APP-060

Whooping Crane
(Grus americana)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Aransas National Wildlife Refuge, Austwell, Texas
and
Corpus Christi Ecological Service Field Office, Texas

5-YEAR REVIEW
Whooping Crane (*Grus americana*)

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office: Southwest Regional Office, Region 2
Susan Jacobsen, Chief, Threatened and Endangered Species, 505-248-6641
Wendy Brown, Endangered Species Recovery Coordinator, 505-248-6664
Jennifer Smith-Castro, Recovery Biologist, 505-248-6663

Lead Field Office:
Aransas National Wildlife Refuge, Tom Stehn, Whooping Crane Coordinator, Austwell, TX, 361-286-3559, ext. 221
Corpus Christi Ecological Services Field Office, Allan Strand, Supervisor, TX, 361-994-9005

Cooperating Field Offices:
Green Bay Ecological Services Field Office, Wisconsin, Joel Trick, 920-866-1737
North Florida Ecological Services Field Office, Billy Brooks, 904-731-3136
Lafayette Ecological Services Field Office, Deborah Fuller, 337-291-3124

Cooperating Regional Offices:
Midwest Regional Office, Region 3, Carlita Payne, Recovery Implementation Coordinator, 612-713-5339
Southeast Regional Office, Region 4, Kelly Bibb, Recovery Coordinator, 404-679-7132
Mountain-Prairie Regional Office, Region 6, Seth Willey, Recovery Coordinator, 303-236-4257

1.2 Purpose of 5-Year Reviews:

The U.S. Fish and Wildlife Service (Service or USFWS) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened (downlisted), or be changed in status from threatened to endangered (uplisted). Our original listing as endangered or threatened is based on the species' status considering the five threat factors described in section 4(a)(1) of the Act. These same five factors are considered in any subsequent reclassification or delisting decisions. In the 5-year review, we consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process including public review and comment.

1.3 Methodology used to complete the review

This review was originally drafted by Tom Stehn, Whooping Crane Coordinator for U.S. Fish and Wildlife Service (Service) and Co-Chair of the International Whooping Crane Recovery Team. Editing was done by Dawn Whitehead and Amber Miller of USFWS Ecological Services Field Office in Corpus Christi, Texas, and by Wendy Brown, Service Recovery Coordinator in Region 2. The review was completed with assistance from other Service field biologists from Regions 3 and 4, and from Lea Craig-Moore, the Acting Canadian Whooping Crane Coordinator, Canadian Wildlife Service (CWS) and LeeAnn Linam, Endangered Species Biologist with the Texas Parks and Wildlife Department (TPWD). No part of this review was contracted to outside parties. All documents and literature used for this review are on file at the Aransas National Wildlife Refuge (ANWR), Austwell, Texas. Information used in constructing this review includes the International Recovery Plan, a 2009 Spotlight Species Action Plan, a Draft 2010 Conservation Framework, a Strategic Habitat Conservation Plan, and annual updates written by the Service Whooping Crane Coordinator.

Additional information used included peer-reviewed manuscripts, symposium proceedings, technical reports, Service reports, published papers, and notes and communications from other qualified biologists who have knowledge of whooping cranes and their habitat requirements.

1.4 Background:

1.4.1 FR Notice citation announcing initiation of this review:

75 FR 15454; March 29, 2010.

1.4.2 Listing history

Original Listing
FR notice: 32 FR 4001
Date listed: March 11, 1967
Entity listed: Whooping Crane (*Grus americana*)
Classification: Endangered without critical habitat.

1.4.3 Associated rulemakings

Critical Habitat for the whooping crane was designated on May 15, 1978 (43 FR 20938-20942) for nine locations in the U.S.: Alamosa and Monte Vista NWRs in CO; Grays Lake NWR in ID; Bosque del Apache NWR in NM; Quivira NWR and Cheyenne Bottoms SWMA in KS; an 80-mile (mi) stretch of the Platte River in NE; Salt Plains NWR in OK; and ANWR and vicinity in TX.

With the extirpation of the Rocky Mountain re-introduced whooping crane population, the four locations in CO, ID, and NM were removed from the list of designated critical habitat areas on July 21, 1997 (62 FR 38932-38939).

Four areas have been designated as experimental nonessential for the reintroduction of whooping cranes into North America: Florida (58 FR 5647-5658, January 22, 1993), five

Rocky Mountain states (CO, ID, NM, UT, and western half of WY; 62 FR 38932-38939, July 21, 1997), nineteen states in the Eastern U.S. (AL, AR, GA, IL, IN, IA, KY, LA, MI, MN, MS, MO, NC, OH, SC, TN, VA, WI, WV; 66 FR 33903-33917, June 26, 2001), and Louisiana (76 FR 6066-6082, February 3, 2011).

Whooping cranes were reintroduced into the Rocky Mountains (1975-1989), Florida (1993-2005), the Eastern U.S. (2001-2010), and Louisiana (2011).

1.4.4 Review history:

The whooping crane was originally listed as an endangered species on 11 March 1967, following establishment of the Endangered Species Preservation Act on October 15, 1966 and is currently listed as endangered under the Endangered Species Act of 1973, as amended. No previous 5-year review has been conducted for this species. Other review documents include:

Annual recovery activities updates (USFWS) by Tom Stehn, Austwell, Texas dated October 2008, November 2009, and October 2010.

Conservation Framework: Whooping Crane, final draft March 30, 2010 (USFWS).

Recovery Data Call Report: 1990, 1992, 1994, 1996, 1998, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010.

International Recovery Plan, Final, Third revision, 2007 (CWS and USFWS).

Safe Harbor Agreement; Coastal Prairie Coalition (GLCI) Grazing Lands Conservation Initiative, July 24, 2007 lasting 99 years.

Strategic Habitat Conservation for Whooping Cranes, USFWS (draft November 12, 2007).

Whooping Crane Spotlight Species Action Plan, USFWS: August 7, 2009.

1.4.5 Species' Recovery Priority Number at start of 5-Year review:

The whooping crane has a Recovery Priority Number of 2C, indicating a full species with a high degree of threat and a high potential for recovery (48 FR 43098).

1.4.6 Recovery Plan

The current *International Recovery Plan for the Whooping Crane, Third Revision* was approved May 29, 2007 (72 FR 29544). The original U.S. recovery plan was approved on January 23, 1980. It was revised for the first time on December 23, 1986 and for the second time on February 11, 1994.

1.3.7 Species Status: From the Recovery Data Calls

2010 Stable
2009 Declining
2008 Stable
2007 Improving

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy.

2.1.1 Is the species under review a vertebrate?

Yes.

2.1.2 Is the species under review listed as a DPS?

No.

2.1.3 Is there relevant new information for this species regarding the application of the DPS policy?

No.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

Yes.

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

Yes.

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?

Yes.

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information.

The whooping crane has a final approved recovery plan most recently revised in 2007 (Canadian Wildlife Service and USFWS 2007). The plan does reflect the best available information on the biology and habitat of the species. The objectives and criteria are the primary basis for measuring progress towards recovery.

The recovery plan lists two objectives, each with measurable criteria as follows (CWS and USFWS 2007):

Objective 1 - Establish and maintain self-sustaining populations of whooping cranes in the wild that are genetically stable and resilient to stochastic environmental events.

Criterion 1 - Maintain a minimum of 40 productive pairs in the Aransas-Wood Buffalo Population (AWBP) for at least 10 years, while managing for continued increase of the population. Establish a minimum of 25 productive pairs in self-sustaining populations at each of two other discrete locations. A productive pair is defined as a pair that nests regularly and has fledged offspring. The two additional populations may be migratory or non-migratory. Population targets are 160 individuals in the AWBP, and 100 each in the Florida non-migratory population and the eastern migratory population. All three populations must be self-sustaining for a decade at the designated levels before downlisting could occur.

Alternative Criterion 1A - If only one additional wild self-sustaining population is re-established, then the AWBP must reach 400 individuals (i.e. 100 productive pairs), and the new population must remain above 120 individuals (i.e. 30 productive pairs). Both populations must be self-sustaining for a decade at the designated levels before downlisting could occur. This alternative is based on the principle that with the re-establishment of only one additional population separate from the AWBP, then crane numbers must be higher in both populations than if there are three distinct populations.

Alternative Criterion 1B - If establishment of second and third wild self-sustaining populations is not successful, then the AWBP must be self-sustaining and remain above 1,000 individuals (i.e. 250 productive pairs) for downlisting to occur. The *Memorandum of Understanding on Conservation of Whooping Cranes*, approved by Canadian and U.S. federal officials in 2001, recognizes a goal of 1,000 individuals in the AWBP population. This higher number ensures a better chance for survival of the AWBP in the event of a catastrophic event within its extremely limited range. The target of 1,000 is reasonable for downlisting given the historical growth of the AWBP and theoretical considerations of minimum population viability. To ensure sufficient genetic variability, the AWBP must increase to the level where the creation of new alleles through genetic mutation will offset the loss of genetic diversity. After reaching the goal of 250 pairs, the population should gain genetic variation faster than the population loses genetic material.

The goal of the plan is to downlist the species from a status of endangered to threatened. Implementation of the steps outlined in the recovery plan, if successful, could lead to downlisting the whooping crane by 2032, although recent work by Gil-Weir et al. (in press) suggests that this target may not be reached until the mid-2060s, and that it may never be achieved. According to the plan, if establishment of second and third wild self-sustaining populations is not successful, then the AWBP must remain above 1,000 individuals for downlisting to occur. To date, the inability to establish self-sustaining populations elsewhere suggests that AWBP expansion to 1,000 individuals is the most promising strategy for downlisting the whooping crane to "threatened".

Progress: Efforts to establish and maintain self-sustaining wild populations of whooping cranes through reintroduction are currently unsuccessful. To date, three reintroductions carried out starting in 1975, 1993, and 2001 have all failed in the establishment of self-sustaining wild populations. Only in the Florida non-migratory population has there been a reasonable amount of breeding, but periodic drought that hampers production and high flock mortality of adults has made the population unsustainable. Breeding pairs in the most recently reintroduced population in Wisconsin have exhibited a chronic pattern of nest abandonment prior to full term incubation; the leading theory for the cause of this observed abandonment is due to harassment from black flies (Joel Trick, Green Bay ES, pers. comm., 2011).

