1973 is excluded from the average, supports his conclusions about the effects of eagles on Osprey production on Murray Key in 1972.

It is also useful to reconsider Ogden's (1975) analysis of how eagles affected the relocation of nest sites by Ospreys. He found that only 38% of Osprey nest sites occupied on Murray Key in 1971 were occupied in 1972, a larger turnover than in other years for that key. However, his analyses for Frank and Palm Keys in 1972 were not provided. Ogden (pers. comm.) has

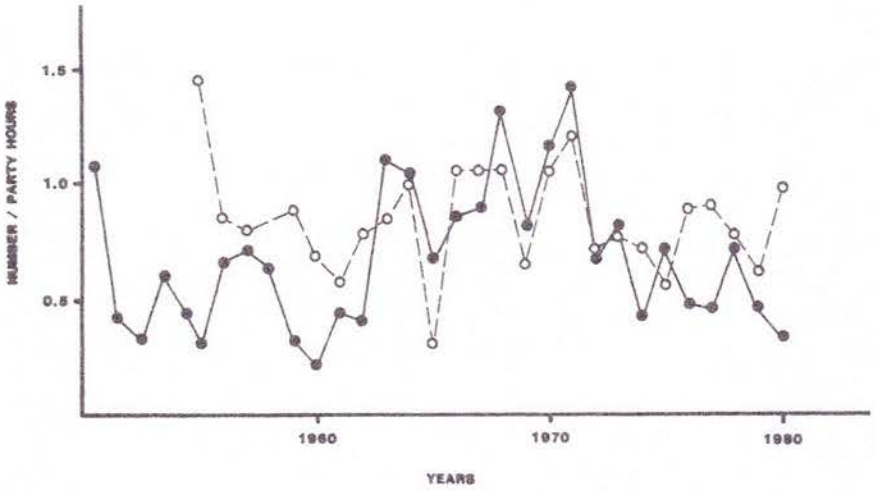

FIGURE 2. Trend of Osprey numbers in Florida Bay as revealed by Christmas Count data. The population is indexed by the number counted per party hour. Solid line is from the Coot Bay Christmas Count near Flamingo, Florida. The dotted line is from the Key Largo-Plantation Key Christmas Count on the upper Florida Keys.

provided this information. On Palm Key 19 of 24 nests (79%) were again active in 1972, on Frank Key 13 of 18 (72%) were active in 1972. These data confirm his proposition that a high number of nests moved location on Murray Key between 1971 and 1972.

Thus our reanalysis agrees with Ogden's (1975) conclusions that Bald Eagles can affect Osprey nesting in Florida Bay. However, for Ospreys to have been markedly affected during this study period, many shifts of eagle nests would have had to occur. However, no movement of eagle nesting sites occurred on the 3 study islands and no extensive change in eagle nest numbers or locations has taken place within Florida Bay during the study (W.B. Robertson, Jr., pers. comm.). Thus, we can conclude that interactions of nesting Ospreys with nesting eagles, although potentially disruptive, were not the cause of the widespread population reductions in Osprey numbers we have found in Florida Bay. Direct predation of nesting Ospreys by eagles does not seem to be common (Ogden 1975, Poole 1982) nor is persistent aggression on adults, as Poole (1982) found little aggression in 150 h of observations.

Another explanation for the Osprey population reduction is that many individuals may have shifted their nesting sites. One place where shifts would have occurred is on the islands near Flamingo. It is possible that the densities of Ospreys found during Ogden's study on the 3 islands near Flamingo were unusually high. If so, the reduction to current levels may have been a relaxation to densities comparable to other Florida Bay islands. However, Ospreys

characteristically nest in high densities (Spitzer and Poole 1980), and so the situation on the Flamingo keys was not abnormal. Furthermore, reductions we found occurred throughout the bay, even on islands not as densely populated as the Flamingo keys. Other shifts may have occurred, such as to the Gulf coast or mainline Florida Keys. Although we lack earlier census information, large-scale shifts to the Gulf coast are unlikely, as the number of Ospreys there is not enough to account for the loss in Florida Bay. Ospreys do appear to nest more frequently on artificial structures on the mainline Florida Keys than previously (J. Ogden, pers. comm.). These could have shifted from the bay. Again, we do not believe the number of Ospreys in the northern keys is sufficient to account for the loss. Furthermore, the Christmas bird count analysis does not indicate a compensatory shift has taken place to the upper keys where populations also seem to have decreased since the late 1960's (Fig. 2).

Pesticides have drastically affected the productivity of Ospreys in many areas (Spitzer and Poole 1980). However, in the latest study in 1971, pesticide contamination was not excessive in Florida Bay Ospreys (Ogden 1971). More current information on pesticide levels is needed to completely discount their impact. However, recent studies of other fish-eating predators in Florida Bay, such as American Crocodiles (*Crocodylus acutus*) (Hall *et al.* 1979) and Brown Pelicans (*Pelecanus occidentalis*) (Kushlan and Frohring, in prep.) showed relatively low levels of contamination in these species.

Human disturbance has been considered to be a factor influencing nesting success in Ospreys (Reese 1977, Swenson 1979). This does not seem to be a primary consideration for Ospreys nesting in Florida Bay, which is in Everglades National Park (Fig. 1). Ospreys are protected from human disturbance because entry on most islands is prohibited, and birds nesting near island edges appear to be undisturbed by nearby boating activity. Poole (1981) considered the effects of intrusive disturbance on Florida Bay Ospreys and concluded that his short-term nest visit had a negligible impact on Osprey reproduction.

The most likely explanation for the population decrease in Florida Bay Ospreys is a reduction in the abundance or availability of food, especially during nesting. Poole (1979, 1982) has studied the relation of nesting success to food delivery in Ospreys nesting near Flamingo. He found that chicks in Florida Bay nests received less food per day than those in New York. Furthermore, he found that greater nestling mortality coincided with a reduction in food delivery, which resulted in nestling starvation. As a result of these observations, it appears that the current low productivity of ospreys in Florida Bay is due to food stress. Because Florida Bay Ospreys, which nest in the winter, have fewer hunting hours available to them than do more northern birds nesting in summer (Poole 1982), even small reductions in the abundance or availability of prey in Florida Bay may have a drastic impact on nestling growth

rates and survival. If the Florida Bay Osprey population is currently experiencing food stress leading to low productivity and the level of productivity has decreased over the past decade, it seems likely that the availability of food resources has ultimately controlled population productivity through that period. We hypothesize that the reduction in population size was also caused by lowered food availability.

Ogden (1977) conducted his study "to establish Ospreys as an indicator species for measuring the ecological well-being of the Florida Bay estuarine ecosystem." Although it has not been conclusively established that Ospreys are suitable indicators of ecosystem processes, this possibility raises questions as to the present viability of their support system. Such concern is furthered by concurrent decreases in the Brown Pelican in Florida Bay (Kushlan and Frohring in prep.). On the other hand, productivity and numbers of Bald Eagles have remained stable in Florida Bay over the same period (W. Robertson, Jr., pers. comm.). The effects of environmental conditions on the Osprey population need to be studied (Bass and Kushlan 1982), especially its food supply, feeding conditions, production, post-fledging survival, and migration. Nonetheless, it appears that the most likely reason for the population decrease is reduced productivity caused by lowered food supplies.

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