

WISCONSIN WHOOPING CRANE BREEDING SITE ASSESSMENT

Final Report

Ron Sauey Memorial Library
International Crane Foundation
Baraboo, Wisconsin, USA

Submitted To:

The Canadian-United States Whooping Crane Recovery Team

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Contributors To This Report

Dr. Richard Urbanek, crane expert and biologist at Seney National Wildlife Refuge, coordinated the field studies that were conducted in the spring and summer of 1999. The central focus of that work was to conduct comparisons of crane food availability at the top three candidate sites. Dr. Urbanek also coordinated information-gathering on sandhill crane surveys and sandhill crane staging numbers in the top three candidate sites. In addition, Dr. Urbanek assessed the physical hazards to cranes at these sites.

Dr. Julie Langenberg, ICF Veterinarian, coordinated the gathering of information on avian diseases and mortalities at or near the top three candidate whooping crane breeding sites. In this effort, Dr. Langenberg enlisted the assistance of Dr. Kim Miller from the National Wildlife Health Center in Madison, Wisconsin, and Ms. Kerry Beheler, DNR Wildlife Health Specialist.

Ms. Beheler provided information on avian mortalities (reported to DNR) in Wisconsin from 1981 through 1999, and she also developed a compendium of physical and toxic factors affecting trumpeter swans in Wisconsin from 1989 through 1998. In addition, Ms Beheler facilitated the analysis of water quality and contaminants at the top three candidate sites.

Dr. Kathleen Patnode, DNR Wildlife Toxicologist, provided an evaluation of the risks posed to whooping cranes by contaminants in the vicinity of the top three candidate breeding sites.

Mr. Mike Mossman, DNR Wildlife Research Biologist, and Ms. Lisa Hartman, DNR Wildlife Research Biologist, analyzed the entire data set from the Wisconsin trumpeter swan reintroduction program to ensure that the most current information on swan productivity and mortality was available for this report.

Mr. Sumner Matteson, DNR Avian Ecologist, coordinated information-gathering about the trumpeter swan program and provided current data on the 1999 trumpeter swan nesting locations.

Mr. Terry Kohler, Mr. John Kubisiak, Ms. Kelly Maguire, and Ms. Su Lying conducted aerial surveys of sandhill crane nests at some of the top candidate sites.

Ms. Nicole Shutt, Wildlife Biology Intern at Seney National Wildlife Refuge, provided the Geographic-Information-Systems-based maps and graphics of the top three candidate breeding sites.

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Disclaimer

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John R. Cannon, Ph.D.
Principal Investigator
Front Royal, Virginia
September 1999

BACKGROUND

The recovery plans for the whooping crane (*Grus americana*) call for the establishment of two self-sustaining wild populations of cranes in addition to the one natural wild population that migrates between Wood Buffalo National Park in Alberta and the Northwest Territories of Canada and Aransas National Wildlife Refuge in Texas (Edwards et al. 1994; U.S. Fish and Wildlife Service 1994).

Establishment of these additional populations will reduce the likelihood that the species could become extinct in the wild. Additional populations that breed in locations other than Wood Buffalo National Park will provide insurance against the possibility that global climate changes or regional weather cycles (e.g., extended droughts) could make the current wetland breeding grounds unsuitable for crane nesting. Populations using additional wintering areas will provide a hedge against the possibility of catastrophic losses in the current natural wild population due to diseases, hurricanes, or chemical spills in the Intracoastal Waterway along the coast of Texas.

If introduction efforts are successful, the first of these two new populations of whooping cranes will be a non-migratory population currently being established in the Kissimmee Prairie region of Florida. Again, if introduction experiments succeed, the second new population will be a migratory population established in Canada or the northern United States and migrating annually to a suitable wintering area in the southeastern United States.

At the August 1998 meeting of the Whooping Crane Recovery Team, the Team recommended that the new introduced population of migratory whooping cranes should be introduced far enough to the east of the current migration corridor of the Aransas/Wood Buffalo population so that the chances of mixing of the two populations would be minimized. The wintering site recommended was Chassahowitzka National Wildlife Refuge and St. Martin's Marsh Aquatic Preserve on the Gulf coast of Florida. These Recovery Team recommendations reflect Alternative #1 as described in the Whooping Crane Wintering Sites Study: Final Report (Cannon 1998).

The Recovery Team further recommended that the state of Wisconsin be assessed in terms of possible sites that might be appropriate as potential breeding sites for an introduced population of migratory whooping cranes. Dr. George Archibald, a Recovery Team member and Director of the International Crane Foundation, volunteered to seek funding for a Wisconsin Breeding Site Assessment study. Dr. John Cannon, principal investigator for the Whooping Crane Wintering Sites Study, was asked by the Recovery Team to serve as principal investigator for the Wisconsin study.

The Wisconsin Whooping Crane Breeding Site Assessment study began in the fall of 1998 and was completed in September of 1999.

METHODS

The Wisconsin Whooping Crane Breeding Site Assessment study involved the completion of the following major tasks:

- Task 1. Consolidate breeding site selection criteria.
- Task 2. Obtain feedback on site selection criteria.
- Task 3. Contact experts on Wisconsin wetlands and managers of potential breeding sites.
- Task 4. Develop first list of candidate breeding sites.
- Task 5. Obtain feedback on candidate breeding sites, and narrow list to top few candidates.
- Task 6. Collect all available ecological and socio/political data on top few sites.
- Task 7. Collect input from Federal, state, and local officials as well as land owners, land users, and other interested parties.
- Task 8. Conduct site visits and flyovers of top few sites.
- Task 9. Conduct field studies during the spring and summer of 1999.
- Task 10. Analyze and synthesize all available information on top sites.
- Task 11. Draft recommendations to the Whooping Crane Recovery Team on breeding site selection.
- Task 12. Obtain feedback on draft recommendations.
- Task 13. Notify affected officials and site managers of final recommendations.
- Task 14. Develop and submit final study report to Recovery Team.

Brief Description of Project Activities

A thorough review of the whooping crane literature was conducted, and a large number of crane experts was contacted, in order to develop a consolidated set of whooping crane breeding site selection criteria. The draft criteria were circulated among whooping crane experts for review and suggested modifications. The final set of site selection criteria is presented in Appendix 1 to this document.

Extensive contacts were made with state, Federal, and non-governmental wetland and crane experts in the state of Wisconsin to begin the process of generating a first list of possible breeding sites that might meet the site selection criteria that had been established. This contact process culminated in a meeting of experts and other interested parties hosted by the Wisconsin Department of Natural Resources (DNR) in Madison, Wisconsin on November 10, 1998. This meeting was attended by approximately 30 representatives of DNR, the U.S. Fish and Wildlife Service (FWS), the Whooping Crane Recovery Team, the International Crane Foundation (ICF), and the Wisconsin Natural Resources Foundation. After introductions, explanations, and briefings, the major outcome of this meeting was to narrow the focus of the breeding site assessment study to five principal areas:

1. Central Wisconsin Conservation Area (Necedah National Wildlife Refuge [NWR], Sandhill Wildlife Area [WA], Meadow Valley WA, Wood County WA, and surrounding area).
2. Horicon NWR, Horicon Marsh WA, and surrounding area.
3. Crex Meadows, Fish Lake, and Amsterdam Sloughs WAs and surrounding area.
4. Bad River marshes and surrounding area.
5. Navarino WA and surrounding area.

As a result of this November meeting, the principal investigator began working with the site biologists at each of the above-named sites to put together the data that was available from each site that would address the final site selection criteria. [It should be noted at this point that the biologists and managers at each of these sites were extremely cooperative and helpful in seeking out and sharing all of the relevant information that was available concerning how these sites match up against the established site selection criteria.]. Appendix 2 to this report presents summaries of the information provided by each of the above-named sites. These summaries were reviewed and edited by personnel from each site before they were finalized, and there was no attempt to obtain cross-validation of the information provided.

On March 5, 1999, a second meeting of wetland experts, crane experts, and other interested parties was hosted by DNR in Madison. Again, approximately 30 individuals attended the meeting and, after reviewing the information provided by the biologists from the five initial sites (presented in Appendix 2), and thoroughly discussing further information provided by DNR experts, ICF experts, and scientists at the National Wildlife Health Center, the group endorsed the principal investigator's recommendation that all further assessment activities be limited to only three of the original five sites. The primary reason for elimination of the other two sites was that there was not a sufficient amount of shallow wetland habitat in the vicinity of either of those sites to support a potential whooping crane population of approximately 125 birds. The three sites on which the remainder of the assessment activities focused were as follows:

1. Central Wisconsin Conservation Area (Necedah National Wildlife Refuge [NWR], Sandhill Wildlife Area [WA], Meadow Valley WA, Wood County WA, and surrounding area). {Hereinafter called "**Central Wisconsin**"}
2. Horicon NWR, Horicon Marsh WA, and surrounding area. {Hereinafter called "**Horicon Marsh**"}
3. Crex Meadows, Fish Lake, and Amsterdam Sloughs WAs and surrounding area. {Hereinafter called "**Crex Meadows**"}

The map on the following page shows the locations within the state of these three possible whooping crane breeding sites. The three maps following the next page present more details on each of the three sites.