Reintroduction efforts are continuing with 16 non-migratory whooping cranes reintroduced at White Lake, Louisiana in December 2011, and the release of 18 whooping cranes in 2011 into areas with fewer black flies in east-central Wisconsin. However, because establishment of one or more additional populations may not be feasible, species recovery may rely on meeting Alternative Criterion 1B to increase the size of the AWBP. In addition, the AWBP will continue to lose genetic material until the flock reaches a flock size of 1,000 individuals. Recent data analysis indicates that breeding success of the adult pairs is quite variable (Lea Craig-Moore, CWS, pers. comm., 2009) which further accelerates the loss of genetic material. The Recovery Program has not started efforts to determine the effective population size of the AWBP. This information is needed for whooping crane managers to maintain genetic viability over the long-term.

Objective 2 - Maintain a genetically stable captive population to ensure against extinction of the species.

Criterion 2 - Maintain 153 whooping cranes in captivity (21 productive pairs). Genetic analysis suggests that 90 percent of the genetic material of the species can be sustained for 100 years at this population size (Jones and Lacy 2003). To achieve this, the recovery plan recommends having 50 captive breeder pairs of whooping cranes by 2010, including 15 pairs at the Patuxent Wildlife Research Center in Maryland (PWRC), 12 at the International Crane Foundation (ICF), 10 at the Calgary Zoo (CZ), 10 at the Species Survival Center in New Orleans (SSC), and three at the San Antonio Zoo (SAZ). A breeder pair (as differentiated from a productive pair) is defined as a pair that breeds or is intended to breed in the future. Production from PWRC, ICF, CZ, SSC, and SAZ will be the principal source of birds for release to the wild for reintroduced populations. However, sources of release birds should be based on the optimal genetic mix to ensure long-term population viability.

Progress: As of June 2011, there were 158 whooping cranes in captivity, with 144 at five breeding centers including 35 breeder pairs, and 14 birds at eight different display facilities. The breeding centers produce anywhere from 25-40 chicks annually for use in reintroductions and maintenance of the captive population. The 34 breeder pairs are below the stated criterion of 50 pairs by 2010. In the wild, AWBP pairs are typically productive at 5 years, whereas birds in captivity often require 10 or more years. This major drawback needs to be overcome through research. Annual captive production is sufficient to increase the size of the captive flocks as required. Some of the breeding centers will need to add facilities to fully meet criterion targets.

Delisting Criteria
Delisting criteria have not yet been established because the status and biology of the species dictate that considerable time is needed to reach downlisting goals. In addition, new threats are expected to arise and will have to be overcome before downlisting occurs. Additional information is also needed on the conservation biology of small populations, including a determination of effective population size (N_e) for whooping cranes to maintain genetic viability over the long-term, and impacts of stochastic and catastrophic events on population survival.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Historically, over 10,000 whooping cranes once populated North America, ranging east of the Rocky Mountains from Canada to Mexico and the Rocky Mountains to the East Coast. Population declines were caused primarily by shooting and destruction of habitat in the prairies from agricultural development (CWS and USFWS 2007). By the mid-1800s, only an estimated 1,400 whooping cranes survived in North America. By the mid-1900s, only a few birds remained that nested in Wood Buffalo National Park (WBNP) and wintered in South Texas at what is now the Aransas National Wildlife Refuge. Ironically, the steadfast use of a traditional summer area that appears to have saved the whooping crane as a small, relict breeding population in WBNP prevents its voluntary return to what was once its principal nesting range. Re-colonization of these historic breeding areas remains unlikely unless humans assist with habitat restoration and reintroductions.

All whooping cranes alive today have come from the all-time low of 15 whooping cranes wintering at ANWR in 1941 (CWS and USFWS 2007, Figure 1). Since then, the AWBP population has slowly increased due to conservation efforts. These have included a combination of strict legal protection, habitat preservation, and continuous international cooperation between Canada and the United States that has allowed the only remaining wild population to increase steadily to an estimated 279 individuals by April 2011.

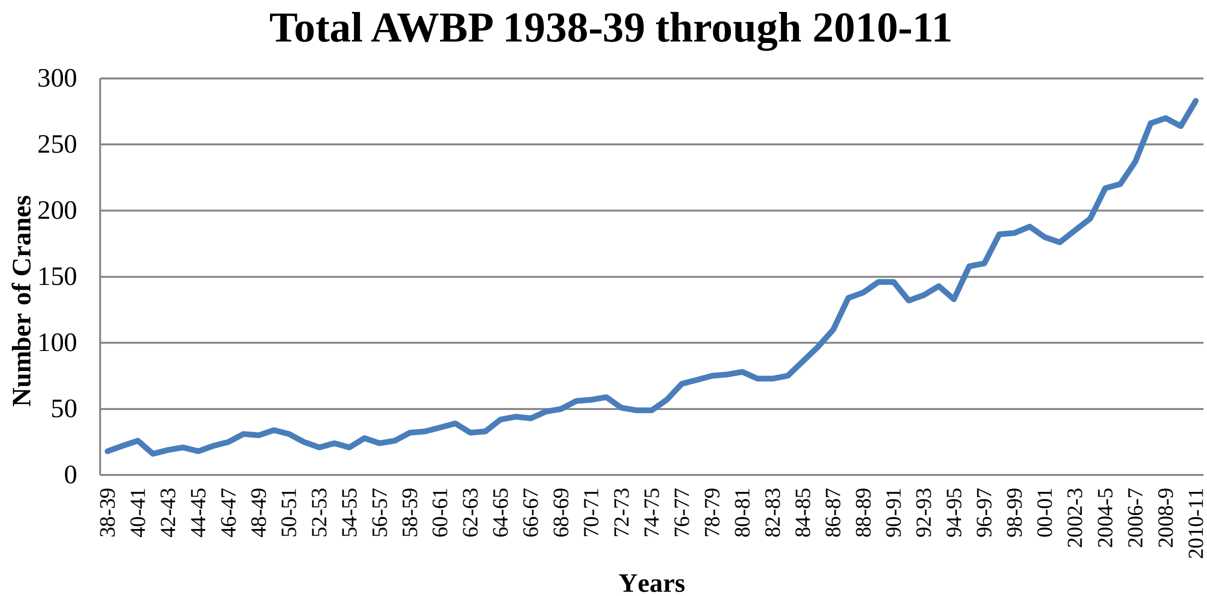

Figure 1. Population of the Aransas-Wood Buffalo (AWBP) whooping crane flock.

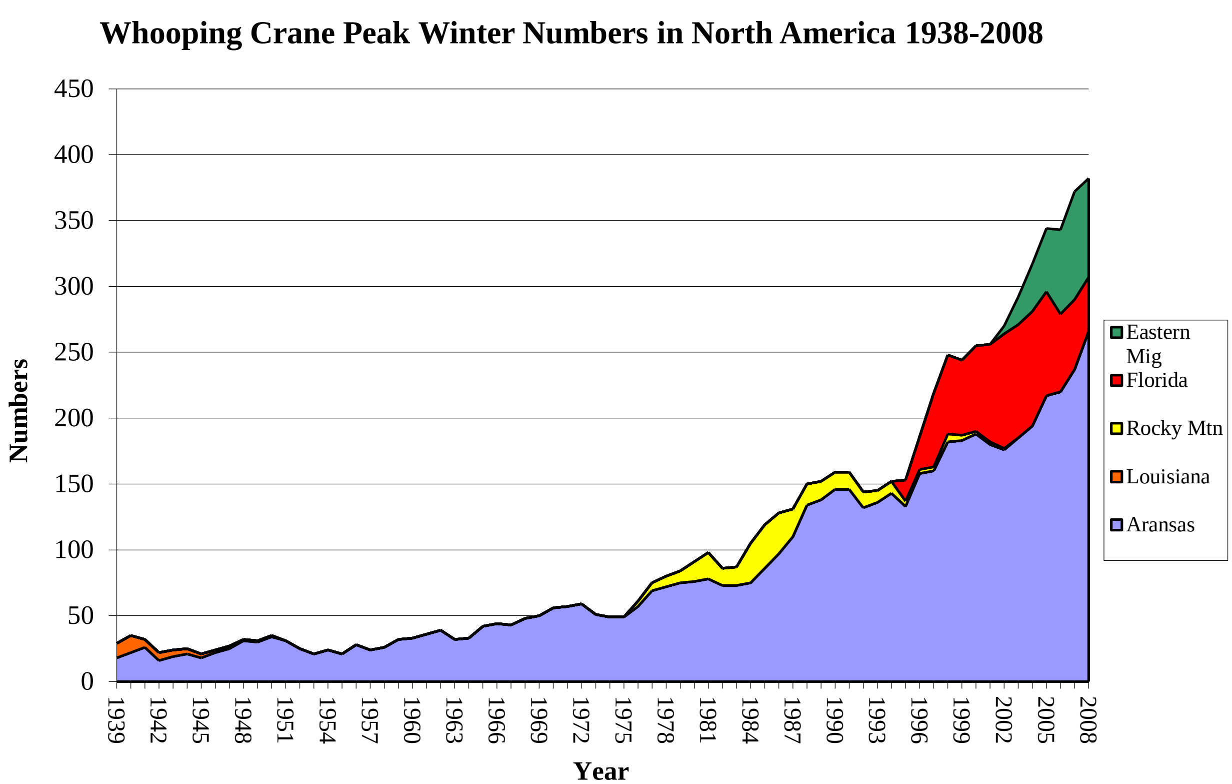

Figure 2. Whooping crane numbers in North America, 1938-2008.

Annual growth of the population over the past 70 years has averaged 4.6 percent per year. The population first surpassed 100 birds in 1987, and 200 birds in 2004 (Figure 2). The flock size is currently at 279 in the spring of 2011, up from the record 270 in the fall of 2008. Population studies indicate a 10-year survivorship cycle of unknown cause (Boyce and Miller 1985, Boyce 1987, Nedelman et al. 1987). An unprecedented 21.4 percent of the flock (53 cranes) died within a 12-month period (April 2008 to March 2009). These mortalities appear to be part of that 10-year cycle. The causes of mortality were only determined in two instances from carcasses recovered at Aransas. A radio-telemetry project initiated in December, 2009 is designed to learn more about mortality. However, it is reasonable to expect continued flock growth as long as threats do not increase.

Four geographically distinct populations exist in the wild; the only natural population at ANWR (n=279), a reintroduced experimental non-migratory population in central Florida (n=20), an experimental population that migrates between Wisconsin and Florida (n=106), and a non-migratory flock in Louisiana (n=4, with an additional 2 individuals of unknown status). None of the reintroduced populations are self-sustaining, and the Whooping Crane Recovery Team has recently recommended abandoning efforts to place more non-migratory whooping cranes in Florida. A reintroduction was initiated in February 2011 to place a non-migratory flock at White Lake, Louisiana where they historically nested as late as the 1930s.

