Bird Monitoring for the South Bay Salt Pond Restoration Project

Data Summary Report

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Bird Monitoring for the South Bay Salt Pond Restoration Project

Preliminary Results. Do Not Cite Without Permission*

EXECUTIVE SUMMARY

- This report summarizes bird monitoring data collected at South Bay Salt Pond Restoration Project ponds of the Alviso, Eden Landing, and Ravenswood complexes. Data presented here were collected subsequent to the original 2-year monitoring program (Takekawa et al. 2005) from Jul 2005 to Aug 2006. It also includes mud flat monitoring data collected during the winter of 2005 and 2006.

- The Alviso complex supported the greatest number of birds followed by Eden Landing and Ravenswood. Foraging guilds used the three complexes in different ways: gulls, ducks, and piscivores comprised more of the community in Alviso, whereas shorebirds and phalaropes were more abundant at Eden Landing and Ravenswood.

- The Alviso island ponds (A19–A21) were breached in Mar 2006. Prior to breaching, gulls dominated the avifauna and roosted on the island ponds as well as ponds 22-23. We conducted monthly counts during high tides, but after the island ponds were breached, we added same-day low tide surveys to capture bird response to changing water levels. We found that during low tide surveys, gulls decreased and small shorebirds increased compared to numbers on high tide surveys. Also, we found similar avian guild composition to pre-breach high tide surveys.

- We conducted simultaneous paired surveys on mud flats and salt ponds during ebb tides. At Eden Landing and Ravenswood sites where high mud flat elevations led to early exposure, we found that most shorebirds left salt pond sites and arrived at mud flat sites during the first hour of ebb tide. Lower mud flat elevations at Alviso led to later availability of mud flats. Fewer shorebirds were present in salt ponds. Observed variability in bird responses to tide stage could reflect effects of initial flock size, species composition, or pond habitat conditions.

- Shorebird abundance during ebb tides at mud flat sites generally remained constant once the maximum number was reached shortly after the initial mud flat exposure. Bird numbers remained constant but densities declined because receding tidelines exposed more mud flat areas. Most shorebird species were observed foraging near the waterline. Thus, extent of their foraging habitats may be better estimated from the length of the waterline and rate of exposure rather than by the total exposed mud flat.

- Shorebird numbers were more variable during flood than ebb tides on mud flats. Although the response varied by species, density and abundance of many shorebirds declined over the course of the flood tide.

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INTRODUCTION

The South Bay Salt Pond Restoration Project (SBSPRP) marked the beginning of a restoration effort unprecedented on the west coast. Commercial salt ponds have been an integral part of the San Francisco Bay (SFB) landscape since 1856 (Josselyn 1983), but over six thousand hectares of former Cargill salt evaporation ponds were transferred to the U. S. Fish and Wildlife Service (FWS) and the California Department of Fish and Game (DFG) in 2003. Restoration of former salt ponds to tidal marsh is intended to reverse a severe decline in tidal salt marsh habitat (Goals Project 1999), benefiting threatened and endangered tidal marsh species such as the California clapper rail (*Rallus longirostris obsoletus*), salt marsh harvest mouse (*Reithrodontomys raviventris*), and steelhead (*Oncorhynchus mykiss*). However, salt ponds are also important for many migratory birds and listed species such as the snowy plover (*Charadrius alexandinus*), which nests on salt pond levees.

Until recently, few management strategies existed for converting ponds to tidal wetlands, or for maintaining salt ponds at the depths and salinities needed by targeted bird species when ponds are no longer in salt production. Managers would like to maximize habitat features of managed ponds after restoration to support past numbers of migratory and wintering birds. However, avian pond selection criteria are not fully understood, and seemingly similar ponds often show high variation in bird use.

Mud flat and shoal habitats are a critical foraging resource for migrating and wintering waterbirds, but their habitat value may change as restoration activities in the South Bay alter the balance of sediments. The salt pond beds are now lower than the adjacent baylands because of groundwater pumping and subsidence. As a result, a large amount of sediment will be required for restoration of salt ponds to tidal marsh elevations (Siegel and Bachand 2002). Natural redistribution of sediments in the South Bay is a likely mechanism for restoration and may result in erosion of South Bay mud flats. Mud flats are further threatened by invasive *Spartina alterniflora* and its hybrids with native *Spartina*, which may colonize open mud flats and vegetate farther onto the intertidal shoals, thereby decreasing available habitat for waterbirds (Stralberg et al. 2004).

More information will be needed to successfully manage pond and tidal habitats that will support the historic bird numbers that make San Francisco Bay an important migratory stopover site on the Pacific Flyway and a Western Hemispheric Shorebird Reserve Network area of hemispheric importance. We have conducted biophysical monitoring at the salt ponds since 2002, which has provided significant baseline data for project planning (Warnock et al. 2002, Miles et al. 2004, Takekawa et al. 2005, Athearn and Takekawa 2006). The 2004 implementation of the Initial Stewardship Plan (ISP; Life Science 2003), including breaching levees of Alviso island ponds A19-A21 in Mar 2006, has already altered pond water quality and circulation patterns. During 2005 and 2006, we conducted waterbird monitoring at salt ponds and adjacent mud flats to track changes in bird use following ISP modifications as well as to provide managers with continued baseline data that can be used to evaluate the effects of future habitat alteration.

OBJECTIVES

1. Conduct monthly waterbird and water quality monitoring at SBSPRP ponds.

2. Document shorebirds on tidal mud flats adjacent to SBSPRP ponds.

We conducted waterbird monitoring at salt ponds and mud flats to provide information about baseline conditions for the restoration project and to examine factors that influence how waterbirds use salt ponds and adjacent habitats within South San Francisco Bay (Figure 1). Our goals were to show the relationship between shorebird use of mud flats and salt ponds through synchronized surveys, and to document and compare shorebird densities on these habitats at varying stages of the tide.

METHODS

Objective 1. Conduct monthly waterbird and water quality monitoring at SBSPRP ponds.

Avian Diversity and Abundance

We counted waterbirds at all 53 South Bay Salt Pond Restoration Project (SBSPRP) ponds in the Alviso, Eden Landing, and Ravenswood salt pond complexes (Figure 1). We followed a bimonthly schedule from Jul-Dec 2005 excluding Sep05 and Nov05. However, we counted island ponds A19-A21 during Nov 2005 to ensure baseline avian use data prior to the planned Mar 2006 breach, and we counted all ponds monthly from Dec 2005 through Aug 2006. We conducted surveys within 3 hours of high tide when bird numbers in ponds were at their peak. We identified birds to species with the exception of some similar species that cannot be readily distinguished in the field (for example, we usually recorded long-billed and short-billed dowitchers together as "dowitchers," and greater and lesser scaup together as "scaup"). After counting the birds, we assigned them to 250 m × 250 m grid cells to document spatial distribution within ponds and associate their use to water depth. To increase our understanding of how birds use ponds, we documented whether they were foraging, not foraging (but on the pond), or roosting on a levee, island, or man-made structure such as a duck blind.

To facilitate analysis of bird species with similar habitat requirements, we assigned species to foraging guilds. These included: 1) dabbling ducks (*e.g.* northern shovelers *Anas clypeata*); 2) diving ducks (*e.g.* ruddy ducks *Oxyura jaimaicensis*); 3) eared grebes (*e.g. Podiceps nigricollis*); 4) piscivores (*e.g.* double-crested cormorants *Phalacrocorax auritis*); 5) gulls (*e.g.* ring-billed gulls *Larus delawarensis*); 6) herons and egrets (*e.g.* great egrets *Ardea alba*); 7) medium shorebirds (*e.g.* marbled godwits *Limosa fedoa*); 8) phalaropes – (*e.g.* Wilson's phalaropes *Phalaropus tricolor*); and 9) small shorebirds (*e.g.* western sandpipers *Calidris mauri*).

Water Quality

We collected monthly water quality measurements at all of the salt ponds throughout the study period, except when levee road conditions prevented access to some ponds during Dec 2005. We measured temperature, dissolved oxygen (DO), pH, and salinity from 1-5 sampling locations per pond, with measurements typically collected near pond corners to account for spatial variability within ponds. We used a Hydrolab Minisonde (Hydrolab-Hach Company, Loveland, CO) to measure conductivity (internally converted to salinity using the 1978 Practical Salinity Scale) at each location. We calibrated sonde sensors prior to each use and performed a calibration check after sampling. Since the salt ponds stratify under certain conditions, we collected readings from the near-surface and near-bottom of the water column at sampling locations where water depth exceeded 60 cm. We also measured the specific gravity of the water at each sampling location with a hydrometer (Ertco, West Paterson, New Jersey) scaled for the appropriate range (Hydrolab sondes may not accurately measure salinity above 40 ppt). At salinities greater than about 70 ppt, we used only hydrometers to measure specific gravity, which we corrected for temperature and converted to salinity.

Objective 2. Document shorebirds on tidal mud flats adjacent to SBSPRP ponds.

Simultaneous Salt Pond and Mud flat Surveys

During the winter of 2005, we conducted paired salt pond and mud flat waterbird counts on 15 receding tides to document shorebird movement between habitats. Mud flat survey sites were established adjacent to salt pond complexes (Figure 1). We used a handheld GPS to establish 400 m wide survey areas on each mud flat site, and estimated distance from shore with a laser range finder (Swarovski 8×30, 3000m). We marked site boundaries with 2" diameter PVC poles with flagging tape on top for visibility. Shorebirds were counted concurrently on the mud flats and within a 12.5 ha (250×500m) area of the highest density salt pond in the adjacent pond complex. Counts were conducted with spotting scopes (Swarovski STS-80 20-60×) and binoculars (Nikon Audubon Monarch 10×42). Surveys began simultaneously when the first mud flat became exposed on ebbing tides. As the water level receded, we recorded bird numbers by species and behavior (foraging or not foraging) every 15-20 minutes. The survey ended at slack tide when maximum mud flat exposure occurred or when birds left the mud flat because of disturbance or adverse weather.

Rising and Falling Tide Mud flat Surveys

During winter 2006, we conducted 12 falling and 15 rising tide surveys of tidal mud flats but did not conduct simultaneous salt pond counts. Methods were similar to simultaneous mud flat and salt pond surveys, except that we added 1" diameter PVC poles to define 100 m counting zones within each mud flat site. Rising tide surveys began from maximum mud flat exposure on slack tide and were repeated each 15-20 minutes until the high tide reached its maximum. We used GPS coordinates to create site boundary polygons and calculate area (ArcGIS 9.1, Environmental Systems Research Institute, Redlands, CA, USA). We calculated bird densities for the total area, each 100-m counting zone, zone closest to the waterline, and difference in total exposed area from the zone nearest the water line.

RESULTS AND DISCUSSION

Objective 1. Conduct monthly waterbird and water quality monitoring at SBSPRP ponds.

Avian Diversity and Abundance

We counted >1.75 million birds representing 69 species in South Bay salt ponds between Jul 2005 and Aug 2006 (Table 1). Alviso supported the greatest number of birds during most survey months, followed by Eden Landing and Ravenswood (Figure 2). Different foraging guilds used the areas differently: gulls, ducks, and piscivores preferred Alviso, whereas shorebirds and phalaropes were more numerous at Eden Landing (Figure 3). Foraging behavior also differed by guild and pond complex. For example, phalaropes and eared grebes were most frequently observed foraging, but feeding rates did not differ noticeably among complexes (Figure 4).

Alviso.-- We counted nearly a million birds from 67 species at the Alviso pond complex between Jul 2005 and Aug 2006 (Table 1, Figure 5). Alviso salt ponds comprised 57% of the total pond area but also 57% of the total birds counted. Alviso supported 96% of gulls, 84% of dabbling ducks, 83% of diving ducks, 74% of piscivores, and 71% of herons counted overall (Figure 3).

The salt ponds were separated into smaller groups in close proximity, sharing circulation, or of similar water quality. For example, A1, A2W, A2E, AB1, AB2, A3N, and A3W comprised 26% of the birds counted on Alviso. These seven ponds had 55% of the diving ducks, 34% of the medium shorebirds, and 33% of the herons and dabbling ducks in Alviso (Figure 6). Ponds A1, A2E, A2W, and A3W each had between 10% and 17% of the diving ducks in the complex (Table 2, Figure 7). Dabbling and diving ducks comprised the largest proportion of birds in this pond group from Dec 2005 to Mar 2006, although Pond A3N had over 9,000 small shorebirds in Dec 2005. During other months, bird numbers were typically lower on all ponds (Figures 8 – 14).

Ponds A5 - A8 had 43% of the birds counted in Alviso (Figure 6), with most of these on A5 and A6. Ponds A5, A6, and A8 together had 80% of the small shorebirds and 42% of the medium shorebirds in Alviso. Pond A5, the largest pond with varying depths also had 27% of the dabbling ducks, 26% of the herons, and 20% of the piscivores in Alviso. Pond A6 had the most birds of any pond, primarily because the large California gull breeding colony supported 34% of Alviso gulls (Table 2, Figure 7). From Dec 2005 to Apr 2006, small shorebirds made up the largest proportion of birds on these ponds, while from May to Aug 2006, gulls made up the largest proportion (Figures 15 – 18).

Ponds A9 – A17, located near the Alviso Marina, comprised 23% of the birds counted in Alviso. The ponds in this group had the greatest diversity in guild composition. These nine ponds supported 43% of the piscivores in Alviso (Figure 6). Pond A9 had over 94,000 birds, almost three times as many birds as in any other pond in the group. Pond A9 alone had 27% of the dabbling ducks and 19% of the diving ducks. Pond A13 had 84% of the phalaropes and Pond

A15 had 38% of the eared grebes in Alviso (Table 2, Figure 7). From Oct 2005 to Apr 2006, there were more dabbling and diving ducks in these ponds than any other guild. Gull numbers were consistently high each month, and even outnumbered ducks in Jan 2005, but in Aug 2006, when total abundance was low, phalaropes on Pond A13 were the most numerous guild (Figures 19-27).

The island ponds (A19 – A21), A22, and A23, comprised 10% of the birds counted in Alviso. Eighty-seven percent of these birds were gulls, comprising 34% of gulls overall (Figure 6). Gulls likely use these ponds in high numbers for roosting between visits to a nearby landfill site. Gulls made up the largest proportion of birds on these ponds every month except Jul 2005. The highest gull numbers were from Dec 2005 to Apr 2006, although the second highest count was in Aug 2006 (Figures 28-32).

After the island ponds were breached in Mar 2006, we added low tide surveys from Apr 2006 to Aug 2006 to document changes in bird use coincident with changing water levels and habitat evolution. There were higher numbers of total birds at low tide in May 2006, Jul 2006, and Aug 2006, but higher numbers of total birds at high tide in Apr 2006 and Jun 2006. High tide numbers were much higher in Jul 2006 and Aug 2006 compared to the same months in 2005 (Figure 33). Guild composition during high tide on the island ponds after the ponds were breached was similar to guild composition before breaching. However, during post-breach low tides surveys, gulls decreased from 90% to 69% of the total count and small shorebirds increased from 7% to 29% of the total count. In Aug 2006, foraging rates peaked at 43% and 26% at high and low tide, respectively, and the foraging rates at high tide in Aug 2006 were much higher than in Aug 2005 (Figure 34).

Eden Landing.-- We counted > 619,000 birds from 65 species at Eden Landing between Jul 2005 and Aug 2006 (Table 1, Figure 35). Eden Landing ponds were shallower overall compared to Alviso ponds and supported foraging guilds in different proportions. The Eden Landing ponds constituted 31% of the total pond area and had 35% of the total birds counted. The complex supported 62% of phalaropes, 55% of small shorebirds, 53% of medium shorebirds, and 40% of eared grebes counted on all the ponds (Figure 3). Foraging rates were highest for two guilds on Eden Landing: 93% for phalaropes and 34% for dabbling ducks (Figure 4).

Ponds B1C – B6C comprised 13% of birds counted in Eden Landing (Figure 36). Ponds B3C, B4C, and B5C each had more than three times as many birds as the other ponds (Table 3, Figure 37). These six ponds had 59% of the phalaropes in Eden Landing with 42% in B5C alone (Figure 36, Table 3). The ponds also represented 32% of the eared grebes (Figure 36). Despite representing only 4% of the total birds, Pond B3C alone had more than 10% of dabbling and diving ducks, eared grebes, gulls, and phalaropes (Table 3). Small and medium shorebirds were the most numerous birds on these ponds overall and for most individual counts. Dabbling and diving ducks also comprised a large proportion of the counts from Oct 2005 to Apr 2006, as did phalaropes in Aug 2005 and 2006 (Figures 38 – 43).

Ponds B1 – B2 and B4 – B7 comprised only 12% of the birds in Eden Landing, but these six ponds supported 75% of piscivores, 64% of diving ducks, 59% of eared grebes, 53% of herons, and 50% of gulls (Figure 36). Pond B2 alone supported 35% of dabbling ducks in Eden Landing

(Table 3). Dabbling and diving ducks comprised the largest proportion of the count overall and from Dec 2005 to Apr 2006. Piscivores, gulls, and shorebirds comprised a larger proportion of the total counts during the other months when fewer ducks were present and total bird numbers were lower (Figures 44 – 49).

Ponds B6A, B6B, B8, B8A, and B9, north of Old Alameda Creek, were generally very shallow, seasonally inundated, and highly saline. These ponds had 46% of the birds counted in Eden Landing, primarily due to high densities of saline specialists (eared grebes and phalaropes) and shorebirds. They supported 55% of the small shorebirds, 37% of the herons, 35% of the phalaropes, and 33% of the small shorebirds in the complex (Figure 36). Pond B8A supported 24% of the birds in Eden Landing overall, more than any other pond in the complex. Ponds B9 and B8 were 3rd and 4th, respectively, in terms of bird numbers (Table 3, Figure 37). Small shorebirds comprised the largest proportion of the count each month except for May 2006 and Jun 2006, when total bird numbers were much lower than other months. During this period, medium shorebirds made up the largest proportion of birds. Small shorebirds were most numerous in Oct and Dec 2005, and Feb 2006 (Figures 50 – 54).

The northern ponds, B10 – B14, comprised 30% of the birds in Eden Landing. The five ponds together had 42% of the medium shorebirds and 33% of the small shorebirds (Figure 36). Pond B10 alone had 22% of the birds and was second to pond B8A overall (Table 3, Figure 37). Small and medium shorebirds made up the vast majority of the counts on these ponds during each survey, although in Mar 2006, there were more dabbling ducks than medium shorebirds. Overall numbers were highest from Dec 2005 to Mar 2006 (Figures 55 – 59).

Ravenswood.-- We counted >131,000 birds belonging to 42 species at Ravenswood between Jul 2005 and Aug 2006 (Table 1, Figure 60). The seven Ravenswood ponds comprised only 11% of the total pond area and had 8% of the total birds counted (Figure 3). In Feb, Mar, and Apr 2006, the complex had 14%, 12%, and 15%, respectively, of the total count (Figure 2). The complex supported 14% of the small shorebirds and 9% of the medium shorebirds found on all ponds. All other guilds made up only 3% or less of the total count (Figure 3).

Ponds R1 and R4 had the most birds, with 43% and 27% of the Ravenswood total, respectively (Table 4, Figure 61). Pond R2 had 44% of the piscivores and 41% of the herons, Pond R5 had 37% of the dabbling ducks, and Pond RSF2 had 37% of the gulls (Table 4). Small shorebirds made up the majority of the counts during most months, but gulls made up the largest proportion in May 2006, and medium shorebirds made up the largest proportion in Jun 2006. Total bird numbers were highest from Jan through Apr 2006 (Figures 62–68).

Water Quality

Salinity in Ravenswood was consistently higher than in the other two complexes, particularly during the summer and the fall. Alviso and Eden Landing had similar salinity levels throughout the study period, although salinity in Alviso was slightly higher than in Eden Landing in all but two months (Figure 69).

The salinity in Alviso ranged from 23.1 ppt in Apr 2006 and 98.0 ppt in Dec 2005. Ponds A6 and A19 – A23 had the highest salinities, although salinity in the island ponds decreased significantly after the breach (Table 5). Eden Landing salinity ranged from 24.2 ppt in Apr 2006 to 103.7 ppt in Oct 2005. Ponds B4C, B6A, B6B, B13, and B14 had the highest salinities in Eden Landing (Table 6). Ravenswood salinity ranged from 53.6 ppt in Jan 2006 to 342.7 ppt in Nov 2005. Pond RS5 had the highest average salinity in Ravenswood, although most of the ponds were similar except Pond R1 which had much lower salinity in the summer and the fall (Table 7).

Objective 2. Document shorebirds on tidal mud flats adjacent to SBSPRP ponds.

Simultaneous Salt Pond and Mud flat Surveys

Eden Landing and Ravenswood.-- Over 80% of birds counted departed within one hour of mud flat exposure at Ravenswood and Eden Landing. During the same initial one-hour period, maximum numbers of shorebirds were attained at mud flat sites (Tables 8-9). Despite increased mud flat area available for foraging as the tide receded, bird numbers at sites not disturbed by predators or anthropogenic factors generally stayed constant for the remainder of the survey.

We completed 6 mud flat surveys at the Ravenswood complex, but only 5 of these were paired with salt pond surveys since no shorebirds were found on salt ponds during the January survey (Figures 70-74). Birds either departed the pond dramatically, with 60-70% leaving within one 15-min period in Feb 2005 (Figure 72), or they departed the pond gradually, with 10-25% of the total birds leaving during each 15-min period, as in Apr 2005 (Figure 74). Although tidal ebb and flood rates were similar among survey dates (Table 8), the difference in salt pond departure rates may reflect different degrees of mud flat exposure due to differences in elevation and water conditions.

We completed 5 surveys at Eden Landing, resulting in 4 paired surveys (Figures 75-80). Shorebird departure rates were more consistent (range 13-33% ± 7% of total birds per 15 min; Table 9) compared with at Ravenswood. During Feb and Apr 2005, surveys were disturbed by a hunting peregrine falcon: birds left the pond on both occasions, but birds did not return to the pond in February (Figure 78), whereas some birds did return in April (Figure 80).

Alviso.-- Ravenswood and Eden Landing mud flats were at higher elevations than Alviso and were exposed earlier in the tide cycle. Bird movements at Alviso were less obvious, though we completed 6 paired surveys (Table 10, Figures 81-86). Fewer shorebirds were detected at the Alviso than at other complexes during monthly counts (Figure 3), so fewer shorebirds may have been present at these sites initially. From Nov 2004 through Jan 2005 mud flat surveys, few shorebirds were located at Alviso except for A5, and birds did not always respond to ebb tides by leaving the ponds. During Nov 2005, western sandpipers comprised 88% of the few shorebirds at the pond and did not respond to tide stage. Instead, birds left the pond briefly during high winds (Figure 81). During Jan 2005 (Figure 83), American avocets comprised > 96% of birds at

pond A5. Avocets represented < 1% of total birds on the mud flat during the first 2 h but increased to 10% as numbers of avocets on the salt pond declined by 50% (Figure 83).

Shorebirds were counted at pond A8 during Feb through Apr 2005. Over 95% of salt pond birds were small shorebirds, whereas both medium and small shorebirds were observed at mud flats. We recorded similar bird movement trends as in other complexes during Feb and Apr 2005 (Figures 84, 86). Conditions were windy and small shorebirds stayed on pond A8 in high numbers in Mar 2005, rather than departing for mud flats. Greater than 75% of species recorded on the mud flat were medium shorebirds (Figure 85).

Rising and Falling Tide Mud flat Surveys

Mud flat density vs. abundance.-- Medium shorebird density reached its maximum shortly after initial exposure, then declined as bird numbers stayed constant but ebbing tides exposed more mud flats (Figures 87-88). This trend was especially evident for marbled godwits and willets, whose density decreased faster than other species. These species were generally observed foraging within a narrower band of the tideline (about 50 m) compared with other species.

Western sandpipers, the most abundant small shorebird, increased in density and abundance during the first hour of mud flat exposure, suggesting that they arrive at the mud flat later than medium shorebirds (Figures 89-90). Other small shorebirds were less variable but increased slightly as the tide receded. Sandpiper abundance remained constant after their initial arrival (Figure 90), and density declined as more mud flat area became exposed (Figure 89).

During flood tide surveys, shorebird density was expected to increase as available mud flats decreased while abundance remained constant. We observed this trend for medium shorebirds such as marbled godwits and willets, but not black-bellied plovers or long-billed curlews (Figure 91). Black-bellied plover and long-billed curlew numbers declined slightly as the tide rose, whereas willets and godwits increased (Figure 92). Small shorebirds declined in both density and abundance over the course of the flood tide (Figures 93-94).

Flood tide vs. ebb tide mud flat use.-- Mud flat site elevation appeared to influence bird use. Higher elevation mud flats remained exposed longer than lower ones and may have received greater use at the beginning of ebb tide periods or near the end of flood tide periods. Small shorebirds generally had lower density on mud flats during flood tide than during ebb tide (Figures 95-96). Medium shorebird densities were generally similar during ebb and flood tides (Figures 97-98), but exhibited a high degree of zonal variability during ebb tides (Figure 97).

The proportion of willets, godwits, curlews, and avocets observed within the zone containing the water line was similar for rising and falling tides (Table 11). Willets and godwits were observed within waterline zones >92% of the time, whereas about 25% of curlews were distributed through other survey zones. This differential use of mud flat adjacent to the waterline may have been due to morphological and dietary differences: curlews had much longer bills than other medium shorebirds and may have been better able to access food resources deeper in the substrate. We also observed avocets farther away from the waterline. These birds were foraging by “sweeping” in shallow puddles on the exposed flats. Black-bellied plovers and small

shorebirds were less frequently observed foraging at the waterline; like avocets, some were observed foraging in small pockets of standing water on the mud flat.

SUMMARY AND RECOMMENDATIONS

ISP actions were initiated in Jul 2004 when five ponds were opened to circulation with Bay waters for salinity reduction, followed by four additional ponds in Apr 2005. Our monthly monitoring of pond water quality and bird use enabled us to document that winter bird use was substantially higher following breaching than in the previous two winters, and that the primary increase in bird numbers was found on ponds that had been affected by the breaches (Takekawa et al. 2005). Similarly, continued avian monitoring has documented early bird response to breached ponds A19-A21 during low tide, when we saw increased pond use by shorebirds compared to high tide surveys (Figure 33). Continued monitoring of salt pond bird use will be critical for understanding habitat changes and maintaining bird numbers in the Bay as restoration proceeds.

South Bay mud flats are an important foraging resource for shorebirds. We documented that shorebirds leave salt ponds near the beginning of ebb tides coincident with arrival of birds on mud flats. These data suggest that both mud flat and salt pond habitats are important for shorebirds; thus, managing salt ponds alone for shorebirds may not be as beneficial if mud flat habitat is not protected. The salt pond beds are now lower than adjacent baylands because of groundwater pumping and subsidence. As a result, a large amount of sediment will be required for restoration of salt ponds to tidal marsh (Siegel and Bachand 2002). Sediment may come from adding dredge material, capturing downstream sediments from nearby creeks, and from redistribution in the South Bay that may result in erosion of South Bay mud flats. In addition, invasive *Spartina alterniflora* may spread into the mud flats and vegetate farther onto the intertidal shoals, thereby decreasing available habitat for waterbirds (Stralberg et al. 2004). Continued monitoring of mud flat use by shorebirds will further document the importance of mud flat habitat to shorebirds and provide guidance for management action.

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TABLES AND FIGURES

Table 1. Monthly counts of waterbird species of the major foraging guilds, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

	July 2005			August 2005			October 2005			December 2005			January 2006			February 2006		
Species	**AL**	**ED**	**RA**	**AL**	**ED**	**RA**	**AL**	**ED**	**RA**	**AL**	**ED**	**RA**	**AL**	**ED**	**RA**	**AL**	**ED**	**RA**
Dabbling Ducks																		
American Coot	3	0	0	46	0	0	1914	2	0	7458	32	0	9284	278	14	9821	87	0
American Wigeon	0	0	0	10	0	0	4261	2	0	16178	2785	0	5966	3570	0	6366	3364	0
Blue-winged Teal	2	0	0	19	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Cinnamon Teal	0	0	0	11	0	0	0	0	0	8	2	0	0	0	0	9	0	0
Common Moorhen	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
Eurasian Wigeon	0	0	0	0	0	0	1	0	0	6	2	0	2	10	0	7	7	0
Gadwall	325	30	0	295	0	0	936	5	0	2119	97	0	1355	1159	0	2485	473	0
Green-winged Teal	0	0	0	0	0	0	33	0	0	213	0	0	193	99	0	110	0	0
Mallard	109	22	0	396	14	0	499	0	0	56	67	0	8	37	0	110	51	9
Northern Pintail	9	2	0	8	1	0	1723	16	0	1888	128	0	849	497	0	770	196	0
Northern Shoveler	0	12	0	2246	0	0	20125	2058	0	20643	3672	7	9046	3238	0	15588	2301	40
Unidentified dabbling duck	0	0	0	0	0	0	1100	0	0	0	0	0	0	0	0	660	0	0
Diving Ducks																		
Bufflehead	1	0	0	2	4	0	234	0	0	1061	763	27	845	679	668	1559	671	749
Canvasback	0	0	0	0	0	0	1	0	0	1854	2	0	854	29	0	1242	117	0
Common Goldeneye	0	0	0	0	0	0	0	0	0	299	442	0	194	414	528	138	71	663
Redhead	0	0	0	6	0	0	4	0	0	9	0	0	16	0	0	42	16	0
Ruddy Duck	137	0	0	205	0	0	16022	60	0	42046	1151	0	27395	7739	2	31459	9350	0
Surf Scoter	1	0	0	0	0	0	0	0	0	0	0	0	0	3	0	5	4	0
Unidentifed Scaup	27	4	0	17	6	0	172	1	0	12779	43	0	10914	156	105	13312	2070	910
White-winged Scoter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
Eared Grebe																		
Eared Grebe	3	0	0	8	3	0	402	48	0	1430	1392	3	1262	2044	108	2214	692	97

Table 1. Continued.

	July 2005			August 2005			October 2005			December 2005			January 2006			February 2006		
Species	**AL**	**ED**	**RA**	**AL**	**ED**	**RA**	**AL**	**ED**	**RA**	**AL**	**ED**	**RA**	**AL**	**ED**	**RA**	**AL**	**ED**	**RA**
Piscivores																		
American White Pelican	685	25	0	1702	100	0	1679	367	0	137	18	0	112	10	0	37	0	0
Black Skimmer	23	0	0	14	0	0	27	0	0	38	0	0	26	0	0	25	0	0
Black Tern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brown Pelican	10	8	0	73	5	0	42	80	0	0	0	0	0	0	0	0	0	0
Caspian Tern	136	3	0	65	0	1	3	0	0	0	0	0	0	0	0	0	0	0
Clark's Grebe	3	0	0	2	0	0	25	2	0	29	37	0	35	39	0	95	14	0
Double-crested Cormorant	828	567	0	1403	632	0	5271	2746	0	561	60	0	350	10	0	318	27	0
Elegant Tern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Forster's Tern	1402	163	9	1093	214	0	639	980	0	40	8	0	73	0	4	20	5	0
Horned Grebe	0	0	0	3	0	0	17	0	0	5	3	0	13	6	0	8	0	0
Least Tern	0	20	0	21	10	0	1	0	0	0	0	0	0	0	0	0	0	0
Pied-billed Grebe	71	0	0	394	3	0	858	16	0	512	24	0	472	23	0	235	21	0
Red-breasted Merganser	0	0	0	1	1	0	1	0	0	206	24	0	395	43	1	186	10	0
Western Grebe	2	4	0	1	2	0	10	2	0	33	1	0	55	1	0	33	6	0
Gulls																		
Bonaparte's Gull	0	4	0	0	0	0	45	0	0	149	1221	0	551	426	0	161	40	0
California Gull	14983	401	0	16195	1735	10	5814	312	25	228	28	21	5953	0	64	6334	33	179
Glaucous-winged Gull	0	0	0	0	0	0	0	0	0	932	0	0	71	0	0	29	3	0
Herring Gull	0	0	0	0	0	0	1054	192	0	17655	131	15	31387	205	5	8914	163	2
Mew Gull	0	0	0	0	0	0	0	0	0	74	39	0	1383	50	0	667	196	0
Ring-billed Gull	0	0	0	174	208	0	901	345	2	1468	690	29	2113	35	36	628	98	227
Unidentified gull	145	0	0	0	0	0	0	0	0	0	0	0	11200	0	0	200	0	0
Western Gull	96	18	0	340	28	0	1106	108	0	944	31	0	840	4	0	577	20	0
Herons																		
Black-crowned Night Heron	17	8	0	11	2	0	5	4	0	11	0	0	0	0	0	0	0	0
Great Blue Heron	18	6	0	23	9	0	42	21	0	32	8	1	35	14	0	27	27	2
Great Egret	45	11	0	199	35	0	452	171	0	94	27	2	94	23	2	135	30	0
Snowy Egret	198	60	0	508	64	0	576	285	0	146	76	0	140	32	0	128	71	2

Table 1. Continued.

	July 2005			August 2005			October 2005			December 2005			January 2006			February 2006		
Species	**AL**	**ED**	**RA**	**AL**	**ED**	**RA**	**AL**	**ED**	**RA**	**AL**	**ED**	**RA**	**AL**	**ED**	**RA**	**AL**	**ED**	**RA**
Medium Shorebirds																		
American Avocet	2739	218	29	3361	746	0	5658	3066	13	3269	1937	220	4239	3367	118	3446	3865	694
Black-bellied Plover	62	563	0	23	2011	122	737	6531	6	740	5764	660	1037	3639	395	626	5993	1374
Black-necked Stilt	657	346	5	1681	1272	0	799	1014	235	1070	1209	294	568	515	438	1430	138	439
Greater Yellowlegs	24	48	0	20	31	0	15	68	0	5	38	0	9	14	5	16	41	13
Killdeer	7	1	8	18	7	0	24	6	6	3	18	41	41	16	54	14	18	24
Lesser Yellowlegs	0	1	0	3	1	0	4	26	0	6	5	1	11	19	2	8	15	4
Long-billed Curlew	355	19	67	703	35	73	571	74	77	156	180	86	198	133	83	334	180	355
Marbled Godwit	1282	20	0	896	679	47	1783	1960	0	775	2632	0	145	1650	50	21	186	0
Red Knot	0	78	0	17	26	0	2	83	0	0	2	0	0	850	0	0	0	0
Ruddy Turnstone	1	0	0	0	3	0	0	7	0	0	7	0	0	0	0	0	0	0
Ruff	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
Whimbrel	0	0	2	0	0	0	0	2	0	0	3	0	0	0	20	0	0	0
Willet	600	160	6	1227	2347	318	953	590	30	1479	4233	97	314	1166	648	520	1367	968
Phalaropes																		
Red Phalarope	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0
Red-necked Phalarope	42	1750	7	715	6131	9	0	0	0	0	0	0	0	0	0	0	0	0
Wilson's Phalarope	7	63	0	272	104	0	0	0	0	0	0	0	0	0	0	0	0	0
Small Shorebirds																		
Dunlin	0	32	0	1	70	0	1533	27024	0	10033	57496	1143	12633	9079	3940	1552	13390	3170
Least Sandpiper	381	10211	826	2122	5833	909	3150	4228	531	3762	3420	1159	2352	331	375	974	951	1155
Sanderling	0	0	0	0	0	0	0	3	0	30	0	0	28	0	0	54	0	0
Semipalmated Plover	415	193	14	61	113	795	74	363	0	89	504	1331	0	176	446	152	790	1754
Semipalmated Sandpiper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Snowy Plover	5	150	11	1	214	15	0	71	3	0	34	0	0	103	0	6	8	14
Western Sandpiper	6085	22417	1378	4288	11020	372	5155	18187	4519	25948	25929	3220	31975	19082	7545	6121	48421	22739
Unidentified Dowitcher	731	43	0	878	187	6	2054	1117	0	6720	2301	20	2698	1870	110	117	405	1
Unidentified Sandpiper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals	32672	37681	2362	41778	33906	2677	88507	72243	5447	185429	118717	8377	179729	62890	15766	120051	96002	35584

Table 1. Continued.

Species	March 2006			April 2006			May 2006			June 2006			July 2006			August 2006			Totals
	AL	ED	RA	AL	ED	RA	AL	ED	RA	AL	ED	RA	AL	ED	RA	AL	ED	RA	
Dabbling Ducks																			
American Coot	10192	25	0	3270	1	0	19	0	0	36	0	0	165	0	0	805	0	0	43452
American Wigeon	4832	1382	0	512	162	0	1	0	0	6	0	0	0	0	0	17	0	0	49414
Blue-winged Teal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23
Cinnamon Teal	2	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	36
Common Moorhen	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Eurasian Wigeon	0	4	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	41
Gadwall	999	290	0	221	154	0	311	125	6	327	86	0	286	41	0	241	14	0	12380
Green-winged Teal	67	4	0	45	25	0	0	0	0	0	0	0	0	0	0	0	0	0	789
Mallard	93	143	7	169	158	7	210	312	6	280	431	2	188	21	0	1906	72	0	5383
Northern Pintail	46	109	0	8	23	0	12	22	0	4	5	0	0	0	0	1	0	0	6317
Northern Shoveler	7559	4141	0	839	1693	0	23	25	0	5	1	0	0	2	0	11	0	0	93275
Unidentified dabbling duck	0	0	0	0	0	0	1	5	0	0	0	0	0	0	0	0	0	0	1766
Diving Ducks																			
Bufflehead	332	871	495	19	252	23	0	12	0	3	0	0	0	1	0	0	0	0	9271
Canvasback	502	4	0	0	0	0	1	0	0	1	0	0	3	0	0	6	0	0	4616
Common Goldeneye	161	114	383	36	23	0	0	0	0	0	0	0	0	0	0	0	0	0	3466
Redhead	48	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	147
Ruddy Duck	20122	5136	2	4871	3271	0	365	274	0	157	45	0	204	11	0	302	4	0	170330
Surf Scoter	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22
Unidentifed Scaup	5683	1070	403	1805	978	26	34	25	0	28	1	0	9	0	0	26	0	0	50604
White-winged Scoter	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Eared Grebe																			
Eared Grebe	657	291	134	457	152	45	70	4	0	6	2	0	6	0	0	10	1	0	11541

Table 1. Continued.

Species	March 2006			April 2006			May 2006			June 2006			July 2006			August 2006			Totals
	AL	ED	RA	AL	ED	RA	AL	ED	RA	AL	ED	RA	AL	ED	RA	AL	ED	RA	
Piscivores																			
American White Pelican	40	2	0	64	0	0	13	3	0	15	21	0	355	56	0	825	383	0	6649
Black Skimmer	18	0	0	5	0	2	2	0	0	0	0	1	0	0	2	2	0	0	185
Black Tern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	3
Brown Pelican	0	0	0	2	0	0	3	0	0	73	38	0	19	15	0	134	5	0	507
Caspian Tern	0	13	0	33	5	34	98	6	0	40	1	2	107	3	2	114	8	0	674
Clark's Grebe	118	22	0	55	19	0	1	0	0	1	0	0	1	0	0	1	0	0	499
Double-crested Cormorant	223	29	0	636	59	2	705	61	3	628	169	0	802	205	0	674	169	0	17138
Elegant Tern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	782	0	782
Forster's Tern	19	21	0	523	154	84	580	175	165	745	227	0	811	225	13	380	385	0	9157
Horned Grebe	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60
Least Tern	0	0	0	0	0	0	0	1	0	0	9	0	1	171	0	0	347	0	581
Pied-billed Grebe	75	6	0	13	8	0	1	0	0	13	0	0	163	0	0	542	7	0	3457
Red-breasted Merganser	149	6	0	21	13	0	0	0	0	0	0	0	0	0	0	0	1	0	1058
Western Grebe	19	28	0	54	4	0	12	8	0	0	1	0	0	1	0	3	1	0	281
Gulls																			
Bonaparte's Gull	0	0	5	1	46	0	22	1	0	0	0	0	0	0	0	2	0	0	2674
California Gull	18179	61	134	22038	36	1	15299	143	479	23677	585	12	20884	54	0	21002	663	258	175820
Glaucous-winged Gull	54	2	3	13	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1109
Herring Gull	5688	40	9	187	3	0	2	1	0	0	0	0	0	0	0	64	0	32	65749
Mew Gull	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2420
Ring-billed Gull	122	114	239	76	17	0	14	6	0	2	11	0	0	50	0	102	191	9	7907
Unidentified gull	3281	0	0	5500	0	0	0	1	0	0	5	0	0	0	0	0	0	0	20332
Western Gull	66	77	0	9	1	0	57	8	0	26	10	0	12	15	0	334	9	1	4737
Herons																			
Black-crowned Night Heron	0	2	0	16	9	0	47	3	0	9	15	0	8	3	0	11	8	0	189
Great Blue Heron	11	33	0	10	23	1	10	23	0	18	35	0	35	32	0	29	8	0	533
Great Egret	45	40	0	58	39	0	109	24	1	108	37	0	163	26	0	332	162	1	2465
Snowy Egret	58	39	2	102	44	0	110	40	3	189	87	0	260	73	0	506	265	0	4064

Table 1. Continued.