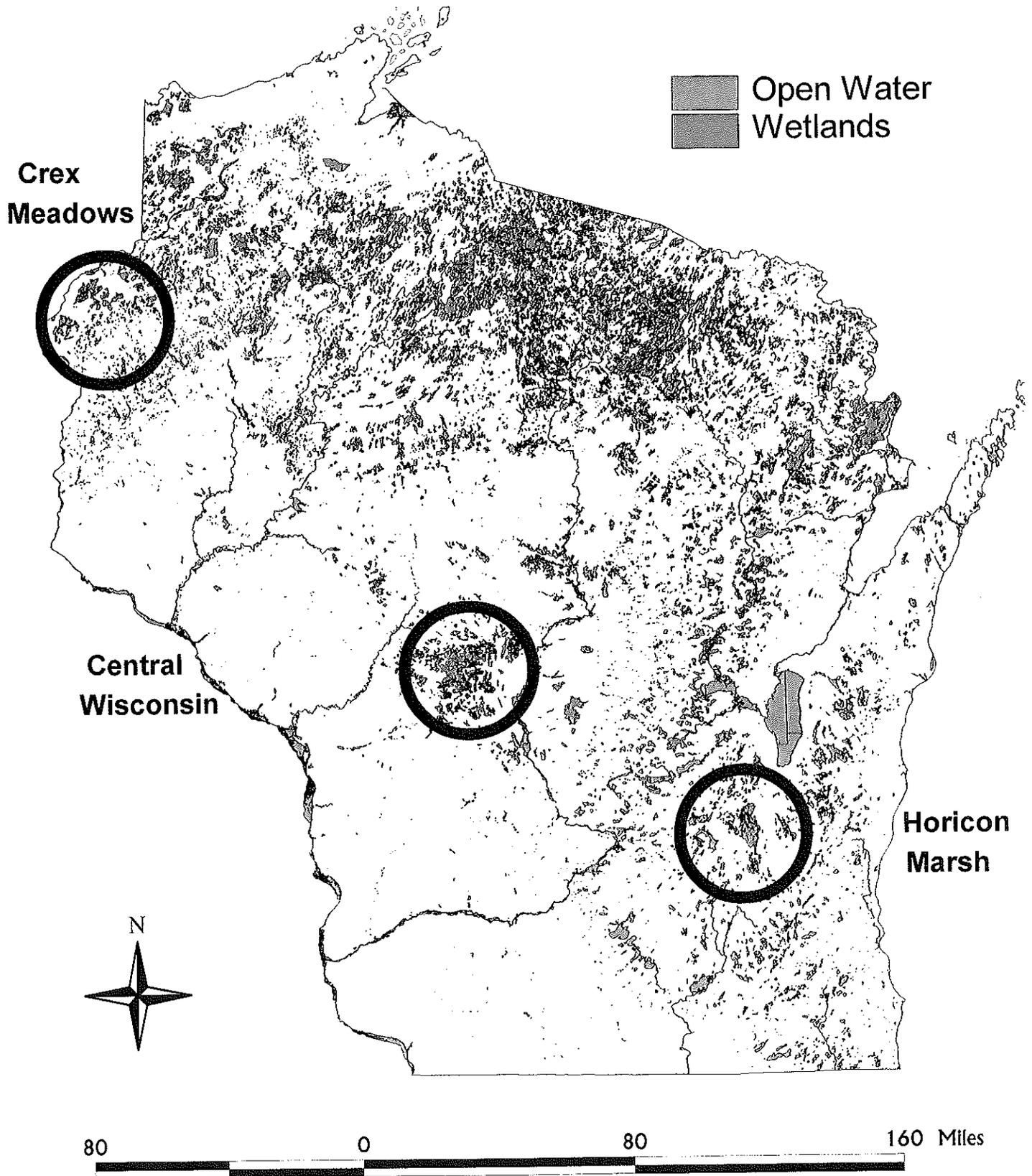
According to the information provided by site managers and biologists (see Appendix 2), the Central Wisconsin site includes 49,800 acres of shallow wetland habitat (i.e., water depths less than 24 inches) that is publicly owned. The Horicon Marsh site includes 9,500 to 13,000 acres of shallow wetland habitat that is publicly owned, and the Crex Meadows site includes 16,000 acres of shallow wetland habitat that is publicly owned.

Using a tight definition of "breeding site," only Central Wisconsin meets the specific criterion for area size established at the beginning of this project (see Appendix 1). However, personnel at the top three candidate sites estimate that additional shallow wetlands in the vicinity of their sites (20-30 mile radius) total as follows: Central Wisconsin -- 42,000 acres; Horicon Marsh -- 21,000 acres; and Crex Meadows -- 44,000 acres in Burnett County and additional acreage in Polk County and in Minnesota adjacent to Burnett County.

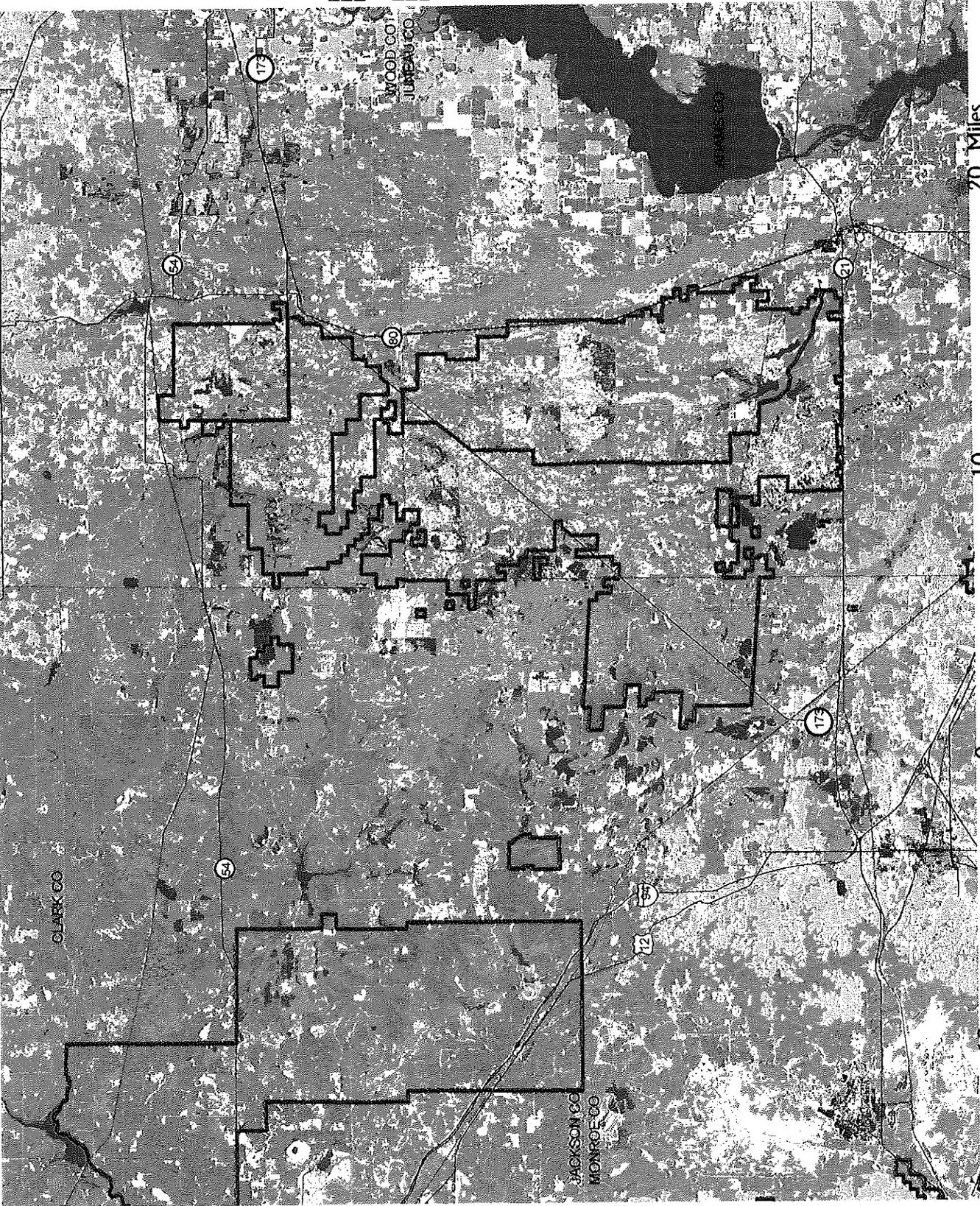
With the addition of these nearby wetlands, it was felt by the assessment team that all three sites should be evaluated as potential whooping crane breeding areas.

[It should be noted at this point that young, unpaired whooping cranes (ages 1-5) tend to disperse widely. Cross-fostered whooping cranes in the west, introduced at Grays Lake National Wildlife Refuge in Idaho, have spent summers in four different states (Tom Stehn, pers. comm.). The young whooping cranes currently being introduced in Florida often disperse over 100 miles from their release site (Marty Folk, pers. comm.). The implication for Wisconsin is that, even though the reintroduction project and this site assessment will focus on specific potential breeding sites, it is probable that, if reintroduction is successful, young whooping cranes may roam quite widely from their release area, at least until they are old enough to pair up and establish nesting territories. Therefore, it is also probable that a number of shallow marsh areas (within a 100-mile radius of the selected project breeding site) will be utilized to some extent as foraging and roosting areas by young whooping cranes. Because there is no way to predict where these areas may be, and, therefore, no way to systematically assess these potential crane use areas, the evaluation of the ecological suitability and safety of Wisconsin for whooping cranes is necessarily limited.]

Proposed Whooping Crane Reintroduction Sites in Wisconsin



Central Wisconsin Cover Map

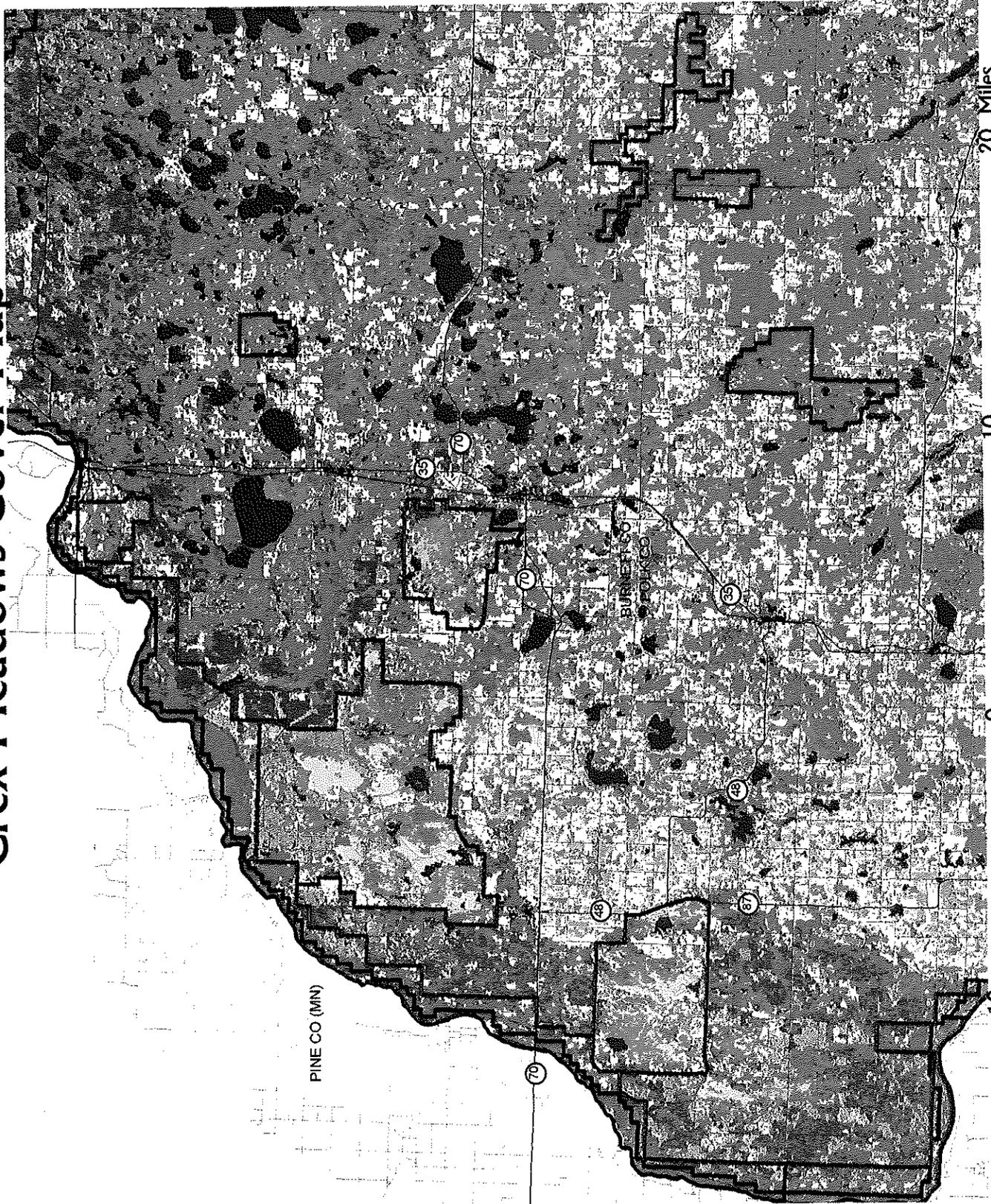


- State Lands
- Federal Lands
- County Boundaries
- State Highways
- Railroads
- Roads
- Riparian