In 2009, production in the wild from reintroduced flocks was disappointing. Due to the continuing drought in Florida, only four of 11 pairs nested and only one chick fledged. Eight Florida pairs nested in 2010, but again only 1 chick fledged. In 2011, 5 nests and 2 re-nests failed to hatch a chick. During the duration of the Florida reintroduction project, 11 chicks have fledged from wild nests, with 4 of those chicks surviving through March, 2011. In Wisconsin in 2009, all 12 nesting pairs abandoned their nests. Five or six pairs re-nested and hatched two chicks, but neither chick survived. In 2010, 7 chicks hatched in Wisconsin from 5 out of 12 nests and renests, and 2 chicks fledged. In Wisconsin, nest abandonment is a major hurdle that must be overcome for that reintroduction effort to succeed. Although efforts to better understand and overcome the nest abandonment problems should continue, the Recovery Team recommended starting reintroductions in different areas. This includes both looking for other release sites in Wisconsin for the migratory whooping cranes, as well as starting a non-migratory flock in Louisiana. The efforts in Louisiana began in February 2011.

An update is provided below on the three reintroduced flocks.

Florida Non-migratory Population

The Florida non-migratory population is found in the Kissimmee Prairie area of central Florida. This reintroduction project is facilitated by the Florida Fish and Wildlife Conservation Commission (FL). The Service designated this population as a nonessential experimental population in January 1993 (58 FR 5647-5658).

Between 1993 and 2004, 289 captive born, isolation-reared whooping cranes were released into Osceola, Lake, and Polk counties in an effort to establish this non-migratory flock. The last releases took place in the winter of 2004-2005. As of June 2011, there were only 20 individuals being monitored, which include eight pairs. Since the first nesting attempt in 1999 through 2011, there have been a total of 87 nest attempts, 36 chicks hatched, and only 11 chicks successfully fledged. One pair has produced and fledged three of these chicks. Problems with survival and reproduction, both of which have been complicated by drought, have been major challenges for this flock. In 2008, scientists from the FL and major project partners conducted a structured-decision making workshop, taking into account the odds of success based on population modeling, scarcity of birds for release, project costs and public relations. The Recovery Team used the report and other considerations, and recommended there be no further releases into the Florida flock. Given that crane reproduction effort and productivity is extremely low in drought years, the periodic droughts in Florida make it extremely unlikely that reproduction in wild-hatched Florida whooping cranes will ever achieve production rates adequate for success. In addition, crane habitat in Florida is faced with tremendous pressure from developers and is expected to decline in the coming decades. The FL accepted the Recovery Team's recommendation. Florida biologists continue to study and monitor the remaining non-migratory whooping cranes to maximize learning about the biology and associated problems faced by a reintroduced population. Recent efforts have focused on nesting ecology.

Eastern Migratory Population

The third population of wild whooping cranes is referred to as the Eastern Migratory Population (EMP). This reintroduction project is facilitated by the Whooping Crane Eastern Partnership (WCEP). The Service designated this population as a nonessential experimental population in June 2001 (66 FR 33903-33917). Since 2001, eggs from the breeding population have been reared at PWRC in the spring and brought to the central Wisconsin summering area. The chicks are trained to fly behind ultralight aircraft by Operation Migration and led to the central Gulf coast of Florida during the fall. This innovative release methodology has established a wild migrating flock of whooping cranes with a core breeding/summering area at Necedah NWR in central Wisconsin and a primary wintering area in west-central Florida (Pasco and Citrus counties and at Paynes Prairie in Alachua County). Portions of this population also winter at Hiawassee Wildlife Refuge in central Tennessee, Wheeler NWR in northern Alabama, and the ACE Basin in coastal South Carolina. Since 2005, additional captive chicks reared at the ICF have been released using the Direct Autumn Release (DAR) method, where birds are released with groups of older whooping cranes in central Wisconsin prior to the fall migration, and then follow the older cranes during migration. As of December 2011, the EMP numbered 106 cranes. During the 2009 spring breeding season, all 12 first nests of the season were abandoned; as were all first nests from the previous years. In 2010, 7 chicks hatched from 5 of the 12 late nests or renests and 2 chicks fledged. In 2011, 4 of

20 nests hatched chicks, but no chicks survived to fledging. From 2005-2011, there were a total of 77 nests and renests, 13 chicks have hatched, and only 3 chicks have fledged. Nesting failure is currently this project's foremost concern. There is compelling evidence of a correlation between nest failure and the presence of biting insects at the nests suggesting that the insects may play a role in nest abandonment (Tom Stehn, pers. comm., September 2009; see section 2.3.1.5).

Louisiana Non-migratory Population
The Louisiana non-migratory population was established in February 2011 with the release of 10 captive-reared juveniles at White Lake located southwest of Lafayette. An additional 16 captive-reared juveniles were released in December of 2011. This reintroduction project is facilitated by the Louisiana Department of Wildlife and Fisheries. The Service designated this population as a nonessential experimental population in February 2011 (76 FR 6066-6082). Releases of between 10 and 20 juvenile whooping cranes annually are expected for the next 2 years before the program is evaluated. Two of the cranes released in February 2011 are missing and four have been confirmed dead as of December 2011.

2.3.1.2 New information on the species' biology and life history:

Lack of successful breeding has plagued all efforts to reintroduce whooping cranes. In addition to the existing reintroduced populations described above, attempts were made to reintroduce a migratory population that would summer at Grays Lake National Wildlife Refuge in Idaho. From 1975 to 2002, a series of cross-fostering, translocation, and guide bird studies were conducted on this reintroduced population. However, high mortality and the absence of breeding resulted in a relatively small population that peaked at 33 individuals in winter 1985. This population in the Rockies declined to two survivors in 2000 and both were dead by spring 2002.

Subsequent studies in Florida and Wisconsin have focused on breeding issues. In Florida, nest success was found to be correlated with water levels in late winter just prior to the nesting season (Spalding et al. 2009). The excessive drought in Florida can be considered one of the major reasons for failure to obtain a self-sustaining population. Florida biologists also discovered that adult cranes were prone to predation during their flightless molt, which occurs every three years in whooping cranes (Folk et al. 2008). It is not known how molting cranes in WBNP fare. In Wisconsin, studies have indicated that black flies are one of the factors causing the whooping cranes to abandon their nests (Urbanek et al. 2010).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

Approximately 2/3 of the genetic material of the species was lost when the whooping crane went through the bottleneck of only 15 birds in 1941. Discussion of genetic theory and whooping cranes is presented in Appendix B of the Recovery Plan (CWS and USFWS 2007). Genetic analysis suggests that 90 percent of the genetic material of the species can be sustained for 100 years at a captive flock size of 153 (Jones and Lacy 2003). This assumes that all pairs are successful breeders, which is currently not the case. The Recovery Plan recommends having 50 captive breeder pairs of whooping cranes by 2010. However, as of June 2011 there were 158 whooping cranes in captivity, with only 35 breeder pairs among them (for more details, see Recovery Plan, CWS and USFWS 2007).

New genetic techniques have been developed and should be utilized to better manage whooping cranes. A study has been initiated by Dr. Ken Jones at the University of Colorado at Denver that should greatly increase our understanding of the captive flock, basing genetic knowledge on 474 loci rather than the current 12 loci. The genetic material which is being collected during the current radio-telemetry study from the AWBP can then be analyzed to see how the genetic variability compares between captive and wild flocks.

2.3.1.4 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):

The Cooperative Whooping Crane Tracking Project, a Federal/State effort to report data on whooping cranes sighted in migration (Lewis 1992) was organized in 1975 and continues to the present time. In 1985, the project was integrated with the Contingency Plan for State-Federal Cooperative Protection of Whooping Cranes. Sightings are obtained opportunistically, often from public reports, with efforts made by biologists to confirm validity of all sightings. Sightings are placed into one of three categories (confirmed, probable, and not likely) based on program criteria. A confirmed sighting requires that an observation be made by a trained biologist or individual with similar bird identification skills. The data set includes 2,384 confirmed sightings documented through the Spring of 2011, and incorporates data from nine radioed whooping cranes followed in migration from 1981 to 1985. Seventy-five percent of all confirmed sightings occur within approximately 40 mi of the calculated centerline of the migration corridor. This type of knowledge allows biologists to assess risk of development projects in the migration corridor based on habitat present and the location of the site within the migration corridor (figures 3, 4).

