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Osprey (*Pandion haliaetus*) Nest Success in Central Chesapeake Bay During 1975–1980

Jan G. Reese

P.O. Box 298, St. Michaels, Maryland 21663; reesejan@ymail.com

Abstract: Presented here are 1975–1980 unpublished results from long-term Osprey, *Pandion haliaetus*, nest success studies begun in 1963 in central Chesapeake Bay. In the primary 552 km² study area, the mean number of active nests was 15% higher than the published 1970–1974 mean, and 46% higher than the published 1963–1969 mean, while mean accessible active nests was 33% and 91% higher, respectively. Higher average values over previous periods also occurred in accessible active nests with eggs (31%, 68%), accessible active nests with nestlings (43%, 100%), and accessible active nests with fledglings (40%, 99%). In 1975–1978, a larger percentage of eggs hatched (52%) than in 1970–1974 (48%) and 1963–1969 (44%) while in 1975–1980, the percentage of nestlings fledged (86%) remained near previous years (85–86%). The average number fledged per accessible active nest rose from 0.96 in 1963–1969 to 1.14 in 1970–1974 and 1.17 in 1975–1980. This suggests more eggs hatched than in previous years despite 44% in 1975–1978 being addled, cracked, broken, punctured, crushed, found as fragments in the nest, or disappeared between nest visits. Nests visited only twice annually in similar-sized north and south adjoining reference areas also showed improved average number fledged per accessible active nest compared to previous years. Results from these studies suggested an increasing number of active nests, plus the average number fledged per accessible active nest, improving since the mid-1960s with almost every year being within the estimated 0.95–1.30 range necessary for population stability.

Keywords: Chesapeake Bay, nest success, Osprey, *Pandion haliaetus*, 1970s

Studies reporting poor reproductive success in decreasing populations of Peregrine Falcon, *Falco peregrinus,* in North America and Great Britain (Ratcliffe 1958, 1963; Hickey 1969), plus Bald Eagle, *Haliaeetus leucocephalus* (Broley 1958), and Osprey, *Pandion haliaetus* (Ames and Mersereau 1964), in the United States in the late 1950s–early 1960s first brought public attention to a problem within some raptor populations. Environmental contaminants such as widely used organochlorine compounds were considered as one of the factors responsible for the declines, with the inhibition of carbonic anhydrase responsible for causing egg shell thinning subsequently affecting reproduction (Peakall 1967, 1969; Ratcliffe 1967; Hickey and Anderson 1968). Awareness of the contaminant problem was amplified in the early 1960s with publication of the widely popular book *Silent Spring* (Carson 1962) which by the late-1960s stimulated notable government and private funding for wildlife contaminant studies. Many bird studies early in the "pesticide era" were confounded trying to gauge contaminant effects on reproductive success since no fundamental baseline reproductive data existed. Species at the top of the food chain such as fish-eating cormorants, pelicans, herons, and gulls were of particular interest for study since many organochlorine pesticides bio-magnify in the food chain. Fish-eating Osprey and Bald Eagle raptors were also of interest, but were among the species lacking reproductive data related to historically stable populations.

The reported decline in some raptor populations plus the lack of baseline reproductive data coupled with plentiful nesting Osprey along Knapp's Narrows and around Tilghman's Island in Chesapeake Bay where I resided provided opportunity to determine the reproductive success of a local nesting population. I informally monitored Osprey nesting near my home starting in 1961, and established an official study of reproductive success and related factors within a vastly expanded area in 1963. Similar Osprey studies (Dunstan 1968, Singer 1974, United States Forest Service 1974, Prevost et al. 1978, MacCarter and MacCarter 1979, Swenson 1979, Spitzer and Poole 1980, Greene and Freedman 1986) provided valuable baseline data for nesting populations in other parts of North America. However, cuts in government and private funds starting in the mid-1970s reduced these and other "pesticide era" studies by the late 1970s. I continued the central Chesapeake Bay Osprey study annually through the 1980 season with results published for 1963–1969 (Reese 1970) and 1970–1974 (Reese 1977), but not for 1975–1980.

