



SAN FRANCISCO BAY
BIRD OBSERVATORY

Cargill Salt Pond Waterbird Surveys Report, October 2008 - September 2009



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EXECUTIVE SUMMARY

The San Francisco Bay Bird Observatory surveyed 22 salt evaporation ponds for waterbirds and sampled water quality from October 2008 through September 2009. The salt ponds surveyed are owned by the Don Edwards San Francisco Bay National Wildlife Refuge and managed for salt production by Cargill Salt. We examined species richness, total abundance within and between complexes. We also examined the difference in abundance of foraging guilds within each complex.

We observed 421,939 birds during our monthly surveys between October 2008 and September 2009. Species richness was greatest in Coyote Hills and Mowry complexes and lowest in the Dumbarton complex. Total abundance was highest in the Mowry complex, followed by Coyote Hills, then Dumbarton. The proportion of birds foraging was greatest in Coyote Hills and Dumbarton complexes, whereas birds mostly roosted in the Mowry complex.

We found that guilds were most abundant in specific ponds and water quality parameters often dictated guild-specific distributions. These distributions were likely driven by the prey distribution and the conditions needed for their survival. For example, we rarely found fish eaters in high salinity ponds because fish species cannot tolerate those salinities. Likewise, we often observed Eared Grebes, phalaropes, and shorebirds in high salinity ponds where brine shrimp and flies are likely abundant. Shorebird abundance is also dependent upon appropriate water depth for foraging and islands for roosting.

As the South Bay Salt Pond Restoration Project progresses, we recommend management of salt pond habitats to retain bird populations by maintaining a variety of water salinities for the guilds. Special consideration should be given to birds that prefer medium to high salinity ponds such as phalaropes and Eared Grebes. We also suggest providing lower water levels in some ponds for small and medium shorebirds during migration, and creating or maintaining islands or undisturbed levees for shorebird roosting habitat. Finally, as the restoration progresses, continuing to monitor avian use of these ponds will allow for managers to assess the success of the restoration in maintaining current bird populations.

INTRODUCTION

In 2002, the U.S. Fish and Wildlife Service and California's Department of Fish and Game entered a historic agreement with Cargill Salt to purchase 15,100 acres of salt evaporator ponds in the South San Francisco Bay. The South Bay Salt Pond Restoration Project (SBSRP) has begun to restore the area to a mix of tidal and ponded habitats and provide flood protection and public access to the South Bay (South Bay Salt Pond Restoration Project).

Salt ponds have been present in the San Francisco for 150 years (Ver Planck 1958) and have significant wildlife value as ponds (Anderson 1970; Accurso 1992; Takekawa et al. 2001; Warnock et al. 2002). As a major migratory and wintering location along the Pacific Flyway, the San Francisco Bay supports a more than a million birds throughout the year and provides important foraging and roosting sites (Page et al. 1999, Warnock et al. 2002). The SBSRP has committed to retain some salt pond habitat (as managed

ponds) to maintain existing ecological value for waterbirds, but information is needed to ensure that habitat requirements of large numbers of waterbirds can be met with reduced pond acreage. The U.S. Geological Survey (USGS) conducts monthly monitoring of waterbird use and water quality of the salt ponds located within the SBSRP area and San Francisco Bay Bird Observatory (SFBO) monitors the ponds owned by the Don Edwards San Francisco Bay National Wildlife Refuge (the Refuge) and operated by Cargill Salt and not slated to be restored to tidal action.

This report presents the results of SFBO's surveys in the Coyote Hills, Dumbarton and Mowry salt pond complexes, from October 2008 through September 2009.

METHODS

Study Area

We conducted bird surveys at 22 salt ponds in the cities of Newark and Fremont, Alameda County, California. Although the ponds are owned by the Refuge, Cargill Salt retains mineral rights and regulates water flow for salt production. The ponds monitored by SFBO include Coyote Hills ponds (N1A - N9), Dumbarton ponds (NPP1, N1 - N3) and Mowry ponds (M1 - M6; Figure 1). The salinity and depth of these ponds varies over the course of the year and according to Cargill management activities.

Data Collection

During each calendar month, we conducted one bird survey at each of the 22 ponds in the Coyote Hills, Dumbarton, and Mowry salt pond complexes. During each survey, we observed birds from the nearest drivable levee, using spotting scopes and binoculars. We counted bird species present on the pond, and recorded their location in the pond using aerial maps of each pond superimposed with 250 m² individually labeled grids. For each individual bird, we recorded foraging behaviors, and, for roosting or resting birds on an island, levee, or manmade structure, we recorded their location on any of these structures. We did not record bird use of these structures if the bird was foraging.

We identified birds at the species level whenever possible, with the exception of Long-Billed and Short-Billed Dowitchers, which we identified as dowitchers, and Greater and Lesser Scaup, which we identified as scaup.

When species identification was not possible, we identified birds to genus or foraging guild (e.g. gulls, small shorebirds, medium shorebirds, or phalaropes). We also categorized each species into a foraging guild for analyses and presentation, based on their foraging methods and prey requirements.

We conducted our surveys exclusively during high tide, defined as a tide of 4.0 feet or greater at the Alameda Creek Tide Sub-Station (37° 35.7' 122°). During each survey, we recorded the pond name, the date and the observer, and the start and end time. In addition, during each bird survey we collected a water sample and determined salinity by measuring specific gravity using hydrometers (Ertco, West Paterson, NJ) and recording the temperature of the pond. We collected this sample at the same grid at

each pond every month. We also recorded a water depth reading using a staff gauge, present in all but a few ponds.

SFBBO sampled water quality at all 22 salt ponds each month, collecting dissolved oxygen, salinity, pH and temperature at each pre-determined sample site. We also recorded barometric pressure the beginning of each day that water quality samples were taken. We used several water quality instruments to obtain our measurements, including Hach HQ10 Luminescent Dissolved Oxygen (LDO) Meter (Hydrolab-Hach Company, Loveland, CO), Hydrolab Minisonde (Hydrolab-Hach Company, Loveland, CO), and YSI 63 pH/Conductivity meter (YSI Incorporated, Yellow Springs, OH) meters. We also determined specific gravity using hydrometers (Ertco, West Paterson, NJ).

Data Analysis

To compare the abundance of each guild between ponds and seasons in each complex, we conducted separate analyses among each guild using ANOVA (Systat 2004). Our models included *pond number* and *season*, and we did not test interaction terms. Prior to analysis, we standardized abundance by acre, and we made pairwise comparisons using Tukey-Kramer Multiple Comparison Tests. For this analysis, we used abundance per acre of the guilds in each salt pond per month as our unit of replication.

We analyzed patterns of foraging guild composition in salt ponds using Canonical Correlation Analysis (CCA) in SPSS (2006). We included water quality variables (salinity, pH, dissolved oxygen, and temperature) and pond area (acres) in the CCA analysis.

RESULTS

Coyote Hills

Species Richness and Abundance.--- In the Coyote Hills complex, species richness was highest in pond N4AB with 49 species recorded, followed by N3A (37; Table 1). Total abundance was highest in ponds N3A, with 17,939 birds recorded, followed by N4AB with 16,293 birds recorded (Table 1). Abundance was highest for all ponds during the winter months (Figure 2), though numbers remained high throughout the survey period on ponds N2A, N3A and N4AB, due to the nesting California Gulls on that pond. The small island in the south east corner of N4 hosted large numbers of roosting medium shorebirds.

Guild Analyses.--- The number of diving ducks differed significantly between ponds ($F_{11,132} = 4.099$, $P < 0.001$). We found significantly more diving ducks per acre in ponds in pond N1A than ponds N4, N4B, N5, N6, N7, N8 and N9 ($P \leq 0.010$). The number of gulls differed significantly between ponds ($F_{11,132} = 6.292$, $P < 0.001$). There were significantly more gulls per acre in ponds N2A and N6 this past year compared to ponds N4, N4AA, N4B, N5, N7, N8 and N9 ($P \leq 0.025$). The number of terns differed significantly between ponds ($F_{11,132} = 2.470$, $P < 0.001$). Pond N2A had a higher number of terns per acre than ponds N3A and N5 ($P \leq 0.050$). There were no other significant relationships between guilds and ponds ($F_{11,132} < 1.854$, $P \geq 0.051$).

Behavior.--- The division of birds by behavior varied greatly between ponds. The majority of the birds observed on ponds N4B and N9 were seen foraging (54.67% and 46.39%, respectively; Table 2). The majority of birds on ponds N4AA, N1A, and N4AB were seen roosting. The most common observed behavior in ponds N8, N7, N6, N3A, N4 and N4A was roosting on a levee (Table 2).

Water Quality.--- Pond N1A had the lowest salinity of all the Coyote Hills complex ponds with an average salinity of 34.51 ppt (Table 3). Pond N4 had the highest salinity with an average of 63.37 ppt. Average temperatures in the Coyote Hills ponds ranged from a low of 18.62°C in pond N1A to a high of 21.88°C in pond N4 (Table 4). The dissolved oxygen ranged from a low of 6.84 mg/l in N8 to a high of 8.85 mg/l in N1A (Table 5). The pH in the Coyote Hills ponds ranged from a low of 8.26 in pond N1A to a high of 8.48 in pond N4 (Table 6).

Dumbarton

Species Richness and Abundance.--- Pond N1 had the highest species richness with 37 species recorded, followed by pond N3 with 36 species recorded (Table 1). Total abundance was highest in pond N1 with 37,878 birds observed followed by pond N3 with 24,648 birds observed (Table 1). Abundance was highest in the winter months when the Dumbarton ponds hosted high numbers of small shorebirds (Figure 3).

Guild Analyses.--- The number of fish eaters differed significantly between ponds ($F_{3,44} = 7.837, P < 0.001$). Pond N1 had a significantly higher number of fish eaters per acre than all the other Dumbarton ponds ($P \leq 0.002$). The number of geese differed significantly between ponds ($F_{3,44} = 3.469, P = 0.024$). Pond N2 had a significantly higher number of geese per acre than N1 and NPP1. ($F_{3,44} = 3.469, P \leq 0.039$). The number of medium shorebirds also differed between ponds ($F_{3,44} = 5.154, P = 0.004$). We found significantly higher numbers of medium shorebirds per acre on pond N1 than compared to N2 and N3 ($P \leq 0.017$). The number of small shorebirds differed between ponds ($F_{3,44} = 3.662, P = 0.019$); pond NPP1 had a higher number of small shorebirds per acre compared to all other Dumbarton ponds ($P \leq 0.033$). The number of terns differed between ponds ($F_{3,44} = 4.972, P = 0.005$). We found significantly higher numbers of terns on pond N1 compared to all other ponds ($P \leq 0.025$). There were no other significant relationships between guilds and ponds ($F_{3,44} \leq 1.823, P \geq 0.157$).

Behavior.--- Ponds N2 and NPP1 supported the highest percentage of foraging birds in the Dumbarton complex (46.24% and 34.77%, respectively; Table 2). Islands in pond N1 hosted almost 73% of all the birds recorded in that pond (Table 2).

Water Quality.--- Pond N3 had the lowest salinity in the Dumbarton complex with an average salinity of 80.38 ppt (Table 3). Pond NPP1 had the highest salinity with an average of 135.63 ppt (Table 3). Average temperature in the Dumbarton ponds ranged from 19.73°C in pond N1 to 20.62°C in pond N3 (Table 4). The dissolved oxygen ranged from an average low of 5.14 mg/l in NPP1 to a high 7.05 mg/l in N3 (Table 5). The pH in the Coyote Hills ponds ranged from 7.92 in NPP1 to 8.51 in N2 and N3 (Table 6).

Mowry

Species Richness and Abundance.--- Pond M1 had the highest species richness with 39 species recorded while M6 had the lowest species richness with 19 species recorded (Table 1). Total abundance was highest in pond M5 with 86,098 birds recorded. The pond with the lowest total abundance was M2 with 18,536 birds recorded (Table 1). The Mowry ponds hosted large numbers of gulls throughout the year as well as large numbers of small shorebirds in the fall and winter (Figure 4).

Guild Analyses.--- The number of Eared Grebes differed significantly between ponds ($F_{5,66} = 3.344$, $P = 0.009$). We found significantly more Eared Grebes per acre on pond M3 compared to M1, M2, M4 and M5 ($P \leq 0.039$). The number of gulls differed significantly between ponds ($F_{3,44} = 10.804$, $P < 0.001$). Pond M5 had significantly more gulls per acre than ponds M1, M2, M3 and M5 ($P \leq 0.002$). Pond M6 had significantly more gulls per acre than pond M3 ($P \leq 0.030$). There were no other significant relationships between guilds and ponds ($F_{3,44} < 2.126$, $P > 0.073$).

Behavior.--- Ponds M3 and M4 supported the highest percentage of foraging birds in the Mowry complex (33.51% and 28.07%, respectively; Table 2). A large percentage of birds observed on M5 (58.65%) and M6 (69.58%) were roosting on islands. Pond M1, M2 and M4 had a large percentage of birds roosting on levees (Table 2).

Water Quality.--- The average salinity in the Mowry complex ranged from a low of 46.77 ppt in M1 to a high of 249.21 ppt in M6 (Table 3). The temperature ranged from 18.62 °C in pond M2 to 22.14°C in pond M6 (Table 4). The average dissolved oxygen ranged from 3.63 mg/l in M6 to 12.54 mg/l in M1 (Table 5). The pH ranged from an average of 7.51 in M6 to 8.37 in M2 (Table 6).