Species	March 2006			April 2006			May 2006			June 2006			July 2006			August 2006			Totals
	AL	ED	RA	AL	ED	RA	AL	ED	RA	AL	ED	RA	AL	ED	RA	AL	ED	RA	
Medium Shorebirds																			
American Avocet	4869	1804	62	824	2000	122	871	1269	136	850	1524	184	1316	1189	31	3984	706	0	58726
Black-bellied Plover	177	3630	60	96	2012	83	0	293	5	0	303	274	1	1024	27	41	1236	58	39603
Black-necked Stilt	8	53	564	31	40	84	91	47	63	38	73	7	225	384	3	118	462	202	14603
Greater Yellowlegs	87	42	5	2	3	0	0	7	2	0	10	0	1	24	0	3	55	0	588
Killdeer	5	9	12	6	16	2	4	6	5	6	9	2	8	8	4	7	0	1	416
Lesser Yellowlegs	36	16	2	4	10	1	0	4	5	0	1	0	0	28	0	10	22	0	245
Long-billed Curlew	1	131	177	11	1	0	7	0	0	44	57	33	110	59	101	431	142	30	5014
Marbled Godwit	2	792	11	2064	306	789	0	0	1	0	446	0	520	138	94	76	636	970	18971
Red Knot	0	0	0	0	62	2	0	563	0	0	6	0	0	211	0	0	92	0	1994
Ruddy Turnstone	0	0	0	0	2	1	0	3	0	0	2	0	0	0	1	0	0	0	27
Ruff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Whimbrel	0	3	0	6	0	0	0	0	0	0	0	0	0	3	0	0	8	0	47
Willet	557	1179	1111	176	330	245	0	166	0	1	118	3	475	952	282	144	1831	356	24949
Phalaropes																			
Red Phalarope	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Red-necked Phalarope	0	0	0	22	25	107	4	490	54	0	0	0	369	365	4	5200	1616	59	16969
Wilson's Phalarope	0	0	0	0	0	0	0	0	0	0	0	0	0	164	0	262	1027	0	1899
Small Shorebirds																			
Dunlin	8894	12279	2463	7814	11959	3461	0	2937	0	0	0	0	0	62	0	14	18	0	190997
Least Sandpiper	674	363	327	255	345	44	0	2	0	0	1	0	1	801	641	647	1135	354	48260
Sanderling	33	8	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	173
Semipalmated Plover	2	686	1544	5	470	379	4	203	0	0	169	33	68	52	59	61	436	378	11819
Semipalmated Sandpiper	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	2
Snowy Plover	22	44	42	0	228	30	35	44	3	3	41	2	4	127	43	0	143	7	1453
Western Sandpiper	45361	37500	20082	19696	26327	16130	0	11421	94	66	42	0	7599	15814	2567	15937	10961	2489	496487
Unidentified Dowitcher	217	737	0	744	801	250	0	956	1	0	0	0	226	701	148	519	666	0	25224
Unidentified Sandpiper	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50
Totals	140471	73407	28278	73431	52328	21955	19150	19724	1032	27405	4624	555	35406	23111	4022	55837	24679	5205	1750438

Table 2. Percentage of foraging guilds by pond, July 2005 – August 2006, Alviso Complex, South Bay Salt Ponds, San Francisco Bay, CA.

Guild	A1	A2E	A2W	AB1	AB2	A3N	A3W	A5	A6	A7	A8	A9	A10
All Birds	4.27	3.29	4.79	3.17	2.06	1.57	4.67	15.37	18.78	2.44	6.17	9.47	2.60
Dabbling Ducks	5.71	5.49	4.99	3.42	2.53	0.05	10.75	26.58	0.00	3.53	0.88	26.50	0.19
Diving Ducks	11.67	9.74	17.23	2.72	2.72	0.00	11.30	10.09	0.25	1.81	0.02	18.75	8.51
Eared Grebes	4.31	3.46	8.43	0.74	0.48	0.31	2.25	4.09	0.34	2.91	8.51	4.14	4.77
Piscivores	4.95	3.79	5.33	1.34	1.75	0.01	7.16	19.91	0.02	10.60	1.44	10.64	9.36
Gulls	1.33	0.50	0.30	0.11	1.16	0.14	0.37	1.43	33.93	0.65	3.54	2.03	2.02
Herons	2.74	5.35	3.17	6.25	5.00	0.23	9.85	26.06	0.25	10.08	0.52	4.92	3.13
Medium Shorebirds	6.00	0.14	1.72	17.53	5.79	1.53	0.85	21.05	12.75	4.05	7.79	1.19	0.05
Phalaropes	0.03	0.00	0.68	0.03	0.00	0.00	0.00	0.22	0.32	0.01	13.93	0.00	0.00
Small Shorebirds	0.04	0.31	0.27	3.34	1.29	5.92	0.31	25.45	36.29	2.59	18.09	0.09	0.02

Guild	A11	A12	A13	A14	A15	A16	A17	A19	A20	A21	A22	A23
All Birds	1.46	0.34	1.24	0.78	1.23	3.39	2.50	3.39	1.21	0.85	1.34	3.60
Dabbling Ducks	0.03	0.01	0.07	0.07	0.27	5.74	2.96	0.13	0.05	0.03	0.03	0.00
Diving Ducks	1.80	0.04	0.01	1.48	0.00	1.15	0.52	0.01	0.01	0.06	0.11	0.00
Eared Grebes	0.57	0.25	1.41	3.57	37.95	3.22	1.76	4.90	0.15	0.67	0.77	0.06
Piscivores	7.58	0.28	1.26	1.42	0.10	9.09	3.59	0.35	0.00	0.03	0.00	0.00
Gulls	2.17	1.16	2.15	1.10	1.25	5.56	5.55	11.64	4.39	1.86	2.38	13.27
Herons	2.14	1.35	0.50	1.95	0.14	8.88	4.75	1.78	0.19	0.77	0.00	0.00
Medium Shorebirds	0.48	0.02	0.08	1.43	7.46	1.21	3.02	0.72	0.11	1.40	3.60	0.03
Phalaropes	0.00	0.00	83.71	0.00	0.59	0.00	0.41	0.01	0.00	0.00	0.00	0.06
Small Shorebirds	0.96	0.00	0.05	0.07	0.47	0.90	0.12	0.53	0.03	0.96	1.83	0.06

Table 3. Percentage of foraging guilds by pond, July 2005 – August 2006, Eden Landing Complex, South Bay Salt Ponds, San Francisco Bay, CA.

Guild	B1C	B2C	B3C	B4C	B5C	B6C	B1	B2	B4	B5	B6
All Birds	0.64	0.81	3.91	3.80	2.94	0.61	2.73	4.37	1.52	0.65	1.32
Dabbling Ducks	1.35	0.77	10.85	1.36	0.85	0.62	0.20	35.05	4.28	2.14	0.51
Diving Ducks	0.25	0.97	13.74	0.29	1.36	0.96	40.20	17.32	4.21	0.82	0.26
Eared Grebes	0.95	0.41	14.17	2.46	1.08	12.64	1.60	2.10	2.74	23.37	21.56
Piscivores	0.12	0.23	0.51	0.00	0.02	0.02	10.76	45.75	7.88	0.89	0.19
Gulls	0.01	0.87	16.15	5.44	0.64	2.62	6.54	13.24	3.70	2.06	14.16
Herons	0.78	0.88	0.68	0.15	0.15	0.93	3.99	14.75	21.86	5.11	1.41
Medium Shorebirds	0.57	1.60	3.60	5.21	3.19	0.39	0.09	2.66	2.69	1.28	1.05
Phalaropes	1.85	0.93	11.05	0.65	42.03	2.71	0.00	0.00	0.00	0.01	3.91
Small Shorebirds	0.62	0.65	2.12	4.17	2.26	0.40	0.11	0.09	0.56	0.10	1.00

Guild	B7	B6A	B6B	B8	B8A	B9	B10	B11	B12	B13	B14
All Birds	0.98	1.93	2.63	6.43	24.28	10.34	22.06	1.35	1.27	3.35	2.08
Dabbling Ducks	0.13	6.34	2.25	4.83	4.51	1.01	13.16	9.37	0.08	0.14	0.20
Diving Ducks	1.26	4.41	2.13	1.75	1.93	5.15	0.72	0.37	0.76	0.60	0.55
Eared Grebes	7.84	0.67	1.99	0.37	0.24	4.86	0.11	0.00	0.00	0.13	0.71
Piscivores	9.32	0.55	0.14	0.06	11.21	11.12	1.10	0.01	0.07	0.07	0.00
Gulls	10.32	1.79	0.03	2.91	8.80	4.56	3.44	0.22	0.00	0.37	2.11
Herons	5.65	6.48	3.12	1.12	11.83	14.65	4.82	0.29	0.05	0.54	0.78
Medium Shorebirds	2.72	1.58	1.49	4.56	16.09	9.69	32.76	1.54	2.30	4.20	0.73
Phalaropes	0.00	4.15	0.41	16.54	7.63	6.36	0.03	0.00	0.44	0.43	0.89
Small Shorebirds	0.19	1.41	3.12	7.39	30.87	11.90	24.19	0.87	1.29	3.93	2.74

Table 4. Percentage of foraging guilds by pond, July 2005 – August 2006, Ravenswood Complex, South Bay Salt Ponds, San Francisco Bay, CA.

Guild	R1	R2	R3	R4	R5	RS5	RSF2
All Birds	42.66	3.75	13.62	27.45	1.91	1.12	9.50
Dabbling Ducks	12.24	3.06	8.16	23.47	36.73	12.24	4.08
Diving Ducks	31.90	6.02	13.68	28.87	1.93	2.57	15.03
Eared Grebes	52.71	1.55	4.13	41.09	0.00	0.00	0.52
Piscivores	52.62	44.31	1.23	1.85	0.00	0.00	0.00
Gulls	25.82	10.13	4.84	7.79	9.63	4.40	37.40
Herons	17.65	41.18	23.53	11.76	0.00	0.00	5.88
Medium Shorebirds	31.02	2.95	11.60	24.37	8.01	6.39	15.66
Phalaropes	34.17	0.00	25.00	28.33	0.00	0.00	12.50
Small Shorebirds	44.94	3.53	14.08	28.14	0.97	0.30	8.03

Table 5. Average salinity by pond in ppt, July 2005 – August 2006, Alviso Complex, South Bay Salt Ponds, San Francisco Bay, CA. — not sampled.

Pond	Jul-05	Aug-05	Oct-05	Nov-05	Dec-05	Jan-06	Feb-06	Mar-06	Apr-06	May-06	Jun-06	Jul-06	Aug-06
A1	24.56	23.91	24.50	25.07	—	16.93	14.38	13.82	10.06	10.42	15.26	23.42	25.24
A2E	19.52	20.30	22.89	22.07	17.46	15.27	11.56	10.77	8.71	8.43	10.52	15.10	20.97
A2W	27.75	34.40	29.23	27.07	—	17.80	17.26	13.52	12.00	10.87	13.09	18.72	23.82
AB1	16.67	18.37	19.87	21.23	17.63	12.79	10.00	11.02	6.71	7.34	9.73	13.42	19.10
AB2	27.07	30.01	24.28	22.46	—	15.44	11.83	11.10	7.82	7.06	11.04	14.95	19.82
A3N	85.13	107.67	56.89	80.07	—	61.72	61.04	58.06	52.70	63.48	85.80	108.67	132.00
A3W	20.34	23.19	21.75	21.12	15.58	16.32	14.80	13.02	9.89	9.18	9.27	12.09	21.51
A5	20.88	22.53	24.77	25.68	21.65	18.68	15.89	10.73	9.01	11.66	11.44	16.35	20.41
A6	80.50	272.50	312.00	314.00	—	63.23	86.40	85.10	68.50	120.00	163.00	213.50	270.50
A7	23.25	25.57	23.74	23.31	19.99	18.82	16.76	11.96	14.60	11.21	12.19	16.32	21.41
A8	127.44	127.00	39.20	62.45	58.08	64.65	65.25	64.14	61.03	86.47	126.67	147.33	163.00
A9	22.18	24.36	25.56	23.57	—	22.68	21.90	20.93	19.85	21.88	15.95	18.04	23.43
A10	35.66	28.99	28.53	30.62	—	27.43	26.49	24.98	20.19	24.44	19.82	22.42	23.18
A11	38.92	35.52	34.74	35.93	—	35.58	35.60	35.92	36.88	33.41	32.71	32.03	29.06
A12	50.58	51.02	53.92	55.53	—	54.08	53.03	51.00	51.21	52.61	58.33	52.06	48.68
A13	58.04	60.95	65.98	67.70	—	62.33	59.58	55.78	55.54	57.00	63.91	66.81	73.41
A14	40.22	38.09	44.38	46.49	—	40.25	39.08	36.68	35.93	39.61	45.23	51.53	55.97
A15	81.30	87.28	101.58	105.75	—	86.13	81.52	85.28	—	86.58	94.38	98.20	112.50
A16	23.58	22.61	7.95	6.88	—	4.42	4.14	10.25	7.33	10.46	15.93	19.18	17.35
A17	16.24	18.75	12.93	9.08	—	5.28	4.57	4.45	5.99	5.49	9.55	15.68	19.19
A19	168.00	195.00	224.00	235.00	172.00	69.30	99.40	101.00	2.65	7.49	6.88	12.22	10.74
A20	170.00	200.00	228.00	240.00	211.00	59.33	67.41	73.90	1.96	6.52	8.95	13.12	13.04
A21	157.00	206.00	240.00	255.00	164.00	55.50	68.41	82.50	1.73	5.62	7.54	12.35	12.75
A22	173.00	305.00	326.00	312.00	73.90	49.23	44.44	50.41	30.95	59.40	98.60	160.00	300.00
A23	288.00	299.00	287.00	308.00	307.00	198.00	237.00	244.00	—	258.00	287.00	294.00	297.00
Average	71.83	91.12	91.19	95.04	98.03	43.65	46.71	47.21	23.10	40.58	49.31	58.70	70.96

Table 6. Average salinity by pond in ppt, July 2005 – August 2006, Eden Landing Complex, South Bay Salt Ponds, San Francisco Bay, CA. — not sampled.

Pond	Jul-05	Aug-05	Oct-05	Nov-05	Dec-05	Jan-06	Feb-06	Mar-06	Apr-06	May-06	Jun-06	Jul-06	Aug-06
B1C	40.20	31.70	47.87	76.89	96.45	20.14	50.25	24.47	5.45	32.07	—	26.00	50.40
B2C	31.53	35.65	35.44	31.62	26.75	18.20	17.09	14.30	2.12	3.26	11.35	25.11	28.88
B3C	33.32	45.76	38.70	35.32	32.09	19.68	18.70	16.32	4.24	5.93	11.13	26.47	28.66
B4C	33.58	50.64	234.00	104.00	94.40	49.21	50.40	53.05	44.89	65.30	—	—	98.60
B5C	—	79.20	—	97.20	86.10	39.72	50.22	52.88	33.90	54.19	—	—	75.20
B6C	91.40	123.00	87.75	67.83	65.63	54.80	—	44.13	37.88	45.78	60.56	82.15	64.15
B1	34.28	36.69	40.18	38.21	32.58	26.14	23.08	20.72	12.84	13.60	18.25	25.97	31.11
B2	38.58	43.14	50.01	48.90	41.72	32.53	21.42	30.22	23.17	27.09	24.29	29.27	35.80
B4	39.52	45.46	51.63	60.50	43.44	33.22	38.70	35.75	30.39	31.09	25.34	32.17	37.54
B5	106.33	139.33	65.27	60.58	67.57	49.23	52.79	44.27	35.75	39.58	47.08	45.78	50.82
B6	65.72	117.80	121.40	71.36	79.40	59.40	52.00	41.30	31.15	31.53	33.37	40.61	50.56
B7	40.67	71.30	65.72	56.51	54.21	41.60	37.54	30.50	23.35	25.66	24.34	31.82	43.88
B6A	130.00	136.50	248.00	250.00	23.24	18.15	29.61	27.15	22.43	37.13	50.48	59.80	85.59
B6B	120.67	135.33	206.67	202.33	41.99	27.24	31.09	27.48	21.88	34.34	49.29	56.71	88.40
B8	70.46	76.74	55.52	43.64	35.94	22.25	18.22	19.75	12.57	21.79	36.71	56.38	46.18
B8A	58.39	52.66	56.60	48.26	33.61	24.67	27.79	29.15	18.54	31.51	40.82	43.46	40.70
B9	54.50	55.21	71.45	71.13	60.69	36.42	38.08	35.01	30.32	38.58	60.46	57.96	46.21
B10	26.76	29.49	29.89	25.58	28.11	18.15	15.86	15.18	10.71	16.40	22.94	30.58	32.76
B11	38.96	37.40	59.19	49.70	59.51	20.68	23.85	22.96	20.24	31.79	42.44	67.20	202.00
B12	—	—	—	—	—	29.85	40.09	24.25	38.20	49.15	124.00	—	—
B13	167.00	156.00	307.00	70.74	130.00	36.47	40.69	43.38	38.72	49.16	68.84	145.40	—
B14	153.00	128.60	201.00	75.56	78.97	45.38	41.60	38.01	33.18	46.44	103.00	133.42	270.00
Average	68.74	77.50	103.66	75.52	57.73	32.87	34.24	31.37	24.18	33.24	44.98	53.49	70.37

Table 7. Average salinity by pond in ppt, July 2005 – August 2006, Ravenswood Complex, South Bay Salt Ponds, San Francisco Bay, CA.

Pond	Jul-05	Aug-05	Oct-05	Nov-05	Dec-05	Jan-06	Feb-06	Mar-06	Apr-06	May-06	Jun-06	Jul-06	Aug-06
R1	137.50	155.00	82.63	189.00	144.30	62.36	65.24	64.64	59.41	68.68	109.75	140.00	169.75
R2	289.00	330.67	346.50	350.00	219.50	29.25	31.41	42.74	41.27	44.98	94.03	187.67	263.00
R3	253.33	322.00	326.00	456.00	227.00	37.43	57.03	72.36	65.60	85.67	166.75	238.50	296.75
R4	301.00	310.00	326.75	333.00	256.50	54.24	68.08	90.58	85.95	113.50	211.75	299.75	314.25
R5	296.50	305.50	339.50	353.50	278.00	52.45	68.13	79.53	85.15	116.00	212.00	304.50	332.50
RS5	253.50	306.50	345.00	354.50	298.50	49.45	86.10	81.55	90.40	115.50	249.00	325.00	367.00
RSF2	320.00	332.67	365.50	362.67	228.37	90.08	36.34	55.29	48.56	60.45	123.00	209.33	282.67
Average	264.40	294.62	304.55	342.67	236.02	53.61	58.90	69.53	68.05	86.40	166.61	243.54	289.42

Table 8. Summary of ebb tide surveys and adjacent pond counts, winter 2005, Ravenswood Complex, South Bay Salt Ponds, San Francisco Bay, CA.

Date	11/22/04	12/22/04	2/18/05	3/17/05	4/17/05
tidal rate (ft/15 min)	-0.36	-0.39	-0.35	-0.33	-0.29
mud flat maximum count	4212	3660	3306	4212	4910
pond maximum count	2510	8466	3763	1075	3270
time to vacate pond (hours)	1:15	2:00; 85% within 1:00	1:00	0:45	3:00; 80% within 1:00
survey pond	R1	R1	RSF2	RSF2	R1

Table 9. Summary of ebb tide surveys and adjacent pond counts, winter 2005, Eden Landing Complex, South Bay Salt Ponds, San Francisco Bay, CA.

Date	1/18/05	2/22/05	3/16/05	4/29/05
tidal rate (ft/15 min)	- 0.23	- 0.25	- 0.25	- 0.30
mud flat maximum count	1502	1697	2124	809
pond maximum count	2625	5268	1676	222
time to vacate pond (hours)	1:00	1:00	2:15; 85% within 1:00	2:15; 70% within 1:00
survey pond	B13	B13	B12	B14

Table 10. Summary of ebb tide surveys and adjacent pond counts, winter 2005, Alviso Complex, South Bay Salt Ponds, San Francisco Bay, CA. — did not leave pond.

Date	11/19/04	12/21/04	1/20/05	2/24/05	3/25/05	4/18/05
mud flat maximum count	1727	6472	2485	2044	1413	7551
pond maximum count	3713	5978	1378	917	5086	4391
time to vacate pond (hours)	—	95% within 1:15	—	1:30 82% within 1:00	—	75% within 1:00
survey pond	A5	A5	A5	A8	A8	A8

Table 11. Percentage of birds by species that remained within 100m of water line during ebb and flood tides, South Bay Salt Ponds, San Francisco Bay, CA.

species	ebb (%)	flood (%)
American avocet	84.2	76.8
black-bellied plover	40.6	56.6
dowitcher	69.3	78.0
long-billed curlew	75.4	77.6
marbled godwit	92.7	96.1
willet	95.1	95.3
dunlin	90.2	59.6
least sandpiper	83.8	54.1
western sandpiper	67.6	35.9

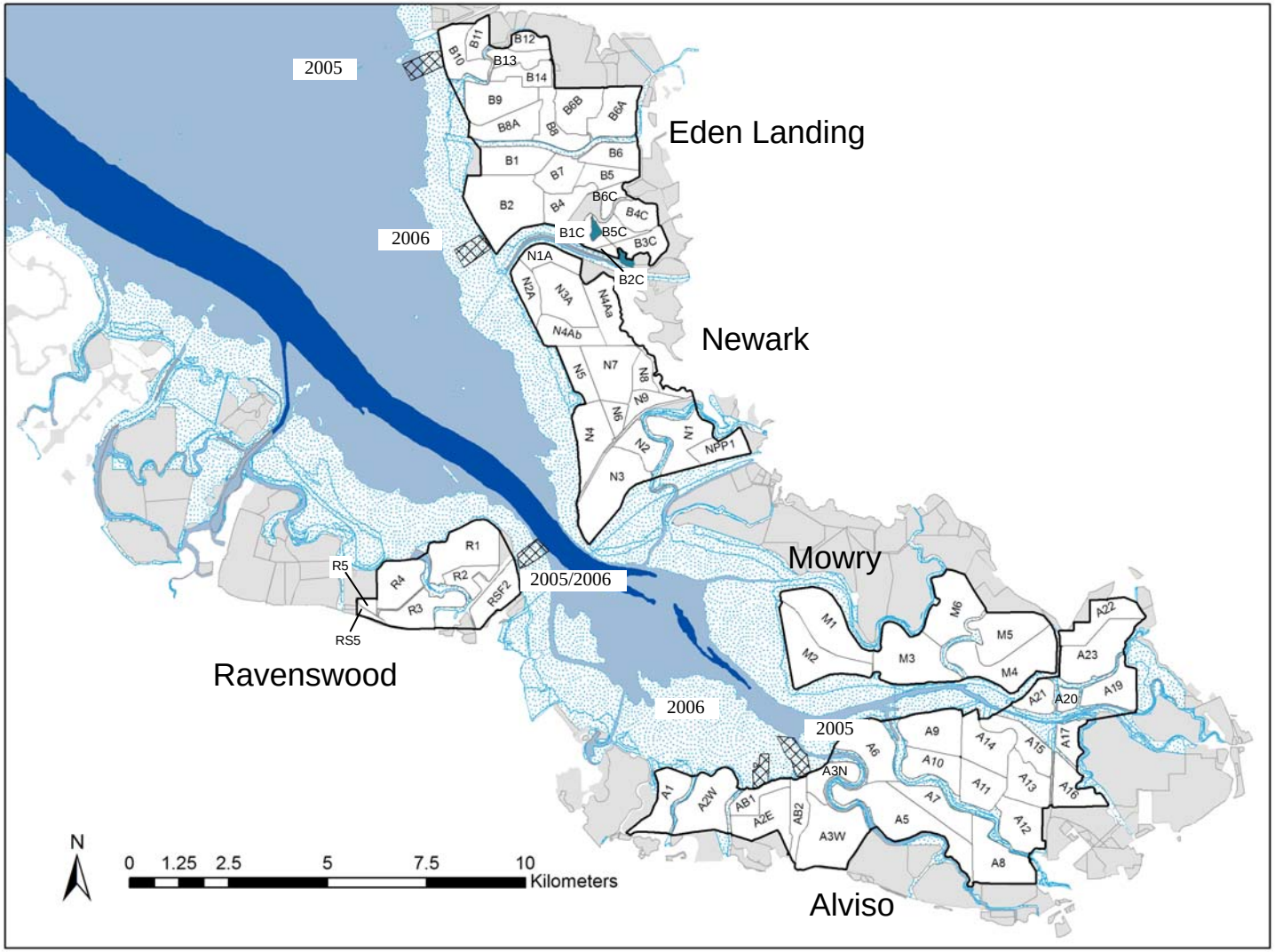

Figure 1. Project area map, South Bay Salt Ponds, San Francisco Bay, CA. Eden Landing, Alviso, and Ravenswood complexes comprise the South Bay Salt Pond Restoration Project; Newark and Mowry complexes remain in salt production. Cross-hatched areas represent mudflat survey sites; 2005 or 2006 season is indicated.

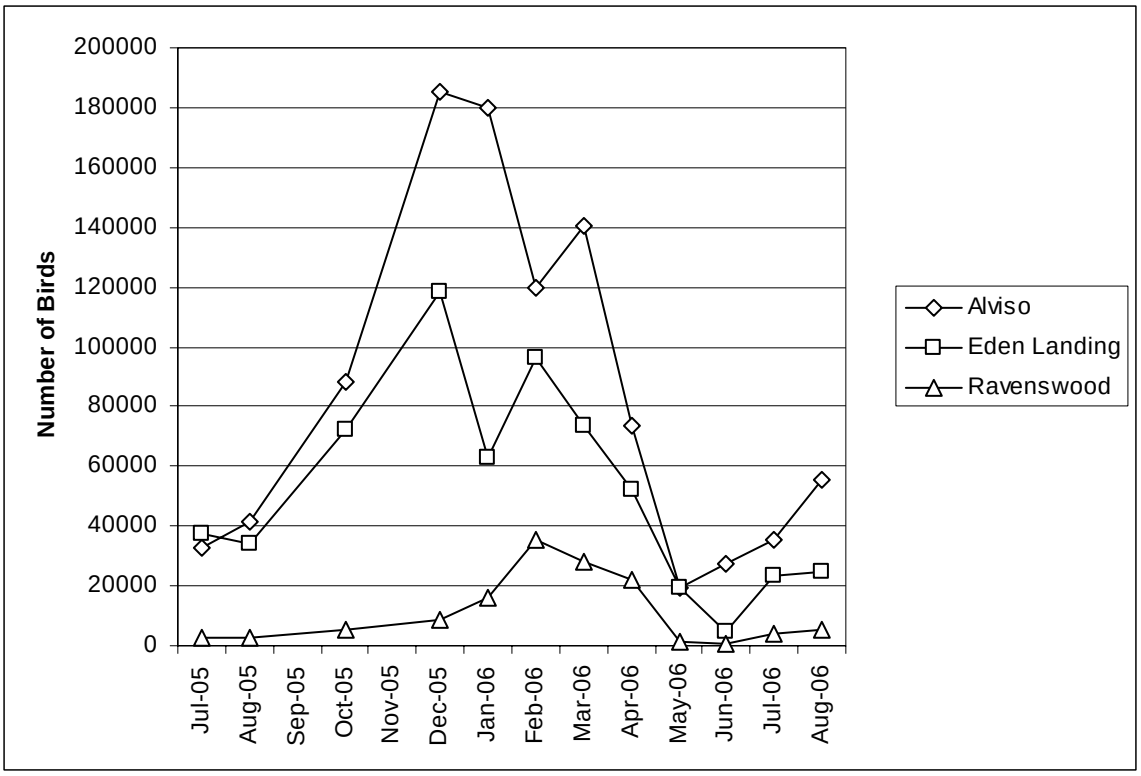

Figure 2. Monthly bird count totals of waterbird species by complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

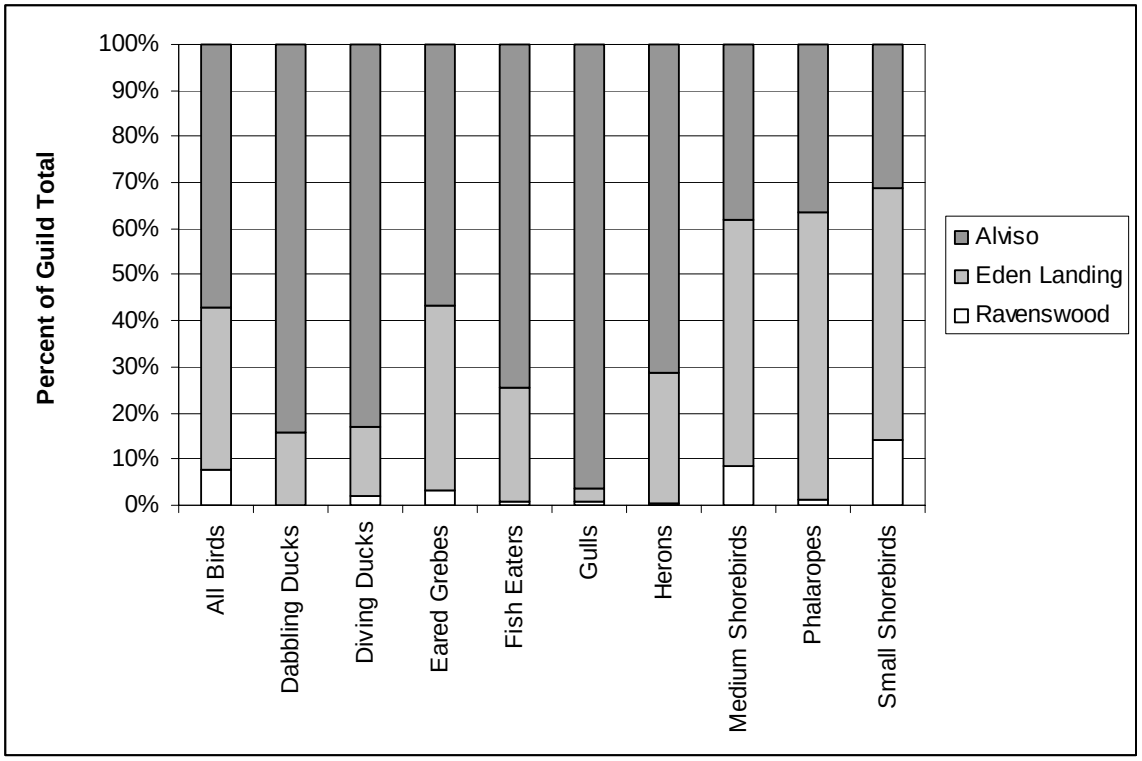

Figure 3. Percentage of foraging guilds by complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

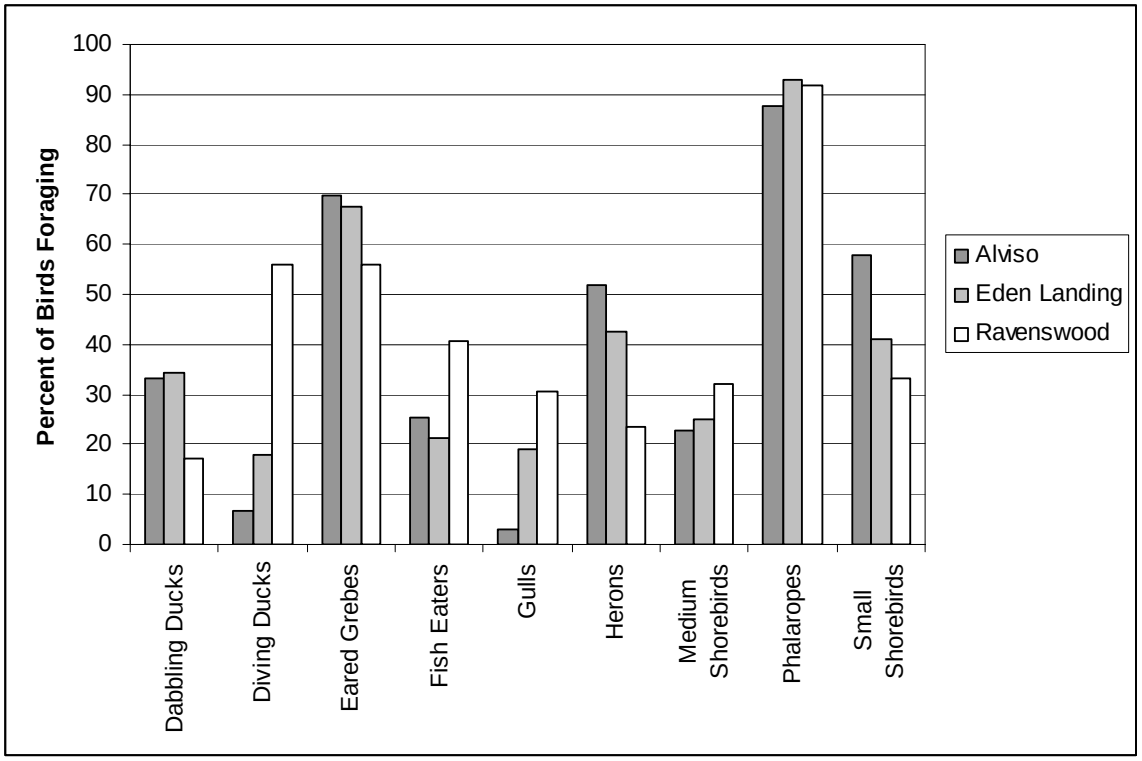

Figure 4. Percentage of birds foraging by complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

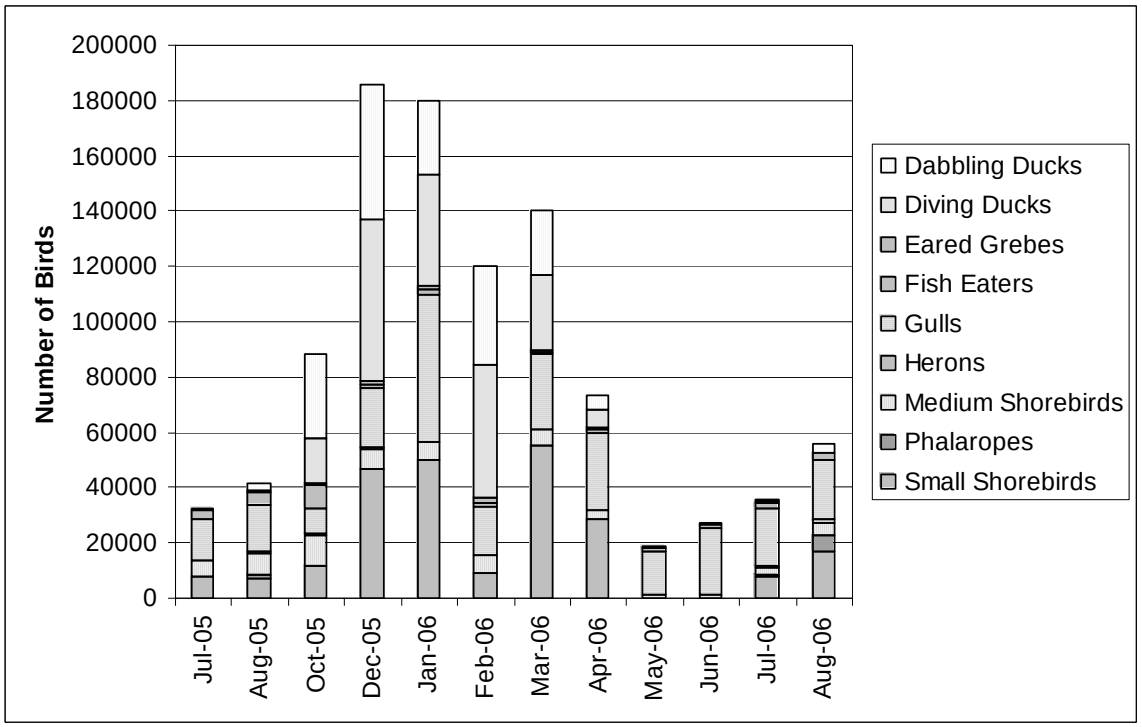

Figure 5. Monthly bird count totals by foraging guild, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

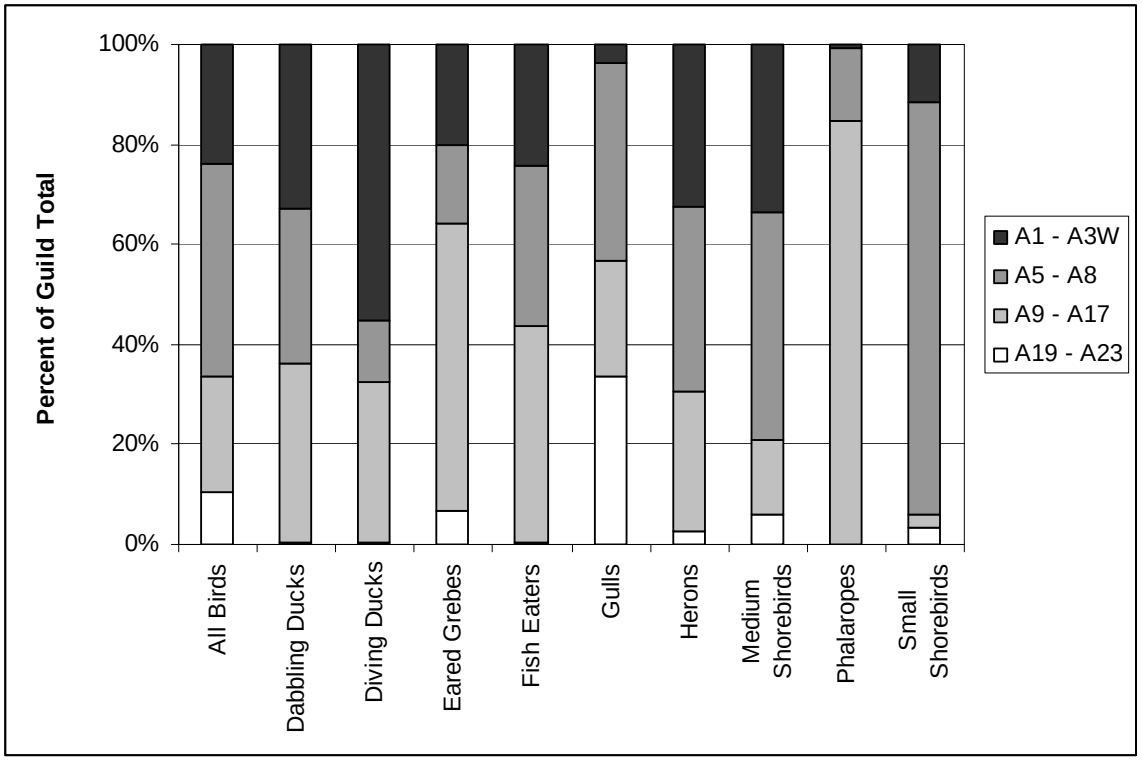

Figure 6. Percentage of foraging guilds by pond group, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

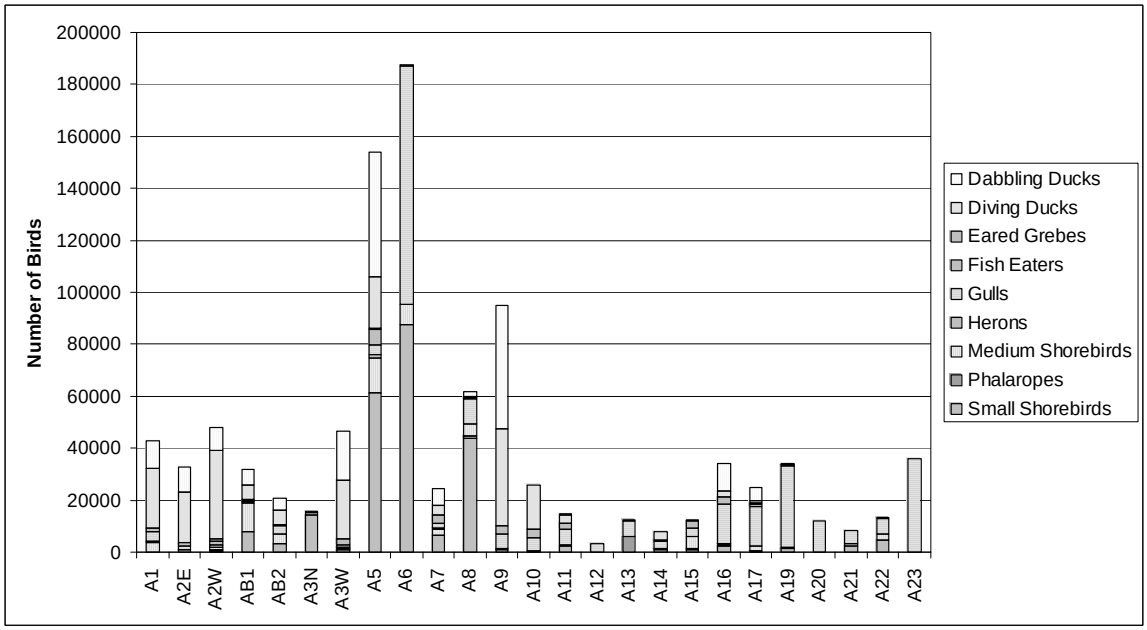

Figure 7. Pond bird count totals by foraging guild, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

