Attwater's Prairie Chicken
Population & Habitat Viability Assessment

ATTWATER'S PRAIRIE CHICKEN
(*Tympanuchus cupido attwateri*)

Population & Habitat Viability Assessment

REPORT

4-6 January 1994
Glen Rose, Texas

FOSSIL RIM

Edited by:
Ulysses S. Seal and The Workshop Participants

A Collaborative Workshop

United States Fish & Wildlife Service
Texas Parks and Wildlife Department
Texas A & M University
Fossil Rim Wildlife Center
IUCN/SSC Captive Breeding Specialist Group

U.S. FISH & WILDLIFE SERVICE
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4 March 1994

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Section 1

EXECUTIVE SUMMARY

Executive Summary

The endangered Attwater's prairie chicken (APC) is geographically isolated from other prairie chicken populations, its small population is fragmented, and it is in danger of extinction. The recovery objective, as written in the U. S. Fish and Wildlife Recovery Plan (USFWS, 1993), is to restore and maintain a genetically viable, self-sustaining, free-living APC population. In order to achieve the goal of recovery, it is necessary to understand the risk factors that affect survival of the prairie chicken. Risk evaluation is a major concern in endangered species management and a goal is to reduce the risk of extinction to an acceptable level. A set of software tools to assist simulation and quantitative evaluation of risk of extinction is available and was used as part of Population and Habitat Viability Assessment Workshop. This technique can improve identification and ranking of risks and can assist assessment of management options.

Historically, an estimated 1 million Attwater's prairie chickens occupied about 6 million acres of coastal prairie grasslands from southwestern Louisiana to the Nueces River in Texas. The Attwater's prairie chicken was found to be reduced to about 8,700 birds in Texas in 1937 with none found in Louisiana. The range-wide population of the APC was estimated at 456 individuals in 5 Texas counties in 1993. It is separated into 3 distinct subpopulations which may have been reproductively isolated since at least 1937. The population has been declining with fluctuations at an average rate of about 5% per year or declining about 50% every 14 years. A characteristic of this decline has been the fragmentation and loss of individual subpopulations. Only 3 subpopulations now remain and these are in jeopardy of disappearance by the year 2000 (Figure 1).

Twenty biologists, managers, and decision makers attended a Population and Habitat Viability Assessment (PHVA) Workshop in Glen Rose, Texas at the Fossil Rim Wildlife Center on January 4-6, 1994 to apply these recently developed procedures to the APC. The workshop was first proposed for the subspecies by the USFWS Attwater's Prairie Chicken National Wildlife Refuge and was a collaborative effort of the USFWS, Texas Parks & Wildlife Department, Fossil Rim Wildlife Center, Texas A&M University and the Captive Breeding Specialist Group (CBSG) Species Survival Commission/World Conservation Union (SSC/IUCN). The purpose was to review data from the wild and captive flocks as a basis for developing stochastic population simulation models. These models estimate risk of extinction and rates of genetic loss from the interactions of demographic, genetic, and environmental factors as a tool for ongoing management of the subspecies. Other goals included determination of habitat and capacity requirements, role of captive propagation, and prioritized research needs.

The first morning consisted of a series of presentations summarizing data from the wild and captive flock. After a presentation on the PHVA process by facilitator Ulysses Seal, CBSG, the participants formed three working groups (wild population, health issues, and the captive flock) to review in detail current information, to brainstorm, and to develop management scenarios and recommendations. Concurrently, Seal developed stochastic population simulation models initialized with ranges of values for the key variables to estimate the viability of the wild population using the VORTEX software modelling package.

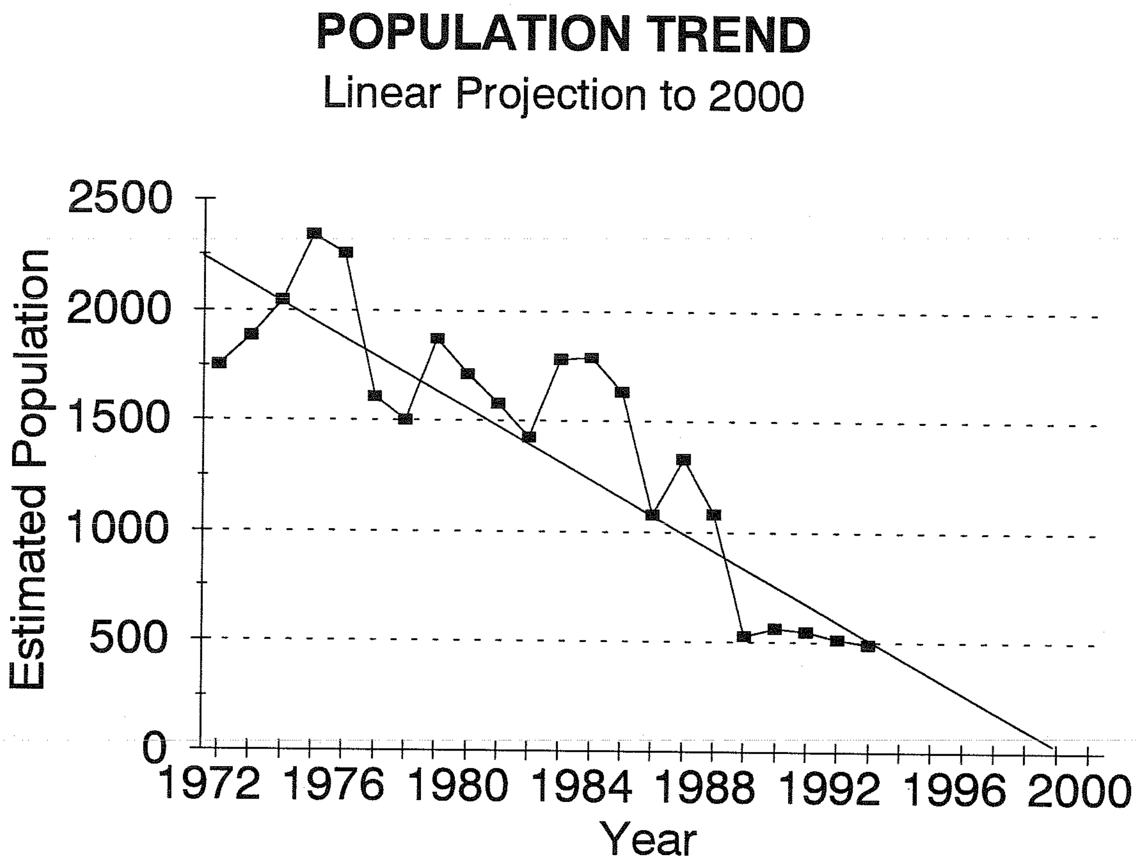

Figure 1. Population numbers 1972-1993 and projections to year 2000.

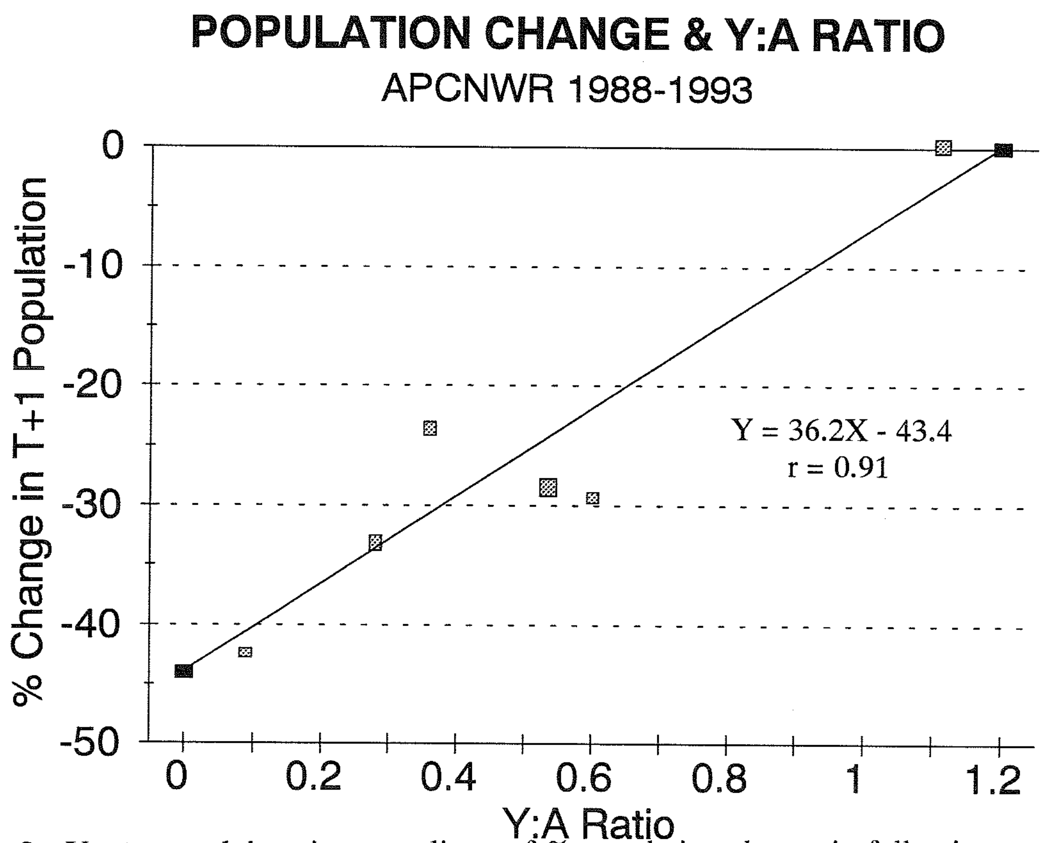

Figure 2. Young to adult ratio as predictor of % population change in following year.

This workshop report includes a set of recommendations for research and management of the wild and captive populations as well as sections on the history of the population, release programs, and the population biology and simulation modelling of the population.

In the models, all adult males were assumed to be available for breeding. The risk of weather events and hurricanes as stochastic events were included in some of the models. The initial population was set at either 35 or 372 (reflecting the 1993 sizes of 2 of the subpopulations) with carrying capacity set at 250 or 1,000. All scenarios were initialized with an equal sex ratio and stable age distribution. Reproduction (here, mean clutch sizes per adult female) were held constant. Effects of inbreeding depression were not included in the scenarios. Variables initialized with a range of values included mean juvenile mortality (ranging from 94.4 to 87.5% for the interval between hatching and 1 year), the variance in juvenile mortality, and annual adult mortality (either 50 or 41% for post 1 year until death) to determine what combination of conditions would produce a viable population; i.e. a positive stochastic growth rate and reduction in risk of extinction to less than 2% in 20 years. Projections were done for 20 years with summary reports at 2 year intervals. Each scenario was run 500 times.

Population Recommendations

1. Steps must be taken to implement population supplementation <u>immediately</u>. Priority should be given to supplementing the populations most threatened with extinction where habitat losses have been stabilized.

2. Steps should be taken immediately to identify and alleviate factors which are contributing to the poor reproductive success observed in recent years. Actions which should be <u>considered</u> include (A) modification of management practices to produce high quality cover for nesting and brood-rearing, and (B) intensive predator control (Bergerud 1988).

3. Efforts should be taken to conserve as much of the genetic make-up of each population as possible through captive propagation efforts.

4. At this point it would be inappropriate to supplement Attwater's population with another subspecies, the greater prairie chicken or to attempt to hybridize the two subspecies for supplementation immediately. However, if the Attwater population continues to decline rapidly despite intensive conservation efforts, the use of hybrids in supplementation strategies may become necessary. Thus, it would be useful to <u>immediately</u> begin hybridization <u>experiments</u> to evaluate its effects in a <u>closely monitored</u> situation. In addition, initiating such experiments as soon as possible will allow more time to evaluate the appropriateness of allowing a subspecies to go extinct versus compromising the "integrity of the subspecies' gene pool."

Wild Population Management Recommendations

1. If the Galveston County population is faced with destruction due to further encroachment on the habitat, the remnant population should be translocated to supplement the APCNWR population.

2. When any APC population goes below the level of 15 individuals there should be, subject to the Recovery Team approval (but government pre-approval of the necessary permits so no time is wasted), the activation of this emergency measure to capture all the remaining birds for captive propagation and translocation purposes.

3. In the event that a decision is made to remove adult males from a population for inclusion in the captive propagation program or translocation efforts, priority should be given to collection of males from the most unstable booming grounds.

4. We do not recommend removing hens from the Austin, Colorado, or Refugio County sites unless it becomes highly probable that loss of the subpopulation is imminent.

5. We recommend that birds captured for translocation undergo a minimal health screening which should include a physical examination and opportunistic biological sampling as needed.

6. Whenever sufficient birds are produced in captivity surplus to the needs for captive flock maintenance, birds should be released to supplement the Austin/Colorado populations. The goal will be to release 40 chicks, of equal sex ratio, at age 12 to 15 weeks.

Health Issues

1. Every effort should be made to obtain diagnostic information and specimens from all deceased captive and wild APC's including gross examination, histopathology, bacterial and fungal culture, viral isolation, and parasite identification.

2. Quarantine of incoming birds to a captive propagation facility is essential.

3. Biosecurity of captive Attwater's prairie chicken flocks is considered important in light of the potential impact of poultry diseases on APC's.

