South Dakota Statewide Colonial and Semi-colonial Waterbird Inventory with a Plan for Long-term Monitoring

Final Report

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EXECUTIVE SUMMARY

Colonial and semi-colonial waterbirds prefer to breed in high-density groups in a relatively small number of locations, favoring predator-free habitats such as flooded timber, islands, and marsh reedbeds. However, this 'all eggs in one basket' breeding strategy makes these species vulnerable to natural or manmade catastrophic events that could wipe out a large portion of the breeding population. In addition, populations have been reduced because of land-use changes leading to wetland loss, bioaccumulation of toxins, and degradation of wintering habitat. Thus many of these species are the focus of conservation efforts throughout North America.

Thirty-three species of colonial and semi-colonial waterbirds breed in South Dakota, including herons, night-herons, egrets, grebes, gulls, terns, White-faced Ibis, American White Pelican, Double-crested Cormorant, and eight shorebird species. Identifying and monitoring breeding colonies are the primary tools for tracking populations. Yet, no systematic inventories or monitoring of waterbird colonies are conducted in South Dakota, impeding the ability of conservationists to manage this vulnerable group of birds. Therefore, the first objective of the South Dakota Colonial and Semi-Colonial Waterbird Inventory and Monitoring Project was to compile an up-to-date list or inventory of waterbird breeding sites. To accomplish this, 1025 sites were surveyed for 46 species of breeding waterbirds during the summers of 2005 - 2007. Of these, 405 sites (39.5%) had confirmed breeding by waterbirds during at least one year. Of those sites with no breeding waterbirds, 43% had suitable habitat while 26.5% had extremely low water levels or were dry. While conducting the surveys, this project also collected data on colonial waterbird breeding population size at each site. Twenty-six sites were identified as being important sites for breeding waterbird colonies, defined as having more than 200 total waterbird breeding pairs and/or more than five breeding species.

Of 46 waterbird species targeted during surveys, breeding was confirmed for 32 species, individuals of another nine species were seen in appropriate habitat but breeding was not confirmed, and five species (Horned Grebe, Bufflehead, Hooded Merganser, King Rail, and Yellow Rail) were never observed during the survey. American White Pelicans and Double-crested Cormorants were the most abundant nesting colonial waterbirds in the state. Great Blue Herons were distributed in the greatest number of colonies of any species and were the most common waterbird in West River. The inventory and associated population information produced from this project will provide baseline data for future monitoring efforts, as well as contribute to regional and national waterbird conservation efforts.

The second objective was to develop a long-term statewide monitoring plan. Monitoring populations will guide waterbird conservation planning, help establish management and research priorities, and serve as a basis for evaluating management actions. Issues that complicate monitoring of breeding colonial

waterbirds in South Dakota include the relative rarity of colonies compared to available habitat, the ephemeral nature of breeding habitat and thus of some colonies, the enormous number of wetlands in South Dakota, and wet-dry climatic cycles which cause dramatic changes in the composition and number of wetlands across the landscape. As a result of these factors, most recommended sampling and statistical designs for monitoring breeding colonies are not practical for South Dakota's statewide monitoring program.

The goal of monitoring South Dakota's breeding colonial waterbirds is to collect information, on a continuous basis and over a long period of time, which managers and landowners can use to manage and conserve colonial waterbirds and to aid in the prevention of future declines of colonial waterbird species that breed in South Dakota.

Specific objectives include:

1. Improve information on conservation status of breeding colonial waterbirds in South Dakota,
2. Identify and track factors that could result in a decline of colonial waterbird species that breed in South Dakota,
3. Determine what and how management actions impact breeding populations,
4. Provide information to aid management of waterbird-fisheries conflicts, and
5. Ensure compatibility with regional and national monitoring efforts.

Monitoring will have two components - monitoring known colonies and searching for new colonies. The state is divided into eight regions, based on each area's wetland resources and demonstrated importance for breeding waterbirds; regions of higher importance will be monitored more intensely than regions of lower importance. New colonies will be identified by soliciting information from biologists and the public, and conducting aerial surveys along transects across the region(s) of interest. Ground visits to colonies will collect data on species presence and abundance, habitat, threats, and other variables that address the objectives.

This monitoring plan will be implemented and coordinated under the lead of the Wildlife Diversity Program, Division of Wildlife, South Dakota Department of Game, Fish, and Parks. A pilot project in 2007 showed that it would be feasible to establish a citizen-scientist volunteer colony monitoring program in the state. However, there are not enough volunteers and they are not distributed widely enough to monitor all colonies. Many federal, tribal, and state agencies, organizations, and individuals could potentially play a role in colony monitoring. Coordination among these groups will achieve greater coverage and ultimately, conservation success.

This monitoring plan should be reevaluated in five years, and then every five - ten years thereafter, to reassess goals and objectives, to update the plan with new developments and information in statistics, modeling, and research, and to evaluate the ability of each aspect of the plan to meet objectives and contribute to the conservation of colonial waterbirds in South Dakota.

ACKNOWLEDGEMENTS

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INTRODUCTION

South Dakota hosts thirty-three species of breeding colonial and semi-colonial waterbird and shorebird species (Tallman *et al*. 2002). Some of these species are locally rare or uncommon in South Dakota and therefore important from a state natural heritage perspective. Others are fairly common within the state but are important from a global perspective as they comprise core portions of the worldwide populations of these species (Beyersbergen *et al.* 2004). These waterbird species nest almost exclusively in predator-free wetland habitats such as flooded timber, islands, and marsh reedbeds. Because these habitats are relatively rare and patchily distributed, these species tend to nest in high densities in relatively few locations. Colonial species always nest in mixed- or single-species colonies while semi-colonial species may nest by themselves, depending on circumstances. Many of these species return repeatedly to their previous breeding site and colonies can persist for decades, if conditions remain favorable. The colonial breeding habits of these species make them especially vulnerable to severe weather events, disturbance, pollution, changes in land use, and other factors that affect the availability and suitability of nesting and brood-rearing sites (Kushlan *et al*. 2002). As a result, these bird groups have become the focus of a variety of conservation and management efforts at a national and regional scale (Brown *et al*. 2001, Kushlan *et al*. 2002, Beyersbergen *et al*. 2004).

Two critical elements of an efficient and effective waterbird conservation strategy are to assess population status of each species and then to establish long-term monitoring programs (Steinkamp *et al.* 2003). Identifying and monitoring breeding colonies are the primary tools for tracking populations. Yet, except for annual surveys of Least Terns and Piping Plovers nesting along the Missouri River, no systematic inventories or monitoring efforts of colonial or semi-colonial waterbirds are conducted in South Dakota, impeding the ability of conservationists to manage this vulnerable group of birds (Bakker 2005). Therefore, the first objective of the South Dakota Colonial and Semi-Colonial Waterbird Inventory and Monitoring Project was to compile an up-to-date inventory of waterbird breeding sites by conducting statewide field surveys in 2005 - 2007. The resulting inventory and associated population information will provide baseline data for future monitoring efforts, as well as contribute to regional and national waterbird conservation efforts. The second objective was to develop a long-term statewide monitoring plan. Monitoring population trends will guide waterbird conservation planning, help establish management and research priorities, and serve as a basis for evaluating management actions.