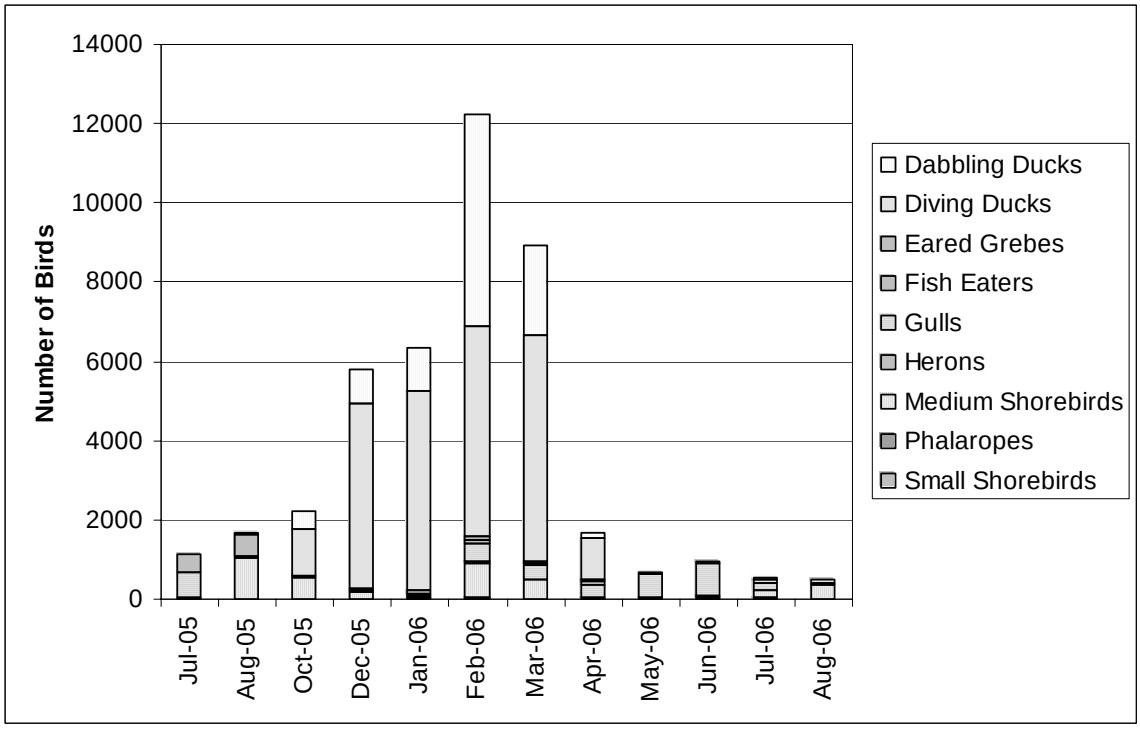

Figure 8. Monthly bird count totals by foraging guild, Pond A1, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

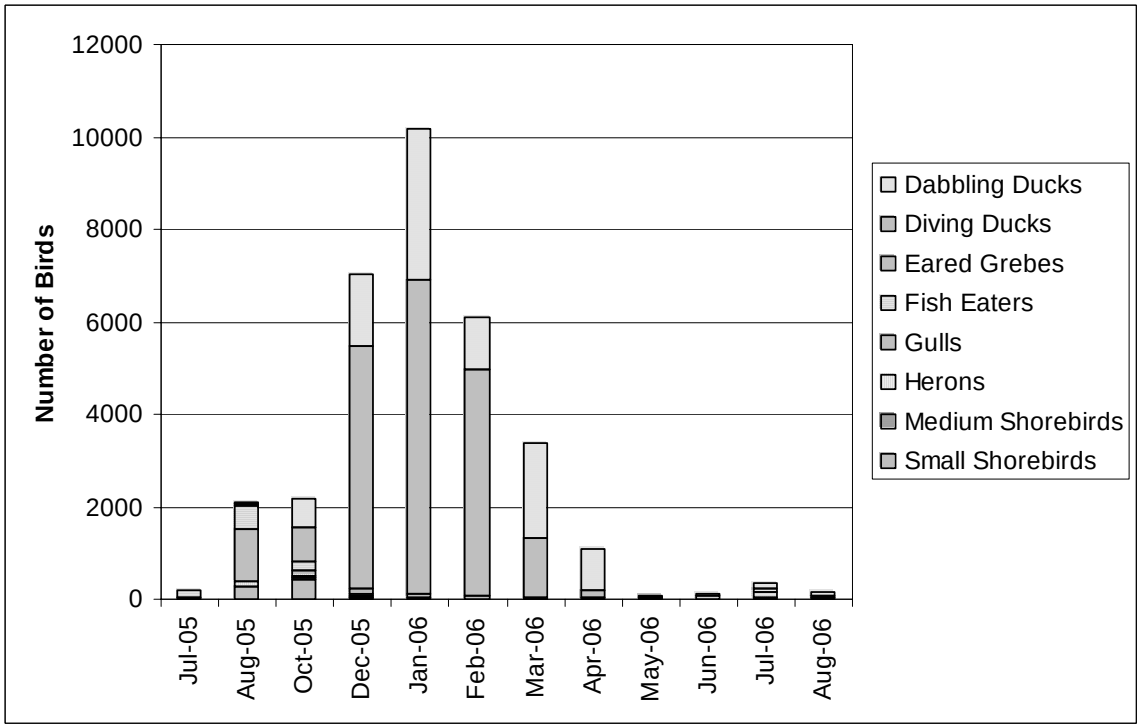

Figure 9. Monthly bird count totals by foraging guild, Pond A2E, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

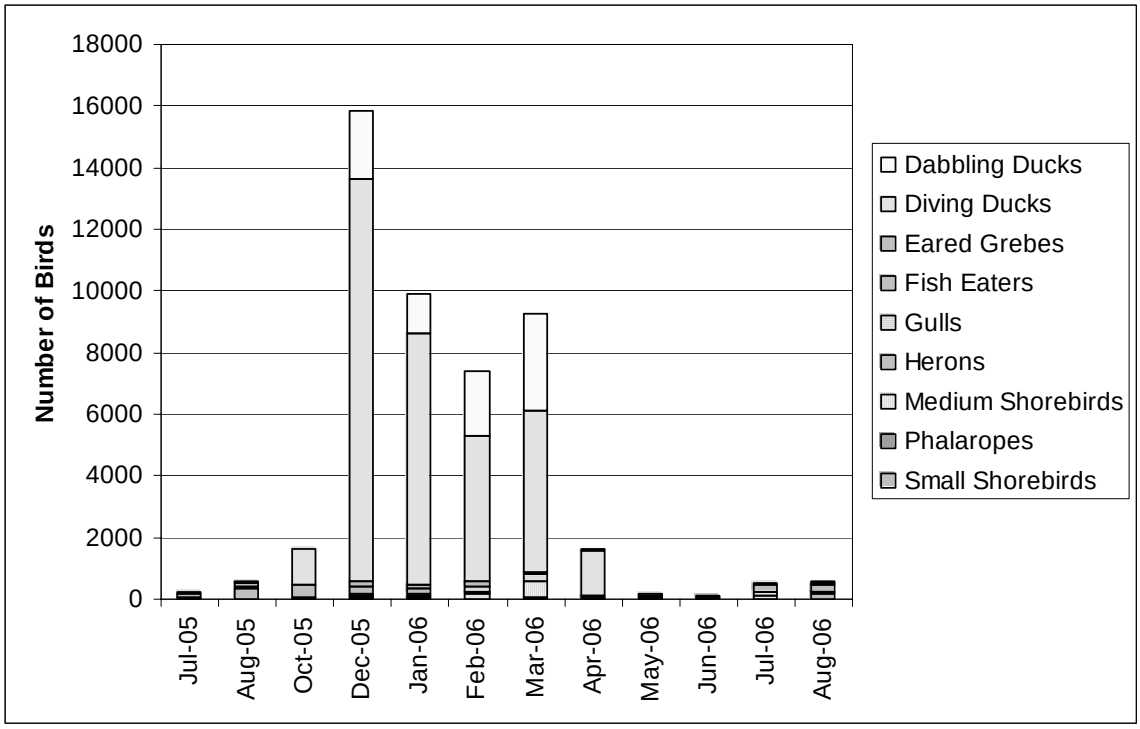

Figure 10. Monthly bird count totals by foraging guild, Pond A2W, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

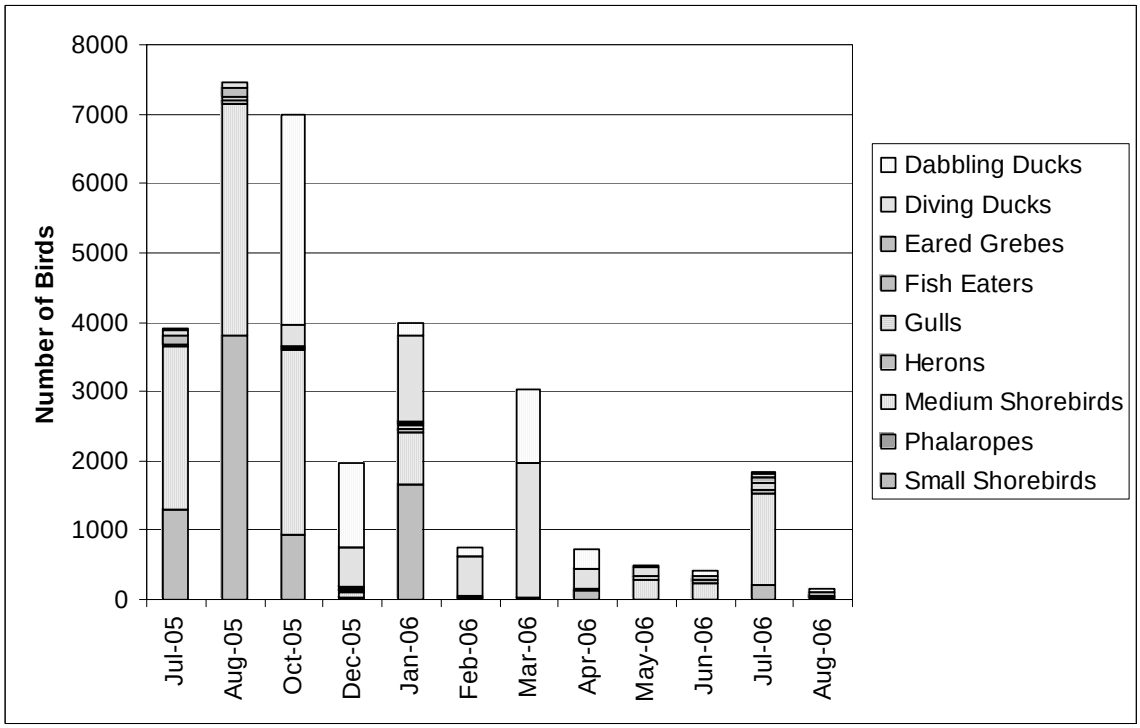

Figure 11. Monthly bird count totals by foraging guild, Pond AB1, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

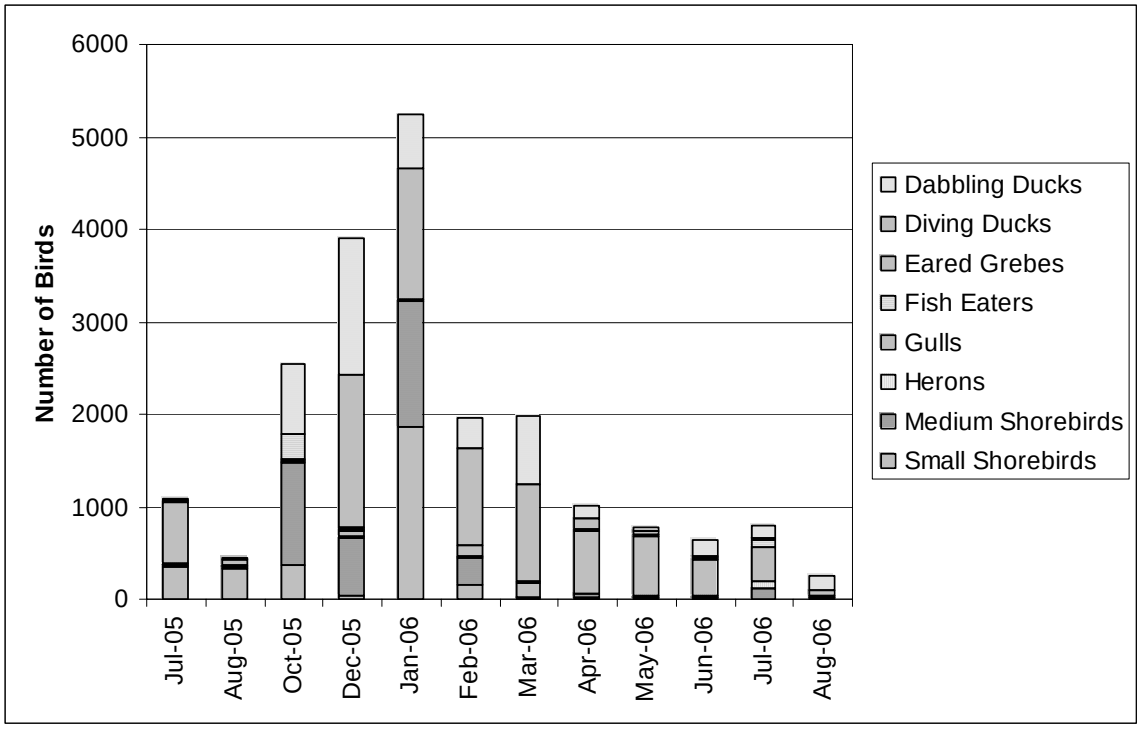

Figure 12. Monthly bird count totals by foraging guild, Pond AB2, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

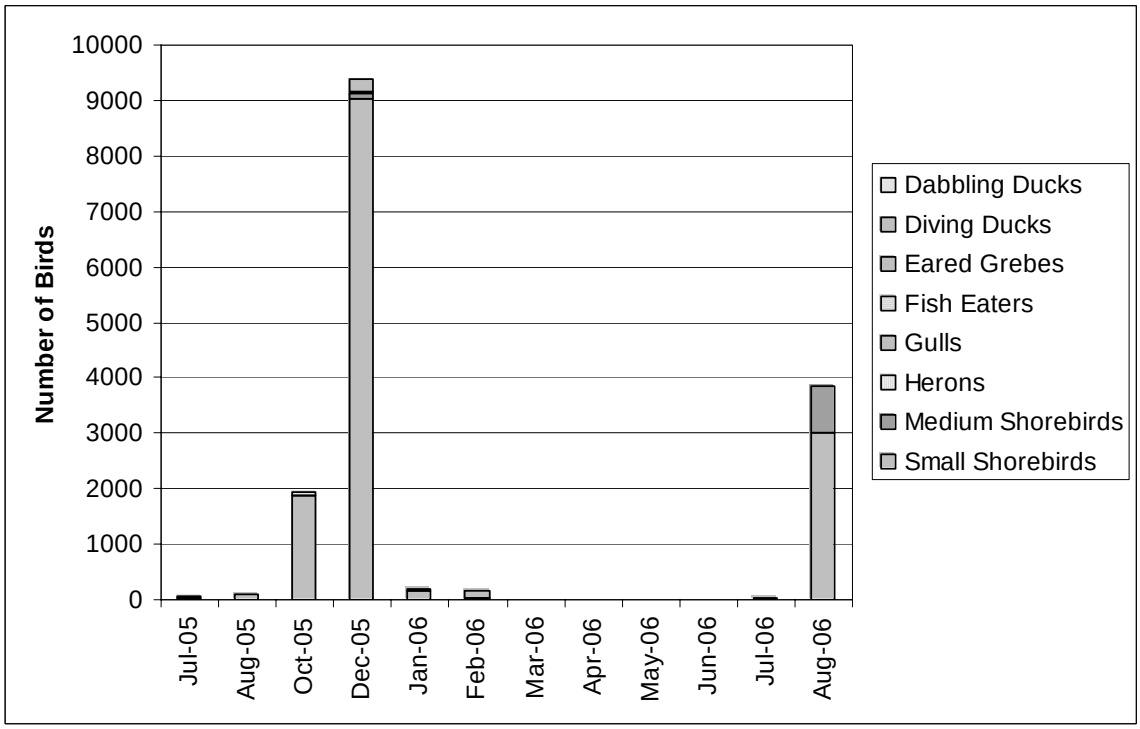

Figure 13. Monthly bird count totals by foraging guild, Pond A3N, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

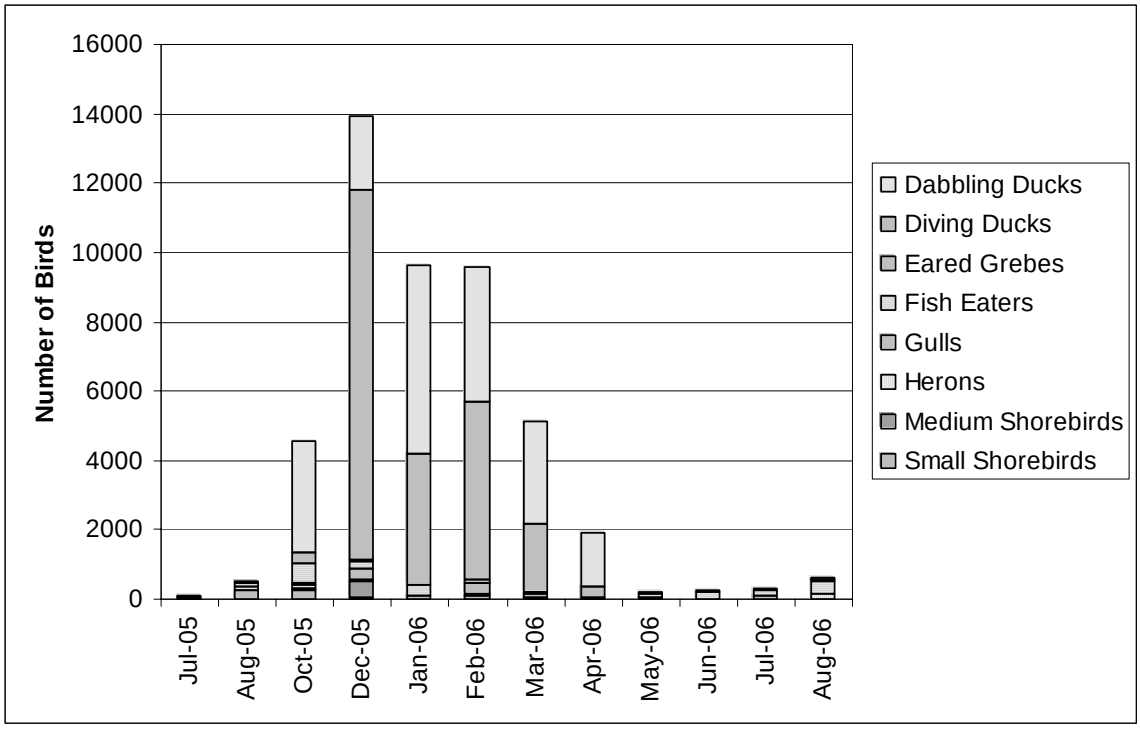

Figure 14. Monthly bird count totals by foraging guild, Pond A3W, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

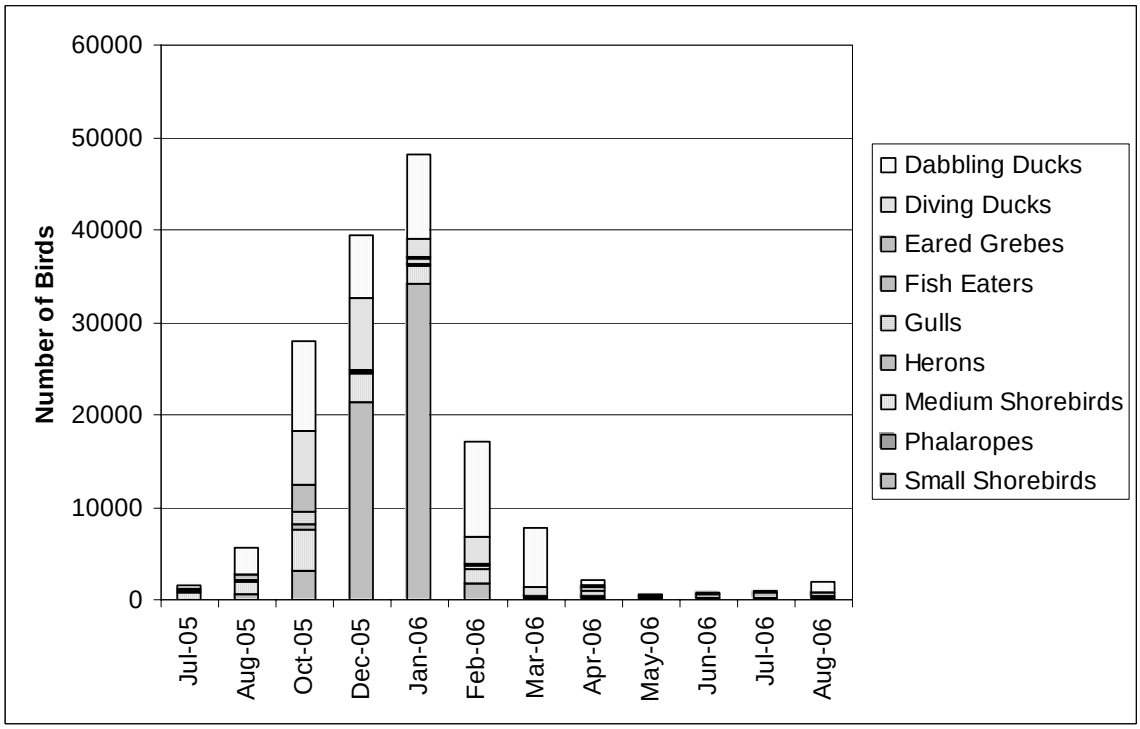

Figure 15. Monthly bird count totals by foraging guild, Pond A5, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

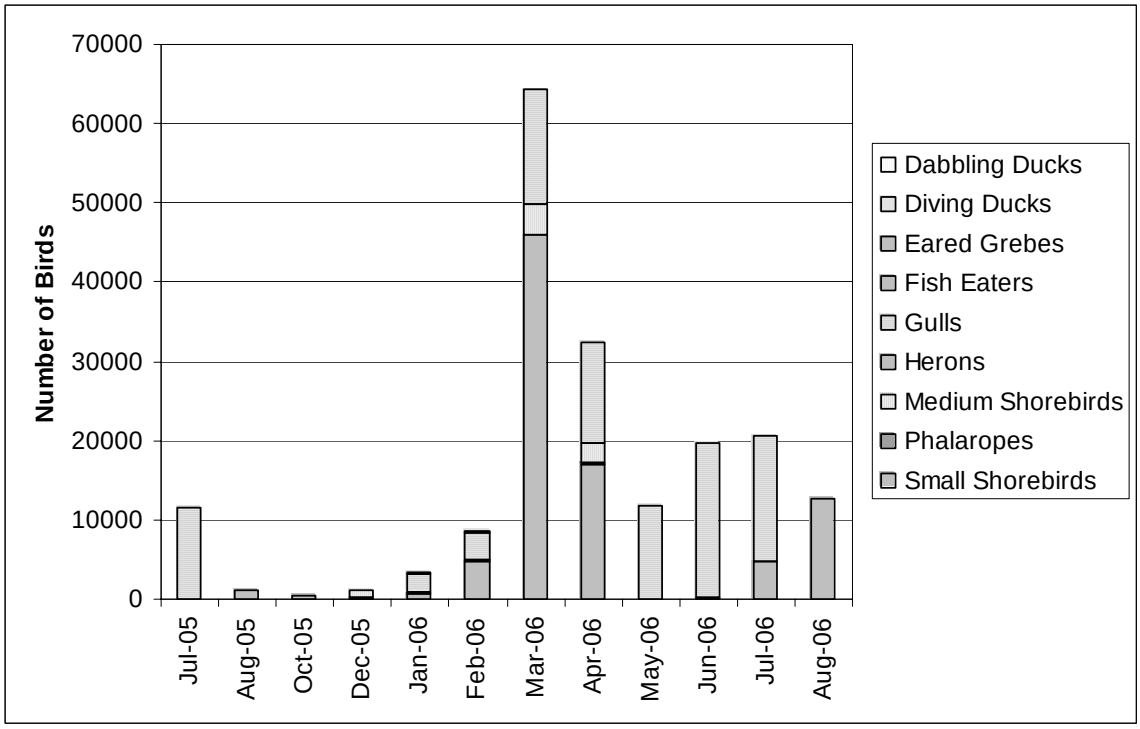

Figure 16. Monthly bird count totals by foraging guild, Pond A6, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

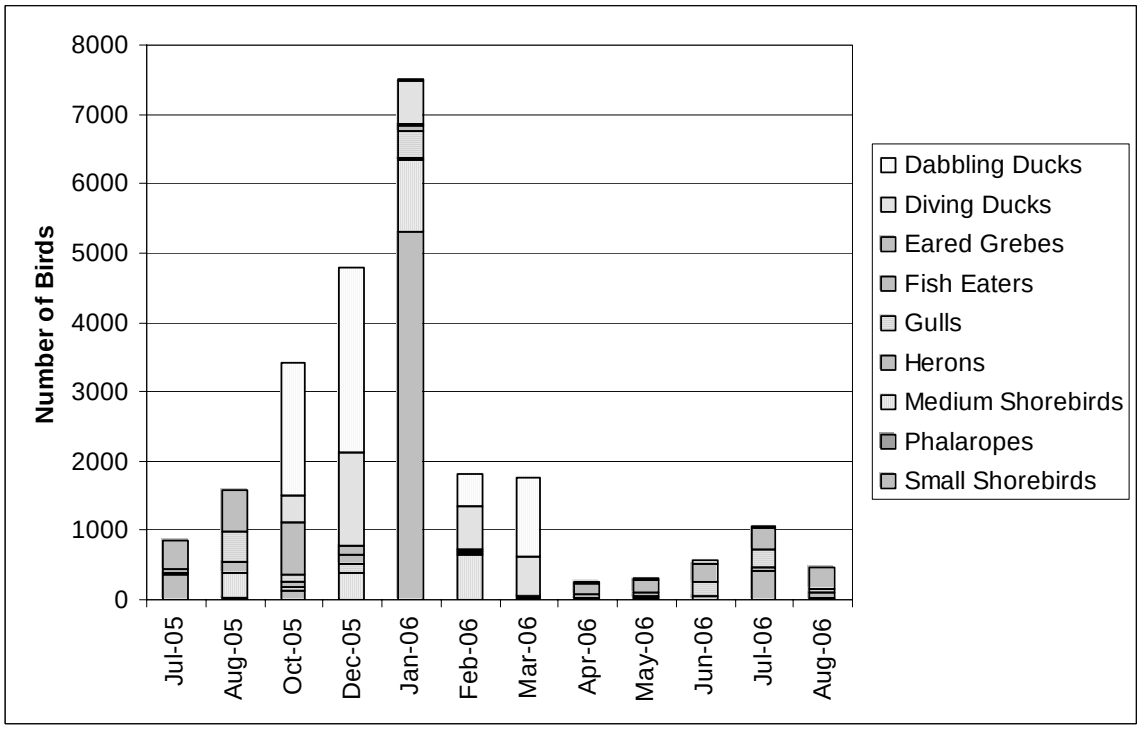

Figure 17. Monthly bird count totals by foraging guild, Pond A7, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

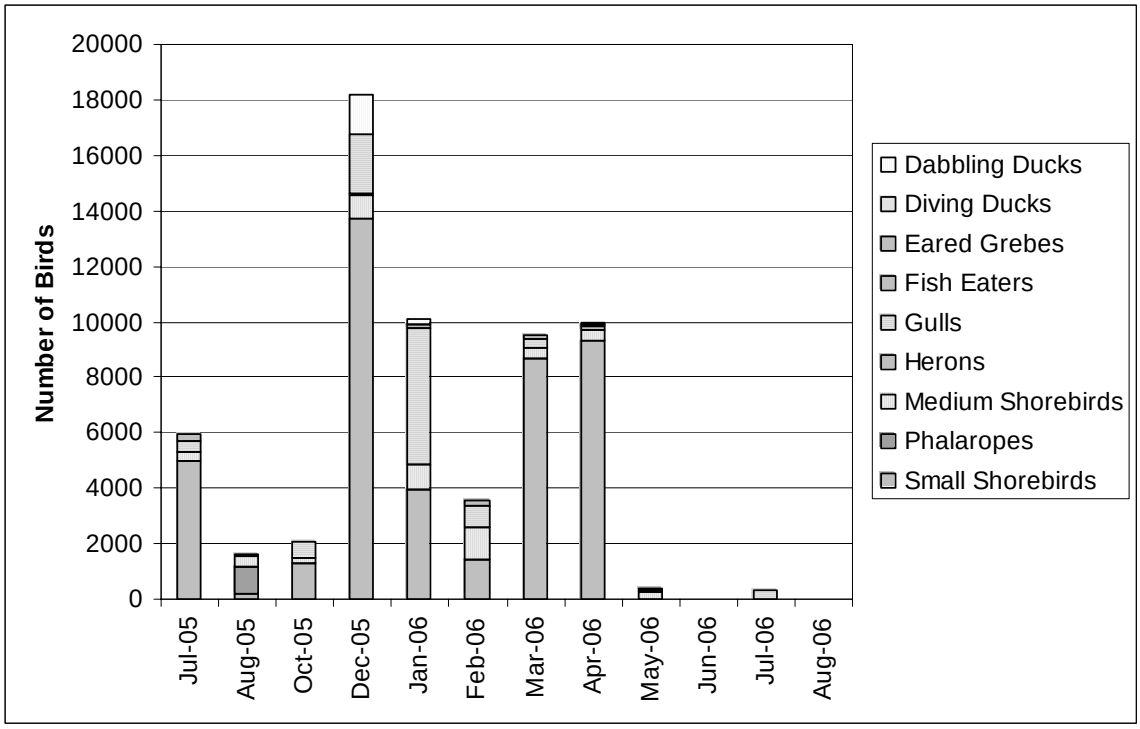

Figure 18. Monthly bird count totals by foraging guild, Pond A8, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

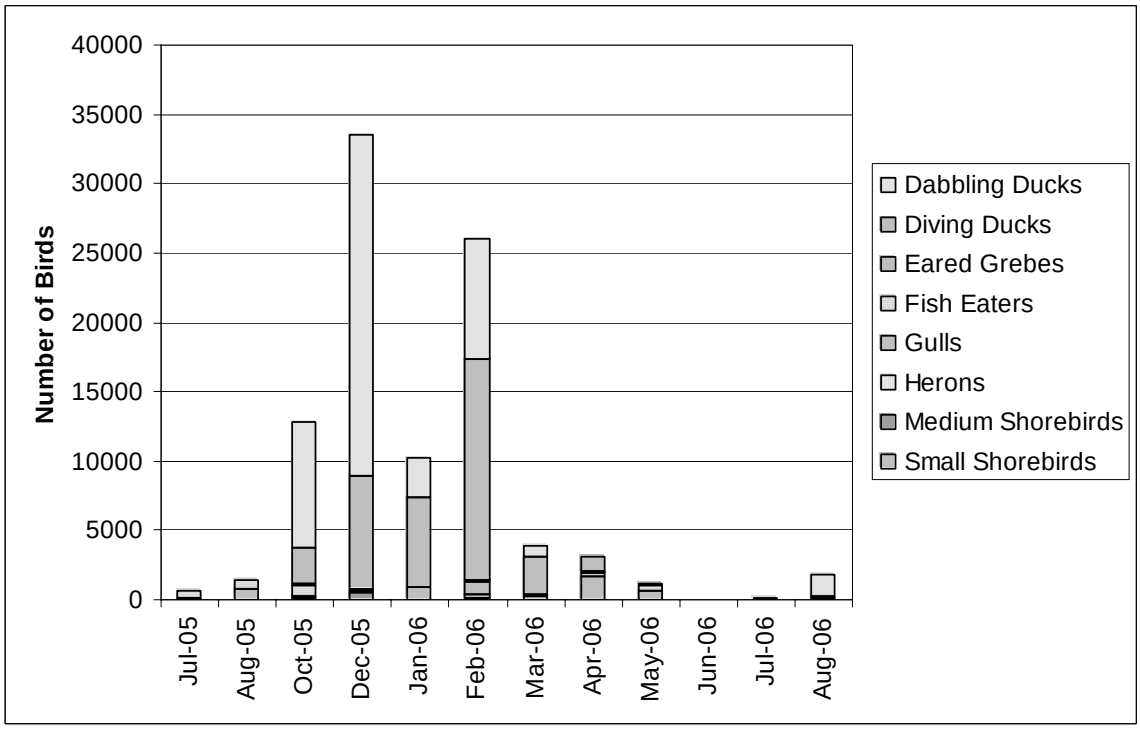

Figure 19. Monthly bird count totals by foraging guild, Pond A9, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

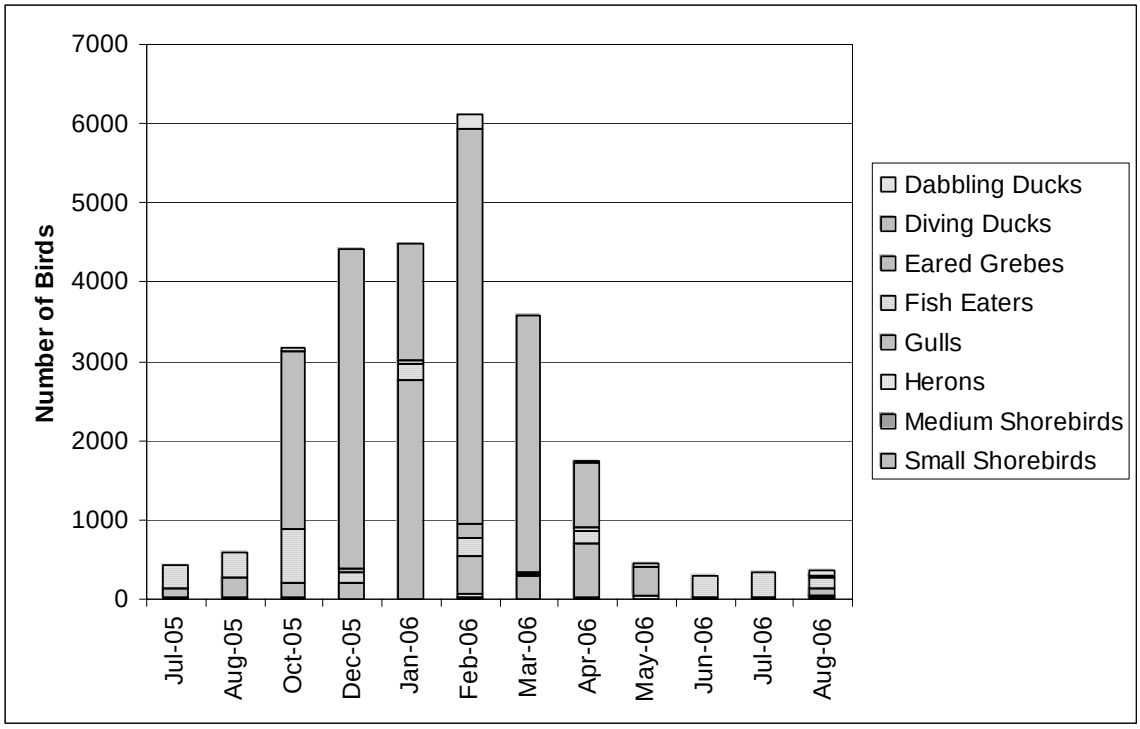

Figure 20. Monthly bird count totals by foraging guild, Pond A10, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

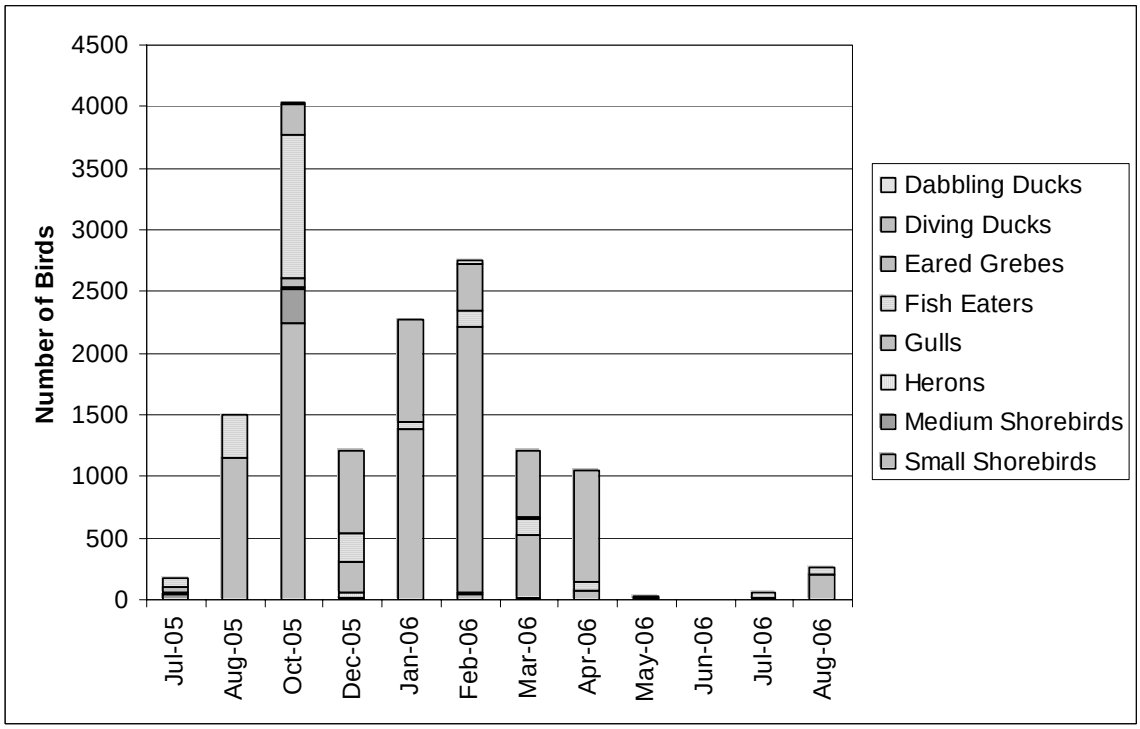

Figure 21. Monthly bird count totals by foraging guild, Pond A11, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

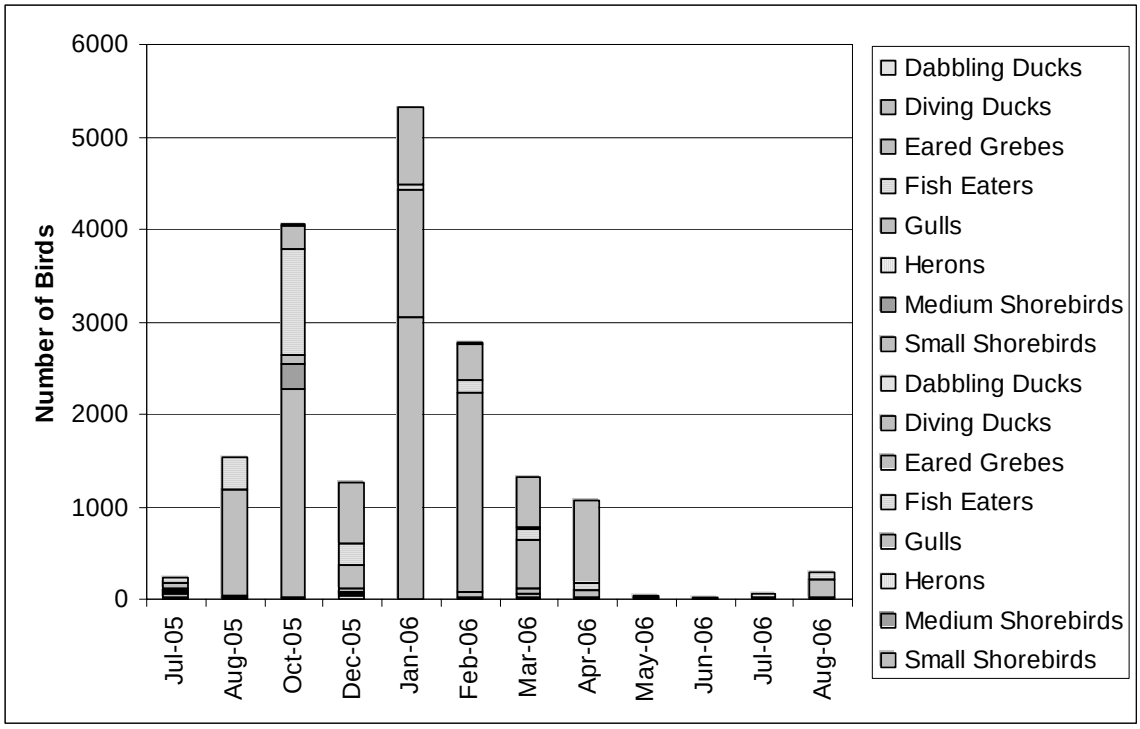

Figure 22. Monthly bird count totals by foraging guild, Pond A12, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

