Progress Toward Developing Field Protocols for a North American Marshbird Monitoring Program[1]

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Abstract

Populations of many marsh-dependent birds appear to be declining, but we currently lack a continental program that provides estimates of population trends for most secretive marshbirds. The survey protocol outlined here is a standardized survey methodology being used on a pilot basis at National Wildlife Refuges and other protected wetland areas across North America and will ultimately be refined and proposed for use in a continental marshbird monitoring program. These protocols: (1) provide flexibility so that data from ongoing local and regional monitoring efforts may be pooled to the extent possible, (2) summarize the full description of proposed survey protocols contained in Conway (2003), and (3) include details on, and rationale for, point spacing, survey duration, seasonal and daily survey windows, and structure of call-broadcast sequences. Attempts to validate abundance indices based on call-broadcast surveys for primary marshbird species will be included in the survey effort by incorporating three methods for estimating different components of detection probability into the field protocols. Implementation of these protocols at a continental scale awaits delineation of a sampling frame and will occur after several years of field testing and review/revision of these draft field protocols. Field testing is currently being conducted at ~80 National Wildlife Refuges in a variety of freshwater and saltwater marshlands distributed across North America.

Introduction

The amount of emergent wetland habitat in North America has declined drastically during the past century (Tiner 1984). Locally, regionally, and even continentally, populations of some secretive marsh-dependent bird species appear to be declining (Tate 1986, Eddleman et al. 1988, Conway et al. 1994, Timmermans and Craigie 2002). Secretive marsh birds of primary concern include all species of rails, bitterns, coots, moorhens, gallinules, Limpkins, and solitary-nesting grebes. Because rails and bitterns consume a wide variety of aquatic invertebrates, populations may be affected by accumulation of environmental contaminants in wetland substrates (Odom 1975, Klaas et al. 1980, Eddleman et al. 1988, Gibbs et al. 1992, Conway 1995). Marshbirds are also vulnerable to invasion of wetlands by purple loosestrife (*Lythrum salicaria*) (Gibbs et al. 1992, Meanley 1992), and may be vulnerable to anthropogenic disturbances to marsh habitats (Adamus et al. 2001). Hence, marshbirds may represent indicator species for assessing wetland ecosystem quality, and their presence might be one way to measure the success of wetland restoration efforts. Marshbirds also have high recreational value; many species are highly sought-after by recreational birders. Finally, several rails are game species in many portions of North America, yet we lack population surveys on which to base harvest limits.

The U.S. Fish and Wildlife Service has identified Black Rails (*Laterallus jamaicensis*), Yellow Rails (*Coturnicops noveboracensis*), Limpkins (*Aramus guarauna*), and American Bitterns (*Botaurus lentiginosus*) 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). Many U.S. states consider these species threatened (or species of special concern) for similar reasons and several species are on the Audubon Society Watchlist. King Rails (*Rallus elegans*) are federally endangered in Canada, Least Bitterns (*Ixobrychus exilis*) are federally threatened in Canada, and Black Rails are federally endangered in Mexico.

Because of their vulnerabilities, value, and largely unknown status, state/provincial and federal management agencies have a high level of interest in monitoring marshbird populations in North America to estimate population trends and to measure health of their supporting wetland habitats. Any management action that alters water levels, 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 marshbirds (Griese et al. 1980, Eddleman et al. 1988, Eddleman

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and Conway 1994, Conway 1995). Long-term monitoring of marshbirds will allow resource managers to evaluate whether management actions or activities adversely impact wetland ecosystems.

