Pacific Outer Continental Shelf Region

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BOEMRE Study 2010-24

# Shorebird Abundance and Distribution on Beaches of Ventura County, California 2007-2010

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*Authored by*:
Donald A. Rodriguez
Angela Chapman
Rachel Cartwright

*Submitted by*:
California State University Channel Islands

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Bureau of Ocean Energy Management
Pacific OCS Region
770 Paseo Camarillo
Camarillo, CA 93010
805-389-7621

Donald A. Rodriguez
Environmental Science and Resource Management
California State University Channel Islands
Camarillo, CA 93012
805-437-8494

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# PREFACE

This final report presents the results of a 3-year study completed from July 2007 through June 2010 of shorebird abundance and distribution at 14 beaches in Ventura County California. This study was a replication of a study performed by the Minerals Management Service (now known as the Bureau of Ocean Energy Management), from 1994-1997. Funding for this study was provided entirely by BOEM to support the CSU Channel Islands student research assistants.

# ACKNOWLEDGEMENTS

This study was funded by the BOEM Pacific OCS Regional Office in Camarillo, California. We gratefully acknowledge the guidance provided by members of the BOEM staff particularly Mr. Greg Sanders that served as the staff project lead throughout the study, Dr. Fred Piltz, Dr. Ann Bull, and Mr. David Pereksta.

This study would not have been possible without the support of the CSU Channel Islands student research assistant team; Ms. Christina Fahim, Ms. Amanda Goldstein, Mr. Chris Kahler, Mr. Garrick Thomsen, and Ms. Lisa Winfrey.  Through their continued efforts we were able to complete over 500 beach surveys over the course of 3 years.

# TECHNICAL SUMMARY

**Study Title:** Shorebird Abundance and Distribution on Beaches of Ventura County, California 2007-2010
**Report Title:** Shorebird Abundance and Distribution on Beaches of Ventura County, California 2007-2010. BOEMRE OCS Study 2010-24
**Contract Number:** MO7AC12460
**Sponsoring OCS Region:** Pacific
**Applicable Planning Area:** Central and Southern California
**Fiscal Years of Project Funding:** 2007-2010
**Completion Date of the Report:** December 2011
**Costs:** $68,680.30
**Cumulative Project Cost:** $68,680.30
**Principal Investigator:** Donald Rodriguez
**Key Words:** Shorebirds, Ventura County beaches, seasonal distribution, temporal distribution, human disturbance

**Background and Objectives:**

The coastline and Central Valley of California are the main areas where shorebirds concentrate in the southern Pacific region of the United States. Tidal wetlands, sand beaches, and rocky shoreline are the principal shorebird habitats on the coast (Hickey et al. 2003). From June 1994 to May 1997 the Minerals Management Service conducted a study to determine shorebird distribution, abundance, and beach use patterns on 14 sandy beaches in Ventura County. Each of the 14 beaches were 1 kilometer (km) in length, and counts were conducted once per month for 3 years. A total of 23 shorebird species were recorded during the three-year period with six species representing 97% of the total number of shorebirds recorded. The six most abundant species were Sanderlings (46%), Willets (32%), Marbled Godwits (7%), Black-bellied Plovers (5%), Snowy Plovers (4%), and Whimbrels (3%). While the overall mean shorebird count was 44.1 birds/kilometer (n=504), there was a great deal of variation in shorebird numbers from month to month and beach to beach (McCrary and Pierson 2002).

The Southern Pacific Region is extremely important to 20 shorebird species relative to the majority of other regions (Hickey at al. 2003). Four of those species were among the six most prevalent species observed during the original survey: Black-bellied Plover (*Pluvialis squatarola*), Snowy Plover (*Charadrius nivosus*), Marbled Godwit (*Limosa fedoa*), and Willet (*Tringa semipalmata*) (McCrary and Pierson 2002).

Most shorebird research has been conducted in wetland habitats, therefore relatively little information exists on shorebird use of exposed sandy and rocky shoreline habitat (McCrary & Pierson 2002). This presents a problem because beaches are becoming increasingly necessary for shorebirds. In southern California the loss of protected habitats, such as wetlands, may be increasing the importance of exposed coastal habitats, such as sandy beaches, for shorebirds (Hubbard and Dugan 2003).

Shorebirds use beaches as a supplement to their wetland diet. Many shorebirds feed on mudflats that become covered during high tides, therefore habitat use between high and low tides is frequently different. Many studies from around the world have noted the same pattern: mudflats are used on low tides; pastures, marshes, mangrove, sand beaches, etc. are used on high tides (Warnock et al. 2002).

The Ventura County coastline is about 62 km in length and consists of 93% wave-swept sandy intertidal beaches (McCrary and Pierson 2002). As part of the original research McCrary and Pierson randomly selected 14, 1-km beach segments (about 20% of the county shoreline) for study. Monthly surveys were conducted from June 1994 through May 1997 to determine spatial and temporal species composition for each site.

Most (12 of 14 or 86%) of the beaches consist of sandy intertidal habitat, reflecting the predominance of this habitat in the county. One segment (Pt. Mugu) is almost entirely (about 95%) rocky intertidal habitat, while another (Deer Creek) is equal parts rocky and sandy intertidal. McCrary and Pierson originally chose the sites based on the number they could survey during the same tidal sequence each month (about a three-day period), which was estimated at about four to five beaches per day, and on the length of the Ventura County shoreline.

This report includes:

- A description of the study area and methods used, including any modifications and improvements made to the survey protocol described in the MMS shorebird study conducted from 1994-19997.
- Results of the surveys conducted including maps, data tables, and graphic representations.
- Discussion of the results and comparison with data collected during previous surveys.
- A description of any data collected incidental to the shorebird surveys (e.g., stranded birds and marine mammals).

All analyses resulting in a database(s) will be submitted to BOEMRE in Microsoft Access and/or Microsoft Excel.

**Description:**

The goal of this study is to continue the development of a long term data set of coastal bird observations in an effort to quantitatively investigate and characterize shorebird species and their seasonal populations along the Ventura County coastline. Fourteen 1-km transects, covering 20% of the Ventura shoreline adjacent to offshore oil and gas operations, were monitored monthly for a three-year period starting in July 2007. Results of the three-year study are compared to a similar three-year study completed from 1994-1997 to improve our understanding of the effects of human activities on the coastal environment. Current data analysis suggests that over the last decade there has been a significant decline in total numbers of shorebirds using Ventura County beaches. The results for the four most prevalent species observed during the original study all show distribution changes. The numbers of Snowy Plovers, however, are generally consistent with the data from 10 years ago. This species is listed as threatened under the Endangered Species Act and efforts are underway to ensure its protection.

**Significant Results:**

From July 2007 through June 2010, we conducted monthly counts of shorebirds on 14 beaches in Ventura County, California to determine shorebird distribution, abundance, and amount of human disturbance on local populations. High energy, ocean fronting beaches are dynamic ecosystems with the potential to be important foraging habitats for shorebirds (Hubbard and Dugan 2003). Shorebird densities and distribution serve as an important barometer of ecosystem condition along the Pacific Coast. This study was a replication of a similar study completed by the Minerals Management Service from June 1994-May 1997. A total of 504 surveys were completed during each project period (1994-1997, 2007-2010), for a total of 1,008 surveys analyzed in this report.

Each of the surveys was completed by walking a 1 km transect on each of the 14 study sites. This was a methodology following the protocols established by McCrary and Pierson (2002). Surveys were done at low tide and timed to coincide with incoming tides and avoiding weekends to minimize human disturbance.

During the survey period (2007-2010) a total of 39,072 birds were counted. Of these, 17,575 were of the six focal species. Six exemplar bird species were counted on each survey and additional field notes include other bird species sighted, notes and counts of disturbances, and basic weather descriptions. Total bird counts are reported for each survey. As each survey was 1 km long, these numbers represent sightings/ linear km of beach.

For each species we then compared the recent survey data with the historical data and used generalized linear models (GLM's) to identify key deterministic factors and interactions between factors.

2007-2010 surveys: Total number of birds counted was 39,072 in the 2007-2010 surveys; of the total count, 17,575 were of the 6 focal species. Mean number of birds sighted per transect (1km) was 77.5 (s.d. 155.3) per transect for all bird species, and 34.8 (s.d. 75.4) birds per transect, when considering only the focal 6 species. Sanderlings were the most commonly sighted of the focal species, accounting for 7,353 of these sightings. Notably large flocks were seen on infrequent occasions (see individual species accounts below).

1994-1997 surveys: Total number of birds counted was 21,623 in the 1994-1997 surveys, however this included only the 6 focal species; non focal species bird counts were not reported. Mean number of focal birds sighted per transect (1km) was 42 (s.d. 72.8) birds per transect. Sanderlings were the most commonly sighted of the focal species, accounting for 10,373 of these sightings, including a number of large flocks. A broad based analysis of sighting rates for all surveys, all beaches indicates significant differences in the numbers of Sanderlings, Willets, and Black-bellied Plovers. See Table 1.

**STUDY PRODUCTS:**

**Presentations:**

Kahler, Christopher. (2007). Shoreline Survey of Coastal Birds in Ventura County. Poster presented at the Southern California Conference for Undergraduate Research. California State University Los Angeles. November 17.

Kahler, Christopher. (2007). Shoreline Survey of Coastal Birds in Ventura County. Poster presented at the Capstone Poster session, Library Collaboratory, California State University Channel Islands. May 3.

Rodriguez, Donald A. (2007). Methodology for monitoring coastal shorebirds. University of Guadalajara Coastal Studies Unit. Melaque, Mexico. March 23

Rodriguez, Donald A., Chapman, Angela, Kahler, Christopher, and Thomsen, Garrick. (2008). Have shorebird populations changed along the Ventura County coastline in the last decade? Paper presented for publication in the Conference Proceedings of the 7$^{th}$ California Islands Symposium. Mandalay Bay Embassy Suites Hotel, Oxnard, California. February 7-9.

Rodriguez, Donald A., Angela Chapman, Greg Sanders, Christopher Kahler, and Garrick Thomsen. (2008). A Comparison of Current and Historical Shorebird Populations in Ventura County: Preliminary Results. Poster presented at the 7$^{th}$ California Islands Symposium. Mandalay Bay Embassy Suites Hotel, Oxnard, California. February 7-9.

Thomsen, Garrick. (2008). Current and Historical Shorebird Populations in Ventura County, California and the Role of Human Disturbance in Limiting Foraging Behavior. Paper presented at the Twenty Second Annual CSU Student Research Competition. California State University, East Bay. May 2-3.

Rodriguez, Donald A. (2009). Ventura County shoreline study. Presented to Kiwanis Club of Oxnard. Marriott Courtyard, Oxnard, California. November 19.

Rodriguez, Donald A. (2009). Monitoring shorebirds in an era of climate change." Presented to Town Meets Gown Lecture Series. Camarillo City Hall, California. November 17.

Chapman, A., Rodriguez, D.A., Fahim, C., Goldstein, A. and Winfry, L. (2009). A comparison of current and historical shorebird populations in Ventura County. Paper presented at the SAGE Faculty Student Research Forum, John Spoor Broome

Library, California State University Channel Islands. May 9.

Chapman, A., Rodriguez, D.A., Fahim, C., Goldstein, A. and Winfry, L. (2009). A comparison of current and historical shorebird populations in Ventura County. Poster presented at the Southern California Academy of Sciences Annual Conference. Loyola Marymount University, Los Angeles, California. May 29.

Rodriguez, Don, Chapman, Angela, Fahim, Goldstein, Amanda, Christina, Kahler, Christopher, Thomsen, Garrick, and Winfrey, Lisa (2010). A comparison of current and historical shorebird populations in Ventura County: Preliminary results. STEM @ CI: 4th Annual Celebration of Excellence. John Spoor Broome Library, California State University Channel Islands. May 5.

Rodriguez, Donald, Chapman, Angela, Cartwright, Rachel, Adolf, Cassidy (2010). A 10 year comparison of shorebird abundance and seasonal distribution in Ventura County. Poster presented at the Ballona Wetland Science and Research Symposium. December 8. Loyola Marymount University, Los Angeles, California.

**Media Coverage**:

For the Birds: CSUCI faculty work with U.S. Dept. of Interior’s Mineral Management Services to inventory birds in Ventura County. Feature article California State University Channel Islands *Current* magazine. Spring 2008, vol. 12 (1) pg. 15

Barlow, Zeke (2007). Team counts shorebirds in case of oil spill off the coast. Ventura County Star. November 22 (front page).

Bond, Andrea (2007). Shorebird counts in Ventura County. New HD News. Direct TV News video. November 18.

Barlow, Zeke producer. (2007). “Counting Shorebirds on County Coast.” Ventura County Star video.

Barlow, Zeke (2007). Team counts shorebirds in case of oil spill off the coast. San Jose Mercury News article. November 23.

Barlow, Zeke (2007). Team counts shorebirds in case of oil spill off the coast. Camarillo Acorn. November 22.

Rodriguez, Donald (2007). Radio interview with Jim Bohannon on KVTA 1520 AM Talk radio. November 23.

# EXECUTIVE SUMMARY

From July 2007 through June 2010, we conducted monthly counts of shorebirds on 14 beaches in Ventura County, California to determine shorebird distribution, abundance, and amount of human disturbance on local populations. High energy, ocean fronting beaches are dynamic ecosystems with the potential to be important foraging habitats for shorebirds (Hubbard and Dugan 2003). Shorebird densities and distribution serve as an important barometer of ecosystem condition along the Pacific Coast. This study was a replication of a similar study completed by the Minerals Management Service from June 1994-May 1997. A total of 504 surveys were completed during each project period (1994-1997, 2007-2010), for a total of 1008 surveys analyzed in this report.

Each of the surveys was completed by walking a 1 kilometer (km) transect on each of the 14 study sites. This methodology followed the protocols established by McCrary and Pierson (2002). Surveys were done at low tide and timed to coincide with incoming tides while avoiding weekends to minimize human disturbance.

During the survey period (2007-2010) a total of 39,072 birds were counted. Of these only 17,575 were of the 6 focal species. Six exemplar bird species were counted on each survey and additional field notes included other bird species sighted, notes and counts of disturbances, and basic weather descriptions. Total bird counts are reported for each survey. As each survey was 1 km long, these numbers represent sightings/ linear km of beach. For each species we then compared the recent survey data with the historical data and used generalized linear models (GLM's) to identify key deterministic factors and interactions between factors.

2007-2010 surveys: Total number of birds counted was 39,072 in the 2007-2010 surveys; of the total count, 17,575 were of the 6 focal species. Mean number of birds sighted per transect (1km) was 77.5 (s.d. 155.3) per transect for all bird species, and 34.8 (s.d. 75.4) birds per transect, when considering only the focal 6 species. Sanderlings were the most commonly sighted of the focal species, accounting for 7,353 of these sightings. Notably large flocks were seen on infrequent occasions (see individual species accounts below).

1994-1997 surveys: Total number of birds counted was 21,623 in the 1994-1997 surveys, however this included only the 6 focal species; non focal species bird counts were not reported. Mean number of focal birds sighted per transect (1km) was 42 (s.d. 72.8) birds per transect. Sanderlings were the most commonly sighted of the focal species, accounting for 10,373 of these sightings, including a number of large flocks. A broad-based analysis of sighting rates for all surveys, all beaches indicates significant differences in the numbers of Black-bellied Plovers, Willets, and Sanderlings. See Table 1.

# I. INTRODUCTION

The 1974 International Shorebird Survey (ISS) found that there are few places in the world where the appropriate combination of resources needed by shorebirds for refueling during their migration are present, and for some species 80% of the North American population may visit a single site. A loss of one of these critical staging areas could devastate a shorebird population (Howe et al. 1989).

The coastline and Central Valley of California are the main areas where shorebirds concentrate in the southern Pacific region of the United States. Tidal wetlands, sand beaches, and rocky shoreline are the principal shorebird habitats on the coast (Hickey et al. 2003). Most shorebird research has been conducted in wetland habitats, therefore relatively little information exists on shorebird use of exposed sandy and rocky shoreline habitat (McCrary & Pierson 2002). This presents a problem because beaches are becoming increasingly necessary for shorebirds. In southern California the loss of protected habitats, such as wetlands, may be increasing the importance of exposed coastal habitats, such as sandy beaches, for shorebirds (Hubbard and Dugan 2003). Shorebirds use beaches as a supplement to their wetland diet. Many shorebirds feed on mudflats that become covered during high tides, therefore habitat use between high and low tides are frequently different. Many studies from around the world have noted the same pattern: mudflats are used on low tides; pastures, marshes, mangrove, sand beaches, etc. are used on high tides (Warnock et al. 2002).

Sandy beaches are an important aspect of Ventura County, California making up 93 percent of the coastline (McCrary and Pierson 2002). The rest is rocky intertidal habitat, which needs to be surveyed also because certain species of shorebirds are only found in this type of habitat (Warnock et al. 2002). Conservation of remaining shorebird populations will require a concerted international effort. Oring et al. (2000) outline many approaches researchers should take to facilitate stable and self-sustaining shorebird populations. The Southern Pacific Region is extremely important to 20 shorebird species relative to the majority of other regions (Hickey at al. 2003). Four of those species were among the six most prevalent species observed during the original survey: Black-bellied Plover (*Pluvialis squatarola*), Snowy Plover (*Charadrius nivosus*), Willet (*Tringa semipalmata*), and Marbled Godwit (*Limosa fedoa*) (McCrary and Pierson 2002).

# II. STUDY AREA and METHODOLOGY

We conducted monthly counts of shorebirds on the outer coast of Ventura County (Fig.1) from July 2007 to June 2010. The Ventura County coastline runs northwest to southeast along the Santa Barbara Channel of southern California and is about 62 km in length. Most of the coast (93%, Smith et al. 1976) consists of wave swept sandy intertidal beaches. Wetland habitats where shorebirds congregate are limited. The most extensive wetland in the county is located at the Pt. Mugu Naval Weapons Station located along the the central portion of the county coastline. Additionally, small amounts of shorebird foraging habitat are located at the Santa Clara River mouth, Ventura River mouth, and ponds associated with various sewage treatment plants, electric generation plants, and agricultural runoff. As part of the original research replicated in this study, McCrary and Pierson (2002) randomly selected 14, 1-km beach segments (about 20% of the county shoreline) for their assessment. Monthly surveys were conducted from June 1994 through May 1997 to determine spatial and temporal species composition for each site. Survey methods were replicated from the original study conducted from 1994-1997. Monthly counts were conducted along the 14 beach segments identified in the original study (Fig. 1).

The survey team consisted of two individual observers (trained by California State University Channel Islands (CSUCI) and the United States Fish and Wildlife Service (USFWS)). For consistency each observer was responsible for the same seven beaches. Observers walked 1 km transects recording shorebirds along the entire length. A total of six students were employed during the course of the project. Student training and field skills varied among participants. While all students were competent observers, some possessed superior field skills and were used extensively throughout the project period. Surveys were conducted during low incoming tides for consistency and maximum sandy beach exposure. Beaches were sampled during weekdays to minimize the influence of human disturbance. Data collected included date, observer, start and stop time, approximate tide height, weather and sea conditions (cloud cover, wind, temperature, wave height and period), numbers of species, abundance, and percentage of wrack cover. Impacts associated with the human dimensions of shorebird ecology (i.e., number of people on a beach, dogs leashed or unleashed, and vehicles on the beach) were quantified to assess human disturbance of foraging behavior. The data collected were entered into a spreadsheet.

While an assessment of the morphodynamic state of the beaches in our study area was not completed, there was considerable spatial and temporal variation in physical characteristics of the 14 beaches included in this study. Most of the beaches sampled are subject to prevailing west winds and large winter swells from the west or northwest. Beaches in the central and southern portion of Ventura County are regularly exposed to southern swells in the summer months (Dugan 2006). Most (12 of 14 or 86%) of the beaches consist of sandy intertidal habitat, reflecting the predominance of this habitat in the county. One segment (Pt. Mugu) is almost entirely (about 95%) rocky intertidal habitat, while another (Deer Creek) is equal parts rocky and sandy intertidal. McCrary and Pierson (2002) originally chose the sites based on the number they could survey during the same tidal sequence each month (about a three-day period), which was estimated at about four to five beaches per day, and on the length of the Ventura County shoreline. While the original intent was to include ArcGIS technology as part of the project deliverables. The creation of Arc GIS maps were beyond the scope of the project given limited resources and the skills of the students involved in the project. Future assessments should include Arc GIS data layers and maps of important shorebird habitat.

Statistical Methods:

Statistical analysis was conducted using SPSS v.18. Total raw counts were compared between the two survey periods, 1994-1997 and 2007-2010, using all data and simply comparing sightings. Data was not normally distributed, so non parametric Mann Whitney tests were used on total counts for each focal species.

Following this, a species by species analysis was conducted. Within each species, summary statistics for sighting rates per transect are provided for each survey period. These include all flocks sighted (flocks defined as single counts > 10% of total counts). These large flocks were then removed from further analysis, to ensure that trends in the data set best reflected typical sighting rates.

As data was still non parametric, overall sighting rates were compared using Mann Whitney tests between the two survey periods, and Kruskal Wallis tests by season, classifying seasons as December through February, Winter (1), March through May, Spring (2), June through August, Summer (3), September through November, Fall (4).

