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NESTING DISTRIBUTION AND POPULATION STATUS OF U.S. OSPREYS 1994

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ABSTRACT.—Ospreys (*Pandion haliaetus*) once nested throughout most of the U.S. The decline in this population due to biocide use has been well documented, as has its recovery following the U.S. ban on DDT in 1972. A general increase in the nesting distribution and abundance of Ospreys was reported in the U.S. in 1981 but there was limited dispersal into states with low or extirpated populations. We conducted a nationwide nesting survey of nesting Ospreys in 1994, updating the 1981 data. Our data indicate a dramatic increase in the U.S. Osprey population from ~8000 nesting pairs in 1981 to ~14 200 in 1994. The most dramatic increases were seen in traditional nesting areas, with some new nesting in the interior U.S. Hacking projects, construction of reservoirs, nest platform management and increased public relations have contributed to the growth of this nesting population.

KEY WORDS: Pandion haliaetus; *Ospreys; population status; limiting factors; dispersal; management.*

RESUMEN.—Aguila pescadoras (Pandion haliaetus), anidaba comunmente en la mayor parte de los EE.UU. hasta que sus poblaciones fueron afectadas severamente debido al uso de insecticidas. Sin embargo, después de la prohibición del uso de DDT en 1972, la especie parece estar recuperandose. En 1981, se reportó un incremento general en la distribución de sitios de nidacion y abundancia de la especie. Sin embargo, la recuperación parece ser menor en los estados en los que las poblaciones fueron mas afectadas o extirpadas. En este estudio, reportamos el resultado de un muestreo nacional de nidos de Aguila Pescadora, que realizamos en 1994 y que reemplaza los datos de 1981. Nuestros datos indican un incremento dramático en las poblaciones del Aquila de ~8000 pares anidando en 1981 a ~14 200 in 1994. Los incrementos mas dramáticos fueron observados en áreas tradicionales de nidación, y en algunos sitios neuvos en el interior de los EE.UU. Proyectos de reintroducción, construcción de presas, implementación de platformas de nidación, y un mejor entendimiento del problema por parte del público, han sido factores importantes que han contribuído a la recuperación de la especie.
[Traducción de Jorge Vega Rivera]

Ospreys generally occur along rivers, lakes, sea coast bays and estuaries, reservoirs, small streams and ponds, or any body of water where fish, their principal food, are available (Poole 1989a). Historical data, though limited, indicate that Ospreys once nested in suitable habitats throughout most of the contiguous U.S., but their numbers were never equally distributed throughout the country. Records suggest that the Central States Region (Fig. 1) had the smallest population, which was nearly extirpated by the early 1900s. The entire U.S. Osprey population declined precipitously throughout the 1950s, 60s and early 70s, a result of widespread use of chlorinated hydrocarbon insecticides and habitat destruction (Ames and Mersereau 1964, Ames 1966, Peterson 1969, Postupalsky 1969, Henny and Ogden 1970). The population was "Redbook listed" under "rare and endangered fish and wildlife of the U.S." and classified as "status undetermined" by the U.S. Fish and Wildlife Service in 1966 and 1968 (Henny 1977).

Henny (1983) conducted a comprehensive survey of the distribution and abundance of the entire U.S. Osprey population in 1981. His research indicated a general increase in the overall population, with limited dispersal into states with low or extirpated populations. This population enhancement was primarily the result of greater reproductive output after the U.S. ban on DDT in 1972. The slow dispersal rate was principally a consequence of high natal site fidelity, especially for males (Spitzer et al. 1983). Such slow, limited dispersal forced hacking methods as a means of restoration in areas with low or extirpated populations. In the