Some regional programs have been implemented to monitor marshbird populations, but lack of standardized methods limits our ability to estimate population trends of secretive marshbird species across North America. Given this, a North American marshbird monitoring program that integrates and standardizes these regional efforts to the extent possible would be advantageous and desirable. A workshop in 1998 was held to synthesize information and to suggest the best approach for developing and implementing a continental marshbird monitoring program. Attendees at that 1998 workshop suggested a two-tier sampling approach. One tier would target National Wildlife Refuges and other publicly-managed wetlands, and the other tier would include all North American wetlands as the scope of inference. Tier 2 would provide the information needed to set harvest limits and to determine conservation status of each species, and tier 1 would provide management agencies with information on species status on lands that are (or can be) actively managed to increase abundance. Both tiers would use the same survey methods. In this paper, we discuss progress made toward developing tier 1 of this program and a pilot effort to evaluate the survey methods that are currently being proposed for use in both tier 1 and tier 2.

Possible goals of a North American marshbird monitoring program include estimation of population trends, abundance, and density of numerous species of marshbirds at various spatial scales. However, surveys rarely count all individuals present in the sampling area because detection probability is typically less than 100 percent. Number of birds responding during standardized surveys can be used as an index of abundance that allows comparisons among wetland basins and vegetative communities. The value of such an index depends on the correlation between number of individuals detected during the survey and number of individuals actually present in the area sampled (i.e., the amount of spatial and temporal variation in detection probability). Unfortunately, a strong positive correlation between number counted on a survey and actual number present cannot be assumed and few reliable estimates of detection probabilities from marshbird surveys are available (but see Conway et al. 1993, Legare et al. 1999, Bogner and Baldassarre 2002, Conway et al. 2004). Incorporating methods to estimate components of detection probability into the large-scale monitoring effort will allow analysts to evaluate the assumption that trends in count data are not caused by temporal changes in detection probability. So, attempts to validate indices based on surveys for primary marshbird species will be included in the survey effort by incorporating three methods for estimating different components of detection probability into the field protocols. The three potential methods for estimating components of detection probability include distance sampling (Buckland et al. 2001), double-observer surveys (Nichols et al. 2000) at a subset of points, and a removal model approach (Farnsworth et al. 2002). Each method has implicit assumptions and only estimates component parameters that contribute to overall detection probability (see Nichols et al. 2000, Buckland et al. 2001, Farnsworth et al. 2002, Conway et al. 2004). For example, the double-observer approach provides estimates of observer bias whereas the removal model approach ignores observer bias and estimates the probability that a bird that has vocalized during one time interval will vocalize during another time interval. A monitoring program that incorporates all three methods offers the best approach for validating the usefulness of count data.

Few estimates of marshbird population trends currently exist, and reliable estimates of population trends will probably require >5 years (and perhaps as much as 15-20 years) of survey data. After 2-3 years of pilot data collection at a variety of sites across the continent we will be able to conduct power analyses to determine the percent annual change detectable with a specific number of survey points, and the number of survey points required to detect a desired annual rate of change over a specified time period. Currently, a power analysis is not warranted because we do not have reliable estimates of temporal variation in numbers counted using standardized surveys across North America.

A continental marshbird monitoring strategy should also include attempts to estimate change in wetland habitat characteristics at each site. Information about vegetation change over time will allow data analysts to: (1) estimate density of marshbirds in each of several vegetative communities within a local area, (2) correlate changes in marshbird numbers with changes in wetland vegetation to identify potential causes of observed population changes (Gibbs and Melvin 1993), (3) identify vegetative communities that need protection or control, and (4) manage wetlands in ways that benefit marsh-dependent birds.

The survey protocol described below is a standardized survey methodology being used on National Wildlife Refuges and other protected wetland areas across North America (i.e., tier 1). With some modification and flexibility, it could be used to monitor secretive marshbirds on all lands where suitable wetlands occur. These protocols have been modified through feedback from participants during the initial pilot years of survey efforts. Although these surveys were designed to target a subset of secretive marshbirds, observers are encouraged to record detections of other species that are also under-sampled by existing monitoring programs, e.g., colonial grebes, herons, egrets, Forster's and Black terns (*Sterna forsteri* and *Chlidonias niger*), Common Snipes (*Gallinago gallinago*), Sandhill Cranes (*Grus canadensis*), Northern Harriers (*Circus cyaneus*), Belted Kingfishers (*Ceryle alcyon*), and numerous marsh-dependent passerines too extensive to list here. Each cooperator should decide which secondary species to include in their surveys in advance and list these species on their datasheet so that all participants in future years will know the list of species recorded in prior years.

