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STANDARDIZED NORTH AMERICAN MARSH BIRD MONITORING PROTOCOLS

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Introduction

The amount of emergent wetland habitat in North America has declined sharply during the past century (Tiner 1984). Populations of many marsh birds that are dependent on emergent wetlands appear to be declining (Tate 1986, Eddleman et al. 1988, Conway et al. 1994, Conway and Sulzman 2007). Despite evidence of population declines and the need to set responsible harvest limits, a monitoring program specifically designed to determine status and estimate population trends of marsh birds is lacking. The Breeding Bird Survey includes survey data on some secretive marsh birds, but does not adequately sample emergent wetlands (Bystrak 1981, Robbins et al. 1986, Gibbs and Melvin 1993, Lawler and O'Connor 2004). Marsh birds include all species that primarily inhabit marshes (i.e., marsh-dependent species). Primary species of concern in North America include King Rails (*Rallus elegans*), Clapper Rails (*Rallus longirostris*), Virginia Rails (*Rallus limicola*), Soras (*Porzana carolina*), Black Rails (*Laterallus jamaicensis*), Yellow Rails (*Coturnicops noveboracensis*), American Bitterns (*Botaurus lentiginosus*), Least Bitterns (*Ixobrychus exilis*), Pied-billed Grebes (*Podilymbus podiceps*), Limpkins (*Aramus guarauna*), American Coots (*Fulica americana*), Purple Gallinules (*Porphyrula martinica*), and Common Moorhens (*Gallinula chloropus*). The U.S. Fish and Wildlife Service has identified Black Rails, Yellow Rails, Limpkins, and American Bitterns as *Birds of Conservation Concern* because they are relatively rare and we lack basic information on status and trends in most areas (U. S. Fish and Wildlife Service 2002). Moreover, Yellow Rails, Black Rails, Clapper Rails, and King Rails are 4 of the 139 "Focal" species that U.S. Fish and Wildlife Service has given management priority because they pose special management challenges (U.S. Fish and Wildlife Species 2005). And Black Rails, Yellow Rails, and Saltmarsh Sharp-tailed Sparrows are 3 of the 20 species on the National Audubon Society's national 'Watchlist' because they are the 'most imperiled' species (National Audubon Society 2007). Many U.S. states consider these species threatened or of special concern for similar reasons. King Rails are federally endangered and least bitterns are federally threatened in Canada (COSEWIC 2002), and Black Rails are federally endangered in Mexico (Diario Oficial de la Federacion 2002). Populations of marsh birds may be affected by accumulation of environmental contaminants in wetland substrates because they consume a wide variety of aquatic invertebrates (Odom 1975, Klaas et al. 1980, Eddleman et al. 1988, Gibbs et al. 1992, Conway 1995). Marsh birds are also vulnerable to invasion of wetlands by purple loosestrife (*Lythrum salicaria*) (Gibbs et al. 1992, Meanley 1992). Hence, marsh birds may represent "indicator species" for assessing wetland ecosystem quality, and their presence can be used as one measure of the success of wetland restoration efforts. Marsh birds also have high recreational value; many species are highly sought-after by recreational birders. Finally, several rails are hunted in many states yet we lack responsible population surveys on which to base harvest limits.

For these reasons, numerous federal agencies are cooperating to monitor marsh bird populations in North America to estimate population trends. Continued monitoring will also allow resource managers to evaluate whether management actions or activities adversely impact

wetland ecosystems. Any management action that alters water levels, alters salinity, reduces mudflat/open-water areas, alters invertebrate communities, or reduces the amount of emergent plant cover within marsh habitats could potentially affect habitat quality for marsh birds (Conway 1995). The survey protocol outlined below is a standardized survey methodology intended for use on National Wildlife Refuges and other protected areas across North America (see website at http://ag.arizona.edu/srnr/research/coop/azfwru/NationalMarshBird/).

Objectives of program

This survey protocol is intended to provide guidance to individuals planning to survey secretive marsh birds to reach different objectives. The most commonly-stated objectives include: 1) document presence or distribution of marsh birds within a defined area, 2) estimate or compare density of secretive marsh birds among management units, wetlands, or regions, 3) estimate population trend for marsh birds at local or regional scale, 4) evaluate effects of management actions (often actions that target other species) on secretive marsh birds, and 5) document habitat types or wetland conditions that influence abundance or occupancy of marsh birds. The National Wildlife Refuge System of the U.S. Fish and Wildlife Service has participated in this program since the outset because the refuge system has a disproportionate amount of wetland within their boundaries, and the management actions employed by refuges have the potential to dramatically affect marsh bird populations.

Density, abundance, and detection probability

Abundance is the total number of birds within a defined area of interest. Density is abundance divided by area, or the number of birds/ha of wetland (or birds/ha of emergent vegetation within a wetland) during one season. Surveys rarely count all individuals present in the sampling area because detection probability is typically less than 100%. Estimates of abundance or density rely upon estimates of detection probability and a **consistent** positive correlation between number of individuals detected during a survey and number of individuals actually present in the area sampled (i.e., low spatial and temporal variation in detection probability). Few reliable estimates of detection probability during marsh bird surveys are currently available (but see Conway et al. 1993, Legare et al. 1999, Conway and Gibbs 2001, Bogner and Baldassarre 2002). However, these survey protocols incorporate methods for estimating components of detection probability. This aspect will allow validation of counts based on call-broadcast surveys for focal marsh bird species. We will also evaluate the usefulness of distance sampling to provide estimates of density because surveyors will estimate distance to each focal bird detected.

Population trend

Population trend is the percent annual change in population size for a particular species at some defined spatial scale. Estimates of population trend allow managers to determine whether local or regional marsh bird populations are declining. Managers can establish *a priori* population trend thresholds or trigger points below which immediate management action should be taken. Such actions can prevent local extinctions by identifying population problems before they become severe. One can estimate population trends of marsh birds by using weighted linear regression to estimate annual changes in the number of individuals detected per survey point for

each target species. Few estimates of marsh bird population trends currently exist.

Survey routes

More detailed guidelines on point placement within a refuge or management area are currently being developed by USFWS and USGS. The number of survey points to include within a local refuge or management area (or the size of the survey area selected) is often dictated by personnel time available and other logistical constraints. A survey route is a permanent grouping of points that are surveyed during the same morning (or evening) survey window during each visit. All survey points should belong to one (and only one) permanent survey route. The number of points to include on a particular survey route can vary among routes based on the number of survey points that one surveyor can get done in a morning (or evening) survey window (see section below title *Time of day for surveys*). A surveyor may only be able to survey a small number of points (e.g., 6 or 8) in a morning or evening if points are far apart or you are dealing with isolated wetlands. This would constitute a "survey route". If travel between adjacent points is relatively easy and the wetland is large, a surveyor may be able to complete 15 or more points in one morning/evening and hence have 15 points on that survey route. All the survey points that make up one survey route do not have to be associated with the same marsh. Including fewer points per survey route and surveying an additional morning/evening (rather than fewer routes with lots of points) will typically result in more detections. Remember, marsh birds are typically most vocal in the 2 hours surrounding sunrise and the 2 hours surrounding sunset. Once you choose the direction with which you conduct a particular survey route, be consistent (e.g., you always survey the points along route #1 in descending order: point 12 is surveyed first and point 1 is surveyed last). Being consistent in this respect will assure that each survey point is completed at approximately the same time of day during each replicate survey. This consistency will help to reduce the bias created by diurnal decreases in vocalization probability of marsh birds as the morning progresses (Conway et al. 2004).

Location of survey points

Fixed, permanent survey points will be chosen and marked with inconspicuous markers in the field. Each survey point receives a unique identification number. Record the UTM coordinates (and UTM zone and map datum used) of each survey point using a GPS receiver. If possible, locations of all survey points should also be plotted on maps of each wetland. Maps should include the direction in which the speakers should be pointed during the survey at each point. This is not always obvious to someone who has not surveyed the route before, and may create unwanted variation in numbers detected if speaker direction is not consistent. Survey points should be located on either the upland-emergent vegetation interface or the open water-emergent vegetation interface. Conducting surveys at points within the interior of marshes is not practical in most inland wetlands because of the tremendous disturbance to emergent plants and to calling rates of marsh birds caused by walking into the interior of a marsh. However, conducting surveys from upland edges, roadside edges, and open water edges may create some bias in estimation of population trends. Hence, surveyors should record whether each point is:
1) along a ditch, dike, or berm with emergent vegetation on both sides,
2) along a ditch, dike, or berm with emergent vegetation on one side,

3) along a public road with emergent vegetation on both sides,
4) along a public road with emergent vegetation on one side,
5) along an upland/emergent edge (record type of upland: grassland, scrub-shrub, or forest),
6) along an open water/emergent edge,
7) within a narrow water channel or tidal creek with emergent vegetation on both sides,
8) within a contiguous patch of emergent vegetation (also record distance from edge), or
9) other (and provide description of point placement).

