Data Collection Protocol
Wetland Bird Monitoring

Developed by the Bird Focus Group
Wetland Regional Monitoring Program

Overall Introduction to the Bird Protocols

Over 100 species of wetland-adapted birds spend all or part of their life cycle on the waters or in the wetlands of San Francisco Bay. They include loons, pelicans, cormorants, mergansers and terns that dive or swim through the water in pursuit of fish prey. Other birds, including most diving ducks and shorebirds seek invertebrate prey in the sediments of the Bay. Marsh-dwelling passerine birds like the Song Sparrow and Salt Marsh Yellowthroat search for insects on plants or the soil surface. Herons and Egrets seek a variety of mobile prey including fish, crabs, small mammals and other birds.

Song Sparrows, yellowthroats and some species of rails are year round residents of San Francisco Bay Estuary. While a few species of shorebirds and waterfowl also nest in the Bay, many others are winter residents, arriving in late summer or fall and remaining through the winter before migrating northward or eastward to nesting areas in spring. A few species, such as Wilson's Phalarope, occur strictly as migrants, stopping in the Bay for short periods in spring and fall before resuming their migration to breeding and wintering areas.

The primary objective of a wetland bird-monitoring program is to establish whether aquatic bird populations are increasing or declining in San Francisco Bay. For those species that nest in the Bay it is also important to determine whether reproductive success is sufficient to maintain population size.

It is not currently economically feasible to monitor all birds or the entire area of the San Francisco Bay Estuary. The solution is a sampling program focusing on a subset of the species and sites for monitoring. The bird focus team selected six groups of birds to monitor in San Francisco Bay. Focus team members most familiar with the ecology and existing survey methods for each species group took the leading in drafting the protocol for the respective group. The six groups selected for monitoring were: Herons and Egrets, Marsh-nesting Passerines, Larids, Rails, Shorebirds, and Waterfowl.

Herons and Egrets

Herons and egrets are recognized as important biological indicators of environmental change in wetlands. Reasons for this recognition include: their position as top carnivores, which can signal changes occurring at lower trophic levels; communal nesting which facilitates sampling of reproductive output; use of human altered

landscapes; sensitivity to disturbance and pollution; and dependence on specific hydrologic and hydrographic functions with associated responsiveness to changes in fundamental physical ecosystem characteristics.

Marsh-nesting Passerines

Among the wildlife affected by the reduction of tidal salt marshes of the San Francisco Bay region are morphologically distinct subspecies of the Song Sparrow and the Common Yellowthroat. In the San Francisco Bay region, they are represented by resident subspecies entirely or mainly restricted to tidal marsh habitat. The Song Sparrow subspecies are the Alameda Song Sparrow (*Melospiza melodia pusillula*) restricted to Central and South San Francisco Bay, Samuel's Song Sparrow (*M. m. samuelis*) found in San Pablo Bay, and the Suisun Song Sparrow (*M. m. maxillaris*) of Suisun Bay. The subspecies of Common Yellowthroat, found throughout the San Francisco Bay region, is the Salt Marsh Common Yellowthroat (*Geothlypis trichas sinuosa*), also referred to as the San Francisco Yellowthroat. These four subspecies are considered State of California Species of Special Concern. An additional species, the Marsh Wren, which currently has no special conservation status, is found in San Francisco Bay tidal and freshwater marshes. This species is of significance because it is aggressive, competes with Song Sparrows and yellowthroats, and may displace these two species. The marsh wrens competitive edge may be further facilitated by the invasion of non-native cordgrass (*Spartina alterniflora*).

Gulls and Terns

Gulls and terns have benefited from the human alteration of the San Francisco Bay estuary. California Gulls, Forster's Terns, Caspian Terns and Least Terns nest in the salt ponds and other man-made habitats in the Bay. The terns are fish-eating birds that forage in the salt ponds and the shallow waters of the Bay. The gulls are scavengers feeding on a wide variety of items including many that are obtained at local landfills. California Gulls were first recorded nesting in the estuary in 1980 when 12 nests were found at a South Bay salt pond. The number of nesting gulls in the South Bay currently exceeds 2000 individuals. Forster's Terns were first recorded breeding in the Bay in 1948 and Caspian Terns in 1922. Although Least Terns were not confirmed as nesting until 1963, they had been reported in the Bay as early as the 1920s and may have bred there undetected for decades.

Rails

In general, Clapper Rails and Black Rails are marsh dependent species with Clapper Rails occupying lower elevation tidal marshes and Black Rails higher elevation tidal marshes. Other rail species (Virginia Rail, Sora, American Coot, Common Moorhen) occur in brackish to freshwater environments, and occur in tidal marshes

during the non-breeding season. Clapper Rails and Black Rails are both listed species because of historic loss and degradation of habitat. The bulk of the entire population of each species is dependent on the San Francisco Bay estuarine system and thus the existence of each taxon depends on the viability of those populations. Each is also highly sensitive to variation in environmental conditions including changing salinity values, water levels, predation pressure, and human impacts to adjacent habitats. In short, the presence and/or absence of these species provide indicators of marsh function. Additionally, ongoing field studies have provided background population estimates against which future estimates of these species may be compared.

Shorebirds

At least 34 species of shorebirds, comprised of plovers, oystercatchers, stilts, avocets, sandpipers and phalaropes, occur regularly in the San Francisco Bay estuary. Most are migrants or winter residents. Only six species nest in the Bay or Delta. Recent studies have shown that the San Francisco Bay estuary holds one of the largest concentrations of migrating and wintering shorebirds on the west coast of the United States. Hundreds of thousands of shorebirds inhabit the Bay during fall and winter. Numbers approach a million birds during the peak of spring migration. Shorebirds in the Bay and Delta eat a wide variety of invertebrates on tidal mudflats, salt ponds, marshes, rocky shores and agricultural fields. Tidal flats are the most used foraging habitat for most species and tides control the availability of these flats for foraging shorebirds. Rising tides force birds to abandon the flats and move to other habitats such as marshes or diked wetlands where they continue to feed, or where they loaf, preen, bath, or sleep on high tides. Shorebird abundance is closely linked to the condition of the benthic invertebrate community.

Waterfowl

The San Francisco Estuary is one of the most important staging and wintering areas for migratory waterfowl populations in the Pacific Flyway. Waterfowl present in San Francisco Bay can be divided into dabbling ducks, diving ducks, mergansers, geese and swans. Even though San Francisco Estuary is particularly vital as a wintering and migration staging area for waterfowl, some reproduction also occurs in the region. Small numbers of Mallards, Gadwalls, Northern Pintails, Northern Shovelers, Cinnamon Teals, and Ruddy Ducks breed in the tidal marshes, diked wetlands, diked farmland or seasonal wetlands of region. Aside from the mergansers, which are primarily fish eaters, waterfowl are plant and invertebrate feeders. Abundance of many waterfowl species also linked to the condition of the invertebrate community.

Data Collection Protocol
Heron and Egret
Breeding Distribution, Abundance, and Success

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Introduction

This protocol will provide annual information on the size, distribution and productivity of heron and egret nesting colonies in the San Francisco Bay region. Colony site data will be summarized by subregion and contribute to regional estimates of nesting distribution, nest abundance, seasonal timing, and reproductive success, with an ability to detect annual changes in regional productivity of 15-20%. The following information will be obtained annually at all known heron and egret nesting colonies in the region.

1. Colony size, based on the peak number of active nests observed during multiple visits, provides an index of the number of pairs of birds attempting to breed.

2. Nest survivorship, based on focal samples of nest fates in each colony

3. Productivity of successful nests, based on prefledging brood size in completely visible broods 4-8 weeks old, for Great Blue Heron and Great Egret, and 7-15 days old for Snowy Egret and Black-crowned Night-Heron

4. Seasonal timing, based on distribution of nests across five behavioral stages

Field data will characterize individual colony sites, although additional effort will be required to monitor large colonies.

Study Species

Study species include the Great Blue Heron, Great Egret, Black-crowned Night-Heron, and Snowy Egret. Because Snowy Egrets and Black-crowned Night-Herons have relatively short incubation and nestling periods, and at most colony sites, nest in well-concealed or inaccessible locations, focal nest data required to determine nest

survivorship, productivity, and timing in these species will often be limited or unavailable.

Sample Universe

The study area includes San Francisco, San Pablo and Suisun Bays, and associated watersheds and upland terraces to a distance of 20 km (estimated maximum distance of foraging flights) from tidal marshes or the bayshore. This area represents the sample universe for reproductive success and regional abundance, based on results from all known nesting colony sites in the study area. The locations of known nesting colonies are determined through communication with state, regional, and local natural resource managers, county breeding bird atlas project coordinators, and local bird watching networks. New colony sites are also detected opportunistically, and ground-based searches for undocumented sites are conducted occasionally throughout the study area. Although the sampling domain of "all known sites" does not include annual random or systematic searches for new sites, samples are assumed to include most of the colony sites in the region, and thus, to provide an effective index of regional abundance and a representative sample of regional reproductive success. Accurate estimates of nest abundance at large or inconspicuous colonies may require site-specific measurement of nest detection probabilities.