- URBANDVELOPED
 - High Intensity
 - Low Intensity
 - Golf Course
- AGRICULTURE
 - General Agriculture
 - Herbaceous/Field Crops
 - Corn/soybean
- GRASSLAND
- FOREST
 - Coniferous
 - Broad-leaved Deciduous
 - Mixed Deciduous/Coniferous
- OPEN WATER
- WETLAND
 - Emergent/Wet Meadow
 - Lowland Shrub
 - Forested
- BARREN
- SHRUBLAND



Crex Meadows Cover Map



- State Lands
- Federal Lands
- County Boundaries
- State Highways
- Railroads
- Roads
- Riparian

- URBAN/DEVELOPED
 - High Intensity
 - Low Intensity
 - Golf Course
- AGRICULTURE
 - General Agriculture
 - Herbaceous/Field Crops
 - Cranberry Bog
- GRASSLAND
- FOREST
 - Coniferous
 - Broad-leaved Deciduous
 - Mixed Deciduous/Coniferous
- OPEN WATER
- WETLAND
 - Emergent/Wet Meadow
 - Lowland Shrub Forested
- BARREN
- SHRUBLAND



20 Miles

10

0

10

PINE CO (MN)

BURNVILLE, MN
BURNVILLE, MN

70

70

35

70

49

48

55

20 Miles

In addition to on-the-ground site visits and flyovers that were conducted by crane experts in the fall of 1998 (before marshes froze), as a result of the March 5 meeting, the following tentative list of additional data was generated as desirable to analyze or collect if possible for these remaining top three candidate sites:

Biological Data

1. Comparative study of crane food abundance at the three sites. (Possible food items to be sampled include dragonfly nymphs, minnows, and crayfish.)
2. Water quality and sediment contaminant data.
3. Data on what chemicals are used, and in what quantities, in the cranberry growing industry. Data on any toxicity studies that have been completed on the chemicals used in cranberry growing.
4. Data on any other industrial or agricultural chemicals that are heavily used near any of the sites being considered.
5. Sandhill crane data on summer populations, numbers of nesting pairs, fledging success, and numbers of cranes staging for fall migration.
6. Avian disease and mortality data.

Socio/Political Data

1. Surveys of local general public near the areas under consideration.
2. Meetings/briefings with key stakeholders who have a particular interest in each area under consideration.
3. [Other data to be determined by DNR/FWS public relations specialists]

Crane Hazard Data

1. Powerlines, fences, and other structural hazards in the vicinity of each site.
2. Predator types and density.
3. Incidents of accidental or intentional shooting of swans and/or sandhill cranes.
4. Incidents of lead poisoning of birds.
5. Level of human disturbance near possible whooping crane breeding areas.

RESULTS: Socio/Political Data

Surveys of the General Public Near the Areas Under Consideration.

In May of 1999, public meetings were conducted at locations (public schools) near each of the top three candidate sites. Representatives from DNR, FWS, ICF, and the principal investigator attended all three of the meetings. At each meeting, information including written handouts, slides, videotape, and displays were provided concerning the whooping crane recovery program, the particular site(s) in the area that is being considered, and the actual process of reintroducing cranes by raising them on site and training them to follow ultralight aircraft as a way of learning a migration route from Wisconsin to their wintering site on the Gulf coast of Florida. During the formal presentation part of the meetings, an opinion survey was distributed to all attendees, and each person was asked to answer several brief questions and then return the survey before they left for the evening. The table below shows the number of completed surveys obtained at each of the three public meetings.

Candidate Site	Horicon Marsh	Crex Meadows	Central Wisconsin
Number of Surveys Completed	25	46	85

The key question on the survey document was: **Based on what you learned tonight, how do you feel about a possible reintroduction of whooping cranes in Wisconsin? Please circle one:**

Strongly Support Support Oppose Strongly Oppose

The following table presents the results obtained from the responses to this question.

Response	Horicon Marsh	Crex Meadows	Central Wisconsin
Strongly Support	88%	85%	76.5%
Support	12%	15%	18.8%
Oppose	0%	0%	1.2%
Strongly Oppose	0%	0%	0%
(Need more information)	----	----	2.3%
(Neutral)	----	----	1.2%
Totals	100%	100%	100%

It is clear from these survey responses that the individuals who attended the public meetings near the three candidate sites are nearly all supportive of a possible reintroduction of whooping cranes in the state of Wisconsin. The only individual who opposed the idea of reintroduction (in Central Wisconsin) later explained to the principal investigator that his objection was based solely on a concern that a reintroduction project would impose limitations on the military training activities that are currently carried out routinely by the organization where this individual is employed.

Unsolicited Expressions of Support

Several communities near the candidate sites sent unsolicited resolutions and other expressions of community support for the reintroduction of whooping cranes in their areas. The city of Mayville, Wisconsin (near Horicon Marsh), the village of Grantsburg, Wisconsin (near Crex Meadows), and the village of Necedah, Wisconsin (near Central Wisconsin) all sent formal resolutions supporting the reintroduction of whooping cranes near their communities. Additional resolutions and proclamations of support were received from the Horicon Chamber of Commerce, the Dodge County Planning and Development Committee, the Beaver Dam Area Chamber of Commerce, the Mayville Area Chamber of Commerce, the School board of the Mayville School District, and the members of the Mayville Middle School Earth Club (all of these organizations are near Horicon Marsh). A resolution of support was received from the Juneau County Economic Development Corporation (in Central Wisconsin). In addition to organizational support, letters of support were received from many individuals who either live near one of the sites or travel from other parts of the state to enjoy one of the sites for recreational purposes. For sheer numbers of unsolicited letters, the award goes to the students of the Mayville Middle School near Horicon Marsh. Forty-six personal letters were received from these students, all supporting the reintroduction of whooping cranes at the Horicon Marsh site. At the Necedah Area School District, 92 students and staff members signed a petition stating, "We, the students and staff of the Necedah Area School District, support the introduction of Whooping Cranes at the Necedah National Wildlife Refuge."

Informal Meetings with Key Stakeholders Near the Candidate Sites

Representatives of DNR and FWS met informally with the Wisconsin State Cranberry Growers Association. Representatives of the Growers Association felt that the whooping crane reintroduction project would be very popular with the people of Wisconsin, and they saw no reason why the Association would not enthusiastically support the project.

The principal investigator and Dr. Richard Urbanek met informally with representatives of the Wisconsin Air National Guard who manage the training activities at the Hardwood Air-to-Ground Gunnery Range located just to the east of Necedah NWR and Sandhill WA. This meeting involved a two-way sharing of information, and no formal statement of support for the possible whooping crane reintroduction was offered or requested. For further discussion of this military training facility and its possible impacts on a reintroduction project, see the later part of the Results section in this report entitled "Crane Hazard Data."

RESULTS: Biological Data

Aerial Surveys of the Top Three Candidate Sites

On November 9 and 11, 1998, whooping crane experts (N = 3) flew over the top three sites in a light aircraft provided by Region 3 of the U.S. Fish and Wildlife Service (special thanks to John Christian and pilot Bob Foster for making these flights possible). The focus of the flights was on assessing the quality of wetland habitat at each site and on estimating the number of pairs of cranes that might find adequate nesting habitat at each site. None of the three sites (i.e., the complexes of publicly-owned lands) appeared to have enough high-quality nesting habitat to accommodate 25 pairs of nesting whooping cranes.

From the air, it appeared that Central Wisconsin had a good combination of open shallow water and emergent vegetation. Expert estimates of the number of crane pairs that could be supported by the habitat ranged from 10 to 25 pairs. The larger estimates were based on the assumption that surrounding private wetlands would be used as well as public lands. It was noted that the best potential crane habitat was spread out (i.e., interspersed with patches of habitat that appeared to be unsuitable for crane use).

At Horicon Marsh, the matrix or mosaic of water and vegetation looked good to the crane experts, but they were unsure about whether the open water portions of the Marsh might be too deep for whooping cranes, and there was some concern about the denseness of the cattails in the Marsh. Expert estimates of the number of crane pairs that could be supported by the habitat ranged from 12 to 15+ pairs, but these estimates were qualified by concerns about the dominance and denseness of cattails and questions about water depths. It was also noted that there is little expansion habitat available in the immediate vicinity of the marsh. The fact that the marsh habitat is all together in one large chunk was seen as positive in regards to keeping the flock fairly close together rather than scattered over a very large area.

At Crex Meadows, the mixture of emergent vegetation and open shallow water was seen as very good by the experts. Some aspects of the site were seen as similar to areas used by nesting whooping cranes at Wood Buffalo National Park. Expert estimates of the number of crane pairs that could be supported by the habitat ranged from 8+ to 15+ pairs. There were differing opinions about the adequacy of the potential expansion habitat that was flown over in wetlands across the St. Croix River in Minnesota.

Comparative Study of Crane Food Abundance at the Top Three Sites.

In the spring and summer of 1999, samples of potential whooping crane food items were collected from each of the top three candidate breeding sites. Samples were collected by site personnel (using minnow and pop-bottle activity traps) under the direction of Dr. Richard Urbanek, crane expert and biologist at Seney National Wildlife Refuge. Following is a summary of the data derived from this crane food availability study. Further information is provided in Appendix 3 to this report.

Abundance of possible whooping crane food items (mean number captured per 100 trapdays) in three candidate reintroduction areas in Wisconsin and at Seney NWR, Upper Michigan.

