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# Historic and Current Status of the American White Pelican Breeding at Chase Lake National Wildlife Refuge, North Dakota

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**Abstract.**—Chase Lake National Wildlife Refuge currently supports the largest breeding colony of the American White Pelican (*Pelecanus erythrorhynchos*) in North America. The first written account of the colony's status was in 1905, when approximately 500 pelicans nested on two islands in Chase Lake. The colony grew to nearly 34,000 breeding birds by 2002. Surveys of breeding pelicans in the colony were sporadic from 1905 until 1972. Because the availability of foraging areas affects recruitment, pond counts from south-central North Dakota were used as an index of the relative availability of foraging areas. Pond counts varied widely in the 1970s and 1980s. In 1993, pond numbers increased dramatically, reached a peak in 1997, then declined but remained relatively high through 2002. Pelican numbers also increased in the mid- to late-1990s, possibly in response to increased and stable foraging opportunities. Because rising water in Chase Lake inundated the original nesting islands during that period, pelicans were forced to relocate nesting areas. Relocation provided more nesting space than the original islands, and nesting pelicans seemed to be gradually filling these areas. Threats to the Chase Lake breeding colony include disease, predation, and human disturbance. Research is needed to better understand the mechanisms that underlie the dynamics of AWPE metapopulations and their sub-units, including factors that influence nest-site selection, productivity, and survival of adults and young in large colonies.

**Key words.**—American White Pelican, breeding colony, numbers, Chase Lake National Wildlife Refuge, North Dakota, *Pelecanus erythrorhynchos*.

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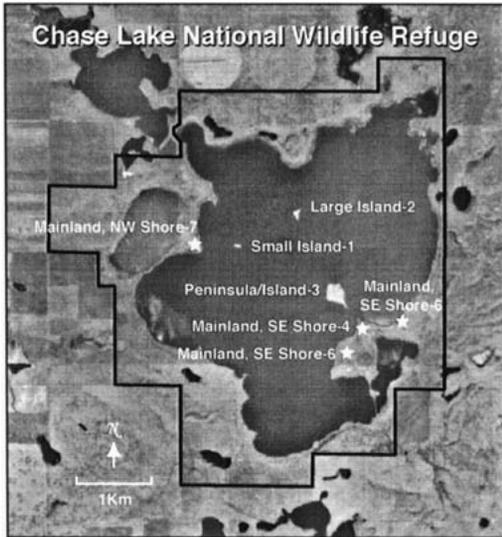
Chase Lake, in western Stutsman County, North Dakota currently supports the largest nesting colony of the American White Pelican (*Pelecanus erythrorhynchos*) in North America (Sloan 1973; Sidle *et al.* 1985; King and Anderson 2005). The first written account of the Chase Lake colony was from Game Warden H. H. McCumber (in Bennett 1926), who stated that about 500 pelicans nested on islands in the lake in 1905. McCumber reported that settlers would spend Sundays at the lake, wagering on how many pelicans they could kill by shooting flying pelicans with rifles. In 1907, concerned that shooting would result in demise of the colony, McCumber contacted the U.S. Biological Survey in Washington, DC, requesting establishment of a refuge at Chase Lake. By 1908 the colony was reduced to only 50 birds. In August of that year, President Theodore Roosevelt issued an executive order designating Chase Lake and surrounding upland

habitats as a National Wildlife Refuge (NWR), primarily to protect the pelicans. In 1975, 1,682 ha of the refuge were designated as a wilderness area. To evaluate the effect of environmental factors on pelican numbers at Chase Lake, historical and current breeding records are summarized for this colony and changes in water conditions of the lake and surrounding wetlands are reviewed.

## STUDY AREA

Chase Lake NWR is 19 km northwest of Medina in Stutsman County, North Dakota (47°01'N, 99°27'W). The 1,775-ha refuge is within the glaciated Missouri Coteau physiographic region (Bluemle 1991). The Coteau is characterized by morainic, gently rolling plains interspersed with closed wetlands, prairie pastures, hayfields, and cropland. An additional 2,474 ha of state and federal lands are adjacent to Chase Lake NWR, and together these areas provide diverse habitats.

