NORTH DAKOTA GAME AND FISH DEPARTMENT

Final Report

Exploration of Factors That May Lead to Colony Abandonment or Reduced Productivity of American White Pelicans in the Northern Plains

Project T-7-R

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PROJECT TITLE: Exploration of factors that may lead to colony abandonment or reduced productivity of American white pelicans in the northern plains

ACTIVITY PERIOD: May 1, 2005 – July 17, 2007

LOCATION: Chase Lake National Wildlife Refuge, North Dakota

BACKGROUND

Nearly half of the North American population of American white pelicans breed at 4 colonies in the northern plains (Bitter Lake, South Dakota; Chase Lake National Wildlife Refuge [NWR], North Dakota; Medicine Lake NWR, Montana; Marsh Lake, Minnesota). Thus, sustained productivity at these colonies is crucial to the health of the entire North American population. Because pelicans are colonial breeders and nesting is concentrated in a few, small areas, they are especially vulnerable to factors (e.g., weather events, disturbance [human or otherwise], loss of nesting habitat) that can influence productivity.

Near the end of the 2002 and 2003 breeding seasons, large die-offs (e.g., >5000 young at Chase Lake in 2003) were observed in the 4 major colonies in the northern plains; West Nile virus (WNv) was the suspected cause. These significant losses prompted a research project by the Northern Prairie Wildlife Research Center (NPWRC), the U.S. Fish and Wildlife Service (Arrowwood and Chase Lake NWRs), and the National Wildlife Health Center to assess the impact of West Nile virus on pelican populations in the northern plains and to identify its importance relative to other mortality factors. That research was focused on 3 colonies, Chase Lake, Bitter Lake, and Medicine Lake. During surveillance of colonies in 2004 for that study, we observed the complete abandonment of the Chase Lake colony, partial abandonment of the Medicine Lake colony, and reduced productivity at the Bitter Lake colony. At Chase Lake, pelicans on the mainland subcolony abandoned all of their eggs during mid- to late May. In June of that year, observers discovered that most chicks on the north island subcolony had died and their parents were gone. The total abandonment at Chase Lake drew national and international attention and considerable speculation on the cause. Reasonable suggestions proposed as cause for the abandonment were (1) coyote depredation and disturbance, (2) anthropomorphic disturbance, (3) disease, (4) weather, (5) reduced or unavailable food resources, or (6) a combination of factors.

Disturbance by coyotes or humans could cause enough stress to induce large-scale abandonment or reduce productivity. Abandonment was first observed at the mainland subcolony at Chase Lake, where there was clear evidence that coyotes had destroyed many eggs. It is unlikely that coyotes directly disturbed subcolonies on the islands in Chase Lake, however it is possible that birds displaced from the mainland subcolony could have tried to settle on the islands, thus causing disturbance to the pelicans nesting on the islands. There was no evidence of disturbance by humans (either colony visitation or harassment via airplane or boat), but such activities easily could have gone undetected at this remote nesting colony.

Colony abandonment at the levels observed at Chase Lake and Medicine Lake were not documented farther east at the Bitter Lake or Marsh Lake colonies. Less stability in water conditions in the western part of the region and somewhat dry spring conditions could have affected availability of some aquatic food resources. If food availability was reduced in 2004, adult pelicans might have been forced to travel farther to forage, which in turn might have caused them to spend more time away from their nests. If so, the added energy costs, and possible losses of eggs and chicks (e.g., to exposure, gull predation) resulting from decreased nest attendance, might have contributed to abandonment. Because little research has been conducted at these colonies, information is deficient regarding distances adults travel to feed, time adults normally spend away from eggs/young, variability in diet, and availability of food resources. Although we cannot completely dismiss a possible link between food resources and colony abandonment at Chase Lake in 2004, there is no recorded precedent for abandonment at this site, despite severe multi-year droughts as recently as 1988−1993.

The role of disease as a factor is being explored through the WNv study that we are currently conducting at the colonies in North Dakota, South Dakota, and Montana. There is no evidence that disease contributed to the Chase Lake abandonment. In 2003 at all 3 colonies and in 2004 at Bitter Lake and Medicine Lake, WNV began impacting young pelicans in mid- to late-July. The disease onset corresponds to the presence and increase in abundance of the mosquito, *Culex tarsalis*, the most common vector of WNv in this region. The abandonment at the Chase Lake colony occurred about 6 weeks before the typical onset of WNv.

A more plausible cause of the departure of adults from the north island at Chase Lake in 2004 was severe weather. The nests on this island had been initiated earlier than those on the mainland; most of these pelicans had chicks that were a few weeks old. At this stage, chicks begin to leave their nests and form small groups (crèches) and are no longer brooded by adults. These chicks are particularly vulnerable to prolonged periods of cold, wet, windy weather, which occurred during 29 May through 1 June 2004. This storm system was believed to have killed about 800 chicks at the Marsh Lake pelican colony in Minnesota. Once the chicks are dead, their parents have no reason to return to the colony.

