Exxon Valdez Oil Spill
Restoration Project Annual Report

Introduced Predator Removal From Islands

Restoration Project 94041
Annual Report

This annual report has been prepared for peer review as part of the *Exxon Valdez* Oil Spill Trustee Council restoration program for the purpose of assessing project progress. Peer review comments have not been addressed in this report.

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Study History: Project 94041 was first funded in FY94 as Introduced Predator Removal From Islands.

Abstract: In order to restore black oystercatchers (*Haematopus bachmani*) and pigeon guillemots (*Cepphus columba*), two species injured by the *T/V Exxon Valdez* oil spill, the introduced predator, arctic fox (*Alopex lagopus*), is being removed from two islands near the western edge of the trajectory of the oil. In 1994, most of the foxes were removed from Simeonof (33 animals) and Chernabura (3 animals) islands, and crews will remove any remaining animals in 1995. Surveys in 1994 indicated that although adequate nesting habitat was available at Simeonof and Chernabura, oystercatcher and guillemot population densities were much lower than at nearby fox-free islands. Elimination of foxes is expected to dramatically increase populations of these injured species as well as other native birds.

Key Words: arctic fox, black oystercatcher, Churnabura I., habitat restoration, introduced predator removal, pigeon guillemot, Simeonof I., Shumagin Is.

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EXECUTIVE SUMMARY

Introduction

Few options have been presented for direct restoration of marine birds injured by the *T/V Exxon Valdez* oil spill. Removal of introduced predators is one way to enhance injured species; therefore, a project was begun in 1994 to remove introduced arctic foxes (*Alopex lagopus*) from two islands near the western edge of the area affected by the oil spill. These islands, Simeonof and Chernabura, contain nesting habitat for two spill-injured species: black oystercatcher (*Haematopus bachmani*) and pigeon guillemot (*Cepphus columba*), but breeding populations have been substantially reduced by fox predation.

Objectives

The object of the project was to enhance populations of black oystercatchers and pigeon guillemots at Simeonof and Chernabura islands by eliminating introduced arctic foxes. Oystercatchers and guillemots were surveyed to record their response to fox removal.

Methods

Study Area.--Simeonof (4,000 ha) and Chernabura (3,000) islands lie in the outer Shumagin Island group south of the Alaska Peninsula. These islands had no native terrestrial mammals except river otters, so the introduction of foxes for commercial fur farming in the late 1800's and early 1900's resulted in large-scale declines in native birds. Fortunately, foxes did not persist on some of the small islands near Simeonof and Chernabura, so substantial populations of oystercatchers and guillemots remain in the vicinity to provide founder sources after fox removal.

Fox Removal.--Leg-hold traps were deployed on fox trails and beaches around the peripheries of Simeonof and Chernabura at a density of about 3.4 traps km^{-1} of coastline. Trapping occurred from 24 May to 24 June on Simeonof and from 24 June to 14 July on Chernabura. Foxes found in traps were killed immediately.

Oystercatcher and Guillemot Surveys.--An inflatable boat was used to circumnavigate Simeonof, Chernabura, and several fox-free "control" islands nearby in order to count oystercatchers and guillemots. Locations of oystercatchers were delineated and later checked on foot to determine the number of breeding pairs and non-breeders. We could not determine the number of breeding pairs of guillemots because they nested in crevices hidden from our view, so we made four replicate counts of birds within 100 m of shore at most sites. The peak count was used as a population index.

Oystercatcher and Guillemot Habitat Surveys.--To compare densities of oystercatchers and guillemots among islands, we determined the amount of breeding habitat for the two species at each site. Oystercatchers nest on open beaches, so we measured the length of all beaches and expressed

nesting density as pairs km^{-1} of beach. Guillemots nest in log and boulder piles and in cliff crevices. We estimated the surface area of potential habitat, and density was expressed as guillemots ha^{-1} of habitat.

Results

Fox Removal.--We removed 33 foxes from Simeonof and 3 foxes from Chernabura. At least 1 fox remained on Simeonof when we left, and 1 or more may have remained at Chernabura.

Black Oystercatcher Densities.--Although oystercatchers were observed on Simeonof and Chernabura, foxes apparently kept them from nesting. We found no nests on Simeonof, and possibly one nest was present on Chernabura. Densities of pairs were 5-20 times higher on fox-free islands nearby.

Pigeon Guillemot Densities.--Some guillemots probably nested on Simeonof and Chernabura, but densities of birds were 2-5 times higher on nearby fox-free islands.

Discussion

Foxes apparently have reduced oystercatcher and guillemot populations on Simeonof and Chernabura islands, but both islands have substantial amounts of breeding habitat for these injured species of birds. Most of the foxes were removed from these islands in 1994, and the remaining animals will be removed in 1995. It is likely that following fox removal, oystercatcher and guillemot populations will increase rapidly until densities are similar to those of surrounding islands.

Conclusions

Most foxes were removed from Simeonof and Chernabura islands, as planned. Any remaining animals will be removed in 1995. Our surveys of oystercatchers and guillemots and their habitats show that conditions are favorable for population increases of these injured species.