Approximately 50% of the refuge consists of wetlands (Fig. 1); the remaining area is native grassland of Little Bluestem (*Schizachyrium scoparium*), Green Needlegrass (*Nassella viridula*), and Needle-and-thread



**Figure 1.** Locations of American White Pelican nesting areas on Chase Lake National Wildlife Refuge, North Dakota. Aerial photograph taken 25 September 1997.

(*Hesperostipa comata*). Chase Lake, the largest wetland, is a shallow, alkaline lake fed by ground water and run-off (Swanson *et al.* 1988). Two gravel-based islands in this lake provide protected nesting areas for pelicans during years of normal to low water levels. When water levels are high, as in recent years, the nesting islands are inundated (discussed below), but new nesting areas are created when peninsulas are cut off by high water and form new islands. In those years, well-drained, gravel-based shorelines also have been used for nesting (Fig. 1). Vegetation in the areas where pelicans nest is primarily Marshelder (*Iva xanthifolia*), Lambsquarters (*Chenopodium album*), Narrow-leaved Goosefoot (*C. leptophyllum*), Kochia (*Kochia scoparia*), Western Snowberry (*Symphoricarpos occidentalis*), Smooth Brome (*Bromus inermis*), and Kentucky Bluegrass (*Poa pratensis*).

Salt concentration increases as the lake draws down (up to 50,000 micromhos per cm, Sidle and Ferguson 1982). The lake does not support fish or the Tiger Salamander (*Ambystoma tigrinum*), the major prey of Chase Lake AWPE (Lingle and Sloan 1980). Brine Shrimp (*Branchinecta* spp. and *Artemia salina*) and Water Boatmen (*Cenocorixa* sp.) are the most numerous invertebrates. Under less saline conditions (e.g., 15,680 micromhos in 2002), invertebrates include amphipods (*Hyaella azteca*) and Water Boatmen (M. Sovada, unpublished data), but the lake remains unsuitable for salamanders.

Other colonial species commonly nesting in and near the pelican colonies include the Double-crested Cormorant (*Phalacrocorax auritus*), American Avocet (*Recurvirostra americana*), Ring-billed Gull (*Larus delawarensis*) and California Gull (*Larus californicus*). Cattle Egret (*Bubulcus ibis*), Great Egret (*Ardea alba*) and Black-crowned Night Heron (*Nycticorax nycticorax*) nest in the few Choke Cherry (*Prunus virginiana*) shrubs located in and on the periphery of the American White Pelican (AWPE) nesting areas. In 2002, Caspian Terns (*Sterna caspia*) colonized the Peninsula/Island-3 (Fig. 1).

## METHODS

We reviewed published papers, theses, annual reports and other records from Arrowwood NWR and Chase Lake NWR to compile historical information about the AWPE colony and the water conditions on Chase Lake NWR. Information on pelicans was sporadic for the years between 1905 and 1970. In 1971, the first aerial survey was conducted (Boeker 1972). However, it was not until 1972 that annual and systematic counts of nesting AWPE began. From 1972 through 1979, biologists conducted annual surveys by walking through the colony and counting nests. Since 1980, annual surveys (except 1985 and 1991) of nest numbers have been completed with aerial photographs (see Sidle and Ferguson 1982 for methods). One active nest equaled one breeding pair.

As an indication of the relative availability of foraging areas and wetland conditions, we present results of U.S. Fish and Wildlife Service's (USFWS) May and July pond counts from 1972-2002 (USFWS 2001, 2002). Pond count data are presented for south-central North Dakota (Strata 46), which includes the area surrounding Chase Lake and much of the accessible foraging areas for the pelicans breeding at Chase Lake (Johnson and Sloan 1978).

Regrettably, no quantitative information about water conditions was available from the refuge. Written descriptions (1970-2002) and aerial photographs (1980-2002) were available from the annual systematic surveys described above. These descriptions and aerial photographs were used to determine when islands were present or inundated and when isthmuses of peninsulas were inundated, creating new islands.

