Baseline Characterization of Sandy Beach Ecosystems in California's North-Central Coast Region

Final Report

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by

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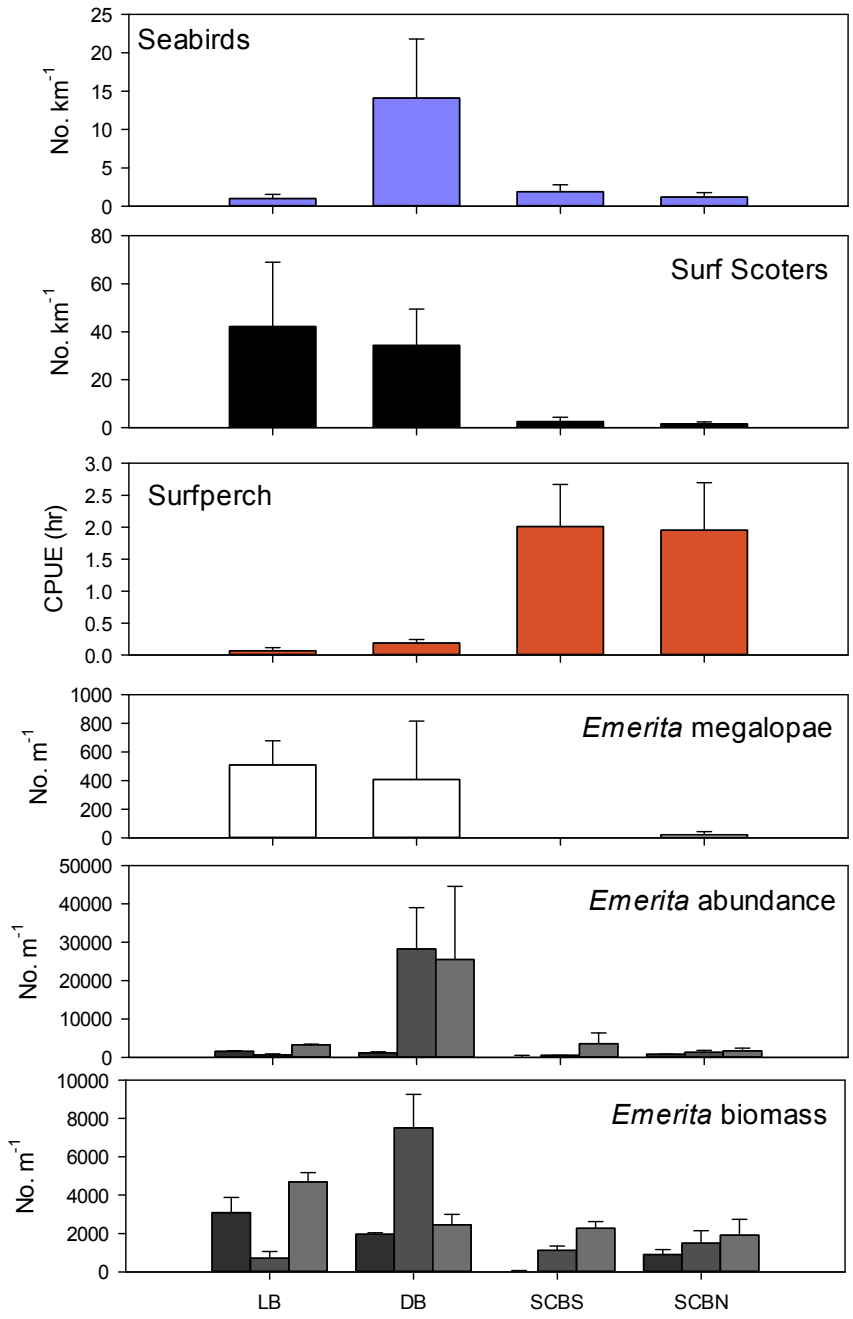

Figure 27. Abundance of seabirds (fish-eating), Surf Scoters, surfperch and sand crabs. Sand crab abundance and biomass data were collected at 10 focal beaches in June and August 2010 and July 2011 (averages from each survey in darkest to lightest gray bars, respectively); megalopae were only found in June 2010. Surf zone seabird data are averages from 11 monthly surveys between June 2010 and May 2011 from a standard 1 km shoreline transect. Surfperch data were collected by a citizen-scientist monitoring program between 2011 and 2012. All data are averages + SE.

Birds: Temporal patterns

Shorebirds

Shorebird abundance exhibited a strong seasonal pattern (Fig. 6). With the exception of three key breeding species, Black Oystercatcher, Western Snowy Plover, and Killdeer most shorebirds observed in the study were migratory species that nest in other regions during the summer. The total number of shorebirds observed on the 10 beaches (6.56 km of beach shoreline) varied more than an order of magnitude among survey months, ranging from 12 shorebirds in June 2010 to 236 shorebirds in May 2011 and averaging 1.8 to 36.0 birds km^{-1}. The greatest numbers of shorebirds were observed on the beaches in the fall (October, November) and spring (March - May), coinciding with migration periods (Fig. 6). The low number of shorebirds observed at the beaches in June 2010, corresponded to the breeding season for many shorebird species. Exceptions to those temporal patterns were observed for the Black Oystercatcher, Western Snowy Plover, and Killdeer all of which nest on a subset of the beaches.

Gulls

Gulls were the most abundant type of bird observed in our surveys of the beaches. The abundance of gulls also varied seasonally with lowest abundance in the summer (Fig. 6). The total number of gulls observed on the 10 focal beaches ranged from 94 gulls in June 2010 to 894 gulls in January 2011. Average monthly abundance ranged from 14 to 136 birds km^{-1} for gulls.

Seabirds

The abundance of seabirds observed on the beaches and in the nearshore waters of the beaches varied seasonally with a distinct peak in the fall surveys (October, November) and low numbers in the spring and summer (Fig. 6). The total number of seabirds observed on the 10 focal beaches ranged from 41 seabirds in April 2011 to 468 seabirds in October 2010. Monthly average abundance for seabirds ranged from 6 to 71 birds km^{-1}.

Birds: Spatial patterns

Regional patterns in overall bird abundance were not easily discerned in our study due to the distribution of the two types of beaches we surveyed. The beaches at and south of Bodega Bay were long beaches (1 km or greater) that generally contained some back beach or dune habitat. This included the MPA sites of Salmon Creek Beach South, Drakes Beach and Ross Cove and the reference sites of Salmon Creek Beach North, Limantour Beach and Montara Beach. At Bodega Bay and to the north, the beaches were pocket beaches that were less than 200 m in length and embedded in rocky habitats. These beaches included the MPA sites of Horseshoe Cove, Stump Beach and the reference sites of Shorttail Gulch and Cooks Beach, all < 200 m in total shoreline length.

Shorebirds

Spatial variation in shorebird abundance and distribution was evident within the two types of beaches. Mean abundance of shorebirds varied over an order of magnitude among the six long beaches, ranging from 4 to 39 shorebirds km^{-1} (Fig. 7). On the four pocket beaches, the abundance of shorebirds ranged from 0.24 to 2 birds 100 m^{-1} (Fig. 7).