[*n* = number of trapdays at each site]

Item	Horicon (<i>n</i> =189)		Central (<i>n</i> =483)		Crex (<i>n</i> =210)		Seney (<i>n</i> =126)	
	\bar{X}	SE	\bar{X}	SE	\bar{X}	SE	\bar{X}	SE
HIRUDINEA								
Leeches >25mm	7.9	4.6	10.8	3.0	32.9	7.2	7.1	2.6
All other leeches	7.9	2.2	4.6	1.2	11.9	4.7	3.2	1.9
Total	15.9	5.5	15.3	3.3	44.8	8.7	10.3	3.9
GASTROPODA								
Snails >8mm	27.0	4.7	11.6	2.4	9.5	2.3	6.3	2.5
All other snails (except Ancylidae)	85.7	12.6	34.0	4.5	25.7	5.5	97.6	26.0
Total	112.7	14.0	45.5	5.2	35.2	6.0	104.0	26.4
PELECYPODA								
Fingernail clams	6.3	2.3	13.0	2.5	32.4	16.1	59.5	15.1
CRUSTACEA								
Crayfish	0.5	0.5	2.1	0.6	1.4	0.8	4.0	1.7
ODONATA								
Dragonfly nymphs >25mm	8.5	2.8	1.4	0.6	2.4	1.1	3.2	1.9
All other dragonfly nymphs	2.6	1.2	27.7	4.0	48.6	7.6	42.1	10.9
Total	11.1	3.0	29.2	4.1	51.0	7.7	45.2	11.2
HEMIPTERA								
Small giant water bug (<i>Belostoma</i>)	39.2	8.2	3.5	1.1	1.0	0.7	4.0	2.1
Large giant water bug (<i>Lethocerus</i>)	1.6	0.9	8.1	1.8	9.0	2.1	11.9	2.9
All other bugs >8mm	5.8	2.3	17.2	4.6	7.6	2.2	19.0	6.1
Total	46.6	8.8	28.8	5.2	17.6	3.3	34.9	6.8
COLEOPTERA								
Giant pred. diving beetle (ad&l)	1.6	0.9	2.9	0.9	1.9	0.9	10.3	3.3
All other beetles >8mm	83.1	13.7	25.5	4.5	41.9	9.1	85.7	18.0
Total	84.7	13.8	28.4	4.6	43.8	9.1	96.0	18.2
DIPTERA								
Diptera larvae >25mm	0.5	0.5	0.0	-	0.0	-	0.0	-
OSTEICHTHYES								
Central mudminnow	184.1	23.4	323.8	21.4	334.8	39.2	215.9	53.2
Redbelly/finescale dace	3.2	1.8	66.9	20.7	616.2	134.0	38.9	16.3
Golden & <i>Notropis</i> shiners (nonlarv)	2.6	2.2	17.8	12.1	5.2	1.9	4.0	2.9
Fathead/bluntnose minnows	3.2	1.8	1.9	1.7	173.8	58.8	0.0	-
Catfish	11.6	7.8	31.5	14.8	34.3	10.0	73.8	42.3
Brook stickleback	28.6	10.5	143.1	31.3	97.6	31.7	18.3	6.4
Sunfish	67.2	29.1	81.6	25.4	0.0	-	69.0	21.0
All other fishes	11.6	5.7	29.2	9.1	0.0	-	15.9	7.9
Total	312.2	41.4	695.7	63.1	1261.4	183.1	435.7	87.5
AMPHIBIA								
Tadpoles >25mm	42.9	12.1	6.6	2.2	0.5	0.5	22.2	4.9
All other amphibia	7.9	2.9	4.1	1.4	63.8	40.4	8.7	3.0
Total	50.8	12.3	10.8	2.5	64.3	40.4	31.0	6.0
GRAND TOTAL	641.3		868.7		1551.9		820.6	

Water Quality and Sediment Contaminant Data: EPA Report to Congress

In September of 1997, the U.S. Environmental Protection Agency (EPA) submitted a report to the U.S. Congress entitled, "The Incidence and Severity of Sediment Contamination in Surface Waters of the United States." In preparation for this report, EPA evaluated 21,000 sampling stations nationwide and analyzed three types of data from each station: sediment chemistry data; chemical residue levels in edible tissue of aquatic organisms; and sediment toxicity data. Each sampling station was classified into one of three categories, or tiers, based on an overall assessment of "probability of adverse effects." The three categories or tiers were as follows:

- Tier 1: associated adverse effects are probable.
- Tier 2: associated adverse effects are possible, but expected infrequently.
- Tier 3: no indication of associated adverse effects (any sampling station not categorized as Tier 1 or Tier 2; includes sampling stations for which substantial data were available, as well as sampling stations for which limited data were available).

In addition to the tier classification, EPA identified 96 watersheds throughout the United States that contain "areas of probable concern for sediment contamination (APCs)." An APC is defined as a watershed that contains 10 or more Tier 1 sampling stations and in which at least 75 percent of all sampling stations have been classified as Tier 1 or Tier 2.

In Wisconsin, two of the candidate whooping crane breeding sites fall in or near EPA areas of probable concern. The Central Wisconsin site is right in the middle of the "Castle Rock" watershed that has been designated as an area of probable concern, and Horicon Marsh is located at the Northwest corner of the "Milwaukee" watershed which also has been designated as an area of probable concern (see Appendix 4 for further information on these two watersheds and the data that has been collected at sampling stations located in these watersheds).

Watershed Environmental Profile Data

In addition to its 1997 report to Congress on sediment contamination in the nation's surface waters, EPA has developed "Watershed Environmental Profile" data on every watershed cataloged by the U.S. Geological Survey. Each of these profiles includes assessments of watershed health translated into an "Index of Watershed Indicators." Appendix 5 to this report presents the complete Watershed Environmental Profiles for the watersheds that include the three candidate whooping crane breeding sites. A composite scale of Watershed Health has been established, and a score from 1 (healthy) to 6 (unhealthy) is assigned to each watershed to indicate overall watershed health. The overall scores for the three watersheds that include the three candidate whooping crane breeding sites are as follows:

- Castle Rock (Central Wisconsin): Score = 5 (described as "more serious water quality problems - low vulnerability to stressors such as pollutant loadings.")
- Upper Rock (Horicon Marsh): Score = 4 (described as "less serious water quality problems - high vulnerability to stressors such as pollutant loadings.")

- Lower St. Croix (Crex Meadows): Score = 3 (described as “less serious water quality problems - - low vulnerability to stressors such as pollutant loadings.”)

Please refer to Appendix 5 for a more complete presentation of this Watershed Environmental Profile data.

Wisconsin Unified Watershed Assessment & Priorities (October 1998)

In 1998, the Wisconsin DNR and the U.S. Natural Resources Conservation Service established four categories of watersheds in Wisconsin for the purpose of setting restoration and protection priorities. The four categories were as follows:

- Category 1. Watersheds with waters in need of restoration
- Category 2. Watersheds with waters in need of protection
- Category 3. Watersheds with pristine/sensitive waters
- Category 4. Watersheds with insufficient information

Two of the candidate whooping crane breeding sites (Central Wisconsin and Horicon Marsh) fell in Category 1, Watersheds with waters in need of restoration. To be placed in this category, a watershed had to meet one or more of the following criteria:

- Watershed (geographic management unit – GMU), as a whole, significant contributing area of pollutants (sediment or nitrogen) to Mississippi River;
- Watershed (GMU), as a whole, significant contributing area of pollutants to Great Lakes, especially Areas of Concern;
- Substantial amount of impaired waters (total miles of streams, percent of streams impaired or percent of contributing area); or
- Substantial water quality improvement need identified in 305(b) report (as expressed in areawide water quality management plans as having more than 50% of the watersheds identified as ranking high).

[Note: The Wisconsin DNR requested that the following note be added at this point in the report: “The ‘Index’ used in the Watershed Environmental Profile Data must be recognized as very coarse and representative of an overall ranking of a particular watershed. There are some uncertainties associated with application of data at one location being extrapolated to a broader watershed scale. In addition, the overall ranking does not distinguish the type of characteristic that controls. Therefore, while a waterbody may have an overall poor ranking due to aesthetic insults, it may be perfectly suitable and safe for fish and other aquatic wildlife. Also, the impairments associated with the Wisconsin Unified Watershed Assessment and Priorities may or may not be significant relative to suitability of habitat - the overall scoring system in the unified watershed assessment process does not factor in specific uses such as whooping crane or other wildlife habitat factors.”]

Water Quality and Sediment Contaminant Data: Wildlife Toxicologist's Analysis

No experimental studies using whooping cranes as subjects have been conducted to assess the actual risks posed to whooping cranes by water quality and sediment contaminants in the vicinity of the top three candidate sites being considered by this report. However, because of the availability of much previously-collected data at DNR, and the great generosity and commitment of Dr. Kathleen Patnode, DNR Wildlife Toxicologist, the principal investigator asked Dr. Patnode to provide her professional opinion regarding the potential risks posed to whooping cranes by contaminants in the vicinity of the three candidate sites. The following brief report was prepared by Dr. Patnode and will be quoted in its entirety (indented sections below):

At the request of the Wisconsin Whooping Crane Site Assessment team, I have conducted an evaluation of the risks posed by contaminants in the vicinity of three proposed Wisconsin whooping crane reintroduction sites: Crex Meadows/Fish Lake/Amsterdam Slough complex, Necedah National Wildlife Refuge/Sandhill Wildlife Area/Wood County Wildlife Area, and Horicon National Wildlife Refuge/Horicon Wildlife Area.

Where quantitative data on contaminants in prey were available, my evaluation was based on adult data on body weights (International Crane Foundation) and diet composition (Hunt and Slack 1989). In absence of food consumption rates for wild whooping cranes, I used the gram per gram body weight value established for great blue heron (USEPA Exposure Factors Handbook 1993) rather than captive whooping crane data as digestibility and caloric content of captive diets are much higher than actual prey. Since toxicity data specific to cranes does not exist, I used the toxicity criteria established to protect avian species in general (USEPA Great Lakes Water Quality Initiative 1995 [GLWQI]).

Insufficient data for these exposure parameters are available to conduct similar assessments for chicks. Juvenile sensitivity for many contaminants is greater than that of adults due in part to incomplete development of detoxification mechanisms and susceptibility of developmental process no longer active in adults. Thus, it is reasonable to assume that risk to juvenile whooping cranes will be higher, to an unknown extent, than that of adult birds.

In the case of agricultural pesticides, exposure data are not available for fish or other crane prey items. I examined the toxicity data, focusing on avian toxicity, and the application rates/frequencies and persistence. From this information, I qualitatively evaluated the potential risk to adult cranes from agricultural chemical exposure.

In my professional opinion as the WDNR wildlife toxicologist, the sites with **LEAST** toxicological risk via food chain exposure are **Horicon Marsh** and **Crex Meadows**, and the site with greatest risk is **Necedah**. The information below describes the process that I undertook at each site to reach this conclusion.

This assessment does not include the risk posed by significant amounts of lead shot deposited in sediments that could be ingested while foraging. The most appropriate risk analysis for that source of contamination is the examination of Wisconsin cases of lead poisoning of waterfowl that has been completed by Kerry Beheler.

Crex Meadows complex:

The principal contaminant of concern in this ecosystem is mercury. Its presence is a result of geology, acid precipitation, and atmospheric fallout. I evaluated concentrations in tissue of fish <10 inches in length within and beyond a 8km radius. Average daily exposure for adult cranes would be 14 $\mu\text{g}/\text{kg}$ body weight/day within 8 km and 20 $\mu\text{g}/\text{kg}$ body weight/day beyond 8km. These exposures are below the no observed adverse effect level (NOAEL) of 32 $\mu\text{g}/\text{kg}$ body weight/day for birds established by the GLWQI. Thus, I concluded that mercury contamination in prey in the Crex Meadows complex should not pose an unacceptable risk to adult whooping cranes.

