Offshore Survey Results

Components of Variation in Offshore Distribution—As with the Near-shore survey data, variation in offshore marine bird density was quantified using ANOVA and ANCOVA models. Although similar analysis techniques were used, far less variation was explained in the offshore area compared to the near-shore area. For example, only 40% of the variation in Long-tailed Duck density in the offshore area was explained by ANOVA and ANCOVA models (Tables 24) compared with 75% in the near-shore area.

Table 24. Final analysis of variance (ANOVA) and analysis of covariance (ANCOVA) models that explain variation in log density (ln[density+1]) of waterfowl and marine birds on Offshore surveys, Beaufort Sea, Alaska, 1999-2000. Non-significant factors and covariates were removed following backward stepwise removal procedures.

	ANOVA		ANCOVA	
Species Group	Model[a]	R^2	Model	R^2
All Eider	S+Y+R+SR	0.23	S+Y+R+SR	0.23
Common Eider	Y+S+R+SY	0.16	S+Wa+SY	0.15
King Eider	S+Y+R+SR+YR	0.32	S+Y+R+SR+YR	0.32
Spectacled Eider	SYR[b]	0.05	SYR[a]	0.05
Long-tailed Duck	S+R+Y+SR+SY	0.40	S+R+Y+SR+SY	0.40
All Scoters	S+Y+SR+YR	0.21	S+Y+SR+YR	0.21
Glaucous Gulls	S+R+SR	0.28	S+ R+ I+SR	0.29
All Loons	S+SR+YR+SYR	0.23	S+Wa+Wi+I+SY	0.21
Pacific Loon	S+SR	0.15	R+Wi+I+SY+SR	0.20
Red-throated Loon	S+SY+SR+YR+SYR	0.21	Y+Wa+I+SY+SR+YR+SYR	0.21
Yellow-billed Loon	S+R+YR+SYR	0.17	S+R+Wi+YR+SYR	0.18

[a] See table 5 for term abbreviations
[b] P=0.058

Densities of marine birds in the offshore environment varied across time and space. Thus, generalizations regarding bird distribution must take into account both the time of year and general area. To illustrate, while Month (June, July, August) and Strata explained a significant portion of variation in density for most focal taxa (Table 25), a significant Strata*Month term was detected among King Eiders, Long-tailed Ducks, Scoters, Glaucous Gulls, Pacific Loons, and Red-throated Loons ($P < 0.05$), revealing that local distribution patterns varied by stage of the summer.

Although the stage of summer impacted distribution patterns of many marine birds, its effect varied between years. For example, the Year*Month term was significant among King Eiders, Scoters, and Red-throated and Yellow-billed Loons. Thus for these species, densities varied by Month to varying extents in 1999 versus 2000. Similarly, the Year*Strata term was significant among Common Eiders, Long-tailed Ducks, and Red-throated Loons ($P < 0.05$) suggesting that these birds used strata differently between 1999-2000.

To better explain variability in density estimates in the offshore area, three covariates were included in an ANCOVA model (Table 6). These covariates included Percent Ice Cover (Arc-sine transformed), Wave Height (Log transformed), and Wind Speed. These covariates were negatively correlated with density of several species (Table 26). Thus, as Ice Cover, Wave Height, and Wind Speed increased, bird density decreased. While these covariates explained a significant portion of variability in density estimates of several taxa, their contribution was relatively small. This is demonstrated by the similarity in R^2 estimates (representing the proportion of variability explained in a given model) in the ANOVA and ANCOVA models (Table 24). For example, among Red-throated Loons, an equal proportion of variability was accounted for in the two models. Similarly, among Glaucous Gulls and Yellow-billed Loons, just 1% more of the variance was explained when covariates were introduced. Thus, with the exception of models describing Pacific Loon density, whose R^2 increased by 5% when covariates were included, Ice Cover, Wave Height and Wind Speed had little effect on density estimates of marine birds.

Several important considerations regarding these covariates should be considered when interpreting these results. First, wind and waves are correlated; thus it is possible that while wind speed may be significant in an ANCOVA model, its inclusion prevents the wave height parameter from appearing significant. Second, it is likely that wave height and wind speed affect the sightability rather than density of marine birds. For this reason, standard protocol requires that surveys be conducted under specific weather conditions. For example, surveys were initiated only when surface winds were less than 15 knots. Similarly, observations were suspended if winds exceeded 20 knots during the course of the survey. Thus, we do not have a random sample of weather conditions to test the effect of wind and waves. It is likely that under severe weather conditions wind speed and wave height could significantly alter the distribution of all marine birds. Given our restricted sampling conditions, however, we could not report the full range of responses to weather conditions that is characteristic of the Beaufort Sea.

Offshore Species Composition and Distribution

We observed 19,924 birds among 28 taxa during Offshore surveys in 1999-2000 (Table 27, Appendix 4). Long-tailed Ducks comprised the largest proportion of these birds (44%) followed by King Eiders (28%), Scoters (10%) Common Eiders (5%), and Glaucous Gulls (5%; Fig. 30). These five groups made up over 90% of the avifauna in the Offshore survey area. When combined with Pacific, Red-throated and Yellow-billed Loons, Spectacled Eiders and unidentified *Somateria* Eider species, these groups represented over 95% of all birds sighted. These "focal" taxa are discussed in this report, whereas Northern Pintail, Geese, Swans, Shearwaters (*Puffinus spp*.), Scaup, Red-breasted Mergansers, Shorebirds, Jaegers, Arctic Terns, Black Guillemots, and Auklets (*Aethia spp*.) were incidental sightings; thus inferences regarding their distribution and density are difficult and not reported here.

Species composition varied among the 8 strata (2 depth classes across 4 west-east regions; Fig. 4), reflecting differences in distribution among depth and regional classes (Table 28). For example, while Long-tailed Ducks represented the majority of birds overall, King Eiders comprised over 84% of the Central Deep-water stratum (Fig. 31). Similarly, while Common Eiders only represented 5% of all birds seen during the Offshore survey as a whole, they represented 33% of birds in the Industrial Deep-water stratum.

Table 25. Results of ANCOVA models that explain variation of marine bird log density (ln [density +1]) in offshore waters, Beaufort Sea, 1999-2000. Non-significant factors and covariates were removed following backward stepwise removal procedures.

Species	Source of Variation	df	F	P-value	R^2
All Eiders	Stratum	7	4.39	< 0.01	
	Month	2	10.94	< 0.01	
	Year	1	6.27	0.01	
	Stratum*Month	14	4.24	< 0.01	
	Error	448			0.23
Common Eider	Stratum	7	9.42	< 0.01	
	Ln (wave ht +1)	1	15.11	< 0.01	
	Stratum*Year	7	3.73	< 0.01	
	Error	457			0.15
King Eider	Stratum	7	8.28	< 0.01	
	Month	2	18.58	< 0.01	
	Year	1	14.59	< 0.01	
	Stratum*Month	14	4.76	< 0.01	
	Year*Month	2	3.53	0.03	
	Error	446			0.32
Spectacled Eider	Stratum*Year*Month	14	1.67	0.06	
	Error	458			0.05
Long-tailed Duck	Stratum	7	24.18	< 0.01	
	Month	2	24.81	< 0.01	
	Year	1	12.21	< 0.01	
	Stratum*Month	14	4.73	< 0.01	
	Stratum*Year	7	2.81	< 0.01	
	Error	441			0.40
All Scoters	Stratum	7	7.92	< 0.01	
	Year	1	5.26	0.02	
	Stratum*Month	14	3.59	< 0.01	
	Year*Month	2	7.68	< 0.01	
	Error	448			0.21
Glaucous Gull	Stratum	7	9.21	< 0.01	
	Month	2	6.56	< 0.01	
	Arc sine %ice	1	6.50	0.01	
	Stratum*Month	14	1.90	0.03	
	Error	448			0.29
All Loons	Stratum	7	3.68	< 0.01	
	Ln (wave ht +1)	1	7.14	< 0.01	
	Wind speed	1	10.32	< 0.01	
	Arc sine %ice	1	18.56	< 0.01	
	Stratum*Year	7	2.40	0.02	
	Error	455			0.21
Pacific Loon	Month	2	10.17	< 0.01	
	Wind speed	1	8.96	< 0.01	
	Arc sine %ice	1	55.42	< 0.01	
	Stratum*Month	14	3.08	< 0.01	
	Stratum*Year	7	2.54	0.01	
	Error	447			0.20
Red-throated Loon	Year	1	5.30	0.02	
	Ln (wave ht +1)	1	7.69	< 0.01	
	Arc sine %ice	1	22.81	< 0.01	
	Stratum*Month	14	1.90	0.02	
	Stratum*Year	7	3.10	< 0.01	
	Year*Month	2	5.31	< 0.01	
	Stratum*Year*Month	14	2.44	< 0.01	
	Error	432			0.21
Yellow-billed Loon	Stratum	7	3.91	< 0.01	
	Month	2	3.41	0.03	
	Wind speed	1	6.27	0.01	
	Year*Month	2	5.76	< 0.01	
	Stratum*Year*Month	14	2.11	0.01	
	Error	446			0.18

Table 26. Results of ANCOVA models that explain variation of marine bird log density (ln [density +1]) in offshore waters, Beaufort Sea, 1999-2000. Non-significant factors and covariates were removed following backward stepwise removal procedures.

Species	Source of Variation	df	F	P-value	R^2
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	Year	1	12.21	< 0.01	
	Stratum*Month	14	4.73	< 0.01	
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	Error	441			0.40
All Scoters	Stratum	7	7.92	< 0.01	
	Year	1	5.26	0.02	
	Stratum*Month	14	3.59	< 0.01	
	Year*Month	2	7.68	< 0.01	
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	Month	2	6.56	< 0.01	
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	Wind speed	1	10.32	< 0.01	
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	Wind speed	1	8.96	< 0.01	
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	Stratum*Month	14	3.08	< 0.01	
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Red-throated Loon	Year	1	5.30	0.02	
	Ln (wave ht +1)	1	7.69	< 0.01	
	Arc sine %ice	1	22.81	< 0.01	
	Stratum*Month	14	1.90	0.02	
	Stratum*Year	7	3.10	< 0.01	
	Year*Month	2	5.31	< 0.01	
	Stratum*Year*Month	14	2.44	< 0.01	
	Error	432			0.21
Yellow-billed Loon	Stratum	7	3.91	< 0.01	
	Month	2	3.41	0.03	
	Wind speed	1	6.27	0.01	
	Year*Month	2	5.76	< 0.01	
	Stratum*Year*Month	14	2.11	0.01	
	Error	446			0.18

Table 27. Bird species observed during six Offshore surveys, Beaufort Sea, Alaska, 1999-2000.

Species	Species Code	Total Count	% of Total
Yellow-billed Loon	YBLO	27	0.14
Pacific Loon	PALO	282	1.42
Red-throated Loon	RTLO	65	0.33
Unidentified Loon *spp*.	UNLO	1	0.01
Shearwater *spp*.	SHWA	37	0.19
Tundra Swan	TUSW	21	0.11
White-fronted Goose	WFGO	155	0.78
Snow Goose	SNGO	25	0.13
Canada Goose	CAGO	25	0.13
Black Brant	BLBR	85	0.43
Northern Pintail	NOPI	173	0.87
Scaup *spp*.	SCAU	154	0.77
Common Eider	COEI	926	4.65
King Eider	KIEI	5493	27.57
Spectacled Eider	SPEI	148	0.74
Unidentified Eider *spp*.	UNEI	333	1.67
Black Scoter	BLSC	46	0.23
White-winged Scoter	WWSC	204	1.02
Surf Scoter	SUSC	1112	5.58
Unidentified Scoter *spp*.	UNSC	542	2.72
Long-tailed Duck	LTDU	8797	44.15
Red-breasted Merganser	RBME	25	0.13
Shorebird *spp*.	SHSP	249	1.25
Jaeger *spp*.	JAEG	52	0.26
Glaucous Gull	GLGU	891	4.47
Arctic Tern	ARTE	51	0.26
Black Guillemot	BLGU	2	0.01
Auklet *spp*.	AUKL	3	0.02
Total		19924	100.00

Table 28. Number observed and percent composition of focal taxa among Offshore survey strata.