This report is divided into two sections to reflect the two objectives of the South Dakota Colonial and Semi-Colonial Waterbird Inventory and Monitoring Project. Part I summarizes the results of the three-year field surveys, presenting information both on important waterbird breeding sites as well as individual species accounts. Part II, the discussion section of this report, presents a long-term state-wide monitoring plan.

METHODS

SPECIES

Species targeted during this project included all colonial and semi-colonial waterbird species that potentially could breed in South Dakota, plus several other rare or little-known wetland-dependent, solitary nesting species (Appendix A). These included all heron, night-heron, egret, grebe, merganser, rail, bittern, gull, and tern species, White-faced Ibis, American White Pelican, Double-crested Cormorant, Bufflehead, eight shorebird species, and two wetland-dependent threatened raptor species (Osprey, Bald Eagle). Caspian Tern and Trumpeter Swan were not on the original list but our surveys found enough breeding pairs to warrant being added to this report. Scientific names of all species are listed in Appendix A.

At the beginning of this project, species were prioritized into three groups to help determine the amount of effort that would be exerted during surveys (Appendix A). Priorities were based on presence on other priority lists, rarity, degree of coloniality, completeness of knowledge about nesting locations within the state, and perceived vulnerability to breeding site disturbances. Tier 1 species were high priority and this project targeted all known breeding sites as well as sites with high potential for hosting the species. Tier 2 species were of moderate priority and this project targeted known major colonies and sites with high potential importance for the species. Tier 3 species were low priority and this project did not specifically target their breeding sites, but incidental observations were recorded during visits.

SITE SELECTION FOR SURVEYS

Before the 2005 field season, we compiled a list of historical breeding sites of all targeted waterbird species from state databases, primarily the Breeding Bird Atlas and the South Dakota Natural Heritage Program (South Dakota Game, Fish, and Parks 2005), published records in *South Dakota Bird Notes*, and information from federal, state, tribal and university biologists, and private citizens. The final list, excluding Least Tern and Piping Plover river colonies, contained 275 historical sites. All historical sites with sufficiently detailed location data were visited at least once during the 2005 - 2007 field seasons. In addition, on April 16, 2005 we flew aerial surveys along the James River, the Missouri River between Yankton and Elk Point, and the Big Sioux River south of Canton to search for new tree-nesting colonies. During each field season we added new sites that were encountered incidentally or reported by others. During the summers of 2006 and 2007, we returned to all sites that had confirmed waterbird breeding or non-active old nests in the previous year. We also returned to all sites that appeared to have suitable waterbird breeding habitat and breeding conditions in a previous year but no confirmed breeding. These sites were revisited to determine whether we missed a breeding species during visits or whether these sites truly did not host breeding waterbirds. In addition, we attempted to visit all Game Production Areas (GPAs) and Waterfowl Production

Areas (WPAs) that were larger than 80 acres in size and reportedly had wetlands (South Dakota Game, Fish and Parks 2003).

SITE SURVEYS

For each site targeted to be visited, locations of possible suitable habitat and access points were identified from the South Dakota Atlas and Gazetteer (DeLorme 2004), aerial photographs downloaded from the South Dakota Game, Fish and Parks web site (*www.sdgfp.info/Wildlife/PublicLands/PubLand.htm*, accessed spring 2006 and spring 2007), or directions from previous observers. If the entire wetland or wetlands could not be viewed from one location or from roads, observers walked or canoed to survey all appropriate habitat. Motorized fishing boats or airboats were used to survey Sand Lake and Renziehausen GPA (Brown Co.), Red Lake (Brule Co.), Waubay and Bitter Lakes (Day Co.), and Lake Oahe colonies.

At each location, site-specific information was collected, regardless of whether any waterbirds were present. Information included location data (latitude and longitude, legal description, and directions to site), ownership and management if known, wetland type and condition, presence of appropriate breeding habitat (marsh, flooded timber, or islands), species sighted, and evidence of breeding.

If water was present, observers spent at least 15 minutes at a site looking for adults, nests, and prefledged chicks of any of the targeted species. At marshes, we played a CD of rail and bittern vocalizations to try to elicit responses from those species. If adults of any targeted species were located, number and behaviors of adults were noted. If adult behavior showed evidence of breeding (carrying food, mating or distraction displays, agitated response to observers), we revisited the wetland to try to confirm breeding. Breeding was confirmed if at least one nest or prefledged chick was present. Major breeding colonies were revisited at least one additional time later in the season to determine colony success, usually by viewing the colony from a distance. At the end of the season, we classified all visited sites as active, non-active, unknown, or no evidence of breeding (Table 1).

TABLE 1. Definitions of status categories of surveyed sites.

Status Category	Definition
Active colony	Breeding confirmed (nest, prefledged chick) for at least one targeted species.
Non-active colony	Old nests present but not used by waterbirds in current season.
Unknown	Could not definitively determine status because of incomplete views, or species present and possibly breeding but breeding not confirmed.
No evidence of breeding	Determined that no waterbirds breed at site because of one of following reasons: habitat not suitable; no individuals of targeted species present; species present but behavior did not indicate breeding at that site plus no nests or prefledged chicks found.

BREEDING POPULATION COUNTS

If any targeted species was breeding at a site, we counted the breeding population, measuring the parameter appropriate for that species and using the protocol that would cause the least disturbance yet yield a relatively accurate count (Appendix A). When possible, we counted from outside the colony using binoculars or spotting scopes. If a colony needed to be entered, we limited time in the colony to less than 30 minutes and entered only under favorable weather conditions (not raining, air temperature between 70°–85° F). In addition, colonies were entered only when most nests were in late incubation or early chick stages of breeding. Pelican colonies were not entered because they are extremely sensitive to human presence (Evans and Knopf 1993); nests were counted from aerial photos taken by U.S. Fish and Wildlife staff. At most colonies, two observers counted simultaneously and their counts were averaged. If the two counts differed by more than 10%, both observers recounted. However, at very large multi-species colonies, only one observer counted a particular species or transect to minimize in-colony time and disturbance to nesting birds.

Counting protocols for all species but secretive marshbirds followed those of Steinkamp *et al*. (2003). Choice of the appropriate protocol to use at a particular colony depended on habitat type, colony size, and species composition. Details are as follows.

Total nest count: A total count of all active nests is the most accurate measurement of the number of breeding pairs in a colony (Steinkamp *et al*. 2003). Thus, active nests was the parameter we measured whenever possible. An active nest was any nest with attending adults, eggs, chicks, or fresh fecal matter. If the contents of a nest was not visible (e.g., nest high up in tree) and no adult was at the nest, we considered the nest active if it was approximately the same size and condition as other active nests in the colony. Total nests counts were conducted at all colonies with tree-nesting species, i.e., those with any heron, egret, night-heron, or raptor species, or Double-crested Cormorants, as well as at colonies of open-water nesting Eared Grebes. We also counted all nests of ground-nesting gull and tern species in colonies with <~100 nests and island-nesting shorebirds. We attempted to count all nests in marsh-nesting grebe and tern colonies, but in the cases of large colony size or dense vegetation, other protocols were used (see below).

For colonies whose nests were in leafless trees, observers positioned themselves so that the entire colony could be counted from one spot to avoid double-counting nests and from outside the perimeter to avoid undue disturbance. Because many Great Blue Heron nests were in live cottonwood (*Populus deltoides*) trees, every effort was made to visit the colony in early spring before leaf-out so that the nests could be counted from outside the perimeter. A small number of colonies with tree nests were too large or too dense to be counted from outside the perimeter. Using flagging tape, these colonies were divided into strip transects 10 - 40 m wide, depending on tree

and shrub density. One observer per transect counted all nests in all trees and shrubs with trunks within their transects.