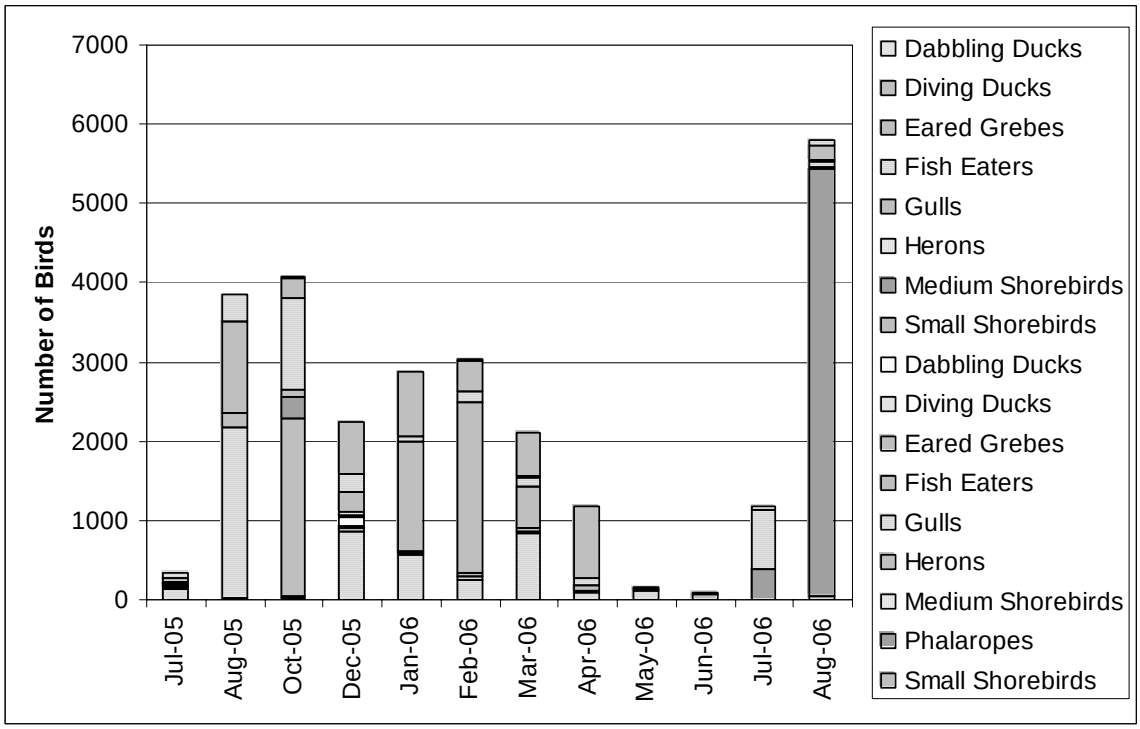

Figure 23. Monthly bird count totals by foraging guild, Pond A13, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

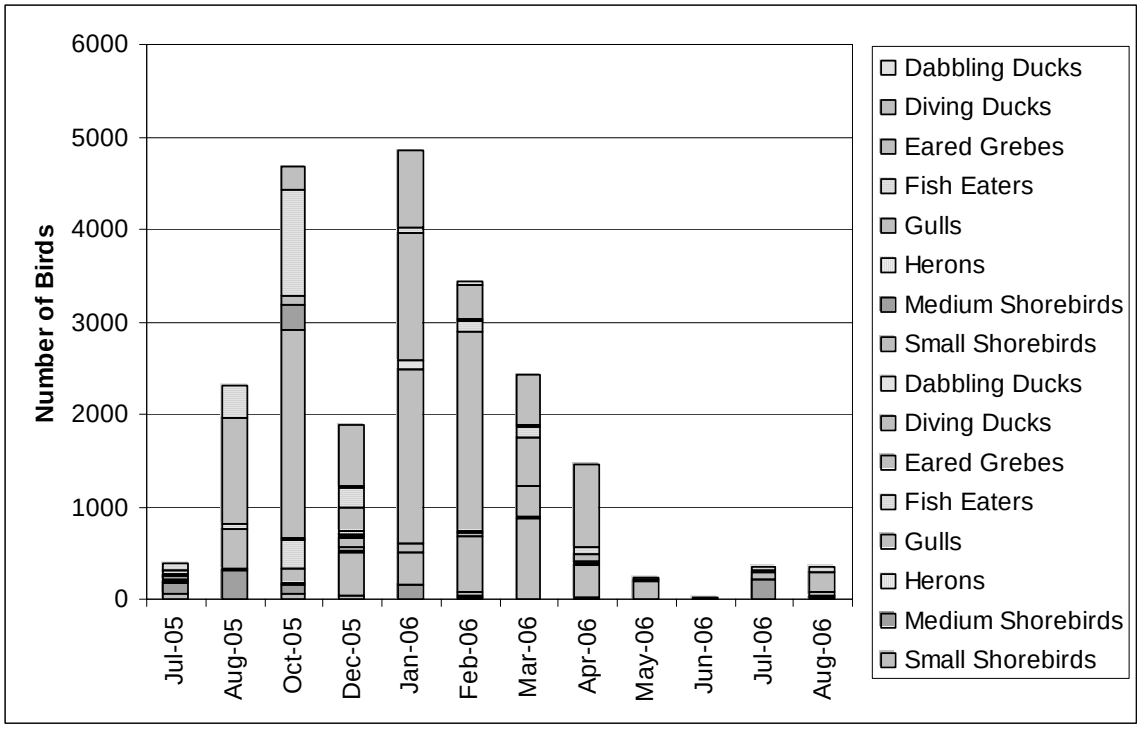

Figure 24. Monthly bird count totals by foraging guild, Pond A14, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

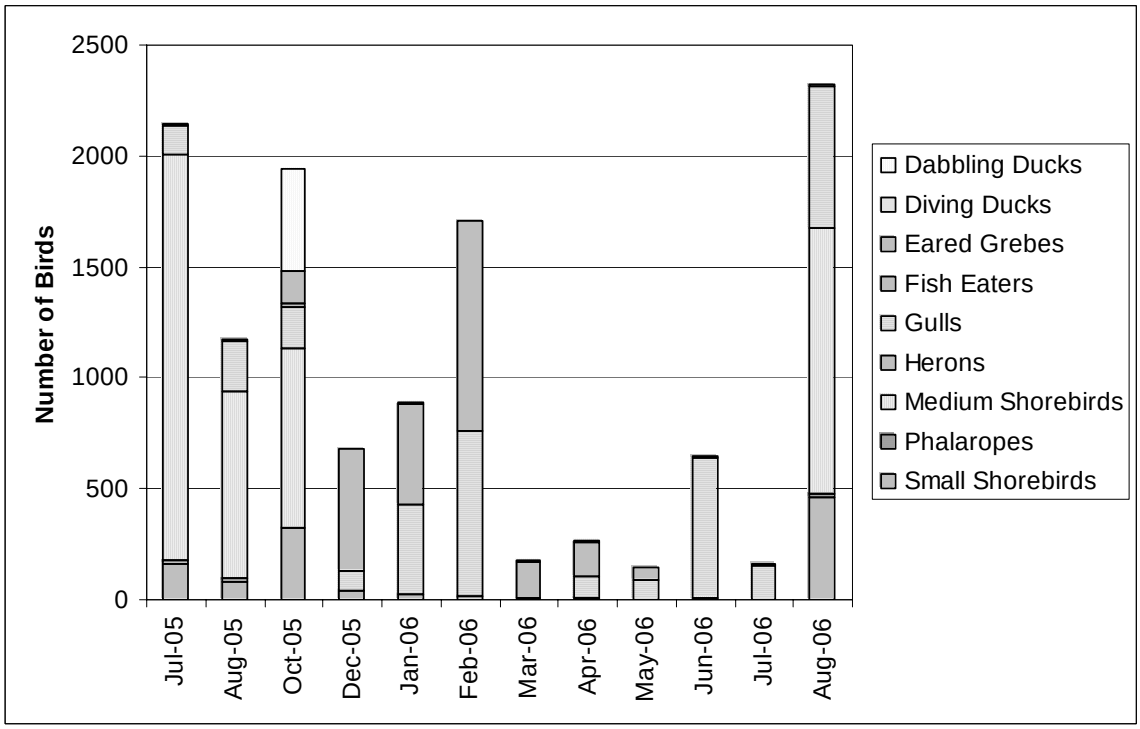

Figure 25. Monthly bird count totals by foraging guild, Pond A15, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

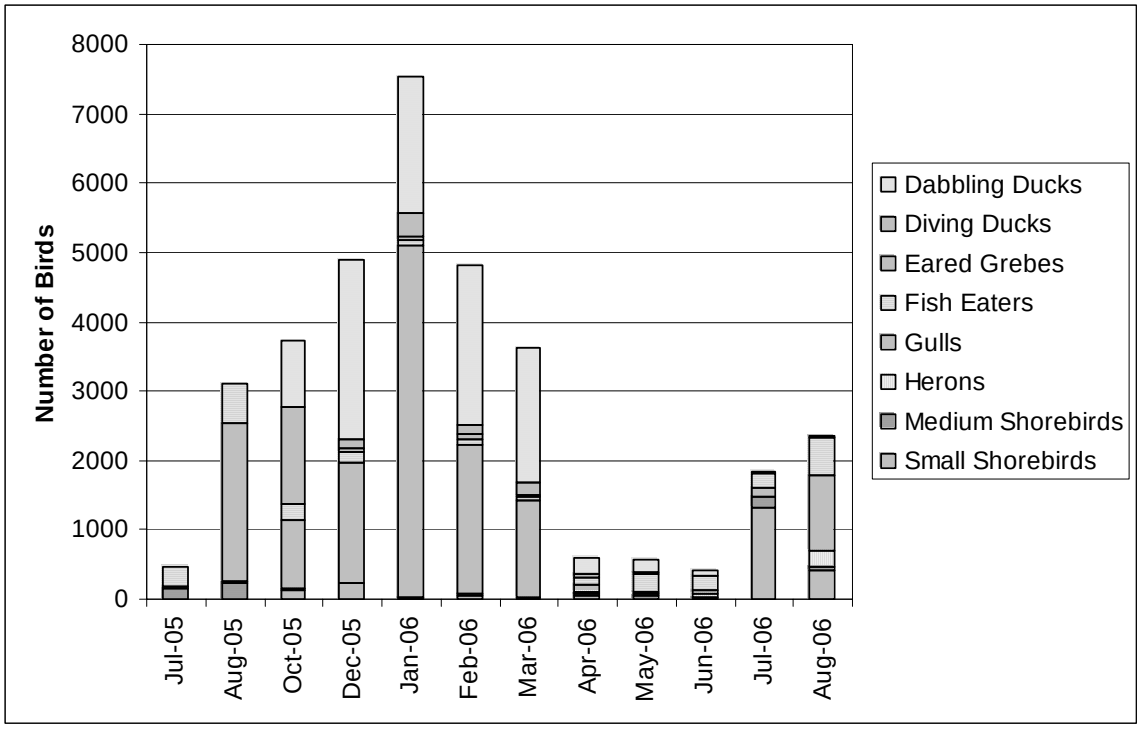

Figure 26. Monthly bird count totals by foraging guild, Pond A16, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

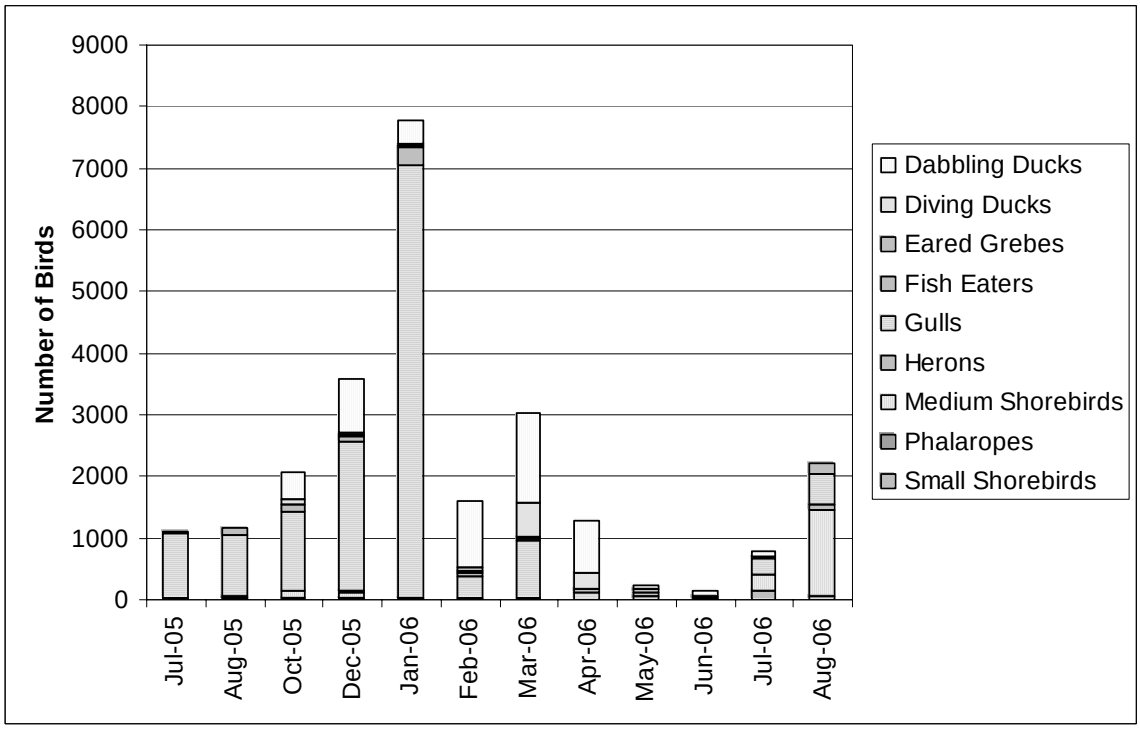

Figure 27. Monthly bird count totals by foraging guild, Pond A17, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

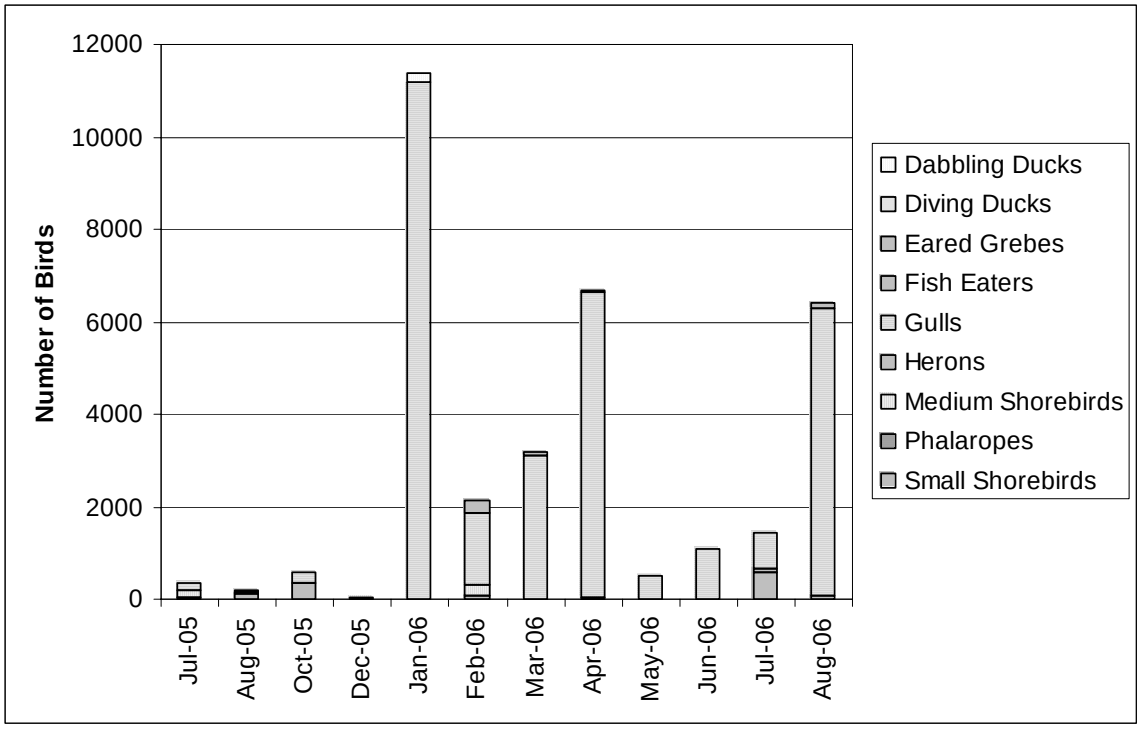

Figure 28. Monthly bird count totals by foraging guild, Pond A19, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

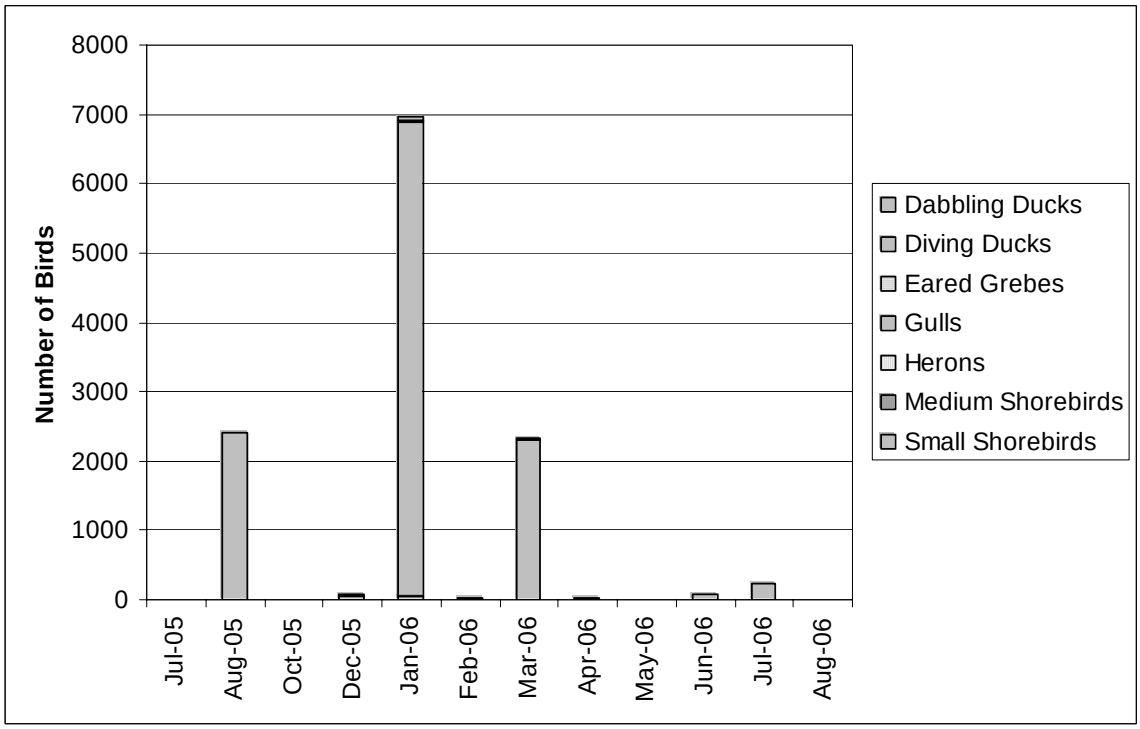

Figure 29. Monthly bird count totals by foraging guild, Pond A20, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

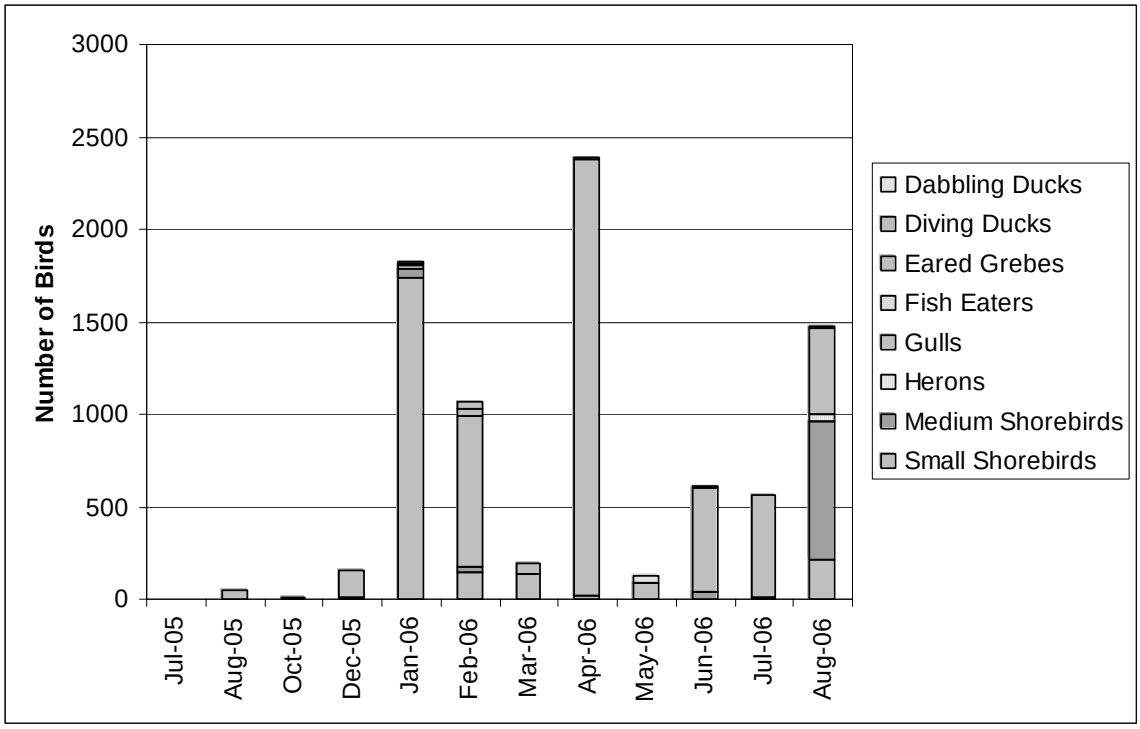

Figure 30. Monthly bird count totals by foraging guild, Pond A21, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

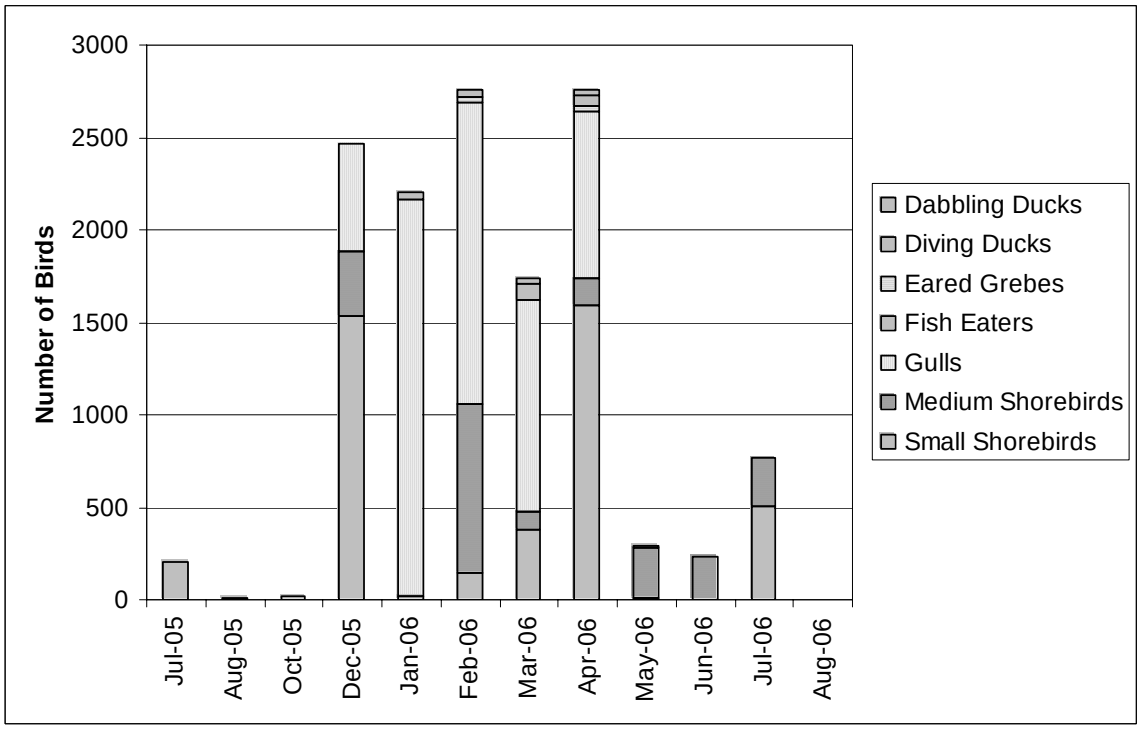

Figure 31. Monthly bird count totals by foraging guild, Pond A22, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

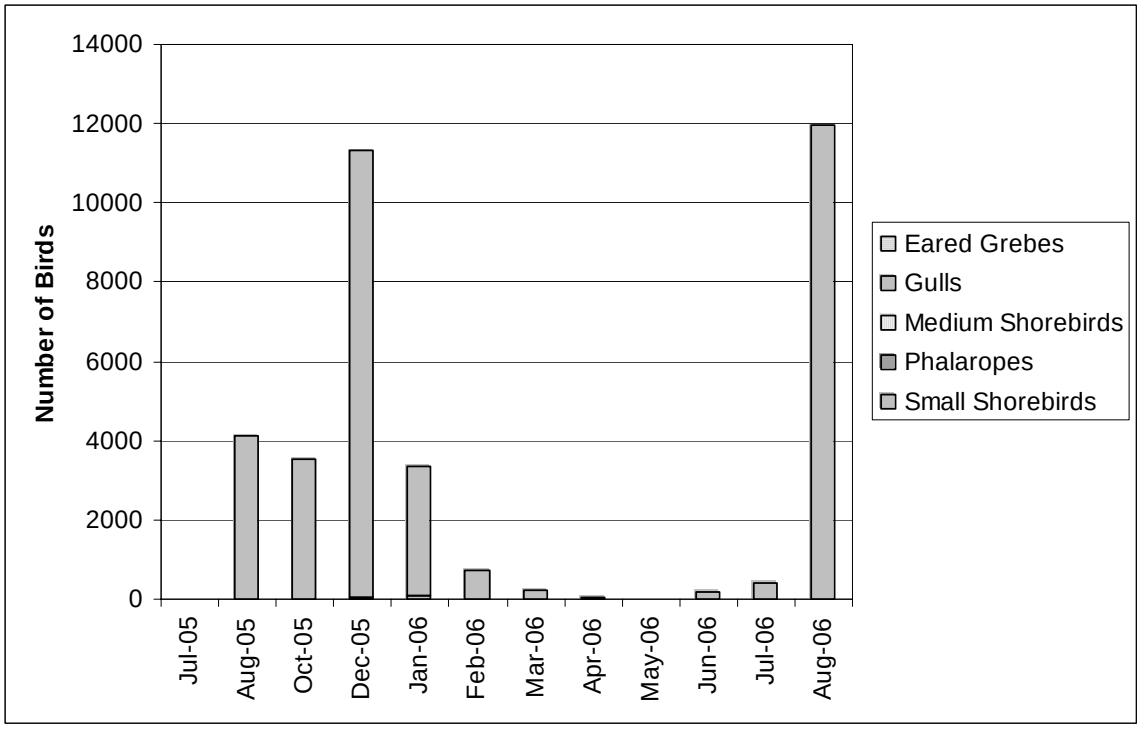

Figure 32. Monthly bird count totals by foraging guild, Pond A22, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

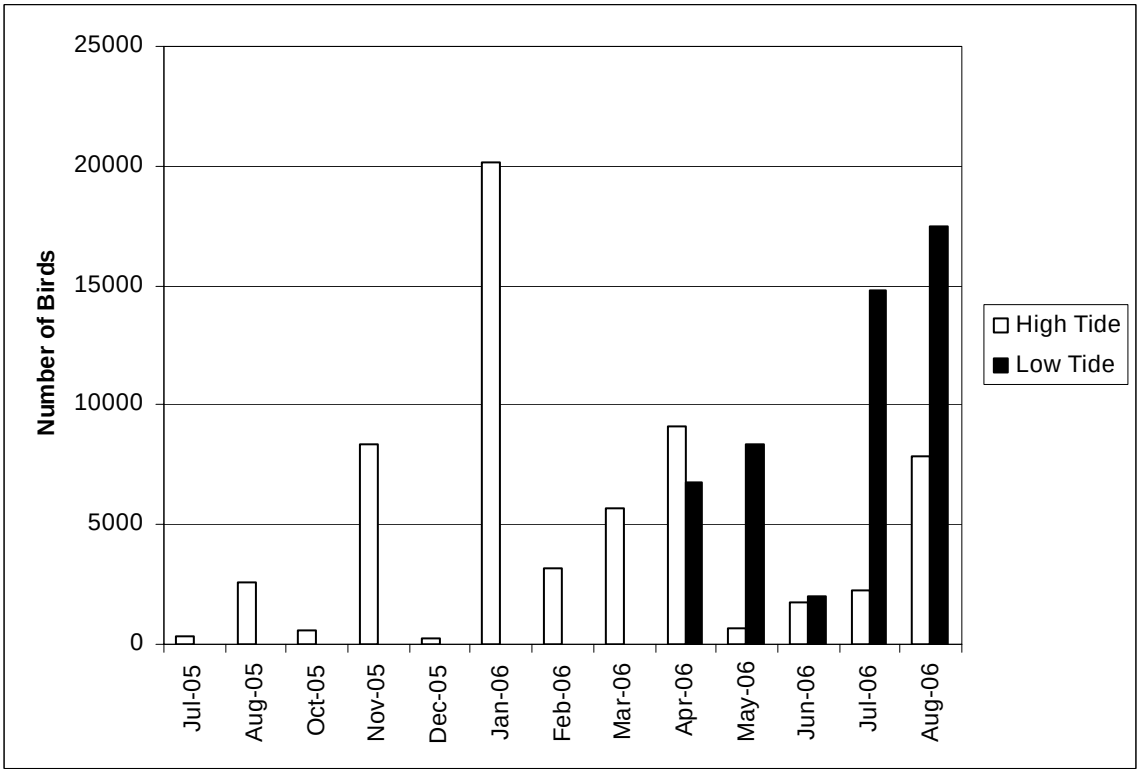

Figure 33. Monthly bird count totals by tide level, Ponds A19 – A21, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

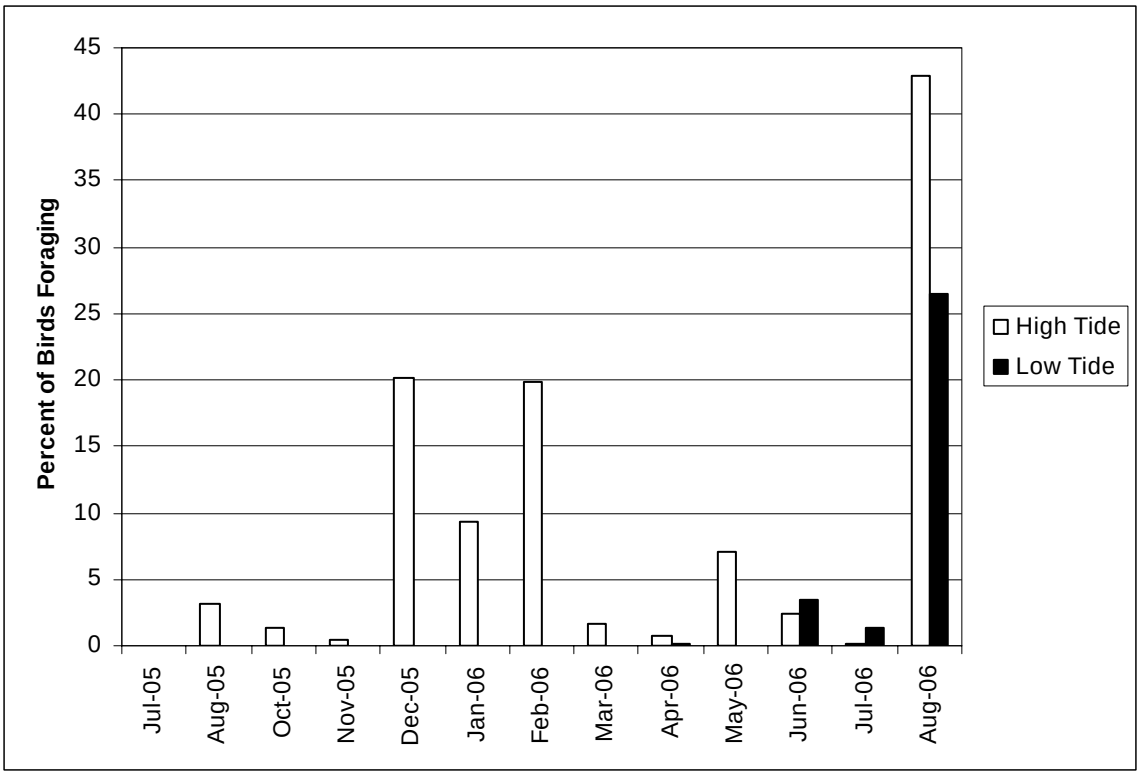

Figure 34. Percentage of birds foraging, Ponds A19 – A21, Alviso Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

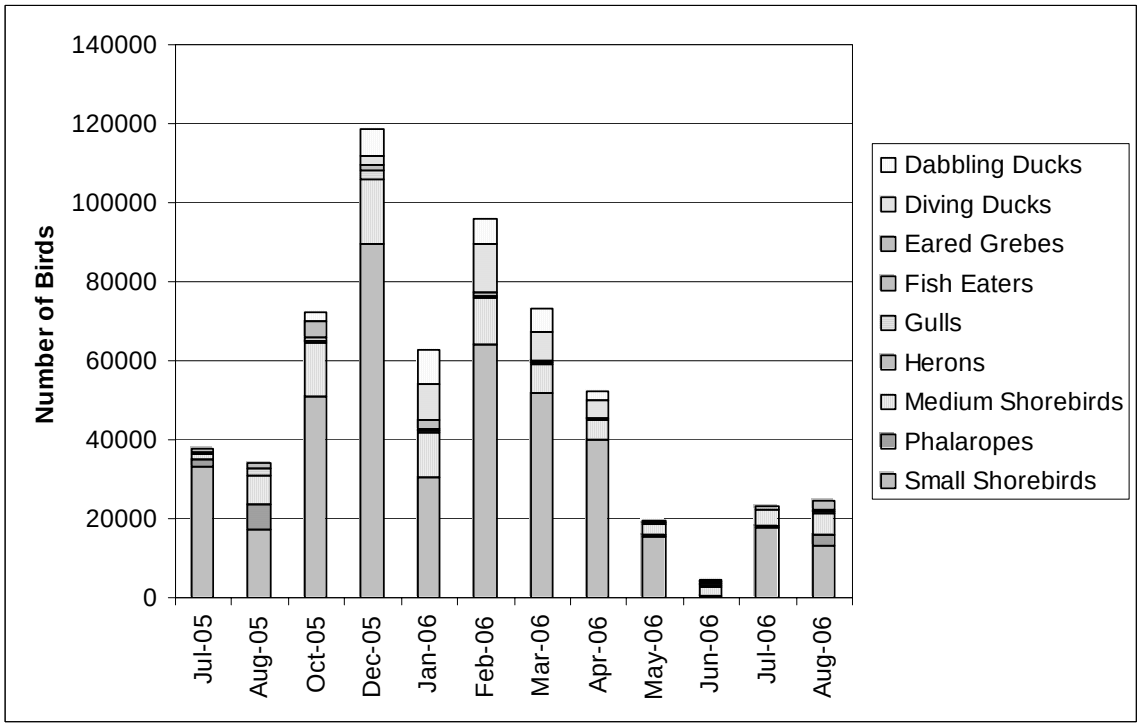

Figure 35. Monthly bird count totals by foraging guild, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

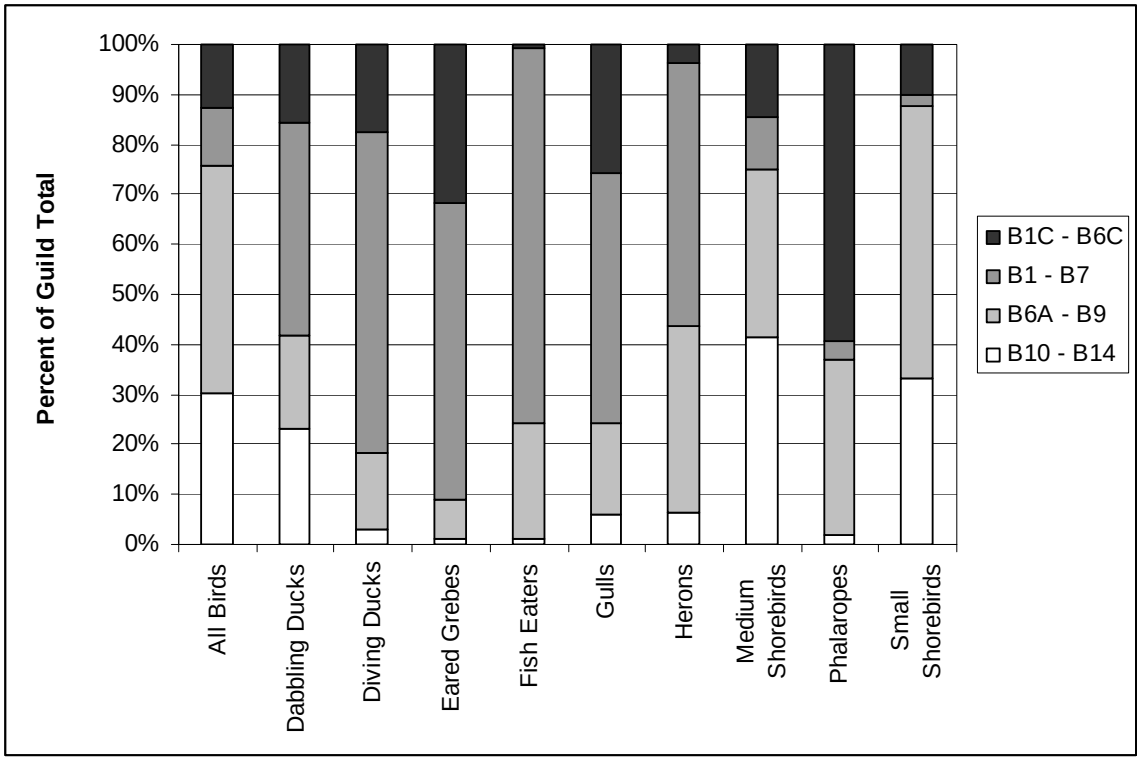

Figure 36. Percentage of foraging guilds by pond group, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

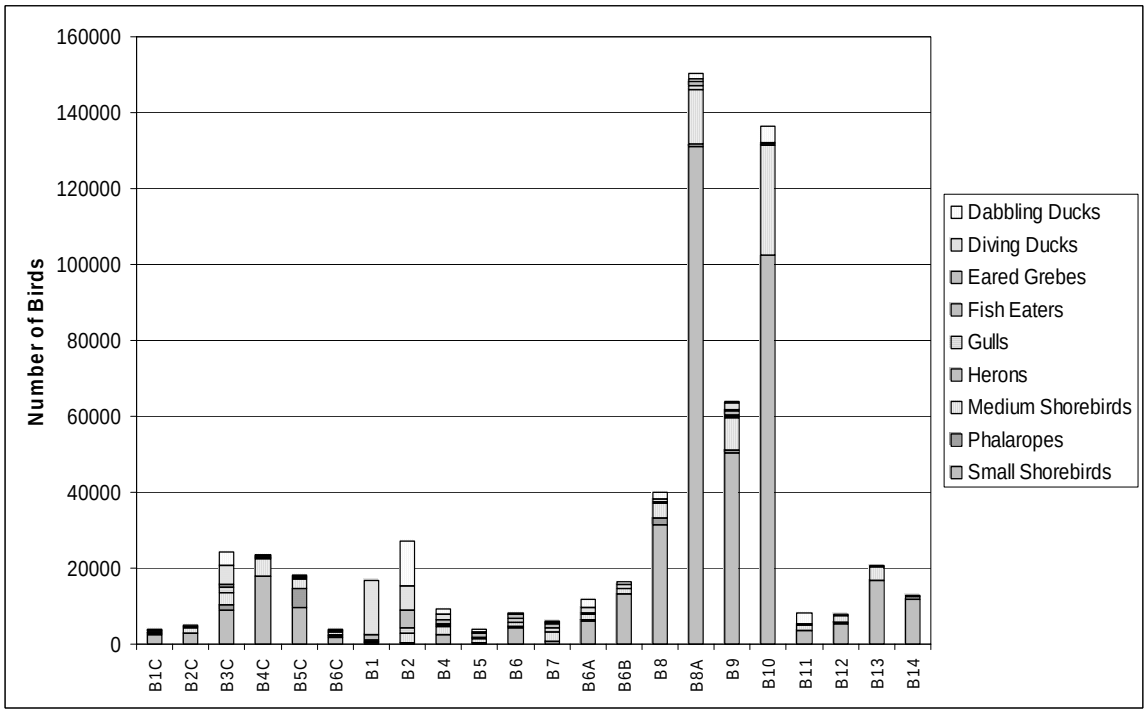

Figure 37. Pond bird count totals by foraging guild, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