Necedah Refuge complex:

The primary contaminants of concern in this vicinity are persistent compounds in the Wisconsin River and its tributaries (particularly dioxins, furans, and mercury) to the south and east of the site and agricultural pesticides used in cranberry production bounding the refuge on the west and north. I evaluated mercury concentrations in tissue of fish <10 inches in length from the Wisconsin River and tributaries. Average daily exposure for adult cranes would be 25 $\mu\text{g}/\text{kg}$ body weight/day, still below the NOAEL of 32 $\mu\text{g}/\text{kg}$ body weight/day for birds established by the GLWQI. Thus, I concluded that mercury contamination in prey in the Wisconsin River should not pose an unacceptable risk to adult whooping cranes.

I evaluated the risk of dioxin and furan exposure in a similar manner and calculated an average daily exposure of 0.000661 $\mu\text{g}/\text{kg}$ body weight/day. This exposure is 2 orders of magnitude below the NOAEL of 0.014 $\mu\text{g}/\text{kg}$ body weight/day cited in the GLWQI. In my opinion, dioxins and furans do not pose an unacceptable risk to adult cranes in the vicinity of the Wisconsin River.

In the case of agricultural pesticides, I evaluated the 19 organic compounds commonly used in cranberry production in Wisconsin. Two of the 19 (chlorpyrifos and diazinon) are highly toxic to birds. According to USEPA statistics (USEPA 1998), these two compounds are used on 75 and 64% of the national cranberry crop, respectively. Two additional compounds of moderate toxicity to birds (acephate and azinphos-methyl) are applied to 34 and 43% of cranberries nationally. Three pesticides (azinphos-methyl, clethodim, and norflurazon) which are persistent have been shown to produce deformities or mortality in mammalian embryos. However, effects on avian embryos is unknown and data are unavailable on level of usage on cranberries. Based on this qualitative evaluation, I conclude that pesticides used in cranberry production may increase the risk to both adults and developing embryos in the Necedah complex, but this risk will fluctuate greatly both spatially and temporally depending on the chemicals selected for use. [**Note:** Of the chemicals of concern listed above, the principal investigator received documentation of the use of the following by cranberry growers in the vicinity of the Central Wisconsin potential whooping crane breeding site: diazinon, acephate, azinphos-methyl, and norflurazon.]

Horicon Marsh complex:

The primary contaminants of concern in the marsh and its streams are heavy metals, particularly mercury. I evaluated mercury concentrations in tissue of fish <10 inches in length from <20km and 20-40km from the refuge. Average daily exposure for adult cranes would be 7 µg/kg body weight/day within 20km and 17 µg/kg body weight/day beyond 20km, well below the NOAEL of 32 µg/kg body weight/day for birds established by the GLWQI. Other metals that are present in the sediments do not readily accumulate in fish and biota; thus cranes would not be exposed to significant concentrations of these toxins. Thus, I concluded that metal contamination in prey in the vicinity of the Horicon Marsh complex should not pose an unacceptable risk to adult whooping cranes.

Trumpeter Swan Reintroduction Productivity Data

The Wisconsin Trumpeter Swan Program is relevant to the current study because the project involved the reintroduction of an avian species in (and beyond) the three sites that are the subject of this whooping crane breeding site assessment. Even though swans and cranes use different parts of wetland habitats, the water in their use areas is the same, and they have several prey items in common (e.g., insects and aquatic invertebrates) [Ehrlich et al. 1988]. Of course, one can not generalize from the productivity of swans to the productivity of cranes at any specific site, but the swan productivity data may be one indicator of the fertility and quality of the marsh habitats at different sites.

The Wisconsin trumpeter swan reintroduction project involved releases of swans in several different regions of the state. Most of the releases in the northwest region were at Crex Meadows WA and Fish Lake WA; most of the releases in the central region were at Sandhill WA, Meadow Valley WA, and Necedah National Wildlife Refuge; and most releases in the southeast region were at Horicon Marsh (Lisa Hartman and Mike Mossman, pers. comm.).

Since releases in the southeast began only recently, it is not meaningful to include that region in swan productivity comparisons. However, the northwest can be compared to the central region in terms of number of young fledged per active nest. A brief summary of those data is presented in the following table:

Region	Area	Number of Swans Released	Mean Number of Young Fledged per Active Nest
Northwest	Crex Meadows	47	3.32
	Fish Lake	8	2.33
	Other	57	2.19
	Total	112	2.61
	Grand Mean		2.61
Central	Necedah	42	1.00
	Sandhill	25	1.33
	Meadow Valley	31	0.00
	Mead	45	1.60
	Wood County	0	2.33
	Other	0	3.00
	Total	143	1.83
	Grand Mean		1.83

Lisa Hartman and Mike Mossman of DNR feel that, “. . . the NW has truly fared better for the swans than has the Central Region.” These researchers believe that at least three factors are involved in the productivity differences between the two areas:

One is probably the greater overall fertility and productivity of wetlands in the NW. Another is probably the higher recorded incidence of mortality due to shooting in Central; the lack of a Canada goose season north of Hwy 70 (putting Crex in the no-hunt area, but not most other NW nesting areas) seems to be an important factor. A third major factor is probably migration routes and wintering areas, which certainly influence mortality rates. We hope to tease these various factors out over the coming year. (Lisa Hartman and Mike Mossman, pers. comm.)

Sandhill Crane Data

Unfortunately, there are no available recent productivity data (defined here as number of young fledged per nest) for sandhill cranes at any of the three candidate whooping crane breeding sites. Therefore, the presentation here is limited to the most recent data available for sandhill crane counts that were taken at each site during the spring (i.e., before the influx of non-resident cranes that use two of these areas [Crex Meadows and Central Wisconsin] for staging for migration in the fall).

Horicon Marsh (Survey taken in the spring of 1998)

Breeding Pairs: 24
Population Total: 91

Crex Meadows (Survey taken on May 18, 1999)

Number of Adults Observed: 112
Number of Nests with Eggs: 6
Number of Eggs: 10
Number of Crane Pairs with Confirmed Chicks: 2
Number of Crane Pairs with Suspected Chicks: 9
Number of Crane Chicks: 2

Central Wisconsin (Survey taken May 13, 1999)

Number of Adults Observed: 106-126
Number of Crane Chicks: 4
Number of Nests with Eggs: 6
Number of Eggs: 11

These data simply establish that there are nesting sandhill cranes at all three of the candidate sites.

Sandhill cranes do not stage at the Horicon Marsh site, but the following table indicates the approximate numbers of sandhill cranes that have staged in the fall at the other two top candidate sites in the last five years.

Approximate Number of Sandhill Cranes Staging at Two Candidate Whooping Crane Breeding Sites (1994-1998)

Year	Crex Meadows	Central Wisconsin
1994	2844	1510
1995	2739	715
1996	4315	2470
1997	4050	1483
1998	6130	2739

RESULTS: Crane Hazard Data

Traumas Experienced by Reintroduced Trumpeter Swans

Again, thanks to the availability of DNR data, and to the great generosity and commitment of Kerry Beheler, DNR Wildlife Health Specialist, it has been possible to develop a picture of the traumas experienced by reintroduced trumpeter swans in Wisconsin. Again, because releases in the southeast region began only recently, only data for Crex Meadows and vicinity and Central Wisconsin and vicinity will be presented here. Following is a brief summary of the reintroduced trumpeter swan trauma and death data for these two candidate sites through 1998:

Index	Crex Meadows	Central Wisconsin
Dead from Lead Poisoning	19	4
Elevated Blood Lead	22	27
Shot	4	10
Powerline Collision	6	3
Other	--	7
Total	51	51

Due to the small numbers involved, and a number of confounding variables (e.g., more testing for lead was done on birds at Crex Meadows [Mike Mossman, pers. comm.]), it is inappropriate to make comparisons between these two areas on these indices. Suffice it to say that lead shot residue, human gunshot, and powerlines have proven to be somewhat hazardous to reintroduced trumpeter swans in both of these candidate whooping crane reintroduction sites. Kerry Beheler also notes that of the 12 captive-raised subadult swans that were released in the Horicon Marsh site in the spring of 1998, 6 of those swans (50%) have been diagnosed with lead poisoning. Of the 6 swans with lead poisoning, 3 died and 3 were successfully treated and released in other parts of the state (Kerry Beheler, pers. comm.). As a qualifier to these results with trumpeter swans, it should be noted here that avian experts consider the risk of lead poisoning to be greater for trumpeter swans than for whooping cranes (Scott Swengel, pers. comm.; Richard Urbanek, pers. comm.).

Predation

Bobcat predation of whooping cranes has been a major problem in the Florida non-migratory population reintroduction project. In Wisconsin, bobcat predation should be much less of a concern. The personnel at each site were asked for information on possible predators of whooping crane adults, chicks, and eggs. Following is a brief summary of the information provided by each site.

Horicon Marsh reports that there are no bobcats at the site. The following animals are listed as potential predators of cranes or eggs: coyote, red fox, gray fox, otter, raccoon, possum, skunk, mink, raptors during migration, and possibly ring-billed gulls and herring gulls. Abundance has not been systematically estimated for the marsh as a whole, but the largest numbers of predators probably include raccoon, coyote, fox, otter, possum, and skunk.

The Central Wisconsin site has an active furbearer trapping program on the state-managed properties. Therefore, there is some control over the density of furbearers on the Wildlife Areas. Predation of a small number of sandhill crane nests has been documented (Howard 1977). In this study, three nests were depredated: two by crows and one by skunk. Other potential predators include raccoons, otter, and coyotes, although the influx of some timber wolves into central Wisconsin may exert some control on coyote numbers (there is one wolf pair on Necedah NWR at this time). The central Wisconsin wolves feed primarily on deer. Finally, bobcats are rare.

Crex Meadows also reports that bobcats are rare, and that timber wolves may be suppressing the population of coyotes. It is estimated that one to a few timber wolves may be using the property. Other potential predators include: fox, raccoon, and skunk.

[Note: it is difficult to assess the overall effects of possibly increasing wolf numbers at both the Central Wisconsin and the Crex Meadows sites. On the one hand, the wolves will tend to suppress coyote numbers, and currently coyotes far outnumber wolves. On the other hand, wolves have been known to prey on whooping crane chicks at Wood Buffalo National Park (Tom Stehn, pers. comm.). If deer are plentiful and water levels in crane marshes do not drop significantly, it is unlikely that wolves will become a significant predator of cranes. So, in the short run at least, it is probable that increasing wolf numbers will decrease coyote numbers and reduce potential predation on cranes. However, the longer term picture is more difficult to predict.]

Avian Disease and Mortality Data

Not counting trumpeter swan deaths (addressed earlier on page 21 of this report), the following data give a very gross picture of avian mortalities (1981-1999) reported to the Wisconsin DNR in the counties that contain the three candidate whooping crane breeding sites (again, special thanks to Kerry Beheler, DNR Wildlife Health Specialist, for providing these data).