Personnel

Trained volunteer field observers assist in much of the fieldwork. All observations are made with binoculars and telescopes. All colonies are observed from the ground or from boats.

Procedure

At each colony site, establishing a monitoring effort involves five steps:

1. Determine number of "active nests" early in the season. Before 1 April, nests are considered active if two adults are present or if one adult is seen carrying nest material or incubating. After 1 April, any occupied nest is considered active.

2. Create a nesting panorama. The nesting panorama is a landscape sketch or photograph that indicates the location of numbered nests to be followed through the season. Each panorama includes an exact description of the viewing position, which should be located far enough from the colony to avoid disturbance to the nesting birds. More than one panorama may be necessary to monitor all focal nests in the colony (see below).

3. Identify focal nests. Focal nests are numbered nests and monitored through the season to measure nest survivorship. Focal nests must be

observed as "active" either before incubation or at Stage 1 (incubation, see below), and should be observed as active in March, although new focal nests can be added until 15 April. In colonies with 15 or fewer active nests, or with volunteer observers that can commit to monitor every nest in the colony, all nests that meet the above criteria are considered focal nests. *Random samples:* In colonies with more than 15 active nests, which cannot be monitored on every visit, a random subset of at least 15 focal nests is selected for each species. Observers are encouraged to monitor as many nests as they can.

4. Obtain necessary access permits or authorization to enter the area. Most colony sites are on privately owned lands, or on public wildlife refuges with restricted access.

5. Visit each site at least four times during the nesting season. Observers are encouraged to conduct more frequent visits if possible (weekly or biweekly). Regional observation periods are scheduled each year, during five 3-day windows at approximately monthly intervals: early March, early April, early May, early June, and late June. During each of these periods, all colony sites are visited. Diurnal timing of observations is generally not important, but site-specific effects on viewing conditions should be considered. For example, position of the sun might affect visibility of nests; low temperatures can cause brooding adults to hide nest contents; and afternoon wind can enhance the visibility of hidden nests. Because average timing of nesting varies among years, colony sites, and species, closely synchronizing colony site visits with nesting phenology is problematical.

Ancillary Information

The following information is recorded for each colony site:

1. geographic location in UTMs

2. description of nesting habitat, including vegetation, topography, and available nesting space

3. nest locations numbered on a standardized panoramic sketch or photo, updated each visit

4. property ownership

5. number of active nests on each visit, and peak number during the season, using the following criteria: *Before 1 April, "active" nests must have either two adults present or one adult carrying nest material or incubating. After 1 April, any occupied nest is "active."*

In locations where Snowy Egrets and Black-crowned Night-Herons hide their nests in dense shrubs or inaccessible vegetation, number of nests is estimated without entering the colonies, by conducting multiple counts and mapping discrete locations of birds perched above, or visible through the foliage, over an extended period of observation. Late in the nestling period, such estimates are facilitated by broods of nestlings that stand conspicuously above nest sites. Occasionally, such estimates are confirmed by clapping, cautiously, to cause hidden birds to rise to the canopy surface where they are counted, and to avoid the confusion of flushing an entire colony. Flushing all birds from a colony may be necessary to obtain annual estimates of adults nesting in dense marsh vegetation, where no other methods for estimating colony size are available. If observer disturbance of the colony is likely, caution should be exercised to avoid predation by nest predators.

6. focal nest status: active or inactive

7. nesting stage of each focal nest. Seasonal timing is indexed by the distribution of focal nests across 5 nesting stages:

   Stage 1: Egg-laying or incubation; adult lying down in nest for long periods, standing to turn eggs, defecate, or for nest relief
   Stage 2: Hatching; small (downy) nestlings, or feeding observed low in the nest
   Stage 3: Nestlings usually standing; most or all of down replaced by juvenal plumage; parent(s) continuously at the nest
   Stage 4: Adults not continuously at the nest, but may be present for some time after feeding; nestlings usually on the nest platform
   Stage 5: Young often off the nest, on nearby branches

8. number of adults and chicks on each focal nest

9. prefledging brood size in completely visible broods 4-8 weeks old, for Great Blue Heron and Great Egret, or 7-15 days old for Snowy Egret and Black-crowned Night-Heron

10. type and level of disturbance, observed or inferred:
    Types: A=avian H=human O=observer M=mammal
    W=weather P=other predator U=unknown
    Levels: 0=none 1=behavioral response only
    2=nest or nestling mortality 3=colony abandonment

11. human land use: a description of human activity and development in the immediate vicinity (within 300 m) of the colony site.

Sample Data Types, Sample Size and Sample Units

Reproductive success (rs) is calculated as the product of focal nest survivorship (s) and prefledging brood size (b): rs = $s \times b$. Regional estimates should use weighted averages of s and b among colonies, based on colony size. Variance of reproductive success is estimated following Goodman (1960, *J. Am. Stat. Assoc.* 55:708-713): $\text{var}(rs) = [s^2 (\text{var}(b)] + [b^2 (\text{var}(s)] - [\text{var}(b) \cdot \text{var}(s)]$.

Nest survivorship (s) is "apparent" survivorship based on focal nests monitored through the nesting season. Great Blue Heron and Great Egret nests are considered successful if they survive to 8 weeks post-hatch. Snowy Egret and Black-crowned Night-Heron nests are considered successful at 15 days post-hatch, but this level of resolution is not achieved unless monitored frequently.

Prefledging brood size (b) is based on the latest counts of completely visible broods observed during Stage 4 (Great Blue Heron and Great Egret nestlings 4-8 weeks old; Snowy Egret and Black-crowned Night-Heron nestlings 7-15 days old). During this period, most nestlings are old enough to be standing and visible, but too young to hop away from the nest platform. Most brood reduction in Great Blue Heron and Great Egret occurs during the first four weeks after hatching (Pratt 1970, *Condor* 72:407-416).

Sample size: Previous (unpublished) data suggest that observations from 65 nests (within or among colony sites) may be adequate to detect a 20% difference in prefledging brood size between consecutive years 80% of the time, with a significance level (a) of 0.10. At some colony sites, the number of brood size observations possible may be substantially limited by incomplete visibility of broods.

Example Breeding Heron and Egret Data Sheet

Notes (inferred or observed disturbance type and level, special conditions, habitat changes, unusual behaviors, potential nest predators, etc.): Number of active nests:												
Nest #	Species	Is this a focal nest?			(A) Active (P) Possible (I) Inactive	Nest stage	# Adults	# Chicks	Entire brood visible?			Comments: behavior, feeding, nest relief, food, etc.
1	GBHE		X		A / P / I	4	1	4		X		Feeding obs.; parent left colony after 12 min.
2	GBHE		X		A / P / I	3	1	3				Nest partly obscured by foliage
3	GBHE		X		A / P / I	4	0	3		X		Lost chick; 4 chicks on April 10
4	GBHE				A / P / I							
5	GBHE		X		A / P / I	-	0	0				Failed last visit (April 10)
6	GBHE		X		A / P / I	3	1	2		X		Feeding observed
etc.												

Data Collection Protocol
Nesting Gulls and Terns

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Introduction

This protocol will provide data about the numbers and reproductive success of nesting gulls and terns in the San Francisco Estuary. More specifically, the protocol will:

?? Document locations and status of traditional and new colonies on a year-to-year basis covering all potential nesting sites.

?? Gather adult and nest data from all colonies to determine local colony size and regional productivity.

?? Evaluate changes in the health and stability of the bay's populations and identify threats, such as disturbance or predation.

?? Provide timely information to federal, state and private wetland habitat managers to minimize human disturbance and predation by introduced species.

?? Provide current information to the public on larid use of the bay.

?? Integrate the laird-monitoring program with other research efforts.

Survey Procedures

Sample Universe

The sample universe is San Francisco Bay south of the Carquinez Straits. The protocol could be applied to other subregions of the San Francisco Estuary.

Species to Survey

California Gull (*Larus californicus*)
Western Gull (*Larus occidentalis*)
Forster's Tern (*Sterna forsteri*)
Caspian Tern (*Sterna caspia*)
California Least Tern (*Sterna antillarum*)
Black Skimmer (*Rynchops niger*)

Sample Strata

The Bay's gulls and terns have shown remarkable ingenuity in searching out and utilizing isolated, flat areas with acceptable substrate and no visual obstructions for nesting. Nearly all of the shoreline surrounding San Francisco Bay should be searched in early May for signs of nesting colonies.

