

# Reassessment of a Western Hemisphere Shorebird Reserve Network Site: Kachemak Bay, Alaska

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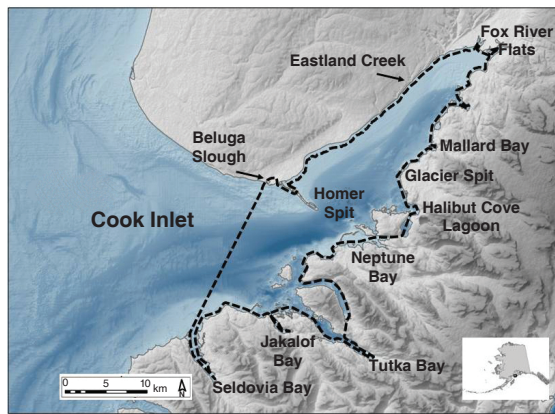
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Two portions of Kachemak Bay, Mud Bay and Mariner Park on the Homer Spit and the Fox River Flats, Alaska, are recognized collectively as a site of International Importance for shorebirds within the Western Hemisphere Shorebird Reserve Network (WHSRN). These sites were designated based on observations collected between the 1970s and 1990s that indicated more than 100,000 shorebirds stopped at the sites each spring during their northbound migration. As part of an effort to assess shorebird use of this area, the Kachemak Bay Birders (KBB), a volunteer citizen-science organization, conducted ground surveys along Homer Spit and nearby waters between 2009 and 2011. They also conducted a series of aerial surveys along the Kachemak Bay coastline in 2010. After restricting data to areas and time periods comparable to historic data, we found the average number of birds observed from the ground on the Homer Spit was down by one-third compared to previous counts (18,436 prior to 1995 versus 7,055 observed between 2009 and 2011). Most of this change was due to a drop in the number of Western Sandpipers *Calidris mauri*, the most numerous shorebird species observed. Numbers of other species fluctuated from year to year but not as much, and the overall species composition remained the same although several new species were observed in low numbers. Contemporary aerial surveys indicated a large qualitative decline in the number of birds on the Fox River Flats relative to aerial surveys conducted during the 1970s–1990s. We discuss the possibilities that these changes represent a temporary decline, a decrease in the use of the area, a reduction in population size of the more common species, or just an artifact of changing methodologies. We also discuss issues to consider when reassessing a WHSRN (or other) designation should contemporary surveys show its declining importance to birds. Finally, we advocate for a broader-based survey within Cook Inlet and along the Pacific Flyway to better understand the trends observed at Kachemak Bay.

## INTRODUCTION

The Western Hemisphere Shorebird Reserve Network (WHSRN) is a conservation strategy that links key shorebird sites in breeding, migration, and wintering areas in the Americas ([www.whsrn.org/western-hemisphere-shorebird-reserve-network](http://www.whsrn.org/western-hemisphere-shorebird-reserve-network)). These sites are each recognized at levels of regional, international, or hemispheric importance for the number of shorebirds or percentage of the biogeographic population of a given species present at the site. Singly and collectively these sites focus conservation efforts on shorebirds. To be included in the WHSRN, the landowner(s) of the site must agree to make shorebirds a conservation priority, to protect and manage the site for shorebirds, and to update the WHSRN at least annually in the event of changes in the site's status (e.g., boundaries, degree of protection; [www.whsrn.org/selection-criteria](http://www.whsrn.org/selection-criteria)). Despite this agreement, there are no legally binding documents that prohibit sites from being developed in any way.

Currently there are 85 WHSRN sites in 13 countries, ranging from Alaska to Argentina ([www.whsrn.org/sites/list-sites](http://www.whsrn.org/sites/list-sites)). Alaska has five sites: the Yukon Delta National Wildlife Refuge, Nushagak Bay, Kvichak Bay, the Copper River Delta, and Kachemak Bay, although an additional 47 sites have been identified as meeting one or more WHSRN criteria (Alaska Shorebird Group 2008). The Kachemak Bay WHSRN site is composed of two areas which were designated separately but are considered one site within WHSRN: Mud Bay and Mariner Park on the Homer Spit, and the Fox River Flats. These sites were collectively designated as a single site of International Importance in January 1995 based on the fact that more than 100,000 shorebirds were documented stopping at these locations in the 1970s during their northward migration ([www.whsrn.org/site-profile/kachemak-bay](http://www.whsrn.org/site-profile/kachemak-bay)). Data that fed into this 100,000 estimate came from ground surveys conducted by GW (1996, unpubl. data) on the Homer Spit and aerial surveys conducted by the Alaska Department of Fish and Game (Erikson 1977) and others at Fox River Flats (Gill



