Exploratory Winter Sea Duck Survey of South Central Alaska – Cape Spencer to Prince William Sound

Jack Hodges – August 2011

Survey Dates: March 19 through March 21, 2011
Pilot: Ed Mallek
Observer: John (Jack) Hodges
Aircraft: N754, Specially modified turbine d'haviland beaver with amphibious floats.
Hours: 22

The purpose of this survey was to test the proposed survey design in Alaska for efficiency, safety and adequacy. Secondarily, population estimates were obtained for a portion of coastline which had never been systematically surveyed for winter sea ducks.

The survey design consisted of a shoreline component and an offshore component. The shoreline component included all shoreline within 10 minute latitude strips. Every other 10 minute latitude strip was surveyed (Figure 1, blue shaded areas). Between these strips, four transects were surveyed at 2 minute intervals (Figure 1, black east-west lines). The shoreline transect width was 300m, 100m of which was between the plane and shore (usually the right side of the plane) and 200m was from the plane to seaward (usually the left side of the plane). The offshore transects began at 300m from shore and ended at 3 nautical miles from shore. The offshore transect width was 100m on each side of the plane.

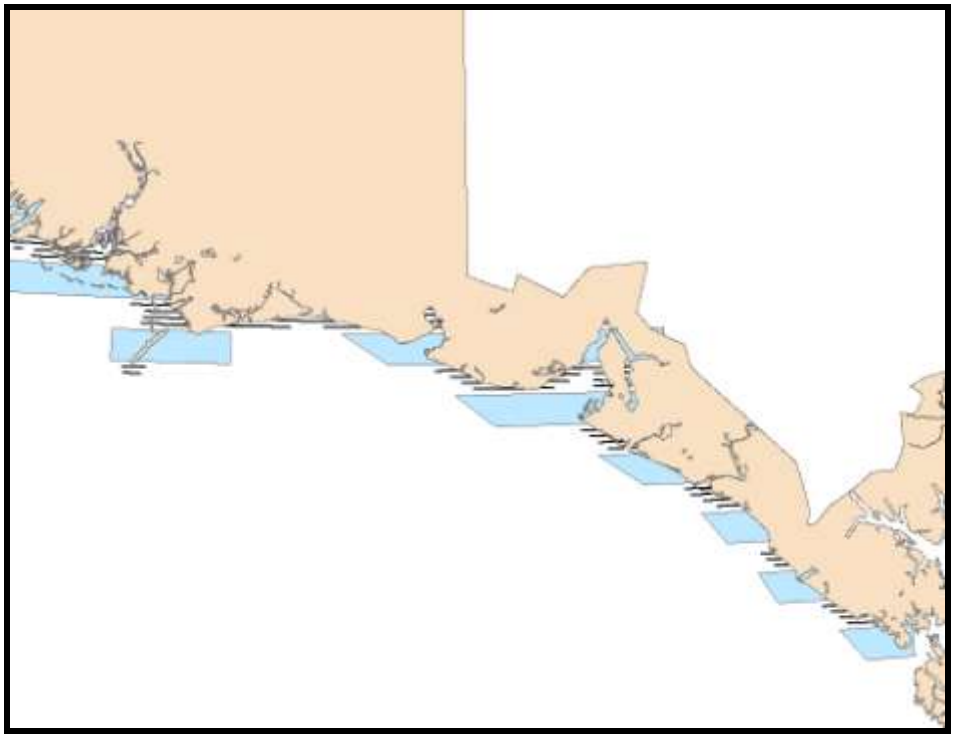

Figure 1. Portion of South Central region of Alaska surveyed for winter sea ducks in March 2011.

We found that the survey design was very efficient. The flow was smooth from shoreline sections to offshore transect sections, and allowed us to move along the coast with a limited amount of back tracking. We had a couple of places with strong localized winds which had to be excluded to maintain safe flying conditions. It seemed doubtful many birds would choose to be in those windy areas. Two short transects were excluded at the south tip of Kayak Island due to low visibility in snow.

We felt that the survey was safe. The turbine engine gave an extra measure of reliability. We did not encounter ocean waves or swells that would have precluded a successful forced landing at sea on the floats. We had a satellite phone on board with which to call for help. We had automatic flight following to show our flight path to anyone with access to the internet. We wore exposure suits in the event we had to abandon the aircraft. We carried a life raft with enclosed canopy. Our life vests had portable 409 Epirbs with integral GPS units to advise our identity and location.

Statistical Methods:

Shoreline Component: Every other 10 minute strip of shoreline was surveyed in its entirety. Mean and standard error were calculated using the seven strips. The mean was expanded to the 14 total strips. The standard error was expanded by 14 as well and a finite population correction factor of ((14-7)/(14-1))^0.5 = .73 was applied.

Offshore Component: The 4 transects in each 10 minute strip were totaled. Each of these totals was treated as a sample unit. The mean and standard error of the 7 sample units were expanded by a factor of (1852*10/800)*14 = 324.

Results:

Tables 1, 2, and 3, show the results by shoreline, offshore and total. White-winged scoters were the most abundant sea duck followed by black scoters, mergansers and long-tailed ducks.

Figures 2, 3 and 4, show the distribution of sightings for three selected species, white-winged scoters, black scoters and mergansers. The area shown is a small portion of the entire study area in order to show the distribution patterns more clearly. Note that the offshore transects started at 300m from shore.

White-winged scoters were the only sea ducks that were distributed out to 3 nautical miles offshore. This suggests there were an unknown number of white-winged scoters beyond our 3 nautical mile survey limit.

Other species of sea birds and marine mammals were also tallied. Our murrelet numbers are not useful for any purpose beyond presence, due to the difficulty of observing them from the air.

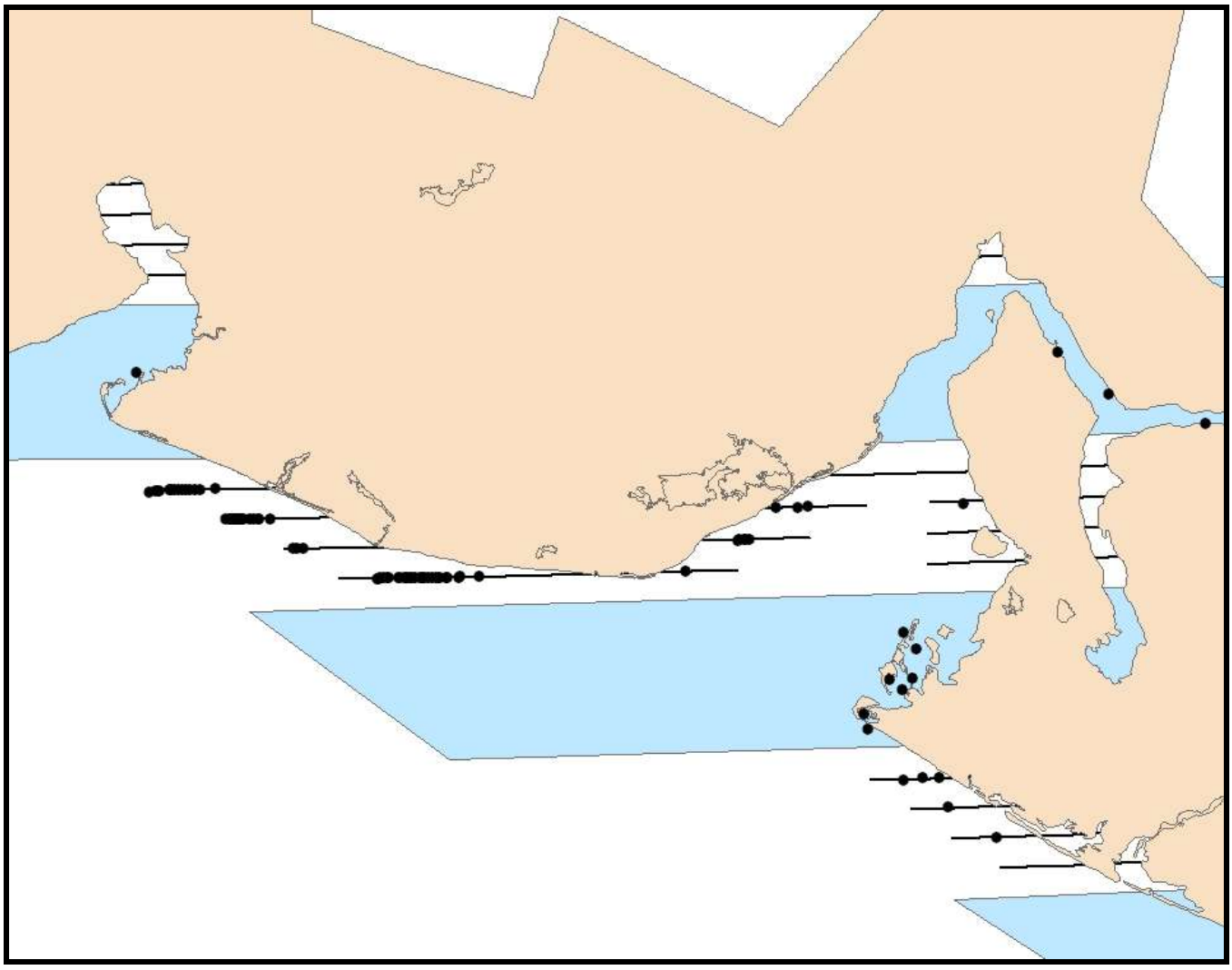

Figure 2. Distribution of white-winged scoter sightings. They were mostly found on the offshore transects. They were still present at the 3 nautical mile extent of some transects, suggesting that there could be significant numbers of white-winged scoters beyond 3 nautical miles from shore.

