2001

INCREASED EGG CONSERVATION-IS IT ESSENTIAL FOR RECOVERY OF WHOOPING CRANES IN THE ARANSASIWOOD BUFFALO POPULATION?

JAMES C. LEWIS
Albuquerque, NM

INCREASED EGG CONSERVATION—IS IT ESSENTIAL FOR RECOVERY OF WHOOPING CRANES IN THE ARANSAS/WOOD BUFFALO POPULATION?

JAMES C. LEWIS, 7712 Midge NE, Albuquerque, NM, 87109, USA

PROCEEDINGS NORTH AMERICAN CRANE WORKSHOP 8:1-5

Key words: conservation, *Grus americana*, management, whooping crane.

The whooping crane (*Grus americana*) is in a race for survival against adversities (genetic, demographic, and environmental) that are only partially understood. There is increasing evidence of genetic problems (drift, inbreeding, and loss of heterozygosity) in the captive population that likely also exist in the wild Aransas-Wood Buffalo Population (AWP), a consequence of the 1940s population bottleneck. Small populations are vulnerable to extinction through catastrophic events and random changes in productivity or survival. Negative environmental effects faced by whooping cranes include upstream diversion which diminish freshwater (nutrient) inflow into Texas wintering habitats, and expanding human activities along the coast of the Gulf of Mexico. Population and genetic specialists tell us that security against genetic problems, demographic fluctuations, and environmental changes, lies in maximizing population size.

An appropriate *minimum* population goal to overcome the aforementioned problems is 1,000 individuals (Shaffer 1981, Salwasser et al. 1984, Mirande et al. 1993). The Canadian–United States Whooping Crane Recovery Team has accepted 1,000 birds as their goal for the AWP. *If habitat is not limiting and inbreeding does not depress viability* (rather large uncertainties), another 30+ years must pass before the AWP reaches 1,000 individuals (Mirande et al. 1993). Can the AWP survive 30+ years to reach a minimum secure population level?

It seems evident that managers should be cautious and consider what might be done to accelerate AWP growth. Two potential techniques come to mind. One would be to supplement the population with introductions of captive-reared cranes. In previous brief discussions by the recovery teams, this approach has been discounted because of potential disease transmission to the only wild self-sustaining population. The second technique would be to initiate intensive egg management (Fig. 1) as described by Ellis and Gee (2001).

The Memorandum of Understanding (MOU) on the Conservation of the Whooping Crane, between Canada and the United States, recognizes the need for continuing *limited* egg collections in Wood Buffalo National Park (WBNP) to benefit genetic management of captive flocks. The MOU does not provide for egg collections to accelerate growth of the AWP, captive flocks, nor other wild populations.

I am guilty, along with recovery team members, of approving the halt in intensive egg management after 1996. [Editor: JCL was Whooping Crane Coordinator, U.S. Fish and Wildlife Service, 1984–1997.] The original goals of the egg pickup had been accomplished. These goals were to establish captive flocks as insurance against extinction in the wild and to support the cross-fostering introduction of whooping cranes in the western United States. Four hundred and fifty eight eggs were transported 1967–96.

Other factors favoring the decision to not retrieve second eggs were budgetary, philosophical, and a feeling of security based on rapid growth of numbers of captive pairs and continued, long-term growth of the AWP. Contributors to the egg-pickup program, Parks Canada, Canadian Wildlife Service (CWS), and U.S. Fish and Wildlife Service (FWS), were all experiencing some budget constraints. The philosophical impetus came from Parks Canada personnel who advocate the idea that, in National Parks, nature should be allowed to run its course without intensive management by or interference from man. Captive flocks were growing at 3 locations and annual captive production was sufficient to support the Florida nonmigratory population introduction. Predictions of future captive production, based on pairs entering reproductive age, indicated production sufficient for 2 simultaneous reintroductions and for research needs. The perceived progress, and optimistic picture for the future, may have led to overconfidence among the managers. In retrospect, after considering the new information on genetics, and survival values for second eggs left in WBNP, I wonder whether ending the intensive egg pickup was premature and unwise.