Point spacing

Point spacing in previous studies has varied from 40m to 800m (Conway and Gibbs 2001). For the standardized continental monitoring program, we recommend 400m between adjacent survey points to avoid the risk of double-counting individual birds and to increase the total area covered by monitoring efforts. If points are too close together (i.e., <400m apart), then the call-broadcast at one point may affect the distribution of birds at adjacent points (because birds within earshot often approach call-broadcast) and hence cause biases in many analyses. Individual refuges that want closer point spacing for some local reason should use an increment of 400m (i.e., 200m) spacing between points. Analysts can ignore every other point at that particular site for the shared (pooled) data set if they choose to do so. In marshlands that have access throughout the marsh, points should be in a 400m grid system (hence, 1 point per 16 ha of marsh). In many locations, emergent habitat occurs in small patchy marshes less than 16 ha in size. Include at least one survey point at all marshes >0.5 ha within the management area. Additional survey points should be added at small marsh patches as long as they are 400m away from all other survey points.

What if area around an existing point is no longer suitable marsh bird habitat?

Original survey points are never dropped from the survey and are always visited in subsequent years. If no suitable habitat is present at an existing survey point during a particular year (i.e, due to drought or change in water flow), then the observers should still make an entry for that point on the datasheet but write in the *Comments* column that "no survey conducted because suitable emergent vegetation is not present". If participants do not conduct a survey at one or more existing points, they must record in the database the reason why a survey was not conducted at those points:
1) lack of suitable habitat (due to temporary change such as flooding, drought, mowing, etc)
2) lack of suitable habitat (due to permanent change)
3) survey not attempted due to logistical reasons.

Time of day for surveys

Survey routes can be either morning or evening survey routes. Observers can conduct either morning or evening surveys on a route as long as each survey route is surveyed during the same period (morning or evening) consistently every year (once a route is designated an evening route, it will always be an evening route in perpetuity). Morning surveys begin 30 minutes before sunrise (dawn) and should be completed prior to the time when marsh birds cease calling (this time varies regionally, but is often 2 hours after sunrise in southern latitudes and 3 hours after sunrise in northern latitudes). The time in the morning when marsh birds cease calling also

varies with temperature and time of year. Evening surveys should begin 2 hours before sunset and must be completed by dark (30 minutes after sunset). When conducting evening surveys, surveyors should start their survey route such that they finish the last point when its getting too dark to see their datasheet. The half hour between sunset and complete darkness is often when detection probability is highest. The morning or evening survey window should correspond to when marsh birds are most vocal in your area. Vocalization probability is typically highest in the 2 hours surrounding sunrise and the 2 hours surrounding sunset - choose the optimal daily survey window for your region and stick to them each year. Including both morning and evening surveys into a standardized monitoring protocol will provide added flexibility and more potential survey hours for field personnel.

Number of surveys per year and seasonal timing of surveys

Optimal seasonal timing for surveys will vary regionally depending on breeding chronology of the focal marsh birds in your area. Conduct at least 3 surveys annually during the presumed peak of the marsh bird breeding season. The peak breeding season in each location will vary among the coexisting marsh birds in that area. For example, American bitterns often breed earlier than both least bitterns and rails in some regions, and clapper rails and king rails breed earlier than Virginia rails and soras in some regions (also see Rehm and Baldassarre 2007). To account for this variation among coexisting species, one survey should be conducted within each of three 15-day survey windows. The 3 survey windows vary regionally and are based on average minimum temperatures in May (Appendix 1). The 3 survey windows increase your probability of conducting at least one survey during the peak seasonal response period of all focal marsh bird species in your area. In many areas, migrants are still moving through when the breeding season is well underway for local breeders. Hence, some surveys will occur prior to when migration is completed for many marsh birds. A common goal of marsh bird surveys is to estimate trends over time in the number of breeding adults of each target species, so we want to complete all 3 annual surveys prior to the initiation of juvenile vocalizations. Three or more surveys are needed to confirm seasonal presence/absence of some marsh bird species in a wetland with 90% certainty (Gibbs and Melvin 1993). Three replicate surveys per year is also warranted because personnel organizing surveys often do not know the local timing of the breeding cycle of their target species at the outset of their survey effort (Rehm and Baldassarre 2007). Finally, including $\geq$3 surveys per year will allow us to estimate the proportion of sites occupied by each species (MacKenzie et al. 2002). However, if for some reason you can not conduct $\geq$3 surveys on your area, your data can still be used for many purposes (i.e., to estimate detection probability, to compare passive with call-broadcast survey methods, to estimate trend). Contact the program coordinator (see contact information below) if you feel that the 3 annual survey windows do not adequately capture the peak breeding seasons of the target species in your area.

Surveys in tidal marshes

When possible, surveys in tidal marshes should always be conducted at a similar tidal stage for each replicate survey both within and across years. The tidal stage within which to conduct local marsh bird surveys should be based on when highest numbers of marsh birds are likely to be detected in your area; optimal tidal stage for surveys may vary among regions.

Many salt marsh passerines are forced to renest during the peak spring high tide, and detection probability is highest during the week after a high spring tide. Clapper rail surveys have been timed to coincide with a high tide since 1972 at San Francisco Bay NWR, but high tide was a period of reduced vocalization probability for clapper rails in southern California (Zembal and Massey 1987) and for black rails in northern California (Spear et al. 1999). Tidal stage did not affect detection probability of clapper rails in Mississippi (S. Rush, pers. comm.). If no local data is available on optimal tidal stage for conducting marsh bird surveys, participants should try to conduct surveys on days when high or low tide does **not** fall within the morning (or evening) survey window (i.e., conduct surveys when tides are coming in or out). Record the following: 1) time of the closest high tide (either the high tide before or after the survey - whichever is closer) for each survey point, and 2) tidal amplitude (difference in water level in meters between the highest and lowest tide on that day) on the day of the survey.

Survey methods

These standardized survey methods for marsh birds originated from suggestions during 2 multi-agency workshops at Patuxent Wildlife Research Center designed to aid agencies developing marsh bird monitoring programs (Ribic et al. 1999, U.S. Fish and Wildlife Service 2006), and incorporate suggestions from Conway and Gibbs (2001) and recent methodological advances in estimating detection probability and observer bias (Nichols et al. 2000, Farnsworth et al. 2002, MacKenzie et al. 2002). Because many marsh birds are secretive, seldom observed, and vocalize infrequently, we will use broadcast calls to elicit vocalizations during vocal surveys (Gibbs and Melvin 1993, Conway et al 2004, Conway and Gibbs 2005). But because we want to estimate detection probability, estimate density using distance estimators, analyze data without the biases associated with call-broadcast (Conway and Gibbs 2001), and survey non-focal species, we will also record birds during a 5-minute passive period prior to broadcasting marsh bird calls. Hence, observers will record all focal species (Appendix 2) detected during both a 5-minute passive period prior to broadcasting recorded calls, and during a period in which pre-recorded vocalizations of focal marsh birds are broadcast into the marsh.

The recorded calls should be obtained from the Marsh Bird Survey Coordinator (contact info below); request a CD or MP3 file of the focal species that breed in your area, and we will ensure that it coincides with the protocol. The CD should include exactly 30 seconds of calls of each of the focal marsh bird species that are expected breeders in your area interspersed with 30 seconds of silence between each species' calls. The 30 seconds of calls consist of a series of the most common calls for that species interspersed with approximately 5 seconds of silence. For example, an entire survey sequence might look like this:

5 minutes of silence (include a verbal statement at the end of each minute to alert surveyors)
30 seconds of calls of first focal species configured like this:
- 3 Least Bittern *coo-coo-coo* calls
  - 6 seconds of silence
- 3 Least Bittern *coo-coo-coo* calls
  - 6 seconds of silence
- 4 series of Least Bittern *kak* calls

30 seconds of silence

30 seconds of calls of second focal species configured like this:
- 2 Sora *whinny* calls
  - 5 seconds of silence
- 3 Sora *per-weep* calls
  - 5 seconds of silence
- 4 Sora *kee* calls

30 seconds of silence
30 seconds of calls of third focal species
- etc.

include a verbal "stop" at end of the final 30 seconds of silence so that surveyors know when to stop the CD (and stop the survey at that point).