If ground nest colonies needed to be entered, each ground nest was marked with a small dot of spray paint as it was counted to avoid double-counting or missing nests. In marshes, we traveled all open water channels to search for nests and watch for adult behavioral cues to nest locations.

Brood count: Three groups of target species have precocial young - grebes, shorebirds, and waterfowl. The nests of these species usually were hard to find or access, and counting broods as they accompany their parents often is a more accurate parameter for assessing the size of the breeding population. Grebe and merganser broods were surveyed by systematically searching open water patches and channels. If shorebirds were present, we searched for chicks along shorelines and islands. In grebe colonies, we often found both nests and broods during the same visit. The counts of these two parameters were added together to obtain an estimate of the total breeding population.

Adult flush count: Number of adults was the parameter used as measure of breeding population size for *Laridae* species' colonies >~100 nests and marsh colonies of reedbed-nesting herons, night-herons, egrets, or White-faced Ibis. To estimate the number of adults, colonies were approached until adults flushed off nests. Observers quickly counted the number of adults before birds begin to settle back down or fly away, using a rapid flock size estimation technique (Bibby *et al*. 1992). We assumed that every bird flushed was a breeding adult in that colony and that both parents were present. Thus the total number of flushed adults was divided by two to estimate the number of breeding pairs. These assumptions most likely are never true; limited studies have shown that the divisor is less than two (i.e., both parents of every nest are not present) but the exact number is highly variable, depending on site, species, and nesting stage (Steinkamp *et al.* 2003). Because we lacked this information in surveyed colonies, we used the both-parents-present assumption to produce a more conservative estimate of number of breeding pairs. When flush counts were employed, breeding status was not considered confirmed unless we found at least one active nest or prefledged chick.

Perimeter counts of large ground-nesting colonies and flush counts of large adult aggregations tend to be less accurate because of large numbers counted in a short period of time (Steinkamp *et al*. 2003). Results from these counts are indicated in this report by the '~' symbol.

Callbacks of taped vocalizations: Rails and bitterns are best surveyed by encouraging birds to call back to taped vocalizations (Conway and Gibbs 2005). We played taped vocalizations of targeted rail and bittern species at all wetlands with suitable marsh habitat using a CD player and Panasonic RP-SPT70 portable speakers. Vocalizations were broadcast in the sequence Least Bittern, Yellow Rail, Sora, Virginia Rail, and American Bittern. Taped vocalizations were provided by C.

Conway of the University of Arizona. In addition, we conducted secretive marshbird point surveys following national protocols (Conway 2004) at three sites in 2006 (66 points at Sand Lake National Wildlife Refuge, 10 points at Putney Slough No. 3 GPA, and 15 points at Renziehausen GPA) and at Sand Lake (10 points) and at Putney Slough (10 points) in 2007. The CD used during point surveys started with 5 minutes of silence, followed by one minute for each species in the same sequence as listed above.

DATABASES

Site- and species-specific data from this project are stored with the South Dakota Natural Heritage Program, Department of Game, Fish and Parks, Pierre, SD and at the Fort Collins, CO branch office of the Rocky Mountain Bird Observatory.

RESULTS

SITES

During the 2005 - 2007 field seasons, a total of 1025 different sites were surveyed for the presence of breeding waterbirds (Figure 1). Of these, 405 sites (39.5%) had confirmed breeding by waterbirds in at least one year, 15 sites (1.5%) had non-active nests in at least one year and were never active during surveys, 567 sites (55.3%) never had evidence of waterbird breeding, and breeding status at 38 sites (3.7%) was never confirmed, despite repeated visits (Table 2, Figure 1).

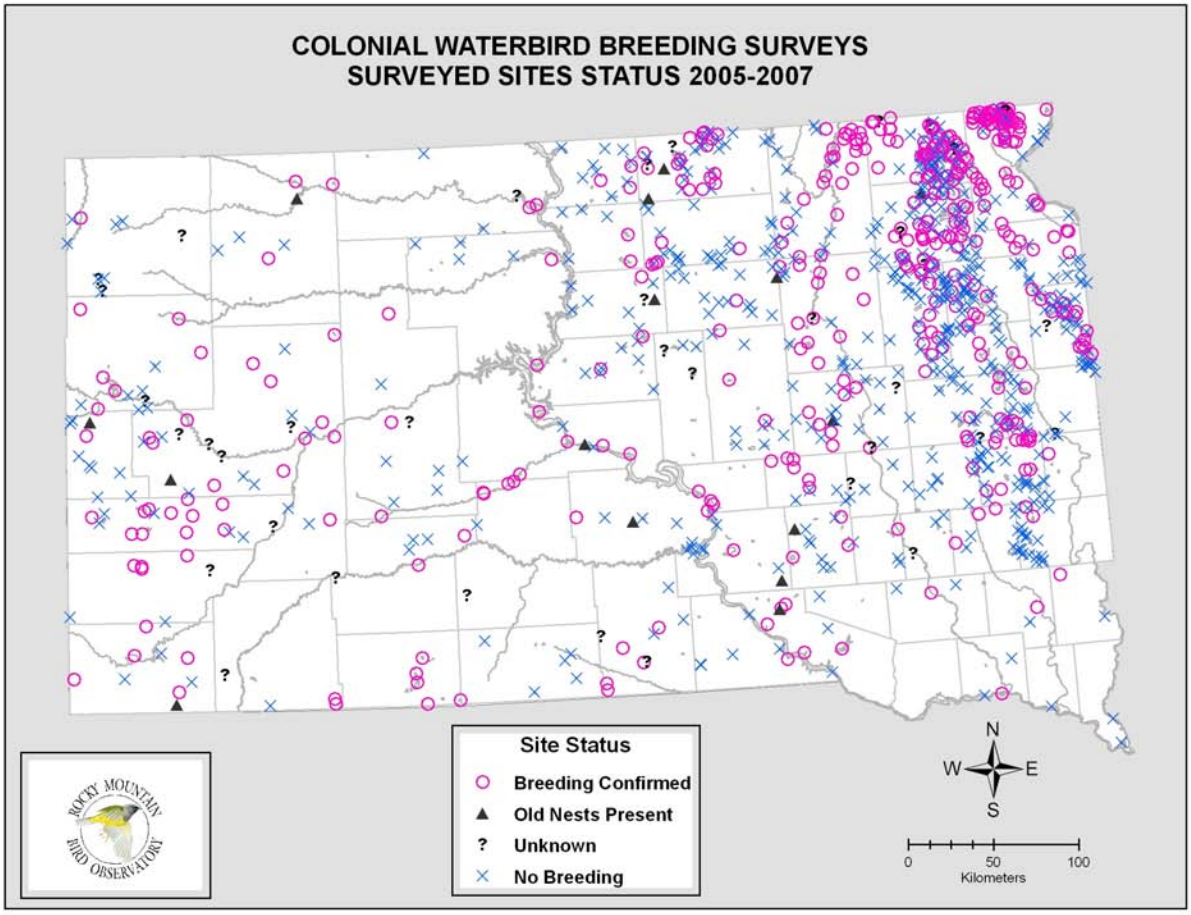
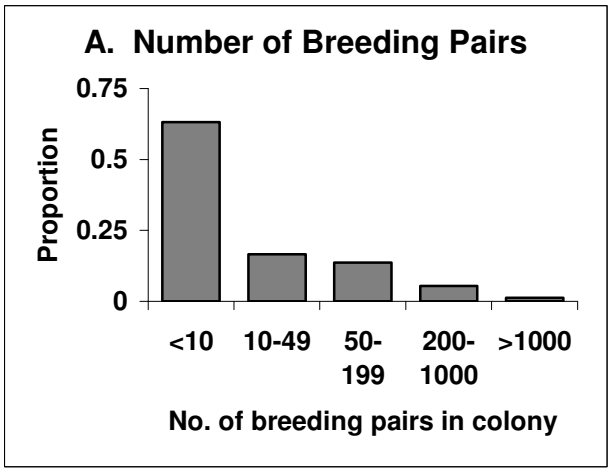