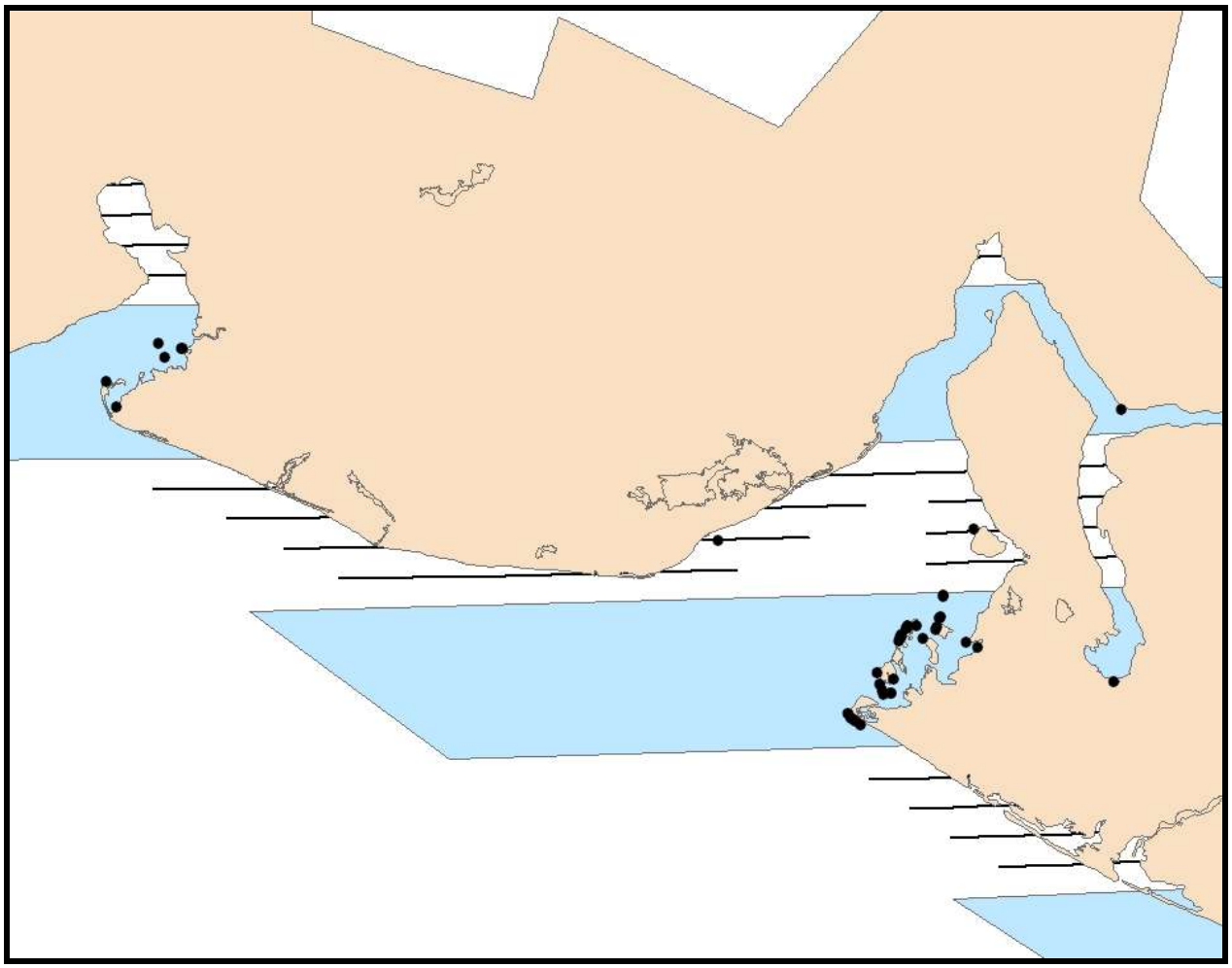

Figure 3. Distribution of black scoter sightings. They were mostly near shore, with very few present on the offshore transects.

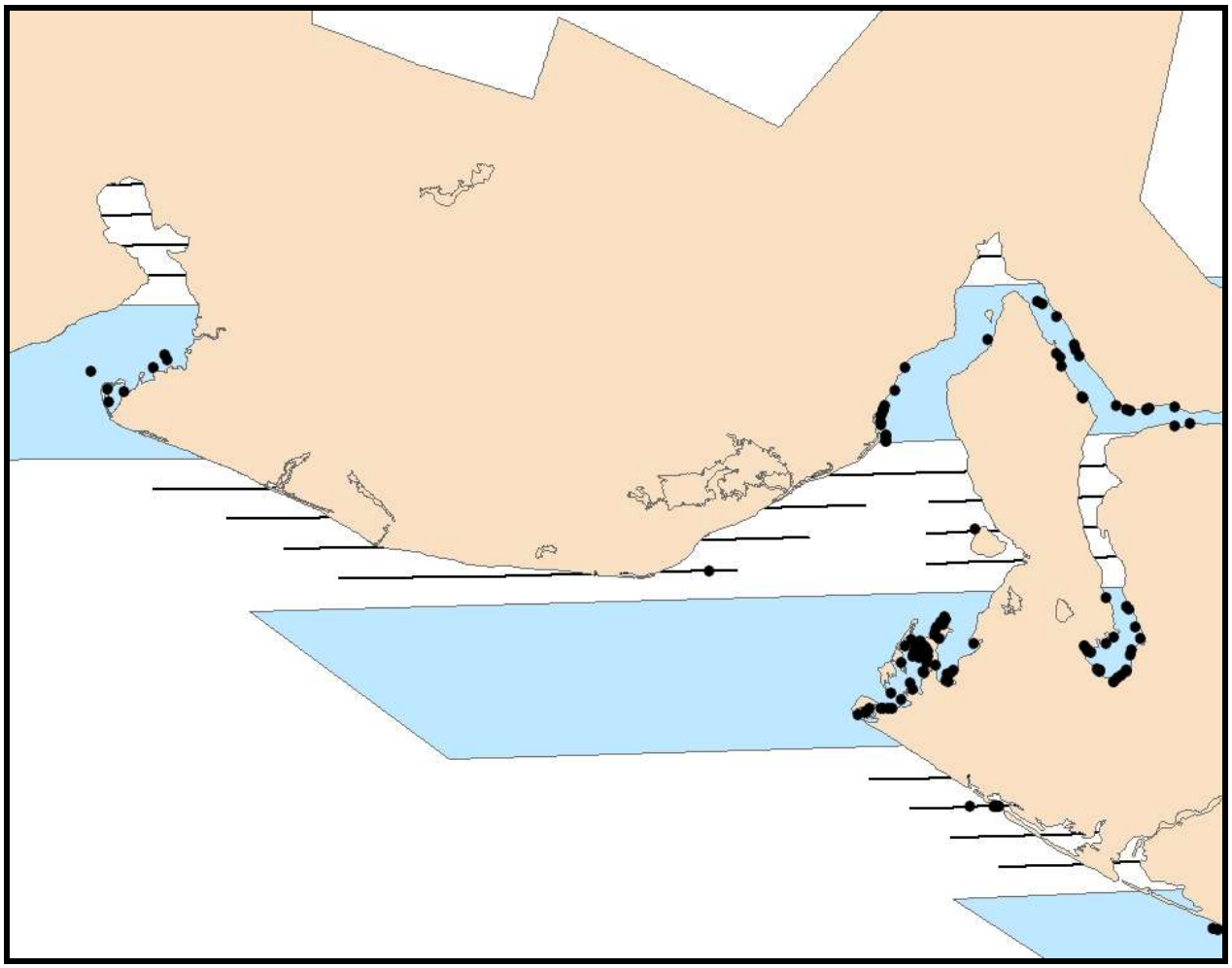

Figure 4. Distribution of merganser sightings. They were mostly near shore, with very few present on the offshore transects.

Discussion:

The survey design worked well operationally. The survey seemed safe in the turbine powered amphibious plane. The ten minute latitude strips of shoreline were generally of comfortable duration, with the exception of the intricate shoreline of the islands near Yakutat. The offshore transects felt comfortable, and the 2 nautical mile separation between transects gave short breaks from surveying. Most of the terrain was easy to negotiate, with few narrow, steep sided fjords. This survey was not representative of the difficult terrain considerations found in southeast Alaska, Prince William Sound, Kenai Peninsula, Alaska Peninsula and Kodiak Island.

Much of the shoreline of this study area had a general east-west orientation. This resulted in a small sample size. The other portions of the coast of Alaska have more of a north-south gradient and will be more conducive to larger sample sizes.

Flying this area again next year with offset survey sections would give complete shoreline coverage and double the offshore transect coverage. This would greatly reduce standard errors associated with the estimates.

Table 1. Shoreline strips.

	Shoreline strips - each 10 minutes of Latitude									
	58° 10'	58° 30'	58° 50'	59° 10'	59° 30'	59° 50'	60° 10'	Total	Shoreline Expanded Population	Shoreline S.E.
LOON	3	9	44	1	2	10	4	73	146	59
GREB	0	10	1	0	123	10	1	145	290	176
CORM	98	20			43	42	4	207	414	138
GBHE	0	0	0	0	2	0	0	2	4	3
SWAN	0	3	0	0	0	0	17	20	40	25
CAGO	0	0	0	0	35	0	0	35	70	51
MALL	12	27	18	0	328	431	73	889	1778	685
NOPI	0	0	0	20	14	0	0	34	68	33
SCAU	0	0	0	0	127	36	65	228	456	189
STEI	0	0	0	0	0	4	0	4	8	6
SPEI	0	0	0	0	15	75	0	90	180	109
HADU	9	6	0	0	128	206	4	353	706	322
SUSC	4	0	108	0	340	474	0	926	1852	759
WWSC	0	102		0	46	44	0	192	384	158
BLSC	0	281	25	0	665	379	55	1405	2810	985
SCOT	10	22	76	12	936	151	6	1213	2426	1322
Total Scoter	14	405	209	12	1987	1048	61	3736	7472	2864
LTDU	0	0	0	0	14		0	14	28	22
BUFF	18	12	0	0	230	103	4	367	734	335
GOLD	40	13	0	0	832	242	5	1132	2264	1196
MERG	31	2	363	16	870	389	425	2096	4192	1222
MURR	2	4	3	2	6	1	1	19	38	7
PIGU	0	3	4	0	0	2	0	9	18	7
MLET	7	0	0	0	0	0	0	7	14	10
ALCID	20	2	0	0	0	0	0	22	44	29
PUFF	0	0	0	0	0	3	0	3	6	4
SELI	131	18	3	4	4	516	3	679	1358	740
SEOT	5	0	0	0	7	10	0	22	44	16
SEAL	0	0	5	0	0	0	16	21	42	23
GRWH	0	0	0	0	0	0	0	0	0	0
PORP	0	0	0	0	0	0	0	0	0	0

Table 2. Offshore transects.