Broadcast equipment and placement

The broadcast player should be placed upright on the ground (or on the bow of the boat), and sound pressure should be 80-90 dB at 1 m in front of the speaker. Use a sound-level meter to adjust volume of the broadcast player at the beginning of each day. If sound quality distorts when volume on your broadcast equipment reaches 80-90 dB, you should obtain higher quality broadcast equipment. If the ground is wet, place the speaker on an object as close to the ground as possible. Observers should stand 2 m to one side of the speaker while listening for vocal responses (standing too close to the speaker can reduce the observer's ability to hear calling birds). Observers should point the speaker toward the center of the marsh and should **not** rotate the speaker during the call-broadcast survey. Speakers should be pointed in the same direction for all replicate surveys. At points where it is not obvious which direction to point the speakers (i.e., on a road or in a canal bisecting two marshes) surveyors should record the direction of the speakers at each point on a map and on their data sheets and refer to this information on all replicate surveys. A few potential broadcast systems include:

CD or MP3 players: Philips Jogproof CD player AX511217 ($49 at www.surprise.com); Lenoxx, model #CD-50 (Walmart $20); Aiwa XP-SP90 or XP-MP3 Portable CD Player; or Panasonic SL-SX286J or SL-SX280G Personal CD Player (e.g., Radio Shack #14-1231 or #42-6014); or Panasonic SLSX420 ($49.99 Circuit City). Or any cheap portable CD player.

Amplified Speakers: These are essentially run-of-the-mill "computer" speakers. Examples we've used include: Optimus AMX-4 amplified speakers (Radio Shack #40-1407); or Sony portable speakers (Circuit City for $19.99).

Inclusion of an initial settling period

When surveyors are using a motorized boat or airboat to travel between survey points, the noise generated by the boat may cause birds to stop calling. In these situations, surveyors may choose to include a "settling" period of a fixed amount of time (e.g., 1 minute) prior to starting the 5-minute passive count at each point. Otherwise, we recommend that **no** settling period be included. If a participant includes an initial settling period prior to each survey, the participant should keep that settling period constant among all points and all replicate surveys. Furthermore, the participant should include a comment on every data form stating that a settling

period during which detections are not recorded must be included. If included, make the settling period a part of the written survey protocol and part of the datasheets for that site so that individuals wishing to repeat the effort in future years will know that a settling period was included.

Species to include in the survey effort

Participants must make 3 decisions regarding the species to include in their survey effort: 1) which species will be recorded on their datasheet, 2) of those species recorded, which species will be recorded during the one-minute segments (i.e., each individual bird of these species will be recorded on a separate row on the datasheet), and 3) of those species recorded, which species calls' will be included in the call-broadcast sequence. The USFWS National Wildlife Refuge System has provided guidance on making these decisions for refuges (Appendix 6). The program website (http://ag.arizona.edu/srnr/research/coop/azfwru/NationalMarshBird/ , click on *Field Collection* and then *what species should I survey for?*) includes a map overlaying the breeding range of each focal species. Participants should examine this map to help determine which focal species likely breed in their area and use this information to determine the species to include in the broadcast sequence.

In general, participants should include in their broadcast sequence all of the following species that are thought to breed in the marshes they intend to survey: King Rail, Clapper Rail, Virginia Rail, Sora, Black Rail, Yellow Rail, American Bittern, Least Bittern, Pied-billed Grebe, Limpkin, American Coot, Purple Gallinule, and Common Moorhen. The number of species included on the call-broadcast portion of the survey increases the duration of the survey by 1 min per species at each point. So, with 8 species, you will spend 13 minutes (including the initial 5 min passive listening period) at each point. If a participant is within the breeding range of the American Coot, Common Moorhen, or Pied-billed Grebe, broadcasting calls of any of these species is considered optional but strongly recommended (Appendix 3). However, all surveyors should still record all detections of these species (see Appendix 3), even if they do not include one (or all 3!) of these "focal" species in their broadcast sequence. Moreover, participants are given the option of recording data for American Coots, Common Moorhens, and Pied-billed Grebes in the one-minute segments or simply recording the total number of these species detected at each point (Appendix 3). See Appendix 6 for guidance on species to include in your broadcast sequence based on the Bird Conservation Region (BCR) where your survey area is located.

Species to include in the call-broadcast sequence

The broadcast sequence includes calls of the focal marsh bird species that are expected breeders in that area and is broadcast using a portable CD or MP3 player. The marsh birds included in the call-broadcast sequence on the CD will vary among survey areas (and hence, among participants), but will always be consistent within a particular survey area across replicate surveys and across years. Recommended species to include in the call-broadcast sequence for a particular survey route (ie, at a particular refuge or management area) is attached (Appendix 3). The goal is to include all of the focal species believed to be potential local breeders (species for which you might reasonably expect to get responses during the breeding season). Order of calls start with the least intrusive species first, and follow this chronological order: Black Rail, Least

Bittern, Yellow Rail, Sora, Virginia Rail, King Rail, Clapper Rail, American Bittern, Common Moorhen, Purple Gallinule, American Coot, Pied-billed Grebe, Limpkin. The calls used for broadcast include at least the primary advertising call of each species (e.g., '*whinny*' for Sora, '*grunt*' for Virginia Rail, '*clatter*' for Clapper Rail, '*click-click-click-click-click*' for Yellow Rail, '*coo-coo-coo*' for Least Bittern, '*pump-er-lunk*' for American Bittern). Other calls associated with reproduction are also included for many of the species. Including all the common calls associated with reproduction of each species on the broadcast sequence will increase detection probability during different times of the breeding season and can help observers learn the less common calls of each target species. A list of common calls for each target species is attached (Appendix 4). Calls given while flying or after being flushed (not associated with reproduction) are probably not useful to include in the broadcast sequence.

Estimating distance to each focal bird

Observers should estimate the distance from the survey point to each individual bird. Estimate distance to each bird when the bird is first detected (birds will approach the call-broadcast [Legare et al. 1999, Erwin et al. 2002] so observers need to record the distance to the bird when the bird was first detected). Recording distance to each individual will allow us to use distance sampling to estimate density for each species in each habitat type. Density indices by habitat type are useful because they allow managers to extrapolate survey data to estimate a minimum number of each marsh bird species on their entire management area. The distance at which most individuals are detected varies among the focal species (Conway and Nadeau 2006a). Surveyors are encouraged to use a range finder to help them determine the distance to specific landmarks surrounding each survey point, which will help estimate the distance to calling marsh birds. Other methods for improving one's ability to estimate distance include: 1) tying surveyors flagging at 50m and 100m away from each survey point in each cardinal direction, 2) carrying aerial photos of the marsh with 50m-, 100m-, and 200m-radius circles drawn around each survey point. Estimating the distance to some individual birds will involve a lot of uncertainty (i.e., estimating distance to birds 5m from the surveyor is much easier than estimating distance to birds that are >100m away). Surveyors should enter on the datasheet and in the database which of the following distance estimation aides they used: 1) range finder, 2) distance bands drawn on aerial photo, 3) surveyor flags tied to vegetation at regular intervals.

Filling out the data sheet

An electronic copy of a data sheet should be obtained from the Survey Coordinator to ensure that all pertinent data is recorded properly. These data sheets can then be tailored by each participant to meet any local needs. The number of species columns on the data sheet will differ among participants. For example, if you intend to only broadcast calls of 3 species, then you will have an 8-minute survey sequence at each point (5 minutes of passive listening and 1 minute of call-broadcast for each of 3 species) and will need a data sheet with 8 response columns. If you intend to broadcast calls of 5 species, you will have a 10-minute survey sequence at each point (5 minutes of passive listening and 1 minute of call-broadcast for each of 5 species) and will need a data sheet with 10 response columns. See the example data sheet attached (Appendix 5). Prior to the beginning of the survey, write down the day, month, and year at the top of the

data sheet. Write out the month or use a 3-letter acronym to avoid confusion between day and month (i.e., so that 6 May is not confused with 5 June). Also write the full name of all observers present during the survey. If more than one observer, write down who recorded the data and **all** individuals that helped identify calling birds. Using multiple observers to detect birds at a point may confound observer bias issues when estimating trend, so its important to record any and all observers who contributed to marsh bird detections (see paragraph regarding multiple-observer surveys at end of this protocol). Write down the name of the survey route and the name of the refuge and/or management area. Record any ancillary information that may have influenced vocalizations or detection probability in the *Comments* column. For example, types of boats used during surveys (canoe vs 25hp outboard motor vs air boat) can potentially affect vocalization probability of marsh birds. Hence, surveyors should record the type of boat used during surveys. Use the same boat and motor on each survey each year to control for possible effects of engine noise on detection probability. If a different boat or different motor is used (or the same boat/motor just sounds better or worse than usual) make a note of the change in the *Comments* column.

