ATLAS OF BREEDING COLONIAL WATERBIRDS IN THE INTERIOR WESTERN UNITED STATES

JOHN F. CAVITT[1], STEPHANIE L. JONES[2], NACOLE M. WILSON[1,3] , J. SCOTT DIENI[4], TARA S. ZIMMERMAN[5,6], ROBERT H. DOSTER[7] AND WILLIAM H. HOWE[8]

[1] Weber State University, Avian Ecology Laboratory, Ogden, UT
[2] U.S. Fish and Wildlife Service, Nongame Migratory Birds, Denver, CO
[3] Current address: Sumter, SC
[4] Redstart Consulting, Evergreen, CO
[5] U.S. Fish and Wildlife Service, Division of Migratory Birds, Portland, OR
[6] Current address: Kinglet Consulting, Washougal, WA
[7] U.S. Fish & Wildlife Service, Migratory Bird Program, Sacramento, CA
[8] U.S. Fish & Wildlife Service, Division of Migratory Birds, Albuquerque, NM

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AUTHOR CONTACT INFORMATION

John F. Cavitt, Ph.D.
Department of Zoology
Weber State University
2505 University Circle
Ogden, UT 84408-2505
Phone: 801-626-6172 or 801-626-8541
E-mail: JCAVITT@weber.edu

Stephanie L. Jones
Nongame Migratory Bird Coordinator
U.S. Fish & Wildlife Service, Region 6
P.O. Box 25486 DFC
Denver, CO 80225
E-mail: Stephanie_Jones@fws.gov

Nacole M. Wilson
1920 Sam Gillespie Blvd
Sumter, SC 29154
E-mail: nacolemarquesswilson@gmail.com

J. Scott Dieni
Redstart Consulting
403 Deer Road
Evergreen, CO 80439
E-mail: Redstart82@gmail.com

Tara S. Zimmerman
Kinglet Consulting
36803 SE 25th Street
Washougal, WA 98671
Phone: 360-608-0044
E-mail: kingletconsulting@gmail.com

Robert H. Doster
Migratory Bird Program
U.S. Fish & Wildlife Service, Region 8
2800 Cottage Way, Suite W-2606
Sacramento, CA 95825
Phone: 916-414-6721
E-mail: rob_doster@fws.gov

William H. Howe
Division of Migratory Birds
U.S. Fish & Wildlife Service, Region 2
500 Gold Avenue SW
Albuquerque, NM 87103
Phone: 505-248-6875
E-mail: Bill_Howe@fws.gov

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INTRODUCTION

Colonial waterbirds comprise a diverse assemblage of species that share important characteristics of ecology and natural history. Waterbirds within this group depend on specific and often limited aquatic habitats for much of their life cycles, and generally breed in high-density groups or colonies, ranging from a few to several thousand individuals. Coloniality within this group likely evolved independently within the different taxa and as a response to various environmental pressures (Burger 1981, Forbes 1989, Rolland et al. 1998). This behavior poses important challenges to waterbird conservation because large proportions of a species population may be concentrated in relatively small isolated areas (Kushlan et al. 2002).

In the arid interior west, colonies occur in relatively few locations. Western breeding habitats include wooded and barren islands, riparian corridors, marshes, seasonal wetlands, managed impoundments and open waters. Many of these aquatic habitats within the western United States are strongly influenced by human activities, resulting in their loss or degradation. Factors responsible for losses and degradation include water diversions, damming, filling, draining, flooding, eutrophication, contaminant concentrations, and agricultural activities, e.g., haying, tilling, and pesticide use. Numerous studies have demonstrated that these and other factors can affect the suitability of nesting and brood-rearing sites for colonial waterbirds (e.g. Catsadorakis et al. 1996, Naugle et al. 2000, Smith et al. 2003). Furthermore, the climatic regime of the western U.S. including long-term drought, coupled with an increasing demand for water resources by human populations, often results in changing aquatic habitat conditions between years. Because of the transitory nature of many of these western aquatic habitats, waterbird colonies can also be transitory, persisting only until the habitats become unsuitable; some species and large colonies will greatly alter nesting locations from year-to-year. This results in an inherent variability of local breeding populations. Their characteristic breeding behavior together with the reliance on often limited and impacted aquatic habitats (Shuford 2010) make colonial waterbirds particularly vulnerable to disturbance and loss of breeding sites.

Coupled with these challenges to waterbird conservation are the increasing effects of global climate change. In general, there has been a trend towards earlier spring arrival and breeding of many waterbird species (e.g. Crick and Sparks 1999, La Sorte and Thompson 2007, Swanson and Palmer 2009, Cox 2010) which could lead to a disconnect between habitat, including food resources, and nesting timing. Furthermore, the breeding, migratory stopover and nonbreeding habitats for many waterbirds are particularly vulnerable to climate change (Cox 2010). Increased temperatures will likely lead to reduced soil moisture causing the loss or reduction of many wetlands (e.g. Johnson et al. 2005).

Consequently, many of these species are targets of conservation efforts throughout North America (Kushlan et al. 2002, Drilling 2007, U.S. Fish and Wildlife Service 2008). Others within this group are experiencing population increases and expanding their distribution (Table 1), resulting in escalating conflicts with agriculture and fisheries (Kushlan et al. 2002) and human residential areas.

Despite their importance and conservation status in the west, no systematic inventory of waterbird colonies has been conducted in this region. This lack of information has greatly impeded the ability of biologists and conservationists to manage this group of birds (Drilling 2007, Seto 2008). Thus, many western states identified information on the distribution and abundance of colonial waterbirds as a conservation priority. This included acquiring abundance and distribution data to determine population status and to identify priority conservation regions and actions (e.g. Montana Fish, Wildlife and Parks 2005). Current distribution and abundance information on western colonial nesting waterbirds is needed for conserving populations, resolving management conflicts stemming from increasing and expanding populations, and providing the data necessary to manage waterbird populations at the local and regional scale (Seto 2008). These concerns resulted in a comprehensive survey throughout the west.