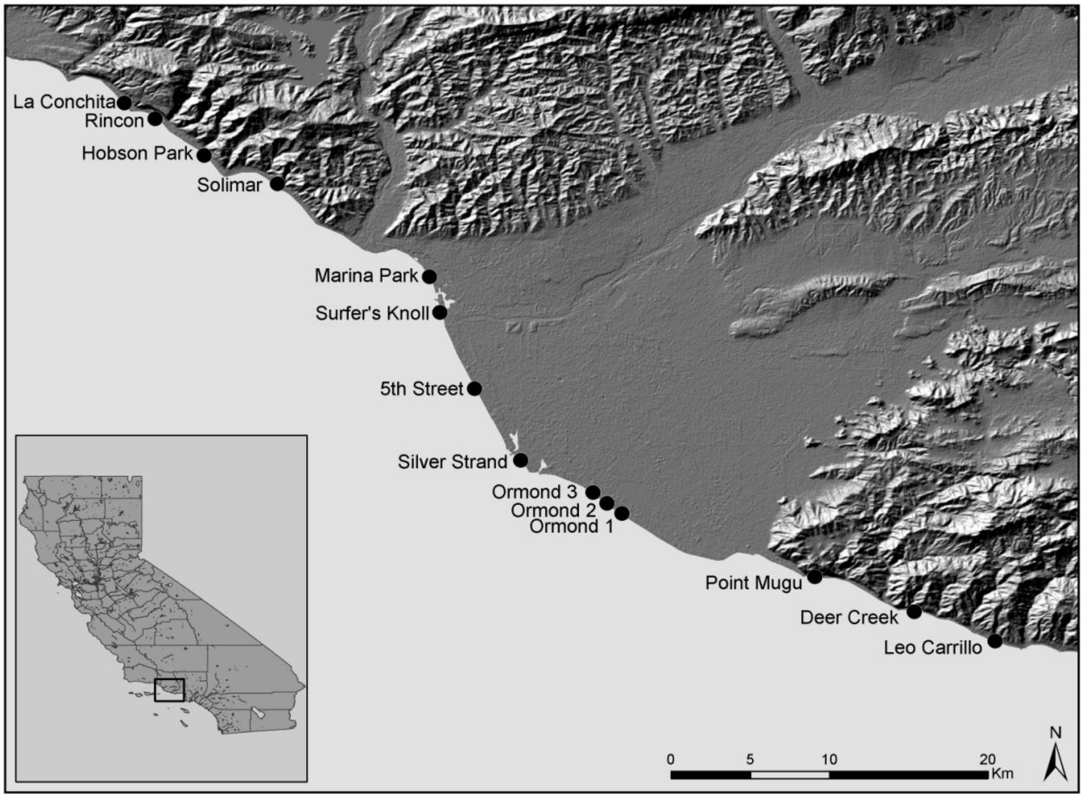
Generalized linear mixed models (GLMM), based on a Poisson distribution and using a log-link were used to determine where significant differences lay according to period, season and beach, and also to detect interactions between seasons and periods, and beaches and time periods. At this point three-way interactions have not been included. Results were considered significant at the 5% level of significance, with Bonferroni corrections for multiple testing applied as required.

In the tables provided in this section (Tables 10-46), within survey variations by seasons and beaches are reported as significantly high and low mean counts and are footnoted in each table. Where differences in seasonal or spatial trends between the two periods were apparent, based on the GLMM analysis, a footnote has been added below the tables.

Survey sites

The following descriptions of the study beaches are provided for reference. These descriptions are taken from the original report (McCrary and Pierson 2002), as provided by (Dugan pers. comm.). Beaches are listed in geographic order from north to south and were described as modally intermediate in morphodynamic state (Dean's parameter 1 to 5), with relatively low wrack cover present. A new element included in this study is the inclusion of Global Positioning System (GPS) coordinates for each of the 1 km study transects used in the execution of this analysis to increase study reliability and insure replicability. All transects were sampled and reported from northernmost end to southernmost end for consistency.

**Figure 1**. ArcGIS 9.3 map of shorebird study beaches




**La Conchita**
This high intermediate to dissipative beach is backed by riprap and Highway 101. There is limited upper beach area with scattered vegetation. The intertidal is wide and flat, with fine sand and long, slow swashes. This beach is ungroomed, and wrack cover is usually light (<1%). GPS coordinates are: Begin N34$^{o}$ 21.947, W119$^{o}$ 26.897; End: N34$^{o}$ 21.354 W119$^{o}$ 26.575.

**Rincon**
This intermediate beach is backed by riprap and Highway 101. There is a broad flat upper beach area with scattered vegetation. The intertidal is wide and flat with fine sand and moderate swashes. This beach is ungroomed, and wrack cover is usually light (<1%). GPS coordinates are: Begin N34$^{o}$ 21.309, W119$^{o}$ 25.924; End: N34$^{o}$ 20.99, W119$^{o}$ 25.309.

**Hobson Park**
This intermediate beach is backed by riprap and has no sandy upper intertidal habitat. This beach is ungroomed, and wrack cover is usually light (<1%). GPS coordinates are: Begin N34$^{o}$ 19.996, W119$^{o}$ 24.229; End N34$^{o}$ 19.592, W119$^{o}$ 23.816.

**Solimar**

This intermediate beach is backed by riprap and the Old Coast Highway. There is a very limited upper beach area with no vegetation. The intertidal is moderate in width, flat, with fine sand and moderate swashes. This beach is ungroomed, and wrack cover is usually light (<1%). GPS coordinates are: Begin N34$^o$ 18.526, W119$^o$ 24.229; End N34$^o$ 18.170, W119$^o$ 21.308.

**Marina Park**

This intermediate beach is interrupted by groins and is backed by a seawall, riprap, and homes. There is a steep upper beach with limited vegetation. The intertidal is wide and flat with fine sand and long slow swashes. This beach is ungroomed, and wrack cover is usually light (<1%). GPS coordinates are: Begin N34$^o$ 15.731, W119$^o$ 16.481; End N34$^o$ 15.269, W119$^o$ 16.228.

**Surfer's  Knoll**

This low intermediate beach is dune backed and located north of the Santa Clara River mouth. There is a wide flat upper beach with limited vegetation. The intertidal is narrow and steep, with coarse sand and short, rapid swashes. This beach is ungroomed, and wrack cover is usually light (<1%). GPS coordinates are: Begin N34$^o$ 14.55, W119$^o$ 16.051; End N34$^o$ 14.028, W119$^o$ 16.035.

**5$^{th}$ Street**

This intermediate beach is backed by a line of boulders, a road, and homes. There is a wide, flat upper beach with very limited vegetation. The intertidal is narrow and steep, with coarse sand and short, rapid swashes. This beach is groomed, and wrack cover is very light (<1%). GPS coordinates are: Begin N34$^o$ 11.846, W119$^o$ 14.924; End N34$^o$ 11.567, W119$^o$ 14.708.

**Silver Strand**

This intermediate beach is backed by a seawall and a dredge pipe. There is a wide flat upper beach with no vegetation. The intertidal is narrow and moderately sloped, with coarse sand and moderate swashes. This beach is groomed, and wrack cover is very light (<1%). GPS coordinates are: Begin N34$^o$ 9.443, W119$^o$ 13.485; End N34$^o$ 9.028, W119$^o$ 13.075.

**Ormond 3**

This intermediate beach is backed by low vegetated dunes and seasonal wetlands. The upper beach is wide. The intertidal is wide, with moderate slope, fine sand, and long slow swashes. The beach is ungroomed and the wrack cover is very light (<1%). GPS coordinates are: Begin: N34 8.213$^o$, W119$^o$ 11.093; End: N34$^o$ 7.896, W119$^o$ 10.564

**Ormond 2**

This high intermediate beach to dissipative beach is backed by low vegetated dunes and seasonal wetlands. The upper beach is wide. The intertidal is wide, with a moderate slope, fine sand, and long, slow swashes. The beach is ungroomed and the wrack cover is very light (<1%). GPS coordinates are: Begin N34$^o$ 7.896, W119$^o$ 10.564; End 34$^o$ 7.544, W119$^o$ 10.068

**Ormond 1**
This high intermediate to dissipative beach is backed by low vegetated dunes and seasonal wetlands. The upper beach is wide. The intertidal is wide, with a moderate slope, fine sand, and long, slow swashes. The beach is ungroomed and the wrack cover is very light (<1%). GPS coordinates are: Begin N34$^{o}$ 7.544, W119$^{o}$ 10.068; End N34$^{o}$ 7.199, W119$^{o}$ 9.563

**Point Mugu**
The site is predominantly rocky with short stretches of very coarse sand. GPS coordinates are: Begin: N34$^{o}$ 5.160, W119$^{o}$ 3.568; End: N34$^{o}$ 5.116, W119$^{o}$ 2.953

**Deer Creek**
This low intermediate beach is backed by riprap and the Pacific Coast Highway 1. There is a narrow upper beach with limited vegetation. The intertidal is narrow and steep, with medium to coarse sand and moderate swashes. The beach is ungroomed and the wrack cover is very light (<1%). GPS coordinates are: Begin N34$^{o}$ 3.992, W119$^{o}$ 0.200; End N34$^{o}$ 3.905, W118$^{o}$ 59.567.

**Leo Carrillo**
This low intermediate beach is backed by a high vegetated bluff and the Pacific Coast Highway 1. There is a narrow upper beach with limited vegetation. The intertidal is moderate in width and steep, with coarse sand and long slow swashes. The beach is ungroomed and the wrack cover is moderate (2%). GPS coordinates are: Begin: N34$^{o}$ 2.983, W118$^{o}$ 57.414; End N34$^{o}$ 2.792, W118$^{o}$ 56.824.

# III. RESULTS

### A. Analysis of Shorebirds during the project period (2007-2010)

During the 3 years of the study from July 2007 to June 2010, we counted a total of 17,575 shorebirds on the 14 study beaches (Table 1). Shorebird abundance varied between the 3 years with year 1 (July 2007-June 2008) being 38% lower than year 2 (July 2008-June 2009), and 17% lower than year 3 (July 2009-June 2010). The variability in shorebird populations were evident in the previous study (McCrary and Pierson 2002), and another multi-year survey (Jurek 1974) of shorebirds at numerous sites throughout California. While many factors may be involved, lower abundance has been commonly reported in shorebird populations worldwide. Data from the Wader Study Group Bulletin (August/December 2003), reported declines in 31 out of 57 shorebird populations surveyed in North America. This finding is consistent with comparisons made with the original study (June 1994 - May 1997) which revealed significant declines in three species (Black-bellied Plovers, Willets, and Sanderlings).

Since most shorebird species recorded were migratory, shorebird abundance varied greatly on a temporal scale (month to month), a seasonal scale (season to season), and a spatial scale (beach to beach) for all species observed. For some species, the majority of migration may occur over a relatively short period of time (less than 3 weeks), which reflect the need to conduct counts more frequently than once per month to describe the seasonal pattern of beach use in greater detail. In addition, shorebirds may be avoiding these beaches during the day and foraging at night due to diurnal human disturbance. As in the original study (McCrary and Pierson, 2002), Figure 2 suggests that shorebird abundance along the Ventura County shoreline is bimodal, corresponding to fall and spring migration. Unlike the previous study which reflected increased numbers of birds after June, our surveys reflect a dip in numbers from June to July for 2 out of 3 years and shorebird numbers increasing rapidly from August through the fall season, a decline during the winter, and increase slightly in spring (with the exception of year 1 when one large flock resulted in a monthly mean of 118.1 birds in May). Although a great deal of variation occurred in other months the most consistent pattern in abundance between the 3 years was the relative absence of shorebirds in the study area during the month of June. The mean counts for June (n=14/yr) for the 3 years were 4.1, 4.0, and 2.6 birds/km respectively. Peak annual abundance occurred in the month of October during the last 2 study years (2008-09, and 2009-10), but due to a sighting of 1,201 Sanderlings on Hobson Beach in May 2008 (see Table 2), shorebird abundance peaked in May for 2007-2008.

Shorebird species abundance also varied significantly from beach to beach (Tables 5-9, and Figure 3. Spatial distribution among beaches was significant for a number of species in the study (Black-bellied Plovers, Snowy Plovers, Willets, and Sanderlings). While there was considerable variation among all the beaches in the study throughout the three year study period, there were two statistical anomalies recorded at Hobson in 2007-2008, and again at Marina Park in 2008-2009. La Conchita beach, Surfer's Knoll, and 5$^{th}$ Street beaches all showed measurable increases in 2008-2009 and again in 2009-2010 over year 1 of the study (2007-2008). All three Ormond Beach study sites remained fairly constant throughout the three year study period (see Figure 3). As in the original study Sanderlings were the most commonly observed shorebird during the 2007-2010 project period accounting for 7,353 birds or 41% of the 17,575 shorebirds counted. Willets were the second most abundant species accounting for 4,416 birds or 25% of the total shorebirds counted. Snowy Plovers were the third highest species recorded at 2,113 birds or 12% of the total shorebirds counted. The following species accounted for the remainder of the focal species counts: Marbled Godwits 1,954 birds (11%), Whimbrels 1,420 birds (8%), and Black-bellied Plovers 319 birds (2%). In comparing these numbers with the original study the total counts for Sanderlings (10,373 birds sighted in 1994-1997 which comprised 48% of the shorebirds counted), Willets (7,078 birds sighted which comprised 32% of the shorebirds counted), and Black-bellied Plovers (1,099 birds counted which comprised 5% of the total shorebird count), all show statistically significant declines in population numbers when compared to the previous study (Mann Whitney U = 107075, 104650, 107794, $p < 0.001$ for Sanderlings, Willets, and Black-bellied Plovers respectively).

Of the six focal species Snowy Plovers, Marbled Godwits, and Whimbrels all showed increased populations over the previous study. Snowy Plover numbers reflected a considerable increase from 963 birds (1994-1997) to 2,113 birds (2007-2010) an increase of 1,150 birds, a 54% increase over the previous study period (it should be noted however there is a likelihood that many resident birds were double counted over the length of the project and they may have significantly impacted these counts). The total number of Snowy Plovers compared to the total shorebird count increased from 5% of the total in 1994-1997 to 12% in 2007-2010. Marbled Godwits comprised 11% (1,954 birds) of the total in 2007-2010 up from 7% (1,447 birds) in 1994-1997; and Whimbrels comprised 8% (1,420 birds) of the total in 2007-2010 up from 3% (663 birds) in 1994-1997.

The one Rock Sandpiper at Deer Creek with the notation "X?" (Table 6) is likely an observer error. Rock Sandpipers are uncommon in California in the winter and rarely occur south of the Mendocino County coast. There are no known records of the species from Ventura County (although McCrary and Pierson had included one in their report, which was likely in error as well).

**Table 1.** Shorebird abundance for six focal species 2007-2010

| | **Year 1** | **Year 2** | **Year 3** | **Mean for project period** |
|---|---|---|---|---|
| Black-bellied Plovers | 103 | 137 | 79 | 106.33 |
| Snowy Plovers | 320 | 910 | 883 | 704.33 |
| Willets | 969 | 1,745 | 1,702 | 1,472 |
| Whimbrels | 268 | 649 | 503 | 1,420 |
| Marbled Godwits | 272 | 1,147 | 535 | 651.33 |
| Sanderlings | 2,662 | 2,833 | 1,858 | 2,451 |
| **Totals** | **4,594** | **7,421** | **5,560** | **5,858.33** |
| Mean | 765.67 | 1,236.83 | 926.67 | |
| St. Deviation | 976.38 | 946.16 | 710.19 | |
| n | 168 | 168 | 168 | 504 |

**Table 2.** Number of shorebirds counted at year 1 (July 2007-June 2008)

| | ***2007*** | | | | | | ***2008*** | | | | | | ***Site*** | ***Site*** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | July | Aug | Sept | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | June | **Total** | **Mean** | **SD** |
| LaConchita | 0 | 3 | 89 | 15 | 14 | 31 | 30 | 75 | 20 | 28 | 8 | 3 | 316 | 26.3 | 28.2 |
| Rincon | 0 | 8 | 20 | 19 | 10 | 2 | 12 | 7 | 17 | 3 | 0 | 0 | 98 | 8.2 | 7.5 |
| Hobson | 32 | 23 | 96 | 63 | 58 | 20 | 17 | 9 | 19 | 16 | 1201 | 0 | 1554 | 129.5 | 338.5 |
| Solimar | 25 | 6 | 17 | 22 | 34 | 16 | 14 | 10 | 164 | 5 | 0 | 0 | 313 | 26.1 | 44.6 |
| Marina Pk | 1 | 40 | 51 | 29 | 15 | 39 | 19 | 22 | 16 | 25 | 0 | 0 | 257 | 21.4 | 16.5 |
| Surfer's K | 86 | 19 | 77 | 28 | 67 | 8 | 16 | 15 | 11 | 9 | 97 | 16 | 449 | 37.4 | 33.8 |
| 5$^{th}$ Street | 11 | 51 | 97 | 88 | 4 | 22 | 8 | 22 | 49 | 34 | 8 | 0 | 394 | 32.8 | 32.5 |
| Silver Str | 0 | 0 | 16 | 21 | 4 | 10 | 5 | 2 | 5 | 0 | 0 | 0 | 63 | 5.3 | 7 |
| Ormond #3 | 90 | 23 | 5 | 99 | 59 | 106 | 21 | 17 | 15 | 26 | 26 | 10 | 497 | 41.4 | 36.9 |
| Ormond #2 | 35 | 42 | 32 | 3 | 10 | 19 | 29 | 13 | 4 | 16 | 305 | 2 | 510 | 42.5 | 83.7 |
| Ormond #1 | 39 | 31 | 79 | 21 | 19 | 8 | 28 | 0 | 32 | 127 | 9 | 6 | 399 | 33.3 | 36.2 |
| Pt. Mugu | 0 | 2 | 1 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0.6 | 0.8 |
| Deer Creek | 0 | 2 | 1 | 10 | 5 | 4 | 0 | 3 | 2 | 9 | 0 | 0 | 36 | 3 | 3.5 |
| L. Carrillo | 6 | 9 | 12 | 11 | 25 | 7 | 10 | 9 | 12 | 17 | 0 | 0 | 118 | 9.8 | 6.8 |
| **Monthly Total** | 325 | 259 | 593 | 430 | 326 | 293 | 209 | 204 | 366 | 315 | 1654 | 37 | | | |
| **Monthly Mean** | 23.2 | 18.5 | 42.4 | 30.7 | 23.3 | 20.9 | 14.9 | 14.6 | 26.1 | 22.5 | 118.1 | 2.6 | | | |
| **SD** | 31 | 17 | 37.6 | 30.5 | 22.5 | 26.9 | 9.9 | 18.9 | 41.7 | 32 | 322.3 | 4.9 | | | |

**Table 3.** Number of shorebirds counted year 2 (July 2008- June 2009)

| | *2008* | | | | | | *2009* | | | | | | *Site* | *Site* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | July | Aug | Sept | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | June | **Total** | **Mean** | **SD** |
| LaConchita | 5 | 53 | 101 | 342 | 20 | 165 | 55 | 71 | 37 | 128 | 11 | 0 | 988 | 82.3 | 96.4 |
| Rincon | 2 | 6 | 20 | 46 | 99 | 127 | 40 | 25 | 15 | 11 | 0 | 0 | 391 | 32.6 | 40.8 |
| Hobson Pk | 17 | 0 | 153 | 135 | 83 | 66 | 45 | 18 | 6 | 16 | 4 | 0 | 543 | 45.3 | 53.3 |
| Solimar | 8 | 1 | 239 | 186 | 124 | 41 | 11 | 17 | 4 | 12 | 0 | 0 | 643 | 53.6 | 82.5 |
| Marina Pk | 0 | 55 | 301 | 332 | 152 | 115 | 123 | 59 | 68 | 104 | 0 | 0 | 1,309 | 109.1 | 109.3 |
| Surfer's K | 63 | 30 | 223 | 188 | 124 | 125 | 62 | 133 | 60 | 40 | 4 | 14 | 1,6 | 88.8 | 69.5 |
| 5th Street | 163 | 45 | 197 | 141 | 96 | 66 | 35 | 47 | 15 | 42 | 0 | 0 | 847 | 70.6 | 65 |
| Silver Str | 26 | 0 | 17 | 31 | 28 | 22 | 16 | 13 | 6 | 6 | 0 | 0 | 165 | 13.8 | 11.4 |
| Ormond #3 | 71 | 18 | 35 | 144 | 56 | 29 | 24 | 18 | 15 | 0 | 57 | 23 | 490 | 40.8 | 38.4 |
| Ormond #2 | 50 | 19 | 71 | 59 | 84 | 72 | 79 | 53 | 6 | 24 | 0 | 11 | 528 | 44 | 30.4 |
| Ormond #1 | 101 | 160 | 108 | 22 | 64 | 33 | 9 | 24 | 20 | 95 | 78 | 8 | 722 | 60.2 | 48.5 |
| Pt. Mugu | 0 | 2 | 1 | 3 | 0 | 0 | 1 | 0 | 0 | 7 | 0 | 0 | 14 | 1.2 | 2.1 |
| Deer Creek | 1 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 0 | 18 | 1.5 | 0.9 |
| L. Carrillo | 2 | 10 | 32 | 19 | 13 | 13 | 27 | 70 | 22 | 6 | 0 | 0 | 214 | 17.8 | 19.4 |
| **Monthly Total** | 509 | 402 | 1,500 | 1,650 | 945 | 875 | 528 | 549 | 275 | 494 | 155 | 56 | | | |
| **Monthly Mean** | 36.4 | 28.7 | 107.1 | 117.9 | 67.5 | 62.5 | 37.7 | 39.2 | 19.6 | 35.3 | 11.1 | 4 | | | |
| **SD** | 48.7 | 42.7 | 99.5 | 114 | 49.3 | 52.4 | 33.9 | 36.1 | 21.3 | 42.4 | 24.4 | 7.3 | | | |

