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MORTALITY OF WINTERING OSPREYS AND OTHER BIRDS AT AQUACULTURE FACILITIES IN COLOMBIA

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ABSTRACT.—Ospreys (*Pandion haliaetus*) winter throughout the country of Colombia. Recoveries of banded Ospreys indicate that many are shot in the country with the number increasing since the 1970s. The increased incidence of shooting has coincided with the development of aquaculture facilities in Colombia that raise tilapia (*Oreochromis* spp.). Because these facilities typically lose production to birds such as Ospreys that depredate fish, we conducted a survey of 83 facilities in three states or departments in Colombia in 2001 to determine the species of birds that take fish at aquaculture facilities and the numbers that are killed each year. Our results showed that bird depredation occurs at aquaculture facilities throughout the country, but mostly in the southern portion of the country in the department of Huila. Facility managers reported shooting Ospreys in all three departments with as few as five individuals shot annually in Antioquia in northern Colombia to as many as 270 shot annually in Huila. In addition, facility managers reported shooting nine other species of birds including Green Kingfishers (*Chloroceryle americana*), Great Kiskadees (*Pitangus sulphuratus*), Snowy Egrets (*Egretta thula*), Great Egrets (*Casmerodius albus*), Olivaceous Cormorants (*Phalacrocorax olivaceus*), Black-crowned Night-Herons (*Nycticorax nycticorax*), White-necked Herons (*Ardea cocoi*), Cattle Egrets (*Bubulcus ibis*), and Striated Herons (*Butorides striatus*), for a total estimate of >9000 birds shot in the three departments annually. A number of alternative methods to shooting had been used to reduce losses to birds including the installation of netting, overhead wires, scarecrows, and noise making devices, but, neither these methods nor shooting, were effective in deterring avian predators.

KEY WORDS: *Osprey*; Pandion haliaetus; *aquaculture facilities*; *mortality*; Oreochromis spp.; *shooting*; *tilapia.*

MORTALIDAD DE AGUILAS PESCADORAS (*PANDION HALIAETUS*) INVERNANTES Y OTRAS AVES EN INFRAESTRUCTIRA PISCICOLA EN COLOMBIA

RESUMEN.—El águila pescadora (*Pandion haliaetus*) pasa el invierno en todo el territorio colombiano. La recaptura de águilas pescadoras anilladas indican que muchas son cazadas en este país con cifras en aumento desde 1970. La incidencia del numero de águilas muertas coincide con el desarrollo de la acuicultura en Colombia y la cría de tilapia roja (*Oreochromis* spp.). Esta industria tradicionalmente ha tenido problemas con aves depredadoras de peces por lo cual realizamos una encuesta en 83 granjas piscícolas en tres departamentos de Colombia en el 2001 para determinar las especies que consumen peces y el numero de aves eliminadas anualmente. Nuestros resultados mostraron que la depredación por aves en la infraestructura piscícola ocurre en todo el territorio pero el problema es mas severo en la porción sur del país en el departamento del Huila. Los propietarios de las granjas reportaron que eliminan águilas pescadoras en los tres departamentos, con pocos individuos en Antioquia (al norte de Colombia) equivalente a 5 individuos, y un numero máximo en el Huila de 270 individuos. Adicionalmente los propietarios reportaron que cazan otras nueve especies de aves las cuales incluyen a *Chloloceryle americana, Pitangus sulphuratus, Egretta thula, Casmerodius albus, Phalacrocorax olivaceus, Nycticorax nycticorax, Ardea cocoi, Bubulcus ibis, Butorides striatus,* para un total estimado de >9000 aves eliminadas anualmente en los tres departamentos. Los propietarios de las granjas reportaron que han probado otros métodos de control aparte de las armas de fuego, para reducir las perdidas tales como la instalación de redes

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protectoras, cuerdas de alambre, espantapájaros, aparatos con sonidos, pero ninguno ha resultado eficiente in incluyendo el uso de las armas de fuego para la reducción de las perdidas económicas causadas por aves.