INTRODUCTION

Among the species of birds injured by the T/V *Exxon Valdez* oil spill were black oystercatchers (*Haematopus bachmani*) and pigeon guillemots (*Cepphus columba*) (Piatt et al. 1990, Andres 1993, Oakley and Kuletz, in press). Few options have been presented for direct restoration of injured populations, but removal of introduced arctic foxes (*Alopex lagopus*) is one method of substantially enhancing oystercatchers, guillemots, and other seabird populations (Bailey 1993, Byrd et al. 1994). The Shumagin Islands, near the western edge of the oil's trajectory, provided an opportunity to employ this restoration method. Fox-free islands in the Shumagins have substantial populations of oystercatchers and guillemots (Bailey 1978, Day 1977, Bailey and McCargo 1984), but two islands in the group, Simeonof and Chernabura (Fig. 1), have introduced foxes and consequently reduced numbers of these injured species.

In 1994, the *Exxon Valdez O*il Spill Trustee Council approved funding for a restoration project at Simeonof and Chernabura islands. During that summer fox removal began, and oystercatcher and guillemot populations were surveyed on these islands and nearby fox-free control sites. Rechecks of the islands will be made in 1995 to remove any foxes that remain, and oystercatchers and guillemots will be counted again for signs of early recovery.

OBJECTIVES

The purpose of this project was to enhance populations of black oystercatchers and pigeon guillemots at Simeonof and Chernabura islands by eliminating introduced arctic foxes, and to document the response of birds to fox removal.

METHODS

Study Area

The outer Shumagin Islands (i.e. southeast of Nagai Island) include five islands over 2,500 ha and 12 smaller islands and islets (Fig. 1). Most of the islands are in the Alaska Maritime National Wildlife Refuge. These islands originally had no terrestrial mammals except river otter (*Lutra canadensis*). Foxes were introduced for fur farming in the late 1800's and early 1900's to all of these islands except the very small ones. Although most fox farming ended prior to WWII, the introduced animals persisted on all five relatively large islands in the outer Shumagins (Bailey 1993). From evidence elsewhere in southwestern Alaska (Murie 1959, Jones and Byrd 1979), and from comparisons of islands with and without foxes in the Shumagins (Moe and Day 1977, Bailey 1978, Sowl 1982, Bailey and McCargo 1984, E.P. Bailey unpubl. data), it is apparent that foxes have substantially reduced oystercatcher and guillemot populations as well as other seabirds.

In addition to fox introductions, ground squirrels (*Spermaophilus undulatus*) were introduced for fox food, and cattle were introduced to Simeonof and Chernabura islands (Bailey 1994). Cattle were removed from both islands in 1983, but ground squirrels remain.

Like the other outer Shumagins, 4,000-ha Simeonof Island and 3,000-ha Chernabura have no native trees; the tallest plants are shrubs: alder (*Alnus sinuata*) and willows (*Salix spp.*). Besides scattered clumps of shrubs, primary plant communities are coastal grass-umbel, subalpine meadows on lower mountain slopes, and crowberry (*Empetrum nigrum*) and other heaths at higher locations (Bailey 1994).

Fox Removal

Trapping was conducted by a crew of up to six people on Simeonof Island from 24 May to 24 June, 1994, and on Chernabura Island from 24 June to 14 July, 1994. Methods similar to those employed at other southwestern Alaskan sites were used (Bailey 1993). Specifically, leg-hold traps were deployed on fox trails and beaches around the periphery of an island and in heavily used interior areas as quickly as possible after personnel arrived (most readily accessible areas had trap lines deployed within 10 days). Trapping density was about 3.4 traps km^{-1} coastline on both Simeonof and Chernabura islands. Traps were rechecked as often as possible, usually at least every 3 days. Foxes found in traps were immediately killed.

Oystercatcher and Guillemot Surveys

In order to evaluate the response of oystercatchers and guillemots to removal of introduced foxes, birds were counted on Simeonof and Chernabura and on nearby fox-free islands (Bird, Herendeen, and Atkins) which will serve as "controls" (Fig. 1).

For oystercatchers, the objective was to census pairs; therefore, most surveys were conducted during the incubation period in June (Day 1977, Kenyon 1964) when pairs were territorial and most conspicuous. Coastlines were surveyed from an inflatable boat by two observers, who recorded locations of all oystercatchers and guillemots seen (see below). All areas were surveyed 3-4 times (except Bird I., which was surveyed twice) to reduce chances of missing birds. A "nesting pair" was defined by one of the following characteristics: courtship behavior, the presence of a nest or young, defensive behavior, or distraction displays. When birds with possible nesting behavior were noted during boat surveys, nearby areas were checked on the ground at a later date to look for nests or other nesting evidence. Flocks of oystercatchers were also recorded.

Unlike oystercatchers, nesting pigeon guillemots are not conspicuous because they lay eggs in crevices. To estimate the number of birds associated with nesting colonies, guillemots were counted where they concentrated on the sea near colonies or on the surface of boulder piles or logs within which they nest. There is disagreement in the literature about the best method for counting guillemots (Drent 1965, Ainley and Boekelheide 1990, Sanger and Cody 1993, and Vermeer *et al.* 1993), but we timed surveys during the incubation period when numbers are least variable (Vermeer *et al.* 1993). Guillemots were counted within approximately 100 m of the shoreline from an inflatable boat operated at slow speeds about 50 m from shore. Attendance of guillemots at nesting colonies is variable, therefore we made four replicate counts at all sites except Bird Island, where only two counts were possible.