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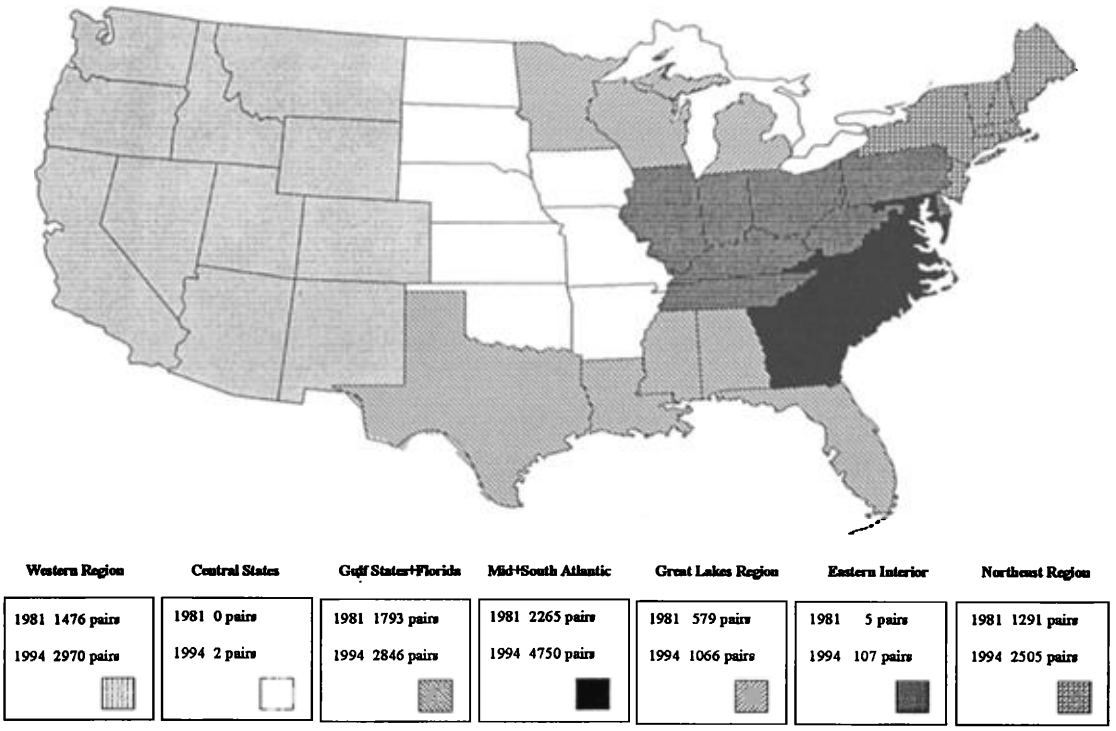

Figure 1. U.S. Osprey regions (1994).

late 1970s and early 1980s, Pennsylvania, New York and Tennessee began programs to restore low or extirpated populations (Hatcher and Hammer 1983, Schaadt and Rymon 1983).

Our objectives in this study were: 1) to survey 48 states for information concerning the general trend of U.S. Osprey nesting populations, 2) to compare the 1994 and 1981 distribution and abundance of U.S. nesting Ospreys, 3) to examine any changes in population numbers and range expansion that may have occurred since 1981, and 4) to suggest continued management options.

METHODS AND MATERIALS

Data on the U.S. Osprey population were obtained from professional sources in each of the lower 48 states. Biologists from state and federal agencies and individual Osprey researchers were contacted by telephone or in person. A follow up questionnaire, state distribution map and completed sample questionnaire was sent to each of the contacted individuals. Survey questions addressed the distribution, abundance, historical data, nesting preferences, reproductive success and hacking status of the U.S. Osprey population. State breeding bird atlases and other published and unpublished sources were also reviewed, as were state bird books, for information on the historical population and broad population and dispersal patterns and trends. To provide an estimate of the completeness of nesting data, we completed a list of nesting survey methods used by each state (some states had no recent surveys) (Table 1).

For purposes of evaluation, Henny (1983) divided the entire U.S. Osprey population into five regional populations: Pacific Northwest, Western Interior, Great Lakes Region, Atlantic Coast, and Gulf States and Florida. An alternate approach was taken in our study. Comparable regional populations (Western Region, Great Lakes, Northeast, Mid and South Atlantic Coast, and Gulf States and Florida) were established, but additional regions (Eastern Interior and Central States) were added to examine dispersal patterns, recent population fluctuations and migratory movements between wintering and breeding areas (Fig. 1)

RESULTS AND DISCUSSION

Mid and South Atlantic Coastal Region. This region begins in Delaware Bay and encompasses all of Delaware, Maryland, the coastal plain of Virginia, North and South Carolina and Georgia (Fig. 2). It supports one of the largest concentrations of nesting Ospreys in the world (Chesapeake Bay) (Henny 1983, Poole 1989a). It is within this major estuarine system that most Ospreys in Virginia and Maryland breed. The number of nests in the Ches-

Table 1. Approximate number of Osprey nesting pairs in the U.S. (1981 vs. 1994).