Site	County	Avian Mortality (1981-1999)
Crex Meadows	Burnett	152
Central Wisconsin	Jackson	--
	Juneau	1
	Monroe	--
	Wood	--
Horicon Marsh	Dodge	2034
	Fond Du Lac	460

A different data set on avian disease and mortality was provided by the National Wildlife Health Center (NWHC) in the form of a 69-page printout (a special thanks to Dr. Kim Miller for providing these data). The printout covers avian disease incidents in Wisconsin from 1976 to

1998 that were reported to NWHC and that occurred in or near the three candidate whooping crane breeding sites. For the purposes of this summary report, the simplest way to present a very gross picture of these data is to list the number of pages in the NWHC printout that cover disease incidents that occurred in or near each of the three candidate whooping crane breeding sites. The full printout, with specific diagnoses for each reported incident, can be obtained from the principal investigator of this study. Following is a summary of the data.

Site	Number of pages of avian disease incidents that occurred in or near the site (1976-1998)
Crex Meadows	2.25
Central Wisconsin	4.50
Horicon Marsh	61.50

It should be noted that, in both the DNR and NWHC reports mentioned above, the vast majority of avian species listed are waterfowl and other birds that use wetlands as their primary habitat.

Powerlines and Tower Hazards (see maps on the following three pages)

The maps on the following three pages were developed using Geographic Information Systems (GIS) technology. Each map illustrates the high-tension powerlines and towers that are in or near each of the top three candidate sites. A brief summary of these potential hazards is provided below for each site.

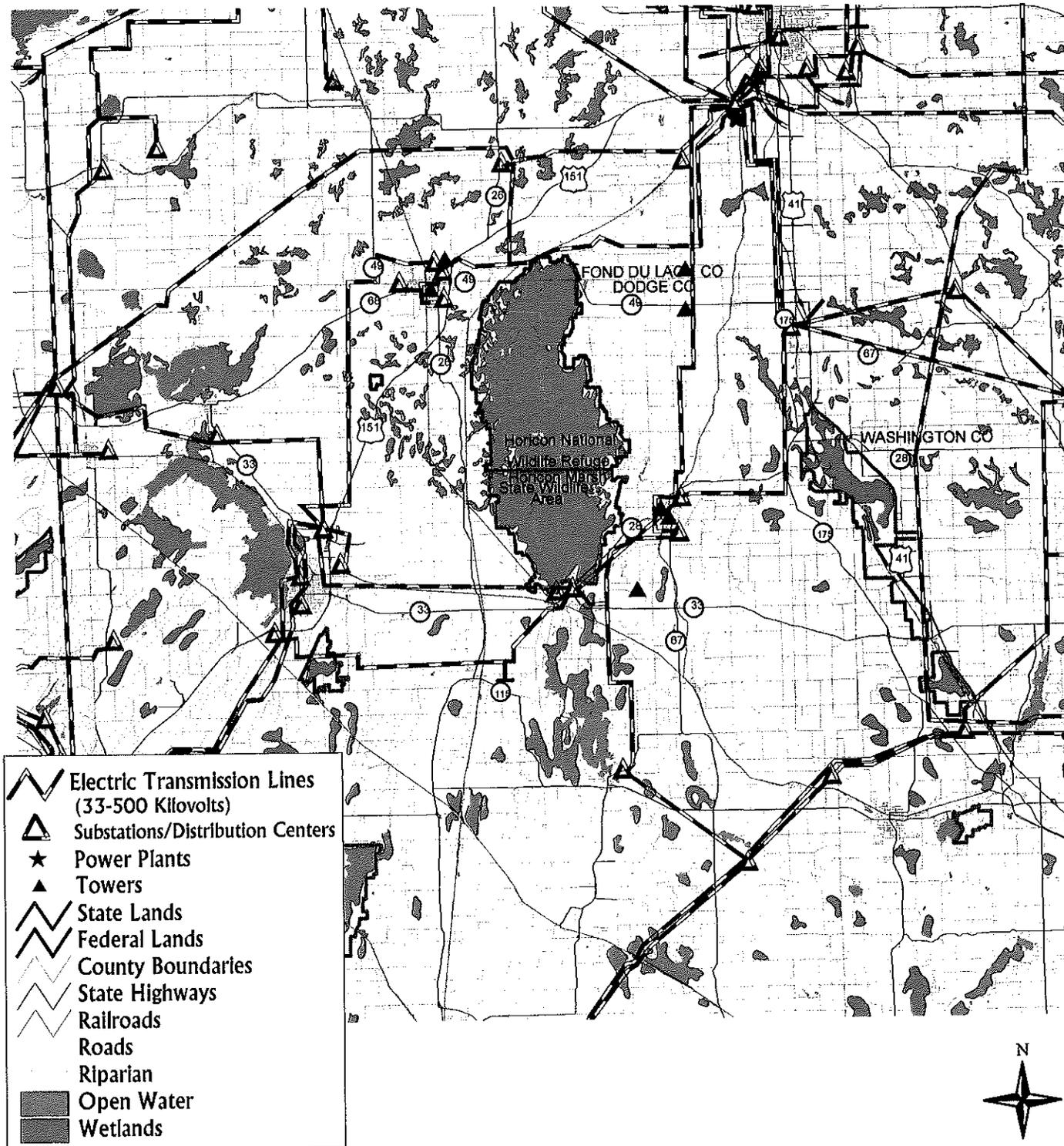
Horicon Marsh: There are no high-tension powerlines or towers in the marsh itself. The site is surrounded on all sides by electric transmission lines (33-500 kilovolts). There are two towers just to the southeast of the marsh, two towers to the northeast of the marsh, and one tower just to the northwest of the marsh.

Central Wisconsin: There are two electric transmission lines that cut through the site. There are two towers just to the northeast of the area and one tower further to the northeast. There are two towers to the southeast of the area (near the village of Necedah), and there four towers well to the west of the area on private lands.

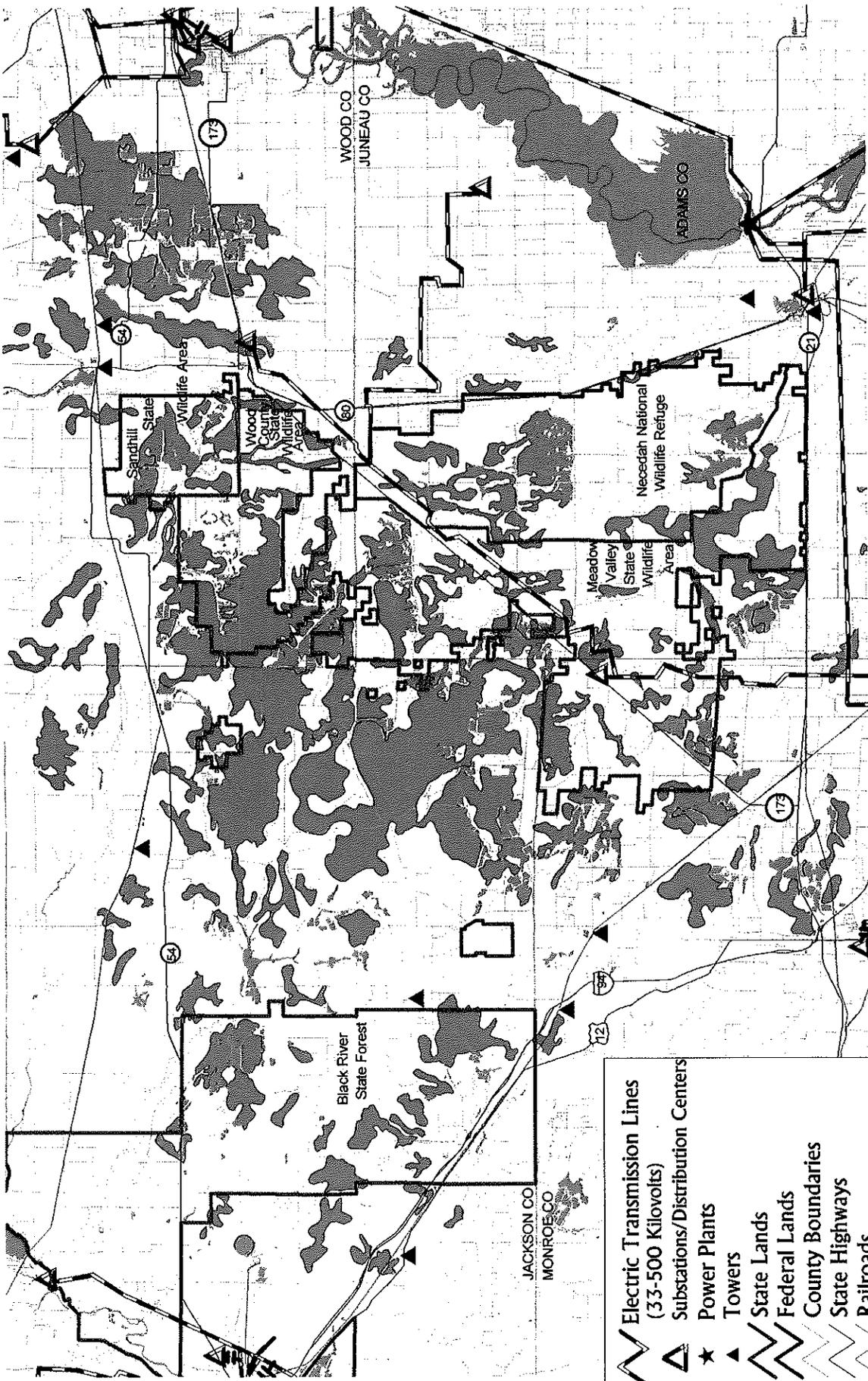
Crex Meadows: There are two electric transmission lines that form a “ + “ separating Crex Meadows WA, Amsterdam Sloughs WA, and Fish Lake WA from each other. There are two towers east of Crex Meadows and northwest of Amsterdam Sloughs, and there is a tower in the town of Grantsburg south of Crex Meadows and north of Fish Lake. There are two towers east of Fish Lake. There is a third transmission line that borders Amsterdam Sloughs to the east, and a fourth transmission line runs southeast just below Fish Lake.