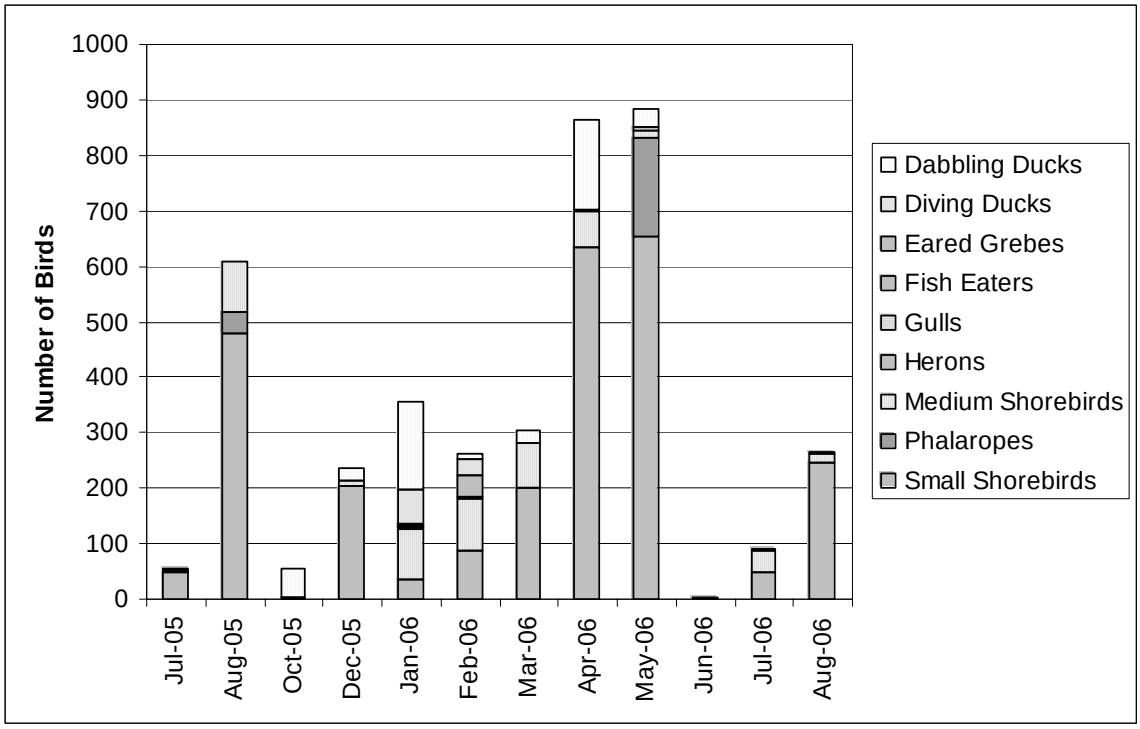

Figure 38. Monthly bird count totals by foraging guild, Pond B1C, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

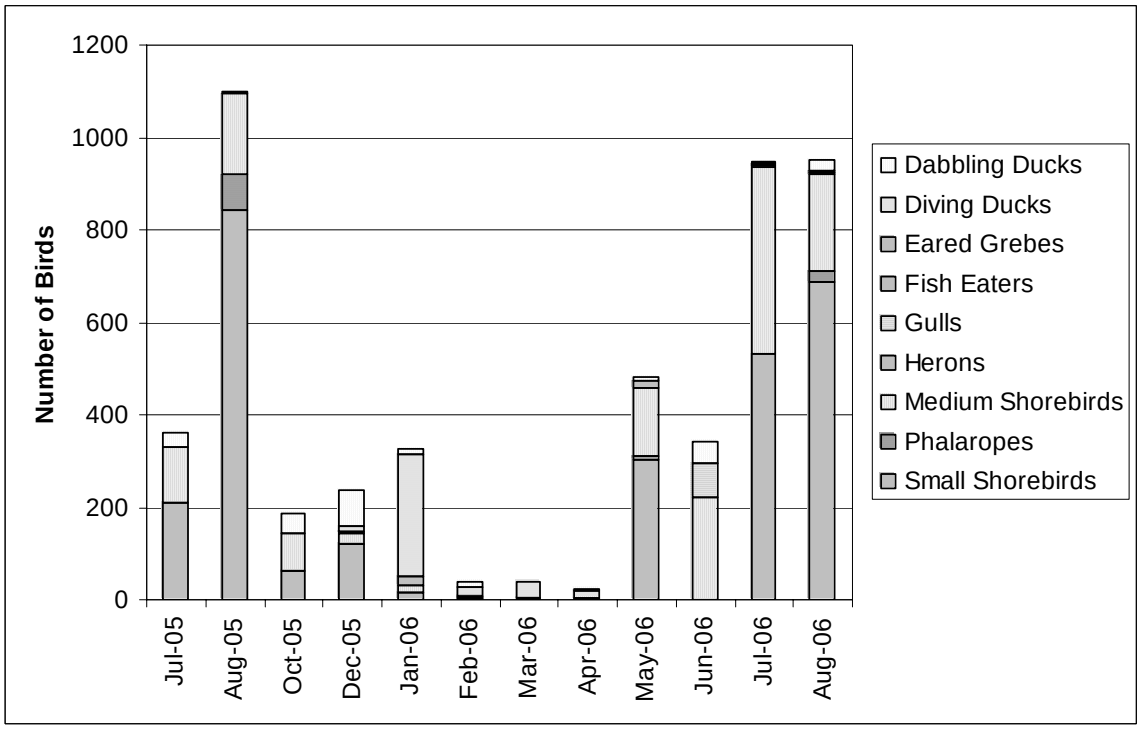

Figure 39. Monthly bird count totals by foraging guild, Pond B2C, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

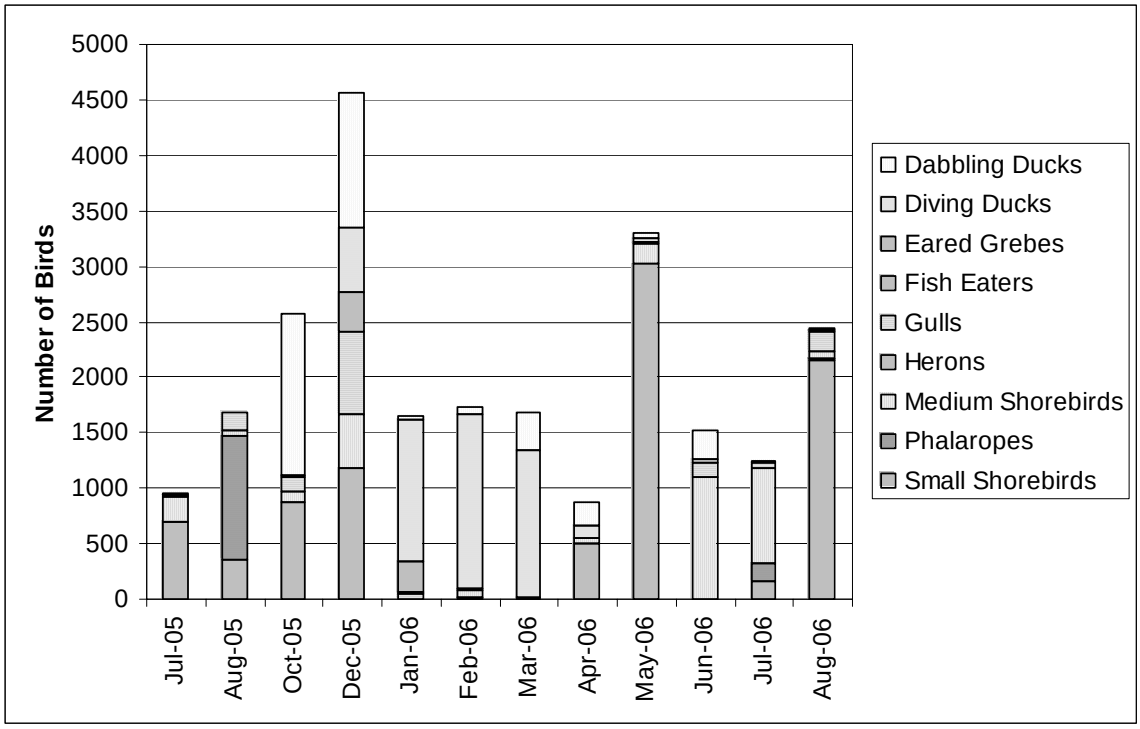

Figure 40. Monthly bird count totals by foraging guild, Pond B3C, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

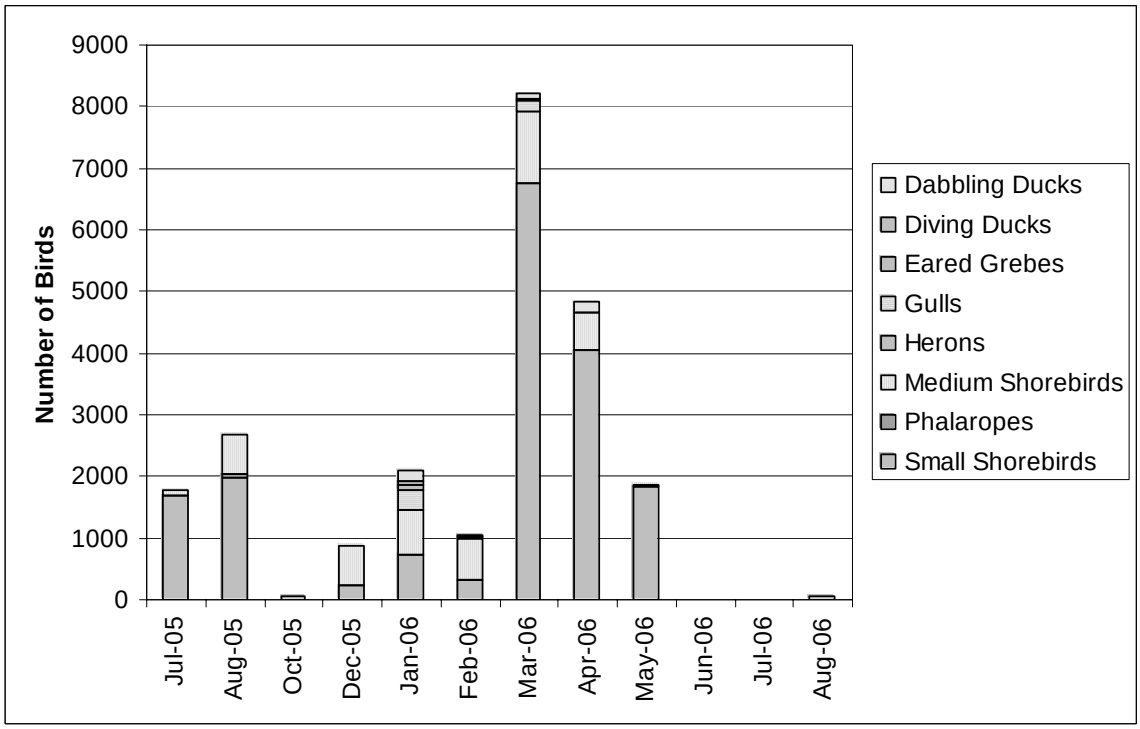

Figure 41. Monthly bird count totals by foraging guild, Pond B4C, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

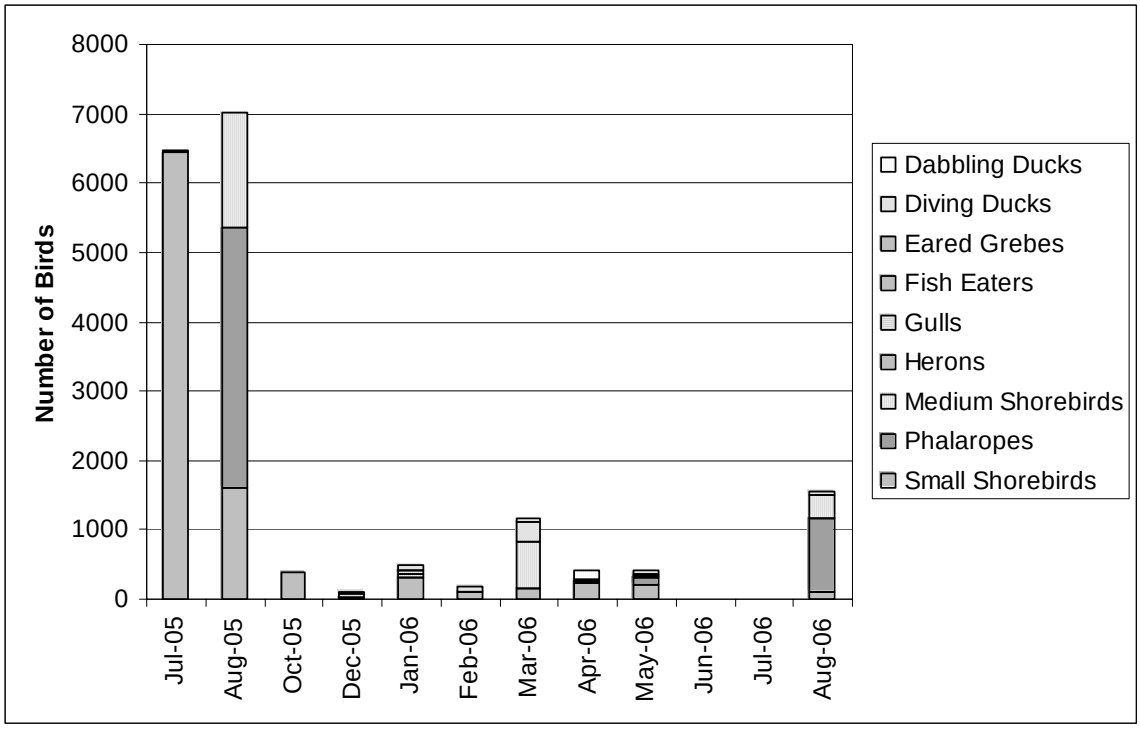

Figure 42. Monthly bird count totals by foraging guild, Pond B5C, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

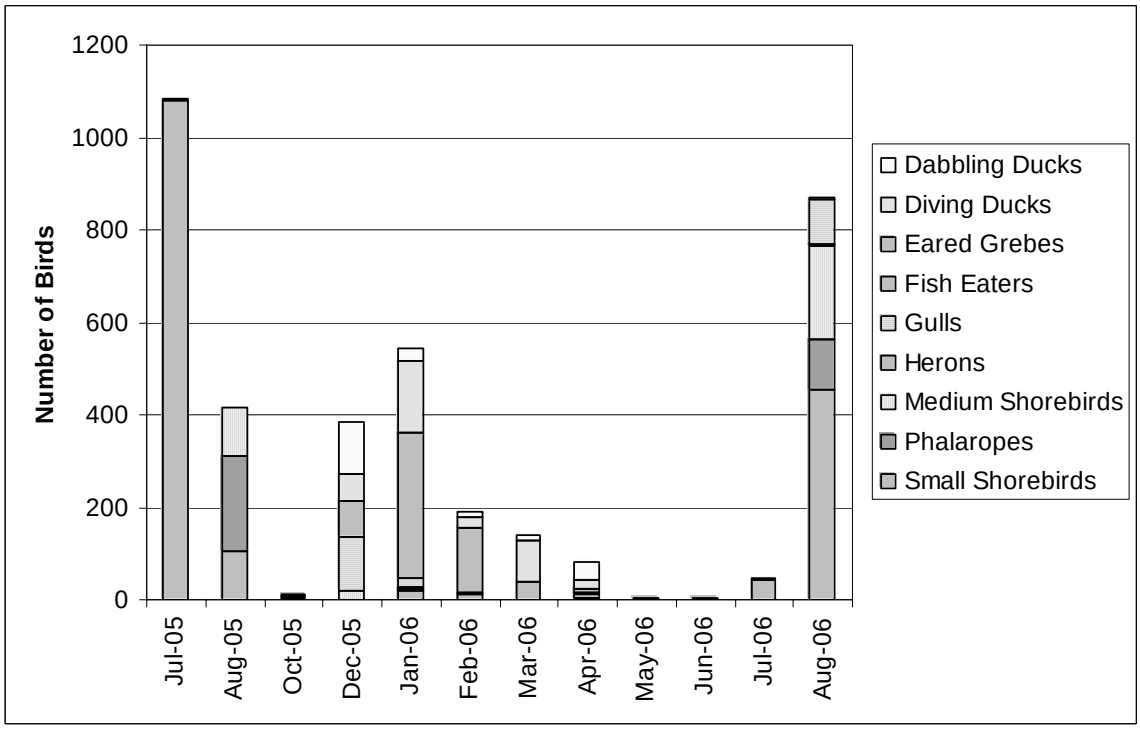

Figure 43. Monthly bird count totals by foraging guild, Pond B6C, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

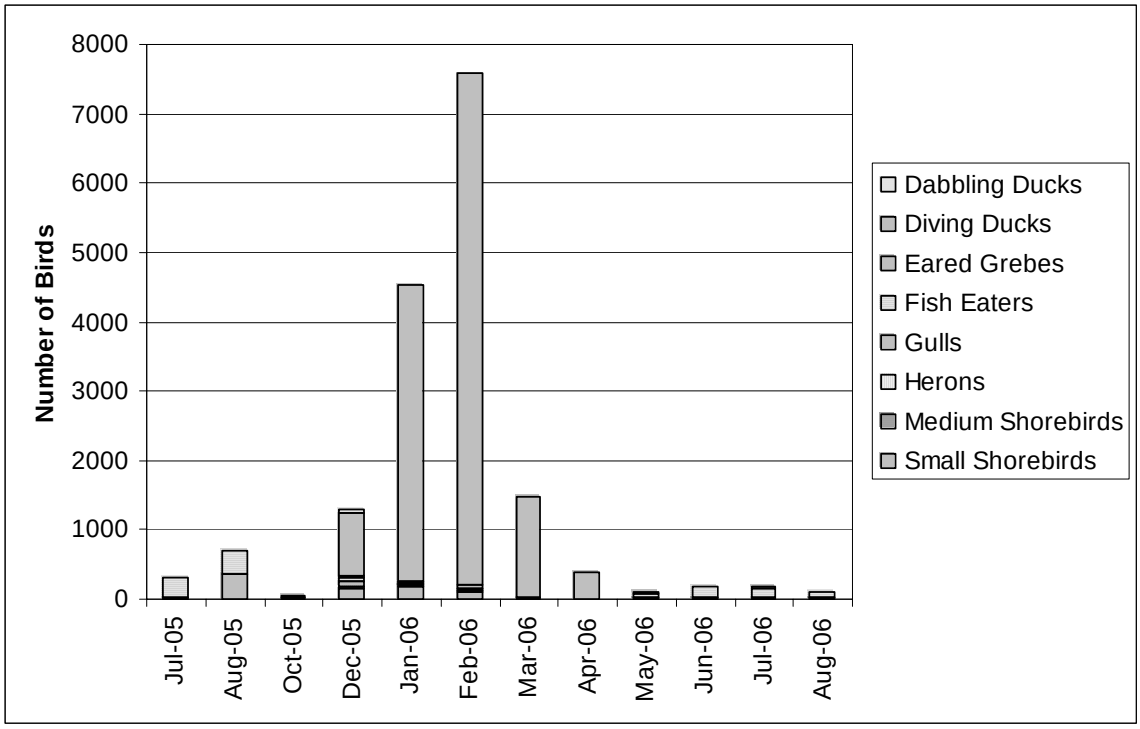

Figure 44. Monthly bird count totals by foraging guild, Pond B1, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

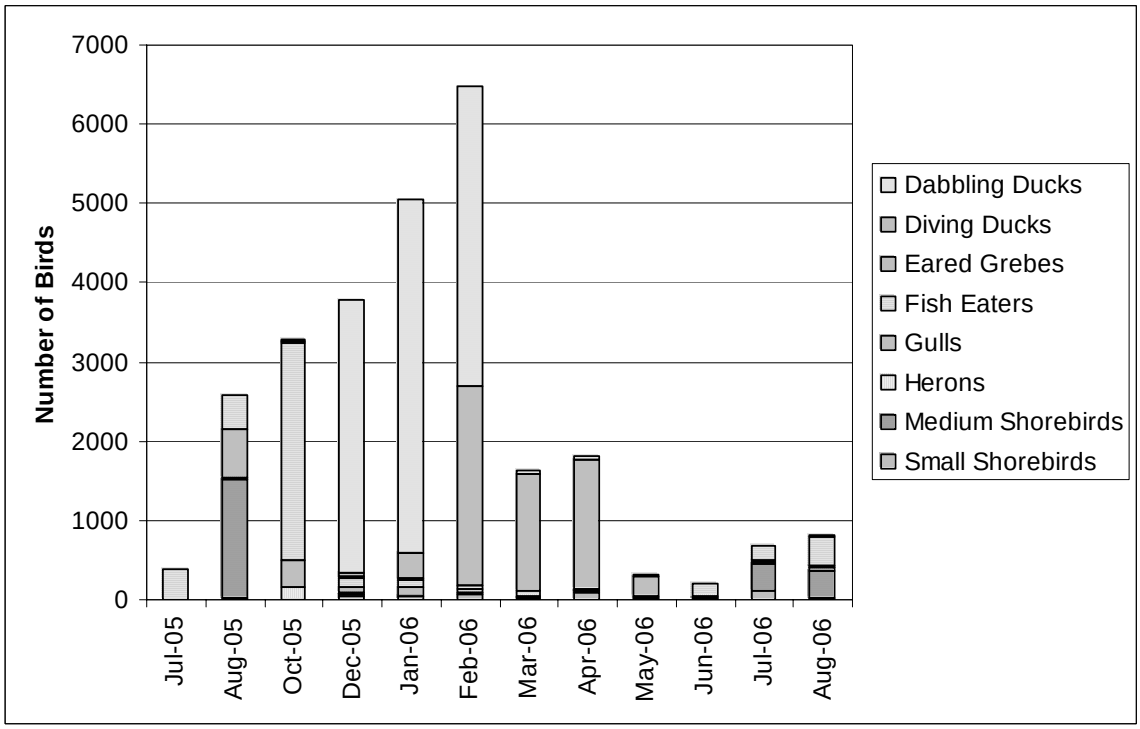

Figure 45. Monthly bird count totals by foraging guild, Pond B2, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

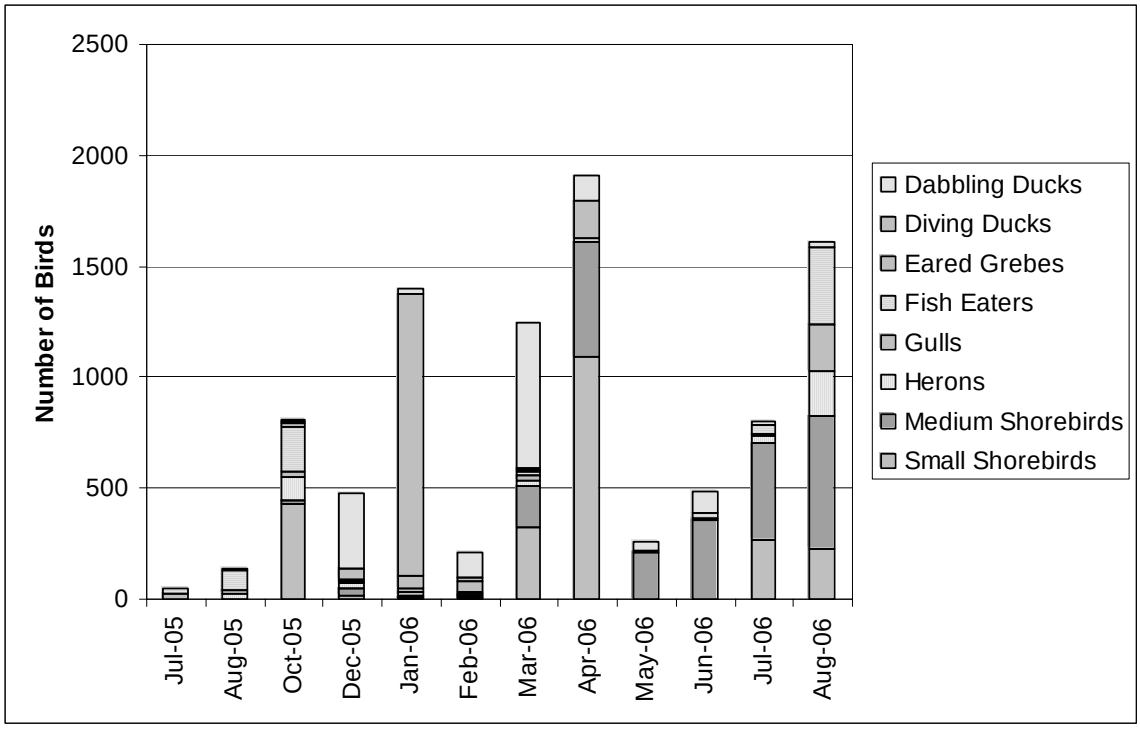

Figure 46. Monthly bird count totals by foraging guild, Pond B4, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

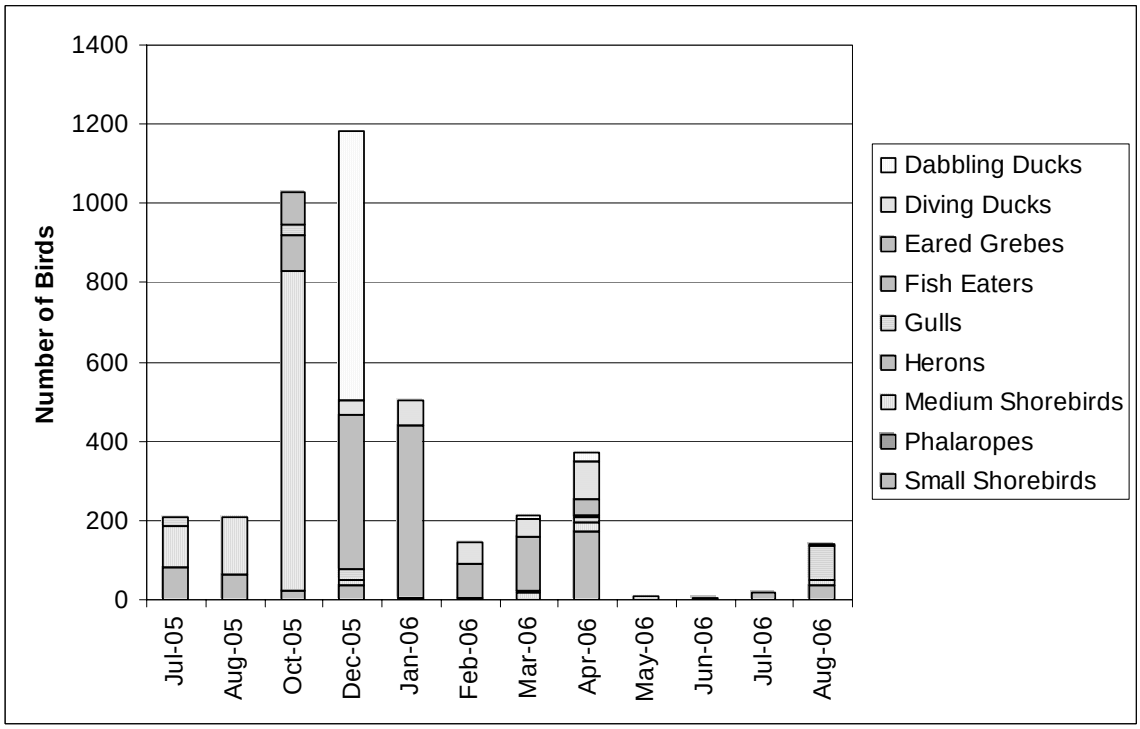

Figure 47. Monthly bird count totals by foraging guild, Pond B5, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

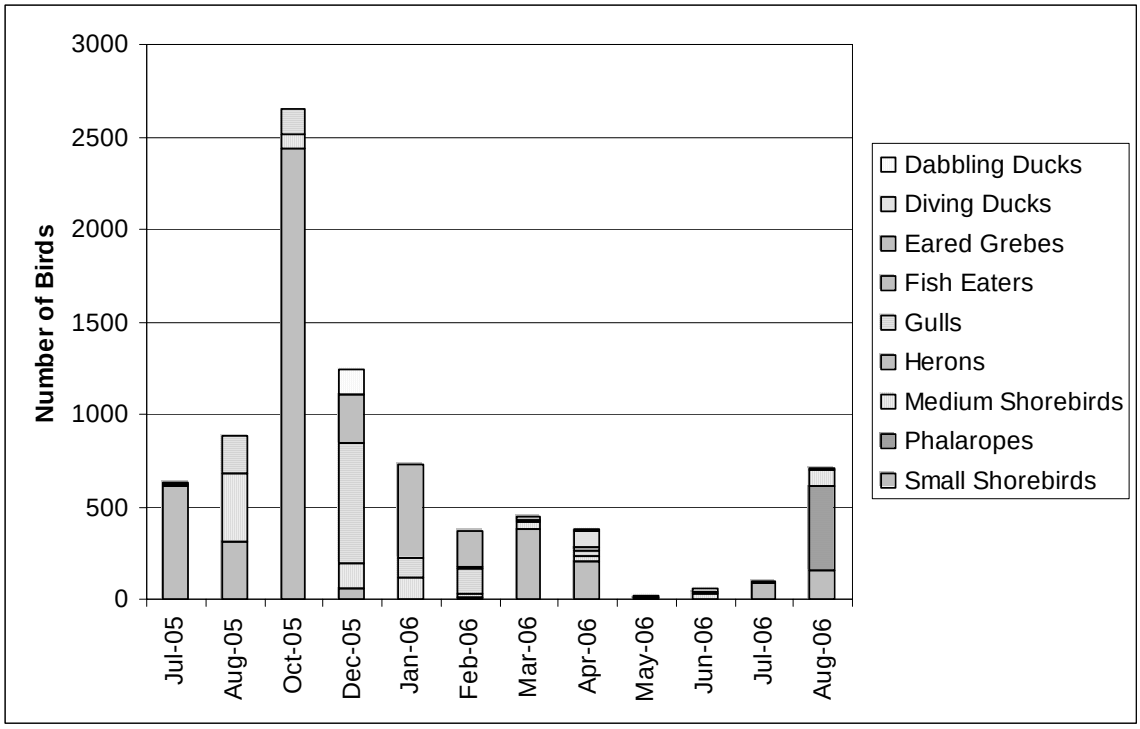

Figure 48. Monthly bird count totals by foraging guild, Pond B6, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

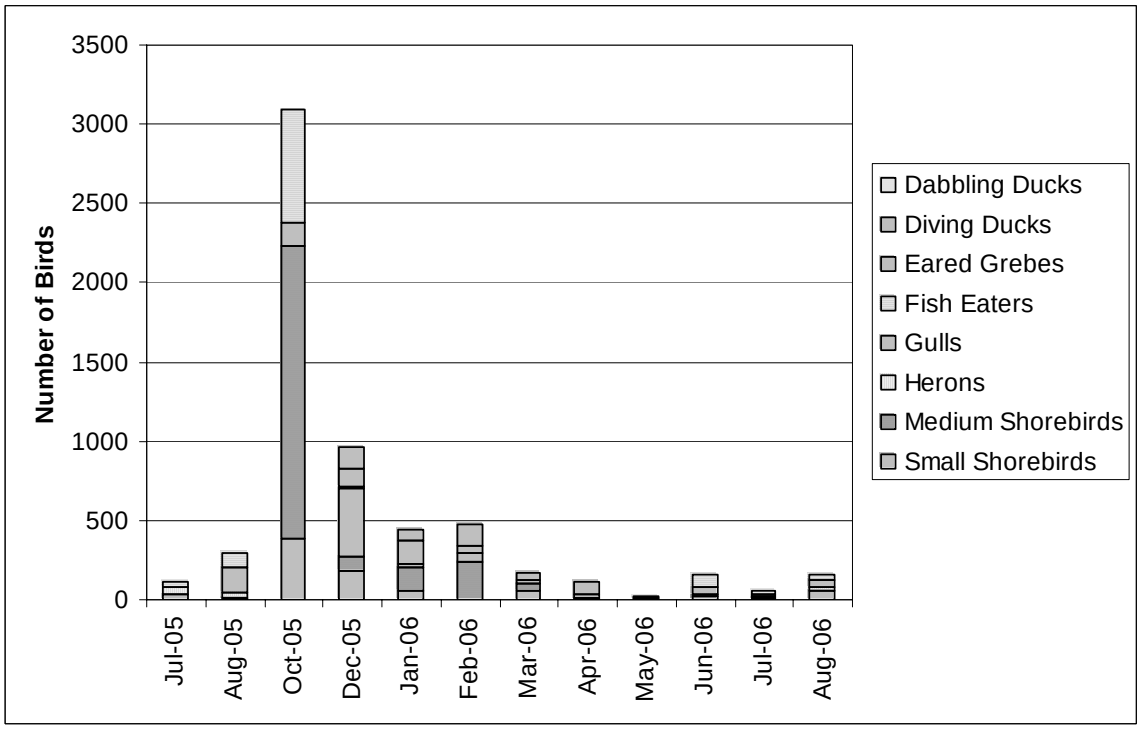

Figure 49. Monthly bird count totals by foraging guild, Pond B7, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

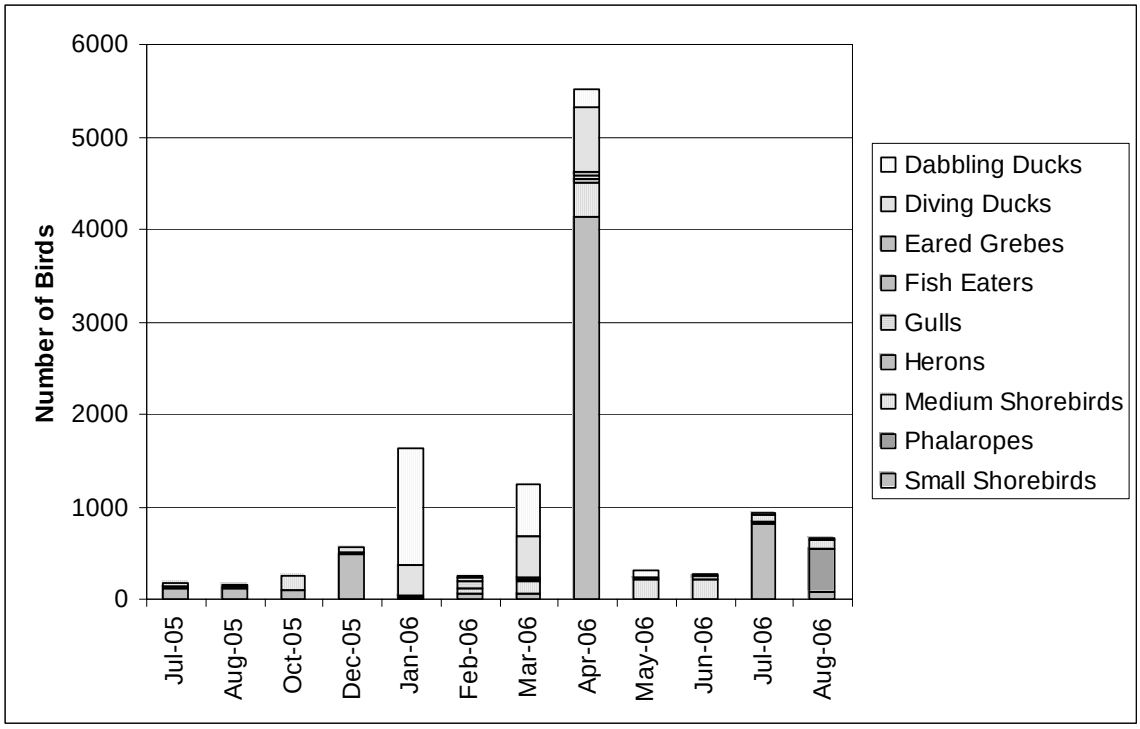

Figure 50. Monthly bird count totals by foraging guild, Pond B6A, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

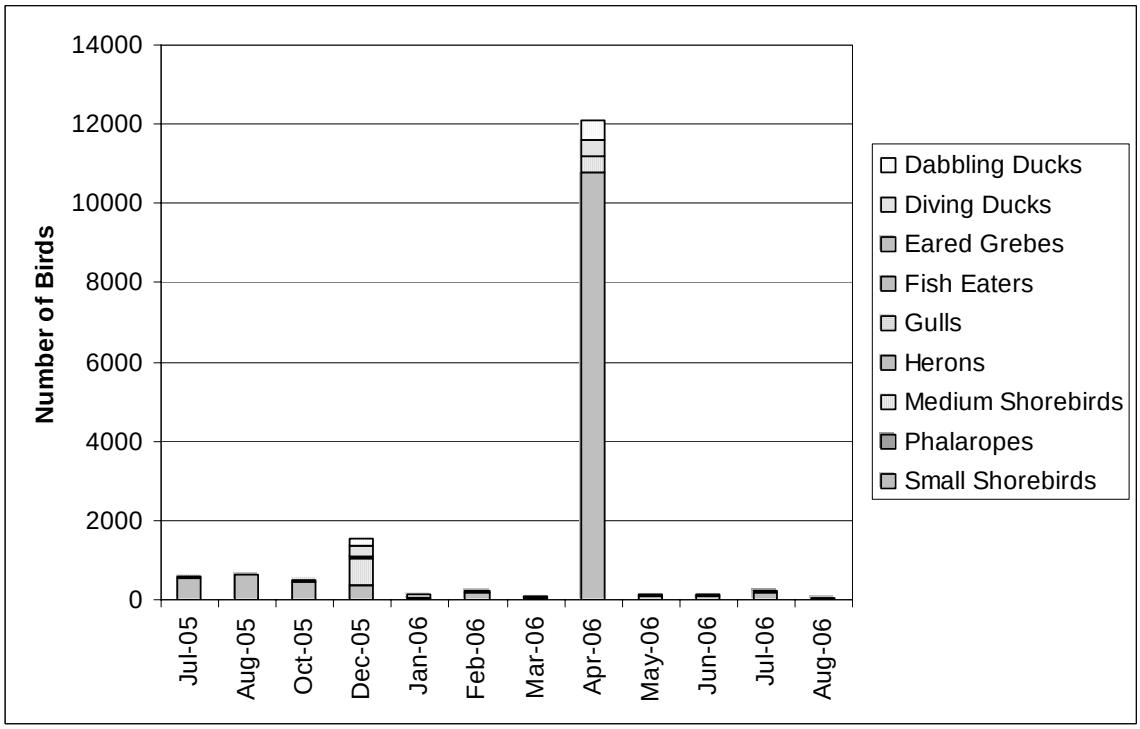

Figure 51. Monthly bird count totals by foraging guild, Pond B6B, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

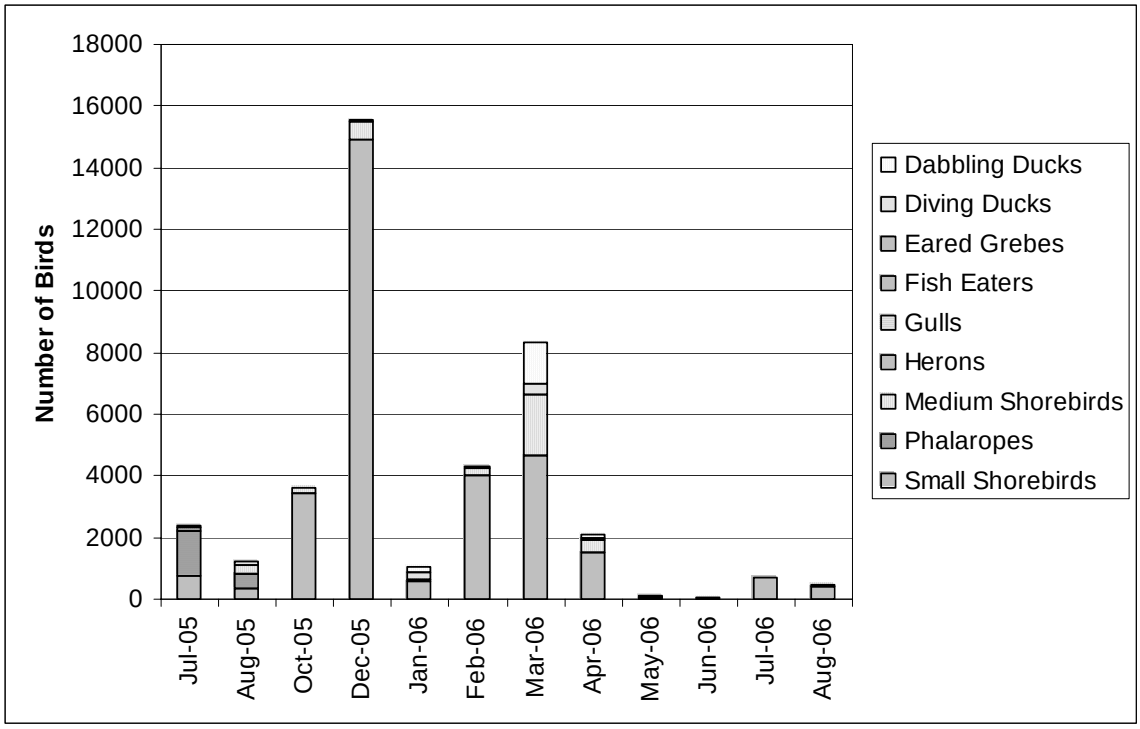

Figure 52. Monthly bird count totals by foraging guild, Pond B8, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

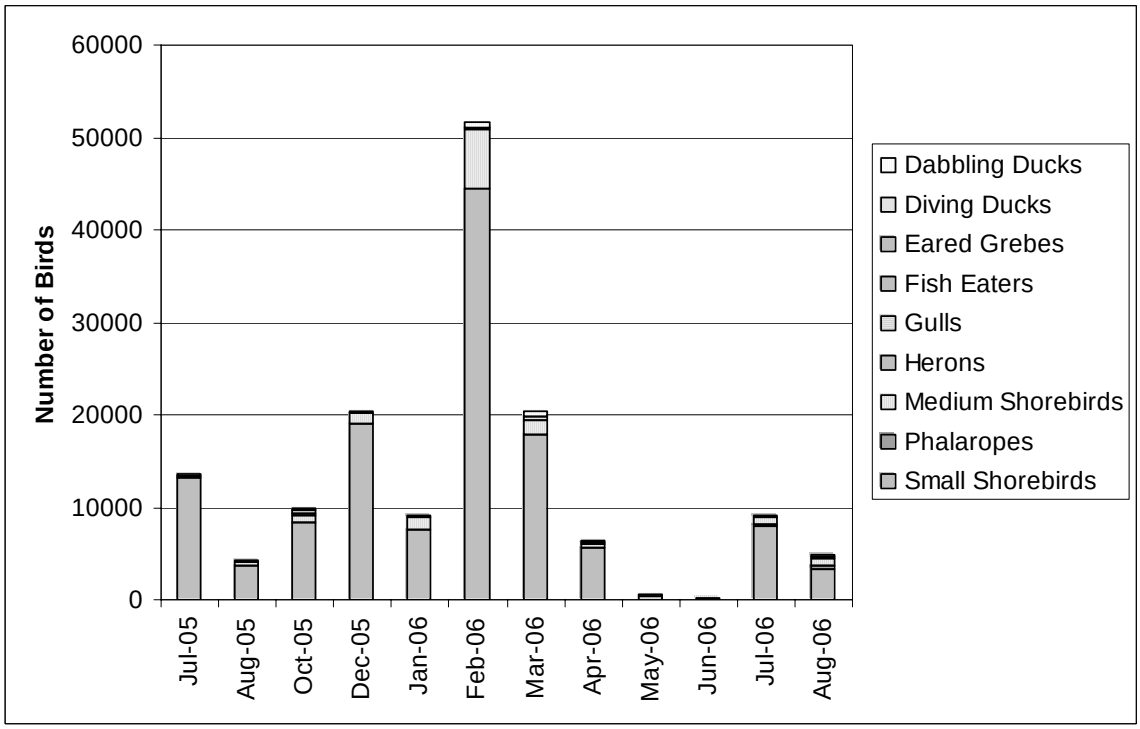

Figure 53. Monthly bird count totals by foraging guild, Pond B8A, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