## RESULTS

### The Colony

Estimated numbers of breeding AWPE increased from 50 birds in 1908 to >33,000 in 2002 (Fig. 2; Appendix). Numbers of AWPE fluctuated in the first half of the twentieth century, but most annual counts indicated around 1,000-3,000 breeding birds. However, during that period, data collection was sporadic, the type of information collected (e.g., number of adults, number of breeding birds, number of fledged young, number of eggs) was inconsistent, and the dates of surveys were variable or not recorded. Only one breeding bird count was recorded in the 1950s, but was double the highest of the previous counts. Records suggest relatively stable numbers of breeding AWPE from the early 1960s through the early 1980s (Fig. 3a). Between 1986 and 1988 the colony increased by 73%, followed by a slight decline (33%) between 1988 and 1990. Between 1990 and 2002 the colony has grown by 192% (Fig. 2).

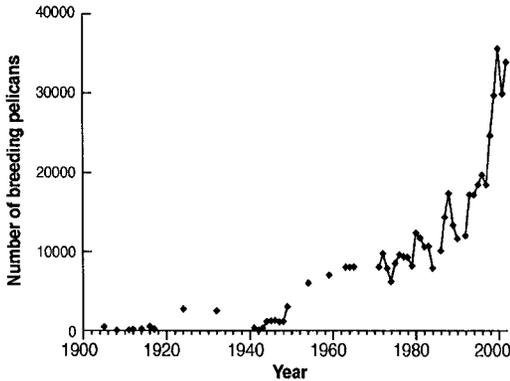


Figure 2. Estimated numbers of breeding American White Pelicans at Chase Lake National Wildlife Refuge, North Dakota, 1905-2002. Lines connecting diamonds indicate continuous data.

#### Wetland Conditions: Availability of Foraging Sites

Water conditions in North Dakota, as indicated by regional pond counts (USFWS 2001, 2002) were highly variable in the 1970s and most of the 1980s (Fig. 3b). North Dakota experienced a drought beginning in 1988, which persisted through 1992 (Winter and Rosenberry 1998). In the summer of 1993, wetland conditions began to improve dramatically; precipitation was above long-term averages for 14 of 19 consecutive months from June 1993 to December 1994 (National Oceanic and Atmospheric Administration 1993, 1994). Since, despite average or below average precipitation, many wetlands persisted; conditions have since been above average.

There is no specific information on the water levels of Chase Lake prior to the 1970s other than consistent reference to the presence of the two islands (Small-1, Large-2; Fig. 1). After 1970, the descriptions in the Refuge annual reports and the aerial photographs taken for counting nests provide the only information about the lake levels. The descriptions and photographs show the persistence of the original two islands through the drought of 1988-1992, until the size of the islands diminished during the extreme wet conditions in the later 1990s. By 1999 the islands were completely inundated.

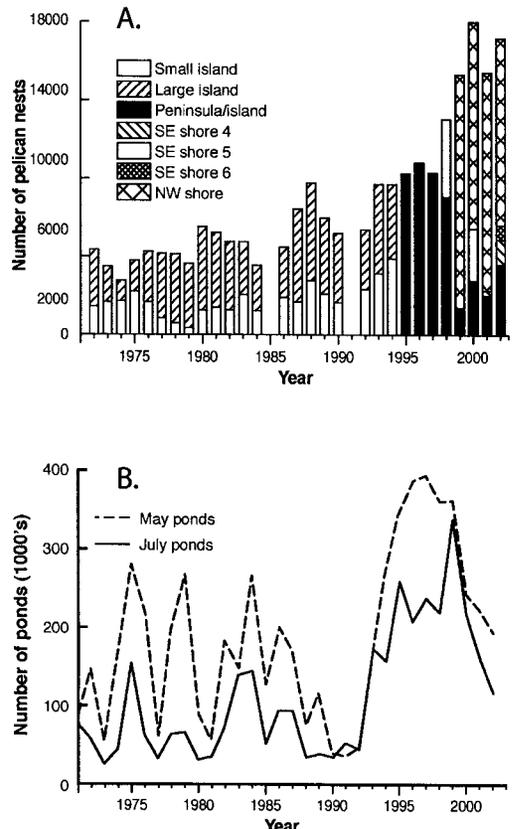


Figure 3. (A) Estimated numbers of American White Pelican nests located on seven sites (see Fig. 1) at Chase Lake National Wildlife Refuge, North Dakota, 1972-2002. (B) Estimated number of ponds for south-central North Dakota (Strata 46) in May ( $\bar{x}$  = 186) and July ( $\bar{x}$  = 110), 1992-2002 (USFWS 2001, 2002).

