WESTERN COLONIAL WATERBIRD SURVEY PROTOCOLS

INTRODUCTION

Many states in the western U.S. have identified information on colonial waterbird distribution and populations as a priority; including determining their status, identifying conservation issues, and refining conservation actions. In part, this concern is due to several colonial-nesting waterbird species in the western U. S. declining in overall abundance or, conversely, others that are increasing in size and expanding in distribution (Table 1), resulting in escalating conflicts at landfills, croplands, recreation sites, and urban interfaces throughout their ranges. Colonial waterbirds concentrate during the nesting season, primarily due to their specialized habitat requirements and the limited availability of suitable habitat. Their colonial natural history make them especially vulnerable to stochastic weather events, pollution, and loss of nesting sites, changes in land use, and other factors that may affect the suitability of nesting and brood-rearing sites. Colonies of these species come and go; indeed, some opportunistic, low site-fidelity species may greatly alter nesting locations among years. A critical element in the eventual conservation of this group is a comprehensive baseline inventory and atlas of these colonies. The prioritized objectives of this survey are: 1) inventory and atlas of current waterbird colonies; 2) inventory of historical sites; and 3) locating new colonies.

Therefore, U.S. Fish and Wildlife Service Regions 1, 2, 6, and 8 are coordinating a survey to inventory and document the status of these species. *Coordinated Colonial Waterbird Inventory and Monitoring in the Western United States: Comprehensive Breeding Season Surveys* will be an inventory of breeding colonial waterbirds from 2009 through 2011 (Seto 2008).

The objective of this document is to discuss the most appropriate protocols for each species and each nesting habitat. This document consists of four sections. The first section is the introduction, with general information on the proposed coordinated survey and information common to all the recommended protocols. The second section consists of the recommended ground-based protocols for colony counts in areas where there are no current colonial waterbird inventories being conducted, while the third section is a discussion of aerial surveys, which may be an appropriate protocol to use for some species at some sites. The fourth section is a list of states included in this survey and their current or historical waterbird surveys, with a brief description of the methods currently being used.

In areas with existing colonial waterbird surveys, these current survey protocols will generally be continued, and combined into an atlas of these colonies. The protocols recommended here are directly derived from the recommendations for counts of all species made by the Colonial Waterbird Monitoring Partnership's *Breeding Season Population Census Techniques for Seabirds and Colonial Waterbirds throughout North America* (Steinkamp et al. 2003) and *South Dakota Breeding Waterbird Colony Monitoring. Part I: Breeding Bird Count Protocols* (Drilling, N. 2007). The primary author and contact for this document is Stephanie L. Jones, USFWS, Nongame Migratory Bird Coordinator, Region 6, P.O. Box 25486 DFC, Denver, CO 80225, email: stephanie_jones@fws.gov, phone: 303-236-4409.

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Coverage.—Geographic coverage is the eleven western states: Washington, Oregon, California, Idaho, Nevada, Arizona, Montana, Utah, Wyoming, Colorado, and New Mexico. Species covered are listed in Table 1, with scientific names and codes. In 2006 and 2007, the coastal areas of Washington, Oregon, and California were surveyed for island-nesting gulls and terns. Therefore, this coastal area will not be included in this proposed survey and this survey will focus on inland breeding colonies.

Detectability.—This survey can have two major types of detectability issues. First, the detectability of the actual colonies (e.g. location), where surveyors are missing colonies. One of the objectives of this survey is to search for new colonies, balancing efficiency of effort and resources with good coverage of potential colony sites. Along with this, using historical data with location information, breeding bird atlases, and other data will help minimize this potential to miss colonies. A second detectability issue is missing nests, particularly in large dense colonies or because the timing of the survey is incorrect for the target species or survey year. We will use the appropriate protocols

demonstrated to be successful for the various species or habitats to minimize measurement error. In addition, using two observers is another way to minimize the detectability issues.

Colony and Regional Population Estimates.—Direct nest counts should be used whenever possible. Colony counts based on direct nest counts provide more accurate information than counting total number of adults, as the latter number may contain both breeding and non-breeding birds. Every individual in a flock can be counted directly if flocks number no more than a few hundred birds. Direct counting is easy with large birds at close range, but becomes progressively more difficult with larger numbers, smaller species, and greater distances. When the number of birds is greater than a few hundred birds estimation procedures have to be used and sampling, rather than total counts, may have to be done within larger and dense colonies. These estimates will be corrected to account for breeding birds away from the colony and for non-breeding birds present in the colony. Therefore, 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 resulting estimate of colony population size is likely to be an under-estimate. 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 will be minimum population estimates.

