PRISM Shorebird Surveys on the Alaska Peninsula/Becharof National Wildlife Refuge and Surrounding Areas

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Prepared by

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Key Words: Alaska Peninsula, Becharof, common snipe (*Gallinago gallinago*), dunlin (*Calidris alpina*), greater yellowlegs (*Tringa melanoleuca*), habitat, least sandpiper (*Calidris minutilla*), Pacific golden plover (*Pluvialis fulva*), Program for Regional and International Shorebird Monitoring, red-necked phalarope (*Phalaropus lobatus*), short-billed dowitcher (*Limnodromus griseus*), shorebirds

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The Program for Regional and International Shorebird Monitoring (PRISM) is a collaborative effort to develop a long-term monitoring program for shorebirds in North America. The goals of PRISM are to (1) estimate the size of breeding populations of 74 shorebird taxa in North America; (2) describe shorebirds' distribution, abundance, and habitat relationships; (3) monitor trends in shorebird population size; (4) monitor shorebird numbers at stopover locations, and; (5) assist local managers in meeting their shorebird conservation goals (Bart et al. 2002). The current program consists of four main components: arctic and boreal breeding surveys, temperate breeding surveys, temperate non-breeding surveys, and neotropical surveys.

In winter of 2001-02, the second author joined the group of biologists supporting PRISM by offering support for arctic shorebird surveys on the Alaska Peninsula/Becharof National Wildlife Refuge and surrounding areas (hereafter the Alaska Peninsula). In this first season of surveys on the Alaska Peninsula, our objective was to gather information on the distribution and abundance of breeding shorebirds. We also planned to collect data on shorebird-habitat associations and assess the accuracy of our GIS land cover map. We will use these baseline data to recommend survey designs for population modeling in subsequent years. Our ultimate goal is to estimate the population size of the shorebird species breeding on the Alaska Peninsula from the Naknek drainage to Port Moller. This was a pilot season, however and we provide population estimates only for the small proportion of the Alaska Peninsula that we surveyed. In this document, we summarize our results from the 2002 field season and present recommendations for future shorebird surveys on the Alaska Peninsula.

METHODS

We conducted shorebird surveys in wetland and tundra habitat on the Alaska Peninsula from 15 May – 5 June. Savage initially selected six areas across the Alaska Peninsula from North Becharof Lake to Chignik. These areas were selected based on wheeled or floatplane access. We acquired GIS land cover information for the Bristol Bay area (Wibbenmeyer et al. 1982) and plotted the potential survey locations on the land cover map. To simplify the survey, we grouped the land cover habitat categories into four habitat types based on their expected association with shorebirds (Fig. 1). Habitat types on the land cover map had a resolution of 50-m pixels. We expected shorebird numbers to be associated with wetland habitats, and therefore, grouped marsh and meadow habitats as wetland. We expected to find some shorebirds in dwarf shrub habitats and grouped all shrub habitats together as tundra. We did not group deciduous or barren habitats. We selected 5 of the 6 areas to survey based on habitat and logistics at each location. The Cinder location was dropped because we lacked land cover information for that area. We drew 5-km radius circles around each landing location from which to select plots.

