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FINAL REPORT

TITLE: Evaluation of the Reintroduction of Attwater's Prairie Chickens in the Refugio-Goliad Prairie, Texas, 2007-2011.

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ABSTRACT

The Attwater's prairie chicken (*Tympanuchus cupido attwateri*) (APC) is considered by many to be the most endangered bird in North America. At this time a successful recovery of the APC can only be accomplished through the release of pen-reared individuals. The population of endangered APC is currently maintained at very low levels primarily through the release of birds raised annually in the captive-rearing facilities in Texas. The first priority of the APC recovery has to be to prevent extinction by maintaining a healthy captive flock which means a portion of every year's production has to be used to maintain numbers, health and the genetic status quo. This project was a continuation of work started in 2007 to evaluate release of pen-reared APC on private land near Goliad, Texas. In addition information was collected on radio-marked released pen-reared APC at the Attwater Prairie Chicken National Wildlife Refuge (APCNWR) and the Texas City Prairie Preserve (TCPP) and incorporated to supplement the evaluation of the releases in Goliad County. Information on radio-marked young of the year GPC was collected in northwestern Minnesota A total of 974 pen-reared APC were released into the wild from 2007-2011. Of these, 962 were radio-marked. In 2007 for the first time surplus pen-reared APC were released on private and a total of 399 pen-reared APC have been released in Goliad County, 2007-2011. A total of 164 young of the year greater prairie chickens (*Tympanuchus cupido pinnatus*) (GPC) were captured via night lighting and radio-marked to compare with data from pen-reared APC. Prior to transfer from the captive rearing facilities to the acclimation pens at the release sites all birds underwent testing to ensure that healthy birds were being released. Almost all the nests of radio-marked pen-reared APC found were enclosed in a predator-deterrent fence and nesting success was 74% highest at APCNWR followed by Goliad and TCPP. Nest success in wild greater prairie chickens in Minnesota ranged from 44% to 57% and totaled 51%. Egg hatchability for nests in the wild ranged from 76-93% and averaged 85%. Survival of banded greater prairie chickens is 48% and ranges from 39-75%. Annual survival by year by area was variable for yearling + pen-reared APC and ranged from 23-73% (Mean=48%) and was highest at APCNWR and TCPP (Means=53%) and Goliad (Mean=32%). When compared with wild radio-marked young of the year GPC mean annual survival was higher for pen reared yearling + APC at 48% versus 42-43%. The almost total failure of the released pen-reared APC to successfully rear young in the wild on their own has been the dominant factor holding back APC recovery. How to increase brood survival has become and is the number one priority for research and management relative to the APC recovery. From 2003-2008 only 3.2% (1/31) of the broods of radio-marked pen-reared APC hens fledged chicks and the other 30 lost all their chicks within two weeks of hatching. During this period young chicks have survived beyond two weeks and fledged in the wild but only by placing the hen in a "brood" box for two weeks and providing the hen and chicks with insects and then releasing them. Insects appeared to be more abundant at both Goliad and APCNWR in 2010. Insect levels were the highest that field personnel had seen in recent years which resulted in 44% of the radio-marked pen-reared hens rearing chicks to 14 days, 63% at APCNWR. The latter is consistent with the brood survival rates seen in wild radio-marked prairie chickens in northwestern Minnesota. In 2010 ten APC hens (40%)

successfully fledged chicks and one fledged at least eight chicks. This includes 9 broods at APCNWR and 1 at Goliad. This is similar to the 33-44% fledging rate seen in wild GPC in northwestern Minnesota. At least 58 chicks were observed alive a 6 weeks of age in 2010. Brood sizes for both groups of radio-marked pen-reared hens (non-head started and head started) ranged from 1-8 and averaged 3.4 and 3.8 chicks/brood at six weeks of in Minnesota 2008-2011 (Mean= 2.8, Range=2.2-3.0 chicks/hen). At Goliad one radio-marked pen-reared hen fledge one chick in 2010. It is obvious based on information presented here that when conditions, weather and insect abundance are good that released radio-marked pen-reared APC can fledge young in the wild at a rate equal to and at times higher than that seen in wild radio-marked GPC. The fact that two APC hens successfully reared chicks in 2011 under the worst drought conditions in Texas in 50 years is encouraging as to the potential for the recovery of APC using pen-reared birds. It indicates that under both good and very poor conditions that radio-marked pen-reared APC can rear chicks in the wild on their own. The brood survival parameters seen so far especially in 2010 at APCNWR refute the misconception held by too many that the pen-reared APC are "maladapted". The progress to date made towards an APC Recovery using pen-reared birds has been positive and the results are obvious as this past spring (2011) as a consequence of the 50 chicks fledged there were 110 APC in the wild an increase of 25% this is the highest number APC recorded in the wild since 1994. The evaluation of released pen-reared APC on private land outlined in this report reinforces the conclusion that chick survival is the factor limiting the recovery of APC and that insect numbers reduced by RIFA are the reason. The idea that grasslands on private land are better suited for APC than the grasslands found on the APCNWR is not true and based on survival and production information grassland habitat on the refuge is better than at Goliad and TCPP. The next five years will be a critical time for APC and what happens next will likely determine the fate of the APC recovery effort. The immediate goal should be to begin to apply what we have learned and focus our very limited resources on establishing a single functional population of at least 250 cocks. All of the information collected so far indicates that the best survival and production have occurred on the APCNWR. It is recommended that future releases focus on establishing this population at the refuge by releasing all of the surplus pen-reared APC at the refuge for the next five years, 2012-2016. Preliminary information on fire ant numbers indicates that they can be reduced with Extinguish Plus to increase insect numbers. Starting in the fall of 2012 through 2016 treat via aerial application the grassland habitat used by APC on the APCNWR with Extinguish Plus to reduce fire ant numbers to increase invertebrate numbers and diversity. In 2017 reevaluate the recovery effort and determine if significant progress has been made and determine if the effort should be modified, ended or expanded. Once a functional population of at least 250 cocks has been reestablished on the refuge efforts should shift to establishing APC on private land.

INTRODUCTION

The Attwater's prairie chicken (*Tympanuchus cupido attwateri)* (APC) is considered by many to be the most endangered bird in North America. This is because of dramatic declines in the wild to the point where wild birds were captured and eggs collected to establish a captive flock to save and recover the species. The Attwater's prairie chicken (*Tympanuchus cupido attwateri*) (APC) has been a federally threatened/endangered species since 1967 (Morrow et al. 2004). The APC population declined from 8,700 birds in 1937 to 1,584 in 1980 (Lawrence and Silvy 1980) to just 56 in 1998 (Silvy et al. 1999). The APC range has contracted "94% from that used in 1980, there are still sizeable areas that appear to offer all the requisites to support APC. However populations have gone extinct in these areas." "It appears the near future of the APC is in the hands of the captive breeding programs (FRWC, TAMU, HZ and SAZ)" (Silvy et al. 1999:154).

The total APC population in the wild in 2007 consisted of just two small populations in Texas 80 miles apart. One was associated with the Texas City Prairie Preserve (TCPP) with no more than 15- 20 birds located near Texas City and the other at the Attwater's Prairie Chicken National Wildlife Refuge (APCNWR) near Eagle Lake with 30-40 birds. These two "populations" have been established or supplemented and sustained by the annual release of APC raised at various captive rearing facilities and zoos in Texas (Fossil Rim, Houston, Sea World, San Antonio, Caldwell and Abilene).

A successful recovery of the Attwater's prairie chicken can only be accomplished through the release of pen-reared individuals. The use of pen-reared individuals has been used to successfully reestablishing populations of black-footed ferrets (*Mustela niger*), peregrine falcons (*Falco peregrinus*) and bald eagles (*Haliaeetus leucocephalus*). However these species are long lived predators/scavengers in contrast to the APC which is a short lived prey species. The APC recovery unfortunately has been perceived as somewhat of a joke in conservation circles. This has set back the recovery process because many see the task of recovery to be intimidating if not impossible because of the wildlife profession's lack of success in reestablishing population by releasing pen-reared birds especially the galliformes (quail, pheasants) and other species such as the high profile whooping crane (*Grus americans*). Efforts to establish a second whooping crane population have spanned over 30 years, involved numerous states and has yet to establish a self sustaining population due to the lack of production of young.

The long-term philosophy with regard to releasing pen-reared galliformes for over 75 years has been to release large numbers of pen-reared individuals to overcome very poor survival. Literally millions of pen-reared birds have been and are released each year to establish populations in vacant habitat or supplement hunting success world wide. Yet surprisingly there has been very little long-term detailed research documenting why releases of pen-reared galliformes have not been successful in reestablishing viable populations in the wild. The failure to document such projects has wasted a lot of money and resources especially birds. However, this has not been the case with the APC release program where the production and release of pen-reared birds has been intensively

documented and evaluated from the very start with just about every possible limiting factor studied and compared with wild birds (i.e. genetics, disease, parasites, survival, nest and chick survival, condition, behavior, insect numbers and size, the influence of fire ants on invertebrate numbers and chicks, diet, gut physiology, feather egg and blood chemistry). These data have been evaluated, updated and regularly examined by the Recovery Team and incorporated into the recovery effort to improve results.

It needs to be emphasized that many of the grouse species around the world are threatened and according to Storch (2007) the management goal for many populations is to prevent them from going extinct. The propagation of grouse in captivity and their use to successfully supplement and reestablish populations in the wild will likely become a critical management tool in the future. Looking down the road it is likely that the future of many endangered species, the masked bobwhite (*Colinus virginianus* ridgwayi), whooping crane and especially the prairie grouse may lie in our ability to develop captive rearing and release methodology to sustain genetic diversity, reestablish and connect populations.

ACKNOWLEDGEMENTS

This evaluation has been a cooperative project between the Coastal Prairie Coalition of the Grazing Lands Conservation Initiative (GLCI), The Nature Conservancy (TNC), US Fish and Wildlife Service (USFWS), The Society of Tympanuchus Cupido Pinnatus, Ltd (STCP), Texas Parks and Wildlife (TPWD), and the APC rearing facilities that produced birds for release: Fossil Rim Wildlife Center (FRWC), Houston Zoo (HZ), Abilene Zoo (AZ), San Antonio Zoo (SAZ), Caldwell Zoo and Sea World some of which were funded by the USFWS. Most of the birds released have been reared by Fossil Rim with the next most coming from the Houston Zoo. Much of the funding for the 2009-2011 evaluation was provided by a Section 6 Endangered Species Grant through the Texas Parks and Wildlife Department (TPWD), to STCP. Earlier funding was provided by GLCI, STCP, TNC and the PI. Survival and reproductive information on pen-reared APC while collected by field personnel with STCP and TNC at Goliad have been provided, to and maintained by Dr. Mike Morrow, USFWS at the APCNWR, Eagle Lake, Texas. This was done to maintain continuity with past work and because the bird is a federally listed endangered species. The author and research assistants have been added as subpermittees to the USFWS Endangered Species and TPWD possession, handling and trapping permits held by Terry Rossignol and Dr. Mike Morrow respectively, USFWS Region 2, Attwater Prairie Chicken NWR, Box 519, Eagle Lake Texas 77434. The permit to trap GPC, radio them, collect chicks and eggs in Minnesota was provided to the author by the Minnesota Department of Natural Resources (MNDNR). Data from APCNWR were collected by Dr. Mike Morrow, and staff, USFWS. Aaron Pratt (2010) summarized the data 2007-2008 and developed a recovery model for a Master of Science at Texas A & M University, Kingsville, Texas. A copy of this thesis has been provided to TPWD. Portions of this thesis have been compiled and updated by the author and incorporated into this report also to maintain continuity. Data for wild prairie chickens from northwestern Minnesota were collected and summarized by the author and by assistants working with STCP. Field information in 2011 in Goliad County was collected by Jay

Kelso Tivoli, Texas, and his current supervisor, Kirk Feuesbacher and past supervisor Dr. Wade Harrell all with TNC. The field information from TCPP was collected by Jared Judy and Tim O'Connell (TNC), their staff and volunteers at TCCP. Clifford Carter with GLCI served as liaison with private landowners. Terry Rossingnol, APC Recovery Team Leader and Rebecca Chester Assistant Biologist at APCNWR provided valuable togistic assistance. Much of the information for this report was provided to the author by Dr. Mike Morrow, USFWS, APCNWR, Eagle Lake, Texas. Finally, and most important we acknowledge the local community for their hospitality and especially the local landowners for their assistance and access to their lands – without their cooperation and land stewardship there will be no future for APC in Texas.

OBJECTIVE

The objective was to evaluate using radio telemetry the releases of pen-reared APC on private land in Goliad County Texas, 2007-2011 and make recommendations regarding habitat management and future releases.

METHODS

This project was a cooperative effort between the GLCI, TNC, STCP, USFWS, private landowners in Goliad County, Texas Parks and Wildlife and the APC captive rearing facilities 2008-2011. This evaluation used radio telemetry to specifically monitor the movements, survival, mortality factors and productivity of pen-reared APC released on private land. The results were compared with similar information collected from past and ongoing releases of pen-reared APC at the APCNWR and TCCP (Mike Morrow, USFWS unpublished data) and will be used to make recommendations regarding future releases of APC. Much of the release methodology has been taken directly from the protocol established in the APC Recovery Plan (Anonymous 2010, APCRP) so that direct comparisons can be made with information from releases at APCNWR and TCPP. Methodology for this project will be adjusted based on input from private landowners and recommendations from the APC Recovery Team, TNC, Texas Parks and Wildlife, USFWS and other interested parties. This will be especially true after the first year of this project

Most of the birds released were pen-reared young of the year raised at the various facilities contracted by the USFWS. The number, age and sex ratio of the birds released depended upon the number of birds raised by the rearing facilities in excess of the needs of the captive rearing program and then for releases at APCNWR and TCCP. Ideally at least 50 birds (25 cocks, 25 hens) should be released for three summers 2007-2011. However, since 2000 the number of birds produced for release into the wild by rearing facilities increased. This means that more birds (75-100) were available for release on private land in 2008-2011. Release procedures followed those successfully conducted by the USFWS at the APCNWR (Anonymous 2010). This involved releasing small groups of predominantly 8-12 week old pen-reared young of the year APC from acclimation pens. All birds were processed, banded and radio-marked. Each bird was individually color banded with four leg bands (Hamerstrom and Matson 1964) weighed

and measured and blood taken for health assessments. A drop of blood was stored in lysis solution for future genetic analysis. All birds were checked for disease and parasites before release and at recapture. Most birds were given a nematocide to reduce internal parasites (intramuscular injection of Ivermectin® and/or an oral dose of Panacur®). These drugs are used to control parasites in captive Attwater's prairie chickens. Birds were also dusted with 5% SEVIN to reduce louse loads prior to placement in acclimation pens. Radio-marked birds that survived to the following year were recaptured by night-lighting and their radios replaced so they can be followed for another year. The radio packages used functioned for at least 15 months. Radio-marked hens with broods were circled at night to determine the number of chicks at 2 and 6 weeks of age. At six weeks of age they were captured and radioed with 4-6 gram transmitter packages that lasted 90-180 day and had colored tabs on the top of the bid so individuals could be identified to avoid recapture or to recapture in the case of radio failure. These radios were replaced with the larger packages when the birds are 10-12 weeks of age (Toepfer 2003).