GENERAL CONSIDERATIONS

Choosing a Protocol. —There are many considerations that are common to all or most of the recommended protocols. The decision of protocol methodology and parameters to use will depend 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 without causing unacceptable levels of disturbance to nesting birds and vegetation. The following factors are general considerations whichever protocol is followed.

All surveys of wetland-nesting species should respect the relative fragility of wetland habitats and the vegetation at the colony sites. Disturbance to the vegetation and breeding birds should be avoided as much as possible to minimize the possibility of nest failure and/or colony abandonment in response to the survey activities. In addition, permits (e.g. State Scientific Collecting Permits, Research MOUs

in California) may be required by the State agency prior to entering a colony. This is particularly important for species that are listed as Threatened and Endangered species or as avian species of special concern in the State or area with the colony.

Season. —Seasonal timing is very important, with the peak count for many species in the mid- to late-incubation period. Only one colony count per year is recommended. Surveys should be counted at approximately the same time or within the same point of the nesting cycle every year. To the extent possible, timing of surveys of selected species should be coordinated with other survey participants (e.g. other states) to minimize over or under-counting due to shifting colony locations associated with annual environmental conditions (e.g. flood/drought or water year cycles).

Markings. —For ground nests, many recommendations include to mark nests as they are counted to aid in accurate counting and to avoid double-counting. Many markers are possible, including the use of plastic or cotton flagging tape, paint, e.g. tempura, and surveyor's flags on stiff wires. These are all designed to allow two people to efficiently do a total nest count without double counting, even in a large colony. Be sensitive and use markers that do not affect aesthetics or survivorship, and make plans to remove all markings, preferably on the same day as the count to avoid disturbance on a second day.

Locations. —Careful recording of the locations of each colony will be critical to the success of this inventory and atlas. Therefore, record the GPS- UTM coordinates of each survey point and colony, being sure to clearly note the datum used, as this can make a large difference in comparison with other surveys.

Predation. —Avoid surveys of ground nesting birds if obvious predators are present and showing an interest in your activities. In addition, the species being surveyed could themselves be egg and chick predators, e.g. RBGU and CAGU. Damage to their own species in a large colony may be minor, however; in a mixed colony of gulls and another species, gull damage to eggs and chicks can be significant enough that one should consider not disturbing such colonies.

Parameters.—It is very important to get an accurate count and the primary parameter will be the number of active nests. Since nests for many species may persist from year to year but may not be

re-used, each nest must be quickly evaluated for activity during each survey period. Active nests are nests with eggs or chicks, incubating or brooding adults, nests that have fledged chicks present, or nests that are otherwise being tended by adults, such as being constructed or repaired. The presence of fecal matter may be helpful to distinguish active nests. The presence of fresh sticks or vegetation may indicate an active nest. An inactive nest is either an old nest not used in the present year, or a nest abandoned early in the season. Signs of inactive nests include lack of fresh fecal material or fresh vegetation, or nest material is falling apart. For some species, including gulls and terns, breeding adults build more elaborate nests than the less well-built structures constructed by non-breeding individuals; however, this is very variable and you can't use a poorly built nest as the only distinguishing characteristic between an active or inactive nests. For all gull species, an active nest should be more than a simple scrape and should include a defined built-up edge. Also, for terns and gulls, an active nest is usually defined as adults that are sitting tight and apparently incubating eggs or brooding chicks.

Observer Disturbance. —When adults are flushed off nests, the eggs or chicks are vulnerable and adults may abandon if there is excessive observer disturbance. Individual pairs or entire colonies may abandon. In particular, AWPE can be sensitive to disturbance (see below on AWPE issues). Additionally, Threatened and Endangered species or avian species of special concern should be treated with the utmost caution.

Ideally, observers should count the nests or adults without disturbing the colony. However, if one must go into the colony to get an adequate count, prior to entering the colony and disturbing the birds you should: 1) decide which protocol to use; 2) have all discussions about who does what, where, etc.; and 3) make all relevant decisions from a distance where you are not disturbing the colony. While in the colony, keep conversation to a minimum and keep your voices down. If possible, after you leave a colony, note how soon the adults return.

If adults are flushed (although for most species flushing adults is the absolutely last resort), consider the following before entering the site:

Weather: do NOT flush adults if:

- the wind chill temperature is below 65^{o} F
- it is sunny and air temperature is above 80^{o} F

- it is cloudy and air temperature is above 90^{o} F
- it is raining, or high probability of rain while you are there

Nesting stage: do NOT flush adults if the majority of the colony is:

- nest-building or early incubation stage
- mobile chicks (>3 weeks old for larger species; >2-5 days for ground-nesting gulls, terns)
- nesting AWPE are present, unless chicks are >3-4 weeks old; may be able to count during late incubation/early hatching without causing abandonment, if time on the site is short, 10-20min.