Recording detections of focal species

When you arrive at the first survey point, write down the unique identification number of the survey point and the time. Start the survey. When a bird is detected, write the species name in the "Species" column. You can use the 4-letter acronym for the species or write the full species name. A list of 4-letter AOU species acronyms is attached to this protocol (Appendix 2). Put a "**1**" in each detection column in which that individual is detected aurally and put a "**s**" in each column in which the individual is detected visually (including flying overhead). For example, if an individual Virginia Rail calls during the first 1 minute of passive listening, put a "**1**" in the first column. Regardless of whether that individual calls once or many times during the first minute, you only put one "**1**" in the first column. If that same individual bird is still calling during the second minute of passive listening, then also put a "**1**" in the second column. If the same individual calls during the 30 second when Sora calls are being broadcast or the 30 seconds of silence immediately following the Sora sequence, put a "**1**" in the column for "SORA". If that same individual bird calls again during the Virginia Rail sequence, you also put a "**1**" in the column "VIRA", and so on. Hence, if an individual bird is calling constantly throughout the survey period, you will have a "**1**" in every column for that individual. If the individual is heard **and** seen, put both a "**1**" and a "**s**" in the appropriate column(s). If you hear a call of the same species but from a different individual (or from an individual of another species), you start a new row on the data sheet and follow the same protocol just described for this individual bird. Recording whether each individual bird responds during each 1-min segment allows us to use removal models (Farnsworth et al. 2002) to estimate detection probability. Surveyors may have difficulty determining whether a call is coming from a new individual or a individual detected earlier at that survey point. Observers must often make this decision without seeing the bird by using their best judgement. The number of rows filled out on the data sheet will differ among survey points and will correspond to the total number of individual focal marsh birds detected at each point. If no marsh birds are detected at a survey point, record the point number and starting time, and write "no birds" in the *Comment*s column. A sample data sheet is included as an example of what survey data might look like (Appendix 5).

If the observer hears a marsh bird but is unsure of its identity, the observer should write "unknown" in the *Species* column and record all data for this individual as described above. Make a verbal description of the unknown call in the *Comments* column (e.g., soft "kak-kak-grr" - sounds like BLRA but harsher'). This will aid future identification of unknown calls if that call is heard repeatedly. Some species of marsh birds give paired duets and some participants may want to distinguish pairs of birds during surveys. ALWAYS record both members of a pair on their own individual row of the datasheet. If you want to identify pairs of birds detected, record "pair" in the *Comments* columns for both of the 2 birds that are thought to be members of a mated pair.

Record types of calls given

Knowing seasonal patterns of different call types in a local area provides useful information. For example, the frequency of different calls given (e.g., single *clatter*, paired *clatter*, *kek*, or *kek-burr* for a clapper rail) varies throughout the season. Frequency of different calls given may also vary across regions. Different call types have different functions and can indicate pairing status and stages of the nesting cycle in a local area (allowing refinement of local survey windows). Moreover, detection probability and observer bias may differ with different call types (e.g., least bittern '*kak*' and Virginia rail '*tick*' can be confused with clapper rail '*kek*' calls) and accuracy of distance estimation may vary with call type (Conway and Nadeau 2006a). Hence, incorporating call types into trend analyses can potentially increase power to detect true population trends. For these reasons, observers are encouraged to record all types of calls given for each target marsh bird detected in the *Calls* column on the data sheet (see sample data sheet; Appendix 5).

Birds detected at a prior survey point or between points

If observers detect a new bird immediately after the survey period at a particular point (or while walking between points) they should record these birds on a separate row and write "after" in the *Comments* column. If a participant detects a focal bird during a survey and the participant believes that this is the same individual bird that was detected and recorded at a previous survey point, the participant should record all the relevant data for that bird and then enter a "Yes" in the *Detected at a Previous Point* column on the datasheet. When in doubt, be conservative as to whether an individual bird detected at the current point was the same individual recorded at a previous point (i.e., record "Yes" when in doubt).

Suppose that: 1) the surveyor detects a focal bird after the survey period at a particular point and records that bird on its own row on the datasheet (and writes "No" in the *Detected at a Previous Point* column and "after" in the *Comments* column), and 2) the surveyor then detects that same bird during the survey at a subsequent survey point. In this situation, the surveyor should write "No" in the *Detected at a Previous Point* column for the entry where the individual bird was detected during the survey, and then go back and change the "No" to "Yes" in the *Detected at a Previous Point* column for the initial entry for this bird (when it was detected after the survey period).

Recording non-focal species

Observers have the option of recording non-focal species. Some participants may want

to record all species detected (including passerines, waterfowl, raptors, etc) or perhaps a subset of all species detected (i.e., include marsh-dwelling passerines, wading birds but not all species) during their marsh bird surveys. Others will want to focus their attention only on the focal marsh birds (especially in areas where densities of secretive marsh birds are relatively high). To accommodate this flexibility, each participant is allowed to record species in addition to the focal species listed in Appendix 3. At each point, record the total number of each non-focal species detected. Individual birds of non-focal species do not receive their own line on the data sheet and observers do not record detections of non-focal birds in each of the 1-min segments (Conway and Droege 2006). The non-focal species included by a surveyor will depend on the marsh birds of interest at that refuge, management area, or physiographic region. For example, participants may want to include non-focal species which are thought to be declining or which are not sampled well by other survey efforts. However, analysts will need to know which additional species were being recorded in order to make these data meaningful (i.e., if no YHBLs are recorded at a point, we need to know whether a surveyor detected zero YHBLs or merely did not record YHBLs on their survey). Hence, each participant must enter in the database their list of "non-focal" species that they were recording during their survey. By recording this list of "non-focal" species, analysts will know whether no entries for a particular species indicates that none were detected. The number of "non-focal" species included in your survey effort may reduce your ability to record all the relevant data for the 24 focal species that are the focus of this monitoring protocol. Moreover, many of the non-focal species may be adequately sampled already by the North American Breeding Bird Survey.

Recording whether focal birds are within the 'target' area

One goal of this effort is to document the effects of management actions on marsh birds, but often times there may be adjacent areas that have undergone different management actions. This presents a problem if some birds detected at a survey point are within one area but others are within another area (one with a different management history). Hence, surveyors should record whether each bird detected was or was not in the "target" management area.

What to do if the surveyor becomes overwhelmed with too many detections

Because many of the focal species occur at relatively low densities through much of their range, many surveyors will detect few or no individual birds at any given survey point. However, some survey points within a survey area will have so many marsh birds calling that observers will find it impossible to record each 1-min segment during which each individual focal bird is detected. For example, an observer may see/hear >20 coots at one survey point. When many birds are calling simultaneously, it can be difficult for the observer to 1) decide whether they are hearing new individuals or previously-detected ones, 2) write new individuals on a new line of the datasheet, and 3) find the correct line where they wrote down previously-detected birds. In these situations, here are a few comments, observations, and suggested remedies. First, individual surveyors do get better at this with practice even with relatively high numbers of calling birds at a point. However, everyone has a threshold when the numbers of calling marsh birds get too high at a particular point. This problem occurs more frequently when a participant has many species in their call-broadcast sequence (and hence many detection columns on their datasheet). If a participant knows at the end of the call-broadcast at a particular

point that he/she was overwhelmed and didn't effectively assign the correct calls to the correct columns (individuals), then they should write a note in the *Comments* column saying that the data in the one-minute segments is dubious. The total number of birds detected at that point will still be useful. If this problem is common on your surveys, below is a list of solutions in decreasing order of preference. If you choose option #3, you need to make a very clear comment on your data sheet about what you were and were not recording at each point:

1) Include a circle on each row of the datasheet and make a 'tick' on each circle identifying the general direction of that individual (this will help you differentiate one individual from other individuals of that species as more are detected at that point),
2) Reduce the number of species in your call-broadcast sequence. Only use call-broadcast for species of management/conservation interest and/or species known to respond well to call-broadcast (e.g., eliminate coots, pied-billed grebes, and moorhens from your call-broadcast sequence so that you have <5 species on your call-broadcast sequence). In other words, still record data for all individuals of all focal marsh bird species in the same way, but just reduce the # of columns on the datasheet (and length of the call-broadcast sequence).
3) For those focal species that are of lower management/conservation interest in your survey area (e.g., coots, moorhens, pied-billed grebes), simply write down an estimate of the total number of individuals detected for that particular species at that point on one line of the data sheet (e.g., write "23 AMCO" on one line of the data sheet - see example on sample data sheet attached; Appendix 5). Only use the 1-min segments for the focal species of higher management concern (e.g., black rails, yellow rails, king rails, clapper rails, bitterns). It is important that surveyors record on the datasheet (and in the database) times when they were overwhelmed and could not record data for individual birds on separate rows of the data sheet (for focal species).