The highest mean number of shorebirds per month 39 birds km^{-1} was observed at Limantour Beach (Ref) during the study (Fig. 7). The highest numbers of shorebirds on a single transect were recorded in five of the 11 monthly surveys at this beach. Mean numbers of shorebirds per month also exceeded 20 birds km^{-1} at Drakes Beach (MPA). Low mean numbers of shorebirds (<10 birds km^{-1}) were observed at Ross Cove (MPA) and Montara Beach (Reference) located at the southern end of the study region. The four pocket beaches in our study supported very low numbers of shorebirds with peak numbers observed at Shorttail Gulch (2 birds 100 m^{-1}) (Fig. 7). For the six long beaches, the greatest peak abundance of shorebirds observed in single surveys were 153 birds km^{-1} at Drakes Beach (MPA) and 125 birds km^{-1} at Limantour Beach (Reference). The site with the lowest peak abundance of shorebirds, 11 birds km^{-1} in a survey was Ross Cove (MPA). For the pocket beaches, the highest peak abundance of shorebirds, 16.7 birds 100 m^{-1}, was observed at Shorttail Gulch and the lowest peak abundance, 1.3 birds 100 m^{-1}, was observed at Cook's Bay (Reference) (Fig. 8).

No consistent differences in the abundance of shorebirds were evident between MPA and Reference beaches, for both long and pocket beaches, during the baseline study (Fig. 9).

Gulls

Spatial variation was also evident in gulls among the beaches. Mean abundance of gulls varied five fold among the six long beaches ranging from 17.4 to 89.5 birds km^{-1} (Fig. 7). On the four pocket beaches, the abundance of gulls ranged from 1.1 to 4.8 birds 100 m^{-1}. Mean abundance of gulls per month exceeded 70 birds km^{-1} at two of the long beaches, Drakes Beach (MPA) and Salmon Creek Beach North (Reference) and (Fig. 7). The highest peak abundance of gulls observed in a single survey was 607 birds km^{-1} at Salmon Creek Beach North (Reference) in month year (Fig. 8). Peak abundance of gulls in single surveys exceeded 240 birds km^{-1} at Drakes Beach (MPA) and Salmon Creek Beach South (MPA) (Fig. 8). On the four pocket beaches, the highest peak abundance of gulls, 18.3 birds 100 m^{-1}, was observed at Shorttail Gulch and the lowest peak abundance, 2.5 birds 100 m^{-1}, was recorded at Stump Beach (MPA) (Fig. 8).

During the baseline study, gulls were more abundant at MPA than reference beaches on long beaches. However on the pocket beaches, gulls were more abundant on reference than MPA beaches (Fig. 9).

Table 3. Abundance (as total counts across all surveys and per km per month), peak abundance (as maximum count) and occurrence (number of times observed) of shorebirds, gulls, seabirds and other birds on MPA (n= 5) and reference (n= 5) beaches from paired monthly surveys between June 2010 and May 2011 (except for July). Five beaches were within MPAs and five were reference beaches. Counts were made along a standard 1 km transect except at four pocket beaches (two MPA and two reference) where transect lengths ranged from 0.12 to 0.17 km (total length of shoreline surveyed each month = 6.56 km).

Common Name	Species	Abundance				Maximum			Occurrence		
		MPA Sites	Ref Sites	All Sites	All sites $km^{-1}mo^{-1}$	MPA Sites	Ref Sites	All Sites	MPA Sites	Ref Sites	All Sites
SHOREBIRDS											
Sanderling	*Calidris alba*	209	538	747	11.4	45	125	125	9	13	22
Marbled godwit	*Limosa fedoa*	188	24	212	3.2	110	17	110	5	3	8
Willet	*Tringa semipalmata*	69	33	102	1.6	50	10	50	8	7	15
Killdeer	*Charadrius vociferus*	52	0	52	0.8	43	0	43	3	0	3
Black oyster catcher	*Haematopus bachmani*	22	10	32	0.5	5	4	5	11	3	14
Black turnstone	*Arenaria melanocephala*	19	2	21	0.3	9	2	9	4	1	5
Western snowy plover	*Charadrius nivosus nivosus*	12	54	66	1.0	6	41	41	4	5	9
Semipalmated plover	*Charadrius semipalmatus*	11	2	13	0.2	8	1	8	4	2	6
Whimbrel	*Numenius phaeopus*	10	32	42	0.6	3	16	16	7	5	12
Black bellied plover	*Pluvialis squatarola*	7	3	10	0.2	4	3	4	3	1	4
Turnstone (unid'd)	*Arenaria* spp.	3	0	3	0.0	3	0	3	1	0	1
Ruddy turnstone	*Arenaria interpres*	2	0	2	0.0	2	0	2	1	0	1
Western sandpiper	*Calidris mauri*	1	4	5	0.1	1	2	2	1	2	3
Sandpiper (unid'd)	*Calidris* sp.	1	0	1	0.0	1	0	1	1	0	1
Spotted sandpiper	*Actitism macularius*	0	1	1	0.0	0	1	1	0	1	1
Surfbird	*Aphriza virgata*	0	8	8	0.1	0	8	8	0	1	1
All shorebirds		***606***	***711***	***1317***	***20.1***						

Table 3 (con't).

Common Name	Species	Abundance				Maximum			Occurrence		
		MPA Sites	Ref Sites	All Sites	All sites $km^{-1}mo^{-1}$	MPA Sites	Ref Sites	All Sites	MPA Sites	Ref Sites	All Sites
GULLS											
Western gull	*Larus occidentalis*	786	73	859	13.1	148	12	148	35	26	61
California gull	*Larus californicus*	176	4	180	2.7	70	1	70	8	4	12
Heermann's gull	*Larus heermanni*	144	118	262	4.0	94	50	94	8	14	22
Herring gull	*Larus argentatus*	95	49	144	2.2	51	17	51	7	6	13
Mew gull	*Larus canus*	40	0	40	0.6	25	0	25	2	0	2
Glaucous wing gull	*Larus glaucescens*	1	0	1	0.0	1	0	1	1	0	1
Gull (unid'd)	*Larus* spp.	616	1071	1687	25.7	277	600	600	33	37	70
All gulls		***1858***	***1315***	***3173***	***48.4***						
SEABIRDS											
Surf scoter	*Melanitta perspicillata*	415	528	943	14.4	150	300	300	17	25	42
Pigeon guillemot	*Cepphus columba*	68	0	68	1.0	61	0	61	3	0	3
Double crested cormorant	*Phalacrocorax auritus*	57	34	91	1.4	33	14	33	11	9	20
Western grebe	*Aechmophorus occidentalis*	46	5	51	0.8	29	5	29	5	1	6
Brown pelican	*Pelecanus occidentalis*	40	72	112	1.7	22	23	23	5	11	16
Horned grebe	*Podiceps auritus*	37	0	37	0.6	37	0	37	1	0	1
Pelagic cormorant	*Phalacrocorax pelagicus*	30	12	42	0.6	12	11	12	10	2	12
Clark's grebe	*Aechmophorus clarkii*	2	0	2	0.0	2	0	2	1	0	1
Loon (unid'd)	*Gavia* sp.	1	1	2	0.0	1	1	1	1	1	2
Tern (unid'd)	*Thalasseus*	1	3	4	0.1	1	2	2	1	2	3
Common loon	*Gavia immer*	0	4	4	0.1	0	4	4	0	1	1
White pelican	*Pelecanus erythrorhynchos*	0	7	7	0.1	0	7	7	0	1	1
Cormorant (unid'd)	*Phalacrocorax* spp.	20	45	65	1.0	8	44	44	5	2	7
All seabirds		***717***	***711***	***1428***	***21.8***						

Table 3 (con't).