#### Relocation of Nesting Areas

Early accounts (Bennett 1926; Henry 1947; Gammell 1957) suggest that nesting was restricted to the original two islands, which provided protection from most predators found on the mainland. However, the exceptionally wet conditions beginning in 1993 that caused inundation of the islands forced breeding AWPE to establish new nesting sites.

AWPE selected new sites for breeding and nesting in 1995 (Fig. 3a). The first new sub-colony, comprising 38% of the nests, was located on a peninsula (Peninsula/Island-3, Fig. 1), which was nearly cut off from the mainland by rising water in 1995. The next year, 89% of all nests were on Peninsula/Island-3, which was, by that time, completely

cut off from the mainland. In 1997, 99.6% of all nests were on Peninsula/Island-3. The colony increased 34% between 1997 and 1998, and in 1998, 36% of the breeding pelicans selected nest sites on the mainland (nests were located at SE Shore-4 and SE Shore-5). In 1999, no AWPE used these mainland sites, but rather 90% of the 14,795 nests were located in a new area (NW Shore-7) and the remaining nests were on the Peninsula/Island-3. The NW Shore-7 nesting area has never been completely cut off from the mainland, but the southeast isthmus was inundated in 1999, leaving access only from a narrow upland area in the northwest. In 2000, the colony increased 20% from the 1999 estimates, and 17% of the nests were again located on the mainland at SE Shore-5. By 1999, the isthmus between the mainland and the SE Shore-4 was inundated; thus, SE Shore-4 and SE Shore-6 were now an island. No nests were located at either site in 1999, and only 2% and 14% of nests were located at these sites in 2001 and 2002, respectively (Fig. 3a).

#### Potential Threats to the Nesting Colony

Historic and current threats to the Chase Lake colony include predation and disease. Although shooting is illegal, it remains a potential threat because the refuge is remote and isolated (i.e., refuge headquarters is 29 km and the nearest human habitation is 11 km from the lake). Although human access to the colony is regulated by permit, unauthorized access is a potential problem.

*Predation*—Although considered a major threat to the colony, there have been limited observations of predation at Chase Lake. Johnson (1976) reported predation on young pelicans by gulls (*Larus* sp.) on three occasions during 600 hours of observation. In 1992, a Coyote (*Canis latrans*) was observed leaving Small Island-1 (around 1 July) after presumably preying on eggs or young birds (Chase Lake NWR 1992). In 1996, several (<25) destroyed eggs were found in the outlying perimeter of the SE Shore-5 nesting area during a banding operation in early July (D. T. King, unpublished data). There is growing concern that the Coyote and possi-

bly the American Badger (*Taxidea taxus*) could cause significant destruction to nests on the mainland NW Shore-7.

*Disease*—Disease seems to be the greatest potential threat to the colony in recent years. Because the severity of an infectious disease outbreak is often density-dependent, an outbreak in the colony could be devastating.

There was an indicated, but unconfirmed outbreak of Newcastle Disease Virus (NDV) in 1992. “Many” dead gulls, Double-crested Cormorants and young AWPE were discovered at Chase Lake in mid-July (Chase Lake NWR 1992). Because NDV was found in pelicans and cormorants in Minnesota and South Dakota, dead birds from Chase Lake were tested for NDV. The resulting pathology supported the presence of NDV, but final diagnosis was inconclusive (Chase Lake NWR 1992; U.S. Geological Survey’s [USGS] National Wildlife Health Center). This die-off occurred during the fifth year of a severe drought in the region, when the availability of foraging wetlands was seriously limited. Pelicans were forced to travel longer distances to forage, which likely caused stress making them more vulnerable to diseases. Ultimately, 1,554 dead pelicans were collected and incinerated between mid-July and 15 October of that year (Chase Lake NWR 1992).