	Strata															
	1 Harrison Bay Deep		2 Industrial Deep		3 Central Deep		4 Control Deep		5 Harrison Bay Shallow		6 Industrial Shallow		7 Central Shallow		8 Control Shallow	
Species	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
YBLO[a]	1	0.0	2	0.2	1	0.1	0	0.0	18	0.4	0	0.0	5	0.2	0	0.0
PALO	55	1.4	28	2.6	24	2.1	17	7.9	91	2.0	30	2.5	32	1.0	5	0.1
RTLO	6	0.2	2	0.2	7	0.6	4	1.9	22	0.5	7	0.6	16	0.5	1	0.0
UNLO	1	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
COEI	7	0.2	58	5.3	25	2.2	68	31.6	276	6.1	161	13.5	184	5.6	147	4.2
KIEI	3051	78.4	542	49.4	956	84.2	21	9.8	708	15.7	47	3.9	138	4.2	30	0.9
SPEI	147	3.8	0	0.0	0	0.0	0	0.0	1	0.0	0	0.0	0	0.0	0	0.0
UNEI	204	5.2	43	3.9	33	2.9	8	3.7	19	0.4	4	0.3	9	0.3	13	0.4
All Scoters	71	1.8	113	10.3	14	1.2	40	18.6	1257	27.9	186	15.6	203	6.1	20	0.6
LTDU	312	8.0	284	25.9	63	5.6	55	25.6	1894	42.1	568	47.7	2371	71.7	3250	92.1
GLGU	36	0.9	25	2.3	12	1.1	2	0.9	216	4.8	187	15.7	351	10.6	62	1.8
Total	3891		1097		1135		215		4502		1190		3309		3528	

[a] See table 26 for species abbreviations

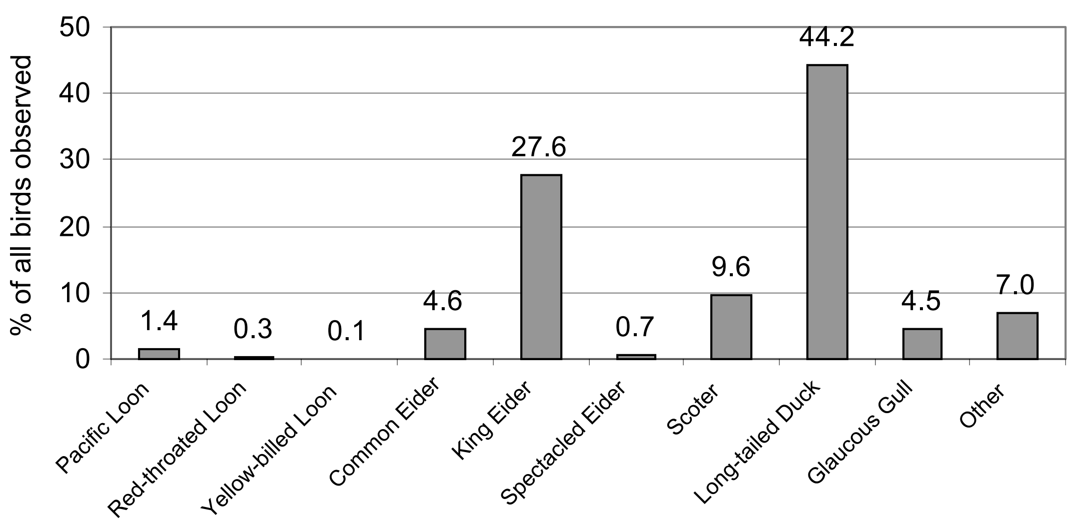

Figure 30. Percent composition of focal taxa observed during Offshore surveys, 1999-2000.

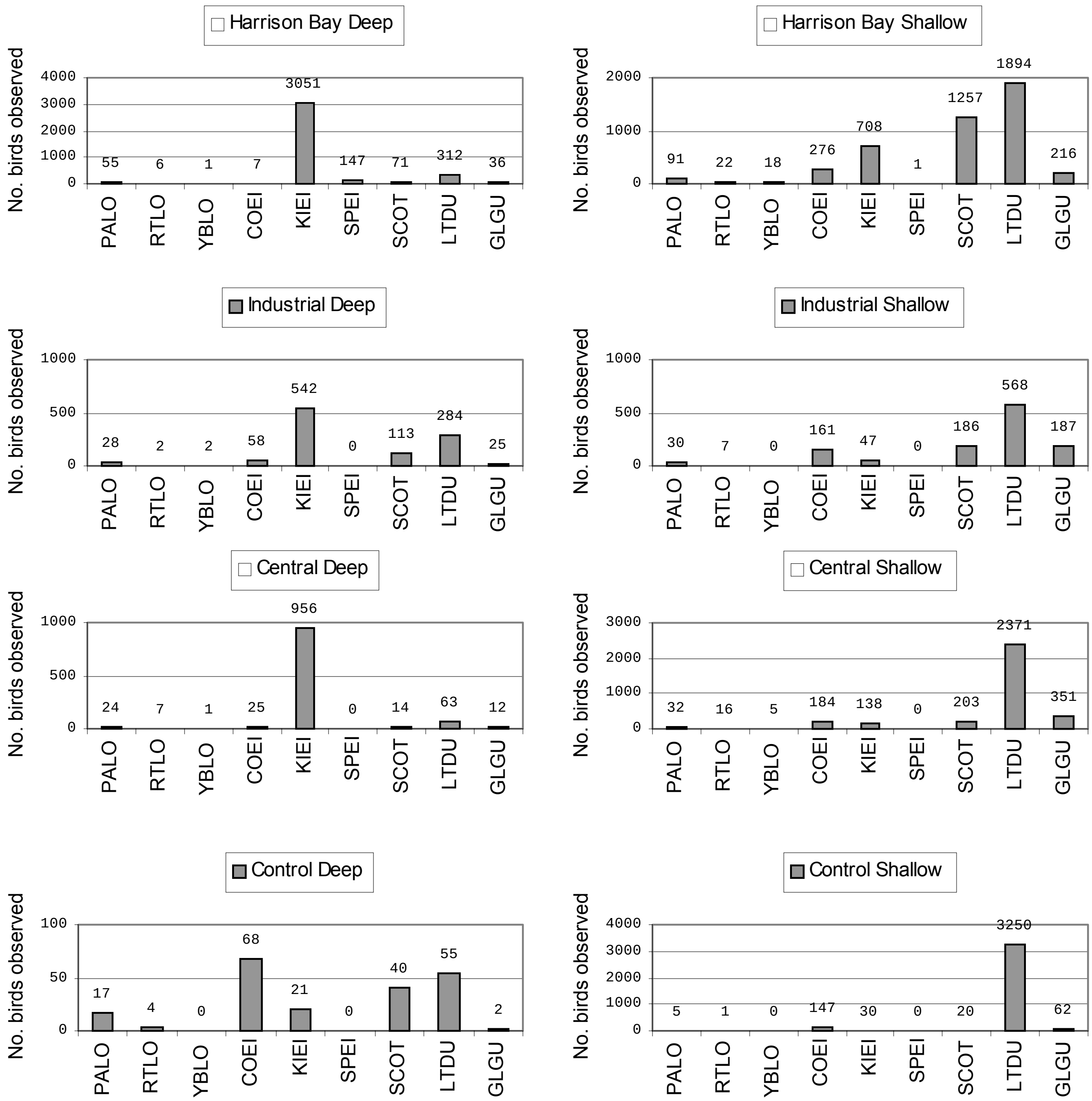

Figure 31. Number of individuals per taxa seen in each strata. Eiders comprised the majority of sightings in deep-water strata, while Long-tailed Ducks dominated the shallow-water strata. PALO- Pacific Loon, RTLO- Red-throated Loon, YBLO- Yellow-billed Loon, COEI- Common Eider, KIEI- King Eider, SPEI- Spectacled Eider, SCOT- Scoter, LTDU- Long-tailed Duck, GLGU- Glaucous Gull.

LONG-TAILED DUCK— The Long-tailed Duck was the most abundant marine bird observed on the Offshore survey, representing 44% of all birds recorded. While Long-tailed Ducks were seen in relatively large groups in near-shore areas (Table 11), flock size in offshore areas was smaller (Table 29).

Densities of Long-tailed Ducks varied by Stratum ($F_{7,441}$ = 24.184, $P < 0.001$). In general, densities were greater in shallow-water than in deep-water strata (Fig. 32); however, distribution among these strata varied through the summer ($F_{14,441}$ = 4.728, $P < 0.001$; Fig. 33). That is, Long-tailed Ducks moved from deep-water strata in June to shallow-water strata in the July post-breeding molt period. By the end of August, ducks began to move back into offshore waters. Moreover, the Control Shallow-water stratum was used to a greater extent in 1999 than in 2000, whereas use of other strata was consistent between years ($F_{7,441}$ = 2.807, P = 0.007; Fig. 34).

COMMON EIDER— Common Eiders were found in relatively small flocks in the Offshore survey compared to the Near-shore survey (Tables 29, 11). As with Long-tailed Ducks, Common Eider densities varied between strata ($F_{7,457}$ = 9.415, $P < 0.001$; Fig. 35) but densities also varied among strata between years ($F_{7,457}$ = 3.727, $P < 0.001$; Fig. 36). In general, high densities were observed in shallow-water areas (Fig. 37) but density in the Control Shallow-water stratum was greater in 1999 than in 2000, whereas density within other strata was consistent between years. Additionally, we found that as Wave Height increased, density estimates of Common Eiders decreased ($F_{1,457}$ = 15.107, $P < 0.001$). Although Wave Height proved to be a significant covariate in the ANCOVA model, it provided little additional explanation of variation than the ANOVA model (Table 24).

Table 29. Flock size of marine birds detected in Offshore surveys, Beaufort Sea, Alaska, 1999-2000.

Species	n	Median	Range	Mean	SE
Scoter *spp*.	180	3	1-200	10.6	1.7
Common Eider	144	2	1-120	6.4	1.2
Glaucous Gull	405	1	1-40	2.2	0.2
King Eider	250	7	1-450	22.0	2.6
Long-tailed Duck	570	3	1-800	15.4	2.0
Pacific Loon	246	1	1-4	1.1	0.0
Red-throated Loon	50	1	1-4	1.3	0.1
Spectacled Eider	7	3	1-100	21.1	13.7
Yellow-billed Loon	22	1	1-3	1.2	0.1

KING EIDER— King Eiders were abundant in the Offshore survey. They were generally found in large flocks (Table 29). King Eiders were concentrated differently among the 8 strata with significantly higher densities in the Deep-water Harrison Bay stratum ($F_{7,446}$ = 8.284, $P < 0.001$). Like other species, however, strata were used differently in each month ($F_{14,446}$ = 4.757, $P < 0.001$; Fig. 38). For example, densities in the Deep-water Harrison Bay stratum were disproportionately high in July, a period when abundance of this species was elevated in all strata ($F_{2,446}$ = 18.576, $P < 0.001$; Fig. 39). Moreover, although densities were highest during July of both years of the study, the magnitude of the difference was significantly greater in 1999 than 2000 ($F_{2,446}$ = 3.531, P = 0.03; Fig. 40).