Is the present situation like the race between the tortoise and the hare? In this analogy, managers of whooping crane recovery could be represented by the hare. The crane's adversaries represent the tortoise. Remember how the hare stopped along the way, overconfident at the perceived slow progress of the tortoise, and his own favorable progress. When the hare tarried, was that similar to our decision to stop intensive egg management of the AWP? As a consequence, will the tortoise (obstacles to the whooping crane's recovery)

Fig. 1. Brian Johns, Whooping Crane Coordinator, Canadian Wildlife Service, floating a whooping crane egg at a nest site in Wood Buffalo National Park, 1995. (Photo by James C. Lewis.)

win the race?

The papers in this section, and others recently published, provide new insight on whether or not we can afford to wait 30+ years for the AWP to reach 1,000 individuals. Two papers address the merits of and need for egg management of the AWP. Discussion of these papers will hopefully stimulate further review of ways to accelerate AWP growth and ensure long-term survival of whooping cranes in the wild.

One caution flag indicating the need to accelerate recovery is the evidence that inbreeding depression may already be reducing chick survival. Megan Lauber, Scott Swengel, and Ken Jones (International Crane Foundation, unpublished data) tested for inbreeding depression effects on egg fertility, hatchability, and chick survival among captive birds. There was a low correlation between reduced chick survival and increasing genealogical interrelationship. It is difficult to detect inbreeding depression in a population that started with 10 to 12 breeders and expanded slowly for decades. Study results did not show strong evidence of inbreeding depression beyond that background level which may affect the entire population, but some families do not produce eggs or fertile eggs, some produce many chicks but few survive well in captivity and after wild release, some fledge many chicks and they survive well in captivity and after wild release, and some families carry genetic defects (Canadian Wildlife Service and U.S. Fish and Wildlife Service 2001 unpublished).

Genetic problems (heart defects, scoliosis, and leg deformities) have been identified in captivity (Olsen et al. 1997) and the wild (heart defects, Drewien et al. 1989 unpublished). Mitochondrial DNA from museum specimens collected before and after the population bottleneck (1941) showed a 66% reduction in haplotypes. The rarest haplotype before 1940 is now the most common (Glenn et al. 1999). Coefficients of inbreeding show increases while diversity estimates show decreases from generation to generation in captivity (Jones and Mirande 2001). These changes threaten to reduce vitality before the population is large enough for mutation to offset losses in diversity from genetic drift (Frankel and Soulé 1981, Ballou et al. 1995). When the population reaches 1,000, recovery of genetic variation by mutation would be expected to exceed further losses by random drift, and variation would slowly be restored.

Would collecting eggs serve to accelerate AWP recovery? Two papers in this section evaluate the merits of collecting whooping crane eggs in WBNP (Cannon et al. 2001, Ellis and

Gee 2001). Theoretically, the benefits of egg collection appear positive. Ellis and Gee (2001) project the number of young fledging in wild and captivity using 2 potential egg management strategies. Using the current breeding population of about 50 nesting pairs, without removal of second eggs, about 20 chicks would arrive at the nesting grounds. With egg removal, they estimate 25 chicks would reach the wintering ground and another 23 would fledge in captivity. Ellis and Gee (2001) conclude that removal of second viable eggs, and transfer of some live eggs into nonviable wild clutches, would increase the number of young produced in the wild. The number of young produced in captivity would double with the addition of removed eggs.

Cannon et al. (2001) compared productivity for egg-collection years and years with no egg collection. Sixteen pairs of "twin" juveniles arrived at Aransas National Wildlife Refuge (ANWR) in 34 years (0.47 juvenile per year) when eggs were not collected. No pairs of twins arrived at ANWR in 27 years of egg collection. Recruitment (defined as the percent of juvenile birds in the total population arriving at ANWR in fall) was significantly greater in years without egg collection (15.24% versus 11.76%). Cannon et al. (2001) acknowledge that egg collection "might be warranted" if the management goal were to maximize the total (captive and wild) population. However, they believe no egg collection would be the best strategy if the goal were to maximize the AWP.

The sharp contrast in conclusions, between Ellis and Gee (2001) and Cannon et al. (2001), prompted a North American Crane Working Group resolution requesting a thorough analysis of data gathered by the CWS from 1985–96. Eighteen months have passed since the resolution was approved. Data analyses are now underway by a professor at the University of Alberta (B. W. Johns, CWS, personal communication).