CCA Results

The canonical correlation analysis showed that the correlations for variates 1 and 2 were significant ($\chi^2 = 0.357$, $df=50.0$, $P \leq 0.001$ and $\chi^2 = 132.538$, $df = 36.0$, $P \leq 0.001$; Table 7). Dabbling ducks were found in ponds with lower temperatures while diving ducks were found in smaller ponds with lower salinity and temperature and high dissolved oxygen. Eared grebes preferred ponds larger ponds with higher salinity. Fish eaters were found in ponds that were smaller and had lower salinity and high dissolved oxygen. Geese preferred areas with lower temperatures. Gulls preferred larger ponds with higher salinity and lower dissolved oxygen. Herons preferred smaller ponds with low salinity and high dissolved oxygen. Medium and small shorebirds were found in ponds with lower temperatures and terns were found in smaller ponds with low salinity and high dissolved oxygen.

DISCUSSION

The salt ponds of the South San Francisco Bay have been long recognized as an important waterbird migration and wintering site (Takekawa et al. 2001; Warnock et al. 2002). The ponds surveyed in the study are managed for salt production and have widely ranging salinities which influences the bird use of ponds.

Coyote Hills

The northern Coyote Hills ponds (N1A, N2A, N3A, and N4AB) provided important habitat for dabblers, divers, fish eaters, medium shorebirds and terns. These ponds had the highest richness and species abundance in the complex. The salinity in these ponds is typically the lowest in the complex; due to the water control structure in N1A that intakes brackish water from the Alameda County Flood Control Channel into the pond system. As the water moves south through the complex, the salinity general increases and we find lower richness and species abundance in these ponds. This year we also observed high numbers of small shorebirds in ponds N8 and N9. The majority of these birds were roosting and on the levee between the two ponds and foraging along the eastern side of N9. The salinity in pond N9 was higher this year than previous years and may have increased the amount of prey available to small shorebirds.

Dumbarton

In previous years, the Dumbarton complex has hosted the highest species abundance (Robinson et al. 2009), however, this year the Dumbarton complex had the lowest species abundance and lowest richness. This may be due to changes in water management as the salinity was much lower than in the previous three years (Robinson et al. 2009) and the water levels were higher than the past two years. This may have changed the prey composition in the ponds. Even with these changes, the Dumbarton ponds hosted large numbers of small shorebirds as well as dabbling ducks. The small shorebirds roosted in high numbers along the levee separating N1 and NPP1.

Mowry

The Mowry complex includes the highest salinity ponds that SFBBO surveys. However, the average salinity for the ponds from Oct 2008 – Sept 2009 was lower than the past three years (Robinson et al. 2009). Herons, terns and fish eaters were seen using M1 and M2; these ponds have lower salinity than the rest of the complex and may support more fish and invertebrates to support foraging for these guilds. The salinity of ponds M3 through M6 was higher and we observed large numbers of eared grebes using the more saline ponds, who feed on invertebrates such as brine shrimp (Cullen et al. 1999). The complex hosted large numbers of small and medium shorebirds, many on roosting on islands in pond M5, which had an average salinity of over 200 ppt.

Guilds

Dabblers.--- Dabbling ducks were associated with low to medium salinity ponds. We observed most of the dabbling ducks using the Dumbarton ponds, but also saw high densities on Mowry pond M3. The affinity of dabblers to these ponds may be related to food abundance. Takekawa et al. (2006) found that the abundance of chlorophyll *a* and macro-invertebrates was highest in low salinity ponds (<80 ppt). Likewise, low salinity ponds are used generalists like Mallard and Gadwall (Leschack et al. 1997; Drilling et al. 2002) that eat plant mater and invertebrates, and vegetarians such as the American Widgeon (Mowbray 1999) that opportunistically eat aquatic vegetation. As salinity rises in salt ponds, the biomass of macro invertebrate copepods decreases, but bring shrimp (*Artemia* spp) biomass increases in ponds

with salinities of 60 – 200 ppt (Carpelan 1957; Takekawa et al. 2006). Dabblers such as Northern Shovelers, which eat small swimming invertebrates but less commonly picks invertebrates off plant matter (Dubowy 1996), may depend on *Artemia* in the medium salinity salt ponds, driving their use of ponds such as M3.

Divers.--- Diving ducks were associated with low to medium salinity ponds. The majority of the diving ducks we observed were seen in the northern Coyote Hills ponds, where the salinity is typically low. Because most of these species forage on macroinvertebrates and plant matter, these lower salinity ponds likely provide the variety of invertebrates and plants these species eat (Takekawa et al. 2006).

Fish eaters and Terns.--- We observed highest numbers of fish eaters, such as cormorants and grebes, and terns in the northern Coyote Hills complex ponds and ponds M1 and M2, which have low salinity. Fish in the South Bay salt ponds cannot survive in salinities greater than 80 ppt (Carpelan 1957), which limits the salinity range where we would expect to observe fish-eating birds foraging. Fish also need moderate amounts of dissolved oxygen in the water column to survive, and sharp drops in dissolved oxygen in the salt ponds, leading to anaerobic conditions, often causes fish to rise to the water surface to obtain oxygen, making them more available for fish-eating birds (K. Henderson, pers. comm.; J. Demers, pers. obs.).

Gulls. --- The California Gull population in the South Bay is growing exponentially (Strong et al. 2004; Robinson-Nilsen et al. 2009a). There are concerns that this expanding population may negatively impact the breeding waterbirds of the South Bay by encroaching on nesting habitat (Strong et al. 2004) or depredating eggs and chicks which has been documented in American Avocets and Black-necked Stilts (Ackerman et al. 2006) and the threatened Western Snowy Plover (Robinson-Nilsen et al. 2009b). This year was the first year since 2004 that the numbers of nesting gulls in the South Bay decreased (Robinson-Nilsen et al. 2009a).

Gulls use of ponds may be more influenced by pond location, rather than water quality parameters. Gulls nested in ponds with a wide range of salinities. For example, the colony in the Coyote Hills complex nests on levees surrounding ponds with an average salinity of just under 40 ppt while the colony on the levees between ponds M4 and M5, whose average salinity was just under 200 ppt.

While almost 5000 California Gulls nested at the Coyote Hills colony, their use of other ponds in the complex was low, suggesting they forage elsewhere. The Coyote Hills colony is less than 2 km south of the California Department of Fish and Game's Eden Landing Ecological Reserve in Hayward, which is the most important Western Snowy Plover breeding habitat in the South Bay (Robinson-Nilsen et al. 2009b). During the 2009 Snowy Plover breeding season, SFBBO captured footage of California Gulls depredating a Snowy Plover nest and newly hatched chicks (Robinson-Nilsen et al. 2009b). This was the first documented evidence that California Gulls are impacting Snowy Plovers. If this colony continues to grow, the potential impact the gulls could have on nesting Snowy Plovers may increase.

The California Gull colony at the Mowry complex continues to grow and gulls were the most abundant guild at Mowry in all seasons (Robinson-Nilsen et al. 2009a). The gulls used the levees for nesting but we also observed large numbers of gulls foraging on M3 and M4. The average salinity in both these ponds was less than 180 ppt and the birds may have been feeding on the brine shrimp and brine flies these ponds supported. The Mowry ponds are also located close to two active landfills, the Tri-Cities Landfill in Fremont and the Newby Island Landfill in Milpitas. The Tri-Cities Landfill is scheduled to close in the next few years, which may reduce the number of gulls nesting and roosting in the Mowry Complex. In addition, the Newby Island Landfill started a gull abatement project in 2008 which has significantly reduced the number of California Gulls feeding at the landfill during the breeding season (Robinson et al. 2009). We may see a reduction of the numbers of gulls nesting in the Mowry ponds if Newby Island continues the abatement program into the future.

Eared Grebes and Phalaropes.--- As the SBSPRP continues, land managers are concerned that the loss of medium and high salinity ponds may impact species that depend on saline habitats such as Eared Grebes and Phalaropes. These species rely on saline bodies of water that host brine flies and brine shrimp (Cullen et al. 1999). We typically recorded Eared Grebes and Phalaropes in ponds with average salinities ranging from 63 ppt to 180 ppt. During this reporting period, we only observed 59 phalaropes during our surveys. Phalaropes migrate through the Bay during a relatively short time period (J. Demers, pers. obs.), and, therefore, by surveying the ponds once a month, we may miss sampling ponds during peak phalarope migration.

Medium and Small Shorebirds.--- Medium and small shorebirds were most abundant in areas with moderate to high salinity. Additionally, the ponds where we observed the most shorebirds had islands or levees that were suitable for roosting or water depth suitable for foraging. Again, brine shrimp and brine flies are both important food sources for these species, but the ability of shorebirds (other than phalaropes) to forage on these prey items is limited by their leg length, and therefore, water depth. Furthermore, shorebird use of salt ponds is highly tide dependant (Warnock et al. 2001), and most shorebird species in the San Francisco Bay use salt ponds as high-tide refugia for roosting or foraging. Therefore, the presence of roosting islands is integral for shorebirds in salt ponds.

MANAGEMENT RECOMMENDATIONS

1. Maintain the pond system to have a variety of water salinities for the various guilds. Special consideration should be given to birds that prefer medium to high salinity ponds such as phalaropes and Eared Grebes.
2. Provide lower water levels in some ponds for small and medium shorebirds during migration.
3. Provide islands or undisturbed levees for shorebird roosting habitat. This is especially important during high tides.
4. Survey ponds every 2-3 days during phalarope migration. This will be necessary to accurately monitor migrating phalaropes use of salt ponds.

5. Continue monitoring the avian use of these ponds as the South Bay Salt Pond Restoration Project starts its restoration activities.

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LITERATURE CITED

- Accurso, L. M. 1992. Distribution and abundance of wintering waterfowl on San Francisco Bay 1988–1990. Master’s Thesis. Humboldt State Univ., Arcata, CA, 252 pp.
- Anderson, W. 1970. A preliminary study of the relationship of salt ponds and wildlife – South San Francisco Bay. California Fish and Game 56: 240–252.
- Brua, Robert B. 2002. Ruddy Duck (*Oxyura jamaicensis*), In The Birds of North America, No. 696 (A. Poole, Ed.). The Birds of North America, Inc., Philadelphia, PA.
- Carpelan, L.H. 1957. Hydrobiology of the Alviso Salt Ponds. Ecology: Vol. 38, No. 3, pp. 375-390.
- Cullen, S. A., J. R. Jehl Jr., and G. L. Nuechterlein. 1999. Eared Grebe (*Podiceps nigricollis*). In Birds of North America, No. 433 (A. Poole and F. Gill, Eds.). The Birds of North America, Inc., Philadelphia, PA.
- Drilling, Nancy, Rodger Titman and Frank Mckinney. 2002. Mallard (*Anas platyrhynchos*), In The Birds of North America, No. 658 (A. Poole and F. Gill, Eds.). The Birds of North America, Inc., Philadelphia, PA.
- Dubowy, Paul J. 1996. Northern Shoveler (*Anas clypeata*), In The Birds of North America, No. 217 (A. Poole, Ed.). The Birds of North America, Inc., Philadelphia, PA.
- Leschack, C. R., S. K. Mckinght and G. R. Hepp. 1997. Gadwall (*Anas strepera*), The Birds of North America No. 283 (A. Poole and F. Gill, Eds.). The Birds of North America, Inc., Philadelphia, PA.
- Mowbray, Thomas. 1999. American Wigeon (*Anas americana*), In The Birds of North America, No. 410 (A. Poole and F. Gill, Eds.). The Birds of North America, Inc., Philadelphia, PA.
- Page, G. W., L. E. Stenzel, and C. M. Wolfe. 1999. Aspects of the occurrence of shorebirds on a central California estuary. Studies in Avian Biology 2: 15–32.
- Robinson, C., J. Demers, C. Schacter. 2009. Gull Abatement Surveys at Newby Island Landfill, 2007-2008. Unpublished Report. San Francisco Bay Bird Observatory, Milpitas, CA.

- Robinson-Nilsen, C., C. Schacter and J. Demers. 2009a. Colonial Waterbird Nesting Summary for the South San Francisco Bay, 2009. Unpublished Report. San Francisco Bay Bird Observatory, Milpitas, CA.
- Robinson-Nilsen, C., J. Demers, and C. Strong. 2009b. Western Snowy Plover Numbers, Nesting Success, Fledging Success and Avian Predator Surveys in the San Francisco Bay, 2009. Unpublished Report. San Francisco Bay Bird Observatory, Milpitas, CA.
- Takekawa, J. Y., C. T. Lu, and R. T. Pratt. 2001. Bird communities in salt evaporation ponds and baylands of the northern San Francisco Bay estuary. *Hydrobiologia* 466: 317–328.
- Ver Planck, W. E. 1958. Salt in California. Calif. Div. of Mines Bull. No. 175.
- Warnock, N., G. W. Page, T. D. Ruhlen, N. Nur, J. Y. Takekawa, and J. T. Hanson. 2002. Management and conservation of San Francisco Bay salt ponds: effects of pond salinity, area, tide and season on Pacific Flyway waterbirds. *Waterbirds* 25: 79–92.

Table 1. Species richness, totals abundance, and acreage by pond and area, Don Edwards San Francisco Bay National Wildlife Refuge, CA, Oct. 2008 – Sept. 2009.