Recommended Standardized Marshbird Monitoring Protocols

Standardized survey methods are based partly on recommendations and discussion resulting from the 1998 workshop designed to begin development of standardized marshbird monitoring strategies (Ribic et al. 1999). Recommendations from Conway and Gibbs (2001) and recent methodological advances in estimating components of detection probability and observer bias were also considered in developing these protocols. Because many marshbirds are secretive, seldom observed, and vocalize infrequently, the protocol to be evaluated in our pilot efforts employs broadcast of calls to elicit vocalizations during vocal surveys (Gibbs and Melvin 1993). However, we also hope to: (1) estimate components of marshbird detection probability; (2) estimate density of marshbirds within several common vegetative communities; (3) evaluate usefulness of call broadcast for future survey efforts, and; (4) monitor marshbird species not included in the broadcast sequence. Hence, the protocol includes a passive listening period that occurs prior to broadcasting calls when all birds detected will be recorded. An initial passive period will provide comparable data to pool among survey areas despite differences in length and composition of call-broadcasts used during the second half of each survey. Data from an initial passive period will also permit estimates of detection probability components for certain species following Farnsworth et al. (2002), resulting in national and continental monitoring standardization.

Wetland Basins to be Included in Tier 1 Surveys

The target 'survey areas' for pilot surveys included in tier 1 are National Wildlife Refuges, National Wildlife Areas, and other managed and/or protected wetland areas. Surveys are to be conducted in all emergent marshes (freshwater, brackish, and salt marshes) >0.5 ha in total area within each survey area. Location and extent of emergent vegetation within a wetland basin often changes over time. Hence, we advocate an area-based rather than a marsh-based sampling scheme.

Location of Survey Points

Fixed, permanent survey points are to be selected and marked with inconspicuous markers in the field. Locations of each survey point should also be plotted on maps, and UTM locations of each point should be recorded using a GPS receiver. This protocol requires a minimum distance between adjacent survey points of 400 m to avoid the risk of double-counting individual birds and to increase the total area covered by the monitoring effort in a local area. Participants who desire closer minimum inter-point spacing (i.e., to meet local management or monitoring needs) are to ensure that there is a minimum distance of 200 m between survey points, and record that this preference was chosen.

Once the survey area is selected, participants should choose their initial survey point randomly based on all possible locations for a survey point (all possible marsh-upland interfaces and all possible marsh-open water interfaces). Many local volunteer marshbird survey efforts place survey points at the interface between emergent marsh and upland. This approach provides easy access to survey points, minimizes travel time between adjacent points, reduces trampling of vegetation within the marsh, and may increase the distance at which observers can hear vocalizing birds due to increased elevation relative to the marsh vegetation.

Number of Survey Points

Surveys are to include as many survey points as possible (with the constraint that no two points are closer than 400 m apart) within the 'survey area'. Hence, the number of survey points in each survey area should be roughly correlated with amount of emergent marsh patches within that survey area. Observers are directed to add survey points (while ensuring not to drop any existing survey points) as emergent marsh vegetation increases or shifts within their defined 'survey area.' Number of survey points to include within a local refuge or management area (or the size of the survey area selected) will depend on personnel time available and other logistical constraints. Points within a 'survey area' are to be organized into ≥1 survey routes. Number of points to include on a particular survey route can vary among routes and the number of points on a particular survey route should correspond to the number that a surveyor can reasonably complete during a morning or evening survey window. Participants who survey fewer total points per morning (rather than fewer survey routes with lots of points per route) will typically detect more marshbirds. One observer should expect to survey approximately 5-20 survey points each morning, depending on travel times between survey points and length of their broadcast sequence. Once the survey route direction is selected, all subsequent survey visits for the route are to be consistently conducted in this same fashion (e.g., route ‘x’ is always surveyed during the morning from north to south commencing at the same time).