[Traducción de los autores]

Ospreys (*Pandion haliaetus*) breed throughout North America (Palmer 1988, Poole 1989, Johnsgard 1990, Poole et al. 2002). During the 1950s and 1960s, pesticide contamination threatened many populations and declines were widespread across the breeding range (Poole 1989). Since then, populations have rebounded and, today, the Osprey is again a common species in coastal, lake, and riverine habitats. The Osprey is migratory with populations from locations in the western U.S. wintering in Mexico and Central America (Henny and Van Velzen 1972, Melquist et al. 1978, Johnson and Melquist 1991, Martell et al. 2001) and populations from coastal areas of the eastern U.S. and Canada and the Great Lakes region of the Midwest wintering in South America (Martell et al. 2001, Poole et al. 2002). Ospreys banded as nestlings in Maryland, Virginia, New York, New Jersey, Michigan, and Wisconsin have mainly been recovered in Colombia, Venezuela, Equador, and Brazil indicating that northern South America is a primary wintering area for eastern and Midwestern populations (Henny and Van Velzen 1972, Poole and Agler 1987, Niemuth 1991).

The Osprey is unusual because it is exclusively piscivorous eating a wide variety of fresh and saltwater fish species (Poole 1989, Poole et al. 2002). It has traditionally been called the "fish hawk" in North America and "aguila pescadora" in South America and it has been shot, had its nests robbed or torn down, and otherwise been persecuted in areas where people believe it competes with them for sport or commercial fisheries. The Osprey is protected from shooting and other forms of human-caused mortality in North America but, on its Caribbean and Central and South American wintering grounds, there are few laws restricting the killing of birds. Band recoveries of dead Ospreys indicate that shooting and trapping continue to threaten the species on its wintering grounds (Poole and Agler 1987, Santana and Temple 1987, Ewins and Houston 1992). The Osprey is also unusual because it does not breed until three years of age and immatures remain on the wintering grounds continuously until they become sexually mature (Henny and Van Velzen 1972, Poole 1989). Therefore, shooting may selectively eliminate younger individuals and possibly decrease recruitment of new breeders into populations. Currently, there is insufficient information to judge the extent and severity of the South American shooting threat, despite the fact that it may have increased since the 1970s (Poole and Agler 1987, Ewins and Houston 1992).

Since the 1970s, fish farming or aquaculture has become a new and thriving business in Latin America. Production systems consisting of extensive ranching operations where fry are released into reservoirs and later harvested as adults have been built in Mexico, Central and South America (Fitzsimmons 2000). Many aquaculture facilities specialize in the production of tilapia (*Oreochromis* spp.), which are now produced in virtually every country of the Americas. By 1998, the annual production of tilapia had grown to 201 067 mt (metric tons) in Latin America and the U.S. imported 72 428 mt of live weight fish in 2000 (Fitzsimmons 2000). Aquaculture facilities typically raise tilapia in shallow ponds that are <1 ha in size, but, with facilities consisting of >30 ponds, they can have large areas of impounded water. Tilapia are surface-feeders and, when thousands of these bright red fish come to the surface to feed, they become easy prey for piscivorous birds.

With its tremendous warm water resources, Colombia has become one of the leading aquaculture fish producers in South America (Fitzsimmons 2000). Commercial fish production began in the 1980s and by 1996, 22 states or departments were producing a mean of 25 063 mt of fish a year (Instituto Nacional de Pesca y Aquicultura de Colombia [INPA] unpubl. data). Some commercial facilities raise rainbow trout (*Oncorhynchus mykiss*), but most are dedicated to the production of tilapia and Colombia produces a mean of 15 000 mt of tilapia each year (Fitzsimmons 2000). There is an obvious potential for large numbers of piscivorous birds to be killed at these aquaculture facilities and, as such, these facilities may have some effect in redistributing populations of resident and wintering piscivorous birds in the country. Because of the escalating numbers of Ospreys that are shot at

aquaculture facilities and brought to rehabilitation facilities in Colombia (pers. observ.) and increasing concern from the birding community about the numbers of Ospreys being killed each year (Nielson 1998), we undertook a survey to assess the extent of the threat to North American Ospreys wintering in Colombia from shooting, trapping, and other human-caused mortality at aquaculture facilities throughout the country.