The majority of larid nesting colonies are in the South Bay salt pond system, on salt pond islands and on degraded and maintained salt pond levees. At least one colony of Forster's Tern nests on an island in diked pickleweed marsh, which is a more usual nesting habitat for this species but not widely available. Several large colonies utilize natural habitats in the North Bay. For example, Brooks Island near Richmond supports Caspian Terns, and Western and California Gulls. Forster's Terns nest in the Napa River Marsh.

Colonies may form manmade structures, such as duck blinds and abandoned wharves. Examples include the Western Gull colony on the helicopter pad on Alcatraz Island and the Bay's single Least Tern colony at the former Alameda Naval Air Station runway system.

Seasonality

Gull and tern adults arrive on territory in April. Egg laying commences in mid-April and continues into early May for California Gulls and into early to mid May for Forster's and Caspian Terns. Gulls begin hatching in early May; terns begin hatching in mid to late May. All species have fledged young by the end of July. Post-breeding roosting occurs on islands and levees around the south bay during August, including Least Tern adults and young from Alameda.

Visual Surveys

Volunteer Tasks

Volunteers are trained in data collection techniques and colony access procedures. In early April they search traditional sites and look for potential new locations for signs of nesting. They map colony locations.

Volunteers are assigned to individual colonies and visit them at two-week intervals beginning in early May. They make observations during the course of one hour, between 0900 and 13000.

Volunteers must monitor the colonies through July to count adults and chicks present on the colony, observe fledging, and document evidence of predation and disturbance.

Equipment

- Binoculars
- Spotting scopes

Professional Tasks

Based on information received from the volunteers, biologists visit all known colonies of all species. In the South Bay most colonies are on salt pond islands and accessible only by kayak or canoe. Early morning surveys are scheduled to collect data on peak clutch size before newly hatched chicks reach two-three days of age. At that age chicks become increasingly mobile and may go into the water or otherwise become prone to predation and exposure.

Adults on the colony are counted before approaching the colony. Visits are limited to one hour or less to minimize disturbance. After all nests are counted, a sample is selected for further data collection including: clutch size, chick number, and egg age (to predict hatch date). Evidence of clutch, chick or adult predation, habitat changes (e.g. water level), or other pertinent information is also recorded.

Number of chicks fledged is based on observed number of chicks at 3-4 weeks post-hatching. Comparisons are made among colonies and regionally within the Bay.

Sampling Sites

Every bayside colony should be visually monitored. New areas should be searched each year to locate new colonies due to the dynamic nature of wetlands, bird movements, and land management changes.

Data Fields

At each colony they collect the following data:

1. Species present.
2. Number of adults and chicks of each species.
3. Number of occupied nests of each species.
4. The nesting stage of the colony:

Nesting Stages:

Stage 0. Pre-nesting, (pairs formed, birds performing courtship displays, mating).

Stage 1. Egg laying or incubation (adults attending nest).

Stage 2. Downy chicks present.

Stage 3. Feathered chicks present.

Stage 4. Fledging young present.

Stage 5. Fledged young still attending colony.

5. Cause or suspected cause of predation or disturbance in colony; e.g. flooding, human intrusion, evidence of mammalian or avian predators.

6. Any other comments such as banded birds, habitat changes, etc.

Quality Control and Data Management

?? Workshops offer volunteer training with emphasis on species identification, behavior recognition, predator detection, completeness of observations, accuracy of data recording, and logistics of accessing remote areas. There is an emphasis on necessity of timely data reporting and the responsibility of completing all assigned surveys.

?? Field data entered on standard forms, reviewed upon receipt for completeness and accuracy, clarified with volunteer observer if necessary and entered into Excel.

?? Data reviewed every two weeks for completeness. When necessary, colonies revisited and multiple observations made.

?? Entered data proofed against field data and checked for accuracy.

?? Copies of hard data and electronic files stored at multiple locations.

Data Analysis

Trends in colony sizes, regional abundance, and regional productivity based on nest counts or adult counts are currently calculated for all South Bay colonies of each target species. This should be expanded to include North Bay, Suisun and Delta sites. Clutch size and productivity should be compared between colonies, regions and years.

Comparing trends in species breeding numbers in San Francisco Bay with other regions of western North America will be facilitated by participation with:

1.The Pacific Seabird Group
2.The North American Waterbird Conservation Plan

Data Collection Protocol
Tidal Marsh Passerines

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Introduction

This protocol describes data collection and inference based on surveys of landbirds using tidal marsh (including muted tidal marsh). The objective is to develop estimates of species richness and diversity of landbirds, and abundance and distribution (i.e., presence/absence) of selected species. The emphasis is on songbirds, especially the Song Sparrow, Marsh Wren, and Common Yellowthroat, but information on other landbirds (especially raptors and corvids) is also a goal. The protocol can be used to obtain information on Black Rails and Clapper Rails, but these two species have their own protocol (see protocol titled "Tidal Marsh Rails").

This protocol for the landbirds of tidal marshes is based on the point count survey (Ralph et al. 1993, Ralph et al. 1995), with each survey station referred to as a "point count station." In addition to these bird survey data, information about the distance at which individual birds are detected should also be collected, which allows one to estimate absolute density using distance-sampling methodology (e.g., the program DISTANCE).

Survey Procedures

Personnel

Trained volunteers can be used to help with the survey. Guidelines on training volunteers can be obtained from the authors of this protocol.

Sampling Universe and Strata

This protocol can be used for tidal marsh, muted tidal marsh, and other baylands (e.g., diked baylands), whether access is by foot or by boat. It is thus well suited for ambient monitoring as well as for monitoring wetland projects. It is not suitable for wetlands that are completely submerged for extended periods of time, since such wetlands do not tend to support landbirds. These protocols cover both breeding season and non-breeding season surveys. Passerines are the main focus, but other landbirds

(e.g., raptors) are included. The sample universe is therefore the baylands of the San Francisco Estuary, excluding the diked areas subject to prolonged inundation.

This protocol employs a stratified-random sampling approach. The survey effort can be distributed among major wetland types (i.e., high tidal marsh, low tidal marsh, muted tidal marsh, diked bayland, etc.). Within a marsh site, the survey effort should include the major geomorphic strata (i.e., foreshore, backshore, large channels; see version 1 WRMP Part 1 Sciew3nce Framework).

Seasonality

Point count surveys can be divided into breeding season surveys and non-breeding season surveys. We recommend at minimum that two surveys be conducted in the breeding season each year. It is also highly desirable to conduct surveys outside the breeding season, on a seasonal basis. Thus the recommended protocol is to conduct surveys at four time periods: fall, winter, early spring, and late spring, with the last two time periods corresponding to the breeding season. In fact, early spring corresponds to both the migratory period and to the beginning of the breeding season for some species (e.g., Song Sparrows). Surveys during the summer would not be a priority

We recommend that early spring surveys be conducted between 20 March and 16 April, but this could be delayed some (e.g., between 1 April and 30 April). The late spring surveys can be conducted between 17 April and 15 May. Again, the late spring surveys can be delayed a couple weeks (i.e., shifted to 1 May and 31 May). We recommend a month between the "early spring" and the "late spring" surveys, but the interval could be as much as six weeks. It would be preferred not to survey in June for several reasons: vegetation is high, thus obscuring birds; singing and territorial behavior is reduced compared to March, April, and May; and more fledged (i.e., flying independent) young are present in the marsh, which can confound survey results.

Fall surveys can be conducted in September and October; winter surveys can be conducted during December to early February. Replicate surveys (i.e., two per season) are preferred, but even one per season would be valuable.

Timing

Surveys begin within 15 minutes of sunrise (before or after) and should be completed within approximately 4 hours (i.e., during the time of maximum bird activity during the day). If possible, surveys should be conducted at a consistent point of the tidal cycle, preferably at high tide. It may not be possible to conduct surveys in the early morning hours and at a high tide, in which case the time of day should take precedence. In any case, one should note tide, and direction of tide, at the time of the survey. Tide status can then be included as a covariate in statistical analyses.

Surveys should not be conducted when conditions prevent normal bird activity or detection, such as during rain or strong winds. If industrial or traffic noise adjacent to the marsh significantly reduces an observer's ability to detect birds, the survey should be conducted on the weekend.

Locating Point Count Stations

The first step in locating the survey stations (i.e., point count stations) is to obtain a photo-map or other suitable map of the site. On this map, a grid is overlaid. One cell on the grid is chosen at random. This randomly chosen point is the "starting point" for locating the stations, which are distributed in a regular grid pattern, beginning at the starting point. Point count stations are placed 200 meters apart (to avoid counting the same birds from adjacent points). If access to the interior of the site is restricted (e.g., the public is legally restricted from many potential sites in South Bay), points may have to be set up along levees. Where the site is too small for two or more points that 200 m apart, it is recommended that several points be placed less than 200 m apart, but as far apart as possible. In analysis, any points that are 150 m or less apart should be treated differently that points further apart; one should not assume statistical independence between sites less than 200 m apart but instead should evaluate the assumption of independence.