Frequent nest visits throughout the season were of concern for possible negative effects on reproductive success in the study area. For comparison, in 1966, I established a north adjoining reference area with limited seasonal nest visits and published the results for 1966–1974 (Reese 1975). In 1968, I established a south adjoining reference area and published those results for 1968–1971 and 1972–1979 (Reese 1972, 1981).

The continuous 13 to 18 years of reproductive data and factors effecting success may be unprecedented and of considerable value to future Osprey studies. Therefore, the purpose of this paper is to document the unpublished 40–45-year-old results from these long-term studies and put them in context of circumstances during that period. No attempt is made here to put the results in context of years subsequent to that period in time, since the results were unpublished portions of on-going studies at that time, not new independent studies.

METHODS

The primary study area of 552 km^2 (213 mi^2) is located between eastern Chesapeake Bay major tidewater tributaries of Eastern Bay and Choptank River. The northern reference area includes Eastern Bay, Crab Alley Bay, Prospect Bay, Kent Narrows and its Chester River entrance area, and Wye River. The southern reference area in Choptank River includes from the Town of Choptank west to the mouth of Island Creek on the north side and to Cooks Point on the south side. All of these areas are characterized by coves, bays, and smaller tributaries indenting the upland.

In all areas, offshore structures like hunting blinds, marine navigation markers, and artificial pole/platforms provided sites for most nests and were accessible for content viewing from a small boat. Nest sites damaged or destroyed by winter storms or ice in the primary study area were reinforced or replaced if possible with artificial nest platforms early in the following nesting season, but not in the reference areas. Nest sites were visited once every 12–15 days throughout the nesting season, but only twice per year in the reference areas, i.e., early-May to locate active nests and late-June to determine the number fledged in accessible active nests. Active sites in the primary study area included those with an adult pair present with a nest on four consecutive visits or a nest with eggs. A map showing the boundary and coordinates of the primary study area, more nest site detail, and data collection methods is given in Reese (1970, 1977). The north and the south adjoining reference areas, habitat, types of nest sites, and methodologies used are described, mapped, and noted respectively in Reese (1975) and Reese (1972, 1981).

Changes between year and active nests were compared using a linear regression. The average number fledged per accessible active nest between the study area and north reference area was compared using Students t-tests. Tests for normality and equal variances were conducted beforehand using a Shapiro-Wilk and a constant variance test, respectively. When the criteria for these tests were not satisfied, a non-parametric test (Mann-Whitney U) was used. Tests conducted between year groups were conducted using a One-Way Analysis of Variance (one-way ANOVA) assuming equal variances and normal distribution of the data. Presented here are the means and standard error of the means. Pairwise comparisons were done using the Holm-Sidak method. All statistical tests were conducted using SigmaPlot (Systat Software, Chicago, IL).

RESULTS

In the primary study area during 1975–1980, 91% (n = 860) of the active nests (n = 950) were accessible for study, 93% (n = 802) of the accessible nests contained eggs, 68% (n = 582) contained nestlings, and 61% (n = 528) contained fledglings (Table 1). Observed eggs in 1975–1978 (1979–1980 are excluded due to fewer nest visits during the egg period than in 1975–1978) totaled 1,497 with 52% (n = 778) hatching and 42% (n = 625) fledging, while 86% of the nestlings fledged in 1975–1980. Eggs found addled (n = 112), cracked or broken (n = 9), punctured or crushed (n = 22), as fragments in the nest (n = 205), or disappearing between nest visits (n = 352) comprised 91% of the losses in 1975–1980 while young found dead in (n = 35) and outside (n = 7) the nest, in nest sites that collapsed (n = 15), and disappeared between nest visits (n = 103) accounted for 94% of nestlings lost (Table 2). In 1975–1980, the average number fledged per nest producing fledglings was 1.9 with 1.17 average number fledged per accessible active nest (Table 1).