Previously documented abandonment at colonies in western North America (e.g., Nevada, Utah), where resources are limited under good conditions, have been attributed to lack of food resources. Instability in water conditions in North Dakota and somewhat dry spring conditions may have affected availability of aquatic food resources. Reduced availability of foods might have forced adults to travel farther to forage and, thus, caused them to spend more time away from their nests. Time away from the colony increases vulnerability of eggs and chicks to losses. Unprotected eggs and chicks are at risk to gull predation and chicks especially are at risk to exposure caused deaths from even slight variation in temperatures (hot or cold). Very little research has been conducted at these colonies and little information is available about amount of time adults spend away from nesting areas, distances they travel to feed under different conditions, variability in diet, and availability of food resources. Thus, no data are available to confirm or refute a food availabilty hypothesis. However, abandonment was not documented in the severe drought years in the late 1980s and early 1990s, and the sudden abandonment rather than attrition of adults through time does not suggest limited food resources as a cause. Also, the 2004 abandonment occurred largely during the incubation stage, when there would have been less demand for food compared to the nestling stage.

The catastrophic abandonment of the Chase Lake colony raised concerns about the stability of colonies in the northern Great Plains and underscored the limits of our understanding of population dynamics and ecology in this colonial breeding bird. To address these shortcomings, we began a multi-faceted effort to gather ecological information about the colonies in South Dakota, North Dakota, and Montana. Our goal is to advance our understanding of white pelican ecology and provide sound science on which to base future management decisions.

OBJECTIVES

1) Document nesting phenology and nesting behaviors,
2) Determine nest-attendance schedules and quantify chick feeding rates,
3) Estimate distances to foraging sites and determine attributes of those sites,
4) Document timing and extent of egg and chick losses,
5) Record evidence of colony disturbances, disease outbreaks, and severe weather events,
6) Obtain fresh carcasses for necropsy if and when significant losses of chicks or adults occur,
7) Apply USGS bands on a sample of chicks.

EXPECTED RESULTS OR BENEFITS

This multi-faceted monitoring effort will help identify factors that may lead to colony abandonment or reduced productivity. This effort also will provide basic information on the pelican's foraging ranges and locations, time budgets, nesting activities, and potential sources of disturbance. Additionally, 10 GPS satellite transmitters deployed on adult pelicans at Chase Lake will help to assess patterns of nest attendance, foraging distances, and foraging site characteristics. Definitive causes of the 2004 abandonment of the Chase Lake colony may never be determined. However, data from transmittered pelicans, surveillance cameras, and observers will contribute to our understanding of pelican biology at the Chase Lake site and other pelican colonies. This effort will provide a foundation for conservation and management decisions that potentially affect the entire North American population of American white pelicans.

The American white pelican is listed as a Level One Species of Conservation Priority by the North Dakota Game and Fish Department (NDGF). The results of this project will contribute to North Dakota's Comprehensive Wildlife Conservation Strategy by providing rationale for the recent colony abandonment and possible guidance to limit further abandonment or reproductive failures.

APPROACH

The North Dakota Game and Fish Department granted money to the Arrowwood National Wildlife Refuge Complex for the purpose of conducting a monitoring effort of American white pelicans at Chase Lake NWR in North Dakota. The funds, received through the State Wildlife Grant Program, support data collection and analysis for Chase Lake National Wildlife Refuge. Data collection continues through 2007, with a final report anticipated within a year of the conclusion of data collection, September 2008. The principal investigators of this project are Marsha Sovada and Pamela Pietz of the Northern Prairie Wildlife Research Center, and Paulette Scherr of Arrowwood NWR. Other sources of support for this project include funding from Northern Prairie Wildlife Research Center and FWS – Challenge Cost Share Program.

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METHODS

Surveillance of Nesting Colony

***Phenology and mortality events.*—**General phenological information, such as courtship flights, nest initiation dates, temporal and spatial settling patterns of nesting areas, and hatch dates, was gathered weekly from remote observation points. Settling patterns of nesting adults in subcolonies were recorded on aerial photographs of the islands as the pelicans settled on nests sites. Mortality events (i.e., mortality beyond normal losses) were documented.

***Intensive observations of activities at nest: video and direct observations.*—** We deployed digital video-camera systems to remotely monitor activities of pelicans at nests and chicks when crèched (Fig. 1). One camera system was deployed in 2005 and 2006, and 2 systems were deployed in 2007. A camera system consists of a high-quality digital video camera with zoom lens in a waterproof housing, a digital video recorder in a weatherproof box, a sealed lead-acid AGM battery (with ≥ 100 amp-hr capacity), and a 120-watt solar panel. Time-lapse recordings from the cameras documented diurnal and crepuscular activities at the colony on Chase Lake, focusing on parental care of chicks that were still in the nest bowl. We selected a sample of nests in close view of the camera to record behavioral information including (1) percent of time that adults attended nests during incubation and brooding, (2) times of adult departures from and arrivals to nests, (3) frequency of chick feedings during the brooding stage, and (4) chick health status.