**Fig. 1.** Location of Kachemak Bay, Alaska, and the approximate aerial survey route (black dashed line) conducted at three-day intervals between 1 and 13 May 2010. Sites where shorebirds were observed in concentrations are identified on the map. Survey areas on Homer Spit are shown in Fig. 2.

& Tibbitts 1993, Krasnow & Halpin 1981, Senner *et al.* 1981). During spring migration, the intertidal areas of Kachemak Bay are frequented principally by Western Sandpipers, with smaller numbers of Dunlins (see Table 1 for scientific names), Short-billed Dowitchers, Surfbirds, Black Turnstones, Least Sandpipers, Black-bellied Plovers, and a smattering of other species (West 1996; GM unpubl. data).

A key component of WHSRN is the systematic review of sites to evaluate their conservation effectiveness. To accomplish this, the WHSRN Executive Office developed the Site Assessment Tool to:

- 1) assess the state of conservation of sites,
- 2) identify the threats they are facing,
- 3) assess the effectiveness of site management and conservation efforts,
- 4) help sites engage in adaptive management,
- 5) provide standardized information that can be used across the network of sites, and
- 6) contribute to wider protected area monitoring schemes ([www.whsrn.org/tools](http://www.whsrn.org/tools), Valencia 2005).

The reassessment of conservation sites is increasing around the world, especially as sites are losing the values for which they were initially designated (Hockings *et al.* 2000, Parrish *et al.* 2003).

In collaboration with the City of Homer and the Alaska Department of Fish and Game, GM applied the Site Assessment Tool to the Kachemak Bay WHSRN site in 2009. As part of this process, information was needed on contemporary shorebird use of the WHSRN site. Fortunately, GM and other members of the KBB had begun conducting ground surveys along the Homer Spit and adjacent waters during spring migration in 2009; these surveys continued in 2010 and 2011. In addition, the KBB conducted fixed-wing aerial surveys along the coast of Kachemak Bay in 2010 to determine whether large concentrations of shorebirds were occurring in locations away from Homer Spit. Here we directly compare contemporary and previous counts of birds made in portions of the Homer Spit and the larger Kachemak Bay where historic data are available. Detailed information on the temporal and spatial distribution of shorebirds observed in other areas of Kachemak Bay (i.e., at specific dates and sites away from those areas surveyed historically) is available on the KBB website ([kachemakbaybirders.org](http://kachemakbaybirders.org)). We discuss several pos-

sible explanations for the changes observed, when and if a WHSRN site should be down-graded or delisted, and the need for broad-based surveys of shorebirds at Pacific Coast migration stopover sites and the value of citizen science networks for conducting such work.

## METHODS

### Study area

Kachemak Bay is a 64-km long, funnel-shaped fiord in the Lower Cook Inlet region of Alaska (Fig. 1). The head of Kachemak Bay is characterized by extensive tidal flats, braided drainages, and marshlands. The northern shore consists of cliffs composed mostly of sand, coal seams, and clay leading down to shallow mud flats. The southern shoreline consists of hard rock cliffs and deep embayments. Many islands are also found along the southern shore. With about 515 km of shoreline, plus tides that reach nearly 9.1 m between extreme highs and lows, Kachemak Bay has extensive intertidal areas available on which staging shorebirds can feed.

Homer Spit divides Kachemak Bay into inner and outer zones that differ in freshwater influence and in wave action (KBNERR 2005). The outer saline bay is a mixing basin for the cold, saline, nutrient-rich Alaskan coastal current. It is a high wave-energy environment that receives the full force of swells from across the inlet. The inner bay has a lower salinity and remains calmer because the Homer Spit blocks the swells from the inlet. The majority of the city of Homer (population 5,003 based on 2010 census) is located on the mainland at the base of the Spit, with a fairly large boat harbor, and a multitude of recreational and tourist facilities occurring on the Spit proper. Besides the city of Homer and a few small communities, most of Kachemak Bay is in relatively pristine condition and nearly all the tidal and submerged land has been designated both as a State of Alaska Critical Habitat Area and a National Estuarine Research Reserve.