Stations should be flagged conspicuously and their GPS coordinates should be recorded, in order to facilitate returning to the exact station locations for repeated surveys and/or vegetation measurements.

Stations should be placed without regard to the major strata within a site (i.e., channels, shorelines, etc.), unless differences in landbird use or support between the strata are to be investigated, in which case the stations need to be replicated within the strata.

Necessary Equipment

- Site Map
- Binoculars
- Rangefinders
- Global Positioning System (GPS)
- Data Sheets

Method of Data Collection and Sample Units

Each station is surveyed for 5 minutes. Detections of each individual of every bird species are recorded in units of distance from the observer, in 10-meter increments up to 100 meters, with an additional column for detections beyond 100 m.

Alternatively, one can record observations in 5 m increments. Record the bird in the distance band in which it was originally detected, even if detection type changes (see below). Whereas distance estimation is recommended (and only with this method is one able to estimate absolute density), one can instead note whether the distance was less than 50 m or greater than 50 m. Such data can be used to estimate relative abundance, as well as presence/absence, species richness, and species diversity. Distance estimation requires more intensive training and can be difficult where detections are auditory. In addition, one should calibrate one's distance estimations on a regular basis using a range finder or other means to verify the accuracy of one's estimation of distances.

For each point, record all individuals of any one species on the same line. Use the AOU 4-letter species code (e.g., SOSP for Song Sparrow, COYE for Common Yellowthroat, MAWR for Marsh Wren).

Birds are noted according to the type of habitat in which they are detected, as follows.

?? Birds detected outside the marsh (e.g., in adjacent upland habitat, in the adjacent neighborhood) are marked with the type of non-marsh habitat they are found in

(T = tidal marsh; U = upland; R = restoration;
S = salt pond; P = other pond, M = muted).

?? Where the focal habitat is tidal marsh, one can just categorize all other, non-tidal marsh habitat as such, rather than categorizing further. The same holds for other focal habitats.

?? Use a separate line for different individuals of a species detected within and outside the marsh at a single point.

?? If the same bird uses both marsh and non-marsh habitat at that point, record it as within the marsh only (e.g., an SOSP sings at the edge of the marsh, flying between upland and marsh vegetation; this bird is included in the focal marsh detections).

?? One of the symbols below is used to indicate how the individual bird was detected.

?? Every effort is made to record each individual once only. Flyovers are recorded in the last column, also using the symbol for detection type (usually V).

?? If an adult bird is detected, the detection type is recorded in order of priority: Song > Visual > Call (see table below). Thus a bird both heard calling and singing is recorded as an "S". If a bird is detected singing and visually, this is recorded

as a circled "S". These distinctions allow one to calculate abundance using either visual or auditory detections, and in particular bird densities can be calculated using separate detection functions for visual and auditory detections.

?? If a juvenile is detected, it is recorded as "J". All other detections are assumed to be adults.

Symbol	Detection Type
S	**Song:** bird heard singing but not detected visually (may have also heard bird calling)
S (circled)	**Song and visual:** bird both heard singing and detected visually (may have also heard bird calling)
V	**Visual:** adult bird detected visually but not heard either calling or singing.
C	**Call:** adult bird call only, not singing and not detected visually (i.e. vocalization other than male territorial song)
C (circled)	**Call and Visual:** both, not singing.
J	**Juvenile:** juvenile bird detected either visually or heard calling (usually begging)

If a detection type changes, (e.g. initially heard calling and later heard singing), cross out the original and write in the new code. If a bird moves during the 5-minute period from one distance band to another, keep the detection in the initial band, even if the detection type changes.

Species detected outside the 5-minute point counts (but not detected during the 5-minute survey at that point count) should be recorded on the back of the form, especially those of the target tidal marsh species (i.e., COYE, BLRA and CLRA), predators and rare or endangered species.

Record weather conditions on the bottom of the form at the beginning and end of survey (wind, temperature and precipitation).

Metrics and Data Analysis

Four components can be analyzed with the data collected:

1. Species diversity and species richness
2. Presence/absence of target species
3. Relative abundance of select species (such as Song Sparrow, Common Yellowthroat, Marsh Wren).
4. Absolute density of select species.

Analysis of the first three components is described by Nur et al. (1999). For the fourth component, absolute density estimation, see Buckland et al. (1993); an example is

given in Nur et al. (1997). In brief: for species richness and species diversity, these can be analyzed as total species richness or as species richness for a subset of species; the same is true for species diversity. Species diversity can be measured using the Shannon index (Nur et al. 1999), also called the Shannon-Weiner or Shannon-Weaver index. Statistical analysis can be carried out using linear models (regression, ANOVA, etc.), after appropriate transformations (examples in Nur et al. 1999).

Presence/absence of target species can be analyzed using logistic regression (Hosmer & Lemeshow 1989). An example of such analysis is provided in Nur (et al. 1999). Relative abundance of select species can be analyzed using linear models if assumptions of this method are met, which is not always the case. Alternatively, one can analyze relative abundance using poisson regression or ordered-logistic regression.

Absolute density can be estimated using the program DISTANCE, a free program available on the World-Wide Web (http://www.ruwpa.st-and.ac.uk/distance).

Sample Size

Optimal sample size will depend on the nature of the questions being addressed. For example, if statistical inference is important, then statistical power considerations can guide sample size determination (Nur et al. 1999). A good rule of thumb is to establish ten point count stations per unit of interest (e.g., per marsh site ort stratum within a marsh), if possible. Only medium to large marshes will be able to accommodate 10-point count stations, however. For example, ten point count stations spaced 200 m apart (the recommended distance) can be placed in a marsh that is about 300 m by 900 m (27 ha); nine point count stations can be placed in a marsh that is about 500 m by 500 m (25 ha). Five point count stations per marsh (or other unit of interest) is probably a good minimum number. The ambient monitoring program will probably require a minimum of about 60 point count stations per subregion (i.e., San Pablo Bay, Suisun Bay, Central Bay, South Bay, Far South Bay).

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Data Collection Protocol
Tidal Marsh Rails

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Introduction

This protocol is mainly pertains to Rallidae (Aves): the California Clapper Rail (*Rallus longirostris obsoletus*) and the California Black Rail (*Laterallus jamaicensis coturniculus)*. Both of these taxa are special status species that breed in the tidal marshes of the San Francisco Estuary. In fact, the Estuary is a population center for these two species.

Indicators for this protocol are presence /absence, seasonal occurrence in a selected marsh sites, measures of abundance and density values, and reproductive success for these two species of rails.

Clapper Rails breed throughout SFB but are confined primarily to the emergent salt and brackish tidal marshlands of the estuary. Population estimates of clapper rails in SFB have been sporadic and rail numbers are thought to vary widely year-to-year. The most recent thorough estimates suggest a real decline since the 1980s (Albertson and Evens 2000), due largely to predation by red fox. In 1990-91 the bay wide population was estimated at 300-500 individuals, with a rebound to over 800 individuals in 1993 (USFWS *in* Albertson and Evens 2000). The most recent surveys estimated 650-700 individuals in the South Bay (1997-1998, USFWS) and 390-564 individuals in the North Bay (Collins et al. 1994). Although these data when pooled provide a total population estimate of 1040-1264 individuals in SFB, there is some indication that numbers have decreased in the North Bay since the mid-1990s, probably due to a combination of predation pressure and flooding during the breeding season. (J. Evens, pers. comm.).

The California Black Rail is also reliant on emergent tidal marsh habitat, however this smaller member of the Rallidae occupies higher elevations within the marsh plain than does the Clapper Rail. In general, clapper rails utilize the slough system from the Mean Higher High Water .down to Mean Tidal Level [0.2 to 0.65 ft. above NGVD (0)], the lower edge of the vegetated zone, whereas black rails occur in emergent marsh above MHW—the pickleweed (*Salicornia*) zone up into the transition zone of peripheral halophytes (Evens et al. 1991). Black rails also occur in freshwater situations away from SFB (Techlin, in Press), however the bulk of the population resides within the tidal reaches of the estuary (Manolis 1977, Evens et al, 1991, Trulio and Evens 2000). Although black rails occur in the South Bay in the non-breeding season, the North Bay marshes (San Pablo and Suisun) support the preponderance of the population. Estimates

of the overall size of the population within SFB are based on two synoptic survey efforts, one in 1986-88 (Evens et al. 1989) and another in 1996 (Nur et al. 1997) Based on these surveys, the population has been estimated at 8000-12000 individuals, however these estimates are confounded by detection difficulties, coarse habitat values, and environmental variables (Spear et al. 1999). The Goals Report (1999) indicates that there are about 5000 hectares of tidal marsh habitat in San Pablo and Suisun bays, however the proportion that occurs above MHW is not available.