**Table 4.** Number of shorebirds counted year 3 (July 2009- June 2010)

| | *2009* | | | | | | *2010* | | | | | | ***Site*** | ***Site*** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | July | Aug | Sept | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | June | **Total** | **Mean** | **SD** |
| LaConchita | 12 | 128 | 70 | 313 | 85 | 102 | 22 | 15 | 12 | 2 | 8 | 0 | 769 | 64.1 | 89.8 |
| Rincon | 13 | 16 | 0 | 145 | 86 | 39 | 39 | 25 | 38 | 18 | 10 | 0 | 429 | 35.8 | 41.6 |
| Hobson Pk | 23 | 3 | 6 | 132 | 39 | 50 | 8 | 30 | 17 | 5 | 16 | 0 | 329 | 27.4 | 36.3 |
| Solimar | 1 | 14 | 1 | 119 | 21 | 15 | 4 | 8 | 9 | 14 | 180 | 0 | 386 | 32.2 | 56.7 |
| Marina Pk | 12 | 53 | 13 | 52 | 32 | 24 | 74 | 17 | 33 | 29 | 15 | 0 | 354 | 29.5 | 21.1 |
| Surfer's K | 32 | 197 | 567 | 235 | 50 | 38 | 6 | 12 | 34 | 14 | 4 | 9 | 1,198 | 99.8 | 165.8 |
| 5th Street | 2 | 19 | 35 | 260 | 109 | 0 | 65 | 95 | 0 | 39 | 18 | 0 | 642 | 53.5 | 75 |
| Silver Str | 0 | 0 | 0 | 1 | 73 | 6 | 6 | 5 | 10 | 10 | 11 | 4 | 126 | 10.5 | 20.1 |
| Ormond #3 | 82 | 89 | 2 | 27 | 20 | 41 | 38 | 35 | 32 | 28 | 11 | 39 | 444 | 37 | 25.5 |
| Ormond #2 | 108 | 64 | 74 | 21 | 15 | 26 | 42 | 5 | 40 | 61 | 82 | 1 | 539 | 44.9 | 33.3 |
| Ormond #1 | 3 | 22 | 117 | 70 | 52 | 36 | 46 | 45 | 67 | 26 | 17 | 1 | 502 | 41.8 | 32.6 |
| Pt. Mugu | 26 | 7 | 12 | 38 | 16 | 13 | 3 | 11 | 12 | 21 | 0 | 0 | 159 | 13.3 | 11.1 |
| Deer Creek | 0 | 0 | 4 | 0 | 4 | 9 | 3 | 0 | 1 | 3 | 0 | 0 | 24 | 2 | 2.8 |
| L. Carrillo | 0 | 9 | 2 | 14 | 10 | 13 | 7 | 7 | 11 | 28 | 0 | 3 | 104 | 8.7 | 7.7 |
| **Monthly Total** | 314 | 621 | 903 | 1,427 | 612 | 412 | 363 | 310 | 316 | 298 | 372 | 57 | | | |
| **Monthly Mean** | 22.4 | 44.4 | 64.5 | 101.9 | 43.7 | 29.4 | 25.9 | 22.1 | 22.6 | 21.3 | 26.6 | 4.1 | | | |
| **SD** | 32.9 | 58.1 | 149 | 103.2 | 33.1 | 25.8 | 24.6 | 24.6 | 18.7 | 15.9 | 48.6 | 10.4 | | | |

**Figure 2**. Mean shorebird counts at 14 Ventura County beaches 2007-2010

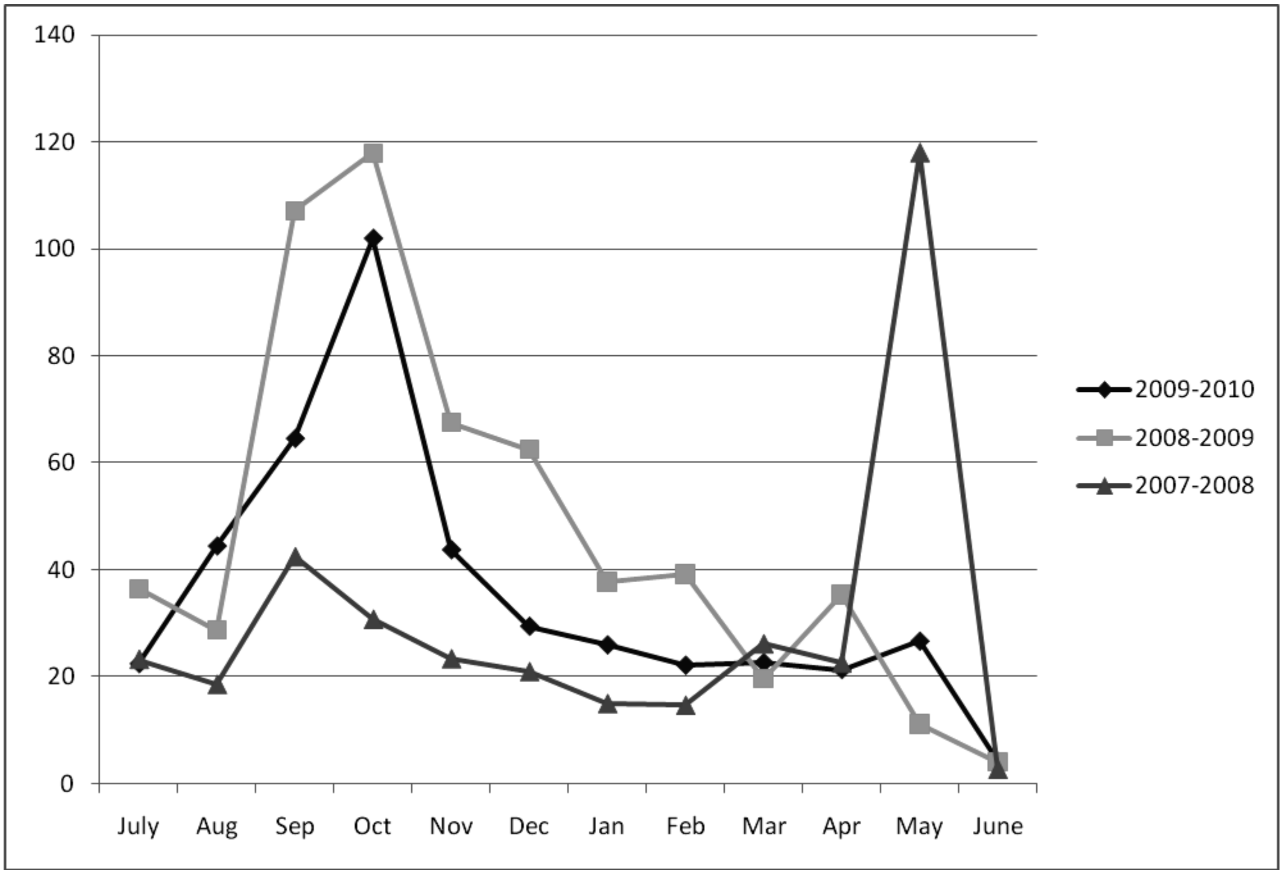


**Table 5.** Six focal species showing mean number of birds counted per kilometer during the 2007-2010 study.

The data in parentheses serve as a comparison with the 1994-1997 study.

| *Species* | ***Year 1*** Mean Birds/km | ***Year 2*** Mean Birds/km | ***Year 3*** Mean Birds/km |
|---|---|---|---|
| Black-bellied Plover (Pluvialis squatarola) | 0.6 (3.8) | 0.8 (1.8) | 0.5 (1.0) |
| Snowy Plover (Charadrius nivosus) | 1.9 (3.8) | 5.4 (1.8) | 5.3 (1.0) |
| Willet (Tringa semipalmata) | 5.8 (14.6) | 10.4 (10.1) | 10.1 (17.4) |
| Whimbrel (Numenius phaeopus) | 1.6 (1.5) | 3.9 (0.8) | 3.0 (1.6) |
| Marbled Godwit (Limosa fedoa) | 1.6 (2.2) | 6.8 (2.8) | 3.2 (3.6) |
| Sanderling (Calidris alba) | 15.5 (24.4) | 16.9 (15.3) | 11.1 (22.6) |

**Table 6.** Shorebird species sighted in 2007-2010 are indicated with an 'X'. An * indicates presence in the 1994-1997 study but absent in the present study. X* indicates presence in the 2007-2010 study but absent in the 1994-1997 study.

| | La Conchita | Rincon | Hobson | Solimar | Marina | Surfers | 5$^{th}$ St. | Silver strand | Ormond 3 | Ormond 2 | Ormond 1 | Pt Mugu | Deer Creek | Leo Carillo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Black-bellied Plover | x | x | x | x | x | x | x | * | x | x | x | | x | x |
| Snowy Plover | x | | x | x* | x | x | x* | * | x | x | x | | * | * |
| Willet | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Whimbrel | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Marbled Godwit | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Sanderling | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| | | | | | | | | | | | | | | |
| Semipalmated Plover | * | * | x | | x | * | | | | x | * | | | |
| Killdeer | x | x | * | | | x* | | | x | x* | x* | x* | | x |
| Black Oystercatcher | x* | | | | x* | x* | | | * | | | | | |
| Black-necked Stilt | | | | | | | | | x | | | | | |
| American Avocet | | | | | | x | x | | x | x | * | | | |
| Spotted Sandpiper | | * | * | | | x* | | | | | x | x | x | x |
| Wandering Tattler | x* | x | * | | x | x | | | x* | | | x | x | x |
| Long-billed Curlew | x | | x* | x | x* | x* | x* | | x | x | x | | x | x |
| Ruddy Turnstone | x | | | | x | * | | | * | | | | | |
| Black Turnstone | x* | | x | | x | x | | | | | | | | x* |
| Surfbird | x* | | | | x* | x | | | | | | | x* | x* |
| Western Sandpiper | x* | | | | x* | * | | | x | * | x | | | x* |
| Least Sandpiper | * | * | | | | * | | | x | * | * | | | |
| Rock Sandpiper | | | | | | | | | | | | | x ? | |
| Dowitcher sp. | x* | x* | | | | | | | * | * | * | | | |
| Red-necked Phalarope | | | | | * | | | | * | | | | | |
| Red Phalarope | | | | * | | * | | | | | | | | |

**Table 7.** Numbers of shorebird species recorded year 1 (July 2007 – June 2008). Numbers in brackets serve as a comparison with the 1994-1997 study.

| | ***2007*** | | | | | | ***2008*** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **July** | **Aug** | **Sept** | **Oct** | **Nov** | **Dec** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Total** |
| La Conchita | 0 | 2 | 8 | 5 | 5 | 4 | 5 | 5 | 3 | 3 | 1 | 1 | 12 (10) |
| Rincon | 0 | 4 | 3 | 6 | 4 | 2 | 4 | 3 | 4 | 1 | 0 | 0 | 8 (10) |
| Hobson | 1 | 3 | 4 | 5 | 5 | 4 | 4 | 2 | 3 | 4 | 2 | 0 | 7 (7) |
| Solimar | 1 | 1 | 3 | 3 | 4 | 3 | 4 | 2 | 5 | 1 | 0 | 0 | 5 (7) |
| Marina | 1 | 8 | 5 | 6 | 3 | 4 | 4 | 5 | 5 | 3 | 0 | 0 | 10 (9) |
| Surfer's | 3 | 4 | 6 | 4 | 4 | 4 | 3 | 1 | 4 | 2 | 2 | 3 | 9 (14) |
| 5th St | 2 | 4 | 3 | 3 | 1 | 3 | 2 | 1 | 2 | 2 | 3 | 0 | 7 (5) |
| Silver Strand | 0 | 0 | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 0 | 3 (6) |
| Ormond 3 | 5 | 4 | 3 | 5 | 3 | 7 | 4 | 2 | 1 | 7 | 2 | 4 | 11 (9) |
| Ormond 2 | 5 | 4 | 4 | 2 | 2 | 1 | 3 | 1 | 2 | 2 | 3 | 1 | 7 (9) |
| Ormond 1 | 6 | 4 | 4 | 5 | 4 | 1 | 3 | 0 | 2 | 4 | 1 | 1 | 7 (8) |
| Pt. Mugu | 0 | 2 | 1 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 (4) |
| Deer Creek | 0 | 2 | 1 | 4 | 2 | 2 | 0 | 2 | 1 | 3 | 0 | 0 | 6 (9) |
| Leo Carrillo | 2 | 5 | 5 | 5 | 7 | 4 | 5 | 4 | 5 | 3 | 0 | 0 | 9 (7) |
| **All Sites** | 7 (14) | 14 (15) | 13 (10) | 10 (11) | 9 (10) | 13 (7) | 8 (7) | 7 (9) | 8 (8) | 11 (9) | 8 (8) | 7 (10) | 19 (21) |

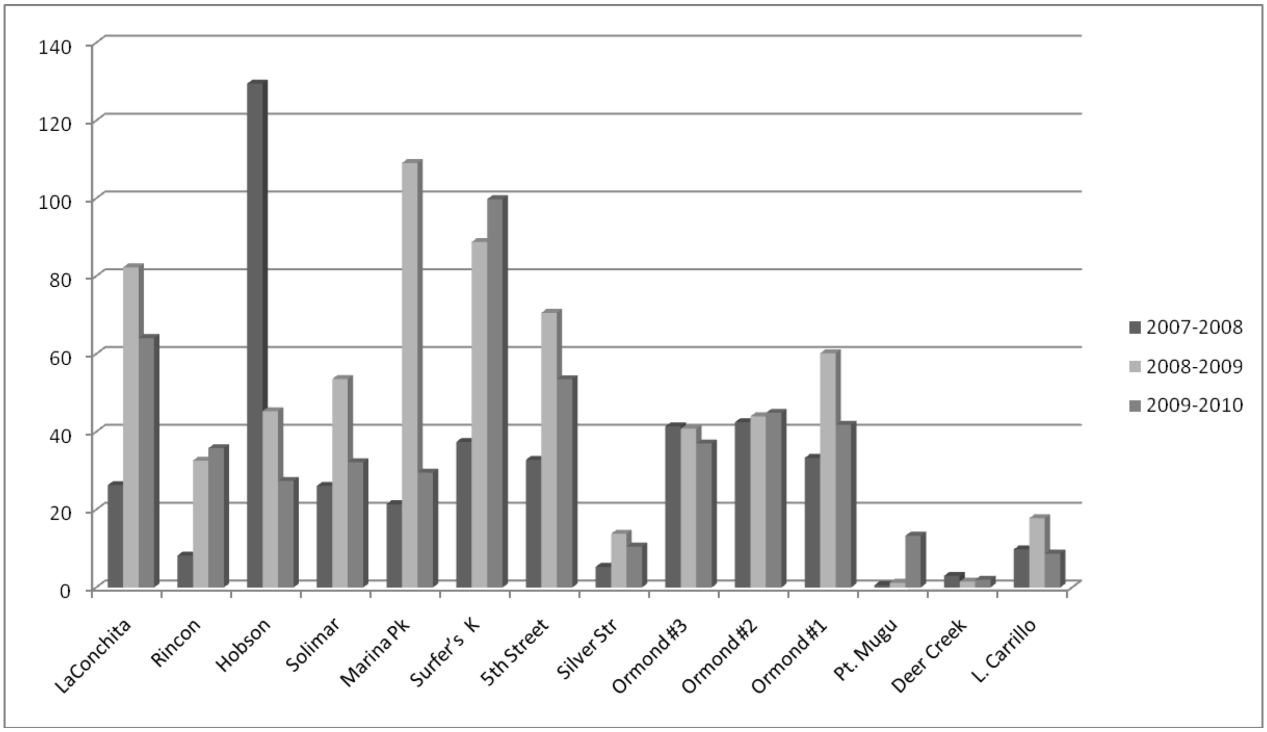
**Table 8.** Numbers of shorebird species recorded year 2 (July 2008 - June 2009). Numbers in brackets serve as a comparison with the 1994-1997 study.

| | *2008* | | | | | | *2009* | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **July** | **Aug** | **Sept** | **Oct** | **Nov** | **Dec** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Total** |
| La Conchita | 1 | 3 | 6 | 5 | 6 | 6 | 5 | 4 | 5 | 3 | 2 | 0 | 8 (7) |
| Rincon | 1 | 3 | 3 | 4 | 5 | 3 | 3 | 2 | 2 | 3 | 0 | 0 | 5 (5) |
| Hobson | 1 | 0 | 6 | 5 | 5 | 3 | 4 | 2 | 1 | 2 | 2 | 0 | 5 (6) |
| Solimar | 1 | 1 | 6 | 6 | 5 | 2 | 4 | 2 | 2 | 1 | 0 | 0 | 6 (5) |
| Marina | 0 | 9 | 9 | 8 | 7 | 7 | 6 | 5 | 4 | 4 | 0 | 0 | 10 (9) |
| Surfer's | 4 | 5 | 9 | 5 | 5 | 6 | 4 | 3 | 4 | 5 | 2 | 1 | 14 (8) |
| 5th St | 1 | 3 | 3 | 4 | 3 | 3 | 3 | 4 | 2 | 3 | 0 | 0 | 6 (6) |
| Silver Strand | 0 | 0 | 2 | 1 | 2 | 3 | 3 | 2 | 2 | 2 | 0 | 0 | 4 (5) |
| Ormond 3 | 6 | 4 | 5 | 10 | 4 | 4 | 3 | 2 | 1 | 0 | 3 | 5 | 11 (12) |
| Ormond 2 | 5 | 2 | 4 | 6 | 2 | 5 | 3 | 3 | 2 | 1 | 0 | 4 | 7 (10) |
| Ormond 1 | 5 | 5 | 4 | 6 | 4 | 2 | 1 | 4 | 3 | 4 | 3 | 1 | 8 (10) |
| Pt. Mugu | 0 | 2 | 1 | 2 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 6 (5) |
| Deer Creek | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 0 | 4 (9) |
| Leo Carrillo | 1 | 3 | 5 | 5 | 5 | 4 | 4 | 6 | 3 | 4 | 0 | 0 | 9 (8) |
| **All Sites** | 9 (6) | 14 (10) | 14 (11) | 13 (10) | 11 (8) | 11 (12) | 8 (6) | 10 (7) | 7 (7) | 10 (13) | 5 (5) | 7 (6) | 18 (18) |

**Table 9.** Numbers of shorebird species recorded at 14 Ventura County beaches in year 3 (July 2009 through June 2010). Numbers in brackets serve as a comparison with the 1994-1997 study.

| | ***2008*** | | | | | | ***2009*** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **July** | **Aug** | **Sept** | **Oct** | **Nov** | **Dec** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Total** |
| La Conchita | 5 | 6 | 5 | 7 | 5 | 7 | 5 | 2 | 2 | 1 | 2 | 0 | 9 (9) |
| Rincon | 2 | 2 | 0 | 4 | 2 | 3 | 2 | 2 | 3 | 1 | 3 | 0 | 5 (5) |
| Hobson | 2 | 1 | 2 | 5 | 4 | 6 | 3 | 3 | 1 | 1 | 3 | 0 | 7 (9) |
| Solimar | 1 | 1 | 1 | 5 | 5 | 7 | 2 | 2 | 2 | 2 | 3 | 0 | 7 (5) |
| Marina | 3 | 6 | 5 | 7 | 8 | 4 | 7 | 3 | 5 | 4 | 3 | 0 | 11 (9) |
| Surfer's | 3 | 5 | 3 | 5 | 5 | 3 | 1 | 1 | 3 | 2 | 1 | 3 | 11 (9) |
| $5^{th}$ St | 1 | 3 | 4 | 4 | 3 | 0 | 4 | 2 | 0 | 3 | 3 | 0 | 7 (5) |
| Silver Strand | 0 | 0 | 0 | 1 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | 1 | 5 (5) |
| Ormond 3 | 5 | 6 | 1 | 1 | 3 | 4 | 3 | 3 | 1 | 2 | 3 | 6 | 8 (9) |
| Ormond 2 | 4 | 6 | 5 | 2 | 2 | 3 | 5 | 2 | 4 | 4 | 7 | 1 | 7 (8) |
| Ormond 1 | 2 | 4 | 5 | 5 | 4 | 4 | 4 | 2 | 6 | 2 | 2 | 1 | 6 (9) |
| Pt. Mugu | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 3 (4) |
| Deer Creek | 0 | 0 | 2 | 0 | 2 | 3 | 2 | 0 | 1 | 1 | 0 | 0 | 6 (8) |
| Leo Carrillo | 0 | 3 | 1 | 5 | 4 | 6 | 4 | 3 | 2 | 4 | 0 | 0 | 8 (9) |
| **All Sites** | 9 (9) | 11 (9) | 10 (11) | 11 (11) | 11 (9) | 10 (10) | 10 (7) | 7 (9) | 7 (8) | 8 (8) | 8 (7) | 7 (5) | 13 (16) |

**Figure 3**. Mean shorebird count by beach 2007-2010.



## B. Comparing Current and Historical Studies

Counts from the historical data (1994-1997) were typically much higher than counts in the recent survey. The total number of birds counted in the 1994-1997 surveys was 21,623; however, this included only the 6 focal species; non focal species bird counts were not reported. Mean number of focal birds sighted per transect (1 km) was 42 (s.d. 72.8) birds per transect in the 1994-1997 surveys.

Sanderlings were the most commonly sighted of the focal species, accounting for 10,373 of these sightings, including a number of large flocks. A broad based analysis of sighting rates including all beaches indicates significant differences in the numbers of Black-bellied Plovers, Willets, and Sanderlings.

Additionally, Marbled Godwit numbers reflected both significant seasonal and spatial differences, Snowy Plover numbers varied significantly between beaches (spatially), while temporal differences were not significant and Whimbrel numbers varied significantly between beaches within both data sets, while temporal differences in Whimbrel numbers showed no significant changes (see Table 10).