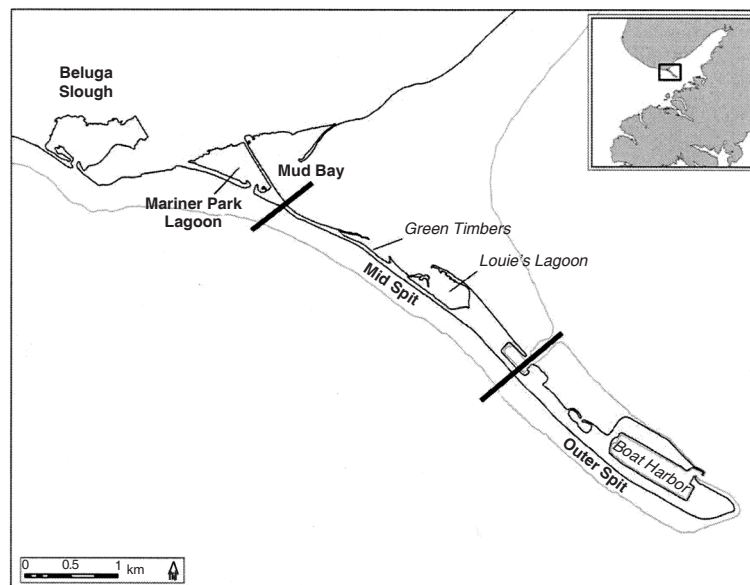
Two portions of Kachemak Bay are included in the WHSRN designation: Mariner Park Lagoon and Mud Bay on the Homer Spit (c.395 ha) and the Fox River Flats in the upper reaches of the Bay (17,544 ha; Figs 1 & 2). A portion of the WHSRN site has some protective status: 65 ha of Mariner Park Lagoon and Mud Bay are zoned for either Conservation or Outdoor Space and Recreation by the city of Homer; and 2,875 ha of the Fox River Flats is a designated state critical habitat area.

### Shorebird surveys

#### Ground surveys

Between 2009 and 2011, the KBB, a volunteer citizen-science organization, conducted ground surveys on or near the Homer Spit (Fig. 2). Members of this group are experienced birders and are familiar with the birds in the Kachemak Bay area. Survey areas included Mud Bay, Mariner Park Lagoon, the Mid Spit including Louie's Lagoon and Green Timbers area, and the Outer Spit including the boat harbor and the shoreline near the Land's End Hotel. In addition, surveys were conducted at Beluga Slough, and islands and islets within Kachemak Bay, including Sixty-foot Rock, Cohen Island, Lancashire Rocks, and Neptune Bay, by crew members of the Bay Excursions charter company. Data from the latter locations are not summarized below (see [kachemakbaybirders.org](http://kachemakbaybirders.org)).

We conducted surveys between 16 April and 26 May 2009, between 15 April and 25 May 2010, and 14 April and 24



**Fig. 2.** Map of the Homer Spit showing ground areas surveyed. Thick black bars separate the Outer and Mid spits, and the Mid Spit and Mud Bay and Mariner Park Lagoon survey areas.