	Offshore Transect Totals - 4 Transects per 10 minute Strip							Grand Total	Transect Expanded	
Transects	58(22-28)	58(42-48)	59(02-08)	59(22-28)	59(42-48)	60(02-08)	60(22-26)	Transects	Population	S.E.
LOON	0	7	12	0	12	4	3	38	9353	624
GREB	2	1	1	0	15	5	0	24	1111	659
CORM	0	5	1	0	2	4	0	12	556	252
GBHE	0	0	0	0	0	0	0	0	0	0
SWAN	0	0	0	0	0	0	0	0	0	0
CAGO	0	0	0	0	0	0	0	0	0	0
MALL	0	0	0	0	0	0	0	0	0	0
NOPI	0	0	0	0	0	0	0	0	0	0
SCAU	0	0	0	0	0	0	120	120	5556	5556
STEI	0	0	0	0	0	0	0	0	0	0
SPEI	0	0	0	0	0	0	0	0	0	0
HADU	0	0	0	0	10	3	0	13	602	461
SUSC	0	3	2	5	27	37	0	74	3426	1840
WWSC	5	46	84	14	544	199	0	892	41300	24050
BLSC	0	13	22	0	47	125	2	209	9677	5535
SCOT	40	26	18	37	128	44	0	293	13566	5007
Total Scoter	45	88	126	56	746	405	2	1468	67968	33228
LTDU	0	210	9	0	20	7	0	246	11390	9487
BUFF	0	0	0	0	0	0	0	0	0	0
GOLD	0	0	0	0	15	7	0	22	1019	716
MERG	0	3	4	130	9	3	10	159	7362	5811
MURR	7	298	41	82	215	12	0	655	30327	14350
PIGU	0	0	0	0	0	0	0	0	0	0
MLET	0	143	10	28	17	4	0	202	30327	6288
ALCID	0	0	0	0	0	0	0	0	0	0
PUFF	0	0	0	0	0	0	0	0	0	0
SELI	0	0	0	0	2	31	0	33	1528	1423
SEOT	0	0	0	0	7	21	23	51	2361	1272
SEAL	0	0	0	0	0	0	1	1	46	46
GRWH	3	0	1	0	1	3	0	8	370	165
PORP	0	0	0	0	7	0	0	7	324	324

Table 3. Shoreline and Offshore combined for total population estimates.

	Shoreline		Offshore			
Species	Expanded Population	S.E.	Expanded Population	S.E.	Grand Total	S.E.
LOON	146	59	9353	624	9499	627
GREB	290	176	1111	659	1401	682
CORM	414	138	556	252	970	288
GBHE	4	3	0	0	4	3
SWAN	40	25	0	0	40	25
CAGO	70	51	0	0	70	51
MALL	1778	685	0	0	1778	685
NOPI	68	33	0	0	68	33
SCAU	456	189	5556	5556	6012	5559
STEI	8	6	0	0	8	6
SPEI	180	109	0	0	180	109
HADU	706	322	602	461	1308	562
SUSC	1852	759	3426	1840	5278	1991
WWSC	384	158	41300	24050	41684	24050
BLSC	2810	985	9677	5535	12487	5622
SCOT	2426	1322	13566	5007	15992	5179
Total Scoter	7472	2864	67968	33228	75440	33351
LTDU	28	22	11390	9487	11418	9487
BUFF	734	335	0	0	734	335
GOLD	2264	1196	1019	716	3283	1394
MERG	4192	1222	7362	5811	11554	5938
MURR	38	7	30327	14350	30365	14350
PIGU	18	7	0	0	18	7
MLET	14	10	30327	6288	30341	6288
ALCID	44	29	0	0	44	29
PUFF	6	4	0	0	6	4
SELI	1358	740	1528	1423	2886	1604
SEOT	44	16	2361	1272	2405	1273
SEAL	42	23	46	46	88	52
GRWH	0	0	370	165	370	165
PORP	0	0	324	324	324	324

Summary of the Winter 2011 Sea Duck Aerial Surveys of the Pacific Coast of Oregon and Washington

Joseph Evenson, Tom Cyra, Bryan Murphie, and Don Kraege

August 2011

Washington Department of FISH and WILDLIFE

INTRODUCTION

This survey was implemented as part of the second phase of the Pacific Coast Winter Sea Duck Survey design project funded by the Sea Duck Joint Venture in FY11. Washington Department of Fish and Wildlife (WDFW) was responsible for testing the proposed survey design along the Pacific coast of Oregon and Washington that would match those efforts being conducted in South-central Alaska. The primary focus of the survey was to systematically survey the Pacific coast of Oregon and Washington to assess efficiency, adequacy, and safety of the survey, and to estimate abundance of sea ducks wintering there.

METHODS

Survey Dates: 02-03 February, 2011 (Oregon) and 07 March, 2011 (Washington)
Navigator: Joe Evenson, WDFW
Observers: Tom Cyra and Bryan Murphie, WDFW
Pilot: Jim Hodgson, WDFW
Aircraft: WDFW Partenavia P-68 twin engine fixed wing
Total Flight Hours (Transit and Survey): 24

Aerial strip surveys were flown at 200ft (61m) AGL and 105 knots airspeed according to protocols developed by Jack Hodges as part of the Pacific Coast Winter Sea Duck Survey project. The survey design split the coastal waters into an offshore stratum and a shoreline stratum. The offshore stratum was defined as generally 300 m from shore and extending offshore to either 20 ftm (36.58 m) or 3 NM (5056 km), whichever was greater. Sample units were separated into 10 minute latitude blocks, of which every other one was sampled. Within a sampled block, four latitudinal transects were surveyed at two minute latitude intervals. The northern most sample unit (at Cape Flattery) was only 5 minutes in length and contained two transects.

The shoreline stratum was defined as running along the shoreline and offshore generally 300m. Survey strip width for this stratum totaled 300m (100m on the shore-side of the aircraft, and 200m on the seaward side of the aircraft). In areas of surf the aircraft was positioned so that the outer edge of the 100m shoreline strip (for the shore-side of the aircraft) extended just into the surf, thus did not extend to the physical shoreline. Sample units for the shoreline stratum were separated into 14 minute latitude blocks, comprised of seven two minute latitude shoreline transects each, separated by six minute latitude sections that were not surveyed. These six minute “off” sections were along the shoreline where the latitudinal transects of the offshore component were located. The southernmost sample unit contained only one-two minute latitude transect, while the northernmost sample unit (not surveyed) also contained one-two minute latitude section (Figure 1).

Transect location data (logged every two seconds) and environmental conditions were digitally recorded using DLOG3 (R.G.Ford Consulting) data logging application. All observations were

recorded on digital voice recorders, including count, species classification, and time. Observations were geo-referenced by interpolation to the log file using observation time.

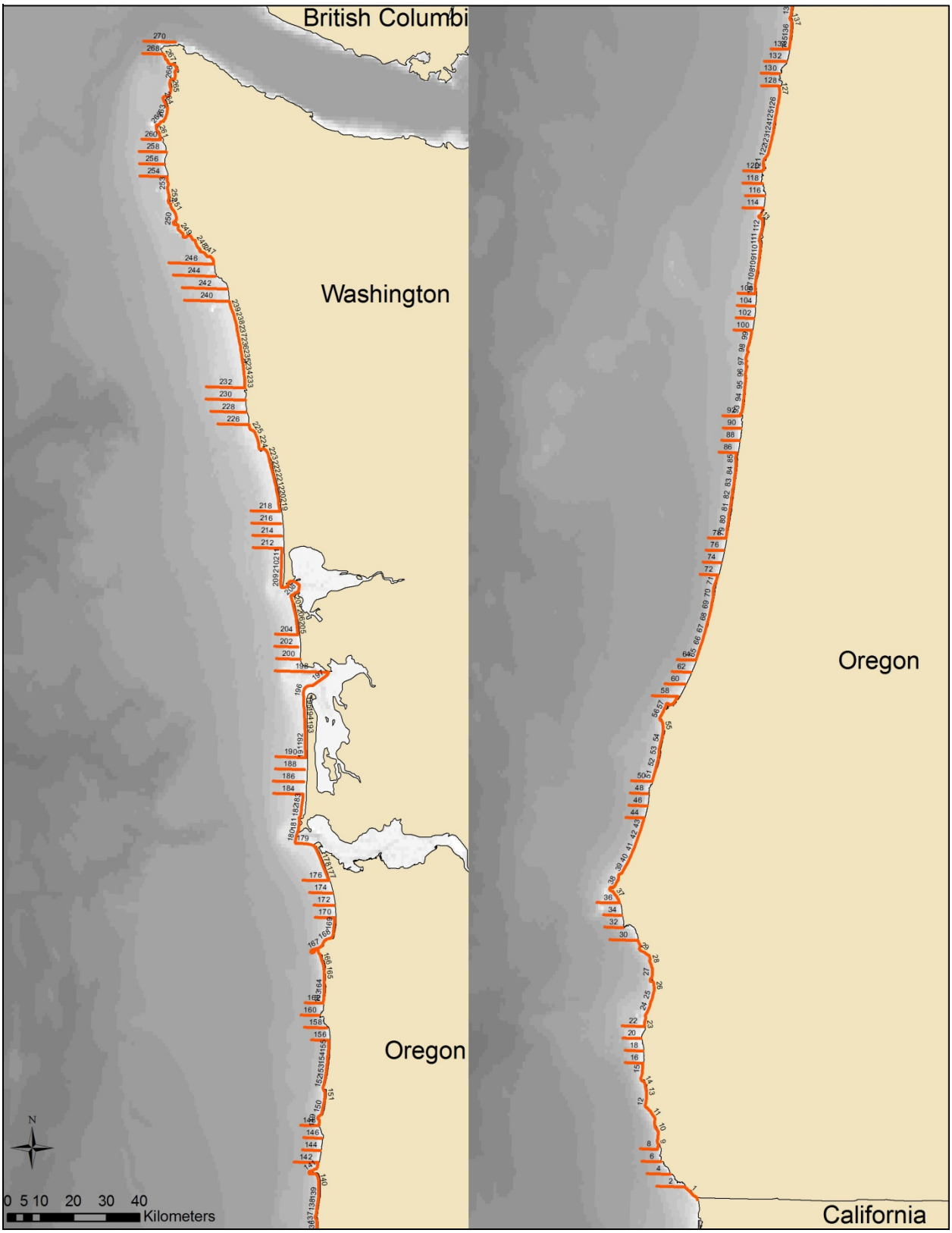

Figure 1. Aerial transects along the Pacific coast of Oregon and Washington surveyed for sea ducks during winter 2011.