SPECTACLED EIDER— Spectacled Eiders were uncommon in the Offshore survey. Sightings were limited to seven flocks in 1999-2000. When seen, however, they occurred in relatively large flocks (Table 29). Owing to the limited sightings of Spectacled Eiders, little variation in density was explained using general linear models (R^2=0.05). Regardless, the interaction term Stratum*Month*Replicate was marginally significant ($F_{14,458}$ = 1.673, P = 0.058; Fig. 41) indicating that density of this species among strata was dependent upon both Month and Year. Specifically, densities were highest in the Deep- and Shallow-water Harrison Bay strata in July 2000 and August 2000, respectively.

SCOTERS— Scoters were seen in medium-sized flocks throughout the offshore study area. Average flock size was nearly identical in the offshore and near-shore study (Table 29, 11). Similar to other taxa, Scoter density varied among strata ($F_{7,448} = 8.595$, $P < 0.001$), but distribution among these strata depended upon Month ($F_{14,448} = 3.438$, $P < 0.001$; Figs. 42, 44). For example, Scoters were generally distributed within shallow-water strata through the summer, but densities increased between Prudhoe Bay and Harrison Bay in July and August. A significant Month*Year term ($F_{2,448} = 7.962$, $P < 0.001$) indicated that an apparent peak in densities during mid-summer was unique to 2000, whereas densities remained constant throughout the summer months in 1999 (Fig. 43).

GLAUCOUS GULLS— Glaucous Gulls were common in Shallow-water strata. There they were typically seen in singles, pairs, or small flocks (Table 29). Although Glaucous Gulls were occasionally seen in Deep-water strata, densities there were significantly lower than strata closer to shore ($F_{7,448} = 9.213$, $P < 0.001$; Fig. 45). While Glaucous Gull density was relatively constant between years ($P > 0.05$), distribution among strata showed a general westward shift in concentrations with progression of the season ($F_{14,448} = 1.871$, $P = 0.027$; Fig. 46). Finally, Percent Ice Cover was negatively related to density estimates of Glaucous Gulls ($F_{1,448} = 6.499$, $P = 0.011$). That is, as ice cover increased, density decreased. While Percent Ice Cover was a significant covariate, it explained only 1% of the variation in density of this species (Table 26).

PACIFIC LOON— Pacific Loons were ubiquitous throughout the offshore survey where they were seen in singles or pairs (Table 29). Analysis of distribution data indicated a significant seasonal shift ($F_{14,447} = 3.077$, $P < 0.001$) highlighted by a scarcity of Pacific Loons in the Industrial Shallow-water stratum between Oliktok Point and Prudhoe Bay during July surveys (Figs. 47, 48). While Pacific Loon densities as a whole remained relatively stable between 1999-2000 ($P > 0.05$), a small-scale shift in distribution was noted between years ($F_{7,447} = 2.538$, $P = 0.014$). Specifically, densities of Pacific Loons in the Control Shallow-water stratum were significantly lower in 2000 than in the preceding year (Fig. 49). Two covariates explained 5% of the variation in Pacific Loon density. Percent Ice Cover ($F_{1,447} = 55.42$, $P < 0.001$) and Wind Speed ($F_{1,447} = 8.959$, $P = 0.003$) were both negatively related to density. That is, Pacific Loon density increased when less ice was present and as winds decreased.

RED-THROATED LOON— Similar to Pacific Loons, Red-throated Loons were seen as singles, pairs or in small groups (Table 29). Although Red-throated Loons occurred in all strata, overall densities were low. Densities within specific strata varied both by Month ($F_{14,432} = 1.902$, $P = 0.024$) and by Year ($F_{7,432} = 3.098$, $P = 0.003$). For example, densities were highest in the Deep-water strata during August surveys, whereas a greater proportion of Red-throated Loons were closer to shore in July (Figs. 50, 51). Similarly, Red-throated Loons used the Control Shallow-water stratum to a far greater extent in 1999 than in 2000, whereas use of other strata was consistent between years (Fig. 52). Two covariates helped explain variance in Red-throated Loon densities. As with Pacific Loons, Red-throated Loons densities were lower in areas with greater ice cover ($F_{1,432} = 22.81$, $P < 0.001$). Moreover, as Wave Height increased, density estimates of Red-throated Loons decreased ($F_{1,432} = 7.687$, $P = 0.006$). While these covariates were statistically significant, they only explained 1% of the variance.

YELLOW-BILLED LOON— Yellow-billed Loons were the least common of the Loon species seen. They occurred in singles, pairs or small groups (Table 29). Densities were significantly higher in the Shallow-water stratum in Harrison Bay than elsewhere in the study area ($F_{7,446} = 3.912$, $P < 0.001$; Figs. 53, 54). Yellow-billed densities were significantly higher in July than other months ($F_{2,446} = 3.408$, $P = 0.034$); however this pattern was apparent in 1999 only ($F_{2,446} = 5.762$, $P = 0.003$, Fig. 55). Finally, Yellow-billed Loon densities tended to decrease as Wind Speed increased ($F_{1,446} = 6.268$, $P = 0.013$) although this additional component added only 1% to the R^2 value of the overall model.

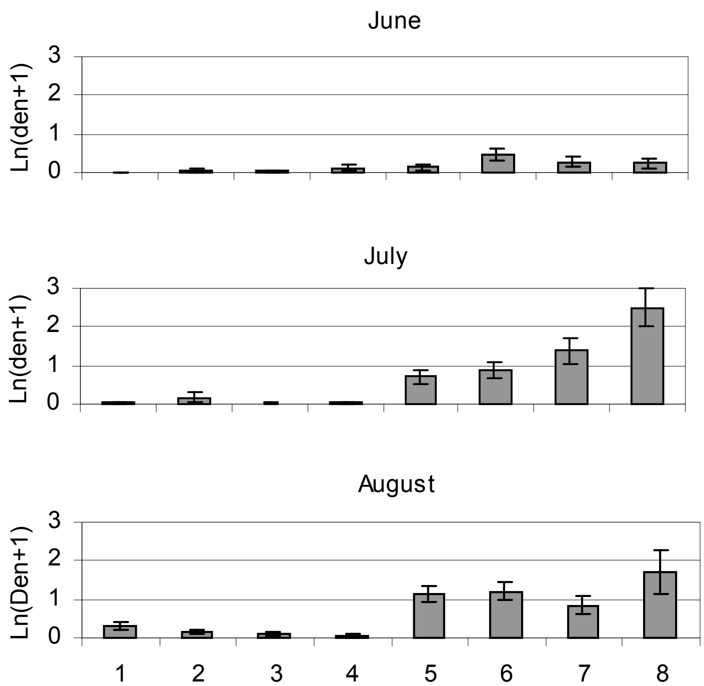

Figure 32. Mean log density (SE) of Long-tailed Ducks among 8 strata during June, July, and August, 1999-2000. Strata: 1- Harrison Bay Deep, 2- Industrial Deep, 3- Central Deep, 4- Control Deep, 5- Harrison Bay Shallow, 6- Industrial Shallow, 7- Central Shallow, 8- Control Shallow.

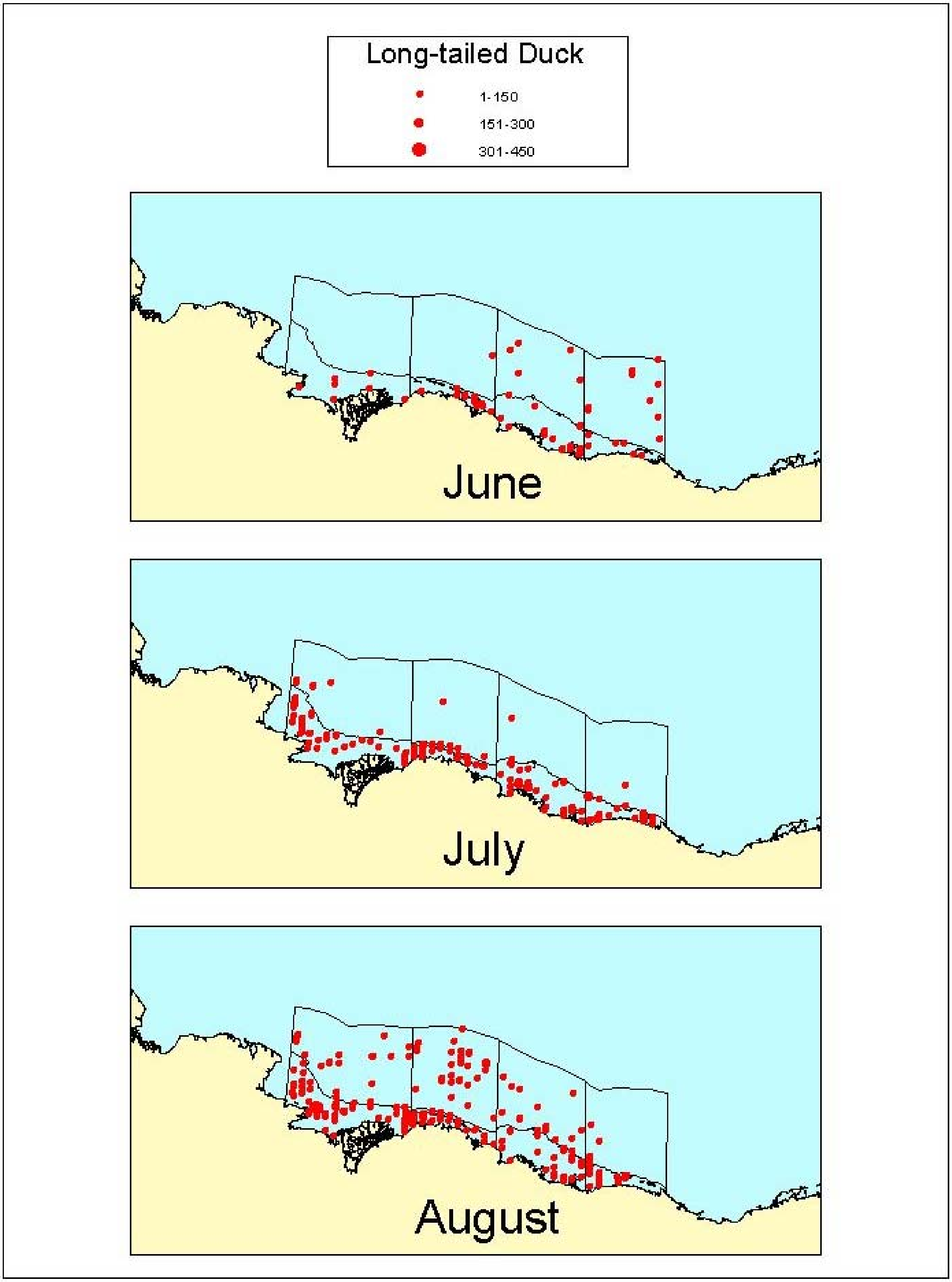

Figure 33. Inter-seasonal distribution patterns of Long-tailed Ducks during Offshore surveys, Beaufort Sea, Alaska, 1999-2000.

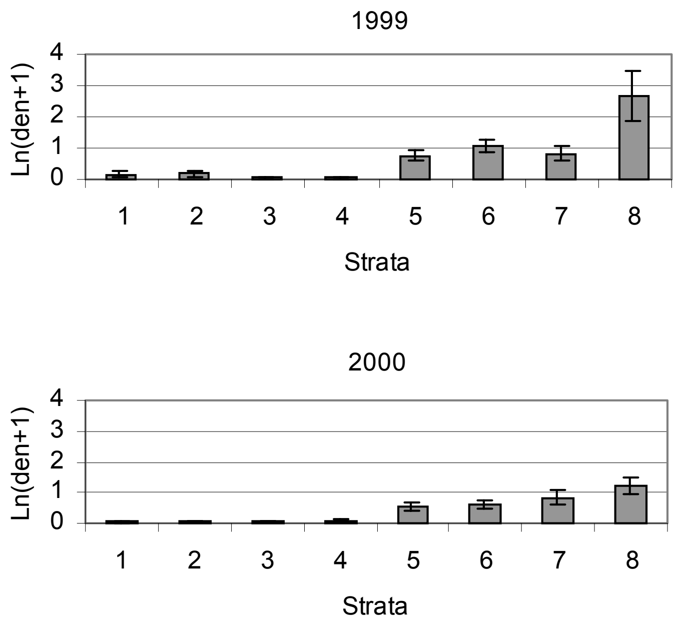

Figure 34. Mean log density (□SE) of Long-tailed Ducks among 8 strata, 1999-2000. Strata: 1- Harrison Bay Deep, 2- Industrial Deep, 3- Central Deep, 4- Control Deep, 5- Harrison Bay Shallow, 6- Industrial Shallow, 7- Central Shallow, 8- Control Shallow.