In these analyses of egg management strategies, it is important to consider the following factors. Two-egg nests frequently remained undisturbed in WBN even in years of egg removal, yet no sibling pairs arrived on the wintering grounds. Analyses of existing data to evaluate past egg management should include comparing success of nests with 1 egg remaining (after removal of 1 egg) versus success of nests with both eggs remaining. Analyses should include within-year comparisons that eliminate some biases associated with long-term trends in habitat quality or population density. Effects of egg removal versus no egg removal should be compared within experienced pairs to tease out the influence of parental experience on chick survival. An experienced pair would include at least 1 member individually identifiable by color markers and known to be breeding for 3 or more seasons. A similar comparison should be made within new pairs, those believed to be nesting their first or second time. Such comparisons would help answer the question, is survival of the remaining chick enhanced when both parents concentrate on care of 1 chick? As Ellis and Gee (2001) point out, a gross evaluation of this question already exists.

During egg collecting years 1985–96, viable eggs were substituted into nests of pairs with consistently low hatching success and nests with eggs of questionable viability (Kuyt 1996; JCL participation in 1990s). What was the outcome? Did these transfers result in successful recruitment by pairs with previous low success? If there was a productivity increase due to egg transfer within WBNP, did the increase exceed the benefit (0.47 chick per year, Cannon et al. 2001) under no egg removal when twin chicks survive to reach ANWR?

The comments that follow could be misinterpreted as criticism of the authors of Cannon et al. (2001). To the contrary, each of these scientists has contributed much to recovery of whooping cranes and is dedicated to the crane's welfare. Cannon et al. (2001) identify the limitations of their analysis saying: "In fact, without controlled experiments, we can make no sound statement about the impact of egg collection on productivity." Unfortunately, they also ". . . hope these data will help to dispel the 16-year-old myth that egg collection from wild crane nests may actually increase the productivity of a naturally-wild crane population." (Cannon et al. 2001).

Three potential weaknesses can be identified in the Cannon et al. (2001) analysis. First, previous studies have noted a 10-year periodicity in survivorship that may be associated with habitat conditions (Boyce and Miller 1985, Nedelman et al. 1987). The extent to which periods of high or low survivorship fit into egg collection or no collection years could bias interpretation of the results.

A second weakness of the analysis (Cannon et al. 2001) is that the differences in survival of "twins," noted in collection versus no egg collection years, could be a consequence of better habitat conditions associated with low population density in the years before egg collections began. That period (1939–66) made up 85% of their sample of no egg collection years. In that period the AWP built slowly from 14 to 38 adults and from approximately 4 to 10 breeding pairs. Mirande et al. (1993) estimated 3 to 4 breeding pairs existed in the 1940s and 5 to 6 in the 1950s. A high proportion of the breeders were likely experienced and with a high probability of successfully rearing twins. Fifteen of the 16 "twins" (94%), that arrived at the Texas wintering grounds, were produced before 1966 when population densities were lower. Higher population densities, with greater competition for habitat resources in breeding and wintering habitat, characterize the years of egg collection.

In egg collection years, the number of adults increased from 38 in 1967 to 130 in 1996 and breeding pairs from about 10 to 45. Whooping cranes do not readily pioneer new areas (Kuyt and Goossen 1987, Stehn and Johnson 1987). A breeding pair tends to return to the same composite nesting area used in previous years (Kuyt and Goossen 1987). New pairs tend to establish winter territories near that of a parent pair (Stehn and Johnson 1987). Consequently, population densities and the potential of competition for limited resources have steadily increased in breeding and wintering habitats. These population density trends could have caused the differences noted by Cannon et al. (2001) in survival of "twins" between years of egg collection and no egg collection.