Notes on Survey and Safety

The layout of transects, including transitions between offshore and shoreline transects were efficient and eliminated the need to backtrack to pick up transects. With the distribution of airports with fuel along the Oregon and southern Washington coasts, paired with the range of the aircraft, a minimal amount of flight time was expended having to back-track for fuel, saving on both flight time, and minimizing the optimal daylight survey hours spent not surveying.

Flight direction generally followed a northward path along the coastline. We avoided flying southbound to reduce the effects of glare on the observers.

Weather conditions were good on all days surveyed with Beaufort ranging from 0 – 3. There was little cloud cover during the 1st two days of survey along the Oregon coast (2-3 February, 2011). This did effect sightability with the latitudinal transects, as the south facing observer had high levels of glare along their respective survey strips.

The Partenavia worked adequately for the survey, however it did have limitations. These include suboptimal comfort, airspeed, and maneuverability. Space within the aircraft was limited, and the observation windows were situated low, requiring the observers to view from an uncomfortable position. Both these factors did cause fatigue on the observers. Airspeed was kept at 105 knots to assist in maintaining safe effective airspeed in the event of an engine failure. Because of the higher airspeed and the aircraft's reduced maneuverability, it was not always possible to fly 100 m from shoreline along the rocky habitats. Because of this, we likely missed sea ducks that utilize these habitats.

A Guardian Mobility SkyTrax automatic flight following device was carried and operating onboard the aircraft. The device was programmed to collect a location, heading, and airspeed each minute and then transmit stored positions every 6 minutes. From the beginning of the survey day, until the aircraft was safely at the destination airport, shore-based personnel monitored flight status by monitoring the Guardian Mobility flight following web application, and by communicating with the survey navigator, adhering to Agency developed flight following protocols.

All personnel on board the aircraft were equipped with and carried, at a minimum, manually inflated PFD's, floating/waterproof marine VHF radios with integral GPS, personal 406 MHz Epirbs with integral GPS, waterproof cell phones, flight helmets, and NOMEX III flight suits. An inflatable life raft and exposure suits were also carried on board the aircraft to be used in the event of a water ditch.

STATISTICAL METHODS

Statistical methods were the same as those used for concurrent surveys in Alaska, coordinated by Jack Hodges.

Shoreline Stratum: Every shoreline sample unit was surveyed in its entirety; these included 19 14 minute and one-two minute sample units. A weighted mean and standard error were

calculated using the sample units. The weighted mean and standard error of the 19.14 sample units were expanded to those sample units that were not surveyed to derive a population estimate for this stratum.

Offshore Stratum: The 4 transects in each 10 minute strip were totaled from the 19 full and one partial sample units. Each of these totals was treated as a sample unit. A weighted mean and standard error of the 19.5 sample units were expanded by a factor of (1852*10/800)*38.5 = 891.275.

RESULTS

Tables 1, 2, and 3 show the results by shoreline, offshore and combined (shoreline + offshore). White-winged scoters were the most abundant of all the scoters (and sea ducks) classified to species with abundance estimates comprising 67% (12,724) of classified scoters. Surf and black scoters abundance estimates comprised 33% (6,337) and <1% (51), respectively. 99% of the white-winged scoter total abundance estimate was within the offshore stratum, while 83% of the abundance estimate of surf scoters was within this stratum; in total, the offshore stratum contained 89% of the scoter population. The scoters were also the far most abundant sea ducks consisting of 98% of the total sea duck abundance estimate.

Figure 2 shows the distribution of white-winged scoter observations. Few were observed from the north-central to the southern coast of Oregon. The majority were distributed from northern Oregon to Cape Alava, Washington. Figure 2 also shows how this species is not closely associated with the shoreline; a few transects had observations of white-winged scoters out to the western edge of the offshore stratum.

Surf scoters were more uniformly distributed from the central Oregon coast to the northern Washington coast. (Figure 3). Observations were also more associated with the shoreline, however, birds were observed offshore as well. Distribution south of central Oregon was sparse.

Figure 4 depicts distribution of all scoters, including those not classified to species. These observations of unclassified scoters show concentrations along the southern Oregon coastline. It is likely that many of these scoters were not classified to species due to the heavy glare the day this area was surveyed.

Figure 5 shows the locations of the other sea duck species. There were only a few observations of merganser, bufflehead, and harlequin ducks. Besides being low in abundance along coastal Oregon and Washington, species like harlequin ducks were likely missed due to aircraft issues related to speed and survey distance to the shoreline along the rock habitats. There were no observations of goldeneyes or long-tailed ducks.

Other species of sea birds and marine mammals were also recorded and are represented in Tables 1, 2, and 3.

DISCUSSION

Operationally, the survey design was efficient and worked well. With the range of the aircraft used, coupled with the spacing of airports with fuel, little backtracking was necessary for fueling stops, as there was usually an airport conveniently located along the transect paths. The spacing of the offshore transects (spaced with 2 NM separation within 10 minute survey blocks) generally worked well. Costs to complete the survey was approximately $13,400 ($6000 for aircraft time and $7400 for agency staff time).

The latitudinal transects were problematic though. By flying surveys in the winter (when the sun is to the south and at a low angle during survey hours) one observer (half of the sample on a given transect) is likely to have issues of glare adversely affecting detectability. Looking to the south, even if overcast, can pose glare issues due to cloud reflectivity on the water.
The shoreline of the study area has a north-south orientation which worked well for this component of the survey. By flying in a northbound direction, glare was rarely an issue. However, it is likely that detectability of sea ducks associated with rocky shoreline habitat were underrepresented in this survey due to the type of aircraft used.

Other aircraft options could include a turbine DHC-2 Beaver or Quest Kodiak on floats, as they would provide a higher level of reliability compared to a piston Beaver, have floats in the event of a water-ditch, and have the ability to follow the shoreline more closely at lower speeds. However, any float equipped aircraft would likely need to be amphibious due to the issue of fueling - these aircraft may be cost-prohibitive.

Because of weather and operational delays, surveys were separated by a one month period (early February – WA, and early March – OR). Due to limited information on migration timing, it is difficult to evaluate potential movement of birds between the Washington and Oregon coastal areas during this period. Satellite telemetry data for surf and white-winged scoters indicate that most movement from wintering areas do not begin until mid-March and later.

RECOMMENDATIONS FOR FUTURE SURVEYS

1. To reduce glare effects on observations, investigate flying offshore transects in a different direction, either in a saw-tooth pattern or parallel transects flown in NW and SE directions. This would not eliminate glare, but would reduce the affects it has on the sightability.
2. Survey shoreline transects in 10 minute latitude blocks, instead of 14 minute. This will make for cleaner transitions from the shoreline transects to the offshore transects, and will provide the observers and pilot a short break.
3. Include a few exploratory transects extending past the 3 NM / 20 ftm boundary as white-winged scoters were observed at the offshore boundary of the offshore stratum

4. Refine optimal survey window based on evaluation of migration timing using available satellite telemetry data.
5. Determine availability and costs of using turbine powered amphibious aircraft.
6. Obtain review of survey design status by SDJV monitoring committee.
7. Evaluate repeating survey in 2012 if feasible, pending the outcome of recommendations from 1-4 above.

ACKNOWLEDGEMENTS

These surveys were funded by the Sea Duck Joint Venture. WDFW Pilot, Jim Hodgson, served as the survey pilot on all survey days. John "Jack" Hodges was instrumental in the survey design and analysis, and provided insightful comments on this report. Heather Tschaekofske assisted in processing survey data, and assisted in preparing the figures, and tables. Mikal Moore flight followed all survey flights. We are exceptionally grateful to all of these parties.

Table 1: Shoreline transects.