STUDY AREAS AND METHODS

We chose three departments, Antioquia in northern Colombia, Valle del Cauca in west-central Colombia, and Huila in southern Colombia, to conduct our survey. We chose these departments because they provided a good representation of the variation in the sizes and production of aquaculture facilities in the country, and each department had ca. 30 commercial aquaculture facilities that were either licensed by the Corporacion de Valle del Cauca or by INPA. Antioquia (05°26′–08°52′N, 73°53′–77°07′W) has a total of 28 licensed aquaculture facilities and was the largest of the three departments surveyed covering an area of 63 612 km^2. The department of Valle del Cauca (03°04′–05°02′N, 72°42′–74°27′W) encompasses a 22 140 km^2 area of west-central Colombia and has 32 licensed aquaculture facilities. The department of Huila in the southern portion of Colombia (01°33′–03°47′N, 74°28′–76°36′W) is the smallest of the three departments covering an area of 19 890 km^2 and it has 27 licensed aquaculture facilities.

Of the 87 licensed aquaculture facilities in the three departments, we visited all except four to interview facility owners and managers who were familiar with the daily operations of the facilities. The four facilities not visited were in the department of Valle del Cauca, and they were not surveyed either because the owners declined to participate or because they were in locations where conditions made them too dangerous to visit. During each visit, we administered a standard questionnaire to owners or managers who were familiar with the daily operations of facilities. Before administering the questionnaire, a statement signed by officials of INPA and the Ministry of the Environment was read stating that all answers would be kept confidential and that no legal proceedings would result from any answers given to the questioner. The questionnaire was administered verbally, and we completed the answers on the questionnaire forms as the interviewees responded to them. The questions asked for information on the size of the facility (number of ponds and ha of impounded water), its annual fish production (mt), if birds were a problem because they impacted annual fish production, the species of birds depredating fish, the seriousness of the impact by each species (on a scale from 1–5 with 1 being a species with one or a few individuals infrequently depredating ponds and 5 being a species with several individuals depredating ponds on a daily basis), if birds were shot, which species of birds were shot, estimated number of each species shot each year (1–10, 11–20, 21–50, 51–75, 76–100, 101–200, or >200 shot annually), and alternative methods to shooting that had been used to decrease the depredation problem (Table 1). Most of the interviewees knew the local common names for the species of birds that caused depredation losses at their farms. When there was any question about the identity of a species of bird, we used color photographs and color plates in Hilty and Brown (1986) to help interviewees identify the species. To estimate the numbers of each species shot annually at each facility, we used the midpoints of the ranges given by interviewees for the numbers of birds they shot each year. To rank species in terms of the seriousness of the threat they posed to the production of fish, we averaged the rankings given by the facility owners in each department.

Table 1. Questionnaire administered to aquaculture facility owners and managers to estimate bird depredation and mortality at aquaculture facilities in the departments of Antioquia, Valle del Cauca, and Huila in Colombia.

Facility name
Permit number
Location
Name of water source
Water temperature (°C)
Number of ponds
Area of impounded water (ha)
Fish species cultivated
Annual fish production (mt)
Annual income (pesos)
Do you have problems with bird depredation?
How much do you estimate you lose annually to bird depredation? (pesos)
Which species of birds are a problem and rank each species in terms of the seriousness of the problem (1 = none or little problem, 2 = slight problem, 3 = moderate problem, 4 = serious problem, 5 = severe problem with fish taken daily).
Do you shoot problem birds? If yes, estimate the numbers of each species that are shot annually (1–10, 11–20, 21–50, 51–75, 76–100, 101–200, >200).
Have you used other methods of deterring birds from taking fish at your facility? If yes, please describe each method and rate its effectiveness.

RESULTS

A total of 82 of the 83 aquaculture facilities surveyed reported experiencing depredation losses to the following 10 species of birds: Green Kingfisher (*Chloroceryle americana*), Great Kiskadee (*Pitangus sulphuratus*), Snowy Egret (*Egretta thula*), Great Egret (*Casmerodius albus*), Olivaceous Cormorant (*Phalacrocorax olivaceus*), Black-crowned Night-Heron (*Nycticorax nycticorax*), White-necked Heron (*Ardea cocoi*), Cattle Egret (*Bubulcus ibis*), Striated Heron (*Butorides striatus*), and Osprey (Table 2). Of the 82 facilities with depredation losses, 35 reported

Table 2. Mean ranking of birds that pose depredation problems at aquaculture facilities in the departments of Antioquia, Valle del Cauca, and Huila in Colombia and estimates of the number of each species shot annually.