The third weakness in the Cannon et al. (2001) analysis is that they use the ratio of young produced to the total population as their index to recruitment. A more accurate measure of recruitment would be the ratio of juveniles to the number of active breeders. Complete counts of adult breeders are available since 1968 (Canadian Wildlife Service and U.S. Fish and Wildlife Service 2001 unpublished). Using only adult breeders in the calculation removes the influence of subadult nonbreeders (ages 1–4 years) that sometimes comprise more than 45% of the total population. Using only adult breeders also omits the influence of experienced pairs that fail to nest (i.e., 4 of 53 pairs [7.5%] in 1998, T. V. Stehn, FWS annual progress report; 7 of 60 pairs [11.66 %] in 2001, T. V. Stehn, FWS, personal communication). The proportion of nonbreeders in the population is particularly high for several years following years of good habitat quality when bumper crops of chicks reach ANWR. The inclusion of these subadults in a production calculation makes recruitment appear lower when measured as a percent of the total population. Annual data on the number of breeding pairs are only available since 1968 (Table 1). Average recruitment (measured per active breeder) was 23.08% in egg collection years (n = 26) versus 18.86% in noncollection years (n = 6) (Table 1), the reverse of the Cannon et al. (2001) findings. This simple analysis confirms the need for further evaluation of intensive egg management before concluding it did not and would not benefit the AWP.

Bergeson et al. (2001) studied survival (1997–99) of 22 sets of twin chicks at WBNP. Ninety one percent of the younger siblings died within 2 weeks after hatching. Only 1 of 22 sets (4.5%) of twins survived the summer. The second egg/chick is evolutionary insurance for success if something happens to the first chick. Ninety one percent of the time the second egg was surplus. Can this evolutionary adaptation be used to accelerate recovery of the species? Ellis and Gee (2001), using calculations from existing data sets, show that with routine egg harvest, the wild population would grow faster and the total benefits would be slightly more than a doubling of the number of chicks fledging each year.

Table 1. Known number of whooping crane adult breeders and juveniles arriving at the Texas wintering grounds, and percent recruitment during years with and without egg collection, 1968–96.

Year	Adult breeders	Juveniles	Recruitment % with EC[a]	Recruitment % without EC[a]
1968	20	6	30.00	
1969	22	8	36.36	
1970	26	6		23.07
1971	26	5	19.23	
1972	30	5		16.66
1973	28	2		7.14
1974	30	2	6.66	
1975	32	8	25.00	
1976	32	12	37.50	
1977	34	10	29.41	
1978	30	7	23.33	
1979	38	6	15.78	
1980	38	6	15.78	
1981	34	2	5.88	
1982	34	6	17.64	
1983	48	7	14.58	
1984	58	15	25.86	
1985	56	16	28.57	
1986	58	21	36.20	
1987	64	25	39.06	
1988	62	19	30.64	
1989	62	20	32.25	
1990	64	13	20.31	
1991	66	8	12.12	
1992	80	15	18.75	
1993	86	16	18.60	
1994	56	8	14.28	
1995	98	28	28.57	
1996	90	16	17.77	
1997	98	30		30.61
1998	100	18		18.00
1999	96	17		17.70
Totals			600.13	113.18
Mean recruitment			23.08	18.86

[a] EC = egg collection.

There are many beneficial uses for added production resulting from saved second eggs. Accelerated growth of the AWP, if a reality, would be the most valuable benefit. Within captive propagation the uses include improving the genetic mix of existing colonies and creating new colonies to save more genetic material. The nonmigratory Florida population would benefit from added genetic material not previously available. Increased captive production would benefit reintroduction research and accelerate establishment of such populations. Increased captive production would make some birds available for disease management research. The results of such research could benefit survival of all populations and further accelerate species recovery.

Ellis and Gee (2001) present the scenario for transfer of all second eggs either to captivity or into wild nests lacking viable eggs. In egg management of the past, only a portion of total second eggs were transferred. The first pairs to return to WBNP in spring are the experienced pairs. Second eggs were often removed from nests of experienced breeders because their nests tended to be concentrated in core nesting habitat. A large number of those eggs, in late stages of incubation, could be efficiently acquired by helicopter in a few flights. New pairs typically arrive later and initiate nesting later. Nests on the periphery of the nesting habitat and those of new pairs often were not visited.

