



International Crane Foundation

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May 9, 2011

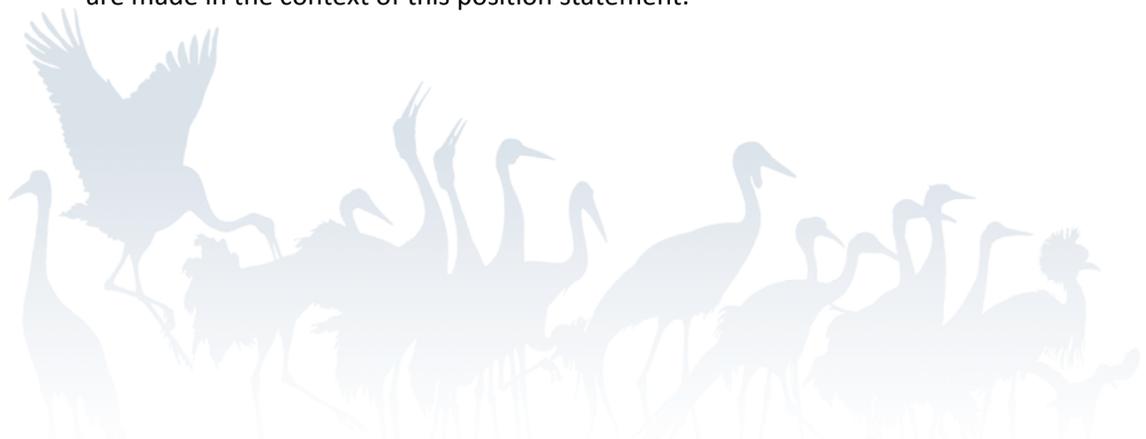
David Roemer
Kentucky Coalition for Sandhill Cranes
294 Drakes Creek Dr.
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Dear David:

Thank you for your inquiry about the Sandhill Crane hunting season proposed by the Commonwealth of Kentucky. Much as I have written for the Kentucky Ornithological Society, I have examined the Commonwealth of Kentucky's proposal and provide a review of it, based on the available scientific data. This review represents the professional judgment of the International Crane Foundation, based on the data discussed with this letter. Since much of the Commonwealth of Kentucky's proposal to open a hunting season on Sandhill Cranes is based on information and assumptions from the Management Plan for the Eastern Population of Sandhill Cranes, I am also sharing comments on that plan. This review, related to the Management Plan, has been expanded since ICF originally commented on the plan 26 months ago. Though the Flyway Council has seen many of these concerns, they have not responded to them.

Importantly, my comments here are restricted to the impacts related to the Commonwealth of Kentucky's proposal on hunting Sandhill Cranes only. ICF is a partner to the Whooping Crane Eastern Partnership (WCEP) and WCEP will comment on Whooping Crane related aspects of the Commonwealth of Kentucky's hunting proposal; ICF will support the response made by WCEP. Joan Garland (jgarland@savingcranes.org) and Joel Trick (joel_trick@fws.gov) are the contact people for the WCEP response.

Finally, since our comments on a similar proposal put forward by the state of Tennessee were construed as ICF taking a stand on the hunting issue, ICF's position statement on crane hunting is included here. The comments for your specific query are made in the context of this position statement:



The International Crane Foundation does not endorse or oppose Sandhill Crane hunting in North America. We recognize the role of regulated hunting in current wildlife population management practices, and the importance of hunting traditions to communities, not just on this continent, but globally. We maintain three strong positions relative to crane hunting. First, the cranes need help from everyone – including hunters, wildlife enthusiasts, farmers, and other landowners – to conserve wetlands that cranes and other waterbirds depend upon for survival. Second, any decisions about hunting should be based on the best scientific information available. Third, it is crucial for individuals to participate in public discussions on the subject. As experts in crane biology and as managers of a long term database on an eastern U.S. Sandhill Crane population, our role is to provide biological information and assessment relevant to issues considered by states as they make management decisions, such as hunting or crop damage, on Sandhill Cranes.

Please let me know if you have additional questions or comments and thank you for your participation in the public discussion about this important issue.

Sincerely yours,

A handwritten signature in black ink that reads "Jeb Barzen". The signature is written in a cursive, slightly slanted style.

Jeb Barzen
Director, Field Ecology
International Crane Foundation

Comments specific to the Commonwealth of Kentucky Proposal for a Sandhill Crane Hunting Season

1. Proposed Harvest Rate

No population modeling has yet been done for the Eastern Population of Sandhill Cranes (EP). The harvest rate proposed for the Commonwealth of Kentucky alone could consume a substantial portion of the productivity of the breeding crane population in the Upper Midwest. Data from one study in Wisconsin suggests that, in the last decade an average of one in three nests fledged a chick each year. If this rate of productivity is comparable for the EP as a whole, 1,500 nesting crane territories would be needed to produce the cranes proposed for harvest in Kentucky. In addition, the fledging rate is declining so the reproduction rate seen in most recent years might be more relevant. In 2009 and 2010, approximately one in five nests fledged a chick to migration. Given this 18% fledging to migration rate, a harvest and crippling removal of 480 birds would require 2,800 nests to replace the hunting loss. Whether 1500 or 2800 nests, this represents a significant percentage of nesting pairs in Wisconsin and Michigan, likely the primary breeding areas for Sandhill Cranes that migrate through Kentucky (see #3 below).