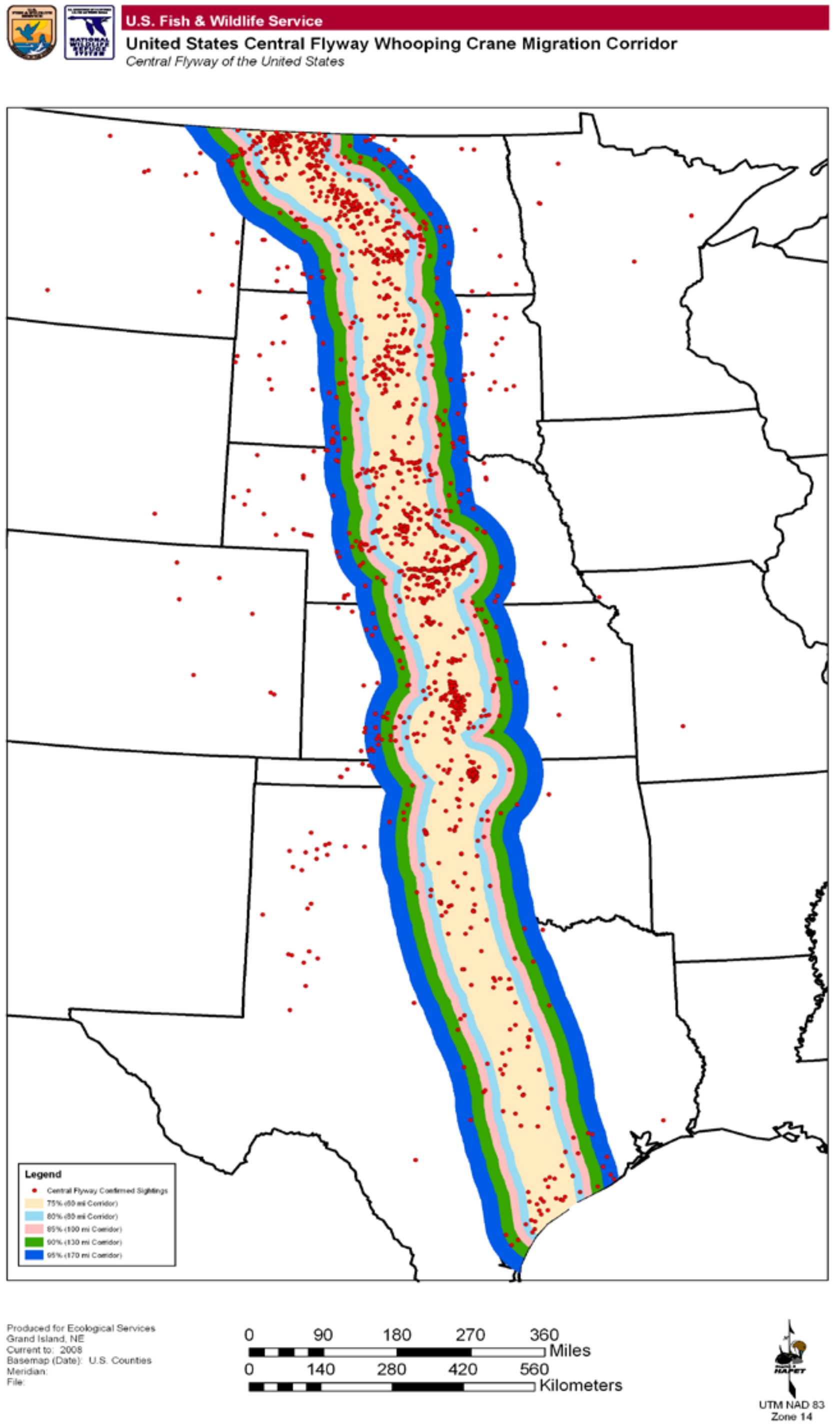

Figure 3. United States Whooping Crane Migration Corridor (M. Tacha USFWS, unpublished data).

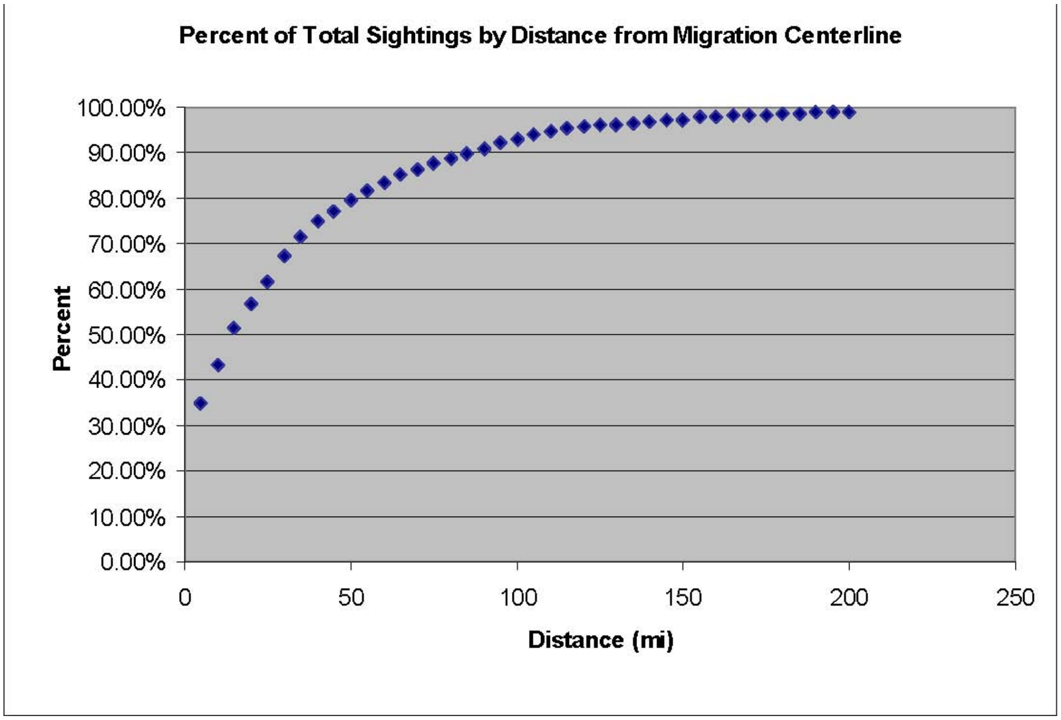

Figure 4. Distribution of points in the whooping crane migration corridor data base (Tacha et al., 2011)

Beginning in 1950 at ANWR, range expansion, including changes in distribution and size of winter territories, was analyzed over a 57-year period as flock size increased by 765 percent. Whooping cranes currently use about 23,240 hectares (ha) of ANWR and adjacent privately and publicly owned wetlands. Adult whooping cranes established distinct winter territories that averaged 172 ha in size (Stehn and Prieto 2010). Crane pairs opted to establish territories in or close to the traditional winter area rather than moving long distances along the coast. This distribution seems to be based on the preference of the male crane to establish a territory as close as possible to its parents (Bishop 1984, Stehn and Johnson 1987). The same territories are used year after year, which include shallow bays, open ponds, salt marsh and sand flats. Each whooping crane territory must have access to all of these habitats or the territory becomes unsuitable to support crane use. Adult whooping cranes remain within their territories most of the time, but must seek out fresh drinking water when marsh salinities exceed 23 parts per thousand (ppt). Use of fresh water in upland swales, dugouts, or at water-producing windmills in upland areas usually occurs when salinities exceed 20 ppt. Subadult and unpaired adult whooping cranes form small flocks and use areas outside occupied territories (Blankinship 1976, Bishop and Blankinship 1982). Subadults tend to winter near the territories where they spent their first year (Bishop 1984).

Based on an average territory size of 172 ha, the current winter range and contiguous areas can support up to 576 whooping cranes (Stehn and Prieto 2010). To determine if enough winter area exists to reach recovery targets and to predict expected use patterns for the near future, all additional salt marsh habitats were measured in a 111 kilometer (km) radius from ANWR. That area encompasses most of the available suitable habitat on the Texas coast south of Brazoria for whooping cranes. This non-contiguous 139,500 acre total saltmarsh area could support an additional 580 whooping cranes to reach a total flock size of 1,156. Of the 139,500 acres needed to support the flock, only 32,000 acres are currently protected on ANWR and adjacent private lands with conservation easements. In order to ensure available area for a downlisted population of whooping cranes, an additional 107,500 acres needs to be protected. Given approximately 30 years, and with continued growth of the population, it seems feasible that someday these identified areas could support over 1,000 whooping cranes and meet the target for downlisting.

<u>Black fly distribution and nesting range of the whooping crane in Wisconsin</u>
Intensive studies headed up by Necedah NWR biologist Rich King with strong support from the ICF indicated that black fly presence at nests was the most likely reason for many of the pairs to abandon nests in central Wisconsin (figure 5).

Figure 5. Black flies on adult whooping crane at Necedah National Wildlife Refuge.

Biting insect numbers at Necedah NWR were documented by Clemson University (Adler 2009) based on the collection of 341,054 specimens including 25 species of black flies and well over 20 additional species of vertebrate-bloodsucking flies. Of the 25 species of black flies, 11 were bird feeders, 12 were mammal feeders, and two were non-blood feeders. The collections included two species recorded for the first time from the state of Wisconsin and one species recorded for the first time from the United States. Video tapes showed swarms of black flies on the nests with the cranes making numerous head rubs and bill flicks apparently in response to the flies. The initial appearance of black flies in the spring coincided with the majority of the nest abandonments. A broken egg collected on April 24, 2009 during the peak of nest abandonment had 757 black flies (all *Simulium annulus*) entrapped in the albumen. A second broken egg collected on May 20, 2009 from a nest had 2,272 black flies (462 *S. annulus*, 1,810 *S. johannseni*) entrapped in its contents.

The majority of nests were abandoned during the period when *S. annulus* was active at the nests. Black flies seemed to hone in on nests since carbon dioxide (CO^2) traps spread around Necedah NWR did not contain large numbers of black flies when the most nest abandonments occurred. Crane decoys on nests attracted substantially more biting insects than decoys placed six meters (m) away from nests. However, the data was not completely conclusive since two nests were abandoned prior to black fly emergence, and two re-nests were successful despite the presence of biting insects. However, a historical map showing the historic range of the whooping crane and range of *Simulium annulus* suggests a negative relationship (figure 6).