Oystercatcher and Guillemot Habitat Surveys

Since the amount of nesting habitat for oystercatchers and guillemots varied among islands, our measurement for comparison was nesting density. This necessitated estimating the amount of nesting habitat on each island.

Black oystercatchers nest in the open on beaches (Andres 1993). Beaches were delineated on maps, and the amount of available oystercatcher habitat was calculated by summing the lengths of all beaches on an island.

The crevices used by pigeon guillemots for nest sites could occur in boulder beaches, cracks in vertical cliffs, or in drift log piles (Drent 1965, Ewins 1993, Sanger and Cody 1993). This diversity in habitat types made it difficult to map all possible nesting areas for guillemots, but we attempted to delineate the surface area of talus slopes, substantial drift log piles, and the areas of sea cliffs with crevices that could be used by guillemots.

RESULTS

Fox Removal

At Simeonof, 33 foxes were killed. One set of track was observed the day before the crew departed, so at least on animal remained on the island. Fewer foxes were found on Chernabura, and only three animals were killed. No fresh sign was observed when the trappers departed.

Black Oystercatcher Densities

Simeonof and Chernabura had relatively large numbers of black oystercatchers, but few were nesting (Table 1, Appendix A). In fact, the densities of nesting pairs on these islands with foxes were only 0.1 pairs km^{-1} beach compared to densities ranging from 0.5-5.0 pairs km^{-1} beach on fox-free control areas. The ratio of birds in pairs to unpaired birds, an index of the proportion of non-breeders and failed-breeders in the population, indicated that a much higher proportion of breeders occurred on fox-free islands than on Simeonof and Chernabura. Moreover, we found no oystercatcher nests on either Simeonof or Chernabura (although a pair giving a distraction display suggested that one nest may have been present on Chernabura), whereas nests were found on all the fox-free islands we searched (Table 1).

On islands with and without foxes, oystercatchers seemed to favor beaches with boulder habitat over those that had sand or rock shelf substrates (Table 2, Appendix B). As indicated, Simeonof and Chernabura have substantial amounts of favorable oystercatcher habitat.

Pigeon Guillemot Densities

The densities of guillemots on the fox-inhabited islands of Simeonof and Chernabura were 3.9 and 7.7 bird ha^{-1} (Table 3, Appendix A). On the fox-free control islands, densities were much higher, ranging from 10.8 to 20.5 birds ha^{-1}. The density at Chernabura was nearly twice as high as that at Simeonof; this was primarily due to the existence of a breeding colony at Chernabura in an area that appeared to be topographically inaccessible to foxes. Excluding this inaccessible portion, the density on Chernabura was lower than on Simeonof.

The primary types of pigeon guillemot nesting substrate at Simeonof and Churnabura were crevices in rocky benches and rocky points and crevices among boulders on beaches (Table 4, Appendix B). Density indices suggested that these habitats hosted relatively high numbers of guillemots on fox-free islands. It appeared guillemots were not using log piles for nesting at any of the islands where this type of habitat occurred (Table 4).

DISCUSSION

Our results indicate that oystercatcher and guillemot breeding populations at Simeonof and Chernabura are below levels that would be expected based on the amount of available breeding habitat. Although few historical data are available for nesting densities of oystercatchers in the Shumagin Islands, the pattern at other areas is clear. If foxes are present, few if any oystercatchers are able to nest (Moe and Day 1977, Bailey 1978, E.P. Bailey unpubl. data). As indicated above, estimated densities on fox-free islands in the Shumagins ranged from approximately 0.5 to 2.0 pairs km^{-1} (Table 1). We had no information about habitat quality, although it must have varied among areas judging from differences in nesting densities. Nevertheless, if habitat quantity is used as a crude measure of predicted nesting populations of oystercatchers following fox removal, Simeonof (with 42 km of beaches) may eventually have 20-80 nesting pairs of oystercatchers, compared to no nesting pairs in 1994. At Chernabura (31 km of beaches), the expected population would be 15 to 60 pairs, up from possibly one pair in 1994.

In contrast to oystercatchers, which are almost completely excluded from nesting on islands with foxes, pigeon guillemots are able to sustain reduced nesting populations because they nest in rock crevices, a proportion of which are inaccessible to foxes. In spite of this protection, foxes prey on guillemots (Murie 1959). Historical data on guillemots in the Shumagin Islands are opportunistic single counts which provide crude indices to population levels, and there are no data on nesting habitat. Strong conclusions would be inappropriate, but at least these data suggest fox-free islands have substantially higher densities of guillemots than those where foxes are present (Table 5). In a case study elsewhere, guillemots increased nearly 20-fold within 15 years after foxes were removed from an island in the western Aleutian Islands (Byrd et al. 1994). The magnitude of increase is dependent upon the quality and quantity of available habitat, so it is difficult to predict how many guillemots ultimately will nest at Simeonof and Chernabura following fox removal. Nevertheless, as indicated above (Table 3), fox-free islands near Simeonof and Chernabura had density indexes approximately 2 to 5 times higher than the islands with foxes.