FIGURE 1. Locations of wetlands surveyed 2005 - 2007 and their status. Confirmed Breeding (active) sites are those confirmed in at least one year, even if they were a different status in other years. See Table 1 for definitions of status categories.

TABLE 2: Summary of 2005-2007 field seasons.

	2005	2006	2007
Survey dates	April 15-July 29	April 14-July 27	March 27-July 28
Number of active sites	160 (39.2%)	247 (45.4%)	292 (41.4%)
Number of non-active sites	17 (4.2%)	16 (2.9%)	22 (3.1%)
Number of sites classified as unknown	50 (12.2%)	58 (10.7%)	28 (4.0%)
Number of sites - no evidence of breeding	181 (44.4%)	223 (41.0%)	364 (51.6%)
Total number of sites surveyed	**408**	**544**	**706**

Important Colonial Waterbird Breeding Sites: Total number of waterbird species confirmed breeding at a site ranged from 1 – 15 species, while total number of confirmed breeding pairs of all species combined at a site ranged from one to almost 22,500 pairs (Figure 2). A total of 24 sites (5.9% of active sites) had ≥200 pairs in at least one year, while 12 sites (3.0% of active sites) had >5 species breeding in at least one year (Table 3). Combined, a total of 26 sites (6.4% of active sites) were in one category and/or the other. Three of these colonies were located on federal public land, seven on state public land, and eight on private land. An additional five colonies on private land straddled federal public land (1 colony), state public land (3 colonies), or tribal land (1 colony). Ten of the 26 colonies were newly-discovered during this project.



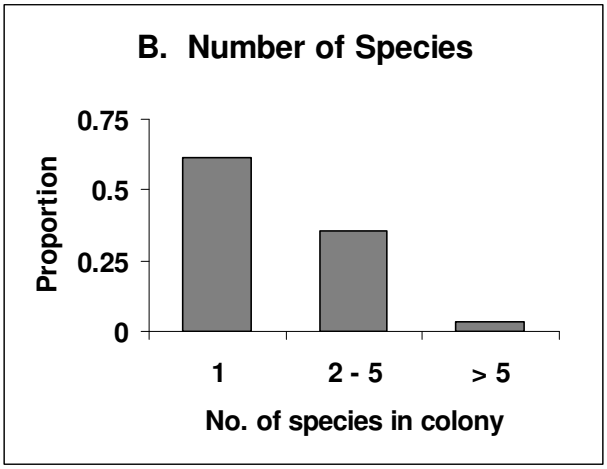


FIGURE 2. Frequency distributions of South Dakota colony sizes 2005 - 2007. For colonies surveyed more than once, only the highest total was used in this analysis. Figure 2A: Proportion of colonies per category of total number of breeding pairs of all species in the colony. Figure 2B: Proportion of colonies per category of total number of species in colony.

TABLE 3. Summary of important Colonial Waterbird breeding sites in South Dakota documented during this study.

	2005	2006	2007
Number sites with > 200 confirmed breeding pairs	14	20	17
Highest number of waterbird pairs at one site	~11,529	~19,117	~22,488
Number sites with > 5 breeding waterbird species	6	6	9
Highest number of breeding species at one site	13	12	15

Colony Failures: Of the active colonies, we observed subsequent total breeding failure at nine sites (Appendix B) - six colonies in 2005, two in 2006, and one in 2007. In 2005, mid-summer rains flooded ground or marsh nests in four colonies, while nests in two tree colonies were abandoned because of human disturbance. These failures affected egrets, Little Blue Heron, White-faced Ibis, cormorants, and night-herons, as well as a small number of Eared Grebes and Western Grebes. In 2006, one colony failed because a marsh dried out allowing predators to access nests, while the second colony was abandoned because of human disturbance. In 2007, July floods again washed away marsh nests, although some nests may have fledged before flooding began. This event affected cormorants, egrets, ibis, night-herons, Franklin's Gulls, and Forster's Terns.

Habitat Conditions: Documentation of habitat conditions at surveyed sites with no evidence of breeding by targeted species indicated that 43% had suitable nesting habitat and water levels (Table 4). Of the remaining sites, 26.5% had extremely low water levels (basin dry, islands no longer isolated, marsh vegetation no longer in water, or nesting trees now on shore), 6.1% had extremely high water levels (islands or marsh vegetation completely under water), 18.2% had an absence of suitable nesting habitat (e.g., no flooded timber, trees down, no marsh, or no mudflats), 3.1% had been converted to housing developments, and 2.1% had been converted to agriculture.

TABLE 4: Habitat conditions at sites with no evidence of breeding by targeted species. Some sites visited in multiple years may be listed in more than one category if habitat conditions changed. See text for definitions of habitat conditions.

Site Habitat Condition	**2005**	**2006**	**2007**
Suitable nesting habitat present	35.9 %	42.6%	50.6%
Unsuitable for breeding because:			
Extremely low water levels or completely dry	30.4%	30.0%	22.0%
Extremely high water levels	2.2%	5.4%	10.7%
Absence of suitable nesting habitat	19.9%	21.1%	13.5%
Converted to housing developments	5.5%	0.9%	3.0%
Converted to agriculture	6.1%	0.0%	0.3%
Total Num Sites - no evidence of breeding	**181**	**223**	**364**

SPECIES

Of 46 waterbird species targeted during surveys, breeding was confirmed for 32 (Table 5, Appendix C). Detailed results for each species are presented in Appendix C. Individuals of four lower priority species (Spotted Sandpiper, Wilson's Snipe, American Bittern, Least Bittern) were detected throughout the state but efforts were not made to find nests and breeding was not confirmed. Individuals of another five species (Yellow-crowned Night-heron, Tricolored Heron, Clark's Grebe, Piping Plover, Least Tern) were seen in appropriate habitat but breeding was not confirmed, despite efforts to find nests or broods (Appendix C). Five species (Horned Grebe, Bufflehead, Hooded Merganser, King Rail, and Yellow Rail) were never observed during the survey.

American White Pelicans and Double-crested Cormorants were the most abundant nesting colonial waterbirds in the state, with maximum yearly total counts of more than 17,700 pelican pairs and almost 9,100 cormorant pairs (Table 5). In addition, known total breeding populations of Ring-billed Gulls, Great Egrets, Great Blue Herons, Eared Grebes, Cattle Egrets, and Franklin's Gulls were each greater than 1,000 pairs. Great Blue Herons were distributed in the greatest number of colonies of any species (115 different colonies), followed by cormorants (96 colonies), and the four grebe species - Pied-billed Grebes (87 sites), Western Grebes (45 colonies), Red-necked Grebes (42 sites), and Eared Grebes (32 colonies) (Table 5).