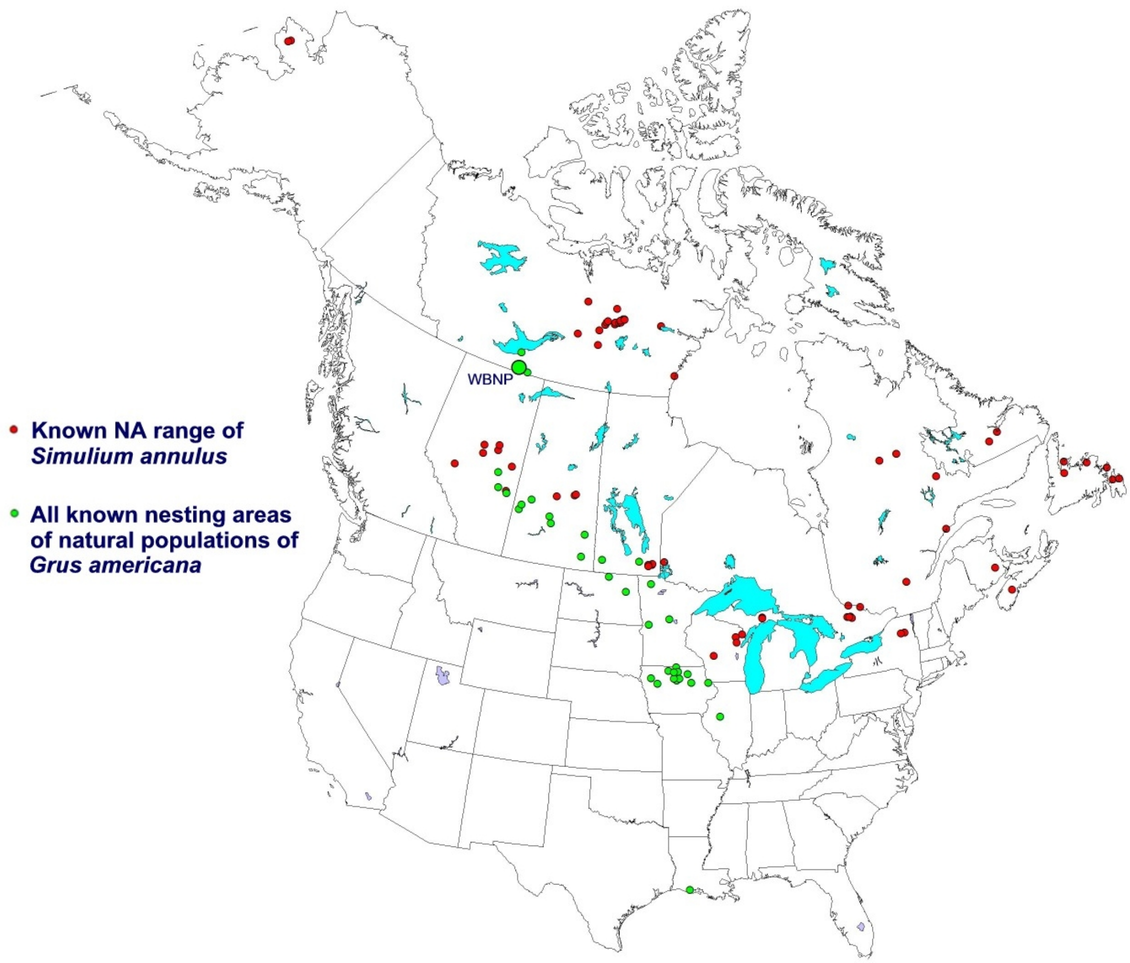

Figure 6. Nesting records of natural whooping crane populations and records of the black fly (*Simulium annulus) from* a study proposal by Urbanek, R., Adler, P. and S. Zimorski. 2008. Entitled "Eastern migratory whooping crane reintroduction: Identification and treatment of the problem of nest desertion."

2.3.1.5 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

The breeding portion of the migratory population nests in the Northwest Territories and adjacent areas of Alberta, Canada, primarily within the boundary of WBNP (Johns 1998). These cranes migrate southeasterly, stopping in southern Canada before continuing migration into the United States where they spend the winter months along 35 mi of the Gulf of Mexico coast at ANWR and adjacent areas. Within the WBNP, available nesting areas are poorly drained potholes and wetlands. Summer foods include large nymphal or larval forms of insects, frogs, rodents, small birds, minnows, and berries (Allen 1956, Novakowski 1966, Bergeson et al. 2001b).

The wintering habitat consists of estuarine marshes, bays and tidal flats (Allen 1952, Blankinship 1976). Some individuals occur occasionally on nearby privately owned pasture or croplands. The winter diet consists mainly of blue crabs (*Callinectes sapidus*), clams (*Tagelus constricta*), and Carolina wolfberry (*Lycium carolinianum*) (Allen 1952, Uhler and Locke 1970, Blankinship 1976 and 1987, Hunt and Slack 1987, Chavez-Ramirez 1996).

During migration, whooping cranes use a variety of habitats including croplands and palustrine wetlands, with most sites being <4 ha in size. Heavily vegetated wetlands were not generally used, however when used family groups appeared to select more heavily vegetated wetlands than nonfamilies (Howe 1987, 1989). See the Whooping Crane International Recovery Plan, third revision for more detail regarding the habitat and dietary requirements (CWS and USFWS 2007). Significant portions of the migratory corridor have been impacted by development, conversion to non-compatible land uses, or on-going land management resulting in habitat loss, degradation and fragmentation caused by draining of wetlands for conversion to croplands, urbanization, construction of roads and power lines, and most recently wind farms.

A big problem for reintroduced whooping crane flocks may be the lack of large blocks of suitable habitat in which the species seems to prosper. Wetland loss in the U.S. has been staggering. For example, the last known whooping crane nest in the U.S. for the AWBP was in Cerro Gordo County, Iowa. Since that county was settled, over 95 percent of its wetlands have been drained (T. Stehn, USFWS, pers. comm., 2007).

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

The growth of the human population in North America has resulted in significant alteration and destruction of whooping crane habitat. One of the primary reasons for the historic decline of the whooping crane was the settlement of the prairie pothole region, including the conversion of wetlands to agricultural production (Allen 1952) making much of the historic nesting habitat unsuitable for whooping cranes. Disruptive practices included draining, fencing, sowing, and the human activity associated with these actions. Drainage of wetlands also resulted in a tremendous loss of migratory habitat available to whooping cranes. Wetland losses are continuing, especially with the recent increase in crops used for ethanol production (De Fraiture and Berndes 2009).

The construction of roads, buildings, power lines, towers and wind turbines have all negatively impacted the species (see section 2.3.2.5). The building of cities and towns directly destroys, as well as fragments, whooping crane migratory habitat. Large metropolitan areas such as Dallas-Ft. Worth make hundreds of square miles unsuitable for crane use, as do smaller towns located throughout the migration corridor. This loss of habitat may exacerbate the normal effects of periodic drought on whooping crane populations that do poorly in all aspects of their life cycle when conditions get drier. The occurrence and severity of drought itself may be made worse by climate change that could dry up wetlands needed by the cranes. The activities of humans continue to be the biggest threat to the species.

Decreases in river flows have resulted in habitat degradation of riverine migration habitat for the species. Water diversions on major river systems such as the Platte River have degraded migration roost habitat. The reduced flows caused by reservoir construction and water withdrawals from the river are insufficient to scour woody vegetation from the riverbed, allowing trees to become established in the river channel. This has greatly reduced the number of unvegetated sandbars with open visibility used by cranes for roosting. The Platte River channel has also gotten deeper so it is no longer the wide braided river that had once been so attractive to cranes, and wet meadow habitats adjacent to the river have also been reduced.

Population growth on the Texas coast resulting from an increase in development is encroaching on salt marsh habitat used by the wintering whooping cranes. If development continues, it will limit the expansion of the species winter range and very shortly preclude recovery. There are currently five housing canal-lot developers applying for permits on lands which whooping cranes have used. Threats are growing as developers build houses on lands needed for whooping crane survival and expansion, and power lines, cell towers and roads are all increasing. Currently, 60 percent of wintering whooping cranes use the ANWR and Matagorda Island NWRs. With development occurring on private lands as people move to the coast, the potential for future flock expansion may soon be limited unless there is a large effort to protect additional lands.

Freshwater inflows starting hundreds of kilometers inland from the Guadalupe and San Antonio rivers flow into whooping crane habitat and critical habitat at and adjacent to ANWR. Inflows are needed to maintain proper salinity gradients, nutrient loadings, and sediments that produce an ecologically healthy and productive estuary (TPWD 1998). Inflows are essential to produce foods used by whooping cranes, especially blue crab populations that do well when inflows are high (Houston Advanced Research Center 2006). A simple inverse relationship exists between blue crab catch rates and mean salinity within an estuary (Longley 1994). Lower salinities in late summer also promote production of Carolina wolfberry that is an important food for whooping cranes in the fall. Inflows also lower salinities in the bays and marshes, providing drinking water for cranes that would otherwise be forced to fly inland for freshwater.

Reduced fresh water inflows are reaching the bays and estuaries on and around ANWR due to diversions for agriculture and human use. Developers seek additional water rights from the Guadalupe River that conservationists allege is over-appropriated. Springs coming from the Edwards Aquifer underneath San Antonio are threatened by increased pumping. These springs can make up 80 percent of San Antonio and Guadalupe river flows during periods of drought.

The TPWD has recommended target inflow levels needed to maintain the unique biological communities of the Guadalupe Estuary (TPWD 1998), which includes whooping crane critical habitat. Unfortunately, mechanisms to guarantee these flows are not provided by Texas water law, and critics have challenged the size of the target inflows. Inflows are already reduced over historic levels and at times are insufficient to maintain bay productivity (CWS and USFWS 2007). Due to constructed diversions, by 2040, a decrease of freshwater inflows into the crane's winter range is projected in an average year to cause an 8 percent decline in blue crab populations (Texas Department of Water Resources 1980), but could have a much larger impact in drought years (Norman Johns, NWF, Austin, Texas, pers. comm., 2004).

Projections indicate the Guadalupe River will be significantly threatened during periods of low flow and could cease to flow into San Antonio Bay if all currently authorized water-use permits are utilized (NWF 2004). In a report entitled *Bays in Peril,* a "Danger" ranking was given to San Antonio Bay because drought periods were predicted to increase by 250 percent, and years with low freshwater pulses in the spring were calculated to increase 26 percent from normal levels (NWF 2004). Texas Water Development Board data indicate natural droughts already threaten the Guadalupe ecosystem. Withdrawals of surface and groundwater for municipal and industrial growth are predicted to leave insufficient inflows to sustain the ecosystem in less than 50 years. Modeling indicates that if all existing water rights were exercised during a repeat of the 1950-1956 drought, estuary inflows would be reduced from 17 percent to 43 percent below current levels and from 36 percent to 72 percent below historic levels, depending on the year (N. Johns, pers. comm., 2004 in Fitzhugh and Richter, 2004). A proposed nuclear power facility near Victoria, Texas would use 75,000 acre-feet annually from an un-utilized water right (M. Orms, pers. comm., 2008).

Even though they are omnivorous and do feed on agricultural crops during migration, they have not adapted to agricultural production the way sandhill cranes have because most of their life cycle is wetland-dependent. Although many important parts of their range have been protected through public ownership (refuges, parks, and wetland management areas), the cranes use migration habitat opportunistically and frequently use private lands. The frequent lack of traditional use areas in migration makes management for the species extremely difficult without being able to predict exactly what areas whooping cranes will use. The species must have a multitude of available stopover sites in order to be able to stop at short notice as darkness or wind shifts make conditions unfavorable for migration. Migration habitat is threatened by climate change with predicted reduction in rainfall for much of the corridor. Cranes may also lose habitat with their expected avoidance of areas developed for wind energy. Also, wetland loss is continuing in the migration corridor through conversion of lands for agriculture.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

A major reason for the decline of the species in the 1800s and early 1900s was indiscriminant shooting and egg collection. Allen (1952) recorded 389 whooping cranes known to have died from gunshot or other causes from colonial times to 1948. The majority of documented mortalities (274 cranes) occurred in migration between 1870 and 1930 (Allen 1952). Considering the low reproductive potential of the species, the shooting mortality possibly exceeded annual reproduction by the early 1900s.