Common Name	Species	Abundance				Maximum			Occurrence		
		MPA Sites	Ref Sites	All Sites	All sites $km^{-1}mo^{-1}$	MPA Sites	Ref Sites	All Sites	MPA Sites	Ref Sites	All Sites
TERRESTRIAL BIRDS											
Brewer's blackbird	*Euphagus cyanocephalus*	62	5	67	1.0	42	5	42	3	1	4
Turkey vulture	*Cathartes aura*	51	28	79	1.2	13	8	13	16	10	26
Raven	*Corvus corax*	47	21	68	1.0	22	5	22	13	11	24
American crow	*Corvus brachyrhynchos*	12	28	40	0.6	4	13	13	6	9	15
Bufflehead	*Bucephala albeola*	11	0	11	0.2	11	0	11	1	0	1
Great blue heron	*Ardea herodias*	8	0	8	0.1	2	0	2	7	0	7
Black phoebe	*Sayornis nigricans*	6	3	9	0.1	2	2	2	4	2	6
Snowy egret	*Egretta thula*	4	0	4	0.1	2	0	2	3	0	3
Osprey	*Pandion haliaetus*	4	4	8	0.1	3	2	3	2	3	5
Barn swallow	*Hirundo rustica*	4	10	14	0.2	3	5	5	2	3	5
Rock dove	*Columba livia*	3	0	3	0.0	3	0	3	1	0	1
Mallard	*Anas platyrhynchos*	2	0	2	0.0	2	0	2	1	0	1
Canadian goose	*Branta canadensis*	2	0	2	0.0	2	0	2	1	0	1
Northern harrier	*Circus cyaneus*	2	2	4	0.1	1	1	1	2	2	4
Cliff swallow	*Hirundo pyrrhonota*	2	0	2	0.0	2	0	2	1	0	1
Swallow (unid'd)		2	0	2	0.0	2	0	2	1	0	1
Sharpshinned hawk	*Accipiter striatus*	1	0	1	0.0	1	0	1	1	0	1
Song sparrow	*Melospiza melodia*	1	0	1	0.0	1	0	1	1	0	1
All terrestrial birds		***224***	***101***	***325***	***5.0***						
TOTAL BIRDS		**3405**	**2838**	**6243**	**95.2**						

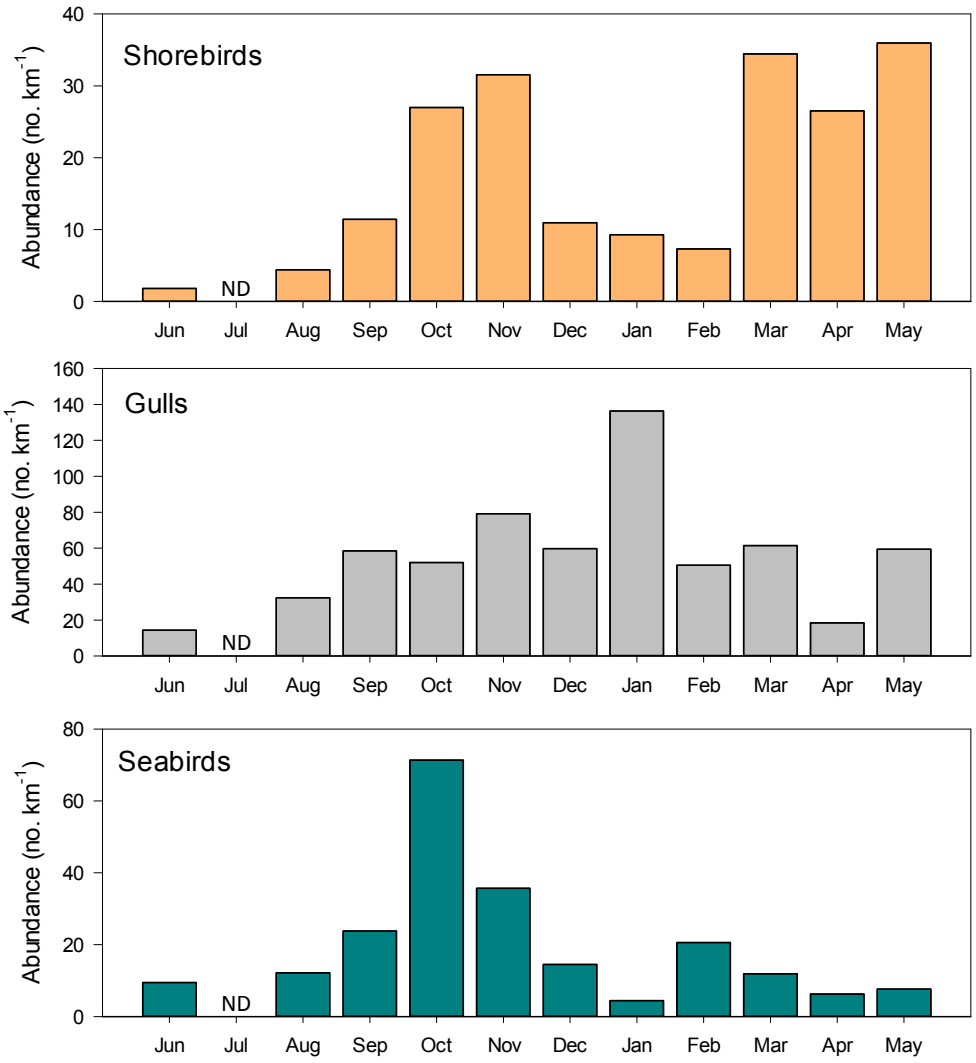

Figure 6. Seasonal abundance of shorebirds, gulls and seabirds observed along NCC) sandy beaches. Surveys were conducted once a month from June 2010 to May 2011 (except in July = ND). Five beaches were within MPAs and five were reference beaches. All observations were made along a standard 1 km transect except at four pocket beaches (two MPA and two reference) where transect lengths ranged from 0.12 to 0.17 km. The data are expressed as total number of birds observed across all 10 sites, within each taxonomic group, divided by the total length of shoreline surveyed each month (6.56 km).