Distinguishing King Rails from Clapper Rails

King rails breed in freshwater marshes and clapper rails breed in saltwater marshes (except the Yuma clapper rail that breeds in freshwater marshes in Arizona and California; Conway et al. 1993). Both species have similar calls. In marshes near coastal areas, surveyors may not be able to determine whether birds heard calling are king rails or clapper rails. In those situations, surveyors should record these individuals as KCRA (King-Clapper Rails).

Recording ambient noise level at each point

Participants should record the level of background noise during the survey at each survey point. This information can be used as a covariate in future analyses because level of background noise varies spatially and temporally and influences detection probability. Categorize background noise at each point on a scale from 0 to 4 (0=no background noise, 1=faint background noise, 2=moderate background noise (probably can't hear some birds beyond 100m), 3=loud background noise (probably can't hear some birds beyond 50m), 4=intense background noise (probably can't hear some birds beyond 25m). Each cooperator can decide whether they have the time and/or need to record noise level at each point. If noise levels are periodically high enough to reduce observers' ability to detect calling marsh birds, this optional component is recommended.

Multiple-observer surveys

Estimating detection probability associated with a particular survey protocol is essential when attempting to interpret count data produced from a monitoring program. The extent to which trends in count data represent the underlying trend in true abundance depends on detection probability and observer bias. We will estimate observer bias associated with our survey effort using the double-observer method (Nichols et al. 2000). This approach involves 2 or more trained observers recording data independently at a series of survey points (Conway et al. 2004, Nadeau et al. 2008). Hence, whenever possible, surveys should be conducted by 2 or more observers simultaneously. Each observer should fill out a separate data sheet and should record their data separately without discussing anything with the other observer. Observers should not point out a call or a bird to the other during the survey period. Each observer should stand 1-2 meters away from each other and should keep their pen on their data sheet at all times so that one observer is not cued by the sudden writing activity of another observer. Once the survey for that morning/evening is completed, the observers can look over each others data and discuss discrepancies, but the data should not be altered; obvious mistakes should be noted in the *Comments* column **but not changed** (the differences between the observers in number of birds detected at each point is what allows us to estimate observer bias so these differences should not be altered). For those conducting multiple-observer surveys, contact the Program Coordinator to obtain a form so that observers can record which birds were detected by both surveyors and which were only detected by one of the surveyors. Multiple-observer surveys will obviously not be possible at all times and at all locations, but try to use multiple observers whenever possible so that we can obtain sufficient data to estimate observer bias.

Weather restrictions

Surveys should only be conducted when wind speed is <20 km/hr, and not during periods of sustained rain or heavy fog. Even winds <20 km/hr (12 mph) affect the detection probability of marsh birds. Participants should postpone surveys if they believe winds are affecting calling probability of marsh birds. Recommendations for conducting surveys in very windy locations include:

1) determine what time(s) of day have the least wind in your area. The daily survey windows in the protocol are recommendations; survey times should be modified under conditions where wind regularly affects vocalization frequency. The important thing is that surveys are conducted during the same daily time window each year at a particular location, and the survey windows at a particular location should be the time of day or night that has the highest detection probability for your target species in your area. In some locations, surveys conducted after sunset (or before sunrise) may have higher detection probability compared to the morning and evening survey windows recommended in the protocol because strong winds are less frequent during the middle of the night. In these situations, surveys should be conducted at night.

2) try to be flexible with your schedule if you can. For example, plan to conduct a survey on a particular day but postpone to the following day if its too windy, and keep postponing

until you get a day that meets the acceptable weather criteria to complete the survey.

If wind speed increases to above 12km/hr during the survey (or sustained rain begins while the survey is already underway), surveyors should stop the survey and repeat the entire survey route another day (i.e., don't just go back and repeat the remaining points on the route).

Record weather conditions

Record ambient temperature, wind speed, wind direction, and sky condition at each survey point. We use the same wind speed codes and sky condition codes as the North American Breeding Bird Survey (see below). Record the ambient temperature in degrees Celcius (^{o}C) and record wind direction in degrees (0-360^{o}).

WIND SPEED CODES: (Enter Beaufort Numbers on data sheet, not mi/hr or km/hr)

Beaufort Number	**Wind Speed Indicators**	**Wind Speed**	
		mi/hr	**km/hr**
0	Smoke rises vertically	<1	<2
1	Wind direction shown by smoke drift	1-3	2-5
2	Wind felt on face; leaves rustle	4-7	6-12
3	Leaves & small twigs in constant motion; light flag extended	8-12	13-19
4	Raises dust and loose paper; small branches are moved	13-18	20-29
5	Small trees with leaves sway; crested wavelets on inland waters	19-24	30-38

SKY CONDITION CODES: (Enter these U.S. Weather Bureau code numbers on data sheet.)
0 - Clear or a few clouds
1 - Partly cloudy (scattered clouds) or variable sky
2 - Cloudy (broken) or overcast
4 - Fog or smoke
5 - Drizzle
7 - Snow
8 - Showers

Recording water conditions associated with each survey point (or each management unit)

Water level influences abundance and distribution of marsh birds. Water levels vary annually and even daily in some marshes and these fluctuations can explain spatial and temporal changes in marsh bird abundance. Some National Wildlife Refuges control water levels in some of their management units and have the ability to directly benefit marsh birds via water management. Hence, surveyors should place one or more water gauges for measuring water level in permanent locations at points that have the same hydrologic regime (i.e., the same daily and annual fluctuations in water level) as the marshes being surveyed. If all marshes along a survey route are subject to the same hydrologic regime (i.e., all survey points are in the same river system or are in a single management unit with the same hydrologic regime), then only one

water gauge is needed for that entire route. If a survey route has points split between ≥2 management units (or ≥2 areas with different hydrologic regimes), then ≥2 water gauges are necessary and participants should record on the data sheet the water gauge associated with each survey point. Water level at each water gauge should be recorded immediately before or immediately after a morning or evening survey route is completed. Participants should also record the type of water gauge used for measuring water depth (i.e., bathymetry, piezometer, river readings at ACOE's gauge, staff gauge stuck into the wetland, etc). Each water gauge must be "re-set" (recalibrated) each year because freezing and thawing can cause gauges to move laterally. Water gauges should be placed in an area where the water is deepest to avoid zero readings when there is still water in other parts of the marsh.

Recording salinity content of water

In coastal marshes or any marshes with varying salinity levels, participants are encouraged to record the salinity content of the water directly in front of each point on each survey. Salinity levels affect habitat suitability of many species of marsh birds and such information is relatively easy to collect and can be used as a covariate to control for variation in models estimating population change. Participants can get an Oregon Scientific Handheld Salinity Meter [ST228] for $25.

Record date of last natural disturbance

Record the month and year of the last flood, wild fire, hurricane, monsoon, tornado, straightline winds, or other major disturbance that occurred in the 'target' area associated with each survey point. Record the month and year for each of those disturbance events that potentially affected marsh bird abundance or marsh bird habitat structure. Record these dates for each survey point, once per year (or more often if a natural disturbance occurs between 2 replicate surveys during the same year).

Record date of last fire

There are indications that periodic burning of emergent marshes may benefit some marsh birds (Conway and Nadeau 2006b). Indeed, several refuges are involved with local studies examining the effects of fire on marsh birds. Hence, it would be useful for all surveyors to record the "month and year of last burn" for the 100-m radius area surrounding each survey point. If all you know is that the area surrounding a particular survey point hasn't burned in the past *x* years, then record >*x* years at that point. This information will allow us to evaluate the effects of fire on marsh bird abundance at a large (continental) spatial scale with the pooled data. The data produced will supplement the more detailed studies evaluating the effects of fire being conducted on specific refuges and will help produce management recommendations regarding the usefulness of fire as a tool for managing marsh bird populations.