Other identified diseases affecting birds near Chase Lake included: 1) West Nile Virus, positively diagnosed in other species from Stutsman County, North Dakota, in 2002 (USGS Center for Integration of Natural Disaster Information; [http://cindi.usgs.gov/hazard/event/west\\_nile/usa\\_avian\\_oct\\_02.html](http://cindi.usgs.gov/hazard/event/west_nile/usa_avian_oct_02.html)) and in pelicans at Bitter Lake, South Dakota (L. Hubers, USFWS, Waubay NWR, pers. comm.); 2) chlamydiosis, which was identified as a cause of death of Ring-billed Gulls in 2002 at a colony located about 100 km south of Chase Lake (R. Sohn, USGS, National Wildlife Health Center, pers. comm.); and 3) avian botulism, which has periodically been reported killing birds in wetlands within reach of the Chase Lake AWPE colony, and in 2004 a confirmed death from botulism was determined by the USGS National Wildlife Health Center (M. Sovada and K. Converse, unpublished data). In Sep-

tember 2002, approximately 1,000 dead pelicans (mostly young) were found at the Chase Lake colony but carcass conditions were such that determining cause of death was impossible. Significant, although not quantified losses of young pelicans were reported for a similar time period at colonies located at Bitter Lake, South Dakota (L. Hubers, USFWS, Waubay NWR, pers. comm.); Marsh Lake, Minnesota (J. DiMatteo, Minnesota Department of Natural Resources, pers. comm.); and Medicine Lake, Montana (E. Madden, USFWS, Medicine Lake NWR, pers. comm.). West Nile Virus was suspected and a study to monitor for West Nile Virus at the Chase Lake, Medicine Lake and Bitter Lake colonies began in 2004. Preliminary results from the study indicated that West Nile Virus has caused an appreciable loss of preflledged pelicans (M. Sovada, unpublished data).

#### DISCUSSION

Information is lacking on the proximate factors that influence the numbers of breeding AWPE at Chase Lake. Complicating a review of these factors is the inconsistent nature in which this information has been collected (e.g., time, type; Appendix). The best records start in 1972.

The AWPE colony at Chase Lake remained relatively stationary in the 1970s and early 1980s, although water conditions were variable during that period (Fig. 3b). Favorable wetland conditions benefit AWPE by reducing the distance to foraging areas and thus optimizing foraging efficiency. In periods of low water, when many wetlands are dry, AWPE must travel long distances to forage. Johnson and Sloan (1978) reported round-trip foraging distances from Chase Lake of up to 611 km. They proposed that extremely high rates of nest abandonment (75%-99%) during their study were related to low water levels, which forced birds to travel farther and spend more time foraging. Johnson and Sloan (1978) further speculated that survival of young during their study was related to water conditions (i.e., lower survival rates occurred when wetland conditions were dryer). However, the initial draw-down of wetlands

may benefit AWPE by concentrating prey and thus making them more vulnerable and accessible (Lingle and Sloan 1980). During the 1970s and early 1980s, water levels were variable, and the colony did not respond numerically to good conditions because poor conditions followed immediately thereafter (Fig. 3b). During the severe drought of 1988-1992 (Winter and Rosenberry 1998), the breeding colony at Chase Lake increased in 1988 and then declined slightly between 1989 and 1992. The return of wet conditions that began in 1993 was dramatic, quickly restoring water in wetland basins, and wetland conditions have since been above average. The growth in the colony that began in the late 1990s might have been in response to the increased availability of ponds for foraging beginning in 1993, thereby improving recruitment (Johnson and Sloan 1978).

Another factor that might influence numbers of breeding AWPE at Chase Lake is the availability of nesting areas protected from mammalian predators. American White Pelican nesting areas tend to be on islands (Evans and Knopf 1993), but mainland nesting has been reported (Evans 1972; our studies). At Chase Lake, accounts prior to 1995 indicated that AWPE nests were confined to the two original islands, which provided protection from mammalian predators from the mainland. The rising lake level in the late 1990s inundated historical nesting areas and created new nesting areas that provided some degree of protection from predators and ultimately provided more space for nesting than the original islands (see Fig. 1). The pelicans seem to be gradually filling these new nesting areas. The reason for the decline in number of breeding pelicans at Chase Lake in 2001, 2002 and 2003 is unclear.