Both rail species also occur and breed or have bred in marshesoutside of the Estuarey, both on the outer coast (Morro Bay, Bolinas Lagoon, Tomales Bay, Bodega Harbor) and in the Sierran foothills (various small marshes in Techlin in press). These 'satellite' populations may exhibit meta-population patterns of colonization and extinction. However, we currently have limited knowledge about the persistence or viability of these satellite populations.

Sampling Procedures

This protocol is designed to provide the following kinds of information about Clapper rails and Black Rails.

- Provide breeding season population estimates at selected sites to determine population trends and to evaluate the health and stability of the population and identify threats;
- Monitor restoration sites to determine rates of colonization by rails after restoration;
- Monitor satellite populations (e.g. outer coast) to determine isolation thresholds and to detect extinction and colonization events (Satellite populations include small (<10 ha) marshes in locations discrete from the tributaries of the sub-regions of the Estuary (e.g. outer coast marshes);
- Document impact and dynamics of *Spartina alterniflora* invasion on clapper rails;
- Monitor reproductive success of each species, if possible.

Required Permits

- U. S. Fish and Wildlife Service Endangered Species Permit, ESA Sec. 10(a)(1)(A)
- Special Use Permits required by U. S. Fish and Wildlife Service for refuges.
- Permits from California Department of Fish and Game.

Sample Universe and Sample Strata

The sample universe encompasses the tidal marshes of San Francisco Bay and Delta, including the major sub-regions (far South Bay, South Bay, Central Bay, North Bay, Suisun Bay, and Delta). Within those regions, the following sites are important population centers:

South Bay:
- Clapper Rail
  - San Francisco Bay National Wildlife Refuge
  - Laumeister Marsh
- Black Rail
  - Dumbarton Marsh

Central Bay:
- Clapper Rail
  - Corte Madera Marshes (Muzzi & Herdt)
- Black Rail
  - none

North Bay:
- Clapper Rail
  - Napa River (White Slough & Coon I.)
  - Petaluma R. (Black John Slough, Day Island)
- Black Rail
  - Napa River (Fagan Slough & Chabot Crk)
  - Petaluma River marshes.

Suisun Bay
- Clapper Rail
  - Hill Slough
  - Cutoff Slough
  - 1st & 2nd Mallard Slough
  - Point Edith Marshes
- Black Rail
  - Concord Naval Weapons Station
  - Rush Ranch (Cutoff Slough) marshes
  - upper Hill Slough

Clapper rails are confined to tidally influenced brackish and saline tidal marshes. Very small populations occur on the outer coast at Morro Bay, Elkhorn slough (formerly?), and Tomales Bay (sporadically). Large marsh parcels (>100 ha) with well-developed channel networks and low marsh foreshores (and associated *Spartina* beds) are preferred. High tide refugia, especially dense transitional vegetation on the backshore, may be crucial to survival.

Black rails in the Estuary occur almost exclusively in marshlands with unrestricted tidal influence. They tend to associate with mature, high elevation, marshes dominated by *Salicornia* and *Scirpus*. Fully vegetated seasonal wetlands with muted tidal influence may be utilized in years of high rainfall if they are adjacent to fully tidal marshes. Peripheral vegetation at and above mean higher high water provides necessary refugia during flood events (Evens et al. 1991, Trulio & Evens 2000). Fully vegetated freshwater ponds and marshes may also be occupied if the soil is continually soggy and water levels are shallow (<3 cm) and relatively stable.

Seasonality

Clapper rail nests with eggs have been found March 25-August 1 (DeGroot 1927, Harvey 1980, Evens and Page 1983), providing evidence that nest occupancy may begin in early March and extend into mid-August. To accommodate this protracted breeding season, USFWS has defined the nesting season as January 15-September 1.

Black rail nests have been found from late March through May (Evens and Page 1983, Spautz et al. 2000). Incubation is estimated at ~17-20 days and second or replacement clutches are possible, therefore the breeding season spans March to mid-June.

Both species seem to experience a post-breeding (fall) dispersal pattern. Extra-limital records of Clapper Rails indicate movement of juveniles August-November. Black Rails seem to disperse to the South Bay in autumn, with many winter records and few spring records. It is likely that dispersal of both species is density dependent, with juveniles leaving breeding grounds when population levels are high. Clapper rails are most vocal in the winter months (December-February), therefore requiring aural censuses during that period. High tide counts are also conducted during winter months.

General Description of Aural and Visual Surveys

Aural Surveys

Because of their secretive natures, both species are surveyed aurally during the breeding season. For California Clapper Rail, methods are prescribed by USFWS protocols, which favor the use of listening stations to detect passive (spontaneous) vocalizations. Taped playback may also be used if conditions dictate, however a permit is required for this activity. Black rail surveys rely heavily on responses to taped playback of vocalizations, i.e. elicited responses.

Visual Surveys

Clapper Rails are counted from airboats on winter high tides when they are flushed out of marsh habitat. Black rails have been surveyed visually on high tides as well, however their cryptic nature makes absolute counts difficult, or impossible.

Equipment

- Binoculars
- global positioning system (GPS)
- Tape recorder (portable cassette deck)
- Taped vocalizations (as specified below).
- Waders or appropriate footwear
- Area map and directions to site
- Site map, description, and survey locations and coordinates
- Species-specific survey forms
- Area boundaries
- Permits, permission, contacts

General Requirements

- 1-10 observers, trained in recognition of rail vocalizations, estimation of distances,
- Study sites should cover discrete marsh parcels (after Dedrick 1989) and rely on previous study sites
- Boundaries should follow natural drainages, visible barriers and edges, and wetland edges, visible on 7.5' topographic maps.
- Size of each study site will be variable, but because marsh size is correlated with rail density (Nur et al. 1997), a variety of size classes should be sampled.
- Tidal regime, time of day, and date should be standardized for consistency.
- Recorded data for each survey should include: date, start time, end time, estimated tide, sub region, location, observers, weather (temp, wind, wind direction, sky cover, precipitation).
- Surveys should not be conducted in high winds (> 10 kph) or heavy rainfall.
- For each survey, observers should record other species present including sign of potential predators (raccoon tracks, raptors pellets, etc. Other information includes number and types of disturbances, background noise, and behavior (especially feeding activity).

Clapper Rails Survey Details

?? Because of the status of Clapper Rail under the endangered species act, observers participating in clapper rail surveys must be permitted by the USFWS. Clapper rail protocols are available through USFWS, Office of Endangered Species, Sacramento, CA. The following methods should be employed only when they do not conflict with USFWS protocols.

?? Surveys should be conducted between January 15 and March 15, although coverage may extend into mid-April.

?? A series of listening stations should be distributed randomly throughout or around each study site. Each station is a circular plot with a census radius of 100m, thus covering an area of about 3.14 ha. (Rails detected outside the circular plot are recorded but not included in density calculations.) Stations are located approximately 200 m apart.

?? The number of stations established at each site varies with site size and accessibility.

?? Censuses are conducted on low or moderate tides (=3.0' above MLLW) within 2 hours of dawn or dusk. Approximately half of the censuses are conducted at dawn and half at dusk. These methods are designed because clapper rails have been reported to vocalize more frequently on lower tides (Zembal and Massey 1981).

?? Each station is surveyed for a total of six minutes.

?? After arriving at a station, an observer stands in silence at one spot for five minutes. Thereafter, if no spontaneous Clapper Rail calls are detected, the observer plays a tape of "clatter" calls for one minute at full volume on a hand held a cassette deck (Sony TCM etc.) to elicit vocalizations.

?? At each station, total number of rail vocalizations, type of vocalization, direction and distance from the observer are recorded and the location plotted on a field map.

?? At the end of the census, a minimum and maximum number of rails detected at each station and within each marsh parcel is estimated based on distribution of the plotted calls. (Duetting clatter calls may mask one another. If the observer is uncertain of the number of birds calling, he/she should estimate the number of detections, e.g. "2 - 4 birds"; the minima and maxima are based simply on the sum of the range of estimates for the census), Each observer also notes other species of birds and evidence of potential predators.

Estimating Clapper Rail Densities

The behavior of Clapper Rails confounds estimation of population size and, except in the smallest and most discrete marshland parcels, precludes absolute counts. The methods described above are standardized means to detect rails during the breeding season and derive an estimate of density based on detection rates. The results derived from the methods provide indices of abundance among stations and between marshes and, perhaps, a measure of annual variation in population size. Certainly the densities calculated for each marsh parcel are minima.

The densities calculated for each census are actually indices of detection rates for each census. To estimate population sizes for each geographic area, the following assumptions are used.