Recruitment rates for a population of color-marked Sandhill Cranes, 1993-2010 (18 years), averaged 0.42 chicks surviving to fall migration per territory (Table 1). For the past decade the average was lower, 0.32 chicks fledged to migration per year. The trend in productivity rates has been declining each year (Figure 1) and this rate in 2009 and 2010 was 18 and 17% (Table 1) respectively or less than one chick fledged to migration out of every five nests.

Following the harvest strategy proposed for the EP, a 50% harvest rate and a 20% crippling rate is assumed (Van Horn et al. 2010). The Commonwealth of Kentucky proposal asks for up to 400 cranes to be harvested so 400 cranes could be retrieved and an additional 80 cranes would be killed or crippled and not retrieved under the assumptions of the management plan. Based on productivity over the last 10 years, the number of territories needed to produce 480 cranes harvested or crippled would be 1,500 ($480 \times 1/0.32$). If productivity rates stay as low as they have in recent years (17%, Figure 1), or decline further, the number of nests might, at a minimum, have to exceed 2,824 nests ($480 \times 1/0.17$).

The number of breeding territories estimated for the state of Wisconsin (from breeding bird atlas data) was 3,000-4,000 in 2001 (Etter-Hale 2006). In addition, recruitment rates provided here estimate survivorship up to the beginning of fall migration only. As such these recruitment rates over-estimate productivity because as much as 7% additional chick mortality occurs during migration and winter (Hayes and Barzen 2006). Exactly how much of this 7% mortality would be compensatory with hunting mortality is unknown.

2. Harvest parameters:

Many parts of the harvest parameters in the proposal for the Commonwealth of Kentucky are appropriate and should result in a harvest that can be monitored and adapted for optimal population management.

a. Season dates

The proposed later season dates are good because they will improve the harvest of birds that primarily winter in Kentucky as opposed to birds that are migrating through. Winter distribution data of Sandhills from one breeding area in south central Wisconsin (Figure 3) demonstrate that,

once on winter areas, considerable mixing of breeding birds from different geographic areas occurs. Harvest of birds on winter grounds therefore reduces the chance of disproportionate harvest of any one breeding population. The one exception to this supposition would be birds from Ohio (see #3 below).

b. Mandatory hunter post-season survey

Having a mandatory post-season survey response from hunters participating in a Sandhill Crane harvest is a good tool to obtain better harvest information. Ultimately, better data will improve any harvest program.

c. Hunter bird identification course requirements

Requiring waterbird I.D. courses for hunters is also a good idea to reduce misidentification of birds by hunters.

d. Closure based on number of birds harvested

Having the ability to close the season whenever the harvest quota is reached is an excellent idea. It is also good that the proposal targets a number that is lower than the maximum harvest allowed so that crippling rates and lags between season closure and cessation of hunting do not exceed limits.

e. Closure of refuge areas

It is good to designate refuge areas where hunting of crane will not be allowed, but more detail needs to be considered on how large these areas will be and how cranes currently use habitats within the closed areas. Without these data it is hard to evaluate how effective the refuges might be. For example, will closure boundaries allow cranes to forage extensively within a refuge area or does that area only include roosting areas? If foraging areas are included within the refuge area are they likely to be used by the whole population using the roost? What is the habitat composition located within the refuge boundaries and how close are these habitats to night roost areas?

3. Source of harvested birds

Data about the origins of birds that would be harvested in Kentucky are incomplete. Without knowing more about how birds from various nesting areas mix on migration and in winter it is difficult to prevent a disproportional harvest of birds from specific breeding areas. For example birds that summer in Ohio, a group of birds that are listed as endangered in the state, could be vulnerable to being disproportionately harvested if hunting occurs too early in the winter season. Support for banding and monitoring the hunted population will be important to implementation of a sustainable hunting plan in the EP.

Banding data suggest that cranes breeding in Minnesota, Wisconsin, southern Ontario and Michigan pass through or winter in Kentucky or Tennessee (Figure 4). Better banded bird resighting data are available from Wisconsin breeding birds (Figure 3) and suggest the same trend. During late fall, birds that summer in Ohio also appear to move through Kentucky primarily in early December (Sherman 2011). It is as yet unclear where birds from the northeastern part of the U.S. mix with cranes flying south from the upper Midwest.

Harvest of birds late in migration is a good strategy to avoid over-harvest of cranes in Kentucky from any one regional summer area and also to minimize disruption of their migratory rhythms. From a current study of birds banded in Ohio (Sherman 2011), a harvest that does not begin until after December 15 and concludes before March 1 will likely avoid harvest from this small but increasing population. Note, however, that Ohio data are based on a very small sample size and that breeding birds in southern Wisconsin tend to migrate later in fall than do non-breeding birds (ICF unpubl. data). This is one reason

why relatively large numbers of cranes are counted during Christmas Bird Counts in northern states during late December (Figure 3).