The AWPE colony at Chase Lake is clearly important to the status and stability of the eastern metapopulation. Monitoring and assessing the factors that influence the health of this colony is paramount for protecting it from imminent threats. Human disturbance, shooting (Strait and Sloan 1975), predation, and disease continue to be potential threats. Sidle and Ferguson (1982) provided recommendations for management. However, in the absence of a

clear understanding of the mechanisms that underlie the dynamics of AWPE numbers, there is a need to investigate the factors that influence nest-site selection, productivity, and survival of adults and young, as well as a need for information on how to actively manage and protect the Chase Lake colony. With an understanding of why pelicans select specific nesting locations, it might be possible to create favorable conditions at abandoned sites and new locations. Attracting breeding birds to unused locations might further safeguard against the effects of catastrophic events at a colony as large as that at Chase Lake.

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## LITERATURE CITED

- Arrowwood National Wildlife Refuge. 1937-1985. Annual report of the Arrowwood National Wildlife Refuge. Unpublished reports. Pingree, North Dakota: USFWS, Arrowwood National Wildlife Refuge.
- Bailey, A. M. 1935. The White Pelican. *Bird-Lore* 37: 329-336.
- Bennett, W. W. 1926. White Pelicans and other birds of Chase Lake, North Dakota. *Wilson Bulletin* 135: 65-79.
- Bluemle, J. P. 1991. The face of North Dakota. Revised edition. North Dakota Geological Survey Education Series 21, Bismarck, North Dakota.
- Boeker, E. L. 1972. A survey of White Pelican nesting colonies in 1971. *American Birds* 26: 124-125.
- Chase Lake National Wildlife Refuge. 1986-2002. Annual report of the Chase Lake National Wildlife Refuge. Unpublished reports. Woodworth, North Dakota: U.S. Fish and Wildlife Service, Chase Lake National Wildlife Refuge.
- Evans, R. M. 1972. Some effects of water level on the reproductive success of the white pelican at East Shoal Lake, Manitoba. *Canadian Field-Naturalist* 86: 151-153.
- Evans, R. M. and F. L. Knopf. 1993. American White Pelican (*Pelecanus erythrorhynchos*). No. 57 in A. Poole and F. Gill (Eds.), *The Birds of North America*. The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, DC.
- Gammell, A. M. 1956. Northern Great Plains region. *Audubon Field Notes* 10: 390-392.
- Gammell, A. M. 1957. Northern Great Plains region. *Audubon Field Notes* 11: 413-314.
- Gammell, A. M., R. T. Gammell and H. S. Huenecke. 1953. Northern Great Plains region. *Audubon Field Notes* 7: 313-315.
- Henry, C. J. 1947. Northern Great Plains region. *Audubon Field Notes* 1: 183-185.
- Johnson, R. F., Jr. 1976. Mortality factors affecting a White Pelican population, Chase Lake National Wildlife Refuge, North Dakota. Unpublished Ph.D. Thesis, Michigan Technological University, Houghton.
- Johnson, R. F. Jr. and N. F. Sloan. 1978. White Pelican production and survival of young at Chase Lake National Wildlife Refuge, North Dakota. *Wilson Bulletin* 90: 346-352.
- King, D. T. and D. W. Anderson. 2005. Recent population status of the American White Pelican: a continental perspective. *Waterbirds* 28 (Special Publication 1): 48-54.
- Lies, M. F. and W. H. Behle. 1966. Status of the White Pelican in the United States and Canada through 1964. *Condor* 68: 279-292.
- Lingle, G. R. 1977. Food habits and sexing-aging criteria of the White Pelican at Chase Lake National Wildlife Refuge, North Dakota. Unpublished M.S. Thesis, Michigan Technological University, Houghton.
- Lingle, G. R. and N. F. Sloan. 1980. Food habits of White Pelicans during 1976 and 1977 at Chase Lake National Wildlife Refuge, North Dakota. *Wilson Bulletin* 92: 123-125.
- National Oceanic and Atmospheric Administration. 1993-1994. Climatological data, North Dakota Nos. 102 and 103.
- Sidle, J. G., P. M. Arnold, and R. K. Stroud. 1984. Notes on mortality of American White Pelicans at Chase Lake, North Dakota. *Prairie Naturalist* 16: 131-134.
- Sidle, J. G., W. H. Koonz and K. Roney. 1985. Status of the American White Pelican: an update. *American Birds* 39: 859-864.
- Sidle, J. G. and E. L. Ferguson. 1982. White Pelican populations at Chase Lake, North Dakota, evaluated by aerial photography. *Prairie Naturalist* 14: 13-26.
- Sloan, N. F. 1973. Status of breeding colonies of White Pelicans in the United States through 1972. *Inland Bird Banding News* 45: 83-96.
- Stewart, R. E. 1975. Breeding Birds of North Dakota. Tri-College Center for Environmental Studies, Fargo, North Dakota.
- Strait, L. E. 1973. Population dynamics of a White Pelican population, Chase Lake National Wildlife Refuge, North Dakota. Unpublished M.S. Thesis, Michigan Technological University, Houghton.
- Strait, L. E. and N. F. Sloan. 1975. Movements and mortality of juvenile White Pelicans from North Dakota. *Wilson Bulletin* 87: 54-59.
- Swanson, G. A., T. C. Winter, V. A. Adomaitis and J. W. LaBaugh. 1988. Chemical characteristics of prairie lakes in south-central North Dakota—Their potential for influencing use by fish and wildlife. U.S. Fish and Wildlife Service, Fish and Wildlife Technical Report 18.
- Thompson, B. H. 1932. History and present status of the breeding colonies of the White Pelican (*Pelecanus erythrorhynchos*) in the United States. National Park Service, Wildlife Division, Occasional Paper No. 1. U.S. Department of Interior, Washington, DC.
- U.S. Fish and Wildlife Service. 2001. Waterfowl breeding population survey for South Dakota and North Dakota. U.S. Fish and Wildlife Service, Washington, DC.
- U.S. Fish and Wildlife Service. 2002. Waterfowl production survey for South Dakota and North Dakota. U.S. Fish and Wildlife Service, Washington, DC.
- Winter, T. C. and D. O. Rosenberry. 1998. Hydrology of prairie pothole wetlands during drought and deluge: A 17-year study of the Cottonwood Lake Wetland Complex in North Dakota in the perspective of longer term measured and proxy hydrological records. *Climatic Change* 40: 189-209.