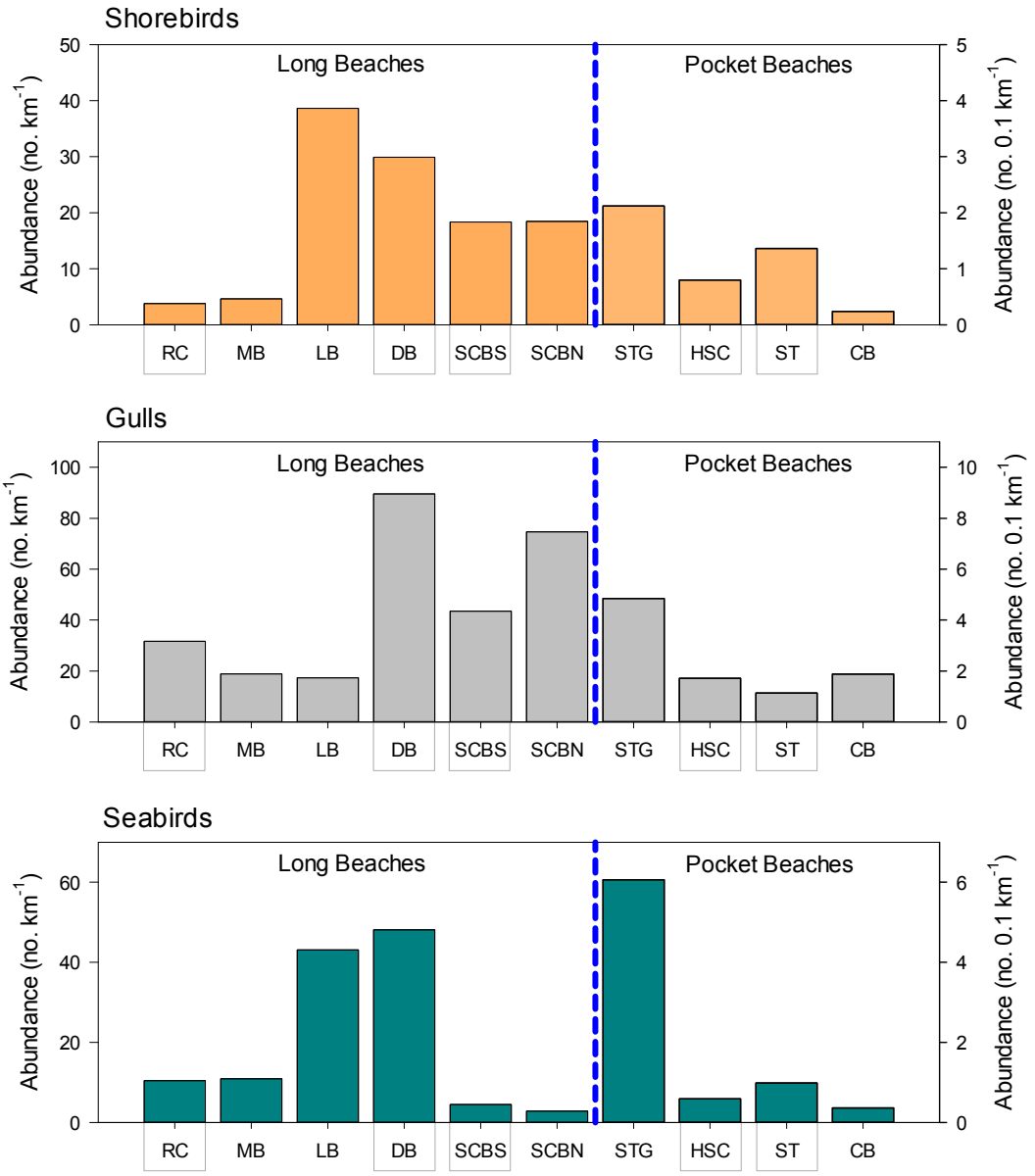

Figure 7. Average abundance of shorebirds, gulls and seabirds observed at 10 beaches from 11 monthly surveys between June 2010 and May 2011 (no survey done in July 2010). All observations were made along a standard 1 km transect except on pocket beaches where transect lengths were truncated to the length of the shoreline present (STG = 0.12 km, HSC = 0.17 km, ST = 0.12 km & CB = 0.15 km). Abundances were normalized to 0.1 km for all pocket beaches. Beaches are arranged from south to north along the horizontal axis within beach type (dashed line separates long from pocket beaches; note difference in axis scaling). Five of 10 the beaches surveyed were within MPAs (indicated by gray boxes). Site codes: RC = Ross Cove Beach, MB = Montara Beach State Park, LB = Limantour Beach, DB = Drake's Beach, STG = Shorttail Gulch Beach, HSC = Horseshoe Cove Beach, SCBS = Salmon Creek Beach (South), SCBN = Salmon Creek Beach (North), ST = Stump Beach and CB = Cook's Beach.

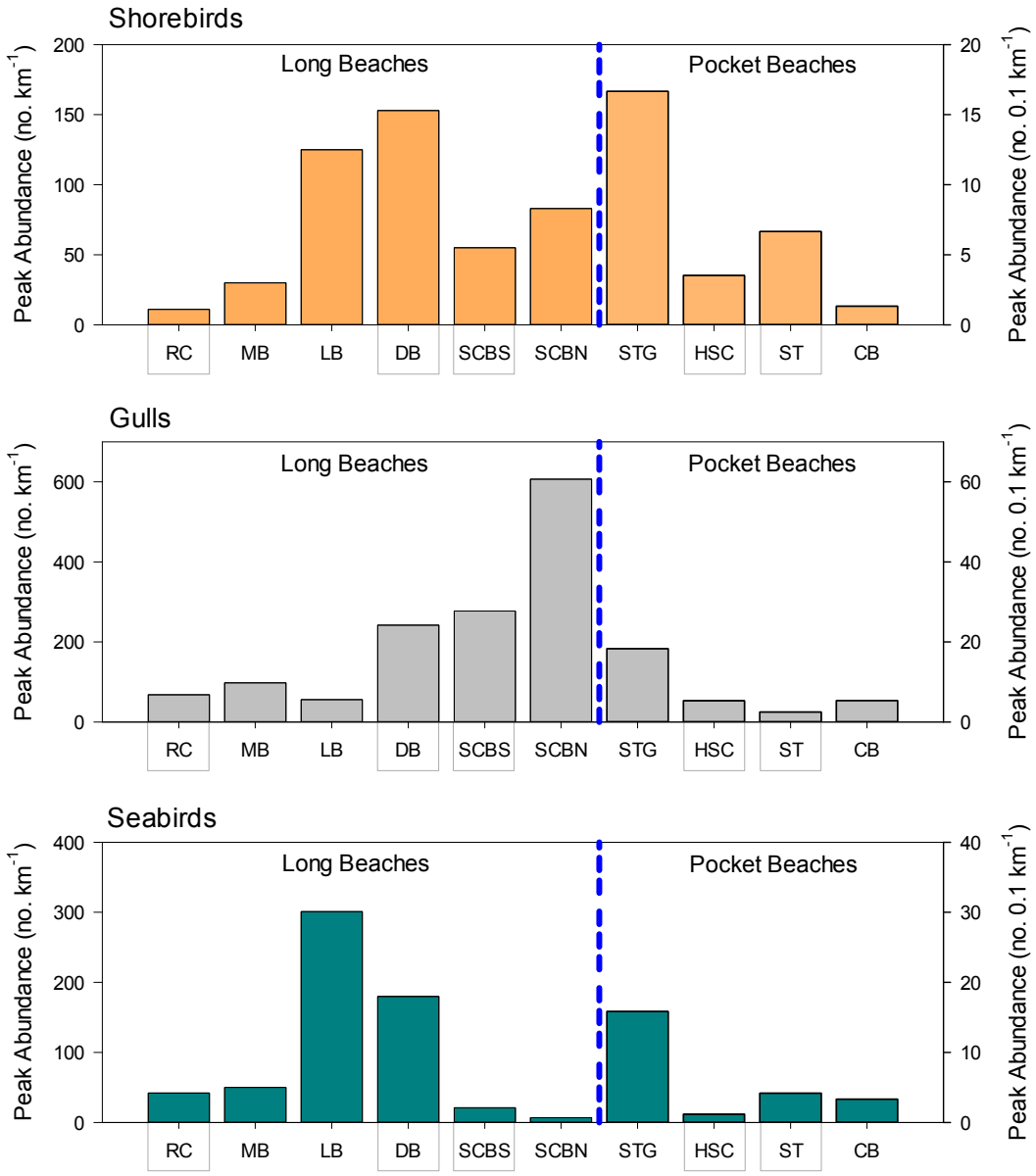

Figure 8. Peak abundance of shorebirds, gulls and seabirds observed at 10 beaches from 11 monthly surveys between June 2010 and May 2011). All other information as in Fig. 7.