Predators: do not flush adults if:

- egg or chick predators are present and clearly interested in exposed nests
- be aware of both mammalian and avian predators

Length of time in colony: as a general rule adults should be off the nest no more than 10-30 minutes, however:

- do not force adults off the nest if chicks are clearly shivering, panting, or excessively weak (leave colony immediately)
- in colonies with high, dense tree canopy and if adults return when observers are out of sight under the trees, the length of time within the colony can be extended

GROUND-BASED SURVEY PROTOCOLS

The following protocols are recommended for those sites in which surveys are not currently conducted, and where established protocols do not exist. These protocols may also be considered as an alternative to ongoing surveys where local or subject area experts determine they are appropriate. In addition, resources and local site conditions should also be considered when selecting from the protocols described below.

Tree- and shrub-nesting species: (e.g. GBHE, GREG, SNEG, BCNH, DCCO, WFIB):

Total nest count: to count all nests within one hour, before trees have fully leafed out.

Perimeter: for species that build conspicuous nests and when one can see all nests from the perimeter (e.g., colony in row of trees); any nesting stage.

Within colony: colonies <1,000 nests, can't see all nests from perimeter or has species that build inconspicuous nests; late incubation or early chick stage.

Partial nest count:

Strip transect: for large (>1,000 nests) colonies; late incubation or early chick stage.

Aerial surveys: could be considered, if resources are available.

Ground-nesting species: (e.g. WFIB, RBGU, CAGU, COTE, FOTE, CATE):

Total nest count:

Within colony: in colonies with <500 nests per available observer. Late incubation and early chick stage. Entering colonies is tricky with terns when co-nesting with gulls; counts from the perimeter are preferred unless that is truly impossible. Depends on colony density, vegetation, and size of the island/nesting area.

Perimeter: If good vantage points are available, and if all nests are readily visible.

Partial nest count: for large colonies, generally >500 pairs.

Quadrats: Late incubation and early chick stage.

Transects: Fairly open and uniform habitats where the nests are relatively visible. Late incubation and early chick stage.

Flush counts of adults: species that defend nests (e.g., gulls, terns), colony is small enough to ensure complete evacuation, and there is an opportunity for birds to return quickly. Late incubation, early chick stage. This technique can have the potential to disrupt the colony and should be avoided, unless there are no predators in the area or there is truly no other way to conduct the count.

Aerial surveys: could be considered, if resources are available.

Marsh-nesting species: (e.g. GBHE, BCNH, GREG, SNEG, WFIB, EAGR, WEGR, CLGR, BLTE, FOTE, RBGU, FRGU):

Total nest counts:

Total nest count within colony: colony ~200 pairs, in discrete patches of vegetation. Late incubation and early chick stage.

Partial nest count, quadrats or transects: larger colonies, relatively even nest distribution

Adult counts:

Flush counts of adults: colony small enough to ensure complete evacuation and opportunity for birds to return quickly (primarily gulls, terns). Late incubation, early chick stage.

Fly-out or flight-line counts: have been used for large colonies, particularly WFIB. Observers are stationed at vantage points away from the colony where the entire colony is within view, and then count all the individuals leaving the colony. Counts should begin shortly after sunrise, and the time of the counting period pre-determined before arriving; recommended timing has been 3 hours (Erwin 1981). Surveys should be conducted during the incubation stage, so that the individuals counted are assumed to equal the number of breeding pairs, based on the assumption that one adult per pair is attending the nest (Erwin 1981).

Aerial surveys: should be considered, if resources are available.

PROTOCOL DESCRIPTIONS

1. *Perimeter Counts – tree-nesting and ground-nesting species:*

- What to count: All nests of all species
- Appropriate nesting stage: any nesting stage
- Time of day: any time during daylight hours

Perimeter counts are conducted from boats or from land-base points around the perimeter of a colony and minimize disturbance. These counts can be conducted at any time of the day and during any nesting stage because ***you should not be flushing adults from the nests***. The number and location of survey points will vary from colony to colony depending upon vegetation structure and density, and colony size and shape. The points should be located at sufficient intervals around the colony to allow for counting the maximum number of nests while minimizing the risk of double-counting nests. Map unique landmarks within the colony that can be used to establish which nests to count from each point. Also, observers should be close enough to allow birds to be counted but far enough so that birds do not flush from their nests. Record the GPS (UTM) and datum coordinates of each survey point; count and record all nests of each species.

2. *Within colony total nest count – tree-nesting:*

Where transects are being set up, there may be a disturbance factor that needs to be considered. Also, many sites will require surveyors to remove any markings.