Field personnel conducted systematic observations of activities at nests to supplement and assist in interpretation of data collected with video systems. Systematic observations were made from a blind at vantage points located so that disturbance to pelicans tending nests was minimal. Detailed information was collected about (1) condition of eggs and young (to the extent possible from a distant observation point), (2) timing and frequency of chick feedings, and (3) levels of nest attendance throughout the nesting period. We attempted to collect observational data for approximately 5-hour sessions on ≥3 days each week (less often in 2007 because of financial constraints), depending on weather (ability to safely access islands) and the time available after other study responsibilities were met. The day was divided into 3 periods of time for observation sessions (0800-1300 hrs, 1000-1500 hrs, and 1300-1800 hrs). We overlapped observation periods to increase data collection during 1100-1300 hr because most exchanges between members of a pair occur around mid-day.

Figure 1. Digital video-camera system monitoring activities of pelicans at nests.

***Nest and chick surveys.*—**Each year in late-May, we obtain aerial photographs of the nesting colony to determine numbers of nests initiated at Chase Lake. A semi-automated GIS-counting program developed at Northern Prairie Wildlife Research Center was used to count the number of nests at each subcolony. To determine numbers of chicks, we used ground count estimations (i.e., walk through the colony after chicks were crèched and count individual chicks in each crèche) and counts from aerial photograph with methods used for nest counts. Ground counts were used under conditions of low productivity.

West Nile Virus Surveillance

(This is part of a larger study including Bitter Lake and Medicine Lake colonies)

***Disease surveillance*.**—Beginning in June of each year (2004–2007), we monitored pelican colonies weekly from vantage points that minimized disturbance to nesting birds. Each week, we estimated ratios of healthy/sick chicks and number of dead chicks to detect the onset of any disease event. We attempted to identify causes of mortality events from available evidence. In 2003, the sudden onset of a die-off in mid-July was conspicuous, with many young birds becoming obviously sick. In 2005, once symptoms of a disease were detected, our weekly goal was to collect a minimum of 10 moribund or recently dead (no sign of autolysis) chicks at each colony. Individual chicks were collected from throughout each colony to ensure a representative sample. Moribund chicks (staggering, unable to stand or hold up head) were included in the sample because it was difficult to find enough dead chicks that were still fresh enough for pathological tests. We euthanized moribund chicks by cervical dislocation (Ad Hoc Committee on the Use of Wild Birds in Research 1988, Andrews et al. 1993, NWHC ACUC guidelines). Prior to euthanasia, we collected a blood sample for use in diagnostic tests. Chick carcasses were kept chilled on ice and shipped to the USGS National Wildlife Health Center for pathological examination within 24 hours of collection. If overnight shipping was not possible, carcasses were frozen and shipped as soon as possible. Prior to examinations, frozen chicks were slowly thawed within a refrigerated room to minimize cell damage. Carcasses that were badly autolyzed and contained mature maggots were considered unsuitable for complete diagnostics and only feathers were collected for WNv testing.

In 2006 and 2007, we discontinued intensive collection of carcasses, reducing our collections to 3 carcasses within 2 weeks of initially observing evidence of a disease event. Our objective was to document the cause of the disease event and the approximate time of its onset. We collected another 3 chicks about 4 weeks later to confirm that the cause of later mortalities continued to be the virus. Chicks collected in 2006 did not undergo diagnostics beyond examination for WNv and thus, are not included in compilation of diagnostic results below.

Suitable chick carcasses underwent complete diagnostic necropsies and hystopathological examination of routine tissues. General body condition of each examined chick was ranked as excellent, good, fair, or poor based on visible fat and stage of development. Condition of the heart was ranked as normal—size of heart is normal, tissues appear healthy, no hemorrhages, pericardial sac clear; mild—heart normal size, 1 or 2 small 1-2 mm pale areas, pericardial sac still clear; moderate—fluid building around heart, more discoloration, some cloudiness in pericardial sac; severe—heart enlarged, many small or a few large areas of discoloration, excess fluid in pericardial sac, pericardial sac fibrous and adhering to liver and heart. During necropsy examinations, histological examinations were made of the brain, lung, heart, liver, spleen, and kidney; tissue samples were collected for WNv tests (brain, heart, kidney, spleen, feathers, and when available, pericardial fluid), botulism type C assay (heart blood), and salmonella culture (liver). Virology samples were tested immediately. Botulism and salmonella samples from 1 chick per site in each weekly shipment were submitted immediately for bacteriological tests. All remaining samples for botulism and salmonella were archived in an ultra low temperature (-80 °C) freezer. After initial salmonella tests were completed, additional samples were selected to achieve testing of approximately 50% of all chicks. Similarly, after initial botulism samples were processed, additional samples for botulism were selected from chicks that were in good post-mortem condition and were not positive for either WNv or salmonella.