4. Preventive health protocols should be instituted for birds in captive propagation programs.

5. Pre-release health protocols should be instituted to minimize the risk or the introduction of disease or parasites into wild populations of APC's.

6. Caseonecrotic typhlocolitis should be investigated in Attwater's prairie chicken chicks at Fossil Rim Wildlife Center (FRWC).

7. Establishment of reference values and ranges for hematologic, serum biochemical, and serologic parameters.

Habitat Management

1. Seek land management advice from land owners of the largest existing population in Refugio County.

2. Habitat enhancement efforts should be focused on sites with existing Attwater's prairie chicken populations.

3. The Austin–Colorado counties populations should be connected via the additions to the APCNWR and/or the additions of conservation easements.

4. Acquisition of the Victoria County 15,000–acre core area and satellite areas should be initiated immediately and completed within 3 years.

Recommendations for Captive Propagation

1. Immediately establish a genetically diverse, self sustaining, captive breeding population.

2. Preserve the remaining genetic diversity of the wild population in the captive population.

3. Immediately, and continue annually for a number of years, to provide captive bred birds for supplementing the existing wild meta-populations.

4. Provide captive bred birds to establish new populations in restored historical habitat.

5. Immediately expand the breeding facilities to maintain 60 breeding hens and produce 600 chicks annually.

6. Increase the number of breeding facilities as needed to meet the expanding needs of the supplementation program and minimize the risk of disease spread.

7. Establish soft release facilities on AWPCNWR for release of captive raised birds in summer 1994.

ATTWATER'S PRAIRIE CHICKEN
(*Tympanuchus cupido attwateri*)

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Section 2

POPULATION BIOLOGY AND SIMULATION MODELLING

Population Biology and Simulation Modelling

Biology

Species: *Tympanuchus cupido attwateri*

Species Distribution: The range-wide population is separated into 3 distinct subpopulations resulting from habitat fragmentation over time (Figure 3). Based on population distribution data presented by Lehmann (1941), these subpopulations have probably been reproductively isolated since 1937. In 1993, 456 individuals were estimated to occur range-wide (Table 1). Numbers in each individual population were as follows:

Refugio-Goliad	- 372
Galveston	- 24
Austin-Colorado	- 60 (Austin County - 26, Colorado County 34)

Birds in Austin and Colorado counties were found in three groups separated by a distance of approximately 6-10 miles. Gene flow between these groups, consisting of 3 and 10 males in Austin County and 17 males in Colorado County, may likely be restricted at present. Therefore, these groups could probably be considered as at least two populations.

Census data were derived from several ground counts of booming males in Colorado and Galveston counties. Single helicopter counts were made during the first week in March to determine the number of booming males in Austin, Goliad, and Refugio counties. Censuses are typically conducted on standardized routes, and therefore these counts are not necessarily total counts of all available habitat. However, especially in recent years, it is likely that a high proportion of the total population of males is censused. Assuming a 50:50 sex ratio, the male counts were doubled to arrive at a total population estimate. Because of the uncertainty associated with the validity of this assumption, the total population estimates should be interpreted with caution. However, male counts should provide a reasonable indication of population trends over time. These census data will serve as the starting points for subsequent simulation analyses.

1993 Population Status

The 1993 spring count of adult Attwater's prairie chickens was conducted by U.S. Fish and Wildlife Service and Texas Parks and Wildlife Department personnel during February and March. Overall, the 1993 population index, determined by census of standard areas each year, was unchanged as compared to 1992 (Table 1). However, the population in Refugio and Goliad counties was the only one which showed an increase (13%) in spring 1993. Declines in Austin and Colorado counties were expected in light of the relatively poor reproduction indicated by the 1992 summer's brood survey (young:adult ratio of 0.27:1.0 with at least a 1:1 ratio needed for a stable population). Heavy rains throughout the 1992 nesting season probably contributed

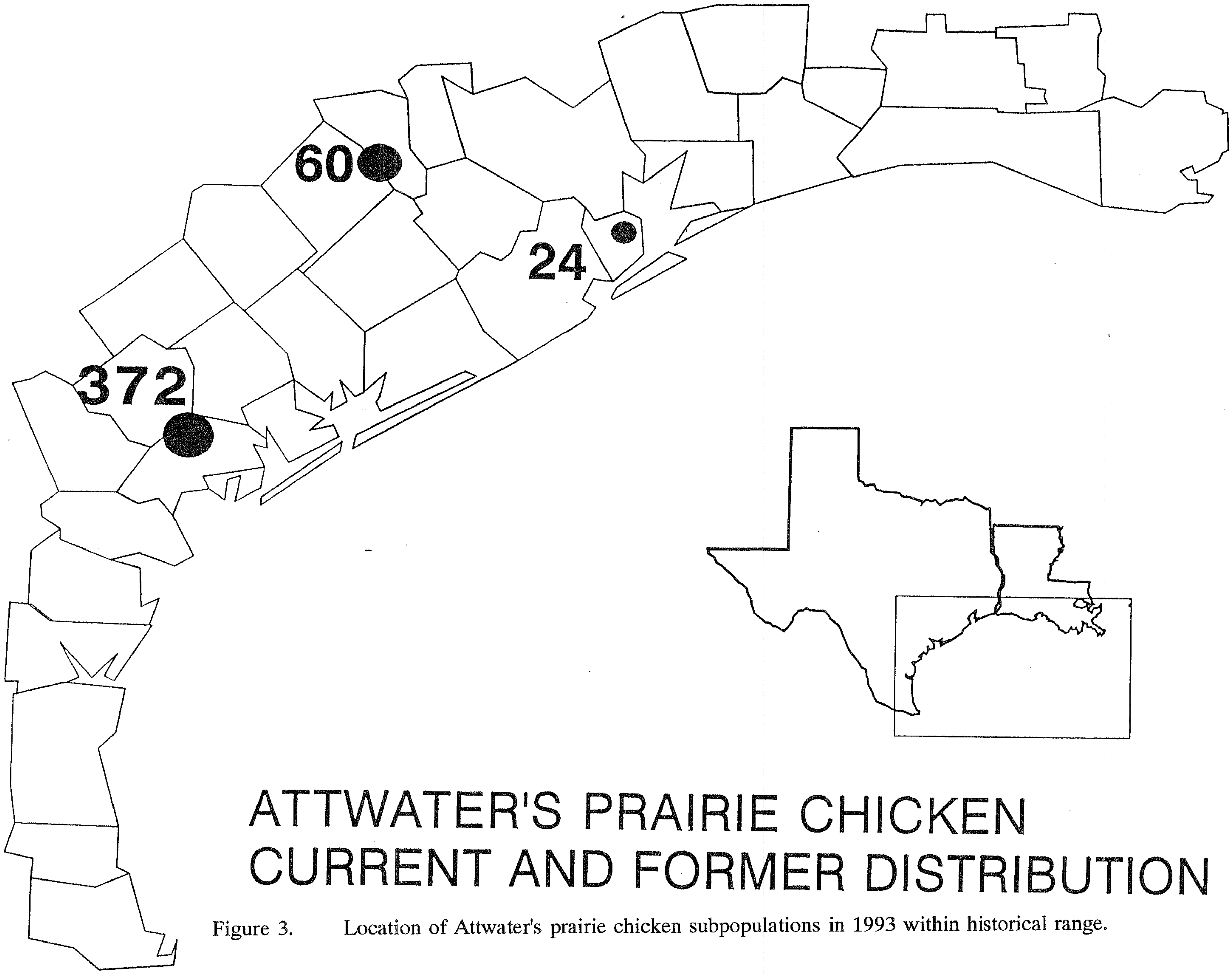


Figure 3. Location of Attwater's prairie chicken subpopulations in 1993 within historical range.

significantly to the poor reproduction in the Austin-Colorado county area. No APC's were observed in Victoria County during the 1993 census.

Only male APC's are counted in the ground count census, however, when helicopters are used all birds flushed are counted as males. This may overestimate the population size in Regugia and Goliad counties since the number of males counted is doubled to estimate the total population size. A 1:1 sex ratio is assumed to arrive at the population index presented below. These data represent complete counts of all known booming grounds except for Refugio and Goliad counties where standardized routes were censused.

Table 1. Attwater's prairie chicken Population Index

County	1992	1993	Change
Aransas	0	0	
Austin	48	26	- 46%
Colorado	50	34	- 32%
Galveston	26	24	- 8%
Goliad	0*	2	
Refugio	330	370	+ 12%
Victoria	2	0	-100%
Total	456	456	0%

* Two birds were flushed from a pasture in Goliad County. However, because these birds were not observed on booming grounds, they were not included in the census totals.

<u>Census and Changes During Past 10-50 Years</u>: Census information, by county is available annually since 1970 with occasional records extending back to 1937 (Table 2, Figures 4-9). The estimated total APC population has declined from about 8,600 in 1937 to 456 in 1993. This represents an average 5% annual rate of decline or about 50% every 14 years. Complete extinction in the wild is likely in less than 10 years if this trend is not reversed. The pattern of decline is similar range-wide (Figures 2-7) despite episodic fluctuations.

<u>Average Age of First Reproduction (female and male)</u>: Females - 1 year. For sister subspecies, the greater prairie chicken (*T. c. pinnatus*), Robel (1970) observed that the two most dominant males on the booming ground performed 89% of 121 copulations observed. These males were at least 2.5 years of age. However, Hamerstrom and Hamerstrom (1973) observed that 18% of 506 greater prairie chicken copulations were by juveniles. For the purposes of the simulation analyses, 2 years was used as the average age of first reproduction by males.

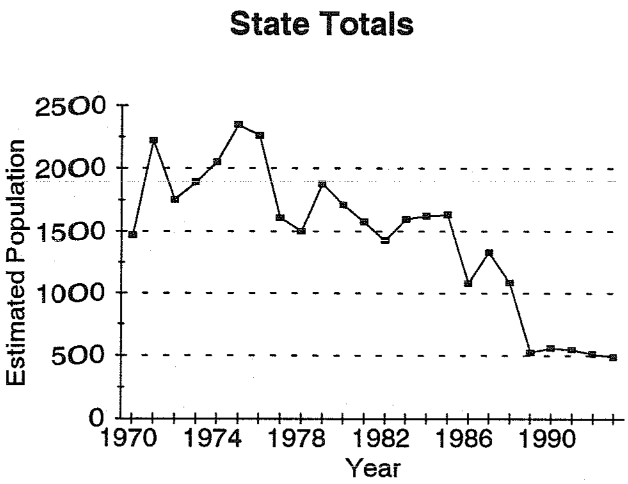


Figure 4.

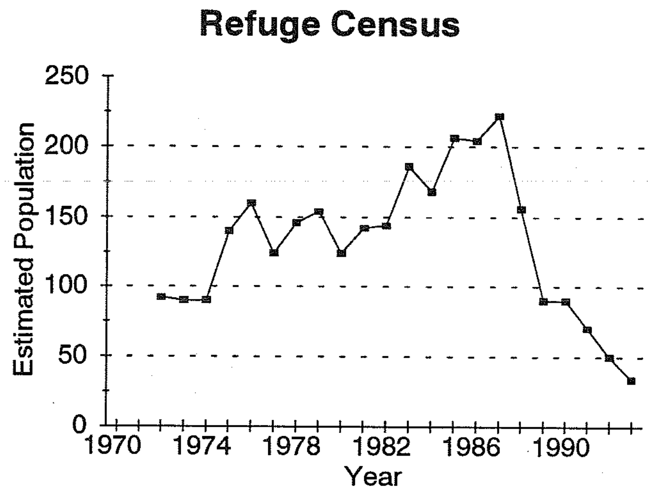


Figure 5.

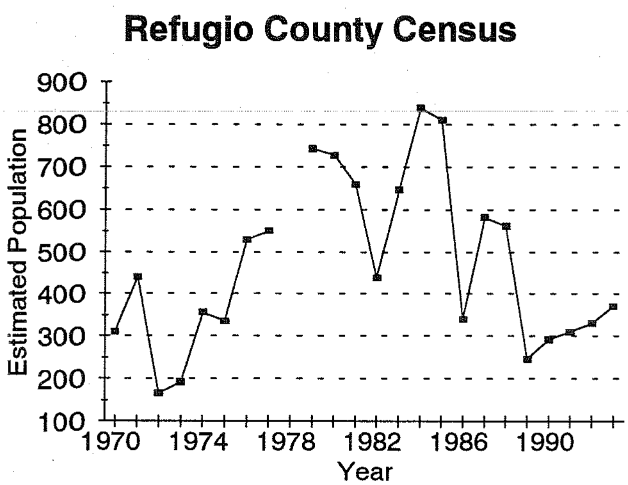


Figure 6.

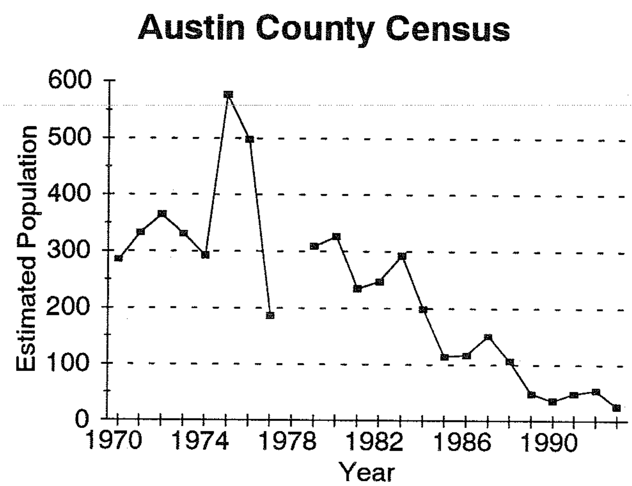


Figure 7.