CONCLUSION

It is apparent that the presence of introduced foxes is detrimental to breeding populations of oystercatchers and guillemots on many islands, and was probably the cause of low breeding populations of these birds on Simeonof and Chernabura islands. Most foxes were removed from Simeonof and Chernabura islands in 1994, and any remaining foxes will be removed in 1995. This restoration project is likely to restore these injured species to higher population levels.

ACKNOWLEDGMENTS

Andrew Durand and Schmidt conducted bird surveys in 1994, and they assisted Bailey, Kyle Larsen, Dave Kehn, and Nina Faust with fox removal. Byrd helped plan the project and write the report. Antony DeGange, Belinda Dragoo and Arthur Kettle reviewed drafts of the report.

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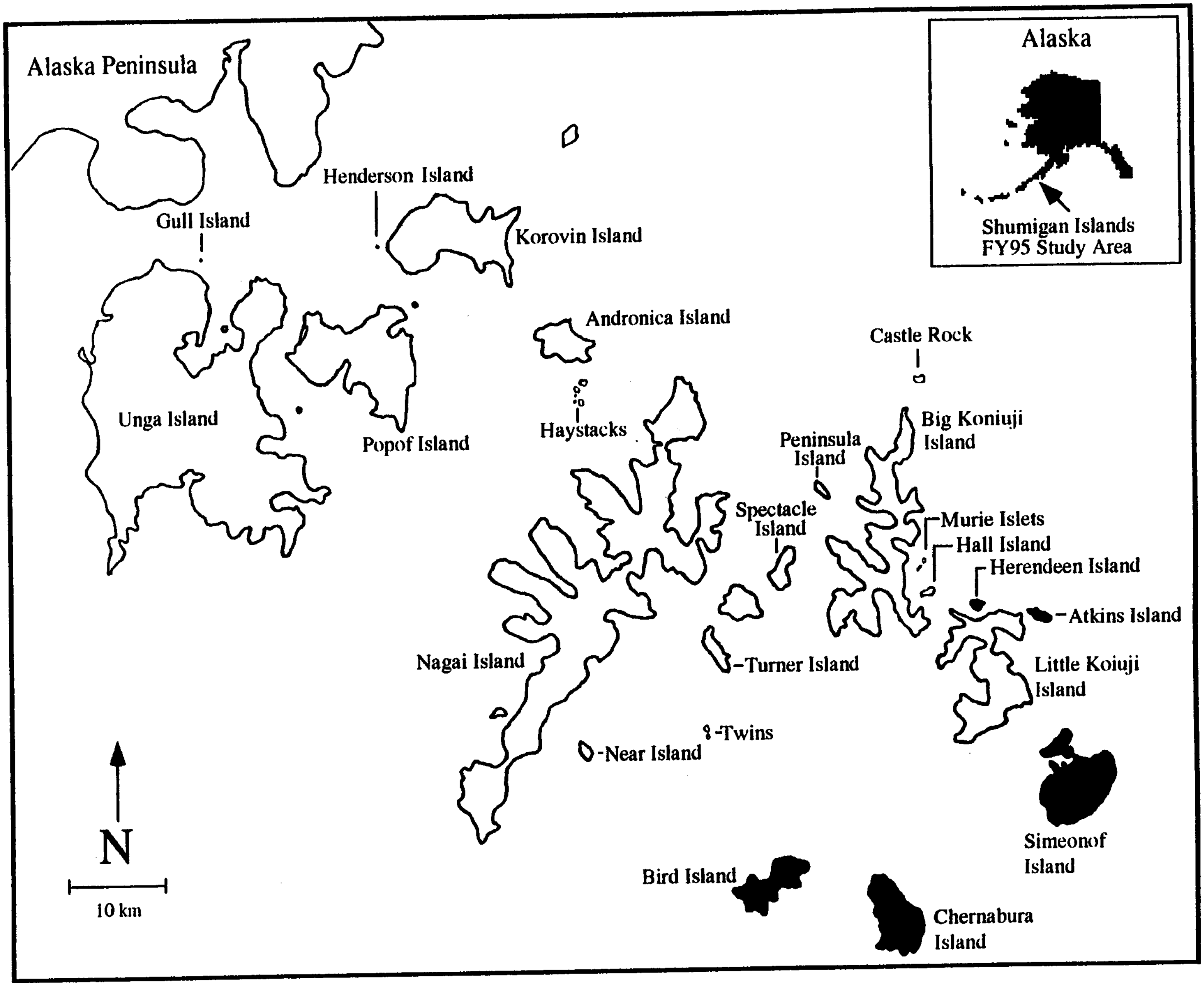

Figure 1. The Shumagin Islands, Alaska (study area shown in black).

Table 1. Black oystercatcher counts and densities at islands with and without introduced foxes in the Shumagin Islands, Alaska, 1994.

Location	Pairs[a]	Individual birds[b]	Total birds	Habitat[c]	Density (pairs)	Density (total birds)	Ratio of paired to unpaired birds
Foxes present							
Simeonof	6 (0)[d]	52	64	42.0	0.1	1.5	1:4.3
Chernabura	4 (0)	25	33	31.1	0.1	0.8	1:3.1
Foxes absent							
Atkins	5 (2)	3	13	10.1	0.5	1.3	1:0.3
Bird	21 (-)[e]	37	79	13.0	1.5	6.1	1:0.8
Herendeen	7 (6)	9	23	3.7	1.9	6.2	1:0.6

[a] Two birds expressing territoriality (see Methods)
[b] Peak counts of unpaired birds
[c] Km of beach
[d] Number of nests found in parentheses
[e] Unable to search for nests
[f] Murie Islets, lying within 0.5 km of Simeonof, were surveyed once

Table 2. Density of black oystercatchers in different nesting habitat types on selected islands of the Shumigan Island group, Alaska, 1994.