	42°, 0'-2'	42°, 8'-22'	42°, 28'-42'	42° 48'- 43° 2'	43°, 8'- 22'	43°, 28'- 42'	43° 48'- 44° 2'	44°, 8'- 22'	44°, 28'- 42'	44° 48'- 45° 2'
N Transects	1	7	7	7	7	7	7	7	7	7
Species/Transect #'s	SL1	SL9-15	SL23-29	SL37-43	SL51-57	SL65-71	SL79-85	SL93-99	SL107-113	SL121-127
Sea Ducks										
BLSC	0	0	0	7	0	0	0	0	15	2
SUSC	0	9	2	11	11	2	13	66	143	159
WWSC	0	8	6	5	0	0	5	0	0	2
UNSC	0	20	4	57	2	0	15	5	67	305
Total Scoters	0	37	12	80	13	2	33	71	225	468
Harlequin Ducks	0	0	0	0	0	0	0	0	0	0
Goldeneyes	0	0	0	0	0	0	0	0	0	0
Long-tailed Ducks	0	0	0	0	0	0	0	0	0	0
Bufflehead	0	0	0	0	0	0	0	0	0	0
COME	0	0	0	0	0	0	0	0	0	0
RBME	0	0	0	0	0	2	0	0	0	0
UNME	0	0	0	0	0	0	0	0	0	0
Total Mergansers	0	0	0	0	0	2	0	0	0	0
Avian Piscivores										
HOGR	0	1	0	0	0	1	0	0	0	1
RNGR	1	4	1	1	3	0	5	0	3	1
WEGR	235	25	270	6	17	0	21	6	14	2
UNGR	0	1	5	0	0	1	0	0	0	0
Total Grebes	236	31	276	7	20	2	26	6	17	4
COLO	0	3	1	3	2	0	3	1	2	0
PALO	0	0	0	0	0	0	0	0	0	0
RTLO	2	4	12	1	3	0	3	3	3	1
UNLO	0	1	2	6	1	0	1	1	0	0
Total Loons	2	8	15	10	6	0	7	5	5	1
DCCO	0	0	2	1	0	0	0	0	0	0
PECO	0	1	0	2	3	0	0	2	0	0
UNCO	23	11	9	13	31	1	2	0	25	4
Total Cormorants	23	12	11	16	34	1	2	2	25	4
ANMU	0	0	0	0	0	0	0	0	0	0
CAAU	0	0	0	0	0	0	0	0	1	0
COMU	0	1	0	0	28	0	0	0	0	0
MAMU	0	1	9	2	2	0	8	0	10	2
PIGU	0	2	0	0	0	0	0	0	0	0
RHAU	0	0	0	0	0	0	0	0	0	0
UNAC	0	0	0	0	0	0	0	0	0	0
UNML	0	0	3	0	0	0	0	0	0	0
USAC	0	0	0	0	0	0	0	2	1	0
Total Alcids	0	4	12	2	30	0	8	2	12	2
BOGU	0	0	0	0	0	0	0	0	0	0
GWGU	0	0	0	2	1	0	0	4	3	0
MEGU	0	0	0	0	0	0	0	0	0	0
UBWG	3	14	3	4	17	4	2	2	4	7
UNGU	3	23	78	86	72	2	3	24	8	12
Total Gulls	6	37	81	92	90	6	5	30	15	19
Miscellaneous Avian Species										
BLBR	0	0	0	0	0	0	0	0	0	0
CAGO	0	0	2	0	0	0	0	0	0	0
GBHE	0	3	1	0	1	0	0	0	0	0
BRPE	0	0	0	0	0	0	0	0	0	0
UNDO	0	0	0	0	0	0	0	0	0	0
USSD	0	0	0	0	0	0	0	0	0	0
BAEA	0	0	0	0	0	0	0	1	0	0
CORA	0	1	0	0	0	0	0	0	0	0
UNDD	0	0	0	0	0	0	0	0	0	0
UNDU	0	0	0	0	0	0	0	0	0	0
UNSB	0	1	0	0	0	0	0	0	4	0
Marine Mammals										
Pinnipeds										
CASL	0	2	1	1	50	0	2	7	2	3
HASE	13	28	2	0	40	0	1	1	0	0
STSL	0	0	0	0	0	0	0	0	0	0
UNSL	0	0	2	0	2	0	0	0	0	1
Cetaceans										
DAPO	0	0	0	0	0	0	0	0	0	0
HAPO	0	0	0	0	1	0	0	0	0	0
PWDO	0	0	0	0	0	0	0	0	0	0
UNPO	0	0	0	0	0	0	0	0	0	0
GRWH	0	0	0	0	0	0	1	0	0	0
Other Marine Mammals										
SEOT	0	0	0	0	0	0	0	0	0	0
UNMM	0	1	0	0	0	0	0	0	0	0

Table 1 cont.: Shoreline transects.

	45°, 8'- 22'	45°, 28'- 42'	45° 48'- 46° 2'	46°, 8'- 22'	46°, 28'- 42'	46° 48'- 47° 2'	47°, 8'- 22'	47°, 28'- 42'	47° 48'- 48° 2'	48°, 8'- 22'
N Transects	7	7	7	7	7	7	7	7	7	7
Species/Transect #'s	SL135-141	SL149-155	SL163-169	SL177-183	SL191-197	SL205-211	SL219-225	SL233-239	SL247-253	SL261-267
Sea Ducks										
BLSC	0	0	17	0	0	0	0	0	0	0
SUSC	33	6	35	150	19	25	11	33	6	20
WWSC	11	3	26	6	0	0	0	3	1	0
UNSC	51	19	89	47	0	5	4	12	1	27
Total Scoters	95	28	167	203	19	30	15	48	8	47
Harlequin Ducks	0	0	0	0	0	0	0	0	0	7
Goldeneyes	0	0	0	0	0	0	0	0	0	0
Long-tailed Ducks	0	0	0	0	0	0	0	0	0	0
Bufflehead	0	0	0	0	0	0	0	0	0	3
COME	0	0	0	0	1	0	0	0	0	0
RBME	0	0	0	0	0	0	0	0	0	0
UNME	0	0	0	0	0	0	0	0	0	0
Total Mergansers	0	0	0	0	1	0	0	0	0	0
Avian Piscivores										
HOGR	0	1	0	0	0	0	0	0	0	3
RNGR	3	3	2	1	0	1	1	0	1	0
WEGR	13	6	0	6	16	1	0	4	0	0
UNGR	0	0	0	0	0	0	0	0	0	0
Total Grebes	16	10	2	7	16	2	1	4	1	3
COLO	2	1	1	5	8	5	3	0	0	1
PALO	0	1	0	0	0	0	0	0	0	0
RTLO	0	0	3	0	3	6	2	0	0	1
UNLO	1	0	0	3	0	31	8	0	0	0
Total Loons	3	2	4	8	11	42	13	0	0	2
DCCO	0	0	0	0	0	0	0	0	1	2
PECO	0	0	1	0	0	0	0	0	1	0
UNCO	4	0	18	29	0	6	10	6	11	83
Total Cormorants	4	0	19	29	0	6	10	6	13	85
ANMU	0	0	0	0	0	0	0	0	0	0
CAAU	0	0	0	0	0	0	0	0	0	0
COMU	0	0	41	0	0	0	0	0	0	0
MAMU	2	0	0	0	0	0	0	0	2	0
PIGU	0	0	0	0	0	0	0	0	0	0
RHAU	0	0	0	0	0	0	0	0	0	0
UNAC	0	0	0	0	0	0	0	0	0	0
UNML	0	0	0	0	0	0	0	0	0	0
USAC	0	0	0	0	0	0	0	0	0	0
Total Alcids	2	0	41	0	0	0	0	0	2	0
BOGU	0	0	0	0	0	0	0	0	0	0
GWGU	0	6	10	3	0	1	0	7	0	0
MEGU	0	0	1	0	0	0	0	0	0	0
UBWG	2	22	1	10	1	6	3	5		3
UNGU	15	52	87	106	25	15	40	18	112	10
Total Gulls	17	80	99	119	26	22	43	30	112	13
Miscellaneous Avian Species										
BLBR	0	0	0	0	13	0	0	0	0	0
CAGO	0	0	0	0	0	0	0	0	0	0
GBHE	0	0	0	0	0	0	0	0	1	0
BRPE	0	0	0	0	0	0	0	0	0	0
UNDO	0	0	0	0	0	0	0	0	0	0
USSD	0	0	0	0	2	15	0	0	0	0
BAEA	0	0	0	0	0	0	1	0	0	0
CORA	0	0	0	0	0	0	0	0	0	0
UNDD	0	0	2	0	0	0	0	0	0	0
UNDU	0	0	0	0	0	0	0	0	0	11
UNSB	0	0	0	4	0	0	0	0	0	0
Marine Mammals										
Pinnipeds										
CASL	1	0	1	6	0	1	0	0	0	0
HASE	0	0	0	1	3	10	8	1	0	31
STSL	0	0	0	0	0	0	0	0	0	0
UNSL	0	0	0	1	0	0	0	0	0	0
Cetaceans										
DAPO	0	0	0	0	0	0	0	0	0	0
HAPO	0	0	1	0	2	0	0	0	0	0
PWDO	0	0	2	0	0	0	0	0	0	0
UNPO	0	0	0	1	0	0	0	0	0	0
GRWH	0	0	0	0	0	0	0	0	0	0
Other Marine Mammals										
SEOT	0	0	0	0	0	0	0	78	104	2
UNMM	0	0	1	1	1	0	0	1	0	0

Table 1 cont.: Shoreline transects.

N Transects Species/Transect #'s	134 Grand Total	Shoreline Expanded Pop.	Shoreline Weighted S.E.
Sea Ducks			
BLSC	41	59	31
SUSC	754	1080	316
WWSC	76	109	38
UNSC	730	1046	426
Total Scoters	1601	2294	697
Harlequin Ducks	7	10	10
Goldeneyes	0	0	0
Long-tailed Ducks	0	0	0
Bufflehead	3	4	4
COME	1	1	1
RBME	2	3	3
UNME	0	0	0
Total Mergansers	3	4	3
Avian Piscivores			
HOGR	7	10	5
RNGR	31	43	9
WEGR	642	631	392
UNGR	7	10	7
Total Grebes	687	695	398
COLO	41	59	13
PALO	1	1	1
RTLO	47	65	18
UNLO	55	79	44
Total Loons	144	204	58
DCCO	6	9	4
PECO	10	14	6
UNCO	286	382	118
Total Cormorants	302	404	121
ANMU	0	0	0
CAAU	1	1	1
COMU	70	100	68
MAMU	38	54	20
PIGU	2	3	3
RHAU	0	0	0
UNAC	0	0	0
UNML	3	4	4
USAC	3	4	3
Total Alcids	117	168	68
BOGU	0	0	0
GWGU	37	53	18
MEGU	1	1	1
UBWG	113	158	37
UNGU	791	1130	226
Total Gulls	942	1342	239
Miscellaneous Avian Species			
BLBR	13	19	18
CAGO	2	3	3
GBHE	6	9	5
BRPE	0	0	0
UNDO	0	0	0
USSD	17	24	21
BAEA	2	3	2
CORA	1	1	1
UNDD	2	3	3
UNDU	11	16	15
UNSB	9	13	8
Marine Mammals			
Pinnipeds			
CASL	77	110	69
HASE	139	183	75
STSL	0	0	0
UNSL	6	9	4
Cetaceans			
DAPO	0	0	0
HAPO	4	6	3
PWDO	2	3	3
UNPO	1	1	1
GRWH	1	1	1
Other Marine Mammals			
SEOT	184	264	177
UNMM	5	7	3

Table 2: Offshore transects.