For many colonial species, most breeding pairs known in the state were nesting in a small number of colonies (Table 5). Thirteen of 19 colonial species were confirmed to be breeding at less than 20 locations in the state, including 10 of 12 top-priority, Tier 1 colonial species. All colonial species, except Great Blue Heron and Double-crested Cormorant, had at least one colony that contained at least 25% of the known total yearly state breeding population (Table 5, last column).

TABLE 5. Total known breeding population size, number of breeding sites, and number of large colonies for 32 species for which breeding was confirmed. Breeding population size is given as the minimum and maximum yearly count of known pairs over the three year survey period. Large colonies are those with >25% of the known state population in at least one year. See Appendix C for detailed species accounts.

Species	Total No. Known Breeding Pairs (3 year min-max)	Total No. Known Breeding Sites	No. Colonies with >25% population
TIER 1 species			
Great Blue Heron	905 - 1691	115	0
Little Blue Heron	0 - 2	2	2
Green Heron	1	1	N/A
Black-crowned Night Heron	~222 - ~281	12	3
Great Egret	1658 - 2241	18	2
Snowy Egret	158 - 510	8	4
White-faced Ibis	~53 - ~162	7	4
American White Pelican	~8760 - ~17,137	2	1
California Gull	~70 - ~481	3	3
Franklin's Gull	~250 - ~1350	4	3
Common Tern	~41 - ~91	6	5
Caspian Tern	0 - ~22	2	2
Black Tern	~54 - ~122	22	3
Red-necked Grebe	11 - 42	42	N/A
Black-necked Stilt	0 - 1	1	N/A
TIER 2 species			
Double-crested Cormorant	~5060 - ~9094	96	0
Ring-billed Gull	~2070 - ~4757	4	1
Forster's Tern	~45 - ~105	7	3
Eared Grebe	283 - 1581	32	2
Western Grebe	132 - 382	45	3
American Avocet	10 - 19	21	N/A
Marbled Godwit	0 - 8	8	N/A
Willet	0 - 2	3	N/A
Wilson's Phalarope	0 - 2	2	N/A
TIER 3 species			
Cattle Egret	~783 - ~1338	10	4
Pied-billed Grebe	23 - 117	87	3
Common Merganser	1 - 2	1	N/A
Trumpeter Swan	0 - 1	2	N/A
Virginia Rail	0 - 1	1	N/A
Sora	1 - 4	6	N/A
Bald Eagle	6 - 8	14	N/A
Osprey	1	2	N/A

SOUTH DAKOTA LONG-TERM COLONIAL WATERBIRD MONITORING PLAN

PURPOSES of this monitoring plan:

1) Describe the elements of a well-designed monitoring plan,
2) Outline current regional and adjacent states' monitoring efforts,
3) Describe issues that complicate colonial waterbird monitoring in SD,
4) List goals and objectives of long-term colonial waterbird monitoring in SD,
5) Present a framework for sampling and outline of protocols, and
6) Make recommendations on implementation and coordination of the plan.

DESIGNING A MONITORING PROGRAM

The purpose of monitoring, as defined by the South Dakota Wildlife Action Plan (2006) is to check on the status of resources and progress towards stated goals or objectives. In this case the 'resource' is statewide breeding populations of colonial waterbirds. A well-designed monitoring plan results in collecting the right type of data that will aid in species conservation while a poorly-designed plan wastes money and resources. Ideally, a state-wide plan, including the objectives, goals, and sampling design and methods, should be in line with regional and continental efforts so that data collected in South Dakota can be used in larger-scale colonial waterbird species assessments.

A bird monitoring plan should have the following elements (adapted from Steinkamp *et al*. 2003, Tear *et al.* 2005, NABCI Monitoring Subcommittee 2007).

1) **Clearly-defined, unambiguous goals**. Monitoring goals are statements by the people of South Dakota and SD Game, Fish, and Parks of why they want to monitor breeding colonial waterbirds. Goals should explicitly relate to management and conservation of colonial waterbirds and lead to specific objectives.

2) **Objectives**. Monitoring objectives specify what information is needed to achieve the goals, i.e., to achieve conservation success. They should be specific and they should be based on science, not on feasibility. For conservation purposes, there should be both long-term and short-term objectives.

3) **Performance indicators.** Indicators tell if progress is being made in meeting the objectives. They must be measurable, consistent over time, and sensitive enough to detect changes.

4) **Sampling Framework and Methods**. Monitoring should be carried out at the appropriate scale, scope, and intensity to address the objectives. The framework describes what will be measured, how samples will be chosen, and when and where monitoring will occur. The methods should be accurate, precise, cost-effective, and feasible. If possible, the analytical methods and database needs should also be described.

5) **Coordination**. Multiple agencies, organizations, and people usually participate in large-scale, long-term monitoring . The monitoring plan should identify probable participants and designate responsibilities for each group.

CURRENT REGIONAL AND NEIGHBORING STATE MONITORING EFFORTS

Ideally, South Dakota's waterbird colony monitoring efforts will be consistent with regional and national monitoring efforts. However, large-scale colonial waterbird monitoring planning, funding, and implementation is still in its infancy, despite almost 10 years of efforts to initiate waterbird conservation across the continent (Kushlan *et* al. 2002, Bart 2006). This section briefly describes current efforts that apply to the northern Great Plains region.

Recently the National Audubon Society (2007) published recommendations on a framework for colonial waterbird conservation and Bart (2006) presented a sampling design for monitoring. Both use a site-based approach which is modeled after an international program, Ramsar Sites of International Importance (Matthews 1993). This habitat-based conservation approach is based on the premise that if all major wetlands are protected, then waterbird species will be protected. Thus, it emphasizes the identification of major colony sites or potential sites and then continual monitoring of this list of sites. The National Audubon Society compiled a list of 587 waterbird Important Bird Areas (IBAs) in the U.S. (*http://www.audubon.org/bird/waterbirds/sites.html* accessed 12/28/07). They do not list any waterbird IBAs in North or South Dakota. Bart (2006) drafted a sampling framework for aquatic bird monitoring in which all highly-important wetland sites within each state are compiled into a database and monitored often while all other wetlands are not delineated. He and his colleagues created a list of possibly important wetlands for every state, for a total of 1984 'designated' sites in the U.S.; 21 are in South Dakota (*http://greatbasin.nbii.gov/marshbird_docs.htm*). Although this approach may be feasible in areas with few wetlands such as the arid West, it is unknown whether any states or regions will implement his recommendations.

For actual monitoring, individual states, which have the primary responsibility for species conservation, have been less active, primarily because of lack of funds, personnel, and feasible sampling schemes (Table 6). All state natural resource agencies or natural heritage programs maintain a list of known waterbird colonies

gathered from incidental reports, breeding bird atlas surveys, research projects, and other miscellaneous sources. Colorado and Wyoming have relatively few wetlands and almost all can be efficiently surveyed and monitored. In Colorado, almost all colonies are monitored annually by volunteers and in Wyoming, state natural resource staff annually monitor most of that state's colonies. In states adjacent to South Dakota, two (Nebraska and Iowa) are initiating volunteer colony monitoring programs. Only Wyoming is known to search for new colonies, and then primarily in cases where Great Blue Heron colonies disappear and staff try to determine the new colony location (A. Cerovsky, *pers. comm.*).