- What to count: All nests of all species
- Appropriate nesting stage: any nesting stage before chicks are large/mobile; do not enter colony if chicks are large – they will prematurely fledge. Be acutely aware of different nesting chronologies in mixed-species colonies.
- Time of day: any time during daylight hours

If the colony is very small or the colony is located along a narrow corridor, walk a single unmarked transect and count every nest. If all nests are not visible from a single transect, establish strip transects by marking the boundary of strips at intervals allowing every nest to be viewed from one line with no double counting occurring. The boundaries of the strips should be marked at intervals that easily allow the surveyor to follow each line through the habitat. Strip width will vary with the density of the vegetation and should be dictated by the observer's ability to see the next transect line in order to accurately determine the boundaries of the strip being surveyed; strips may be only 2-5m wide in dense habitats, but widths of 30-60m are possible in open woodlands. Extend transects from one end of the colony to the other. Count all nests located on one side of the flagging. For nests located in trees or shrubs that extend over the transect boundary, nests should be counted only when the base of the supporting tree/shrub is located within the strip, regardless of the actual position of the nest. When you reach the end of the strip, move over to the next strip and count all nests between the boundaries of the previous strip and the current strip. Continue until the entire colony is counted.

3. *Within colony total nest count – ground-nesting and marsh-nesting:*

- What to count: All nests of all species
- Appropriate nesting stage: late incubation, early nestling stage. Do NOT enter if chicks are large/mobile
- Time of day: best between 0900 and 1600, especially important to be within weather guidelines

Ground-nesting species. The entire colony is surveyed and each nest marked to avoid omission or double counts. For gulls, nest counts should be conducted during the mid- to late incubation period as most nesting pairs should be present at this time. These counts should be made between 0900 and 1600 hrs since colony attendance is most stable during these hours, making it easier to find nests.

However, only survey in the morning if the heat of the day could affect the viability of eggs if they are exposed too long. Small and newly established colonies tend to be very prone to desertion after disturbance and great caution should be exercised when surveying these colonies. AWPE may be particularly sensitive to disturbance, and surveys should be carefully coordinated with this in mind.

Marsh-nesting species. A total nest count is generally used in relatively small colonies (~200 nesting pairs) and do not require transects, especially where the colonies are located in discrete patches of vegetation and can be fairly easily located within the wetland. See also the discussion of terns, below; habitats must allow for access by boat or on foot so that the nests can be counted without causing excessive disturbance to adults and chicks. Move through the colony on foot, vehicle, or by boat to locate and count the nests of all breeding pairs, marking each nest or near each nest if you can't reach it.

Terns. FOTE and BLTE tend to nest in small colonies, usually totaling fewer than 50 pairs, and they regularly nest as isolated pairs or in small groups of 5 or fewer pairs. You can conduct either direct nest counts or flush counts of adults. Direct nest counts are preferred but the challenge is actually finding all of the nesting locations that may be scattered within a large wetland. Systematically search these habitats (normally by boat) at potential breeding sites in order to locate all nesting pairs. The defensive behavior of the adults is frequently a good indicator that you are near a nest site. Counts of foraging adults should not be used as an index of breeding population size, since both species will forage at wetlands away from their nesting colony. Other tern species will occasionally nest in marshes, generally in small numbers that are surveyed using direct nest counts (preferred) or flush counts of adults. In large and impenetrable marshes, aerial surveys could be considered as the best method for complete coverage.

Pelicans. AWPE may be extremely sensitive to disturbance of all types, including over-flights of aircraft, at their nesting colonies. AWPE tend to flush excitedly into the water and then fly off in such a manner that the disturbance can cause destruction of eggs, delays in egg-laying, and loss of eggs and/or young through chilling or overheating. This effect can also occur if the nesting islands are approached by humans in boats. If observers land on the nesting islands during incubation or if incubating pelicans are put off their nests repeatedly by human visitors *(e.g.,* fishermen), then abandonment of nests can occur. AWPE are sensitive to aircraft, especially helicopters, on foraging

lakes and may take flight upon approach within 1km (Province of British Columbia 1998). Be sensitive to the potential to cause abandonment when working with AWPE.