Table 1. Reproductive success of accessible active Osprey nests in the primary study area, 1975–1980. () = %

	1975	**1976**	**1977**	**1978**	**1979**	**1980**	**Total***	**Mean***
Total active nests found	149	150	148	156	170	177	950	158
Accessible active nests	128 (86)	136 (91)	131 (89)	143 (92)	157 (92)	165 (93)	860 (91)	143
Accessible nests with eggs	121 (95)	129 (95)	129 (98)	141 (99)	147 (94)	135 (82)	802 (93)	134
Accessible nests with nestlings	85 (66)	89 (65)	103 (79)	99 (69)	92 (59)	114 (69)	582 (68)	97
Accessible nests with fledglings	81 (63)	81 (60)	80 (61)	84 (59)	88 (56)	114 (69)	528 (61)	88
Total eggs known	371	379	368	379	186	268	1497	374
Eggs per nest with eggs	3.1	2.9	2.9	2.7	1.3	2.0		2.9
Eggs hatching	178 (48)	196 (52)	209 (57)	195 (51)	169 (91)	231 (86)	778 (52)	195
Eggs fledging	162 (44)	154 (41)	158 (43)	151 (40)	153 (82)	230 (86)	625 (42)	156
Percent of nestlings fledged	(91)	(79)	(76)	(77)	(91)	(100)	(86)	
Average number fledged per nest producing fledglings	2.0	1.9	2.0	1.8	1.7	2.0		1.9
Average number fledged per accessible active nest	1.27	1.13	1.21	1.06	0.97	1.39		1.17

* Egg values for 1979 and 1980 (inset box) are not included in the 1975–1980 "Total" or "Mean" values due to constraints on nest visits during the egg period in those years. Therefore, the data are not directly comparable to previous years with frequent nest visits.

Table 2. Causes of egg (E) and nestling (N) loss in accessible active Osprey nests in the primary study area, 1975–1980.

	1975		1976		1977		1978		1979		1980		Total	
	E	**N**	**E**	**N**	**E**	**N**	**E**	**N**	**E**	**N**	**E**	**N**	**E**	**N**
Disappeared between nest visits	70	14	92	19	63	29	107	34	3	7	17		352	103
Found as fragments in nest	74		45		37		41		5		3		205	
Cracked or broken	5								3		1		9	
Punctured or crushed	3		9		7		1		1		1		22	
No contents											2		2	
Addled	25		30		22		23		3		9		112	
Abandon			1						2				3	
Buried in nest material	6				2		2						10	
Beneath plastic bag used as nest material							1						1	
Found outside or beneath nest			1		3		1				3		8	
Predator	5		2		8		2						17	
Wind and/or wave action	1												1	
Destroyed by people					9	1					1		10	1
Found dead in nest				15		16				4				35
Found dead outside nest		1		2				3				1		7
Rain exposure fatality		1												1
Found tangled in monofilament fishing line				3										3
Female cannibalism								1						1
Deformed nestling collected for analysis				1						3				4
Nest site collapsed	4		3	2	8	5	6	6		2			21	15
Totals	**193**	**16**	**183**	**42**	**159**	**51**	**184**	**44**	**17**	**16**	**37**	**1**	**773**	**170**

In the northern reference area in Eastern Bay during 1975–1980, 75% (n = 175) of the active nests (n = 234) were accessible, 83% (n = 146) of accessible nests contained eggs, 61% (n = 107) contained nestlings, and 57% (n = 99) contained fledglings (Table 3). Observed eggs in 1975–1978 (1979–1980 are excluded due to fewer nest visits during the egg period than in 1975–1978) totaled 243 with 56% (n = 136) hatching and 51% (n = 125) fledging, while 92% of the nestlings fledged in 1975–1980. Eggs addled (n = 9), cracked or broken (n = 2), found as fragments in the nest (n = 33), and disappearing between nest visits (n = 57) constituted 89% of the losses (Table 4). Young found dead in (n = 3) or out (n = 2) of the nest and disappeared between nest visits (n = 7) accounted for 75% of the nestlings lost. The average number fledged per nest producing fledglings was 2.1 with 1.15 average number fledged per accessible active nest (Table 3).

Table 3. Success of accessible active Osprey nests in the adjoining north reference area in Eastern Bay, 1975–1980. () = %.