TABLE 6. Current monitoring efforts in the region. Regional efforts are recent recommendations and have yet to be implemented. Information for state efforts received from personal communications with state non-game coordinators.

	Systematically monitor current colonies?	Systematically survey for new colonies?	Coordinator	Who monitors?
Regional				
Nat. Audubon Waterbird IBAs	not specified	no	National Audubon	not specified
Bart 2006	yes?	no	not specified	not specified
State				
Nebraska*	not yet	no		sporadically by NE G&P, in future-volunteers
Iowa*	some	no	IA DNR	volunteers
Minnesota	no	no	MN DNR	sporadically by MN DNR
North Dakota	no	no		----
Wyoming	yes	?	WY G&F	WY G&F
Colorado	yes	no	RMBO	volunteers

* Volunteer Colony Monitoring Programs in planning or organizing stages

ISSUES THAT COMPLICATE COLONY MONITORING IN SD

Monitoring populations of colonially-nesting waterbirds in South Dakota has two components - monitoring known colonies and finding new colonies. Several issues complicate the execution of these components.

BREEDING BIOLOGY OF COLONIAL WATERBIRDS. Colonial waterbird nests are distributed in a highly local and clumped manner compared to most landbird species. For example, 500 pheasant nests may be distributed in 500 different fields whereas 500 egret nests may all be located in one spot. For the South Dakota Colonial Waterbird Inventory Project, we surveyed over 1,000 sites most likely to host colonies (historical colony sites, large wetlands, GPAs and WPAs) and 13 species each were found breeding at <20 sites (Table 5, Figure 1). American White Pelicans, with a peak of 17,000 breeding pairs, nested at only two locations (0.2% of surveyed sites). For this reason, standard breeding landbird survey and monitoring methods - point counts or transect methods such as the Breeding Bird Survey routes, do not adequately detect waterbird colonies (Kushlan *et al.* 2002, Steinkamp *et al*. 2003). Landbird protocols are based on randomly placed points or transects in the proper habitat, but because there are so few waterbird colonies even in suitable habitat, the odds of a random point or transect falling next to a colony are very small.

A second characteristic of colonial waterbirds is that they establish traditional breeding colonies to which they return year after year, sometimes for many decades, as long as the quality of the colony site and surrounding foraging areas are maintained (Kushlan *et al.* 2002). For example, cormorants nested almost every year on Waubay Lake from at least 1910 until the mid-1990s when high water inundated their island colony (Lundquist 1932, 1949). Traditional colonies tend to be larger and to experience higher reproductive success than shorter-lived colonies (Butler *et al*. 1995). Although South Dakota may have relatively few traditional colonies because of wet-dry climatic cycles (see below), some species, such as pelicans, nest almost exclusively at such sites. Thus, their significance indicates that the identification and monitoring of these sites needs to be specifically incorporated into the sampling framework.

A third consideration is that different colonial waterbird species nest in different habitats utilizing different nest substrates (Table 7). For monitoring and survey purposes, each habitat requires different search techniques and different count protocols. Because few wetlands have all three habitat types at one site, this potentially increases the amount of effort needed to discover and monitor breeding colonies of a long list of targeted species.

NUMBER OF WETLANDS IN SOUTH DAKOTA. Eastern SD has approximately 932,830 wetland basins and under normal water conditions, surface water covers approximately 9.8% of the surface area (Johnson *et al*. 1997). If we consider just larger, more permanent wetlands where colonial waterbirds may be more likely to breed (classified as semipermanent and permanent), there are 24,600 basins. Western South Dakota is considerably drier, but there still are approximately 60,665 permanent and semipermanent wetlands (Bakker 2005). This is an enormous amount of potential colonial waterbird breeding sites to survey and monitor. To put this into perspective, during the South Dakota Colonial Waterbird Inventory Project, two teams surveying full-time five days a week for 10 weeks in each of three field seasons made approximately 3100 total visits to wetlands.

TABLE 7. Three types of site habitat and nest substrates used by nesting colonial waterbirds in South Dakota. Species in bold are Species of Special Concern (Bakker 2005, SD WAP 2006)

Colony Site Habitat	Nest Substrate	Breeding Species
- Live trees on islands, oxbows -Flooded timber	In trees	**Great Blue Heron**, **Black-crowned Night-heron**, other herons, egrets, cormorants
Sparsely vegetated islands	On ground	**American White Pelican**, **Common Tern**, Caspian Tern, Ring-billed Gull, California Gull, cormorants
Marshes	In reedbeds	**Western Grebe**, **Eared Grebe**, **Franklin's Gull**, **Black Tern**, Forster's Tern, **Black-crowned Night-heron**, egrets, White-faced Ibis

WET-DRY CLIMATIC CYCLES. South Dakota experiences dramatic annual variation in precipitation, ranging from drought to floods, which cycles over a 10-20+ year period. These wet-dry cycles cause water levels in South Dakota wetlands to fluctuate dramatically, which in turn alternately creates and destroys waterbird nesting habitat such as islands, flooded timber, and marsh vegetation (Winter 1989, van der Valk 2005). Wet-dry cycles affect marsh vegetation by altering the ratio of emergent vegetation to open water over periods of five to >30 years, creating a vegetation cover cycle which can range from open water to complete vegetation cover (Kantrud *et al.* 1989, Johnson *et al*. 2004). Wet-dry cycles not only affect individual wetlands but also the number of wetlands in the landscape (Larson 1995).

Breeding colonial waterbirds respond to these natural cycles by opportunistically shifting breeding sites as appropriate nesting substrate becomes available or destroyed (Naugle *et al*. 1996, Murkin *et al.* 1997, Olson 2007). In addition, many waterbird species respond to the number of wetlands at a landscape level (Naugle *et al.* 1999, Fairbairn and Dinsmore 2001, Niemuth and Solberg 2003). The South Dakota Colonial Waterbird Project documented breeding colony shifts away from historical colonies sites. Many of the major colonies of the 1970s, 1980s and early 1990s no longer existed by 2005 because of habitat changes. Colonies at Waubay Lake, Rush Lake, Piyas Lake, Dry Lake No. 2, Lakes Whitewood, Preston, and Thompson all were flooded in the late 1990s; currently only a handful of birds nest in flooded timber at some of these sites. Former major sites located outside of northeast South Dakota, such as Lake Andes National Wildlife Refuge, Bear Butte Lake, Grass and Scatterwood Lakes, and many sites along the Missouri River, suffered from years of drought and no longer had suitable habitat. Because of the climate regime and resulting water-level cycles, many of these sites could be expected to again host breeding colonies at some time in the future. Water-level changes also create new habitat. For example, current breeding sites at Bitter Lake are located in newly-flooded areas that are far outside the pre-1998 shoreline. In

addition, short-term colony shifts were observed over the three years of the colonial waterbird surveys (Table 8). These shifts in active colony site locations are natural throughout the northern Great Plains, but the ephemeral nature of some colonies presents a challenge to monitoring breeding waterbird populations. Specifically, apparent changes in the number of colonies or number of breeding pairs in a colony may reflect changes in wetland conditions rather than true population changes (Beyersbergen *et al.* 2004).