	42°,2-8'	42°,22-28'	42°,42-48'	43°, 2-8'	43°,22-28'	43°, 42-48'	44°,2-8'	44°, 22-28'	44°,42-48'	45°,2-8'
N Transects	4	4	4	4	4	4	4	4	4	4
Species/Transect #'s	OW 2-8	OW16-22	OW30-36	OW44-50	OW58-64	OW72-78	OW86-92	OW100-106	OW114-120	OW128-134
Sea Ducks										
BLSC	0	0	0	0	0	0	0	0	0	0
SUSC	0	2	4	1	0	0	2	5	0	0
WWSC	1	4	0	0	2	0	0	0	0	2
UNSC	1	0	7	0	0	0	0	2	0	0
Total Scoters	2	6	11	1	2	0	2	7	0	2
Harlequin Ducks	0	0	0	0	0	0	0	0	0	0
Goldeneyes	0	0	0	0	0	0	0	0	0	0
Long-tailed Ducks	0	0	0	0	0	0	0	0	0	0
Bufflehead	0	0	0	0	0	0	0	0	0	0
COME	0	0	0	0	0	0	0	0	0	0
RBME	0	0	0	0	0	0	0	0	0	0
UNME	0	0	0	0	0	0	0	0	0	0
Total Mergansers	0	0	0	0	0	0	0	0	0	0
Avian Piscivores										
HOGR	0	0	0	0	0	0	0	0	0	0
RNGR	1	0	0	1	0	0	7	0	0	0
WEGR	0	16	0	0	0	1	4	10	4	1
UNGR	0	0	0	0	0	0	0	0	1	0
Total Grebes	1	16	0	1	0	1	11	10	5	1
COLO	0	1	0	1	1	5	0	0	1	1
PALO	0	0	0	0	0	0	0	0	0	0
RTLO	2	1	0	0	0	1	3	9	1	2
UNLO	0	1	0	0	1	0	1	0	1	0
Total Loons	2	3	0	1	2	6	4	9	3	3
DCCO	0	1	0	0	0	0	1	1	1	0
PECO	0	0	2	2	1	0	0	0	0	0
UNCO	1	9	32	1	3	0	14	1	3	1
Total Cormorants	1	10	34	3	4	0	15	2	4	1
ANMU	0	0	0	0	0	10	0	0	0	3
CAAU	0	0	0	0	0	0	0	0	0	0
COMU	168	4	153	42	3	2	12	242	22	49
MAMU	0	5	0	0	0	2	2	10	2	0
PIGU	0	0	0	0	0	0	0	0	0	0
RHAU	0	0	0	0	0	0	0	2	1	2
UNAC	0	0	0	0	0	2	0	5	0	0
UNML	6	2	1	0	0	0	0	4	0	0
USAC	0	0	0	0	1	0	0	1	0	0
Total Alcids	174	11	154	42	4	16	14	264	25	54
BOGU	0	0	0	0	0	0	0	0	0	0
GWGU	0	0	0	0	0	0	0	1	2	0
MEGU	0	0	0	0	1	0	0	0	4	0
UBWG	11	2	0	2	0	0	3	4	5	7
UNGU	20	1	24	10	17	3	7	2	5	9
Total Gulls	31	3	24	12	18	3	10	7	16	16
Miscellaneous Avian Species										
BLBR	4	0	0	0	0	0	0	0	0	0
CAGO	0	0	0	0	0	0	0	0	0	0
GBHE	0	0	0	0	0	0	0	0	0	0
BRPE	0	0	0	0	0	0	0	0	0	0
UNDO	0	0	0	0	0	0	0	0	0	0
USSD	0	0	0	0	0	0	0	0	0	0
BAEA	0	0	0	0	0	0	0	0	0	0
CORA	0	0	0	0	0	0	0	0	0	0
UNDD	0	2	0	0	0	0	2	0	0	0
UNDU	0	3	0	0	0	0	0	0	0	0
UNSB	0	0	0	0	0	0	0	0	0	0
Marine Mammals										
Pinnipeds										
CASL	0	1	0	0	0	1	0	0	0	1
HASE	0	0	0	0	0	0	0	0	0	0
STSL	0	0	0	0	0	0	0	0	0	0
UNSL	0	0	0	1	0	0	0	0	0	0
Cetaceans										
DAPO	0	0	0	0	0	2	0	0	0	0
HAPO	9	2	1	0	6	2	0	0	0	3
PWDO	0	0	0	0	0	0	0	0	0	0
UNPO	0	0	1	0	0	0	0	0	0	0
GRWH	0	0	0	0	0	0	0	0	0	0
Other Marine Mammals										
SEOT	0	0	0	0	0	0	0	0	0	0
UNMM	0	0	0	0	0	0	0	0	0	0

Table 2 cont.: Offshore transects.

	45°,22-28'	45°,42-48'	46°,2-8'	46°,22-28'	46°,42-48'	47°,2-8'	47°,22-28'	47°,42-48'	48°,2-8'	48°22-24'
N Transects	4	4	4	4	4	4	4	4	4	2
Species/Transect #'s	OW142-148	OW156-162	OW170-176	OW184-190	OW198-204	OW212-218	OW226-232	OW240-246	OW254-260	OW268-270
Sea Ducks										
BLSC	0	0	0	0	0	0	0	0	0	0
SUSC	0	0	4	12	9	3	6	52	15	0
WWSC	50	43	34	38	15	12	5	10	60	0
UNSC	0	0	1	0	0	0	2	3	14	0
Total Scoters	50	43	39	50	24	15	13	65	89	0
Harlequin Ducks	0	0	0	0	0	0	0	0	0	0
Goldeneyes	0	0	0	0	0	0	0	0	0	0
Long-tailed Ducks	0	0	0	0	0	0	0	0	0	0
Bufflehead	0	0	0	0	0	0	0	0	0	0
COME	0	0	0	0	0	0	0	0	0	0
RBME	0	0	0	0	0	0	0	0	0	0
UNME	0	0	0	0	7	0	0	0	0	0
Total Mergansers	0	0	0	0	7	0	0	0	0	0
Avian Piscivores										
HOGR	0	0	0	0	0	1	1	0	0	0
RNGR	0	0	0	0	1	0	0	1	0	0
WEGR	4	1	3	93	22	86	42	82	12	0
UNGR	0	0	0	0	0	0	0	0	0	0
Total Grebes	4	1	3	93	23	87	43	83	12	0
COLO	1	0	2	0	3	3	0	3	4	0
PALO	0	0	0	0	0	0	0	0	0	0
RTLO	8	5	13	10	3	2	24	156	13	0
UNLO	0	0	0	21	0	1	1	18	4	0
Total Loons	9	5	15	31	6	6	25	177	21	0
DCCO	0	0	0	0	0	0	1	0	0	0
PECO	0	0	0	0	0	0	2	0	0	0
UNCO	9	3	2	0	0	1	48	11	12	1
Total Cormorants	9	3	2	0	0	1	51	11	12	1
ANMU	0	0	0	0	0	0	0	0	0	0
CAAU	1	0	0	0	0	0	0	19	0	0
COMU	426	5	9	26	59	284	85	129	256	74
MAMU	0	0	2	2	0	0	1	0	0	7
PIGU	0	0	0	0	0	0	0	0	0	1
RHAU	0	0	0	0	0	6	43	114	23	0
UNAC	0	0	0	2	1	0	4	9	0	0
UNML	0	0	0	0	0	0	2	0	0	0
USAC	0	0	0	0	0	0	0	0	0	0
Total Alcids	427	5	11	30	60	290	135	271	279	82
BOGU	0	0	0	0	4	1	0	0	0	0
GWGU	2	4	0	1	0	0	2	1	2	2
MEGU	0	1	0	0	0	0	0	1	0	0
UBWG	4	7	2	11	6	7	10	21	1	1
UNGU	50	5	11	11	23	48	67	112	66	3
Total Gulls	56	17	13	23	33	56	79	135	69	6
Miscellaneous Avian Species										
BLBR	0	0	0	0	17	0	0	0	0	0
CAGO	0	0	0	0	0	0	0	0	0	0
GBHE	0	0	0	0	0	0	0	0	0	0
BRPE	0	0	0	0	1	0	0	0	0	0
UNDO	0	0	0	0	0	0	0	1	0	0
USSD	0	0	0	0	0	0	0	0	0	0
BAEA	0	0	0	0	0	0	0	0	0	1
CORA	0	0	0	0	0	0	0	0	0	0
UNDD	3	1	0	2	1	0	8	8	0	1
UNDU	0	0	0	0	0	0	0	0	0	0
UNSB	0	0	0	0	0	0	0	0	0	0
Marine Mammals										
Pinnipeds										
CASL	0	1	0	1	4	0	0	0	0	0
HASE	0	0	0	0	0	3	4	3	0	0
STSL	0	0	0	0	0	0	0	0	1	130
UNSL	0	0	0	0	0	0	0	0	0	0
Cetaceans										
DAPO	0	0	0	0	0	0	0	0	0	0
HAPO	1	0	3	8	1	18	3	12	0	0
PWDO	0	0	0	0	0	0	0	0	0	0
UNPO	0	0	0	3	1	8	3	4	0	0
GRWH	0	0	0	0	0	0	1	0	0	0
Other Marine Mammals										
SEOT	0	0	0	0	0	0	3	2	2	0
UNMM	0	0	0	0	0	0	0	0	0	0

Table 2 cont.: Offshore transects.