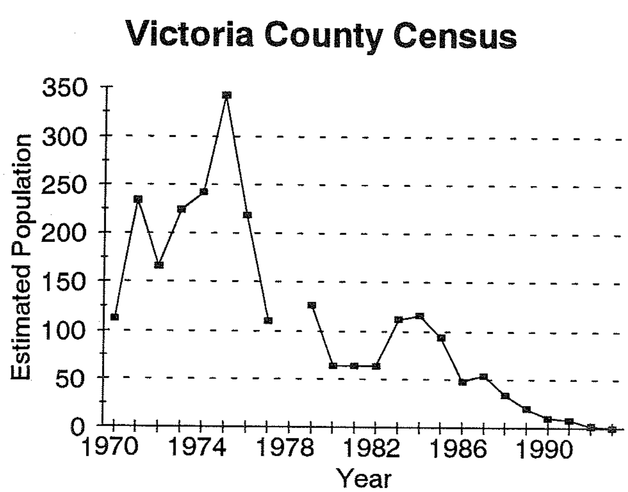


Figure 8.

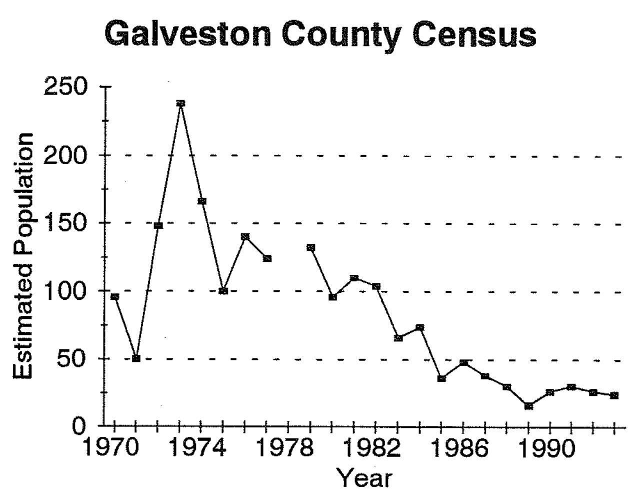


Figure 9.

Table 2. ATTWATER'S PRAIRIE CHICKEN CENSUS DATA

(1937-1993)

County	1937	1950	1963	1967	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Aransas	1212	902	-	-	35	30	10	10	15	14	50	96	35	50	76	20	19	22	24	16	22	10	12	6	2	2	0	0
Austin	339	200	200	200	284	332	364	330	292	576	498	186	-	308	326	234	246	292	198	114	116	150	106	46	36	48	54	26
Brazoria	948	53	-	-	20	20	20	40	20	20	20	20	-	20	20	20	20	0	0	0	0	0	0	0	0	0	0	0
Calhoun	25	40	15	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chambers	220	15	-	10	2	0	0	6	8	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Colorado	926	350	200	175	186	378	166	144	150	422	324	178	-	206	186	184	280	320	218	246	228	242	162	90	90	70	50	34
(Refuge)[a]							92[b]	80[b]	90	140	160	124	146	154	124	142	144	186	168	206	204	222	156	90	90	70	50	34
DeWitt	272	-	80	-	12	12	12	12	6	8	8	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fort Bend	10	-	30	35	22	26	92	136	114	148	96	80	-	78	54	44	48	54	38	32	38	16	8	4	2	0	0	0
Galveston	332	35	90	130	96	50	148	238	166	100	140	124	-	132	96	110	104	66	74	36	48	38	30	16	26	30	26	24
Goliad	4	-	23	75	216	402	290	260	486	188[c]	164	80	-	56	34	100	62	84	114	78	34	16	12	4	12	8	0	2
Harris	261	123	140	120	78	56	92	92	112	58	16	24	-	-	2	4	0	0	0	0	0	0	0	0	0	0	0	0
Jackson	35	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jefferson	220	85	-	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Liberty	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Matagorda	15	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Refugio	3030	2100	412	175	310	440	166	192	356	336	530	550	-	742	726	658	438	646	838	810	340	582	562	246	292	310	330	370
Waller	64	32	15	-	20	26	26	26	10	10	10	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wharton	75	50	30	40	76	214	108	72	42	24	16	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Victoria	620	200	100	90	112	234	166	224	242	342	218	110	-	126	64	64	64	112	116	94	48	54	34	20	10	8	2	0
Total	8618	4200	1335	1070	1469	2220	1660	1782	2019	2254	2090	1506	1500[b]	1718	1584	1438	1281	1596	1620	1426	874	1108	926	432	470	482	456	456

[a] Part of Colorado County - data included in Colorado County totals. Refuge was established in 1972.
[b] Estimate only - survey data incomplete.
[c] Incomplete count.

Table 3. ATTWATER PRAIRIE CHICKEN NWR - Brood Survey Results

	Spring			Propor	95%CL			95%CL		Deviat	T+1	Popula
Year	Popul	Young	Adults	Young	Lower	Upper	Y:A	Lower	Upper	1:1 %	Popula	% Chg
1971		74	64	.54	.46	.62	1.16	.85	1.63	15.6	92	
1972	92	23	69	.25	.16	.34	.33	.19	.52	-66.7	80	-13.0
1973	80	16	63	.20	.12	.31	.25	.14	.45	-74.6	90	12.5
1974	90	60	45	.57	.48	.67	1.33	.92	2.03	33.3	140	55.6
1975	140	16	16	.50	.33	.67	1.00	.49	2.03	0	160	14.3
1976	160	NA	NA	NA	NA	NA	NA	NA	NA	NA	124	-22.5
1977	124	22	28	.44	.32	.56	.79	.47	1.27	-21.4	146	17.7
1978	146	NA	NA	NA	NA	NA	NA	NA	NA	NA	154	5.5
1979	154	17	28	.38	.24	.52	.61	.32	1.08	-39.3	124	-19.5
1980	124	NA	NA	NA	NA	NA	NA	NA	NA	NA	142	14.5
1981	142	31	11	.74	.60	.86	2.82	1.50	6.14	181.8	144	1.4
1982	144	6	26	.19	.09	.45	.23	.10	.82	-76.9	186	29.2
1983	186	35	9	.80	.66	.90	.389	1.94	9.00	288.9	168	-9.7
1984	168	36	17	.68	.53	.80	2.12	1.13	4.00	111.8	206	22.6
1985	206	37	31	.54	.43	.66	1.19	.75	1.94	19.4	204	-1.0
1986	204	46	38	.55	.44	.65	1.21	.79	1.86	21.1	222	8.8
1987	222	14	24	.37	.21	.53	.58	.27	1.13	-41.7	156	-29.7
1988	156	4	48	.08	.02	.19	.08	.02	.23	-91.7	90	-42.3
1989	90	39	35	.53	.42	.64	1.11	.72	1.78	11.4	90	0
1990	90	8	24	.25	.12	.46	.33	.14	.85	-66.7	70	-22.2
1991	70	15	28	.35	.21	.49	.54	.27	.96	-46.4	50	-28.6
1992	50	6	22	.21	.08	.40	.27	.09	.67	-72.7	34	-32.0
1993	34	3	17	.15	.03	.38	.18	.03	.61	-82.4		

Note: CI's on the proportion of young were from Steel & Torrie (1980), pp 598-601 and Zar (1974) p.296.
CI's on Y:A were calculated by: Lower CL(Prop Young)/(1-Lower), Upper CL(Prop Young)/(1-Upper).

Oldest Age (Senescence): In populations undergoing a 50% average annual mortality, complete population turnover could be expected in 8.6 years. The oldest greater prairie chickens observed by Hamerstrom and Hamerstrom (1973) were at least 8 years old.

Monogamous or Polygynous: Lek mating system - polygynous.

Inbreeding: Unknown whether inbreeding and inbreeding depression occurs, but possible in smaller populations. Available data from genetic finger printing studies conducted by Texas A&M and Texas Tech universities do not show significant reductions in genetic variability in Attwater's populations from Colorado and Galveston counties when compared to stable greater prairie chicken populations. However, as small populations continue to dwindle, the potential for inbreeding increases. Also, as individual populations go extinct, overall genetic diversity may decrease.

Catastrophes: The impacts of two types of catastrophes, hurricanes and adverse weather (e.g., extremely wet or dry years) resulting in reproductive failure, were included in some simulation analyses. It was assumed that hurricanes strike an area on average once every 70 years (data presented by National Oceanic and Atmospheric Administration personnel during a recent PBS show). Lehmann (1968) indicated that populations in Refugio County dropped from 1,200-1,500 in the spring prior to hurricane Beulah to approximately 250 in October following that storm. Therefore, it was assumed that catastrophic hurricanes would result in 80% mortality of the adult (post-fledging) population. Because hurricanes typically occur during late summer and autumn, it was assumed that hurricanes would not affect reproductive success.

Over the last 23 years, reproductive failure was apparently observed 4 times in Austin and Colorado counties, and 3 times in Refugio County. This was determined by examining census data from 1970-93, and assuming that reproductive failure occurred during those years when the population dropped by approximately 50% (the approximate average mortality rate of adults). It was assumed that these reproductive failures were not associated with changes in adult mortality.

All Males in Breeding Pool? Unlikely. Robel (1970) reported that only approximately 10% of the male greater prairie population in his study were directly involved in breeding.

Maximum Young Produced per Year: Average clutch size: 12.2 (from Horkel 1979, Lutz 1979, Lawrence 1982, Morrow 1986).

Within brood mortality:	50% by 4-6 weeks (Lehmann 1941) - APC
	58% by 10 weeks (Bowmann and Robel 1977) - GPC
Brood unit mortality:	50% by 2 weeks (N=4) (Lutz 1979)
	66% by 8 weeks (N=8) (Morrow 1986)
Young : Adult ratios:	See Table 3.

Proportion of Adult Females Reproducing per Year: It is assumed that all females have at least one nesting attempt.

Post-Fledge (Adult) Mortality: Probably averages around 50%. Hamerstrom and Hamerstrom (1973) estimated mortality of unhunted greater prairie chicken cohorts at 52% based on analysis of data from over 1,751 banded birds. Mortality rates for specific age-sex classes from this study are as follows, although no statistical differences (P > 0.05) existed between the classes:

Juvenile males	-	52%
Juvenile females	-	59%
Adult males	-	55%
Adult females	-	51%

Horkel (1979) and Lutz (1979) observed turnover rates of 57% and 77%, respectively, for Attwater's prairie chicken. Unpublished data from the Attwater Prairie Chicken National Wildlife Refuge on the relationship between productivity data and annual population change suggests that mortality on the refuge has averaged around 43% in recent years (Fig. 2).

Carrying Capacity and Projected Changes: Hamerstrom et al. (1957) reported maximum densities of greater prairie chickens on native range of 38.8 males/259 ha (640 acres). Arthaud (1968) reported a density of 68 males/259 ha on a 700-ha management area in Missouri. The Missouri Department of Conservation (1984) reported 32-43 males/259 ha for continuous prairie in Kansas. Population densities reported on managed areas of "ecologically-patterned" habitat in Illinois ranged from 80-107 males/259 ha (Missouri Dept. Conserv. 1984). However, Illinois populations have since dropped to precariously low levels (<50 total) (Westemeier et al. 1993). Lehmann (1941:7) estimated the following carrying capacities for the Attwater's prairie chicken:

1. Well-drained, well-populated (with prairie chickens): 1 bird/acre (<15% of historical range).

2. Fairly well-drained (about 55% of historical range): 1 bird/10 acres.

3. Poorly drained (about 30% of historical range): <1 bird/50 acres.

Note that the density estimate for "fairly well-drained" prairie is approximately the same as reported for the best greater prairie chicken native range (assuming an approximate 1:1 sex ratio). The population on the 3,232-ha (7,984-acre) Attwater Prairie Chicken National Wildlife Refuge peaked at an estimated 222 birds (8.9 males/259 ha, 1 bird/36 acres). However, 95% of prairie chicken observations during that time were within a 1,077-ha (2,669-ac) "core area" of the refuge. Assuming this core area was the only area on the refuge which provided all habitat requisites, the density estimate (26.7 males/259 ha, 1 bird/12 acres) would be close to Lehmann's 1 bird/10 acres. Therefore, 1 bird/10 acres (4 ha) is probably a reasonable carrying capacity estimate for good quality prairie habitat.

Simulation Scenarios

Scenario Parameters Held Constant

Based on the above background information, the following simulation scenarios were investigated assuming that:

(1) all females attempted reproduction in a given year and each unsuccessful hen is capable of attempting nesting at least 3 times,

(2) the average age of male reproduction is 2 years,

(3) annual mortality post-fledge is 50%,

(4) the average carrying capacity is 1 bird/10 acres,

(5) the probability of a catastrophic hurricanes strike each year is 1.4%, and

(6) the probability of a catastrophic weather event resulting in a reproductive failure is 17.4% for Austin and Colorado counties and 13% for Refugio County.