From 2009 through 2011, U.S. Fish and Wildlife Service Regions 1 (Pacific), 2 (Southwest), 6 (Mountain-Prairie), 8 (Pacific-Southwest), and 9 (National Headquarters), together with biologists from the interior western states designed and implemented a survey to inventory and document the status of these species (Seto 2008). The Western Colonial Waterbird Survey (WCWS) and resulting *Atlas of Breeding Colonial Waterbirds in the Interior Western United States* (Atlas) were designed primarily to provide biologists, resource managers, regulatory agencies, and researchers with the best available data on the size and location of inland western waterbird colonies, in a standardized format. This Atlas presents summary results of surveys conducted in the eight participating interior western states (Figure 1). A summary atlas of WCWS survey results for the three participating Pacific Coastal states is currently in preparation (M. McDowell and N. Seto, pers. comm.). The information compiled here serves as a baseline of recent and available historical distribution and abundance. Finally, future surveys and monitoring can be planned using these data as a comprehensive baseline inventory and atlas of these colonies.

OBJECTIVES

The objectives of the WCWS were to conduct a comprehensive inventory of waterbird breeding sites and populations in the western United States. Specific objectives included:

1) Document the species composition, size, and location of breeding colonies from 2009 through 2011.
2) Produce an atlas of western colonial waterbird breeding colonies. This included an inventory and mapping of current (2009-2011) colonies, compiling existing information on historical sites (where available) and locating and mapping new colonies.
3) Establish a baseline for the development of a long-term monitoring program for colonial waterbirds in the west.
4) Estimate the minimum regional population size of breeding waterbirds.

METHODS

Species. —The coordinators for the WCWS selected 18 target species from six families (scientific names are in Table 1); Neotropic Cormorant was added later for Arizona and New Mexico to account for this species' increasing occurrence throughout the southwest. These 19 species were the primary colonial nesting waterbird species in the west at the time of the survey; other waterbirds that are primarily solitary breeders (e.g., Pied-billed Grebe, *Podilymbus podiceps*) were not included in this effort.

Geographic Coverage. —This Atlas contains the WCWS results from the eight interior western states: Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming (Figure 1).

Season. —The WCWS was a breeding survey, and for the most part, surveys were conducted in May-July. The optimal timing for the survey was an important consideration and thus was locally determined to account for the peak of waterbird breeding in each state. The criterion for each state was for the counting period to occur during the mid- to late-incubation period for each species. Only one colony count per year was recommended with surveys conducted at approximately the same time or within the same point of the nesting cycle every year (Jones 2008).

Parameters. —The primary parameters for the WCWS were the number of active breeding individuals and active nests. Because nests for many species may persist from year to year but may not be reused, each nest was quickly evaluated for activity during survey periods (Jones 2008). Active nests were defined as nests with

eggs or chicks, incubating or brooding adults, nests with fledged chicks present, or nests that were otherwise being tended by adults, such those that were under construction or being repaired. An inactive nest was either an old nest not used in the present year, or a nest abandoned early in the season (Jones 2008).

Detectability. —The WCWS had two detectability concerns. The first involved determining the location of colonies. Because this project included a large geographic area, surveyors could potentially miss colony locations. To assist in reducing this concern, state coordinators used historical data, breeding bird atlases, and local experts in an attempt to locate all previously known colonies. One of the objectives for the survey was to locate previously unknown colonies. Surveyors were asked to balance efficiency of effort and resources with good coverage to locate these potential colony sites (Jones 2008). A second detectability issue was missing nests within colonies. This could potentially be a problem within large, dense colonies or because the timing of the survey was incorrect for the target species or survey year. In an attempt to minimize this concern, we utilized protocols that have been demonstrated to be successful for a wide variety of species and habitats surveyed (Steinkamp et al. 2003).

Colony and Regional Population Estimates. —Direct nest counts were used whenever possible (Steinkamp et al. 2003). Colony counts based on direct nest counts provide more accurate information than counting total number of adults. Adult counts can be biased as they may contain both breeding and non-breeding individuals. In addition, direct counting of adults is easy with large birds at close range, but becomes progressively more difficult with larger numbers, smaller species, and greater distances (Jones 2008). Consequently, a direct nest count was suggested whenever possible. Population estimates (without correction factors) can be derived from this inventory, but these will not be based on sampling and inferential statistics at the population level. The colony population sizes presented within this Atlas are likely conservative and underestimates of true population size. Correction factors for colonies using the estimate of colony size, per species, can be taken from the published literature (if needed) to account for breeding birds away from the colony and for non-breeding birds present in the colony. The regional population estimates (without correction factors) derived from this inventory are also minimum population estimates.

Protocol. —The protocol or methodology and parameters depended on resources available, species, habitat, colony size, presence of predators, accessibility, ability to find nests within the vegetation, and the number of people available to conduct the survey. All of these considerations were also balanced with the ability of surveyors to collect data without causing unacceptable levels of disturbance to nesting birds and vegetation. Detailed protocols were recommended for those sites that were not

currently being counted, and where established protocols did not exist (Jones 2008). These protocols were also considered as an alternative to ongoing surveys where local or subject area experts determined they were appropriate (Jones 2008).

INTERIOR WESTERN COLONIAL WATERBIRD ATLAS

The Atlas consists of two parts: the maps for all the sites surveyed during the WCWS and a data table (Atlas Tables). In addition to the Atlas, the final data includes the survey data for each state (State Databases).