May 2011. These dates bracket the beginning and end of the spring shorebird migration based on prior records (Senner *et al.* 1981, West 1996). Surveys were conducted using a modified version of the PRISM/International Shorebird Survey (ISS) Monitoring protocol ([www.shorebirdworld.org](http://www.shorebirdworld.org)). First six teams of two or three (rarely one) people, as opposed to a single observer in the PRISM/ISS protocol, conducted surveys simultaneously at all ground sites. Observers used primarily scopes and occasionally binoculars to count all birds for a 2-hr period within each survey area beginning when the outgoing tide was at 4.57 m (15 ft) or at high tide when the high tide was less than 4.57 m. This tide height provided the best opportunity for observers to record species and number of shorebirds. Observers also recorded the time and the direction that any flocks flew in or out of their survey area to identify duplicate counts of individuals. A second difference between these surveys and the PRISM/ISS protocol were that these surveys were conducted every five days (as opposed to ten days). Based on turnover rates that averaged less than 2.2 days for Western Sandpipers (the most abundant species in the counts) on the Copper River Delta, the Yakutat Forelands, and Cook Inlet (Bishop & Warnock 1998, Warnock & Bishop 1998), the five day interval between surveys almost surely resulted in independent counts of Western Sandpipers. No comparable data on turnover rates are available for other species; therefore we assumed a 5-day turnover rate for them as well; we consider this is not unreasonable given that they have comparable migration chronology and use of stopover sites in the Pacific Flyway to Western Sandpipers. Thus, combining counts across all survey dates is unlikely to lead to double counting birds and may underestimate the true number of birds present. We did not correct our counts for the probability of birds being detected because we felt most birds were detected on the open mudflats. Nevertheless, our counts should be viewed as estimates of the minimum number of birds present.

For the historic comparison, we restricted our ground counts to areas surveyed in both time periods (i.e., data from Beluga Slough and islands were removed), and then limited the data collected by GW to those dates on which we collected data (or as close as possible). This resulted in six surveys conducted once every five days between 26 April and 21

May for 1986, 1989–1994 and 2009; between 25 April and 20 May 2010; and between 24 April and 19 May 2011. We could not control for the fact that West (1996, unpubl. data) conducted his survey alone and drove from site to site over a 2–3 hr period, whereas we had teams of people who conducted simultaneous surveys of the entire study area within a 2-hr period.

### Aerial surveys

Aerial surveys were conducted once every three days between 1 and 13 May 2010, the range of dates thought to encompass most shorebird migration in the area (Fig. 1). This survey provided information on the Fox River Flats – the portion of Kachemak Bay WHSRN site that could not be accessed from the ground – as well as many other bays, coves and small river deltas. Surveys were conducted from a Cessna 206 on floats at about 46 m (150 ft) altitude and 160 kph (100 mph) beginning 3.5 hrs before high tide. The pilot positioned the plane so it traveled over the intertidal areas, increasing the likelihood roosting shorebirds would flush and be more easily observed. In areas with wide tidal flats, the pilot circled numerous times so as to flush all the shorebirds within the area. Two observers located in the back seat of the aircraft collectively located and counted the birds. A third person recorded the data and GPS locations of the flocks observed for future mapping. The number of birds were estimated and quantified by size class, including small (e.g., sandpipers), medium (e.g., plovers) and large (e.g., whimbrels and godwits), however because the vast majority of observations were of small shorebirds (98.7%), we do not differentiate by size in our presentation of the data below. Typically, each entire survey lasted 1.6 to 1.8 hrs. Like the ground surveys, we did not apply a detection correction to our observations so the numbers counted are likely an underestimate of the number of birds present. Additionally, we feel that few individuals were double counted if turnover rates were as high as in previous studies (Bishop & Warnock 1998, Warnock & Bishop 1998). The number of birds observed is presented by location and date. We could not make quantitative historic comparisons since previous surveys were conducted only once and did not follow the same procedures as ours (e.g., tide height was not

controlled for, coastlines were not followed systematically; see e.g., Erikson 1977). We do, however, provide an overview of counts in the discussion for comparative purposes.

## RESULTS

### Ground surveys

After limiting data to consistent locations and sampling periods, we found that there was a significantly higher number of birds observed in the early survey years relative to the 2009–2011 period (1986–1994:  $18,436 \pm 10,043$  [ $\pm$ SD]; 2009–2011:  $7,055 \pm 1,945$ , t-value for unequal variance = 2.875, df = 6.9,  $P = 0.024$ ; Table 1). Most of this change was due to a drop in the number of Western Sandpipers, the most numerous species recorded. The highest count of 20,725 Western Sandpipers occurred in 1992, while the lowest of 3,071 occurred in 2009 (Table 1). This is true even if the 103 unidentified sandpipers (i.e., a combination of Western, Least, and Semipalmated Sandpipers) recorded in 2009, 640 recorded in 2010, and 2,987 recorded in 2011 are added to the Western Sandpiper total. The numbers of other species fluctuated from year to year, but not to anything like the same extent. In 2009, fewer shorebirds were observed than in any other year. The number of shorebirds recorded in 2010 and 2011 were the third and fourth lowest counts after the low counts of 1990 and 2009. The lowest counts during the historic survey period were in 1990 and 1993. Other notable trends across survey years were a steady increase in the number of Semipalmated Plovers, and increasing numbers of several scarce species, including Pacific Golden-Plover, yellowlegs, Whimbrel, Wandering Tattler, and Least Sandpiper.