N Transects Species/Transect #'s	78 Grand Total	Offshore Expanded Pop.	Offshore Weighted S.E.
Sea Ducks			
BLSC	0	0	0
SUSC	115	5256	2355
WWSC	276	12615	3919
UNSC	30	1371	683
Total Scoters	421	19242	5203
Harlequin Ducks	0	0	0
Goldeneyes	0	0	0
Long-tailed Ducks	0	0	0
Bufflehead	0	0	0
COME	0	0	0
RBME	0	0	0
UNME	7	320	316
Total Mergansers	7	320	316
Avian Piscivores			
HOGR	2	91	62
RNGR	11	503	317
WEGR	381	17414	6236
UNGR	1	46	45
Total Grebes	395	18054	6241
COLO	26	1188	305
PALO	0	0	0
RTLO	253	11564	6910
UNLO	49	2240	1193
Total Loons	328	14992	7805
DCCO	5	229	89
PECO	7	320	150
UNCO	152	6925	2455
Total Cormorants	164	7473	2586
ANMU	13	594	464
CAAU	20	914	856
COMU	2050	92007	23871
MAMU	33	1348	520
PIGU	1	23	33
RHAU	191	8730	5390
UNAC	23	1051	472
UNML	15	686	326
USAC	2	91	62
Total Alcids	2348	105445	25387
BOGU	5	229	184
GWGU	17	731	226
MEGU	7	320	188
UBWG	104	4731	1032
UNGU	494	22510	5874
Total Gulls	627	28521	6600
Miscellaneous Avian Species			
BLBR	21	960	778
CAGO	0	0	0
GBHE	0	0	0
BRPE	1	46	45
UNDO	1	46	45
USSD	0	0	0
BAEA	1	23	33
CORA	0	0	0
UNDD	28	1257	492
UNDU	3	137	135
UNSB	0	0	0
Marine Mammals			
Pinnipeds			
CASL	9	411	190
HASE	10	457	249
STSL	131	3017	4250
UNSL	1	46	45
Cetaceans			
DAPO	2	91	90
HAPO	69	3154	975
PWDO	0	0	0
UNPO	20	914	413
GRWH	1	46	45
Other Marine Mammals			
SEOT	7	320	176
UNMM	0	0	0

Table 3. Population Estimates of Shoreline and Offshore transects combined.

	Shoreline		Offshore		Grand Total	
Species	Expanded Pop.	Weighted S.E.	Expanded Pop.	Weighted S.E.	Expanded Pop.	Weighted S.E.
Sea Ducks						
BLSC	59	31	0	0	59	31
SUSC	1080	313	5256	2355	6337	2669
WWSC	109	38	12615	3919	12724	3957
UNSC	1046	419	1371	683	2417	1103
Total Scoters	2294	690	19242	5203	21536	5893
Harlequin Ducks	10	10	0	0	10	10
Goldeneyes	0	0	0	0	0	0
Long-tailed Ducks	0	0	0	0	0	0
Bufflehead	4	4	0	0	4	4
	0	0	0	0	0	0
COME	1	1	0	0	1	1
RBME	3	3	0	0	3	3
UNME	0	0	320	316	320	316
Total Mergansers	4	3	320	316	324	319
Avian Piscivores						
HOGR	10	5	91	62	101	67
RNGR	43	9	503	317	546	326
WEGR	631	466	17414	6236	18045	6702
UNGR	10	7	46	45	56	52
Total Grebes	695	470	18054	6241	18749	6710
COLO	59	13	1188	305	1247	318
PALO	1	1	0	0	1	1
RTLO	65	17	11564	6910	11629	6928
UNLO	79	43	2240	1193	2318	1236
Total Loons	204	57	14992	7805	15196	7862
DCCO	9	4	229	89	237	93
PECO	14	5	320	150	334	155
UNCO	382	116	6925	2455	7306	2571
Total Cormorants	404	118	7473	2586	7877	2704
ANMU	0	0	594	464	594	464
CAAU	1	1	914	856	916	857
COMU	100	66	92007	23871	92107	23937
MAMU	54	20	1348	520	1403	540
PIGU	3	3	23	33	26	35
RHAU	0	0	8730	5390	8730	5390
UNAC	0	0	1051	472	1051	472
UNML	4	4	686	326	690	330
USAC	4	3	91	62	96	65
Total Alcids	168	67	105445	25387	105612	25455
BOGU	0	0	229	184	229	184
GWGU	53	18	731	226	784	244
MEGU	1	1	320	188	321	189
UBWG	158	36	4731	1032	4889	1068
UNGU	1130	226	22510	5874	23640	6101
Total Gulls	1342	240	28521	6600	29863	6840
Miscellaneous Avian Species						
BLBR	19	18	960	778	978	796
CAGO	3	3	0	0	3	3
GBHE	9	4	0	0	9	4
BRPE	0	0	46	45	46	45
UNDO	0	0	46	45	46	45
USSD	24	21	0	0	24	21
BAEA	3	2	23	33	26	35
CORA	1	1	0	0	1	1
UNDD	3	3	1257	492	1260	494
UNDU	16	15	137	135	153	150
UNSB	13	8	0	0	13	8
	0	0	0	0	0	0
Marine Mammals						
Pinnipeds	0	0	0	0	0	0
CASL	110	68	411	190	522	258
HASE	183	74	457	249	640	322
STSL	0	0	3017	4250	3017	4250
UNSL	9	4	46	45	54	49
	0	0	0	0	0	0
Ceteceans	0	0	0	0	0	0
DAPO	0	0	91	90	91	90
HAPO	6	3	3154	975	3159	978
PWDO	3	3	0	0	3	3
UNPO	1	1	914	413	916	414
GRWH	1	1	46	45	47	46
Other Marine Mammals						
SEOT	264	174	320	176	584	350
UNMM	7	3	0	0	7	3

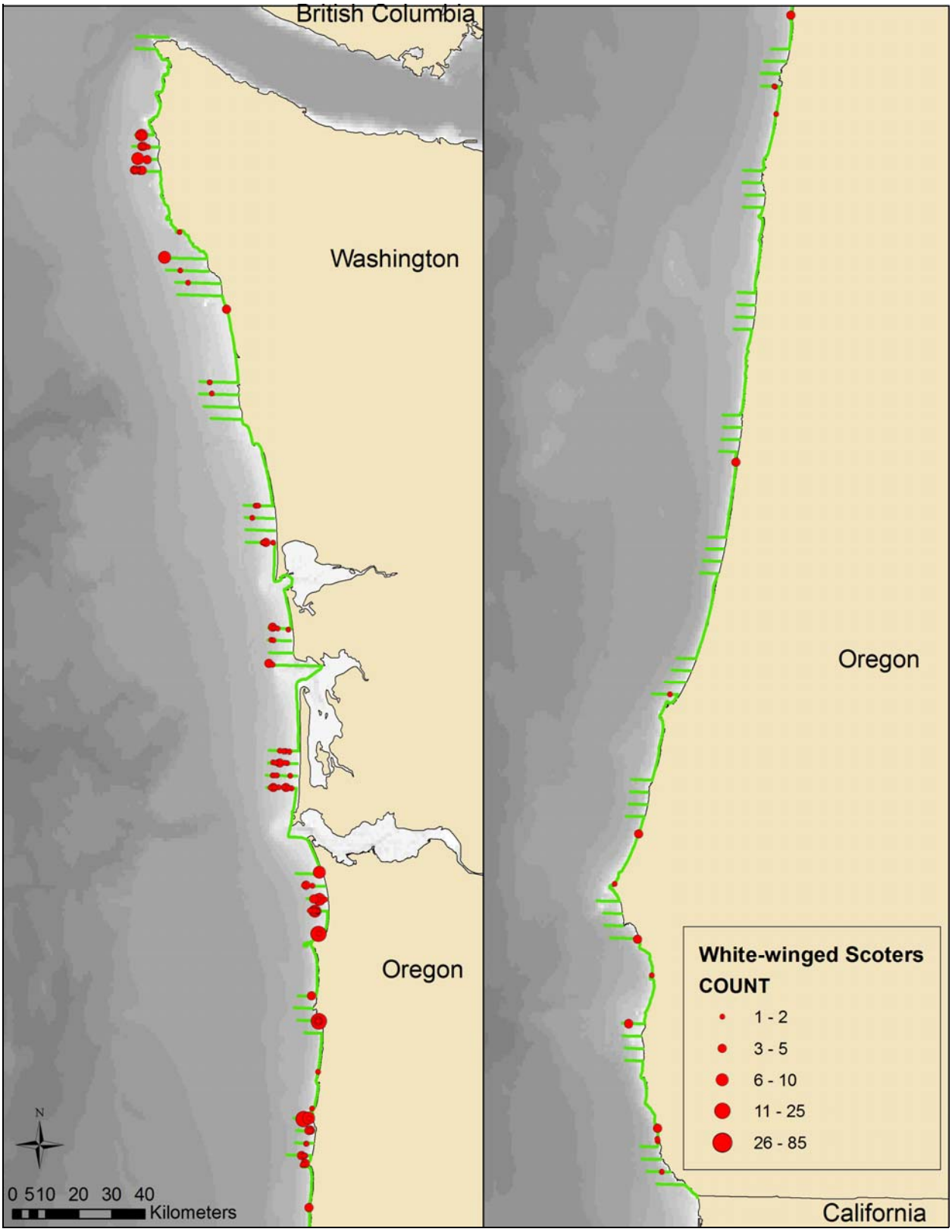

Figure 2. Distribution of white-winged scoter observations.