Wetland Habitat Measurements

Natural changes in water level and management activities (e.g., dredging, wetland restoration efforts, prescribed burning, etc.) can lead to dramatic changes in marsh vegetation. Patterns of distribution and local population trends of marsh birds can often be best explained by local changes in wetland vegetation. Consequently, quantifying the percent coverage by wetland

plants and major vegetation types (e.g., % *Typha domingensis, Schoenoplectus pungens, Schoenoplectus californicus, Phragmites australis, Spartina foliosa, Salicornia virginica, Baccharis salicifolia, Tamarix ramosissima, Populus fremontii, Distichlis stricta, Pluchea sericea*, open water, mudflat) surrounding each survey point each year can help identify the cause of observed changes in marsh bird populations. Information on emergent habitat availability will allow one to: 1) extrapolate estimates of population density to total numbers of marsh birds within a given marshland, 2) correlate changes in marsh bird numbers with changes in habitat availability to help identify potential causes of observed population changes (Gibbs and Melvin 1993), 3) identify emergent habitats that need protection, and 4) design management actions in ways that either improve or minimize adverse effects to preferred habitat of specific species of marsh birds. The habitat features that participants should record include: 1) the National Wetland Inventory classification at each survey point (http:/www.charttiff.com/pub/WetlandMaps/Cowardin.pdf), 2) the *Ecological System* (aka hydrological regime) from the National Vegetation Classification Standard (NVCS) for the area surrounding each survey point (see: http://biology.usgs.gov/npsveg/nvcs.html), 3) the dominant or co-dominant wetland plant species or genera at each survey point (list 1-3 dominant or co-dominant species). "Dominant" is defined as any plant species that comprises >25% of the vegetative cover within a 50-m radius of the survey point. Hence, observers should visually estimate the percent coverage by each wetland plant and each major vegetation type within a 50m-radius circle around each survey point. The list of species and genera from which to choose is based on the U.S. Department of Agriculture's "PLANTS" database. Surveyors should list the 1-3 dominant species at each survey point in decreasing order of abundance. The NVCS is available on NatureServe Explorer (www.natureserve.org/explorer/servlet/NatureServe?init=Ecol). In addition to Ecological System, surveyors are encouraged to also record the *Alliance* (aka dominant cover type) and *Association* (aka dominant plant community).

In some locations, there is substantial seasonal change in annual growth in emergent plants. Participants should estimate percent coverage of wetland plants at a time that overlaps the breeding season for all of their target marsh birds. The important thing is to estimate percent coverage at a time when you are most likely to detect important changes in vegetation 5 or 10 years from now (changes that might help explain increases or decreases in number of marsh birds detected). If the vegetation doesn't change during the annual survey period, participants should consider quantifying percent coverage of vegetation within the 50-m radius circles during their final survey each year. However, **vegetation data does not have to be collected while the vocal survey is being conducted** (it might be most effective to make a separate trip to each survey point to collect vegetation data). Regardless of when participants choose to estimate percent coverage, they should be sure to estimate percent coverage at that same time each year. As an example, visual estimates of percent coverage of each wetland plant and vegetation type at a survey point might look like this: 15% water, 10% California bulrush, 20% three-square bulrush, 5% southern cattail, 20% seep willow, 10% mudflat, 20% upland shrub community. Record percent coverage to the species level because some marsh birds preferentially use only one species of emergent plant. Record percent coverage in the *Comments* column of the data sheet or on a separate data form. Percent coverage at each point is only recorded once each year. Surveyors should enlist the help of a botanist or other qualified assistance to identify plant

species if necessary (remember, these surveys do not have to be conducted during one of your bird surveys). Differentiating plants by species is difficult in some taxa and not all surveyors will be able to consult with a botanist prior to estimating percent coverage at each of their survey points. In these cases, surveyors can pool species by taxa or functional group (e.g., sedge spp., bulrush spp., mixed shrub). If the vegetation changes substantially at a particular point during the course of a single survey season, surveyors should make a note in the *Comments* column stating how the vegetation has changed over the course of the season. Participants should estimate percent coverage at all points each year (even if no emergent vegetation currently exists at some points during some years) to document changes over time in habitat availability. Because most survey points will be at the marsh/upland or marsh/open-water interface, approximately half of the 50-m radius circle within which you record percent coverage might be "upland vegetation". There is no need to characterize upland vegetation by species. Hence, include categories in your vegetation classification called "upland vegetation", "road", and "open water" if appropriate. There may be some points that are on peninsulas or in narrow open water channels (surveyed by boat) and these points may have emergent marsh within most of the 50-m radius circle.

Personnel and training

All observers should have the ability to identify all common calls of focal and non-focal marsh bird species in their local area. Regularly listening to the recorded calls used for surveys can help you learn calls, but observers should also practice call identification at marshes (outside the intended survey area if necessary) where the focal species are frequently heard calling. Annual training workshops occur, so contact the Program Coordinator for information on upcoming training workshops. All observers should also be trained to accurately determine distance to calling marsh birds, and to identify the common species of wetland plants within the survey area. Methods for training observers to accurately estimate distance include: 1) place a CD player in the marsh at an known distance and have observers estimate distance, 2) choose a piece of vegetation in the marsh where the bird is thought to be calling from and use a range-finder to determine distance, 3) have an observer estimate the distance to a bird that is calling with regularity and is near a road or marsh edge, then have a second observer walk along the road/edge until they are adjacent from that calling bird, and then measure this distance (by pacing or use of a GPS) and see how accurate the observer was at estimating distance. *Multiple-observer surveys* (see below) are very useful here - after the survey is complete have the 2 observers discuss what they heard and their distance estimates to each bird. Periodic multiple-observer surveys not only produce estimates of detection probability (see below) but also allow participants to determine whether one person is constantly underestimating or overestimating distance to calling birds. First-time surveyors can tag along on surveys conducted by more experienced surveyors in their region prior to starting their own surveys. They should do at least one "trial run" before their first data collection window begins because it takes time to get used to the data sheet and recording the data appropriately.

Hearing tests

Surveyors are strongly encouraged to have a hearing test (audiogram) at a qualified hearing or medical clinic before, during, or immediately after the survey season each year. We

encourage surveyors or potential surveyors to discuss the results of their hearing with their doctor and with their supervisor (or the Program Coordinator) to determine whether the quality of the data they collect may be compromised. Remember, ~90% of marsh bird detections are aural and many calls are very faint. These data could be included as a covariate and would help control for observer bias in trend analyses.

Supplies needed for surveys

- surveyor flagging (to mark survey points)
- GPS receiver
- clipboard, datasheets, pencils
- CD (obtained from the program coordinator - see contact info below)
- CD player
- amplified speakers
- batteries for CD player and amplified speakers
- sound level meter with ±5 dB precision (e.g., Radio Shack model #33-2050 for $34.99; or EXTECH sound level meter, $99 from Forestry Suppliers, Inc.)
- thermometer
- water gauge(s)
- salinity meter (e.g., Oregon Scientific Handheld Salinity Meter [ST228] for $25)

Batteries should be changed or re-charged frequently (before sound quality declines). Participants should routinely ask themselves if the quality of the broadcast sound is high. Request a new CD if quality declines. Observers should always carry replacement batteries on all surveys. A spare CD player should be kept close-by in case the primary unit fails to operate.

Data entry

Surveyors are asked to enter their data to the pooled database online at: http://www.pwrc.usgs.gov/point/mb/. Each participant needs to request a Username and Password from Mark Wimer (mwimer@usgs.gov) in order to enter their data on this website. Participants will be able to proof their data on the website after its been entered, and will be able to obtain an electronic copy of their data (ie, in EXCEL) immediately after entry. The database enables efficient entry and storage of marsh bird survey data and ensures that data entered is done so in a consistent way that minimizes data entry errors. In addition to entering your marsh bird survey data, you can also export data, obtain data summaries and simple data summary reports on your marsh bird survey data.