Given these parameters, the following scenarios were investigated in model simulations by varying survival from egg to fledging, which represents the net product of nesting success, brood unit mortality, and within brood mortality. Survival from fledging to 1 year was assumed to be 50% (average adult survival).

Stable Population

Estimates for survival from egg to fledging were derived from theoretical estimates of the reproduction needed to achieve replacement of adult mortality on an annual basis. Assuming a 50% annual post-fledging mortality, an approximate 1:1 young:adult ratio would be required at fledging to produce a stable population. To achieve that level of reproductive output, reproductive success from egg to 1 year would have to equal $8.3 \pm 7.0\%$. The standard deviation for this scenario was derived as a proportional estimate from actual standard deviations obtained from decreasing and increasing populations. Assuming values reported in the literature for brood unit survival of 50%, within brood survival of 50%, and survival post-fledge to 50%, nesting success would have to average 66% to achieve this level of reproductive success.

Increasing Population

Estimates of survival from egg to fledging for this scenario were derived from young:adult ratios collected during brood surveys conducted on the Attwater Prairie Chicken National Wildlife Refuge during 1971-86, a period when the population was generally increasing (Tables 2, 3; Fig. 5). These data indicate that a 10.8±9.1% survival from egg to 1 year resulted in a gradually increasing population. Using the survival values for brood unit, within brood, and post-fledge as discussed for the stable population scenario, nesting success for this scenario would have to average approximately 86%.

Decreasing Population

Estimates of survival from egg to fledging for this scenario were derived from young:adult ratios collected during brood surveys conducted on the Attwater Prairie Chicken National Wildlife Refuge during 1987-93, a period when the population was generally decreasing (Tables 2, 3; Fig. 5). These data indicate that a 3.6±2.9% survival from egg to 1 year resulted in a decreasing population. Using the survival values for brood unit, within brood, and post-fledge as discussed for the stable population scenario, nesting success for this scenario would have to average approximately 28.8%. Peterson (1994) reported a weighted average nesting success for 195 Attwater's nests of 27.7%.

For each of these scenarios, model simulations were conducted to determine the probability of extinction (P_e) for a given population and the average time to extinction (T_e). Additional simulations were conducted to determine (1) how much of an increase in survival from egg to 1 year would be required to reduce P_e to <5%, (2) in the absence of such increases, what level of supplementation would be necessary to reduce the P_e to <5%, and (3) what change in heterozygosity could be expected if only a small proportion of females successfully breed (as might be expected in a small population).

Results And Discussion

General Conditions of Simulations:

The simulations were done with VORTEX 6.2. Adult mortality of 50±5 % was used except in one set of scenarios in Table 5. The standard deviations of 0-1 % survival values were varied in different sets of scenarios to examine the impact of changes in environmental variance on P_e and population sizes. Projections were for 20 years with 500 runs (iterations or repetitions) in all scenarios. Starting population sizes used were either 35 or 372 with K=250 or 1,000, respectively, reflecting the sizes of the small and single large populations in 1993. All scenarios were initialized with a stable age distribution calculated from the Leslie matrix in the program. Survivals to 1 year were estimated from stage of eggs laid with an average clutch size of 12 eggs and all adult females laying at least one clutch each year. Females are adult and breed at 1 year and males breed at 2 years in the wild. No inbreeding depression effects were included in the models. Addition of inbreeding would increase risk of extinction. The sex ratio at hatching was set at equal or 1:1. Mating system is polygynous but with only 10% of breeding age males in the breeding pool each year. Reproduction was taken as density independent at current population levels. The effects of two catastrophes on population projections were compared with no catastrophe. One (hurricane) was set at a frequency of 1.43% (once in 70 years based upon historical weather information) with no effect on reproduction and 0.25 severity (reduction) on survival. The second catastrophe (weather-related) was set at frequency of 17.4 % (4 times in 23 years) with 0.0 severity effect (complete failure) on reproduction and no effect on survival in the year of occurrence.

Table Column Headers:

The headers in the columns of Tables 4-7 have the following definitions. 'File #' = identification number of the scenario output file from VORTEX. '0-1 Surv %' = Survival (survivorships) from time the eggs were laid to 1 year as %. 'SD' = standard deviation of the 0-1 year % survival calculated over several years of data. "POP # '93" = population size in 1993 census. 'Deter r' = deterministic instantaneous growth rate calculated (in VORTEX) by a Leslie matrix algorithm with catastrophes averaged into calculation. 'Stochastic r' = mean of r values calculated for each year of the simulation with the set of values for each of the variables selected with a random number generator based upon the distribution derived from the initialized values of their means and standard deviation. 'SD' = standard deviation of the stochastic r. 'P_e' = probability of extinction at 20 years (i.e. proportion of iterations or populations that went extinct during the 20 years). 'N' = mean size of the surviving populations at 20 years. 'SD' = standard deviation of N. 'H' = expected mean heterozygosity remaining in the surviving populations. 'T_e' = mean time to first extinction of populations becoming extinct during the 20 years. This distribution is typically skewed, but where of interest the distribution can be plotted and characterized from either the 2 year reports of from the optional plot files.

Population Projections

Model simulation results are presented in Tables 4-7 and Figures 10-13. Under all three scenarios, the simulations indicated a >38% P_e for the Colorado County population in the absence of supplementation (Table 4, files B109-111). T_e for the Colorado County population ranged from 7-12 years depending upon the scenario. The projected proportion of heterozygosity remaining (H) for surviving populations at the end of the 20-year simulation ranged from 46-64% for this population.

The risk of extinction - P_e for the Refugio County population over the 20-year simulation period was 98%, 24%, and 8% for the decreasing, stable, and increasing population scenarios, respectively. T_e for these scenarios were 12, 16, and 15 years, respectively (Table 4, files B106-108). H for this population under these simulation scenarios ranged from 69-86%. Therefore, even in the largest population under "increasing" conditions, the high variability associated with survival of eggs to 1 year resulted in an unacceptable P_e under the stochastic model simulations.

Results of simulations V109-117 illustrate the significance of the high variability typically associated with Attwater's prairie chicken reproductive efforts in influencing P_e (Table 4).

First Year Survival

Increasing egg survival to 12.5% (16% above the increasing population values observed in the wild population) only decreased P_e to 20% for the small Colorado County population, while P_e for the Refugio County population dropped to 2% under those conditions. Therefore, increasing egg survival by approximately 250% over that observed in recent years (decreasing scenario) would not reduce P_e to an acceptable level for the small Colorado County population (Table 4, file B114). Such an increase in survival would reduce P_e for the larger Refugio County population to an acceptable level (Table 4, file B117). This level of increase would require an increase in average nesting success and chick survival to approximately 43 and 38%, respectively. While the potential for increasing chick survival to this level is unknown given the paucity of that type of data in the literature, increasing average nest success to 43% is clearly within ranges observed for greater prairie chickens (Peterson 1994). However, given the recent population trends observed for the Attwater's, and average nest success reported in the literature for Attwater's of 27.7% (Peterson 1994), average egg survival increases of this magnitude are likely unrealistic.

Supplementation

Model simulations indicated that an annual continuing addition of 5 females/year to both the small Colorado County and the larger Refugio populations would result in a P_e reduction to 0%, even under the decreasing scenario (Table 6). Supplementation at this level also had the additional benefit of increasing H to 97% for both populations. However this He result is misleading since the model assumes a large source population for the supplemented birds.

Simulations of levels of supplementation required to maintain the current 2 population sizes of 35 and 372 were done by systematic variation in the numbers of birds added annually. The added birds were subjected to the demographic parameters of the wild population. The larger population, under current conditions, will require addition of 20-40 females per year depending upon the Y:A ratio in the previous year (annual variation in juvenile survivorships and hence recruitment in the next years breeding population). The small populations could be maintained with the addition of 5 female and 5 male birds each year (Table 6, D109). The Pe is always 0 because of the annual additions.

Figures 10-13. Summary of population simulation results, for wild populations of Attwater's prairie chicken, as a function of survivorships from the time of egg laying to 1 year and population size. All other conditions are constant. Figure 10 illustrates the greater vulnerability to extinction (Pe) of the smaller population at all levels of juvenile mortality. In Figure 11, the deterministic r is the same for both populations and the stochastic r is lower.

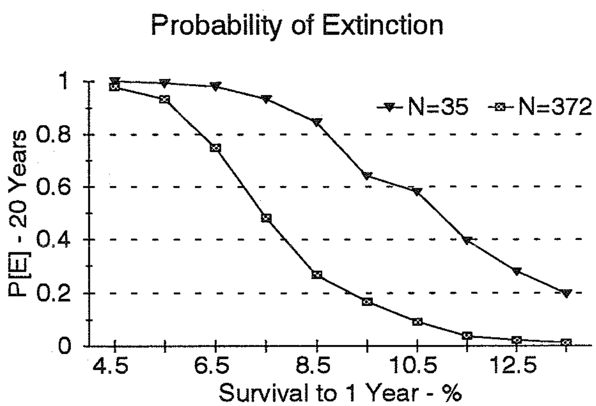


Figure 10.

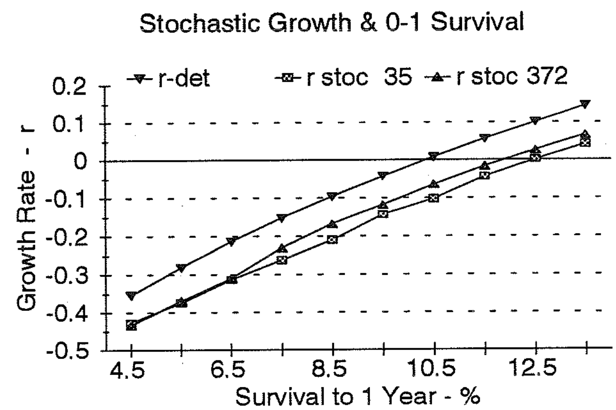


Figure 11.

Figure 12.

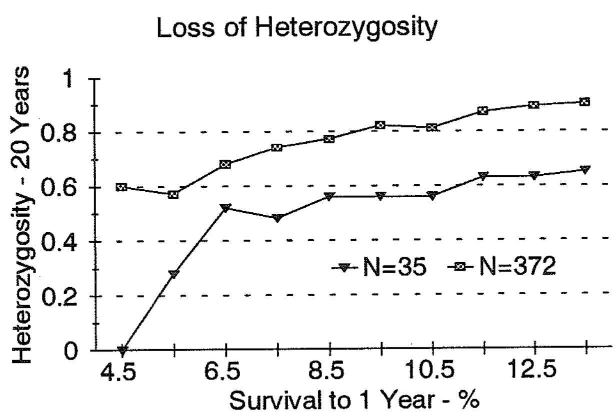
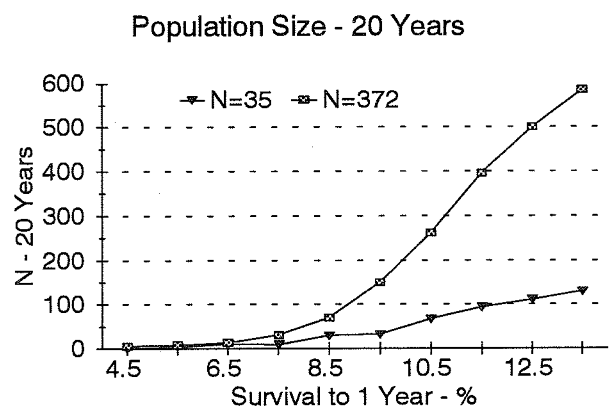


Figure 13.



In Figure 12, more heterozygosity is retained by the larger population and an increasing amount is retained as juvenile survival increases, but the rate of loss is still high at 2-10% per generation. The mean size of surviving populations, Figure 13, increases with increasing juvenile survivorship but still falls well below the respective carrying capacities of 250 and 1000. The 20 year mean population size for the larger population is lower than the starting population size at values of juvenile survivorships below 11.5%.

Heterozygosity

Table 7 illustrates the effects on H of only a small proportion of hens successfully producing offspring. In general, H is not affected substantially until 75% of females fail to rear young. Even then, only the scenario with the poorest reproductive success (file 75.106) showed an appreciable difference (30% reduction) from the baseline scenarios (files 106-117). However, assuming 30% average nest success, thre possible nesting attempts, and 50% brood survival, only approximately 33% of Attwater's hens are likely to produce young each year. Therefore, it is probable that an appreciable reduction in H is occurring due to the low proportion of hens producing offspring.

Catastrophes

Addition of the two catastrophes increases the risk of extinction and requires an increase in mean juvenile survivorship to achieve a stable or growing population. About 75% of the catastrophes' effect is contributed by the more frequent event - severe weather conditions on the average of every 6 years - (B07 vs B17). Reduction of adult mortality from 50% to 43% (Fig. 2) increases the r value by 0.1 (B07 vs B22) but still requires a juvenile survivorship greater than 8.5% even with a low SD.

Recommendations

The following recommendations are made based on the simulation results discussed above:

1. Steps must be taken to implement population supplementation immediately. Priority should be given to supplementing the populations most threatened with extinction where habitat losses have been stabilized.

2. Steps should be taken immediately to identify and alleviate factors which are contributing to the poor reproductive success observed in recent years. Actions which should be considered include (A) modification of management practices to produce high quality cover for nesting and brood-rearing, and (B) intensive predator control (Bergerud 1988).