TABLE 8. Short-tem breeding waterbird colony persistence and reasons for non-persistence in three habitat types during 2005-2007 waterbird colony surveys. Marsh habitat includes open-water Eared Grebe colonies.

		Marsh	**Island**	**Tree**
Persist between years?	yes	51% (*n*=64)	86% (*n*=6)	77% (*n*=103)
	no	49% (*n*=61)	14% (*n*=1)	33% (*n*=30)
Reasons for non-persistence	dried out	51%	0%	63%
	flooded out	15%	100%	0%
	humans disturb	0%	0%	17%
	trees gone	----	----	10%
	still suitable	34%	0%	7%

RAMIFICATIONS. The overall ramification of these factors is that many sampling and statistical designs and protocols that have been proposed or are used for other bird groups will not be effective for monitoring South Dakota breeding colonial waterbirds.

1) Most current programs only monitor known colonies. Because of frequent shifts in colony site locations, waterbird colony monitoring in South Dakota must incorporate searches for new colonies, as well as monitor known colonies and historical colony sites.

2) Estimating population size of most colonial waterbird species within the state is unlikely to be feasible (Beyersbergen *et al.* 2004).
    a. Population size estimation requires a sampling design in which samples are chosen in a random or systematic manner (NABCI 2007). As described in the breeding biology section above, the likelihood is very low that random samples would be located near a sufficient number of colonies for population estimates, unless hundreds or perhaps thousands of sites were sampled.
    b. Because of variable wetland conditions and frequent colony shifts, an even larger sample size would be required for the estimates to have reasonable statistical power.

3) Sampling frameworks that revolve around a list of important sites are problematic.
    a. A site that is important now may not be important in five or ten years because of water level fluctuations (Appendix C, Table 8). For example, only 10 of the 21 important South Dakota sites listed by Bart (2006) hosted colonies during the 2005-2007 surveys. Conversely, a site with unsuitable habitat now may become an important site in the future with the right conditions.
    b. The sum total number of important sites over the long term (50+ years) is likely to be large because of the large amount of available habitat, shifting colony sites, and almost 20 species of colonial waterbirds. There are not enough resources to efficiently and effectively monitor all of these sites in addition to surveying the landscape for new colonies.
    c. The majority of individuals of a few colonial waterbird species of special concern nest in single-species colonies away from the major mixed-species colonies, especially Black Tern, Western Grebe, Eared Grebe, and Great Blue Heron. These species would not be adequately monitored if only a specified list of sites were checked.

4) Typical schemes for selecting wetlands to be surveyed and monitored require identifying potential habitat from maps. However, because of the constantly changing nature of wetlands, static wetland maps (National Wetland Inventory maps, which classify wetlands under 'normal' precipitation, maps of wetland basins, aerial photos) do not adequately show the current status of wetland condition and abundance. Thus, more real-time indices such as the Palmer Drought Index or May pond numbers counted during waterfowl surveys will need to be used to determine sampling sites and regions for a particular survey. These indices can shed light on marsh and stream conditions but determining the location and extent of islands and flooded timber will require on-the-ground or aerial reconnaissance.

GOAL and OBJECTIVES

Monitoring GOAL

To collect information on breeding colonial waterbirds, on a continuous basis and over a long period of time, which managers and landowners can use to manage and conserve these species and to aid in the prevention of future declines of colonial waterbird species that breed in South Dakota.

OBJECTIVES and how to meet each objective

1. Improve information on conservation status of breeding colonial waterbirds in South Dakota.
    - establish and track status of each species within the state
    - track distribution, species composition, and sizes of breeding colonies
    - maintain up-to-date database of historic and current colony sites
    - long-term: determine each species' state-level conservation status in relation to its regional status

2. Identify and track factors that could result in a decline of colonial waterbird species that breed in South Dakota.
    - identify actual or potential threats to colonies
    - track habitat quality at colony site
    - identify why colonies fail or disappear (within and between years)
    - long-term:
        - set population size objectives and track population trends
        - determine landscape-level land use impacts
        - identify limiting factors to breeding waterbirds

3. Determine what and how management actions impact breeding populations, positively or negatively
    - determine land use and management practices at time of visit at 3 scales (colony site, wetland, within 0.5 mile)
    - identify ownership category (federal, state, tribal, or private)
    - promote compatible management actions among land managers

4. Provide information to aid management of waterbird-fisheries conflicts
    - track location and sizes of cormorant, pelican, egret, and heron colonies

5. Ensure compatibility with regional and national monitoring efforts
    - coordinate data-sharing with regional and national databases
    - participate in regional monitoring planning

SAMPLING FRAMEWORK and PROTOCOLS

SCOPE of this monitoring plan. This monitoring plan is intended to cover breeding colonial waterbirds, which includes herons, egrets, night-herons, pelicans, cormorants, colonial grebe species, ibis, gulls, and terns. This plan does not cover shorebirds, rails and bitterns, waterfowl, wetland-dependent raptors, or landbirds. This plan also does not concern monitoring of any species during the migratory or winter periods. The spatial scale is statewide.

STRATA. Different regions of South Dakota vary in the number and types of wetlands and rivers (Bakker 2005) as well as their importance to breeding colonial waterbirds. Monitoring efforts should reflect these variations so that areas of higher importance to waterbirds are sampled with more intensity than areas of lower importance. Figure 3 shows regions listed in decreasing order of sampling effort, based on that region's relative importance to breeding waterbirds.

FIGURE 3. Regions for breeding colonial waterbird monitoring.

Each region's relative importance to breeding waterbirds is based on number of breeding species of conservation concern found during the 2005-2007 surveys, overall number of breeding species during the 2005-2007 surveys, number of important sites and overall number of colonies found during the 2005-2007 surveys, and number of historical colony sites (Table 9). Priority order may switch through the years, depending on precipitation patterns. In any particular year, region-wide wetland condition can be determined from May pond counts conducted by U.S. Fish and Wildlife Service while general moisture patterns, especially dryness, can be

obtained from the Palmer Drought Index as displayed through the Drought Monitor (*http://drought.unl.edu/dm/monitor.html*) or other sources.

TABLE 9. Regions for monitoring breeding colonial waterbirds in South Dakota, listed in decreasing order of importance, and criteria for prioritization.

Region	Number Special Species	Number Other Species	Number 2005-2007 Colonies: Important, All	Number Historic Colonies	Major Nesting Habitats
1. Prairie Coteau	9	10	10, 122	43	all 3
2. Lk Thompson	4	5	3, 14	21	tree, marsh
3. N. Potholes	8	6	9, 48	42	tree, marsh
4. Missouri River	3	5	0, 12	12	tree, island
5. S. Potholes	3	7	3, 17	19	marsh
6. Sandhills	4	4	1, 5	6	marsh
7. West River	3	4	1, 45	52	tree, island
8. Southeast	0	2	0, 7	10	marsh

PROTOCOL SELECTION and RATIONALE

This section describes the types of field protocols that will be used to collect data that address the monitoring objectives. Specifics of the protocols, including issues of detectability, bias, and data analyses, are detailed in separate documents that are available from the Wildlife Diversity Program, Department of Game, Fish, and Parks.