Organizational information

Visit the following website for additional information on these protocols, obtaining data sheets, obtaining CDs, and marsh bird monitoring in general: http://ag.arizona.edu/srnr/research/coop/azfwru/NationalMarshBird/. Send or email the name, address, phone#, and email address of all participants to the address below. This list will be used to disseminate information to each participant at the end of each field season and to send results of annual data analyses. Several U.S. Fish and Wildlife Service National Wildlife Refuges and several other participants began using these marsh bird survey methods in 1999 (Conway and

Nadeau 2006a). Over 200 refuges and management areas have used this protocol and submitted data to a pooled database which includes data from over 30,000 marsh bird surveys (Conway and Nadeau 2006a). For assistance obtaining appropriate CDs, additional information, or questions regarding standardized marsh bird survey methods, please contact:

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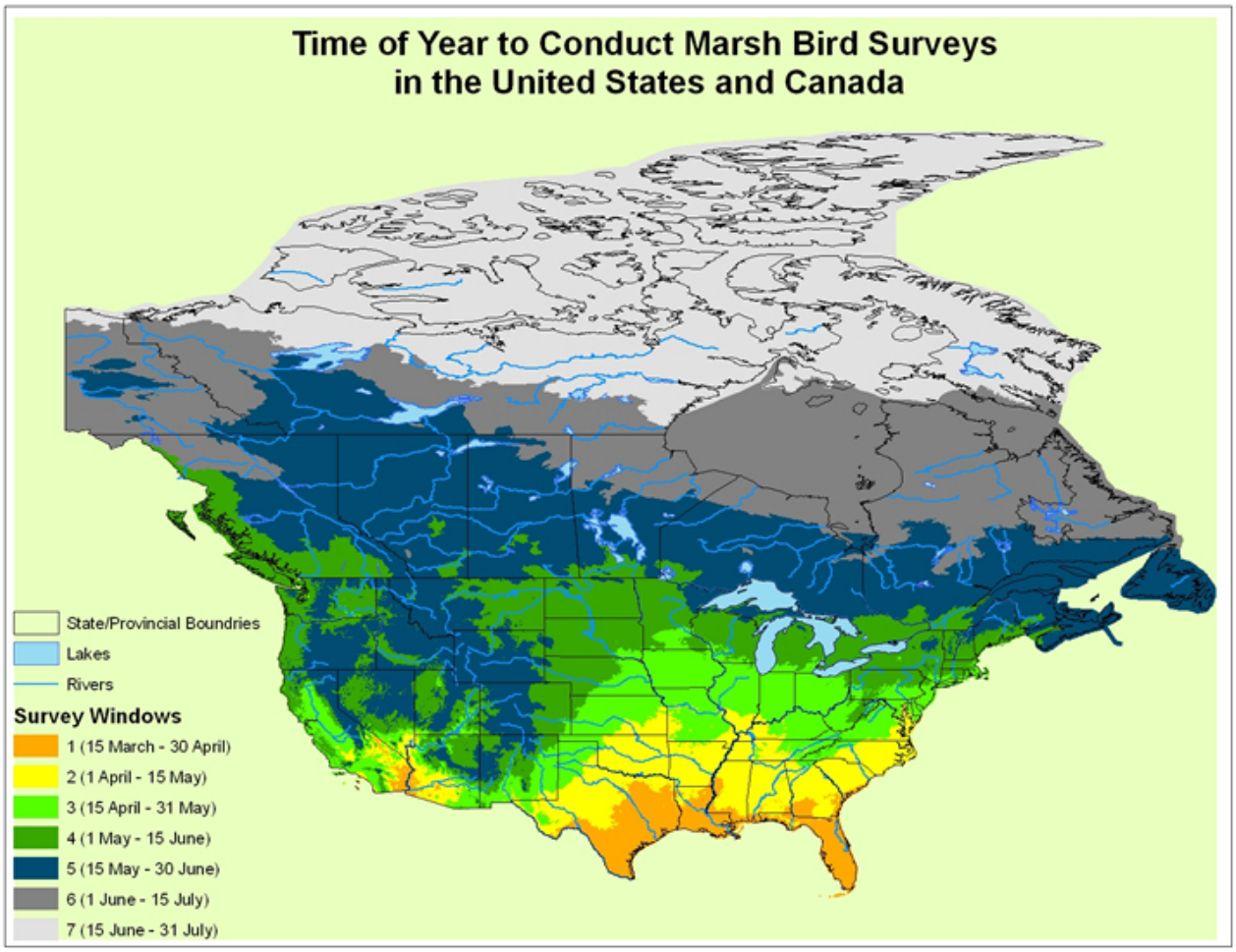
Appendix 1. Dates of 3 annual survey windows for different areas in North America. The isoclines are based on average minimum temperatures in May, from PRISM at Oregon State University (for the U.S.) and Environment Canada (for Canada).



Appendix 2. List of AOU 4-letter species acronyms for the focal marsh birds for which these protocols were developed.

BLRA	black rail
YERA	yellow rail
SORA	sora
VIRA	Virginia rail
KIRA	king rail
CLRA	clapper rail
LEBI	least bittern
AMBI	American bittern
LIMP	limpkin
PUGA	purple gallinule
COMO	common moorhen
AMCO	American coot
PBGR	pied-billed grebe
CARC	Caribbean coot
YBCR	yellow-breasted crake
LEGR	least grebe
EAGR	eared grebe
RNGR	red-necked grebe
HOGR	horned grebe
CLGR	Clark's grebe
WISN	Wilson's snipe
BLTE	black tern
SSTS	saltmarsh sharp-tailed sparrow
NSTS	Nelson's sharp-tailed sparrow
SESP	seaside sparrow
WILL[1]	willet (Eastern)

Examples of Non-focal Species (these are just some examples - there are other wetland birds that a participant may want to include; each cooperator should decide which non-focal species to include in their surveys in advance and list these species on their datasheet and in the database so that analysts (and surveyors in future years) will know the list of species recorded in prior years.

GRHE	green heron
GBHE	great blue heron
GLIB	glossy ibis
FOTE	Forster's tern
SEWR	sedge wren
MAWR	marsh wren
LCSP	LeConte's sparrow
SWSP	swamp sparrow
YHBL	yellow-headed blackbird

Appendix 3. Marsh bird species and field data requirements for conducting marsh bird monitoring using the North American Marsh Bird Monitoring Protocol for NWRS.

Species	Focal	Broadcast Required?	Data Recording Optional?	Record One Individual/Line?
BLRA	YES	YES	NO	YES
YERA	YES	YES	NO	YES
SORA	YES	YES	NO	YES
VIRA	YES	YES	NO	YES
KIRA	YES	YES	NO	YES
CLRA	YES	YES	NO	YES
YBCR	YES	YES	NO	YES
LEBI	YES	YES	NO	YES
AMBI	YES	YES	NO	YES
LIMP	YES	YES	NO	YES
PUGA	YES	YES	NO	YES
COMO	YES	Recommended	NO	Recommended
AMCO	YES	Recommended	NO	Recommended
CARC	YES	Recommended	NO	Recommended
PBGR	YES	Recommended	NO	Recommended
WILL (Eastern)	YES	NO	NO	NO
RNGR	YES	NO	NO	NO
EAGR	YES	NO	NO	NO
HOGR	YES	NO	NO	NO
CLGR	YES	NO	NO	NO
LEGR	YES	NO	NO	NO
WISN	YES	NO	NO	NO
SSTS	YES	NO	NO	NO
NSTS	YES	NO	NO	NO
SESP	YES	NO	NO	NO
BLTE	YES	NO	NO	NO
GRHE	NO	NO	YES	NO
FOTE	NO	NO	YES	NO
SEWR	NO	NO	YES	NO
MAWR	NO	NO	YES	NO
LCSP	NO	NO	YES	NO
SWSP	NO	NO	YES	NO
YHBL	NO	NO	YES	NO

FOCAL species: the intended species for which the Marsh Bird Monitoring Program is designed to monitor well. Surveyors should always record at least total # detected at each point for all these species.

BROADCAST REQUIRED: species for which surveyors must broadcast calls if they are conducting surveys within the breeding range of that species. Recommended= use of broadcast is optional (BUT strongly encouraged) for these species even if surveyor is within the breeding range of that species.

Appendix 4. List of the most common calls for the focal species of marsh birds.