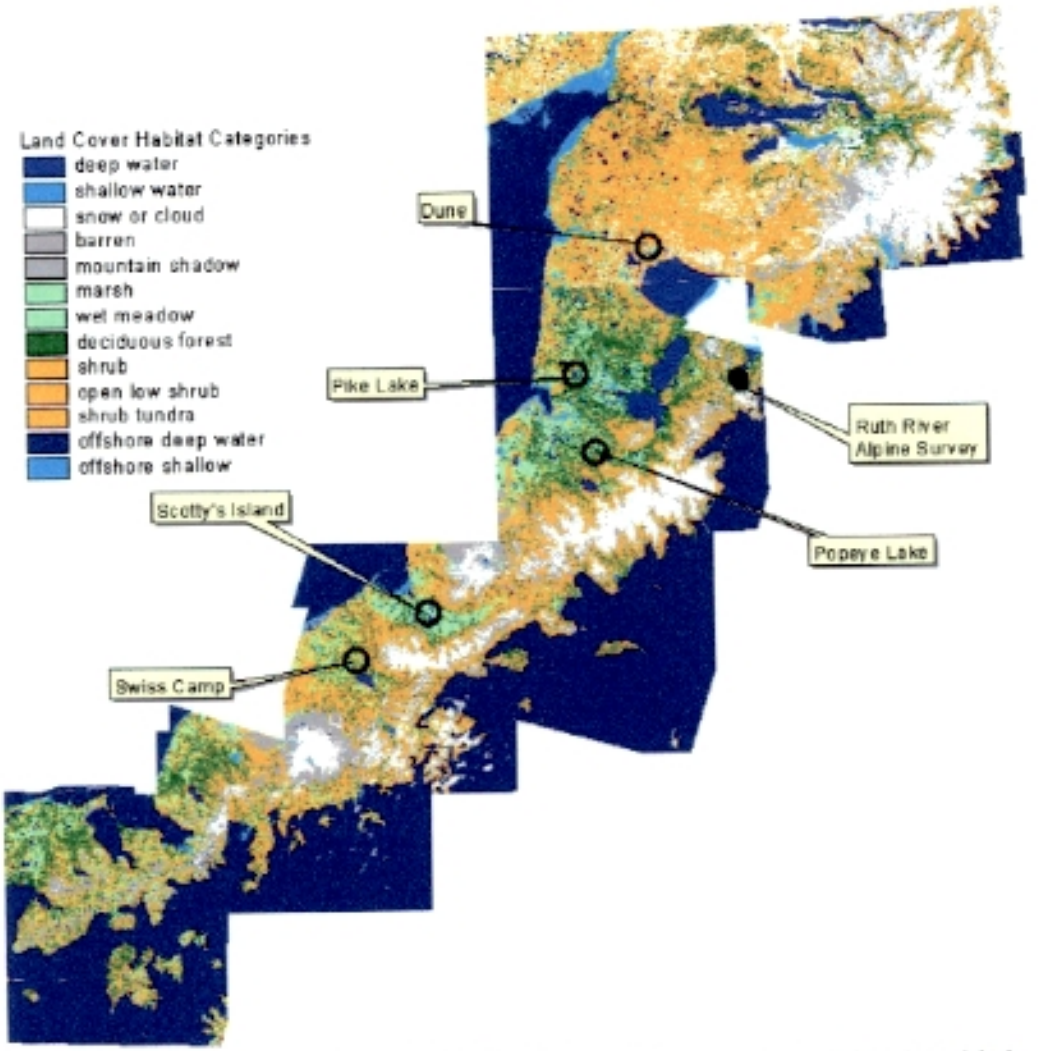

Figure 1. Land cover map of the Alaska Peninsula and areas selected for shorebird surveys. Colors of habitat type indicate groupings. Open circles represent the five wetland and tundra survey locations. Each circle has a radius of approximately 5-km. The closed circle represents the alpine survey area. Map resolution is 50-m^2.

Plots were16-ha squares (400m^2) and we estimated that surveyors would be able to conduct 12 plots/survey location. At each location, we generated 15 random starting points for the plots. We did not stratify the random points by habitat. Some starting points for plots were inaccessible (e.g. in water) and were eliminated from consideration. Each starting point was the northwest corner of the plot. One surveyor systematically covered one 16-ha plot in 1.5 hours. Surveyors recorded all nests and birds observed and kept track of individual birds on each survey. Immediately after completing the survey, the surveyor totaled the estimated number of territorial males on the plot by species.

Once in the field, we found that we could only effectively survey accessible areas within a 2-3 km radius from the landing location. We also discovered that the deciduous category on the land cover maps generally indicated alder thickets. As shorebirds do not

typically use or breed in alder thickets, we eliminated any plots that were approximately 40% or more deciduous. We surveyed all pre-selected plots in wetland or tundra habitat that were within the reduced sampling area. When additional starting points were needed at a survey location, we randomly selected them from within the tundra or wetland habitats.

Three alpine areas were also selected based on access, however only one area was sampled from 2-5 June (Fig. 1). We delineated the alpine areas that were accessible from camp and generated random starting locations for alpine plots as described above. We surveyed plots in tundra and barren habitats in this area.

At each plot we collected general habitat information. Surveyors categorized each plot as barren, tundra or wetland. They described plots further by selecting some of 20 habitat subcategories. They also estimated percent ground cover of bare ground, water and vegetation. Surveyors recorded the dominant moisture level on the plot and described the terrain by recording slope, aspect and relief. We compared our field observations of habitat type with the GIS land cover map to assess the accuracy of the land cover data. Because we do not have general habitat data for the entire study area, we used the land cover habitat data for the population modeling.

To calculate population estimates for the study area, we followed the modeling guidelines in Bart and Earnst (2002). We delineated the total accessible area at each location and summed these as our study area. For each plot, we collected GPS coordinates of the four corners and delineated the survey plots in GIS. We then determined the total area of each plot and the proportion of land cover habitat types in each plot. We calculated species density as the number of each species recorded per plot area. In addition to the seven original terrestrial habitat types, we considered whether survey location, date of survey and distance to coast might be associated with species density. All three were correlated with each other. Thus, we eliminated the date of survey and the distance to coast from the regression models. Survey location was not significantly associated with density for any species; therefore, we did not stratify by location. We retained variables in the models only when their coefficients were positively and significantly different from 0.0 with $\alpha = 0.10$ and when the relationships were consistent with our knowledge of the species' natural history. We estimated the number of territorial males that would be recorded in the study area as

$$\hat{Y} = A(b_0 + b_1 f_1 + b_2 f_2 + \ldots)/d$$

where A is the size of the study area, the bs are the regression coefficients derived from the model-construction process, the fs are the fractions of the study area covered by each habitat type used in the model, and d is the estimated detection rate. When none of the habitat variables were significantly associated with density for a species, we estimated the number of territorial males as density multiplied by study area. We had no estimate of the average detection rates for each species. Therefore, we used a detection rate of 0.80 for all species based on research conducted on the North Slope of Alaska (Bart and

Earnst 2002). We then doubled our estimate of territorial males for an estimate of the breeding population size.