Timing of Surveys

Marshbirds are typically most vocal during the two hours surrounding sunrise and sunset, so surveys can be conducted during either early morning (dawn) or early evening (dusk). Once a route is assigned to be surveyed during morning or evening, the route must be consistently surveyed during that period (i.e., always morning or always evening) each year. Time windows for both morning and evening surveys are described by Conway (2003). Allowing both morning and evening surveys in a standardized monitoring protocol provides added flexibility and more potential survey hours for participants.

Number of Replicate Surveys at Each Point

The protocol requires that at least three survey visits be completed at each survey point annually. Each of these three replicate surveys must be conducted during a ten-day window and the three ten-day windows must be separated by seven days. Seasonal timing of these three survey windows will vary regionally depending on migration and breeding phenology of focal marshbirds breeding in an area. The first survey window should be when migratory passage is over, but prior to breeding, and the second and third survey windows should occur during the breeding season. Our intent is to estimate trends over time in number of breeding adults, so it is essential that the three annual survey windows occur prior to initiation of juvenile vocalizations.

Three or more surveys are needed to confirm seasonal presence/absence of some marshbird species in a wetland with 90 percent certainty (Gibbs and Melvin 1993, Conway et al. 2004). Including ≥3 replicate surveys annually at each point will provide data on temporal variation in numbers counted (a key parameter needed to conduct reliable power analyses once enough preliminary data are available) and will also allow us to estimate proportions of sites occupied by each species (MacKenzie et al. 2002).

Survey Methods

At each survey point, observers should record the number of individuals of all primary species (see list in *Appendix 1*) detected during both a 5-minute passive period prior to broadcasting recorded calls as well as during the subsequent call-broadcast period in which pre-recorded vocalizations are broadcast into the marsh. The broadcast sequence at a particular location includes calls of those species from *Appendix 1* that are expected to occur in that area. Calls should be broadcast at 80-90 decibels (measured 1 m in front of the speaker) using a portable CD player or MP3 player attached to amplified speakers. Recorded calls of each species will be made available by the program coordinator. Additional details describing specifications of call-broadcast equipment and protocols describing how call-broadcast surveys are designed can be found in Conway (2003).

Observers are to record the time interval(s) within the survey period when each individual bird was detected. Observers should also estimate the distance from each individual focal bird to the survey point. This should be done by estimating distance to each bird when the bird is first detected because some birds will approach the call broadcast (Legare et al. 1999, Erwin et al. 2002). Such distance sampling will enable estimations of density for each species in each vegetative community. Habitat-specific density estimates are useful because they allow managers to extrapolate survey data to estimate a minimum number of each marshbird species on their entire management area.

Observers have the option of recording species of birds that are not included in their broadcast sequence (*Appendix 2*). The suite of species recorded by a particular observer will depend on the marshbirds of interest or occurrence at a given wetland or region. For example, participants may want to include species that are thought to be declining or that are not sampled well by other survey efforts in their region.

Surveys should be conducted only when wind speed is <20 km/hr and not during periods of sustained rain or heavy fog; even winds <10 km/hr (12 mph) can affect the detection probability of marshbirds (C. Conway, pers. obs.). Participants should postpone surveys if winds are affecting calling frequency of marshbirds or the ability to hear calls. Surveyors who will be conducting surveys in constantly windy locations should determine the time(s) of day when detection probability of primary marshbirds is highest (given temporal variation in both wind velocity and calling frequency). Participants who include an initial settling period (e.g., one minute between arrival and initiation of survey) prior to each survey should consistently do so for each survey point and during each visit and should record the duration of the settling period on each survey form. See Conway (2003) for sample survey forms.