Species	Standardized Call Name	Sibley Name(s)	BNA Name(s)	possible function	sample on BNA website
AMBI	pump-er-lunk	bloonk-adoonk	pump-er lunk and dunk-a-doo	mate attraction, territorial signal	
AMBI	chu-peep	chu-peep	chu-peep	during copulation ceremony	
AMBI	kok	kok-kok-kok	kok-kok-kok or haink	when flushed	
AMCO	puhk-cowah		puhk-cowah; cooah	perturbation (puhk-cowah male, cooah female)	y
AMCO	pow-ur	priKI	pow-ur	perturbation (pow-ur male)	y
BLRA	kic-kic-kerr	keekeedrr, deedeedunk	kickee-doo or kic-kic-kerr, or ki-ki-do	mate attraction, territorial signal	y
BLRA	grr	krr-krr-krr, growling	Growl, grr-grr-grr, brrrr or churr-churr-churr	alarm call, territorial defense	y
BLRA	churt		churt ; curt; yip, bip or kik ; yelp ; kek, ki	alarm call	
BLRA	tch	ink-ink-ink	kik-kik-kik or kuk-kuk-kuk-kuk; ink-ink-ink	when on the nest?	
CLRA	clatter	clapper	Clapper or Clatter; chock-chock ; cac-cac-cac or jupe-jupe-jupe	mate communication	y
CLRA	kek	ket	kek-kek-kek, kik-kik-kik, bup-bup-bup	mate attraction	y
CLRA	kek-burr	ket-ket-karr	kek-burr		y
CLRA	kek-hurrah	grunting	kek-hurrah		y
CLRA	hoo		Hoo; oom-oom-oom		
CLRA	squawk		Screech or Shriek; Chase Squeal or kak	alarm call, territorial disputes	
CLRA	prrr		purr; agitated purrrr; churr		
COMO	cackle	pep-pep-pehr-peehr	cackle - ka-ka-ka-ka-ka-kee-kree-kree-kree		y
COMO	keek	kulp, keek	squawk, yelp, cluck		y
COMO	kr-r-ruk				
KIRA	chac-chac	clapper	cheup-cheup-cheup, jupe-jupe-jupe, gelp-gelp-gelp-gelp- ; chac-chac-chac	mate communication	y
KIRA	kik	ket	kik-kik-kik	mate attraction	y
KIRA	kek-hurrah	grunting			
KIRA	ket-karr	ket-ket-karr			y
KIRA	squawk				
LEBI	coo	poopoopoo	coo or cooing ; tut-tut-tut	mate attraction	y
LEBI	kak	rick-rick-rick	gack-gack	mate communication, alarm call	y
LEBI	ert	kuk	tut-tut-tut; quoh, hah or cackle	alarm call	y
LEBI	ank-ank		ank-ank	when flushed	
LIMP	kreow	kwEEEeeer, KIAAAar	kreow	mate attraction	y
LIMP	gon		gon		
PBGR	donkey bray	ge ge gadum gadum gwaaaaow	series of wut, whut or kuk notes followed by 4-20 kaow or cow notes	courtship, communication btwn pair, territorial	y
PBGR	chatter	chatter	ek-ek-ek, hn-hn-hn	greeting call	y
PUGA	cackle	pep-pep-pePAA-pePAA, to-to-terp	Cackle		y
PUGA	squawk		gheeek!		y
PUGA	cac-cac	grunt	Slow Clucking and Grunt Call; cac-cac-cac		
SORA	whinny	whinny	decending whinny	territorial defense, mate communication	y
SORA	per-weep	kooEE	per-weep; ker-wee; ter-ee	mate attraction?	y
SORA	kee	keek	kee or weep	alarm call	y
VIRA	grunt	grunt	grunt	mate communication	y
VIRA	tick-it	gik gik gik gik gidik gidik gidik gidik	tick-it	mate attraction	y

VIRA	kicker	chi chi chi chi treerrr	kicker	solicitation	y
VIRA	kiu	skew; kweek	kiu	alarm call, territorial dispute	y
VIRA	kikik	kikik ik-ik, pit-ti-ti-tip			y
YERA	click-click	clicking, tic-tic tictictic	click-click, click-click-click	mate attraction	y
YERAl	cackle	cackle	cackle		
YERA	wheeze	wheezing, clucking	wheezes	hostility	

Appendix 5. Example of a completed data sheet for a marsh bird survey that followed the methods recommended in the Standardized North American Marsh Bird Monitoring Protocols.

National Marsh Bird Monitoring Program Survey Data Sheet

Date *(eg 10-May-04)* **:** *20 April 2006*

Multiple Observer Survey: Y / N

List all non-focal species surveyed:

SESP, AMCO

Name of marsh or route : Hidden Shores Marsh

Boat type: John boat (20 hp)

Observer(s) *(list all)** **:**

Chris Nadeau, Bob Blabla

High tide time:

Water depth:

location: Mallard Marsh location: Duck Pond location:

depth (in) 10 depth (in) 15 depth (in)

**list all observers in order of their contribution to the data collected*

put an "S" in the appropriate column if the bird was seen, a "1" if the bird was heard, and "1S" if both heard and seen

Station#	Start Time (military)	Temp (F)	Sky	Wind (Beaufort)	Salinity (ppt)	Background noise	Species	Responded During										Call Type(s)	In target area	Distance (meters)	Detected at a Previous Point	Comments
								Pass 0-1	Pass 1-2	Pass 2-3	Pass 3-4	Pass 4-5	BLRA	LEBI	SORA	VIRA	Outside survey period					
HSM1	1710	66	0	1		0	BLRA	1	1				1				1	grr	Y	95	N	
							BLRA		1				1	1	1	1		kic-kic-ker	N	110	N	
							VIRA			1S								ticket,grunt	N	30	N	
HSM2	1721	68	1	2		1	CLRA	1	1								1S	clatter	Y	40	N	pair
							CLRA										S	clatter	N	45	N	pair
							VIRA		1	1	1					1		grunt	Y	100	Y	
							CLRA									1		hoo	Y	10	N	
							AMCO (10)															
							SESP (1)															
HSM3																						Not surveyed unsuitable habitat
HSM4	1750	72	1	2		1	COMO	1	1	1		1		1	1			cackle	Y	150	N	
							SORA				1	1			1			per-weep	Y	210	N	
							SESP (2)															

Background noise: 0 *no noise* 1 *faint noise* 2 *moderate noise (probably can't hear some birds beyond 100m)*
3 *loud noise (probably can't hear some birds beyond 50m)* 4 *intense noise (probably can't hear some birds beyond 25m)*

Beaufort scale: 0 *smoke rises vertically;* 1 *wind direction shown by smoke drift;* 2 *wind felt on face, leaves rustle; 3 leaves, small twigs in constant motion, light flag extended*
4 *raises dust and loose paper; small branches are moved* 5 *small trees with leaves sway; crested wavelets on inland waters*

Sky: 0 *clear or a few clouds* 1 *partly cloud or variable sky* 2 *cloudy or overcast* 4 *fog or smoke* 5 *drizzle* 6 *snow* 8 *showers*

Appendix 6. Guidelines developed by U.S. Fish and Wildlife Service to aid refuges in deciding which species to include in their call-broadcast sequence. These are meant to be an aid and the final list of species included in the call-broadcast sequence at a particular refuge should be verified based on local expertise and information. Core species are species whose published breeding range overlaps ≥30% of the BCR. Possible add-on species are species whose published breeding range overlaps 1-29% of the BCR and hence should be included based on local knowledge of suitable habitat and species' presence at the survey location. These are just meant to be guidelines for developing the call-broadcast sequence for an area if more detailed knowledge of the area is not available.

BCR	Core species	Possible add-on species
5	SORA VIRA AMBI	LEBI
9	SORA VIRA AMBI	LEBI
10	SORA VIRA AMBI	
11	SORA VIRA AMBI	LEBI YERA KIRA
12	SORA VIRA AMBI	LEBI YERA
13	SORA VIRA AMBI	YERA KIRA
14	SORA VIRA AMBI	LEBI YERA
15	SORA VIRA	BLRA AMBI
16	SORA VIRA AMBI	
17	SORA AMBI	YERA VIRA
18	SORA VIRA	LEBI AMBI
19	SORA VIRA	BLRA LEBI KIRA AMBI
20	none	LEBI KIRA
21	LEBI	KIRA
22	LEBI SORA AMBI	VIRA KIRA
23	LEBI SORA VIRA AMBI	YERA KIRA
24	LEBI AMBI	KIRA
25	LEBI	KIRA PUGA
26	LEBI PUGA	KIRA
27	LEBI	BLRA VIRA KIRA CLRA AMBI PUGA
28	LEBI	SORA VIRA KIRA AMBI
29	LEBI	SORA VIRA KIRA AMBI
30	LEBI SORA VIRA AMBI	BLRA KIRA CLRA
31	BLRA LEBI	KIRA CLRA PUGA
32	LEBI SORA VIRA	BLRA CLRA AMBI
33	VIRA	BLRA LEBI SORA CLRA
34	none	SORA
35	none	LEBI SORA
36	LEBI	KIRA
37	LEBI PUGA	BLRA KIRA CLRA

39	SORA	
saltmarsh	CLRA	
Caribbean		