These methods have been used by the author to successfully, trap, handle, measure, radio mark and translocate several thousand GPC in Wisconsin, Minnesota, Nebraska, Kansas, Illinois, South Dakota (Toepfer 2003). These same procedures have also been used successfully to recapture, change radios, measure and collect blood samples from APC released at APCNWR and TCCP. There has been only one trapping and handling mortality of a night-lighted APC so far. Radio-marked birds were monitored daily and general telemetry techniques, followed those used on radio-marked GPC by Toepfer 2003, Toepfer 1988.and that used by the TNC and the USFWS at TCCP and the APCNWR. Radio-marked birds were located at least once per day first 90 days post release August/October and then the surviving radio-marked birds were located at least weekly to monitor survival and general movements November/February. Radio-marked birds were again monitored daily March/July to monitor movement, survival and reproductive success of surviving radio-marked birds. The nests of hens were enclosed with a predator exclusion fence similar to those used successfully at APCNWR and TCPP to increase nesting success (Morrow et al. 2003). In addition a sample of at least 35 young of the year greater prairie chickens (*Tympanuchus cupido pinnatus*) were radio-marked in northwestern Minnesota in August and September each year to serve as a control with the pen-reared birds to compare general movements and survival.

RESULTS AND DISCUSSION

This project has been a continuation of the initial effort to evaluate the release of pen-reared APC on private land in Goliad County initiated in 2007; consequently data from 2007 have been incorporated into this report to maintain continuity. The author (PI) has coordinated the Goliad Evaluation project and compiled the data provided by field staff Aaron Pratt, Jay Kelso and Jereme Didier through the database maintained by Dr. Mike Morrow, USFWS for this report. Figures 1-16 and Tables 1-6 can be found at the end of the report following the Literature Cited section. Sample sizes at times are small but in the case of the released pen-reared birds most were banded and radio-marked.

Study Area

The main study area was located in Goliad County near Goliad, Texas on the Papalote Ranch (2007-2011) and the Vidauri Ranch (2009 and 2010) (Figure 1). In addition information collected on radio-marked released pen-reared APC at the APCNWR and TCPP was provided by Dr. Mike Morrow, USFWS and incorporated to supplement the evaluation of the releases in Goliad County. See Pratt (2010) and Anonymous (2010) for mores specifics on each of the release areas in Texas. Information on radio-marked young of the year GPC was collected in northwestern Minnesota. (Figure 2) and were used as a "bench mark" to make comparisons with the released radio-marked pen-reared APC. For more specifics on this area see Toepfer (2003) and Svedarsky et al (1999). The main release area was the Papalote Land and Cattle Company located in Goliad County near Goliad, Texas. This ranch supports about 4,000 acres of coastal prairie habitat and is surrounded by about 50,000 acres of unbroken coastal prairie. In 2009 in an effort to spread the released birds out pen-reared radioed APC were released on the Vidauri Ranch located adjacent approximately six miles to the main release area.

Number of Pen-reared APC Released 2007-2011

A total of 974 pen-reared APC were radio-marked and released to supplement and/or reestablish a population in the wild from 2007-2011. (Mike Morrow, USFWS, unpublished data). In 2007 for the first time surplus pen-reared APC were released on private land in association with the Papalote Ranch near Goliad in Goliad County, Texas. Since 2007 a total of 399 or 41.0% of the surplus pen-reared APC available were released in Goliad County. A total of 144 pen-reared APC were released this past year (2011), 72 in Goliad County and 72 at the APCNWR. Most of the birds released were radio-marked to monitor survival and production. Table 1 summarizes releases by year and area, 2007-2011. No birds were released at TCPP in 2011 and as per recommendations of the APC Recovery Team this site has been temporarily abandoned and future releases will focus on establishing a population at the APCNWR.

Pen-reared APC were processed (weighed, checked for disease, dusted for parasites, blood samples taken, individually color banded and radio-marked) and transferred from the rearing facilities in an air conditioned van to the acclimation pens at the respective release sites. Birds were held in pens for 14 days and then released from acclimation pens and fed outside the closed pen for 30 days post release. See the USFWS Attwater's prairie chicken (*Tympanuchus cupido attwateri*) recovery plan, (Anonymous 2010) for specifics on release protocol. The protocol requires that most pen-reared APC be released at a young age so as to avoid physical deterioration and habituation to the penned environment (Toepfer 1988). The latter documented that pen-reared GPC held overwinter for release in April altered their response to predators from flying to running as result of repeatedly flying into the side of the pen. In addition it was documented that the pen-reared GPC weighed less than wild birds of a comparable age.

In 2010 the released birds were fed frozen green vegetables while in the acclimation pens at APCNWR and TCCP to assist in the adjustment to wild food and reduce blockage of their digestive systems. The frozen vegetables were fed to birds in acclimation pens at Goliad in 2011. Birds were also dusted with 5% SEVIN before being put into the acclimation pens to control external parasites. Figure 3-6 shows an APC being treated for parasites, the transfer holding boxes, the gentle acclimation pen at the Goliad County release site, and the radio collar used to follow prairie chickens. The radio-transmitter package (Figure 6) consisted of a tuned loop modified after Amstrup (1980). Note the lack of an exposed whip antenna on the radio package, ultimately the breast feathers are pulled through the head hole so it ends *up* situated completely under the feathers next to the breast bone. Long exposed transmitter whip antennas hit the wings of prairie grouse when they fly.

The number of surplus pen-reared APC available for release has increased over the years so that the number of birds available for release has remained relatively consistent from year to year at about 150-300 birds. This author has been involved in recapturing radio-marked pen-reared APC in the wild since 2002 and the body and feather condition of the birds released the last five years (2007-2011) has improved. Pre 2007 it was common to find biting lice on the radio-marked pen-reared APC recaptured via night lighting to replace radio collars so individual birds could be followed for multiple years. The most and some of the better birds come from the Fossil Rim Wildlife Center. The greater numbers and high quality of the birds from FRWC is due to the fact that they have a modern facility and have full time year round staff to take care of the prairie chickens. The staff at FRWC is supplemented with temporary staff to care for their captive flock during the breeding season and chick rearing season. The numbers and cost for the captive rearing program is such that captive reared APC should not be wasted because any production must first be used to sustain captive flock numbers and genetic health and then and only then can any surplus be used for release into the wild.

Wild Young of the Year Northwestern Minnesota

A total of 164 young of the year greater prairie chickens (*Tympanuchus cupido pinnatus*) (GPC) were captured via night lighting August-October and radio-marked from 2007-2010 and survival monitored: 28 in 2007, 44 in 2008, 50 in 2009 and 42 in 2010. These birds were captured by night lighting during August and September with their radio-marked mothers at 6-7 weeks of age and radio-marked with a 6-7 gram radio. The "chicks" that survived were recaptured at 10 plus weeks of age and the smaller radio package replaced with a 17-19 gram package that will run for 15-24 months. These wild birds were used as controls to compare survival and production of the released radio-marked pen-reared APC.

Disease and Parasites

Prior to transfer from the captive rearing facilities to the acclimation pens at the release sites release candidates underwent an extensive battery of testing to ensure that healthy birds were being released. The pre-shipment testing protocol includes a physical

examination, CBC/plasma chemistry analysis, and testing for fecal parasites, *Salmonella pullorum, S. typhimurium,* avian influenza, *Chlamydophila*, reticuloendotheliosis virus (REV), fecal *Salmonella*, and other infectious disease recognized in the flock of origin that could present a risk to the birds (J. Flanagan, DVM, Houston Zoo, Inc., unpublished protocol).

Each year the pen-reared APC were checked for diseases and parasites and dusted with 5% SEVIN before being placed in the acclimation pens for release. Each bird was chemically treated to reduce/eliminate internal parasites (Figure 3). Early on feather lice were abundant on the recaptured radio-marked pen-reared APC. The SEVIN treatment has reduced or eliminated lice as few if any have been detected when recaptured to change radios since this treatment began.

Nest Success

Either a nest hatches or it does not consequently the normal standard for nest success should be 50%. If success is lower than 50% something is negatively influencing nest success and if it is higher than 50% something is positively affecting nest success. Almost all the nests of radio-marked pen-reared APC found were enclosed in a predator-deterrent fence made from 3-foot high ¼ inch hardware cloth according to the same protocol used at APCNWR and TCPP. This method was developed by STCP on wild greater prairie chicken nests in northwestern Minnesota, Wisconsin and North Dakota in the mid-90's (Morrow et al 2003).

Not all nests fenced were successful because at times some hens abandon their nest, snakes have apparently unknowingly been enclosed within the fence, hens are killed while off feeding and when a fence is initially placed around a nest it is left at a 45 degree angle for several days while the hen learns to "jump" over it before the fence is put vertical. Before the fence is vertical the nest is susceptible to being destroyed. The eggs of hens killed or that abandoned nests were salvaged when possible and sent to captive rearing facilities for incubation. Figure 7 shows a protective fence surrounding the nest of a radio-marked APC nest at the Goliad County release site. Extinguish plus was broadcast within and around the fence surrounding the nest to suppress red imported fire ant (*Solenopsis invicta*) numbers and activity.

A nest was considered successful if one egg hatched in the wild. Overall, APC nest success 2008-2011 was 74% which is 24% above what one would expect and higher than that seen in wild greater prairie chickens and 42% higher than APC historically (Peterson and Silvy 1999). Nesting success was highest at APCNWR (82%) followed by Goliad (67%) and TCPP (50%). Table 2 presents nest success by area for radio-marked Attwater's and greater prairie chickens in northwestern Minnesota, 2008-2011. The higher nest success seen at the refuge probably relates to the fact that mammalian predator numbers are controlled and that there are more people working at the refuge which means the nests are found sooner and the predator deterrent fences are put up faster. At times much of the field work done a TCPP was done part-time and/or by volunteers. The reader should note that the timing of biological events in the life cycle of

APC in Texas is approximately a month ahead of that for GPC in northwestern Minnesota.

Nest success in wild greater prairie chickens in northwestern Minnesota ranged from a low of 44% to 57% and totaled 51% for 2007-2011(Table 2). Renesting after the initial nest is destroyed is common in GPC and some radio-marked hens have established three nests, one four during a single nesting season. APC like GPC renest and the released radio-marked pen-reared APC have renested in this study but because initial nests are "fenced" as soon as the radio-marked hen starts incubating nest success has been artificially increased reducing the number of renests. This narrows the natural hatching peak in this APC population. In GPC in northwestern Minnesota nest hatching is spread out over a month and a half from about 1 June to 20 July or 50 days. The only concern that this might raise is that more early nests will hatch and in some years may hatch when insects are not as abundant.

Egg Hatchability

Very low egg hatchability due to low genetic diversity was the factor that was thought to have led to the decline of GPC in Illinois to just 19 cocks in 1992 (Westemeier et al 1998). Low egg hatchability has not been a concern so far for the pen-reared APC nesting in the wild. Egg hatchability for nine years (2003-2011) from nests in the wild at APCNWR has been variable ranging from 76-93% but has averaged 85%. (Data courtesy Mike Morrow, USFWS). At Goliad egg hatchability was 73% in 2011 and 88% in 2010 but only 44% in 2009. Why the low hatchability in 2011 and especially 2009 is not known but thought to relate to very dry conditions during this nesting season. No information on egg hatchability is available for TCPP. Peterson and Silvy (1996) reported that egg hatchability reported in a review of the literature averaged 87%.

Post Release Survival

Overall mean post release survival (to 1 March) of the released radio-marked pen-reared APC for all years ranged from 22-29% and averaged 28% for the period 2007-2010. Survival was highest at APCNWR at 36-47% (Mean=42%), followed by Goliad County 26-38% (Mean=27%) and then TCPP, 4-24% (Mean=14%). Post release survival rates (to 1 March) by area are presented in Table 3. APC post-release survival levels reported here are much higher than those reported for other pen-reared galliformes (Pratt 2010, Toepfer 1988).

Survival over a period comparable to the post release period of pen-reared APC (autumn to spring or 15 September to 1 April) by area by year for radio-marked young of the year GPC in northwestern Minnesota averaged 65% and ranged from 62-70% (Table 3). Table 4 compares survival of wild young of the year GPC (65%) with pen-reared APC released at the APCNWR where survival was highest (42%). The difference in autumn to spring (1 April) mean survival rates of young of the year wild radio-marked greater prairie chickens with post release survival of pen-reared APC (to 1 March) are large (Overall=29% versus 65%) but not as large for pen-reared APC released at

APCNWR=(42% versus 65%) (Table 3 and 4). Data on survival for pen-reared were provided by Dr Mike Morrow, USFWS. Note that common biological events in Minnesota occur approximately one month earlier in Texas (1 March=1 April).