**Appendix. Estimated<sup>1</sup> number of nests and young American White Pelicans at Chase Lake National Wildlife Refuge, North Dakota, 1905-2002.**

Year	Date: nest survey	Nests	Young	Source <sup>2</sup>
1905		250 <sup>3</sup>		H. H. McCumber (in Bennet 1926)
1908		25 <sup>3</sup>		H. H. McCumber (in Bennet 1926)
1911		48		H. H. McCumber (in Stewart 1975)
1912		80		H. H. McCumber (in Stewart 1975)
1914		100		H. H. McCumber (in Stewart 1975)
1916		250 <sup>3</sup>		Bennett 1926
1917	Jun	111	131	H. C. Oberholser (in Stewart 1975)
1924		1250-1500 <sup>3</sup>		H. H. McCumber (in Bennet 1926)
1927		1250-1500 <sup>3</sup>		H. H. McCumber (in Stewart 1975)
1928	Jun	500		Bailey 1935
1932		1000-1500 <sup>3</sup>		Thompson 1932
1934			325	Bailey 1935
1935				Bailey 1935
1937		200	65	Arrowwood NWR 1937, Henry 1947 (young)
1941		150 <sup>3</sup>		Lies & Behle 1966
1942		23 <sup>3</sup>	25	Lies & Behle 1966
1943		138 <sup>3</sup>	25	Lies & Behle 1966
1944		750	1000	Lies & Behle 1966
1945		600 <sup>3</sup>	900	Lies & Behle 1966
1946		500	950	Lies & Behle 1966
1947		400	925	Henry 1947, Lies & Behle 1966
1948		550 <sup>3</sup>	1100	Lies & Behle 1966
1949		1500 <sup>3</sup>	1100	Lies & Behle 1966; N. B. Nelson (in Stewart 1975)
1950			1300	Lies & Behle 1966
1951			1400	N. B. Nelson (in Stewart 1975)
1952			1400	Gammell et al. 1953
1953			1200	Gammell et al. 1953
1954		3000 <sup>3</sup>	many	N. B. Nelson (in Stewart 1975)
1955				Lies & Behle 1967
1956			1200-1500	Gammell 1956
1957			1500	Gammell 1957
1958				Lies & Behle 1966
1959		3500		Lies & Behle 1966
1960		500		Lies & Behle 1966
1961		4000		Lies & Behle 1966
1962				Lies & Behle 1966
1963		4000		Lies & Behle 1966
1964		4000 <sup>3</sup>	3000	Lies & Behle 1966
1965		4000 <sup>3</sup>		D. A. Anderson (in Stewart 1975)
1966		"numerous"		Stewart 1975
1967		3000	6000	Arrowwood NWR 1966
1968			"many"	Stewart 1975
1970		1746	2339	Arrowwood NWR 1970
1971		2150		Boeker 1972, Sloan 1973
1972	28 May	4827	1500-2000	Strait 1973, Johnson 1976; Sidle & Ferguson 1982
1973	27 May	3911	2100	Johnson & Sloan 1978; Sidle & Ferguson 1982
1974	25 May	3082	1200	Johnson & Sloan 1978; Sidle & Ferguson 1982
1975	24 May	4221		Johnson 1976; Sidle & Ferguson 1982
1976	31 May	4755		Lingle 1977, Sidle & Ferguson 1982