Location	Beach habitat [a]			Total habitat (km)
	Sand	Boulder	Rock/Rock shelf	
Foxes present				
Simeonof	0.1 (8.3)[b]	0.1 (29.6)	0.0 (4.1)	42.0
Chernabura	0.1 (2.6)	0.4 (21.5)	0.0 (7.0)	31.1
Foxes absent				
Atkins	--- [c]	1.4 (3.2)	0.2 (6.9)	10.1
Bird	0.0 (1.6)	1.1 (9.8)	0.4 (1.6)	13.0
Herendeen	--- [c]	1.2 (1.3)	0.3 (1.1)	2.4

[a] See Table A7 for definitions
[b] Density (pairs km^{-1}) followed by km of habitat in parentheses
[c] No sand beaches present

Table 3. Pigeon guillemot counts and densities at islands with and without introduced foxes in the Shumagin Islands, Alaska, 1994.

Location	Birds[a]	Habitat[b]	Density[c]
Foxes present			
Simeonof	12	3.1	3.9
Chernabura	43[d]	5.6	7.7
Foxes absent			
Atkins	41	2.3	17.8
Bird	194	17.9	10.8
Herendeen	43	2.1	20.5

[a] Values are based on the high count of pigeon guillemots seen in each survey segment and provide an index of abundance.

[b] Hectares of nesting habitat

[c] Birds ha^{-1}

[d] Forty of these birds were observed in a portion of the island inaccessible to foxes.

Table 4. Density of pigeon guillemots in different nesting habitat types on selected islands of the Shumigan group, Alaska, 1994.

Location	Habitat types[a]							
	Boulder	Rock crevice	Rock crevice/ boulder	Log pile	Talus	Talus/ mixes	Cliff	Cliff/ boulder
Foxes present								
Simeonof	-----[b]	5.0[c] (1.87)	8.3 (0.70)	0.0 (0.53)	-----	-----		
Chernabura	-----	7.3 (3.29)	13.8 (1.73)	0.0 (0.61)	-----	-----		
Foxes absent								
Atkins		44.2 (0.27)	-----	-----	12.0 (0.58)	13.8 (1.45)	-----	-----
Bird	7.0 (9.94)	22.9 (1.14)	17.3 (3.29)	0.0 (1.57)	-----	-----	58.7 (1.96)	-----
Herendeen	-----	-----	30.8 (0.29)	-----	14.0 (0.85)	-----	-----	26.4 (0.98)

[a] See Table A7 for definitions of habitat classifications
[b] Dash indicates this type of habitat was absent
[c] Number of birds counted ha^{-1} followed in parentheses by area of habitat in ha

Table 5. Comparison of pigeon guillemot densities on selected islands in the Shumagin Island group, Alaska.

Island	Coastline (km)	Estimated number of birds	Density (birds km^{-1} coast)[a]	Survey date	Source
No fox present during survey					
Hall/Murre Rocks	3	1250	417	2 Jul 1976	Moe and Day 1977
Peninsula	5	60	12	24 Jul 1976	Moe and Day 1977
Gull (near Unga)	<1[b]	20	100	9 Jun 1973	Sowl 1982
Henderson	1	20	20	9 Jun 1973	Sowl 1982
Near	6	400	67	10 Jul 1977	Bailey 1978
Haystacks	1	6	6	7 Jul 1977	Bailey 1978
Castle	3	50	17	6 Jul 1976	Moe and Day 1977
Twins	2	20	10	15 Jul 1977	Bailey 1978
Murie Islets	3	161	54	8 Jun 1994	K. Schmidt unp. data
Andronica	16	230	14	10 Jun 1973	Sowl 1982
Turner	13	30	2	14 Jul 1977	Bailey 1978
Spectacle	12	80	7	17 Jul 1977	Bailey 1978
Popof	55	40	1	10 Jun 1973	Sowl 1982
Mean density[c]			56		
Fox present during survey					
Big Koniuji	90	40	<1	-- Jul 1976	Moe and Day 1977
Simeonof	42	12	<1	-- Jun 1994	this report
Chernabura	33	43	1	7 Jul 1994	this report
Mean density			<1		

[a] Rounded to nearest integer
[b] 0.2 km of coastline
[c] Island is sample unit for calculating means

APPENDIX A

Survey data for black oystercatchers and pigeon guillemots at study areas in the Shumagin Islands in 1994.

List of Tables

Table A1. Counts of black oystercatchers and pigeon guillemots at Simeonof Island, Shumagin Islands, Alaska, 1994.