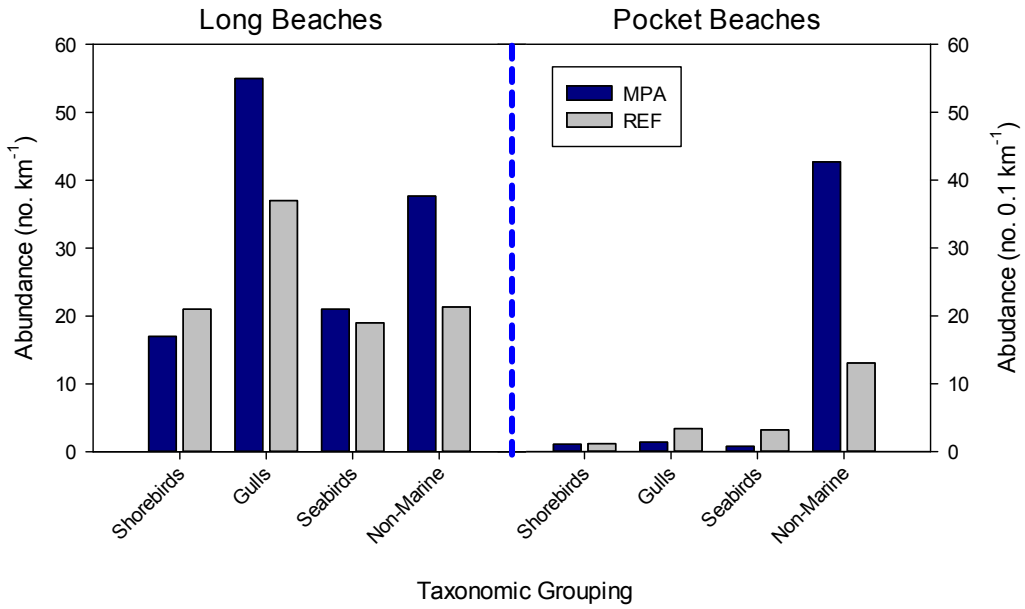

Figure 9. Average abundance of shorebirds, gulls, seabirds and non-marine (or terrestrial) birds observed in MPA and reference beaches by beach type. Data are from 11 monthly surveys at 10 sites between June 2010 and May 2011. Beaches are arranged from south to north along the horizontal axis within beach type (dashed line separates long from pocket beaches). Note the differences in vertical scale for long and pocket beaches; the left scale *only* applies to the long beaches and the right hand scale *only* applies to the pocket beaches.

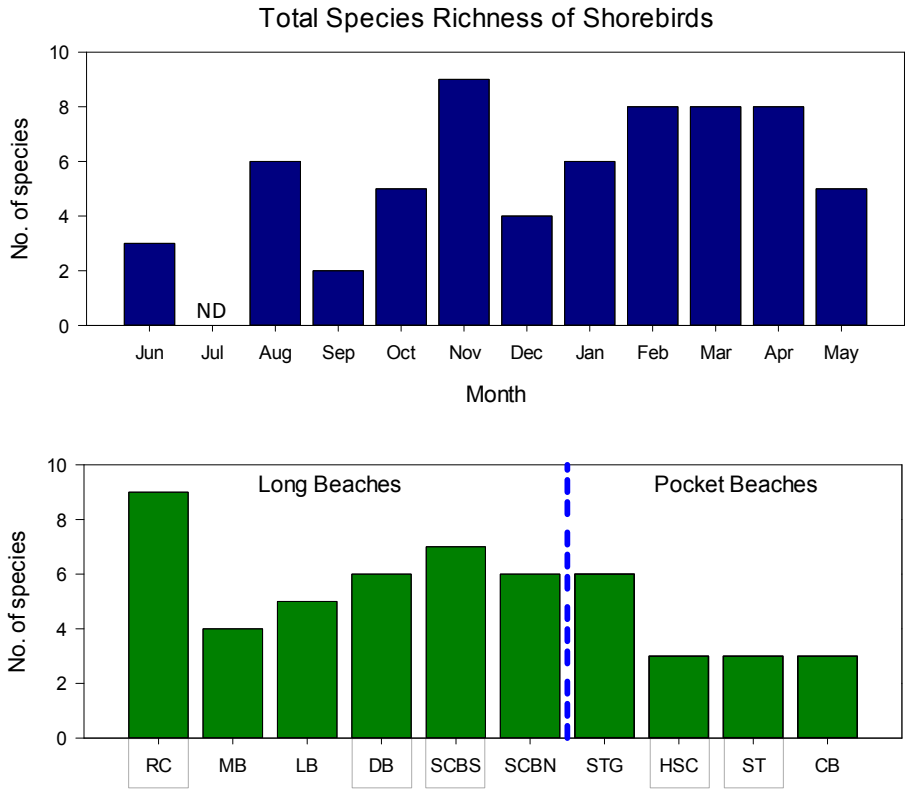

Figure 10. Total species richness (gamma diversity) of shorebirds by month and site. All observations were made along a standard 1 km transect except at four pocket beaches where transect lengths were truncated to the length of the shoreline present (STG = 0.12 km, HSC = 0.17 km, ST = 0.12 km & CB = 0.15 km). See captions of Figs. 6 & 7 for additional information.

Seabirds

The mean abundance of seabirds also varied strikingly among the beaches (Fig. 7). On the long beaches mean seabird abundance per month varied over an order of magnitude ranging from 2.8 birds km-$^{-1}$ to 48.1 birds km^{-1} (Fig. 6). Mean abundance of seabirds per month exceeded 40 birds km^{-1} at two beaches, Limantour Beach and Drakes Beach, but was less than 11 birds km^{-1} at the other four long beaches. Seabird abundance on the pocket beaches showed a similar pattern with an average of 6 birds 100 m^{-1} at Shorttail Gulch and averages of $\leq$ 1 birds 100 m^{-1} at the other three pocket beaches (Fig. 7). The peak abundance of seabirds observed in a single survey was 301 birds km^{-1} at Limantour Beach in month/year (Fig. 8). A peak abundance of 180 birds km^{-1} was recorded at Drakes Beach. Peak abundances were 50 birds km^{-1} or fewer at the other four long beaches. For the pocket beaches, the peak abundance of seabirds in a single survey was 16 birds 100 m^{-1} at Shorttail Gulch (Fig. 8).

For both long and pocket beaches, we found no consistent differences in the abundance of seabirds between MPA and Reference beaches in the baseline study (Fig. 9).

Terrestrial Birds

There were strikingly more terrestrial (non-marine) birds than marine birds on pocket beaches, and their overall abundance was also almost an order of magnitude greater on pocket beaches (Fig. 9). Terrestrial birds were also more abundant on MPA beaches than reference beaches regardless of beach type (Fig. 9).

Birds: Species Richness of Shorebirds

Fourteen species of shorebirds were observed in the 110 surveys of the beaches (Table 3). Peak species richness occurred during migration in the fall and spring (Fig. 10). Total species richness also varied among months ranging from two to nine species observed each month on the 10 focal beaches (Fig. 10). The average total number of shorebird species observed was 5.7 species per month.

The total number of species observed during the study varied more than two fold among the beaches, ranging from three to nine species and averaging five species per study beach (Fig. 10). Note that these values are not corrected for transect length or the number of individuals observed. The highest number of shorebird species (eight) was observed at Ross Cove, a site where Black Oystercatchers occurred. Other beaches with high total species richness (> 6 species) included Drake's Beach, Salmon Creek Beach North and Salmon Creek Beach South and the pocket beach of Shorttail Gulch. The maximum number of species of shorebirds observed on a single 1 km survey was five species during the study.

Beaches where greater numbers of shorebird species were observed generally had high habitat heterogeneity, containing some rocky outcrops (Ross Cove, Shorttail Gulch) or occurring near estuaries (Salmon Creek N and S and Limantour Beach). Relatively low total species richness (three species) occurred on the pocket beaches at Horseshoe Cove, Cooks Bay and Stump Beach (Fig. 10). The latter two beaches have creek mouths and rocky habitat but are very short embayed beaches with tall trees and cliffs overlooking the beach habitat. These landscape features can provide perches for raptors that prey on shorebirds and affect bird distributions.