Late breeding season mortality rates.—For the years just prior to the arrival of WNv in the region, available banding records were used to estimate pre-fledge mortality rates for the period of mid-July to fledging (i.e., period that WNv is prevalent in colonies; hereafter, late breeding season). We banded chicks at Chase Lake in post-WNv years; banding records were used to estimate late-breeding season mortality rates from mid-July through fledging. Pelican chicks were banded in late June or early July each year, which fortuitously was just prior to onset of WNv infections in colonies in mid-July. We estimated mortality rates by calculating the proportion of bands applied each year that were recovered from dead pre-fledged pelicans after WNv was detected in the colony.

For years prior to this study, banding records were available for the colony at Chase Lake (1998, 2001, 2002). For post-WNv years, our goal was to band 2500 pelican chicks at Chase

Lake each year. Bands were periodically collected from chicks that had died. In all years, after chicks fledged, we conducted intensive systematic searches of the nesting sites (islands and peninsulas) to recover all bands from pre-fledging young that died. To eliminate chicks that might have died because of stress or injury caused by banding activities, bands collected within the first week of banding were not included in calculations of mortality rates. Banding activities always occurred ≥ 1 week before the initial WNv deaths were detected. We assume our assessment of late-breeding season losses are conservative because not all dead chicks with bands are found.

***Disease transmission.*—**In 2006 and 2007, we collected blood samples from 3-week old chicks to see if there is evidence of immunity conferred by the female to the chick. Samples were collected prior to the detection of WNv in the colony. Later in the breeding season, we collected blood from nearly fledged healthy chicks to determine if they had been exposed to WNv and survived.

We also collected throat and fecal swabs from sick chicks to determine if they are shedding the virus. This will help us assess whether chick-to-chick transmission of WNv is possible. WNv transmission is believed to occur only from mosquito to bird; however, if disease transmission is also occurring directly between chicks, it could explain why pelican chicks appear to be uniquely susceptible to this disease.

Figure 2. Biologist collecting oral swabs from sick pelican chick to assess shedding of WNv.

***Mosquito monitoring*.**—The mosquito, *Culex tarsalis*, has been identified as the major vector of WNv in our region of study. Each year, beginning the first week of June and continuing through August, we monitored the presence and relative abundance of mosquitoes at and in the vicinity of the Chase Lake colony. We collected samples of adult mosquitoes weekly with New Jersey traps. Our trapping was coordinated with a monitoring effort being conducted by the North Dakota Department of Health (see http://www.ndhealth.gov/WNV/Data/Summary.aspx). Many of our weekly samples were too wet to assess species content. Therefore, we used the North Dakota Department of Health data (average weekly counts) as an index to the prevalence of *C. tarsalis*, through the season. Usable samples at our study areas reflected the state wide trends reported by the North Dakota Department of Health.

Monitoring adult movements with Satellite GPS Transmitters

In 2005 and 2006, after most pelican eggs had hatched, we captured adult pelicans at loafing sites away from the nesting areas and attached a 70-g solar-powered GPS satellite transmitter (PTT-100) to each pelican. Transmitters should provide ≥ 3 years of location data (<24 locations/day at 1-hour intervals) with GPS accuracy. Locations can be used to assess (1) colony attendance, (2) foraging site locations and distances from the colony, and (3) proportion of time spent away from the colony. In addition, location data during the non-breeding season can be used to assess (1) migration routes and movements, (2) wintering areas, and (3) onset of spring and fall migration. Delaying transmitter attachment until post-hatch was intended to minimize the chances of nest abandonment. Data from 4 additional birds fitted with GPS transmitters in 2004 at Chase Lake by T. D King, USDA's National Wildlife Research Center, may be available to supplement this information if those individuals return to breed at Chase Lake.

PRELIMINARY RESULTS

Surveillance of Nesting Colony

Phenology.—Each year pelicans began to arrive at Chase Lake in early April and egg-laying began during the first or second week in April (Table 1). We observed nest initiations through May and a small proportion the first week of June.

In 2005, nesting adult pelicans used only the 3 islands within Chase Lake (Fig. 2); initiating nests first on the north island and lastly on the more heavily vegetated south island. Nests were initiated within a few days of the arrival of adults. On 19 May 2005, we observed the first newly hatched chicks on the north island and the middle island. The first detection of chicks on the south island was on 6 June 2005. These chicks appeared to be ≤ 2 days old. Chicks began to crèche when approximately 3 weeks of age. First flights were detected around 28 July. We estimate only about 300 chicks fledged in 2005 (see mortality events below).

In 2006, nests were first initiated on the north island and then the south island (Table 1, Fig. 2). The first hatched chicks were observed on 9 May and the first flights of young were observed on 20 July. Our last visit to the subcolonies was on 25 August when about 1,000 chicks remained on the islands; most of these young could fly. We estimate that approximately 10,000 chicks fledged.