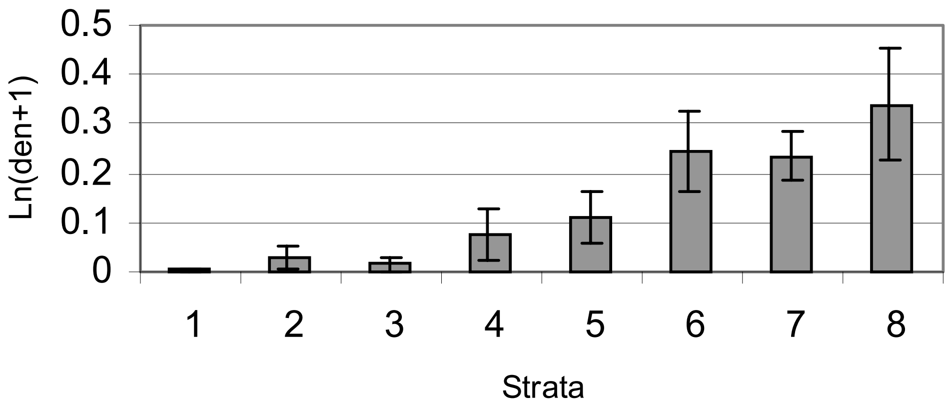

Figure 35. Mean log density (±SE) of Common Eiders among 8 strata. Strata: 1- Harrison Bay Deep, 2- Industrial Deep, 3- Central Deep, 4- Control Deep, 5- Harrison Bay Shallow, 6- Industrial Shallow, 7- Central Shallow, 8- Control Shallow.

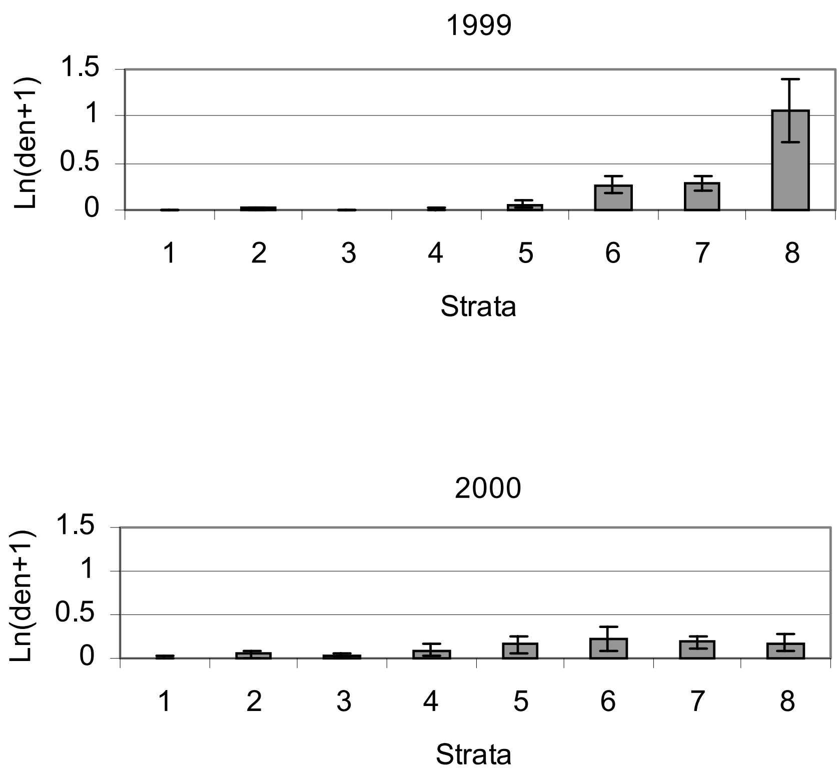

Figure 36. Mean log density (±SE) of Common Eiders among 8 strata, 1999-2000. Strata: 1- Harrison Bay Deep, 2- Industrial Deep, 3- Central Deep, 4- Control Deep, 5- Harrison Bay Shallow, 6- Industrial Shallow, 7- Central Shallow, 8- Control Shallow.

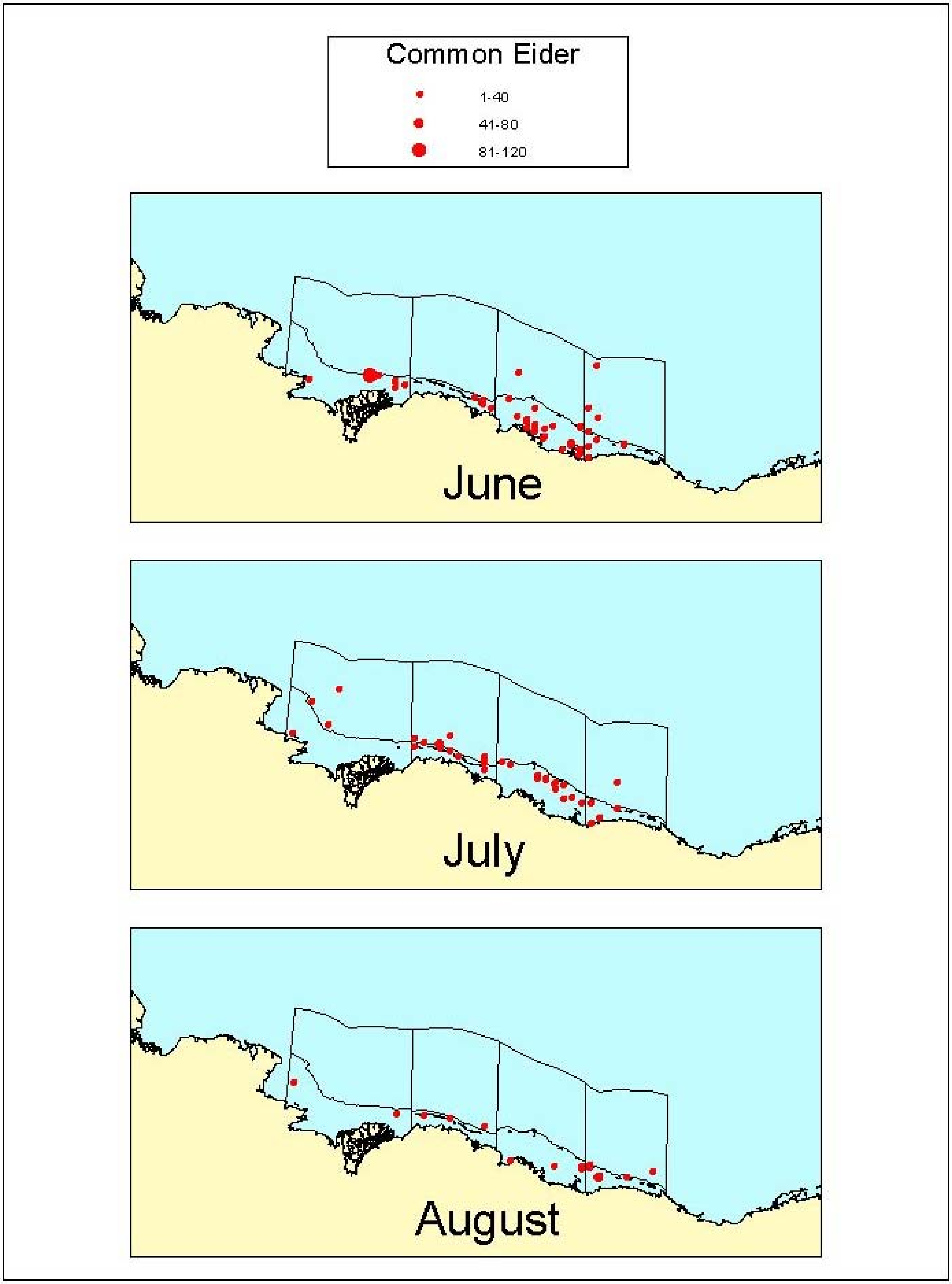

Figure 37. Inter-seasonal distribution patterns of Common Eiders during Offshore surveys, Beaufort Sea, Alaska, 1999-2000.

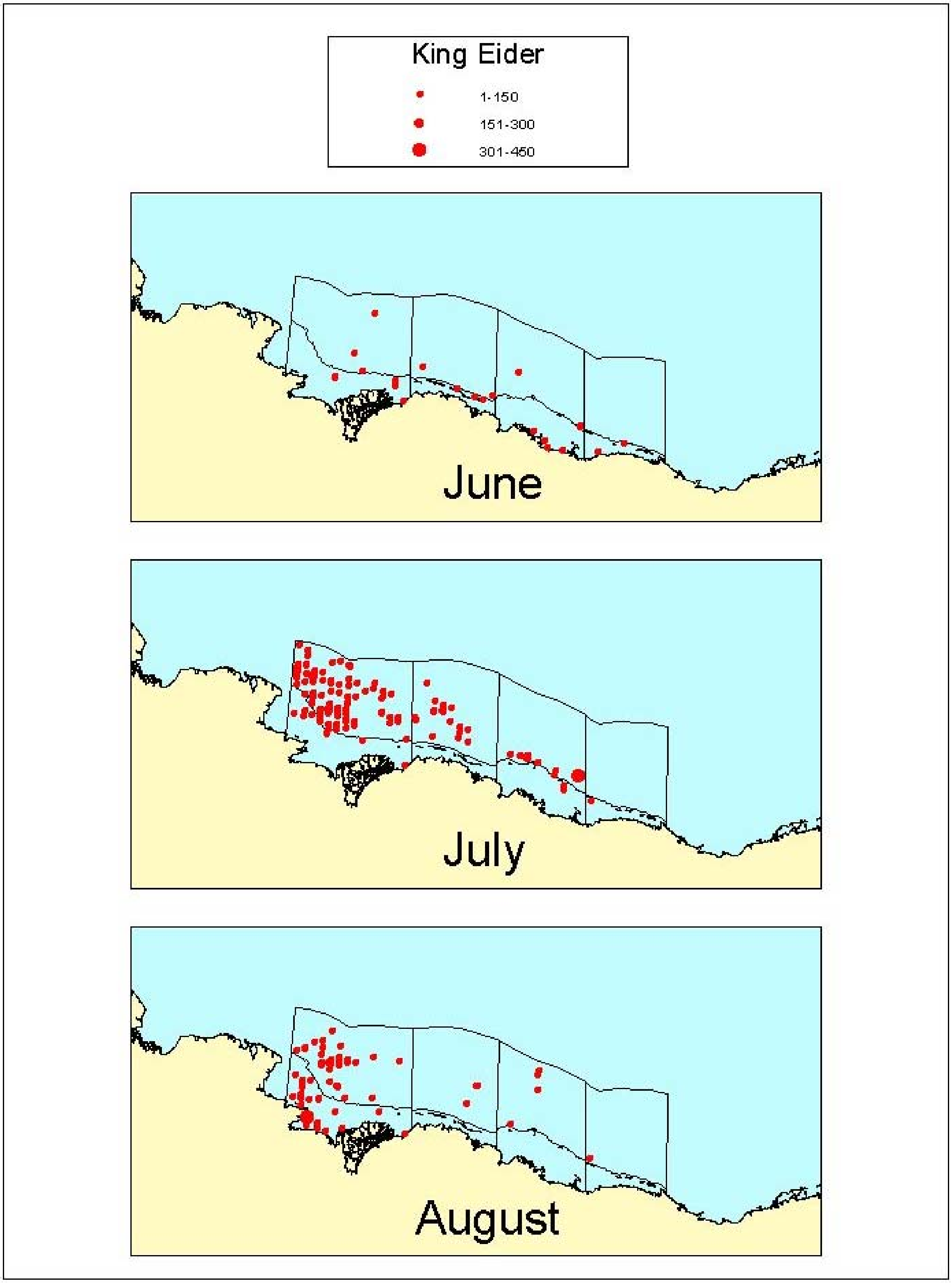

Figure 38. Inter-seasonal distribution patterns of King Eiders during Offshore surveys, Beaufort Sea, Alaska, 1999-2000.