Some survey points within a survey area will have too many focal birds calling to permit observers to record each temporal sub-segment during which each individual bird is detected and/or to estimate distance to each calling bird. For example, an observer may detect >20 American Coots (*Fulica americana*) at one survey point. In these situations, participants are asked to estimate the total number of individuals detected for that particular species during the entire survey period on one line of the data sheet (e.g., "23 AMCO" on one line of the data sheet) instead of recording each bird on a separate line.

Habitat Descriptions and Measurements

Natural changes in water level and management activities (e.g., dredging, wetland restoration efforts, prescribed burning) can lead to dramatic changes in marsh vegetation composition and structure. Patterns of distribution and local population trends of marshbirds might best be explained by local changes in wetland vegetation. Consequently, quantifying the relative proportions of major vegetation types surrounding each survey point can help identify causes of observed changes in marshbird populations.

Vegetation should be quantified at two spatial scales: (1) observers should visually estimate the relative proportions of open water, mudflats, and each major vegetation type within a 50-m radius circle around each survey point, and; (2) aerial photographs should be used by an analyst to periodically determine amount of each major vegetation type on each management area. To control for the seasonal progression of annual growth in emergent plants, observers should quantify vegetation types within the 50-m radius of each point during their final survey each year. However, vegetation data need not be collected while bird surveys are being conducted. An example of visual estimates of proportions of each vegetation type at a survey point might be: 15 percent water, 10 percent California bulrush, 20 percent three-square bulrush, 5 percent cattail, 20 percent seep willow, 10 percent mudflat, 20 percent upland shrub community. Observers are encouraged to estimate proportion of each plant species present, because some marshbirds preferentially use habitats dominated by only one species of emergent plant. If necessary, participants should enlist the help of a botanist or other qualified assistance to conduct vegetation surveys (or bring samples to a herbarium for later identification). Upon request, program coordinators will provide survey participants with standard instructions for describing marsh vegetation at their survey points.

Personnel and Training

Each observer should be able to identify all common calls of marshbird species in their local area. Regularly listening to the recorded calls used for surveys can help observers learn calls, but observers should also practice call identification at marshes where species of interest are frequently heard calling. All observers should also be trained to determine distance to calling marshbirds and have a hearing test (audiogram) at a qualified hearing or medical clinic before, during, or immediately after the survey season each year. See Conway (2003) for recommended methods for training participants.

Integration with Other Monitoring Protocols

These protocols were designed to allow maximum flexibility for integration with existing regional marshbird survey efforts. The authors are aware of at least five existing regional marshbird survey efforts and 11 more localized or discontinued survey efforts (Conway and Gibbs 2001) which all use different survey methodologies (*table 1*). In particular, survey efforts vary in the duration of each survey and in the sequence of species' calls included in the call-broadcast periods. Some of these survey efforts do not include an initial passive listening period prior to broadcasting calls. Survey protocols described in this paper and detailed in Conway (2003) will allow at least a portion of data produced from all of these survey efforts to be comparable by allowing participants to conduct either morning or evening surveys, and by having participants record numbers of marshbirds detected during each 1-min segment of the survey. Finally, some investigators and resource managers have interest in monitoring marshbirds without the use of call-broadcast (particularly for salt marsh passerines; Ribic et al. 1999; S. Droege, unpubl. ms.). The survey program outlined here allows such individuals to participate in this program because participants need only conduct the five-minute passive observation period (i.e., skip the call-broadcast portion of the survey) at each survey point. Data produced from such surveys will still be compatible with survey protocols outlined herein because birds detected during these initial 5-min passive periods can be analyzed separately from those detected during the call-broadcast segment.