State Databases. —All data from the WCWS were entered into Microsoft EXCEL spreadsheets, one for each state. Each spreadsheet has three parts: 1) Breeding birds; 2) Nonbreeding, if collected in that state. AZ, ID and NM did not generally collect nonbreeding data; however, there were some records that were nonbreeding and were included; and 3) historical data, if compiled for that state. Historical data are incomplete in many states, e.g., MT did not compile historical data from before 2009. The purpose of these State Databases is to allow summary and location data to be available in an accessible format. The breeding bird data sheets are the data collected during the WCWS (2009-2011) and are the data that were used to produce the maps for the Atlas. In producing the Atlas Tables, if more than one visit to any one site was completed in the same year, the Atlas Table records only the record with the maximum numbers of individuals or the record identified as the most recent, accurate or representative when such data were provided. In the State Databases, all records were recorded.

Survey Summary. —Data were combined into a single spreadsheet file for error checking, correction and analysis. All statistical analyses were conducted using SPSS (SPSS Inc. 2008). Variables and data were inspected using a combination of cross tabulation and frequency tables to search for misspellings, missing data, discrepancies, improper cell formatting, and data inconsistencies. We summarized the following variables for breeding birds: estimates of the number of breeding individuals in total and for each state. The maximum value obtained across all visits and years for the WCWS was used for colonies that had been counted more than once. All variables except for count data were treated as nominal-level measurements.

Table Construction and Mapping. —Data were compiled and proofed by each state coordinator and survey coordinators. Data were then prepared into corresponding tables for each state. The Universal Transverse Mercator (UTM) coordinates for each site were recorded and mapped using base maps from ArcGIS (Environmental Systems Research Institute 2012). In an attempt to avoid disturbance to active colonies, the UTM coordinates provided often represent the location of the observer

rather than the location of the colony itself. Typically, when multiple surveys were conducted for each site within a single breeding season, the highest colony counts for each species were reported and are recorded in the tables.

How to Use This Atlas. —The Atlas is divided into eight state sections. Each state section contains maps depicting the locations of colonies, as well as tables of recent and historical data (only for the colonies still active during the WCWS) throughout the state. We have included several different maps which contain information about state land ownership, colony location and colony size or density. The first map of each state section is the state's land ownership map overlaid with the location of all colonies recorded for this atlas. The second map provides the "Area" name for each of the USGS 1:250,000 topographic maps covering the state. Colony locations for the state were overlaid on these maps to provide a reference for the reader. The colony tables are then arranged within each Area subsection. The Area subsections include an Area map, as an index to locations, and the relative densities of waterbird colonies. The pages following this map include colony data tables and detailed maps of colony locations. The accompanying tables present the recent and historical (where available) counts of the number of breeding birds, for each species, at each colony.

Colony Numbers and Names. —Colonies were assigned unique identifying numbers during the WCWS and Atlas development. USGS maps were sequentially numbered for the conterminous United States and served as the basis for the standardized colony number system (Spendelow and Patton 1988, Naughton et al. 2007). Within each state area, colonies were numbered sequentially from north to south with the first seven characters representing the map number and the last three digits representing the colony number, beginning with 001 (Naughton et al. 2007). Colony names were derived from maps or charts whenever possible.

Atlas Data Tables. —The data on the following tables contain the recent estimates of colony size, and include the current abundance and distribution of breeding colonial waterbirds within the state. Data from the WCWS (2009-2011) were used to generate the maximum total statewide counts for each species. Figures 2a and 2b provide an example of a data table with an explanation of the columns and codes. Historical data are provided where available; however, for many states this is the first statewide estimate of breeding colonial waterbird populations.

RESULTS

INTERIOR WESTERN COLONIAL WATERBIRD ATLAS

The Atlas, consisting of the maps, data tables and state databases described here, are available on the internet; addresses and contacts are provided in Table 2.

SURVEY SUMMARY

Overall, 19 colonial waterbird species from four orders and six families were identified across eight western U.S. states (Table 1). Members of the family Laridae were collectively the most abundant, accounting for about 60% of all breeding individuals (Table 3). This family also had the most species (N= 7). Interestingly, Threskiornithidae, comprising just a single species (White-faced Ibis), was the second most abundant family (22%). Members of the family Ardeidae, largely driven by Great Blue Herons, were collectively the most frequently occurring species (55%).

We recorded over 605,000 breeding individuals. Nearly 45% of these were recorded in Idaho, followed by 31% in Utah (Table 4). In contrast, < 1% was recorded in New Mexico and Wyoming. We identified 1,255 breeding colonies among all species; 23% in Montana, followed by 20% in Utah. Again, we observed relatively few breeding colonies in Wyoming (6%) or New Mexico (4%). Utah had the most breeding species (N= 17), Arizona the fewest (N= 8).

Across the region, California (27%) and Franklin's (26%) gulls, White-faced Ibis (23%), American White Pelican (7%) and Ring-billed Gull (6%) were the most abundant species, comprising 89% of all identified breeding birds (Figure 3; Table 5). The largest colony occurred at the Great Salt Lake at Hat Island in Utah with nearly 36,000 breeding California Gulls in 2010. Idaho had the next two largest colonies: ca. 32,000 (Gray's Lake National Wildlife Refuge) and ca. 29,000 (Market Lake Wildlife Management Area), both for Franklin's Gull in 2010. A 24,500-sized colony of breeding White-faced Ibis was also observed at Market Lake that year. Great Blue Herons represented 2% of all breeding individuals but accounted for 39% of all colonies, the most for any species. Moreover, this species was the most frequent colony in seven of eight states. (White-faced Ibis got the top honors in Nevada, accounting for 24% of all colonies in that state.)