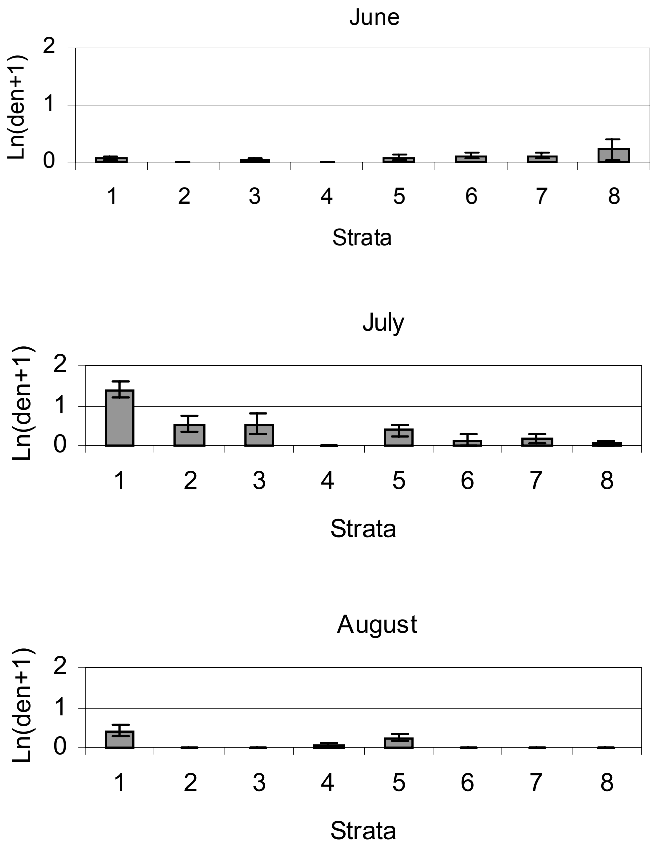

Figure 39. Mean log density (±SE) of King Eiders among 8 strata during June, July, and August, 1999-2000. Strata: 1- Harrison Bay Deep, 2- Industrial Deep, 3- Central Deep, 4- Control Deep, 5- Harrison Bay Shallow, 6- Industrial Shallow, 7- Central Shallow. 8- Control Shallow.

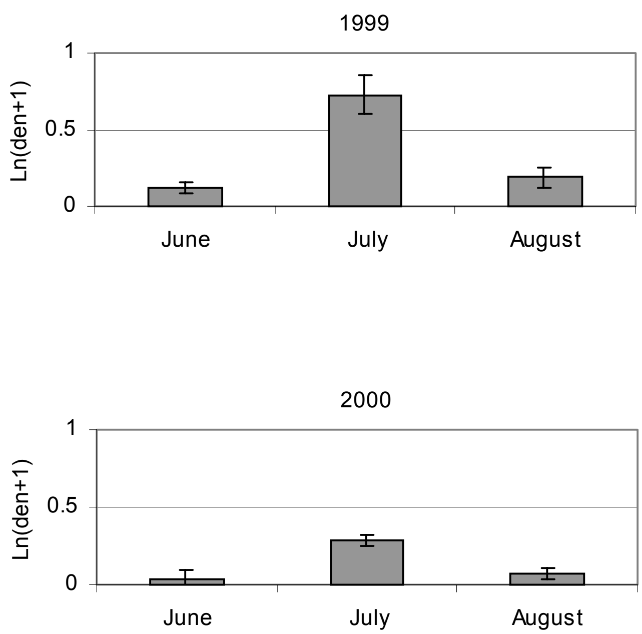

Figure 40. Inter-seasonal differences in mean log density (±SE) of King Eiders in 1999 and 2000.

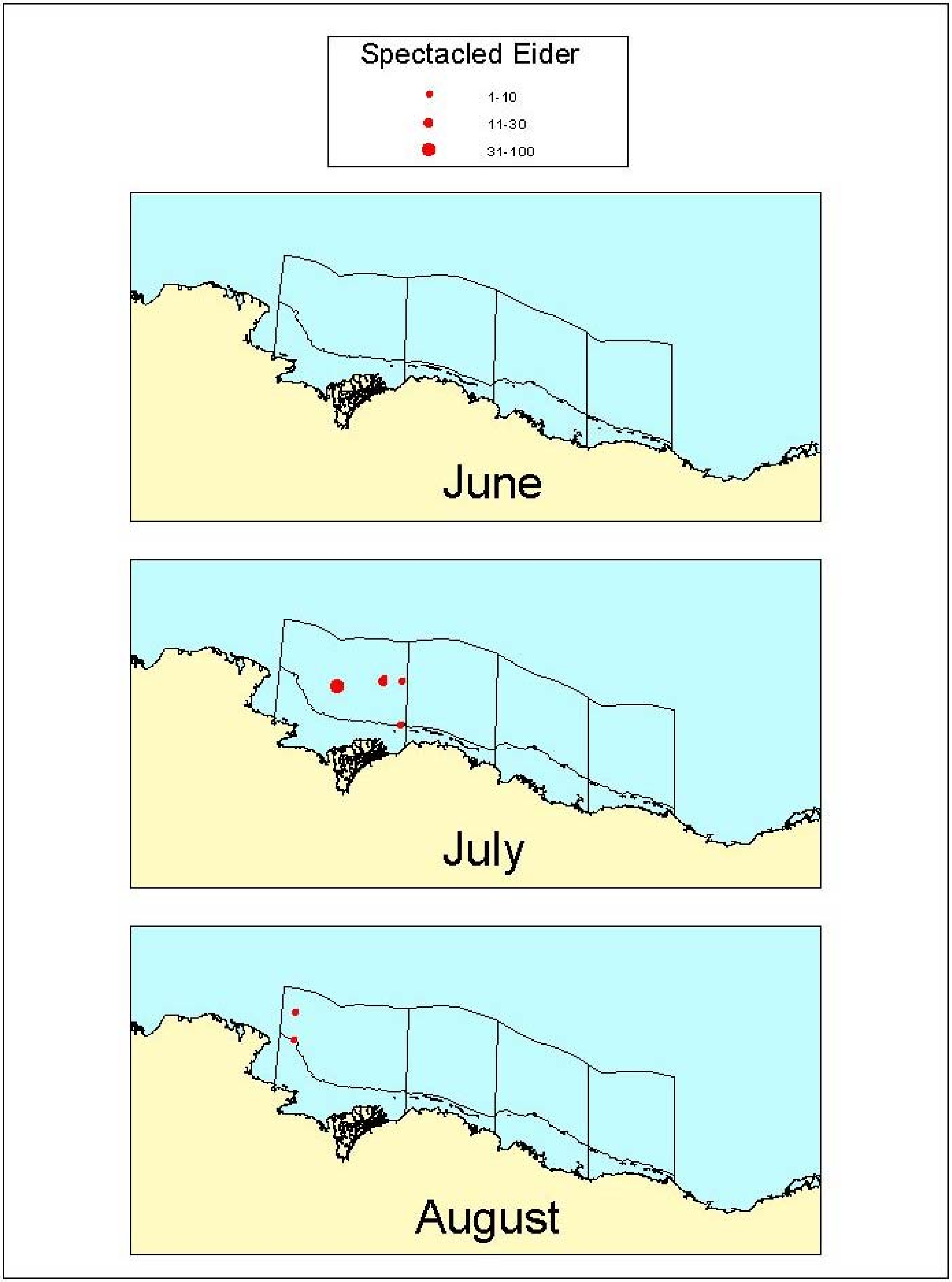

Figure 41. Inter-seasonal distribution patterns of Spectacled Eiders during Offshore surveys, Beaufort Sea, Alaska, 1999-2000.

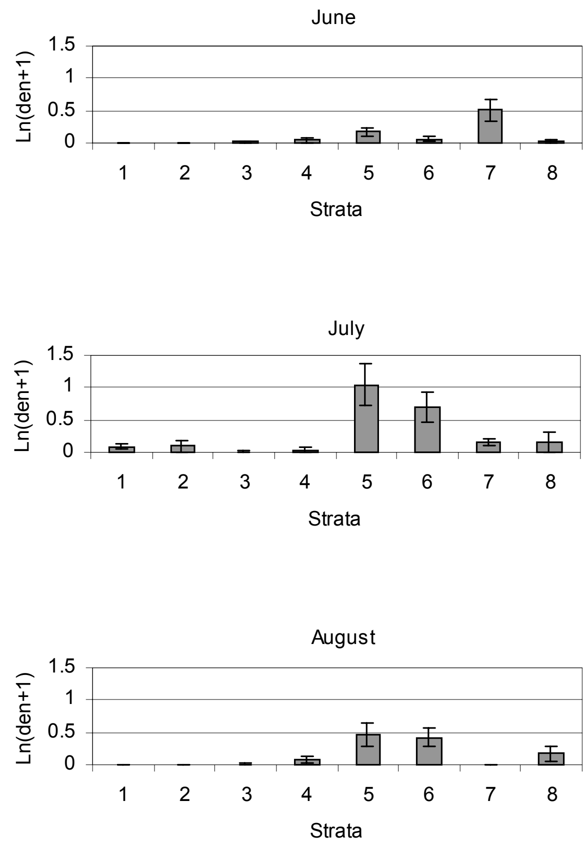

Figure 42. Mean log density (±SE) of Scoters among 8 strata during June, July, and August, 1999-2000. Strata: 1- Harrison Bay Deep, 2- Industrial Deep, 3- Central Deep, 4- Control Deep, 5- Harrison Bay Shallow, 6- Industrial Shallow, 7- Central Shallow, 8- Control Shallow.

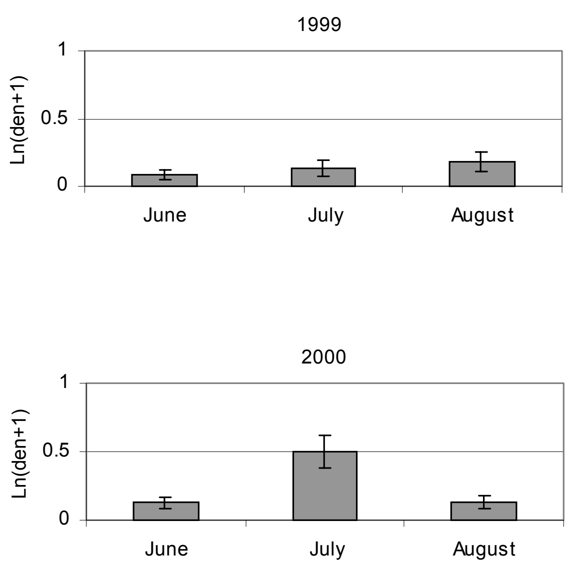

Figure 43. Inter-seasonal differences in mean log density (±SE) of Scoters in 1999 and 2000.