In 2007, we observed the first nests on both north and south islands on 18 April. We observed pipped eggs on 18 May; chicks likely hatched from those eggs by 19 May.

Mortality events.—On 16 June 2005, we found that nearly half of the chicks on the north island were dead. Carcasses were not fresh enough to determine cause of death. Cool, wet, windy weather during the previous week could have contributed to these deaths (and also prevented access to the islands by researchers). These chicks might have been especially vulnerable because they had reached the age at which their parents stop brooding them. A catastrophic weather event during the night of 2-3 July 2005 (sustained winds of 50-60 mph) may have led to

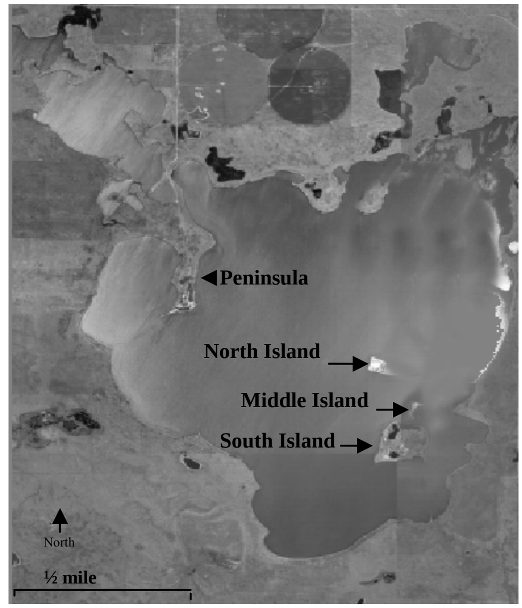

Figure 2. Locations of 3 subcolonies (3 islands, peninsula) used by breeding American white pelicans at Chase Lake, North Dakota, 2004—2007.

a large number of chick deaths which were discovered on all islands at Chase Lake on 5 July 2005. Dead chicks were found, often in piles, already too decomposed for necropsy. On 7 July 2005, severe infestations of pouch lice were found on numerous chicks on the south island. These chicks were blinded and immobile. It is not known if the chicks were predisposed to lice infestations by other diseases or by the hot, humid weather and wind.

In 2006, severe weather on 8–10 June caused deaths of approximately 400 chicks at Chase Lake. Again, chicks that died were approximately 2–4 weeks old, the vulnerable period of transition between brooding and crèching.

In 2007, the Chase Lake colony once again suffered nearly complete failure in productivity, at least partly because of severe weather. From 1 May to 18 June, Chase Lake received 10.18 inches of rain, 7.85 inches of that rain came in a 3-week period (29 May -18 June) (Table 2). Average rainfall for this period is <3 inches. Moreover, low temperatures were in the 30s and 40s degrees Fahrenheit. The nests initiated earliest would have hatched around 19 May.

Table 1. Breeding phenology data from island subcolonies of nesting American white pelicans at Chase Lake, North Dakota, 2005–2007. Nest initiation is the first nest at the subcolony, number of nests was determined from aerial photographs taken on 31 May 2005 and 2006, and 2 June 2007.

2005	
First arrivals	Pelicans first observed at Lake on 3 Apr
Nest initiated	North Island – ~13 Apr; South Island – ~20 Apr
Number nests	North Island – 1,765; South Island – 7,387; Middle Island – 179
Number chicks	Estimate about 300 chicks fledged.
2006	
First arrivals	Pelicans first observed at Lake on 5 Apr 2006
Nest initiated	North Island – 5 Apr; South Island – 13 Apr
Number nests	North Island – 3,202; South Island – 14,100
Number chicks	Estimate about 10,000 chicks fledged.
2007	
First arrivals	Pelicans first observed at lake on 12 April 2007
Nest initiated	North Island – 18 Apr; South Island – 23 Apr
Number nests	North Island – 1,157; South Island – 10,105
Number chicks	On 28 June 2007, <100 chicks on North Island and ~531 chicks on south island.

Table 2. Rainfall, temperature and wind at Chase Lake National Wildlife Refuge, 5 May—19 June 2007.

Date	Rainfall (in)	Temperature (ºF)		Sustained wind speed (mph)	
		High	Low	High	Low
1 May	0.02	60	35	6	4
8 May	0.73	77	49	3	2
14 May	0.16	45	37	6	5
22 May	0.23	80	45	2	0
25 May	1.19	54	34	7	2
29 May	1.32	73	59	5	4
5 June	2.50	76	41	6	4
8 June	0.80	73	43	7	2
14 June	0.78	60	77	1	0
18 June	2.45	71	56	5	4

During this late-May—early- June period many chicks would have been vulnerable to severe weather. Starting on 5 June, we began to see the effects of cold, wet, windy weather. We observed dead chicks in nests on the east side of the north island (nest initiated around 20 April). Observations of chick losses continued through the month of June. On 28 June, a conservative ground count of chicks indicated a minimum of 531 on the south island and < 50 chicks remained on the north island (we assume we missed some chicks because of high vegetation restricting detections). There were 2 small groups that appeared to be sitting on nests with young chicks (we did not disturb these birds).