- ?? A "clatter" call emanating from a given area of marsh represents a single pair, whether the clatter is given by a single bird or two birds calling in synchrony. (The significance of single clatters is equivocal. The assumption that each represents a pair may result in an over estimate, whereas the assumption that each "clatter" represents UN unmated male would result in an under estimate. About 50% of the detections are single clatters. For the purposes of deriving a population estimate, we assume that each detection represents 1.5 pair of rails and we restrict the estimate to the effective habitat, thus providing a rationale for a minimum population estimate).
- ?? A "kek" call (or any of its variations) represents a single bird, but that bird is assumed to be part of a pair.
- ?? a "kek-burr" call represents a female, but that too is assumed a member of a pair.
- ?? To estimate population size for a particular marsh, therefore, multiply highest density estimate for a given year by marsh size. The more frequently the parcel is sampled, the more accurate the estimate.

Additional Clapper Rail surveys

Winter high tide surveys have been used to provide population estimates of rails in sub regions of SFB (Harvey 1980). Repetition of these earlier surveys could provide valuable information on presence/absence or population sizes in discrete areas.

Black Rail Survey Details

?? Listening stations (aural sampling stations) are located along transects randomly located across elevational changes within each marsh site, and are distributed throughout the length and breadth of the high marsh (i.e., above Mean High Water).

?? Census stations are distributed at 100 meter intervals through each marsh parcel and, where possible, each station is located a minimum of 50 m from upland habitat. When stations are located on the marsh backshore (for example on a levee), the area of the listening station is calculated as one-half the size of a circular plot.

?? Each listening station should be occupied for six minutes.

?? All censuses should be conducted within 2 hours of sunrise or 2 hours before dark.

?? Census efforts should be canceled when wind exceeds approximately 25 km/hr or when the observer determines that background noise is interfering with his/her ability to detect rail vocalizations.

?? After arriving at a listening station, the observer waits silently for one minute then broadcasts a tape recording of California Black Rail vocalizations at moderate volume in each ordinal direction for a total of 1.5 minutes. The tape recording consists of a repetitive series of "grr" calls followed by 0.5 min of "kik-ki-kerr" calls (Repking and Ohmart 1977). Maximum sound pressure 1 m from the source should not exceed 90 dB.

?? For each rail response heard within 5 minutes of initiating the broadcast, the observer should record the time, call type, and estimated distance and direction of the response from the observer (from the center of the station).

?? An effective 30 m census radius is used, because field-testing has found that the observer's ability to estimate distance accurately, or hear low range vocalizations consistently, decline precipitously beyond that distance (Evens and Page 1985). (This is particularly true of “grr” calls; “kik-ki-kerr” calls can be detected at greater distances).

?? All calls coming from one compass direction during the six minute listening period are considered to represent only one rail unless two calls are heard simultaneously. Calls from different (>30°) compass directions are considered to represent different rails, however some discretion by the observer is required to distinguish between different birds. In an earlier study it was estimated that Black Rails move toward the source of a broadcast tape an average

of 6.2 m (Evens and Page 1985). [Subsequent studies have increased that estimate to 7.2 m (Legar et al. 1999), however those study involved a different race (*jamaicensis*) in a different habitat.] Therefore, although we counted birds only within 30 m of the observer, we calculated densities using sampling stations with a radius of 36.2 m, covering an area of .4115 ha.

?? Given the vagaries of movement, it is advisable to calculate densities using a variety of radii, perhaps in 5 m increments from 30 m to 50 m. The values derived from the average number of detections in each marsh parcel are used to calculate density indices for each region and extrapolate abundance estimates (see Nur et al. 1997). Because the California Black Rail is a threatened taxon (USFWS 1991), and because these estimates rely on extrapolated data, these calculated values should be considered density indices rather than absolute densities.

Additional Black Rail Surveys

The survey protocol described above is useful for monitoring rails during the breeding season. Other surveys would include:

1) Winter season studies of home range size (via telemetry).
2) Surveys of adjacent or satellite habitats to determine inter-annual occupancy.
3) Winter high tides predation surveys on to determine habitat values (see Evens & Page 1986).
4)

Surveys to examine success of restoration projects should include more frequent surveys (seasonal or monthly) and if possible, multiple comparison sites.

Units of Data (applicable to both species)

Counts will be summarized as detections per station and/or detections/ha,. and/or presence/absence.

Numbers of birds detected can be converted to densities (numbers per hectare) or abundance indices (detections per hectare) for comparison among sites.

Quality Control and Data Management (applicable to both species)

?? Ground observers should be trained and field-tested in identification and ability to estimate the distance of sound.

?? Data will be recorded on forms and entered into spreadsheet files such as Excel.

?? Data will be proofed by the observer and checked for accuracy by a different reviewer such as the project leader.

Data Analysis (applicable to both species)

?? Data to be analyzed by sub region, site size and location, call type, and season or date.

?? Data to be recorded on forms and entered into spreadsheet files such as Excel.

?? Analyses may be converted to densities or detection indices to compare areas.

?? A coefficient of (detection) variation should be derived from these surveys.

?? Abundance rankings can be assigned to each site based on the density index calculated from the 36.2 m radius circular plot as follows: <0.6 rail/ha (low); 0.6-2.1 rails/ha (moderate); >2.1 rails/ha (high). This scale conforms to earlier analyses (Evens et al. 1989).

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Data Collection Protocol
Shorebirds

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Introduction

San Francisco Bay is ranked by the Western Hemisphere Shorebird Reserve Network as a site of hemispheric importance for migrating and wintering shorebirds, and it holds more shorebirds than any other wetland on the conterminous U. S. Pacific coast in fall, winter and spring (Page et. al. 1999). An estimated 340,000 to 396,000 shorebirds are found in the Bay in fall, 325,000 to 358,000 in early winter, and 589,000 to 932,000 in spring (Stenzel et al. *in press*). Currently there is considerable interest in restoring large acreages of diked wetlands to tidal marsh and tidal flats to simulate historic conditions in the Bay. Shorebirds make heavy use of tidal flats and diked wetlands in San Francisco Bay. Since it is an important area for migrating and wintering shorebirds and shorebirds are numerically abundant relative to most other bird assemblages within the Bay, it is valuable to implement an ambient monitoring program for shorebirds in the San Francisco Bay estuary.

An ambient monitoring program for shorebirds would have the following goals.

?? Provide data on key species to determine shorebird population trends in the Bay.

?? Integrate shorebird monitoring in the Bay with the Western Shorebird Survey to enable comparison of trends within the Bay with other sites in western North America.

?? Provide information on shorebird abundance and population trends for federal, state and private wetland habitat managers.

?? Provide up to date information to the public on shorebird use of the Bay.

Required Permits

?? Permits required by U. S. Fish and Wildlife Service to conduct surveys in the Don Edwards San Francisco Bay National Wildlife Refuge.
?? Permits required by the endangered species office of the U. S. Fish and Wildlife Service to survey Snowy Plovers anywhere in the Bay during their March through September nesting season.
?? Permits require by the California Department of Fish and Game to conduct surveys in their Ecological Reserves.
?? Permits require by Cargill to conduct surveys on their properties.

Survey Procedures

Sample Universe and Sample Strata

The sample universe is the baylands including tidal flats, tidal marshes, and dked baylands in the San Francisco Estuary west of the Delta. There is some shorebird use of tidal flat areas in Suisun Bay but numbers are a very small fraction of those found in the rest of the Bay (PRBO unpubl. data). Most of the tidal flat is also fairly inaccessible. Therefore, it is not proposed to undertake land–based shorebird surveys on tidal flats in Suisun Bay. The tidal flats of Suisun Bay would be included in aerial surveys.

Most shorebirds in San Francisco Bay forage on the tidal flats when they are exposed during low to moderately high tides although some species such as Black-necked Stilt, Wilson's Phalarope and Red-necked Phalarope prefer salt ponds and other diked wetlands regardless of tide. Tidal salt marshes are used to a limited extend especially when they contain channels or ponds. For the ambient monitoring program we will focus the surveys on tidal flats since the majority of species prefer them to other habitats.

Species to Survey

For the Goals Project the bird focus team settled on seven shorebird species characteristic of one or more of the wetland habitats within the Bay. These are Snowy Plover, Marbled Godwit, Black Turnstone, Red Knot, Western Sandpiper, Long-billed Dowitcher, and Wilson's Phalarope.

Species that are most abundant in the Bay, are identified in Stenzel et al. (*in press*). They are Black-bellied Plover, Snowy Plover, Semipalmated Plover, Killdeer, Black-necked Stilt, American Avocet, Greater Yellowlegs, Willet, Whimbrel, Long-billed Curlew, Marbled Godwit, Ruddy Turnstone, Black Turnstone, Red Knot,

Sanderling, Western Sandpiper, Least Sandpiper, Dunlin, dowitchers, Wilson's Phalarope and Red-necked Phalarope. We recommend surveying as many of these species as possible.