						Black oystercatcher	Pigeon guillemot	
Segment[a]	Date	Time (hr)	Tide[b]	Wind[c]	Swell[d]	Birds	Pairs	Others
1	27 May	1000-1245	0.6	10	0	-[e]	0	12
1	2 Jun	1140-1240	3.4	10	1	0	-	-
1	3 Jun	1100-1200	4.2	15	2	0	-	-
1	4 Jun	1300-1400	4.2	15	2	0	1	0
1	6 Jun	1636-1710	1.8	20	2	0	2	1
1	8 Jun	1100-1200	2.9	15	1	0	1	0
1	10 Jun	1950-2020	3.2	10	1	0	1	2
2	27 May	1245-1640	3.6	15	0	-	0	0
2	2 Jun	1200-1300	3.1	10	2	0	-	-
2	3 Jun	1100-1200	4.2	15	2	0	-	-
2	4 Jun	1400-1420	3.6	15	2	0	0	0
2	8 Jun	1430-1500	5.3	15	1	0	1	0
2	10 Jun	1830-1950	3.2	10	1	0	1	6
3	2 Jun	1200-1300	3.3	10	2	0	-	-
3	3 Jun	1100-1200	4.2	15	2	1	-	-
3	4 Jun	1420-1445	3.2	15	2	0	0	1
3	8 Jun	1500-1530	5.1	15	1	0	0	1
3	10 Jun	1950-2020	3.1	10	1	0	1	3
4	2 Jun	1300-1400	2.5	10	2	2	-	-
4	3 Jun	1100-1200	4.2	15	2	0	-	-
4	3 Jun	1300-1430	3.2	15	2	-	0	2
4	4 Jun	1440-1500	3.6	15	2	1	1	0
4	11 Jun	2030-2100	2.5	5	1	0	0	0
5	2 Jun	1500-1600	1.4	10	2	0	-	-
5	3 Jun	1100-1200	4.2	15	2	0	-	-
5	3 Jun	1200-1500	2.6	15	2	-	0	0
5	4 Jun	1500-1610	2.2	15	2	2	0	0
5	9 Jun	1504-1917	6.2	15	4	0	0	0
5	11 Jun	1700-1730	4.6	5	1	0	0	6

Table A1 (cont.). Counts of black oystercatchers and pigeon guillemots at Simeonof Island, Shumagin Islands, Alaska, 1994.

						Black oystercatcher	Pigeon guillemot	
Segment	Date	Time (hr)	Tide	Wind	Swell	Birds	Pairs	Others
6	2 Jun	1600-1700	2.2	10	2	0	-	-
6	3 Jun	1500-1600	2.8	15	2	2	-	-
6	4 Jun	1610-1704	2.2	15	2	0	0	0
6	7 Jun	1520-1718	4.2	10	2	0	0	0
7	30 May	1100-1700	1.0	10	1	0	0	22
7	2 Jun	1700-1800	3.1	10	2	0	-	-
7	3 Jun	1600-1700	1.8	15	2	3	-	-
7	4 Jun	1704-1750	2.1	15	2	2	0	0
7	7 Jun	1435-1520	4.2	10	2	0	0	0
8	1 Jun	1200-1700	0.9	20	1	2	-	-
8	4 Jun	1750-2030	4.5	15	2	0	1	0
8	6 Jun	1430-1600	4.6	20	2	0	0	1
8	7 Jun	1806-1847	2.9	10	2	0	0	0

[a] See figures 2 and 7 for delineation of habitat types and survey segments
[b] Tide height (in feet) based on midpoint of survey time range
[c] Estimated velocity in knots
[d] Approximate height of swell in feet
[e] No count

Table A2. Counts of black oystercatchers and pigeon guillemots at Atkins Island, Shumagin Islands, Alaska, 1994.

Segment[a]	Date	Time (hr)	Tide[b]	Wind[c]	Swell[d]	Black oystercatcher Birds	Pigeon guillemot Pairs	Pigeon guillemot Others
1	15 Jun	1902-1948	5.1	12	2	3	2	0
1	17 Jun	1630-1800	3.2	0	1	2	3	1
1	20 Jun	1549-1627	2.7	15	2	8	1	1
1	22 Jun	1500-1525	4.2	5	2	28	-[e]	-
2	15 Jun	1948-2039	4.9	12	2	0	0	0
2	17 Jun	1800-1915	4.3	0	1	0	2	2
2	20 Jun	1410-1545	2.8	15	2	3	2	1
2	22 Jun	1525-1550	4.2	5	2	13	-	-

[a] See figures 3 and 9 for delineation of habitat types and survey segments
[b] Tide height (in feet) based upon the midpoint of the survey time range
[c] Estimated velocity in knots
[d] Approximate height of swell in feet
[e] No count

Table A3. Counts of black oystercatchers and pigeon guillemots at Herendeen Island, Shumagin Islands, Alaska, 1994.