STATE	NESTING PAIRS 1981	1994	SOURCE
Alabama	2	23[2]	R. Clay, Alabama Game and Fish
Arizona	4	25–35[3]	G. Beatty, Bald Eagle Management Coordinator
Arkansas	0	0[4]	K. Yaich, Arkansas
California	359 (1975)	500–700[5]	Ron Jurek, California Dept. of Fish and Game
Colorado	9	17[2]	J. Craig, Colorado Division of Wildlife
Connecticut	25	95[2]	J. Victoria, CT Supervisor of Wildlife Research
Delaware	56	75–85[2]	L. Galvin-Innvaeer, DE Div. of Fish and Wildlife
Florida	1750	2500–3000[4]	Mark Westall, President TIOF
Georgia	95	225–275[3]	J. Ozier, GA Dept. of Natural Resources
Idaho	323 (1974–80)	400–425[4]	W. Melquist, Idaho Fish and Game Department
Illinois	0	0[4]	V. Kleen, Department of Conservation
Indiana	0	1[3]	J. Castrale, Indiana Nongame Biologist
Iowa	0	0[4]	B. Harrisman, IA Dept. of Natural Resources
Kansas	0	0[4]	J. Zimmerman, Div. of Biology, KSU
Kentucky	0	16[1]	D. Yancy, KY Dept. of Fish and Wildlife Resource
Louisiana	1	10[3]	S. Shively, LA Dept. of Wildlife and Fisheries
Maine	1000	1300–1800[5]	D. Hudson, ME Fish and Game
Maryland	847 (1973–75)	1000–1400[4]	S. Cardano, MD Dept of Natural Resources
Massachusetts	32 (1980)	260[2]	B. Davis, MA Division of Fisheries and Wildlife
Michigan	123	223[1]	S. Postupalsky pers. comm.
Minnesota	160	350–450[2]	M. Martell, UMN Raptor Center
Mississippi	40	55–65[2]	M. Woodrie, MS State Ornithologist
Missouri	0	0[4]	W. Crawford, Raptor Res. Tyson Research Center
Montana	149	500–600[4]	D. Flath, Montana Fish, Wildlife and Parks, MSU
Nebraska	0	0[4]	J. Dinan, NE Game and Parks Commission
Nevada	1	4[3]	G. Herron, NV Department of Wildlife
New Hampshire	8	29[2]	C. Martin, Audubon Society of New Hampshire
New Jersey	87	200[2] (1993)	C. Clark, Endangered + Nongame Species Program
New Mexico	0	2[3]	S. O. Williams III, NM Dept. of Game and Fish
New York	120	315[2]	B. Loucks, NY Endangered Species Unit
North Carolina	450 (1974)	800–1200[4]	R. Wilson, NC Wild Resource Commission
North Dakota	0	0[4]	C. Grondahl, ND Game and Fish Department
Ohio	0	1[3]	D. Case, Ohio Division of Wildlife
Oklahoma	0	0[4]	S. Sherrod, Dir. G.M. Sutton Avian Res. Center
Oregon	308 (1976)	675–700[2]	C.J. Henny, NBS Leader NW Research Station
Pennsylvania	0	20[2]	L.M. Rymon, Environmental Studies Dir., ESU
Rhode Island	19	44[2]	L. Suprock, Div. Fish, Wildl. and Estuarine Res.
South Carolina	151 (1979)	800–1000[4]	T. Murphy, South Carolina
South Dakota	0	2[3]	D. Backlandi, SD Game and Fish Department
Tennessee	5	66[2]	B. Hatcher, TN Nongame and Endangered Species
Texas	0	3[3]	B. Ortego, Biologist, TX
Utah	12	30[3] (1995)	S. Cranney, UT Division of Wildlife Resources
Vermont	0	12[2]	S. Parren, VT Fish and Wildlife
Virginia	722 (1973–75)	1300–1500[4] (1987)	Westall 1990
Washington	229	350–400[2]	K. McCallister, WA Department of Wildlife
West Virginia	0	3[3]	S. Butterworth, WVA Div. of Wildlife Resources
Wisconsin	176	391[1]	D. Flaspohler, WN Bureau of Endangered Res.
Wyoming	82 (1974–81)	150–200[4]	B. Oakleaf, WY Game and Fish Department
Estimated Total	8000	12,769–15,603	

Completeness of data

[1] Both aerial and ground surveys, this percent was established by Henny et al. (1974) for the efficiency of combined aerial and ground

Table 1. Continued.

surveys and based on visibility rates.

[2] Less intense aerial, ground, or boat surveys (Osprey nests recorded during Bald Eagle aerial surveys, or incomplete aerial and ground surveys).

[3] Intense local surveys, or only surveying/monitoring of suspected and/or traditional nesting areas.

[4] No statewide surveys, information acquired from local biologist and/or other individuals aware of current nesting and population trends.

[5] No statewide data available, therefore, a percent increase for regional data was determined and this percent increase was applied to the most recent statewide nesting data in order to provide a current estimate.