Complex	Pond	Species Richness	Total Birds	Percent of Total birds in Survey Area	Acreage	Percent of Total Acreage in Survey Area
Coyote Hills	N1A	46	11730	2.8%	172.574	2.5%
	N2A	40	14263	3.4%	171.392	2.5%
	N3A	47	17939	4.3%	417.868	6.1%
	N4	30	11288	2.7%	339.648	5.0%
	N4AA	44	6240	1.5%	299.309	4.4%
	N4AB	49	16293	3.9%	237.529	3.5%
	N4B	34	1950	0.5%	72.95	1.1%
	N5	25	1801	0.4%	193.632	2.8%
	N6	27	5284	1.3%	94.175	1.4%
	N7	34	4399	1.0%	383.576	5.6%
	N8	32	5514	1.3%	114.133	1.7%
	N9	35	4886	1.2%	128.431	1.9%
		Coyote Hills Total	73	101587	24.1%	2625.217
Dumbarton	N1	37	37878	9.0%	344.733	5.0%
	N2	26	7363	1.7%	193.109	2.8%
	N3	36	24648	5.8%	553.502	8.1%
	NPP1	32	21920	5.2%	195.309	2.9%
		Dumbarton Total	51	91809	21.8%	1286.653
Mowry	M1	39	23441	5.6%	496.541	7.3%
	M2	27	18536	4.4%	485.474	7.1%
	M3	35	27669	6.6%	549.936	8.0%
	M4	23	33441	7.9%	537.507	7.9%
	M5	23	86098	20.4%	415.117	6.1%
	M6	19	39358	9.3%	449.461	6.6%
		Mowry Total	55	228543	54.16%	2934.036
	Survey Area Total	84	421939	100%	6845.906	100%

Table 2. Percentage of total birds foraging, resting, or on levees, manmade structures or islands in each salt pond, Don Edwards San Francisco Bay National Wildlife Refuge, CA, Oct. 2008 – Sept. 2009.

Complex	Pond	% Foraging	% Resting	% Levee	% Manmade	% Island
Coyote Hills	N1A	21.51%	50.28%	20.91%	5.71%	1.59%
	N2A	5.88%	33.67%	60.05%	0.14%	0.26%
	N3A	9.82%	21.66%	68.15%	0.27%	0.09%
	N4	20.97%	2.09%	61.92%	0.27%	14.75%
	N4AA	23.46%	56.46%	13.97%	4.36%	1.75%
	N4AB	5.90%	44.45%	46.18%	0.28%	3.19%
	N4B	54.67%	8.72%	26.00%	10.05%	0.56%
	N5	7.22%	4.78%	71.63%	8.22%	8.16%
	N6	13.40%	0.42%	85.79%	0.00%	0.40%
	N7	5.71%	7.77%	74.49%	1.00%	11.03%
	N8	1.69%	5.68%	92.38%	0.02%	0.24%
N9	46.38%	4.24%	28.86%	0.08%	20.45%	
Dumbarton	N1	14.01%	7.13%	3.40%	2.89%	72.57%
	N2	46.24%	36.63%	3.94%	0.33%	12.86%
	N3	25.44%	18.69%	15.81%	3.01%	37.05%
	NPP1	34.77%	12.39%	0.77%	0.03%	52.05%
Mowry	M1	7.45%	37.11%	51.91%	0.24%	3.28%
	M2	3.26%	1.58%	49.99%	0.04%	45.13%
	M3	33.51%	49.68%	11.27%	0.63%	4.92%
	M4	28.07%	30.51%	40.66%	0.00%	0.75%
	M5	9.80%	7.45%	24.10%	0.00%	58.65%
	M6	3.80%	5.99%	16.39%	4.25%	69.58%

Table 3. The monthly average salinity (ppt) by area and pond, Don Edwards San Francisco Bay National Wildlife Refuge, CA, Oct. 2008 – Sept. 2009. We were unable to access ponds M1-M3 to collect water quality data in August 2009 due to levee maintenance.

Area	Pond	2008			2009								
		October	November	December	January	February	March	April	May	June	July	August	September
Coyote Hills	N1A	37.79	33.75	36.74	38.93	36.79	33.59	37.74	31.53	31.65	31.06	31.36	33.20
	N2A	38.51	36.37	38.41	40.07	37.70	34.32	37.47	41.51	32.04	32.43	34.66	36.10
	N3A	43.07	41.46	42.72	42.35	39.42	34.76	38.68	48.11	36.45	37.23	41.31	42.38
	N4	63.28	60.46	61.84	63.17	58.95	52.44	56.84	68.45	67.61	61.90	65.17	80.30
	N4AA	43.82	42.97	44.36	43.09	40.33	34.84	39.31	49.74	37.51	39.44	44.67	44.33
	N4AB	42.47	38.29	39.46	40.88	38.22	34.55	37.92	44.26	32.78	33.28	36.56	38.15
	N4B	45.62	45.23	48.77	50.01	48.04	38.29	49.08	69.49	39.12	41.76	48.57	50.13
	N5	61.67	56.95	60.89	61.91	58.04	50.89	55.26	67.17	59.50	55.22	60.88	67.81
	N6	51.36	49.40	53.32	55.25	51.96	46.73	52.31	62.02	41.36	42.24	50.77	51.62
	N7	54.74	44.80	55.39	55.79	52.84	47.38	53.08	63.53	52.68	48.99	56.84	61.07
N8	48.67	49.12	51.91	54.06	51.05	46.19	51.58	65.57	45.79	44.88	51.78	53.69	
N9	47.00	46.46	50.39	52.98	49.68	45.61	50.98	64.63	40.42	42.64	48.57	47.85	
Dumbarton	N1	135.00	104.00	99.40	95.00	96.50	85.10	95.00	128.00	148.00	138.00	126.00	135.00
	N2	104.10	80.59	88.08	83.80	83.30	68.38	79.02	105.00	111.00	92.11	98.18	109.50
	N3	83.99	78.87	80.21	77.06	77.62	64.17	73.50	92.79	89.05	71.61	82.12	93.60
	NPP1	159.50	111.00	110.00	112.50	112.00	99.00	111.00	150.50	179.00	167.00	153.00	163.00
Mowry	M1	41.74	55.97	56.92	58.84	57.31	53.67	60.83	37.00	33.73	29.23		29.23
	M2	53.75	26.16	59.88	64.54	60.77	59.25	63.81	59.67	51.12	56.37		52.72
	M3	124.00	131.75	145.25	127.75	128.50	116.00	124.75	131.00	107.75	129.50		105.92
	M4	160.33	170.00	170.00	181.00	182.33	175.00	194.00	206.50	191.00	174.00	171.00	153.67
	M5	180.33	227.67	238.33	202.67	216.00	214.33	231.00	240.67	238.33	238.67	202.00	216.33
	M6	209.00	262.67	258.33	233.00	233.00	217.67	240.67	275.67	279.33	283.00	245.50	252.67

Table 4. The monthly average temperature (degrees Celsius) by area and pond, Don Edwards San Francisco Bay National Wildlife Refuge, CA, Oct. 2008 – Sept. 2009. We were unable to access ponds M1-M3 to collect water quality data in August 2009 due to levee maintenance.

Area	Pond	2008			2009								
		October	November	December	January	February	March	April	May	June	July	August	September
Coyote Hills	N1A	22.27	17.51	13.48	12.60	14.27	12.43	16.90	20.96	20.85	24.94	23.25	24.02
	N2A	22.40	17.14	14.97	12.27	14.73	13.26	16.96	21.13	20.79	24.45	23.58	23.33
	N3A	20.38	17.09	13.44	11.58	16.23	13.19	15.58	20.25	19.23	22.29	23.60	30.09
	N4	24.31	20.75	16.44	13.89	18.68	16.13	19.79	26.24	24.59	29.08	25.74	26.87
	N4AA	22.11	17.82	14.85	13.19	15.52	13.31	16.74	21.03	20.76	24.07	24.54	27.63
	N4AB	24.16	17.30	15.82	12.36	17.17	13.12	16.56	21.41	21.15	25.51	25.16	24.45
	N4B	23.25	19.32	16.12	14.27	15.60	14.22	17.98	24.49	22.79	26.53	26.04	27.37
	N5	21.36	17.84	15.30	12.50	15.59	13.43	16.56	20.80	20.99	25.04	23.78	24.68
	N6	22.70	19.95	16.34	16.23	16.64	13.82	18.80	26.65	22.99	26.30	25.83	26.53
	N7	20.71	17.11	14.10	15.09	14.67	12.61	15.55	19.63	20.49	23.38	23.80	25.07
N8	21.58	17.29	14.65	13.32	17.24	13.51	16.87	21.20	20.56	24.74	22.99	24.58	
N9	22.99	17.56	15.36	13.44	15.00	13.15	17.67	24.04	23.20	27.06	25.35	26.63	
Dumbarton	N1	24.22	14.84	14.24	14.76	19.21	12.22	16.55	17.70	24.88	25.13	24.83	28.13
	N2	24.58	20.49	14.86	17.48	15.65	15.01	17.71	22.54	22.29	26.35	24.16	25.64
	N3	24.07	19.57	14.94	16.01	17.18	15.54	18.83	23.31	22.20	25.15	24.47	26.18
	NPP1	24.72	14.84	13.14	18.91	18.08	12.56	16.86	17.13	26.30	25.28	24.18	28.62
Mowry	M1	24.52	20.83	15.83	16.98	19.66	12.16	20.86	22.57	24.27	25.46		28.46
	M2	23.75	18.81	14.26	12.03	17.51	12.74	17.71	21.72	23.82	26.28		27.19
	M3	24.14	18.99	13.81	14.56	16.21	15.55	18.61	21.21	23.60	26.82		27.76
	M4	24.46	18.72	14.02	14.83	18.77	15.49	20.42	23.73	25.86	27.11	27.70	30.69
	M5	24.60	19.26	14.61	15.13	17.92	14.83	19.39	22.45	24.95	27.73	27.28	30.64
	M6	25.46	19.49	14.61	16.03	17.98	14.46	20.16	22.88	27.37	29.49	27.43	30.32

Table 5. The monthly average dissolved oxygen (mg/l) by area and pond, Don Edwards San Francisco Bay National Wildlife Refuge, CA, Oct. 2008 – Sept. 2009. We were unable to access ponds M1-M3 to collect water quality data in August 2009 due to levee maintenance.

Area	Pond	2008			2009								
		October	November	December	January	February	March	April	May	June	July	August	September
Coyote Hills	N1A	8.83	10.85	9.60	11.61	8.51	11.53	7.08	7.20	8.16	7.88	7.69	7.24
	N2A	9.80	8.77	10.38	8.98	5.28	12.10	5.87	7.99	6.96	8.09	6.75	6.54
	N3A	5.78	14.37	5.61	9.31	8.53	10.70	8.55	12.26	7.43	5.43	7.80	7.99
	N4	8.58	8.61	10.00	9.12	9.61	7.53	3.96	6.59	8.55	7.46	7.78	6.48
	N4AA	4.57	9.87	4.91	9.52	10.80	10.11	6.77	10.67	6.70	6.10	5.94	5.04
	N4AB	2.70	6.83	9.61	10.62	8.18	10.35	5.41	8.99	9.42	9.73	8.50	3.57
	N4B	9.87	8.93	9.41	12.51	11.02	9.47	5.73	8.61	8.84	7.30	8.00	5.68
	N5	6.00	7.94	8.24	9.61	12.11	9.86	3.87	5.69	6.34	5.48	6.86	5.25
	N6	7.92	9.30	11.08	8.60	9.36	10.12	4.78	5.89	9.61	8.72	9.81	7.74
	N7	4.73	8.29	7.55	9.44	11.25	9.14	4.13	5.01	4.80	3.80	7.35	6.86
	N8	5.46	9.01	8.03	8.98	10.44	8.11	3.94	5.16	6.18	4.74	6.98	5.02
N9	7.20	9.40	8.55	8.70	10.18	8.58	4.04	6.31	9.18	8.72	9.04	6.36	
Dumbarton	N1	4.29	6.53	6.61	9.85	6.02	5.38	3.66	5.26	4.29	4.53	4.82	8.17
	N2	7.79	9.61	7.84	9.85	7.34	8.53	3.08	4.55	5.84	4.16	6.41	8.21
	N3	9.22	7.38	8.06	8.28	8.37	9.43	3.62	5.21	5.94	3.87	7.84	7.39
	NPP1	4.02	6.68	5.66	8.84	6.02	4.86	4.73	6.85	4.20	1.03	3.01	5.82
Mowry	M1	8.59	7.01	9.46	11.03	7.33	8.06	7.29	40.74	17.97	6.91		13.58
	M2	9.34	8.02	7.61	6.61	4.91	7.70	5.59	19.49	8.79	8.72		6.98
	M3	6.20	5.49	8.52	7.18	4.40	4.73	2.55	7.20	4.33	4.59		7.20
	M4	3.42	4.77	2.53	11.87	4.86	5.25	3.08	2.18	2.22	2.16	1.26	4.27
	M5	2.13	4.26	2.81	8.80	5.03	5.08	2.63	3.47	2.53	2.37	2.35	4.27
	M6	4.35	3.53	2.51	7.10	5.69	4.91	3.19	3.11	2.15	2.99	1.29	2.77

Table 6. The monthly average pH by area and pond, Don Edwards San Francisco Bay National Wildlife Refuge, CA, Oct. 2008 – Sept. 2009. We were unable to access ponds M1-M3 to collect water quality data in August 2009 due to levee maintenance. The pH meter was broken in September and we were unable to collect that data.