3. Efforts should be taken to conserve as much of the genetic make-up of each population as possible through captive propagation efforts.

4. At this point it would be inappropriate to supplement Attwater's population with greater prairie chickens or to attempt to hybridize the two subspecies for supplementation immediately. However, if the Attwater's continue to decline rapidly despite intensive conservation efforts, the use of hybrids in supplementation strategies may become necessary. Thus, it would be useful to immediately begin hybridization experiments to evaluate its effects in a closely monitored situation. In addition, initiating such experiments as soon as possible will allow more time to evaluate the appropriateness of allowing a subspecies to go extinct versus compromising the "integrity of the subspecies' gene pool.

Table 4. ATTWATER'S PRAIRIE CHICKEN - BASE SCENARIOS FROM FIELD DATA

File #				Results							
	0-1 Surv %	SD	Pop # '93	Population Growth			20 Years				T_e
				Deter r	Stochastic r	SD	P_e	N	SD	H	
Basic Scenarios - 5 Levels of 0-1 Year Survivorships											
B106	3.6	2.9	372	-.354	-.427	.385	.978	6	5	.69	12
B107	8.3	6.9		-.004	-.125	.356	.240	163	239	.82	16
B108	10.8	9.0		.137	-.002	.546	.078	396	357	.86	15
B116	11.5	9.2		.173	.049	.542	.046	491	364	.88	14
B117	12.5	9.2		.223	.098	.514	.018	586	359	.90	16
B109	3.6	2.9	35	-.354	-.440	.453	.998	7	-	.46	7
B110	8.3	6.9		-.004	-.125	.419	.632	43	51	.60	11
B111	10.8	9.0		.137	-.016	.574	.386	103	89	.64	12
B113	11.5	9.2		.173	-.022	.568	.288	113	87	.65	10
B114	12.5	9.2		.223	.079	.545	.206	146	86	.66	11
Effects of Reduced Variance in 0-1 Year Survivorships											
V109	3.6	1.4	35	-.354	-.421	.404	1.00	-	-	-	7
V110	8.3	3.6		-.004	-.083	.379	.450	50	56	.60	13
V111	10.8	4.5		.137	.081	.347	.084	161	84	.68	12
V113	11.5	4.5		.173	.127	.327	.030	187	75	.70	11
V114	12.5	4.5		.223	.176	.306	.020	219	54	.72	10
V106	3.6	1.4	372	-.354	-.403	.329	.986	4	2	.51	13
V107	8.3	3.6		-.004	-.040	.296	.016	276	267	.88	16
V115	10.8	4.5		.137	.092	.310	0	721	300	.94	-
V116	11.5	4.5		.173	.130	.296	0	837	223	.95	-
V117	12.5	4.5		.223	.192	.282	0	912	172	.95	-
Scenario V111 with Varying SD and either 2 or No Catastrophes. N=35.											
V3.111	10.8	6.5	2-C	.022	-.134	.551	.626	52	62	.58	10
V1.111		4.5	2-C	.022	-.104	.508	.568	70	79	.59	11
V2.111		2.5	2-C	.022	-.080	.454	.468	63	67	.60	12
V6.111		6.5	NoC	.137	.038	.436	.204	130	88	.66	11
V4.111		4.5	NoC	.137	.077	.345	.090	160	86	.67	11
V5.111		2.5	NoC	.137	.112	.220	.018	203	64	.70	13

The basic scenarios (B106-B114) were constructed from best estimates from field data. Current juvenile survivorships (B106, B109) result in extinction (Pe) within 20 years and an approximately 50% Pe in 7 years (Te) for N=35 and in 12 years for N = 372. Reduction in half of the environmental variance (SD) has no impact on Te or Pe for the low juvenile survivorships but reduces the Pe at higher values. Addition of catastrophes increases Pe and reduces the growth rates. Note the lack of sensitivity of the deterministic r to SD in survival and to population size.

Table 5. ATTWATER'S PRAIRIE CHICKEN - EFFECTS OF CATASTROPHES											
File				Results							
	0-1 Surv %	SD	Pop #	Population Growth			20 Years				T_e
				Deter r	Stochastic r	SD	P_e	N	SD	H	
#1 @ 1.43%, 1.0 x Repro & 0.25xSurv; #2 @ 17.4%, 0.00 x Repro & 1.0xSurv											
B03	4.5	2.5	372	-.354	-.433	.417	.978	6	3	.60	12
B04	5.5			-.281	-.369	.428	.932	8	9	.57	14
B05	6.5			-.214	-.309	.419	.750	14	16	.68	15
B06	7.5			-.153	-.230	.411	.480	31	46	.74	16
B07	8.5			-.096	-.168	.399	.266	70	104	.77	16
B08	9.5			-.043	-.119	.406	.168	150	201	.82	17
B09	10.5			.008	-.065	.425	.092	262	298	.81	15
B10	11.5			.056	-.016	.408	.038	396	339	.87	15
B11	12.5			.101	.025	.421	.022	500	362	.89	15
B12	13.5			.145	.066	.430	.012	585	357	.90	18
#1 @ 1.43%, 1.0 x Repr & 0.25 x Surv; #2 @ 17.4%, 0.0 x Repr & 1.0 xSurv											
B23	4.5	2.5	35	-.354	-.427	.469	1.00				7
B24	5.5			-.281	-.374	.470	.992	4	2	.28	8
B25	6.5			-.214	-.314	.474	.980	11	10	.52	9
B26	7.5			-.153	-.262	.477	.932	10	7	.48	10
B27	8.5			-.096	-.210	.477	.846	29	36	.56	11
B28	9.5			-.043	-.144	.456	.640	32	38	.56	11
B29	10.5			.008	-.103	.473	.580	67	71	.56	12
B30	11.5			.056	-.044	.460	.396	94	85	.63	12
B31	12.5			.101	.001	.463	.278	111	87	.63	11
B32	13.5			.145	.041	.460	.196	129	90	.65	11
Only the #1 Catastrophe @ 1.43%, 1.0 x Repro & 0.25 x Surv											
B33	4.5	2.5	35	-.284	-.370	.442	.998	9	-	.78	8
B34	5.5			-.204	-.284	.432	.956	8	6	.50	10
B35	6.5			-.132	-.222	.427	.882	13	11	.48	11
B36	7.5			-.065	-.153	.409	.686	22	21	.58	12
B37	8.5			-.003	-.066	.361	.396	53	52	.61	13
B13	4.5	2.5	372	-.284	-.356	.401	.892	7	6	.63	14

Table 5. ATTWATER'S PRAIRIE CHICKEN - EFFECTS OF CATASTROPHES											
File				Results							
	0-1 Surv %	SD	Pop #	Population Growth			20 Years				T_e
				Deter r	Stochastic r	SD	P_e	N	SD	H	
B14	5.5			-.204	-.268	.368	.594	15	16	.70	15
B15	6.5			-.132	-.179	.340	.246	43	72	.76	16
B16	7.5			-.065	-.110	.309	.078	98	119	.82	16
B17	8.5			-.003	-.041	.283	.024	294	264	.88	16
No Catastrophes											
A33	4.5	2.5	35	-.274	-.366	.437	.996	11	3	.61	8
A34	5.5			-.194	-.273	.417	.964	8	5	.50	10
A35	6.5			-.121	-.196	.396	.822	17	16	.53	12
A36	7.5			-.054	-.120	.356	.552	24	24	.53	13
A37	8.5			-.003	-.073	.362	.416	51	53	.58	13
A13	4.5	2.5	372	-.274	-.336	.360	.852	8	6	.65	15
A14	5.5			-.194	-.255	.335	.578	16	24	.70	17
A15	6.5			-.121	-.162	.289	.178	41	55	.77	17
A16	7.5			-.054	-.084	.244	.022	128	141	.84	17
A17	8.5			-.003	-.046	.289	.018	275	259	.87	16
Adult Mortality 41 ± 5 %; 2 Catastrophes as above.											
B18	4.5	2.5	372	-.244	-.311	.371	.744	10	10	.71	15
B19	5.5			-.176	-.243	.368	.516	22	31	.76	16
B20	6.5			-.115	-.169	.353	.238	55	91	.81	17
B21	7.5			-.058	-.119	.353	.118	128	188	.84	17
B22	8.5			-.005	-.066	.355	.046	234	266	.87	15
B38	4.5	2.5	35	-.244	-.334	.421	.994	3	2	.30	9
B39	5.5			-.176	-.254	.423	.936	9	7	.55	11
B40	6.5			-.115	-.206	.419	.832	12	11	.59	11
B41	7.5			-.058	-.142	.420	.618	26	33	.60	12
B42	8.5			-.005	-.077	.399	.422	53	61	.64	12

Addition of the two catastrophes increases the Pe and requires an increase in mean juvenile survivorship to achieve a stable or growing population. About 75% of the catastrophes' effect is contributed by the more frequent event (B07 vs B17). Reduction of adult mortality from 50% to 41% (as reported for a population of greater prairie chicken) increases the r value by 0.1 (B07 vs B22) but still requires a juvenile survivorship greater than 8.5% even with a low SD.

Table 6. ATTWATER'S PRAIRIE CHICKEN - SUPPLEMENTATION											
File				Results							
	0-1 Surv %	Pop #	Sup ple # ♀	Population Growth			20 Years				T_e
				Deter r	Stochastic r	SD	P_e	N	SD	H	
Annual addition of 5 Females & 5 Males											
D106	3.6	372	5	-.354	-.120	.286	0	36	12	.97	-
D107	8.3			-.004	-.026	.310	0	260	249	.95	-
D108	10.8			.137	.052	.515	0	468	347	.94	-
D116	11.5			.173	.076	.519	0	528	336	.94	-
D117	12.5			.223	.121	.501	0	640	332	.95	-
Annual addition of 5 Females & 5 Males											
D109	3.6	35	5	-.354	-.002	.246	0	36	13	.97	-
D110	8.3			-.004	.073	.297	0	130	68	.93	-
D111	10.8			.137	.130	.487	0	153	76	.91	-
D113	11.5			.173	.160	.486	0	174	76	.90	-
D114	12.5			.223	.203	.478	0	187	68	.90	-
Annual addition of 10 Females & 10 Males											
C106	3.6	372	10	-.354	-.085	.261	0	71	21	.98	-
C107	8.3			-.004	-.001	.302	0	363	275	.97	-
C108	10.8			.137	.072	.505	0	524	318	.96	-
C116	11.5			.173	.097	.506	0	607	322	.96	-
C117	12.5			.223	.142	.492	0	687	308	.96	-
Annual addition of 10 Females & 10 Males											
C109	3.6	35	10	-.354	.031	.229	0	68	22	.98	-
C110	8.3			-.004	.115	.292	0	175	59	.96	-
C111	10.8			.137	.186	.468	0	185	69	.95	-
C113	11.5			.173	.203	.474	0	193	67	.94	-
C114	12.5			.223	.245	.460	0	206	58	.93	-
Annual addition of 20 Females & 20 Males											
E106	3.6	372	20	-.354	-.051	.236	0	141	42	.99	-
E107	8.3			-.004	.031	.294	0	511	260	.98	-
E108	10.8			.137	.093	.487	0	613	308	.98	-

Table 6. ATTWATER'S PRAIRIE CHICKEN - SUPPLEMENTATION											
File				Results							
	0-1 Surv %	Pop #	Sup ple # ♀	Population Growth			20 Years				T e
				Deter r	Stochastic r	SD	P_e	N	SD	H	
E116	11.5			.173	.133	.494	0	675	297	.98	-
E117	12.5			.223	.180	.479	0	779	267	.98	-
Annual addition of 20 Females & 20 Males											
E109	3.6	35	20	-.354	.068	.250	0	141	41	.99	-
E110	8.3			-.004	.184	.299	0	216	41	.98	-
E111	10.8			.137	.256	.448	0	213	50	.97	-
E113	11.5			.173	.290	.451	0	218	49	.97	-
E114	12.5			.223	.316	.439	0	221	46	.96	-
Annual addition of 30 Females & 30 Males											
F106	3.6	372	30	-.354	-.029	.224	0	216	63	.993	-
F107	8.3			-.004	.057	.286	0	641	264	.989	-
F108	10.8			.137	.130	.477	0	701	293	.984	-
F116	11.5			.173	.157	.479	0	735	293	.983	-
F117	12.5			.223	.203	.468	0	783	257	.981	-
Annual addition of 40 Females & 40 Males											
G106	3.6	372	40	-.354	-.016	.218	0	282	82	.995	-
G107	8.3			-.004	.073	.283	0	701	240	.991	-
G108	10.8			.137	.151	.463	0	752	266	.988	-
G116	11.5			.173	.177	.475	0	767	267	.987	-
G117	12.5			.223	.214	.485	0	827	230	.986	-

Simulations of levels of supplementation required to maintain the current 2 population sizes of 35 and 372 were done by systematic variation in the numbers of birds added annually. The added birds were subjected to the demographic parameters of the wild population. The larger population, under current conditions, will require addition of 20-40 females per year depending upon the Y:A ratio in the previous year (annual variation in juvenile survivorships and hence recruitment in the next years breeding population). The small populations could be maintained with the addition of 5 female and 5 male birds each year (D109). The Pe is always 0 because of the annual additions.