[6] Very low number of nesting pairs (<15), no statewide survey (* states with <15 nests are listed under other categories where appropriate).

apeake Bay area has increased slowly over the past 20 years. Apparently, there has been a large increase in occupied nests along the Patuxent River from 22 in 1973 to 72 in 1994 (S. Cardano pers. comm.). Overall, the number of Ospreys nesting in the Bay area appears to be leveling off and Spitzer (1989) suggests that the population is nearing carrying capacity. Spitzer (1989) estimated the mean age at first breeding in part of the Chesapeake Bay region to be about two years higher than that of the region between New York City and Boston (5.7 vs. 3.7 yr), apparently the result of limited nest-site availability. This delay should slow population growth rate by bringing mortality into balance with natality (Spitzer 1989, Poole 1989b). The number of Ospreys nesting in Virginia, the coastal Carolinas and Georgia has more than doubled since 1981. Several new interior sites have contributed to this growth (T. Murphy and J. Ozier pers. comm., Westall 1990).

Despite fluctuations, the overall number of nesting pairs in Delaware increased from 56 pairs in 1981 to 75–85 in 1994 (L. Gelvin-Innaer pers. comm.). In Delaware Bay, however, where breed-

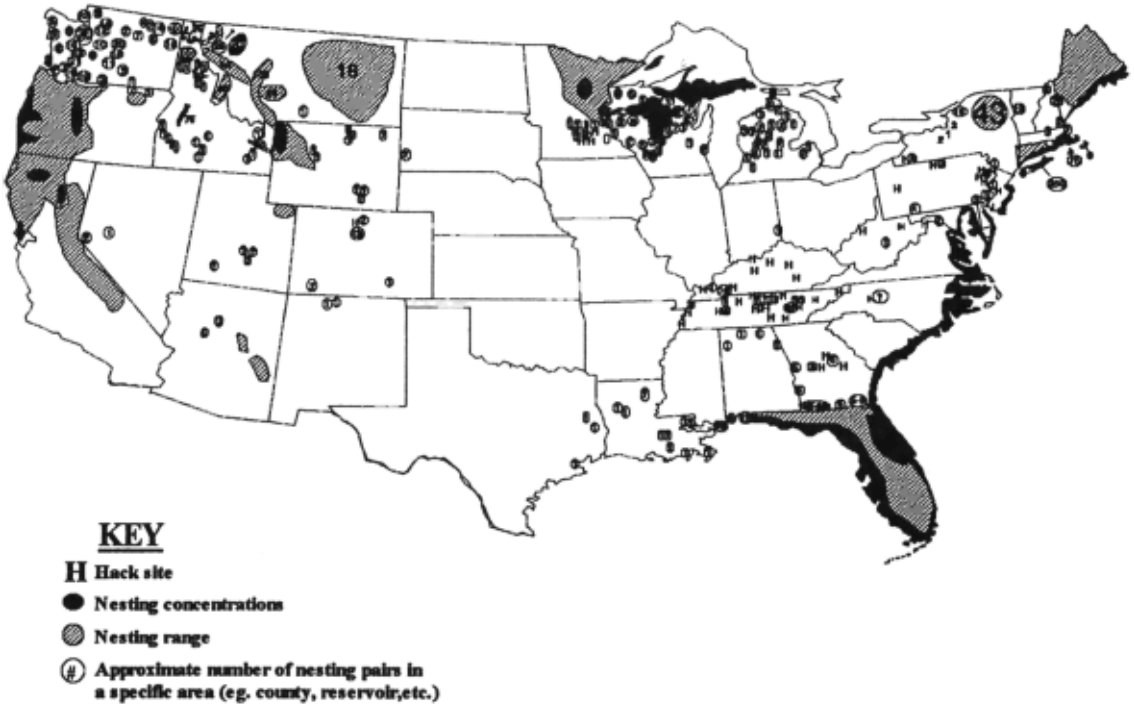

Figure 2. U.S. Osprey nesting distribution and abundance (1994).

ing pairs declined drastically in the 1960s and early 1970s apparently due to use of biocides, recovery has not occurred. On the Delaware side of the Bay, a region which historically supported numerous nests, only three nests were occupied in 1987 (Spitzer 1989) and approximately the same number were reported in 1994 (L. Gelvin-Innaer pers. comm.). Spitzer (1989) suggests increased water turbidity may be one limiting factor.

The general trend in traditional areas of these states has been rapid population growth but very limited range expansion.