4. Public input

The proposal does not include details about the degree of public participation that will be sought in the decision regarding if and how to hunt cranes. Public input to the EP management plan was not extensive because public participation was to be considered by the individual states in their proposal processes. Therefore, it is very important that the Commonwealth of Kentucky provide adequate opportunity for the public, both KY citizens and those from other states who share the EP Sandhill resource, to have input on the proposal.

Two proposals have been submitted for hunting cranes in 2010 and 2011. In Minnesota, a sub-population of Greater Sandhill Cranes that is not a part of the EP was proposed for harvest in 2010 and the harvest was implemented in fall, 2010. Minnesota did not provide for public participation arguing that public participation had occurred at the federal level and was thus not needed at the state level. The State of Tennessee created a hunting proposal in 2010 and in early 2011 postponed a decision on that proposal. Part of the reason for the postponement was the need for further input and consideration of information from the public, including public from other states and provinces who share the EP.

The conservation of wetlands that cranes and other waterbird species depend upon requires the support of the diverse constituency that owns those wetlands (Harris and Archibald 1999). Agricultural producers, hunters, bird-watchers, other private landowners, and government agencies all own or control wetlands in the eastern U.S. In Wisconsin volunteers counted 2,159 pairs during the annual Midwest Crane Count in 2007 (the latest year where we have analyzed crane count data). Of these pairs, 607 (28%) were on sites that had a significant amount of public lands within the site monitored. The remaining 72% of the pairs used wetlands and adjoining uplands that were predominantly privately owned. How the public perceives important decisions about a species that is representative of wetlands in the Midwest is therefore of great importance. It is important, therefore, to make sure that discussion of hunting includes dialogue and input from the full constituency of people who engage with this resource.

Comments specific to the Management Plan for the EP Sandhill Cranes

1. Population indices

The fall population survey, upon which population management plan goals were based, did not describe the population size or distribution adequately. Survey effort has been increased since the management plan goals were completed and this appears as a population increase, when, in fact, it represents primarily better survey effort. The discrepancy is noted in the management plan (p. 10 at the bottom of Table 1; Van Horn et al. 2010). Harvest regulations are based on the new population estimates whereas the population goals are based on the survey results before the survey effort was expanded. This leads to the possibility of dramatic overharvest in the EP, reducing the population from the current 60,000 birds to 30,000, a 50% reduction.

The flyway management plan's goal is to manage the EP population at a sustainable population level, but is based on incomplete survey information. Management guidelines were based on population estimates derived from the fall survey that under-estimated significant numbers of cranes up until 2008. After the management goals were developed, a stronger survey effort was implemented, resulting in

the counting of many more cranes as new locations were surveyed. As a result, the population estimate for the EP increased by over 15,000 birds (from 44,110 cranes in 2008 to 59,876 cranes in 2009; Van Horn et al. 2010). This change in numbers was mostly a result of survey effort, not a population increase. Population management goals in the management plan, however, were not adjusted.

Currently, the plan allows the population to fall as low 30,000 before reducing harvest rates. A population size of 30,000 birds in the EP has not been seen since the early 1990's (Van Horn et al. 2010). If the present population estimate of 60,000 birds, derived from expanded survey effort, is used the population would have to drop by 50% before harvest regulations would be altered. It would be difficult to argue that allowing a halving of the population is a sustainable harvest strategy and public acceptance of such a population decline is not likely.

We would instead suggest that: a) continue to gain a better idea of the current population size by conducting an improved fall survey for 2-3 years, including the Atlantic Flyway states where nesting cranes occur. b) Once surveys are established as an appropriate index, and total population goals are set, establish the objective for the plan as sustaining the population at plus or minus 10% of that figure. In this scenario, other management measures align better. For example, hunting closure might go into effect at a 20% reduction from the current population size (If the improved three-year index showed 50,000 birds currently, that would mean a reduced harvest or closure should occur at 40,000). In the interest of attempting to serve very diverse interests, it is far easier to set the management plan's goal as sustaining the current population size than it would be to have the plan aim to reduce the population substantially.

2. What EP population levels are desired and appropriate?

In the management plan there appears to have been little direct consideration as to what population goal is desired and appropriate for this population. On what basis was the goal of 30,000 birds set as a minimum? Or 60,000 birds as a maximum?

Harvest regulations were developed assuming that the population size, as it existed at the time the management plan was developed, was large enough and that population size should serve as the management goal. For states or provinces that are interested in expanding crane distribution in their areas (primarily states in Ohio, New York, Pennsylvania, the northeastern states or provinces in the Maritimes, Figure 1) higher population numbers may be desired. Little attempt to contact individual states for input on desired population size, especially in the Atlantic Flyway, was made. Concern was expressed about excessive Sandhill Crane numbers occurring in some areas. Large crane numbers were, in turn, being linked to crop damage (for instance in Tennessee) but this linkage was not defined sufficiently to be the primary reason for not ignoring states/provinces interests in having populations increase in their area (see # 6 below).