It was difficult to document the cause and timing of losses for two main reasons. First, gulls (*Larus spp.*) often depredate young chicks, thus no evidence of the failed nest is present. Second, we were cautious not to unduly disturb the colony, thus viewing of small chicks at nests, alive or dead, were opportunistic observations. We did not systematically assess nest success and failure because we were not willing to risk our disturbance causing loss of nests. Our understanding of these mortalities is further confounded by our systematic observations (direct and video). We noted what we believe to be unusual tardiness (or no return) for transitions between pair members tending the nests. On at least a couple occasions, 3 or more days would pass with no sign of exchange at nests by mates. Eventually the bird tending the nest would walk away for short periods or not return, leaving chicks unattended. These vulnerable chicks sometimes died of exposure or were depredated by gulls. We have not completed transcription of video data nor analyzed data, thus prevalence of these behaviors may not be different from past years. We caution against any conclusions regarding these observations until we evaluate our data.

Intensive observations of activities at nest: video.—On 4 April 2005, we placed a camera system on the peninsula before most of the pelicans returned from their spring migration. The recording system was placed away from the nesting area; the camera was placed when birds returned when an appropriate location could be selected. Cable connected the recording system and camera. The pelicans did not use the peninsula that year, so the camera system was moved to the south island on 15 May 2005. We monitored nests initiated in mid-April. In 2005, data collection by video was inadequate, largely because severe weather (e.g., wind) limited consistent access to the islands and our camera system often failed because of inadequate power. Thus, our 2005 data from the camera is limited. The camera system was modified and in 2006 and 2007, it has operated without serious problems.

In 2006, the camera was first placed on the mainland with a panoramic view of the north island, which allowed us to view nesting activity on the island while ice conditions on the lake prevented access to the islands. We were unable to get to the island because of ice on the lake. On 21 April we were able to move the camera to the north island where we monitored nests that were initiated in early April. We monitored these nests until the chicks, at about 3 weeks old, began to leave their nests and form crèches. Nests at the colony were initiated over a period of approximately 8 weeks providing a prolonged availability of sites with young chicks in nest bowls at which to collect camera data. To take advantage of this, the camera was moved twice to sites where chicks had recently hatched and remained at each site until the chicks crèched. Once all chicks crèched, we continued to record activities, but the mobile chicks were not within camera view at all times.

Our first camera deployed in 2007 was on 18 May. It was located on the north island and the nests being monitored contained pipped eggs, thus nests were initiated in mid-April. A second camera was deployed on 29 May on the south island at nests that were initiated in mid-April. The view for each camera was changed 2 times to monitor adults and chicks at nests.

We have completed transcribing the data from all of the 2006 video; however, we may review video for additional information. Data have yet to be summarized; once all video data are transcribed and a summary is completed, we will begin analyses.

Intensive observations of activities at nest: direct observations.—In 2005, we completed 80.5 hours of direct observations. We completed 4 early-morning periods (19 hrs), 12 mid-day periods (46 hr 50 min), and 4 late-afternoon periods (14 hrs 45 min). In the interest of safety and because we were unable to use a powered boat to access the islands, severe weather (wind or rain) often caused delayed onset or shortened observation periods. During bad weather, we attempted with limited success to observe nesting activities from the mainland with a high-powered spotting scope. In 2006, we completed 8 observation sessions during mid-day periods, 3 sessions during early-morning periods, and 3 sessions during late-afternoon periods. Observations began on 16 May 2006 and ceased on 7 July 2006. Data from direct observations have not been summarized or analyzed.

Nest and Chick Surveys.—On 31 May 2005, we obtained aerial photographs (Fig. 3) indicating 1,765 nests initiated on the north island, 179 nests on the middle island, and 7,387 nests initiated on the south island. Based on estimates on the ground, fewer than 300 chicks fledged in 2005.

On 31 May 2006, we obtained aerial photographs indicating 3,202 nests were initiated on the north island and 14,100 nests were initiated on the south island. On 13 July 2006, we obtained aerial photographs of the subcolonies from which we estimated the number of chicks to be 2495 on the north island and 8526 on the south island (Table 1). We estimate between 9,400 and 10,000 chicks fledged in 2006.

In 2007 data from aerial photographs taken on 2 June 2007 indicated 1,157 nests initiated on the north island and 10,105 nests initiated on the south island. A ground count of chicks conducted on 28 June indicated only 531 chicks on the south island and less than 50 birds remained on the north island.

Adult pelicans beginning nest building at Chase Lake National Wildlife Refuge.