### Aerial surveys

A total of 4,843 shorebirds were observed at 14 sites in Kachemak Bay during aerial surveys conducted between 1 and 13 May 2010 (Table 2, Fig. 1). Only 750 birds were counted on the Fox River Flats – part of the Kachemak Bay WHSRN site – over five survey periods. Over 75% of the shorebirds were observed on 13 May, the last day of our aerial surveys. The largest count occurred at Seldovia Bay with 1,870 shorebirds, although five other sites had at least 100 shorebirds present throughout the surveys. Mud Bay on the Homer Spit was the only site where shorebirds were observed consistently across survey dates.

## DISCUSSION

### Reassessment of Kachemak Bay

This study and previous investigations show that Kachemak Bay remains an important resting and refueling site for shorebirds as they travel between the Copper River Delta and the breeding grounds in W Alaska and Russia (Andres & Browne 1998, Bishop & Warnock 1998, Warnock & Bishop 1998). Using the definition of staging and stopover sites in Warnock (2010), it seems likely that Kachemak Bay serves as stopover rather than a staging site, based on high turnover rates (Bishop & Warnock 1998, Warnock & Bishop 1998) and the temporary nature of shorebird use of Kachemak Bay (2–3 weeks, West 1996, our data). The presence of large concentrations in the 1970s led to the initial designation of two areas of Kachemak Bay as a Site of International Importance within WHSRN in 1995. Due to declines in many shorebird

species (Bart *et al.* 2007, Morrison *et al.* 2006) and possible changes in habitat quality or quantity, reassessment of sites such as Kachemak Bay are needed to maintain and implement conservation plans at these important locations (via for example the Site Assessment Tool, Valencia 2005). Part of this assessment is to evaluate the current number and diversity of shorebirds using an area.

Kachemak Bay is ideally suited for reassessment because surveys were conducted prior to the designation of the area as a WHSRN Site of International Importance. A comparison of our recently acquired ground data with historic information appears to show a substantial decline in the number of shorebirds using Kachemak Bay (Table 1). The ground surveys at Homer Spit indicated about one-third of the average number of birds previously observed currently uses the area. An even larger decline seems likely given that Senner *et al.* (1981) counted >25,000 Western Sandpipers in a  $300 \times 500$  m section of Mud Bay alone. The small number of birds observed at the Fox River Flats pales in comparison to historic counts. Indeed, an observation of 1–2 million “small shorebirds” was reported on the Fox River Flats on 11 May 1976 (in Erikson 1977). Similarly, more than 600,000 small shorebirds were recorded on 6 May 1977 in the same area (Senner *et al.* 1981). Smaller numbers (60,000 in the first week of May 1977, Krasnow & Halpin 1981; 98,703 in early May 1993, Gill & Tibbitts 1993) have been observed since these very large counts but they are still substantially larger than the survey estimates obtained in 2009–2011. It is possible that the initial estimate of 1–2 million shorebirds was a gross overestimate (no photo-verification was conducted in 1977) and it seems possible that historic use was closer to 100,000–300,000. Our recent estimates of the number of shorebirds using the entire Kachemak Bay coastline may also be biased low. The fact that observers counted the largest number of birds during the last aerial survey (Table 2) suggests that the peak arrival might have occurred later. It seems unlikely however that high numbers would have continued for more than a few days (based on ground surveys) and consequently would not have reached historic levels (even 100,000).