3. Lack of analysis with existing data.

No population modeling for the EP has yet been done. Data from one study in Wisconsin suggests that, in the last decade an average of one in three territories fledged a chick each year. In addition, the fledging rate has declined significantly over time. In 2009 and 2010 respectively the study population fledged 0.18 chicks and 0.17 chicks per territory to migration. A harvest rate of 10% may be too high for the EP and should be assessed using data specific for the EP before it is applied. In addition, there are biases associated with extrapolating rates of harvest from the Mid-continent Population (MCP), which is 10 times larger than the EP. Small changes in harvest rates and harvest behavior can have a relatively larger impact on the smaller EP population. A sustainable harvest is

possible with the EP but the primary question is: If a harvest occurs, at what rate should birds be harvested and is this the best use of this particular resource?

It is unknown if the declining productivity rate observed for south central Wisconsin is a density dependent response or is a result of some other phenomenon. If density-dependent, increasing the mortality might actually cause productivity rates to increase but this hypothesis has no available data to test it. There is evidence for significant variation in recruitment rates regionally: In Ohio, Sherman (2011, unpubl.) reports 19 chicks fledged from 23 pairs in 2008, 23 chicks fledged from 19 pairs in 2009, and 36 young fledged from 25 pairs in 2010. In contrast, productivity from another pioneering breeding population in New York has very low productivity where only one chick has fledged from 4-5 pairs since 2003 (per. comm. with Bob Spahn). If there are significant factors causing mortality of chicks in pioneering breeding populations, then hunting mortality could be additive to the population. A 10% harvest rate, coupled with a 7% mortality after chicks leave in fall migration, might result in overall mortality rates equal or exceeding recruitment, leading to a population decline.

The overall MCP was estimated at 605,957 birds in 2009 (Kruse et al. 2010). Original harvest rates for the MCP were based on determining percentages of young in the population seen on staging or winter areas. Accurate surveys estimating the proportion of young in the EP, however, have not been done. Further, the degree of precision used in estimating population size of the MCP, which is approximately an order of magnitude larger than the EP, is much lower. The 95% confidence limits on the corrected MCP were larger than 100,000 birds (Kruse et al. 2009) as compared to a population estimate of 60,000 cranes in the entire EP (Van Horn et al. 2010). Transferring harvest information between populations of such different size is difficult to accomplish without significant distortion.

Before any hunting season should be considered, the population of the EP should be modeled. Existing data should be used to generate these estimates. First, what will this population, with known recruitment rates, do under proposed harvest rates? Will it still expand? Will it decline or be stable? This type of population analysis should be central to a sustainable harvest program so that key parameters such as harvest size, number of permits to be issued, response to observed population or distribution changes after a hunt were initiated, can be determined. Though current analysis is insufficient, it is likely that a sustainable harvest is possible.

4. Assumptions for the MCP and EP

The assumption that harvest conditions for the MCP of Sandhill Cranes are comparable to the EP is untested. The management plan states that harvest strategies and conditions of these two populations should be comparable but insufficient data are presented to indicate why this would be true.

Some factors suggest that these two populations are not comparable:

- a) Sandhill Cranes in the EP are much more concentrated on fall staging and winter areas than Sandhills are in the MCP. Both Jasper-Pulaski and Hiwassee can concentrate 1/3 to 1/2 of the EP at one time (Figure 3). In fall, there is no similar concentration of this proportion in the MCP; concentrations of Sandhill Cranes along the Platte River occur primarily in the spring. Large concentrations of birds during hunting seasons requires more careful planning as area closures would be required to mitigate additional vulnerability of birds to harvest in areas where birds are concentrated. The Commonwealth of Kentucky has taken this point into consideration in their hunting proposal but other states, such as Tennessee, did not.

- b) Impact of the hunting season may also be much greater to the migration ecology of the cranes in situations where they are concentrated in the EP as compared to the MCP. There are few data available regarding this question but it is likely that hunting seasons may cause birds to spend less time wintering as far north as they do now (Figure 3). The cranes have recently wintered further north in Tennessee and Kentucky because of food availability and, if hunting decreases access to that food, use of these northern states by wintering birds might then decrease. Concentrating the wintering population further south may cause crowding of cranes in southern states

5. Source of Harvested Birds

Data are poor regarding the origins of birds that would be on winter areas where they are hunted. Without knowing more about how birds from various nesting areas mix on migration and in winter it is difficult to prevent a disproportional harvest of birds from specific breeding areas.