There are several alternatives for types and frequency of monitoring (Appendix D). Monitoring should have two components: monitoring known colonies and searching for new or previously-unknown colonies. This is analogous to a dual-frame statistical design (Haines and Pollack 1998). This approach, among other considerations, meets the information needs of objectives that require visits to colonies and objectives that require tracking colony and population shifts. Therefore, option #4 (Appendix D) – conducting aerial surveys to locate new colonies and ground visits to all major colonies, is the recommended option for colonial waterbird monitoring in South Dakota.

SEARCHING FOR NEW COLONIES. Information on the location of new or previously-unknown colonies can come from two sources - incidental reports and data collected in other projects, and field searches conducted for the sole purpose of finding waterbird colonies. During the 2005-2007 colonial waterbird surveys, 64 of 405 active colonies (16%), including 6 of the 26 important waterbird colonies, were reported by the public or agency staff and contractors. Thus an on-going and assertive effort should be made to solicit information from those who are in the field for other reasons (e.g., birders, hunters, agency biologists, trappers) and from data collected in other projects (e.g., Breeding Bird Atlas, shorebird surveys, Breeding Bird Surveys, secretive marshbird surveys).

To conduct searches for new or previously-unknown colonies, two alternatives are available - ground searches or aerial searches. Because of the high number and density of wetlands in some areas, lack of roads, and costs and resources needed to gain landowner access permission, ground searches for new or previously-unknown colonies is not the most efficient option. Flying fixed-width permanent transects across regions is an effective and efficient method of covering large inaccessible areas quickly (Resources Inventory Committee 1998). However, in Region 4 (the Missouri River) and Region 8, the major river drainages should to be surveyed rather than transects. Aerial surveys are best at finding conspicuous species (large body size, white coloration) and large colonies; colonies of smaller species such as night-herons and more cryptic species, such as ibis, are more difficult to detect, at least in some studies (Frederick *et al*. 1996, Rodgers *et al.* 2005). In South Dakota, these cryptic species often are present in colonies with more conspicuous species and this bias may be less pronounced. Another issue is that a group of roosting birds can be mistaken for a nesting colony (Rodgers *et al*. 2005). However, the South Dakota protocol mandates making ground visits to all colonies detected from the air, which will verify if nests are present.

Studies show that counting nests (or birds) during aerial surveys underestimates the true number, except in small colonies (Dodd and Murphy 1995, Frederick *et al*. 1996). Therefore, unless there is no ground access, number of nests or birds in colonies will not be counted during the aerial survey; colonies will be marked on maps for later ground visits.

Another function of aerial surveys is to take photographs of colonies; later, nesting birds are counted from the photo on a computer screen (Steinkamp *et al.* 2003). This technique is most effective for colonies of white birds in a relatively flat habitat, i.e., ground nesting pelicans and gulls, and marsh-nesting Franklin's Gulls. Monitoring crews should be prepared to take photographs whenever they encounter these colonies. This is the only method that should be used with American White Pelicans because this species is extremely sensitive to human disturbance (Evans and Knopf 1993, Resources Inventory Committee 1998).

Aerial surveys should be conducted in regions 1-3 within two years and then every five years thereafter. Aerial surveys for regions 4-8 should be conducted every five years. Specific information on procedures, equipment needed, transect locations and sizes, data forms, and analyses are in a separate procedures document available from the Wildlife Diversity Program, SD Department of Game, Fish, and Parks.

GROUND VISITS TO COLONIES. Although ground visits to colonies are relatively time-consuming and expensive, data needed to address objectives 1 – 4 can only be collected during visits to colonies. During the 2005-2007 surveys, visiting and counting nests in one large colony, on average, took approximately ½ day for two people; five exceptionally large colonies required up to five people. Thus, recruiting

and training as many people as possible to visit colonies would increase the effectiveness of monitoring. One important source of colony monitors is volunteer citizen-scientists. A pilot project to test the feasibility of using volunteers to monitor colonies in South Dakota demonstrated that a trained cadre of volunteers could potentially monitor up to 20% of the known waterbird colonies, with some caveats (Appendix E). Other potential monitors could be recruited from various agencies and organizations (see list of cooperators, below).

All major colonies should be visited every 2 – 3 years. A major colony is one with >200 pairs of breeding waterbirds or the largest colonies for each species. In addition, any newly-discovered or newly-reported colonies should be visited the same year in which they first are discovered. Specific information on procedures, data collection and forms, and analyses are in a separate procedures document available from the Wildlife Diversity Program, SD Department of Game, Fish, and Parks.

DATA ANALYSES AND DISSEMINATION. Data will be housed with the Wildlife Diversity Program and for state-listed species, the state Natural Heritage Program, in Pierre, SD. The Wildlife Diversity Program also is responsible for producing progress reports and maps for dissemination to other departments, agencies, researchers, and interested parties.

IMPLEMENTATION and ASSESSMENT

COOPERATORS. There are many agencies, organizations, and people who could play a role in colonial waterbird monitoring in South Dakota, either because colonies are located within their jurisdiction or because they share an interest in conservation of these species. Involving these groups will take considerable coordination but will greatly strengthen the capacity of the state to monitor and manage breeding colonial waterbirds. The following is a list of potential participants and possible contributions by each.

1) **State**: Department of Game, Fish, and Parks
   a) Division of Wildlife, Wildlife Diversity program: coordination, monitoring plan implementation and evaluation, data collection, database management
   b) Division of Wildlife- Wildlife biologists, trappers: data collection
   c) Division of Wildlife, Fisheries: data collection, especially cormorants and other species in conflict
   d) Private landowner programs: landowner liaison, data collection
   e) Division of State Parks: data collection

2) **Federal**:
   a) US Fish and Wildlife Service (Wetland Management Districts, National Wildlife Refuges): data collection, monitoring plan evaluation, wetland data

b) US Geological Services (HAPET offices): statistical and habitat models, monitoring plan evaluation
c) US Forest Service, Region 2 (Black Hills): data collection
d) Army Corps of Engineers: data collection, monitoring plan evaluation
e) US Dept. of Agriculture, NRCS and Wildlife Services: data collection, monitoring plan evaluation, landowner liaison

3) Tribal: especially Sisseton Wahpeton, Lower Brule, Crow Creek, and Rosebud tribes: data collection, monitoring plan evaluation

4) **Organizations**:
a) South Dakota Ornithologists' Union - data collection, monitoring plan evaluation
b) Universities - data collection, research, monitoring plan evaluation, wetland and habitat models
c) Joint Ventures (Prairie Pothole and Northern Great Plains) - funding, research, monitoring plan evaluation
d) Ducks Unlimited: data collection, research, funding, monitoring plan evaluation
e) National Audubon Society: data collection (through local chapters), funding, monitoring plan evaluation
f) The Nature Conservancy: data collection, monitoring plan evaluation

5) **Volunteers**: incidental reports, Citizen-Scientist Colony Monitoring Project

PLAN EVALUATION AND ASSESSMENT. This monitoring plan should be evaluated periodically to assess goals and objectives, to update the plan with new developments and information in statistics, modeling, and research, and to evaluate the ability of each aspect of the plan to meet objectives and contribute to the conservation of colonial waterbirds in South Dakota. The sampling framework, design, survey protocols, and data sheets should be evaluated after the first season of monitoring, to assess the feasibility of the planning and field portions of the plan, and make adjustments. The entire plan should be evaluated after two field seasons or after 5 years, whichever occurs first, and then every five - ten years thereafter.

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