### Is the decline in shorebird numbers real?

Given that we have ground surveys for only three years (2009–2011), it is difficult to know if our counts represent a temporary decline, an overall decrease in the use of the area, a reduction in population size of the more common species, or just an artifact of changing methodologies. A temporary decline might occur if weather patterns altered their migration patterns, perhaps leading to birds bypassing this area as they proceeded to their breeding grounds in W Alaska and Russia. During our study, 2010 was colder than normal (*ine.uaf.edu/accap//dispatch.htm*), perhaps resulting in the late arrival of birds. The number of birds, however, was higher than that observed in 2009, suggesting that the cold weather did not alter the number of birds using the Homer Spit area. Lacking aerial survey data for multiple years for the entire Kachemak Bay, we cannot say whether bird numbers changed at a greater scale.

A second explanation for the changes in shorebird use at Kachemak Bay could be due to birds shifting to the opposite side (i.e., west) of Cook Inlet. Embayments along the west side of the Lower Cook Inlet were used regularly by large numbers of shorebirds during migration between 1997 and 1999 (Gill & Tibbitts 1999). Indeed, Redoubt Bay had >10,000 birds on average per day, while Trading Bay and

**Table 1.** Aggregate total numbers of shorebirds counted during six surveys conducted at 5-day intervals at Mud Bay, Mariner Lagoon, Mid Spit and Outer Spit on the Homer Spit, Kachemak Bay, Alaska, between 26 April and 21 May of 1986, 1989–1994 and 2009; between 25 April and 20 May of 2010; and between 24 April and 19 May 2011. See Fig. 2 for location of areas surveyed. (\* Unidentified sandpipers are likely to be a mixture of Western, Least & Semipalmated Sandpipers.)

Species	1986	1989	1990	1991	1992	1993	1994	2009	2010	2011
Semipalmated Plover <i>Charadrius semipalmatus</i>	6	8	1	9	27	22	28	159	158	142
American Golden-Plover <i>Pluvialis dominica</i>			5	26	9		1	3		
Pacific Golden-Plover <i>Pluvialis fulva</i>							7	4	39	2
Black-bellied Plover <i>Pluvialis squatarola</i>	275	1	86	52	244	51	79	170	307	241
Black Oystercatcher <i>Haematopus bachmani</i>									1	
Greater Yellowlegs <i>Tringa melanoleuca</i>					17	4		7	13	19
Lesser Yellowlegs <i>Tringa flavipes</i>									20	3
Yellowlegs species									3	
Whimbrel <i>Numenius phaeopus</i>				1	9	1		2	6	14
Bar-tailed Godwit <i>Limosa lapponica</i>				1	2			3		
Hudsonian Godwit <i>Limosa haemastica</i>							1	18		2
Marbled Godwit <i>Limosa fedoa</i>		4		1	1		2	3	10	1
Wandering Tattler <i>Tringa incana</i>				5	2	1	2	3	37	20
Surfbird <i>Aphriza virgata</i>	1,000	75	3,015	602	10,010	1,200	830	69	39	238
Ruddy Turnstone <i>Arenaria interpres</i>	1		3		7	1	8		6	
Black Turnstone <i>Arenaria melanocephala</i>	600	451	1,812	766	1,730	500	262	46	294	89
Western Sandpiper <i>Calidris mauri</i>	14,000	12,025	2,010	20,510	20,725	7,200	17,469	3,071	4,935	3,908
Least Sandpiper <i>Calidris minutilla</i>	50			2	21	2	20	121	195	169
Semipalmated Sandpiper <i>Calidris pusilla</i>								1	4	3
Unidentified sandpipers*								103	640	2,987
Sanderling <i>Calidris alba</i>									1	8
Pectoral Sandpiper <i>Calidris melanotos</i>	2			1	1					0
Dunlin <i>Calidris alpina</i>	130	1,760	133	1,219	3,271	562	642	1,091	535	938
Rock Sandpiper <i>Calidris ptilocnemis</i>					7	2				0
Baird's Sandpiper <i>Calidris bairdii</i>								1		
Red Knot <i>Calidris canutus</i>						1	2			
Short-billed Dowitcher <i>Limnodromus griseus</i>	600	525	58	183	1,354	325	175	22		32
Dowitcher species <i>Limnodromus</i> spp.								97	71	42
Red-necked Phalarope <i>Phalaropus lobatus</i>				100			100			1
<b>Total</b>	<b>16,664</b>	<b>14,849</b>	<b>7,123</b>	<b>23,478</b>	<b>37,437</b>	<b>9,872</b>	<b>19,628</b>	<b>4,994</b>	<b>7,314</b>	<b>8,858</b>

**Table 2.** Number of shorebirds counted during aerial surveys of Kachemak Bay in 2010. See Fig. 1 for location of sites. Mud Bay and Fox River Flats are part of the Kachemak Bay WHSRN site.