Area	Pond	2008			2009								
		October	November	December	January	February	March	April	May	June	July	August	September
Coyote Hills	N1A	8.13	7.98	8.27	8.45	8.09	8.76	8.49	8.21	8.13	8.45	7.94	
	N2A	8.53	8.15	8.22	8.29	7.97	8.48	8.31	8.38	8.36	8.80	7.92	
	N3A	8.40	8.33	8.05	8.18	8.35	8.17	7.68	8.02	8.23	8.56	8.95	
	N4	8.66	8.55	8.65	8.50	8.79	8.73	8.29	8.26	8.23	8.36	8.31	
	N4AA	8.48	8.26	8.07	8.32	8.24	8.14	7.73	7.97	8.22	8.50	8.82	
	N4AB	7.65	8.00	8.17	8.29	8.25	8.38	8.11	8.23	8.43	9.23	8.39	
	N4B	8.75	8.34	8.51	8.49	8.44	8.06	7.82	8.33	8.28	8.75	8.78	
	N5	8.53	8.50	8.59	8.51	8.65	8.72	8.00	8.00	8.17	8.34	8.34	
	N6	8.71	8.59	8.70	8.54	8.47	8.39	7.80	7.69	8.33	8.88	9.08	
	N7	8.52	8.46	8.52	8.47	8.44	8.34	7.56	7.84	8.15	8.36	8.75	
N8	8.54	8.45	8.46	8.55	8.37	8.29	7.57	7.90	8.18	8.55	8.86		
N9	8.63	8.42	8.41	8.36	8.36	8.23	7.70	8.06	8.32	8.95	8.97		
Dumbarton	N1	7.82	8.39	8.59	8.49	8.63	8.24	7.66	7.31	7.88	7.87	7.77	
	N2	8.27	8.50	8.73	8.78	8.86	9.09	8.90	8.58	8.15	7.98	7.82	
	N3	8.63	8.41	8.60	8.55	8.86	9.00	8.73	8.54	8.21	8.10	8.00	
	NPP1	7.69	8.16	8.24	8.43	8.44	8.35	7.40	7.39	7.89	7.64	7.56	
Mowry	M1	8.30	8.15	7.88	8.48	8.49	8.16	8.25	8.51	9.08	7.90		
	M2	8.41	8.22	8.44	8.27	8.33	8.20	8.18	8.30	8.71	8.65		
	M3	8.02	7.94	8.11	8.21	8.03	7.88	7.43	7.57	8.06	7.96		
	M4	7.82	7.66	7.72	8.00	7.88	7.78	7.51	7.33	7.66	7.84	7.49	
	M5	7.73	7.55	7.59	7.79	7.82	7.79	7.46	7.25	7.55	7.65	7.45	
	M6	7.62	7.44	7.51	7.63	7.75	7.80	7.41	7.16	7.45	7.51	7.32	

Table 7. Correlation and Standardized Canonical Coefficients between Water Quality and Guild Variables.

	First Canonical Correlation		Second Canonical Correlation	
	Loading	Coefficient	Loading	Coefficient
Water Quality				
Acres	-0.736	-0.434	-0.183	-0.232
pH	0.393	-0.387	0.160	0.289
Dissolved Oxygen	0.544	0.122	0.275	-0.025
Salinity	-0.880	-0.881	-0.042	0.422
Temperature	-0.101	0.093	-0.945	-0.991
Guilds				
Dabbler	-0.103	-0.062	0.385	0.117
Diver	0.444	0.314	0.686	0.708
Eared Grebe	-0.387	-0.328	0.367	0.167
Fish eater	0.419	0.045	-0.200	-0.111
Goose	0.215	0.144	0.392	0.371
Gull	-0.627	-0.520	-0.054	0.039
Heron	0.635	0.345	-0.068	-0.086
Medium Shorebird	-0.243	-0.104	0.371	0.209
Small Shorebird	-0.259	-0.068	0.421	0.275
Tern	0.415	0.216	-0.260	-0.167

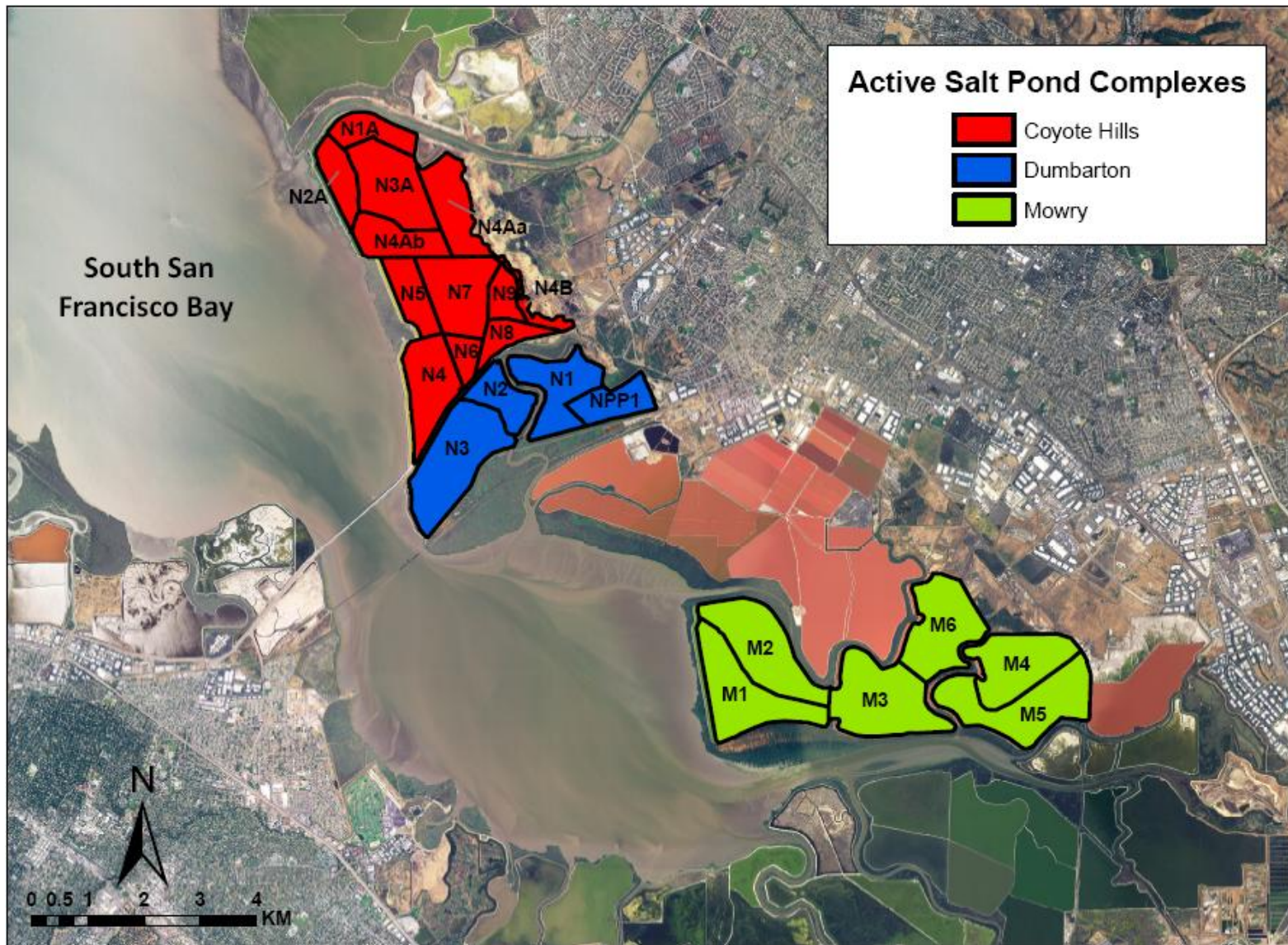


Figure 1. The Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, CA.

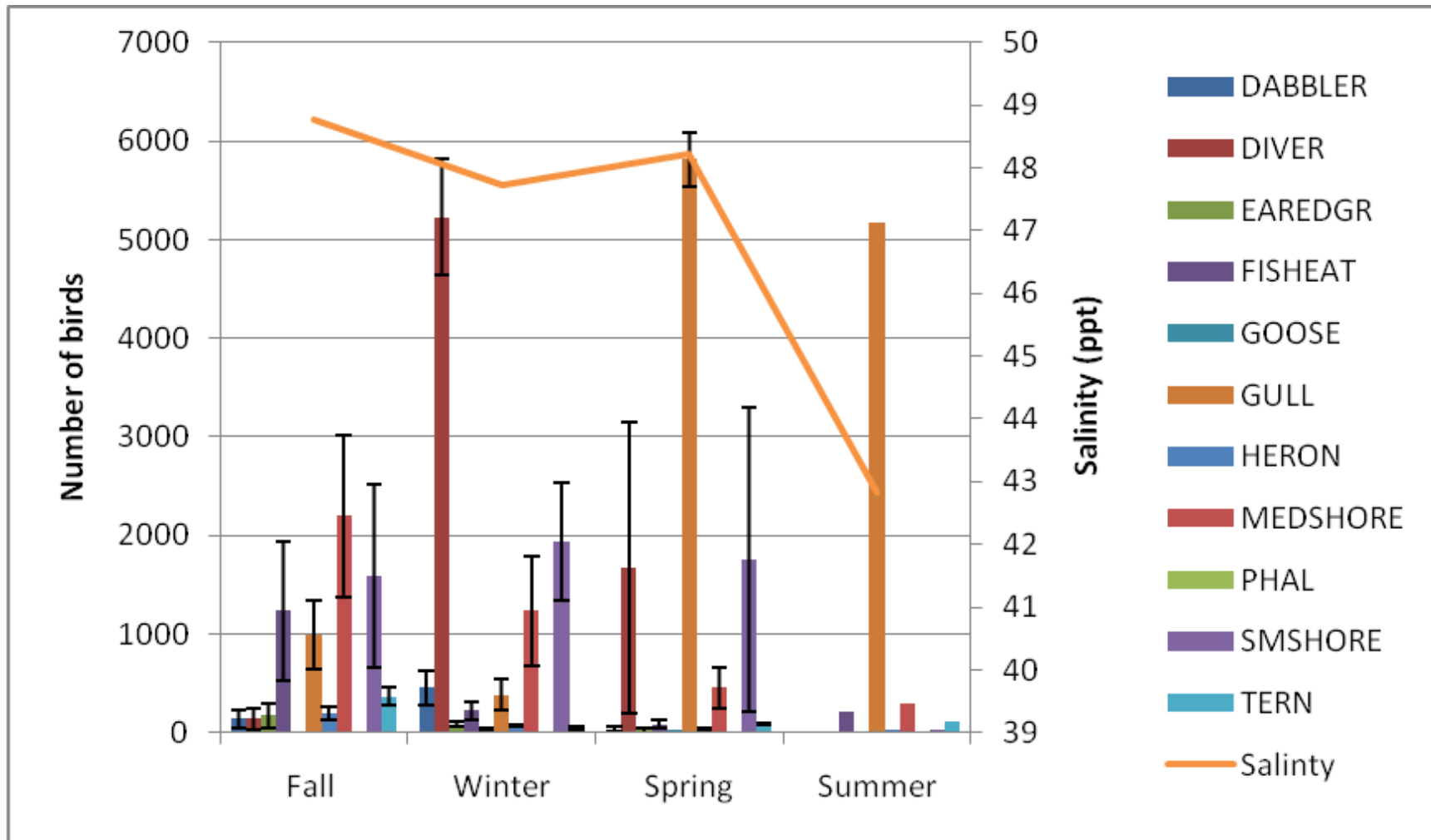


Figure 2. Average (± 1 standard error) seasonal bird use by guild and salinity (ppt) in the Coyote Hills Complex, Don Edwards San Francisco Bay National Wildlife Refuge, CA, Oct. 2008 -Sept. 2009.