	1975	**1976**	**1977**	**1978**	**1979**	**1980**	**Total***	**Mean***
Total active nests found	37	33	35	34	45	50	234	39
Accessible active nests	29 (78)	27 (82)	23 (66)	23 (68)	36 (80)	37 (74)	175 (75)	29
Accessible nests with eggs	27 (93)	25 (93)	20 (87)	21 (91)	29 (81)	24 (65)	146 (83)	24
Accessible nests with nestlings	18 (62)	18 (67)	13 (57)	12 (52)	23 (64)	23 (62)	107 (61)	18
Accessible nests with fledglings	17 (59)	16 (59)	12 (52)	12 (52)	20 (56)	22 (59)	99 (57)	17
Total eggs known	66	68	57	52	41	43	243	61
Eggs per nest with eggs	2.4	2.7	2.9	2.5	1.4	1.8		2.6
Eggs hatching	37 (56)	40 (59)	32 (56)	27 (52)	36 (88)	42 (98)	136 (56)	34
Eggs fledging	35 (53)	35 (51)	29 (51)	26 (50)	33 (80)	40 (93)	125 (51)	31
Percent of nestlings fledged	(95)	(88)	(91)	(96)	(92)	(95)	(92)	
Average number fledged per nest producing fledglings	2.1	2.2	2.4	2.2	1.7	1.8		2.1
Average number fledged per accessible active nest	1.21	1.30	1.26	1.13	0.92	1.08		1.15

* Egg values for 1979 and 1980 (inset box) are not included in 1975–1980 “Total” or “Mean” values since a single nest visit late in the egg period missed detecting most eggs. Nests were visited during the early egg period in 1975–1978.

Table 4. Causes of egg (E) and nestling (N) loss in accessible active Osprey nests in the adjoining north reference area in Eastern Bay, 1975–1980.

	1975		**1976**		**1977**		**1978**		**1979**		**1980**		**Total**	
	E	**N**	**E**	**N**	**E**	**N**	**E**	**N**	**E**	**N**	**E**	**N**	**E**	**N**
Disappeared between nest visits	11	1	21	5	10		12		3	1			57	7
Found as fragments in nest	17				7		8		1				33	
Cracked or broken			1								1		2	
Addled	1		4		1		2		1				9	
Buried in nest material							3						3	
Found outside or beneath nest			2										2	
Predator					3								3	
Found dead in nest										2		1		3
Found dead outside nest		1						1						2
Nest site collapsed					4							1	4	1
Nestlings stolen for pets						3								3
Totals	**29**	**2**	**28**	**5**	**25**	**3**	**25**	**1**	**5**	**3**	**1**	**2**	**113**	**16**

The number of active nests in the study area increased significantly from 1975 to 1980, but not in the north reference area (study area: $R^2 = 0.82$, p=0.013; reference area: $R^2 = 0.60$, p=0.07, Figure 1). Comparing the 1975–1980 productivity between the study area and north reference area finds there was no difference in the average number of fledged per accessible active nest (p=0.15).