Location	1 May	4 May	7 May	10 May	13 May	Total
Beluga Slough	0	0	0	0	88	88
Mid Spit	74	0	0	25	1	100
Millers Landing	15	0	0	0	0	15
Mud Bay	11	400	150	27	700	1,288
Eastland Creek	0	0	0	0	50	50
Fox River Flats	7	90	0	65	588	750
Mallard Bay	0	0	0	0	1	1
Glacier Spit	60	0	0	0	350	410
Halibut Cove Lagoon	0	40	0	0	0	40
Neptune Bay	0	0	200	0	0	200
Tutka Bay	0	0	0	0	29	29
Jakolof Bay	0	0	2	0	0	2
Seldovia Bay	0	0	0	0	1,870	1,870
<b>Total</b>	<b>93</b>	<b>604</b>	<b>352</b>	<b>117</b>	<b>3,677</b>	<b>4,843</b>

Tuxedni Bay had between 1,001 and 10,000 birds per day during spring migration. One portion of southern Redoubt Bay supported over 24,000 birds per day. Tracking of Western Sandpipers equipped with radio transmitters indicated that six of nine birds relocated stopped on the west side of Cook Inlet in 1995 and 1996 (Bishop & Warnock 1998). These large counts and the preponderance of telemetry relocations support the notion that shorebirds may have shifted to the west side of Cook Inlet, although this is impossible to know without conducting surveys simultaneously across all of Cook Inlet.

If a shift did occur then a relevant question might be whether something has changed in Kachemak Bay to cause such a shift. During the recent site assessment in January 2009, GM and colleagues did not identify any major changes in habitat conditions that had occurred in the area since the 1970s. In fact, much of Kachemak Bay is protected in one way or another and appears to be in relatively pristine condition. The small exception is parts of Homer Spit regularly visited by people vacationing during the spring and summer months; human disturbance here has surely increased over the past 40 years (GW & GM, pers. obs.). However, most of this disturbance is restricted to one portion of the Spit and the main shorebird areas (i.e., Mud Bay and Mariner Park) are typically left alone. It is possible that the quality of Kachemak Bay has been lowered due to oil contamination coming from boats using the medium-sized boat harbor, as well as a small amount of oiling that occurred shortly after the Exxon Valdez oil spill on 24 March 1989. Invertebrates may have ingested some of these contaminants, negatively affecting migrating shorebirds that feed on the mudflats. None of these changes seem very significant however considering that Kachemak Bay is very large and the main historic shorebird stopover site (Fox River Flats) is 64 km from any of these disturbances.

A third explanation for the trends observed at Kachemak Bay is that the global population of Western Sandpipers, the predominant species, has declined. Morrison *et al.* (2006) considered that the global population of the Western Sandpiper was possibly declining although B. Andres (unpubl. data) concluded the population was stable based on data from the International/Maritime Shorebird Survey and the Christmas Bird Count. To us, it is unclear whether the population is stable or declining. Data from other sites on the Canadian Pacific coast are consistent with the apparent declines observed in Kachemak Bay (Butler & Lemon 2001), although

the declining numbers are thought to be in part due to Western Sandpipers migrating through the area more rapidly to avoid increasing predation risk from Peregrine Falcons *Falco peregrinus* (Ydenberg *et al.* 2004). Predator numbers on the Homer Spit have likely declined due to an ordinance banning people from feeding Bald Eagles *Haliaeetus leucocephalus*; trends in the numbers of other avian predators in the greater Kachemak Bay area are unknown.