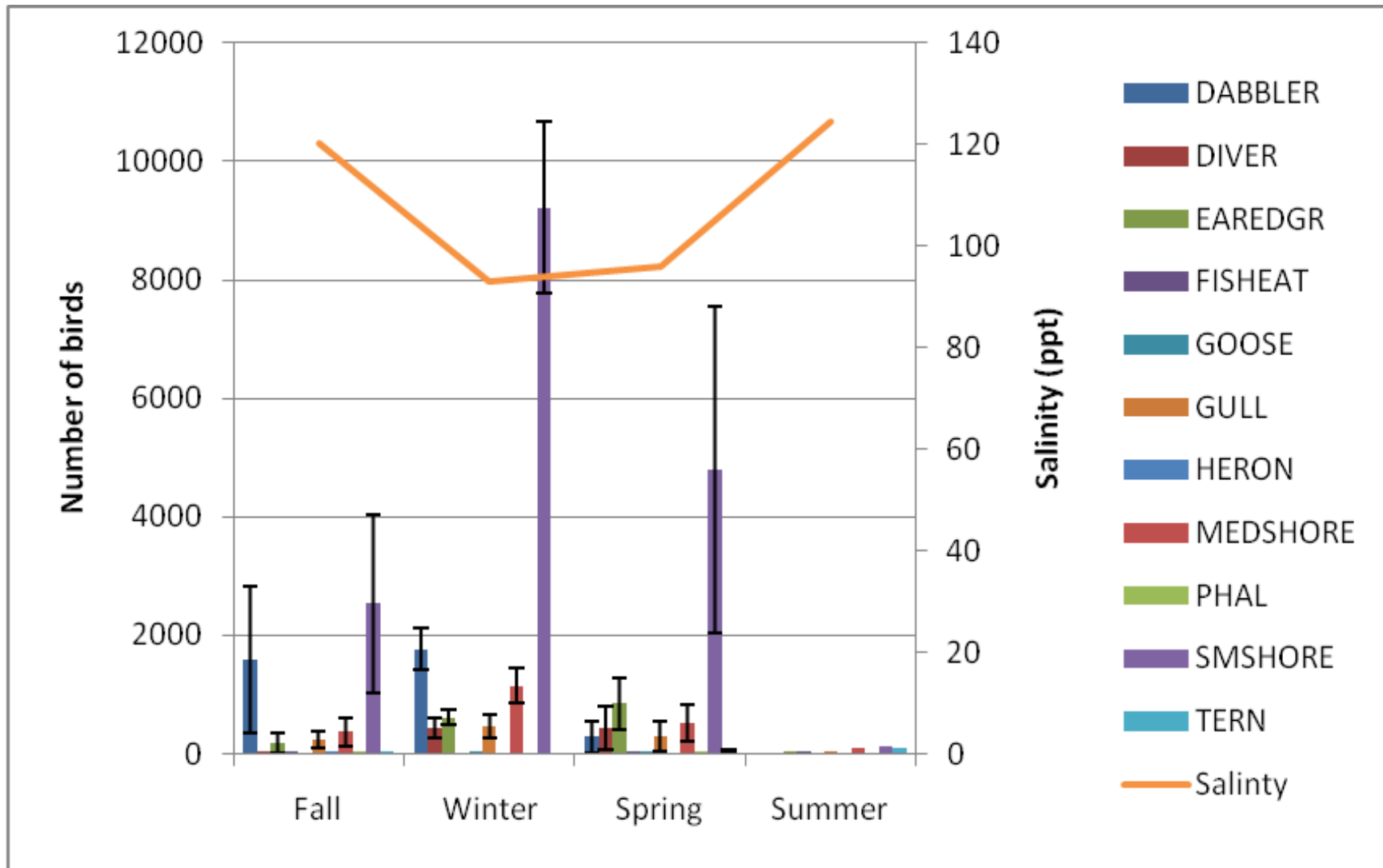


Figure 3. Average (± 1 standard error) seasonal bird use by guild and salinity (ppt) in the Dumbarton Complex, Don Edwards San Francisco Bay National Wildlife Refuge, CA, Oct. 2008 -Sept. 2009.

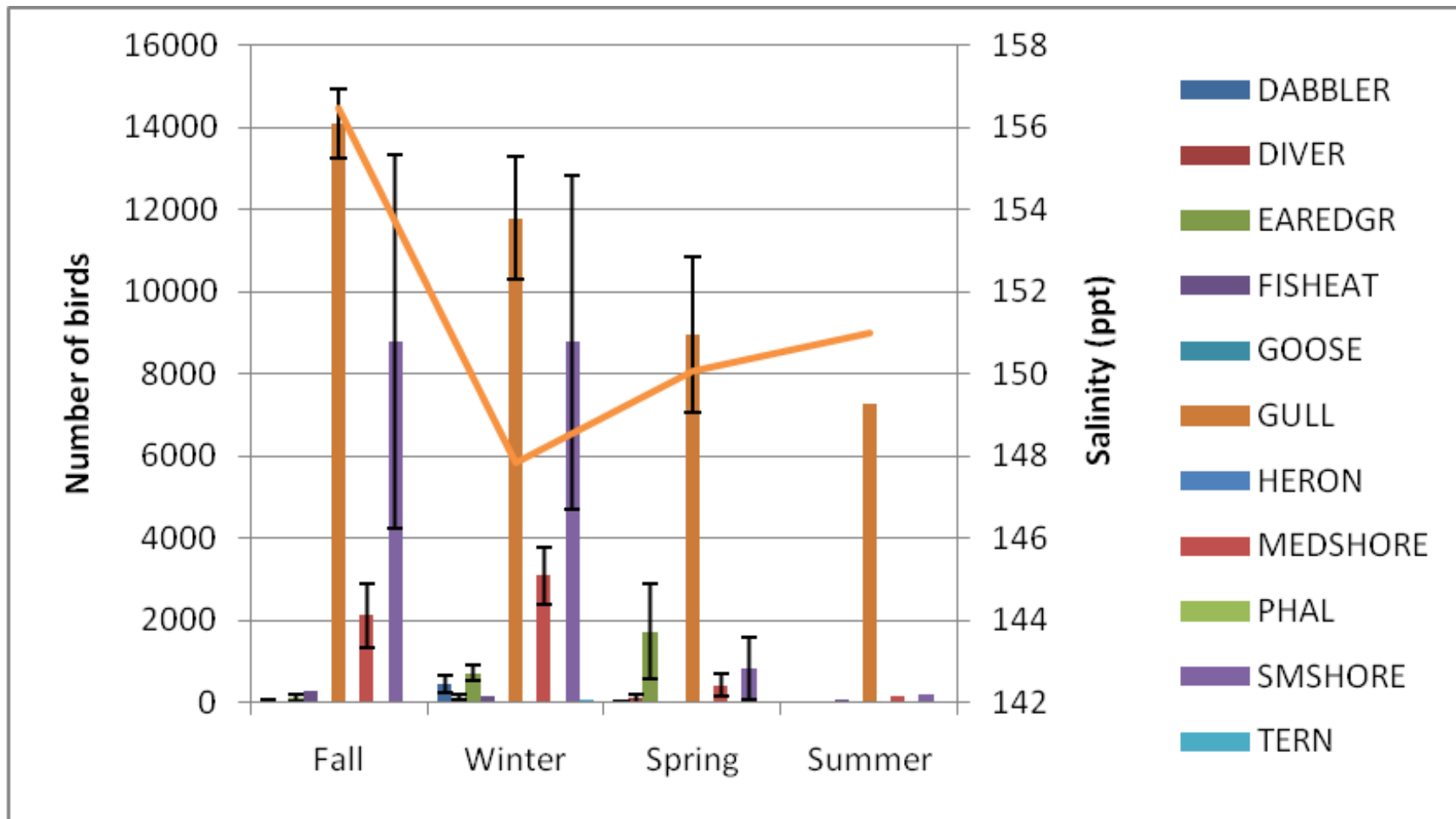


Figure 4. Average (± 1 standard error) seasonal bird use by guild and salinity (ppt) in the Dumbarton Complex, Don Edwards San Francisco Bay National Wildlife Refuge, CA, Oct. 2008 -Sept. 2009.

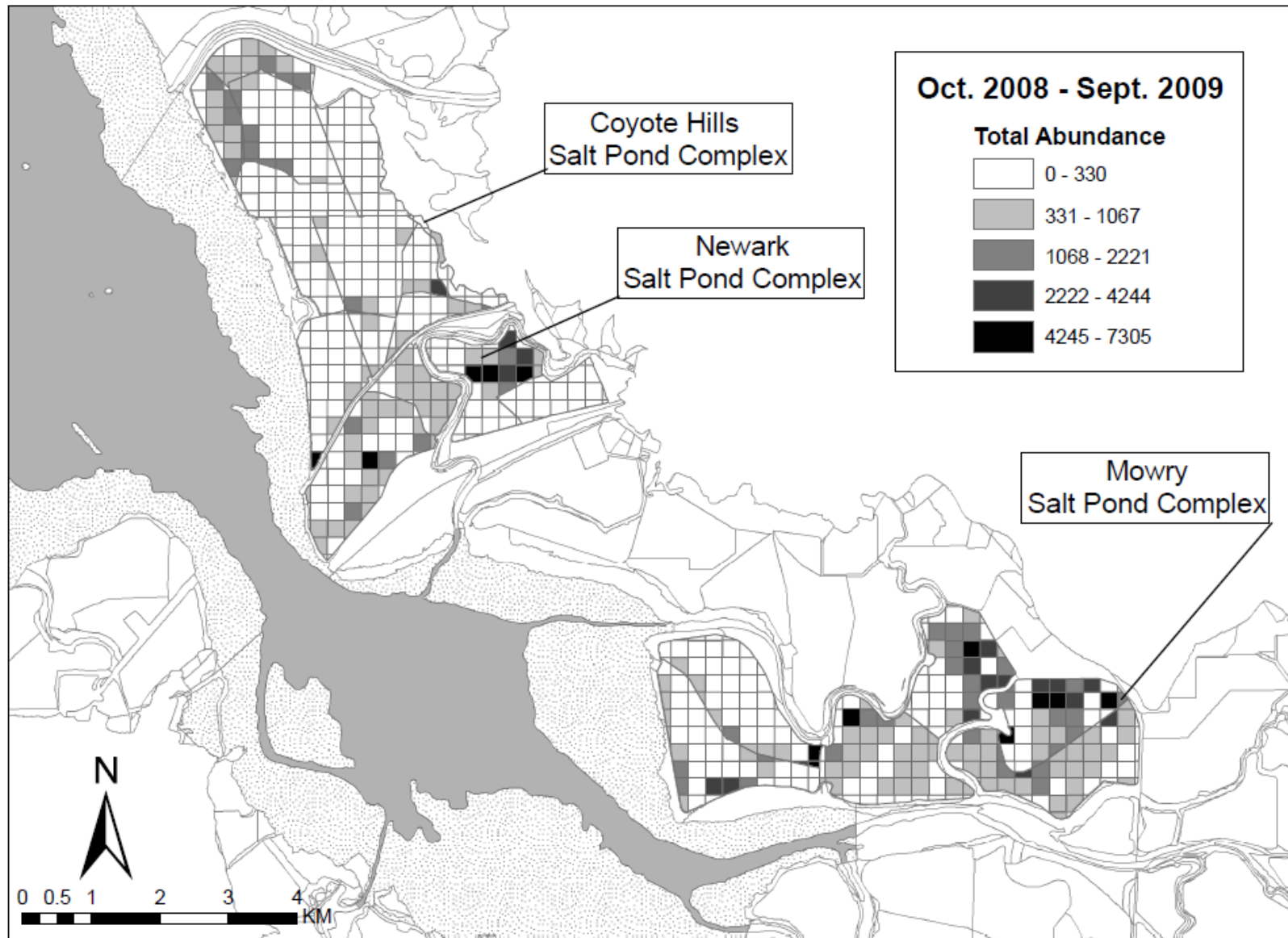


Figure 5. Total abundance in each 250 m² salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, CA, Oct. 2008 -Sept. 2009.

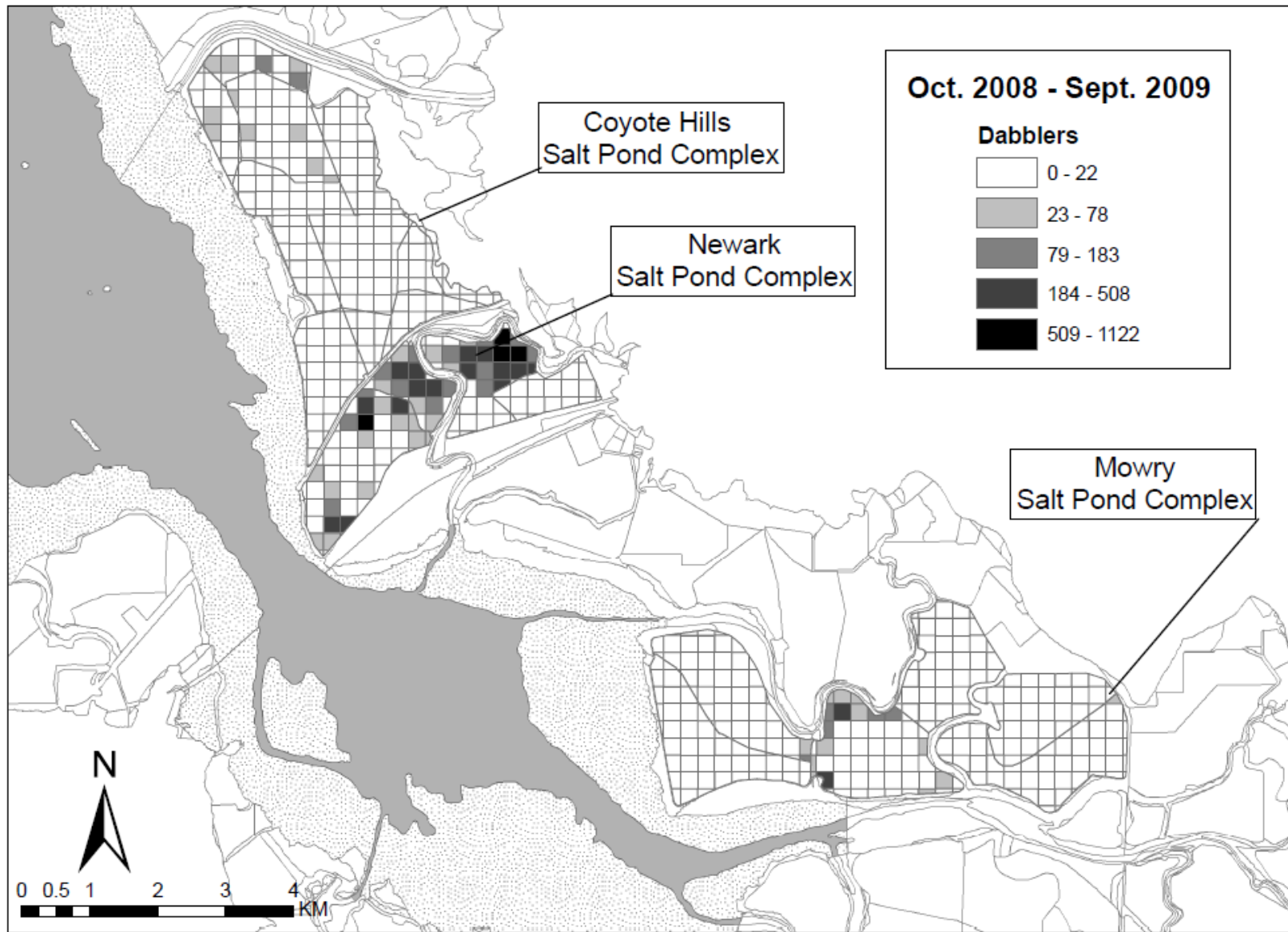


Figure 6. Dabbler guild abundance in each 250 m² salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, CA, Oct. 2008 -Sept. 2009.