Adult pelican incubating eggs by holding the eggs under foot webs.

Figure 3. Aerial photograph of nesting American White pelicans on the peninsula (2004) and the south island (2007), Chase Lake National Wildlife Refuge.

West Nile Virus Surveillance

(This is part of a larger study including Bitter Lake and Medicine Lake colonies)

Disease surveillance.— We submitted 53 chick carcasses in 2005 that were suitable for WNv testing. In 2004, adults abandoned the colony prior to emergence of *Culex tarsalis.* Although we were unable to determine gender when collecting chicks, post-mortem examinations revealed both sexes were well represented with 28 females, 18 males, and 7 unknown. The first positive WNv culture/serology reports were from chicks collected 19 July 2005. Once a positive WNv sample was confirmed, 83% of the chicks collected were WNv positive (Table 3). The proportion of sampled female and male chicks diagnosed with WNv was similar.

Among 19 WNv-negative chicks, 42% were categorized in poor to fair body condition and the rest were in good or excellent condition. No specific etiology was clear for any of these chicks except 2 tested positive for botulism and 2 were positive for salmonella.

Among 34 chicks that tested positive for WNv, 35% were considered to be in excellent body condition, 35% in good condition, 15% in fair condition, and 15% in poor condition. The most notable internal conditions observed in chicks with WNv were heart lesions and hemorrhaging. Of the chicks diagnosed with WNv, 66% were categorized with mild to severe gross heart lesions.

Table 3. Diagnostic results from American white pelican chick carcasses collected from Chase Lake National Wildlife Refuge and submitted to the National Wildlife Health Center for diagnostics, 2005.

Number tested	53
% WNv+	64
% WNv+ (post onset) [b]	83
WNv+/tested via serology	12/50
Salmonella +/n	2/17
Salmonella +/n (post onset) [a]	2/11
Botulism +/n	2/18
Botulism +/n (post onset) [a]	0/12

[a] Carcasses collected after the onset of WNv in the colony that year.

Mortality rates.—In 2005, we banded 201 pelican chicks with USGS metal leg bands and numbered colored leg bands; in 2006 and 2007, we similarly banded 1,277 and 435 pelican chicks, respectively. In previous years, we have banded over 2,000 pelican chicks per year at Chase Lake, but because of mortalities (see below) earlier in the season, fewer young were available to be banded in the years of our study.

After the onset of West Nile virus each year, we retrieved 10% and 37% of the bands in 2005 and 2006, respectively. At the writing of this document (July 2007), WNv had begun to affect chicks in the colony. Because bands are difficult to find, we assume that our assessment post-banding losses is conservative. Other studies conducted prior to the arrival of WNv in the region, reported 3-4% mortality from mid-July to the time of fledging. Data from a sample of collected chicks that were tested at the National Wildlife Health Center suggests that the greater mortality rate in recent years during this pre-fledging period is largely a consequence of WNv.

Disease transmission.—We are waiting for the final results of lab tests from the National Wildlife Health Center. Preliminary results indicate low transference by oral/fecal transmission.

American white pelican chick infected with West Nile Virus.

Pile of pelican carcasses collected during West Nile virus outbreak.

Monitoring adult movements with Satellite GPS Transmitters

We deployed 8 transmitters on adult pelicans in 2005 and 4 in 2006 (Table 4). Each bird displayed breeding plumage so we assumed all were nesting adults. None of the transmittered pelicans remained at the colony more than a week after tagging. Thus, we did not collect data on nest-attendance patterns or lengths of foraging trips the year of marking individual pelicans. However, we did document the wide range of aquatic habitats used by these pelicans during the breeding season (Figs. 4 and 5)

Of the pelicans with transmitters in 2005, 1 female died at a wetland in Kidder County in early July 2005 (see Table 5 for brief summary of movements). We suspect that the bird had been illegally shot based on evidence found near the carcass. Signals from 2 transmittered males were lost during fall migration in 2005. Transmission ceased in late August for 1 male on the Missouri River in South Dakota. The other male died at a reservoir in Kansas during mid-December; the carcass was recovered for necropsy, results are pending but collision with a power line is likely. The remaining 5 pelicans transmittered at Chase Lake in 2005 spent the winter in 5 separate locations near the Gulf Coast: 1 in southern Louisiana, 1 in southeastern Texas, and 3 in eastern Mexico. Four of these birds began their return migration between 18 April and 4 May, 1 started north in early June. One male returned to Chase Lake to nest (Fig. 6)

The 4 birds tagged in 2006 similarly did not continue nesting but stayed in the region. All 8 tagged birds survived to migrate south, starting in late August through early October (Table 5). Five pelicans wintered in Mexico; 1 in Florida; 1 in Texas; and 1 in the Mississippi, Louisiana, Arkansas region. We believe the bird in Florida either died or lost its radio tag. We lost the signal for 1 bird in Mexico. The others have migrated north to Minnesota, North Dakota, and South Dakota (Table 5). None appear to have attempted nesting, which may indicate that transmitters may be influencing breeding attempts or that pelicans may not breed every year. Radio-tagged pelicans (not marked at Chase Lake) have nested at Bitter Lake, South Dakota and Medicine Lake, Montana.