Horicon Marsh

Transmission Line and Tower Hazards



Central Wisconsin Transmission Line and Tower Hazards

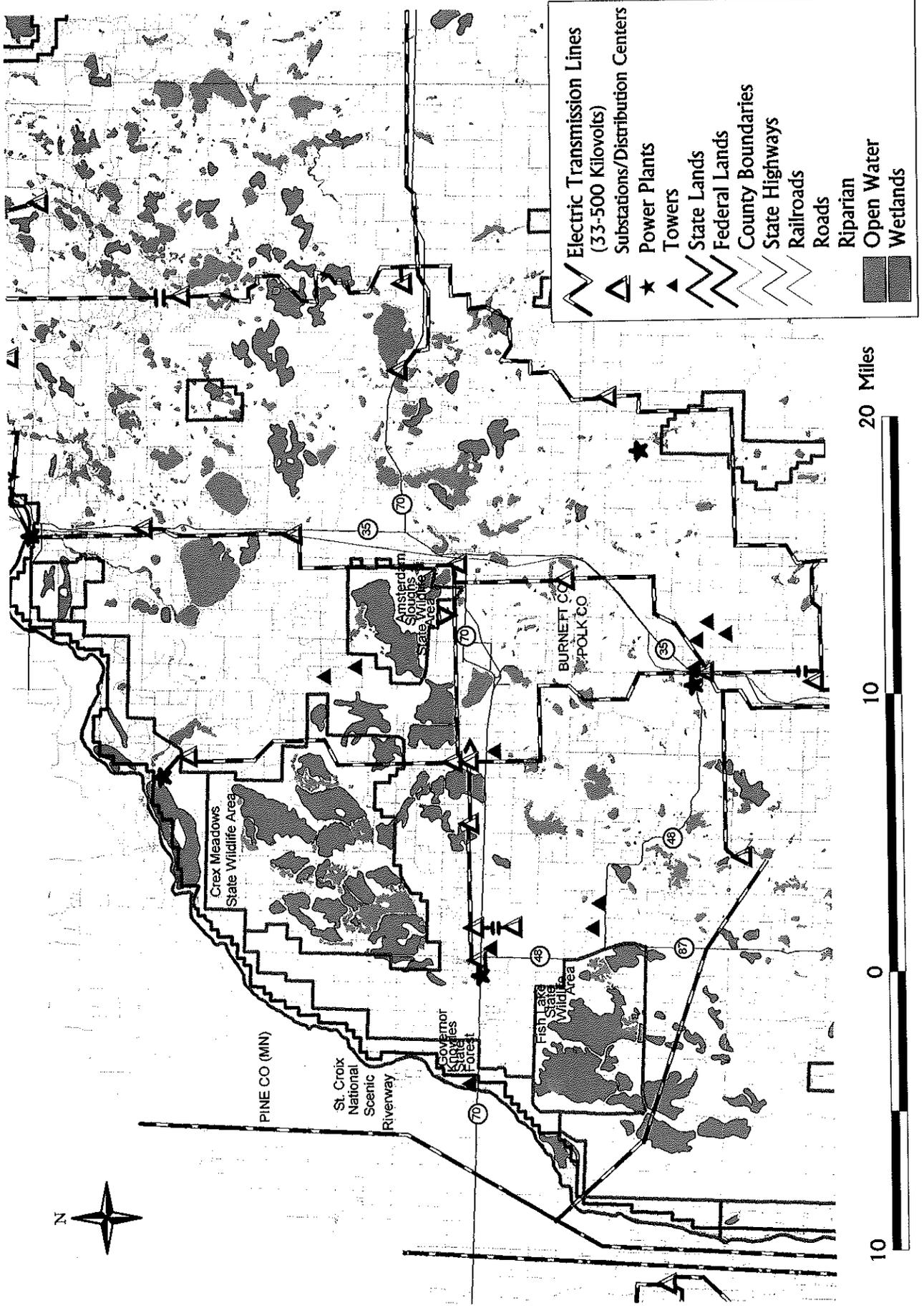


	Electric Transmission Lines (33-500 Kilovolts)
	Substations/Distribution Centers
	Power Plants
	Towers
	State Lands
	Federal Lands
	County Boundaries
	State Highways
	Railroads
	Roads
	Riparian
	Open Water
	Wetlands



Crex Meadows

Transmission Line and Tower Hazards



In addition to the GIS analysis of high-tension powerlines and towers at the three sites, Dr. Richard Urbanek conducted an on-the-ground survey of all three areas focusing on all types of powerlines, fences, towers, and any other observable types of physical hazards to cranes. Following is Dr. Urbanek's summary of his observations:

Powerlines

There were no aerial line hazards observed in the wetlands at any of the sites except for a quarter-mile distribution line along a dike to a pump station on the southwest corner of Horicon Marsh (Horicon WA).

Transmission lines are a very low to negligible concern at all sites. All transmission lines were the single pole type about 50 feet high. There were no higher double-pole-supported lines and no 100-foot metal-tower-supported lines. Few or no transmission lines were adjacent to wetlands or in areas likely to be used by low-flying cranes. Some lines were also shielded by taller wooded areas on one or both sides, particularly in Central Wisconsin and at Crex Meadows. The transmission lines as depicted on the GIS maps are accurate.

Shorter (~30-foot) distribution lines were abundant across the countryside associated with all areas and occurred along most public roads. These low lines along roads would normally present little or no hazard to cranes. Exceptions might be in the cranberry farms in Central Wisconsin.

Distribution lines to operator residences and work buildings were often present adjacent to cranberry beds and open fields that might be used by low-flying cranes, although local residents noted little or no mortality to local sandhill cranes. Distribution lines in areas of concern also occurred sporadically at other sites (e.g., along a public road traversing Fish Lake WA, where cranes might feed in fields on both sides of the road). Distribution lines in the surrounding countryside (e.g., most abundant in the high-density farming country around Horicon Marsh) could pose some threat to cranes leaving the wetlands to forage in these areas, but it is not expected that such forays would be frequent. As noted above, only one distribution line (at Horicon Marsh) was actually observed traversing a wetland.

Fences

Fences do not constitute a major hazard at any of the sites. No fences occurred in the wetlands at any site, although 4-strand barbed wire fences were noted bordering Horicon Marsh at two locations. A small amount of 8-foot deer fence was also present adjacent to some wetlands at a cranberry farm in Central Wisconsin. In the surrounding countryside, Horicon Marsh had the greatest occurrence of fences, but even here it was low. Most of the area consists of unfenced cornfields and a few soybean fields. No beef cattle operations (and associated large fenced pastures) were observed near Horicon Marsh. Most cattle were dairy cattle penned in feedlots; two small pastures observed were surrounded by 4-strand barbed wire or a 1-strand electric fence. Old decrepit barbed wire fence was noted on some field boundaries, indicating that in the past, pasturing cattle may

have been more extensive. Some of these fences may have been unobservable because of overgrowth by vegetation.

At Crex Meadows, some dairy farming occurs between Fish Lake WA and the village of Grantsburg. There are also some fenced pastures southeast of Crex Meadows WA and between Crex Meadows and Amsterdam Sloughs WAs. Cranes would not likely frequent these areas. Numerous dairy farms and one large pasture containing beef cattle were observed north of a private cranberry farm in Central Wisconsin. There are also fenced pastures west of Necedah near Tomah. At Sandhill WA, an 8-foot deer fence with 2-3 strands of barbed wire at the top forms the entire 17-mile border of the area.

Towers

Towers are a negligible concern at all sites. Tower locations depicted on the GIS maps are accurate, but the towers represented are highly variable: they could be >200-foot well-lit monsters or just 100-foot HAM radio operator antennae. A significant LARGE radio tower not included in the GIS map is located right at Horicon Marsh NWR headquarters. None of the other towers were adjacent to an area which would likely be used by cranes.

Overall Hazard Ratings by Site

Hazard	Sites		
	Horicon Marsh	Central Wisconsin	Crex Meadows
Powerlines	Low	Low*	Low
Fences	Low	Low/Very Low	Very Low/Negligible
Towers	Almost Negligible	Negligible	Negligible

*Note on powerlines in Central Wisconsin: hazard is low but variable (i.e., very low over most of the area, but moderate on cranberry properties).

Conclusion

Structural hazards appear to be relatively minor at all sites and should not be a primary consideration in site selection.

Human Disturbance

Human disturbance is extremely difficult to assess. For the purposes of this report, personnel at each of the potential whooping crane breeding sites were asked to estimate the number of visitor days per year at their respective sites. Since some areas within sites are restricted in terms of access, or completely closed to visitors, it is very difficult to make meaningful comparisons among the sites in terms of potential human disturbance to nesting whooping cranes. The following table simply presents rough estimates of total annual visitor days to each site. All sites reported the potential for “double counting” when they actually conducted daily counts. Some sites were only able to provide rough guesses for some or all of the months in a year. No inferences about disturbance can really be made from these numbers other than to note the gross differences that exist in terms of the estimated annual human presence in or near the three sites.

Site	Year	Estimated Annual Visitor Days
Crex Meadows	1993	90,000
	1994	92,000
	1995	98,000
Central Wisconsin	1997/8	225,000
Horicon Marsh	1998	500,000

In addition to rough numbers of visitors, site managers were asked to provide information on boat access to the waters at each site. Following is a brief summary of the responses to this question.

At Horicon Marsh, there is no public access permitted to the waters in the National Wildlife Refuge portion of the marsh. Therefore, there are no public boat ramps. The state Wildlife Area end of the marsh has four public boat launches which are identified on the map of the property. In addition, there is an improved boat launch in the City of Horicon that provides access to the marsh.

In Central Wisconsin, the state-managed Wildlife Areas have no improved boat ramps. Motors are not allowed on any boats (an exception would be made for a disabled permit, but this situation is rare). Necedah NWR has boat access on one of its pools. Motorized boat traffic is prohibited on the Refuge at all times of year except on this one pool.

At Crex Meadows, there are three boat landings on the Crex Meadows Wildlife Area. These are graveled ramps and would allow a small boat to be launched if water levels are high enough. All flowages are shallow and have a large amount of submergent and emergent vegetation. Motors on boats do not work well at Crex Meadows. There is no access to the Crex Meadows flowages from outside of the property. There are no game fish populations in any of the flowages so fishing does not occur. Most boat access occurs in October during the fall waterfowl hunting season.

Impacts of Low-Flying Aircraft

This potential hazard must be considered due to the presence of the Air National Guard's Hardwood Air-to-Surface Gunnery Range located immediately to the east of Necedah NWR and Sandhill WA. In the airspace above the Central Wisconsin site, the Military Operations Areas (MOAs), that are used for low-level approaches of aircraft to the Hardwood Range, cover practically all of the potential whooping crane nesting habitat in the area. The current level of activity is approximately 2,800 sorties per year, and this level will be increasing to about 3,500 sorties per year. The maximum currently assessed utilization of the range is 4,928 sorties per year. The aircraft involved include jet fighters, helicopters, and bombers. The altitudes flown go down to 500 feet above ground level and sometimes lower depending upon the particular purpose of the training flights.

There is a fairly large body of literature concerning the impacts on wildlife of low-altitude aircraft overflights (for reviews of this literature, see Larkin et al. 1996; Knight and Gutzwiller 1995; U.S. Department of the Interior/National Park Service 1995; Mancini et al. 1988; Gladwin et al. 1988b).

The quality of the studies and reports ranges from pure opinion surveys to carefully-controlled experiments, with exceedingly few of the latter. The results of the studies also range from findings of basically "no effects" (e.g., Black et al. 1984; Ellis et al. 1991) to findings of serious negative impacts on wildlife (e.g., Bunnell et al. 1981; Belanger and Bedard 1989a, 1989b; Temple 1993; Fleming et al. 1996).

Another serious limitation of the existing literature is the lack of any long-term studies to determine if there are long-term effects that do not become immediately apparent.

Most authors state explicitly that their findings may not generalize to other species of wildlife or even to the same species under different conditions. The only study that could be found that mentioned whooping cranes was Gladwin et al. (1988a) which is a compilation of survey responses from FWS facilities. The respondents from Aransas NWR indicated the following about wintering whooping cranes:

It is believed that whooping cranes have habituated to low-altitude light aircraft overflights during the last 30 years. Sandhill cranes will flush at the approach of light aircraft and have apparently not habituated. Whooping cranes are flushing at the approach of low-altitude helicopters and remaining away from the Refuge until the noise level returns to ambient. (Gladwin et al., 1988a, p.11)

[Note: Current personnel at Aransas NWR assert that the last statement above is not completely accurate. Whooping cranes do flush at the approach of low-altitude helicopters (or else get very alert and agitated), and they will fly to a different part of their territory, but they do not remain away from the refuge until the noise level has returned to ambient (Tom Stehn, pers. comm.)]