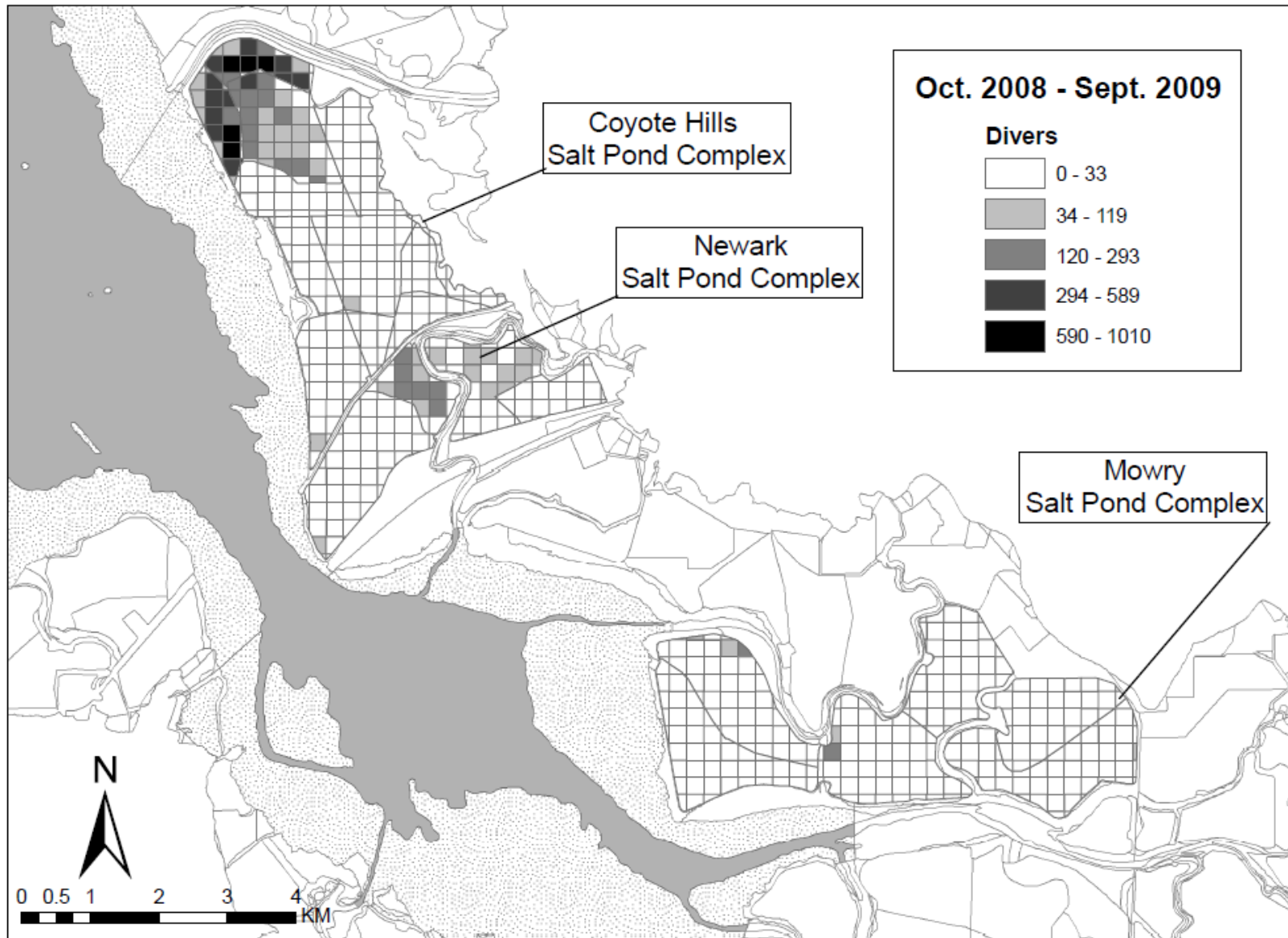


Figure 7. Diver guild abundance in each 250 m² salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, CA, Oct. 2008 -Sept. 2009.

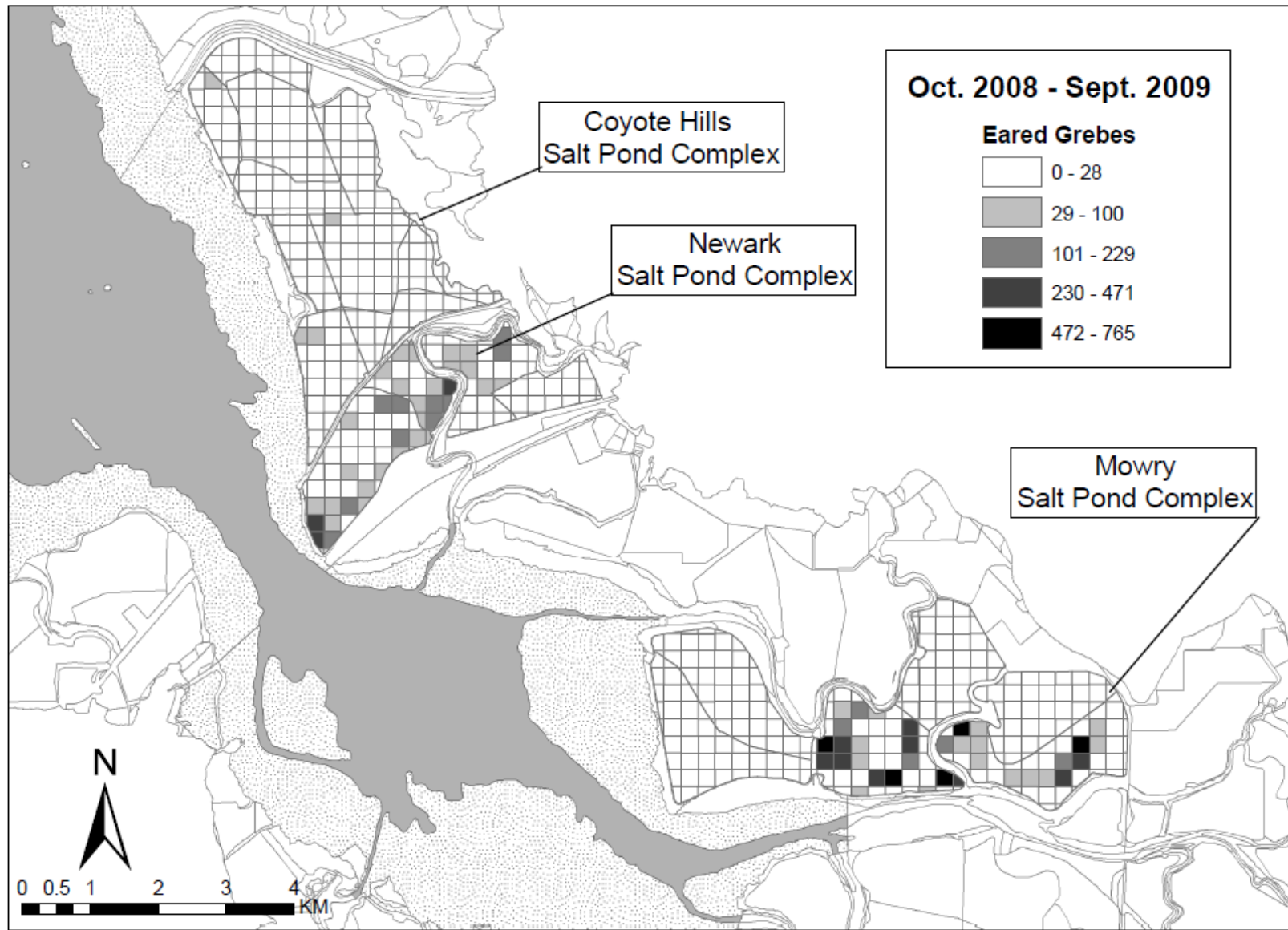


Figure 8. Eared Grebe guild abundance in each 250 m² salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, CA, Oct. 2008 -Sept. 2009.

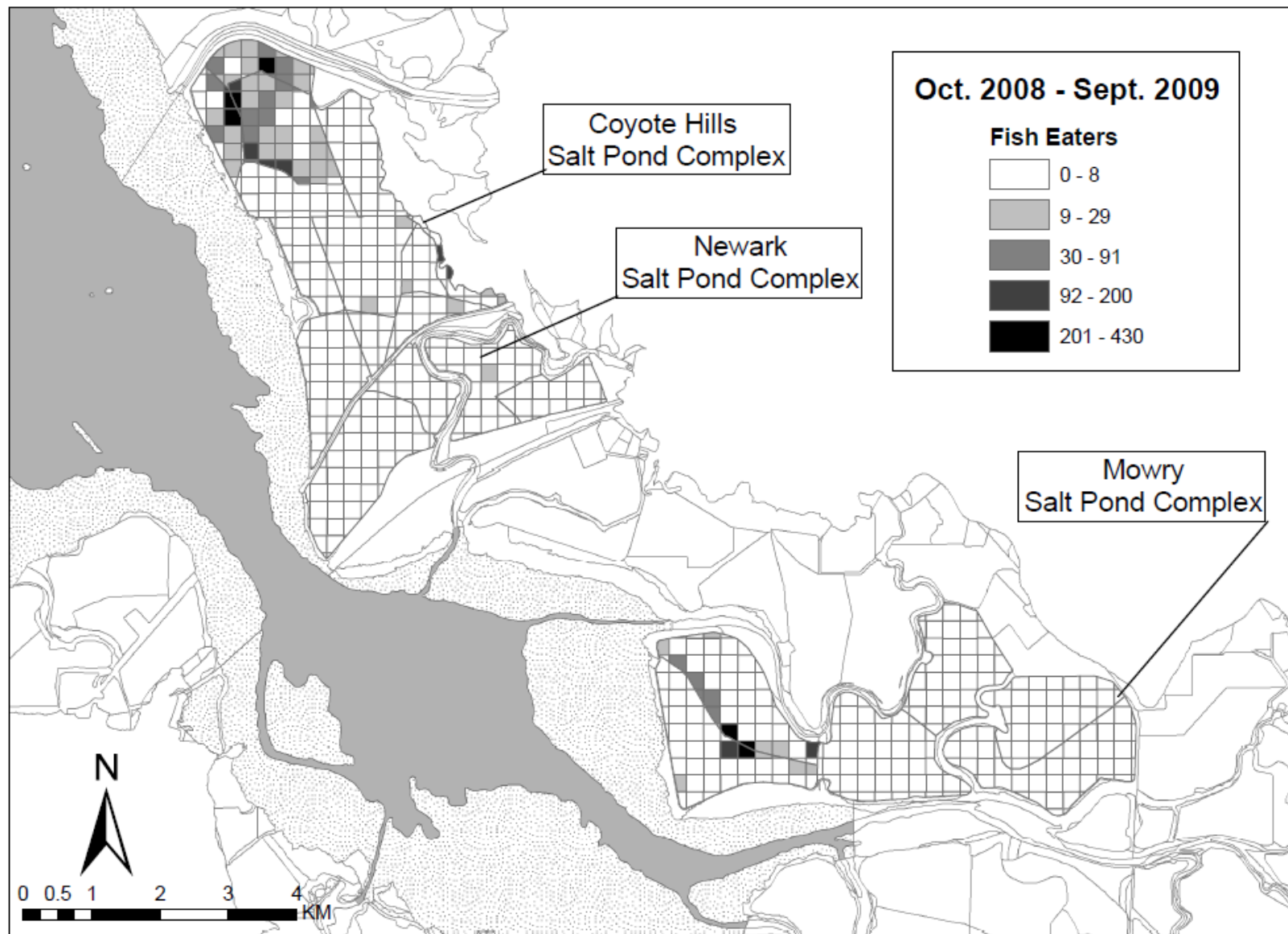


Figure 9. Fish eater guild abundance in each 250 m² salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, CA, Oct. 2008 -Sept. 2009.