Hunting mortality for birds breeding in Wisconsin (where we have extensive data - Figure 3), Minnesota, Ontario and Michigan (where we have few data – Figure 4) may be disproportionately high for birds harvested from Indiana, Kentucky or Tennessee. Harvested birds in Georgia and Florida, on the other hand are more likely to contain a full mixing of the EP. Ohio birds could be disproportionately harvested in Kentucky but less so elsewhere (Sherman 2011). As long as seasons in Kentucky do not begin before December 15 and end before February 28, breeding birds from Ohio should have little chance of being killed from hunting (Sherman 2011). More data on this aspect of bird movements, especially from birds breeding in the northeast, is needed. The EP management plan did not consider movement patterns by Sandhill Cranes when formulating harvest strategies.

6. Crop Damage

Hunting is often proposed to solve conflicts between cranes and agriculture, specifically to control crop damage. No study, however, has documented a situation where hunting has prevented crop damage caused by cranes. In addition, no comparison of the costs and benefits of various crop damage solutions has been done, so it is difficult to compare hunting as a solution to crop damage with alternatives. Hunting, however, can have an impact on attitudes about crop damage. As soon as cranes are hunted, pressure will grow to use funds from hunting licenses to pay for crop damage that occurs in the areas occupied by the EP. Can the revenues raised through hunting fees provide sufficient funds for damage compensation? How will hunting, one management issue in the EP management plan, affect crop damage, another important issue identified in the plan?

The management plan for the EP should fully address all the issues facing the EP. Instead, it extensively investigates hunting issues but does not evaluate other issues such as crop damage sufficiently. Importantly, the interaction among different management options is not explored. What are the comprehensive costs and benefits of a crane harvest vs. no harvest option? Though difficult to assess, crop damage issues are often raised as an additional reason for why a crane hunt should be implemented and this argument should be addressed. Will hunting solve crop damage issues effectively? At what cost? Will states acquire liability for crop damage once the population is hunted in their state, especially if one reason for the hunt is to reduce crop damage? How will the costs of crop damage abatement compare to income derived from the expected hunting licenses to be sold?

Hunting has been identified or implied as a solution for crop damage issues in Tennessee and elsewhere. The Commonwealth of Kentucky has not raised this issue in their proposal. No examples, however, exist that demonstrate hunting is an effective solution to crane-caused crop damage. Alternative, solutions for crane damage to planted seeds (e.g. corn) exist and have been deployed over a broad area at no cost

to conservation organizations (Lacy and Barzen 2009, Schramm et al. 2010). In 2010 over 71,000 acres of corn were effectively treated in Wisconsin, Michigan and Minnesota alone (ICF unpubl. data). Planted winter wheat seed should be protected from crane consumption in a similar manner but this crop has not been tested.

A full cost/benefit assessment of hunting and other issues related to Sandhill Cranes would be quite important to understand in view of the current proposals on hunting cranes. For example, USDA estimated \$263,000 in crane damage during 2007 (the most recent year for which an estimate is available) in WI alone and they concede that this is likely an underestimate. In 2010, WI, MI, and MN farmers paid an estimated \$500,000 in deterrent costs through chemical treatment of planted corn. Since cranes are not currently hunted no government money is available to pay for crop damage abatement described above. Currently growers pay abatement costs themselves. Once hunting is initiated, however, this situation may change legally and psychologically. Will income from hunting license fees pay for abatement costs? How much abatement money can be raised from the sale of permits and how does this income compare to the expected costs? Will growers demand support and how will government agencies reply? Further conflict over private landowners and public agencies would reduce the diverse collaboration that is currently building and maintains the broad array of wetlands remaining under private ownership in the eastern U.S. (see comment #4 in the section for the Commonwealth of Kentucky above).

Beyond economics of the hunt and grower attitudes, will hunting of this population reduce the probability of finding a marketplace solution to crop damage issues because it changes who is responsible for paying for the costs of deterrence? Though the answer to these questions may be debatable, they should be raised and addressed within the management plan and state proposals. Information has been brought together to address these questions but it is important to analyze and evaluate the data gathered and this has not been done by any individual state nor in the management plan process to date.

7. Disruption of Sandhill Crane social behavior

Though not specifically discussed in the EP Management Plan, a frequent argument against hunting cranes also appears to be incorrect. Sandhill Cranes are known for forming long-term pair bonds. From this observation people fear that killing one mate of a pair will prevent the surviving adult from breeding in the future. From a study of color-marked cranes we know that adults in a large population (as opposed to a pioneering population) will quickly replace lost mates. So hunting in fall or winter will not likely disrupt the social matrix of breeding Sandhill Cranes significantly.

Sandhill Cranes form long-term pair bonds typical of most crane species (Nesbitt 1989). Some have argued that, because of long-term pair bonds formed, once a mate is lost it will not be replaced. If this were true, the effect of mortality for one breeding adult would effectively be doubled. Even though cranes do form long-term pair bonds, mate switches are frequent (Hayes and Barzen 2011) and a lost mate is quickly replaced by a new mate from an adjacent breeding territory or from the members of the non-breeding flock that co-exist with breeding birds on summer territories (Hayes and Barzen 2006). This dynamic relationship between breeding and non-breeding adult birds in summer areas means that mortality of adult birds due to hunting would not likely cause additional disruption of the social system for Sandhill Cranes.