	ANTIOQUIA		VALLE DEL CAUCA		HUILA		
SPECIES	RANKING[1]	NO. SHOT	RANKING[1]	NO. SHOT	RANKING[1]	NO. SHOT	TOTAL SHOT
Green Kingfisher	2.6	44	2.5	65	3.5	1836	1945
Great Kiskadee	1.7	0	1.7	0	2.5	1692	1692
Snowy Egret	1.1	0	1.1	0	2.9	1621	1621
Great Egret	1.8	45	2.25	65	2.75	931	1041
Olivaceous Cormorant	1.8	230	1.4	19	1.0	288	537
Black-crowned Night-Heron	1.0	0	2.6	105	2.0	318	423
White-necked Heron	1.6	5	2.0	13	1.4	403	421
Cattle Egret	1.0	15	1.0	0	1.7	400	415
Striated Heron	1.3	0	2.5	35	1.1	364	399
Osprey	1.5	5	2.6	40	2.8	270	315
Total shot		356		342		8323	9021

[1] 1 = none or little problem, 2 = slight problem, 3 = moderate problem, 4 = serious problem, 5 = severe problem with fish taken daily.

shooting birds killing a combined estimate of >9000 birds per year. Facilities in all three departments reported Green Kingfishers as causing the most serious losses and managers at these facilities reported killing more kingfishers (ca. 2000/yr) than any other species. Facilities also experienced depredation losses to Great Kiskadees, which took pelletized fish food and fingerlings, and managers at these facilities shot an estimated 1700 kiskadees per year. As a group, ciconiiforms were viewed as causing the most serious depredation losses at fish farms with Snowy Egrets, Great Egrets, and Black-crowned Night-Herons generally considered to be the biggest threats to facility production. Managers of facilities shot an estimated total of >3000 egrets and night-herons. An estimated 315 Ospreys were shot each year at facilities. Ospreys were considered to cause the most serious depredation losses in southern Colombia in the department of Huila. The one facility that did not experience bird depredation problems was located in Antioquia and it raised primarily rainbow trout that were grown in completely-covered raceways and protected from birds.

Aquaculture facilities in Antioquia ranged in size from 1–400 ponds ($\bar{x}$ = 36.8 ± 74.8, N = 28, ±SD) with 0.01–26.0 ha of impounded water ($\bar{x}$ = 1.8 ± 5.1, N = 28) raising a mean of 79.02 ± 155.9 mt of fish per year (range = 1.5–600, N = 28). Twenty-two of the facilities raised mostly rainbow trout and the remaining six raised mainly tilapia. A total of 27 facilities in Antioquia experienced losses in production to bird depredation. At 23 facilities, birds ranked as causing the most serious depredation losses were Green Kingfishers, Great Egrets, Olivaceous Cormorants, Great Kiskadees, and White-necked Herons that took fish either while perching on overhead wires or while wading along the edges of ponds (Table 2). Only four facilities in Antioquia ranked Ospreys as causing the most serious production losses, and all of these facilities specialized in tilapia production. Eight facility managers said they shot an estimated 230 Olivaceous Cormorants, 45 Great Egrets, 44 Green Kingfishers, 15 Cattle Egrets, and 5 White-necked Herons annually, but only 5 Ospreys per year.

Valle del Cauca, the second-largest, fish-producing department in Colombia, had a mean annual fish production of 4560 mt, most of which was tilapia. The aquaculture facilities consisted of fewer ponds ($\bar{x}$ = 13.1 ± 13.3 ponds, range = 1–56, N = 28) but they were much larger in size ($\bar{x}$ = 5.5 ± 5.8 ha of impounded water, range = 0.4–18.2, N = 28), than in Antioquia. Twenty of the facilities raised a mean of 67.6 ± 90.6 mt (range = 5–240) of tilapia each year. All 28 of the facilities surveyed in Valle del Cauca reported losses in fish production to bird depredation. Black-crowned Night-Herons, Ospreys, Green Kingfishers, Striated Herons, and Great Egrets were considered to be problem species with mean rankings >2 (Table 2). Fourteen facility managers reported Ospreys to be a serious problem species. Only four facility managers in Valle del Cauca said they shot birds and

estimated killing 105 Black-crowned Night-Herons, 65 Great Egrets, 50 Striated Herons, 40 Ospreys, and 20 White-necked Herons each year.