<sup>1</sup>Little information was available regarding how estimates were determined prior to 1970; systematic annual surveys of nest numbers began in 1972; 1980-2002 number of nests was determined by aerial surveys.

<sup>2</sup>Annual reports (Arrowwood National Wildlife Refuge 1937-1985, Chase Lake National Wildlife Refuge 1986-2002) were examined to corroborate published reports.

<sup>3</sup>Published accounts indicated number of breeding adults. That number was divided by two for estimation of number of nests.

**Appendix. (Continued) Estimated<sup>1</sup> number of nests and young American White Pelicans at Chase Lake National Wildlife Refuge, North Dakota, 1905-2002.**

Year	Date: nest survey	Nests	Young	Source <sup>2</sup>
1977	29 May	4619		Lingle 1977, Sidle & Ferguson 1982
1978	2 Jun	4589		Sidle & Ferguson 1982
1979	30 May	4051		Sidle & Ferguson 1982
1980	3 Jun	6142		Sidle & Ferguson 1982; Sidle et al. 1984
1981	3 Jun	5826		Sidle et al. 1984
1982	1 Jun	5268		Sidle et al. 1984
1983	14 Jun	5292		Sidle et al. 1984
1984	25 Jun	3921		Chase Lake NWR 1984
1985	No survey conducted			Chase Lake NWR 1985
1986		4995		Chase Lake NWR 1986
1987		7139		Chase Lake NWR 1987
1988		8640		Chase Lake NWR 1988
1989		6629		Chase Lake NWR 1989
1990		5784		Chase Lake NWR 1990
1991	No survey conducted			Chase Lake NWR 1991
1992	5 Jun	5976		Chase Lake NWR 1992
1993	26 May	8553		Chase Lake NWR 1993
1994	27 May	8545		Chase Lake NWR 1994
1995	2 Jun	9180		Chase Lake NWR 1995
1996	5 Jun	9781		Chase Lake NWR 1996
1997	5 Jun	9182		Chase Lake NWR 1997
1998	11 Jun	12281		Chase Lake NWR 1998
1999	2 Jun	14795		Chase Lake NWR 1999
2000	2 Jun	17733		Chase Lake NWR 2000
2001	31 May	14896		Chase Lake NWR 2001
2002	28 May	16883		Chase Lake NWR 2002

<sup>1</sup>Little information was available regarding how estimates were determined prior to 1970; systematic annual surveys of nest numbers began in 1972; 1980-2002 number of nests was determined by aerial surveys.

<sup>2</sup>Annual reports (Arrowwood National Wildlife Refuge 1937-1985, Chase Lake National Wildlife Refuge 1986-2002) were examined to corroborate published reports.

<sup>3</sup>Published accounts indicated number of breeding adults. That number was divided by two for estimation of number of nests.