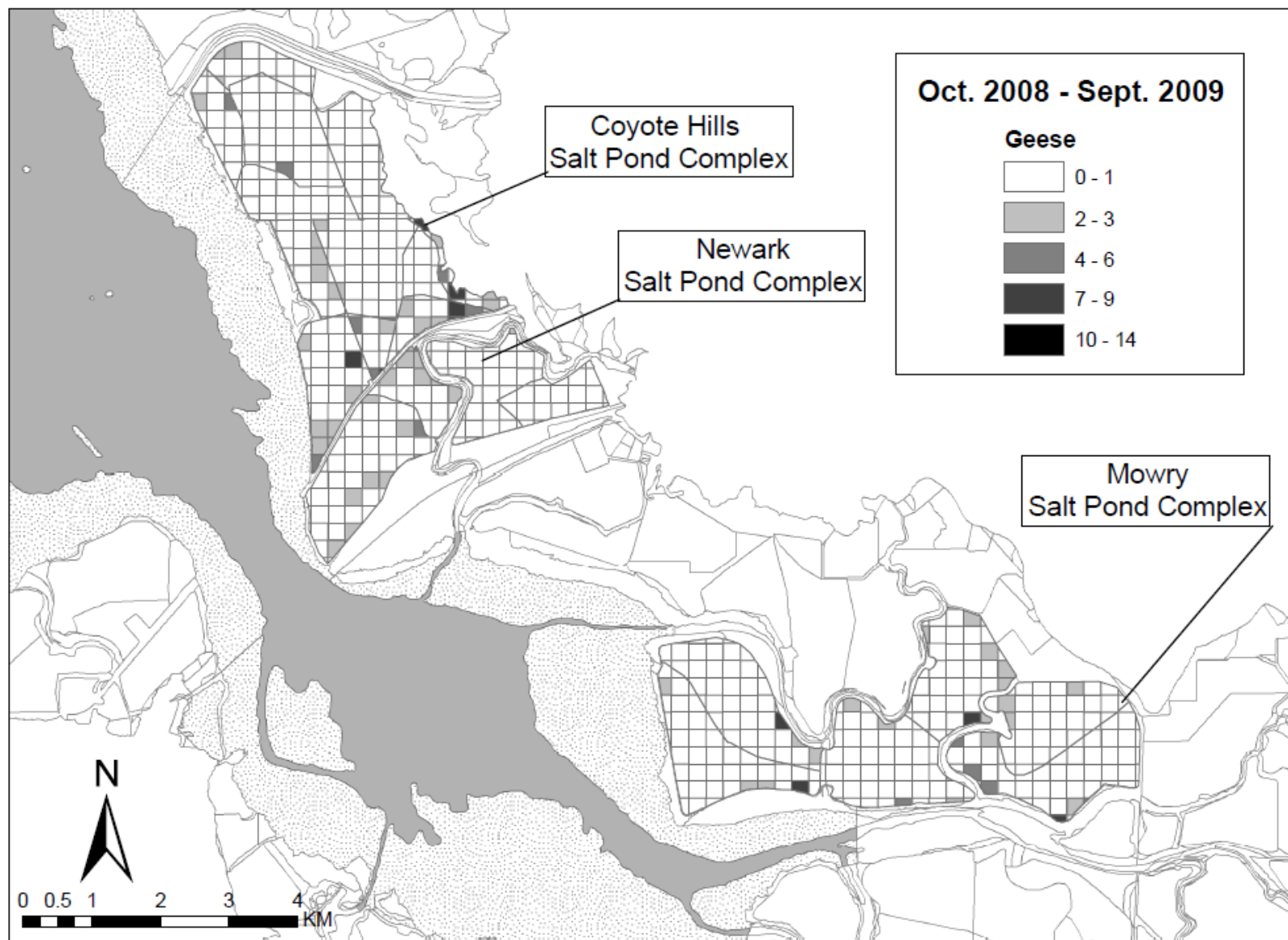


Figure 10. Goose guild abundance in each 250 m² salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, CA, Oct. 2008 -Sept. 2009.

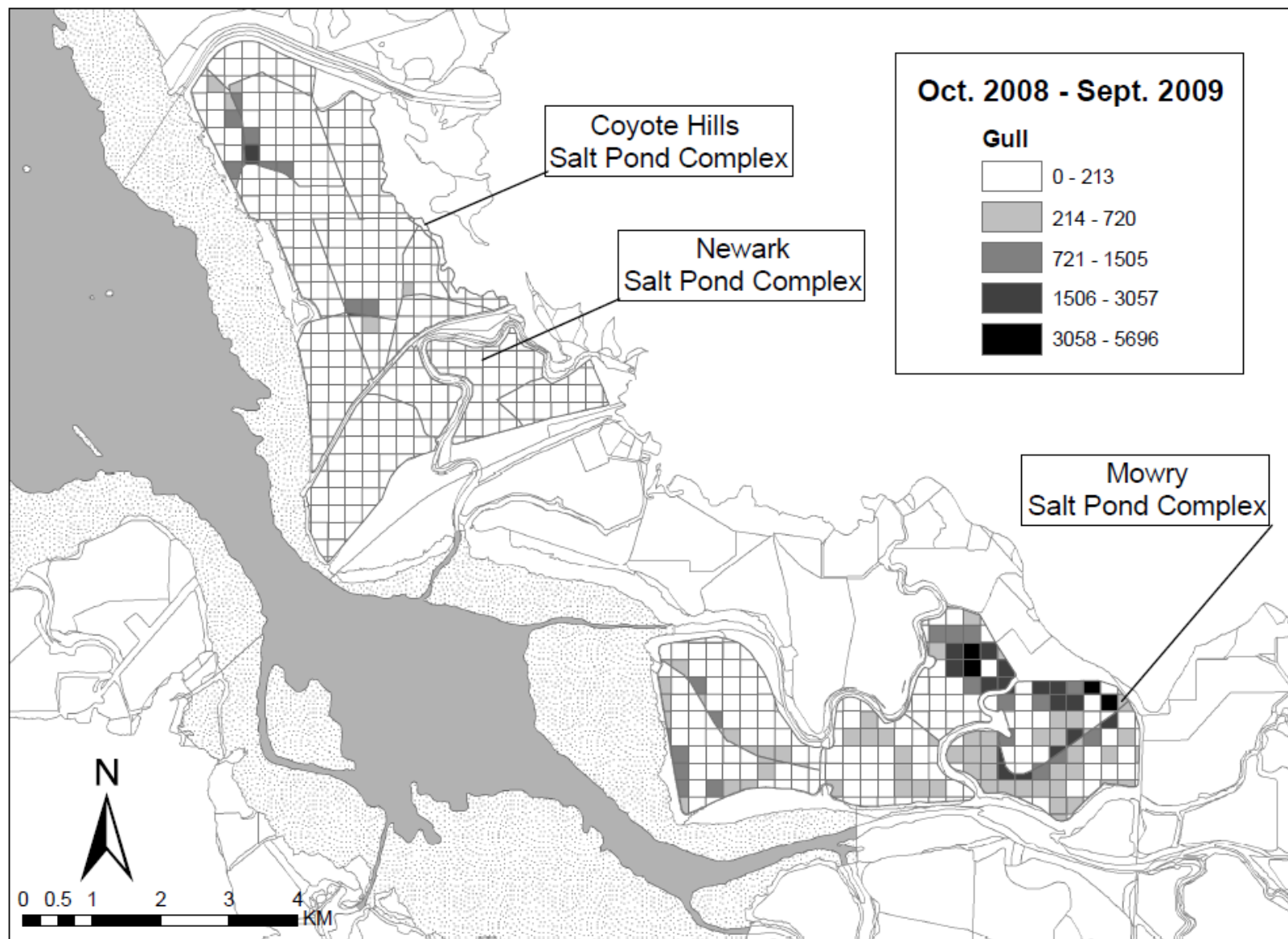


Figure 11. Gull guild abundance in each 250 m² salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, CA, Oct. 2008 -Sept. 2009.

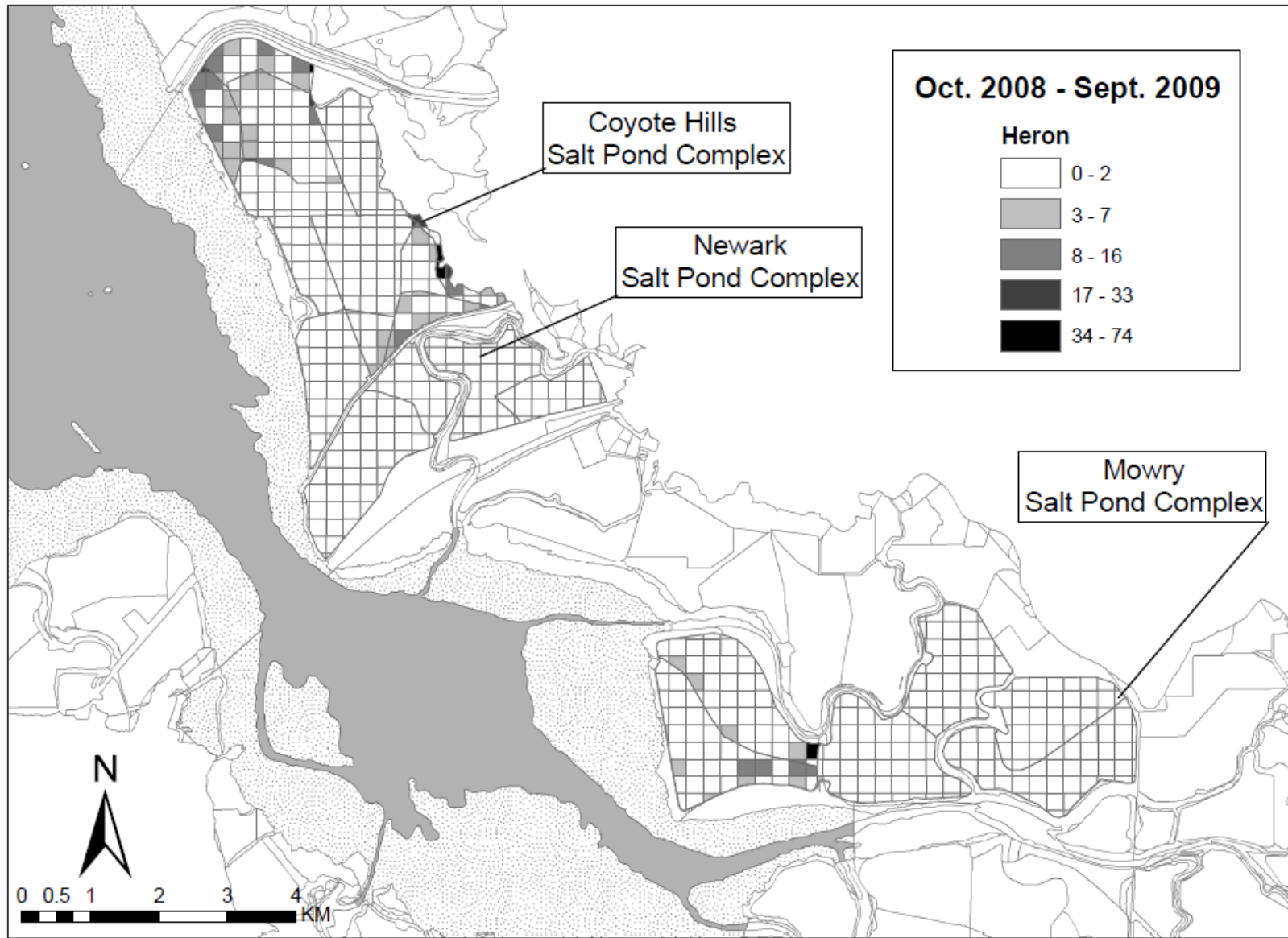


Figure 12. Heron guild abundance in each 250 m² salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, CA, Oct. 2008 -Sept. 2009.

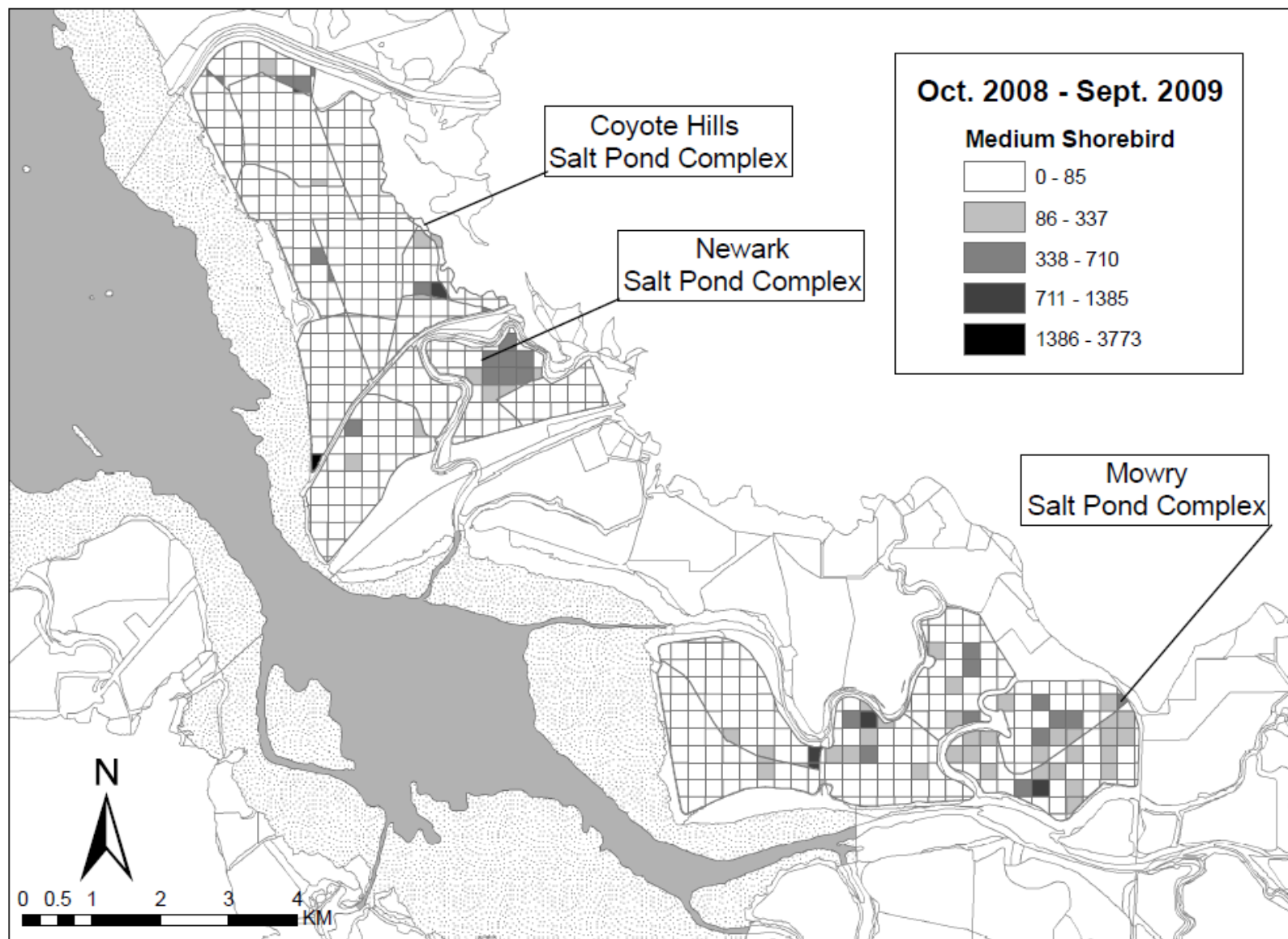


Figure 13. Medium Shorebird guild abundance in each 250 m² salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, CA, Oct. 2008 -Sept. 2009.