Though an increase in mortality of breeding birds will not likely affect the overall number of breeding pairs in the EP, productivity rates may decline. On average, productivity is low for 2-3 years following a

mate switch (Hayes and Barzen 2011). Increases in mate switches, caused by mortality of breeding adults could therefore cause a negative pressure on reproduction rates.

The ability to replace mates may be a function of population density. Where populations are pioneering in new areas (such as in Ohio, Pennsylvania, Massachusetts, New York or Nova Scotia) replacement of a mate may take longer and this could reduce these populations' sustainability if hunted.

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Table 1. Survival data for chicks from territories where one or both adults are color-marked. Survival to fledging means to the point where sustained flight is achieved by the chick. Survival to migration is where the chick survives to departure on fall migration. Highlighted estimates include estimates based on samples sizes of over 12 marked, territorial birds.

SUMMARY STATISTICS

YEAR	1990		1991		1993		1994		1995		1996		1997		1998		1999		2000	
Period Measured	Fled	Mig																		
# of Banded Pairs (1 or 2 Adults Banded)	1	1	5	5	13	13	17	17	19	19	26	26	33	32	33	33	37	37	45	45
Total Chicks of Marked Birds	1	1	4	4	8	8	9	9	15	15	16	16	16	14	11	10	26	25	18	15
Productivity (Chicks/Territory) for Marked Birds Only	1.00	1.00	0.80	0.80	0.62	0.62	0.53	0.53	0.79	0.79	0.62	0.62	0.48	0.44	0.33	0.30	0.70	0.68	0.40	0.33

YEAR	2001		2002		2003		2004		2005		2006		2007		2008		2009		2010	
Period Measured	Fled	Mig																		
# of Banded Pairs (1 or 2 Adults Banded)	49	49	45	45	54	54	38	38	55	54	52	51	55	55	59	59	55	55	53	53
Total Chicks of Marked Birds	21	17	17	15	22	22	18	16	18	15	27	20	13	12	28	24	11	10	9	9
Productivity (Chicks/Territory) for Marked Birds Only	0.43	0.35	0.38	0.33	0.41	0.41	0.47	0.42	0.33	0.28	0.52	0.39	0.24	0.22	0.47	0.41	0.20	0.18	0.17	0.17