Prior to the passage of the Migratory Bird Treaty Act in 1918, it was legal to shoot whooping cranes. Through education, whooping cranes at present are only rarely shot (Lewis et al. 1992a). Some of these shootings are strictly acts of vandalism, while most are associated with migratory bird hunting. Whooping cranes of the AWBP occasionally associate with sandhill cranes during migration. Hunting of sandhill cranes and snow geese occurs in and adjacent to areas used by migrating and wintering AWBP whooping cranes. Hunters may misidentify and shoot whooping cranes as these species. Sandhill crane hunting seasons in Canada and the United States in the migration corridor were originally seasonally timed or geographically limited to protect whooping cranes (Buller 1967, Archibald et al. 1976, Thompson and George 1987). Recent expansions of sandhill crane hunting seasons offer an increased potential for overlap with whooping crane migration periods and increased risks to whooping cranes (Konrad 1987). In some instances, large land units have been closed to sandhill crane or waterfowl hunting due to the presence of a flock or flocks of whooping cranes. Quivira NWR in Kansas is closed during most fall migrations whenever whooping cranes stopover (David Hilley, Quivira NWR, pers. comm., 2002). Tundra swan hunts recently initiated in the northern Great Plains (Montana, 1983; North Dakota, 1988; South Dakota, 1990) also present a risk of misidentification and accidental shooting of whooping cranes.

The most recently documented shooting losses in the AWBP were two adults shot by sandhill crane hunters in central Kansas in November 2004. On occasion, whooping cranes have been mistakenly shot at ANWR by hunters who lack bird identification skills. The last known case at ANWR was an adult female shot in 1989. Twelve documented shootings of whooping cranes in North America have occurred in the 17-year period between 1989 and 2005. Three of the eastern migratory whooping cranes designated as “experimental nonessential” whooping cranes were shot and killed in Georgia in December 2010, two were shot in

Alabama in January 2011, and two more were shot in Louisiana in October 2011. Investigations are ongoing but facts to date indicate the shootings were acts of vandalism not connected with migratory bird hunting, as was the one whooping crane shot and killed in Indiana in 2009. It is not known what percentage of shootings go undetected, nor what percentage of unexplained losses can be attributed to shootings. However, it is very important to remember that sportsmen and other conservationists have played a crucial role in helping whooping cranes by protecting thousands of acres of stopover habitat.

The whooping crane is sensitive to disturbance on the breeding grounds and will not remain near human activity. Some disturbances cause the birds to leave an area; the effects of others may be more subtle. However, the egg transfer and banding programs in WBNP have demonstrated that cranes will tolerate human intrusion for short intervals.

The public does not have access to most of the whooping crane nesting habitat, but does have significant access to whooping crane winter habitat, as these coastal waters are public domain. The human presence in the crane wintering area is greater than in any other part of the crane range. Human presence is increasing dramatically as more and more people settle and/or recreate on the Texas coast. For example, the population of Rockport, Texas just south of the crane wintering area has increased by 39 percent since 1990. The accessibility of the cranes to humans at ANWR has led to a vast number of people coming specifically to see the cranes. Up to 8,000 people ride whooping crane tour boats and in excess of 70,000 people visit the refuge annually, many hoping to see the cranes. These interactions build support for the species both locally and nationally, create awareness of existing threats to the cranes, and provide educational opportunities.

Human disturbance occurs from hunters, sport fishermen and commercial crabbers, and birders, and boaters reduce the habitat available to the species, at least on a temporary basis. The growing use of shallow-water craft including airboats and kayaks has made the crane area accessible even during periods of the lowest tides experienced mid-winter.

The increasing disturbance to whooping cranes on the wintering grounds has been a concern for many years as more and more people settle on the coast (T. Lewis, USFWS, *In prep*.). As the Texas coast is developed, whooping cranes will have more interactions with people. Access in the salt marshes, because of their status as navigable waters, has in most cases been unregulated. Cranes are somewhat tolerant of people in carefully operated boats and land vehicles (Mabie et al. 1989). On ANWR, whooping cranes responded negatively to 40 percent of all disturbances (T. Lewis, *In prep.*). Whooping cranes disturbed for 17 minutes for each hour observed, moved an average of 525 m from human disturbances and were displaced most often from open bay and wet marsh habitats (T. Lewis, *In prep*.). Airboats, low-altitude aircraft, and especially helicopters cause disturbance, and resulted in short-term or long-term loss of habitat and social disruption of the flock. Furthermore, disturbance to cranes limits their ability to obtain food resources and thus impacts fitness (T. Lewis, *In prep.*). Although whooping cranes sometimes may be found close to humans in familiar situations, it is unknown what levels of stress may be associated with these encounters.

2.3.2.3 Disease or predation:

<u>Disease</u>
Little is known about the importance of diseases or parasites as mortality factors for wild whooping cranes. Although wild whooping cranes are presumably susceptible to a variety of infectious and toxicological diseases, evidence of disease-related mortality is infrequently documented. From 1976 to 1989, the USFWS necropsied or examined 25 whooping crane carcasses found dead in the field or removed from the wild because of sickness or debility. Of these, nine were diseased. Seven had avian tuberculosis (Snyder et al. 1997), a subadult crane captured in New Mexico was suffering from avian cholera (Snyder et al. 1987), and an adult died from acute lead poisoning (Brand et al. 1992, Snyder et al. 1992). The high incidence of avian tuberculosis indicates that whooping cranes may be particularly susceptible to that disease. In 2009, an unknown herpes virus was isolated from a juvenile at ANWR. Infectious bursal disease (IBD) has been known to cause mortality in whooping cranes reintroduced in Florida, and sandhill cranes captured in Nebraska in 2009 showed an antibody response to IBD and/or to a herpes virus. Eastern equine encephalitis has also been documented in the Florida flock.

Human impacts on the environment and global movements are resulting in emerging disease problems of possible significance to whooping cranes. For example, West Nile virus appeared for the first time in North America in 1999 and spread rapidly. The H5N1 strain of avian influenza that surfaced in Asia in 2005 is an emerging threat to both captive and wild flocks. Aflatoxin and other molds growing on farm crops can be toxic to cranes. In addition, the toxin produced by red tide phytoplankton blooms (*Karenia brevis*) can be transferred through whooping crane prey items including clams. It has been known to cause bird mortality and could pose a significant threat to whooping cranes that feed heavily on clams in mid-winter. Red tide historically occurred infrequently on the Texas Coast. In recent years, it has occurred nearly annually during late summer and fall, lasting for several months. Red tide has been documented in the whooping crane area in recent years, and there have been occasional severe outbreaks along the Texas coast. In late 2011 through the time of publication, all Texas coastal waters were closed to the commercial and recreational harvesting of oysters, clams and mussels due to the presence of red tide (TPWD, Red Tide Update 2011, online). It is not known what factors are causing the increased number of outbreaks of red tide, but may be related to coastal urbanization causing changes in water quality.

Coccidia, an internal parasite, have been found in a whooping crane with an injured wing captured in WBNP and in whooping crane droppings collected on the Texas wintering grounds (Forrester et al. 1978), and are common in cranes in the Florida release population (Spalding et al. 1996). Coccidia have caused deaths of several whooping crane chicks in captivity (Carpenter et al. 1980). The defense of large territories and small brood size ensures low density use of the WBNP natal area, and thereby reduces the likelihood of coccidia oocysts (spores) being ingested in quantities sufficient to cause significant disease. A variety of other parasites have been documented in released whooping cranes in Florida, but none has been proven to cause significant disease (Spalding et al. 1996).

Loss of wetlands has concentrated birds using aquatic habitat, thereby increasing the risk of disease exposure and transmission between birds. For example, avian cholera epizootics occur fairly regularly in several areas used by cranes; this disease has been confirmed in one whooping crane. The *Federal-State Cooperative Whooping Crane Contingency Plan* calls for hazing cranes out of areas where disease outbreaks are occurring.

Predation

Adult whooping cranes generally are not susceptible to predation unless they are weakened by disease or injury, or are flightless during feather molt. However, eggs and chicks are predated (Bergeson et al. 2001a). Potential predators on the nesting grounds include black bear (*Ursus americanus*), wolverine (*Gulo luscus*), gray wolf (*Canis lupus*), red fox (*Vulpes fulva*), mink (*Mustela vison*), lynx (*Lynx canadensis*), and raven (*Corvus corax*). Black bears and other mammals destroy eggs, and wolves, foxes, and ravens kill chicks (Kuyt 198la, 198lb, Bergeson et al. 2001a). The overall impact of predation on AWBP recruitment remains uncertain, but Boyce et al. (2005) have correlated the 10-year crane population cycle with that of boreal forest predator cycles. Predator control is not considered an appropriate management technique within Canadian National Parks.

Whooping cranes are exposed to predators during migration (Lewis et al. 1992b). In the west, two golden eagle attacks on juvenile whooping cranes were documented during migration of reintroduced birds behind an ultralight. In 2002, a bald eagle killed a whooping crane hatchling in Florida. Bobcats (*Lynx rufus*) and alligators (*Alligator mississippiensis*) are significant predators of reintroduced whooping cranes in Florida. Bobcat predation appears most severe on individuals that do not show proper roosting behaviors or use habitat with heavy cover. Predation rates are significant in Florida, but appear to be low in wild birds in Texas where more time is spent in coastal wetlands. However, bobcats and coyotes have taken cranes that are sick or injured at ANWR (Hunt et al. 1987).

2.3.2.4 Inadequacy of existing regulatory mechanisms:

The current legal framework including the Endangered Species Act (ESA), Migratory Bird Treaty Act, the National Environmental Protection Act (NEPA), and Species at Risk Act in Canada, can provide for adequate protection and conservation of the whooping crane and its habitat. However, implementation of these Acts to address all the issues facing whooping cranes is difficult and can often only be applied on a project-by-project basis. This is especially difficult with the ESA when there is no federal nexus for the project activity. Habitat used by whooping cranes everywhere except in its nesting range continues to be lost or degraded bit by bit. Some extremely large-scale threats, such as climate change and sea level rise, are not being adequately addressed by the ESA or any current legislation.