File	0-1 Surv %	Pop #	% 0 Clutch	Results							
				Population Growth			20 Years				T_e
				Deter r	Stochastic r	SD	P_e	N	SD	H	
All Females Potentially Contribute.											
106	3.6	372	0	-.354	-.427	.385	.978	6	5	.69	12
107	8.3			-.004	-.125	,356	.240	163	239	.82	16
108	10.8			.137	-.002	.546	.078	396	357	.86	15
117	12.5			.223	.098	.514	.018	586	359	.90	16
25% Females Lose Clutch.											
25.106	4.8	372	25	-.354	-.414	.363	.990	7	7	.599	13
.107	11.0			-.007	-.071	.286	.062	213	239	.854	17
.108	14.4			.137	.052	.419	.014	529	330	.906	15
.117	18.7			.295	.234	.360	0	894	189	.945	-
50% Females Lose Clutch.											
50.106	7.2	372	50	-.354	-.403	.336	.980	6	4	.637	13
.107	16.6			-.004	-.048	.234	.028	270	269	.878	16
.108	21.6			.137	.096	.364	0	743	267	.889	-
.117	25.0			.223	.188	.258	0	937	127	.949	-
75% Females Lose Clutch.											
75.106	14.4	372	75	-.354	-.401	.331	.980	5	2	.481	13
.107	33.2			-.004	-.020	.160	.002	336	247	.891	17
.108	43.2			.137	.120	.178	0	940	117	.948	-
.117	50.0			.223	.208	.167	0	988	43	.949	-

Table 7. ATTWATER'S PRAIRIE CHICKEN - FEMALE REPRODUCTIVE SUCCESS

Losses of juveniles could be spread over all clutches with some surviving from most clutches or could favor losses of entire clutches with fewer females contributing to the next generation. These scenarios were constructed by varying the number of females with a 0 clutch size and varying the juvenile survivorships to yield approximately the same proportion of survivors at 1 year in the population. Starting with 372 birds, in a growing or stable population this had no effect on the He (mean heterozygosity remaining in the population - compare 25.117, 50.117, & 75.117) over the 20 years of these projects. There would be a greater loss of rare alleles. In smaller populations the rate of inbreeding would increase.

ATTWATER'S PRAIRIE CHICKEN
(*Tympanuchus cupido attwateri*)

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Section 3

WILD POPULATION MANAGEMENT

Wild Population Management

Overview

Efforts to reintroduce prairie grouse or to supplement existing populations have recently been summarized by Toepfer et al. (1990) and Lawrence and Silvy (1987). Such efforts began in the mid to late 1800s. Many of these population recovery efforts were poorly documented and the follow-up evaluation of success was limited or nonexistent. Between 1952 and 1990 there were 52 attempts to establish prairie grouse populations. Most attempts failed or only resulted in temporary populations. Reasons for failure were difficult to identify because follow up studies were inadequate.

To clarify the subsequent discussions, we provide definitions of several terms. Translocation refers to wild capture of Attwater's prairie chicken at one site and their transfer and release at a second site. We can justify such capture efforts in two circumstances. In one, the area trapped would have a healthy population which could sustain removal of some birds without jeopardy to itself. In the other circumstance, the population of the area trapped is on the verge of disappearing, and the wise action will be to remove the remnant birds to a more suitable site with an extant population. In both circumstances, the birds removed would be used to (1) supplement the genetics and numbers of the captive populations or (2) to supplement a wild population with low but recoverable numbers, to diminish the probability of extinction of that wild population.

Supplementation refers to adding to an existing wild or captive population by the transfer of eggs or birds. Reintroduction refers to the release of wild-trapped or captive-reared birds into suitable habitat currently unoccupied by APC.

The following conclusions can be drawn from Toepfer et al. (1990) and Lawrence and Silvy (1987). Their application to Attwater's prairie chicken recovery is noted below.

1. Some release sites were unsuitable habitat or of inadequate habitat size. "Thus, the amount of quality habitat is the ultimate factor that will determine whether a translocation effort will succeed or fail." (Toepfer et al. 1990:575). The minimum required area for a release site for prairie chickens is 9.7 square miles (6,210 acres) of which undisturbed grass should make up no less than one third of the acreage (2,050 acres). These area guidelines confirm that the Galveston County site is not large enough to warrant supplemental releases. The Austin, Colorado, and Refugio County sites still contain sufficient habitat to justify supplemental releases.

2. Dispersal of birds post-release was excessive and survival of released birds was poor. Both factors limit the ability to build a core population sufficient to maintain itself.

3. Translocations in summer, after nesting and brood rearing, are more successful than spring translocations. Birds translocated in summer disperse less from the release site and have

higher survival. Molt restricts movement while the birds adjust to the release site. Movement is less when the birds are not sexually active. Summer release is better because food, cover, and buffer prey species are abundant. Consequently, we presently are proposing late summer releases for translocations and reintroductions.

4. Historical evidence indicates that when isolated prairie grouse populations fall below 100 males they will eventually disappear unless there is habitat acquisition or habitat improvement. This means the Refugio County population is the only one with some security. Modelling suggests it has a 98% probability of extinction in an average of 12 years (half before 12 years and half after)(Table 4, File B106). For the 2% of the populations which did not go extinct, the average remaining population size was only 6 individuals.

5. If a translocation is involved, the release area should be very similar habitat to the capture site (otherwise the birds disperse while seeking habitat to which they are accustomed). With the limited opportunities for translocation, we lack the flexibility to capitalize on this knowledge.

6. Genetics of the release stock is important. Toepfer et al. (1990) did not expand upon this idea but genetic principles make it imperative that we attempt to maintain good genetic diversity in wild and captive populations. This goal can be accomplished through transfer of eggs and males.

7. Examine translocated birds for parasites and disease and delete from the release those which would create problems. This objective is discussed later in a separate paragraph under the heading Recommendations.

8. Reintroduction with wild-trapped birds is more successful in reestablishing populations than reintroductions with captive-raised animals. This conclusion supports the merits of translocation whenever such action is biologically sound.

9. If captive-reared birds are released, predator control should be practiced before and after birds are released. This conclusion recognizes the naivete of captive-reared birds to the dangers of predators.

10. Recommended selective cutting of trees used as hunting perches by raptors on the release area. The numbers of trees potentially useful for perches may make this action impractical to apply.

11. If the merits of translocation are being evaluated, Toepfer (1988) reported unhunted prairie chicken populations were capable of compensating for removal of 35% of hens and 50% of cocks from a booming ground. Attwater's prairie chicken experts believe the ability of Attwater's prairie chicken populations to compensate for removal of birds will be somewhat lower than the percentages identified for other prairie chicken subspecies.

12. Some reintroductions combined the release of captive-reared and wild-trapped translocated birds. Such releases appeared to have a greater likelihood of successfully establishing a population. This principle is applied in the proposed release of captive-reared chicks with wild-trapped hens.

13. Wild-trapped birds held 1 to 3 months in a pen at the release site lost weight and flight muscles atrophied. Such prolonged holding in pen is not recommended.

14. In one release, decoys and booming ground recordings were used to promote use of booming grounds by released birds.

From studies of reintroduction experiments (Griffith et al. 1990) on other wildlife the following conclusions can be drawn.

15. The number of individuals released annually is positively correlated to success (more is better) as long as quality of released individuals is not sacrificed for production of numbers. When captive-reared birds are to be used, captive management should include efforts to produce high quality birds for release. Special rearing efforts should include A) training birds to recognize natural foods and how to acquire them; B) training of birds to fear man and predators; C) rearing birds in pen habitat similar to that they are expected to utilize when released; and (D) promoting behavior in pen (roosting, etc.) which will have survival advantages post release.

16. Successful reintroductions are those involving long-term releases (10 years or more). We recognize that successful recovery of Attwater's prairie chicken will require long-term commitment to captive propagation, and manipulation of wild populations.

17. Post-release monitoring (radio-tracking) is essential to evaluate success.

Recommendations

Translocation

If the Galveston County population is faced with destruction due to further encroachment on the habitat, the remnant population should be translocated to supplement the APCNWR population. That population is currently low, possibly due to stochastic events, but the area appears to have suitable unoccupied habitat. The translocated birds should be moved after brood-rearing is over (late summer). They should be released at the best remaining habitat in APCNWR. In the event that no new threat arises to the continued existence of the Galveston County habitat, that site should continue to be a source of harvested eggs for building the captive flocks, supplementing the wild populations, and experimental reintroductions.

Emergency Action Plan

This option would need to be pre-approved by the appropriate government agencies and invoked as needed. A review of many species at low population levels shows that extinction is inevitable when populations get below 100 individuals. Furthermore, when subpopulations get to less than 15 individuals there is no hope of that population's natural recovery. This has unfortunately already proved true for Attwater's prairie chickens. There was 100% extinction of 9 populations that went below 15 individuals.

Therefore, when any APC population goes below this level there should be, subject to the Recovery Team approval (but government pre-approval of the necessary permits so no time is wasted), the activation of this emergency measure to capture all the remaining birds for captive propagation and translocation purposes. This Emergency Action Plan would of course not be activated for small re-introduced, supplemented, or indigenous populations that are expanding under a management program.

Priorities for Translocation

In the event that a decision is made to remove adult males from a population for inclusion in the captive propagation program or translocation efforts, priority should be given to collection of males from the most unstable booming grounds. Biologists indicate that booming ground stability is directly related to the number of attending males, especially at low population levels when the number of booming males/lek is less than 5 (pers. comm., R. Jurries, Texas Parks and Wildl. Dept.; M. Morrow, U.S. Fish and Wildl. Serv.; N. Silvy, Texas A&M Univ.). Robel and Ballard (1974) reported that decreased lek stability resulted in an increased number of aggressive encounters between males, which in turn resulted in a drastically reduced number of successful copulations. The resulting decline in fertile clutches is one possible explanation for the discovery of an apparently infertile clutch of eggs on the Attwater Prairie Chicken NWR during 1993. Therefore, the first males collected should be those attending peripheral booming grounds occupied by only a few males.

We previously noted that populations which decline to less than 100 males will eventually disappear unless the habitat is improved. The 100 male population size is suggested as a danger signal of future population loss unless favorable actions are undertaken. Another indicator is the population level of 8 to 15 males remaining in a subpopulation. When we reviewed historical census data for individual Attwater's prairie chicken subpopulations we noted that such populations generally disappear within 3 or 4 years. The subpopulations which represent exceptions to this timing did experience a temporary population increase before eventually disappearing. Thus, we identify the population level of 8 to 15 males as a point to evaluate the merits of capturing all survivors in that population and using them for supplementing the captive flocks or translocation to viable wild populations where unoccupied suitable habitat exists. Where the subpopulation declines to the 8 to 15 male level, we recommend review of habitat conditions and other factors potentially causing the low population level. If it appears unlikely that the population trend can be reversed long-term, then we recommend immediate efforts to capture the remaining birds for use in supplementing genetics and numbers in captive and other wild populations

We do not recommend removing hens from the Austin, Colorado, or Refugio County sites unless it becomes highly probable that loss of the subpopulation is imminent. These sites might potentially provide a source of surplus males to benefit the genetics of captive and wild populations.

We recommend that birds captured for translocation undergo a minimal health screening which should include a physical examination for obvious abnormalities (i.e. feather condition, muscle development, physical abnormalities to eyes, oral cavity, feet etc) , body weight, and appropriate, opportunistic biological sampling as needed or indicated (i.e. hematology, serum biochemistry, serology, and/or fecal examination for parasites). A disease evaluation of both the flock of origin and the recipient flock should be done prior to capture and release of birds.

Trapped and transported birds are potentially susceptible to trauma and/or exertional myopathy. We would recommend that agents for the treatment or prevention of these (i.e. selenium, vitamin E, antibiotics, anti-inflammatory drugs, and fluids) be available during or shortly after the capture event. A disease evaluation of both the flock of origin and the recipient flock should be done prior to capture and release of birds. It has been shown that the duration of captivity is related to the condition of the animal post-release. Therefore we recommend that the duration of holding of birds be limited to 24 hours if at all possible.

Reintroduction/Supplementation With Captive-reared Birds

Captive rearing techniques are currently being developed at two locations, at Fossil Rim Wildlife Center and at Texas A&M University and planned for the Houston Zoo. Fossil Rim has achieved egg production and survival to age 1 year is 4.7%, close to that of the declining population in the wild. A 58% survival to age 1 year of greater prairie chicken chicks has been achieved by Texas A&M but the technique has not yet been tested on Attwater's prairie chicken. The latter technique is designed to investigate methods for maximizing survival of released birds.

Whenever sufficient birds are produced in captivity surplus to the needs for captive flock maintenance, birds should be released to supplement the Austin/Colorado populations. Gentle (soft) release techniques are proposed. The birds should be reared using techniques which will promote post-release survival. These will include negative conditioning to potential predators, introducing the birds to natural foods and how to acquire them, acquaintance with suitable wild habitat, and training in behaviors or habitat use conducive to survival.