Northeast Region. This region has both coastal and interior populations. Maine is the only state in this region which shows a contiguous population linking the coast with the interior. New Hampshire has an interior nesting population contiguous with that of Maine. Other northeast interior populations are located in northeastern Massachusetts, western Vermont, western New York and the Adirondack Mountain region of New York (Spitzer 1989).

Expansion of the breeding range of Ospreys in this region has been slow. From 1975–87, there was only a gradual spread of breeders along the coast of Connecticut, New York (Long Island), Rhode Island and Massachusetts, and relatively few Ospreys dispersed 25 km or more into substantially different and unoccupied habitats (Poole 1989a, Spitzer 1989). Spitzer (1989) recorded eight pairs that made moderate dispersals to the interior zone and this number has increased slightly (2–5 additional pairs) within the past 5 yr.

Most new nests in the Northeast region are located in the vicinity of previously established Osprey breeding habitats. In the coastal region, this trend has been due in large part to intensive management, including nest-site protection and nest platform construction during the last two decades (1967–87) (Poole 1989a, Spitzer 1989).

The area from Cape May, New Jersey to Cape Cod, Massachusetts was most heavily affected by biocide use. The number of nesting pairs in this vicinity declined from over 1000 nesting pairs in the early to mid 1900s to less than 200 nesting pairs in the mid 1970s (Henny 1977, Spitzer et al. 1983). Following the 1972 ban on DDT, nesting pairs in this region have gradually increased (Poole 1989a, Spitzer 1989).

In Massachusetts, nesting has increased dramatically as a result of nesting platform construction. Over 90% of the Ospreys nesting in Massachusetts now use such platforms (B. Davis pers. comm.). In 1994, seven out of the 12 Vermont nests were on platforms and active management should continue to play a major role in the expansion of this population (S. Parren pers. comm.). Nest management, particularly predator guarding of natural nests, is credited for recent increases in the Osprey breeding population in New Hampshire (C. Martin pers. comm.).

The number of Ospreys nesting between New York City and Boston has grown approximately 10% annually since 1975. If this trend continues, the number of Ospreys nesting there in the year 2000 should equal or exceed historical records (Spitzer 1989). New Jersey has experienced an increase of approximately 6% annually (Clark and Jenkins 1993). New limiting factors (loss of suitable habitat and decreased suitability of nest sites), however, may prevent the number of nesting pairs from reaching historical or pre DDT numbers (Clark and Jenkins 1993).

Western Region. Statewide aerial and ground surveys have been limited in this region so available data are less conclusive. Despite this, the Osprey population is considered to be expanding and increasing in the region.

In Montana, Ospreys nest primarily in western portions of the state, mostly at Flathead Lake. In 1974, approximately 23 nesting pairs were located along the Northern Valley of Flathead Lake. In 1986, there were 66 (Henny and Anthony 1989) and, in 1994, there were close to 100 nesting pairs (D. Flath pers. comm.). Overall, statewide nesting increased from 149 nesting pairs in 1981 to 500–600 in 1994 (D. Flath pers. comm.).

Wyoming Ospreys are concentrated near the Montana border, in the northwestern part of the state (Yellowstone and Grand Teton National Parks). Henny and Anthony (1989) indicated that new nesting occurred in Johnson, Sheridan, Crook and Carbon Counties and it is estimated that the number of nesting pairs in Wyoming at least doubled between 1981–94 from 80 to ~160 pairs (B. Oakleaf pers. comm.).

In Idaho, nesting concentrations occur at Lake Coeur d'Alene, Lake Pend Oreille, Palisades Reservoir and Cascade Lake (W. Melquist pers. comm.). Henny and Anthony (1989) reported nesting productivity at Lake Coeur d'Alene in the mid to late 1980s to be among the highest reported in the literature. W. Melquist (pers. comm.) estimated the 1994 population to be over 400 nesting

pairs, a number which greatly exceeds historical records (Larrison et al. 1967).

Washington state conducted aerial and ground surveys in 1984 and 1989. Nesting data from these surveys indicated major nesting concentrations in both eastern and western portions of the state. These surveys showed an increasing population, with 275 nesting pairs in 1984 and 346 in 1989 (Watson and K. McCallister unpubl. data). The average annual percent increase from 1981–89 was approximately 5%. If the rate of growth remained constant between 1989–94, the number of nesting pairs in 1994 should have been approximately 450–500. However, because of potential limiting factors such as a lack of suitable nest sites and habitat availability, a more conservative estimate for this population in 1994 is 350–400 pairs.