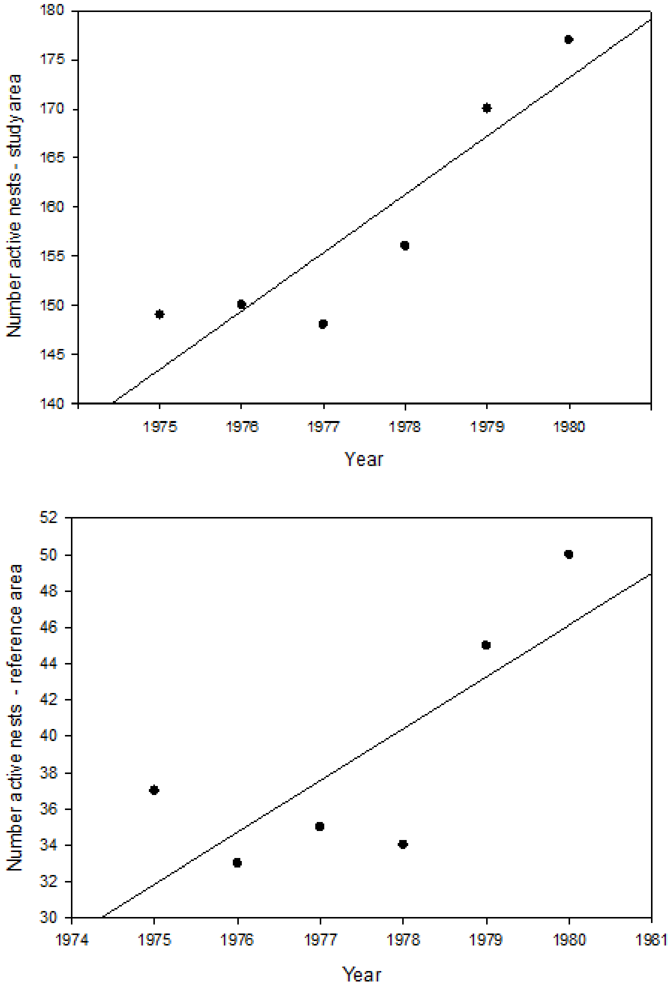

Figure 1. Number of active nests during 1975–1980 in the study area (top) and north reference area (bottom). Study area: ($R^2 = 0.82$, slope = -11593.667 + (5.943 * year), p=0.013); north reference area: ($R^2 = 0.60$, slope 1969.307 + (0.210 * year), p=0.07).

Regarding the southern reference area, the 1968–1971 results were published in Reese (1972) and the 1972–1979 results were published in Reese (1981). Only the 1980 results were previously not published and are summarized here. In 1980, the adjoining southern reference area in Choptank River had 41 active nests with 40 (98%) accessible. A total of 27 (68%) accessible nests contained eggs, 25 (63%) contained nestlings, and 24 (60%) contained fledglings. A total of 57 eggs were observed with 53 (93%) hatching and 52 (91%) fledgling, while 98% of the nestlings fledged. Causes of egg and nestling losses included four addled eggs and one nestling in a nest site that collapsed. The average number fledged per nest producing fledglings was 2.2 with 1.30 average number fledged per accessible active nest.

ANALYSES

Comparing 1975–1980 data in Table 1 with those collected from the study area in previous years, the mean number of active nests was 15% higher than the 1970–1974 mean (Reese 1977), and 46% higher than the 1963–1969 mean (Reese 1970), while the mean number of accessible active nests was 33% and 91% higher, respectively. The mean numbers were also higher for accessible active nests with eggs (31%, 68%), accessible active nests with nestlings (43%, 100%), and accessible active nests with fledglings (40%, 99%). The comparison data is not presented here since all comparisons have a p=0.001. There was no difference between periods in the percent of accessible nests with eggs (p=0.43); however, there was a difference in the percent with nestlings (mean % 54±3.7, 63±2.1, 68±2.7; p=0.015) and fledglings (mean % 50±3.7, 58±2.9, 61±1.8; p=0.036), for the periods 1963–1969 [Reese 1970], 1970–1974 [Reese 1977], and 1975–1980, respectively).

There was no difference in the percent of eggs hatching (p=0.28) and eggs fledging (p=0.87) between time periods since 1963, while the percent of nestlings fledged (86.4±1.8%) remained near previous periods (85.6±2.6% in 1970–1974 [Reese 1977], 85.4±1.9% in 1963–1969 [Reese 1970], p=0.91). Similarly, the average number fledged per nest producing fledglings (1.9) remained the same as in previous periods (p=0.97). There was also no difference between periods in the average number fledged per accessible active nest despite an annual increase over the previous period, i.e., 0.94±0.06 in 1963–1969 (Reese 1970), 1.13±0.09 in 1970–1974 (Reese 1977), and 1.17±0.06 in 1975–1980 (p=0.062).

In the northern reference area, there was no difference when comparing 1975–1980 with 1966–1974 (Reese 1975) for the average number fledged per nest producing fledglings (p=0.55) and the average number fledged per accessible active nest (p=0.07).

DISCUSSION

A long-term study of Osprey nest success within a specific area in central Chesapeake Bay began in 1963 and continued through 1980 with the 1975–1980 average number fledged per accessible active nest 1.17 despite 44% of the 1975–1980 known eggs (n = 1497) lost to addled, cracked, broken, punctured, crushed, found as fragments in the nest, or disappearing between nest visits (n = 654). A northern reference area of comparable-size showed a similar average number fledged per accessible active nest (1.15) in 1975–1980, while 1.30 fledged in a similar-sized southern reference area in 1980.