Seasonality

Breeding Season: especially May and June -- times when Snowy Plover, Killdeer, Black-necked Stilt and American Avocets are actively breeding in the Bay. We recommend annual breeding season surveys for these species but do provide the methodology for these surveys in this protocol.

Migration Seasons: Shorebirds should be monitored during the fall migratory period --July to early November and during the spring migratory period – March to early May.

Winter Season: Shorebirds should be monitored during the winter season -- mid November until late February.

Survey Types and Methods

Ground Surveys

Volunteers, trained to identify and count shorebirds, would be recruited to conduct ground surveys at pre-selected tidal flat locations during fall, winter and spring. Survey frequency would be once per month during fall (July through October, once per month during winter (November, December, and January), and twice in spring (third week of April and first week of May). Survey dates and starting times would be predetermined so that as many sites as possible would be surveyed simultaneously.

Volunteers conduct these surveys as follows.

- ?? Survey done on moderately high rising tides (start at 0.3 m MLLW at Golden Gate Bridge).
- ?? Survey areas sized so that they can be covered in 1-2 hours by team of 1-6 people.
- ?? Survey teams use binoculars and have at least one 20x spotting scope.
- ?? Surveyors must be experienced in identifying and counting shorebirds.
- ?? There should be a written ground survey protocol for each site.

Ground Survey Equipment

- Map of site.
- Site description.
- Area Boundaries.
- Shoreline Type/Upland Habitat.
- Estimated Census time/Number of People required.
- Access Point Descriptions.
- How to Cover Area.
- Census Area Hazards.

Aerial Surveys

Aerial surveys of all tidal flat in Suisun Bay and inaccessible tidal flat in North Bay should be conducted by professional biologists. In North Bay only the area from the Mare Island jetty to China Camp would be covered -- once during spring (about 25 April) and once during early winter (around 30 November). These flights are included to obtain some information from tidal flat areas that are very inaccessible for ground counts.

- Two experienced observers plus pilot (one observer on each side of the plane).
- Observers have experience counting shorebirds from aircraft.
- Fly at 200 ft. and at about 75 mph.
- Count on moderately high rising tides (start at 0.3 m mllw at Golden Gate Bridge).
- Will require three passes of tidal flats; first pass to count large shorebirds; 2nd to count Black-bellied Plovers, and 3rd to count dowitchers and peeps
- For large shorebirds fly over water and look back towards the land; for BBPL and peeps fly over mudflat by water line and count.
- Early morning is probably preferable if the tides are suitable given the light conditions and the wind.

Airboat Surveys

Airboat surveys of tidal flat south of the Dumbarton Bridge would be conducted by professional biologists once annually during spring (about 25 April) and once annually

during early winter (around 30 November). They are included to cover key tidal flat areas that are unlikely to become accessible for ground counts after salt pond conversion to tidal marsh.

?? Method has to be developed; two possible alternatives.

a) Do the survey like an aerial one counting bird number while traveling. May return to some areas later to sample for species composition or

b) Select a set of points (either randomly or in some pattern) and go out and survey those points (will need to figure out a way to define a given area that will be sampled using possible a GPS unit and a range finder?)

?? Use 2 observers and one pilot for either method.

?? Survey using scopes set up in boat.

Units of Data

The units of the data are number of shorebirds by species counted in the predefined survey areas. Numbers may be converted to densities for some purposes.

Quality Control and Data Management

?? Courses will be given to volunteers for species identification and estimating shorebird numbers using workshops such as those used for PRBO's Pacific Flyway Project.

?? Data will be entered on to standard census forms. Data forms would be styled after PRBO's Pacific Flyway Project and include all the information require for the Western Shorebird Survey (WSS).

?? A web site will be developed where data forms can be submitted electronically.

?? Data will be proofed by the counter and then reviewed for accuracy by someone with an appropriate level of experience (i.e. the project leader).

?? Data will be stored at a designated site.

?? Copies of data will be submitted electronically to the WSS web site.

Data Analysis

?? Data would be organized by site, taxa and season.

?? Regression analysis would be applied to these data as described in Howe et al. (1989).

Additional Surveys

The survey protocol described above is useful for monitoring the majority of shorebird species that use the Bay because it focuses on tidal flat, the most important habitat for the majority of species using the Bay. For those species relying heavily on diked wetlands, especially salt ponds, other surveys would be necessary to monitor status. These could include:

5) Breeding season (mid May to mid June) surveys of American Avocets and Black-necked Stilts in North and South Bay diked wetlands and marshes.

6) November high-tide surveys of the same habitat for American Avocets, Black-necked Stilts and Greater Yellowlegs.

7) July survey of same habitat for fall migrating Wilson's Phalaropes.

8) August survey of the same habitats for fall migrating Red-necked Phalaropes.

9) Breeding season surveys of salt ponds from last week of May to first week in June for Snowy Plovers. This survey would focus primarily on the South Bay -- from the former Oliver Brother's salt ponds just north of San Mateo Bridge on the east side of the Bay around the South Bay to San Mateo Bridge on west side of the Bay.

Comparing trends in species numbers in San Francisco Bay with trends in shorebird numbers at other western North American sites will be facilitated by participating in the Western Shorebird Survey, organized by USGS-BRD. This will help determine if trends observed in San Francisco Bay are part of region-wide trends or are unique to the Bay.

Within San Francisco Bay other information that would assist in the interpretation of changes in shorebird numbers would be:

?? Changes in the acreage of available habitat, especially tidal flat, salt ponds, and other diked wetlands.

?? Changes in the benthic invertebrate communities of the tidal flats.

?? Spread of *Spartina alternaflora* on to the tidal flats.

?? Changes in predator abundance, especially Peregrine Falcons, Merlins, American Crows and Common Ravens.

?? Changes in levels of contaminants likely to affect adult survival or breeding success.

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CENSUS FORM: SHOREBIRDS & ASSOCIATES – SAN FRANCISCO BAY

LOCATION_____ COUNTY_____ DATE

Census Team Members (First and Last Names)_____

Area			Area			Area		
Start Time								
End Time								
Black-bellied Plover			Western Sandpiper			American Bittern		
Lsr. Golden-Plover			Least Sandpiper			Great Blue Heron		
Snowy Plover			Least/Western sandp.			Great Egret		
			(*) Ratio					
Semipalmated Plover			Least/West/Dunlin			Snowy Egret		
			(*) Ratio					
Killdeer			Baird's Sandpiper			Cattle Egret		
Black-necked Stilt			Pectoral Sandpiper			Green-backed Heron		
American Avocet			Dunlin			Blck-cr. Night Heron		

CENSUS FORM (Cont'd):

Greater Yellowlegs			Short-bill. Dowitcher			Clapper Rail		
Lesser Yellowlegs			Long-bill. Dowitcher			White Pelican		
yellowlegs spp.			dowitcher spp.			White-faced Ibis		
Willet			Common Snipe					
Wandering Tattler			Wilson's Phalarope			Osprey		
Spotted Sandpiper			Red-necked Phalarope			Black-should. Kite		
Whimbrel			Red Phalarope **(u)**			Northern Harrier		
Long-billed Curlew			phalarope spp.			Red-tailed Hawk		
Marbled Godwit			Other species **(u)**			American Kestrel		
Black Turnstone						Merlin		
Ruddy Turnstone						Peregrine Falcon		
Red Knot						Prairie Falcon **(u)**		
Sanderling						Black Skimmer		

(u) indicates species we suspect will be very uncommon or local.

Dowitchers: We suggest that censusers count all dowitchers as **dowitcher spp.** If dowitchers are identified to species we would like some information on how the determination was made.*

Mixed Species Groups: Indicate the possible species and number. For example, if you saw a mixed flock of 155 Willet and Marbled Godwit, you would write *Willet/Marbled Godwit - 155*. **Whenever possible, indicate proportions of mixed species groups.**

(*) Use these spaces only to record numbers of sandpipers that you are unable to separate into Leasts, Westerns, or Dunlin. Count the species together and record the total number. **If possible, list the ratio of the unseparated species.**

Data Collection Protocol
Waterfowl

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Introduction

The San Francisco Bay estuary supports a large number of migrating and wintering waterfowl including more than 50% of some diving duck populations in the Pacific Flyway. As many as 700,000 waterfowl are counted in the Bay and Delta during the aerial midwinter waterfowl survey, with 300,000 in the open bays and salt ponds of the South, Central, North, and Suisun Bay sub regions (Accurso 1992). The only long-term monitoring of waterfowl in the estuary on a regional scale has been the annual January midwinter aerial survey that has been conducted since 1955. However, survey coverage and methods varied prior to establishment of a fixed route beginning in 1987 (Accurso 1992). These surveys included the open bays and salt ponds with limited coverage of the bayland wetlands except for some separate surveys in the Suisun Marsh.