However, these data do not tell the complete story because the post survival data are taken out of context of the life equation. A standardized comparison with wild GPC and selected other species starting with 100 eggs laid indicates that the current APC rearing methods and release protocol are getting the same or more individuals to survive to the following breed season (15-20%) than seen in wild prairie chickens when starting with 100 eggs laid in the wild (Morrow et al 2010, Figure 2). This same pattern and number approximately 15-20% also emerges when one examines the number of young that survive to the following breeding season from pen-reared and 100 eggs of peregrine falcons and whooping cranes (Toepfer unpublished data provided by Greg Septon).

The difference here is not if but when mortality occurs in the life equation. In the wild GPC and probably wild APC lose half of their eggs before they hatch eggs while in a penned environment the eggs are protected and approximately 85% of the eggs hatch. This number is eventually dramatically reduced by the high post release mortality (autumn to breeding season) observed in released pen-reared APC. This number is such that the number of individuals that survive to the following breeding season from 100 eggs laid in captivity eventually ends up being the same as what occurs in wild GPC starting with same 100 eggs but laid in the wild.

One suspects that a sizable number of the chicks that hatch from eggs protected in captivity will never have a chance to fledge (release age) in the wild. These are likely inferior individuals that are quickly "culled" after release. This pattern of early high mortality post release can be seen in the Kaplan-Meier survival graphs. In wild birds these chicks are likely eliminated long before fledging and surviving wild individuals fledged unlike pen-reared birds have been hardened by the outdoor/wild environment.

Annual Survival

The accepted standard for survival of prairie chickens is Hamerstrom and Hamerstrom (1973). They calculated annual survival at 46% using a life table spanning 23 years for banded wild greater prairie chickens in Wisconsin. However, they did not report the variation in survival by breaking down annual survival by individual years. Toepfer (1988) working in the same study area found comparable survival at 48% for banded birds and reported yearly survival for 7 years ranging from 39-75%. No attempt has been made here to breakdown survival by sex. This is because the pen-reared APC and young of the year GPC were radio-marked at an age when sex cannot be accurately determined for some birds. Also Hamerstrom and Hamerstrom (1973) found no assumed statistical significance in survival between GPC cocks and hens. Likewise analysis of survival of released pen-reared APC by sex was also similar (Mike Morrow, personal communication).

For those birds that survived the first year post release and their yearling offspring, annual survival by year, 2008-2011 by area was quite variable ranging from 23-73% (Mean=48%) for the released radio-marked pen-reared APC, 2008-2011 and was highest at APCNWR and TCPP (Both Mean=53%) and Goliad (Mean=32%). (Table 3 and 4). Longevity appears to be higher at TCPP than at Goliad and APCNWR yet post release survival is the lowest of all the areas (Pratt 2010). The reason for this difference is not known.

When compared with wild radio-marked young of the year greater prairie chickens the overall mean annual survival of radio-marked pen-reared APC for 1 plus years of age and yearling offspring of released birds for 2008-2011 was actually higher for the pen reared APC 48% versus 42-43%. The difference in annual survival of pen-reared versus wild was greatest for the radio-marked pen-reared APC at the APCNWR 48-53% versus 42-43% (Table 3 and 4). Hamerstrom and Hamerstrom reported annual survival of 46% for banded adult GPC in Wisconsin based on a 23 year composite life table. Toepfer (1988) working in the same study area 1973-1978 reported that annual survival of banded GPC varied each year from a low of 39% to a high of 75% and averaged 48%.

Kaplan-Meier annual survival distributions (Kaplan and Meier 1958) for pen-reared Attwater's prairie chickens released in Texas at the APCNWR, in Goliad County and TCPP 2007-2010 are presented in Figures 8-11. The survival trends exhibit similar patterns with survival distribution trends being highest for pen-reared APC released at APCNWR, followed by Goliad County with TCCP being the lowest. Figures 8-11 for 2007, 2008 and 2009 respectively compare the survival distribution with wild young for the young of the year wild greater prairie chickens. In all years annual survival distributions of wild birds are higher than that seen in the pen-reared APC. Figure 12 compares annual survival distributions by year for 2007-2010 for pen-reared APC released at Goliad County. Graphs for figures provided by Dr. Mike Morrow, USFWS and Aaron Pratt. As indicated earlier these figures are taken out of context of the life equation and should be standardized relative to the number of eggs laid. The most valid comparison is annual survival and that indicates that as older bird's annual survival of pen-reared APC is comparable to that seen in wild GPC.

Annual survival of APC chicks fledged in the wild 2010-2011 was 38% and pooled 2007-2011 was 36%. This is on the low end but within the range of that seen in wild GPC range 39-58% (Toepfer 1988). Pooling data across years for birds released 2007 survival for yearlings was 38% (n=90) at APCNWR, 31% at Goliad (n=28) and 39% at TCPP. Third year survival at APCNWR was 63% (n=20) and 0 (n=6) at Goliad and fourth year survival at the refuge was 29% (n=8) (Mike Morrow, unpublished data). Telemetry data indicate that survival of chicks fledged in 2009 from autumn to the following breeding season (1 March) was 75% which is slightly higher than that seen in wild fledged GPC chicks (62-72%)(Table 3).

Brood Survival

The variables that most influence prairie chicken population levels are survival and production and the latter is a function of weather, nesting success, survival of chicks to two weeks and beyond, and especially the percentage of hens that fledge a chick. Two weeks is a critical time for galliformes because at this age they are dependent upon the hen for thermoregulation (warming and cooling) (Dahlgren 1990). Greater prairie chickens in northwestern Minnesota are still brooded at night until 4-5 weeks of age depending upon the weather and size of chicks (Toepfer unpublished data). In Texas it is likely that the brood hen may have to brood young chicks to keep them cool rather than warm.

The almost total failure of the released pen-reared APC to successfully rear young in the wild on their own prior to 2009 has been the dominant factor holding back APC recovery (Pratt 2010). How to increase brood survival has become and will be the number one priority for research and management concerning recovery of the APC.

From Morrow et al (2010): From 2003-2008 only 3.7% (1/27) of the broods from released pen-reared radio-marked APC hens successfully fledged chicks and the other 26 lost all their chicks within two week of hatching. During this period young chicks have survived beyond two weeks and fledged in the wild but only by placing the hen in a "brood" box for two weeks and providing the hen and chicks with insects and then releasing them. (See Brood Box Section Below). In 2009 brood survival over the first two weeks increased to 28% (5/18) of the broods at APCNWR and Goliad County. Table 5 shows brood survival to 2 weeks of age for pen-reared APC and wild GPC, 2008-2011.

Insects appeared to be more abundant at both Goliad and APCNWR in 2010 than in the past. Insect levels were the highest that field personnel had seen in recent years (Mike Morrow, Aaron Pratt and Jay Kelso, personal communication). This increase in insects resulted in 44% of the radio-marked pen-reared hens rearing chicks to 14 days, 63% at APCNWR. The latter is consistent with the brood survival rates seen in wild radio-marked prairie chickens in northwestern Minnesota 2008-2011(Table 5). Ten hens (40%) successfully fledged chicks in 2010 and one fledged at least eight chicks. This includes a brood at Goliad and 9 broods at APCNWR. This is also similar to the 33-44% fledging rate seen in wild GPC in northwestern Minnesota for 5 years, 2007-2011. (2007=44%, 18/41; 2008=41%, 24/58; 2009=33%, 20/61; 2010=39%, 23/59; 2011=43%, 17/40; Total=39%, 102/259). At Goliad one radio-marked pen-reared hen fledge one chick in 2010. This bird, a hen, was radio-marked, survived to the following spring (2011) when it disappeared while exhibiting movements consistent with egg laying behavior.

Brood survival in 2010 from 2- weeks was 90% for broods released at hatch and 100% for head-started broods. These rates are quite a bit larger than those observed in wild prairie chickens (Table 5). A minimum of 58 chicks were observed alive a 6 weeks of age in 2010. Brood sizes for both groups ranged from 1-8 and averaged 3.4 and 3.8 chicks/brood at six weeks of age. These averages are larger than those seen in wild

prairie chickens in northwestern Minnesota 2008-2011 (Mean= 2.8, Range=2.2-3.0 chicks/hen).

In 2011 two hens reared chicks in the wild an unmarked second year hen fledged one chick and a radioed hen at TCPP was observed with 3 chicks at five weeks of age before her radio failed. Brood survival in contrast to 2010 was undoubtedly impacted by drastically reduced insect availability due in part to drought conditions.

It is obvious based on information presented here that when weather conditions and insect abundance are good that released radio-marked pen-reared APC can fledge young in the wild at a rate equal to and at times higher than that seen in wild radio-marked GPC. The fact that two APC hens successfully reared chicks in 2011 under the worst drought conditions in Texas in 50 years is exciting and extremely encouraging as to the potential for the recovery of APC using pen-reared birds. It indicates that under both good and very poor conditions that radio-marked pen-reared APC can rear chicks in the wild on their own. The brood survival parameters seen so far especially in 2010 at APCNWR refute the misconception held by too many that the pen-reared APC are "maladapted".

Brood survival is not just a concern for pen-reared APC. Recent results from long term research on brood sizes indicates that the number of chicks fledged per radio-marked GPC hens in northwestern Minnesota has been declining significantly for 20 years (1992-2011)(Toepfer unpublished data). Information spanning 1965-2006 in North Dakota shows that sharp-tailed grouse (*Tympanuchus phasianellus)* average brood sizes have also declined significantly for past 42 years. (Data courtesy Gerald Kobriger retired and Stan Kohn North Dakota Game and Fish Department). These data also indicate that at 6 weeks of age broods exceeding 6 chicks are becoming rare. Warner et al (1999) also reported that chick survival based on brood sizes in pheasants has declined from the early 1950's to the early 1990's from 7.7 to 4.2). The reason(s) for these declines are not known at this time but raise very serious concerns that insect numbers and distributions may be declining throughout the prairie grouse range.

The Brood Box

The only way APC hens were able to get broods to survive to fledging until 2009 was to confine the hen and chicks at hatch at the nest site in a "brood box". These are free-ranging radioed hens that have been allowed to nest on their own, hatch and then the box is placed over the hen and chicks at night. Insects swept from the prairie are then provided to the hen and chicks every two hours during the day. The chicks are periodically weighed to make sure they are getting enough insects and gaining weight. In addition to the insects, food supplements are also provided for the hen. At two weeks post-hatch, the hen and brood are released and allowed to fend for themselves. Figure 13 shows the brood box used to "head start" a brood of radio-marked pen-reared APC released into the wild that survived to the following breeding season. Figure 14 shows five week old wild GPC chicks ready for release in northwestern Minnesota.

The use of a brood box to confine a radio-marked hen with brood hatched in the wild and feed them insect for two weeks has emphasized the critical role of an abundance of insects in the early survival of chicks. Survival of chicks held in brood boxes to release at two weeks has averaged 84%, much higher than the two-week survival in captivity at about 65%. Survival of broods managed in this manner (head-start broods) to fledging of at least one chick averaged 35% which is similar to that observed for wild APC and greater-prairie chickens (Morrow 1986, Toepfer, unpublished data). This has been a critical development in the recover effort as it pointed out the critical role of insects in chick survival for the first two weeks. Brood boxes have been used for eight years since 2004 and survival of hens in the brood box has been 100% and chick survival while in the box very high at over 80% and 89% in 2011 (Mike Morrow personal communication). These survival rates are much higher than that seen in wild birds and for chicks raised to two weeks of age in captivity.

The fact that the wild hatched APC broods survived when fed insects in the brood box indicated that insects are the dominant factor limiting early survival of chicks. These results led to the development of the working hypothesis that red imported fire ants. (RIFA) have and are negatively impacting insect populations and hence survival of chicks. The latter conclusion has been corroborated by reducing RIFA numbers and documenting an increase in insect numbers. The brood box was developed and incorporated into the recovery effort by Mike Morrow, USFWS. Limited manpower precluded the use of brood boxes in Goliad County during the course of this project.

Pratt Model

From Pratt (2010): The population of endangered APC currently is maintained at critically low levels by the reintroduction of birds raised in captive-breeding facilities. The success of the reintroduction program is a function of the number of birds released and their rates of survival and production. A population model was developed to simulate an APC population through a 50-year period. The model determined the threshold needed for a successful recovery of 6,000 APC in year 50 and the sensitivity of the model predictions for 3 variables: number of bird's released, post-release survival, and brood survival to fledging. Brood survival was the only variable that could be increased independently and have a successful recovery. Sensitivity of population size was constant and identical for the number of birds released and post-release survival, but exponentially increasing for brood survival. Releasing more birds with higher survival will help recover the APC faster but a successful recovery will not be possible without improved brood survival. The latter being dependent upon increasing the quantity and quality of invertebrates currently suppressed by RIFA. For more specifics see Pratt (2010).

Red Imported Fire Ants

Red Imported Fire Ants (RIFA) invaded APC range a few years before APC populations began their final decline in the wild. The evidence is obvious that the presence of RIFA has impacted insect numbers and size distribution affecting the survival of APC chicks

especially the very young chicks. In April 2009, an area totaling 760 acres of the APCNWR was treated with Extinguish Plus (donated by Wellmark International) to control RIFA. By September, RIFA activity was reduced by 75% compared to untreated areas, and insect numbers were significantly higher in the control area. Consistent with the RIFA insect availability hypothesis discussed above, insect samples collected at APCNWR yielded lower weight/insect (i.e., more smaller insects) in 2009 compared to 2003 (Pratt et al 2003). Surveys in September 2009 indicated that insect numbers within the fire ant control area were twice that of the untreated area. All this indicates that RIFA are negatively impacting APC habitat by altering insect communities and limiting chick survival. Unpublished data provided by Dr. Mike Morrow, USFWS.

It is thought by some that the increased insect abundance observed in 2010 may have been due to reduced red imported fire ants activity related to drought conditions (Bart Drees, personal communication). The disruptive impacts of RIFA on native insect and wildlife communities have been well documented. Texas northern bobwhite populations consistently declined after RIFA infestation in the 1970's-1980's. and bobwhite populations were higher on sites where RIFA numbers were reduced (Allen et al 1995). Concurrent field research on fire ants indicates that they are the dominant limiting factor suppressing insect numbers and diversity. When insect were abundant as seen in 2010 survival of young chicks was higher and the released pen-reared APC fledged chicks at the APCNWR and Goliad. And when insect numbers were low they fledge few if any chicks the exception being those "broods head-started" in brood boxes.