RESULTS

We surveyed 49 plots at the five lowland locations and five plots at the alpine location (Table 1, Appendix I). Dunlins were the most abundant shorebird recorded on survey plots, followed by Least Sandpipers. Common Snipe, Short-billed Dowitchers, Red-necked Phalaropes, and Greater Yellowlegs were also recorded in moderate numbers. In the habitats surveyed, we recorded Black-bellied Plovers, Pacific Golden-Plovers and Semipalmated Plovers breeding in lower densities relative to other shorebirds (Table 2). These three species were recorded in the two northern lowland areas (Dune and Pike Lake) and at the alpine location only. We did not observe these species south of 57° 30' latitude. We regularly observed Marbled Godwits at two survey areas in the central portion of the Peninsula (Pike and Popeye Lakes). We were unable, however, to determine, with confidence, which of the individuals observed were breeding birds. Observers used behavioral clues to decide whether to record individuals as present on the plot. Hudsonian Godwits were observed infrequently, but their breeding status is also uncertain. Therefore, the data recorded for Marbled Godwits and Hudsonian Godwits should be interpreted with care. Three additional shorebird species were observed incidentally. B. Blush observed an American Golden-Plover in the Dune area on 18 May. C. Wightman and A. Leppold observed a pair of Wandering Tatlers near the Popeye Lake camp on 23 May. C. Wightman and C. Adler observed Rock Sandpipers on the Bristol Bay coast at Port Heiden on 26 May. We did not observe this latter species in any of the study areas, however. Shorebird species codes can be found in Appendix II and a list of incidental birds seen on the Peninsula can be found in Appendix III.

Table 1. Number of territorial males for each shorebird species recorded on 16-ha survey plots on the Alaska Peninsula in May and June 2002. Plots 1-49 were conducted in wetland or tundra habitat. Plots 101-105 were conducted in alpine habitat.

ID[1]	BBPL	PAGP	SEPL	GRYE	HUGO	MAGO	WESA	LESA	DUNL	SBDO	COSN	RNPH
1	0	0	0	0	0	0	0	0	3	2	1	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	1	0	1	0
4	0	0	0	0	0	0	0	0	9	0	1	0
5	1	0	0	0	0	0	0	0	0	1	0	0
6	1	1	0	0	0	0	0	0	3	1	2	0
7	0	0	0	0	0	0	0	4	1	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	1	0	0	0	0	0	0	0	1	1
10	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	1	0	0	0	0	0	0	2	0
13	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	1	0	0	1	0
15	0	0	0	1	0	0	0	1	0	0	1	0
16	0	0	0	1	0	0	0	2	1	0	1	0

ID[1]	BBPL	PAGP	SEPL	GRYE	HUGO	MAGO	WESA	LESA	DUNL	SBDO	COSN	RNPH
17	0	0	0	0	0	0	0	1	0	1	1	0
18	0	0	0	0	0	1	0	0	1	0	0	2
19	0	1	0	1	0	0	1	4	3	5	2	1
20	0	0	0	0	0	0	0	0	1	0	1	0
21	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	2	0	0	1	1
23	0	0	0	0	0	0	0	1	0	0	0	0
24	0	0	0	0	2	0	1	2	0	1	0	0
25	0	0	0	0	0	0	0	1	0	0	0	0
26	0	0	0	1	0	0	0	1	0	1	0	2
27	0	0	0	1	0	0	0	2	0	1	0	0
28	0	0	0	3	0	1	1	2	0	0	1	0
29	0	0	0	0	0	0	0	1	0	0	0	0
30	0	0	0	1	0	2	0	0	0	0	2	0
31	0	0	0	0	0	0	0	1	6	0	0	2
32	0	0	0	0	0	0	0	0	3	1	0	1
33	0	0	0	0	0	0	0	1	3	0	0	0
34	0	0	0	0	0	0	0	0	5	0	0	0
35	0	0	0	0	0	0	0	0	5	0	1	0
36	0	0	0	0	0	0	0	0	4	0	0	0
37	0	0	0	0	0	0	0	1	16	1	0	0
38	0	0	0	0	0	0	0	2	4	0	0	0
39	0	0	0	0	0	0	0	1	8	0	0	0
40	0	0	0	0	0	0	0	0	7	0	0	2
41	0	0	0	0	0	0	0	1	2	0	0	0
42	0	0	0	0	0	0	0	2	1	0	0	0
43	0	0	0	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0	1	1	0	0	0
45	0	0	0	0	0	0	0	0	5	0	0	1
46	0	0	0	0	0	0	0	0	3	0	0	0
47	0	0	0	0	0	0	0	0	1	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0	1	0
101	0	0	0	0	0	0	0	0	0	0	0	0
102	0	0	0	0	0	0	0	0	0	0	0	0
103	0	0	1	0	0	0	0	0	0	0	0	0
104	0	0	0	0	0	0	0	0	0	0	0	0
105	0	0	0	0	0	0	0	0	0	0	0	0
Total	2	2	2	10	2	4	3	35	97	15	21	13

[1]general plot information referenced by ID in Appendix I.

Table 2. Number and density of territorial male shorebirds on rapid survey plots on the Alaska Peninsula in 2002.