State-level statistics for each identified species are provided in Table 6.

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Databases were compiled and corrected by S. L. Jones, N. M. Wilson, J. F. Cavitt, J. S. Dieni, and Trina Nixon. This report benefited by helpful reviews from J. Neill, and J. A. Wheeler. J. F. Cavitt and the Avian Ecology Lab at Weber State University developed and managed the GIS colony location databases and produced the colony maps and tables. Crystal Wikstrom and Justin Williamson developed and produced the maps and Tess Woodward provided the graphic design and layout of the Atlas. Partial funding to compile this Atlas was provided by U.S. Fish and Wildlife Service, Division of Migratory Birds and Habitat Programs, Mountain Prairie Region, Denver, CO through the efforts of Casey Stemler, and the Division of Migratory Bird Management, Arlington, VA through the efforts of J. A. Wheeler. The findings and conclusions in this publication are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

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Table 1. Bird species targeted during the Western Colonial Waterbird Survey (2009-2011) across eight western interior U.S. states, listed taxonomically by order, family and subfamily (American Ornithologists' Union 1998).

Order	Family	Subfamily	Common Name	Scientific Name
Podicipediformes	Podicipedidae		Eared Grebe	*Podiceps nigricollis*
			Western Grebe	*Aechmophorus occidentalis*
			Clark's Grebe	*A. clarkii*
Suliformes	Phalacrocoracidae		Neotropic Cormorant	*Phalacrocorax brasilianus*
			Double-crested Cormorant	*P. auritus*
Pelecaniformes	Pelecanidae		American White Pelican	*Pelecanus erythrorhynchos*
	Ardeidae		Great Blue Heron	*Ardea herodias*
			Great Egret	*A. alba*
			Snowy Egret	*Egretta thula*
			Cattle Egret	*Bubulcus ibis*
			Black-crowned Night-Heron	*Nycticorax nycticorax*
	Threskiornithidae	Threskiornithinae	White-faced Ibis	*Plegadis chihi*
Charadriiformes	Laridae	Larinae	Franklin's Gull	*Leucophaeus pipixcan*
			Ring-billed Gull	*Larus delawarensis*
			California Gull	*L. californicus*
		Sterninae	Caspian Tern	*Hydroprogne caspia*
			Black Tern	*Chlidonias niger*
			Common Tern	*Sterna hirundo*
			Forster's Tern	*S. forsteri*

Table 2. Location (internet addresses and contact information) of the state maps and tables for the *Atlas of Breeding Colonial Waterbirds in the Interior Western United States* and state databases.

State	Atlas (pdf format)	Databases (EXCEL format)	Contacts
Arizona	**Arizona:** http://departments.weber.edu/avianecologylab/WesternWaterbirdAtlas/Chapter/ArizonaFinal.pdf	**Arizona:** http://departments.weber.edu/avianecologylab/WesternWaterbirdAtlas/Database/AZdatabase.xlsx	**Troy Corman**, Arizona Game and Fish Department, 5000 W. Carefree Highway, Phoenix, AZ 85086-5000, 623-236-7508, TCorman@azgfd.gov
Colorado	**Colorado:** http://departments.weber.edu/avianecologylab/WesternWaterbirdAtlas/Chapter/coloradoFinal.pdf	**Colorado:** http://departments.weber.edu/avianecologylab/WesternWaterbirdAtlas/Database/COdatabase.xlsx	**David Klute**, Colorado Division of Wildlife, 6060 Broadway, Denver, CO 80216, 303-291-7320, David.Klute@state.co.us **David Hanni**, RMBO, 230 Cherry St., Fort Collins, CO 80521, 970-482-1707ext.13, David.Hanni@rmbo.org
Idaho	**Idaho:** http://departments.weber.edu/avianecologylab/WesternWaterbirdAtlas/Chapter/IdahoFinal.pdf	**Idaho:** http://departments.weber.edu/avianecologylab/WesternWaterbirdAtlas/Database/IDdatabase.xlsx	**Colleen Moulton,** Idaho Dept. of Fish and Game, P.O. Box 25 Boise, ID 83707, 208-287-2751, colleen.moulton@idfg.idaho.gov
Montana	**Montana:** http://departments.weber.edu/avianecologylab/WesternWaterbirdAtlas/Chapter/MontanaFinal.pdf	**Montana:** http://departments.weber.edu/avianecologylab/WesternWaterbirdAtlas/Database/MTdatabase.xlsx	**Catherine Wightman**, Montana Fish, Wildlife and Parks, PO Box 200701 Helena, MT 59620, 406-444-3377 (o), cwightman@mt.gov
Nevada	**Nevada:** http://departments.weber.edu/avianecologylab/WesternWaterbirdAtlas/Chapter/NevadaFinal.pdf	**Nevada:** http://departments.weber.edu/avianecologylab/WesternWaterbirdAtlas/Database/NVdatabase.xlsx	**Rob Doster**, Migratory Bird Program, Region 8, 2800 Cottage Way, Suite W-2606, Sacramento, CA 95825, 916-414-6721, rob_doster@fws.gov **Laura Richards**, Wildlife Diversity Division, Nevada Department of Wildlife, 1100 Valley Road, Reno, NV 89512, 775-688-1569, lrichard@ndow.org **Jennifer Ballard,** Great Basin bird Observatory**,** 1755 E. Plumb Ln., Ste. 256A**,** Reno, NV 89502, 775-323-4226**,** ballard@gbbo.org
New Mexico	**New Mexico:** http://departments.weber.edu/avianecologylab/WesternWaterbirdAtlas/Chapter/NewmexicoFinal.pdf	**New Mexico:** http://departments.weber.edu/avianecologylab/WesternWaterbirdAtlas/Database/NMdatabase.xlsx	**Bill Howe**, Migratory Bird Program, P.O. Box 1306, Albuquerque, NM 87103, 505-248-6875, bill_howe@fws.gov
Utah	**Utah:** http://departments.weber.edu/avianecologylab/WesternWaterbirdAtlas/Chapter/UtahFinal.pdf	**Utah:** http://departments.weber.edu/avianecologylab/WesternWaterbirdAtlas/Database/UTdatabase.xlsx	**John Cavitt** (Interior UT), Weber State University, 2505 University Circle, Ogden, UT 84408-2505, 801-626-6172, jcavitt@weber.edu **John Neill** (GSL), Great Salt Lake Ecosystem Program, Utah Division of Wildlife Resources, 4790 S. 7500 W, Hooper, UT 84315, 801-538-4868, johnneill@utah.gov
Wyoming	**Wyoming:** http://departments.weber.edu/avianecologylab/WesternWaterbirdAtlas/Chapter/WyomingFinal.pdf	**Wyoming:** http://departments.weber.edu/avianecologylab/WesternWaterbirdAtlas/Database/WYDatabase.xlsx	**Andrea Orabona**, Wyoming Game and Fish Department, 260 Buena Vista, Lander, WY 82520, 307-332-2688, Andrea.Orabona@wyo.gov