Mortality Factors

One can never actually determine with certainty what killed a radio-marked bird unless one witnesses the event. However, based on the examination of the remains of 94 dead radioed APC at Goliad, 80.9% (76/94) were classified as being fed upon and presumably killed by predators. Of the 76 radio-marked birds fed upon by predators 31.6% (24/76) were classified as unknown predation. The remaining 52 were classified as to being fed upon by a raptor 67.3% (35/52) based on stripped tendons, clean bones and 32.7% (17/52) were classified as being fed upon by mammalian predators based on crushed bones and chewed feathers. However, it is not uncommon for mammalian predators to scavenge the remains of raptor kills meaning that any incidence of raptors killing APC could be underestimated (Toepfer 2003). Toepfer (1988) in examining the remains of radio-marked pen-reared GPC observed that the incidence of mammalian feeding was higher than that of raptors' just the reverse of wild birds' and felt that because the pen-reared GPC altered their behavior over time to running rather than taking flight (based on observations while in the pen). Running would make them more susceptible to mammalian predators when released. Information on wild pheasants which tend to run rather than fly from danger shows a ratio favoring mammalian predation (Dumke and Pils 1973).

Raptor Control/Open Space

Hamerstrom et al (1957) indicated that the best predator control was accomplished by providing prairie chickens with good habitat. Open space and treeless terrain are an important component of grassland ecosystems. This means maintaining grasslands and open space – one broad definition of prairie is a "treeless area". The concept of cutting trees to eliminate hunting perches for raptors to increase survival was originally addressed by Peterson (1979). He reported that perching raptors such as great horned owls (*Bubo virginianus*) and red-tailed hawks (*Buteo jameicensis*) cannot effectively hunt an area without adequate perches. He recommended the selective removal of solitary trees to limit their hunting range.

The impact of tree removal on prairie chicken survival was tested in central Wisconsin in 1999 when some sixty scattered trees were removed surround a booming ground called SERR. Tree removal expanded the treeless area surrounding this booming ground almost four fold from 140 to 540 acres. Survival of the radio-marked cocks using this booming grounds increased from 33.3% to 55.5% after the trees were cut while survival of cocks on two control booming grounds remained about the same (Toepfer 2003). As a result of this research all of the solitary trees on state land were removed on the Buena Vista Wildlife Management area in central Wisconsin. This increased annual survival of radio-marked adult cocks pre tree removal in 2000-2001 by 14.2% from 48.2% (13/27) to 62.4% (22/35) in 2006-2007 post tree removal (Toepfer unpublished data). This increase in survival was accompanied by a 15% increase in numbers the following year based on booming ground counts (Kardash 2011) but the higher numbers have not been maintained indicating that factors other than just survival are influencing numbers and trends in Wisconsin.

Prairie chickens prefer open treeless landscapes especially for booming grounds. At Lac Qui Parle in west central Minnesota the booming grounds established by the first birds translocated into unoccupied grassland areas were in the largest treeless landscapes while subsequent booming grounds were established in less open areas (Toepfer and Trauba unpublished data).

The increase and peak in autumn mortality of released radio-marked APC is associated with the arrival of migrating raptors especially Northern harriers. Northern harriers (*Circus cyaneus*) also kill and eat prairie chickens especially young ones and because they hunt while flying the removal of trees will likely not alter their impact.

Population Trends

APC Population – 2011: It was estimated that there were a total of 110 Attwater's Prairie Chicken (APC) in the wild in March 2011. This is based on 55 cocks counted in March 2011 which is an increase of 10 cocks (24.3%) from the 45 counted in 2010. The greatest increase 31 to 41 cocks (32%) occurred at the APCNWR. Table 5 shows APC populations by area 2008-2011 and Figure 15 shows APC population trends in the wild, 1996-2011. The progress to date made towards an APC Recovery using pen-reared birds

has been very positive and the results are obvious as increases this past spring (2011) were a consequence of the 50 plus chicks fledged at APCNWR resulting in an increase of 25%. This is the highest number APC recorded in the wild since 1994. The APC population in the wild has increased 8 times in the last 15 years and four of the last 5 (Figure 15).

GPC Population – 2011: In northwestern Minnesota the GPC population has declined 51.1% since 2007. This decline has been associated with loss of habitat specifically the loss of permanent grasslands enrolled in the USDA's Conservation Reserve Program (CRP) and several sever winters with a deep permanent snow cover for much of the winter. The deep snow cover eliminates much of the waste grain in the harvested agricultural fields making it difficult for birds to find food. GPC unlike many of the other northern grouse do not survive well when they have to depend upon browse for winter food (Hamerstrom et al 1941).

General Movements

Field efforts in this project to evaluate the reintroduction of pen-reared APC on private land holdings in Goliad Count have concentrated on documenting survival and production. Movements and habitat use of radio-marked pen-reared APC have been similar to those reported in studies on wild APC (Lockwood et al (2005), Morrow et al 2010). Information on movements here will be limited to general observations specifically the distances moved from the release pens/area. At Goliad 95% of the released radioed birds remained within 3 miles of the release pens. All of the nests and booming grounds were within two miles of the release pens. At the APCNWR all the radio-marked APC released in past have remained within 10 miles (Mike Morrow, USFWS, personal communication) and at TCPP all have remained within 1.5 miles (Jared Judy, TNC, personal communication). Figure 16 shows distribution of nests relative to booming grounds and release pens for one year 2009 (Pratt, unpublished data)

Several radio-marked hens have dispersed 5-13 miles from their release site; one hen in particular dispersed 13 miles and then returned to her release area for the breeding season. It is reassuring to realize that the pen-reared APC still retain the ability to move relatively long distances and find their way back to other birds. Birds that could not be located within several miles of the release sites were eventually searched for by airplane. Wild radio-marked immature prairie chicken hens at times have dispersed 32 miles from their natal areas in Wisconsin and 41 miles in northwestern Minnesota, while immature cocks have dispersed 7 miles (Halfmann 2002, Toepfer unpublished data). Transplanted greater prairie chickens hens have been documented dispersing 90 and 100 miles (Toepfer unpublished data). Hamerstrom and Hamerstrom (1973) documented banded immature hens have moved up to 50 miles and cocks up to 10 miles. The typical pattern for greater prairie chickens is for hens to move further than cocks and immature further than adults. This same pattern of hens dispersing greater distances than cocks has also been observed so far in the released pen-reared APC

Other Peripheral Research

Additional pertinent research associated with work under this project was the collection of eggs to document nutrient differences between GPC, APC in the wild and in captivity, 2007-2011. Feathers were collected to assay feather isotope composition using sources in the diet of captive-reared and post-release Attwater's Prairie Chickens in Texas to compare with GPC, APC in the wild and APC in captivity. Briefly both the egg analysis and isotope assays indicated that there are differences in the nutrient content between the eggs produced by APC in captivity and feather composition with wild GPC and pen-reared APC after they have lived in the wild. These differences likely relate to the nutrient composition or lack of in the commercial foods fed to APC in captivity and in the wild. These data have and are being used to modify and hopefully improve the diet of the APC captive flock. The most striking aspect of this is that after being in the wild eating natural foods the composition of APC eggs (Morrow and Toepfer unpublished data) and new feathers changed (M. Mora, unpublished manuscript) to what was "normal" when compared to wild GPC. The GPC eggs for nutrient analysis were collected from nests of wild GPC in Minnesota, no more than 2/nest.

In 2009, a total of 34 eggs (2 eggs at most 3 per nest) were collected from the nests of incubating radio-marked wild GPC in Minnesota. These eggs were transported to the Fossil Rim Wildlife Center in Texas where the eggs were incubated and the chicks reared under the same conditions as captive reared Attwater's prairie chickens. A sample of these chicks was collected at 5, 10 and 15 days and their intestinal and ceacum histology examined to document changes (if any) in the gut as a result of being reared in captivity and eating commercial food. These results were compared with those obtained from the 18 wild GPC chicks also collected at 5, 10 and 15 days in northwestern Minnesota in 2008. The histological analysis of these samples indicated there were no detectable differences in the guts of wild prairie chicken chicks and prairie chicken chicks reared in captivity and fed a commercial diet (Meier 2010).

RECOMMENDATIONS

The APC range in Texas has contracted "94% from that used in 1980, there are still sizeable areas that appear to offer all the requisites to support APC. However populations have gone extinct in these areas." (Silvy et al 1999) Based on what we now know it is probable that the establishment and spread of RIFA and its impact on insect numbers, size and distribution is the reason for the dramatic decline seen in the numbers and distribution of the APC in Texas. The evaluation of released pen-reared APC on private land outlined in this report reinforces the conclusion that chick survival is the factor limiting the recovery of APC and that insect numbers reduced by RIFA are the reason. This compilation has confirmed that when insects are abundant chick survival and recruitment have been high and equal to or higher than that observed in wild greater prairie chickens. In all portions of their life cycle released radio-marked pen-reared APC have preformed at levels comparable to or greater than that seen for radio-marked young of the year greater prairie chickens. The idea that grasslands on private land are better suited for APC than the grasslands found on the APCNWR is not true and based on

survival and production information outlined here grassland habitat on the refuge is better than at Goliad and TCPP.

It needs to be pointed out that results restoration projects seem to get better when full time, on site, experienced personnel are doing the field work. The population of endangered Attwater's prairie-chicken is currently maintained at very low levels primarily through the release of birds raised annually in the APC captive-rearing facilities. Unfortunately there are a limited number of very expensive pen-reared APC available for release each year. The first priority of the APC recovery has to be to prevent extinction which means maintaining a healthy captive flock. Consequently a portion of every year's production has to be used to sustain the captive flock to maintain their numbers, health and genetic status quo. This means maintaining support for the captive rearing facilities to sustain numbers to maintain the APC, and then produce surplus birds for release into the wild. There is a very real need for more pen-reared APC for release and efforts need to continue to pursue the establishment of a dedicated prairie grouse rearing facility to produce more APC and if not existing facilities need to be expanded to house more breeding pairs.

The next five years will be a critical time for APC and what happens next will likely determine the fate of the APC recovery effort. The immediate goal should be to begin to apply what we have learned and focus our very limited resources on establishing a single functional population of at least 250 cocks. This should be done at one release site the best one the one that affords the best chance for success. All of the information collected so far indicates that the best survival and production has occurred on the APCNWR indicating that it has the best APC habitat and logistical support giving us the best chance of achieving the goal of establishing a functional population. It is recommended that future releases focus on establishing this population at the refuge by releasing all of the surplus pen-reared APC at the refuge for the next five years, 2012-2016.

Starting in the fall of 2012 through 2016 treat via aerial application the grassland habitat used by APC on the APCNWR with Extinguish Plus to reduce fire ant numbers to increase invertebrate numbers and diversity. This will increase insect numbers and improve brood survival. For the next five years all of the surplus pen-reared APC produced by the captive rearing facilities should be released at the refuge. At the end of five years this population should be large enough to sustain itself contingent upon the suppression of fire ants and normal weather conditions. All the hens and a portion of the cocks released should be radio-marked to monitor survival and productivity. All the nests of released radio-marked pen-reared hens should be encircled with protective fences to maximize nest success. A significant portion of the pen-reared hens that hatch should be "head started broods" and placed in brood boxes to further increase the number of chicks that survive to two weeks of age. A booming ground survey should be conducted each spring to monitor population trends. In 2017 or in five years reevaluate the recovery effort and determine if significant progress has been made and determine if the effort should be modified, ended or expanded. Once a functional population of at least 250 cocks has been reestablished on the refuge efforts should shift to establishing APC populations on private land and other suitable areas using the protocol used at the

APCNWR. The long term recovery of the species will eventually have to occur on private land and once a population is reestablished on the refuge recovery efforts should be expanded to once again include releases on private grasslands in Refugio and Goliad County.

It is estimated that there are currently about 60,000 acres of quality contiguous costal prairie in southern Texas. The limited amount of state and federal land in Texas means any long-term recovery of the Attwater's prairie chicken will have to occur on private land. In concert with the releases on the refuge outreach in the form of habitat development on private land will need to be initiated to maintain and create more habitat on private land. This effort will serve to develop and improve relationships with landowners so that access can be obtained to make future releases on ranches with the best grassland habitat.