						Black oystercatcher	Pigeon guillemot	
Segment[a]	Date	Time (hr)	Tide[b]	Wind[c]	Swell[d]	Birds	Pairs	Others
1	15 Jun	1539-1630	3.2	10	2.0	2	0	0
1	17 Jun	1230-1300	3.9	0	1.0	26	0	6
1	18 Jun	1551-1610	1.8	10	1.5	2	1	4
1	22 Jun	1420-1428	5.9	5	2.0	14	-[e]	-
2	15 Jun	1635-1726	3.7	10	2.0	2	2	1
2	17 Jun	1300-1350	2.9	0	1.0	7	2	1
2	18 Jun	1611-1634	2.1	10	1.5	0	2	2
2	22 Jun	1428-1434	5.8	5	2.0	13	-	-
3	15 Jun	1731-1841	4.6	10	2.0	1	4	0
3	17 Jun	1350-1430	1.2	0	1.0	0	3	0
3	18 Jun	1636-1655	2.2	10	1.5	3	1	1
3	22 Jun	1434-1440	5.8	5	2.0	4	-	-

[a] See figures 4 and 11 for delineation of habitat types and survey segments
[b] Tide height (in feet) based upon the midpoint of the survey time range
[c] Estimated velocity in knots
[d] Approximate height of swell in feet
[e] No count

Table A4. Counts of black oystercatchers and pigeon guillemots at Chernabura Island, Shumagin Islands, Alaska, 1994.

Segment[a]	Date	Time (hr)	Tide[b]	Wind[c]	Swell[d]	Black oystercatcher Birds	Pigeon guillemot Pairs	Pigeon guillemot Others
1	28 Jun	1230-1700	3.1	10	1	0	0	8
1	1 Jul	1430-1745	2.8	20	1	0	0	6
1	6 Jul	1630-1720	4.0	20	2	0	1	15
1	7 Jul	1001-1130	2.4	5	3	0	0	4
2	6 Jul	1720-1800	3.4	20	2	0	0	1
2	7 Jul	1130-1215	2.8	5	3	0	0	0
2	10 Jul	1423-1451	3.7	20	4	0	0	0
2	11 Jul	1800-1830	4.6	10	4	0	0	0
3	5 Jul	1500-1730	3.2	25	2	-[e]	1	0
3	7 Jul	1215-1300	4.2	5	3	0	1	0
3	10 Jul	1300-1400	3.8	20	4	0	0	0
3	11 Jul	1640-1800	6.4	10	4	0	1	1
4	7 Jul	1300-1340	4.8	5	3	1	0	1
4	10 Jul	1230-1300	1.2	20	4	2	0	0
4	11 Jul	1505-1525	4.9	10	4	0	0	0
5	7 Jul	1340-1346	4.7	5	3	1	0	1
5	7 Jul	1410-1425	5.1	15	2	0	0	0
5	10 Jul	1200-1210	1.0	20	4	0	0	0
5	11 Jul	1458-1505	3.9	10	4	0	0	0
6[f]	7 Jul	1515-1600	5.0	5	3	11	0	6
6	7 Jul	1350-1500	5.1	5	3	15	1	4
6	9 Jul	1320-1410	3.6	15	2	22	2	1
6	9 Jul	1500-1553	6.0	15	2	11	0	0
6	10 Jul	1105-1200	0.7	20	4	40	0	0
6	11 Jul	1400-1455	3.3	10	4	34	2	4
6	12 Jul	1500-1553	4.1	10	2	6	2	0

[a] See figures 5 and 8 for delineation of habitat types and survey segments
[b] Tide height (in feet) based upon the midpoint of the survey time range
[c] Estimated velocity in knots
[d] Approximate height of swell in feet
[e] No count
[f] Segment 6 has several portions of rugged pigeon guillemot breeding habitat that are inaccessible to marauding foxes

Table A5. Counts of pigeon guillemots and black oystercatchers at Bird Island, Shumagin Islands, Alaska, 1994.

Segment[a]	Date	Time (hr)	Tide[b]	Wind[c]	Swell[d]	Black oystercatcher Birds	Pigeon guillemot Pairs	Pigeon guillemot Others
1	13 Jul	1105-1151	-0.4	0	1	47	4	2
1	13 Jul	1830-1850	6.1	0	1	1	2	5
2	13 Jul	1151-1243	1.2	0	1	37	2	9
2	13 Jul	1850-1940	5.8	0	1	10	4	6
3	13 Jul	1243-1512	1.4	0	1	33	4	4
3	13 Jul	1940-2110	4.9	0	1	7	1	8
4	13 Jul	1512-1704	6.7	0	1	20	3	0
4	13 Jul	2110-2128	4.9	0	1	20	2	5
5	13 Jul	1704-1725	6.2	0	1	12	2	1
5	13 Jul	2128-2138	4.6	0	1	7	3	1
6	13 Jul	1725-1803	6.5	0	1	37	3	3
6	13 Jul	2138-2200	4.5	0	1	45	3	9

[a] See figures 6 and 10 for delineation of habitat types and survey segments
[b] Tide height (in feet) based upon the midpoint of the survey time range
[c] Estimated velocity in knots
[d] Approximate height of swell in feet

Table A6. Counts of pigeon guillemots and black oystercatchers at the Murie Islets, Shumagin Islands, Alaska, 1994.

						Black oystercatcher	Pigeon guillemot	
Segment[a]	Date	Time	Tide[b]	Wind[c]	Swell[d]	Birds	Pairs	Others
1	06/08/94	1230-1250	4.8	15	1	65	3	5
2	06/08/94	1300-1315	4.8	15	1	39	2	4
3	06/08/94	1320-1400	4.8	15	1	35	9	6
4	06/08/94	1420-1425	5.1	15	1	22	1	1

[a] See figure 12 for delineation of habitat types and survey segments
[b] Tide height (in feet) based upon the midpoint of the survey time range
[c] Estimated velocity in knots
[d] Approximate height of swell in feet

Table A7. Descriptions of habitat types identified on selected islands in the Shumagin Islands, Alaska, 1994.