Table 3. Colonial waterbird atlas summary, by taxonomic family including taxa identified to genera (American Ornithologists' Union 1998). *Total count* is the estimate of the total number of breeding individuals.

Family	Total count	%	*N* colonies	%	*N* species
Podicipedidae	22,885	4	161	13	3
Phalacrocoracidae	14,163	2	98	8	2
Pelecanidae	41,709	7	24	2	1
Ardeidae	30,378	5	686	55	5
Threskiornithidae	135,652	22	79	6	1
Laridae	360,238	60	207	16	7
Total	**605,025**		**1,255**		**19**

Table 4. Colonial waterbird atlas summary, by U.S. state (2009-2011). *Total count* is the estimate of the total number of breeding individuals.

Parameter	Arizona	Colorado	Idaho	Montana	Nevada	New Mexico	Utah	Wyoming
Total count	11,482	15,097	270,497	86,412	30,395	1,551	185,859	3,732
N colonies	104	218	143	285	130	51	252	72
N species	8	15	15	15	15	9	17	9
N families	3	6	6	6	6	3	6	6
Most abundant species	Cattle Egret	Great Blue Heron	Franklin's Gull	Franklin's Gull	White-faced Ibis	Eared Grebe	California Gull	American White Pelican
N birds	7,789	3,186	124,210	23,960	9,153	282	109,810	1,142
Largest individual colony	Cattle Egret	Double-crested Cormorant	Franklin's Gull	Franklin's Gull	American White Pelican	Eared Grebe	California Gull	California Gull
N birds	4,400	968	31,996	9,666	7,790	190	35,940	1,000
Most frequent species	Great Blue Heron	Great Blue Heron	Great Blue Heron	Great Blue Heron	White-faced Ibis	Great Blue Heron	Great Blue Heron	Great Blue Heron
N colonies	59	82	65	133	31	17	63	48

Table 5. Colonial waterbird atlas summary, by bird species. Includes only taxa identified to species. *Total count* is the estimate of the total number of breeding individuals.

Species	Total count	%	Min colony size	Max colony size	*N* colonies	%	*N* states
Eared Grebe	13,957	2	2	3,678	67	5	5
Western Grebe	8,183	1	1	4,700	70	6	7
Clark's Grebe	268	<1	1	67	17	1	5
Neotropic Cormorant	98	<1	2	96	2	<1	1
Double-crested Cormorant	13,963	2	2	1,268	92	7	8
American White Pelican	41,709	7	2	10,228	24	2	6
Great Blue Heron	13,874	2	1	430	483	39	8
Great Egret	1,538	<1	2	640	38	3	6
Snowy Egret	2,356	<1	2	367	55	4	7
Cattle Egret	8,194	1	4	4,400	14	1	5
Black-crowned Night-Heron	4,082	<1	1	350	93	8	8
White-faced Ibis	135,652	23	2	24,500	79	6	7
Franklin's Gull	158,448	26	4	31,996	23	2	4
Ring-billed Gull	33,387	6	5	6,080	23	2	4
California Gull	160,105	27	2	35,940	56	5	6
Caspian Tern	566	<1	2	200	18	1	4
Black Tern	533	<1	2	80	30	2	5
Common Tern	323	<1	2	74	11	<1	1
Forster's Tern	1,376	<1	2	302	40	3	6

Table 6. Colonial waterbird atlas summary, by U.S. state, region (for Utah), and species. *Total count* is the estimate of the total number of breeding individuals.