The total species richness of shorebirds was not significantly correlated with the total abundance of shorebirds or with transect length.

Birds: Species Accounts

Shorebirds

Overall, abundance varied greatly among individual species of shorebirds, ranging over two orders of magnitude from 0.01 birds km^{-1} to 11.4 birds km^{-1} for total monthly observations (Table 3). The average abundance of three species of shorebirds exceeded 1 individual km^{-1} during the baseline study. Based on average abundance observed over the study, the most abundant shorebird species were Sanderling (11.4 birds km^{-1}), Marbled Godwit (3.2 birds km^{-1}) and Willet (1.6 birds km^{-1}), all of which breed outside the study region. Other important species included Whimbrel (0.6 birds km^{-1}) and

three species that nest in the study region, Western Snowy Plover (1.0 birds km^{-1}), Killdeer (0.8 birds km^{-1}), and Black Oystercatchers (0.5 birds km^{-1}). Sanderlings comprised 57%, Marbled Godwits comprised 16%, Willets comprised 8% and Western Snowy Plovers comprised 5%, of the total shorebirds observed in the study. Nine species of shorebirds were observed in five or more of the monthly surveys (Table 3). Sanderlings, Willets and Whimbrels which use NCC beaches as migration and wintering habitat were observed in 22, 15 and 12 of the surveys, respectively. Black Oystercatchers, which are resident and nest in the study area, were observed in 14 surveys. Western Snowy Plovers, which also nest on the beaches were observed in nine of the surveys. Killdeer also nest on beaches in the NCC region, including one of the focal beaches during the baseline study.

Sanderling

Sanderlings were the most abundant shorebird observed in the baseline study and accounted for 57% of the shorebirds observed. A total of 747 Sanderlings were observed in 110 surveys of the 10 beaches (Table 3). The average total abundance of Sanderlings was 11.4 birds km^{-1}. Sanderlings were observed in 10 months of the baseline surveys and total numbers observed on the 10 focal beaches ranged from 0 to 209 birds $month^{-1}$. The total abundance of Sanderlings showed strong seasonal patterns corresponding to fall and spring migration with total abundance exceeding 100 birds km^{-1} in November, March and May on the beaches.

Although they were the most abundant shorebirds observed and occurred in the greatest number of our surveys (22 surveys or 20%), Sanderlings only occurred at five of the six long beaches and were never recorded on the four pocket beaches during our baseline study (Fig. 11). In addition, the average abundance of Sanderlings varied nearly an order of magnitude among the long beaches, ranging from 0 to 31 birds km^{-1} (Fig. 11). The study beach with the highest average numbers of Sanderlings (31 birds km^{-1}) was Limantour Beach. Other study sites where average abundance of Sanderlings was >10 birds km^{-1} included Salmon Creek Beach North and Salmon Creek Beach South. Sanderlings were never observed on the transect at Ross Cove.

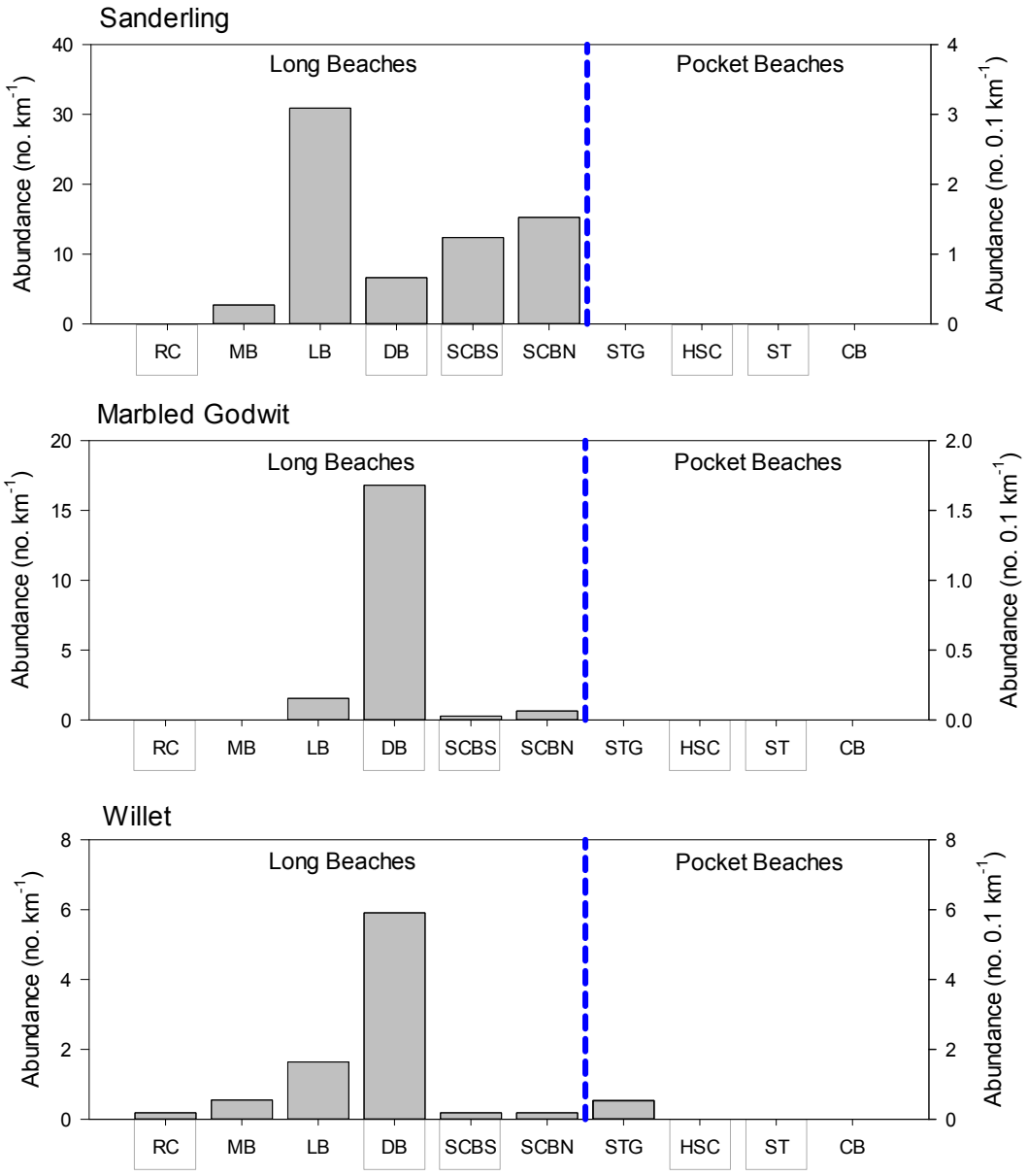

Figure 11. Average abundance of the seven most abundant shorebird species (non-breeding: Sanderling, Marbled Godwit, Willet and Whimbrel; breeding: Black Oystercatcher, Killdeer and Western Snowy Plover) and the terrestrial Raven across the 10 beaches surveyed in the NCC region between June 2010 and May 2011. All other information as in Fig. 7.