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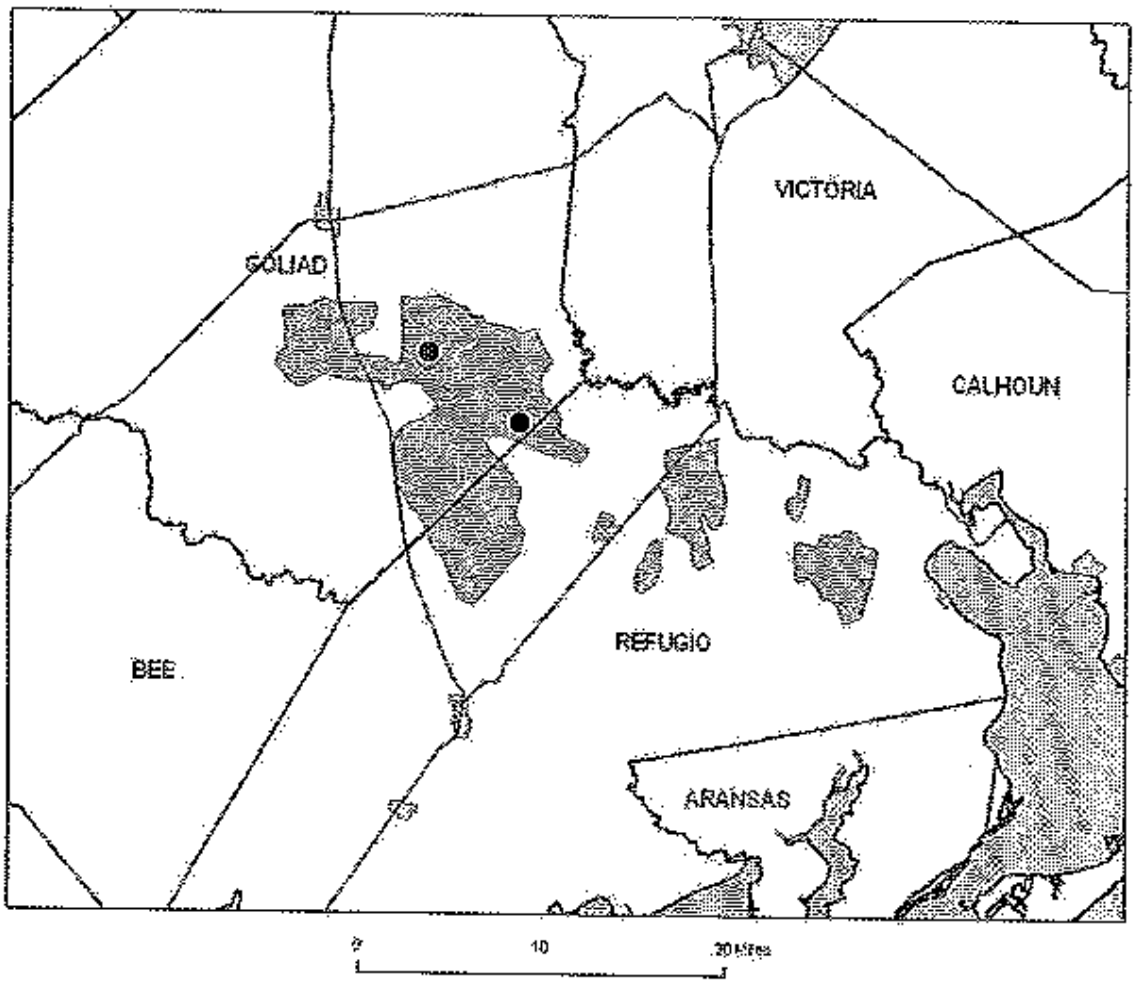

Figure 1. The Goliad County Texas study area and release site locations: (2007-2011=red and 2009-2010=black). Map from Pratt (2010).

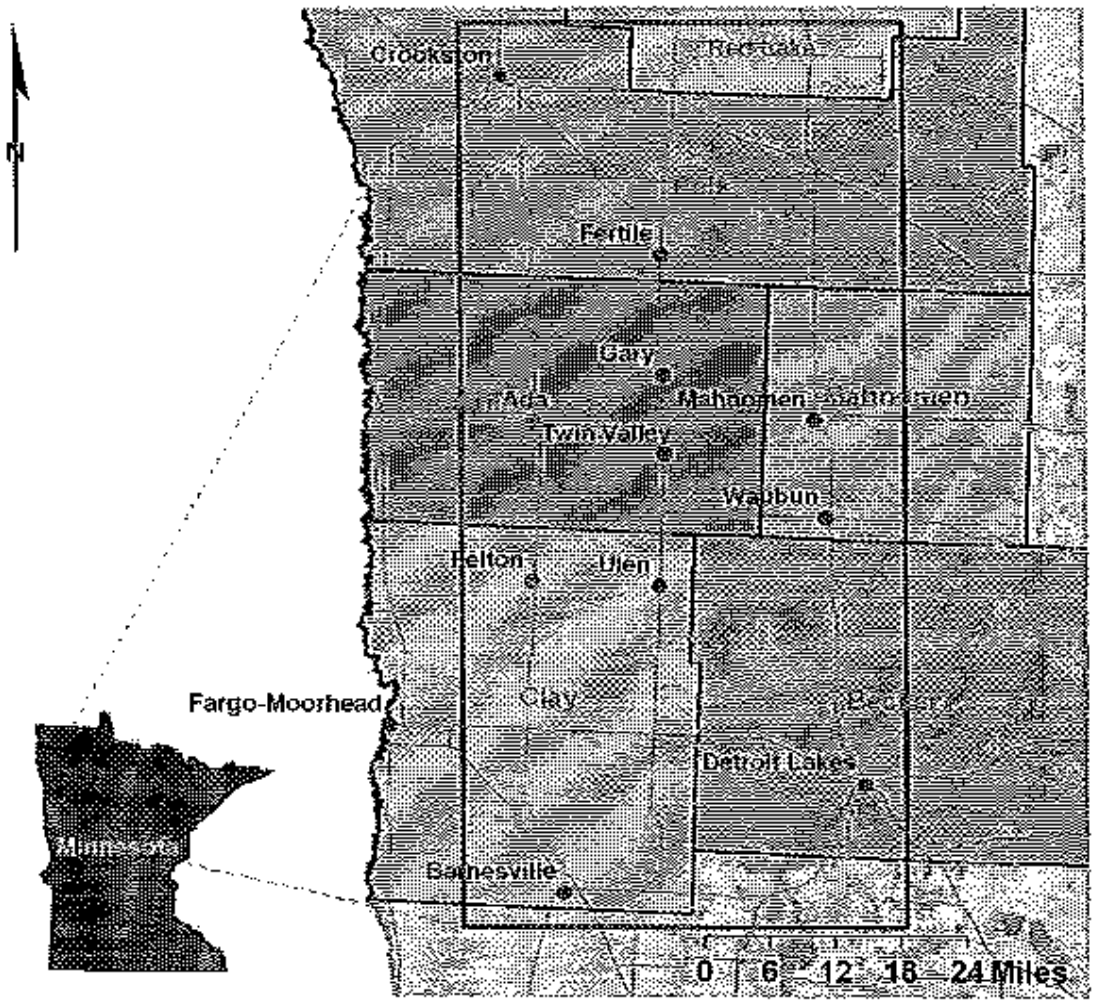

Figure 2. Northwestern Minnesota study area, 2007-2011.

Figure 3. Pre-release parasite treatment for radio-marked pen-reared Attwater's prairie chicken at Fossil Rim Wildlife Center, Texas 2007.

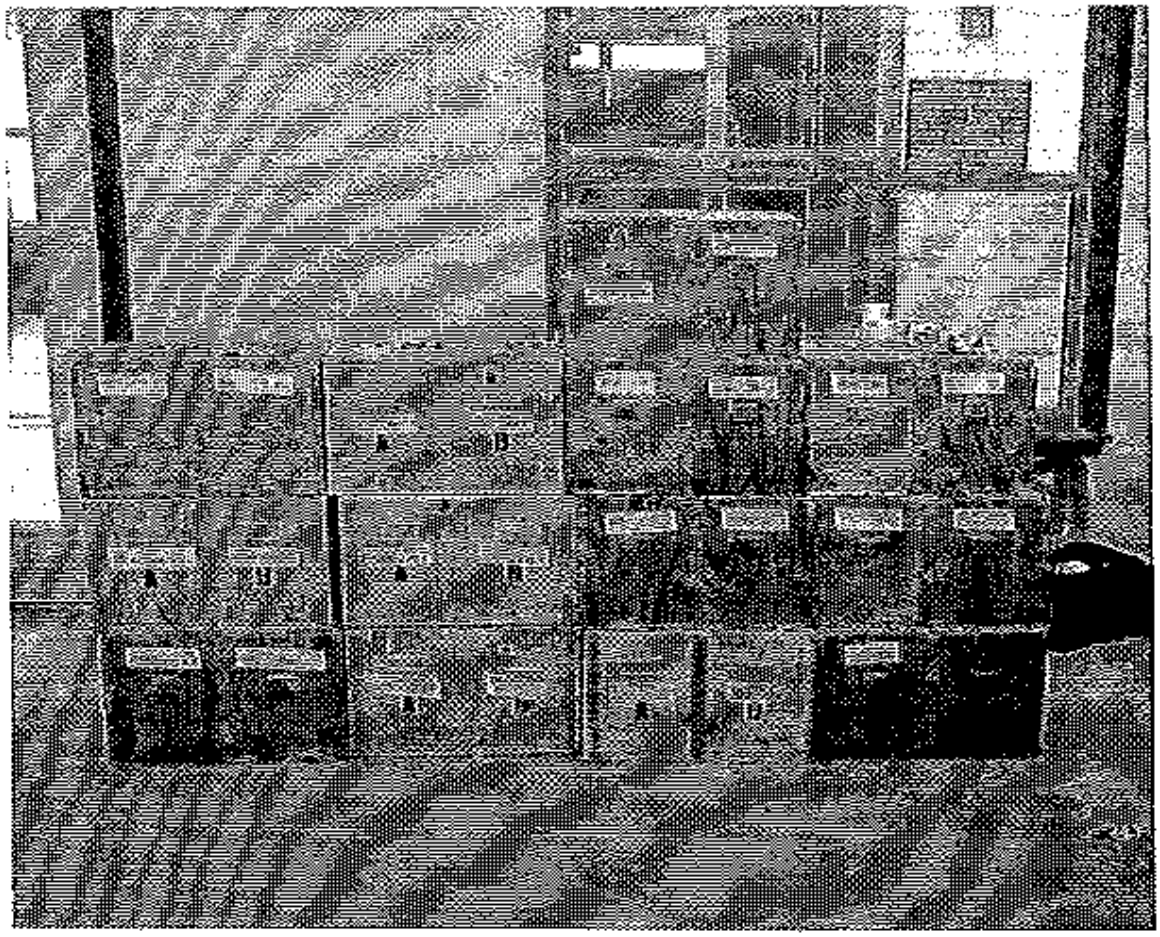

Figure 4. Transport boxes containing pen-reared Attwater's prairie chickens at Fossil Rim Wildlife Center ready for transport to Goliad County, Texas, 2007.

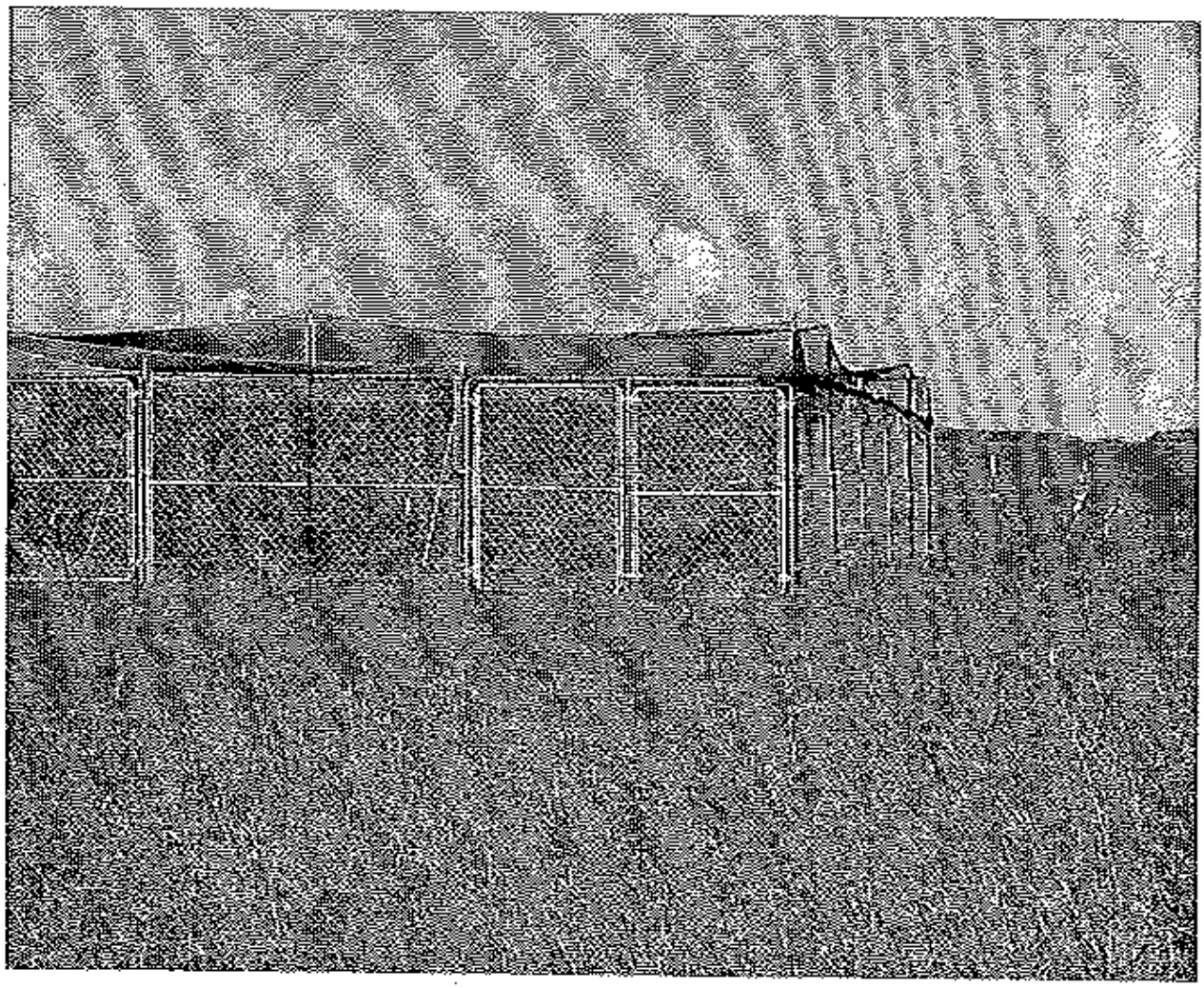

Figure 5. An acclimation pen used to hold pen-reared APC for 14 days pre-release at the Goliad County release site, Texas 2007-2011