State	Region	Species	Total count	Min colony size	Max colony size	*N* colonies
Arizona	Statewide	Neotropic Cormorant	98	2	96	2
		Double-crested Cormorant	1,150	2	298	15
		Great Blue Heron	1,243	1	84	59
		Great Egret	64	2	30	6
		Snowy Egret	165	3	60	7
		Cattle Egret	7,789	9	4,400	5
		Black-crowned Night-Heron	91	2	50	6
		White-faced Ibis	882	6	700	4
Colorado	Statewide	Eared Grebe	2,122	4	786	24
		Western Grebe	978	2	300	25
		Clark's Grebe	8	4	4	2
		Double-crested Cormorant	2,901	2	968	17
		American White Pelican	1,496	2	800	6
		Great Blue Heron	3,186	2	288	82
		Great Egret	8	8	8	1
		Snowy Egret	519	2	200	9
		Cattle Egret	94	94	94	1
		Black-crowned Night-Heron	1,272	2	350	19
		White-faced Ibis	1,018	2	800	15
		Franklin's Gull	67	12	40	3
		California Gull	1,273	159	614	3
		Black Tern	79	2	50	6
		Forster's Tern	76	2	24	5
Idaho	Statewide	Western Grebe	5,585	31	4,700	7
		Clark's Grebe	68	1	67	2
		Double-crested Cormorant	3,450	40	1,268	12
		American White Pelican	7,712	80	2,736	6
		Great Blue Heron	2,626	2	262	65

Table 6. Colonial waterbird atlas summary, by U.S. state, region (for Utah), and species. *Total count* is the estimate of the total number of breeding individuals.

State	Region	Species	Total count	Min colony size	Max colony size	*N* colonies
		Great Egret	44	2	20	5
		Snowy Egret	264	2	166	6
		Black-crowned Night-Heron	382	26	236	4
		White-faced Ibis	88,504	8,032	24,500	6
		Franklin's Gull	124,210	13,714	31,996	5
		Ring-billed Gull	11,378	14	3,604	7
		California Gull	26,080	30	11,550	9
		Caspian Tern	166	6	110	4
		Black Tern	24	2	12	3
		Forster's Tern	2	2	2	1
Montana	Statewide	Eared Grebe	1,583	2	740	19
		Western Grebe	291	2	158	7
		Clark's Grebe	10	4	6	2
		Double-crested Cormorant	3,361	2	742	19
		American White Pelican	13,299	90	5,902	5
		Great Blue Heron	3,666	2	230	133
		Black-crowned Night-Heron	486	4	194	9
		White-faced Ibis	588	2	390	6
		Franklin's Gull	23,960	174	9,666	7
		Ring-billed Gull	18,848	50	6,080	11
		California Gull	13,454	12	6,732	12
		Caspian Tern	336	2	200	6
		Black Tern	288	4	38	18
		Common Tern	323	2	74	11
		Forster's Tern	265	2	60	12
Nevada	Statewide	Eared Grebe	954	21	787	6
		Western Grebe	12	12	12	1
		Double-crested Cormorant	978	3	814	6
		American White Pelican	7,790	7,790	7,790	1
		Great Blue Heron	411	1	70	16
		Great Egret	1,293	2	640	16
		Snowy Egret	161	2	33	11

Table 6. Colonial waterbird atlas summary, by U.S. state, region (for Utah), and species. *Total count* is the estimate of the total number of breeding individuals.

State	Region	Species	Total count	Min colony size	Max colony size	*N* colonies
		Cattle Egret	4	4	4	1
		Black-crowned Night-Heron	695	1	200	23
		White-faced Ibis	9,153	5	1,800	31
		Ring-billed Gull	321	5	310	3
		California Gull	8,386	40	7,260	5
		Caspian Tern	14	2	6	4
		Black Tern	140	60	80	2
		Forster's Tern	23	3	10	3
New Mexico	Statewide	Eared Grebe	282	92	190	2
		Western Grebe	49	7	34	3
		Clark's Grebe	56	12	44	2
		Double-crested Cormorant	184	4	92	6
		Great Blue Heron	222	2	26	17
		Great Egret	100	30	70	2
		Snowy Egret	230	6	106	5
		Cattle Egret	134	14	50	4
		Black-crowned Night-Heron	104	8	40	5
Utah	Great Salt Lake	Eared Grebe	8,431	23	3,678	8
		Western Grebe	43	1	24	6
		Clark's Grebe	10	4	6	2
		Double-crested Cormorant	1,261	8	699	5
		American White Pelican	10,228	10,228	10,228	1
		Great Blue Heron	718	1	430	17
		Great Egret	21	2	14	4
		Snowy Egret	669	2	367	12
		Cattle Egret	23	9	14	2
		Black-crowned Night-Heron	610	1	320	11
		White-faced Ibis	27,333	9	8,000	12
		Franklin's Gull	10,133	63	6,630	6
		Ring-billed Gull	176	176	176	1

Table 6. Colonial waterbird atlas summary, by U.S. state, region (for Utah), and species. *Total count* is the estimate of the total number of breeding individuals.

State	Region	Species	Total count	Min colony size	Max colony size	*N* colonies
		California Gull	99,398	8	35,940	20
		Caspian Tern	24	2	22	2
		Forster's Tern	940	6	302	13
Utah	Interior	Eared Grebe	585	10	246	8
		Western Grebe	1,217	2	322	19
		Clark's Grebe	116	2	36	7
		Double-crested Cormorant	478	4	192	8
		American White Pelican	42	6	36	2
		Great Blue Heron	812	2	68	46
		Great Egret	8	2	2	4
		Snowy Egret	346	14	179	4
		Cattle Egret	150	150	150	1
		Black-crowned Night-Heron	356	2	74	10
		White-faced Ibis	8,022	70	7,311	4
		Franklin's Gull	78	4	74	2
		Ring-billed Gull	2,664	2,664	2,664	1
		California Gull	10,412	166	3,746	4
		Caspian Tern	26	12	14	2
		Black Tern	2	2	2	1
		Forster's Tern	20	2	18	2
Utah	Statewide	Eared Grebe	9,016	10	3,678	16
		Western Grebe	1,260	1	322	25
		Clark's Grebe	126	2	36	9
		Double-crested Cormorant	1,739	4	699	13
		American White Pelican	10,270	6	10,228	3
		Great Blue Heron	1,530	1	430	63
		Great Egret	29	2	14	8
		Snowy Egret	1,015	2	367	16
		Cattle Egret	173	9	150	3
		Black-crowned Night-Heron	966	1	320	21
		White-faced Ibis	35,355	9	8,000	16
		Franklin's Gull	10,211	4	6,630	8

Table 6. Colonial waterbird atlas summary, by U.S. state, region (for Utah), and species. *Total count* is the estimate of the total number of breeding individuals.