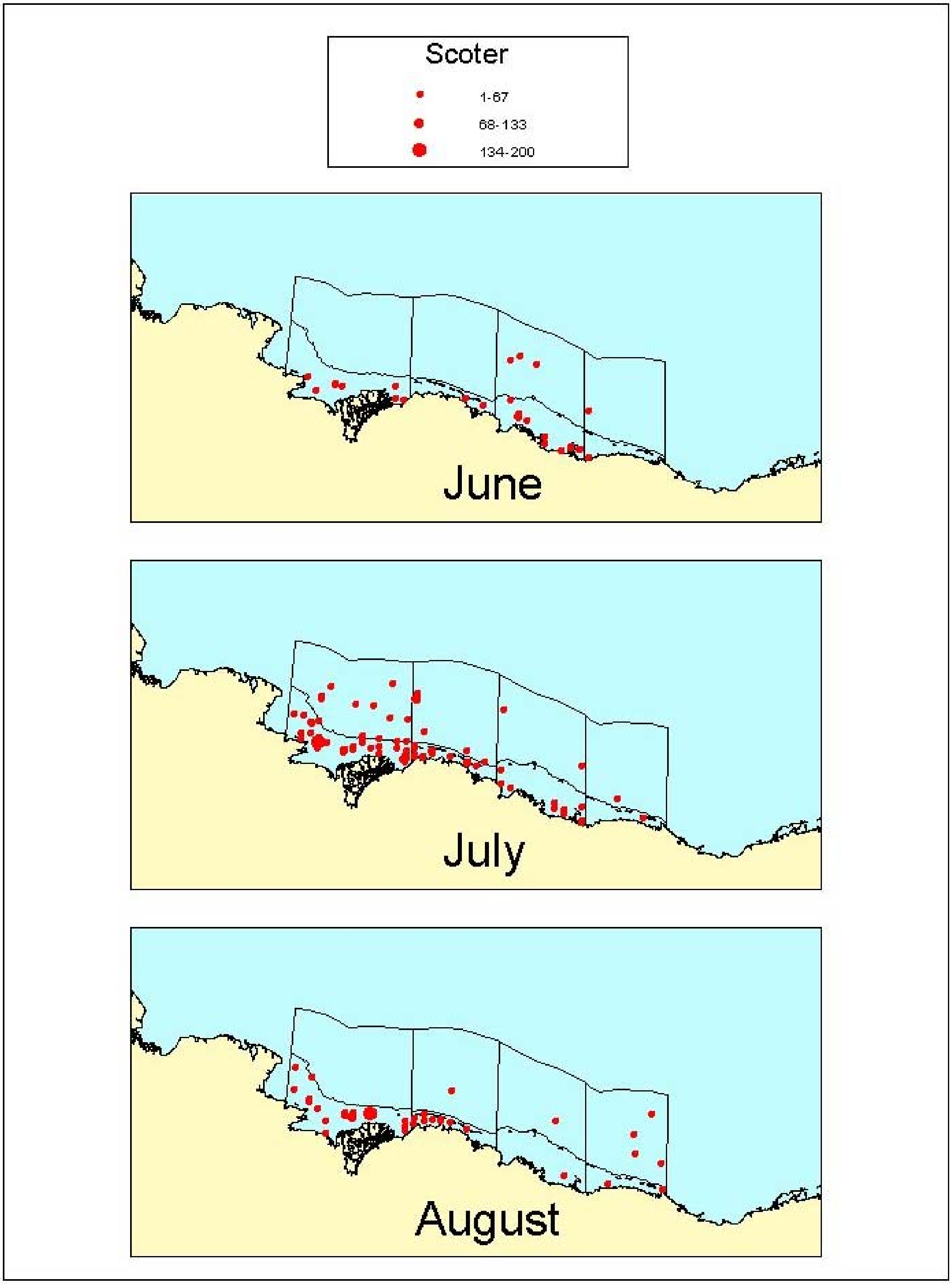

Figure 44. Inter-seasonal distribution patterns of Scoters during Offshore surveys, Beaufort Sea, Alaska, 1999-2000.

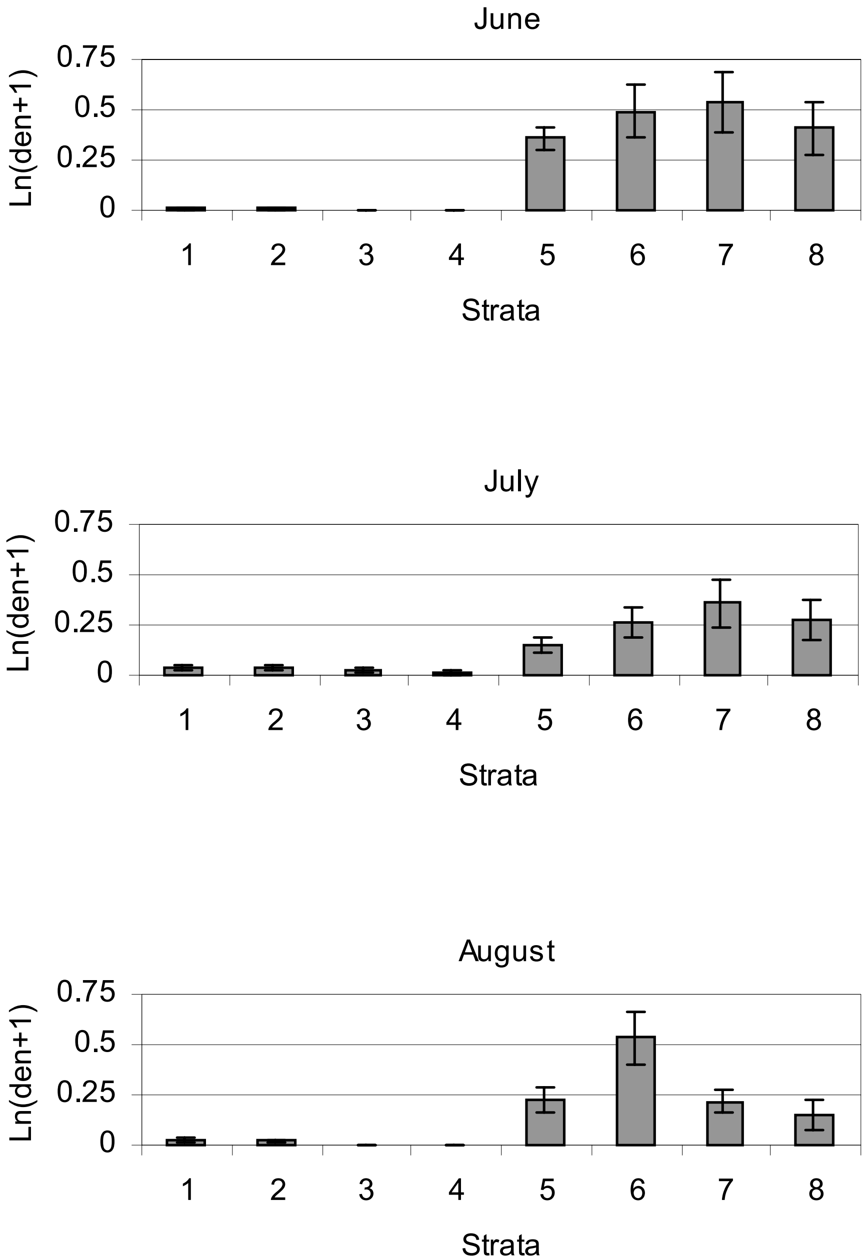

Figure 45. Mean log density (SE) of Glaucous Gulls among 8 strata during June, July, and August, 1999-2000. Strata: 1- Harrison Bay Deep, 2- Industrial Deep, 3- Central Deep, 4- Control Deep, 5- Harrison Bay Shallow, 6- Industrial Shallow, 7- Central Shallow, 8- Control Shallow.

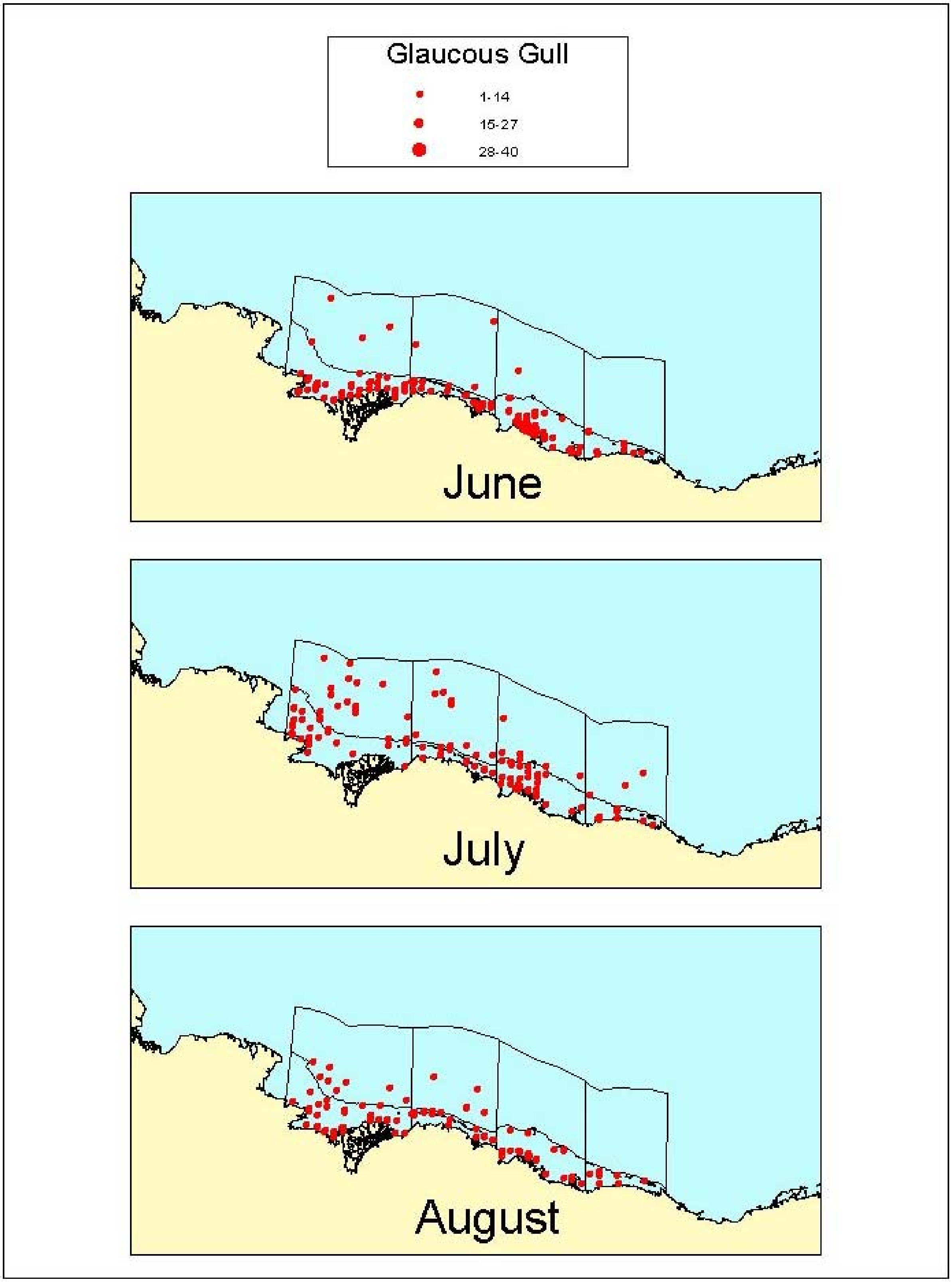

Figure 46. Inter-seasonal distribution patterns of Glaucous Gulls during Offshore surveys, Beaufort Sea, Alaska, 1999-2000.