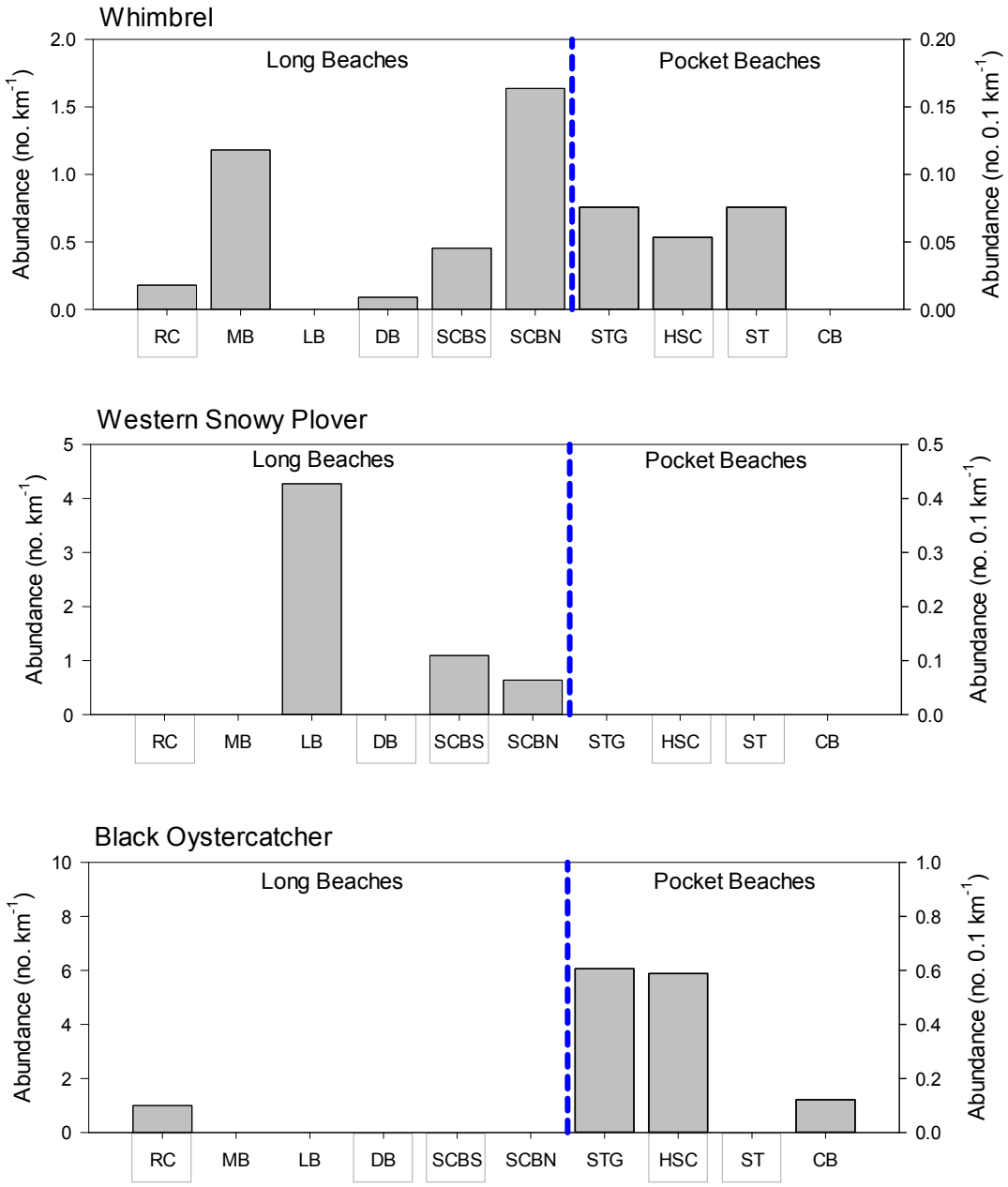

Figure 11. (Con't).

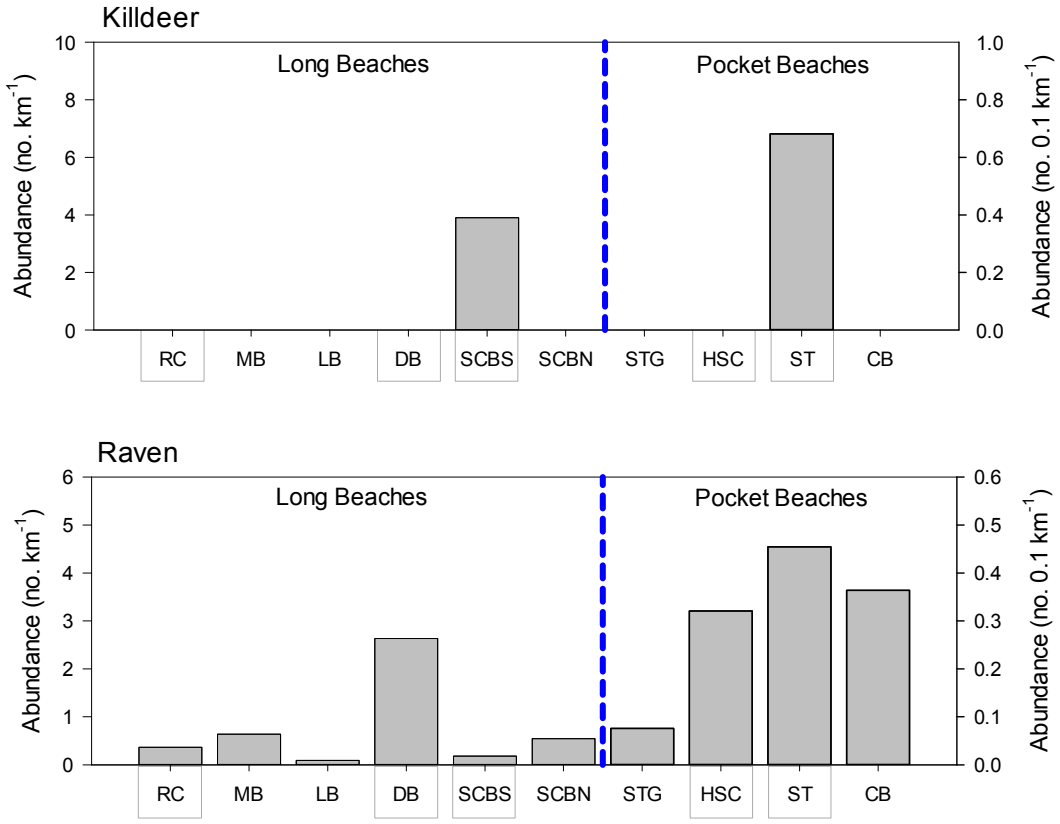

Figure 11. (Con't).

Marbled Godwit

A total of 212 Marbled Godwits occurred in the study (Table 3). Marbled Godwits accounted for 16% of the total shorebirds and were observed in eight surveys. The overall average abundance of Marbled Godwits was 3.2 birds km^{-1} (Table 3).

Marbled Godwits were observed in six months of the baseline surveys and total abundance varied among months, ranging from 0 to 110 birds $month^{-1}$. Peaks in the total abundance of this species (17 to 110 birds) occurred during fall migration (October and November). However, very few individuals (<10) were observed in spring migration on the beaches. Although they were the second most abundant shorebirds we observed, Marbled Godwits only occurred at four of the six long beaches and were never recorded on the four pocket beaches during our baseline study (Fig. 11). Average abundance of Marbled Godwits varied nearly an order of magnitude among the long beaches, ranging from 0 to 17 birds km^{-1} (Fig. 11). The study beach with the highest average numbers of Marbled Godwits (17 birds km^{-1}) was Drakes Beach.

Willet

A total of 102 Willets were observed in the baseline study. Willets accounted for 8% of the total shorebird abundance and were observed in 15 surveys (Table 3). The overall average abundance for Willets was 1.4 birds km^{-1} during the study.