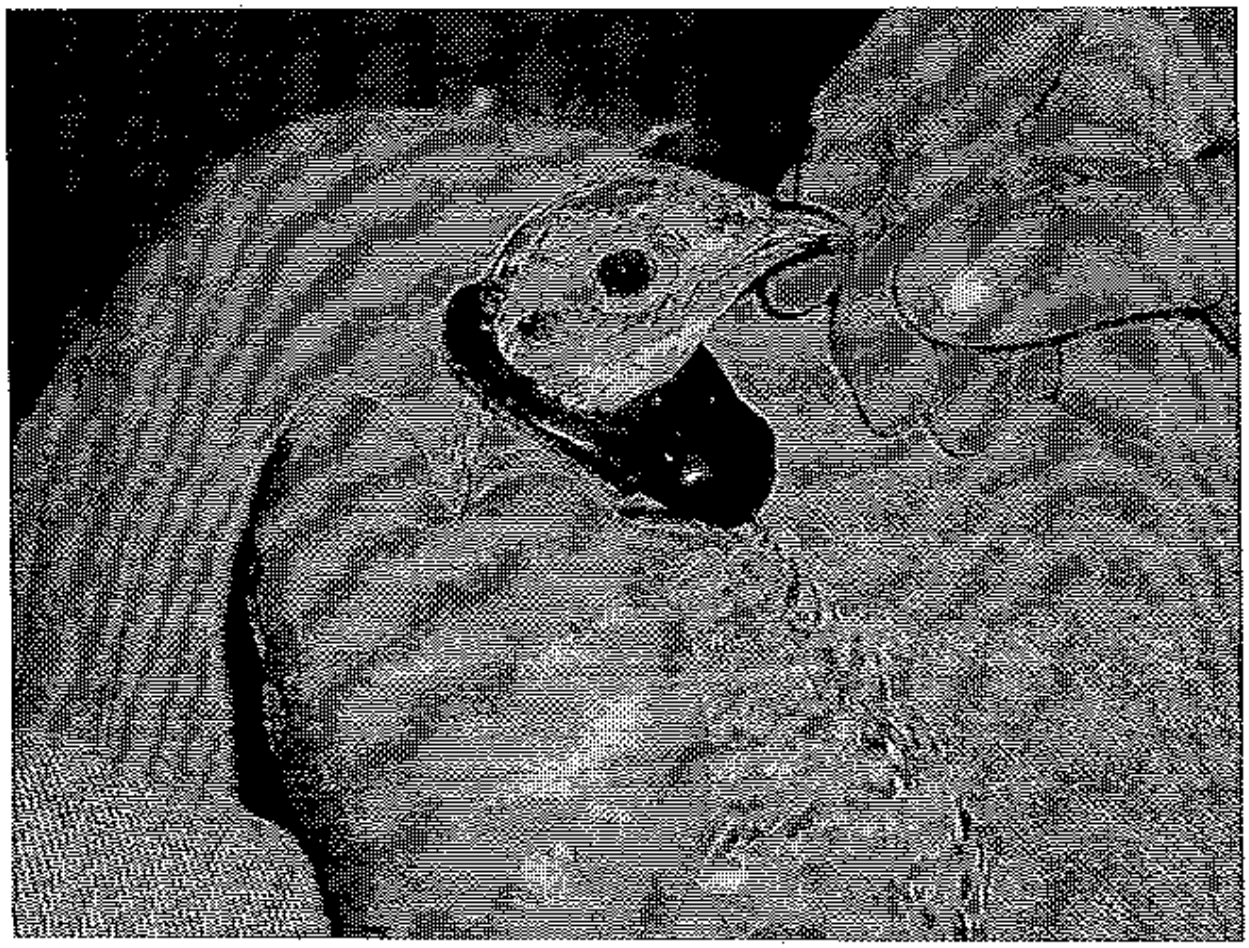

Figure 6. Tuned loop radio collar being placed on pen-reared Attwater's prairie chicken at Fossil Rim Wildlife Center, 2007. Note the lack of an exposed long whip antenna which slap the wings when they fly (Marks and Saab Marks, 1987). . The breast and neck feathers are eventually pulled through the head hole so the collar ends up under feathers next to the breast bone.

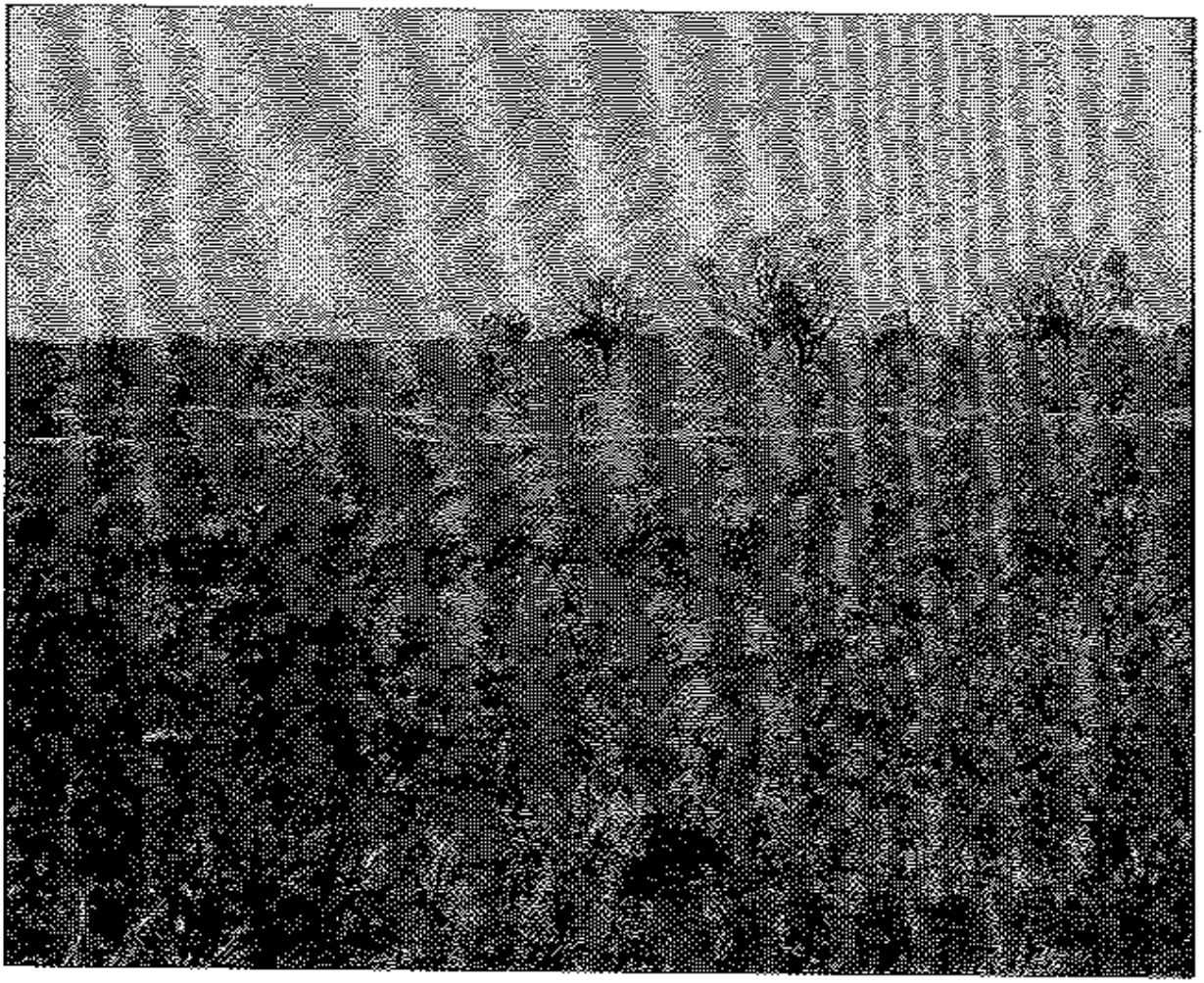

Figure 7. Predator deterrent fence surrounding nest of radio-marked pen-reared Attwater's prairie chicken hen, Goliad County, Texas, 2007.

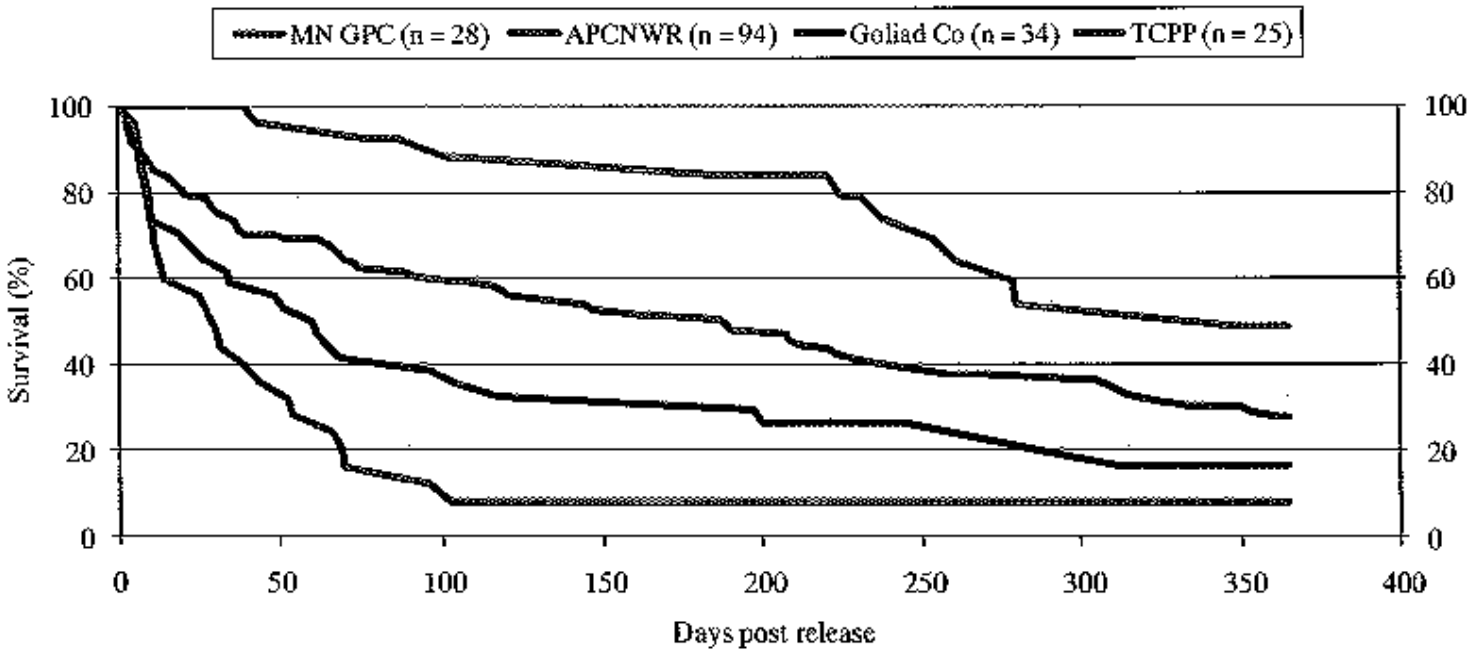

Figure 8. Kaplan-Meier annual survival distribution for released radio-marked pen-reared Attwater's prairie chickens by area, Texas and radio-marked young of the year wild greater prairie chickens northwestern, Minnesota 2007. From Pratt (2010).

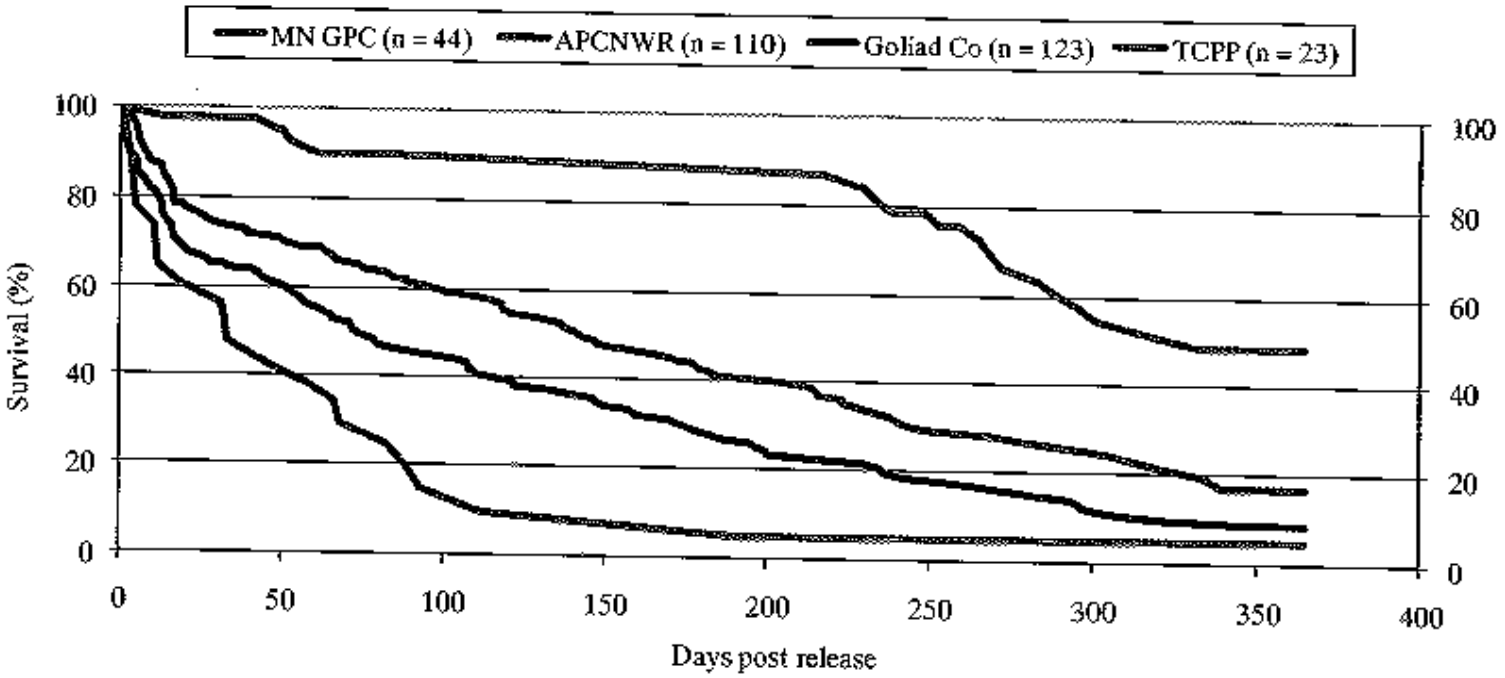

Figure 9. Kaplan-Meier annual survival distribution for released radio-marked pen-reared Attwater's prairie chickens by area, Texas and young of the year radio-marked wild greater prairie chickens northwestern, Minnesota 2008. From Pratt (2010).