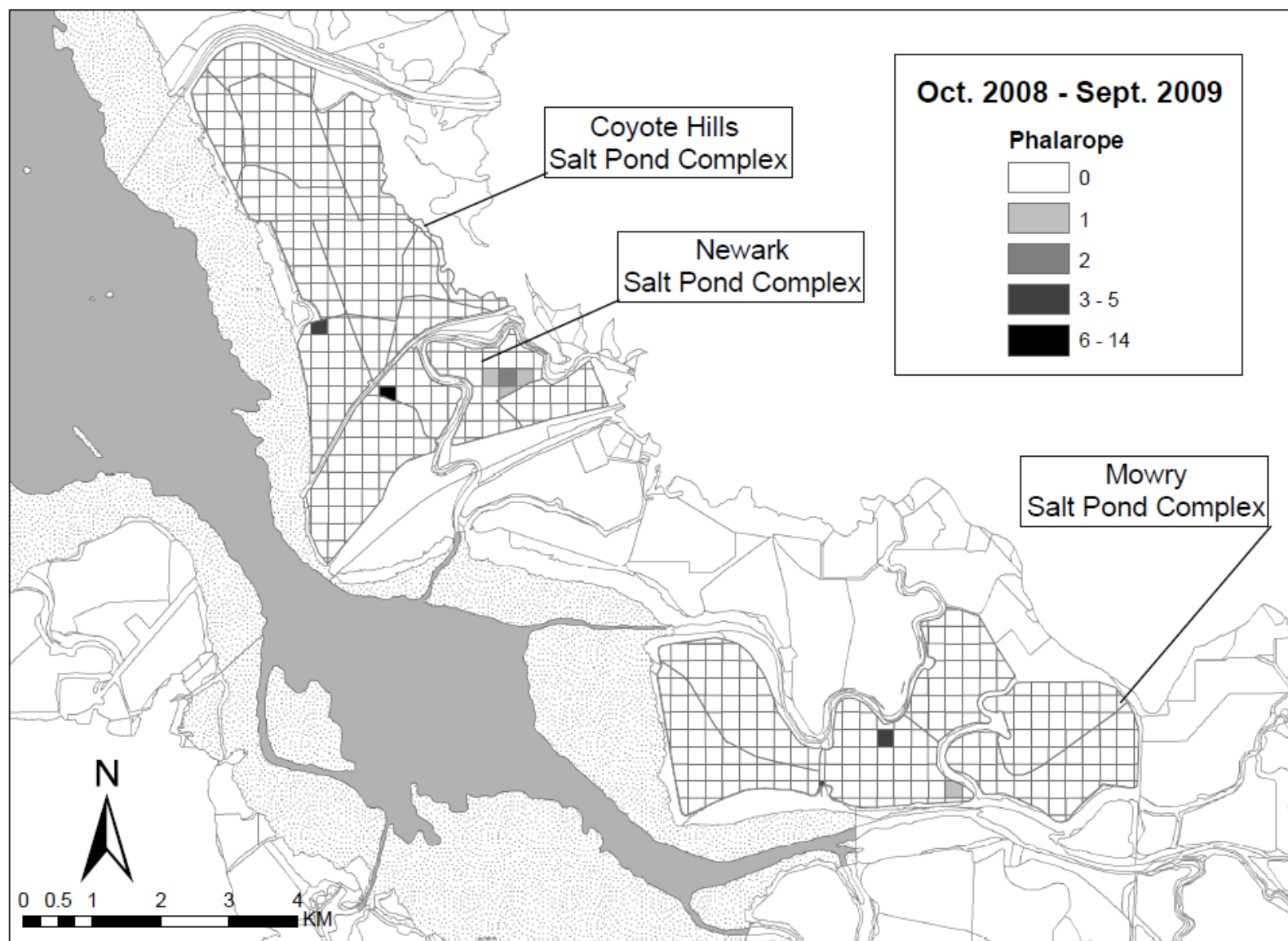


Figure 14. Phalarope guild abundance in each 250 m² salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, CA, Oct. 2008 -Sept. 2009.

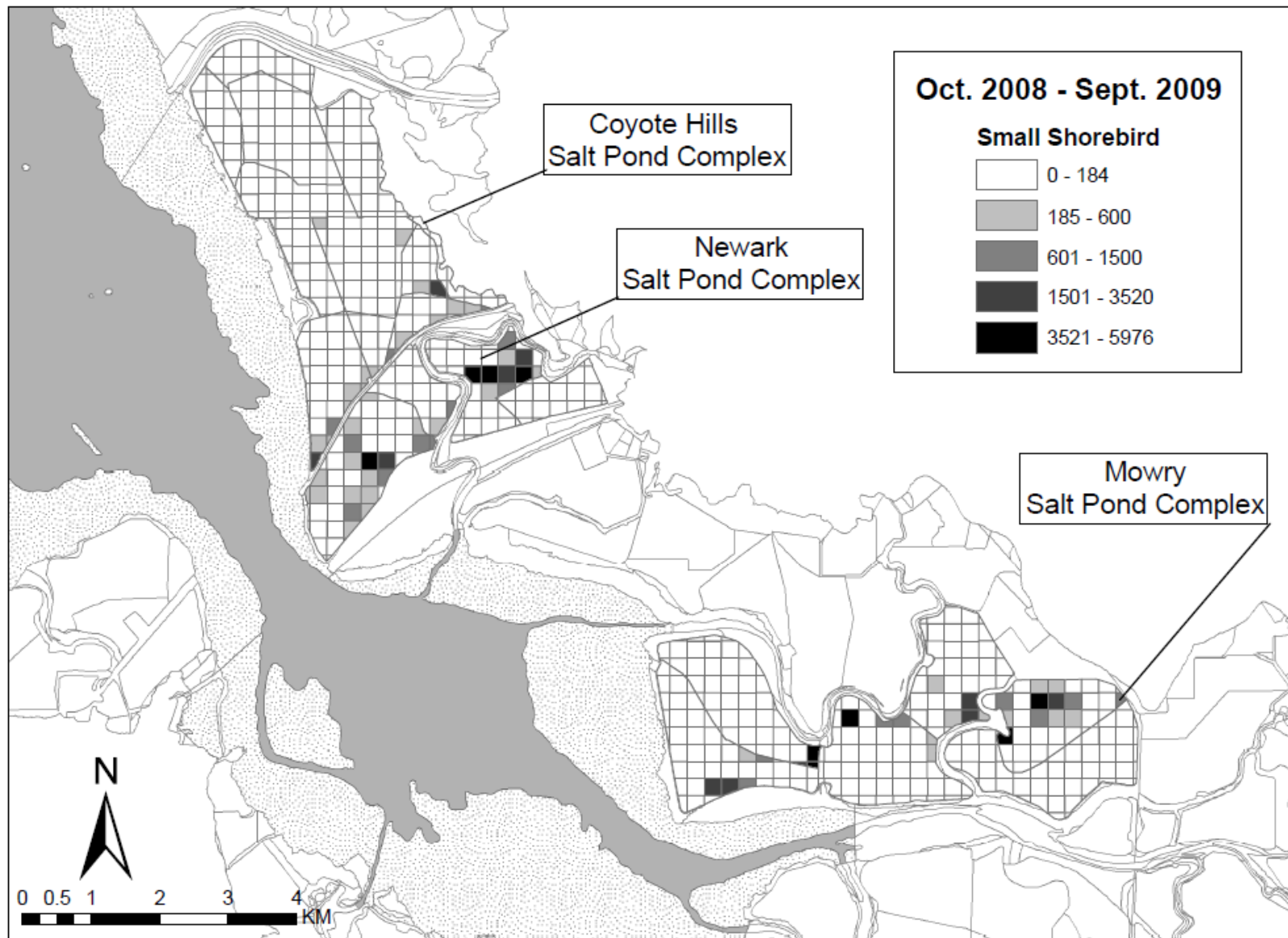


Figure 15. Small Shorebird guild abundance in each 250 m² salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, CA, Oct. 2008 -Sept. 2009.

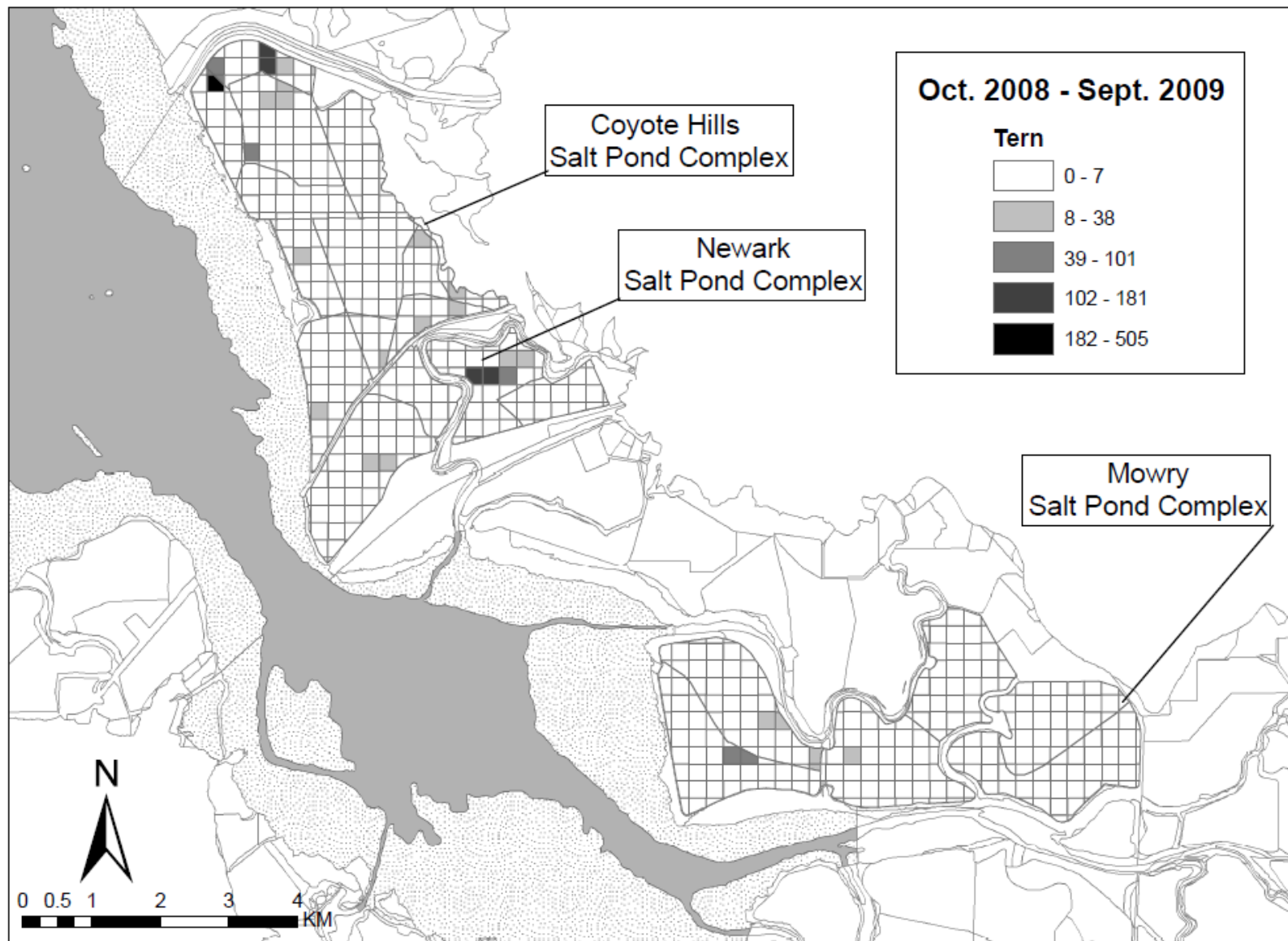


Figure 16. Tern guild abundance in each 250 m² salt pond grid in Coyote Hills, Dumbarton, and Mowry salt pond complexes, Don Edwards San Francisco Bay National Wildlife Refuge, South San Francisco Bay, CA, Oct. 2008 -Sept. 2009.