Regional Context

Estimates of change in marshbird populations in one survey area will be compared to local population changes in other parts of the region and to other regions. These data will allow comparisons among management areas in a particular region so that local managers can determine the relative importance of specific wetlands to the regional population health of specific species. Several U.S. Fish and Wildlife Service National Wildlife Refuges began using these marshbird survey methods in 1999 and participation has increased each year. In 2002 and 2003, over 111 participants conducted marshbird surveys using these protocols (85 in the United States, 25 in Mexico, and 2 in Canada) at over 2800 survey points. For assistance initiating survey routes, obtaining appropriate CDs or the most recent survey protocols, or questions regarding standardized marshbird survey methods, please contact the program coordinator: Dr. Courtney J. Conway, Arizona Coop. Fish and Wildlife Research Unit, 104 Biological Sciences East, University of Arizona, Tucson, AZ 85721, ph: 520-626-8535, FAX: 520-621-8801, email: cconway@ag.arizona.edu.

Additional Optional Components to Survey Protocol

Recording Water Depth at Each Point (or Each Management Unit)

Water level is thought to influence abundance and distribution of marshbirds. Water levels vary annually and even daily in some marshes and these fluctuations can explain spatial and temporal changes in marshbird abundance (Craigie et al. 2002). Some National Wildlife Refuges and National Wildlife Areas control water levels in some of their management units and have the ability to directly benefit marshbirds via hydrologic management. Participants are encouraged to place gauges for measuring water level change in permanent locations at numerous points within their survey area(s). Water level should be recorded before or after each marshbird survey. If water levels vary annually (or seasonally) within survey areas, we recommend that this component become incorporated into the participant's marshbird survey effort.

Recording Noise Level at Each Point

Recording the level of background noise during the survey at each survey point is useful for trend analysis. This information can be used as a covariate in future trend analyses because level of background noise varies spatially and temporally and influences detection probability. If noise levels are periodically high enough to reduce an observers' ability to detect calling marshbirds, this optional component should be considered mandatory. Record background noise on a scale from 0 (no background noise) to 4 (cannot hear birds beyond 25 m; see Conway 2003).

Table 1— *Summary of methods associated with other marshbird survey efforts.*

Survey coordinator	Location	Num. of species in broadcast sequence	Years	Minutes per point[1]	Number of points	Point spacing (m)	Number of surveys	Number of surveys per point	Time of day[2]	Season
Paine	Illinois	4-11	1996-1998	8/8/3	142	175	1094	1-8	m	Apr-Aug
Penttila	Wisconsin	7	1983-2000[3]	2/3-6/2	58	800	1632	1-10	m	Apr-Jun
Fitzpatrick	Arizona/California	1	1979-2003	0/5-6/0	1066	180	3222	1-3	m,e	Apr-Jun
Timmermans	Great Lakes	5	1997-2003	0/5/5	900	250	1450	1-8	e	May-Jul
Shieldcastle	Ohio	5	1991-2003	0/5/0	525	unk	3660	1	m	May-Jun

[1]minutes initial passive period/minutes during call broadcast/minutes final passive period.
[2]m=morning, e=evening, n=nighttime.
[3]1987-89 not surveyed; converted to survey methods described in this document in 2001.

Two-Observer Surveys

The extent to which trends in count data represent the underlying trend in true abundance depends on variation in detection probability and observer bias associated with the particular survey method. Two observers conducting a subset of surveys simultaneously but without sharing information will allow analysts to estimate observer bias associated with their survey efforts using the double-observer method (Nichols et al. 2000). Hence, whenever possible, surveys should be conducted by two observers simultaneously (Conway 2003).

Summary

This paper is a summary of progress made to develop standardized survey methods that could be used as part of a continental marshbird monitoring program. The information here summarizes draft field protocols in Conway (2003). Those interested in participating in this initiative and/or in developing localized or regional standardized marshbird monitoring initiatives following the protocols described herein are encouraged to contact Courtney Conway (at the address given above) to obtain a copy of the technical documentation that describes these protocols in greater detail. This paper is meant to generate discussion and debate of methods that should or should not be included in a continental marshbird monitoring program. These protocols are being implemented on many National Wildlife Refuges and other protected areas across North America. This initial effort will allow these draft field protocols to be field-tested and improved prior to implementation of a continental marshbird monitoring program in which the data generated will provide inference to status and trends of continental populations of marshbirds.