4. *Strip transect partial nest count – tree-nesting colonies:*

- What to count: nests
- Appropriate nesting stage: any nesting stage before chicks are large/mobile
- Time of day: any time during daylight hours

This procedure involves counting a portion of the colony along strip transects to estimate the number of nests for the entire colony. First, the size of the entire colony needs to be determined by mapping the boundary. Walk the boundary, recording UTMs. After the colony boundary has been mapped, determine the size and location of the strip transects. In general, the area covered by transects should total 20% to 40% of the entire colony; 40% is preferred under most circumstances, because this coverage will produce more accurate estimates of total population size. In extremely large colonies or habitats that are very difficult to traverse, 20% coverage is adequate. For multi-species colonies that are partially or entirely segregated by species into sub-colonies, a random sample approach stratified by species distribution should be used to ensure that all species are adequately surveyed (i.e., each species receives 40% coverage).

Once the location of transects has been decided, mark the boundaries of the strip transects at intervals that easily allow you to follow each line through the habitat. Strip width will vary with the density of the vegetation and should be dictated by the observer's ability to see the next transect line in order to accurately determine the boundaries of the strip being surveyed; strips may be only 2-5m wide in dense habitats, but widths of 30-60m are possible in open woodlands. Extend transects from one end of the colony to the other. Count all nests located between the strip boundaries. For nests located in trees or shrubs that extend over the transect boundary, nests should be counted only when the base of the supporting tree/shrub is located within the strip, regardless of the actual position of the nest. When you reach the end of the strip, move over to the next strip and count all nests between the boundaries. Continue until all strip transects are counted.

5. *Partial nest counts – ground-nesting, marsh-nesting colonies:*

- What to count: nests

- Appropriate nesting stage: incubation for precocial species; mid-incubation to mid-chick stage – all others.
- Time of day: any time during daylight hours

For large colonies, generally those in excess of 1,000 pairs (although some counts have been successful in excess of this size if the birds quickly settle back once observers move through the area), and for colonies where the nests are hidden in vegetation and more difficult to locate, complete nest counts are not feasible without causing unacceptable levels of disturbance to nesting birds. In these situations, nest density is estimated in a portion of the colony, and these densities are used to extrapolate to the total number of nesting pairs at the site. In order to develop these estimates, the total area of the colony must be established; by transversing the perimeter and recording the UTMs at regular intervals (use UTMs because the area can be directly calculated). The number of sampling units (transects or quadrats) will depend upon the colony size, relative ease of locating nests, and the availability of personnel to conduct the survey. Ideally, 20% to 40% of the total colony area should be sampled to develop an estimate of population size, assuming that sufficient personnel are present to conduct the survey without causing unacceptable levels of disturbance to the nesting birds. There should be a minimum of 10% coverage under most circumstances, except at huge colonies (tens of thousands of nesting pairs over a large area) or sites where the nests are very difficult to locate and only a small number of units can be adequately sampled within the appropriate period of time. In these situations, only 5% coverage may be realistic. Transects normally are preferred in fairly open and uniform habitats where the nests are relatively visible. If the vegetation is relatively dense and nests are not easily found, the quadrat method is preferred under most circumstances. If habitats are heterogeneous at a colony, then both methods may be employed.

*Transects***.** Once a colony has been mapped, transects need to be defined in order to obtain a representative sample of the population. Parallel transects should be placed 5m apart. Marking the lines with colored string may facilitate following transects through the colony, or GPS a route, with one observer following the route (and recording) while a second observer looks for nests. The subset of transects chosen for the survey should be randomly selected from all possible transects crossing the colony. The number of occupied nests sites within 2m on either side of each transect are counted and marked to avoid double counting.

Quadrats. Choice of quadrat size will reflect the nest density and vegetation density at the colony. The standard size is 10x10m, but a 20x20m may be employed where nests are widely spaced. Smaller quadrats may be used where nests are tightly packed or where the vegetation is fairly dense and the nests are located with some degree of difficulty. Quadrat location should be selected at random, although stratification by sub-areas within the colony may be necessary to ensure that the sites are representative of the entire colony. These locations can be points placed at equal distances along randomly selected transect lines, or they can be sites randomly chosen within the colony to include both nests along the periphery and in the center of the colony. Use flagging to mark the corners or edges of the quadrat or GPS the center target of the quadrat (circle) and use it as a pivot point. Count every nest within each quadrat, marking each nest with spray paint to avoid double counting.

One suggested alternative is to mark the GPS center of the target quadrat, and use this as a pivot point of a pole temporarily placed in the ground, with a 10-20m piece of string/rope. Observers then can walk around pivot point counting all nests that fall under the rope. When completed, pick up pole and rope and move to the next point. Area covered is similar, but being unlikely to result in double-count, this makes marking unnecessary.

6. *Flush counts of adults*:

This technique should only be used as a last resort if you clearly cannot get a nest count since entering the colony could result in higher disturbance or the entire colony is not within survey view and would result in an inaccurate count. In particular, Threatened and Endangered species or avian species of special concern in the state should be treated with the utmost caution. Flushing adults during a survey may not be acceptable. If resources are available, aerial surveys may be a preferable alternative.