SPECIES	# OF TERRITORIAL MALES RECORDED	MEAN DENSITY OF TERRITORIAL MALES	SE
BBPL	2	0.25	0.18
PAGP	2	0.23	0.16
SEPL	2	0.22	0.15
GRYE	10	1.21	0.46
HUGO	2	0.23	0.23
MAGO	4	0.46	0.28
WESA	3	0.33	0.19
LESA	35	4.36	0.90
DUNL	97	11.20	2.53
SBDO	15	1.71	0.62
COSN	21	2.55	0.57
RNPH	13	1.54	0.50
ALL SHOREBIRDS	206	24.30	6.77

Based on our field observations of habitat, we surveyed 36 wetland plots, 13 tundra plots, four barren plots and one water plot. We compared these general habitat types with the GIS land cover habitat map to determine whether the land cover map is a reliable indicator of habitat conditions (Fig. 2). The wetland and water habitats had proportionately more marsh and wet meadow habitat and less shrub habitats than the tundra and barren habitats. In general, our comparison suggests that the land cover map is a relatively reliable predictor of field conditions and can be used in future survey planning.

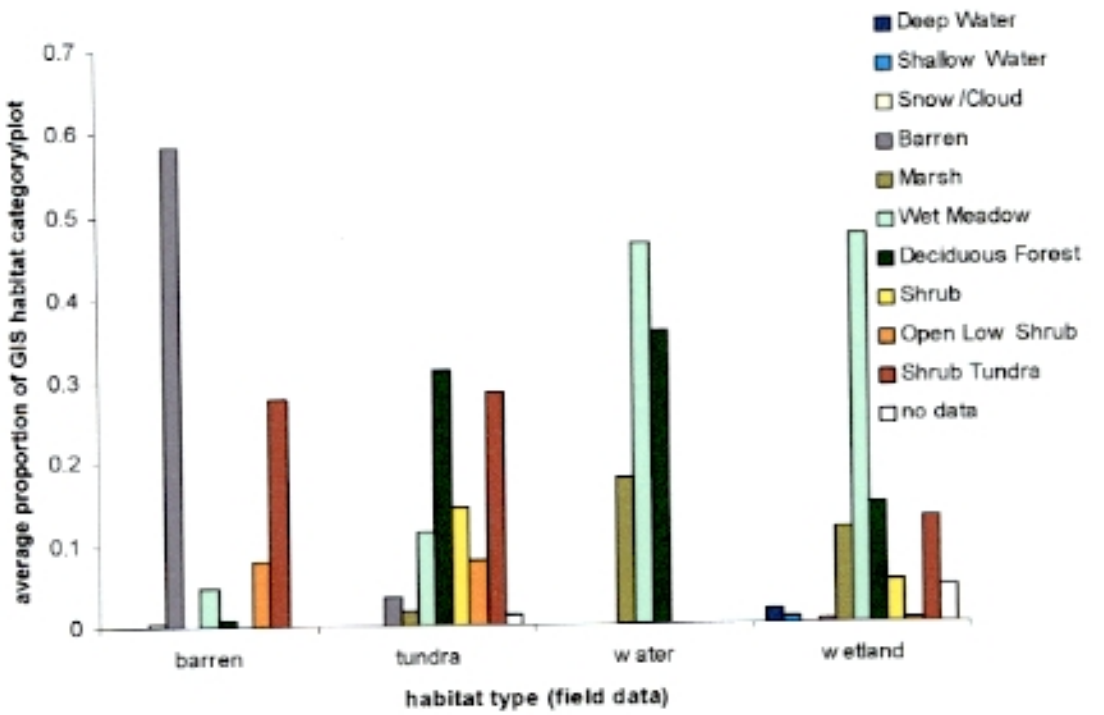

Figure 2. Average proportion of land cover habitat category in each habitat type described in the field. Land cover habitat data has a resolution of $50m^2$.

Of the seven terrestrial habitat types in the land cover map, we found three that were significant predictors of species densities in regression models (Table 3). Wetland habitats were positively and significantly associated with Dunlin, Least Sandpiper, Red-necked Phalarope and Western Sandpiper densities. Wetlands were also the best predictor of Greater Yellowlegs and Short-billed Dowitcher densities, although these associations were not significant. Shrub tundra habitats were significantly associated with Black-bellied Plover and Common Snipe densities. Although not significant, shrub tundra habitats were also the best predictor of Pacific Golden-Plover densities. We also found barren habitat to be a positive predictor of Black-bellied Plover and Semipalmated Plover densities. We did not develop regression models for Marbled Godwits or Hudsonian Godwits because we are uncertain whether our data is representative of the breeding distribution and habitat associations of these species.

Table 3. Regression models using habitat type to predict number of territorial male shorebirds per km^2 on the 2002 study area on the Alaska Peninsula.

SPECIES	VARIABE	COEFFICIENT	SE	T	P	Adj R squared
BBPL	Intercept	-0.08144	0.20156	-0.4	0.6879	0.1253
	ShrubTun	1.28611	0.57917	2.22	0.0308	
	Barren	2.0525	0.88849	2.31	0.025	
PAGP	Intercept	0.07383	0.18691	0.39	0.6945	0.0299
	ShrubTun	0.90461	0.55727	1.62	0.1106	
SEPL	Intercept	0.12101	0.15385	0.79	0.4351	0.0727
	Barren	1.7916	0.78911	2.27	0.0274	
GRYE	Intercept	0.38844	0.6817	0.57	0.5713	0.0287
	wetland	1.82173	1.13719	1.6	0.1152	
WESA	Intercept	-0.04763	0.28068	-0.17	0.8659	0.0415
	wetland	0.84974	0.46823	1.81	0.0753	
LESA	Intercept	2.59509	1.32706	1.96	0.0559	0.0391
	wetland	3.93229	2.21374	1.78	0.0815	
DUNL	Intercept	2.53818	3.50635	0.72	0.4724	0.1566
	wetland	19.26055	5.84914	3.29	0.0018	
SBDO	Intercept	0.72087	0.92771	0.78	0.4407	0.0189
	wetland	2.19874	1.54756	1.42	0.1613	
COSN	Intercept	1.96163	0.65458	3	0.0042	0.0366
	ShrubTun	3.38774	1.95162	1.74	0.0885	
RNPH	Intercept	0.28988	0.73326	0.4	0.6942	0.0735
	wetland	2.79064	1.22319	2.28	0.0266	