Federal and state policies often help to promote development, which results in habitat loss for the cranes. Examples include Federal flood insurance aiding residential development in coastal salt marshes in the species' winter range, State water law that allocates water diversions, farm subsidies that encourage land use conversion in the migration range, and Federal tax breaks given to wind-power companies, resulting in proliferation of infrastructure for wind power generation throughout the range.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

An important natural factor affecting the recovery potential of the whooping crane is the low reproductive rate of the species. The delayed sexual maturity until three to five years of age, small clutch size of one or two eggs, and low recruitment rate preclude rapid population recovery. Only 52 percent of chicks hatched in Canada survive to reach Texas (B. Johns, CWS, pers. comm., 2008). Cold weather and precipitation soon after hatching may lead to loss of chicks; in particular, pairs with two young often lose one during these periods of adverse weather (Brian Johns, CWS, pers. comm., 2008). Most immediate post-hatching mortality may also be related to sibling aggression and short-term food shortage because eggs hatch asynchronously and the precocial young are extremely aggressive toward each other. The dominant chick apparently obtains principal access to food made available by the parents; consequently, brood-size is rapidly reduced during periods of food shortage (Drewien 1973, Miller 1973, Bergeson et al. 2001b). Chicks that fledge have a high probability of successfully completing their first migration (Kuyt 1976a).

<u>Climatic Factors</u>
Whooping cranes do not do well faced with drought conditions. Production is reduced dramatically, possibly from increased predation (Kuyt 1981b). Food supplies are diminished, and newly hatched chicks are forced to travel longer distances between wetlands. Habitat becomes more limited in migration as many non-permanent wetlands go dry. Drought affecting the wintering grounds influences availability and abundance of the natural food supply by altering salinity of tidal basins and estuaries (Blankinship 1976). Blue crab and wolfberry populations are reduced, the preferred foods of the whooping crane, and winter mortality increases (Pugesek et al. 2008). The species is also threatened by extreme storm events including blizzards, hail, and lightning. A whooping crane

in Florida was struck and killed by lightning in 2009, and 18 captive-raised juveniles were killed in their release pen at Chassahowitzka NWR in Florida by a lightning strike. A late-season hurricane at the ANWR could place cranes at risk due to high wind velocities and flooding; fortunately, the hurricane season ends (November 30) just after most whooping cranes arrive. Any climate change that would increase the intensity of extreme storm events over historical patterns or would cause a general drying of wetland habitat would threaten the species.

Global warming and associated climate changes constitute a potential threat to whooping crane recovery. Rising temperatures could increase evaporation and dry up wetlands that whooping cranes use throughout the year. If the warmer temperatures are not counter-balanced by increased precipitation, the species would struggle facing increased drought-like conditions. Warming temperatures that could reduce the number and severity of winter freezes at ANWR could allow black mangrove (*Avicennia germinans*) to spread its range northward into the crane area, an event that has been occurring over the past decade (T. Stehn, USFWS, pers. comm., 2010). The dense mangrove shrubs would reduce visibility for the cranes and would make much crane habitat unusable.

Sea level rise and flooding of coastal wetlands is a major threat. Since whooping cranes mostly only use water < 20 inches deep, a projected sea level rise that could exceed 39 inches (0.99 m) by the end of the century announced by climate scientists meeting in Copenhagen in March 2009 would make the current whooping crane winter range unusable (Tom Stehn, ANWR, pers. comm., 2010). The realization that glaciers are melting more rapidly and waters are rising faster than originally predicted makes it even more important to carry out a land protection initiative for whooping cranes. Upland areas next to existing marshes need to be purchased based on forecasts of marshland changes. However, bulk-headed developments will prevent new marshes from developing.

Waters along the Texas coast have been rising ever since records have been kept at the first Texas water level gauge installed in Galveston in 1922. Sea level has been rising 3.1 millimeters (mm) per year between 1993 and 2003 with a long-term average of 2 mm per year. Land subsidence of the Texas Coast is also occurring as minerals and water are pumped from the ground. In places along the Texas coast, the combined effect has been over 6 mm per year with land subsidence accounting for a 4 mm drop. Sea level rise, combined with land subsidence, is projected to be 0.46 to 0.87 m on the Texas coast by 2100 (Tunnel et al. 2007); this is greater than earlier projections of 0.43 m (Twilley et al. 2001).. Coastal wetlands are particularly vulnerable to erosion. As waters have risen, gulf beaches have been retreating between 0.6 - 2 meters and the side of the barrier islands touching bays have also been retreating over a majority of the coast.

Loss of 2/3 of the genetic material of the species that occurred during the population bottleneck when only 15 whooping cranes remained in the AWBP makes it less likely that the species will be able to adapt to environmental change.

Genetic material will continue to be lost until flock size can increase to over 1,000 individuals. The loss of genetic diversity may be hurting survival of young chicks as well as impacting flock disease resistance.

<u>Collisions with Power and Electrical lines:</u>
Collisions with power lines are a substantial cause of whooping crane mortality in migration (Brown et al. 1987, Lewis et al. 1992b). Collisions with both transmission and distribution power lines are responsible for the death or serious injury of at least 45 whooping cranes since 1956 (Stehn and Wassenich 2008). In the 1980s, two of nine radio-marked whooping cranes from AWBP died within the first 18 months of life as a result of power line collisions (Kuyt 1992). Of 27 documented mortalities in the Rocky Mountain reintroduced whooping crane population, almost 2/3 were due to collisions with power lines (40.1 percent) and wire fences (22.2 percent) (Brown et al. 1987). Twenty individuals within the Florida populations and at least four individuals in the migratory Wisconsin population have died hitting power lines. As an additional concern, power lines can cause habitat fragmentation.

The Avian Power Line Interaction Committee (APLIC) composed of nine investor-owned electric utilities and the USFWS was established in 1989 to address the issue of whooping crane collisions (Lewis 1997). In 1994, APLIC provided voluntary guidelines to the industry on avoiding power line strikes (APLIC 1994). At present, the USFWS is requesting the development of avian and bat protection plans by participating companies to reduce bird strikes (Manville 2005). Tests of line marking devices, using sandhill cranes as surrogate research species, have identified techniques effective in reducing collisions by up to 61 percent (Morkill 1990; Morkill and Anderson 1991, 1993; Brown and Drewien 1995). Techniques recommended include marking lines in areas frequently used by cranes and avoiding placement of new line corridors around wetlands or other crane use areas.

<u>Renewable Resources: Wind Energy</u>
Increasing interest in development of renewable energy sources as one part of addressing global climate change, in many regions of the United States, including the range of the whooping crane, has created the need for additional generation and transmission lines to move power to the grid and transport it to the population centers (i.e., areas of demand). Often these sources of renewable energy are located in areas distant from population centers and existing electricity generation sources, and as such have limited transmission infrastructure and limited capacity within the existing infrastructure. Planning for new transmission is ongoing and directed at addressing the transmission bottleneck to further facilitate development of thousands of megawatts of wind energy facilities (i.e., thousands of wind turbines with associated habitat loss and fragmentation). Proposed extreme high voltage transmission lines (EHV; 345 to 765 kilovolts) could remove transmission capacity bottlenecks that are currently limiting further expansion of wind energy facilities.

An estimated 16,000 new wind turbines may be constructed in the U.S. in the next decade, adding to the existing 15,000 turbines (Manville 2005). The development of wind farms in the whooping crane migration corridor has the potential to cause significant mortality. Cranes could be killed directly by wind turbines or from colliding with new power lines associated with wind farm development.

Research and management are needed to reduce this new threat. The effects of wind energy development on whooping crane populations have not been investigated, but the effects of similar disturbances such as oil and gas development can serve as a surrogate in many instances and suggest that the effects will not be neutral or beneficial. Like oil and gas development, wind energy development involves loss of habitat due to the installation of roads, turbine pads, substations, maintenance/operation facilities, and generation interconnect lines; these features also serve as sources of habitat fragmentation. It is likely that migrating whooping cranes coming upon wind farms will be less likely to stop due to the presence of the tall turbines since whooping cranes are known to avoid tall structures such as buildings.

<u>Other Vertical Structures:</u>
Collisions with other objects including fences, aircraft, vehicles and possibly wind turbines and communications towers are a threat to the species. Whooping cranes, particularly in the western population reintroduced at Grays Lake, Idaho were documented either colliding with or getting entangled in fences as they tried to walk through them. Fences crossing wetlands are particularly hazardous as whooping cranes may be coming in to land and simply not see the thin fence wire. Human settlement including roads and buildings has resulted in the fragmentation of whooping crane habitat, particularly in migration. This has reduced the total amount of habitat available to the species. When given a choice, whooping cranes will avoid roads and buildings. Whooping cranes prefer to avoid humans. However, whooping cranes reintroduced in the eastern U.S. that are less wary of people have been documented feeding on roadsides and being killed by vehicle collisions. Guy wires associated with telecommunication towers (radio, television, cellular, and microwave) present another potential collision obstacle to cranes. Although a whooping crane has not yet been documented hitting a tower, particularly worrisome is the use of support guy wires that are thin and thus difficult for whooping cranes to see. Visible markers should be placed on guy wires to reduce the risk of avian collisions. Whooping crane collisions with aircraft rarely occur because of the small number of whooping cranes, but are a growing threat. One whooping crane was killed in June 1982 during a KC-135 tanker takeoff from Minot Air Force Base, North Dakota (Harrison 1983). Feather remains were identified by the Smithsonian Institute. A crane over North Dakota may have been hit by a plane in April 2007; the bird suffered massive internal injuries from collision with a blunt object, but the exact cause of death was never determined. In October 2007, a recently released, naïve DAR bird was

struck and killed by a jet aircraft at the Dane County airport in Madison, Wisconsin (WCEP 2007).

Chemical Spills:

The release of chemicals at ANWR associated with ship traffic on the Intracoastal Waterway and oil and gas development including platforms and pipelines could cause a disaster, killing a large number of cranes outright or degrading their habitat (Robertson et al. 1993). Many barges carrying toxic chemicals travel the Gulf Intracoastal Waterway (GIWW) daily through the core of whooping crane winter habitat.

The U.S. Coast Guard has the lead responsibility for spill response and containment. The USFWS has response plans for the Gulf of Mexico (USFWS 1979) and specifically for Aransas (Robertson et al. 1993). However, it is impossible to provide full protection for the cranes as long as chemicals are transported on the GIWW through the heart of the winter range. When a spill occurs, high winds would greatly reduce the effectiveness of containment booms for products floating on the surface. Gaseous materials leaked could directly kill all cranes downwind. Spills of hazardous chemicals may limit human approach to only those personnel wearing special protective suits and breathing apparatus. An event occurring at night or in bad weather (the most probable times) would slow response.