- What to count: all adults of target species (gulls and terns) that fly up from colony
- Appropriate nesting stage: incubation, very early chick stage
- Time of day: any time during daylight hours

Species that defend nests, particularly gulls and terns, react aggressively to near approach of the nests by potential predators. At small colonies, this behavior makes it relatively easy to count flying birds. This approach also may be used at small tree-nesting and marsh-nesting colonies late in the incubation or early in the brooding period. At these sites, entry into the colony area will flush all

incubating and/or brooding birds, which usually return quickly after the intruder departs and are readily counted as they flush.

One observer approaches the colony until all of the adults have congregated about the observer. One or more other observers should be stationed at a distance to count flying adults. The count should be completed as quickly as possible after the birds flush, generally within the first minute. If the counts of the different observers are within 10% of each other, they are averaged.

AERIAL BASED SURVEYS

Aerial surveys are often used to survey colonial waterbirds, primarily ground-nesting species in open habitats, in extremely large colonies, and in colonies that are not accessible by other methods, and that can be visually estimated from the flight or from aerial photographs. Aerial surveys have also been used as a means to inventory multiple colonies over a broad geographic area in a limited window of time (e.g. a specific drainage, or portion of a state).

Aerial surveys are usually conducted with either fixed-winged airplanes or helicopters. The observers either count nesting birds directly during the flight or photographs or videos are taken for counting at a later date. Direct counts are considered accurate and acceptable in small colonies, but visual estimates of larger colonies often result in underestimation (Carter et al. 2001). Estimates derived from aerial photographs are preferred for large colonies.

Aerial photos are of two type: (1) overview photos of an entire island/nesting colony (usually using a 50mm lens); and (2) overlapping, close-up photos of colonies (using a 200mm or 300mm lens). Survey altitudes can vary from 150 to 400m above the colony, depending upon the response of particular species to the aircraft. Historically, counts of aerial photos have been done manually using slides. This involved projecting the photographs onto a large sheet of white paper on a wall and marking nests and birds with a fine marker (“dotting”) using identifiable landmarks as reference points to avoid double-counting (Carter et al. 2001). A correction factor, if available, can also be applied to the count data to estimate number of breeding adults at a colony. In recent years, digital images have been taken on surveys and nests are electronically marked (“dotted”) and tallied using computer software (e.g., Image-Pro Express). If possible, ground-truthing of the aerial surveys

should be conducted to assist in determining the breeding to non-breeding ratio of the target species, and to correct for over-estimating the number of nesting pairs. This usually involves observers conducting ground counts of nesting birds in portions of the nesting colony within two or three days of the flight and aerial photograph.

Aerial surveys can be expensive, making this survey technique less feasible if ground-based methods can be used. Although the accuracy of counts obtained in-flight during aerial surveys have been demonstrated to low (Green et al. 2006), counting nesting birds using aerial photographs is considered to be more accurate than ground or boat surveys for extremely large colonies in which observers are not able to view the entire nesting colony (Carter et al. 2001).

ON-GOING SURVEYS AND DIFFERENT APPROACHES ACROSS THE WEST

Geographic coverage is the eleven western states: Washington, Oregon, California, Idaho, Nevada, Arizona, Montana, Utah, Wyoming, Colorado, and New Mexico.

WASHINGTON: CATE and DCCO nesting in the Potholes Reservoir region are surveyed every year by USGS/OSU (D. Roby pers. commun.).

OREGON: Large islands used by colonial nesting waterbirds in the Columbia River are photographed every year by Bonneville Power Administration. Counts of nesting birds are conducted for CATE and DCCO by USGS/OSU.

PRBO and the Klamath Basin NWR Complex collaborated on surveys of all colonial waterbirds in the Klamath Basin of Oregon and California in 2003 and 2004; the refuge complex also does annual counts for many species on their lands

From 1974-1998, Malhuer NWR staff annually estimated populations of all colonial nesting waterbirds on the refuge and within the Harney Basin by aerial surveys, supplemented with ground surveys. Currently, Malheur NWR conducts colonial waterbird surveys every two to three years using air boats or ground surveys. Oregon Department of Fish and Wildlife conducts aerial surveys of colonial nesting waterbirds every year in Lake County. No photos are taken, counts are conducted during flight. Counts focus on gulls, terns, pelicans, herons, egrets, ibis,

and cormorants. Ground counts of nesting grebes are conducted at the Summer Lake Wildlife Area annually (M. Saint Louis pers. commun.).