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Appendix 1—*Proposed list of marshbirds that would be the focus of a North American marshbird monitoring program, and the most common calls for each species.*

Species	Call
Least Grebe (*Tachybaptus dominicus*)	loud, high-pitched *gamp* (advertising call), *trill* (often paired duet), *nye-nye-nye-nye* (rushing call)
Pied-billed Grebe (*Podilymbus podiceps*)	3-part gurgling song, *quaa-aaa-aaa* (wavering, guttural copulation call), *kwah* (alarm call), *ek-ek-ek* (rapid, staccato greeting call), *tshick-tshick*
Least Bittern	*coo-coo* (male advertisement), *kak-kak-kak*, *gack-gack* (given from nest), *ank-ank* (given when flushed)
American Bittern	*pump-er-lunk* (territorial/advertisement call), *chu-peep* (given during copulation ceremony), *kok-kok-kok* (given when flushed)
Black Rail	*kickee-doo* (primary breeding call), *grr-grr-grr, churt, ticuck*
Yellow Rail	*click-click*, *wheese* (female call), *descending cackle* (pair maintenance), *squeak* (given by retreating bird)
Sora (*Porzana carolina*)	*whinny* (territorial defense and mate contact), *per-weep*, *kee* (may be given to attract mates)
Virginia Rail (*Rallus limicola*)	*grunt* (pair contact, territorial call), *tick-it* (male advertisement call), *kicker* (female advertisement call), *kiu* (sharp, piercing call)
King Rail	*chac-chac* (pair communication), *kik-kik-kik* (mating call)
Clapper Rail (*Rallus longirostris*)	*clatter* (pair contact, territorial call), *kek* (male advertisement call), *kek-burr* (female advertisement call), *kek-hurrah ,hoo, squawk* (chase squeal), *purr*
Common Moorhen (*Gallinula chloropus*)	*cackle* (primary advertising call), *squawk, yelp, cluck*, *purr*
Purple Gallinule (*Porphyrula martinica*)	*cackle* (primary advertising call), *squawk*, *grunt*
American Coot	*pow-ur* (crowing for territorial defense), *puhk-ut* (warning), *puhk-kuh-kuk* (crowing for territorial challenge), *puhlk*, *tack-tack* (cackling), *kerk* (sharp cough)
Limpkin	*krr-oww*

Appendix 2— *Examples of 'secondary' species that would be part of the proposed North American marshbird monitoring program, but participants would not include their calls in the call-broadcast sequence.*

Species
Green Heron (*Butorides virescens*)
Great Blue Heron (*Ardea herodias*)
Glossy Ibis (*Plegadis falcinellus*)
White-faced Ibis (*Plegadis chihi*)
White Ibis (*Eudocimus albus*)
Northern Harrier
Sandhill Crane
Willet (*Catoptrophorus semipalmatus*)
Common Snipe
Forster's Tern
Black Tern
Belted Kingfisher
Alder Flycatcher (*Empidonax alnorum*)
Sedge Wren (*Cistothorus platensis*)
Marsh Wren (*Cistothorus palustris*)
Common Yellowthroat (*Geothylpis trichas*)
Yellow Warbler (*Dendroica petechia*)
Saltmarsh Sharp-tailed Sparrow (*Ammodramus caudacutus*)
Nelson's Sharp-tailed Sparrow (*Ammodramus nelsoni*)
LeConte's Sparrow (*Ammodramus leconteii*)
Swamp Sparrow (*Melospiza georgiana*)
Savannah Sparrow (*Passerculus sandwichensis*)
Seaside Sparrow (*Ammodramus maritimus*)
Red-winged Blackbird (*Agelaius phoeniceus*)
Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*)
Boat-tailed Grackle (*Quiscalus major*)