State	Region	Species	Total count	Min colony size	Max colony size	*N* colonies
		Ring-billed Gull	2,840	176	2,664	2
		California Gull	109,810	8	35,940	24
		Caspian Tern	50	2	22	4
		Black Tern	2	2	2	1
		Forster's Tern	960	2	302	15
Wyoming	Statewide	Western Grebe	8	4	4	2
		Double-crested Cormorant	200	18	92	4
		American White Pelican	1,142	60	856	3
		Great Blue Heron	990	2	110	48
		Snowy Egret	2	2	2	1
		Black-crowned Night-Heron	86	4	22	6
		White-faced Ibis	152	152	152	1
		California Gull	1,102	2	1,000	3
		Forster's Tern	50	2	32	4

Figure 1. Location of the interior portion of the Western Colonial Waterbird Survey (2009-2011) and *Atlas of Breeding Colonial Waterbirds in the Interior Western United States*.

Data Codes. Codes used within the site tables are defined below.

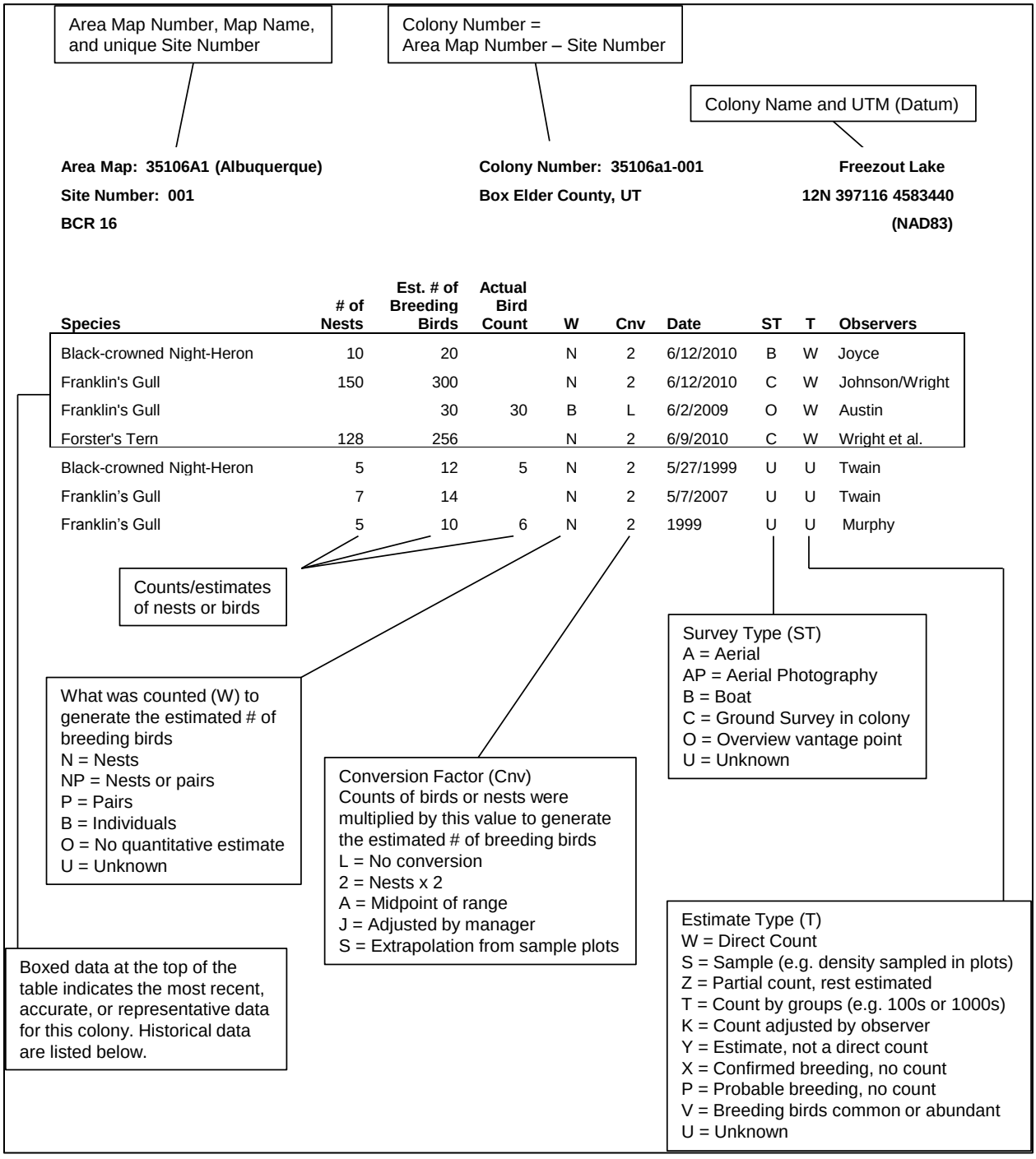

Figure 2a. Key to data tables and codes used in the maps in the *Atlas of Breeding Colonial Waterbirds in the Interior Western United States*.

Data Codes. Codes used within the site tables are defined below.

Universal Transverse Mercator.–The geographic coordinates for each colony are presented as Universal Transverse Mercator (UTM). The format for each location is presented in zone number, letter, easting and northing.

What Counted (W).--What was counted, birds or nests.