**Table 10.** Comparing mean sighting rates for the six focal species (current study vs. historical study)

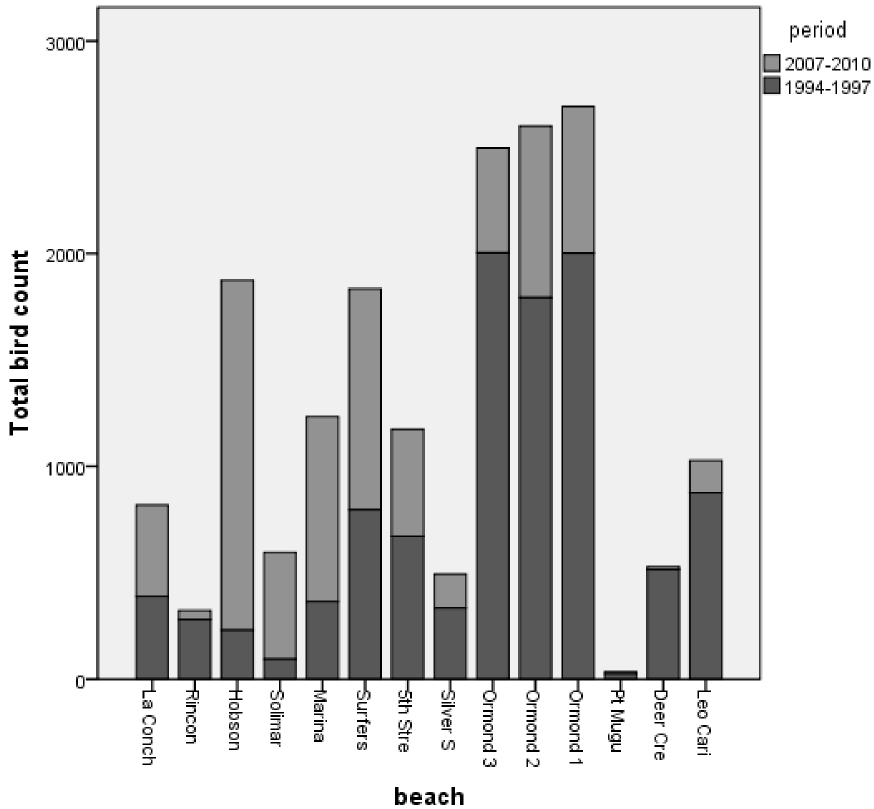
| *Species* | ***2007-2010*** | | ***1994-1997*** | |
|---|---|---|---|---|
| | **Total** | **Mean sighting rates (s.d.)** | **Total** | **Mean sighting rate (s.d.)** |
| Black-bellied Plovers | 319 | 0.6[2] (1.7) | 1,099 | 2.2 (8.7) |
| Snowy Plovers | 2,113 | 4.2 (16.2) | 963 | 1.9 (7.2) |
| Willets | 4,416 | 8.8[2] (19.2) | 7,078 | 14.0 (31.5) |
| Whimbrels | 1,420 | 2.8 (10.5) | 663 | 1.3 (3.8) |
| Marbled Godwits | 1,954 | 3.9 (10.5) | 1,447 | 2.8 (8.6) |
| Sanderlings | 7,353 | 14.6[2] (63.3) | 10,373 | 20.6 (49.4) |
| Total of focal species | 17,575 | 34.8 (75.4) | 21,623 | 42.4 (72.9) |

[1]Significantly high mean counts over 1994-1997 study
[2]Significantly low mean counts over 1994-1997 study

Declines in mean sighting rates were (*) significant at 5% level; Mann Whitney U = 107075, 104650, 107794, $p < 0.001$, for Sanderlings, Willets and Black-bellied Plovers respectively.

**Individual Analysis for 6 Focal Species:**

**Figure 4**. Comparison of total birds by beach for 1994-1997 and 2007-2010




1. BLACK-BELLIED PLOVERS

In the Western Hemisphere Black-bellied Plovers nest on the Canadian and Alaskan coastal tundra beginning in late May or early June (Hayman et al. 1986; Paulson 1993). Considered common and widespread the Black-bellied Plover occurs nearly around the globe wintering in coastal areas from southern Canada and the U.S. to southern South America, western Europe, Africa, southeast Asia, and Australia. In late July following the breeding season, they migrate southward along both U.S. coasts overwintering from British Columbia to Peru on the Pacific shore. Young birds (especially first-year) may remain on overwintering areas year round. The world population is estimated at 498,000 with 200,000 in North America (O'Brien et al. 2006).

For the project period 2007-2010:

The total number of Black-bellied Plovers sighted was 319 with a mean sighting rate of 0.6 (s.d. 1.8) birds per survey. The maximum flock size for a single flock was 14 birds. Using a flock definition of 10% of total sightings, there were no large flocks sighted.

Other highest values were 12, 11. On 403 of the 504 surveys, no Black-bellied Plovers were encountered.

**Table 11.** Summary data for Black-bellied Plovers 2007-2010

| | | Statistic | Std. Error |
|---|---|---|---|
| Mean | | 0.6 | 0.1 |
| 95% Confidence Interval for Mean | Lower Bound | 0.5 | |
| | Upper Bound | 0.8 | |
| Median | | 0 | |
| Std. Deviation | | 1.8 | |
| Minimum | | 0 | |
| Maximum | | 14 | |
| Range | | 14 | |
| Interquartile Range | | 0 | |

For the project period 1994-1997:

The total number of birds sighted was 1,099 with a mean sighting rate of 2.2 (s.d. 8.7) birds per survey. Maximum flock size was 128 birds. Using a flock definition of 10% of total sightings, there was 1 large flock sighted, and it is an outlier (other highest values were 70, 51). When the 1 clear outlier (128) was removed, mean sighting rates fell to 1.9 (6.6) birds per survey. On 327 of 504 surveys no Black-bellied Plovers were encountered.

**Table 12.** Summary data for Black-bellied Plovers 1994-1997

| | | Statistic | Std. Error |
|---|---|---|---|
| Mean | | 2.2 | 0.4 |
| 95% Confidence Interval for Mean | Lower Bound | 1.4 | |
| | Upper Bound | 2.9 | |
| Median | | 0 | |
| Std. Deviation | | 8.7 | |
| Minimum | | 0 | |
| Maximum | | 128 | |
| Range | | 128 | |
| Interquartile Range | | 1 | |

Temporal Trends

Comparing overall sighting rates for all surveys classified by time period, sighting rates fell significantly, between the recent and the historical study (Mann Whitney U = 107957, $p < 0.001$).

Seasonal Trends

Comparing overall sighting rates for all surveys classified by season, seasonal trends were also significant (Kruskal Wallis; $X^2_{3,1005} = 141.54$, $p < 0.001$). Clear seasonal trends emerge here, with low numbers in the summer months in both data sets.

The GLMM also indicates that season and period were independently significant, as was the interaction between these factors (Wald's chi square = 91.874 df = 3, p = <0.001, for season, Wald's chi square = 8.795, df = 1, p = 0.003 for period and Wald's chi square = 12.048, df = 3, p = 0.007 for the interaction).

The inference here is that numbers varied seasonally and between the two time periods, and additionally, seasonal trends changed between the two time periods.

**Figure 5**. Temporal trends comparison between studies for Black-bellied Plovers.

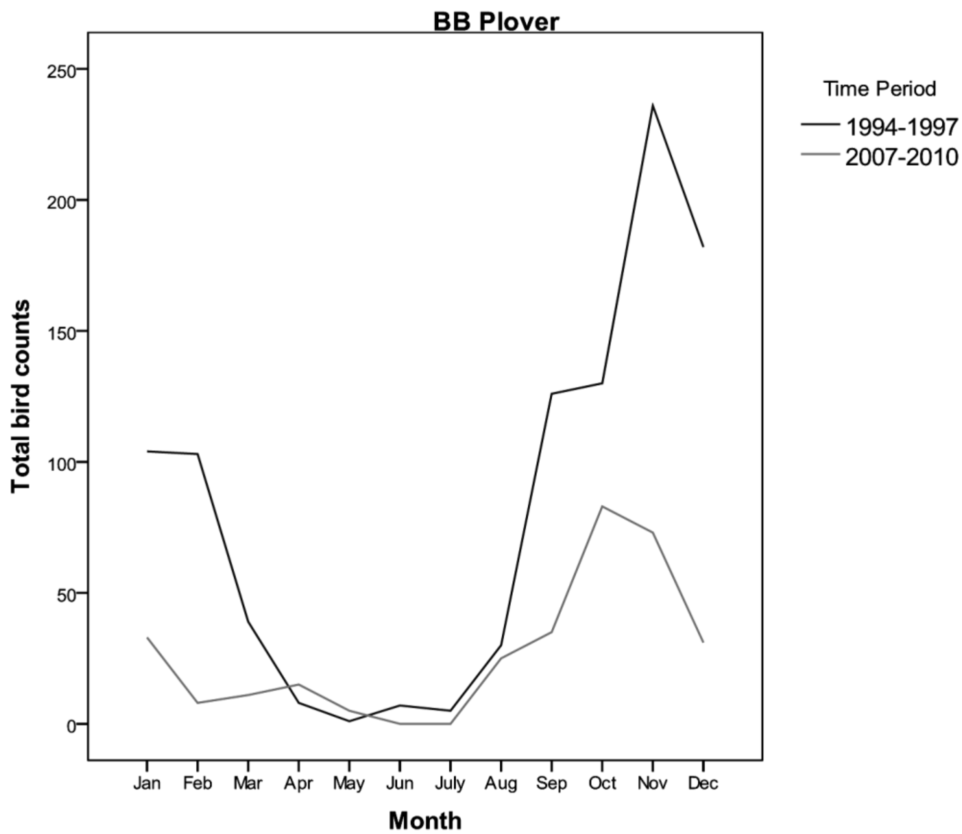


**Table 13.** Black-bellied Plover seasonal counts 2007-2010

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Min | Max |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | |
| Winter | 127 | 0.6 | 1.7 | 0.2 | 0.3 | 0.9 | 0 | 14 |
| Spring | 125 | 0.2 | 1.2 | 0.1 | 0 | 0.5 | 0 | 11 |
| Summer | 126 | 0.2 | 0.7 | 0.1 | 0.1 | 0.3 | 0 | 5 |
| Fall[1] | 126 | 1.5 | 2.5 | 0.2 | 1.1 | 2 | 0 | 12 |
| Total | 504 | 0.6 | 1.8 | 0.1 | 0.5 | 0.8 | 0 | 14 |

[1]Significantly higher than 1994-1997 seasonal count

**Table 14.** Black-bellied Plover seasonal counts 1994-1997

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Min | Max |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | |
| Winter[1] | 125 | 3.1 | 8.5 | 0.8 | 1.6 | 4.6 | 0 | 51 |
| Spring[2] | 126 | 0.4 | 1.7 | 0.2 | 0.1 | 0.7 | 0 | 18 |
| Summer[2] | 126 | 0.3 | 1.1 | 0.1 | 0.1 | 0.5 | 0 | 7 |
| Fall[1] | 126 | 3.9 | 9.5 | 0.8 | 2.2 | 5.6 | 0 | 70 |
| Total | 503 | 1.9 | 6.6 | 0.3 | 1.4 | 2.5 | 0 | 70 |

[1]Significantly higher than 2004-2007 seasonal count
[2]Significantly lower than 2004-2007 seasonal count

Spatial trends

Comparing overall sighting rates for all surveys classified by beach, distribution between beaches also varied significantly within both data sets, (Kruskal Wallis $X^2_{3,499} = 77.894$, $p < 0.001$ for the 2000 data and Kruskal Wallis $X^2_{3,499} = 62.625$, $p < 0.001$ for the 1994-1997 data).

The GLMM also indicates that beach location was independently significant, as was the interaction between these factors (Wald's chi square = 43.130, df = 13, p = <0.001, for season, and Wald's chi square = 42.068, df = 3, p = <0.001 for the interaction).

Evidently, sighting rates varied between beaches and distribution varied between surveys.

**Figure 6**. Spatial trends comparison between studies for Black-bellied Plovers

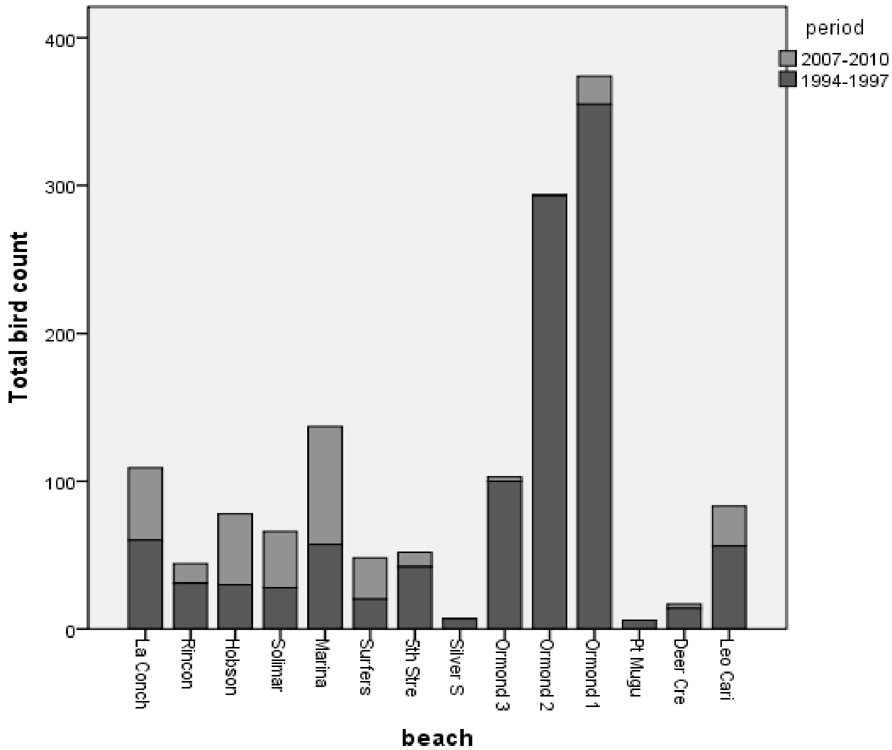


**Table 15.** Black-bellied Plovers 2007-2010 by beach

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean: Lower Bound | 95% Confidence Interval for Mean: Upper Bound | Min | Max |
|---|---|---|---|---|---|---|---|---|
| La Conchita | 36 | 1.4 | 2.2 | 0.4 | 0.6 | 2.1 | 0 | 9 |
| Rincon | 36 | 0.4 | 0.8 | 0.1 | 0.1 | 0.6 | 0 | 3 |
| Hobson | 36 | 1.3 | 2.4 | 0.4 | 0.5 | 2.1 | 0 | 9 |
| Solimar[1] | 36 | 1.1 | 1.7 | 0.3 | 0.5 | 1.6 | 0 | 6 |
| Marina | 36 | 2.2 | 4 | 0.7 | 0.9 | 3.6 | 0 | 14 |
| Surfers | 36 | 0.8 | 1.5 | 0.3 | 0.3 | 1.3 | 0 | 6 |
| 5th Street | 36 | 0.3 | 1 | 0.2 | -0.1 | 0.6 | 0 | 5 |
| Silver Strand[2] | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ormond 3 | 36 | 0.1 | 0.4 | 0.1 | 0 | 0.2 | 0 | 2 |
| Ormond 2 | 36 | 0 | 0.2 | 0 | 0 | 0.1 | 0 | 1 |
| Ormond 1 | 36 | 0.5 | 2 | 0.3 | -0.1 | 1.2 | 0 | 11 |
| Pt Mugu[2] | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deer Creek | 36 | 0.1 | 0.3 | 0 | 0 | 0.2 | 0 | 1 |
| Leo Carrillo[1] | 36 | 0.8 | 1.2 | 0.2 | 0.4 | 1.1 | 0 | 5 |
| **Total** | **504** | **0.6** | **1.8** | **0.1** | **0.5** | **0.8** | **0** | **14** |

[1]Significantly higher than 1994-1997 count
[2] Significantly lower than 1994-1997 count

**Table 16.** Black-bellied Plovers 1994-1997 by beach

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Min | Max |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | |
| La Conchita[1] | 36 | 1.7 | 1.8 | 0.3 | 1.1 | 2.3 | 0 | 7 |
| Rincon | 36 | 0.9 | 1.3 | 0.2 | 0.4 | 1.3 | 0 | 5 |
| Hobson | 36 | 0.8 | 1.3 | 0.2 | 0.4 | 1.3 | 0 | 4 |
| Solimar | 36 | 0.8 | 1.5 | 0.2 | 0.3 | 1.3 | 0 | 7 |
| Marina | 36 | 1.6 | 2.2 | 0.4 | 0.8 | 2.3 | 0 | 9 |
| Surfers | 36 | 0.6 | 1 | 0.2 | 0.2 | 0.9 | 0 | 4 |
| 5th Street | 36 | 1.2 | 5.2 | 0.9 | -0.6 | 2.9 | 0 | 30 |
| Silver Strand[2] | 36 | 0.2 | 0.5 | 0.1 | 0 | 0.4 | 0 | 2 |
| Ormond 3 | 36 | 2.8 | 7.2 | 1.2 | 0.4 | 5.2 | 0 | 31 |
| Ormond 2 | 36 | 8.1 | 16.9 | 2.8 | 2.4 | 13.9 | 0 | 70 |
| Ormond 1 | 36 | 6.5 | 13.1 | 2.2 | 2 | 11 | 0 | 51 |
| Pt Mugu[2] | 36 | 0.2 | 0.6 | 0.1 | 0 | 0.4 | 0 | 3 |
| Deer Creek[2] | 36 | 0.4 | 0.8 | 0.1 | 0.1 | 0.6 | 0 | 3 |
| Leo Carrillo[1] | 36 | 1.6 | 1.6 | 0.3 | 1 | 2.1 | 0 | 6 |
| **Total** | **504** | **1.9** | **6.6** | **0.3** | **1.4** | **2.5** | **0** | **70** |

[1]Significantly higher than 2004-2007 count
[2] Significantly lower than 2004-2007 count

## 2. SNOWY PLOVERS

The Pacific coast population of the Western Snowy Plover was listed as threatened in 1993. Human disturbance, predation, inclement weather, and loss of nesting habitat to urban development and introduced plant species led to poor reproductive success, a decline in active breeding colonies, and an overall decline in the plover population along the U.S. Pacific coast (Page and Stenzel 1981; Page et al. 1986, 1991). Recent efforts to protect critical nesting habitat have accelerated in Ventura County through the efforts of the USFWS Recovery Plan For the Western Snowy Plover (USFWS 2007).

Western Snowy Plovers breed primarily on coastal beaches from southern Washington to southern Baja California (Page and Stenzel 1981). Larger concentrations of breeding birds occur in the south along the Pacific coast, indicating that the center of the plover's coastal distribution lies in southern California (Page and Stenzel 1981). Breeding is known to occur in the Ormond Beach and Surfer's Knoll areas among the sites surveyed in this study. The breeding season lasts from mid-March through mid-September. World population is estimated at 16,000-21,000 (O'Brien et al. 2006).

For the project period 2007-2010:

The total number of Snowy Plovers sighted was 2,113 with a mean sighting rate of 4.2 (s.d. 16.3) birds per survey. The maximum flock size for a single flock was 186 birds. Using a flock definition of 10% of total sightings, there were no large flock sighted (other highest values were 157, 123). On 401 of the 504 surveys, no Snowy Plovers were encountered.

**Table 17.** Summary data for Snowy Plovers 2007-2010

| | | Statistic | Std. Error |
|---|---|---|---|
| Mean | | 4.2 | 0.7 |
| 95% Confidence Interval for Mean | Lower Bound | 2.8 | |
| | Upper Bound | 5.6 | |
| Median | | 0 | |
| Std. Deviation | | 16.3 | |
| Minimum | | 0 | |
| Maximum | | 186 | |
| Range | | 186 | |
| Interquartile Range | | 0 | |

For the project period 1994-1997:

The total number of birds sighted was 963 with a mean sighting rate of 1.9 (s.d. 7.2) birds per survey. Maximum flock size was 89 birds; Using a flock definition of 10% of total sightings, there were no large flocks sighted (other highest values were 72, 52). On 394 of 504 surveys no Snowy Plovers were encountered.

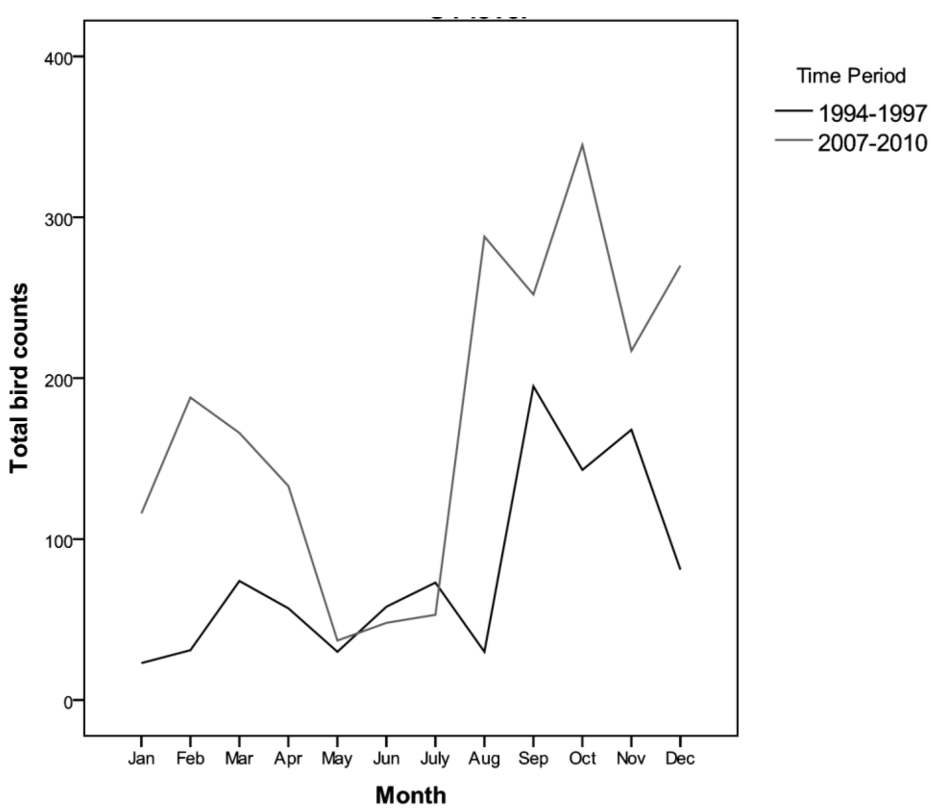
**Table 18.** Summary data for Snowy Plovers 1994-1997

| | | Statistic | Std. Error |
|---|---|---|---|
| Mean | | 1.9 | 0.3 |
| 95% Confidence Interval for Mean | Lower Bound | 1.3 | |
| | Upper Bound | 2.5 | |
| Median | | 0 | |
| Std. Deviation | | 7.2 | |
| Minimum | | 0 | |
| Maximum | | 89 | |
| Range | | 89 | |
| Interquartile Range | | 0 | |

Temporal Trends

Comparing overall sighting rates for all surveys classified by time period, sighting rates did not vary significantly, between the recent and the historical study (Mann Whitney U = 126885, p = 0.970).