We estimated the number of territorial males that would be recorded if rapid surveys were conducted on the entire study area using the regression models for those species with significant habitat associations only (Table 4). We used the total proportion of habitat type in our 126.75 km^2 study area in the regression equations.

We found over 6000 shorebirds total in the delineated study area (Table 5). Our estimates range from approximately 60 Western Sandpipers to almost 2500 Dunlin. The study area represented a very small proportion of available shorebird habitat on the Alaska Peninsula. Therefore, the population size for all species on the Alaska Peninsula is potentially much larger than these estimates.

Table 4. Significant regression equations for shorebird species on the Alaska Peninsula study area in 2002. Habitat names refer to the proportion of habitat in the study area.

SPECIES/KM^2	REGRESSION EQUATION
BBPL	= -0.08144 + 1.28611(shrub tundra[1]) + 2.0525(barren[2])
SEPL	= 0.12101 + 1.7916(barren[2])
WESA	= -0.04763 + 0.84974(wetland[3])
LESA	= 2.59509 + 3.93229(wetland[3])
DUNL	= 2.53818 + 19.26055(wetland[3])
COSN	= 1.96163 + 3.38774(shrub tundra[1])
RNPH	= 0.28988 + 2.79064(wetland[3])

[1]proportion of shrub tundra = 0.249
[2]proportion of barren ground = 0.042
[3]proportion of wetland = marsh + meadow = 0.277

Table 5. Population estimates for all shorebirds recorded on rapid survey plots on the Alaska Peninsula study area in 2002.

SPECIES	DENSITY (KM^2)	DENSITY (KM^2) FROM REGRESSION MODELS	ESTIMATED NUMBER OF TERRITORIAL MALES OBSERVED IF RAPID SURVEYS OF ENTIRE STUDY AREA WERE CONDUCTED	ESTIMATED NUMBER OF TERRITORIAL MALES IN THE STUDY AREA*	ESTIMATED BREEDING POPULATION IN THE STUDY AREA
BBPL		0.32	41	51	103
PAGP	0.23		29	37	73
SEPL		0.20	25	31	62
GRYE	1.21		153	191	383
HUGO	0.23		29	37	73
MAGO	0.46		59	73	147
WESA		0.19	24	30	60
LESA		3.68	467	584	1168
DUNL		7.88	998	1248	2496
SBDO	1.71		217	271	542
COSN		2.81	356	445	889
RNPH		1.06	135	168	337
ALL SHOREBIRDS			2532	3165	6331

*0.80 detection rate used for all species

DISCUSSION

Surveys from the 2002 field season provided us with an inventory of the shorebird species breeding on the Alaska Peninsula/Becharof NWR and surrounding areas. Of special interest is the breeding distribution of Pacific Golden-Plovers. We recorded Pacific Golden-Plovers performing display flights to approximately 57 degrees 30 minutes latitude. The southern limit of breeding Pacific Golden-Plovers was previously recorded as Cape Peirce and the Nushagek River Valley (Johnson et al. 2001). Although we did not find an active nest, our data indicates that the breeding distribution of Pacific Golden-Plovers may extend farther south than previously reported. American Golden-Plovers, Wandering Tatlers and Rock Sandpipers were observed incidentally, but not recorded on our surveys. It is possible that the latter two species are nesting in low densities on the Alaska Peninsula. There may also be a few additional shorebird species that are breeding on the Alaska Peninsula but were not observed incidentally or recorded on our surveys. These species may be present at low densities, may select habitats different from those sampled, or may have been misidentified as a more common species. Future surveys should indicate whether there are additional shorebird species breeding on the Alaska Peninsula. Additional work is also necessary to understand the breeding distribution and habitat associations of Marbled Godwits and Hudsonian Godwits.

Our comparison of the general habitat types observed in the field with the GIS land cover habitat map indicates that the land cover map, on a large scale, is a fairly reliable indicator of habitat conditions (Fig. 2). At Dune, the northern-most survey area, we expected to find relatively dry tundra conditions based on our initial grouping of the land cover habitat categories. On the land cover map, much of this area was classified as shrub tundra, which we initially grouped under the generic shrub category. We found, however, that 5 of the 8 plots in this area were functioning as wetland habitat and were being used by shorebirds, such as Dunlin, that are typically associated with wetter habitats. Wibbenmeyer et al. (1982), in the User's Guide for Bristol Bay Land Cover Maps, describes the shrub tundra habitat on the Alaska Peninsula as typically mesic to wet graminoid/graminoid shrub tundra. We found this shrub tundra habitat to be associated with breeding Black-bellied Plover, Pacific Golden-Plovers and Common Snipe on the Alaska Peninsula. Therefore, in future studies, we recommend that the shrub tundra habitat be separated from the general shrub category and considered suitable shorebird habitat. Our analyses indicate that the other shrub categories are not important predictors of shorebird densities and should be considered unsuitable for shorebirds.