In Oregon, the largest concentration of nesting Ospreys is located in the Central Cascade Mountains. The overall Osprey population in Oregon appears to be expanding. Henny and Kaiser (1996) reported that the nesting population along the Willamette River (between Portland and Eugene) increased from 13 pairs in 1976 to 78 pairs in 1993. Sixty-six of the pairs were nesting on utility structures in 1993, while none were nesting on them in 1976. The number of Osprey nesting within the state has increased from 308 in 1976 (Henny et al. 1978) to >700 in 1994 (C. Henny pers. comm.)

California nesting populations are concentrated in northern coastal and mountain regions (P. Bloom pers. comm.). Henny and Anthony (1989) identified four major populations at Klamath-Trinity system, Shasta Lake, Eagle Lake and Lake Alman, but an estimate for the state's nesting population in 1994 was not available. R. Jurek (pers. comm.) indicated that there were 21–23 nests on Tamales Bay, 15–20 nests along the Russian River, 35 pairs along the upper Sacramento River and 52 occupied and 30 successful nests in Marin County. He also noted that the overall number of Ospreys nesting in California has risen dramatically over the past 20 yr. Numbers of nesting pairs at Eagle Lake do not appear to be increasing (Bloom pers. comm.). Henny and Anthony (1989) indicated a substantial range expansion and population increase on small reservoirs in extreme northeastern California (Modoc County) where the population increased from three pairs in 1980 to 10 pairs in 1987. They also noted an increase in nesting pairs at Kent Lake (Marin County) from seven pairs in 1975 to 22 in 1986, and an increase in the number of nesting pairs located within the Sierra Nevada region. Since 1975, newly reported Osprey nesting areas have included: Lake Tahoe (El Dorado County), Lake Oroville (Butte County), Basse Lake (Madera County), New Melones Reservoir (Tuolumne County) and New Bullards Bar Reservoir (Yuba County) (Henny and Anthony 1989).

The number of Ospreys nesting in Nevada remains low. Two of the four existing pairs are located at Lake Tahoe and the other two pairs are nesting along the Huntington Valley (Gary Herron pers. comm.).

In Arizona, a sizable increase in nesting pairs has taken place within the past 10 yr. Most of the Ospreys nest at the White River east/west fork and the main stem of the Black River in southeastern Arizona. However, three nests are located near Flagstaff, there was a new breeding attempt on Lynx Lake near Prescott in 1994 and, in 1996, a pair nested for the first time in over 30 yr at the confluence of the Salt and Verde Rivers, east of Mesa (G. Beatty and R. Vahle pers. comm.).

New Mexico had its only two pairs of Osprey (1994) nesting on reservoirs in the northern portion of the state. Both pairs began nesting in the 1990s (S. Williams pers. comm.).

The Colorado Osprey population (1994) is small and concentrated in the northcentral portion of the state. Hacking has been undertaken to enhance the already existing population and to extend breeding to the front range of the Rockies. Currently, three nesting pairs are located far from the hacking areas; two are located in La Plata County and one in Pueblo County (J. Craig and K. Luft pers. comm.).

Most Ospreys in Utah nest along the Green River and Flaming Gorge Reservoir area in the northeast corner of the state (S. Cranney unpubl. data). C. Monson (unpubl. data) reports that nesting also occurs at Fish Lake (six pairs), Panguitch Lake Navajo (two pairs), and, in 1995, one pair nested on Deer Creek Reservoir and another pair nested in Highland. Construction of reservoirs appears to have increased growth of Utah's Osprey population.

Many western states continue to show an expansion of nesting pairs eastward, partially due to changes in inland habitat, particularly the construction of reservoirs (Swenson 1981, Henny 1983). Reservoirs often provide foraging advantages over rivers and lakes because their still, shallow, open, water areas and reduced turbidity result in

increased water clarity and higher visibility of fish (Swenson 1981, Henny 1983).

A comparison of foraging times and nesting densities between free-flowing river habitat and three river impoundments on the upper Missouri River in Montana showed food sources and Osprey nesting densities to be higher at impoundments (Grover 1984). This indicates that additional impoundments could benefit Osprey populations and encourage future range expansion.

Florida and the Gulf Coast. Florida has the highest number of nesting Ospreys in this region, with distinct concentrations from the St. Johns River south to Lake Okeechobee (Westall 1990). Ospreys also nest along the east and west coasts and across Florida Bay, including the Ten Thousand Islands area (southwest Florida). Ospreys nesting in peninsular Florida south of the 29th parallel are nonmigratory or resident birds and, therefore, may be subject to different biological limiting factors than Ospreys nesting further north (Poole 1989a).