CALIFORNIA: Klamath Basin NWRC conducts counts of nesting AWPE, DCCO, and GREG from aerial photographs at Clear Lake, Lower Klamath and Upper Klamath NWRs. CATE, GBHE, CAGU, RBGU, and WFIB are counted from boat or land at Clear Lake, Eagle Lake, and Lower Klamath NWRs. Nesting Eared and Western/Clark's grebes are counted from land or boat at Lower Klamath and Tule Lake NWRs (J. Beckstrand pers. commun.). Nesting grebe surveys are currently conducted at Clear Lake and Eagle Lake (S. Hampton pers. commun.).

Audubon Canyon Ranch and S.F. Bay Bird Observatory conduct annual surveys at all known heron and egret colonies in the entire San Francisco Bay region (online atlas available). PRBO conducted statewide surveys of AWPE, DCCO, RBGU, CAGU, FOTE, CATE, and BLTE from 1997–1999; continues to count the state's largest CAGU colony at Mono Lake annually. Other counts, generally smaller in scope, are also conducted (D. Shuford, pers. commun.).

Survey of nesting Western and Clark's grebes in 2003 (G. Ivey, pers. commun.).

IDAHO: Surveys are all ground based and follow recommendations from Steinkamp et al. 2003. For island nesters, Idaho conducts transect surveys (with 3-10 observers) to get complete nest counts. Surveys are conducted only once, targeting the late incubation/early hatching period, and cover the entire island starting from one end and working towards the other. Birds in Idaho settle down very quickly after observers pass, thus birds are generally only off the nest for 5-10min even in large (>5000 pairs) colonies. Transects are run perpendicular to the long edge of the island, so each group of birds is only disturbed once, and the edge of the transect line is marked with flagging that is removed when the line of observers passes by during the next transect. All nests with eggs or chicks are counted as one nest/one nesting pair. No correction factors have been incorporated, as the nests are quite visible and error is likely to be fairly low. However, incorporation of correction factors is being considered for future surveys at priority sites. For tree nesters, Idaho surveys from the perimeter – rookeries are fairly small and most nests are visible from outside the rookery. Target the early nesting period, before trees have fully leafed out. Idaho tested transect, quadrat, and flight line counts for WFIB and FRGU in 2008 (C. Moulton, pers. commun.).

NEVADA: Surveys are aerial -- helicopter flights from about 24m elevation approximately 100kph and cover the Lahontan Basin, conducted by Nevada Division of Wildlife. Count all birds flying, where one bird equals one nesting pair and no correction factors. Nevada does one flight approximately 20 May and another between 10-15 June. May counts are often higher than June counts under normal conditions -- generally consider the May count to roughly equal the nesting pair count while the June count is considered roughly equal to the successful nest count, but annual variation exists. Nevada flies all known colony areas -- marsh, tree, island and has been flying Lahontan Valley since 1986. Humboldt River above Battle Mountain gets flown once every three years. There is a water bird count framework that is planned to be implemented statewide that would provide better coverage, but it is a site census, not colony counts. Stillwater NWR provides the Pyramid Lake/Anaho Island AWPE, etc. coverage (ground counts) (L. Neel, pers. commun.)

USFWS refuge staff monitors AWPE, CAGU, DCCO, GBHE, and CATE nesting populations on Anaho Island NWR, Pyramid Lake, Nevada annually using ground counts from vantage points overlooking the colony areas. Ground counts are verified by photographs taken from these vantage points. Aerial counts are conducted of AWPE feeding areas within 160km to the east of Pyramid Lake (D. Withers, pers. commun.)

ARIZONA: As part of the Arizona Coordinated Bird Monitoring Program, an on-going statewide inventory of waterbird colony locations is being conducted by cooperating agency staff and volunteers. Various methods are being used to locate and document colonies, with most being ground-based. Colonies are also discovered while conducting other field surveys, such as during Bald Eagle nest monitoring flights. Colonies are mapped as they are discovered, with many then assigned to land-managing agency biologists or volunteers. One or two active nest count surveys are to be conducted annually at each assigned (adopted) colony. Participants complete a one page data form and submit it to the Arizona Game and Fish Department for data entry. (T. Corman, pers. commun.).

MONTANA: No systematic surveys have been conducted, however; the Montana Bird Conservation Partnership has been working toward coordinated bird monitoring, including colonial waterbirds Colonies associated with habitat projects or National Wildlife Refuges are surveyed where

possible. Regional surveys in Eastern Montana funded by State Wildlife Grant were completed in 2005-2006. Tree-nesting species in areas surveyed for Bald Eagles are incidentally recorded. Survey and inventory for waterbirds is a priority of Montana's Comprehensive Fish and Wildlife Conservation Strategy (A. Puchniak, pers. commun.).