**Figure 7**. Temporal trends comparison between studies for Snowy Plovers




Seasonal Trends

Comparing overall sighting rates for all surveys classified by season, seasonal trends also were not significant (Kruskal Wallis; $X^2_{3,1005} = 0.397$, p =0.941). This could be attributed to the high variability (see standard deviations).

The GLMM indicates that season was significant, while period was not, and the interaction was not significant, once multiple testing is taken into account (Wald's chi square = 64.055, df = 3, p = <0.001, for season, Wald's chi square = 0.011, df = 1, p = 0.918 for period and Wald's chi square = 8.932, df = 3, p = 0.030 for the interaction). This would infer that overall bird numbers did vary between seasons, but seasonal trends did not vary between the two surveys.

**Table 19.** Snowy Plovers seasonal counts 2007-2010

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Min. | Max. |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | |
| Winter | 127 | 4.5 | 15.2 | 1.4 | 1.8 | 7.2 | 0 | 123 |
| Spring[2] | 125 | 2.7 | 7.1 | 0.6 | 1.4 | 4 | 0 | 49 |
| Summer[2] | 126 | 3.1 | 15.6 | 1.4 | 0.3 | 5.8 | 0 | 157 |
| Fall | 126 | 6.5 | 22.9 | 2 | 2.4 | 10.5 | 0 | 186 |
| Total | 504 | 4.2 | 16.3 | 0.7 | 2.8 | 5.6 | 0 | 186 |

[1]Significantly higher than 1994-1997 seasonal count
[2]Significantly lower than 1994-1997 seasonal count

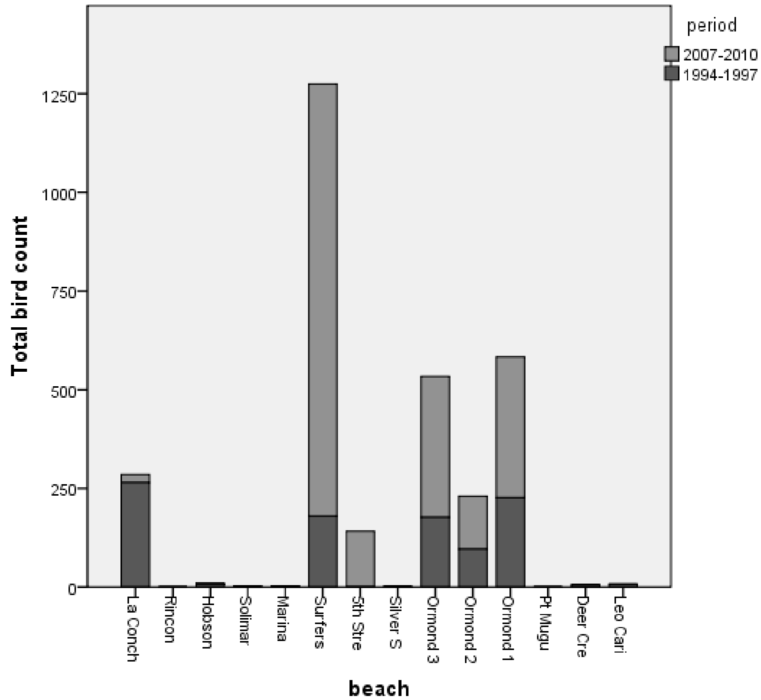
**Table 20.** Snowy Plovers seasonal counts 1994-1997

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Min. | Max. |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | |
| Winter[2] | 126 | 1.1 | 2.9 | 0.3 | 0.6 | 1.6 | 0 | 17 |
| Spring[2] | 126 | 1.3 | 3.6 | 0.3 | 0.6 | 1.9 | 0 | 24 |
| Summer[2] | 126 | 1.3 | 3 | 0.3 | 0.7 | 1.8 | 0 | 16 |
| Fall | 126 | 4 | 13.1 | 1.2 | 1.7 | 6.3 | 0 | 89 |
| Total | 504 | 1.9 | 7.2 | 0.3 | 1.3 | 2.5 | 0 | 89 |

[1]Significantly higher than 2004-2007 seasonal count
[2]Significantly lower than 2004-2007 seasonal count

Spatial Trends

**Figure 8**. Spatial trends comparison between studies for Snowy Plovers.




Comparing overall sighting rates for all surveys classified by beach, distribution between beaches varied significantly within both data sets (Kruskal Wallis $X^2 = 241.920$, df = 3, p < 0.001 for the 2007-2010 period and Kruskal Wallis $X^2 = 215.638$, df = 3, p < 0.001 for the 1994-1997 period).

The GLMM also indicates that beach location was independently significant, as was the interaction between these factors (Wald's chi square = 112.586, df = 13, p = <0.001, for season, and Wald's chi square = 46.352, df = 6, p = <0.001 for the interaction).

This infers that distribution varied between beaches and these spatial characteristics varied between the two time periods.

**Table 21.** Snowy Plover 2007-2010 by beach

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean Lower Bound | 95% Confidence Interval for Mean Upper Bound | Min. | Max. |
|---|---|---|---|---|---|---|---|---|
| La Conchita[2] | 36 | 0.6 | 3 | 0.5 | -0.4 | 1.6 | 0 | 18 |
| Rincon[2] | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hobson[2] | 36 | 0.1 | 0.3 | 0.1 | -0.1 | 0.2 | 0 | 2 |
| Solimar[2] | 36 | 0.1 | 0.5 | 0.1 | -0.1 | 0.3 | 0 | 3 |
| Marina[2] | 36 | 0 | 0.2 | 0 | 0 | 0.1 | 0 | 1 |
| Surfers[1] | 36 | 30.4 | 49 | 8.2 | 13.9 | 47 | 0 | 186 |
| 5th Street | 36 | 3.9 | 10.7 | 1.8 | 0.3 | 7.5 | 0 | 43 |
| Silver Strand[2] | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ormond 3[1] | 36 | 9.9 | 13.7 | 2.3 | 5.3 | 14.6 | 0 | 72 |
| Ormond 2[1] | 36 | 3.7 | 5.8 | 1 | 1.8 | 5.7 | 0 | 24 |
| Ormond 1[1] | 36 | 9.9 | 10.6 | 1.8 | 6.3 | 13.5 | 0 | 42 |
| Pt Mugu[2] | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deer Creek[2] | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Leo Carrillo[2] | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **504** | **4.2** | **16.3** | **0.7** | **2.8** | **5.6** | **0** | **186** |

[1]Significantly higher than 1994-1997 count
[2] Significantly lower than 1994-1997 count

**Table 22.** Snowy Plover 1994-1997 by beach

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Min. | Max. |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | |
| La Conchita | 36 | 7.3 | 16.7 | 2.8 | 1.7 | 13 | 0 | 72 |
| Rincon[2] | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hobson[2] | 36 | 0.2 | 1 | 0.2 | -0.1 | 0.5 | 0 | 6 |
| Solimar[2] | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Marina[2] | 36 | 0.1 | 0.2 | 0 | 0 | 0.1 | 0 | 1 |
| Surfers | 36 | 5 | 15.4 | 2.6 | -0.2 | 10.2 | 0 | 89 |
| 5th Street[2] | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Silver Strand | 36 | 0 | 0.2 | 0 | 0 | 0.1 | 0 | 1 |
| Ormond 3[1] | 36 | 4.9 | 4.5 | 0.8 | 3.4 | 6.4 | 0 | 16 |
| Ormond 2[1] | 36 | 2.7 | 3.7 | 0.6 | 1.4 | 3.9 | 0 | 15 |
| Ormond 1[1] | 36 | 6.3 | 9.6 | 1.6 | 3 | 9.5 | 0 | 52 |
| Pt. Mugu[2] | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deer Creek[2] | 36 | 0.1 | 0.5 | 0.1 | 0 | 0.3 | 0 | 3 |
| Leo Carrillo[2] | 36 | 0.2 | 1.2 | 0.2 | -0.2 | 0.6 | 0 | 7 |
| **Total** | **504** | **1.9** | **7.2** | **0.3** | **1.3** | **2.5** | **0** | **89** |

[1]Significantly higher than 2007-2010 count
[2] Significantly lower than 2007-2010 count

## 3. WILLETS

In Western North America, Willets nest near lakes and ponds in the U.S. and Canadian Great Basin and Plains (Haymen et al., 1986; Paulson, 1993). Willets winter in coastal areas from Washington south to Peru and Argentina. The world population is estimated at 250,000 (O'Brien et al, 2006). The Willet was the second most abundant species observed during the project period in Ventura County.

For the project period 2007-2010:

The total number of Willets sighted was 4,416, with a mean sighting rate of 8.8 (s.d. 19.2) birds per survey. The maximum flock size for a single flock was 179 birds. Using a flock definition of 10% of total sightings, there were no large flock sightings. Other notable flocks sighted numbered 118 and 111. On 188 of the 504 surveys, no Willets were encountered.

**Table 23.** Summary data for Willets 2007-2010

| | | Statistic | Std. Error |
|---|---|---|---|
| Mean | | 8.8 | 0.9 |
| 95% Confidence Interval for Mean | Lower Bound | 7.1 | |
| | Upper Bound | 10.4 | |
| Median | | 2 | |
| Std. Deviation | | 19.2 | |
| Minimum | | 0 | |
| Maximum | | 179 | |
| Range | | 179 | |
| Interquartile Range | | 8 | |

For the period 1994-1997

The total number of birds sighted was 7,078 with a mean sighting rate of 14.0 (s.d. 31.5) birds per survey. Maximum flock size was 312 birds; using a flock definition of 10% of total sightings, this would not constitute a large flock; other highest flock numbers include 260 and 217. On 113 of 504 surveys no Willets were encountered.

**Table 24.** Summary data for Willets 1994-1997

| | | Statistic | Std. Error |
|---|---|---|---|
| Mean | | 14 | 1.4 |
| 95% Confidence Interval for Mean | Lower Bound | 11.3 | |
| | Upper Bound | 16.8 | |
| Median | | 4 | |
| Std. Deviation | | 31.5 | |
| Minimum | | 0 | |
| Maximum | | 312 | |
| Range | | 312 | |
| Interquartile Range | | 11 | |

Temporal Trends

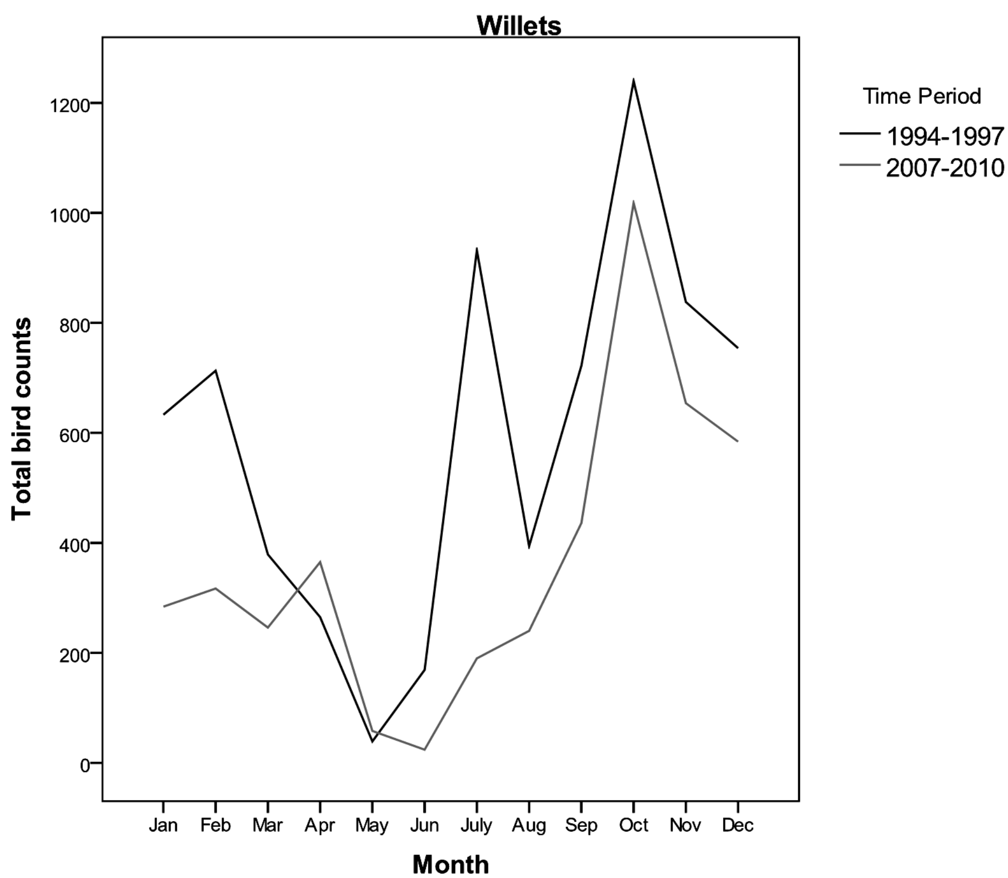
Comparing overall sighting rates for all surveys classified by time period, sighting rates fell significantly, between the recent and the historical study (Mann Whitney U = 104707, p <0.001).

Seasonal Trends

Comparing overall sighting rates for all surveys classified by season, seasonal trends were also significant (Kruskal Wallis; $X^2_{3,1005}$= 132.614, $p < 0.001$).

This likely reflects the change in numbers seen in July; the peak in numbers in 1994-1997 is not evident in the 2007-2010 data.

**Figure 9.** Temporal trends comparison between studies for Willets.




The GLMM indicates that season and period were independently significant, as was the interaction between them (Wald's chi square = 107.974, df = 3, p = <0.001, for season,

Wald's chi square = 9.281, df = 1, p = 0.002 for period and Wald's chi square = 13.361, df = 3, p = 0.004 for the interaction.
This infers that numbers did change seasonally, differences between the two time periods were significant and also seasonal trends varied between the two time periods. Most notably, the peaks in February and July in the 1994-1997 data were absent in the 2007-2010 data, while the peak in October was consistent for both periods.

**Table 25.** Willets seasonal counts 2007-2010

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Min. | Max. |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | |
| Winter[1] | 127 | 9.3 | 15.7 | 1.4 | 6.6 | 12.1 | 0 | 111 |
| Spring[2] | 125 | 5.4 | 12.4 | 1.1 | 3.2 | 7.5 | 0 | 98 |
| Summer[2] | 126 | 3.6 | 8.9 | 0.8 | 2 | 5.2 | 0 | 63 |
| Fall[1] | 126 | 16.7 | 30 | 2.7 | 11.4 | 22 | 0 | 179 |
| Total | 504 | 8.8 | 19.2 | 0.9 | 7.1 | 10.4 | 0 | 179 |

[1]Significantly higher than 1994-1997 seasonal count
[2]Significantly lower than 1994-1997 seasonal count

**Table 26.** Willets seasonal counts 1994-1997

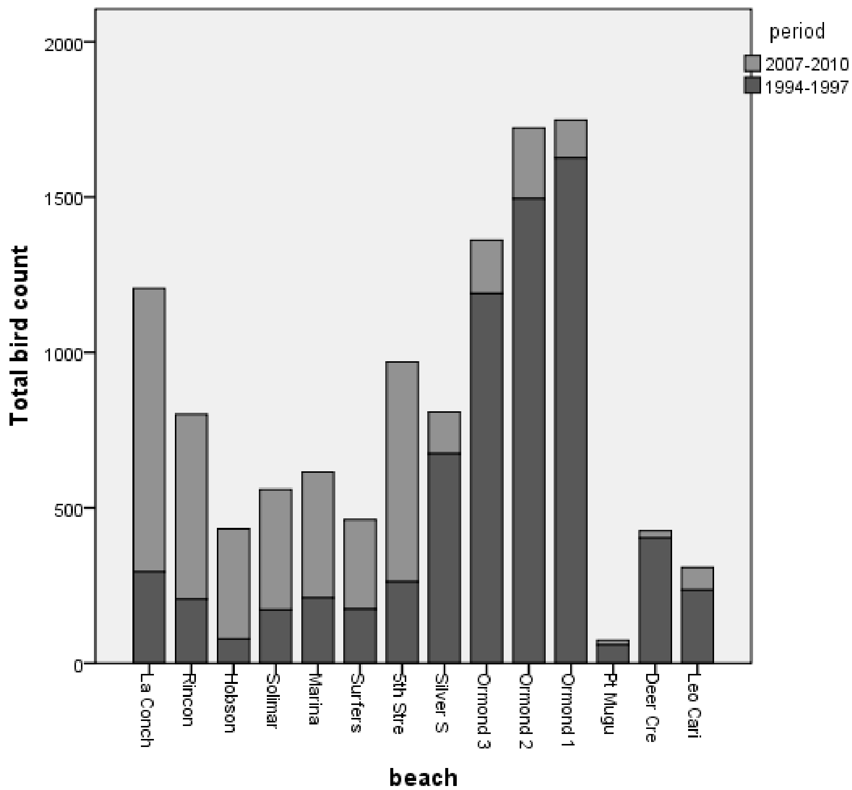
| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Min. | Max. |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | |
| Winter | 126 | 16.7 | 40.3 | 3.6 | 9.6 | 23.8 | 0 | 312 |
| Spring[2] | 126 | 5.4 | 10.6 | 0.9 | 3.5 | 7.3 | 0 | 74 |
| Summer | 126 | 11.9 | 27 | 2.4 | 7.1 | 16.6 | 0 | 217 |
| Fall | 126 | 22.2 | 37 | 3.3 | 15.7 | 28.7 | 0 | 200 |
| Total | 504 | 14 | 31.5 | 1.4 | 11.3 | 16.8 | 0 | 312 |

[1]Significantly higher than 2004-2007 seasonal count
[2]Significantly lower than 2004-2007 seasonal count

Spatial Trends

Comparing overall sighting rates for all surveys classified by beach, distribution between beaches also varied significantly within both data sets, (Kruskal Wallis $X^2_{3,499} = 95.795$, $p < 0.001$ for the 2007-2010 data and Kruskal Wallis $X^2_{3,499} = 177.739$, $p < 0.001$ for the 1994-1997 data).

**Figure 10**. Spatial trends comparison between studies for Willets.




The GLMM also indicates that beach location was independently significant, as was the interaction between these factors (Wald's chi square = 61.360, df = 13, p = <0.001, for season, and Wald's chi square = 153.623, df = 3, p = <0.001 for the interaction).

This infers that mean sighting rates varied between beaches, and these spatial trends varied between the two survey periods.

**Table 27.** Willets 2007-2010 by beach

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Min. | Max. |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | |
| La Conchita[1] | 36 | 25.4 | 39.5 | 6.6 | 12 | 38.7 | 0 | 179 |
| Rincon | 36 | 16.5 | 27.2 | 4.5 | 7.3 | 25.7 | 0 | 107 |
| Hobson | 36 | 9.8 | 16.5 | 2.7 | 4.3 | 15.4 | 0 | 79 |
| Solimar | 36 | 10.8 | 21.1 | 3.5 | 3.6 | 17.9 | 0 | 100 |
| Marina[1] | 36 | 11.3 | 15 | 2.5 | 6.2 | 16.3 | 0 | 70 |
| Surfers | 36 | 8 | 12 | 2 | 3.9 | 12.1 | 0 | 63 |
| 5th Street[1] | 36 | 19.7 | 29.6 | 4.9 | 9.6 | 29.7 | 0 | 118 |
| Silver Strand | 36 | 3.7 | 10.7 | 1.8 | 0.1 | 7.3 | 0 | 64 |
| Ormond 3[2] | 36 | 4.8 | 7.1 | 1.2 | 2.4 | 7.2 | 0 | 22 |
| Ormond 2 | 36 | 6.3 | 9.5 | 1.6 | 3.1 | 9.5 | 0 | 37 |
| Ormond 1 | 36 | 3.4 | 5.4 | 0.9 | 1.6 | 5.2 | 0 | 19 |
| Pt Mugu | 36 | 0.4 | 0.7 | 0.1 | 0.1 | 0.6 | 0 | 3 |
| Deer Creek[2] | 36 | 0.6 | 1 | 0.2 | 0.3 | 1 | 0 | 5 |
| Leo Carrillo[2] | 36 | 2 | 2.1 | 0.3 | 1.3 | 2.7 | 0 | 8 |
| **Total** | **504** | **8.8** | **19.2** | **0.9** | **7.1** | **10.4** | **0** | **179** |

[1] Significantly higher than 1994-1997 count
[2] Significantly lower than 1994-1997 count

**Table 28.** Willets 1994-1997 by beach

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean Lower Bound | 95% Confidence Interval for Mean Upper Bound | Min. | Max. |
|---|---|---|---|---|---|---|---|---|
| La Conchita | 36 | 8.2 | 9.1 | 1.5 | 5.1 | 11.2 | 0 | 43 |
| Rincon | 36 | 5.7 | 5.7 | 1 | 3.8 | 7.7 | 0 | 24 |
| Hobson[2] | 36 | 2.2 | 3.5 | 0.6 | 1 | 3.3 | 0 | 19 |
| Solimar | 36 | 4.8 | 4.8 | 0.8 | 3.2 | 6.4 | 0 | 17 |
| Marina | 36 | 5.8 | 5.7 | 1 | 3.9 | 7.8 | 0 | 27 |
| Surfers | 36 | 4.8 | 5.6 | 0.9 | 2.9 | 6.7 | 0 | 23 |
| 5th Street | 36 | 7.3 | 9.5 | 1.6 | 4 | 10.5 | 0 | 51 |
| Silver Strand | 36 | 18.7 | 23.6 | 3.9 | 10.7 | 26.7 | 0 | 91 |
| Ormond 3[1] | 36 | 33.1 | 33 | 5.5 | 21.9 | 44.2 | 0 | 115 |
| Ormond 2[1] | 36 | 41.5 | 57 | 9.5 | 22.2 | 60.8 | 0 | 260 |
| Ormond 1[1] | 36 | 45.2 | 71.7 | 12 | 20.9 | 69.4 | 0 | 312 |
| Pt Mugu[2] | 36 | 1.6 | 5.3 | 0.9 | -0.2 | 3.4 | 0 | 32 |
| Deer Creek | 36 | 11.2 | 26.3 | 4.4 | 2.3 | 20.1 | 0 | 142 |
| Leo Carrillo | 36 | 6.5 | 15.8 | 2.6 | 1.2 | 11.9 | 0 | 90 |
| **Total** | **504** | **14.0** | **31.5** | **1.4** | **11.3** | **16.8** | **0** | **312** |

[1]Significantly higher than 2007-2010 count
[2] Significantly lower than 2007-2010 count

## 4. WHIMBRELS

In the Western Hemisphere, Whimbrels nest from May-August in Canadian and Alaskan boreal moorland and tundra near the treeline (Hayman et al.1986; Paulson 1993). Birds begin moving southward in July and overwinter from Oregon south to Tierra del Fuego on the Pacific coast, where they occur in many habitats from outer beaches to salt marshes and mud flats. The birds are listed as common and widespread occurring nearly around the globe but populations are reported as quite localized at all seasons. Whimbrels winter in coastal areas from the southern U.S. to South America, southwest Europe, Africa, southeast Asia, Australia, and New Zealand. The world population is estimated at 797,000 with 57,000 in North America (O'Brien et al. 2006).