Another compilation of reports from National Wildlife Refuges indicates that both sandhill cranes and wood storks may experience negative impacts from low-altitude overflights:

Wintering sandhill cranes leave feeding and loafing areas (resting areas) for extended periods when low-altitude overflights take place over Cibola and Imperial Wildlife Refuges. Wood storks may also abandon habitat in response to overflights. (USFWS 1993)

In particular to whooping cranes, if the flushing and moving to a different part of their territory, demonstrated by the Aransas whooping cranes (in response to helicopter overflights), were to occur in the summer when pairs are nesting, the impacts could be extremely negative for eggs or chicks.

It is not appropriate in this document to try to present an extensive review of the literature on possible impacts on wildlife of low-level aircraft overflights. The primary purpose here is to determine whether the military operations related to the Hardwood Range represent a possible hazard to reintroduced whooping cranes in the Central Wisconsin site. One well-controlled set of experimental studies leads the principal investigator to conclude that, although the hazard to adult whooping cranes may not be excessive in this situation, the potential negative effects on young cranes and, therefore, on the survival and growth of the reintroduced population, may be significant. Fleming et al. (1996) compared impacts on waterfowl at "high noise" (from military aircraft and bombing activities) and "low noise" (control) sites. Although adult ducks did not appear to be impacted either behaviorally or physiologically by proximity to the low-level aircraft flights and bombing activities, juvenile ducks (less than one year old) who were at the "high noise" site routinely weighed less than the juvenile ducks at the control site. Also, adult pairs of black ducks produced fewer young at the "high noise" site than did adult pairs at the control site. The black duck young at the "high noise" site demonstrated "poor growth and survival." In a related experiment, mallard ducklings were played recordings of aircraft noise. The experimental ducklings showed "noise-induced depression of growth" when compared to a control group. The authors conclude that their studies support "the hypothesis of an age-dependent component in the response of waterfowl to aircraft activities." In one of the studies that was part of the series mentioned above, Temple (1993) focused on black duck reproduction in the "high noise" versus "low noise" environments. His conclusions are unequivocal:

There were no significant differences ($p > 0.05$) in pair formation, nesting chronology, and hatching and nesting success between the two study sites. Reproductive behavior (egg removal rates), duckling survival rates, and duckling growth rates were lower at PI [the high noise site] than at BI [the low noise site] ($p < 0.05$). The results of this study suggest that aircraft noise may reduce the production of young and recruitment rates of resident black duck populations nesting in HNLE [high noise level environments].
(abstract)

In summary, it is the principal investigator's opinion that, even though these studies may not generalize exactly to whooping cranes, they raise enough serious questions to conclude that the activities related to the Air National Guard's Hardwood Range constitute a potential hazard to the survival and growth of reintroduced whooping cranes and their future young in the Central Wisconsin site.

CONCLUSIONS

Analysis and synthesis of all of the information developed during this assessment lead the principal investigator to assign the following overall ratings to the three candidate whooping crane breeding sites:

Site Selection Criteria (see Appendix 1)	Candidate Whooping Crane Breeding Sites		
	Crex Meadows	Central Wisconsin	Horicon Marsh
A. Area (quantity)	2	4	2
B1. Macro-Habitat	4	4	2
B2a. Water types	4	4	3
B2b. Water pH	2	3	3
B2c. Water depth	3	3	2
B2d. Water area	4	4	4
B2e. Water quality	4	1	2
B3. Food	5	4	3
C. Sociological	5	5	5
D. Administrative	5	5	5
E1. Powerlines	3	3	3
E2. Shooting	4	2	2
E3. Human disturbance	4	3	2
E4. Contaminants	4	1	2
E5. Disease pathogens	4	5	1
E8. Aircraft disturbance	4	1	3
Unweighted Totals	61	52	44

Scale: 5 = Excellent; 4 = Very Good; 3 = Good; 2 = Fair; 1 = Poor
 Highest Possible Score: 80

[Of course, specific selection criteria could be weighted differentially by different experts, and, undoubtedly, there would be differences of opinion on the relative importance of various factors to the success of a reintroduction project. Thus, the Recovery Team may wish to discuss these criteria and their relative importance, and compare total site scores when some of the criteria receive a higher weighting than others. Based on the history of successful and unsuccessful reintroduction projects, however, it is the principal investigator's opinion that the overall rank ordering of the sites would not change based on such an exercise in the differential weighting of these criteria.]

The most important major conclusion of this study is that none of the three sites investigated during this assessment process fully meets the site selection criteria established at the beginning of the assessment project (see Appendix 1). [Note: In order to “fully meet” the established site selection criteria, a site would need to receive ratings of 5 or 4 on most criteria and no rating lower than 3 on any criterion.]

Both Crex Meadows and Horicon Marsh do not have the extent of shallow wetland habitat that was originally sought. The one area that appears to have enough shallow wetland habitat (Central Wisconsin) also has the worst profile in terms of potential risks to whooping cranes from poor water quality and contaminants. All three areas have some hazards that could pose health and/or safety problems for nesting whooping cranes and their young.

Given that none of the Wisconsin sites studied appears to be ideal, the question to the assessment team and to the Recovery Team is: If a Wisconsin whooping crane reintroduction project is to be initiated, which site offers the highest prospects for success with the lowest number of potential problems that are foreseeable at this point in time?

Based on a “preponderance of evidence” analysis, it is the opinion of the principal investigator of this study that the Crex Meadows site offers the best prospects for a successful whooping crane reintroduction project in Wisconsin. The wetland area size deficit at Crex Meadows may turn out not to be limiting to a population of 125 whooping cranes. Studies of territory size of whooping crane pairs have revealed a very large range of territory sizes. Stehn and Johnson (1987) found an average winter territory size of approximately 290 acres on the east shore of Aransas NWR in the winter of 1984-1985. Current average winter territory sizes at Aransas NWR and vicinity have increased to approximately 400 acres (Tom Stehn, pers. comm.). In contrast, Kuyt (1993) studied summer territories at Wood Buffalo National Park from 1970 to 1991 and found that territory sizes ranged from 790 acres to over 4,600 acres, with an average in relatively dense nesting areas of about 1,000 acres. So far, in the Florida whooping crane reintroduction project, nesting territory size has ranged from as little as 100 acres to as much as 1,000 acres (Marty Folk, pers. comm.). The point here is simply to emphasize that it is very hard to predict how much actual nesting area might be needed for a population of 125 whooping cranes reintroduced into Crex Meadows and vicinity. Also, it should be noted again that there are additional wetland areas outside of the three state wildlife areas that make up the Crex Meadows site complex that may provide nesting habitat as the population grows. Perhaps more importantly, Crex Meadows does not appear to have some of the more serious potential health hazards that could cause problems at both the Central Wisconsin and Horicon Marsh sites. Water quality and the possible negative impacts on young cranes of military operations are two factors that cause deep reservations about the Central Wisconsin area. The avian disease history and concerns about water quality at Horicon Marsh are also factors that raise serious questions about the suitability of that site for a whooping crane reintroduction project.

[It should be noted here that informal contacts have been made with the Minnesota Department of Natural Resources. The Minnesota DNR is positively disposed towards a whooping crane reintroduction project, and they foresee no problems if some of the cranes released in Wisconsin should wander into nearby wetland areas in Minnesota.]

RECOMMENDATIONS

Based on all of the findings of this assessment study, the following recommendations are offered:

Alternative #1. Select Crex Meadows as the Initial Wisconsin Reintroduction Site.

IF the Whooping Crane Recovery Team feels that one or more of the Wisconsin sites is acceptable,

AND if the Team feels that it is important to begin the implementation of an eastern migratory flock reintroduction project as soon as possible,

THEN it is recommended that:

- a. Crex Meadows and vicinity should be selected as the initial (if not only) reintroduction site for a new population of migratory whooping cranes;
- b. Contingency plans should be developed for the possibility that the reintroduced population will “outgrow” the available good habitat in the Crex Meadows vicinity; and
- c. Assessment activities should continue at the other two candidate sites and, perhaps, at other sites not yet considered, in order to complete a better picture of possible “secondary reintroduction sites” if the new population of cranes begins to outgrow the available good habitat in the Crex Meadows vicinity. [Note: studies at Horicon Marsh and Central Wisconsin might focus on the potential negative factors noted in this assessment report. For example, at the Central Wisconsin site, controlled experiments with sandhill cranes might further clarify the potential hazard situation posed by the military overflight and bombing activities related to the Hardwood Range. At Horicon Marsh, further studies might clarify the risks posed by potential disease pathogens and potential water quality problems.]

Implementation of Alternative #1 will take advantage of the very positive socio/political climate supporting a whooping crane reintroduction project in Wisconsin. Alternative #1 also will minimize the known negative factors related to the sites investigated during this assessment project. On the other hand, the Crex Meadows site is not ideal in terms of the established site selection criteria, and there are some known potential hazards (e.g., lead shot residue and powerlines) that could pose problems for a successful reintroduction project.

Alternative #2. Continue to Search for a More Ideal Whooping Crane Breeding Site.

IF the Whooping Crane Recovery Team feels that none of the Wisconsin sites is acceptable, **AND** if the Team feels that additional time spent in searching for a better site will be worth it in the long run,

THEN it is recommended that:

- a. Site assessment activities should be expanded beyond Wisconsin to other possible U.S. and Canadian sites;
- b. To avoid possible mixing with the Aransas/Wood Buffalo population, the areas considered should be even farther to the east than western Wisconsin; and
- c. Specifically, areas in Ontario and the Upper Peninsula of Michigan should be investigated.

Implementation of Alternative #2 may cause delays in the timetable for the overall Whooping Crane Recovery Program. On the other hand, if a more suitable nesting area can be found, the chances for a successful eastern migratory population reintroduction project will increase.

Supporting Recommendations

- A. Regardless of which of the above alternatives is selected, it is recommended that a Whooping Crane Wintering Site Survival Study be initiated as soon as feasible at the selected wintering site. Captive-raised whooping cranes would be released at the wintering site without being led on migration south. These birds would be studied to assess the adequacy of the selected site to support introduced wintering whooping cranes before extensive investments are made in training whooping cranes to migrate to the selected site. Later, when migrating cranes are brought to the site (assuming that the survival study yields positive results), the survival-study birds could remain as role models for survival at the site; or these birds could be removed if it were determined that their presence would be detrimental to the objectives of the migratory population introduction project.
- B. It is recommended that migration training experiments, using sandhill cranes as surrogates, be conducted using the selected migration corridor. The end points of the migration route could be varied somewhat to accommodate the different habitat preferences of sandhill cranes (e.g., an alternate wintering site might include more upland habitat and access to waste grain feeding resources).

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