Study area increases over previous periods in the number of nests, plus the percent of nests with eggs, nests with nestlings, and nests with fledglings suggest rates of return and nest success has improved over previous periods of published study. Structural maintenance and/or replacement of damaged nest sites plus erection of new artificial nest structures may have contributed to retaining previous nesting pairs and provided for new pairs attracted to the area.

Constraints in the need and support for the study curtailed the 12–15-day nest visits in 1979–1980. With fewer nest visits came failure to detect most clutch sizes, disposition, and losses as in previous years of study. Thus, egg data for those two years is not directly comparable to that of previous years. Regardless, the 1975–1978 percent of eggs hatching (52%) was greater than previous periods (48% in 1970–1974 [Reese 1977] and 44% in 1963–1969 [Reese 1970]), despite 44% being addled, cracked, broken, punctured, crushed, found as fragments in the nest, or disappeared between nest visits (Table 2). Continuous improvement in the percent of eggs hatching during the 18 years (1963–1980) of nest monitoring suggest bans in the 1970s on organochlorine compounds use may be leading to declining residues of parent compounds of these pesticides in the environment, thus lessening their suppressive effect on female Osprey physiology, egg viability, and reproductive nest success. Increasing hatchability may be the most important factor contributing to the observed improvement in nest success.

Each period, the percent of nestlings fledged was 85–86%, while the average number fledged per nest producing fledglings (brood size) remained at 1.9 indicating little to no change in the rate of nestling mortality through the 18 years. However, seasonal mortality may vary, such as finding 31 young dead in the nest from unidentified causes in 1976–1977 (Table 2), plus adverse weather conditions in 1977.

The average number fledged per accessible active nest increased over the previous period throughout the 18 years. This suggests more eggs hatched in accessible active nests in the mid–late 1970s than in previous years of study, potentially boosting population nest success. Osprey studies in tidewater areas ranging from the mouth of Chesapeake Bay north to Massachusetts Bay also found improving nest success in the mid–late 1970s (Henny et al. 1977, Spitzer and Poole 1980, Poole and Spitzer 1983). It also supports theories implicating organochlorine toxicity in egg loss during the laying and incubation period of some raptors and fish-eating birds. It was expected that bans on use of those compounds in the United States during the early–mid 1970s, with their subsequent decline in the environment, would contribute to improved nest success of affected species. Observed ongoing egg loss, however suggests it may take many years for the contaminant effects to abate significantly.

In the absence of actual reproductive data prior to the appearance of organochlorines in the mid-1940s, life tables have been created from New York and New Jersey recoveries of Ospreys banded as nestlings in 1926–1961 (Henny and Wight 1969). Assuming the species begins to breed at age-three, these data demonstrate each female must produce between 0.95–1.30 fledglings to balance mortality and maintain a stable population (Henny and Wight 1969, Henny et al. 1970). Osprey nesting studies in tidewater areas of eastern Long Island Sound continuing east and north to Massachusetts Bay demonstrated productivity of 0.80 fledglings per nest in the 1970s (Poole and Spitzer 1983, Spitzer et al. 1983). In 1963–1980, the annual average number fledged per accessible active nest in this Chesapeake Bay study area ranged 0.87–1.43 with the exception of 1963 when it was 0.64 (Reese 1970, 1977). This suggests nearly every year Osprey nest success in the study area has been within the estimated productivity range necessary to maintain population stability.

In the north adjoining reference area in 1975–1980, increases over 1966–1974 (Reese 1975) occurred in the percent of nests with fledglings (24%) and the average number fledged per accessible active nest (37%). Improvement in the 1975–1980 nest success in the north reference area similar to that of the primary study area suggests frequent nest visits in the primary area had no discernable influence on productivity.

In the southern reference area in Choptank River, comparisons of the single year 1980 nest success with previous years of published results are mixed. The percent of nests with fledglings was 10% lower than in 1972–1979 (66%) (Reese 1981), but up 115% over 1968–1971 (52%) (Reese 1972), while the average number fledged per accessible active nest was unchanged from 1972–1979 (1.3) but up 37% over 1968–1971 (0.95). These data were not statistically compared, since comparing a single year to that of previous multiyear means may be misleading.

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