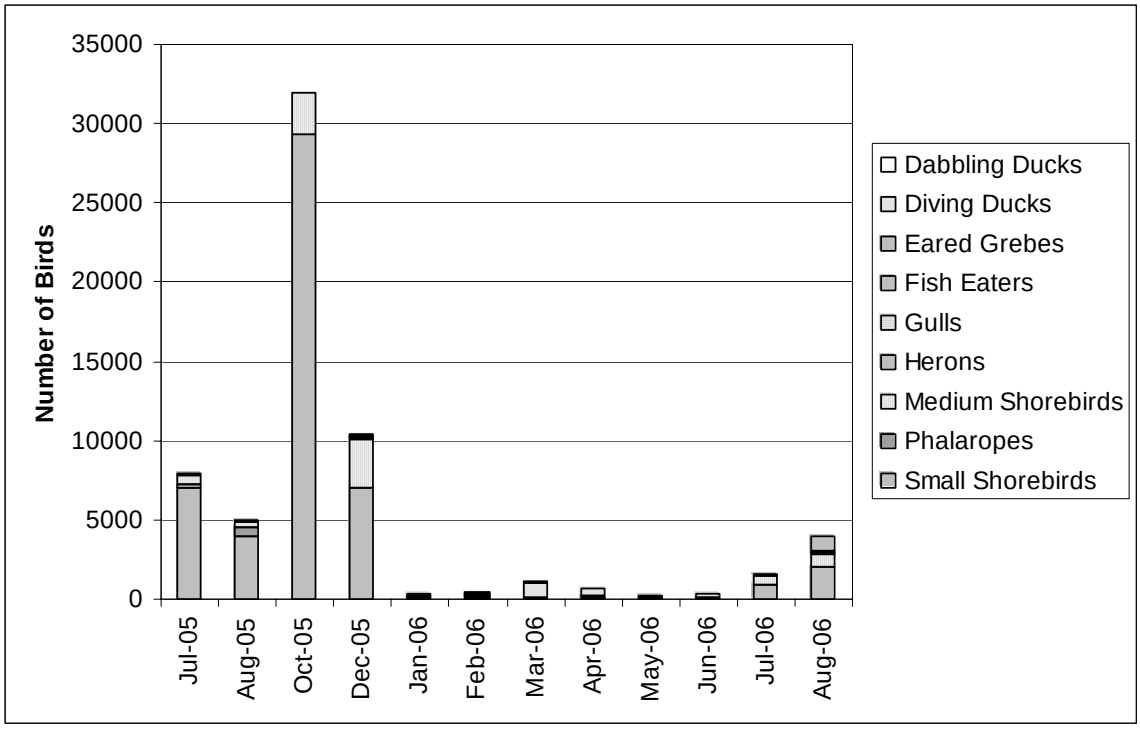

Figure 54. Monthly bird count totals by foraging guild, Pond B9, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

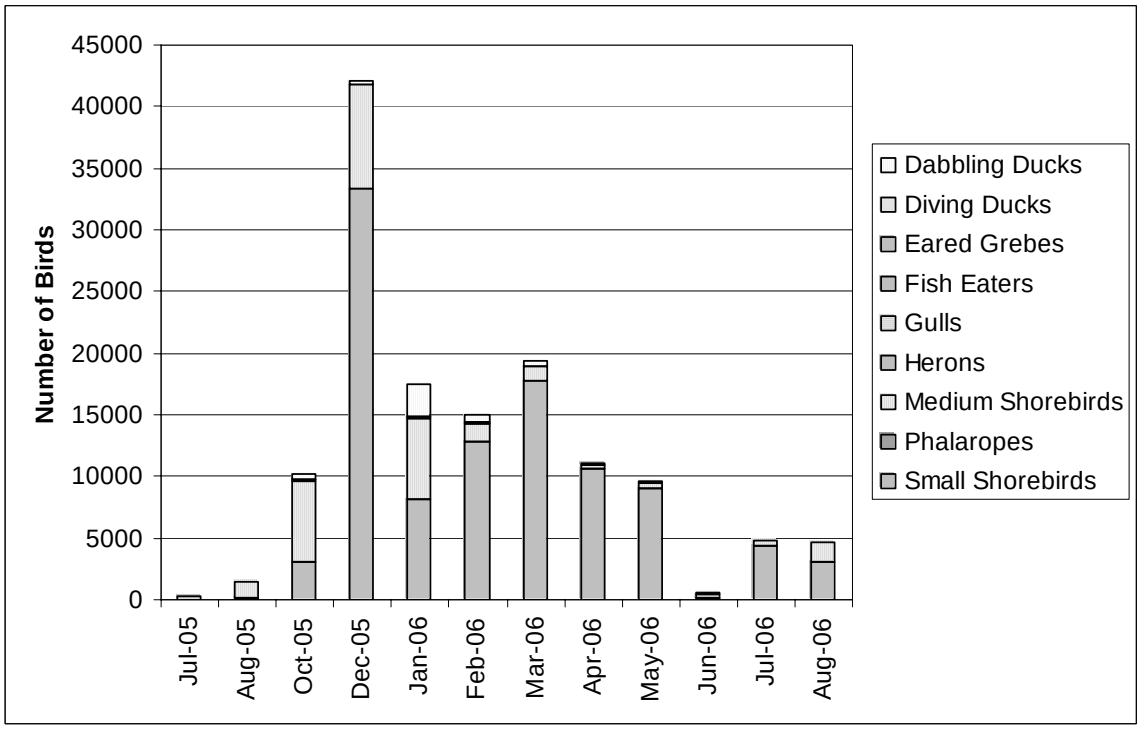

Figure 55. Monthly bird count totals by foraging guild, Pond B10, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

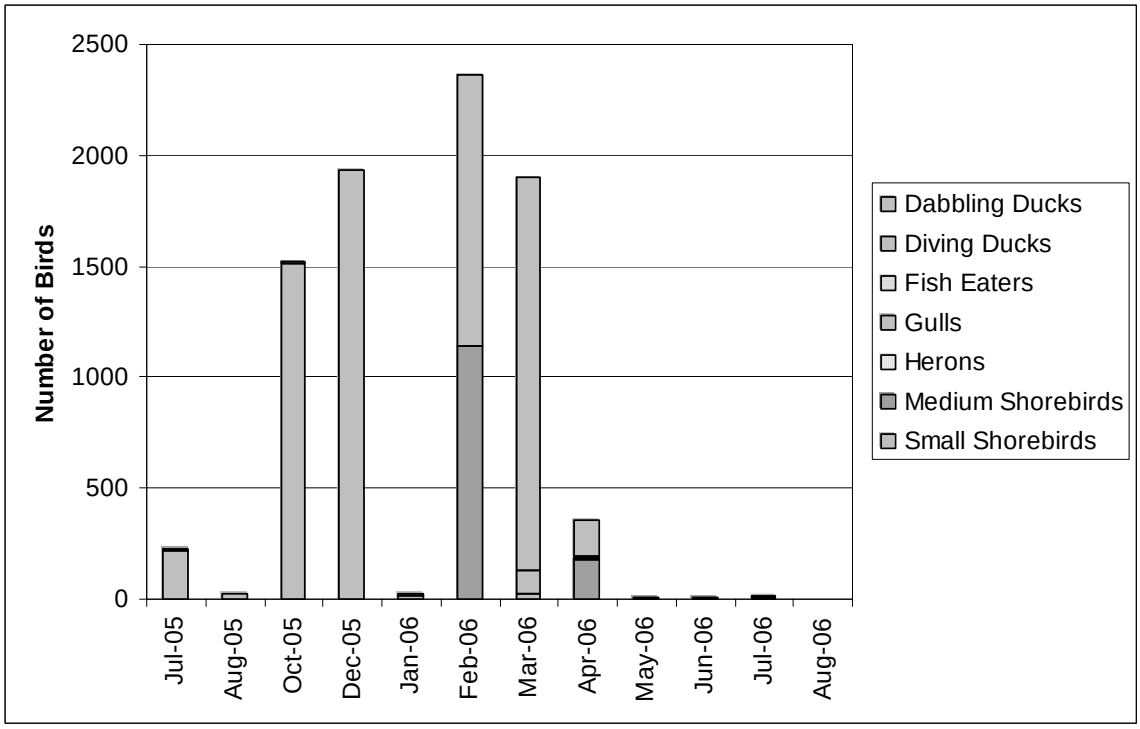

Figure 56. Monthly bird count totals by foraging guild, Pond B11, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

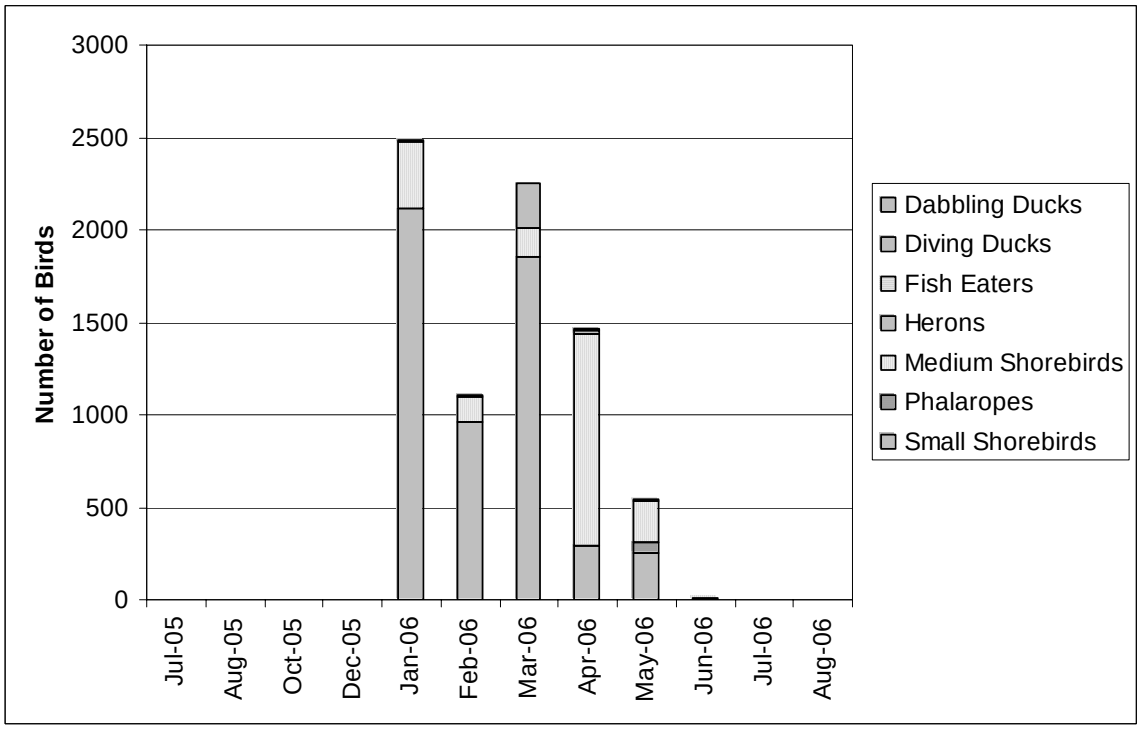

Figure 57. Monthly bird count totals by foraging guild, Pond B12, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

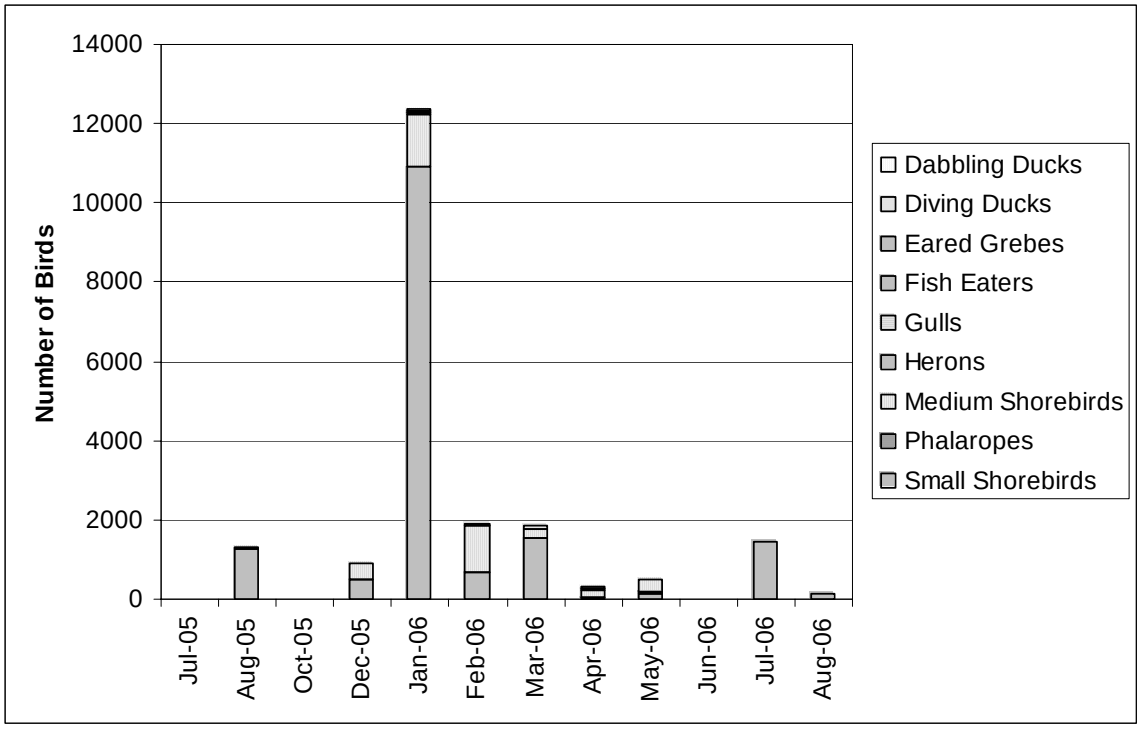

Figure 58. Monthly bird count totals by foraging guild, Pond B13, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

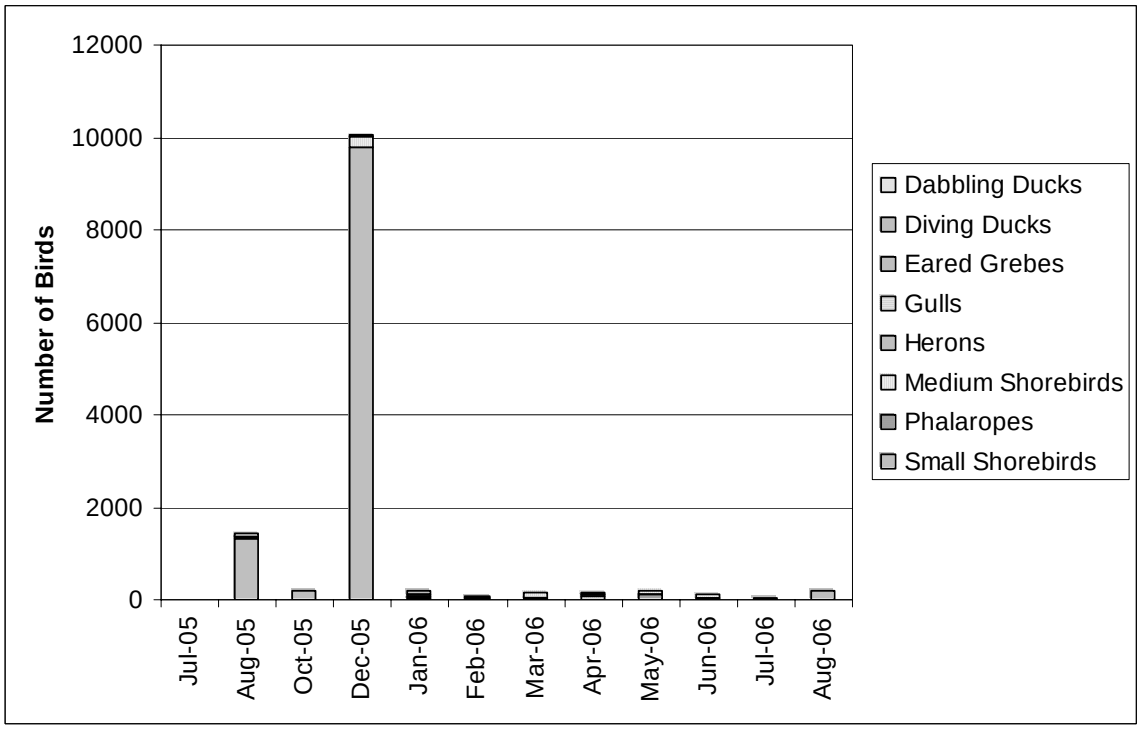

Figure 59. Monthly bird count totals by foraging guild, Pond B14, Eden Landing Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

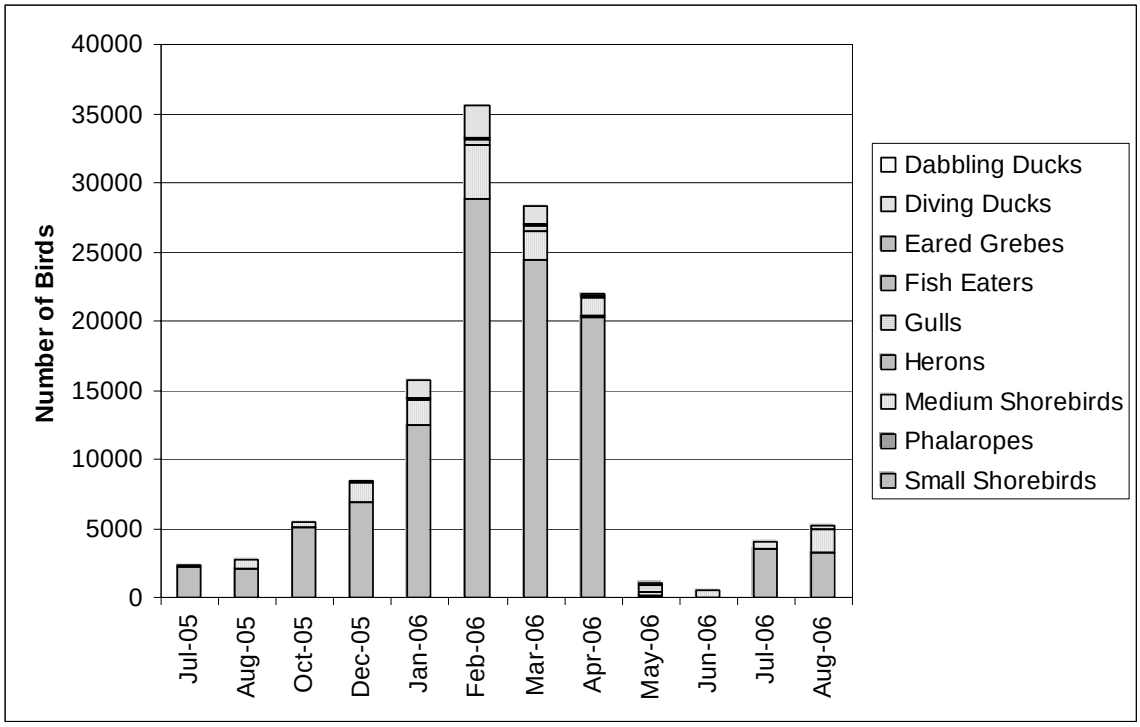

Figure 60. Monthly bird count totals by foraging guild, Ravenswood Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

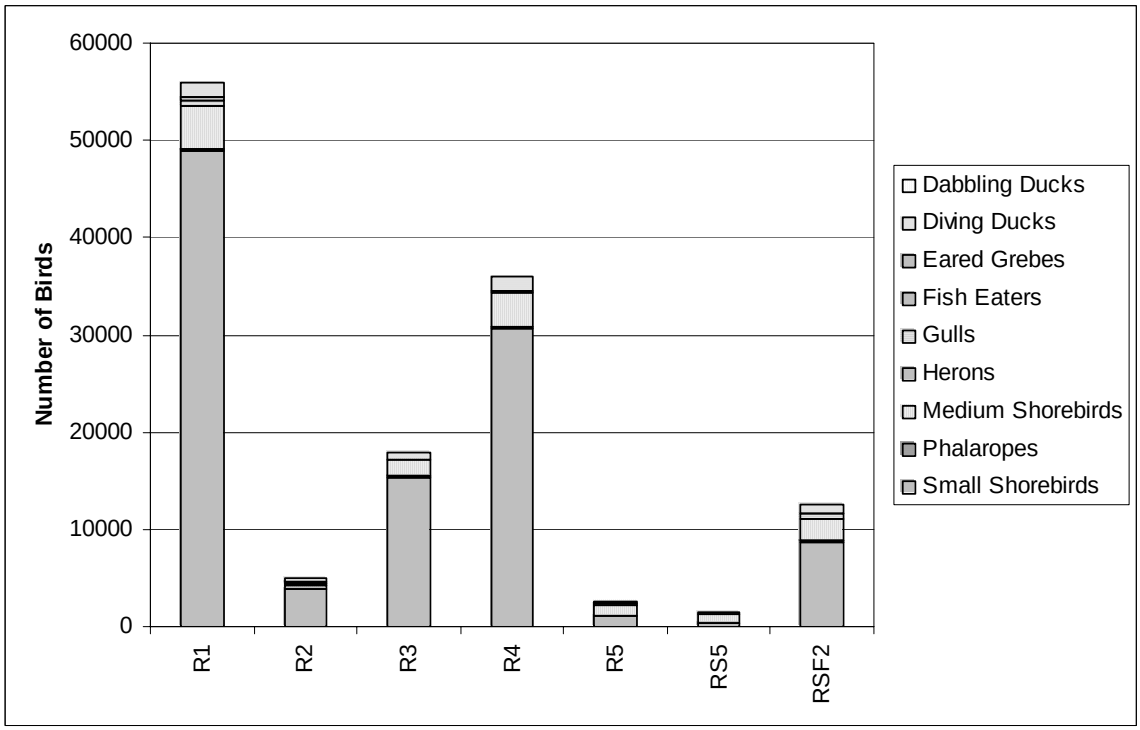

Figure 61. Pond bird count totals by foraging guild, Ravenswood Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

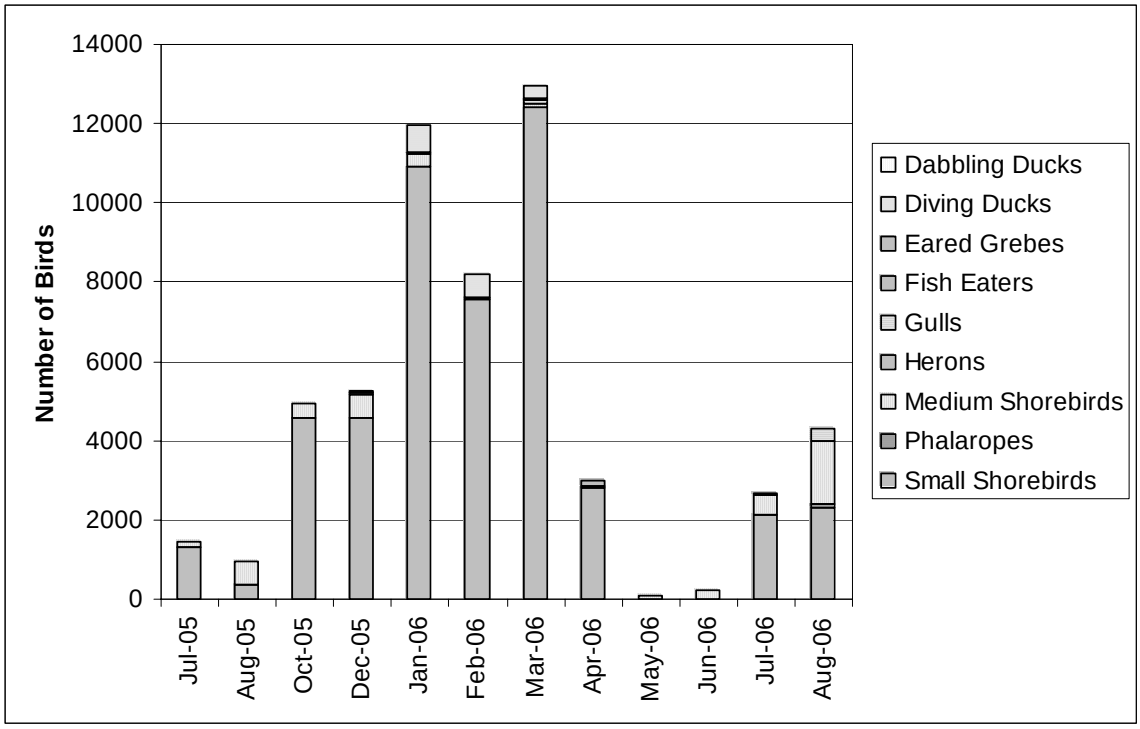

Figure 62. Monthly bird count totals by foraging guild, Pond R1, Ravenswood Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

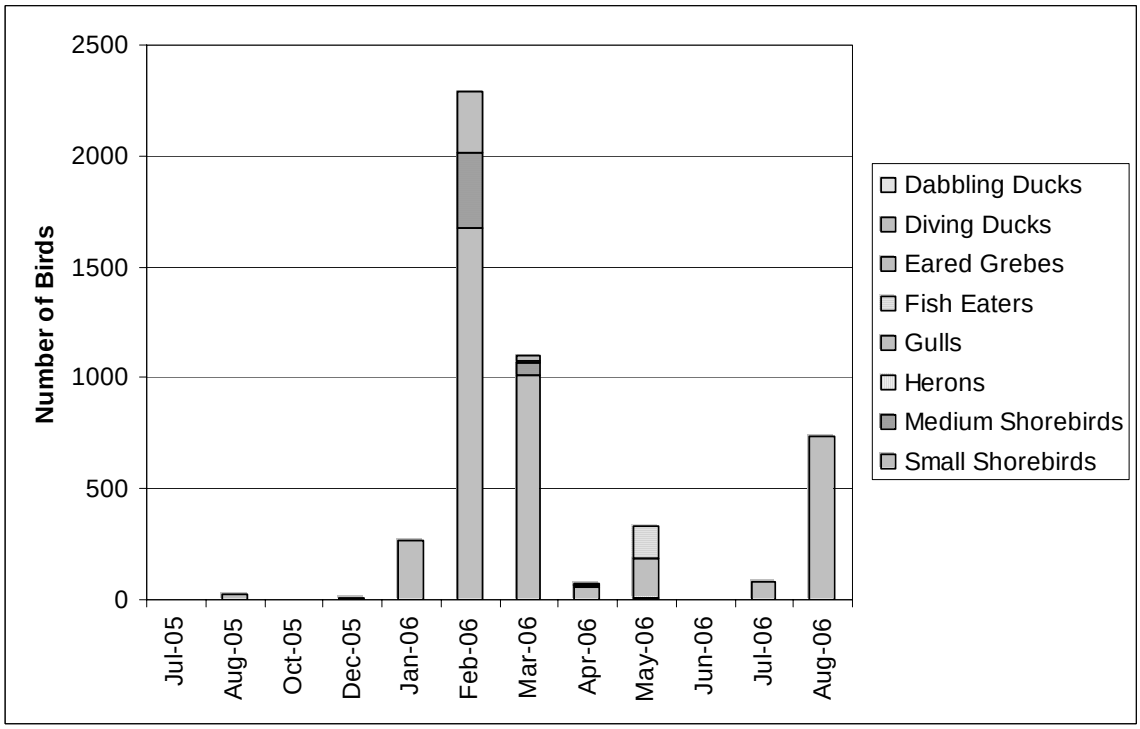

Figure 63. Monthly bird count totals by foraging guild, Pond R2, Ravenswood Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

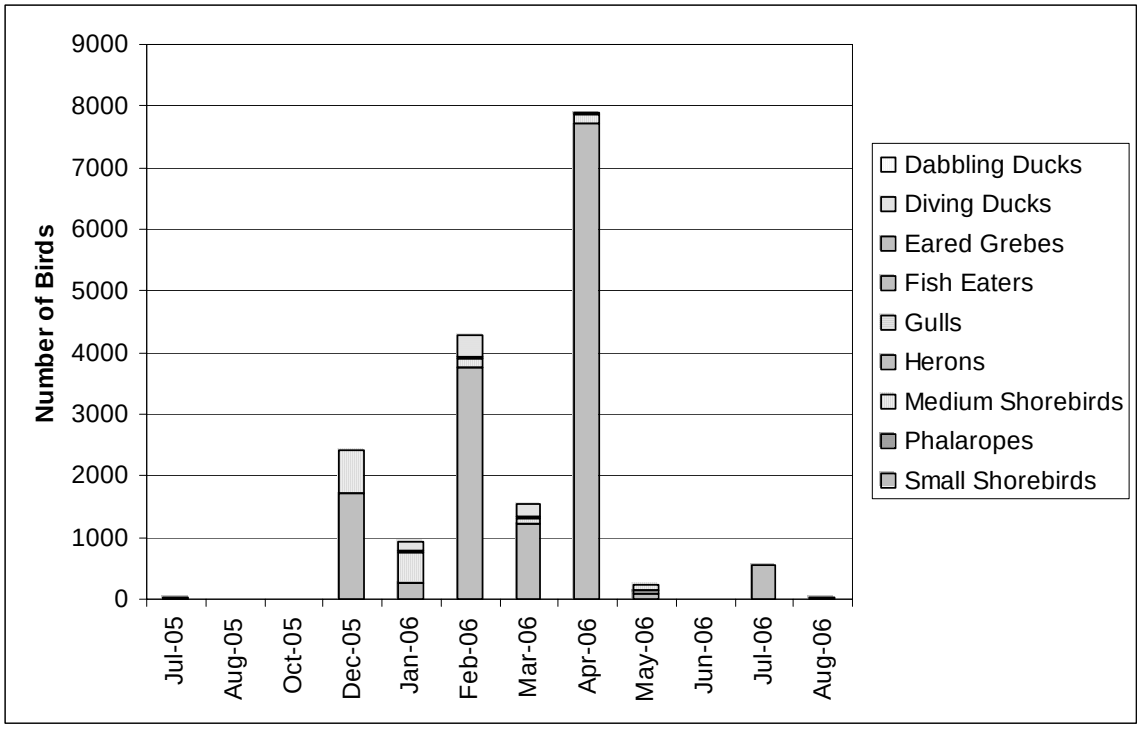

Figure 64. Monthly bird count totals by foraging guild, Pond R3, Ravenswood Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

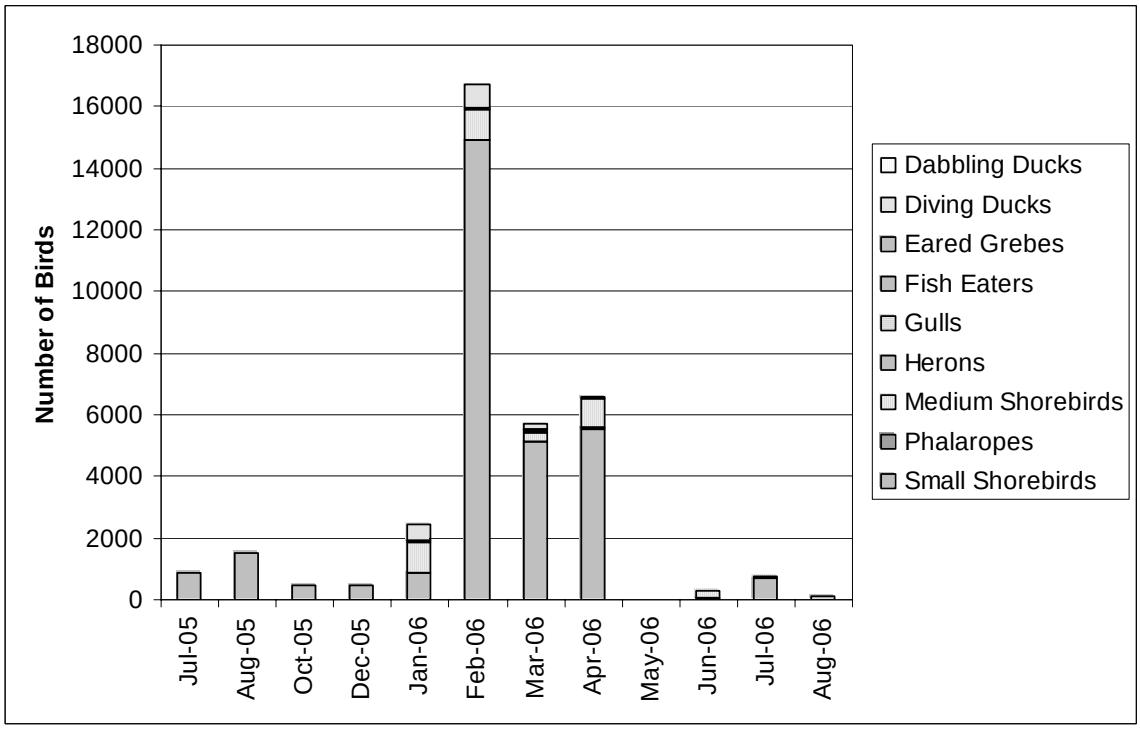

Figure 65. Monthly bird count totals by foraging guild, Pond R4, Ravenswood Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

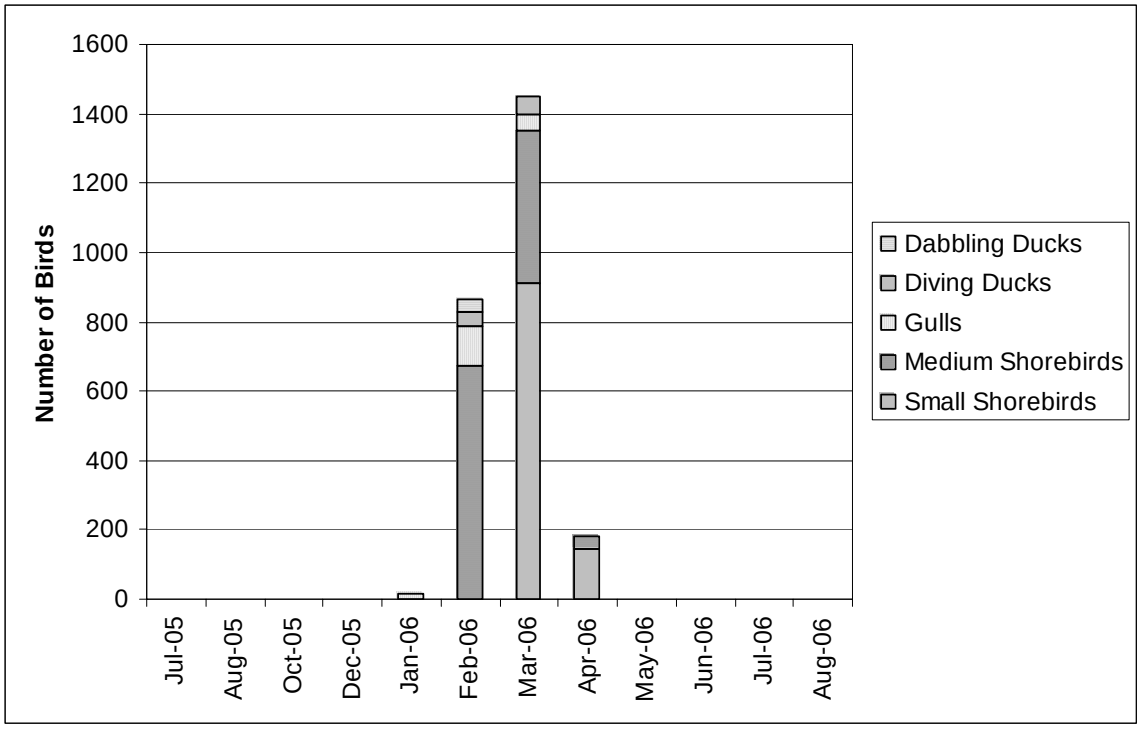

Figure 66. Monthly bird count totals by foraging guild, Pond R5, Ravenswood Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

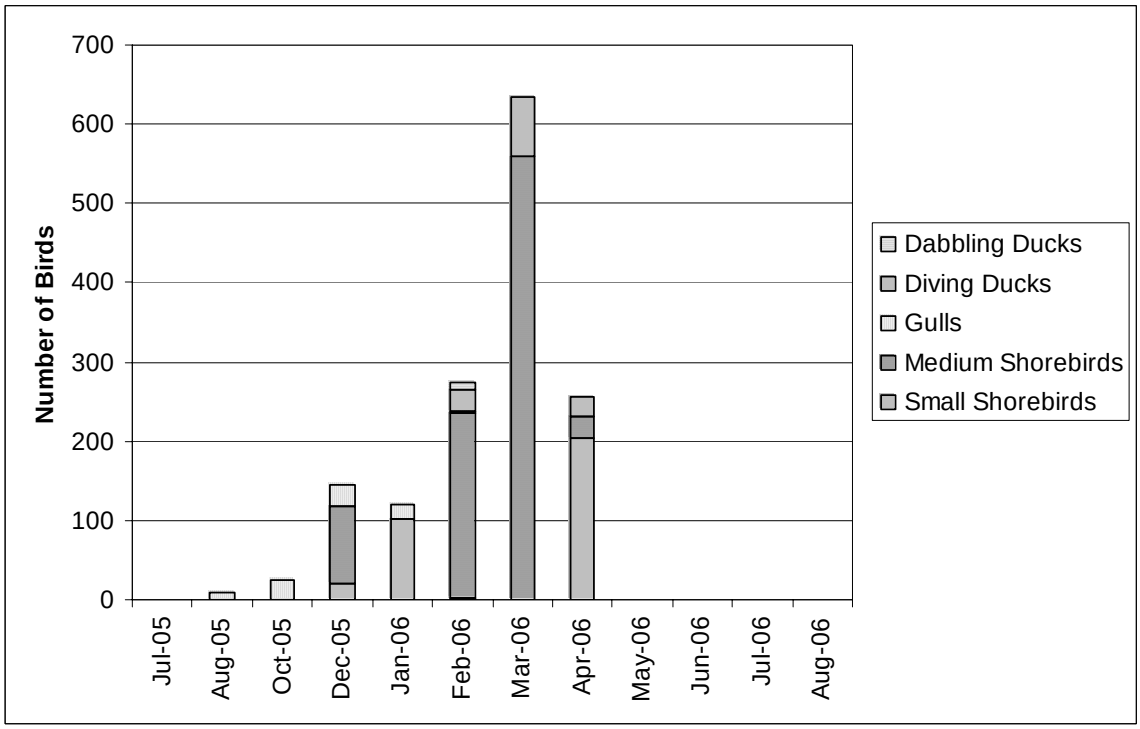

Figure 67. Monthly bird count totals by foraging guild, Pond RS5, Ravenswood Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

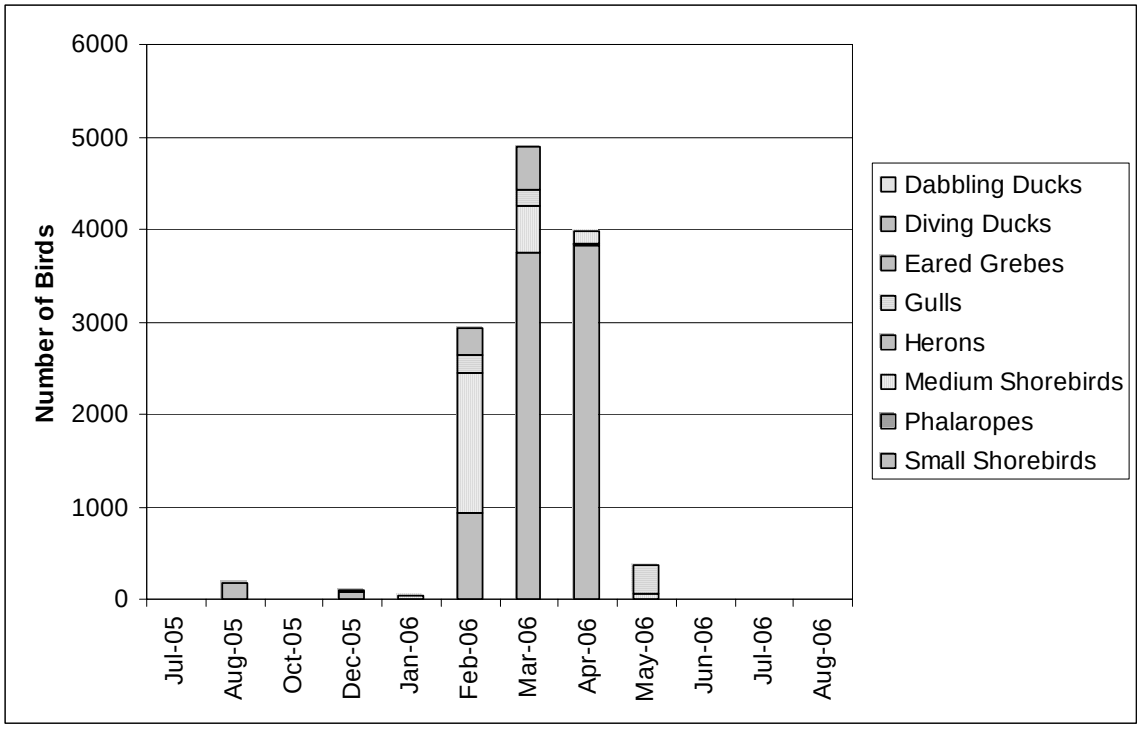

Figure 68. Monthly bird count totals by foraging guild, Pond RSF2, Ravenswood Complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

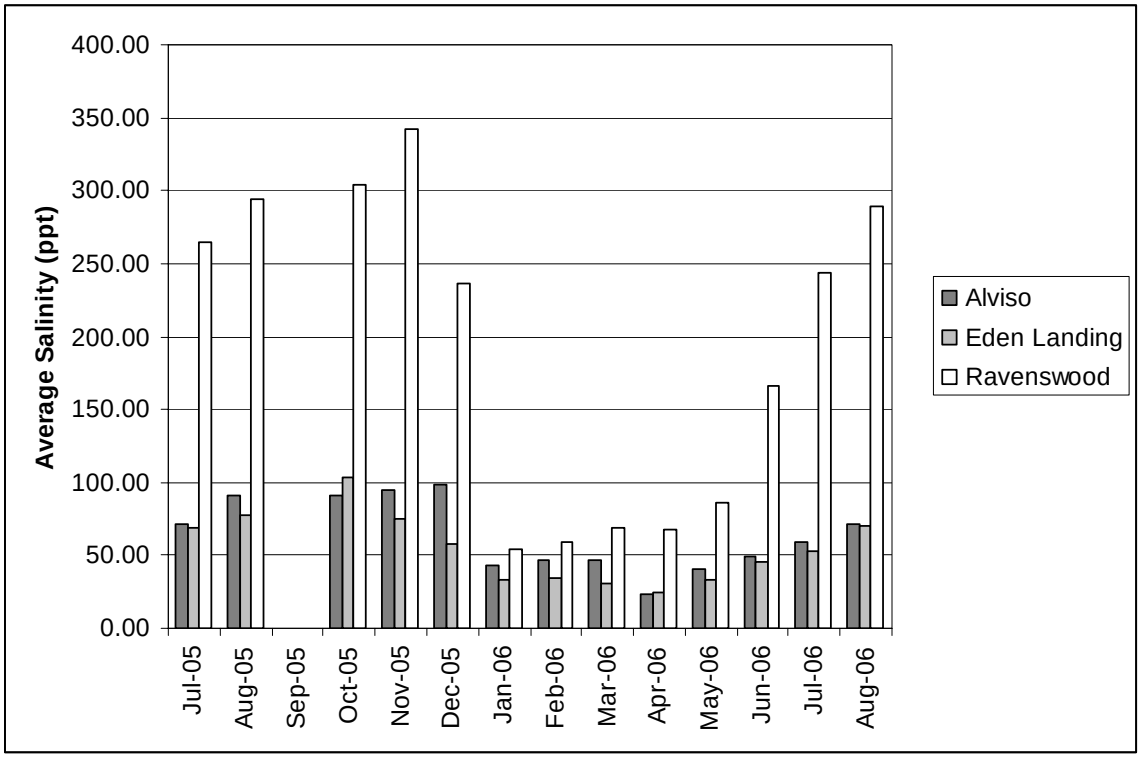

Figure 69. Average monthly salt pond salinity by complex, July 2005 – August 2006, South Bay Salt Ponds, San Francisco Bay, CA.