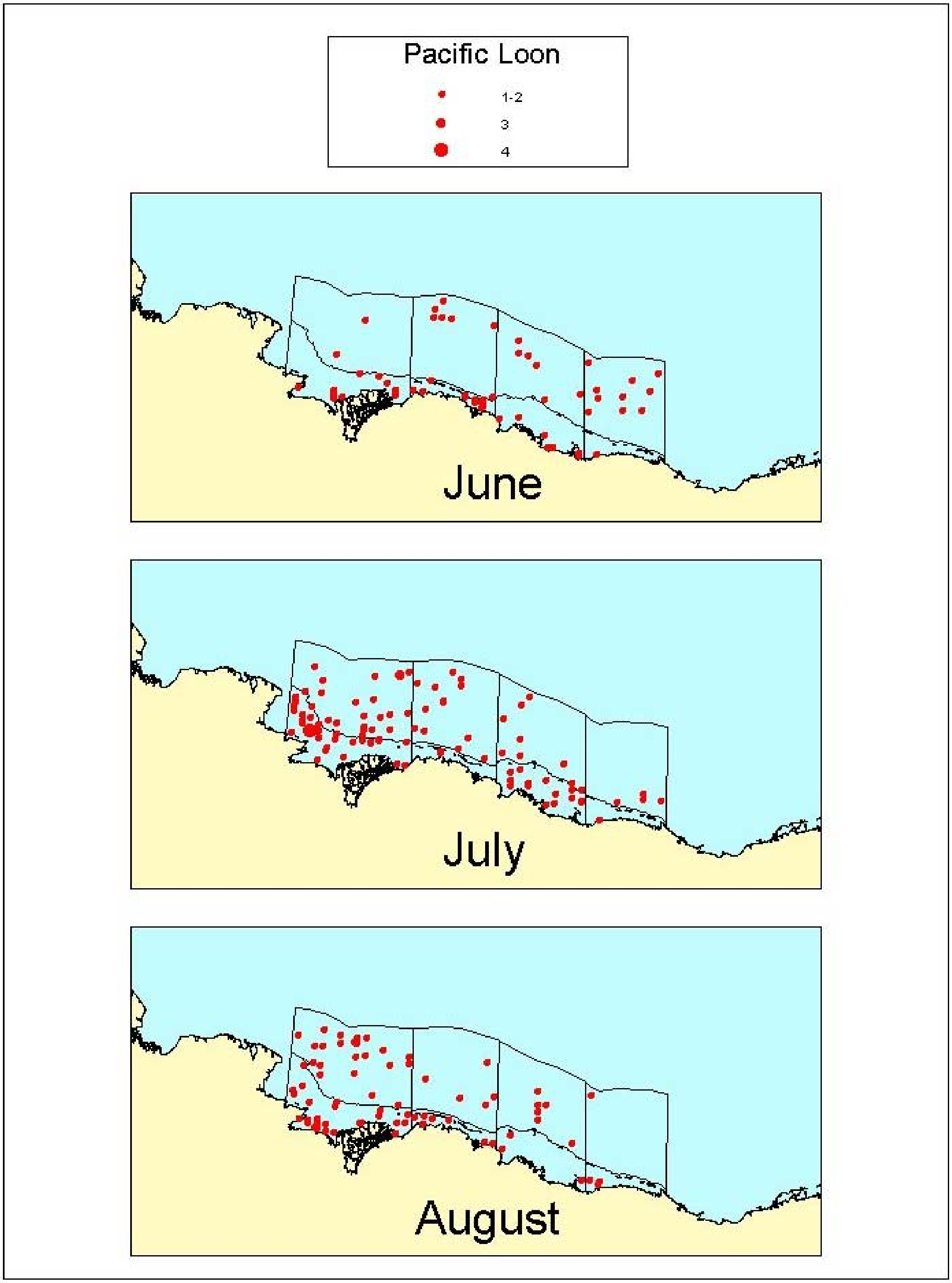

Figure 47. Inter-seasonal distribution patterns of Pacific Loons during Offshore surveys, Beaufort Sea, Alaska, 1999-2000.

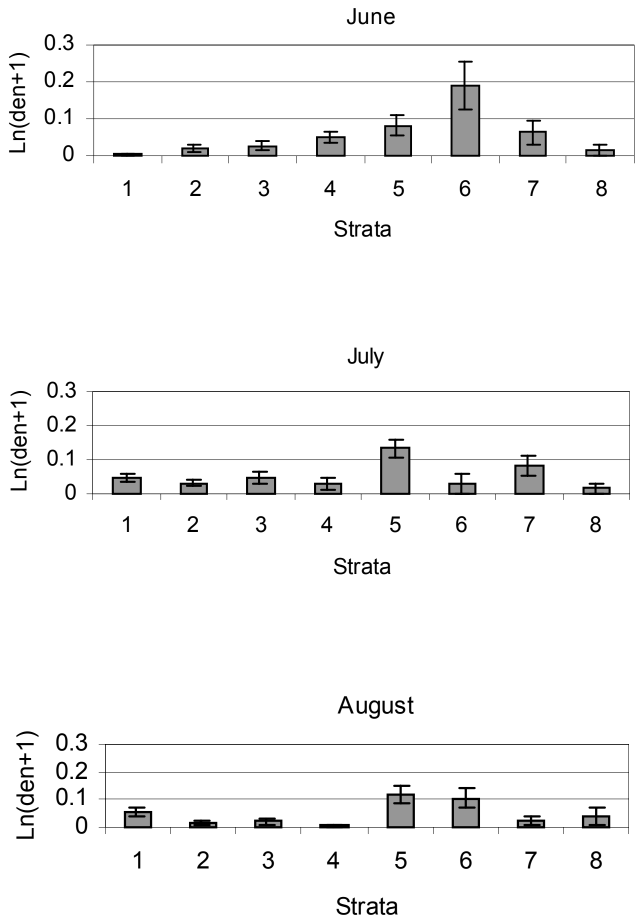

Figure 48. Mean log density (±SE) of Pacific Loons among 8 strata during June, July, and August, 1999-2000. Strata: 1- Harrison Bay Deep, 2- Industrial Deep, 3- Central Deep, 4- Control Deep, 5- Harrison Bay Shallow, 6- Industrial Shallow, 7- Central Shallow, 8- Control Shallow.

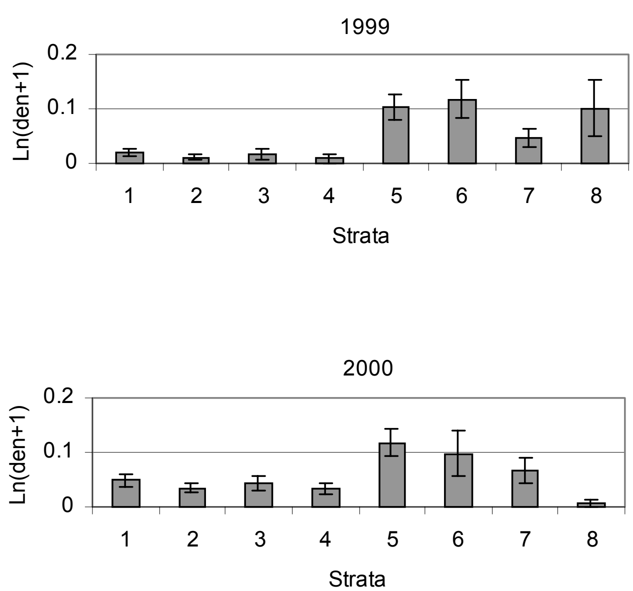

Figure 49. Mean log density (±SE) of Pacific Loons among 8 strata, 1999-2000. Strata: 1- Harrison Bay Deep, 2- Industrial Deep, 3- Central Deep, 4- Control Deep, 5- Harrison Bay Shallow, 6- Industrial Shallow, 7- Central Shallow, 8- Control Shallow.

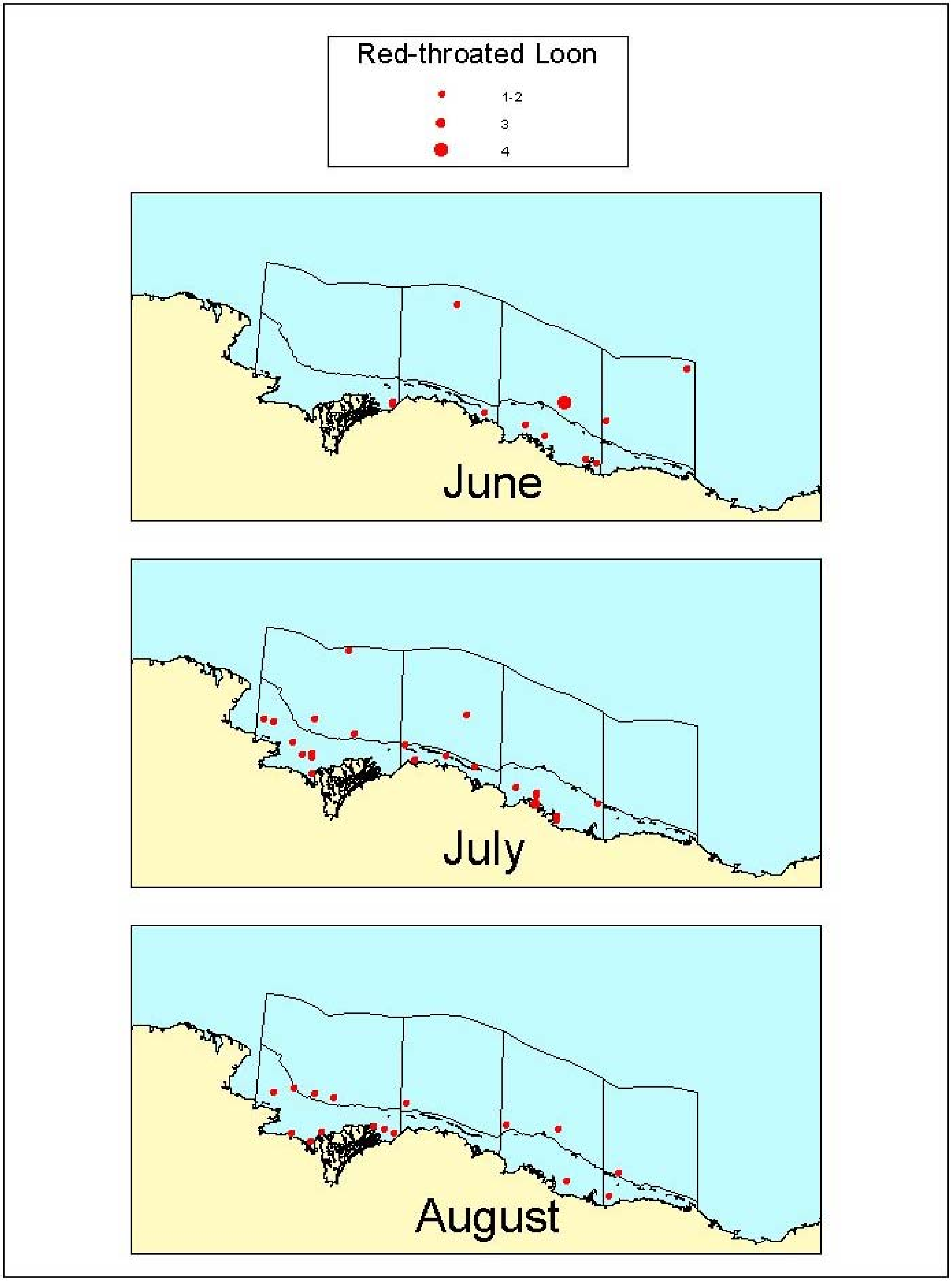

Figure 50. Inter-seasonal distribution patterns of Red-throated Loons during Offshore surveys, Beaufort Sea, Alaska, 1999-2000.