Food stress may be affecting the once healthy Florida Bay population (Poole 1989). Declines there have prompted Florida to designate Osprey as a species of concern in Monroe, County. Although Florida Ospreys are currently adapting to an exploding human population, further land development could limit food supply and nesting habitat and thus should be carefully monitored (Ogden 1978, Westall 1990).

Nesting in the Gulf Coast has been extremely limited and sporadic (Lowery 1974, Imhof 1976, Henny 1983, Reinman 1984). The number of Ospreys nesting in this region has fluctuated throughout this century and only limited nesting has been documented (Henny 1983). J. and B. Jackson (unpubl. data) note that Ospreys were historically more abundant along the lower Mississippi than now. A decrease in the number of nesting pairs there has most likely resulted from human disturbance and manipulation (change in water flow, industry and pollution, and loss of nesting habitat).

In 1994, Gulf Coast Ospreys were most abundant on the gulf islands at the southern tip of Mississippi (50–55 pairs) (M. Woodrie pers. comm.). Only three nesting pairs were recorded in Texas in 1994, and though no statewide survey was conducted, it is unlikely that many more Ospreys nested there. However, many Ospreys migrate through Texas and several have been recorded during winter months (B. Ortego pers. comm.). Alabama and Louisiana have increasing populations (Table 1), but inland nests remain sparse and irregular. The low number of documented nests in these states may be partially related to a lack of survey coverage. Why nesting remains low is unclear, but it merits further attention (Westall 1990). This region is an important study area for future productivity, range expansion, nesting and predation research.

The Great Lakes Region. The total number of breeding pairs in the Great Lakes region has almost doubled from an estimated 579 pairs in 1981 to approximately 1014 in 1994. Today's distribution of nests is similar to that reported for the period of 1963–71 (Postupalsky 1969, 1977); however, the aggregations are larger, additional adjunct nests exist between traditional clusters and some range expansion has occurred. Nests still remain concentrated in northcentral and northeastern Minnesota and in northern portions of Michigan and Wisconsin (M. Martell pers. comm.).

The growth of the statewide population in Michigan observed during 1977–92 has apparently stopped and some local declines have been noted, despite high availability of nest sites. The statewide total remained near 225 pairs from 1992–94 (S. Postupalsky pers comm.). Wisconsin Osprey nesting data indicate that the number of nesting pairs there increased steadily during 1983–93, however, S. Postupalsky (pers. comm.) suggests that present numbers may be leveling off. Minnesota's nesting data was inconclusive but >200 nests were unoccupied in 1994 (M. Martell pers. comm.).

Wisconsin, Minnesota and Michigan all show signs of range expansion to the south. The expansion in Minnesota has been enhanced by hacking efforts initiated in Hennepin County in 1984 (M. Martell pers. comm.). Further expansion and dispersal is expected as nesting continues and more hacked birds return. A recent surge of nesting on artificial structures (~68% of nests in Wisconsin), could affect future Osprey numbers and status in this region. This region should continue to be evaluated for factors limiting population growth (e.g., measurements of aquatic productivity, fish population dynamics, prey accessibility to Ospreys, predators and competitors, and land use) (S. Postupalsky pers. comm.).

Eastern Interior. Major nesting concentrations such as those in Florida and Chesapeake Bay may never be realized in this region, but with the advent of large water-management projects such as the TVA reservoir and waterway system, and the hacking projects that have been implemented

throughout this region, a sizable increase in the number of nesting pairs and distribution may be expected (Westall 1990).

Freshwater reservoirs have been most beneficial to the nesting success here, particularly in Kentucky, Tennessee, West Virginia and Pennsylvania where impoundments have benefited recent Osprey reintroductions. Overall, the Osprey population in these states surged from five nesting pairs in 1981 to 105 in 1994. Many of these breeding pairs are known to be the result of several intensive hacking programs. For example, in Pennsylvania 17 of the 20 statewide nesting pairs include hacked birds, four of which were hacked in West Virginia (L. Rymon unpubl. data). All three of West Virginia's pairs are the result of hacking in West Virginia. Most of the Ospreys now nesting in Tennessee are either the direct result of hacking or were attracted by recruits from local hacking projects (B. Hatcher pers. comm.). Kentucky has had similar results but the birds in both Tennessee and Kentucky have not been well monitored.