Willets were observed in eight months of the baseline surveys and the total number observed on the 10 focal beaches varied among months, ranging from 0 to 55 birds $month^{-1}$. The peak in the total abundance of Willets occurred in April 2011 during spring migration (Table 3). Total abundance of Willets exceeded 10 birds in only two other months December and February. At total of five or fewer willets were recorded in the 10 focal beaches in all other months.

Willets were more widely distributed than Sanderlings and Marbled Godwits occurring on all of the long beaches and one of the pocket beaches. The average abundance of Willets varied five-fold among the long beaches, ranging from 0.2 to 6 birds km^{-1} (Fig. 11). The highest average number of Willets occurred at Drake Beach, which averaged 6 birds $survey^{-1}$.

Whimbrel

A total of 42 Whimbrels were recorded in the baseline study (Table 3). Whimbrels accounted for 3.8% of the total shorebirds and were observed in 12 surveys. The overall average abundance of Whimbrels was 0.6 birds km^{-1}.

Whimbrels were observed in six months of the baseline surveys and total abundance varied among months, ranging from 0 to 19 birds $month^{-1}$. Peak abundance of this species was observed during spring migration (April and May) while a total of < 3 individuals occurred on the beaches during fall migration (August, October, November).

Whimbrels were the most widely distributed shorebird, occurring on eight of the 10 focal beaches including five of the long beaches and three pocket beaches. The average abundance of Whimbrels varied more than four fold among sites, ranging from 0.0 to 1.6 birds km^{-1} on the long beaches and 0 to 0.08 birds km^{-1} (Fig. 11). The highest average abundance of Whimbrels (1.6 birds km^{-1}) occurred at Salmon Creek Beach North.

Western Snowy Plover

Western Snowy Plovers are listed as a threatened species. These shorebirds nest on beach, river bar, salt flat and estuarine habitats in the study region. On beaches, they depend on macroalgal wrack associated prey resources making them important species to consider as potential indicators of ecosystem condition and connectivity in MPA baseline evaluation. A total of 66 Western Snowy Plovers were observed in the baseline study (Table 3). Western Snowy Plovers accounted for 5% of the total shorebirds and were observed in nine surveys. The overall average abundance for Western Snowy Plovers was 1.0 birds km^{-1} (Table 3).

Western Snowy Plovers were recorded in seven months of the baseline surveys and peak abundance of this species occurred between the months of August and February at wintering/staging sites. The peak number of Snowy Plovers observed in a single survey, 41 birds, was in March 2011 at Limantour Beach, where a roost site may occur during pre-breeding dispersal. The highest abundance of this species was observed in winter and early spring. Our observations of low numbers of this species present in June 2010, and April and May 2011 suggests that one or more pairs nested at Salmon Creek Beaches during the study period. This was corroborated by direct observation of brooding by at least one pair made by a Bodega Marine Reserve manager at Salmon Creek Beach South (Jackie Sones, pers. comm.) and our research team along the survey transect during the same field season. However, raptors were also present at the site; we observed a Sharp-shinned Hawk hunting over the area while the breeding pair was nesting on the beach. Ultimately, the breeding attempt was not successful. This was the first recorded observation of a breeding attempt by Western Snowy Plovers at this site (Jackie Sones, pers. comm.).

Western Snowy Plovers had a restricted spatial distribution, occurring at only three of the beaches during the baseline surveys (Fig. 11). Snowy Plovers were not observed at three of the long beaches or any of the pocket beaches during the study.

Black Oystercatcher

Black Oystercatchers are not a listed species but are a shorebird of high conservation concern. These shorebirds nest in the study area and on the beaches, making them important species to consider as potential indicators of ecosystem condition and connectivity in MPA baseline evaluation. A total of 32 Black Oystercatchers occurred in the baseline study (Table 3). This species accounted for 2.4% of the total shorebirds and were observed in 14 surveys. The overall average abundance of Black Oystercatchers was 0.5 birds km^{-1} (Table 3).

Black Oystercatchers were observed in eight months of the baseline study, and total abundance varied among months, ranging from 0 to 7 birds $month^{-1}$. Peak monthly abundance of this species was observed in September, and in February and March.

The distribution of Black Oystercatchers was restricted (Fig. 11) and they were observed on only four beaches during the baseline study, Ross Cove, Shorttail Gulch, Horseshoe Cove and Cooks Beach, all beaches with either rocky outcrops along the transect (Ross Cove) or bounded by rocky cliffs and outcrops in the case of the three pocket beaches (Shorttail Gulch, Horseshoe Cove and Cooks Beach). The average abundance of Black Oystercatchers ranged from 1 bird km^{-1} at the long beach, Ross Cove and from 0.1 to 0.6 birds 100 m^{-1} on the three pocket beaches.

Killdeer

Killdeer also nest in the study area and on the beaches making this plover species a potential indicator of ecosystem conditions. A total of 52 Killdeer were observed in the baseline study with an average abundance of 0.8 birds km^{-1} (Table 3).

Killdeer were observed in three months of the study with abundance ranging from 4 to 43 birds month^{-1}. The largest numbers of Killdeer on the focal beaches were recorded outside the nesting season (October, December and January), including a large wintering flock in January 2011.

Killdeer were observed on only two of the focal beaches (Fig. 11), one long beach (Salmon Creek Beach South) and one pocket beach (Stump Beach). A pair of Killdeer was present during the breeding season at Stump Beach indicating that nesting likely occurred at that site during the baseline study.

Gulls

Overall, abundance varied greatly among individual species of gulls, ranging over two orders of magnitude from 0.01 birds km^{-1} to 13.1 birds km^{-1} for total monthly observations (Table 3). The average abundance of four species of gulls and of unidentified gulls exceeded 1 individual km^{-1} during our study. Based on average abundance observed over the study, the most abundant gull species were Western Gull (13.1 birds km^{-1}), Heerman's Gull (4.0 birds km^{-1}), California Gull (2.7 birds km^{-1}), and Herring Gull (2.2 birds km^{-1}) (Table 3). Western Gulls comprised 27%, Heerman's Gulls comprised 8.3%, California Gulls comprised 5.7% and Herring Gulls comprised 4.5%, of the total gulls observed in the study. Unidentified gulls were generally immature individuals, were likely of the species recorded as adults in the surveys. Gulls were frequently observed with three species of gulls and unidentified gulls recorded in 20 or more of the monthly surveys (Table 3).

Seabirds

Overall, abundance varied greatly among individual species of seabirds, ranging over two orders of magnitude from 0.03 birds km^{-1} to 14.1 birds km^{-1} for total monthly observations (Table 3). The average abundance of three species of seabirds exceeded 1 individual km^{-1} during our study. Based on average abundance observed over the study, the most abundant seabird species were Surf Scoter (14.1 birds km^{-1}), Brown Pelican (1.7 birds km^{-1}), and Double Crested Cormorant (1.4 birds km^{-1}) (Table 3). Surf Scoters comprised 66%, Brown Pelicans comprised 7.8 %, and Double Crested Cormorants comprised 6.4% of the total seabirds observed in the study. Seabirds were regularly observed with three species of seabirds and unidentified cormorants observed in 10 or more of the individual surveys (Table 3).

Terrestrial Birds

Scavenging and carrion feeding birds were regularly recorded and were among the most abundant terrestrial birds on both the MPA and reference beaches during the baseline study (Table 3). The corvids, Ravens and American Crows, were important components, together making up 33% of the total terrestrial birds observed and recorded (Table 3). Turkey vultures were also important making up 24% of the terrestrial birds observed and recorded in 26 of the 110 surveys (Table 3). Brewers' blackbird was the most abundant passerine species observed (67 individuals, 0.9 birds km^{-1}) but were only recorded in four individual surveys in the baseline study (Table 3).