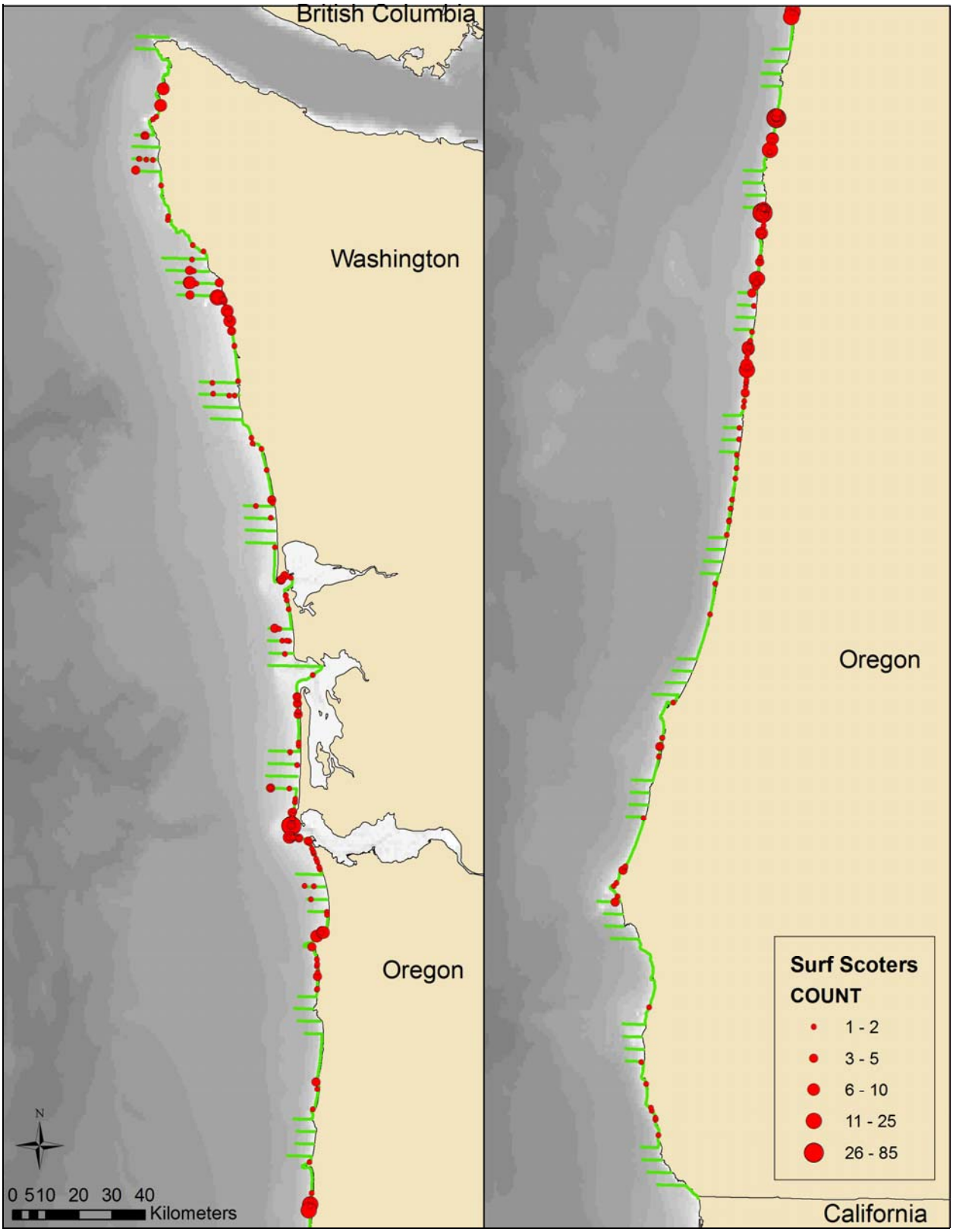

Figure 3. Distribution of surf scoter observations

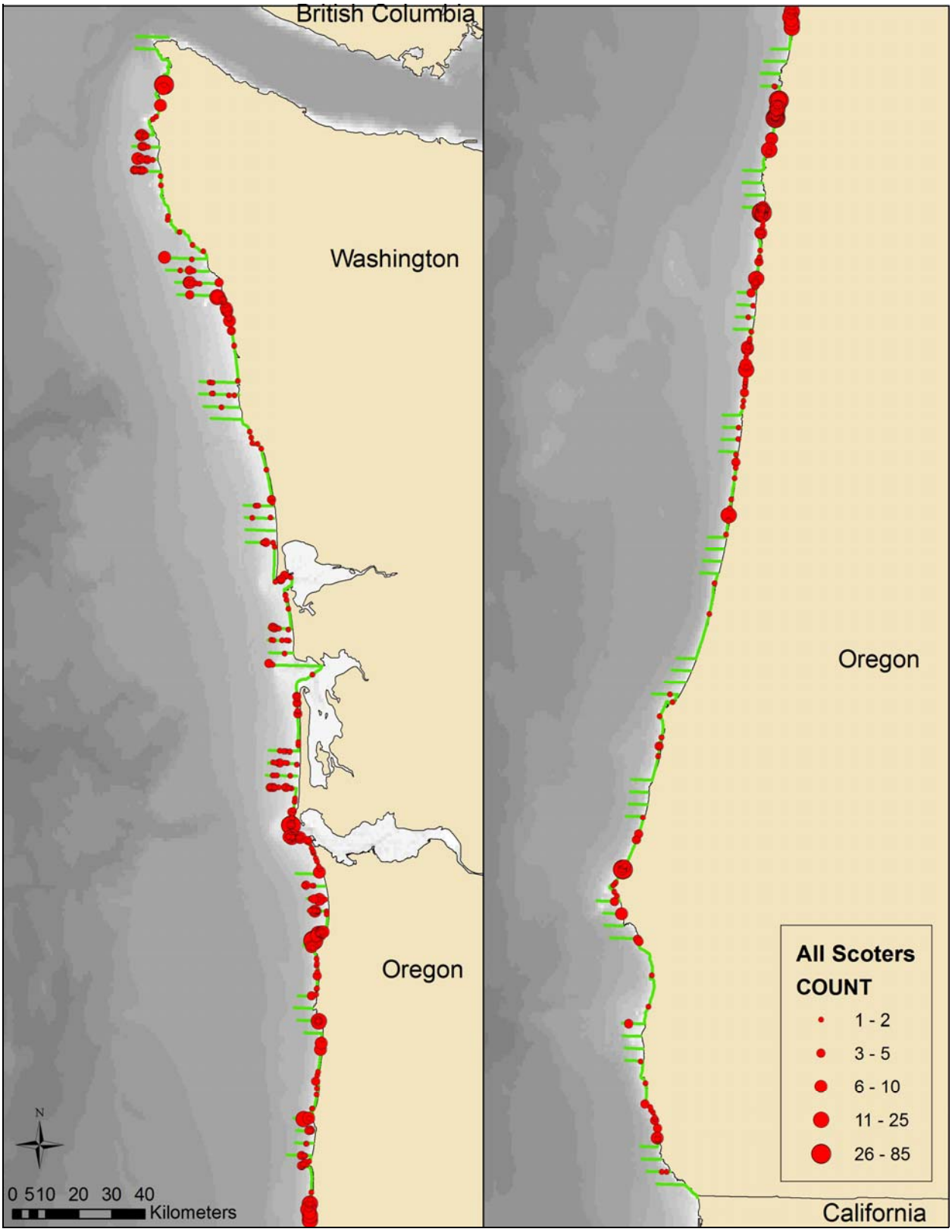

Figure 4. Distribution of all scoter observations.

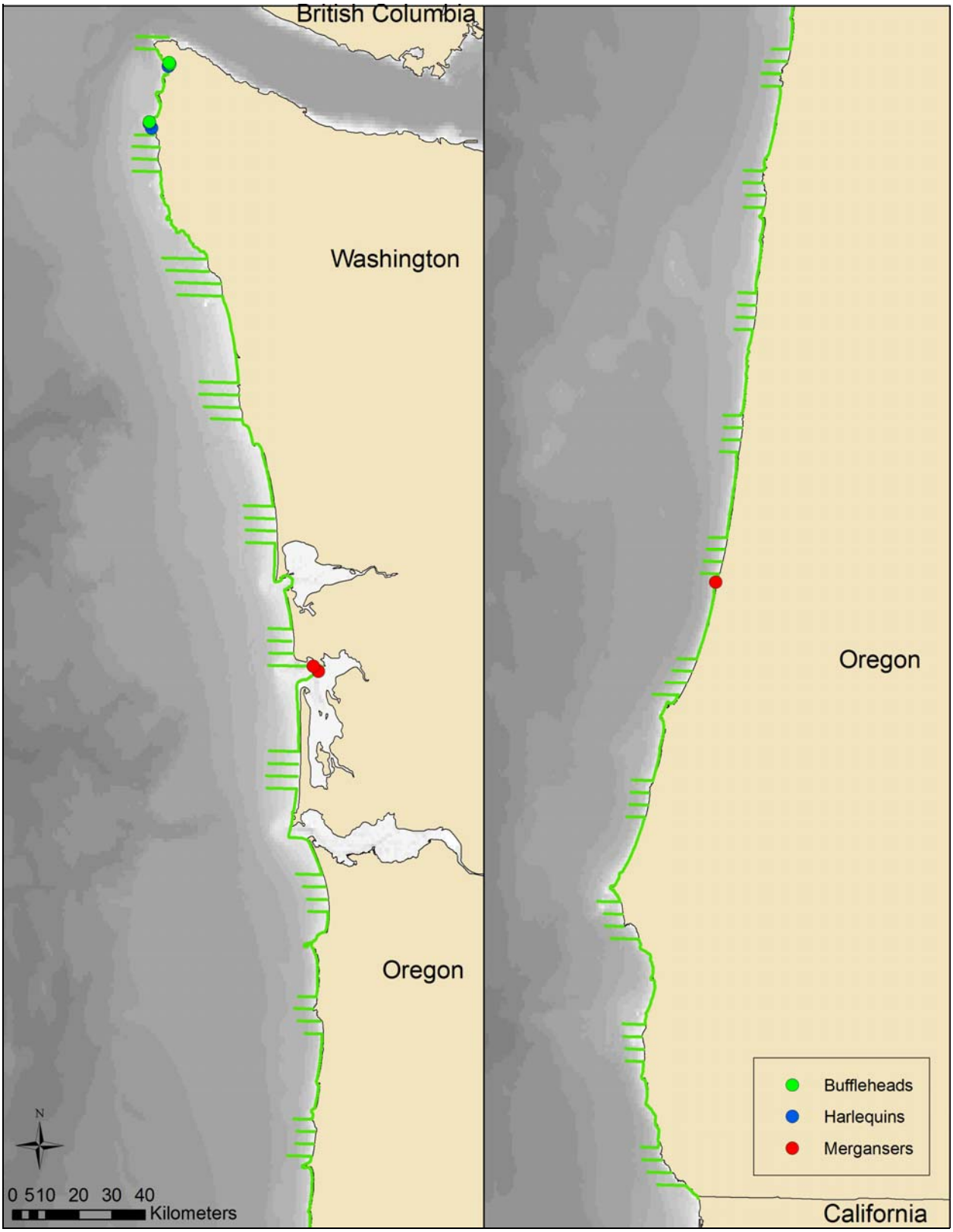

Figure 5. Distribution of Bufflehead, Harlequin, and Merganser observations.