According to our regression modeling, wetland habitats are the best positive predictor of densities for many of the shorebird species breeding on the Alaska Peninsula. For example, Dunlins, the most abundant shorebirds, are very rare (2.5/km^2) when wetland habitat is not present.

We estimated the total population size of shorebird species in the six accessible, surveyed areas. Because much of the Alaska Peninsula was not accessible to us in 2002, our estimates do not reflect a random sample of shorebirds and habitats on the Alaska

Peninsula. Our models are intended to serve as an example of the methods for estimating the regional population size only and should not be applied to the larger area at this time.

RECOMMENDATIONS FOR FUTURE SURVEYS

Our analyses suggest stratifying the Alaska Peninsula into wetland, shrub tundra, barren and unsuitable habitats for future surveys (Fig. 3). One-half to two-thirds of all plots should be randomly selected from within all available wetland habitats. One quarter of all plots should be randomly selected from within shrub tundra habitat and the remainder of plots should be in barren habitats. No plots should be placed in unsuitable habitats, as we do not expect to find breeding shorebirds associated with these areas.

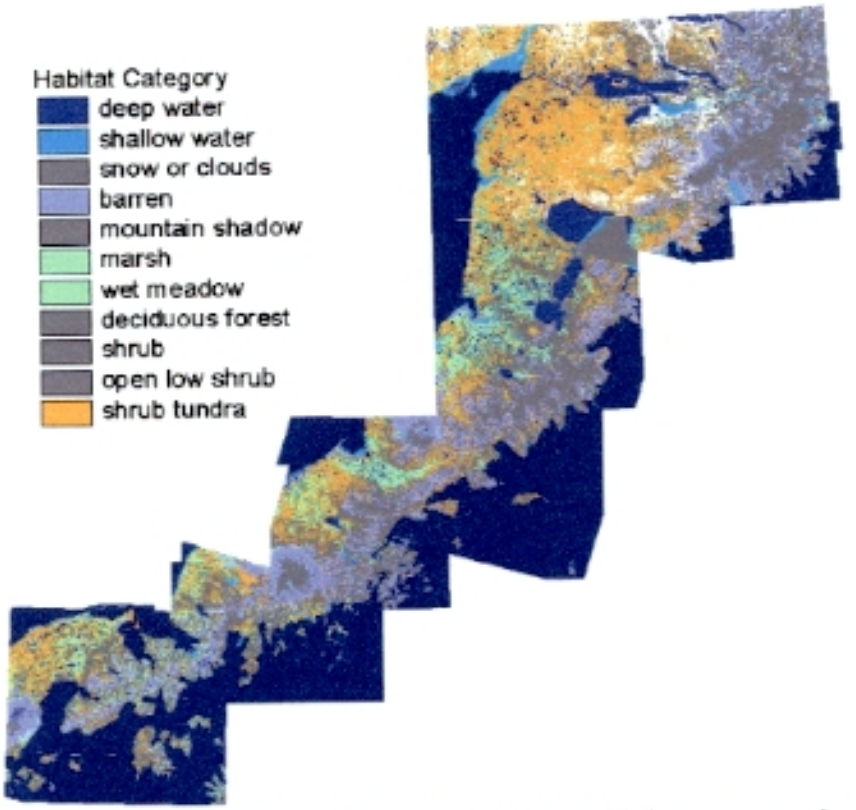

Figure 3. Recommended habitat categories for 2003 shorebird surveys on the Alaska Peninsula. Marsh and wet meadow habitats are grouped for the wetland category and shrub tundra is the tundra category. Barren habitat areas are also identified. Other habitat categories are considered unsuitable for shorebirds based on 2002 survey data.

We also recommend conducting a few intensive plots. These plots are surveyed by one observer throughout the study period. The assumption is that each intensive observer finds all nests and territories on their plots. The rapid surveyors also conduct rapid surveys, as described above, on the intensive plots. The results from intensive and rapid surveyors are compared to calculate the average detection rate for shorebirds on rapid surveys. This detection rate is then used to adjust the regression models to account for birds missed on rapid surveys. More detailed instructions on intensive survey methods can be found in Bart and Earnst (2002).