New pairs typically are less successful (Kuyt 1996). It seems appropriate to consider removing second eggs from nests of inexperienced pairs because they have a lower probability of success. An egg from a new pairing offers new genetic material for captivity. New pairs with infertile eggs would be benefitted through egg switches. Chick survival might be enhanced in inexperienced pairs if they can concentrate on rearing a single chick.

The need to carefully evaluate the effects of past egg management seems evident. Using those results, managers need to evaluate whether intensive management of all second eggs can be implemented to accelerate growth of the AWP to the minimum secure level of 1,000 individuals. None of us wish to be overconfident in long-range predictions of recovery and, as a consequence, lose the race to ensure survival of the whooping crane.

LITERATURE CITED

Ballou, J. D., M. Gilpin, and T. J. Foose. 1995. Population management for survival and recovery. Columbia University Press, New York, New York, USA.

Bergeson, D. G., B. W. Johns, and G. L. Holroyd. 2001. Mortality of whooping crane colts in Wood Buffalo National Park, Canada, 1997-99. Proceedings North American Crane Workshop 8:6-10.

Boyce, M. S., and R. S. Miller. 1985. Ten year periodicity in whooping crane census. Auk 102:658-660.

Canadian Wildlife Service and U.S. Fish and Wildlife Service. 2001 unpublished. International recovery plan for the whooping crane. Technical agency draft (April), Ottawa, Ontario, Canada, and Albuquerque, New Mexico, USA.

Cannon, J. R., B. W. Johns, and T. V. Stehn. 2001. Egg collection and recruitment of young of the year in the Aransas/Wood Buffalo Population of whooping cranes. Proceedings North American Crane Workshop 8:11-16.

Drewien, R. C., W. Brown, and E. Bizeau. 1989 unpublished. Whooping crane cross-fostering experiment. Report to U.S. Whooping Crane Recovery Team.

Ellis, D. H., and G. F. Gee. 2001. Whooping crane egg management: options and consequences. Proceedings North American Crane Workshop 8:17-23.

Frankel, O. H., and M. E. Soulé. 1981. Design criteria for nature reserves. Pages 98-122 *in* Conservation and evolution. Cambridge University Press, Cambridge, London, U.K.

Glenn, T. C., W. Stephan, and M. J. Braun. 1999. Effects of a population bottleneck on mitochondrial DNA variation in whooping cranes. Conservation Biology 13:1097-1107.

Jones, K. L., and C. Mirande. 2001. Genealogy of the whooping crane. International Crane Foundation, Baraboo, Wisconsin, USA.

Kuyt, E. 1996. Reproductive manipulation in the whooping crane *Grus americana*. Bird Conservation International 6:3-10.

_____, and J. P. Goossen. 1987. Survival, age composition, sex ratio, and age at first breeding of whooping cranes in Wood Buffalo National Park, Canada. Pages 230-244 *in* J. C. Lewis and J. W. Ziewitz, editors. Proceedings 1985 crane workshop. Platte River Whooping Crane Habitat Maintenance Trust, Grand Island, Nebraska, USA.

Mirande, C., R. Lacy, and U. Seal. 1993. Whooping crane (*Grus americana*) conservation viability assessment workshop report. Captive Breeding Specialist Group, IUCN, Apple Valley, Minnesota., USA.

Nedelman, J., J. A. Thompson, and R. J. Taylor. 1987. The statistical demography of whooping cranes. Ecology 68:1401-1411.

Olsen, G. H., J. A. Taylor, and G. F. Gee. 1997. Whooping crane mortality at Patuxent Wildlife Research Center, 1982-1995. Proceedings North American Crane Workshop 7:243-248.

Salwasser, H., S. P. Mealy, and K. Johnson. 1984. Wildlife population viability: a question of risk. Transactions North American Wildlife and Natural Resources Conference 49:421-439.

Shaffer, M. L. 1981. Minimum population size for species conservation. BioScience 31:131-134.

Stehn, T. V., and E. F. Johnson. 1987. The distribution of winter territories of the whooping crane on the Texas coast. Pages 180-195 *in* J. C. Lewis and J. W. Ziewitz, editors. Proceedings 1985 crane workshop. Platte River Whooping Crane Habitat Maintenance Trust, Grand Island, Nebraska, USA.