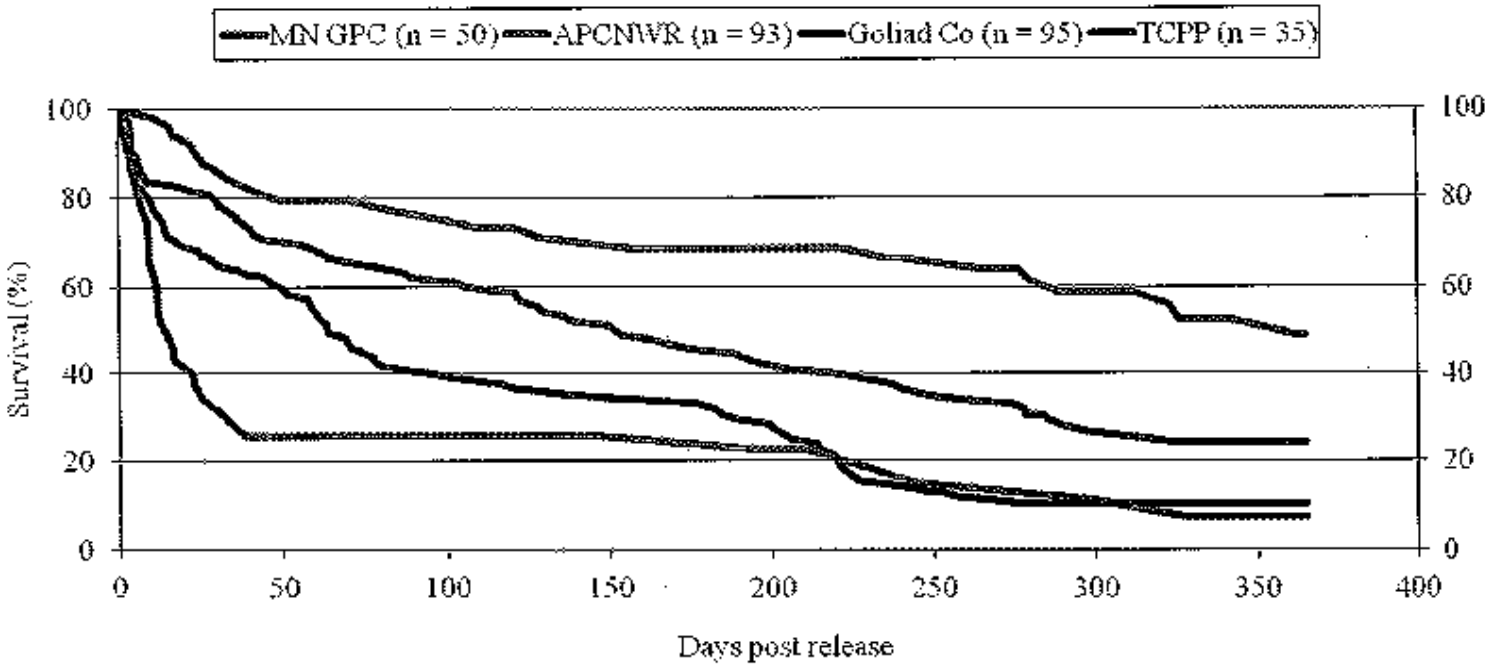

Figure 10. Kaplan-Meier annual survival distribution for released radio-marked pen-reared Attwater's prairie chickens by area, Texas and radio-marked young of the year wild greater prairie chickens northwestern, Minnesota 2009. From Pratt (2010).

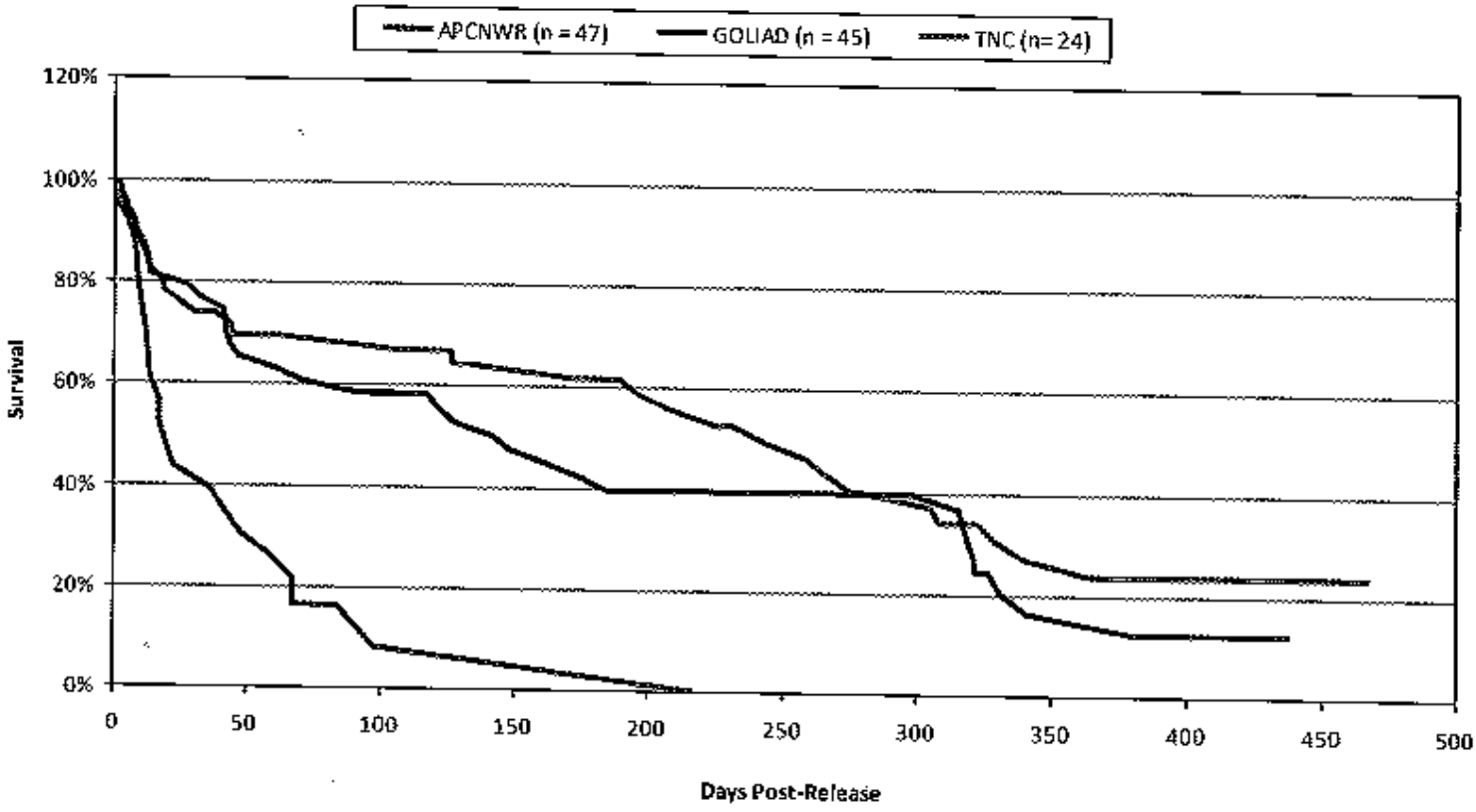

Figure 11. Kaplan-Meier annual survival distribution for released radio-marked pen-reared Attwater's prairie chickens by area, Texas, 2010. Graph provided by Dr. Mike Morrow, USFWS.

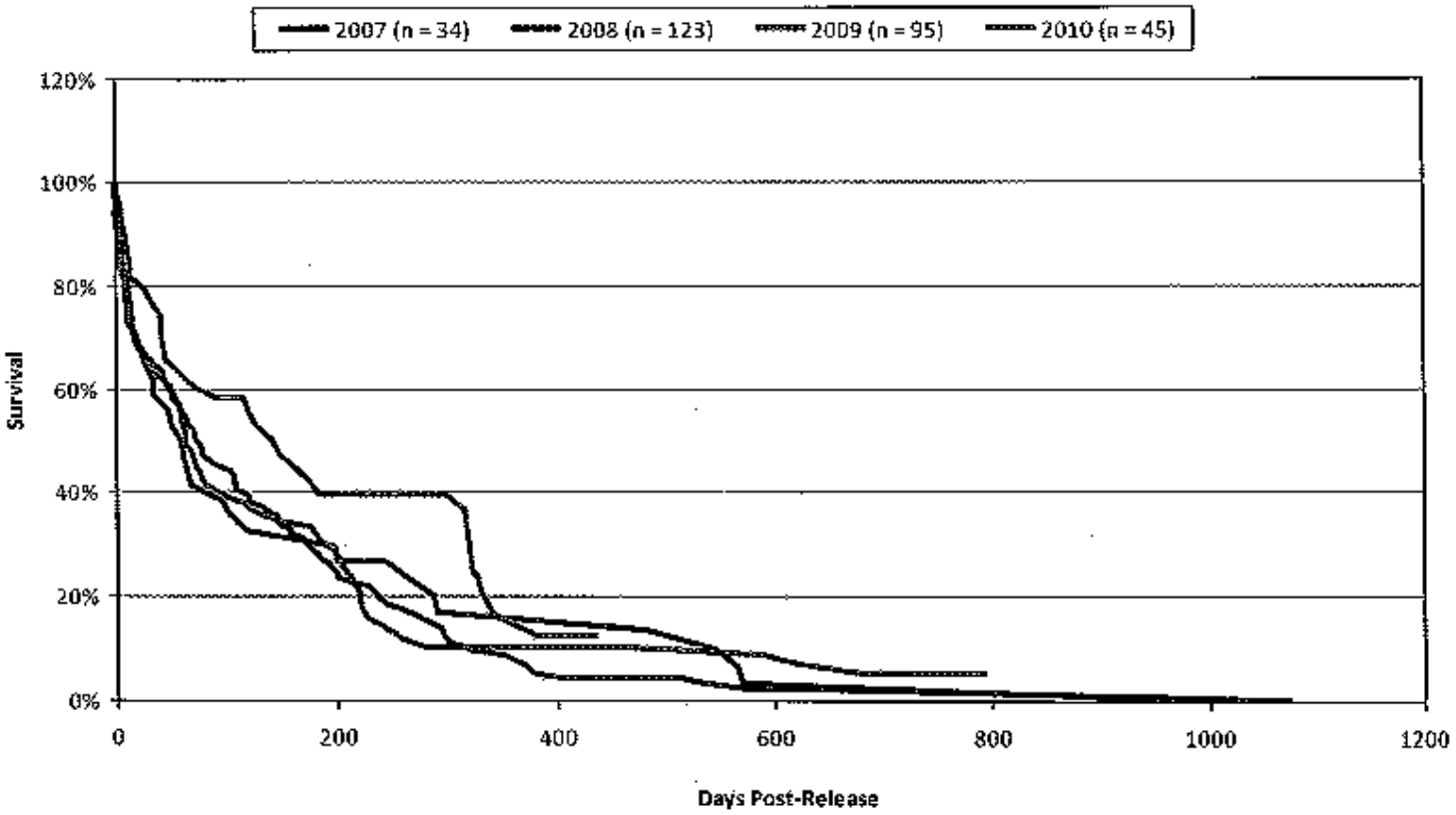

Figure 12. Kaplan-Meier annual survival distribution by year for pen-reared radio-marked Attwater's prairie chickens released in Goliad County, Texas by year, 2007-2010. Graph provided by Dr. Mike Morrow, USFWS.

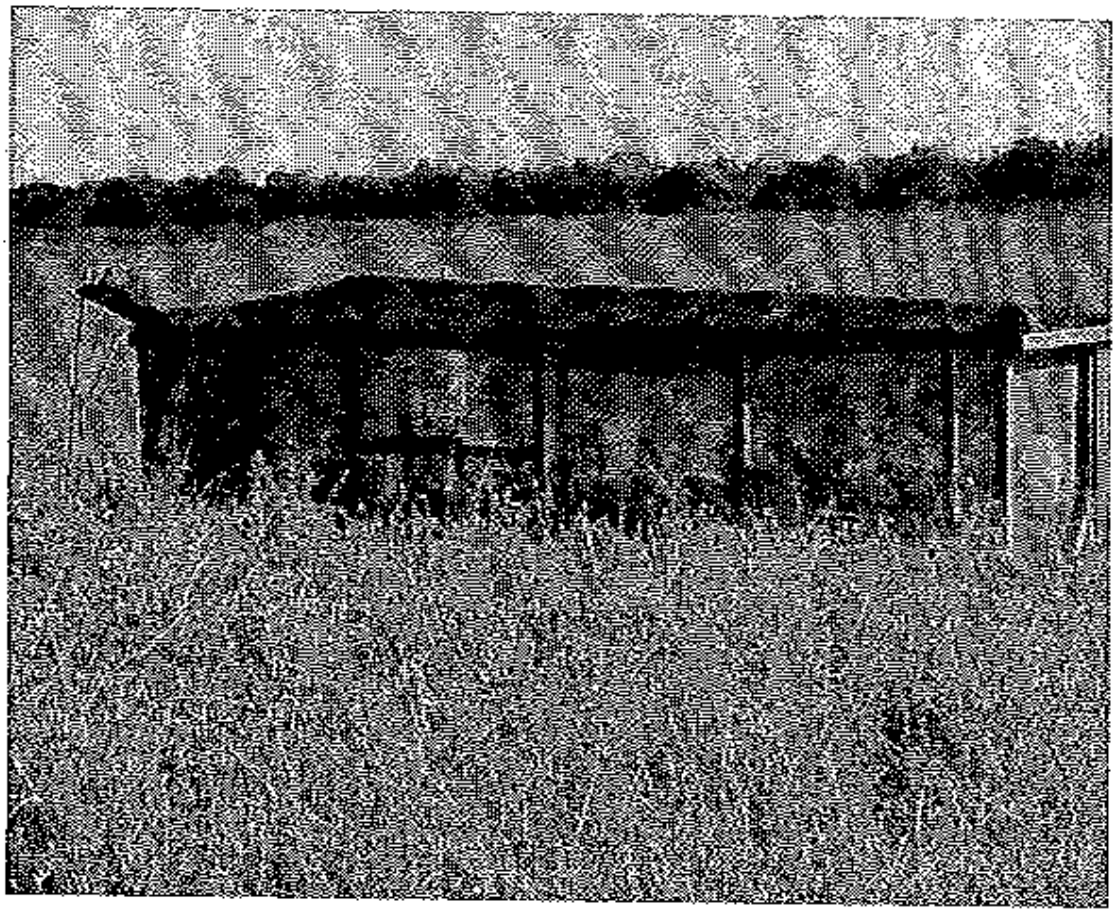

Figure 13. Brood box used to confine a radio-marked pen-reared hen and brood hatched in wild for two weeks to increase survival and determine if feeding brood and hen insects could increase survival for 14 days post hatch. Box is placed over hen and brood at night. Box and protocol developed by Mike Morrow, USFWS.