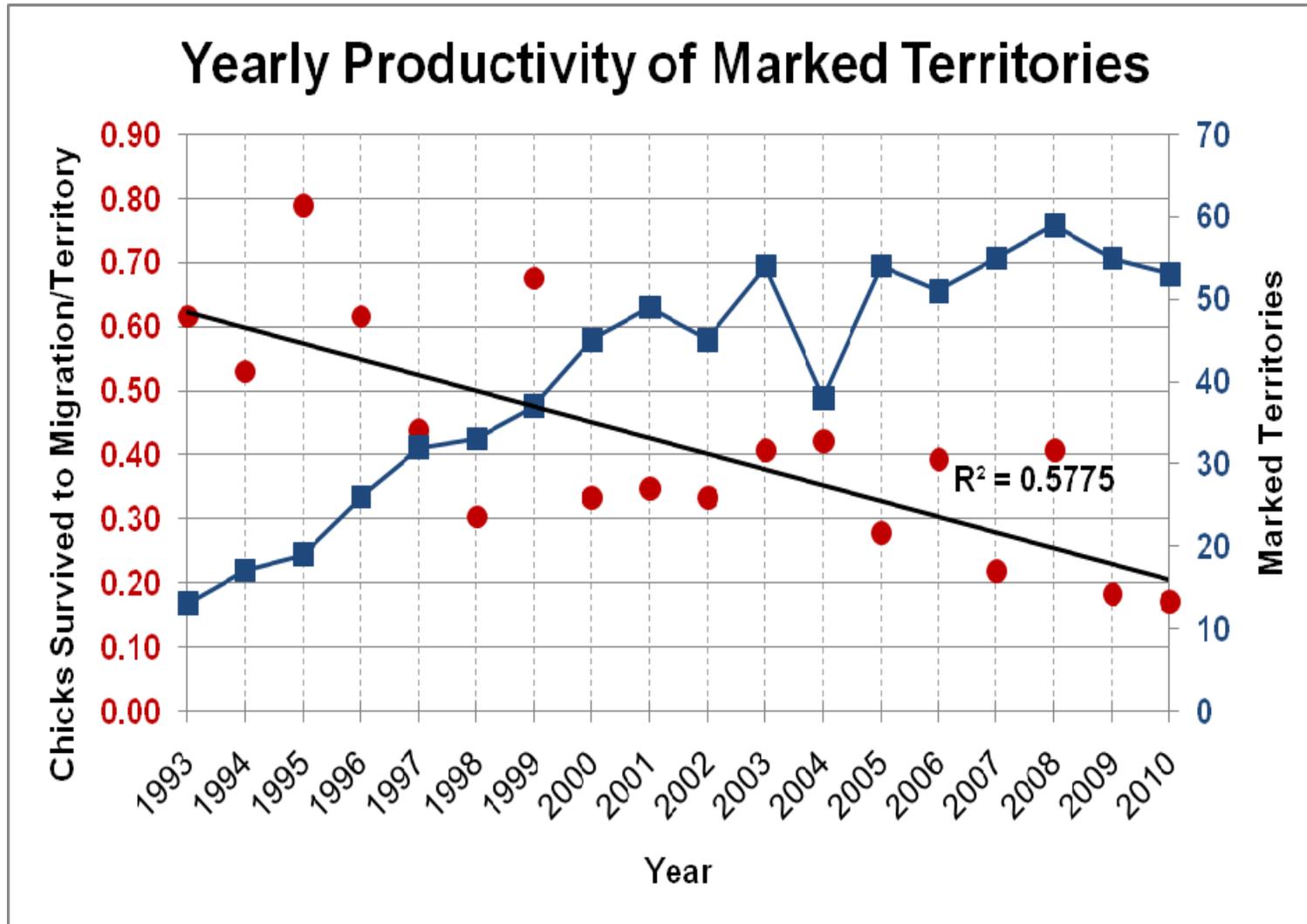


Figure 1. Regression of the number of chicks fledged each year against calendar year (blue) and the number of territories containing at least one marked adult bird (red) upon which this analysis is based. The regression of fledged chicks on calendar year is significant ($P < 0.001$).

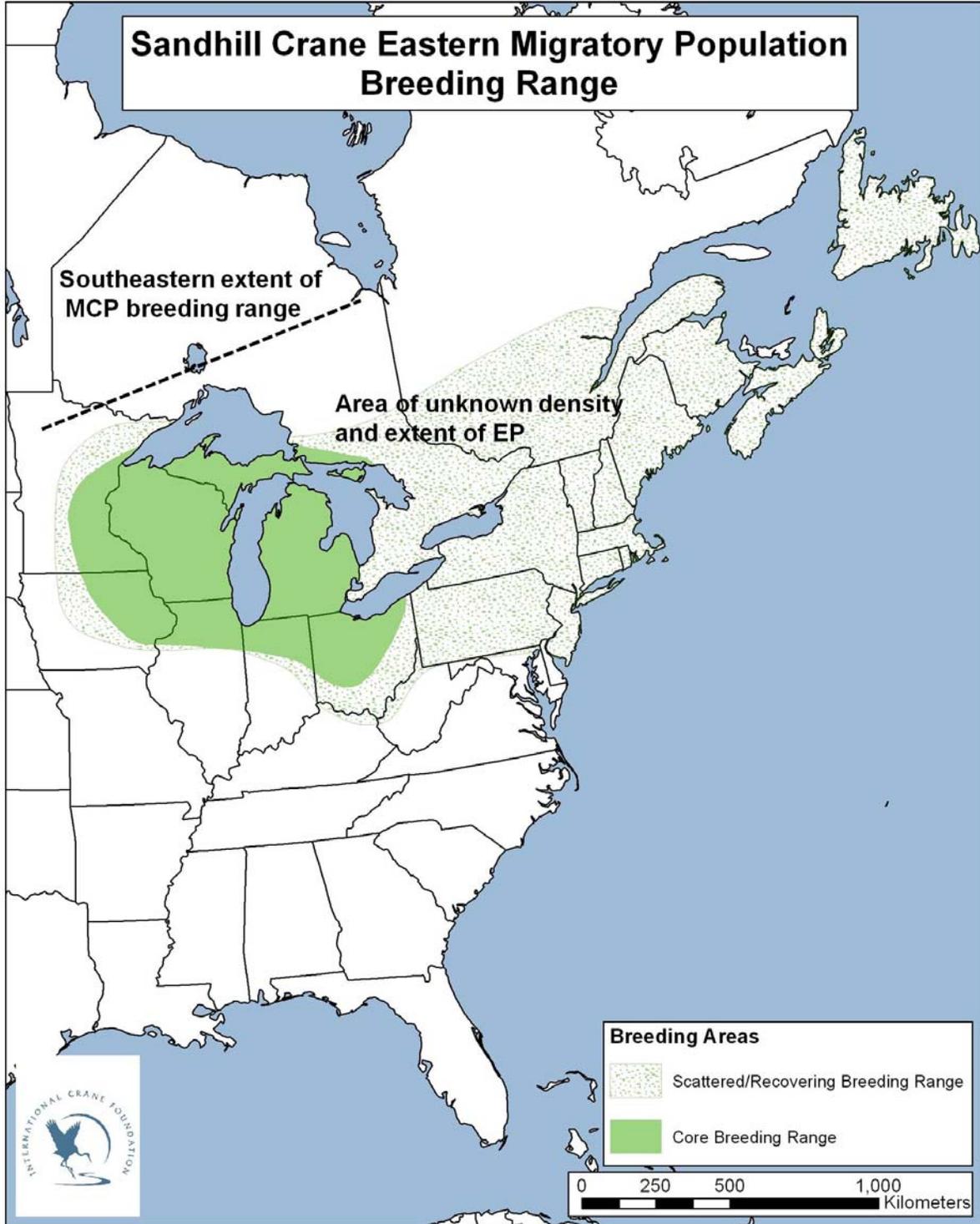


Figure 2. Estimated summer distribution of Sandhill Cranes in the Eastern Population.