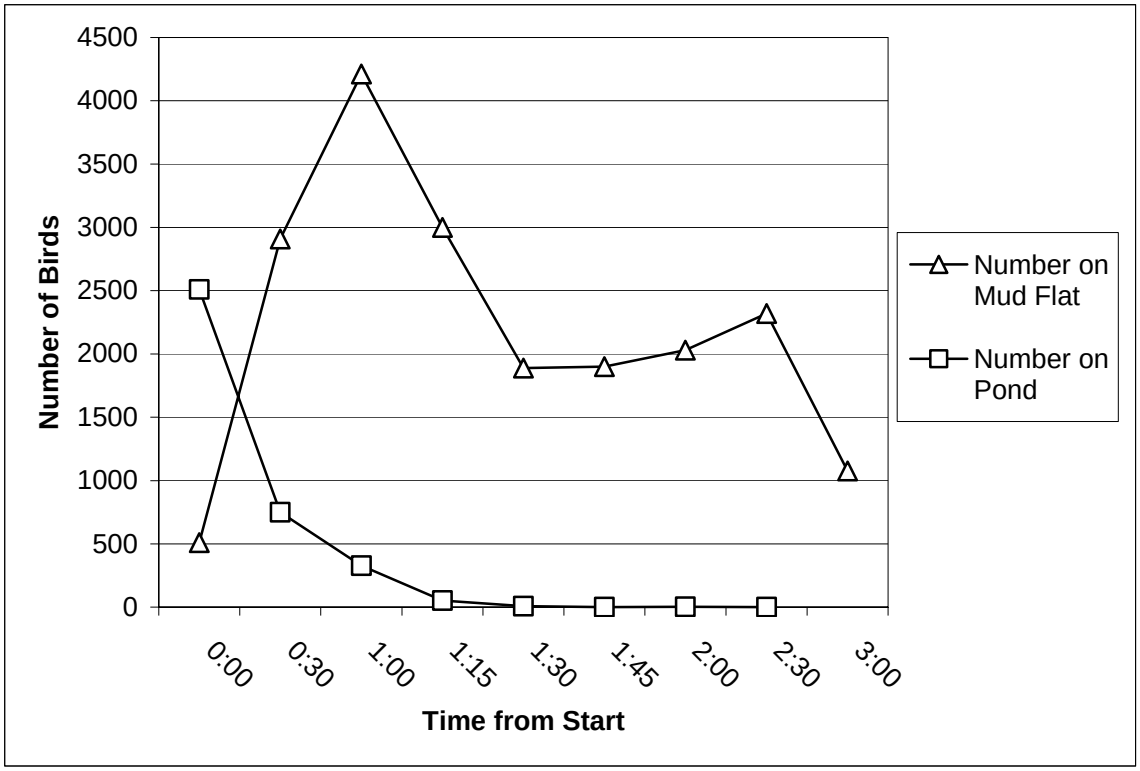

Figure 70. Total number of shorebirds over time on an ebb tide at the Ravenswood mudflat and number of birds on adjacent pond R1 on 11/22/2004.

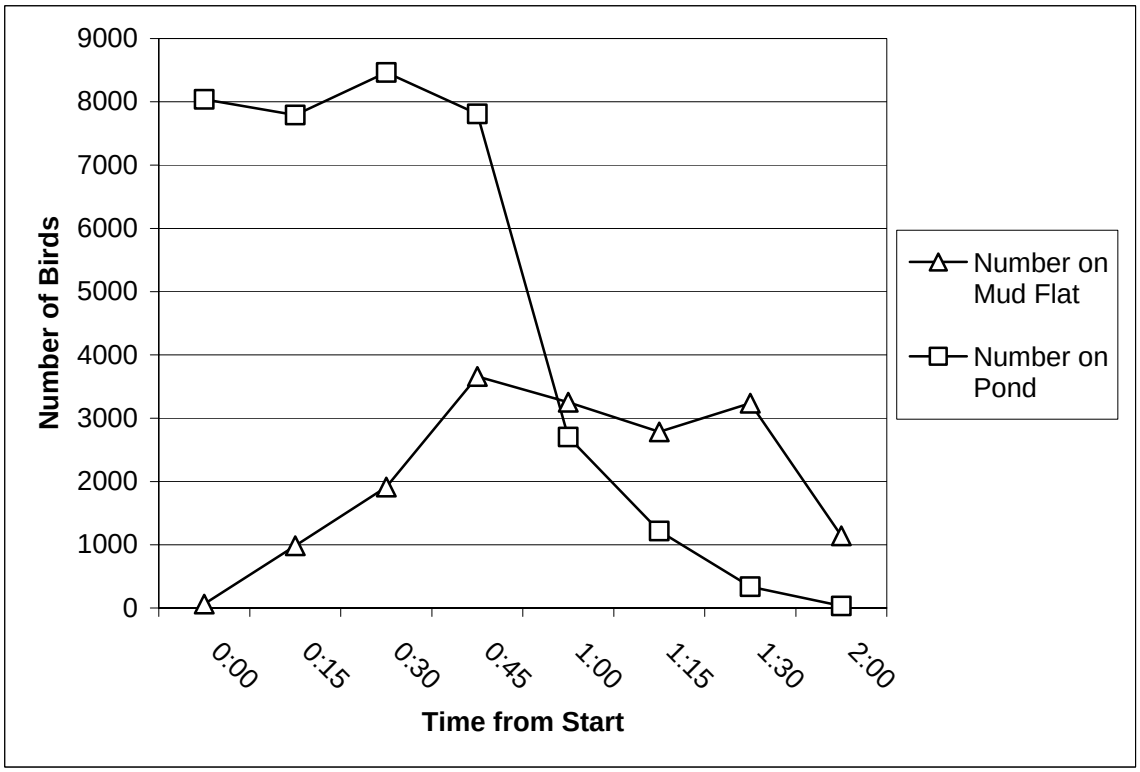

Figure 71. Total number of shorebirds over time on an ebb tide at the Ravenswood mudflat and number of birds on adjacent pond R1 on 12/22/2004.

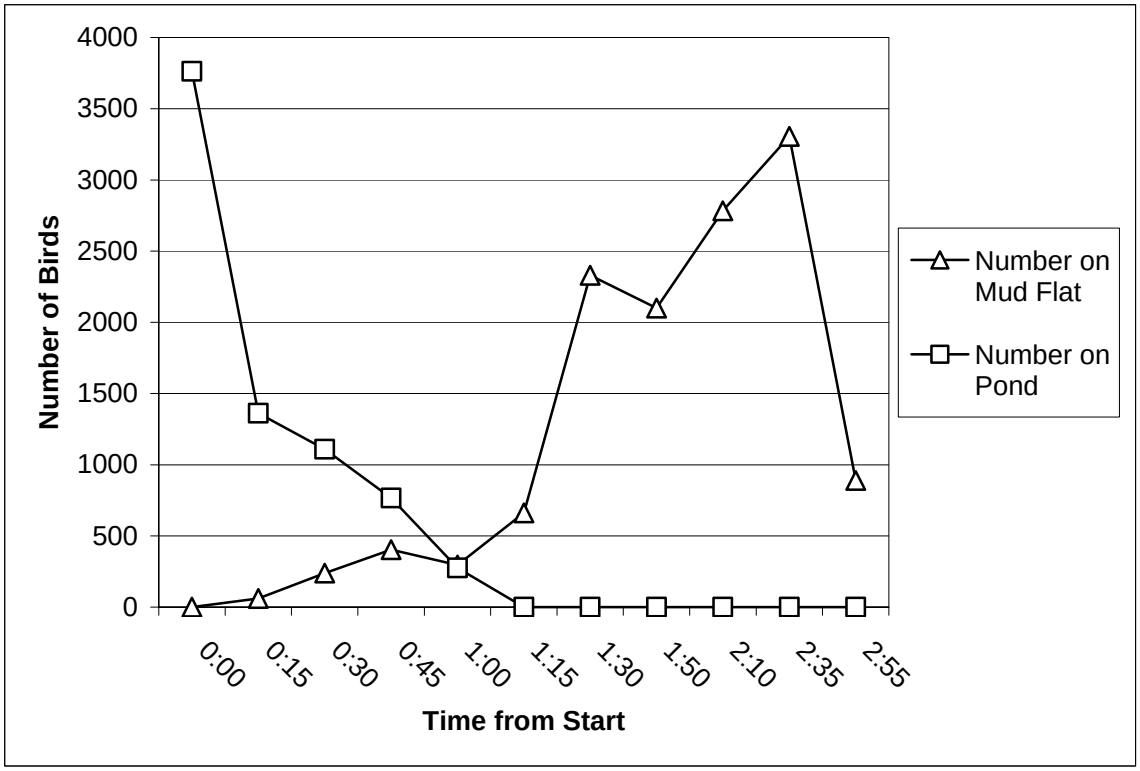

Figure 72. Total number of shorebirds over time on an ebb tide at the Ravenswood mudflat and number of birds on adjacent pond RSF2 on 02/18/2005.

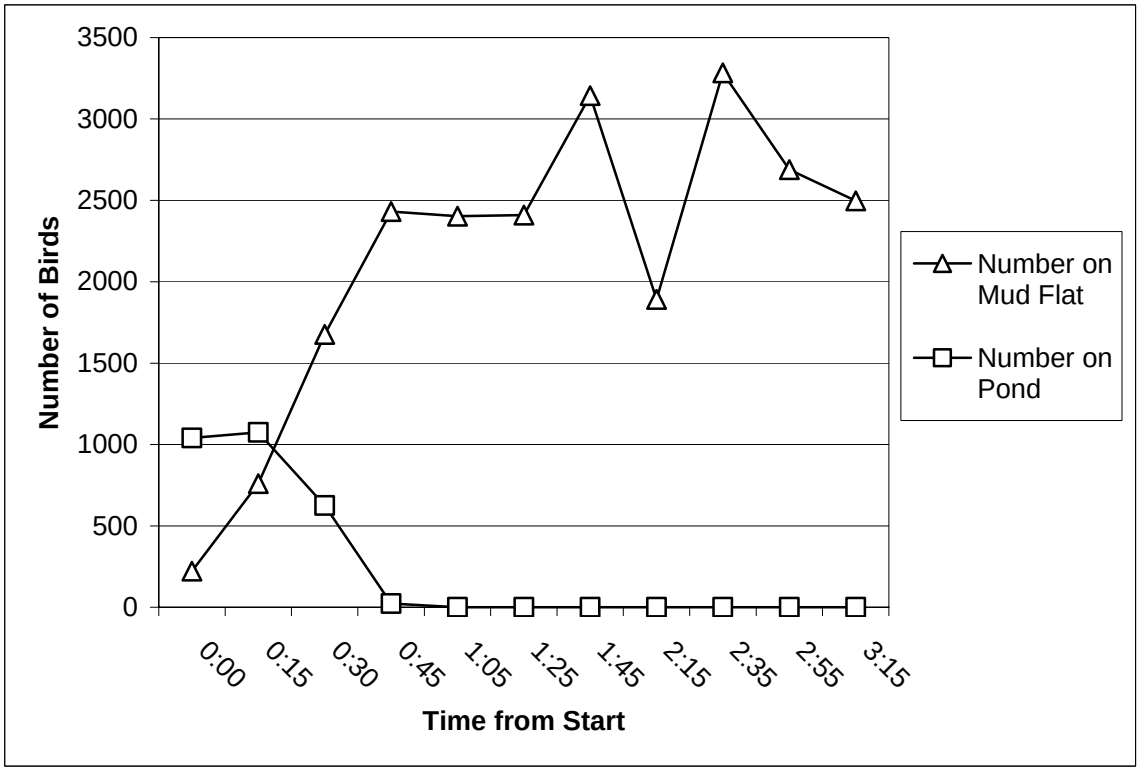

Figure 73. Total number of shorebirds over time on an ebb tide at the Ravenswood mudflat and number of birds on adjacent pond RSF2 on 03/17/2005.

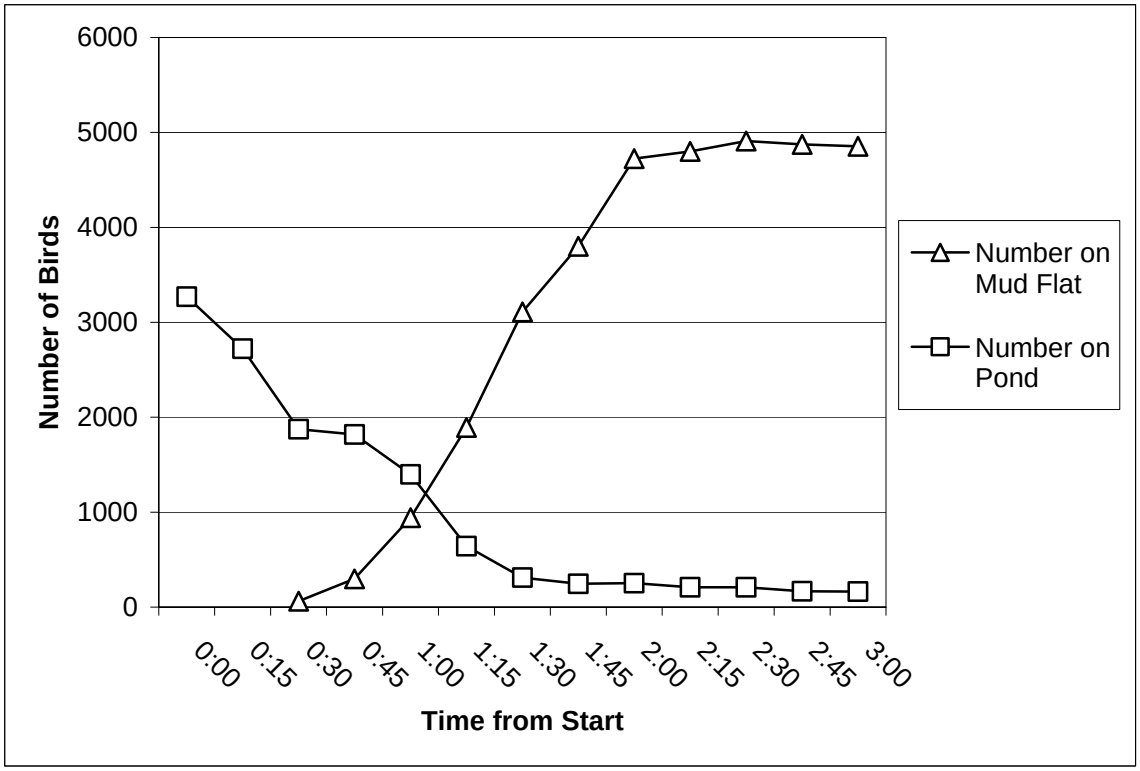

Figure 74. Total number of shorebirds over time on an ebb tide at the Ravenswood mudflat and number of birds on adjacent pond R1 on 04/17/2005.

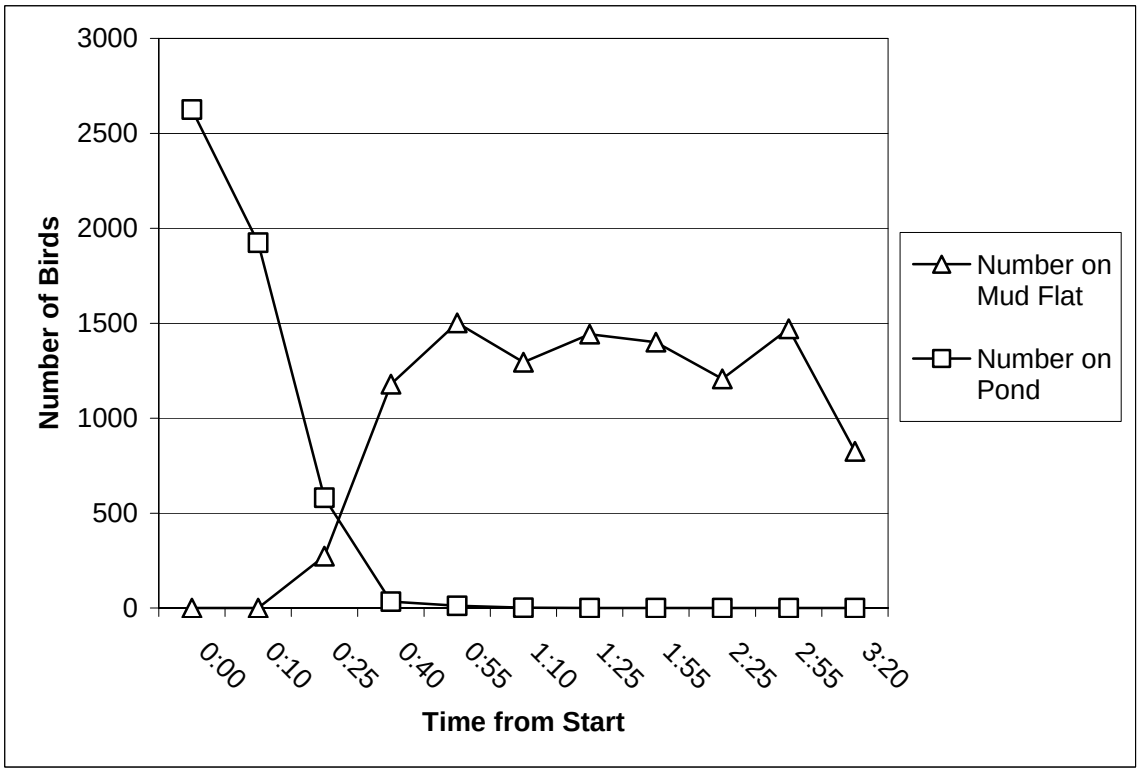

Figure 75. Total number of shorebirds over time on an ebb tide at the Eden Landing mudflat and number of birds on adjacent pond B13 on 01/18/2005.

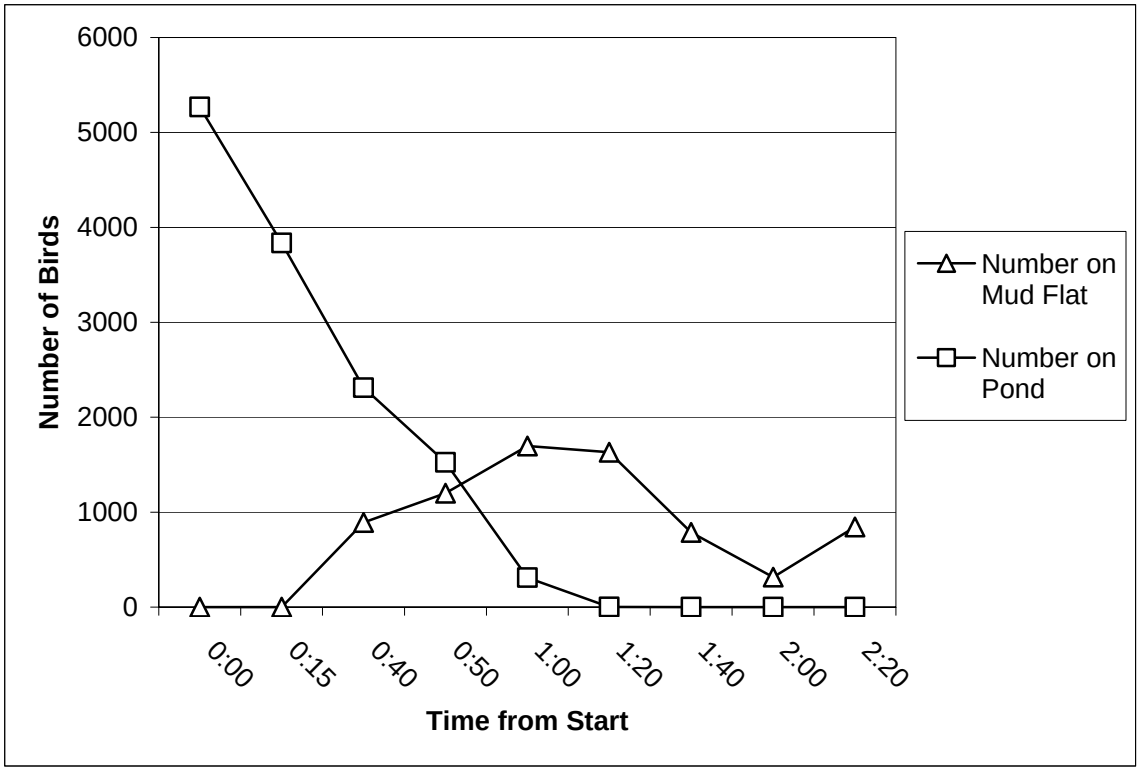

Figure 78. Total number of shorebirds over time on an ebb tide at the Eden Landing mudflat and number of birds on adjacent pond B13 on 02/22/2005.

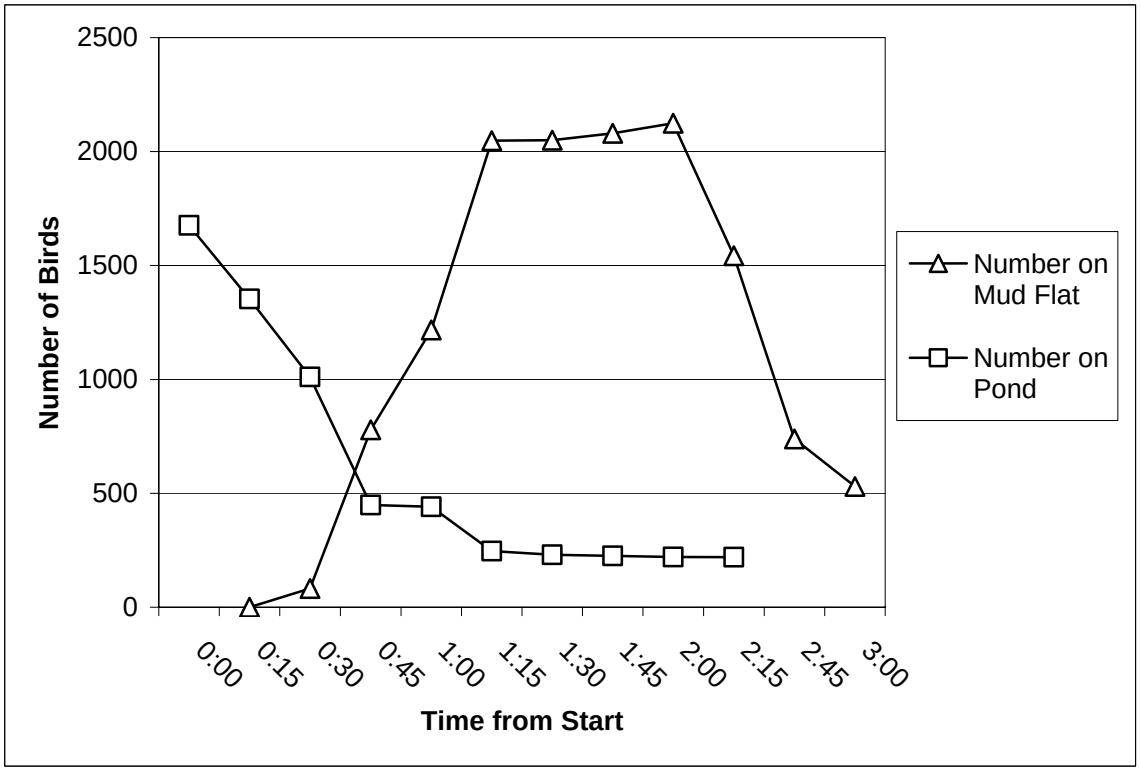

Figure 79. Total number of shorebirds over time on an ebb tide at the Eden Landing mudflat and number of birds on adjacent pond B12 on 03/16/2005.

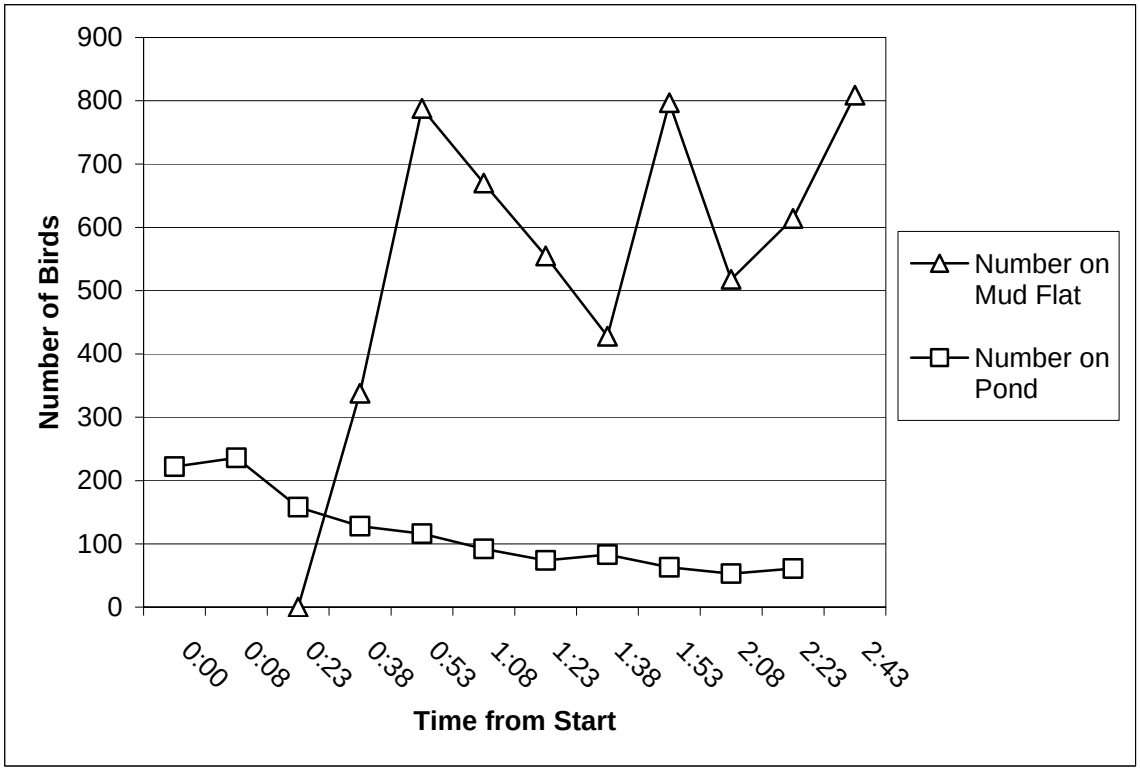

Figure 80. Total number of shorebirds over time on an ebb tide at the Eden Landing mudflat and number of birds on adjacent pond B14 on 04/29/2005.

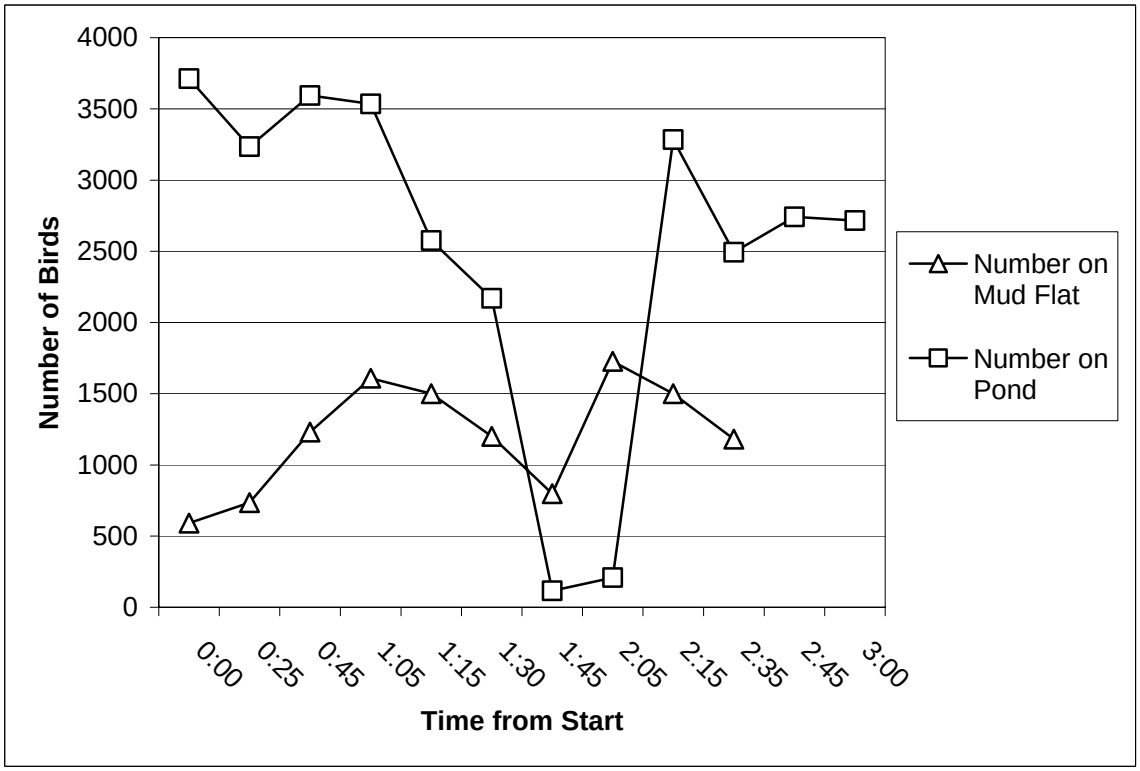

Figure 81. Total number of shorebirds over time on an ebb tide at the Alviso mudflat and number of birds on adjacent pond A5 on 11/19/2004. Wind speed increased one hour and thirty minutes into the survey. Shorebirds got up and left the pond but returned within 30 minutes.

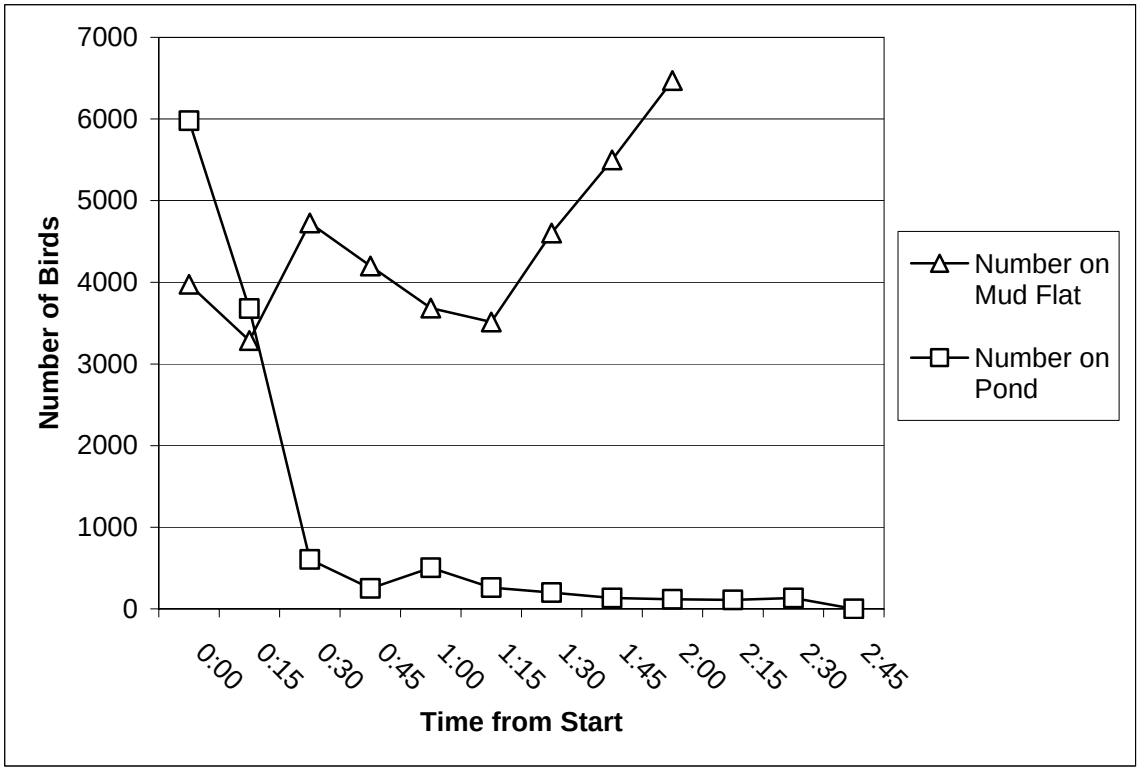

Figure 82. Total number of shorebirds over time on an ebb tide at the Alviso mudflat and number of birds on adjacent pond A5 on 12/21/2004.

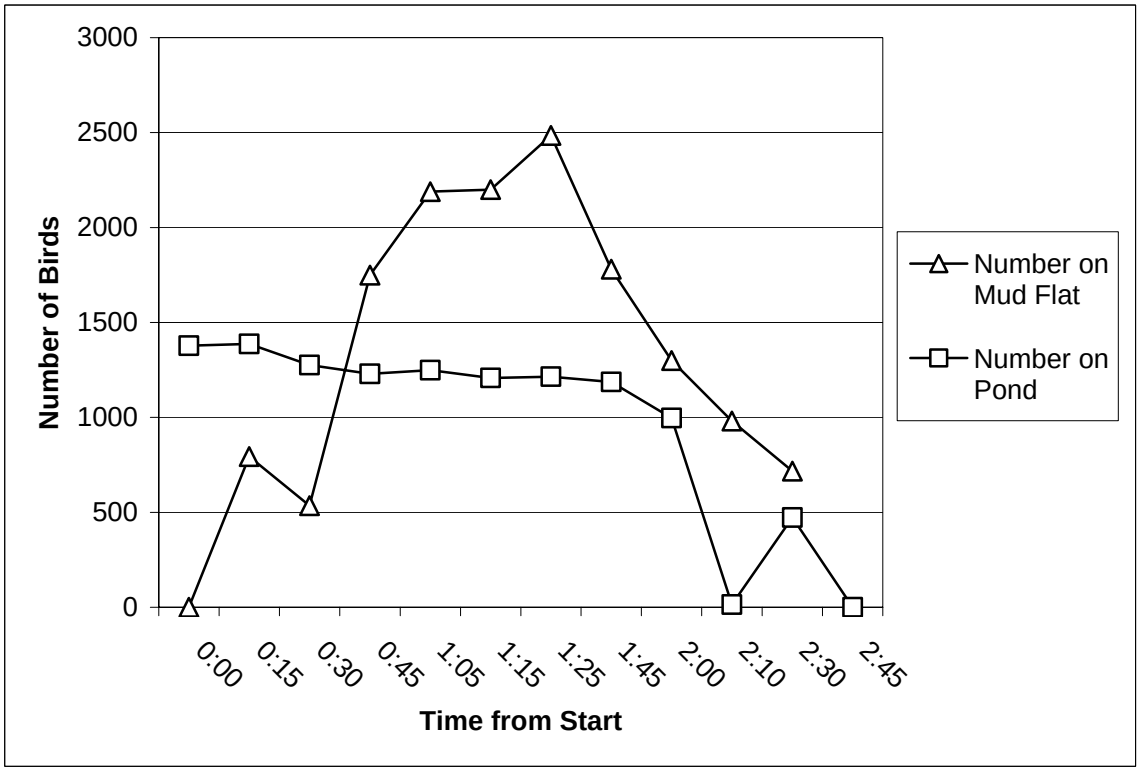

Figure 83. Total number of shorebirds over time on an ebb tide at the Alviso mudflat and number of birds on adjacent pond A5 on 01/20/2005. Over 96% of the shorebirds counted on the pond during this survey were American avocets.

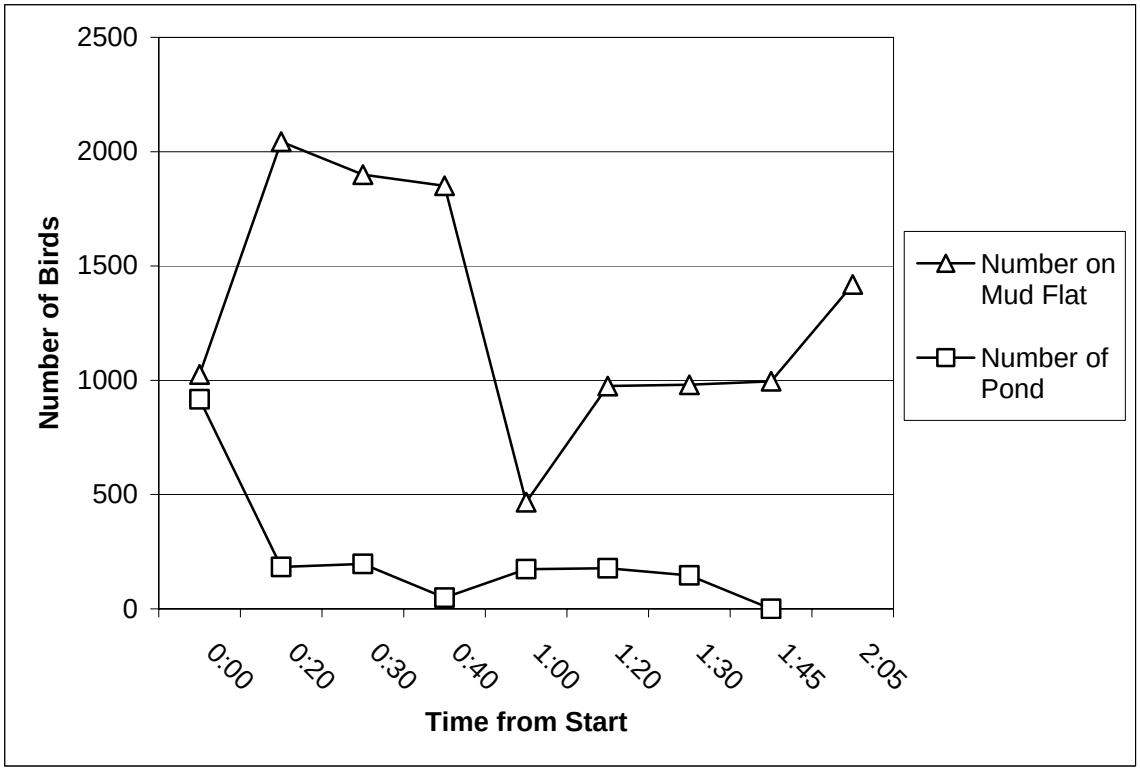

Figure 84. Total number of shorebirds over time on an ebb tide at the Alviso mudflat and number of birds on adjacent pond A8 on 02/24/2005.