Figure 14. Five week old radio-marked wild greater prairie chickens radio-marked and ready for release in northwestern Minnesota, 2010.

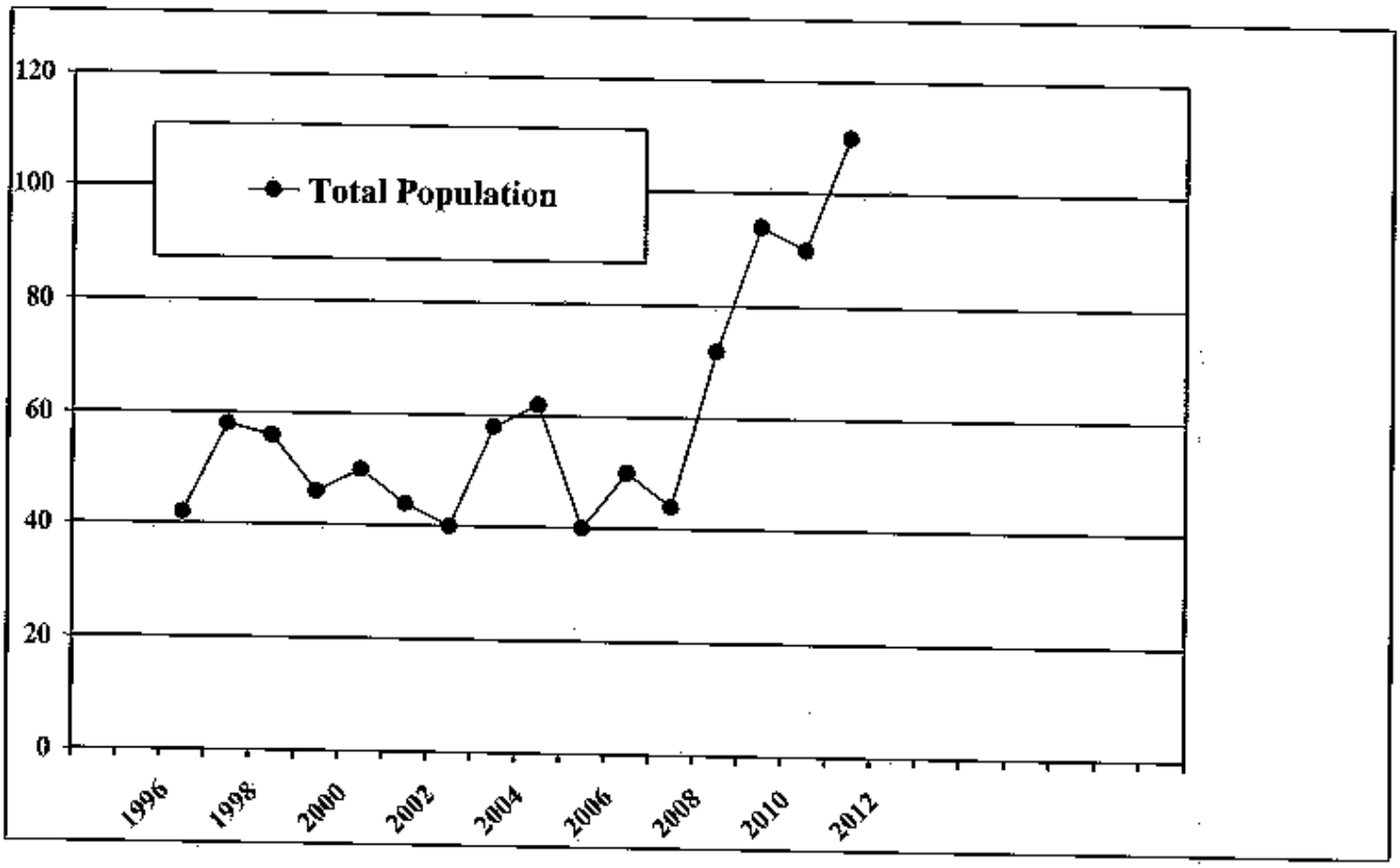

Figure 15. Attwater's prairie chicken population trends, Texas 1996-2011. Data provided by Dr. Mike Morrow, USFWS.

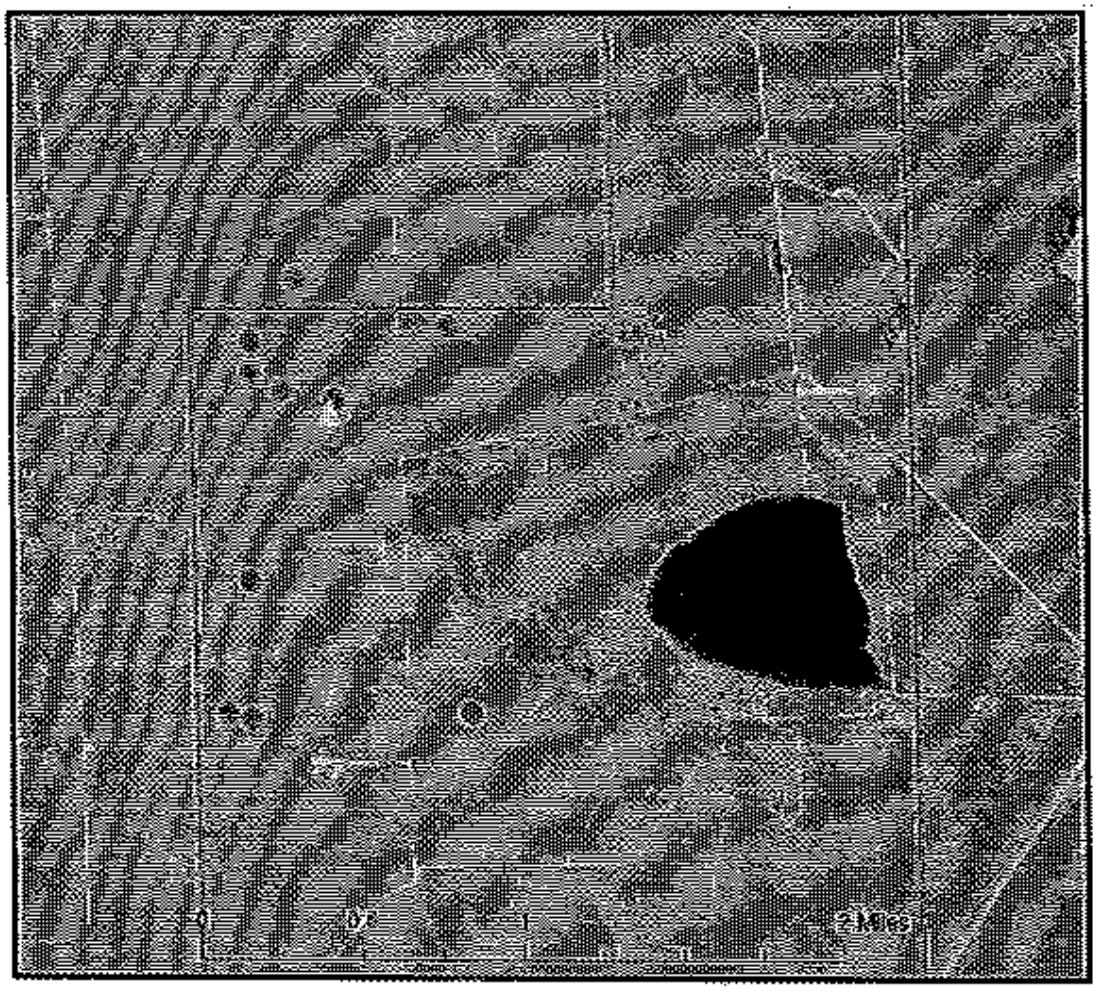

Figure 16. Nest (red), release pens (green) and booming ground (yellow) locations Papalote Ranch (ranch boundary blue line) near Goliad in Goliad County, Texas, 2009. Map provided by Aaron Pratt.

Table 1. Number of pen-reared Attwater's prairie chickens released by year and area, Texas, 2007-2011.

YEAR	APCNWR	TCCP	GOLIAD COUNTY	TOTAL
2007	95	25	55	175
2008	123	31	132	286
2009	110	35	95	240
2010	56	28	45	129
2011	72	0	72	144
Total	456	119	399	974

Table 2. Nest success (%) by area for radio-marked Attwater's and greater prairie chickens, 2008-2011. Number of nests in parentheses. Percentages rounded to nearest whole. number.

YEAR	APCNWR	TCPP	GOLIAD COUNTY	TOTAL APC	NORTHWESTERN MINNESOTA
2008	72 (18)	67 (3)	70 (8)	72 (29)	57 (101)
2009	76 (25)	0 (5)	71 (14)	66 (44)	50 (121)
2010	96 (24)	100 (4)	50 (10)	84 (38)	50 (119)
2011	80 (20)	50 (2)	71 (7)	69 (29)	44 (92)
TOTAL	82 (87)	50 (14)	67 (39)	74 (140)	51 (433)

Table 3. Comparison of annual and post release survival (%) to following spring for radio-marked pen-reared Attwater's prairie chickens (release to March 1) by area with annual and autumn (September 1) to spring (April 1) survival of radio-marked young of the year greater prairie in northwestern Minnesota, 2007-2011. Number of birds in parentheses. Percentages rounded to nearest whole number.

Year	Post Release Pen-Reared APC (to 1 March)	Autumn-Spring Young Year GPC (15 Sept to 1April)	Annual Pen-reared APC (Yearling plus)[a]	Annual Young Year GPC (15 Sept to 15 Sept)
2007-2008				
APCNWR	42(94)		–	
Goliad	32(34)		–	
TCPP	12(26)		–	
Mean	29		–	
Total		68(19/28)		50(14/28)
2008-2009				
APCNWR	36(110)		73(11)	
Goliad	26(123)			
TCPP	8 (24)		33 (3)	
Mean	23		53(14)	
Total		64(28/44)		39(17/44)
2009-2010				
APCNWR	43(93)		23(29)	
Goliad	28(95)		33 (6)	
TCPP	17(35)		50 (4)	
Mean	29		35(39)	
Total		62(31/50)		38(19/50)
2010-2011				
APCNWR	47(47)		63(28)	
Goliad	38(45)		30 (6)	
TCPP	4(24)		75 (5)	
Mean	22		56(39)	
Total		62(26/42)		43(18/42)
Total		64(104/164)		42(68/164)
Mean	28(12)	64 (4)	48 (8)	43 (4)

[a] Includes yearling wild produced (wild/ head start) and relcased birds that survived > 1 year post release.

Table 4. A comparison of annual and post release survival (%) to the following spring for radio-marked pen-reared Attwater's prairie chickens (release March 1) with yearling and older Attwater's prairie chickens at APCNWR with radio-marked young of the year wild radio-marked greater prairie chickens (15 September to 1 April) in northwestern Minnesota, 2007-2011. Number of birds in parentheses. Percentages rounded to nearest whole number.

	Post Release Pen-reared Attwater's Prairie Chickens (to 1 March	Autumn to Spring "Post Release" Young of the Year Greater Prairie Chickens (15-September-1 April)	Annual Pen-reared Attwater's Prairie Chickens (Yearling +)[a]	Annual Young of the Year Greater Prairie Chickens (15 Sept to 15 Sept)
YEAR				
2007-2008	42 (94)	68 (19/28)	NA	52 (14/27)
2008-2009	36(110)	64 (28/44)	73 (11)	39 (17/44)
2009-2010	43 (93)	62 (31/50)	23 (29)	38 (19/50)
2010-2011	47 (47)	62 (26/42)	63 (28)	43 (18/42)
TOTAL	42(344)	64 (104/164)	48 (68)	42 (68/163)
MEAN	42 (4)	65 (4)	53 (3)	43 (4)

[a] Includes yearling wild produced (wild/ head start) and released birds that survived > 1 year post release.

Table 5. Radio-marked Attwater's and greater prairie chicken brood survival to two weeks of age by area Texas, 2003-2011 and northwestern Minnesota, 2008-2011. Number of broods in parentheses. Percentages rounded to whole numbers.

YEAR	APCNWR	GOLIAD COUNTY	TOTAL[a]	NORTHWESTERN MINNESOTA
2003-2008	0 (0/16)	0 (0/6)	3 (1/31)	58 (35/60)
2009	38 (3/8)	20 (2/10)	28 (5/18)	70 (43/61)
2010	63 (10/16)	20 (1/5)	44 (11/25)	67 (37/55)
2011	17 (2/12)	0 (0/5)	17 ((3/18)	62 (24/42)
Total	29 (15/52)	12 (3/26)	22 (20/92)	64 (139/218)
Total 2009-11	42 (15/36)	15 (3/20)	31 (19/61)	66 (104/158)

[a] Includes the Texas City Prairie Preserve, Galveston County, Texas.

Table 6. Attwater's prairie chicken population by area in Texas, 2007-11.

YEAR	APCNWR	TCCP	GOLIAD COUNTY	TOTAL
2007	38	6	0	44
2008	52	4	16	72
2009	50	4	40	94
2010	62	6	22	90
2011	82	2	26	110