The most abundant waterfowl species in the estuary are ducks, although geese (excluding urban Canada Geese) and swans were historically found in several areas but are now primarily limited to the Delta and Suisun Marsh. Ducks are typically divided into dabblers – which dip their head below the surface of the water to feed on benthos or other organisms, and divers -- which swim below the water surface to feed on the benthos or prey in the water column. San Francisco Bay is known for its diving ducks, while Suisun Marsh has large numbers of dabbling ducks.

An ambient monitoring program for waterfowl would have the following goals.

- Determine population trends of key waterfowl species in different sub regions of the Bay.
- Integrate the Bay monitoring program with the USFWS midwinter waterfowl survey of the Bay as well as other regions including the Pacific Coast and Central Valley.
- Present updated information on the importance of estuary habitats for waterfowl.

Required Permits

?? Special use permits required by USFWS for refuges.

?? Permits required for areas managed by the California Department of Fish and Game.

?? Permits for ground surveys of Cargill salt ponds.

Species to Survey

All species of waterfowl should be counted. Six representative species identified in the Goals Report (1999) included Mallard (*Anas platyrhynchos*), Northern Pintail (*Anas acuta*), Canvasback (*Aythya valisneria*), Surf Scoter (*Melanitta perspicillata*), Ruddy Duck (*Oxyura jamaicensis*), and Tule Greater White-fronted Goose (*Anser albifrons gambeli*). These species may be useful as indicators for developing more detailed surveys, for determining general habitat preferences for waterfowl groups, or for examining trends through time. Emphasis could also be focused Greater Scaup (*Aythya marila*) and Lesser Scaup (*Aythya affinis*) as these species are declining in abundance in western North America.

Sample Universe and Sample Strata

The sample universe consists of the San Francisco Bay and Delta, including the sub regions, Fat South Bay, South Bay, Central Bay, North Bay, Suisun Bay, and Delta.

Most diving ducks are concentrated in open bay and salt pond areas of the estuary (Accurso 1992). However, dabbling ducks, geese, and swans are typically found in bayland wetlands. Northern Shovelers are abundant in salt ponds. Tidal salt marshes are used by waterfowl to a limited extend, primarily in channels or ponds. Some species, such as Mallards and Northern Pintails, breed in upland or marsh plain habitats, especially in Suisun Marsh, but breeding surveys are not included in this protocol. The focus of surveys for ambient monitoring should include open water areas and fresh-to-brackish bayland wetlands, and generally exclude marsh plains. Different areas should be equally represented in each subregion. For example, half of the surveys should be conducted in the open bay waters and half bayland areas.

Seasonality

Breeding Season: March through June – dabbling ducks such as Northern Pintails, Mallards, and Gadwall (*Anas strepera*) breed in the estuary. Suisun Marsh has been surveyed to examine waterfowl production and other sub-regions could be surveyed during the spring to examine productivity and trends. Survey techniques for breeding waterfowl are not included in this protocol.

Migration Season: Waterfowl should be monitored during fall and the spring migration periods, September through November, and February through May. Both migrating and wintering populations are found in the estuary at the same time. To monitor populations migrating through the estuary, surveys may be timed to catch peaks above background wintering numbers. Birds will need to be marked to separate them from the wintering populations and to determine their arrival and departure times.

Winter Season: Waterfowl should be surveyed during the winter season – December through January.

Survey Procedures

Ground Surveys

Surveys may be conducted in conjunction with other waterbird counts. Survey frequency would be once per month during the migration and winter (Oct-Apr). Areas should include at least 5-10 major sites in each subregion (see below) to establish trends.

- 1-2 observers, trained in species identification and number estimation, should count birds in each area with binoculars and spotting scopes.
- Several observation points should be established at each site to provide views of the entire surveyed area. The total visible survey area should be outlined on site maps. Boundaries should follow natural breaks, visible barriers, and wetland edges. In open bay expanses, birds may be located within 1x1 km UTM grid squares overlays on 7.5' topographic maps.
- Size of each site will be variable, but samples of more areas would be preferred to counts of a single large area. Since some waterfowl species may respond to area size, larger areas should be sub-sampled.
- Surveys may be standardized to a few hours surrounding high tides (> 1.3 m at the Gold Gate Bridge) for consistency, but waterfowl may be surveyed at other times since unlike many shorebirds, they are not found feeding primarily on mud flats exposed at low tide. Since waterfowl are typically more active at dawn or dusk, surveys during those periods increase variation and should be avoided. Surveys should not be conducted in high winds (> 30 kph), heavy fog, or heavy rainfall.
- Recorded data for each survey should include: date, start time, end time, estimated tide, sub-region, location, observers, weather (temperature, wind speed and direction, sky cover, precipitation).

Also note number and types of disturbances. For each observation, observers record species, group such as diver or dabbler, or unknown; sex; and number. Behavioral information is optional.

Ground Surveys Equipment

- Binoculars
- spotting scope and tripod or window mount
- Global Positioning System (GPS)t
- Area map and directions to site
- Site map, description, and survey locations and coordinates
- Area boundaries
- Permits, permission and contacts

Aerial Surveys

Biologists experienced in conducting aerial surveys should conduct aerial surveys of the open bays and salt ponds should during the fall (October) and spring (March) to complement the annual midwinter survey (January).

- Flights are scheduled with twin engine (open water) or single engine high-winged aircraft for ≤6 h survey time (≤8 h per day including ferry time).
- Crew should consist of observer and pilot for small bayland wetlands, but 2 observers (for each side of the plane) and a pilot with navigator as needed (salt ponds, open water). Repeated use of the same observers and pilots with experience and training is preferred.
- Fly at 90 m elevation at 100 knots counting along transects (±500 m wide, requires practice or calibration area for consistency, possibly marking the window for the proper horizon line at survey altitude) on open bay or large wetland areas, to unit boundaries on medium-sized wetlands (>4 ha), or passing nearby or over small wetlands (< 4 ha). Transect endpoints or small wetland locations should be programmed in a GPS unit.
- Maps are crucial for flight safety and accuracy in low-level survey. Maps should include clearly marked hazards (power lines, obstacles), flight lines, and unit identification.

?? Observers should identify the date, time, and observer on each tape. Recording proceeds as birds are encountered and summarized by the observer, including time when encountering new wetlands or transect endpoints. If estimated position is desired in open water surveys, data must be recorded real-time with time of transect endpoints recorded and frequent changes of tapes (alternatively, a handheld portable digital audio tape recorder may be used that stores the time of an observation).

Equipment for Aerial Surveys

✍✍Flight safety gear

✍✍Pause- or voice-activated handheld tape recorder and tapes

✍✍Global Positioning System in plane.

✍✍Area maps with hazards, transects, and unit names (We prefer custom maps or annotated aviation maps).

✍✍Table of endpoint coordinates for GPS, entered prior to flight.

✍✍Low-level flights require special flight plans, requirements, and training depending on the organization.

Units of Data

Counts will be summarized as numbers per site or transect to examine trends. Numbers may be converted to densities (numbers per hectare) for comparison among sites.

Quality Control and Data Management

?? Ground observers should be trained and field tested in identification and counting. Counting is as much an art as a science, and undercounting is typical. Incorrect identification may be a larger problem in aerial counts, and aerial observers typically require more training.

?? Data will be recorded on forms and entered into spreadsheet files such as Excel.

?? Data will be proofed by the observer and checked for accuracy by a different reviewer such as the project leader.

Data Analysis

- Data will be analyzed by subregion, site, species, sex, and season or date.
- Analyses may be converted to densities to compare areas.

Additional Surveys

The survey protocol described is useful for monitoring waterfowl during the winter. Other surveys would include:

- Breeding season (Mar-Jun) duck surveys of uplands and tidal marsh plains.
- Riparian surveys for species such as mergansers and Wood Ducks (*Aix sponsa*).
- Park, golf course, and upland surveys for the urban Canada Goose (*Branta Canadensis*).
- Marking and re-sighting surveys of species such as Greater White-fronted Goose to separate wintering and migrating populations (*see* Ely and Takekawa 1996).
- Surveys to examine success of restoration projects should include more frequent surveys (seasonal or monthly) and if possible, multiple comparison sites.

Annual midwinter surveys may be compared with those in California, especially the outer coast and Central Valley, and from surveys throughout North America summarized by the U. S. Fish and Wildlife Service, Division of Migratory Bird Management. Trends also may be compared with Audubon Christmas Bird Counts or Breeding Bird Counts.

Other information that would be useful in tracking and interpreting trends of waterfowl populations would include:

- Changes in the acreage of available habitat, especially tidal flat, salt ponds, and other diked wetlands
- Changes in the benthic invertebrate communities of the tidal flats and subtidal shoals
- Changes in levels of contaminants in invertebrate prey
- Hunting regulations and harvest rates
- Weather data
- Waterfowl May pond and breeding survey results

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