Central States. Both the Mississippi and Missouri Rivers seem ideal as conduits for interior nesting, yet they remain virtually unoccupied by Ospreys. Historical data suggest that Ospreys once nested in small numbers along parts of the Mississippi (J. and B. Jackson unpubl. data). Other historical records indicate that very few Ospreys nested within the Central States Region (Hicks 1935, Black 1992, Robbins and Easterla 1992). Reasons why Ospreys are not presently nesting in most of this region remain unclear but the Osprey's slow pioneering rate may be responsible. Many of these states appear to have some suitable habitat and most are adjacent to states where Ospreys currently nest. Habitat Suitability Indices could be used to determine if habitat is a major limiting factor (Vana-Miller 1987). However, recent dispersals into South Dakota, New Mexico, Texas, Ohio and Indiana, all states with no known nesting pairs in 1981, indicate that it may only be a matter of time before Ospreys expand their range into this region also. If time is inhibitory, hacking may be one option for accelerating the process (Rymon 1989a).

CONCLUSION

1994 U.S. Osprey Distribution and Abundance. There has been a significant increase in the number of nesting pairs in the U.S. from 1981–94. The overall estimate for the population in 1981 (Henny 1983) was approximately 8000 nesting pairs. Our 1994 population estimate was ~14 186 ± 1417 (SD) indicating that the U.S. Osprey population has increased ~75% in just over the past decade.

There were many similarities in the distribution and abundance of Osprey nesting pairs between 1981 and 1994. Largest increases in numbers of nesting pairs took place in areas of traditional nesting: the Atlantic Coast, Pacific Northwest and the Great Lakes Region. A large increase in nesting pairs also occurred in the Eastern Interior Region where hacking has taken place. Although the recent interior population expansion can be attributed to hacking efforts, hacking has only expanded the range and played a very modest role in the growth of the entire U.S. Osprey population.

Overall, population growth has resulted from: 1) increased production rates following the 1972 ban on DDT, most prominent in the Northeast and Great Lakes Regions, 2) construction of numerous new impoundments, especially in the Western and Eastern Interior Regions, 3) artificial nest construction in nearly all regions, particularly the relatively recent use of utility structures and other man-made structures in the west (Henny and Kaiser 1996), 4) hacking projects in the interior, and 5) increased public awareness and support. These dramatic changes stress the importance for regional Osprey management while monitoring the entire U.S. population.

Growth and Expansion of the U.S. Osprey Population. The future growth of regional Osprey populations depends, in part, on the rate at which new breeders are recruited. Regional differences in the dispersal distances of young may be a reflection of the differences in the density and availability of nest sites (Poole 1989b). In New England, where nesting pairs were severely reduced by pesticides during the 1950s and 60s, artificial nest sites are now clustered, abundant and widely available so most new recruits find nests quickly and breed soon after arrival (Poole 1989b). In New England, dispersal distances >50 km are rare (Poole unpubl. data).

Ospreys in western and midwestern North America seem to be dispersing much greater distances. There the breeding range may be restricted by lack of suitable nest sites and large expanses of unsuitable habitat (Poole 1989a). Ospreys in the western U.S. have traditionally nested in trees or snags near lakes and rivers (Henny 1983); however, nesting areas are becoming saturated (C. Henny pers. comm.) For this reason, they are slowly dispersing

into new breeding areas around reservoirs where breeding densities may largely exceed those along nearby free-flowing rivers (Henny 1983, Swenson 1981, Grover 1984). Lack of natural nest sites at traditional nesting areas in the western states may have caused longer dispersal and colonization at newly constructed impoundments and along utility structures (Henny and Kaiser 1996).

In the Chesapeake Bay area where nest sites are saturated, Ospreys have begun to delay breeding rather than disperse to new areas (Spitzer 1989). Perhaps this is due to their high natal-site fidelity. Changes in breeding rates, proportions of nonbreeders in different populations, choices of nest sites, competition for nest sites, natal dispersal distances, age at first breeding and nesting dispersion should be monitored in future seasons (Spitzer 1989).

An increase in the use of artificial nest structures has played an important role in the overall increase in the number of nesting pairs in the U.S. (Poole 1989a). Regional data on nesting structures indicate that approximately 64% of Ospreys in the U.S. nest on artificial structures, particularly artificial platforms erected specifically for them (approximately 50%). Excessive construction of nesting platforms may have drawbacks in the long run, including habituation to humans, necessary maintenance of platforms and higher predation rates (Poole 1989a).

The construction and addition of artificial nest structures on public lands has played a critical role in increasing public awareness and support for Osprey. Several states have had volunteer Osprey nest platform projects, and some have set aside viewing areas for aesthetic and educational purposes. Nest platform management is just one example of expanding public awareness. Support from public utilities and media coverage appear to be enhancing efforts in public relations which will continue to be important for the preservation of this species (Rymon 1989b).

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