Code	*Description*
B	Birds: count or estimate of individual birds in colony.
N	Nests: count or estimate of nests in colony.
NP	Nests or Pairs: count or estimate of nests or breeding pairs.
P	Pairs: count or estimate of breeding pairs in colony.
O	No count or estimate: observer provided no quantitative estimate of colony size, only non-numeric data like "Present"" or "Rare".
U	Unknown: unexplained how the number was generated.

Conversion (Cnv).--This code describes how the count or survey data were adjusted to generate estimates of breeding birds. Counts of nests were multiplied by 2 and counts of birds were often adjusted by a conversion factor to account for non-breeding birds at the colony and breeding birds away from the colony.

Code	*Description*
L	Literal count or estimate reported by observers; no adjustment.
2	Counts of nests were multiplied by 2 to estimate the number of breeding birds.
A	Midpoint of range (e.g., 500-1000 entered as 750).
J	Manager adjusted observer's data another way.
S	Extrapolation of data from sampling (e.g., nest densities in sample quadrats).

Survey Type (ST).--Survey method used to census or survey the colony. Codes were sometimes combined to indicate that more than one method was used.

Code	*Description*
A	Aerial survey from fixed-wing airplane or helicopter
AP	Aerial photography
B	Boat
C	Colony, ground survey in the colony or on the island
O	Overview, ground survey from a vantage point
U	Unknown

Estimate Type (T).--Type of estimate or count made by the observer. Codes may be qualitative or quantitative.

Code	*Description*
W	Direct Count
S	Known percent of colony. Exact count of birds, pairs, or nests in known fraction of colony area; count extrapolated to total number.
Z	Part estimated, part counted: exact count on part of colony area; remainder of colony and total number in colony estimated.
T	Count by groups: count of birds, pairs, or nests by groups (e.g., 10s or 1000s).
K	Count adjusted by observer: observer adjusted count of individuals, nests, pairs to give better estimate of total population (e.g., using study of attendance at nests).
Y	Estimate, not actual count: observer estimated birds, nests, or pairs by some other method.
X	Present, no count. Observer reported breeding birds of this species at colony, but no estimate of numbers.
P	Probable: observer reported breeding birds probably or possibly present at colony, but no numerical value.
V	Common or abundant: observer reported breeding birds common or abundant at colony, but no numerical estimate.
U	Type of estimate unknown: census method or accuracy of method unknown.

Figure 2b. Key to data tables and codes used in the maps in the *Atlas of Breeding Colonial Waterbirds in the Interior Western United States*.

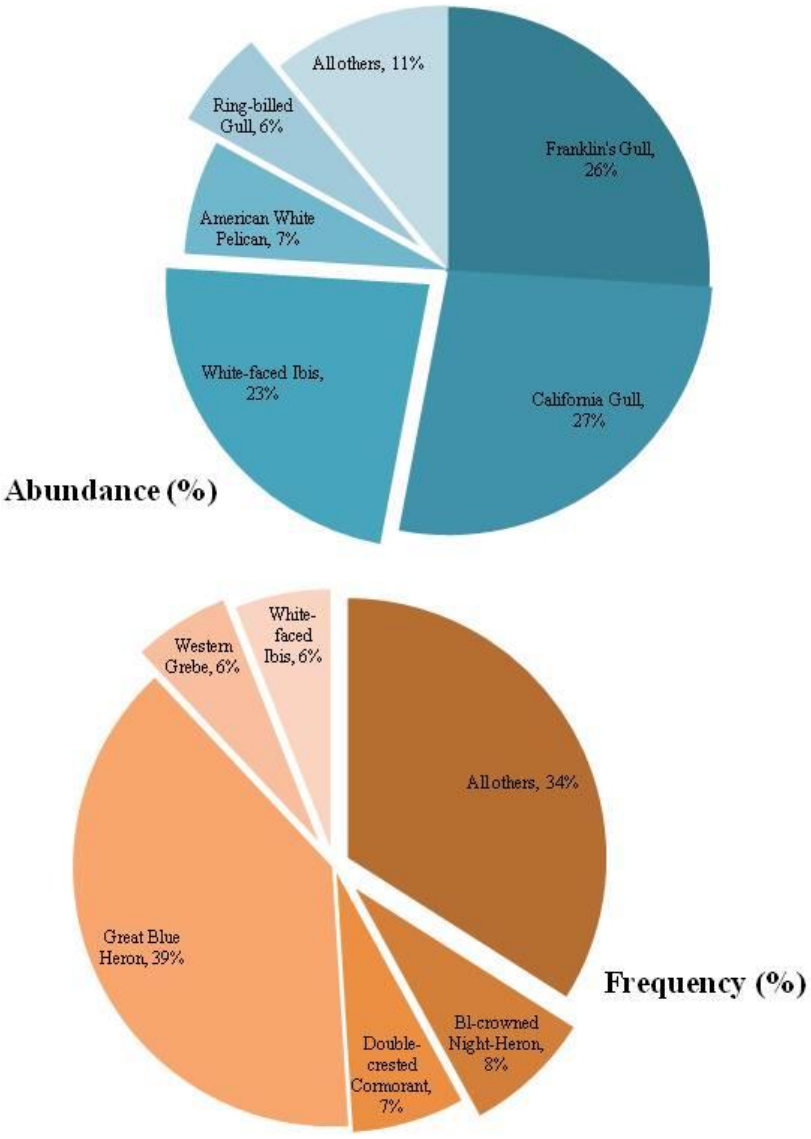

Figure 3. Western Colonial Waterbird Survey summary (2009-2011). Relative abundance (top) and relative frequency (bottom) for the top colonial waterbird species across eight interior western U.S. states.