We have described some modifications to the current survey that should allow us to estimate the population size of shorebird species on the Alaska Peninsula. Our recommendations are summarized as follows:

1. Group the GIS land cover habitat categories into wetland, shrub tundra, barren and unsuitable habitats
2. Delineate all accessible habitat of each type across the study area.
3. Randomly select plot locations from among wetland, tundra and barren areas
4. A helicopter should be used to move surveyors from plot to plot. If there are 2 surveyors, place 2 plots at each location. If each observer surveyed up to 4 plots/day and if surveys are conducted for 14 days, 2 observers could survey 108 plots.
5. Allocate the survey effort proportionately to the relative importance of habitat type to shorebirds. For example, 100 plots could be allocated as follows:
    a. wetlands – 60 plots
    b. shrub tundra – 25 plots
    c. barren – 15 plots
    d. unsuitable – 0 plots
6. Select intensive plots to estimate the detection rates on rapid surveys. Intensive plots should be in a representative area(s) and plots should be chosen randomly. One observer can survey two intensive plots per season. Therefore, with two intensive surveyors, two plots could be in wetland habitat and two plots could be in tundra habitat.
7. Conduct rapid surveys on intensive plots and use data to estimate the average detection rate on rapid surveys
8. Develop regression models using proportion of habitat type to predict species density and adjust using the detection rates
9. Extrapolate regression models to the entire study area to estimate total number of each species on the Alaska Peninsula

SUMMARY

We achieved our objectives for this first year of shorebird surveys on the Alaska Peninsula. We gathered information on the distribution and abundance of shorebirds. This includes information that indicates that the breeding distribution of Pacific Golden-Plovers may be more extensive than currently reported. We assessed the accuracy of using a GIS land cover map and evaluated shorebird-habitat associations. These baseline data are to be used in designing future surveys to estimate the size of the shorebird populations on the Alaska Peninsula. In this document, we provide our detailed recommendations for these future shorebird surveys.

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APPENDICES

Appendix I. Description of shorebird survey plots conducted on the Alaska Peninsula in 2001.

ID	Site	Plot	Date	Time In	Time Out	Surveyor	NW Corner Location UTM Zone 4 Northing	Easting
1	Dune	5	16-May	1710	1840	C. Wightman	632907	6446021
2	Dune	6	16-May	1715	1835	B. Blush	632451	6443807
3	Dune	16	17-May	1420	1552	C. Wightman	630505	6445150
4	Dune	19	17-May	1555	1755	B. Blush	630763	6446270
5	Dune	17	18-May	1243	1416	C. Wightman	626770	6446057
6	Dune	20	18-May	1200	1340	B. Blush	629882	6446673
7	Dune	22	18-May	1420	1600	B. Blush	629799	6447561
8	Dune	23	18-May	1608	1720	C. Wightman	627758	6446222
9	Pike Lake	1	20-May	1336	1508	C. Wightman	590362	6390927
10	Pike Lake	6	20-May	1600	1740	C. Adler	591870	6392651
11	Pike Lake	9	20-May	1320	1450	C. Adler	590574	6392446
12	Pike Lake	12	20-May	1830	1940	C. Adler	593420	6392677
13	Pike Lake	15	20-May	1626	1740	C. Wightman	591927	6389963
14	Pike Lake	19	21-May	1300	1435	C. Adler	595253	6388873
15	Pike Lake	20	21-May	1233	1348	C. Wightman	593000	6388030
16	Pike Lake	23	21-May	1456	1633	C. Wightman	593062	6388477
17	Pike Lake	25	21-May	1550	1725	C. Adler	594881	6388034
18	Pike Lake	16	22-May	1130	1310	C. Adler	593327	6390763
19	Pike Lake	26	22-May	1123	1301	C. Wightman	593004	6390060
20	Popeye Lake	5	23-May	1316	1448	C. Wightman	603918	6358309
21	Popeye Lake	16	23-May	1614	1727	A. Leppold	601348	6357859
22	Popeye Lake	19	23-May	1235	1402	A. Leppold	603238	6357683
23	Popeye Lake	20	23-May	1610	1730	C. Wightman	602732	6356597
24	Popeye Lake	9	24-May	1610	1758	A. Leppold	601008	6355761
25	Popeye Lake	17	24-May	1755	1836	C. Wightman	601909	6355433
26	Popeye Lake	18	24-May	1526	1652	C. Wightman	601650	6354740
27	Popeye Lake	22	24-May	1217	1343	C. Wightman	600429	6355369
28	Popeye Lake	26	24-May	1244	1416	A. Leppold	600677	6356235
29	Popeye Lake	21	25-May	1134	1259	C. Wightman	603982	6354706
30	Popeye Lake	28	25-May	1151	1322	A. Leppold	604501	6355063
31	Scotty's Island	6	27-May	1541	1715	C. Wightman	529368	6286928
32	Scotty's Island	8	27-May	1645	1815	C. Adler	528268	6286575
33	Scotty's Island	12	27-May	1425	1600	C. Adler	527350	6286894
34	Scotty's Island	2	28-May	1405	1535	C. Wightman	528064	6289955
35	Scotty's Island	9	28-May	1628	1759	C. Wightman	527235	6289294
36	Scotty's Island	11	28-May	1315	1445	C. Adler	528509	6288921
37	Scotty's Island	16	28-May	1545	1720	C. Adler	527770	6288298
38	Scotty's Island	5	29-May	1600	1735	C. Adler	526125	6285394
39	Scotty's Island	13	29-May	1327	1458	C. Wightman	528479	6283871
40	Scotty's Island	17	29-May	1617	1746	C. Wightman	526939	6283588