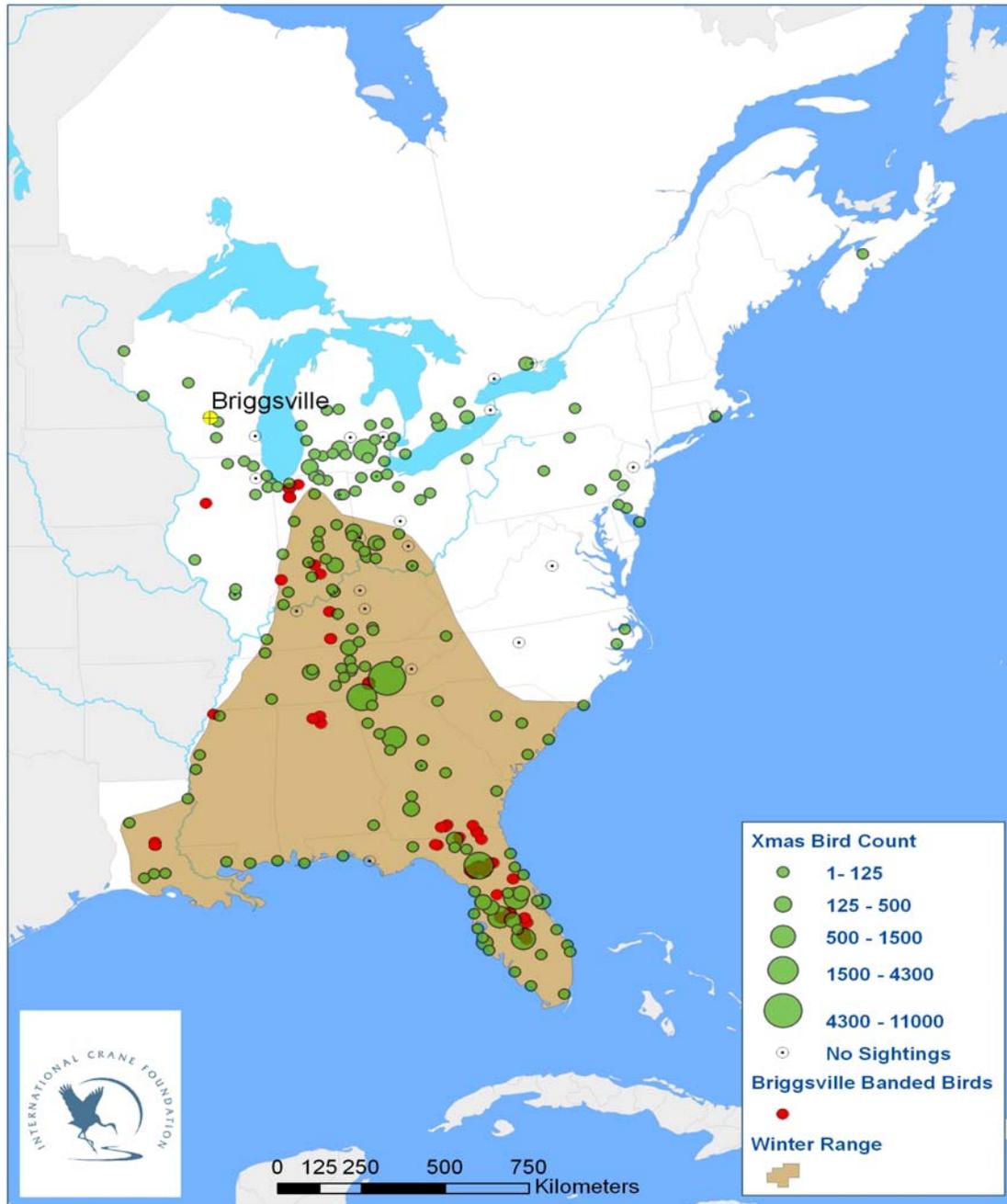


Figure 3. Winter distribution of Greater Sandhill Cranes in the Eastern Population. Count data (green) come from Christmas Bird Counts (CBC, see legend). Sightings of color-marked Sandhill Cranes outside of Wisconsin (red) that were banded on breeding territories located at Briggsville, WI (Yellow). Over 86% of cranes counted in the CBC data are located in the brown areas.



Figure 4. Re-sightings (circles) of cranes color-banded as flightless chicks on breeding territories (stars) outside of the long-term study area in Briggsville, Wisconsin. The color of the symbol matches breeding areas with re-sightings. Black symbols contain re-sightings from more than one breeding area and each breeding area is then listed.