The cranes are exposed to gas and oil development in migration, including waste oil pits and tar sands development in Canada. In the fall of 2006, a crane family group was seen in Nebraska with what appeared to be oil-stained feathers on the lower half of their bodies. It looked like they had walked into an oil waste pit. The huge oil waste pits connected with tar sands oil extraction in Canada located in the migration corridor is another risk to the whooping cranes.

There is no evidence that pesticide contamination has ever been a significant threat to whooping cranes. Whooping crane egg and tissue specimens examined for pesticide residues have shown concentrations well below those encountered in most other migratory birds (Robinson et al. 1965, Lamont and Reichel 1970, Anderson and Kreitzer 1971, Lewis et al. 1992b). Eggshell thickness, a measure of contaminant exposure, has been measured in eggs taken from the wild and those in captivity from the 1970s to the present; no evidence of shell thinning has been detected. However, knowledge of potential indirect or sub-lethal effects of pesticides on whooping cranes is inadequate and poorly understood. The baseline contaminant impacts research comes from research on other birds including sandhill cranes, but has never been done on whooping cranes.

Whooping cranes on the winter range are exposed to contaminants associated with runoff from agricultural and industrial activities. Nearby Lavaca Bay was closed for multiple years to the harvesting of fish and crabs because of industrial pollution including high levels of mercury (Lewis et al. 1992b).

2.4 Synthesis

The whooping crane has made a remarkable comeback from a low of 15 individuals in 1941 at ANWR to give the species a fighting chance to survive. The comeback was enabled by protective legislation and public awareness that stopped shooting, as well as protecting the summer and winter grounds as conservation areas. The only self-sustaining wild flock of AWBP whooping cranes numbered 279 individuals in June, 2011. The flock suffered 21.4 percent mortality in the 12 months following spring, 2008. With efforts to establish reintroduced populations so far unsuccessful, the downlisting Alternate Criteria 1B (AWBP over 1,000 individuals), is the best way of measuring the status of the whooping crane. With the size of the AWBP first reaching over 100 birds in 1987 and over 200 birds in 2004, and a historic growth rate of 4.6 percent maintained over the past 70 years, one can remain optimistic about recovery chances for the whooping crane. However, reaching a target of over 1,000 birds (to reach consideration for downlisting) will likely take 30 or more years, and de-listing criteria have not yet been set. Threats found throughout the range of the species are growing in magnitude as the human population continues to grow and wildlife habitats are lost. The increasing threats and the drop in number of whooping cranes are signified by the "decreasing" status in 2009. Habitat loss on and adjacent to ANWR from housing developments, invasion of black mangrove, increased disturbance, continued loss of inflows into the winter critical habitat making the habitat less productive, and wind energy development and the associated power line construction in the migration corridor all are taking habitat and recovery potential away from the species. In addition, the forecast sea level rise of 0.46 to 0.87 m by 2100 (Tunnell et al, 2007) would make the entire current whooping crane winter habitat too deep for the species to use. Given the low number of individuals in the AWBP, the continuing loss of genetic material from a small population, and the growing threats, it is clear that the status of the whooping crane should remain as "endangered".

3.0 RESULTS

3.1 Recommended Classification:

No change is needed

3.2 New Recovery Priority Number: No change is needed.

Brief Rationale: We carefully considered whether it was appropriate to change the recovery priority number from 2C (high degree of threat and high recovery potential) to 5C (high degree of threat and low recovery potential). In order to determine the recovery priority number, we assessed the magnitude of each threat as well as the species' overall recovery potential. Species are considered to have a high recovery potential when the biological and ecological limiting factors are well understood, threats are easily alleviated, and if intensive management techniques are required, they are well-documented and highly successful.

It is clear that whooping cranes are exposed to a high level of threats that have increased in number and intensity since listing. Historical threats due to the settlement of prairie pothole regions, drainage of wetlands, and habitat conversion in and around the wintering grounds, are now increasing. To accommodate the growing human population along the Texas coast, additional roads, buildings, large development projects, power lines, and renewable energy sources are being developed. It is unknown how the species will react to the large landscape changes that these projects will bring; however, the chances of increased crane mortalities and/or diversion into areas with less suitable habitat may become the norm. The whooping crane depends on coastal wetland communities for overwintering habitat and with the projected impacts from climate change, including inundation of existing marshes, potentially more extreme salinities, water temperature induced reduction in prey base, and fluctuations in water temperature, the species is likely to be negatively impacted, although the degree of impacts is unknown.

It is less clear whether the potential for recovery is "high" or "low". Some limiting factors, such as available wintering habitat, are relatively well-understood. Other limiting factors, such as the lack of successful breeding in the reintroduced populations, require further research and experience to understand.

The threats to the species, as described above, are relatively well understood, but many are difficult to alleviate. For example, the ability to conserve additional habitat via fee title acquisitions and conservation easements is becoming more constrained by increasing land prices and limited funding to pay for acquisitions. The limitations on land acquisitions in combination with the elevated threats from development, wind energy, climate change, and diversion of freshwater inflows, provide significant challenges to recovery.

Conversely, population growth of the AWBP has been steady and significant suggesting that we understand the limiting factors and are successfully implementing appropriate management actions to address these threats. In addition, reintroduction techniques have allowed tremendous expansion of the potential range, provided that the issues with successful recruitment can be addressed. These factors suggest that the recovery potential remains high.

In summary, while threats are high and increasing, successful management techniques have facilitated continued growth in the population. Much has been learned about the species' ecological requirements and the management techniques that work, in spite of ongoing conflicts with development. Therefore, we recommend that the species recovery priority number remain 2C. Future status reviews will have to carefully weigh this question as new information is acquired.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

Recovery of the whooping crane needs to be a 3-pronged approach to; protect and enhance the AWBP; reintroduce 1 or 2 separate self-sustaining flocks; and enhance the captive flocks.

<u>To enhance the AWBP</u>

To Protect Winter Habitat;

Determine peak flock size, number of nests, number of fledged chicks, and number of chicks that reach ANWR during each of the next 5 years on aerial surveys. Document spring to fall, and winter mortality.

Enhance foraging opportunities on 5,000 acres/year at ANWR by prescribed burns.

Obtain additional funding and purchase easements and fee title lands for 40,000 acres of occupied winter habitat, potential habitat and upland buffer in the next 5 years with a 10-year goal of 100,000 acres.

Obtain additional funding to restore, enhance and/or maintain 40,000 acres of occupied and potential habitat, including upland buffer, in the next 5 years. Use Cooperative Agreements with non-government organizations and Private Lands Agreements with landowners.

Map and characterize the invasion of black mangrove into the crane range at ANWR, coordinate with National Marine Fisheries Service (NMFS), and implement a control program if feasible.

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Consider expansion of designated Critical Habitat.

Minimize and mitigate for impacts to whooping cranes and crane habitat from development projects through ESA, Section 7 consultations, or Section 10 incidental take permits (Habitat Conservation Plans or HCPs).

Continue to work to ensure freshwater inflows reach the crane wintering grounds. Assemble data to describe flow levels needed to provide the resources needed for a healthy whooping crane population.

Continue education and public relations programs such as community based conservation initiatives, working with news media, doing public presentations, and working with schools.

To Protect Migration Habitat:

Carry out cooperative tracking project during migration periods. Update annually and post-on-line the GIS corridor database and map.

Capture, health check, radio and track 50 whooping cranes. Determine habitat use in migration and detect causes of mortality.

Collaborate with the wind industry to write an HCP to minimize and mitigate wind farms impacts.

Work with APLIC to write an HCP to minimize and mitigate whooping crane collisions with power lines.

Annually carry out the State-Federal contingency plan for protecting cranes in migration. Minimize shooting mortalities related to migratory bird hunting.

<u>To establish reintroduced populations</u>

Rear, train, release and manage cranes in the EMP to reach objectives of 25 breeder pairs.

Overcome nest abandonment issue for the eastern migratory population by controlling black flies and/or by identifying and using new release sites.

Raise and release birds annually for a reintroduction of a non-migratory flock in Louisiana (Year 1 of 10 of this reintroduction project has been completed).

<u>To improve captive breeding programs</u>

Maintain and expand to 50 breeder pairs the captive breeding flocks by supporting captive breeding facilities.

Complete genomic mapping of the captive flock and compare with genetic material sampled from the AWBP.

Initiate research to determine how to get whooping cranes to breed at an earlier age in captivity.

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5.1 GLOSSARY OF ACRONYMS

ACE	Ashepoo-Combahee-Edisto
ANWR	Aransas National Wildlife Refuge
AWBP	Aransas-Wood Buffalo Population
CWS	Canadian Wildlife Service
CZ	Calgary Zoo
EMP	Eastern Migratory Population
FL	Florida Fish and Wildlife Conservation Commission
FR	Federal Register
ICF	International Crane Foundation
NWF	National Wildlife Federation
NWR	National Wildlife Refuge
PWRC	Patuxent Wildlife Research Center
SAZ	San Antonio Zoo
SSC	Species Survival Center
SWMA	State Wildlife Management Area
TPWD	Texas Parks and Wildlife Department
USFWS	U.S. Fish and Wildlife Service
WBNP	Wood Buffalo National Park
WCEP	Whooping Crane Eastern Partnership

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW OF THE WHOOPING CRANE

Current Classification: Endangered with critical habitat

Recommendation resulting from the 5-Year Review:

_X_ No change is needed.

Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By: Tom Stehn, Whooping Crane Coordinator, Aransas National Wildlife Refuge, Austwell, TX

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service, Corpus Christi Ecological Services Field Office, Allan Strand

Approve Allan M. Strand Date 11-04-11

The lead Field Office must ensure that other offices within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. The lead field office should document this coordination in the agency record.

REGIONAL OFFICE APPROVAL:

The Regional Director or the Assistant Regional Director, if authority has been delegated to the Assistant Regional Director, must sign all 5-year reviews.

Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Region 2

Acting Approve Dawn Baker Date 2-13-2012

The Lead Region must ensure that other regions within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. Written concurrence from other regions is required.

Cooperating Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Region 3

_X_ Concur _____ Do Not Concur

Signature Lynn M. Lewis Date 11/28/11

Cooperating Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Region 4

X Concur ____ Do Not Concur

Signature Franklin J Arnold III, Acting Date 12/20/2011

Cooperating Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Region 6

X Concur ____ Do Not Concur

Signature ______________________ Date 12/16/11