The recommended supplementation strategy for APCNWR is as follows. Releases will occur in late summer (probably August). At this time wild chicks are becoming independent of the hen and beginning to socialize in larger flocks. The rationale for release of captive-reared chicks with or near a hen is to promote socialization with wild birds so survival of captive-reared birds will benefit from such association. The goal will be to release 40 chicks, of equal sex ratio, at age 12 to 15 weeks. All birds will be banded. Ten young birds may be released with each radio-tagged adult hen captured from the population to be supplemented. The subject hen will be penned with the chicks for a day before she and 10 chicks are released as a unit, or the chicks maybe released in the vicinity of a hen. We assume the mortality rate of pen-reared chicks released in the wild will be 4 times the mortality rate of wild chicks. We assume that 100 % of the released females which survive will nest the following spring. We assume the subsequent mortality rate of released birds and their offspring will be comparable to that of wild birds. This supplementation strategy is designed to reduce the probability of extinction of the supplemented population to below 5%, if the supplementation is continued indefinitely. Control of mammalian predators is potentially a part of this release strategy.

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(*Tympanuchus cupido attwateri*)

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Section 4

DISEASES AND PARASITES

Diseases and Parasites of APC

Diseases and mortality associated with disease are poorly documented in free-ranging and captive North American prairie grouse. Based on data from other gallinaceous species in captive and free-ranging situations, diseases can have significant impact on populations. The following discussion is a brief summary of available information on reported diseases and parasites in North American grouse and in particular the APC. In addition, specific research and management recommendations are provided concerning disease prevention and investigation during the recovery process.

General Overview of Diseases in North American Prairie Grouse.

The majority of literature documents the presence of helminth fauna including nematodes (*Seurocyrnea colini, Ascardia galli, Heterakis gallinae, Dyspharynx nasuta*, and *Capillaria* spp.), and cestodes (*Rhabdomata nullicollis, Raillietenia variabilia*, and *Choanataenia infundibulum*) and ectoparasites. Documentation of infectious diseases is minimal, but does include histomoniasis, salmonellosis, and aspergillosis.

Free-ranging Attwater's prairie chickens

Causes of mortality in wild adult, juvenile and chick APC's are not well documented. However, given the population decline and the current population status of APC, the risk of disease negatively impacting the current population is high.

A recent serological survey conducted by Texas A&M University at the APCNWR indicated non-significant serological titers to several common poultry diseases including Newcastle's disease, Avian influenza, Avian cholera, Infectious bronchitis, *Salmonella typhimurium, Mycoplasma gallisepticum* and *M. synovia.* The consequences of contact or infection and detection with these diseases is of great concern for the remaining APC population because very little is known about the significance of these diseases in wild populations.

Recent hematologic and fecal surveys for parasites by Texas A&M University on APC's at the APCNWR have identified no hemoparasites. Analysis of cecal dropping show presence of the cecal nematode *Trichostrongylus tenuis,* unspecified coccidia, and unidentified cestodes. Prevalence and intensity of infection are unknown. The potential effect of infection with *T. tenuis* makes the presence of this parasite in APC's a cause for concern and merits further study. The prevalence and intensity of infection with *T. tenuis* has been correlated with decreased survival and reproduction in red grouse (*Lagopus lagopus*).

The APCNWR is in a migratory pathway for a large number of avian species and has a resident bobwhite quail population. Infectious diseases and parasites present in these migratory and resident species may have an impact on APC's. Thus a wide variety of avian diseases and parasites must be considered in evaluating the health status of individual APC's and APC populations.

Captive Attwater's prairie chickens

In 1992, 49 eggs were collected from 5 clutches, of these 42 hatched and 5 survived to 1 year of age. In 1993, 29 eggs were collected from 3 clutches and 49 eggs were laid by captive APC. Of these, 38 chicks hatched and one survived to 1 year of age. Average survival rates in 1992 and 1993 from oviposition to 1 year of age were 10.2% and 1.2%, respectively. Causes of mortality are tabulated in Table 8 and a summary of the disease conditions that occurred in APC chicks at FRWC in 1992 and 1993 are provided below.

Table 8. Causes of mortality of 74 APC chicks hatched in captivity.

Cause of Death	1992 N	1992 %	1993 N	1993 %
Yolk Sac Infection	2	5.9	0	0
Enteritis (3-5 D)	2	5.9	4	10.8
Enteritis (10-70 D)	7	18.9	1	2.7
Caseonecrotic Typhlocolitis	18	48.6	22	59.5
Cardiomyopathy	0	0	2	5.4
Trauma	2	5.9	2	5.4
Aortic Rupture	1	2.9	0	0
Euthanasia	1	2.9	0	0
Ventriculitis	1	2.9	0	0
Tracheitis	0	0	1	2.7
Pneumonia	0	0	1	2.7
Unknown	3	8.8	6	16.2
TOTAL	37		37	
Tibiotarsal Rotations	3	8.8	4	10.8

<u>Age 0-12 Months</u>:

1. Peracute and acute enteritis in 3-5 day old chicks

   A. Bacteria cultured included *E. coli, Pseudomonas aeroginosa, Enterococcus* sp., *Enterobacteur* sp., and *Clostridium perfringens. Clostridium difficile* toxins detected in some samples

   B. Responsive to Amoxicillin PO in drinking water.

2. Enteritis in older chicks (10-70 days of age).

   A. Bacteria cultured as above.

B. Occurred during antibiotic therapy and bacteria cultured from intestinal contents were always resistant in vitro to antibiotic being used.

C. Cecal cores are not present however it is possibly an acute manifestation of Caseonecrotic typhlocololitis (CNTC).

3. Caseonecrotic typhlocololitis syndrome

A. Subacute to acute clinical course.

B. 6-75 days of age.

C. Laminar caseous cores seen in ceca on gross necropsy.

D. Cores consist of feed material, necrotic cellular debris, fibrin, and many bacteria of different types.

E. Histopathology of cecum and colon consist of multifocal superficial mucosal epithelial necrosis. A layer of degenerating epithelial cells and mononuclear inflammatory cells with heterophils line the luminar surface.

F. No etiologic agent identified to date.

1) Bacteria cultured include *E. coli*, *Pseudomonas aeroginosa*, *Enterococcus* sp., *Enterobacter* sp., and *Clostridium perfringens*. *Clostridium difficile* toxons detected in some samples.

2) No evidence of viral, fungal, or protozoal agents.

G. Non-responsive to antibiotic treatment. Symptomatic treatment may prolong survival but does not alter outcome in majority of cases.

H. Survivors undergoing intensive therapy have been seen to pass cecal cores.

4. Tibiotarsal rotation

A. Unilateral

B. 10-20 days of age when first seen.

C. Reason for sole euthanasia. Other cases succumbed to other problems.

5. Cardiomyopathy

A. Galveston origin birds only.

B. Etiology unknown.

6. Ventriculitis, Tracheitis and Pneumonia.

A. Seen in older animals i.e. >4 months

B. Animals considered undersized or had physical defect.

C. Usually coincided with extreme weather conditions.

7. Unknown cases include both autolyzed specimens and specimens where no lesions were found.

Adults

1. Mortality in adult APC's at Fossil Rim Wildlife Center has not occurred since acquisition.

2. Causes of mortality in an Attwater's prairie chicken captive propagation project at Texas A&M University in the 1960's included Newcastle's Disease (n=3), Histomoniasis (n=8), Avian Pox (n=3), *Trichostrongylus* sp. (n=2), *Tetrameres americana* (n=1), enteritides (n=1) and Aspergillosis (n=5). These birds were raised in a poultry facility with unknown access to domestic fowl.

Captive Greater prairie chickens

Since GPC have been kept previously in captivity and are currently being used as surrogates in the Attwater's prairie chicken captive propagation program, it is important to recognize disease conditions that have been documented and make allowances to provide preventive medical programs for these diseases as well as those already documented for Attwater's prairie chicken in captivity. The following diseases and parasites have been documented in captive GPC at FRWC and TAMU.

1. Dispharynx nasuta
2. Coccidiosis
3. Trauma to heads and wings.
4. Capillaria
5. Presumptive Histomoniasis
6. Grass impactions
7. Starvation / parental neglect / exposure
8. Wry neck and spraddle leg
9. Ectoparasites
10. Caseonecrotic typhlocolitis
11. Colibacillosis

General Health Issue Recommendations

1. Every effort should be made to obtain diagnostic information and specimens from all deceased captive and wild APC's including gross examination, histopathology, bacterial and fungal culture, viral isolation, and parasite identification. (Appendix 1 for necropsy protocol).

2. Quarantine of incoming birds to a captive propagation facility is essential to prevent the introduction of infectious diseases into the captive population (Appendix 2 for quarantine protocol).

3. Biosecurity of captive Attwater's prairie chicken flocks is considered important in light of the potential impact of poultry diseases on APC's. Biosecurity measures should include complete isolation from domestic poultry and other gallinaceous birds, restriction of visitor traffic, footbaths, and clothing changes prior to entry into Attwater's prairie chicken facilities, disinfection of all equipment within the facility, feeding and cleaning to proceed from the youngest chicks to the adults, and a separate facility for sick birds.

4. Preventive health protocols for birds in captive propagation programs should be instituted (Appendix 3).

5. Pre-release health protocols should be instituted to minimize the risk or the introduction of disease or parasites into wild populations of APC's. Health screening should include physical examination, review of facility health records and completion of appropriate serologic and parasitologic testing. Both donor and recipient flocks should be tested for the appropriate diseases considering the naive status of the refuge population.

6. Further investigations of the caseonecrotic typhlocolitis in Attwater's prairie chicken chicks at Fossil Rim Wildlife Center might include:

A. Further investigations into etiologic agents that may be involved in the disease process.

B. Comparative diet trials.

C. The effect of prophylactic antibiotics and coccidiostats on chick survival.

D. Investigation of husbandry practices that may influence the disease process including nutrition factors, diet pH, water pH, cecal function, feed analysis, the role of exercise, etc.

E. Experimental infections in related gallinaceous species.

7. Establishment of reference values and ranges for hematologic, serum biochemical and serologic parameters.

ATTWATER'S PRAIRIE CHICKEN
(*Tympanuchus cupido attwateri*)

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Section 5

HABITAT MANAGEMENT

Habitat Management

Habitat Management Recommendations

Lack of native prairie habitat is the major factor currently limiting Attwater's prairie chicken (APC) populations. The APC's prairie grassland habitat has been reduced by an estimated 97% of historic levels. Remaining habitat is fragmented, making isolated Attwater's prairie chicken populations more susceptible to localized, stochastic population reductions. Currently, the largest Attwater's prairie chicken populations are found at two sites, the Refugio County site and the Austin–Colorado County site which includes the Attwater Prairie Chicken National Wildlife Refuge (APCNWR). The relatively large population in Refugio County is essential to the conservation of APC. The Refugio population occurs on relatively flat, poorly drained habitat that is highly susceptible to flooding, and the present landowners are to be commended for their management. We appreciate the positive contribution of the private land management practices on the Refugio County site and encourage private–public partnerships to continue the positive stewardship. We recommend that the Recovery Team seek the management advice of the landowners to assist in the recovery of APC.

Strategies for habitat protection and enhancement will require acquisition and/or management of two areas of 15,000 acres each. These two core areas are comprised of: (1) a 7,000 acre addition to the APCNWR and (2) a second, geographically separated, refuge of 15,000 acres in Victoria County. We believe that these reserves will meet habitat needs to support at least 1,000 birds (based on APCNWR maximum density estimate). The Attwater's prairie chicken Recovery Plan identifies a long–term target of 5,000 birds to achieve delisting. Because of the imminent threat of extinction in 7 years, we recommend that highest priorities for habitat management should focus on those actions which stabilize the Austin–Colorado and Refugio populations.

Land purchase is recommended over other types of agreements as it offers greater control for habitat management. All land acquisitions will include purchases from willing sellers only. However, if purchase is not possible, second priority should be given to some form of lease agreements. Short term lease agreements should be avoided if possible as benefits gained could be lost at expiration of leases. If lands currently overrun with running live oak and/or Macartney rose are made productive to APC, they also would be much more productive to cattle production. If lease agreements could be worked out (e.g., where government paid for control of brush with the agreement to have control of grazing pressure), local ranchers may be more receptive to a conservation easement agreement than to selling their lands.

The Recovery Plan identifies an additional 40,000 acres of satellite areas to be associated with the two core areas (Victoria County and APCNWR). The associated core and satellite areas will produce 2 metapopulation complexes. Each 15,000–acre core area will have 20,000 acres of satellite habitats. These surrounding satellite areas should be connected to each core area with corridors for Attwater's prairie chicken movements. If satellite areas are achieved via long–term lease agreements, they should ensure genetic flow and/or dispersal among satellite areas and the core populations. The additional 40,000 acres is intended to complete the recovery objective (delisting) of 5,000 birds. However, it is not clear if 40,000 acres are sufficient to achieve this goal. Additional acreage may be necessary depending on habitat quality, Attwater's prairie chicken density, and other factors.

Home range studies by Morrow (1986) and Juries (1979) found that home ranges of females varied from 750–1,470 acres and 455–890 acres for males. Therefore, we recommend that minimum satellite areas be 1,000 acres or more. One thousand acre sites would ensure that both males and females would have enough habitat to carry out their life cycles.

Land management practices on existing or acquired habitat should continue to focus on maintenance of habitat structure with cattle grazing, burning, and brush control. Mowing temporal wetlands prior to nesting season should be used to minimize Attwater's prairie chicken nesting in low, potential flooded sites. The ultimate goal of management practices should be to produce a coastal prairie ecosystem which mimics prairie ecosystems found prior to intensive human development. Habitat enhancement efforts should be focused on sites being restored as part of the metapopulation complexes. We recognize the importance of forbs in the life history of APCs (as food for adults and indirectly as related to insect abundance). Therefore, we recommend that herbicide treatments on core sites and/or satellite areas be avoided. Because of the importance of insects during the first 10 weeks of Attwater's prairie chicken life, insecticide usage on core habitats and/or satellites should be avoided. Herbicides and insecticides should be used on core habitats only after U. S. Fish and Wildlife Service (USFWS) approval.