For the project period 2007-2010:

The total number of Whimbrels sighted was 1,420, with a mean sighting rate of 2.8 (s.d. 10.5) birds per survey. The maximum flock size for a single flock was 163 birds. Using a flock definition of 10% of total sightings, there was one large flock sighted and it is an outlier (other highest values were 81, 77). When the 1 clear outlier (163) was removed, mean sighting rates fell to 2.5 (s.d.7.7) birds per survey. On 310 of the 504 surveys, no Whimbrels were encountered.

**Table 29.** Summary data for Whimbrels 2007-2010

| | | Statistic | Std. Error |
|---|---|---|---|
| Mean | | 2.8 | 0.5 |
| 95% Confidence Interval for Mean | Lower Bound | 1.9 | |
| | Upper Bound | 3.7 | |
| Median | | 0 | |
| Std. Deviation | | 10.5 | |
| Minimum | | 0 | |
| Maximum | | 163 | |
| Range | | 163 | |
| Interquartile Range | | 2 | |

For the period 1994-1997:

The total number of birds sighted was 663 with a mean sighting rate of 1.3 (s.d. 3.8) birds per survey. Maximum flock size was 39 birds; Using a flock definition of 10% of total sightings, there were no large flocks sighted (other highest values were 38, 34). On 323 of 504 surveys no Whimbrels were encountered.

**Table 30.** Summary data for Whimbrels 1994-1997

| | | Statistic | Std. Error |
|---|---|---|---|
| Mean | | 1.3 | 0.2 |
| 95% Confidence Interval for Mean | Lower Bound | 1 | |
| | Upper Bound | 1.6 | |
| Median | | 0 | |
| Std. Deviation | | 3.8 | |
| Minimum | | 0 | |
| Maximum | | 39 | |
| Range | | 39 | |
| Interquartile Range | | 1 | |

Temporal Trends

Comparing overall sighting rates for all surveys classified by time period, sighting rates did not change significantly between the recent and the historical study (Mann Whitney U = 120189.0, p=0.088).

Seasonal Trends

Comparing overall sighting rates for all surveys classified by season, seasonal trends were significant (Kruskal Wallis; $X^2_{3,1005} = 46.690$, $p < 0.001$).

The GLMM also indicates that season was significant, but period was not, and the interaction is not significant (Wald's chi square = 122.900 df = 3, p = <0.001, for season, Wald's chi square = 4.858 , df = 1, p = 0.028 f or period and Wald's chi square = 2.761 df = 3, p = 0.430 for the interaction).

Evidently, sighting rates varied seasonally, but not between the surveys, and seasonal trends were consistent between the two surveys.

**Figure 11**. Temporal trends comparison between studies for Whimbrels.

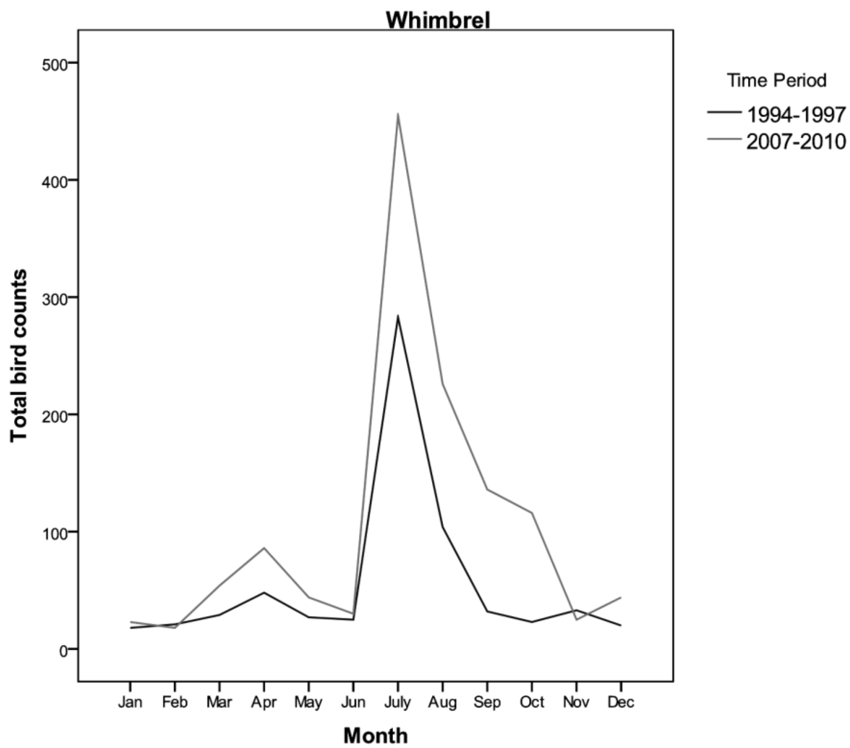


**Table 31.** Whimbrel seasonal counts 2007-2010

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Min. | Max. |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | |
| Winter[2] | 127 | 0.7 | 2.3 | 0.2 | 0.3 | 1.1 | 0 | 23 |
| Spring | 125 | 1.5 | 3.5 | 0.3 | 0.8 | 2.1 | 0 | 30 |
| Summer[1] | 125 | 5.7 | 13.4 | 1.2 | 3.3 | 8.1 | 0 | 81 |
| Fall | 126 | 2.2 | 5.3 | 0.5 | 1.3 | 3.1 | 0 | 42 |
| Total | 503 | 2.5 | 7.7 | 0.3 | 1.8 | 3.2 | 0 | 81 |

[1]Significantly higher than 1994-1997 seasonal count
[2]Significantly lower than 1994-1997 seasonal count

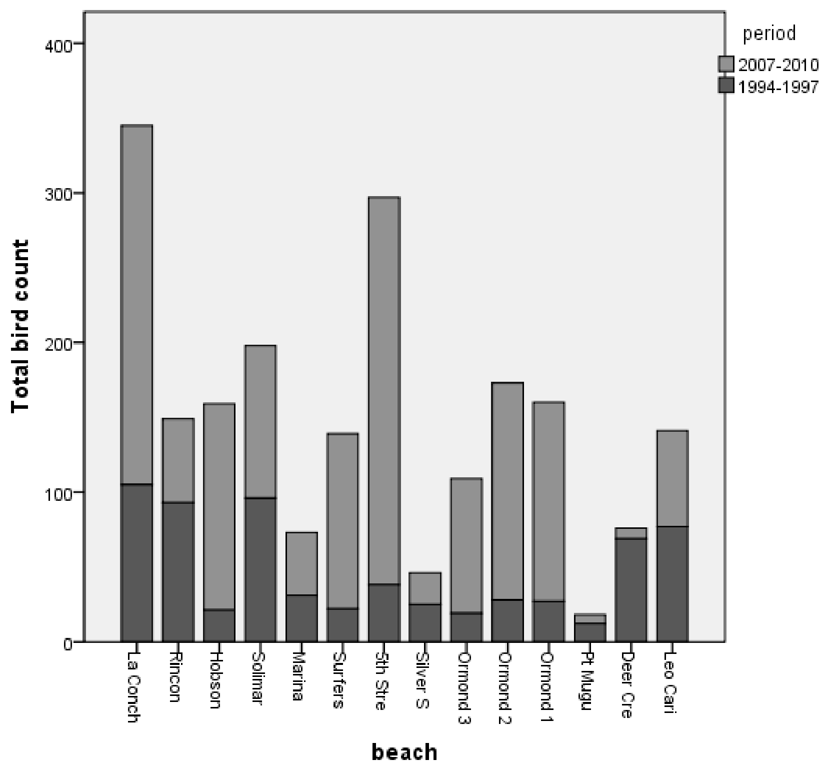
**Table 32.** Whimbrel seasonal counts 1994-1997

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Min. | Max. |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | |
| Winter | 126 | 0.5 | 1 | 0.1 | 0.3 | 0.6 | 0 | 5 |
| Spring | 126 | 0.8 | 1.8 | 0.2 | 0.5 | 1.1 | 0 | 13 |
| Summer[1] | 126 | 3.3 | 6.9 | 0.6 | 2.1 | 4.5 | 0 | 39 |
| Fall | 126 | 0.7 | 1.2 | 0.1 | 0.5 | 0.9 | 0 | 5 |
| Total | 504 | 1.3 | 3.8 | 0.2 | 1 | 1.6 | 0 | 39 |

[1]Significantly higher than 2004-2007 seasonal count
[2]Significantly lower than 2004-2007 seasonal count

Spatial Trends

**Figure 12**. Spatial trends comparison between studies for Whimbrels.




Comparing overall sighting rates for all surveys classified by beach, distribution between beaches varied significantly within both data sets, (Kruskal Wallis $X^2_{3,499} = 92.631$ $p < 0.001$ for the 2007-2010 period and Kruskal Wallis $X^2_{3,499} = 96.063$, $p < 0.001$ for the 1994-1997 period).

The GLMM also indicates that beach location was independently significant, as was the interaction between these factors (Wald's chi square = 60.100, df = 13, p = <0.001, for season, and Wald's chi square = 35.250, df = 13, p = 0.001 for the interaction).

Evidently, distribution varied between beaches and varied at specific beaches between the two time periods. This again highlights an area where further analysis at the level of individual beaches, taking seasonal distribution into account will further elucidate these trends.

**Table 33.** Whimbrel 2007-2010 by beach

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Min. | Max. |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | |
| La Conchita | 36 | 6.7 | 12.9 | 2.1 | 2.3 | 11 | 0 | 66 |
| Rincon | 36 | 1.6 | 2.8 | 0.5 | 0.6 | 2.5 | 0 | 15 |
| Hobson | 36 | 3.8 | 7.2 | 1.2 | 1.4 | 6.3 | 0 | 32 |
| Solimar | 36 | 2.8 | 5.7 | 0.9 | 0.9 | 4.8 | 0 | 25 |
| Marina | 36 | 1.2 | 1.7 | 0.3 | 0.6 | 1.8 | 0 | 9 |
| Surfers | 36 | 3.3 | 9 | 1.5 | 0.2 | 6.3 | 0 | 50 |
| 5th Street | 35 | 2.7 | 6.1 | 1 | 0.6 | 4.8 | 0 | 30 |
| Silver Strand | 36 | 0.6 | 2.9 | 0.5 | -0.4 | 1.6 | 0 | 17 |
| Ormond 3 | 36 | 2.5 | 6.2 | 1 | 0.4 | 4.6 | 0 | 29 |
| Ormond 2 | 36 | 4 | 14.1 | 2.3 | -0.7 | 8.8 | 0 | 81 |
| Ormond 1 | 36 | 3.7 | 13.2 | 2.2 | -0.8 | 8.2 | 0 | 77 |
| Pt Mugu | 36 | 0.2 | 1 | 0.2 | -0.2 | 0.5 | 0 | 6 |
| Deer Creek | 36 | 0.2 | 0.6 | 0.1 | 0 | 0.4 | 0 | 3 |
| Leo Carrillo | 36 | 1.8 | 2.6 | 0.4 | 0.9 | 2.6 | 0 | 10 |
| **Total** | **503** | **2.5** | **7.7** | **0.3** | **1.8** | **3.2** | **0** | **81** |

**Table 34.** Whimbrel 1994-1997 by beach

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Min. | Max. |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | |
| La Conchita | 36 | 2.9 | 7.3 | 1.2 | 0.4 | 5.4 | 0 | 39 |
| Rincon[1] | 36 | 2.6 | 1.9 | 0.3 | 2 | 3.2 | 0 | 9 |
| Hobson | 36 | 0.6 | 3 | 0.5 | -0.4 | 1.6 | 0 | 18 |
| Solimar | 36 | 2.7 | 6.3 | 1.1 | 0.5 | 4.8 | 0 | 34 |
| Marina[2] | 36 | 0.9 | 1.2 | 0.2 | 0.5 | 1.3 | 0 | 5 |
| Surfers[2] | 36 | 0.6 | 1.5 | 0.2 | 0.1 | 1.1 | 0 | 7 |
| 5th Street | 36 | 1.1 | 3.2 | 0.5 | 0 | 2.1 | 0 | 14 |
| Silver Strand[2] | 36 | 0.7 | 2.2 | 0.4 | 0 | 1.4 | 0 | 11 |
| Ormond 3[2] | 36 | 0.5 | 1.3 | 0.2 | 0.1 | 1 | 0 | 7 |
| Ormond 2[2] | 36 | 0.8 | 2.3 | 0.4 | 0 | 1.6 | 0 | 13 |
| Ormond 1[2] | 36 | 0.8 | 1.4 | 0.2 | 0.3 | 1.2 | 0 | 6 |
| Pt Mugu | 36 | 0.3 | 1.4 | 0.2 | -0.1 | 0.8 | 0 | 8 |
| Deer Creek | 36 | 1.9 | 4.3 | 0.7 | 0.4 | 3.4 | 0 | 24 |
| Leo Carrillo | 36 | 2.1 | 6.6 | 1.1 | -0.1 | 4.4 | 0 | 38 |
| **Total** | **504** | **1.3** | **3.8** | **0.2** | **1.0** | **1.6** | **0** | **39** |

[1]Significantly higher than 2007-2010 count
[2] Significantly lower than 2007-2010 count

## 5. MARBLED GODWITS

The Marbled Godwit is fairly common in the Western and Southern U.S. breeding in the Great Plains from Alberta and southwest Ontario south to Montana and South Dakota. Marbled Godwits winter along the Pacific Coast from southern Washington to Costa Rica, and in smaller numbers along Gulf and Atlantic coastlines from New Jersey south to the Yucatan Peninsula. They migrate relatively short distances for shorebirds with non-breeding birds staying on the coast year round. The world population of Marbled Godwits varies between 140,000 and 200,000 (O'Brien et al. 2006).

For the project period 2007-2010:

The total number of Marbled Godwits sighted was 1,954, with a mean sighting rate of 3.9 (s.d. 10.5) birds per survey. The maximum flock size for a single flock was 118 birds. Using a flock definition of 10% of total sightings, there were no large flocks sighted. Other notable flocks sighted numbered 84 and 75. On 300 of the 504 surveys, no Marbled Godwits were encountered.

**Table 35.** Summary data Marbled Godwits 2007-2010

| | | Statistic | Std. Error |
|---|---|---|---|
| Mean | | 3.9 | 0.5 |
| 95% Confidence Interval for Mean | Lower Bound | 3 | |
| | Upper Bound | 4.8 | |
| Median | | 0 | |
| Std. Deviation | | 10.5 | |
| Minimum | | 0 | |
| Maximum | | 118 | |
| Range | | 118 | |
| Interquartile Range | | 3 | |

For the period 1994-1997:

The total number of birds sighted was 1,447 with a mean sighting rate of 2.9 (s.d. 8.6) birds per survey. Maximum flock size was 99 birds; using a flock definition of 10% of total sightings, this would not constitute a large flock, other high values include 96, 84. On 271 of 504 surveys no Marbled Godwits were encountered.

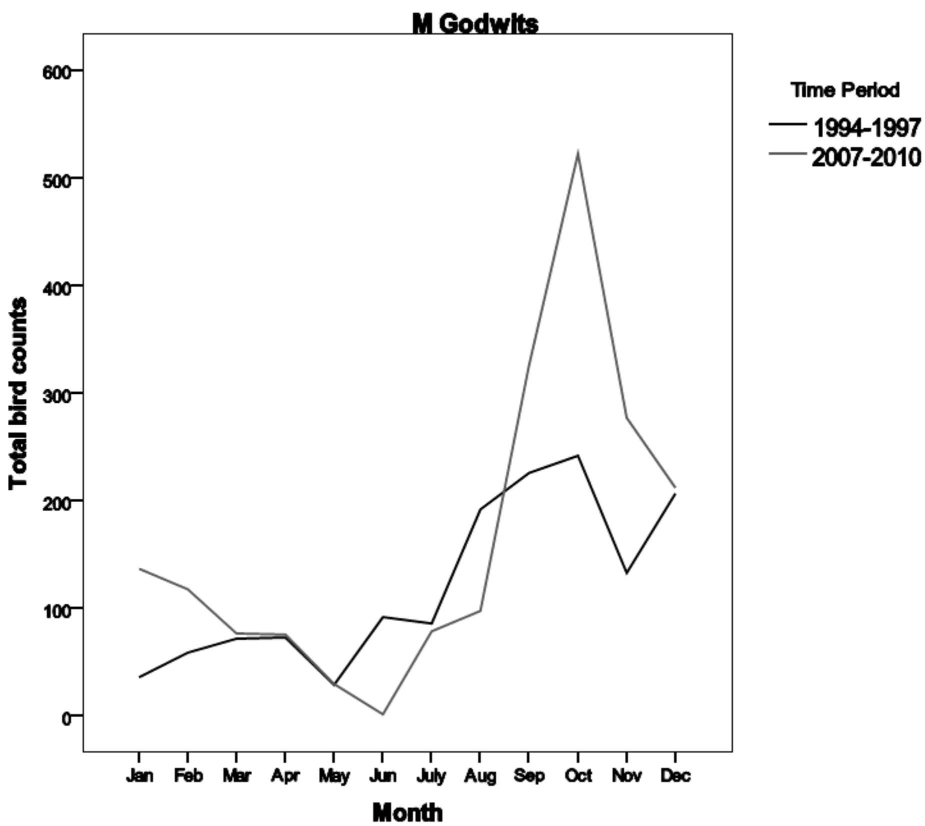
**Table 36.** Summary data Marbled Godwits 1994-1997

| | | Statistic | Std. Error |
|---|---|---|---|
| Mean | | 2.9 | 0.4 |
| 95% Confidence Interval for Mean | Lower Bound | 2.1 | |
| | Upper Bound | 3.6 | |
| Median | | 0 | |
| Std. Deviation | | 8.6 | |
| Minimum | | 0 | |
| Maximum | | 99 | |
| Range | | 99 | |
| Interquartile Range | | 2 | |

Temporal Trends

Comparing overall sighting rates for all surveys classified by time period, sighting rates remained consistent, between the recent and the historical study (Mann Whitney U = 125245, p = 0.673) (*see below (GLMM) for further details).

**Figure 13**. Temporal trends comparison between studies for Marbled Godwits




Seasonal Trends

Comparing overall sighting rates for all surveys classified by season, seasonal trends were significant (Kruskal Wallis; $X^2_{3,1005} = 80.615$, $p < 0.001$).

The GLMM also indicates that season was significant, but period was not, however, the interaction between season and period is significant (Wald's chi square = 87.061, df = 3, p = <0.001, for season, Wald's chi square = 0.361, df = 1, p = 0.548 for period and Wald's chi square = 14.527, df = 3, p = 0.002 for the interaction.

The inference here would be that seasonal trends were evident and changed between the two study periods, even though overall mean sighting rates remained consistent.