Finally, a fourth explanation for the apparent declines is that the likelihood of detecting shorebirds may have declined through time (Bart *et al.* 2007). Such a decline in detection might occur due to changes in the way observers survey birds. This seems unlikely, especially with regard to our ground surveys, because we compared historic and contemporary data that were collected in the same area and on virtually the same dates, and the survey window encompassed the entire migration period (i.e., there was no temporal shift). If anything, the likelihood of detecting shorebirds may have actually increased due to the fact that we had multiple observers conducting surveys simultaneously rather than only a single observer. In contrast, aerial survey methods did differ substantially through time; contemporary surveys were conducted more systematically (multiple times within a year and close to high tide to get maximum counts of birds) and thus should have resulted in higher counts (not lower as we found). It is possible that we stopped our aerial surveys too soon in 2010, although data from the ground surveys indicate shorebird numbers declined within a few days of stopping our aerial counts.

### Should conservation sites be down-graded or delisted?

Kachemak Bay was originally designated a Site of International Importance based on the fact that >100,000 shorebirds were documented as using the area. Had this site designation been based on data collected during surveys conducted between 2009 and 2011, Kachemak Bay might have ranked as a Site of Regional Importance at best. These facts beg several questions pertinent to any site that has received some designation of importance. For example, should a site be downgraded or delisted when information suggests it is no longer being used at historic levels? If the answer is yes, then what type of information is needed before a site is down-graded or

delisted? All ecological systems evolve over time and most of their ecological attributes have some temporal variation (Landres *et al.* 1999); therefore the question becomes what is the “acceptable range of variation” (Parrish *et al.* 2003) under which we should continue to support the designated status quo? One could argue that an overwhelming amount of evidence should be accumulated, especially considering the fact that a site might be needed in the future should a depressed population rebound. This argument suggests that an area be managed for potential future needs rather than present needs. Another factor to consider is that a site’s designation may be based on either the total number of shorebirds using it or the percentage of a biogeographic population it supports (1, 10 or 30% depending on whether it is a Regional, International or Hemispheric site). The latter criterion is particularly valuable since the number of individuals needed to qualify a site at each level changes as the overall population changes. Thus sites could still be designated as important even if the number of shorebirds using the area declines. Moreover an area may become important to other species through time and such changes also would need to be included in any reassessment. In the case of Kachemak Bay, we suggest that the current WHSRN designation be maintained until more is learnt about population sizes and trends, the way in which the site is used, and the reasons for the variations in numbers and phenology observed, especially in respect of the dominant migratory species using the area. After all, retaining sites such as Kachemak Bay is essential if there is to be any hope that declining species will eventually recover.

### Implementation of coast-wide surveys along the Pacific Flyway

A proper understanding of shorebird use of migration sites along the Pacific Flyway would require a large-scale survey throughout the entire flyway over a period of several years. Such a survey was conducted in California, Oregon and Washington between 1988 and 1995 (Page *et al.* 1999) and a more comprehensive Pacific Flyway Shorebird Survey is currently being initiated (M. Reiter & R. Butler, pers. comm.). More localized surveys have been conducted at migration sites in British Columbia (Butler & Lemon 1991) and Alaska (Andres & Browne 1998, Bishop & Meyers 2000, Iverson *et al.* 1996). Conducting such large-scale surveys requires extensive coordination and effort by a large number of organizations and their staff. We believe many of these obstacles can be overcome by instituting a citizen science network that relies on people volunteering their time to conduct surveys. The work at Kachemak Bay has already led to interest by volunteers at other National Estuarine Research Reserves to begin similar surveys. A comparable network called the International/Maritime Shorebird Survey has been in operation on the eastern coast of North America since 1974, and has provided some of the first statistically-derived population trends for shorebirds (Bart *et al.* 2007). The time seems right to replicate this successful program on the Pacific Coast of the United States and Canada so that counts at Kachemak Bay can be viewed in a larger context.

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A flock of Rock Sandpipers flying over the Mid Spit area, Kachemak Bay, Alaska. A couple of thousand Rock Sandpipers overwinter at Homer Spit and begin departing when spring migrant shorebirds start arriving. The Rock Sandpipers often forage in Mud Bay (photo: George Matz).



George Matz scanning for shorebirds at the Mariner Park Lagoon viewing platform, Kachemak Bay, Alaska (photo: Carol Harding).