The department of Huila was the smallest fish producer of the three departments surveyed, producing a mean of 2132 mt of fish per year, nearly 94% of which was tilapia. Aquaculture facilities in Huila had more ponds than in either Antioquia or Valle del Cauca ($\bar{x}$ = 62.1 ± 139.7 ponds, range = 3–650, N = 27), but they were smaller in size and covered a mean of 4.1 ± 6.1 ha (range = 0.2–25, N = 27). Nevertheless, five of the facilities in Huila were very large consisting of >20 ponds and >15 ha of impounded water. Facilities in Huila were very productive, producing a mean of 99.08 ± 132.42 mt of tilapia (range = 2.5–840, N = 27) annually. In Huila, all 27 aquaculture facilities surveyed reported losses in fish production to bird depredation. Green Kingfishers, Great Egrets, and Great Kiskadees were again ranked as causing serious depredation problems (Table 2). Twenty-two facility managers reported Ospreys to be a serious depredation problem and 11 of these reported Ospreys to be their most serious problem species. Unlike the other departments, aquaculture facilities in Huila experienced serious depredation losses to Snowy and Cattle Egrets. Birds were shot at 23 facilities with an estimated 8323 birds killed annually including 1836 Green Kingfishers, 1692 Great Kiskadees, 1621 Snowy Egrets, 931 Great Egrets, 403 White-necked Herons, 400 Cattle Egrets, 364 Striated Herons, 318 Black-crowned Night-Herons, and 270 Ospreys. One facility manager reported shooting >100 Ospreys at a communal roost tree located on the Magdalena River, where as many as 50 Ospreys would roost each night. The number he shot did not reduce the depredation problem at his facility because as many as 20 Ospreys fed there daily. The day we visited the facility, we observed 10 Ospreys taking fish from his ponds.

DISCUSSION

Of the 22 departments in Colombia that have INPA-licensed commercial aquaculture facilities, annual fish production averages <100 mt in the departments of Arauca, Atlantico, Casanare, Cauca, Cesar, Choco, Guaviare, and Vichada, and <1500 mt in the departments of Boyaca, Cundinamarca, Risaralda, Putumayo, and Santander. Most of this fish production is rainbow trout so we did not consider facilities in any of these departments to pose serious shooting threats to birds because these facilities are relatively small and trout are mainly raised in covered raceways that are protected from birds. The departments of Antioquia, Cordoba, Huila, Meta, Tolima, and Valle del Cauca each average >2000 mt of fish production annually, ranging from a low of 2100 mt in Cordoba to a high of 6589 mt in Meta. These departments have the largest aquaculture facilities and raise mainly tilapia in large, shallow ponds that are prone to bird depredation. Therefore, these departments have the greatest potential for developing bird depredation problems and the shooting of birds at aquaculture facilities.

The results of our survey showed that several species of birds depredate aquaculture facilities in Colombia with the depredation problem apparently increasing from north to south in the country. The most common solution to the problem that has been used by facility managers is shooting, and shooting appears to increase from as few as 100 birds shot in Antioquia in northern Colombia to as many as 8000 shot annually in Huila in southern Colombia. This increase appears to be due to a shift in the emphasis of fish production at aquaculture facilities in the country from mostly trout production at facilities in northern Colombia to mostly tilapia production in southern Colombia. In northern Colombia, most facility managers do not consider the bird depredation problem to be severe enough to warrant killing birds and only eight of them said they shot kingfishers, herons, egrets, and Ospreys. In Huila, facility managers appear to see bird depredation as a more serious problem. This attitude was reflected in the numbers and variety of birds they shot. All of the fish farm managers who shot birds, also said that shooting was not an effective method of decreasing their losses because new birds simply replaced birds that were shot.

The numbers of Ospreys reported shot each year also increased from five in Antioquia to over 270 in the southern department of Huila. Ospreys were considered to be only a minor problem in Antioquia causing production losses at only those facilities that emphasized tilapia production. The shooting in Huila increased correspondingly with an increase in the productivity of tilapia in this department. Warmer water temperatures in this department are more conducive to the production of tilapia. Tilapia are raised in large, shallow impoundments averaging nearly 5 ha in size. At any time, aquaculture facilities in Huila have as many

as 1 million tilapia in various stages of growth. The combination of the large amount of impounded water and the multitude of easily-captured fish prey are natural lures for Ospreys.