Table 4. Adult pelicans captured at Chase Lake, North Dakota, and fitted with a 70-g solar-powered GPS satellite transmitter (PTT-100) harness, 2005-2006.

Date	PTT no.	Band no.	Sex	Age	Culmen (mm)	Tarsus (mm)	Wing chord (mm)	Weight (kg)
26 May 2005	21922	509-85764	M	≥ 3	365	127	604	7.0
26 May 2005	21893	509-85785	F	≥ 3	280	118	568	5.7
31 May 2005	21917	509-85786	M	≥ 3	340	123	596	6.7
1 June 2005	21932	509-85787	M	≥ 3	360	126	595	6.0
3 June 2005	21913	509-85788	F	≥ 3	280	112	536	4.7
4 June 2005	21925	509-85789	M	≥ 3	344	120	570	6.0
4 June 2005	21959	509-85790	M	≥ 3	342	127	607	6.6
16 June 2005	21944	669-02752[1]	F	5	284	110	562	3.4
1 June 2006	64537	669-18683	F	≥ 3	284	124	545	4.1
1 June 2006	64533	669-18682	F	≥ 3	275	109	550	5.2
1 June 2006	64530	509-85798	F	≥ 3	303	111	570	4.3
10 June 2006	21722	669-18692	M	≥ 3	370	124	605	6.4

[1] Banded as a chick at Chase Lake in 2000. Colored leg band—green w/white letters, D126.

Table 5. Chronology of movements and general destinations (breeding and wintering seasons) for American white pelicans tagged with satellite GPS transmitters. Pelicans were tagged as adults at Chase Lake National Wildlife Refuge, but away from the nesting areas (i.e., loafing areas).

		Pelican ID number-Sex											
		893-F	922-M	925-M	917-M	913-F	932-M	959 -M	944-F	722-M	530-F	531-F	533-F
2005	Date tagged	26 May	26 May	4 Jun	31 May	3 Jun	1 Jun	4 Jun	16 Jun	-	-	-	-
	South migration	-	Mid-Aug	Aug-Sep	Mid-Aug	Late Sep	IA-MN Jul Sep south	IA-MN Jul Sep south	Late Aug	Late Aug			-
2006	Winter location	-	-	-	Mexico	Mexico	TX	LA	Mexico	-	-	-	-
	North migration	-	-	-	18 Apr	1 May	Late Apr	4 May	Early Jun	-	-	-	-
	Summer location	-	-	-	ND	ND	SD	MN	SD, ND	-	-	-	-
	Date tagged	-	-	-	-	-	-	-	-	-	1 Jun	1 Jun	1 Jun.
	South migration	-	-	-	18 Aug	Sep	Sep	Sep	Late Aug	Late Aug	Sep	Early Oct	Sep
2007	Winter location	-	-	-	Mexico	Mexico	TX	LA	Mexico	MS LA AR	FL	Mexico	Mexico
	North migration	-	-	-	20 Apr	29 Apr	24 Apr	1 May	25 May	Mid-Apr	-	-	Early May
	Summer locatio	-	-	-	SD, MN	MN, ND	SD	MN	SD	MN, ND	-	Lost signal	

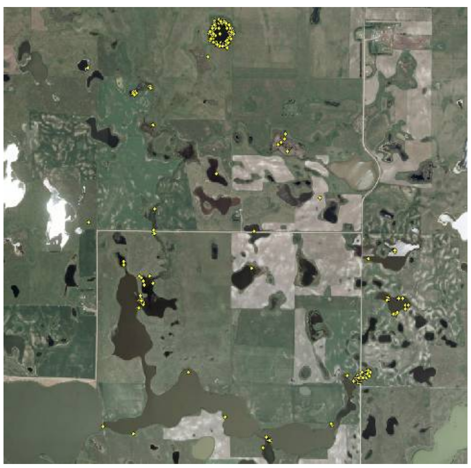

Figure 4. Locations of a female American white pelican central North Dakota, July 2005 (approximately 5 days).

Figure 6. GPS data showing movements of a male pelican nesting at the Chase Lake colony, July 2006. Extent of stay at the colony could be from < 1 hour to overnight.

Figure 5. Locations of a male American white pelican in July 2007, central North Dakota.

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HAZARD ASSESSMENT: All personnel assigned to the study were advised on safety responsibilities, safe operation of vehicles, and anticipated risks. Observers were made fully aware of the risks of West Nile virus and instructed to use the safety equipment provided, which included mosquito head-nets, insect repellent, gloves, and filter masks. Observers were trained in the proper and safe handling of diseased birds. Observers were trained in safe use of small boats with electric motors.