**Table 37.** Marbled Godwits seasonal counts 2007-2010

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Min. | Max. |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | |
| Winter[1] | 127 | 3.7 | 6.7 | 0.6 | 2.5 | 4.8 | 0 | 38 |
| Spring[2] | 125 | 1.5 | 3.4 | 0.3 | 0.9 | 2.1 | 0 | 23 |
| Summer[2] | 126 | 1.4 | 4.4 | 0.4 | 0.6 | 2.2 | 0 | 30 |
| Fall[1] | 126 | 8.9 | 18.1 | 1.6 | 5.7 | 12.1 | 0 | 118 |
| Total | 504 | 3.9 | 10.5 | 0.5 | 3 | 4.8 | 0 | 118 |

[1]Significantly higher than 2004-2007 seasonal count
[2]Significantly lower than 2004-2007 seasonal count

**Table 38.** Marbled Godwits season counts 1994-1997

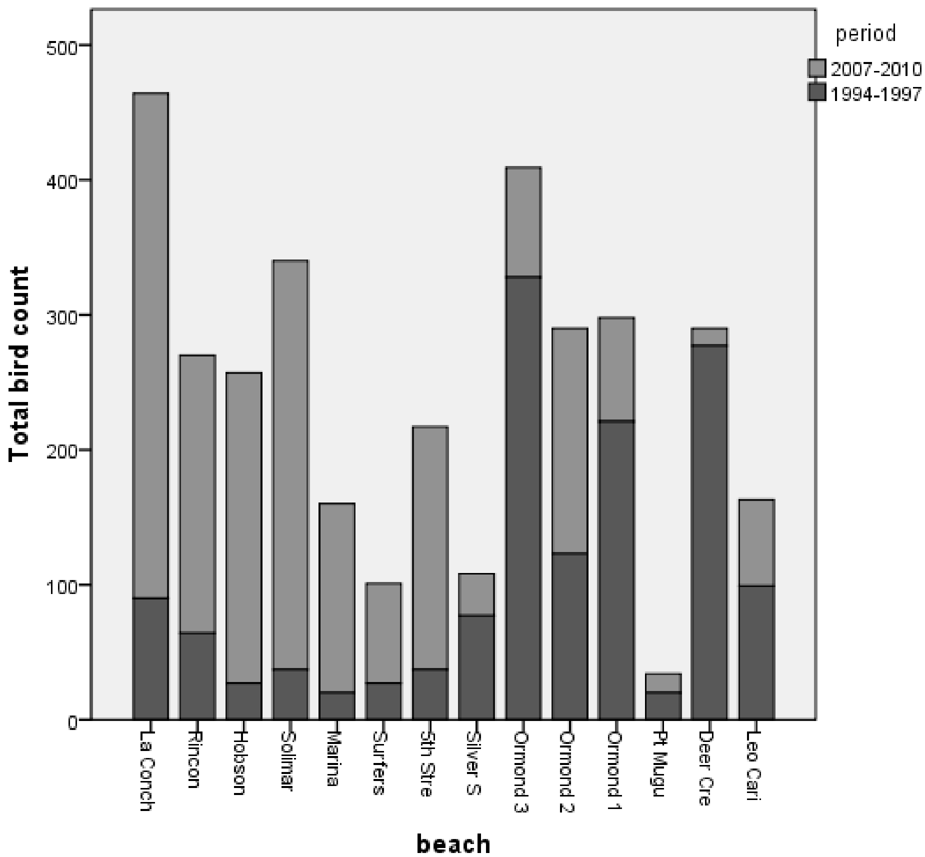
| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Min. | Max. |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | |
| Winter | 126 | 2.4 | 9.2 | 0.8 | 0.8 | 4 | 0 | 99 |
| Spring[2] | 126 | 1.4 | 2.9 | 0.3 | 0.9 | 1.9 | 0 | 17 |
| Summer | 126 | 2.9 | 9.4 | 0.8 | 1.3 | 4.6 | 0 | 84 |
| Fall | 126 | 4.8 | 10.6 | 0.9 | 2.9 | 6.6 | 0 | 96 |
| Total | 504 | 2.9 | 8.6 | 0.4 | 2.1 | 3.6 | 0 | 99 |

[1]Significantly higher than 2004-2007 seasonal count
[2]Significantly lower than 2004-2007 seasonal count

Spatial Trends

Comparing overall sighting rates for all surveys classified by beach, distribution between beaches also varied significantly within both data sets, (Kruskal Wallis $X^2_{13,490} = 59.521$, $p < 0.001$ for the 2007-2010 data and Kruskal Wallis $X^2_{13,490} = 66.622$, $p < 0.001$ for the 1994-1997 data).

**Figure 14**. Spatial trends comparison between studies for Marbled Godwits




The GLMM also indicates that beach location was independently significant, as was the interaction between these factors (Wald's chi square = 40.505, df = 13, p = <0.001, for season, and Wald's chi square = 77.563, df = 3, p = <0.001 for the interaction). Evidently, there was significant variation between beaches and across the time period, at specific beaches, for example - high numbers were seen at Ormond 1 in 1994-1997 data, but not persistent in the 2007-2010 data.

**Table 39.** Marbled Godwits 2007-2010 by beach

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean Lower Bound | 95% Confidence Interval for Mean Upper Bound | Min. | Max. |
|---|---|---|---|---|---|---|---|---|
| La Conchita | 36 | 10.4 | 21.6 | 3.6 | 3.1 | 17.7 | 0 | 118 |
| Rincon | 36 | 5.7 | 13.1 | 2.2 | 1.3 | 10.1 | 0 | 72 |
| Hobson | 36 | 6.4 | 10.1 | 1.7 | 3 | 9.8 | 0 | 41 |
| Solimar | 36 | 8.4 | 16.8 | 2.8 | 2.7 | 14.1 | 0 | 75 |
| Marina | 36 | 3.9 | 8.4 | 1.4 | 1 | 6.7 | 0 | 46 |
| Surfers | 36 | 2.1 | 5.3 | 0.9 | 0.3 | 3.8 | 0 | 30 |
| 5th Street | 36 | 5 | 14.3 | 2.4 | 0.2 | 9.8 | 0 | 84 |
| Silver Strand | 36 | 0.9 | 1.8 | 0.3 | 0.2 | 1.5 | 0 | 7 |
| Ormond 3 | 36 | 2.3 | 4.7 | 0.8 | 0.6 | 3.9 | 0 | 22 |
| Ormond 2 | 36 | 4.6 | 8 | 1.3 | 1.9 | 7.3 | 0 | 30 |
| Ormond 1 | 36 | 2.1 | 4.1 | 0.7 | 0.8 | 3.5 | 0 | 19 |
| Pt Mugu | 36 | 0.4 | 1.8 | 0.3 | -0.2 | 1 | 0 | 11 |
| Deer Creek | 36 | 0.4 | 1.3 | 0.2 | -0.1 | 0.8 | 0 | 7 |
| Leo Carrillo | 36 | 1.8 | 3.3 | 0.5 | 0.7 | 2.9 | 0 | 15 |
| **Total** | **504** | **3.9** | **10.5** | **0.5** | **3** | **4.8** | **0** | **118** |

**Table 40.** Marbled Godwits 1994-1997 by beach

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean Lower Bound | 95% Confidence Interval for Mean Upper Bound | Min | Max |
|---|---|---|---|---|---|---|---|---|
| La Conchita | 36 | 2.5 | 3.5 | 0.6 | 1.3 | 3.7 | 0 | 14 |
| Rincon | 36 | 1.8 | 2.6 | 0.4 | 0.9 | 2.6 | 0 | 11 |
| Hobson[2] | 36 | 0.8 | 1.3 | 0.2 | 0.3 | 1.2 | 0 | 5 |
| Solimar[2] | 36 | 1 | 2.2 | 0.4 | 0.3 | 1.8 | 0 | 11 |
| Marina[2] | 36 | 0.6 | 1.1 | 0.2 | 0.2 | 0.9 | 0 | 5 |
| Surfers[2] | 36 | 0.8 | 1.9 | 0.3 | 0.1 | 1.4 | 0 | 10 |
| 5th Street | 36 | 1 | 2.3 | 0.4 | 0.2 | 1.8 | 0 | 12 |
| Silver Strand | 36 | 2.1 | 2.9 | 0.5 | 1.1 | 3.1 | 0 | 13 |
| Ormond 3 | 36 | 9.1 | 21.9 | 3.7 | 1.7 | 16.5 | 0 | 96 |
| Ormond 2 | 36 | 3.4 | 6.3 | 1 | 1.3 | 5.5 | 0 | 34 |
| Ormond 1[1] | 36 | 6.1 | 7.3 | 1.2 | 3.7 | 8.6 | 0 | 25 |
| Pt. Mugu[2] | 36 | 0.6 | 1.7 | 0.3 | 0 | 1.1 | 0 | 8 |
| Deer Creek | 36 | 7.7 | 18 | 3 | 1.6 | 13.8 | 0 | 99 |
| Leo Carrillo | 36 | 2.8 | 5 | 0.8 | 1.1 | 4.4 | 0 | 25 |
| **Total** | **504** | **2.9** | **8.6** | **0.4** | **2.1** | **3.6** | **0** | **99** |

[1]Significantly higher than 2004-2007 count
[2]Significantly lower than 2004-2007 count

## 6. SANDERLINGS

Sanderlings are often referred to as the most widespread shorebird in the world, occurring on every continent except Antarctica. Breeding occurs in high Arctic regions from northern Northwest Territories to northeast Greenland. Sanderlings winter along almost all temperate and tropical beaches from British Columbia and Nova Scotia south to South America. The world population has been estimated at 643,000 with 300,000 in North America (O'Brien et al. 2006).

Sanderlings prefer sandy ocean beaches and outer estuaries and are the most abundant shorebirds on Ventura County beaches during the winter months. Sanderlings begin moving northward in late March, but non-breeders may remain in southern areas all year.

For the project period 2007-2010:

The total number of birds sighted was 7,353 with a mean sighting rate of 14.6 (s.d. 63.3) birds per survey. The maximum flock size for a single flock was 1,200 birds. Using a flock definition of 10% of total sightings, this was the only large flock sighted. Other notably large flocks sighted numbered 470 and 300. When the 1 clear outlier (1,200) was removed, mean sighting rates fell to 12.2 (s.d. 34.7) birds per survey. On 290 of the 504 surveys, no Sanderlings were encountered.

**Table 41.** Summary data for Sanderlings 2007-2010

| | | Statistic | Std. Error |
|---|---|---|---|
| Mean | | 14.6 | 2.8 |
| 95% Confidence Interval for Mean | Lower Bound | 9.1 | |
| | Upper Bound | 20.1 | |
| Median | | 0 | |
| Std. Deviation | | 63.3 | |
| Minimum | | 0 | |
| Maximum | | 1200 | |
| Range | | 1200 | |
| Interquartile Range | | 9 | |

For the period 1994-1997:

The total number of birds sighted was 10,373 with a mean sighting rate of 20.6 (s.d. 49.4) birds per survey. Maximum flock size was 600 birds; using a flock definition of 10% of total sightings, this would not constitute a large flock, but it is an outlier, from a statistical standpoint. When the 1 clear outlier (600) was removed, mean sighting rates fell to 19.4 (s.d. 42.2) birds per survey. On 222 of 504 surveys no Sanderlings were encountered.

**Table 42.** Summary data for Sanderlings 1994-1997

| | | Statistic | Std. Error |
|---|---|---|---|
| Mean | | 20.6 | 2.2 |
| 95% Confidence Interval for Mean | Lower Bound | 16.2 | |
| | Upper Bound | 24.9 | |
| Median | | 3 | |
| Std. Deviation | | 49.4 | |
| Minimum | | 0 | |
| Maximum | | 600 | |
| Range | | 600 | |
| Interquartile Range | | 20 | |

Note: Analyses were run without the highest outliers (one flock of 1,200 for 2007-2010 data and one flock of 600 for 1994-1997 data).

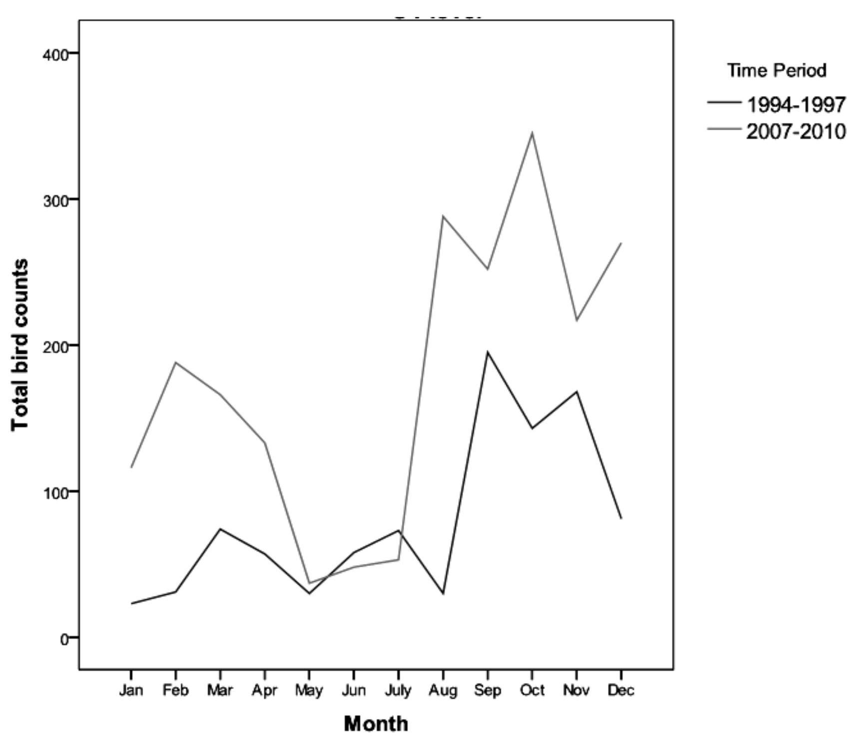
Temporal trends

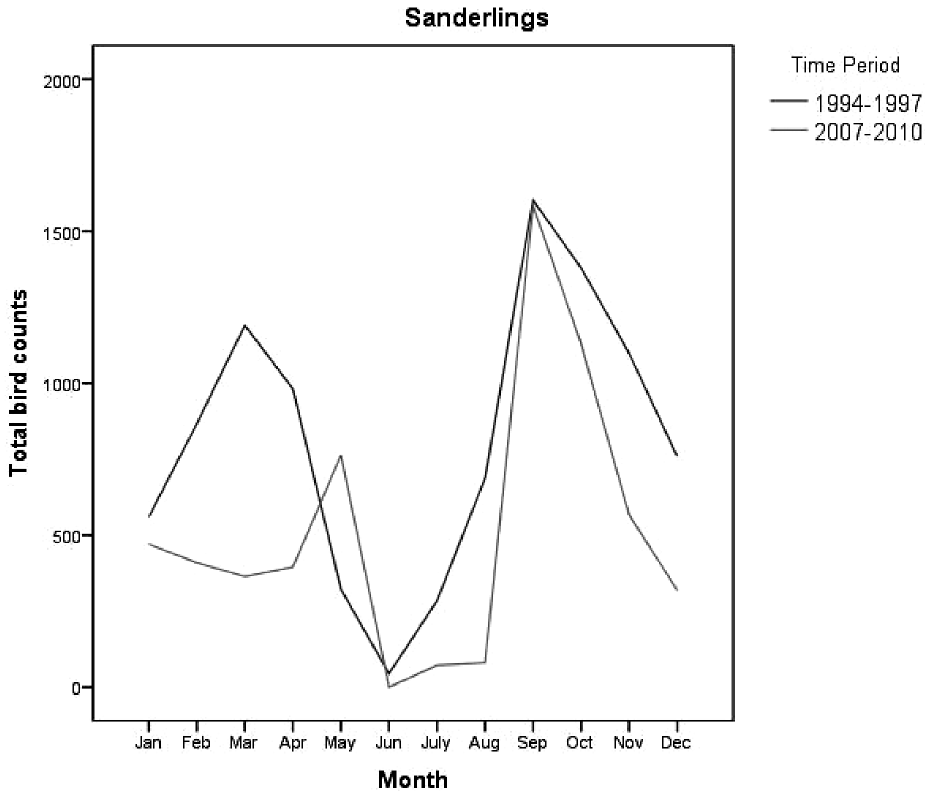
Comparing overall sighting rates for all surveys classified by time period (1994-1997 vs. 2007-2010), sighting rates fell significantly, between the recent and the historical study (Mann Whitney U = 107075, p <0.001).

Seasonal Trends

Comparing overall sighting rates for all surveys classified by season, seasonal trends were also significant (Kruskal Wallis; $X^2_{3,1005} = 89.048$, $p < 0.001$). Numbers clearly peaked in spring and fall, and fell in the summer and winter.

**Figure 15**. Seasonal and temporal trends comparison between studies for Sanderlings.






.

The GLMM model also indicates that season and period were independently significant; however, the interaction was not significant, once multiple testing is taken into account (Wald's chi square = 77.184, df = 3, p = <0.001, for season, Wald's chi square = 9.955, df = 3, p = 0.002 for period and Wald's chi square = 8.420, df = 3, p = 0.038 for the interaction).

This infers that while numbers do change seasonally, and numbers did change between the two time periods, there was no overall change in seasonal trends between the two time periods.

**Table 43.** Sanderling seasonal counts 2007-2010

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean Lower Bound | 95% Confidence Interval for Mean Upper Bound | Min. | Max. |
|---|---|---|---|---|---|---|---|---|
| Winter | 127 | 9.4 | 15.3 | 1.4 | 6.7 | 12.1 | 0 | 83 |
| Spring | 125 | 21.8 | 112.3 | 10 | 1.9 | 41.7 | 0 | 1200 |
| Summer[2] | 126 | 1.2 | 5.5 | 0.5 | 0.2 | 2.2 | 0 | 47 |
| Fall | 126 | 26 | 54.3 | 4.8 | 16.5 | 35.6 | 0 | 471 |
| Total | 504 | 14.6 | 63.3 | 2.8 | 9.1 | 20.1 | 0 | 1200 |

[1]Significantly higher than 1994-1997 seasonal count
[2]Significantly lower than 1994-1997 seasonal count

**Table 44.** Sanderling seasonal counts 1994-1997

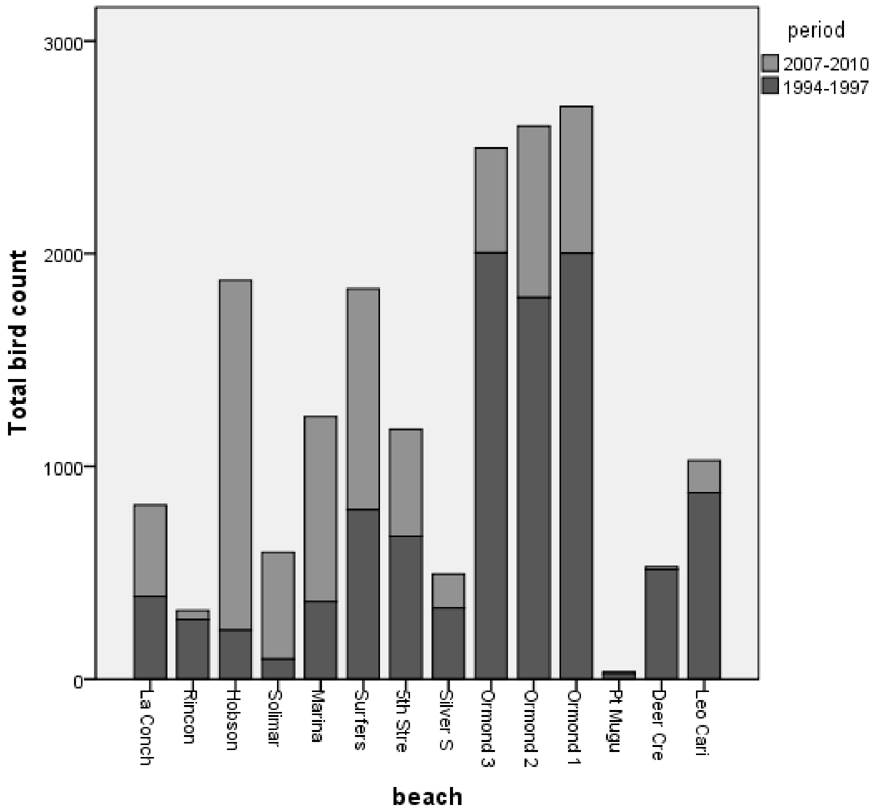
| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean Lower Bound | 95% Confidence Interval for Mean Upper Bound | Min. | Max. |
|---|---|---|---|---|---|---|---|---|
| Winter | 126 | 17.3 | 29.9 | 2.7 | 12.1 | 22.6 | 0 | 203 |
| Spring | 126 | 19.8 | 46.6 | 4.1 | 11.6 | 28 | 0 | 284 |
| Summer[2] | 126 | 12.8 | 58.4 | 5.2 | 2.5 | 23.1 | 0 | 600 |
| Fall | 126 | 32.4 | 56.1 | 5 | 22.5 | 42.3 | 0 | 373 |
| Total | 504 | 20.6 | 49.5 | 2.2 | 16.3 | 24.9 | 0 | 600 |

[1]Significantly higher than 1994-1997 seasonal count
[2]Significantly lower than 1994-1997 seasonal count

Spatial Trends

Comparing overall sighting rates for all surveys classified by beach, distribution between beaches also varied significantly within both data sets, (Kruskal Wallis $X^2_{3,499} = 88.024$, $p < 0.001$ for the 2007-2010 data and Kruskal Wallis $X^2_{3,499} = 123.689$, $p < 0.001$ for the 1994-1997 data).

**Figure 16**. Spatial trends comparison between studies for Sanderlings.




The GLMM also indicates that beach location was independently significant, as was the interaction between these factors (Wald's chi square = 92.796, df = 13, p = <0.001, for beach, and Wald's chi square = 33.875, df = 13, p = 0.001 for the interaction).

This infers that mean sighting rates varied between beaches, and these trends varied between the two survey periods.