Of the species that were shot, only Great Egrets, Snowy Egrets, Cattle Egrets, Black-crowned Night-Herons, and Ospreys are considered to be boreal migrants in northern South America (Davis 1993, Parsons amd Master 2000, McCrimmon et al. 2001, Ridgley and Greenfield 2001). All, excluding the Osprey, are also resident species that breed as well as winter in Colombia (Hilty and Brown 1986); therefore, it was impossible to assess the overall threat of Colombian aquaculture facilities to boreal migrants. We recovered a total of six USGS bands that owners had removed from dead birds, but had not reported to the Bird Banding Laboratory. All were from dead Ospreys. Two were from Ospreys that had been banded as nestlings in Maine and one each came from Wisconsin, Virginia, New York, and Connecticut, further supporting the view that Colombia is an important wintering area for Ospreys from the eastern and Midwestern U.S.

Aquaculture of tilapia first began in the Americas in the 1960s and 1970s. Currently, Mexico is the biggest producer of tilapia but the industry is rapidly growing in Honduras, Costa Rica, Cuba, Jamaica, Colombia, Ecuador, Peru, Venezuela, and Brazil (Fitzsimmons 2000). Future production trends include further intensification of production in every country with Brazil expected to become the biggest producer of tilapia in the next 20 yr (Fitzsimmons 2000). Ospreys winter in all of these countries, therefore, if this trend continues, we could expect an increase in the shooting of Ospreys on their wintering grounds. In North America, the construction of reservoirs for irrigation and flood control have had a substantial effect on the redistribution of breeding Ospreys, particularly in the western U.S. (Henny et al. 1978a, 1978b, Swenson 1981, Poole 1989). A similar phenomenon may be currently underway in Latin America. Aquaculture facilities may redistribute wintering populations of Ospreys away from natural habitats such as coastal, lake, and river areas to man-made reservoirs, where they are lured by the abundance of easily-captured fish prey. Unlike North America, where legislative controls and public education has reduced the risk of Ospreys being shot (Poole and Agler 1987), in Latin America shooting continues to be a very real threat. Many of the countries lack any laws that prevent shooting and those that do frequently lack enforcement. Shooting is an easy method of eliminating problem birds and band recovery data from Central and South America support that this is the usual method of reducing the avian depredation problem. Of the Ospreys banded in Canada, 39% have been recovered shot and the number shot appears to have increased since the 1970s, which coincides with the timing of the first construction of aquaculture facilities in Latin America (Poole and Agler 1987, Poole 1989, Ewins and Houston 1992). Populations of Ospreys continue to increase throughout North America (Poole et al. 2002) indicating that the mortality at aquaculture facilities has probably not yet reached numbers great enough to impact populations of North American Ospreys. Nevertheless, in view of the current growing global trend in fish farming, mortality from shooting will only increase in years to come, perhaps developing into a serious problem for Osprey populations in the eastern and Midwestern U.S.

Our survey showed that fish farm owners had tried a variety of nonlethal bird deterrents to reduce their annual losses to birds. The most widely-used alternatives to shooting were noise-making devices, such as guns, cannons, and fireworks, and patrols by people who flushed birds from the edges of ponds. None of these methods had proven effective because problem birds apparently either became habituated to the noise makers or simply learned to ignore people patrolling ponds. A few facility managers had tried using scarecrows and dogs to frighten birds away. Neither of these methods was effective after problem birds became accustomed to them. Another widely-used deterrent was the installation of netting around ponds. Nets were frequently used to reduce loses to birds such as herons and egrets that hunt along the edges of ponds. Owners reported that the devices were relatively effective provided the netting was maintained along the edges of ponds. Such maintenance was labor intensive and it was difficult to make certain that the netting was in place at all times. Only five fish farms reported having tried using overhead lines to deter depredation from aerial foragers such as Ospreys (Salomon and Conte 1981). The five that tried this method found it to be relatively inexpensive and potentially effective in reducing losses to large aerial-hunting birds like Ospreys.

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LITERATURE CITED

DAVIS, W.E. 1993. Black-crowned Night-Heron (*Nycticorax nycticorax*). *In* A. Poole and F. Gill [EDS.], The birds of North America, No. 74. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, DC U.S.A.