ID	Site	Plot	Date	Time In	Time Out	Surveyor	Northing	Easting
41	Scotty's Island	18	29-May	1320	1450	C. Adler	525975	6286764
42	Swiss Camp	10	30-May	1708	1847	S. Savage	500495	6264787
43	Swiss Camp	12	30-May	1802	1914	C. Wightman	499195	6264893
44	Swiss Camp	7	31-May	1238	1417	S. Savage	501814	6261451
45	Swiss Camp	11	31-May	1214	1342	C. Wightman	501417	6262298
46	Swiss Camp	16	31-May	1446	1619	C. Wightman	500822	6262753
47	Swiss Camp	17	31-May	1530	1718	S. Savage	502455	6263507
48	Swiss Camp	18	1-Jun	1255	1429	C. Wightman	498726	6264025
49	Swiss Camp	20	1-Jun	1305	1449	S. Savage	499195	6264292
101	Ruth River	5	3-Jun	1542	1640	C. Wightman	669141	6386921
102	Ruth River	7	4-Jun	1535	1650	C. Wightman	670141	6386556
103	Ruth River	13	4-Jun	1550	1715	R. Kaler	669695	6387100
104	Ruth River	4	5-Jun	1235	1405	R. Kaler	669670	6388549
105	Ruth River	17	5-Jun	1214	1338	C. Wightman	670374	6388109

Appendix II. Codes, common name and scientific name of shorebird species seen on plots and incidentally on the Alaska Peninsula in 2001.

CODE	COMMON NAME	SCIENTIFIC NAME
BBPL	Black-bellied Plover	*Pluvialis squatarola*
AMGP[1]	American Golden-plover	*Pluvialis dominica*
PAGP	Pacific Golden-plover	*Pluvialis fluva*
SEPL	Semipalmated Sandpiper	*Charadrius semipalmatus*
GRYE	Greater Yellowlegs	*Tringa melanoleuca*
WATA[1]	Wandering Tattler	*Heteroscelus incanus*
HUGO	Hudsonian Godwit	*Limosa haemastica*
MAGO	Marbled Godwit	*Limosa fedoa beringiae*
WESA	Western Sandpiper	*Calidris mauri*
LESA	Least Sandpiper	*Calidris minutilla*
ROSA[1]	Rock Sandpiper	*Calidris ptilocnemis*
DUNL	Dunlin	*Calidris alpina*
SBDO	Short-billed Dowitcher	*Limnodromus griseus*
COSN	Common Snipe	*Gallinago gallinago*
RNPH	Red-necked Phalarope	*Phalaropus lobatus*

[1] species not recorded on survey plots

Appendix III. Observations of all avian species on plots or in adjacent areas (off plot). If found only off plot, cell is shaded. Breeding status: O=Observed, X=Possible, P=Probable, C=Confirmed.

SPECIES	Dune	Pike Lake	Popeye Lake	Ruth River	Scotty's Island	Swiss Camp
Red-throated Loon					O	
Pacific Loon		P		O		
Common Loon	O			O		
Red-necked Grebe		O				P
Greater White-fronted Goose	P	P				
Canada Goose		P				
Tundra Swan	O	P			P	
Gadwall						P
American Wigeon		P	P		P	
Mallard	O	P			O	P
Northern Shoveler	O	P		O		
Northern Pintail	P	C	P		O	P
American Green-winged Teal		P				
Greater Scaup			P	P	O	
Harlequin Duck					O	
Black Scoter		O		P		
Common Merganser				O		
Red-breasted Merganser				O		O
Osprey					O	
Bald Eagle	O		O	O	O	O
Northern Harrier			O	O		
Rough-legged Hawk	O	O				
Golden Eagle	O					
Merlin				O		
Gyrfalcon	O				O	
Willow Ptarmigan	C	C		P	C	C
Rock Ptarmigan				P		
Sandhill Crane	P	C	P		O	P
Black-bellied Plover	P					
American Golden Plover	P					
Pacific Golden Plover	P	P				
Semi-palmated Plover	P	P		C		P
Greater Yellowlegs		P	P	O		P
Wandering Tattler			O			
Hudsonian Godwit			P			
Marbled Godwit		P	P			
Western Sandpiper	O	P	P			
Least Sandpiper	P	P	P	O	P	P
Rock Sandpiper					O	
Dunlin	P	P	P		P	P
Short-billed Dowitcher	P	P	P		P	P
Common Snipe	P	P	P	P	P	P

SPECIES	Dune	Pike Lake	Popeye Lake	Ruth River	Scotty's Island	Swiss Camp
Red-necked Phalarope		P	P		P	P
Parasitic Jaeger	O	O			X	O
Long-tailed Jaeger	O	O				
Bonaparte's Gull			O			
Mew Gull		P		O	O	P
Glaucous-winged Gull	O	O		O		
Arctic Tern				O	O	
Snowy Owl			O			
Alder Flycatcher			X			
Northern Shrike					O	
Black-billed Magpie				O		O
Horned Lark				O		
Tree Swallow		P	O	O		P
Bank Swallow						O
American Robin	O	P	P	P		P
Hermit Thrush		O	P	P	O	P
American Pipit	P	C		P		
Orange-crowned Warbler		P	P		P	P
Yellow Warbler			P			
Wilson's Warbler		P	P	P	P	P
American Tree Sparrow	P	P	P		P	P
Savannah Sparrow	P	P	P	P	P	P
Fox Sparrow				O	P	
Gambel's White-crowned Sparrow	O	P	P	P		P
Golden-crowned Sparrow		P	P	P		P
Lapland Longspur	P	P	P		P	P
Snow Bunting				P		
Common Redpoll	O	O	O	O		O