**Table 45.** Raw data 2007-2010 Sanderlings by beach

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Min. | Max. |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | |
| La Conchita | 36 | 11.9 | 25.2 | 4.2 | 3.4 | 20.5 | 0 | 112 |
| Rincon[2] | 36 | 1.2 | 4 | 0.7 | -0.2 | 2.5 | 0 | 22 |
| Hobson | 36 | 12.7 | 30.7 | 5.2 | 2.2 | 23.3 | 0 | 125 |
| Solimar | 36 | 13.9 | 39.2 | 6.5 | 0.7 | 27.2 | 0 | 160 |
| Marina | 36 | 24.2 | 43.1 | 7.2 | 9.6 | 38.8 | 0 | 181 |
| Surfers | 36 | 28.9 | 80.8 | 13.5 | 1.5 | 56.2 | 0 | 471 |
| 5th Street | 36 | 13.9 | 28.3 | 4.7 | 4.4 | 23.5 | 0 | 139 |
| Silver Strand | 36 | 4.4 | 6.9 | 1.2 | 2.1 | 6.8 | 0 | 31 |
| Ormond 3 | 36 | 13.7 | 14.4 | 2.4 | 8.8 | 18.5 | 0 | 50 |
| Ormond 2 | 36 | 22.4 | 52.6 | 8.8 | 4.6 | 40.2 | 0 | 300 |
| Ormond 1 | 36 | 19.2 | 27.3 | 4.6 | 9.9 | 28.4 | 0 | 108 |
| Pt Mugu[2] | 36 | 0.3 | 1.1 | 0.2 | -0.1 | 0.6 | 0 | 5 |
| Deer Creek[2] | 36 | 0.4 | 1.3 | 0.2 | -0.1 | 0.8 | 0 | 7 |
| Leo Carrillo | 36 | 4.2 | 10.7 | 1.8 | 0.6 | 7.8 | 0 | 61 |
| **Total** | **503** | **12.2** | **34.8** | **1.5** | **9.2** | **15.3** | **0** | **471** |

[1]Significantly higher than 1994-1997 count
[2]Significantly lower than 1994-1997 count

**Table 46.** Raw data 1994-1997 Sanderlings by beach

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean Lower Bound | 95% Confidence Interval for Mean Upper Bound | Min. | Max. |
|---|---|---|---|---|---|---|---|---|
| La Conchita | 36 | 10.8 | 18.9 | 3.2 | 4.4 | 17.2 | 0 | 82 |
| Rincon | 36 | 7.8 | 26.3 | 4.4 | -1.1 | 16.7 | 0 | 125 |
| Hobson | 36 | 6.4 | 13.6 | 2.3 | 1.8 | 11 | 0 | 70 |
| Solimar | 36 | 2.6 | 4.1 | 0.7 | 1.2 | 4 | 0 | 15 |
| Marina | 36 | 10.1 | 22.1 | 3.7 | 2.6 | 17.6 | 0 | 127 |
| Surfers | 36 | 22.1 | 39.2 | 6.5 | 8.8 | 35.4 | 0 | 176 |
| 5th Street | 36 | 18.7 | 27.2 | 4.5 | 9.5 | 27.9 | 0 | 125 |
| Silver Strand | 36 | 9.3 | 13.8 | 2.3 | 4.6 | 14 | 0 | 47 |
| Ormond 3 | 36 | 55.7 | 100.3 | 16.7 | 21.7 | 89.6 | 0 | 600 |
| Ormond 2 | 36 | 49.8 | 77.6 | 12.9 | 23.6 | 76.1 | 0 | 373 |
| Ormond 1 | 36 | 55.6 | 84.1 | 14 | 27.1 | 84.1 | 0 | 337 |
| Pt. Mugu | 36 | 0.7 | 2.3 | 0.4 | -0.1 | 1.5 | 0 | 12 |
| Deer Creek | 36 | 14.3 | 33.7 | 5.6 | 2.9 | 25.7 | 0 | 177 |
| Leo Carrillo | 36 | 24.3 | 41.5 | 6.9 | 10.3 | 38.3 | 0 | 167 |
| **Total** | **504** | **20.6** | **49.5** | **2.2** | **16.3** | **24.9** | **0** | **600** |

# IV. DISCUSSION

The status of shorebird populations serves as a measure of the health of coastal communities and potentially as an indicator of human disturbances such as oil spills, harassment from pets or recreational activities, and pipeline beach construction.

Shorebirds are highly sensitive to changes in their environment and can be used as indicators of environmental decline (Warnock et al. 2002). Recent oil spill events along the California Coast have validated the need for baseline data on shorebird populations. Catastrophic events require accurate species counts if environmental impact assessment and accurate contingency planning is to be accomplished (McCrary and Pierson 2002). According to a report entitled *National Shorebird Research Needs*, “The success of conservation and management programs depends to a large extent on how much prior information we have on the distribution and abundance of each species” (Oring et al. 2000).

The results presented in this study highlight within survey differences in seasonal trends (Spring, Summer, Fall, Winter) and spatial trends (the 14 beaches), along with overall differences, and changes in these trends, between the two time periods (1994-1997 versus 2007-2010).

The number of Sanderlings changed seasonally, and between the two time periods, but there was no overall change in seasonal trends between the two time periods. However, use of specific beaches has changed between the two time periods. The three beaches where significant declines occurred across the two time periods were Deer Creek, Point Mugu and Rincon.

Willet numbers changed seasonally which is expected given the migratory nature of the species. However, observations for Willets fell significantly between the recent and the historical study. Most notably, the peaks in February and July in the 1994 -1997 data were absent in the 2007-2010 data, while the peak in October was consistent for both periods.

There was also significant variation between beaches within each survey. In the 2007-2010 survey, La Conchita, Marina and 5$^{th}$ Street beaches showed significantly higher numbers whereas Ormond 3, Deer Creek, and Leo Carrillo showed significantly lower numbers. However, this distribution was markedly different to spatial trends in the 1994-1997 surveys.

In comparing specific beaches between the two time periods, a very distinct drop in numbers is revealed in 2007-2010 at Ormond 3, along with low numbers at Deer Creek and Point Mugu. Further detailed and targeted analysis at the level of specific beaches could further describe these localized variations.

Marbled Godwits showed no overall change in abundance between time periods, but there was significant variation between beaches and across the time period, at specific beaches. This again suggests that specific beaches should be targeted for further investigation, as localized seasonal variations and temporal changes could be pronounced at specific beaches. For example, high numbers were recorded at Ormond 1 in the 1994-1997 data, but this did not persist in the 2007-2010 data. In terms of seasonal trends, a pronounced spike in numbers in October during 2007-2010 survey period emerged. Again, further analysis could determine whether this surge in numbers was associated with specific beaches.

For Black-bellied Plovers, seasonal and spatial trends were evident and changed between the two survey periods. Seasonally, the low numbers of Black-bellied Plovers for both project periods were very consistent during the spring and summer which reflects the strong migratory nature of this species. However, the fall and winter numbers show an alarming reduction in numbers.

Spatially, numbers were high at Leo Carrillo and Solimar and low at Point Mugu and Silver Strand in the 2007-2010. While these low numbers were also evident in the 1994-1997 data, pronounced changes were seen at other beaches, such Ormond 1, 2 and 3. High variability in counts at Ormond during the 1994-1997 survey, and at Marina and La Conchita during the 2007-2010 surveys, likely mask trends at these beaches, as they were not significant in these analyses. More detailed analyses of these specific beaches is warranted.

In considering the dramatic decline of this species it is important to note that there was a corresponding dramatic decline during the first 3 years of the historic study (1994-1997) that was almost entirely localized to the 3 Ormond Beaches. Bird numbers fell 48% from year 1 to year 2 and 55% from year 2 to year 3. In the current study the numbers fell 77% from year 1 to year 3. Only 79 individuals were recorded in 2010. In 1994, 633 individuals were recorded.

Snowy Plover abundance data was highly variable; numbers did not vary significantly between the survey periods, however numbers did vary between seasons. Seasonal peaks in September and November were evident in both studies, while declines in spring and summer counts emerged as significant.

Distribution varied distinctly between beaches and varied between the two time periods, at specific beaches. Notably, sighting rates between beaches were highly variable. This explains why locally high counts and / or spikes in raw counts were not statistically significant, however trends at these beaches warrant closer attention.

Reviewing raw count data, Snowy Plovers were principally confined to 5 sites during the 1994-1997 study (La Conchita, Surfers Knoll and the 3 Ormond beaches, see Table 40). In the present study, they were detected at 9 sites, but principally confined to 4 sites (Surfers knoll and the 3 Ormond beaches, see Table 39). Numbers declined at La Conchita beach but increased at 5$^{th}$ Street beach. During the current study, 4 beaches had no sightings and 4 beaches had less than 20 sightings.

Overall, it is encouraging to note that Snowy Plover abundance has not decreased since the last study. Possibly because this species is listed as Threatened under the Endangered Species Act, the efforts that are underway by the U.S. Fish and Wildlife Service to promote its recovery are perhaps successful.

Changes in Whimbrel numbers between the two time periods were not significant. Seasonal peaks in the summer and declines in the winter months were consistent between the two study periods. Indeed, the seasonal distribution of the 2007-2010 study was almost a mirror image of the 1994-1997 study. It is however, encouraging to note the trend in Whimbrel numbers from 663 in the previous study to 1,420 in the current study.

Distribution varied between beaches and varied at specific beaches between the two time periods. This again highlights an area where further analysis at the level of individual beaches, taking seasonal distribution into account will further elucidate these trends. Reviewing the data, the abundance of Whimbrels is currently increasing at beaches that were previously characterized by low numbers, potentially suggesting that habitat availability and/or quality may have improved. Since this species is primarily a seasonal migrant, disturbance patterns, or other variables may have improved resulting in increased population counts over these areas in 1994-1997.

Further analyses for all the focal species that take into account within-season trends in abundance and targets specific beaches would be useful. This would remove any masking or skew that could be related to underlying seasonal and spatial trends, and therefore would highlight the beaches that warrant careful management, either to ensure that consistent numbers of birds persist, or to better understand why abundance of birds has changed between these two surveys.

The past decade has seen major physical and climatic changes along the California coast caused by major El Nino events, global climate change with shifting temperatures related to the Pacific Decadal Oscillation (PDO), and increasing urbanization of the coast. Shorebirds in the Southern California region have experienced particularly high levels of habitat loss, alteration, and degradation from agricultural and urban development over the past two centuries. This is compounded by the fact that the Pacific coast of Mexico is experiencing unprecedented development. Changes in cropping patterns, a shift from cattle grazing to viticulture, may also reduce the value of agricultural lands to shorebirds. Accelerated sedimentation in wetlands from watershed alteration is a particular problem in the Ventura County region. This has been exacerbated by infrastructure construction within wetlands which has reduced tidal prism and circulation at several coastal wetlands in the area.

The spread of exotic plants such as Arundo (*Arundo donax*) throughout local watersheds has reduced local wetlands. This coupled with the introduction of many non-native invertebrates into the benthos of coastal wetlands through ship ballast discharges, and other human activities is altering the composition of potential shorebird prey in an unpredictable manner (Hickey et al. 2003).

Nesting shorebirds in the region have experienced high rates of nest loss and disturbance due to introduced mammalian predators such as the Red Fox (*Vulpes vulpes*), and growing recreational use of beaches and wetlands. Conservation of nesting habitat has been a particular focus in the area since the initial study 10 years ago and population estimates will be an important barometer of the success of these efforts.

The current data set will enable management agencies such as the BOEM, National Park Service (NPS), and the National Oceanic and Atmospheric Administration (NOAA) to perform rigorous analyses on any potential effects of offshore operations on the sensitive coastal shorebirds that inhabit the region. Seabirds and shorebirds are recognized as among the most vulnerable fauna in the case of oil spills and as sensitive harbingers of the health of the coastal marine ecosystem because of their unique ecology.

All these factors make it even more imperative that a long term data set of shorebird populations be established and continued in order to distinguish more spatially and temporally limited changes in coastal populations (that may be triggered by human induced impacts) from those that are more global in nature and therefore detectable only over longer temporal and spatial scales.

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# VI. APPENDIX

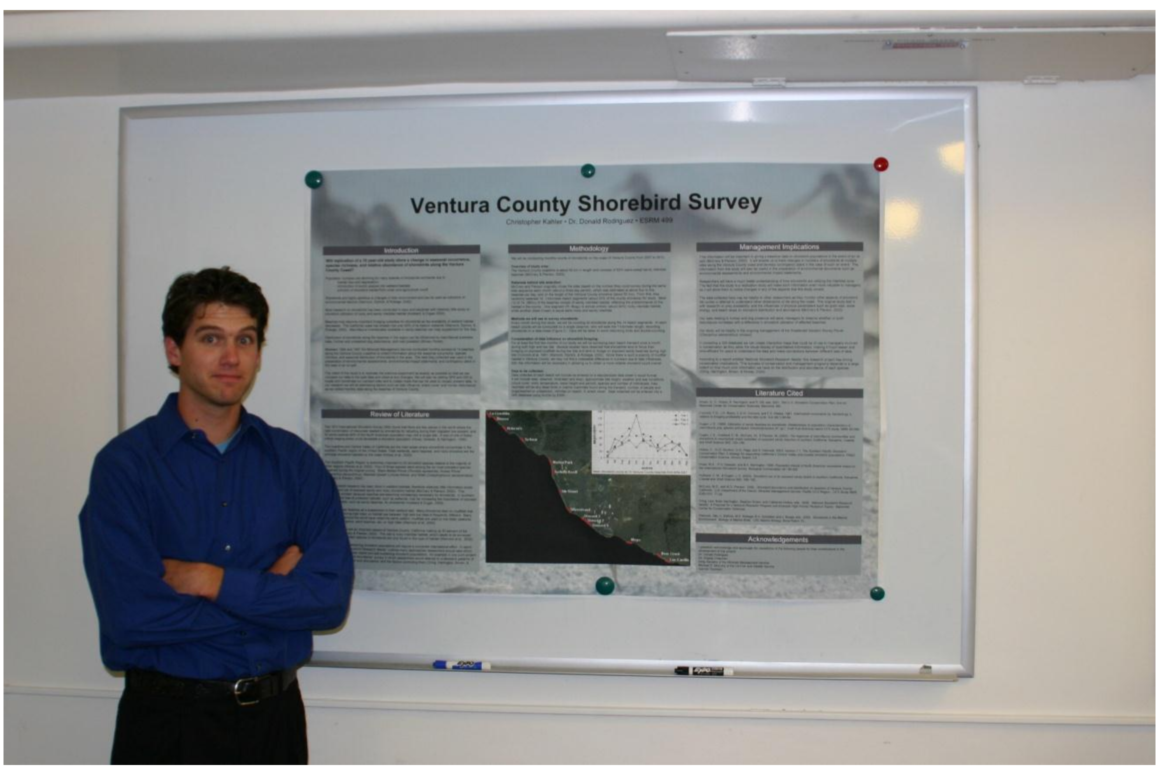
## Appendix A. CSUCI Datasheet

### Shorebird Datasheet

| | |
|---|---|
| site name | |
| date | |
| researcher name | |
| time | |
| weather | |
| wind speed-mph | |
| wind direction | |
| wave height- ft | |
| tide-coming in or out | |
| wrack cover- % cover | |
| wrack type | |
| other site conditions | |
| | |
| american avocet | |
| black-necked stilt | |
| black oystercatcher | |
| dowitcher | |
| killdeer | |
| long-billed curlew | |
| phalarope, red | |
| phalarope, red-necked | |
| sandpiper, least | |
| sandpiper, rock | |
| sandpiper, spotted | |
| sandpiper, western | |
| semipalmated plover | |
| surfbird | |
| turnstone, black | |
| turnstone, ruddy | |
| wandering tattler | |

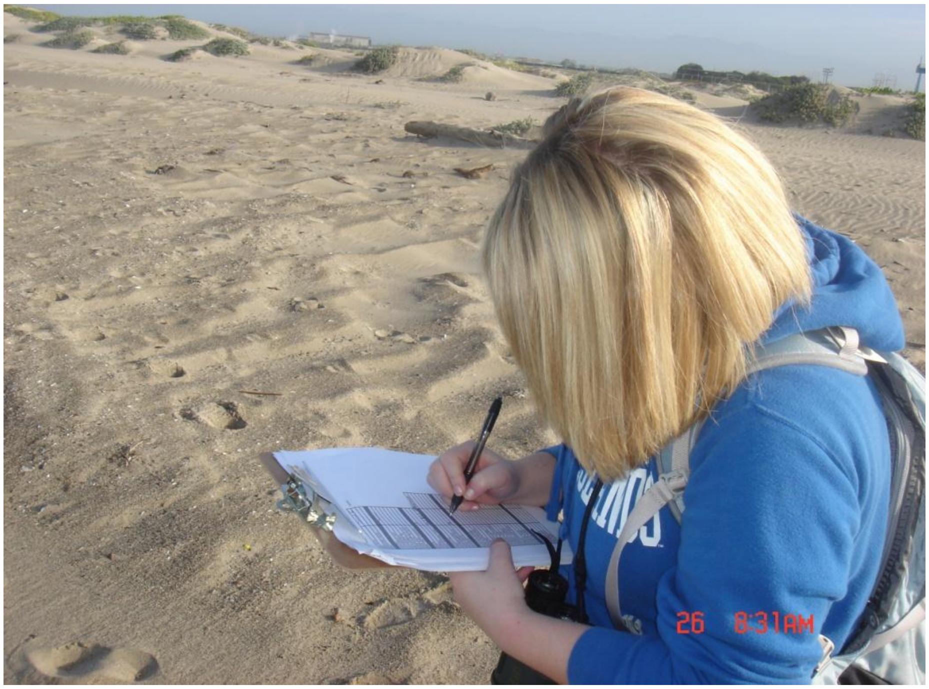
| | |
|---|---|
| sanderling | |
| willet | |
| marbled godwit | |
| black-bellied plover | |
| snowy plover | |
| whimbrel | |
| | |
| western gull | |
| california gull | |
| heerman's gull | |
| ring-billed gull | |
| mew's gull | |
| herring gull | |
| brown pelican | |
| | |
| other- list below | |
| | |
| | |
| people | |
| dogs (leashed) | |
| dogs (unleashed) | |
| vehicles | |
| dead animals- type | |
| | |
| Notes: | |
| **Final Count** | |

**Appendix B. Photos of Student Poster Sessions**


**2007 Southern California Conference on Undergraduate Research**

**Appendix C. Photos of Students in the Field**




**Appendix D. Example of Project Media Coverage**

# Fire crews to stay in Camarillo

Santa Anas expected today, CalFire battalion chief says

By John Scheibe
jscheibe@VenturaCountyStar.com

State fire officials said on Monday hundreds of firefighters will remain camped next to the Camarillo Airport as more Santa Ana winds are scheduled to blow through Southern California starting today.

"Those of you who were counting on going home will have to stay here a while longer," Mike Abarca, a battalion chief with the California Department of Forestry and Fire Protection, told a group of firefighters during a lunch hour briefing at the Freedom Park camp on Monday.

More than 1,000 firefighters were in Camarillo at the height of the fire in Malibu over the weekend. That

See FIRE on A8

**Online extra**

Log on to **VenturaCountyStar.com** for video of the Corral fire, as well as Star staff photographer slide shows and Associated Press photos and videos.

TEAM COUNTS SHOREBIRDS IN CASE OF OIL SPILL OFF THE COAST

# Setting a baseline

Photos by James Glover II / Star sta

Chris Kahler, center, and Garrick Thomsen, right, are working to get baseline data of bird populations in case there's an accident with one of the oil rigs off the coast. Too often shorebirds, which live and forage mainly in the tidal zone, are overlooked in research, according to Greg Sanders, a biologist with the U.S. Minerals Management Service.

## Appendix E. Marine Mammal sightings by Beach

| Beach | Date | Year | Marine Mammal Sightings | Running |
|---|---|---|---|---|
| La Conchita | 3/5/2010 | 2010 | seal pup | 1 |
| Rincon | 4/3/2009 | 2009 | 1 dead seal | 2 |
| Rincon | 6/11/2010 | 2010 | 1 sea lion basking on rock | 3 |
| Hobson | 9/14/2007 | 2007 | 1 blue whale | 4 |
| Hobson | 6/11/2010 | 2010 | 1 dead sea lion | 5 |
| Surfers Knoll | 10/25/2007 | 2007 | 1 dead sea lion | 6 |
| Surfers Knoll | 2/26/2008 | 2008 | 1 dead sea lion | 7 |
| Surfers Knoll | 3/13/2008 | 2008 | 1 dead sea lion | 8 |
| Surfers Knoll | 8/18/2008 | 2008 | 2 dead sea lions | 10 |
| Surfers Knoll | 6/4/2009 | 2009 | 2 dead sea lions | 12 |
| Surfers Knoll | 9/18/2009 | 2009 | 1 dead dolphin | 13 |
| Surfers Knoll | 6/22/2010 | 2010 | 5 dead sea lions | 18 |
| 5th Street | 4/14/2008 | 2008 | stranded harbor seal | 19 |
| 5th Street | 9/26/2008 | 2008 | 1 dead sea lion | 20 |
| 5th Street | 8/18/2008 | 2008 | 1 dead seal, 1 dead sea lion | 22 |
| 5th Street | 5/19/2009 | 2009 | 3 dead seals | 25 |
| 5th Street | 7/27/2009 | 2009 | 1 dead seal | 26 |
| Silver Strand | 5/29/2008 | 2009 | 1 dead seal | 27 |
| Ormond 3 | 7/5/2007 | 2007 | 1 dead harbor seal, 1 dead sea lion | 29 |
| Ormond 3 | 8/16/2007 | 2007 | 1 dead sea lion | 30 |
| Ormond 3 | 7/12/2008 | 2008 | 3 dead sea lions | 33 |
| Ormond 3 | 9/19/2008 | 2008 | 1 dead sea lion | 34 |
| Ormond 3 | 7/22/2009 | 2009 | 5 dead sea lions | 39 |
| Ormond 3 | 20/5/2009 | 2009 | 3 dead sea lions | 42 |
| Ormond 2 | 1/18/2008 | 2008 | 1 dead elephant seal | 43 |
| Ormond 2 | 7/12/2008 | 2008 | 1 dead sea lion | 44 |
| Ormond 2 | 10/30/2008 | 2008 | 1 dead sea lion, | 45 |
| Ormond 2 | 4/24/2009 | 2009 | 1 dead sea lion | 46 |
| Ormond 2 | 6/22/2009 | 2009 | 5 dead sea lions | 51 |
| Ormond 2 | 7/22/2009 | 2009 | 2 dead sea lions | 53 |
| Ormond 2 | 5/25/2010 | 2010 | 1 dead sea lion | 54 |
| Ormond 2 | 6/8/2010 | 2010 | 1 dead sea lion | 55 |
| Ormond 1 | 11/21/2007 | 2007 | 1 dead sea lion | 56 |
| Ormond 1 | 8/19/2008 | 2008 | 1 dead sea lion | 57 |
| Ormond 1 | 6/22/2008 | 2009 | 3 dead sea lions | 60 |
| Ormond 1 | 9/25/2009 | 2009 | 2 dead sea lions | 62 |
| Ormond 1 | 10/23/2009 | 2009 | 1 dead sea lion | 63 |
| Ormond 1 | 6/8/2010 | 2010 | 1 dead sea lion | 64 |
| Leo Carrillo | 2/22/2008 | 2008 | 1 dead seal | 65 |
| Leo Carrillo | 10/23/2009 | 2009 | 1 dead sea lion | 66 |