EWINS, P.J. AND C.S. HOUSTON. 1992. Recovery patterns of Ospreys, *Pandion haliaetus,* banded in Canada up to 1989. *Can. Field-Nat.* 106:361–365.

FITZSIMMONS, K. 2000. Future trends of tilapia aquaculture in the Americas. Pages 252–264 *in* B.A. Costa-Pierce and J.E. Rakocy [EDS.], Tilapia aquaculture in the Americas, Vol. 2. World Aquaculture Society, Baton Rouge, LA U.S.A.

HENNY, C.J. AND W.T. VAN VELZEN. 1972. Migration patterns and wintering localities of American Ospreys. *J. Wildl. Manage.* 36:1133–1141.

———, D.J. DUNAWAY, R.D. MALLELTE, AND J.R. KOPLIN. 1978a. Osprey distribution, abundance, and status in western North America: I. The northern California population. *Northwest Sci.* 52:261–272.

———, J.A. COLLINS, AND W.J. DEIBERT. 1978b. Osprey distribution, abundance, and status in western North America: II. The Oregon Population. *Murrelet* 59:14–25.

HILTY, S.L. AND W.L. BROWN. 1986. A guide to the birds of Colombia. Princeton Univ. Press, Princeton, NJ U.S.A.

JOHNSGARD, P.A. 1990. Hawks, eagles, and falcons of North America. Smithsonian Institution Press, Washington, DC U.S.A.

JOHNSON, D.R. AND W.E. MELQUIST. 1991. Wintering distribution and dispersal of northern Idaho and eastern Washington Ospreys. *J. Field Ornithol.* 62:517–520.

MARTELL, M.S., C.J. HENNY, P.E. NYE, AND M.J. SOLENSKY. 2001. Fall migration routes, timing, and wintering sites of North American Ospreys as determined by satellite telemetry. *Condor* 103:715–724.

MCCRIMMON, D.A., JR., J.C. OGDEN, AND G.T. BANCROFT. 2001. Great Egret (*Casmerodius albus*). *In* A. Poole and F. Gill [EDS.], The birds of North America, No. 570. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, DC U.S.A.

MELQUIST, W.E., D.R. JOHNSON, AND W.D. CARRIER. 1978 Migration patterns of northern Idaho and eastern Washington Ospreys. *Bird-Banding* 49:234–236.

NIELSON, G.J. 1998. Las aguilas pescadoras. *Acuioriente* 3: 10.

NIEMUTH, N.D. 1991. Recoveries of Osprey banded in Wisconsin. *Passenger Pigeon* 53:109–114.

PALMER, R.S. 1988. Handbook of North American birds, Vol. 4. Yale Univ. Press, New Haven, CT U.S.A.

PARSONS, K.C. AND T.L. MASTER. 2000. Snowy Egret (*Egretta thula*). *In* A. Poole and F. Gill [EDS.], The birds of North America, No. 489. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, DC U.S.A.

POOLE, A.F. 1989. Ospreys: a natural and unnatural history. Cambridge Univ. Press, Cambridge, U.K.

——— AND B. AGLER. 1987. Recoveries of Ospreys banded in the United States, 1914–1984. *J. Wildl. Manage* 51:148–155.

———, R.O. BIERREGAARD, AND M.S. MARTELL. 2002. Osprey (*Pandion haliaetus*). *In* A. Poole and F. Gill [EDS.], The birds of North America, No. 683. The Birds of North America, Inc., Philadelphia, PA U.S.A.

RIDGLEY, R.S. AND P.J. GREENFIELD. 2001. The birds of Ecuador. Cornell Univ. Press, Ithaca, NY U.S.A.

SALOMON, T.P. AND F.S. CONTE. 1981. Control of bird damage at aquaculture facilities. Wildlife Management Leaflet No. 475, USFWS Cooperative Extension, Univ. California, Davis, CA U.S.A.

SANTANA, E.C. AND S.A. TEMPLE. 1987. Recoveries of banded Ospreys in the West Indies. *J. Field Ornithol* 58:26–30.

SWENSON, J.E. 1981. Status of the Osprey in southwestern Montana before and after the construction of reservoirs. *West. Birds* 12:47–51.

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