UTAH: GREAT SALT LAKE (GSL): Surveys for colonial nesters have been sporadic in Utah. Bear River NWR does annual perimeter adult counts for marsh nesters and some ground/island nesting surveys within the refuge. The Utah Division of Wildlife Resources and the Great Salt Lake Ecosystem Program (GSLEP) does some colonial nesting surveys associated with the GSL and State WMAs, mainly focused on AWPE, CAGU, and WFIBs. This program has been conducting an annual aerial photo survey of the Gunnison Island AWPE colony for nearly 3 decades now. In 2008, GSLEP did perimeter surveys of some EAGR colonies and aerial photo surveys of WGIB and some CAGU colonies. From 1998-2001 GSLEP conducted some marsh nester surveys conducted by perimeter adult counts. Other surveys on the GSL are sporadic. There have been a few comprehensive surveys of CAGU colonies for the GSL and northern Utah using strip transects, perimeter counts, and aerial photos (J. Neill, pers. commun.).

WYOMING: Currently conduct a colonial waterbird survey every three years; previously, it was conducted every year. Lat-log report issued every 5 years with locations (A. O. Cerovski, pers. commun.).

COLORADO: RMBO coordinates 'Colony Watch' throughout the state, where volunteers count waterbirds at known colonies. This program began in 1999 and continues to the present, although it has been unfunded since 2006 and thus coverage has become more sporadic. Results are summarized in the annual 'special species report' (N. Drilling, pers. commun.). Breeding Bird Atlas completed, with second atlas started in 2006 (D. Klute, pers. commun.).

NEW MEXICO: No systematic surveys except on a localized basis. New Mexico will be using aerial surveys to locate new colonies (W. H. Howe, pers. commun.).

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Table 1. Species and geographic areas covered in the 11 western states. Primary species occur in the State in large numbers and multiple colonies; secondary species occur in limited geographic areas or in small number in the State. All species in both categories should be included in survey. Trends from the Breeding Bird Survey (BBS) are for 1996-2007, in the western BBS survey area. Significant trends (P<0.1) are marked with an asterisk (*).

English Name	Scientific Name	CODE	Survey coverage		BBS Trend
			Primary	Secondary	
Eared Grebe	*Podiceps nigricollis*	EAGR	CO, UT, WY, MT, ID, OR, CA, NV	WA, NM	3.13*
Western Grebe	*Aechmophorus occidentalis*	WEGR	ALL		0.50
Clark's Grebe	*Aechmophorus clarkii*	CLGR	CO, UT, WY, ID, OR, CA, NV, NM, AZ	MT, WA	0.50
American White Pelican	*Pelecanus erythrorhynchos*	AWPE	CO, UT, WY, MT, ID, OR, WA, CA, NV		1.57
Neotropic Cormorant	*Phalacrocorax brasilianus*	NECO	NM, AZ		n/a
Double-crested Cormorant	*Phalacrocorax auritus*	DCCO	ALL		2.47
Great Blue Heron	*Ardea herodias*	GBHE	ALL		-0.45
Great Egret	*Ardea alba*	GREG	ID, OR, WA, CA, NV, NM, AZ	CO, UT	2.73*
Snowy Egret	*Egretta thula*	SNEG	CO, UT, WY, ID, OR, CA, NV, NM, AZ	MT, WA	2.70*
Cattle Egret	*Bubulcus ibis*	CAEG	CO, UT, ID, CA, AZ	OR, WA, NM, CA	2.05*
Black-crowned Night-Heron	*Nycticorax nycticorax*	BCNH	CO, UT, WY, MT, NM, ID, OR, WA, NV, AZ		1.60
White-faced Ibis	*Plegadis chihi*	WFIB	CO, UT, WY, MT, OR, NV, CA	WA, NM, AZ, MT	6.48
Franklin's Gull	*Larus pipixcan*	FRGU	MT, UT, WY	OR, CA	2.24*
Ring-billed Gull	*Larus delawarensis*	RBGU	MT, UT, WY, OR, WA, NV, CA	CO	0.75
California Gull	*Larus californicus*	CAGU	CO, UT, WY, MT, OR, WA, NV, CA		-1.30
Caspian Tern	*Hydroprogne caspia*	CATE	MT, UT, WY, ID, OR, WA, CA	NV	0.79*
Black Tern	*Chlidonias niger*	BLTE	CO, UT, WY, MT, CA, OR	WA, NV, ID	-1.86
Common Tern	*Sterna hirundo*	COTE	MT		-2.10
Forster's Tern	*Sterna forsteri*	FOTE	CO, UT, WY, MT, NV, CA	WA	-0.78