Action Priorities

Because of the urgency of extinction threat to APCs we recommend the following high priority actions for habitat management effort:

1. Seek land management advice from land owners of the largest existing population in Refugio County.

2. Habitat enhancement efforts should be focused on sites with existing Attwater's prairie chicken populations.

3. The Austin–Colorado counties populations should be connected via the additions to the APCNWR and/or the additions of conservation easements.

4. Acquisition of the Victoria County 15,000–acre core area and satellite areas should be initiated immediately and completed within 3 years.

Additional recommendations

1. Pesticides should be used on core areas only after USFWS approval.

2. The ultimate goal of management practices should be to produce a coastal prairie ecosystem which mimics prairie ecosystems found prior to intensive human development.

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Section 6

CAPTIVE POPULATION MANAGEMENT

Captive Population Management

Acknowledging that estimates from the population model simulations indicate an average time to extinction of 7-12 years for the Attwater's prairie chicken, the following captive propagation program is devised to facilitate this species' continued presence in the wild through supplementation and eventual reintroduction to restored historical habitat in support of the Attwater's Prairie Chicken Recovery Plan.

Goals

1. Immediately establish a genetically diverse, self sustaining, captive breeding population.

2. Preserve the remaining genetic diversity of the wild population.

3. Immediately, and continue annually for a number of years, to provide captive bred birds for supplementing the existing wild meta-populations, and finally to

4. Provide captive bred birds to establish new populations in restored historical habitat.

Priorities

1. Immediately expand the breeding facilities to maintain 60 breeding hens and produce 600 chicks annually.

2. Increase the number of breeding facilities as needed to meet the expanding needs of the supplementation program and minimize the risk of disease spread. This would involve increasing the captive facilities in 1994 to 3 and in 1995 to 5 or 6. At this time an evaluation of the need for additional facilities should be made perhaps in the context of an SSP program, if one is established. Some of these facilities might be in conjunction with field release stations so birds can be produced on site for soft release into the wild.

3. Establish soft release facilities on APCNWR for release of captive raised birds in summer 1994.

Strategies 1994

1. Develop sustainable and repeatable protocols for captive propagation, rearing, and release techniques for supplementing wild populations.

2. Maximize production of chicks and expand breeding stock from the existing 2 male and 4 female APC's at Fossil Rim Wildlife Center.

3. Distribute field collected eggs between Fossil Rim Wildlife Center, Texas A&M University, and the Houston Zoo.

4. Expand research avenues through surrogate use of Greater prairie chickens or other closely related grouse species at Fossil Rim Wildlife Center, Texas A&M, and the Houston Zoo.

5. Expand the outdoor holding facilities at Fossil Rim Wildlife Center and Texas A&M to meet the projected holding/rearing requirements.

6. Undertake minor enhancement of facilities at Houston Zoo for hatching, brooding, rearing and propagation.

7. Develop facilities at APCNWR for soft release of 1994 chicks.

8. Initiate Attwater's prairie chicken x GPC hybridization project by use of APC male so as not to conflict with production of APC's.

Strategies 1995 and Beyond

Pursue similar objectives but refocus priorities after annual review of accomplishments.

Action Plan for the Spring of 1994

1. Collection of 200 wild APC eggs is recommended. This is based upon the projected needs of the captive propagation and soft release projects and is in consideration of the urgency of providing birds for augmentation of the declining populations. If possible, 25% of the eggs should be collected from the Galveston County population, 25% from the Austin/Colorado County population, and 50% from various localities in the Refugio County population. If the smaller populations will not yield the number of eggs needed, a higher proportion of eggs will be needed from the Refugio population.

2. Egg collection will be facilitated by use of telemetry. Hens will be trapped on the leks, radio tagged and then later tracked to the nest site. Where an insufficient number of hens can be radio tagged rope dragging also will be used to locate further nests.

All bird and egg handling procedures have some risk associated with them. Alternatively, there are high risks of predation in leaving the birds and their eggs in the wild where nearly 70% of wild nests will be predated. Considerable attention has been focused on risk reduction through the use of trained personnel and proven collection methods.

3. During capture of hens for telemetry it is likely that some males also will be captured. These will be banded and released, some may be retained for supplementing the captive gene pool, and others may be used to augment other populations. Blood and fecal samples should be obtained fron these males for disease and genetic studies.

Some Additional Considerations

The activation of the Emergency Action Plan (see p. 42) must be left to the field workers to best assess the speed and comprehensiveness of the actions undertaken. While many environmental factors may bear on the action, such as impending weather or man induced influences, the following elements might be taken into consideration in the timing of the event.

(a) Capture all the radio tagged hens.

(b) Capture all hens after collection of first and second clutches of eggs.

(c) Capture all hens and males.

(d) If there is some hope of changing environmental problems that might suggest some future hope for reestablishment of the population, and if males are surplus to captive breeding and augmentation needs, it might be desirable to leave extra males in place in order to perpetuate lek occupancy and facilitate future augmentations.

A review of recent population declines at both the Galveston County and Austin/Colorado County leks suggests that this emergency plan may have to be invoked within the next year or two.

Hybridization Potential -- An Experimental Option

The PHVA committee has decided that hybridization of APC x GPC should be initiated as soon as possible. This would be only done in the captive state and no birds would be released until the experiment was fully evaluated and the Recovery Team deemed this a desirable option. This experimental cross would enable early evaluation of the hybrid stocks of the F1 and subsequent generations should it later be considered a necessary method for augmenting wild populations. This can readily be accomplished by housing a female GPC in a breeding pen adjacent to an excess male APC'. This design of a cross breeding experiment would not jeopardize any production from the APC's.

Preliminary Recommendations For Captive Husbandry

1. Husbandry techniques for Attwater's prairie chicken are still in the experimental stage though the facilities have used established grouse husbandry procedures and are continually adapting the facilities to local circumstances. This work will continue with both the APC's and GPC's.

2. Each facility housing Attwater's prairie chicken will develop written protocols for the incubation, rearing, holding, and veterinary considerations. These protocols will receive periodic review with changes and results documented.

3. It is anticipated that husbandry guidelines will substantially differ depending upon whether the final birds are for further breeding stock or to be used for release purposes.

4. A studbook will be maintained, using SPARKS, for all captive stock to facilitate the maximization of genetic diversity. This committee recommends that an SSP program be developed for the APC.

5. Continue development of a model for the annual bird production and facility requirements to provide birds needed for a supplementation or population reinforcement program and for a potential reintroduction program.

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Section 7

PUBLIC OUTREACH

Public Outreach

The plight of the Attwater's prairie chicken has been publicized through the efforts of the Gulf Coastal Prairie Foundation, Fossil Rim Wildlife Center, U. S. Fish and Wildlife Service, Texas A&M University, and Texas Parks and Wildlife Department. However, the Attwater's Prairie Chicken Recovery Plan calls for an increased pro-active approach to educate and inform the general public, conservation organizations, and policy makers. To this end we recommend efforts on the following fronts:

Local Level

1. Educational programs centered at zoos involving audio/visual displays.

2. Zoological display of surplus APC's or GPC's along with graphical interpretation of the birds life history and plight.

3. Television and print media coverage of the APC's breeding behavior.

4. Educational outreach programs to public schools and civic groups.

5. Develop informational handouts for use in outreach programs and distribution at the facilities and refuges.

6. Produce a 4 color poster for the outreach campaign for mailing to schools, hunting clubs, conservation clubs, and private ranchers holding potential APC lands.

7. Produce several 4 color mountable prints (for framing), again for distribution to above groups --- particularly or exclusively for ranchers.

8. Produce a 16 to 32 page colorful booklet on the APC and associated coastal prairie lands. This could be an updated more popular version of Royce W. Jurries Attwater's Prairie Chicken for schools and public. Tell the story of the APC and the coastal prairie.

9. Produce in-house articles on APC's, their life cycle, various relationships with the land for magazines and newspapers. Supply with photos.

10. Produce video for TV (perhaps produced at no cost by local TV station), schools, and clubs.

11. Produce and release the above material to all of the above outlets describing the Captive Breeding Project.

12. Get tour operators (e.g., Aransas operators) involved with promoting the APC and their habitat needs.

13. Find a further public involvement such as "buying" a square meter of land to be used in APC habitat reclamation. At $2000 per acre this is less than .50 cents per square meter. The Nature Conservancy or the GCPF could be the holding agency. This could be promoted with offering of poster or print as additional bonus. Get schools, nature clubs or hunting clubs raising such funds. Get a competition or challenge going between hunters and birders, between schools, between different companies or types of businesses! Feature the APC's but stress total habitat reclamation. You could sell the little booklet as a fundraiser or as part of this promotion --- perhaps giving it to people who bought more than $10 or $100 worth of prairie! Call it a Patrons Edition!

14. Work with Texas Agricultural Extension Agents and Wildlife Specialists to promote APC's to ranchers.

15. Work with Soil Conservation Service to promote APC's to ranchers.

16. Work with Texas parks and Wildlife Extension Biologists to promote APC's.

Regional Level

Increased publicity through the Gulf Coastal Prairies Foundation, Texas Audubon Society, Texas Sierra Club, Sportsmen Clubs of Texas, Texas Nature Conservancy, and Texas parks and Wildlife Department.

National Level

Increased support and publicity from national conservation organizations like National Wildlife Federation, Audubon Society, Sierra Club, and the Nature Conservancy.

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Section 8

APPENDIX

Appendix 1

ANIMAL NECROPSY REPORT

INSTITUTION/OWNER:

ADDRESS:

SUBMITTED BY:

SPECIES:	**DATE:**
TAG, BAND, TRANSPONDER#:	**ISIS#**
SEX: AGE:	
FOUND BY: LOCATION OF ANIMAL:	
CONDITION OF ANIMAL WHEN FOUND:	

POST MORTEM EXAM YES____ NO____	**DATE:**
PERFORMED BY:	
SUMMARY OF FINDINGS:	

HISTOPATHOLOGICAL SAMPLES SUBMITTED?	**YES____**	**NO____**
LABORATORY:	**DATE:**	
TISSUES SUBMITTED:		
LABORATORY SAMPLES SUBMITTED?	**YES____**	**NO____**
LABORATORY:	**DATE:**	
SAMPLES SUBMITTED:		

APPARENT CAUSE OF DEATH:

Appendix 1

GENERAL CONDITION: (Nutritional, physical, skin)

BODY CAVITIES: (Fat stores, abnormal fluids)

CARDIOVASCULAR: (Heart, pericardium, great vessels)

RESPIRATORY: (Nasal cavity, larynx,trachea, lungs, regional lymph nodes)

HEMOLYMPHATIC: (Spleen, lymph nodes, thymus)

GASTROINTESTINAL: (Mouth, teeth, esophagus, stomach, intestines, liver, pancreas)

UROGENITAL: (Kidney, ureters, bladder, urethra, gonads, sex organs)

ENDOCRINE: (Adrenals, thyroid, parathyroid, pituitary)

MUSCULOSKELETAL: (Bones, joints, muscles)

NERVOUS: (Brain, spinal cord, peripheral nerves, eyes, ears)

Appendix 2

QUARANTINE PROTOCOL:

A. Goal:

To prevent the introduction of infectious diseases into the population.

B. General Rules:

1. All efforts should be made to quarantine all incoming animals.

2. While in quarantine there should be no direct contact between newly arrived animals and resident animals. Care of quarantined animals should be performed after caring for resident animals. Attention must be paid to avoid contamination of resident animal areas by drainage from quarantine areas or sharing of feeding utensils.

3. Length of quarantine will vary, however a minimum of 30 days should be completed. (Length will depend on incubation periods for the infectious diseases considered most important.)

4. Initial screening shall include review of husbandry and medical history, a thorough physical exam, fecal flotation, and a direct fecal smear. CBC, and collection of serum for serological tests and storage shall be performed as needed.

5.A minimum of 2 fecal exams shall be performed interspersed through out the quarantine period.

6. Treatment courses given during quarantine shall be completed prior to quarantine termination. Treatment effectiveness shall be documented by negative testing when possible.

7. Approval for release from quarantine must be given by the Animal Care Coordinator and the Staff Veterinarian prior to release.

C. Specific Instructions:

Appendix 3

PREVENTATIVE HEALTH PROTOCOL

I. Annual Exam

A. Physical exam.
B Body weight.
C. Laboratory evaluation as needed.
1. Complete blood count.
2. Blood chemistries.
3. Fecal examination.
4. Serology.

II. Parasite Control

A. Control of intermediate hosts.
B. Clean up of fecal material.
C. Prophylactic treatment based on periodic fecal examinations.
D. Exclusion of free flying birds.
E. Mosquito control if hemoparasites are detected.

III. Infectious Diseases

A. Biosecurity and quarantine should reduce potential of disease in captive birds.
B. Prompt diagnosis of mortalities in wild birds will determine control procedures.
C. Vaccinations for common poultry diseases may be indicated.

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