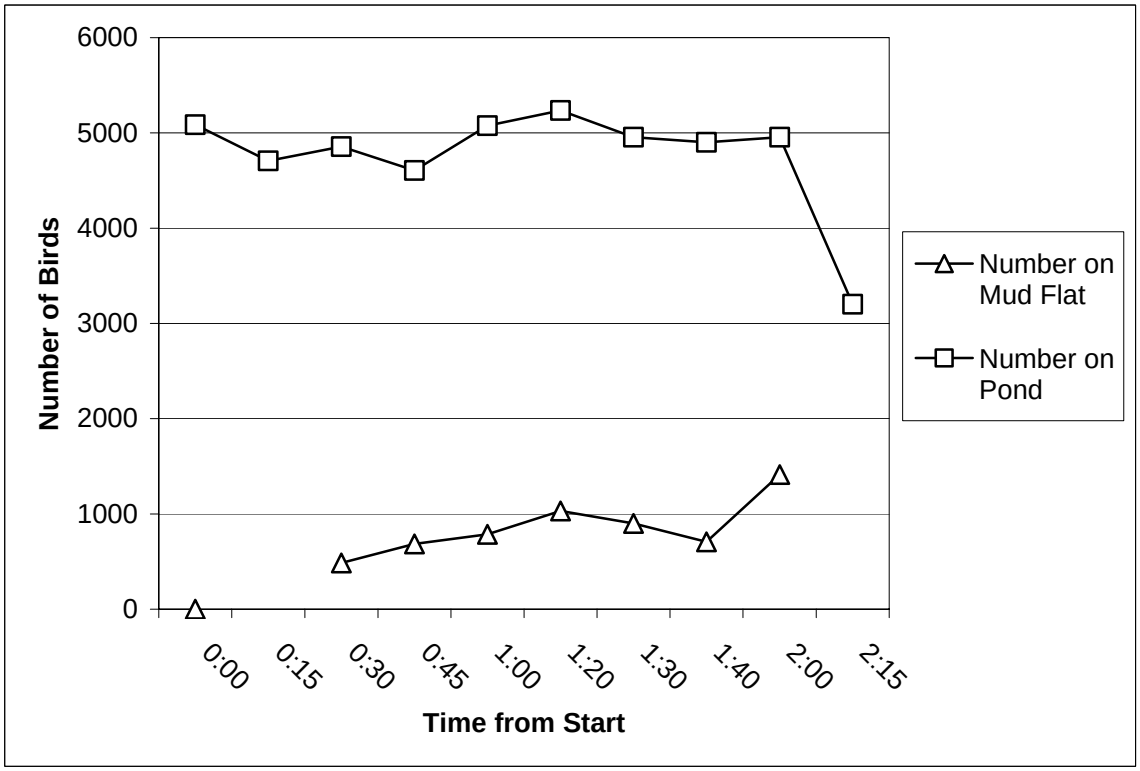

Figure 85. Total number of shorebirds over time on an ebb tide at the Alviso mudflat and number of birds on adjacent pond A8 on 03/25/2005.

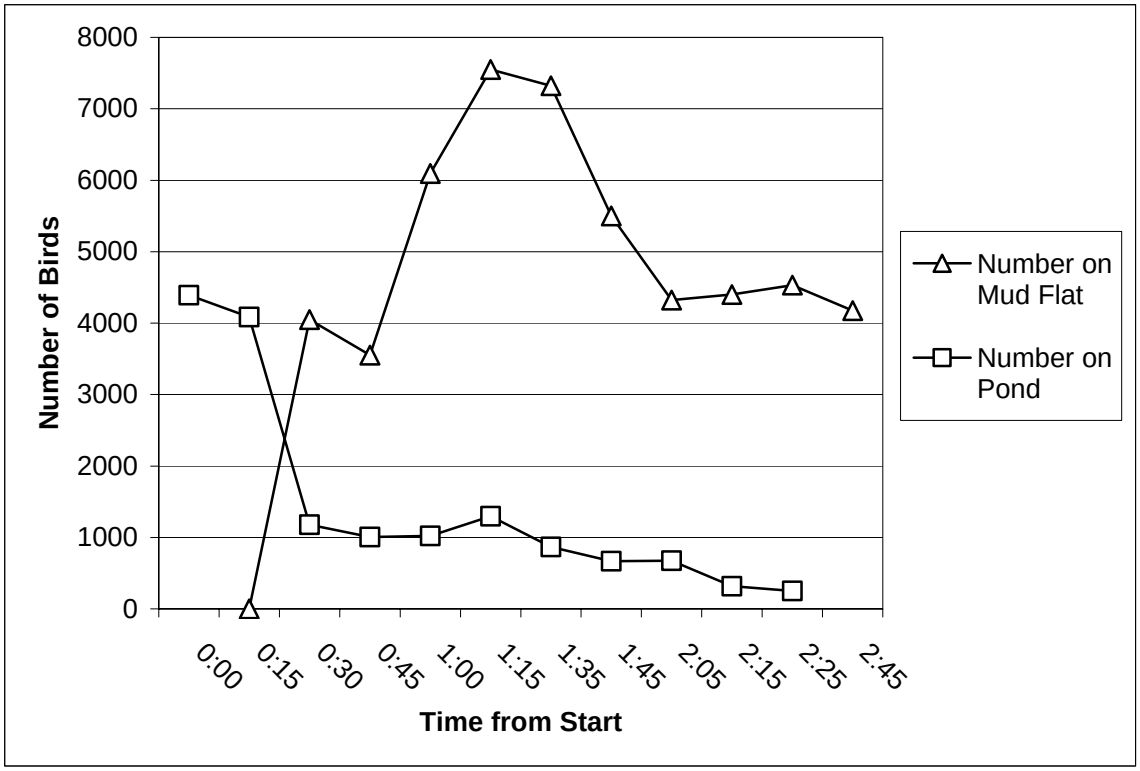

Figure 86. Total number of shorebirds over time on an ebb tide at the Alviso mudflat and number of birds on adjacent pond A8 on 04/18/2005.

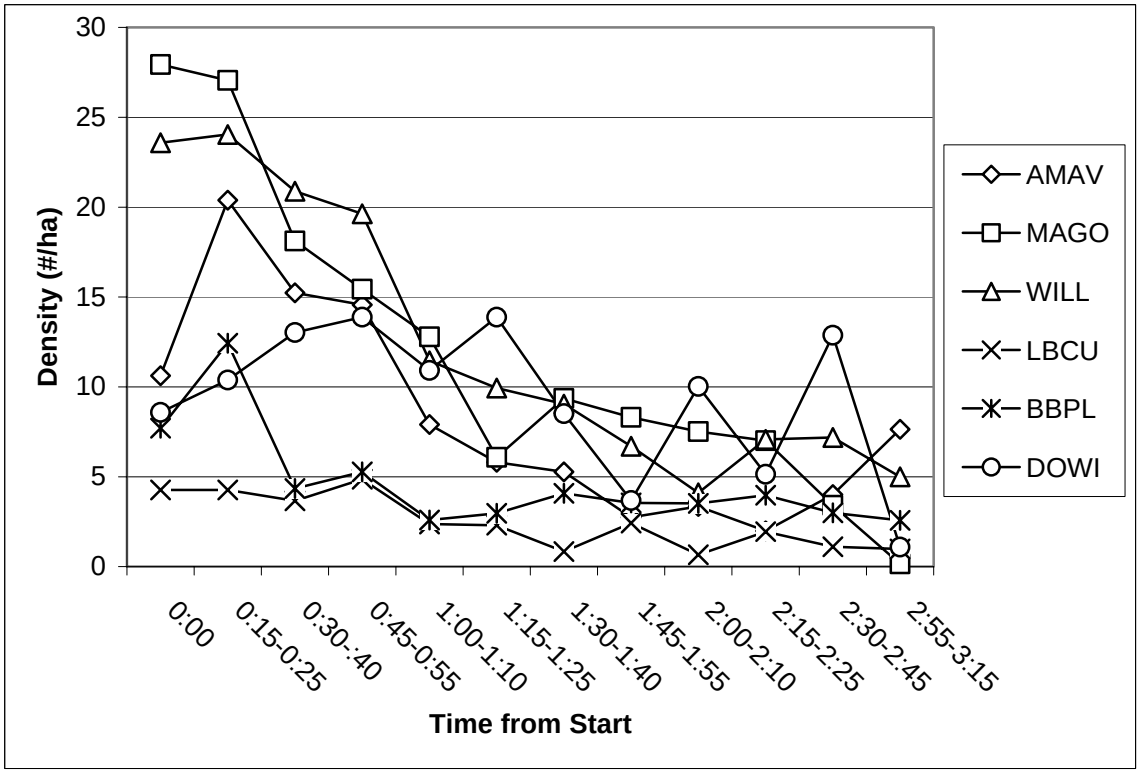

Figure 87. Average density (#/hectare) by species of medium shorebirds over 29 ebb tide surveys as tide recedes and mud flat is exposed. Time 0:00 is the first count of the survey.

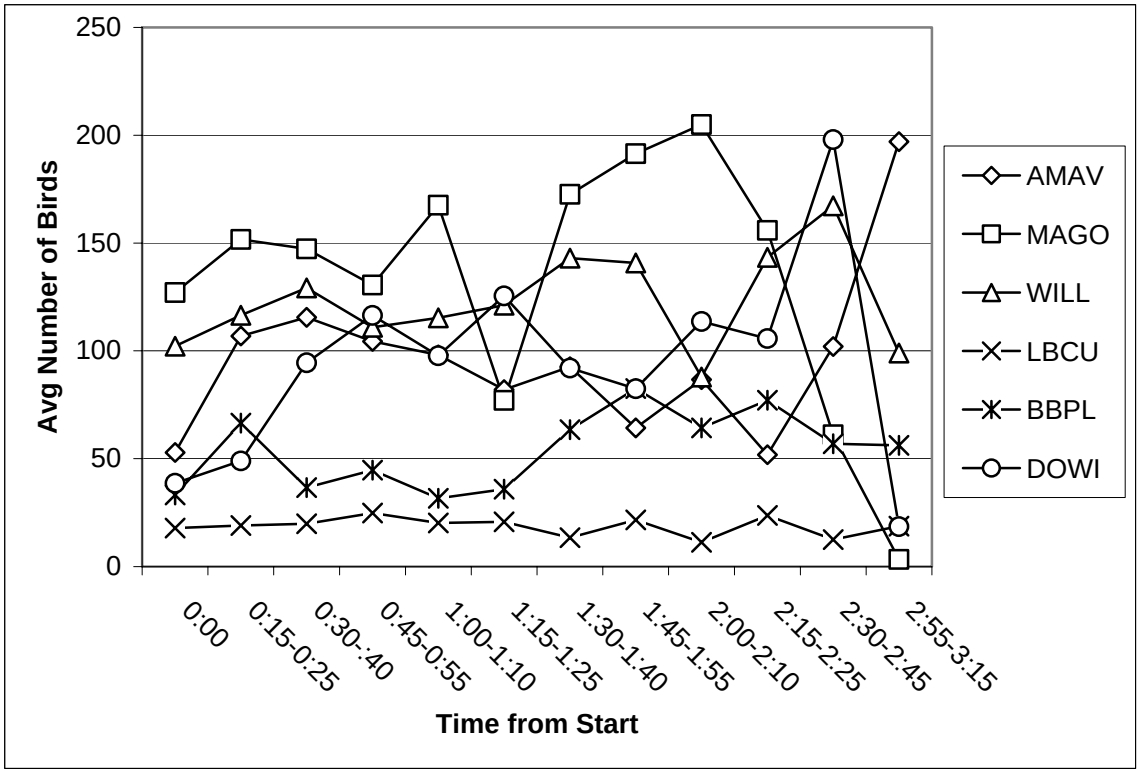

Figure 88. Average total number on mudflat by species of medium shorebirds as tide recedes and mud flat is exposed over 29 ebb tide surveys.

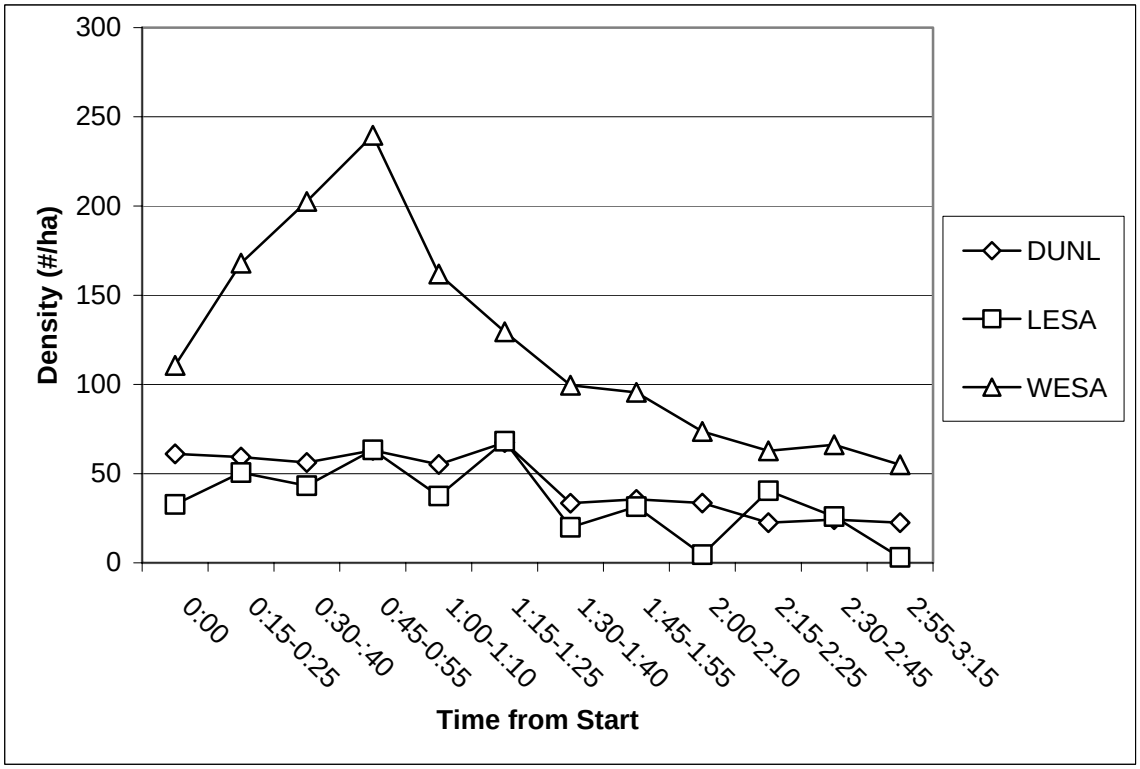

Figure 89. Average density (#/hectare) by species of small shorebirds over 29 ebb tide surveys as tide recedes and mud flat is exposed.

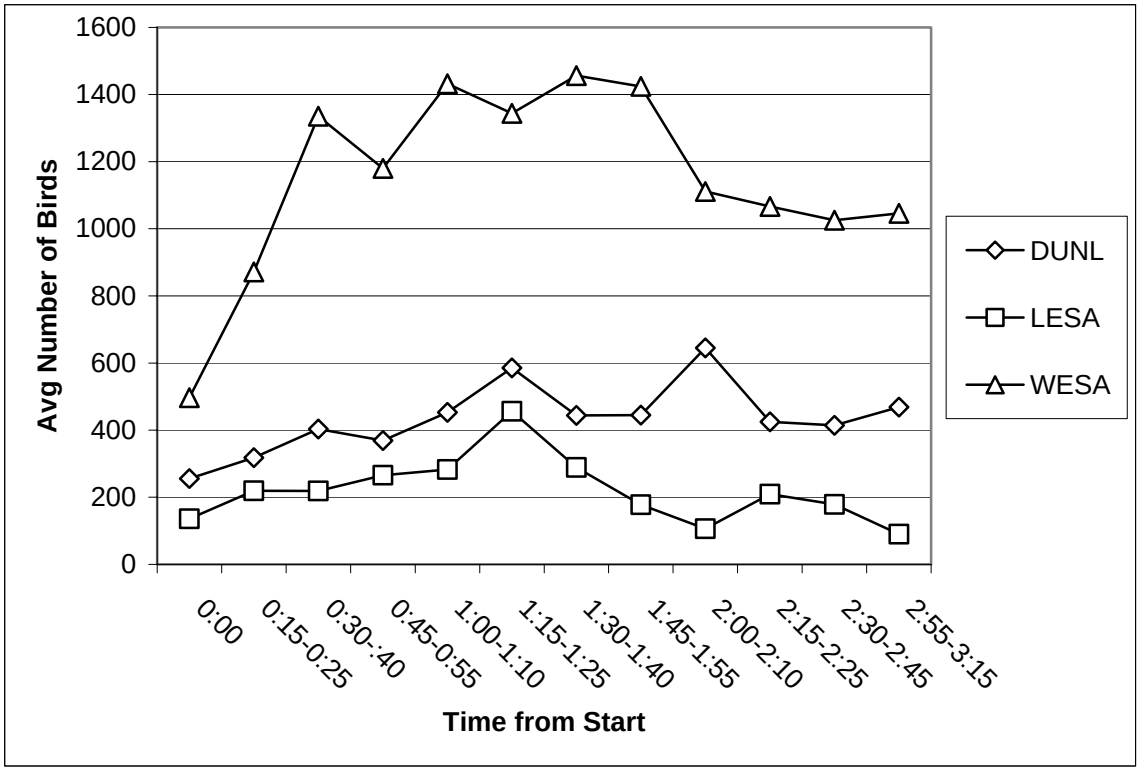

Figure 90. Average total number on mud flat by species of small shorebirds as tide recedes and mudflat is exposed over 29 ebb tide surveys.

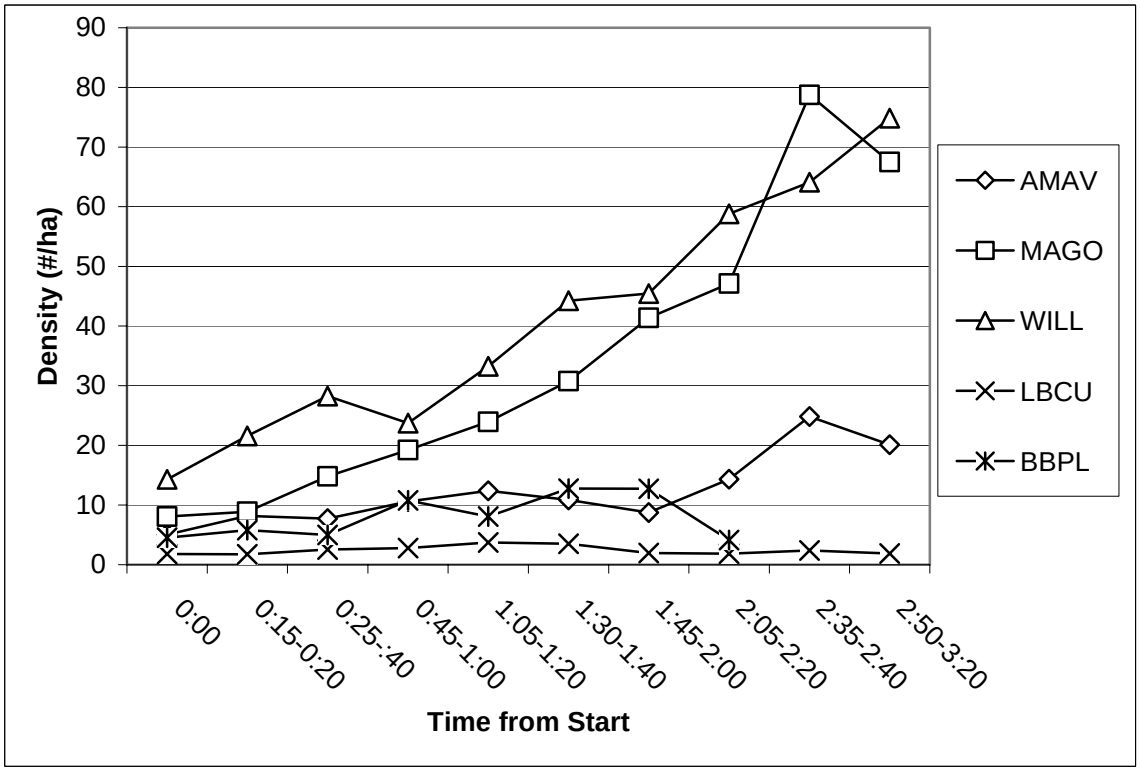

Figure 91. Average density by species of medium shorebirds on 15 flood tide surveys during 2005-2006. Dowitchers were few in number and represented less than 1% of population during the second season and were not included on flood tide survey analysis.

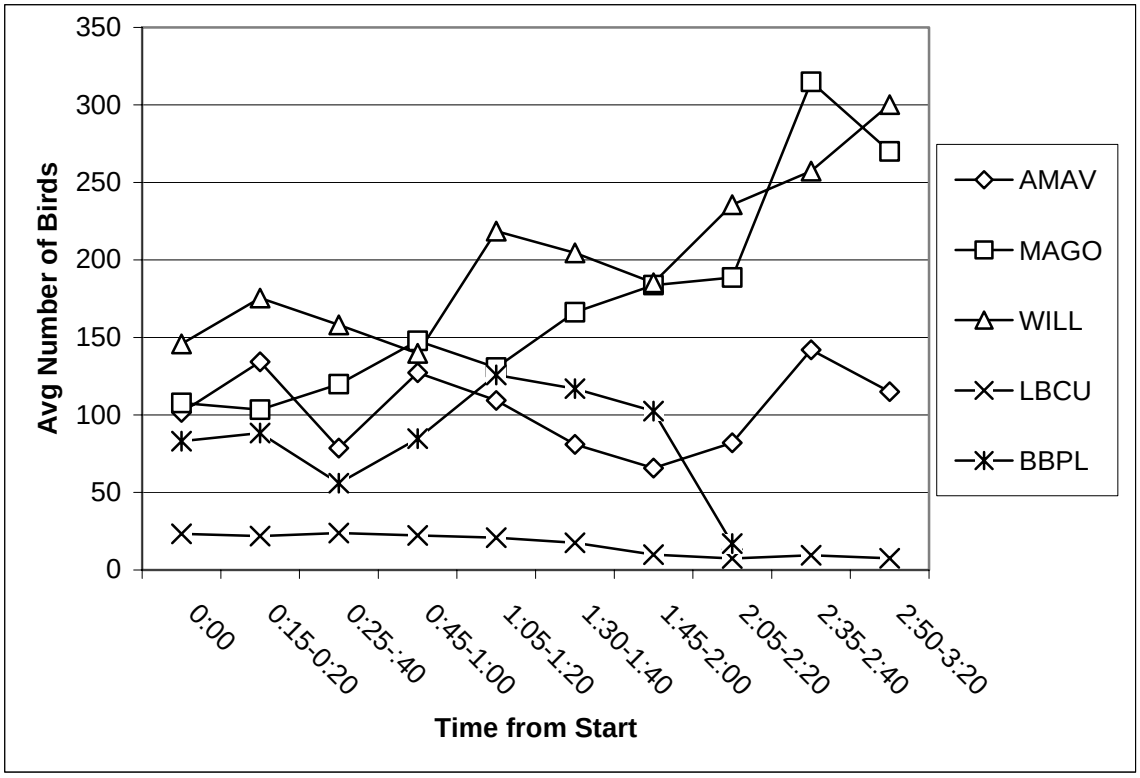

Figure 92**.** Average total number on mudflat by species of medium shorebirds as tide recedes and mud flat is exposed over 15 flood tide surveys.

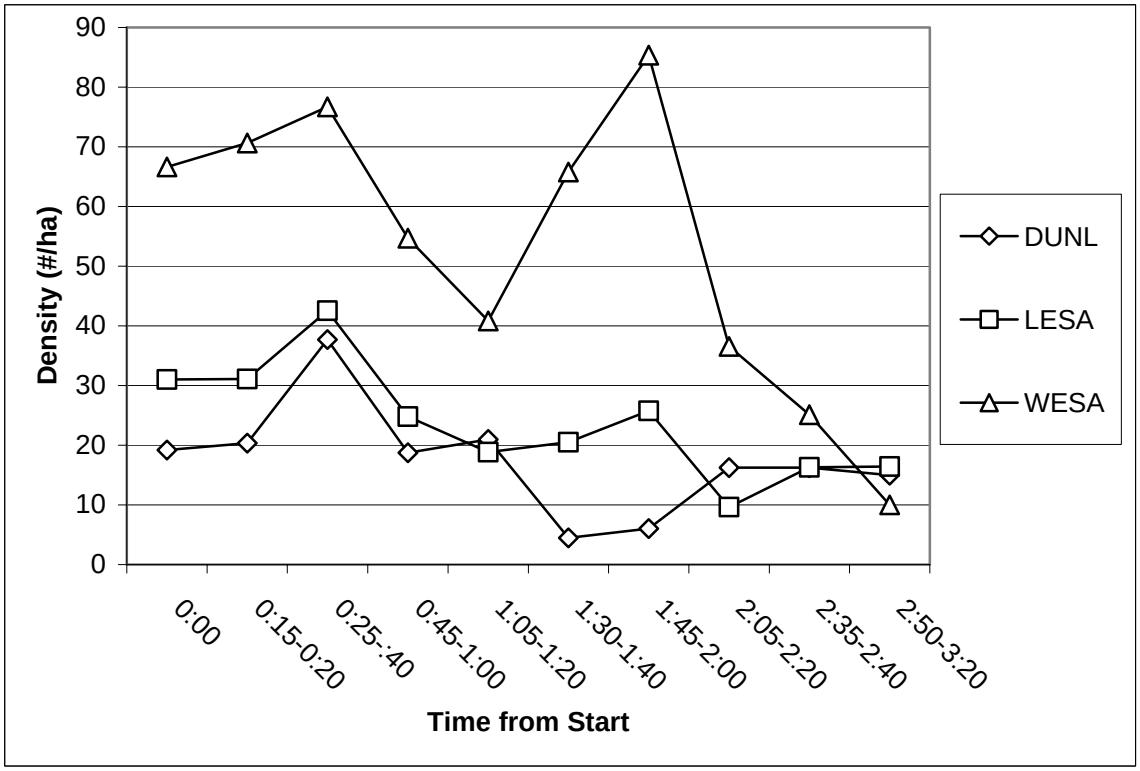

Figure 93. Average density by species of small shorebirds on 15 flood tide surveys in 2005-2006.

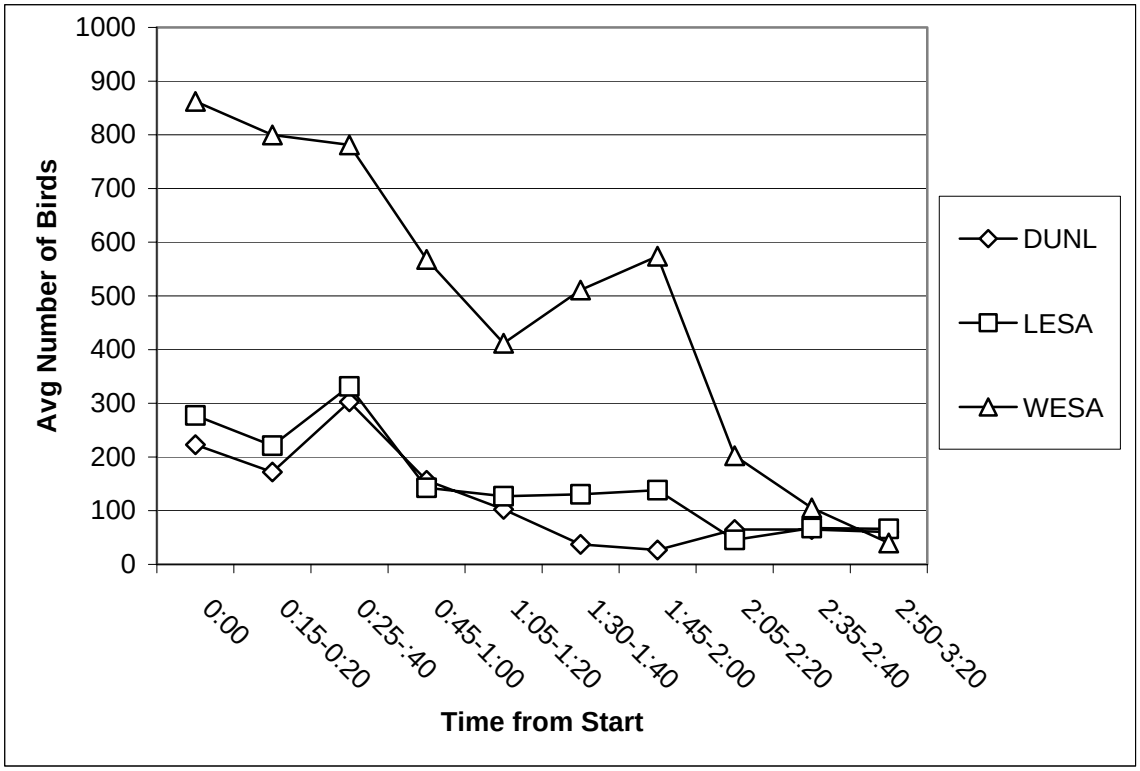

Figure 94**.** Average total number on mudflat by species of small shorebirds as tide recedes and mud flat is exposed over 15 flood tide surveys.

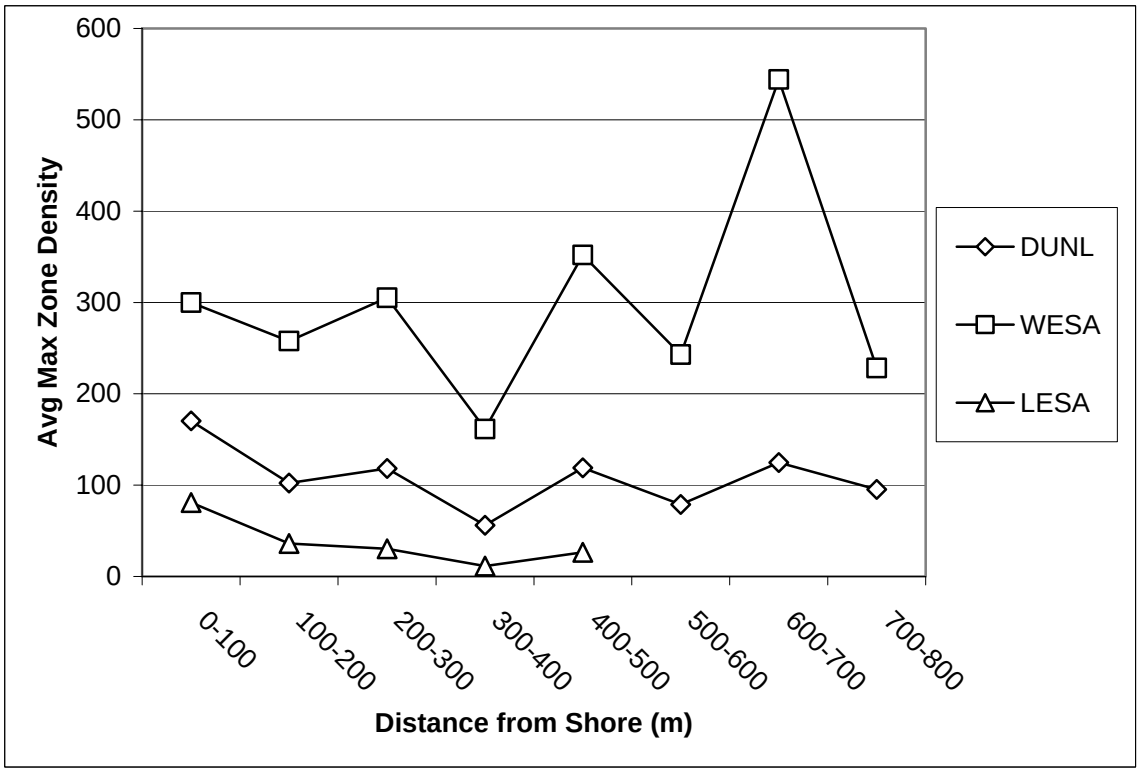

Figure 95. Average maximum zone density (16 surveys) by species of small shorebirds on an Ebb tide.

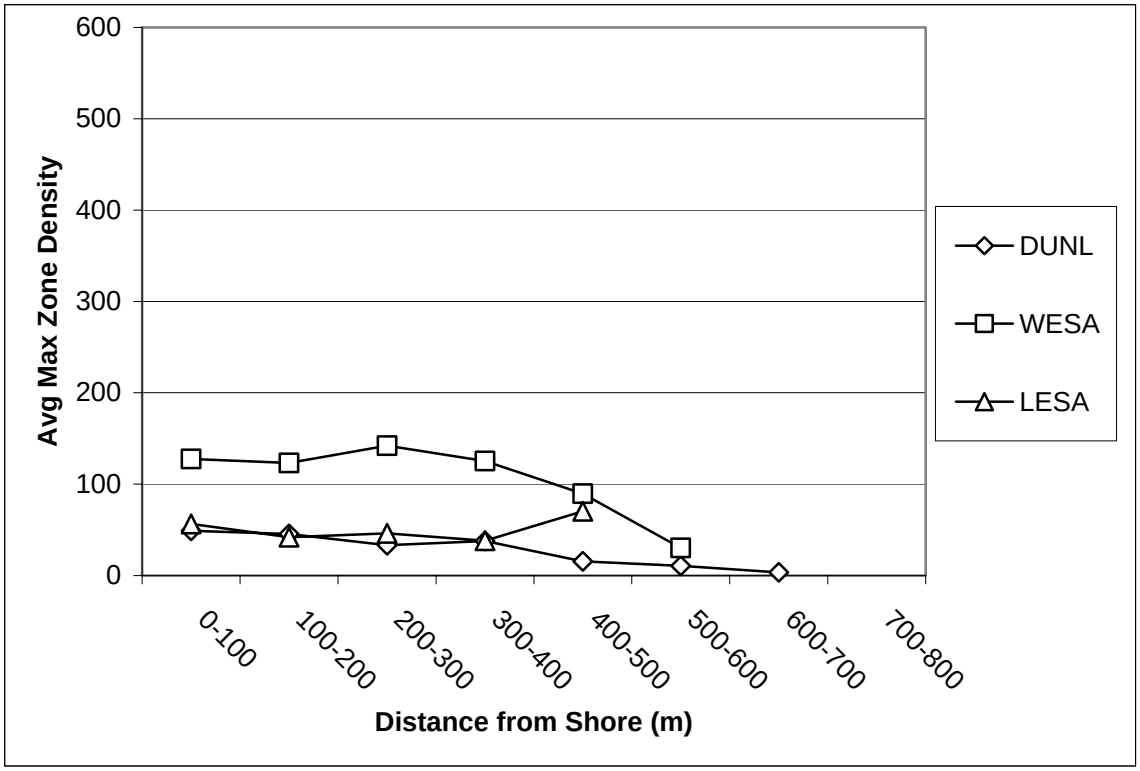

Figure 96. Average maximum zone density (13 surveys) by species of small shorebirds on an Flood tide.

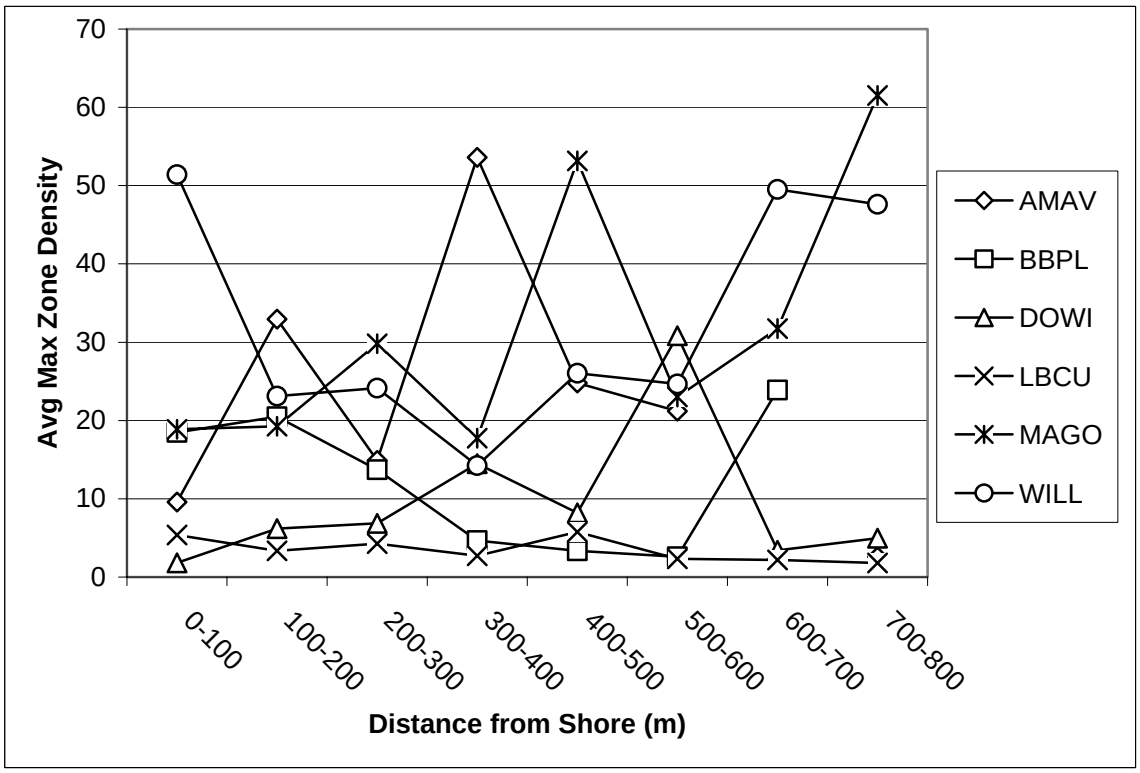

Figure 97. Average maximum zone density (16 surveys) by species of medium shorebirds on an Ebb tide.

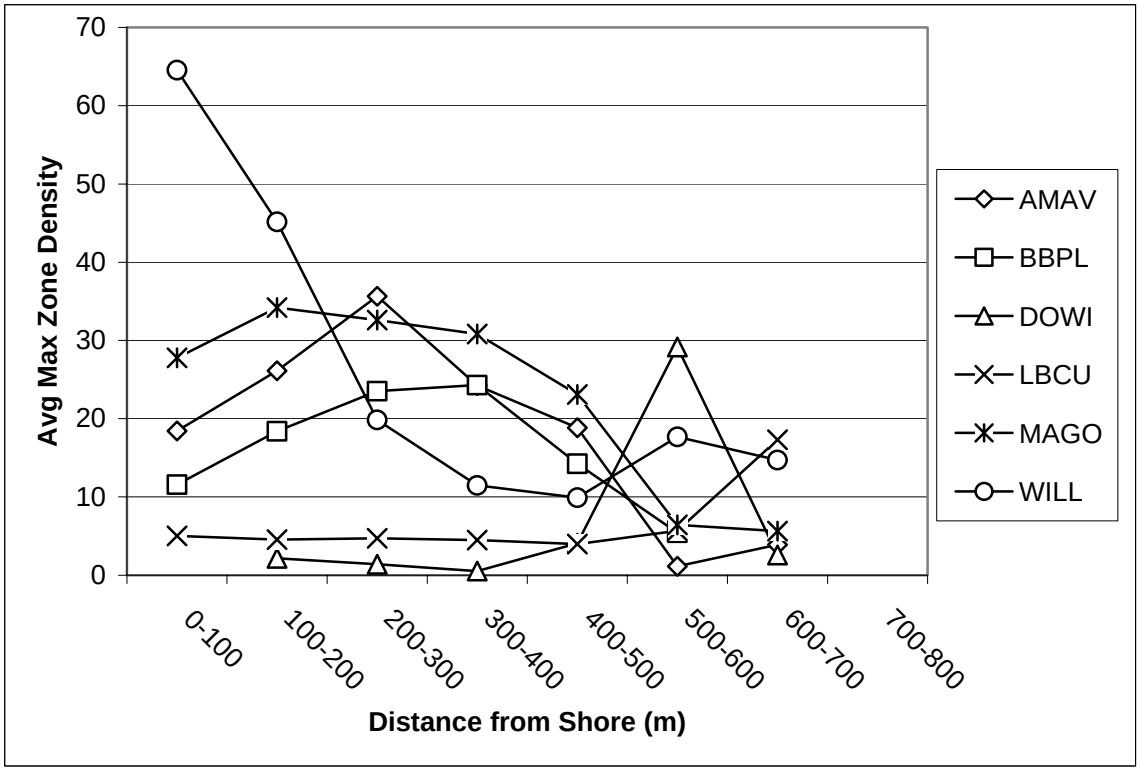

Figure 98. Average maximum zone density (13 surveys) by species of medium shorebirds on a flood tide.