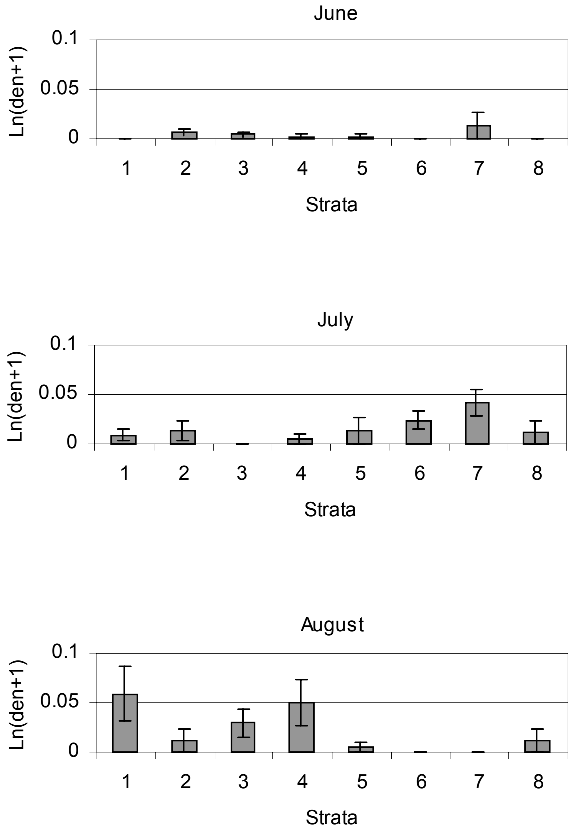

Figure 51. Mean log density (±SE) of Red-throated Loons among 8 strata during June, July, and August, 1999-2000. Strata: 1- Harrison Bay Deep, 2- Industrial Deep, 3- Central Deep, 4- Control Deep, 5- Harrison Bay Shallow, 6- Industrial Shallow, 7- Central Shallow, 8- Control Shallow.

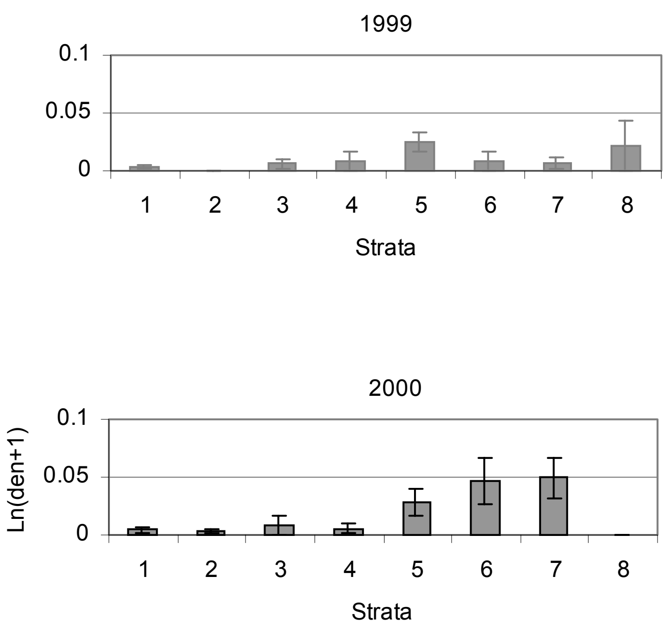

Figure 52. Mean log density (±SE) of Red-throated Loons among 8 strata, 1999-2000. Strata: 1- Harrison Bay Deep, 2- Industrial Deep, 3- Central Deep, 4- Control Deep, 5- Harrison Bay Shallow, 6- Industrial Shallow, 7- Central Shallow, 8- Control Shallow.

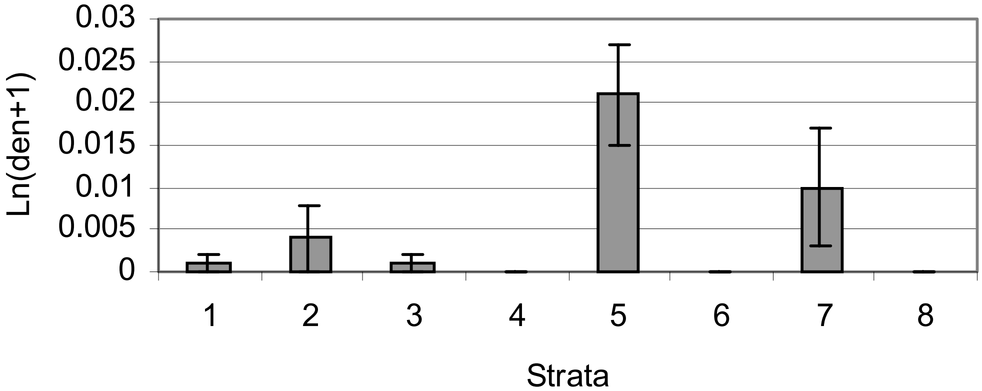

Figure 53. Mean log density (SE) of Yellow-billed Loons among 8 strata. Strata: 1- Harrison Bay Deep, 2- Industrial Deep, 3- Central Deep, 4- Control Deep, 5- Harrison Bay Shallow, 6- Industrial Shallow, 7- Central Shallow, 8- Control Shallow.

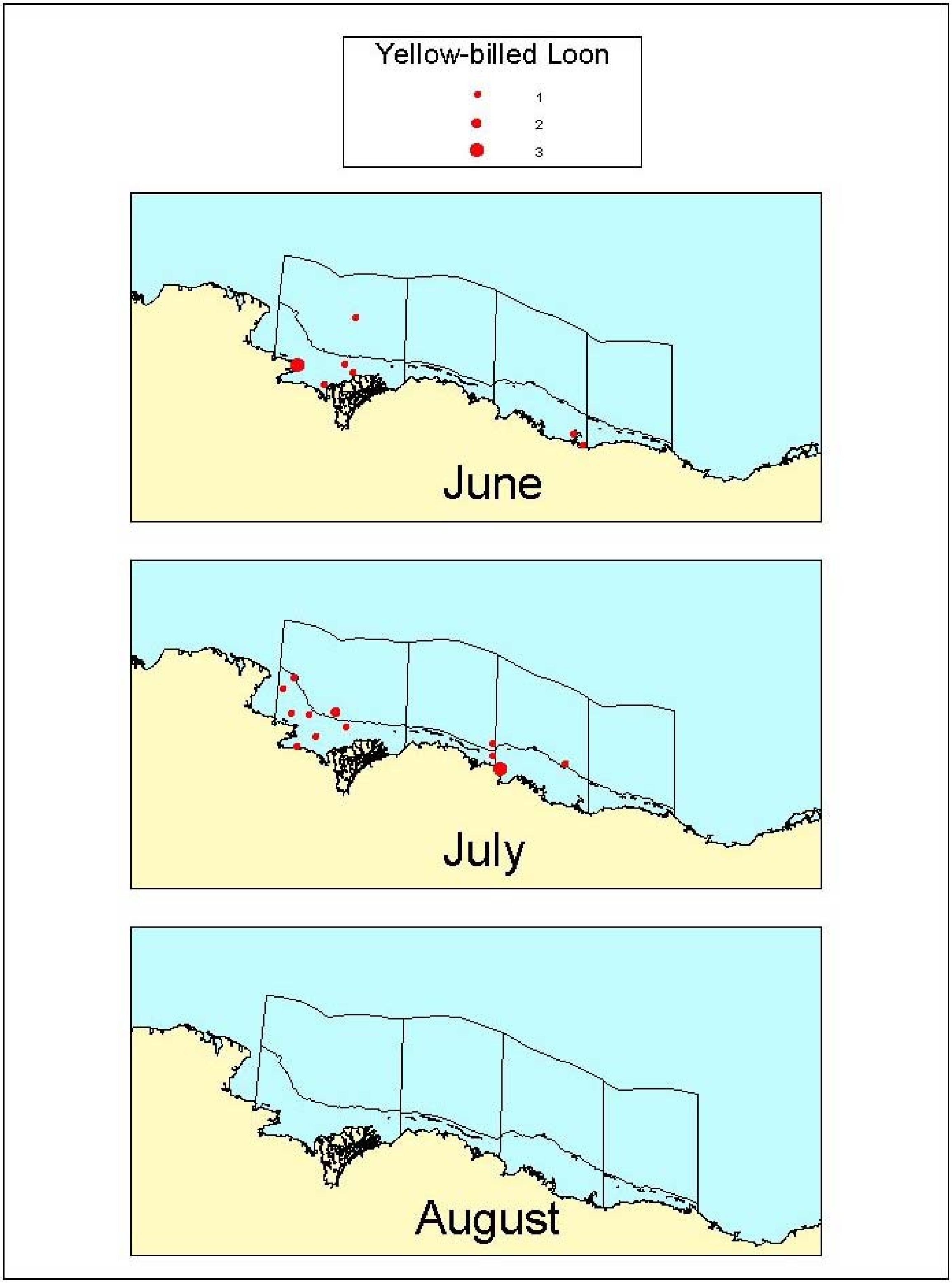

Figure 54. Inter-seasonal distribution patterns of Yellow-billed Loons during Offshore surveys, Beaufort Sea, Alaska, 1999-2000.

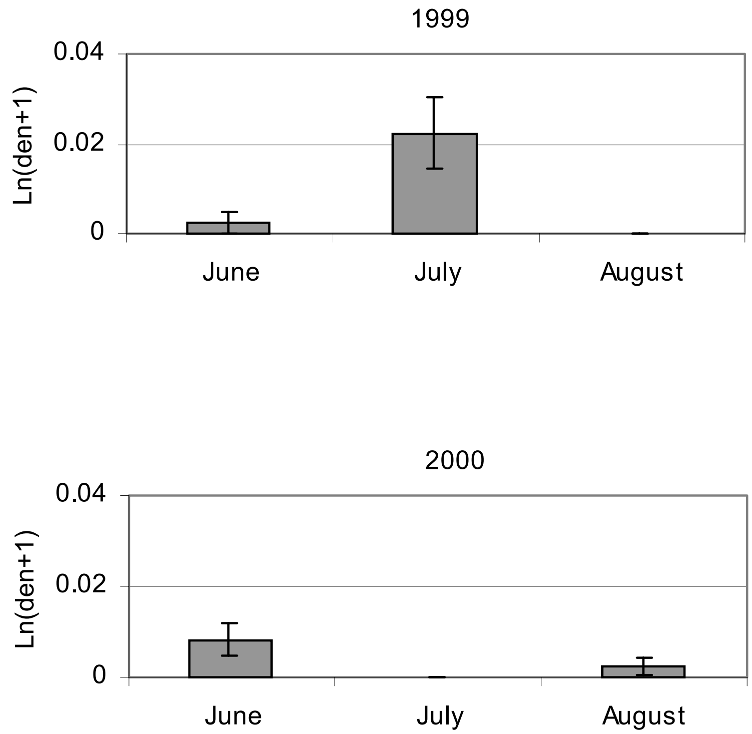

Figure 55. Inter-seasonal differences in mean log density (±SE) of Yellow-billed Loons in 1999 and 2000.

<u>Bias Due to Changes in Survey Altitude</u>

We compared Long-tailed Duck densities estimated from surveys at two altitudes to test for potential bias. We measured the effect of survey altitude in two ways. First we conducted a two-tailed *t*-test with Long-tailed Duck log density as the independent variable and Altitude (300 ft vs. 150 ft) as a grouping variable. This test showed that difference in mean log density obtained from the two altitudes was insignificant ($t_{471} = -1.505$, $P = 0.133$) suggesting that Altitude did not bias density estimates. Second, to further verify this result, we found that altitude did not contribute significantly to explanation of variance in Long-tailed Duck log density estimates ($F_{1,440} = 1.844$, $P = 0.175$) when controlling for confounding variables. In other words, the effect of survey altitude on density estimation was insignificant given the variation that can be attributed to Stratum, Month, Year, Stratum*Month, and Year*Stratum.