Species	Habitat[a]	Habitat Description
Black oystercatcher	Sand	Aggregate size <1.3 cm
	Boulder	Aggregate size 8 - 127 cm in diameter
	Rockshelf	Generally contiguous substrate with < 50° slope
	Talus	Any large angular rubbles
Pigeon guillemot	Boulder	Round aggregates large enough to create openings that could potentially hold guillemots (>25cm).
	Cliff	Any vertical substrate that may contain overhangs, pockets, crevices and cracks that might hold guillemots
	Log Pile	Log and flotsam of any dimension, laying high upon the beach and providing crevices which could hold guillemots
	Rock Crevice[b]	Any sort of contiguous rocky substrate that contains cracks or fissures large enough to hold a guillemot
	Talus	Any large angular rubbles that provide cavities large enough to hold guillemots

[a] Any of these types may be joined together in combination, usually seperated by a slash, and the capital letter used for acronymic headings on figures

[b] Frequently listed as "rock" to conserve space on figures

APPENDIX B

Description and delineation of habitats for black oystercatchers and pigeon guillemots at study areas in the Shumagin Islands in 1994.

List of Figures

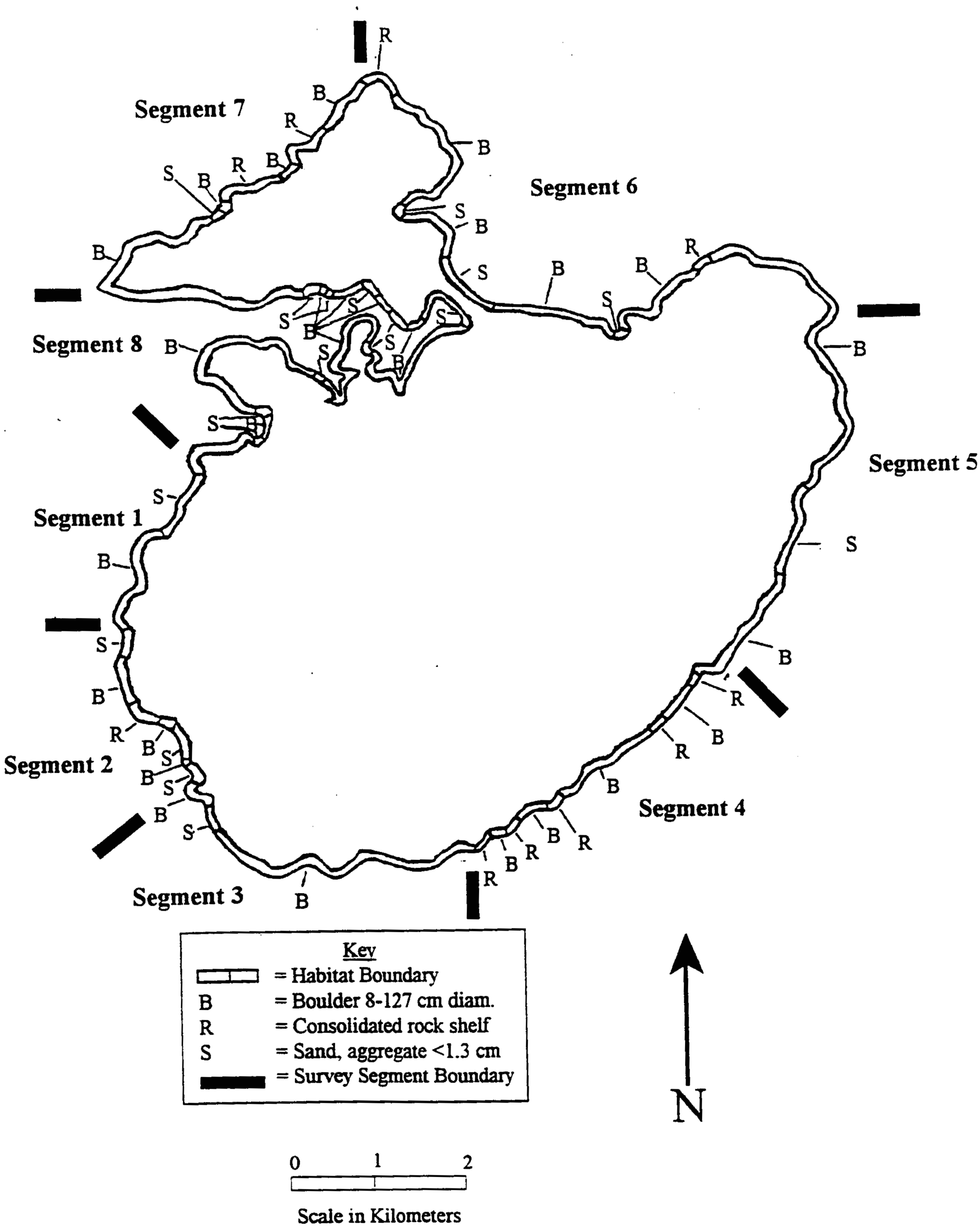

Figure B1. Delineation of habitat types and survey segments for black oystercatchers at Simeonof Island, Shumagin Islands, Alaska, 1994.

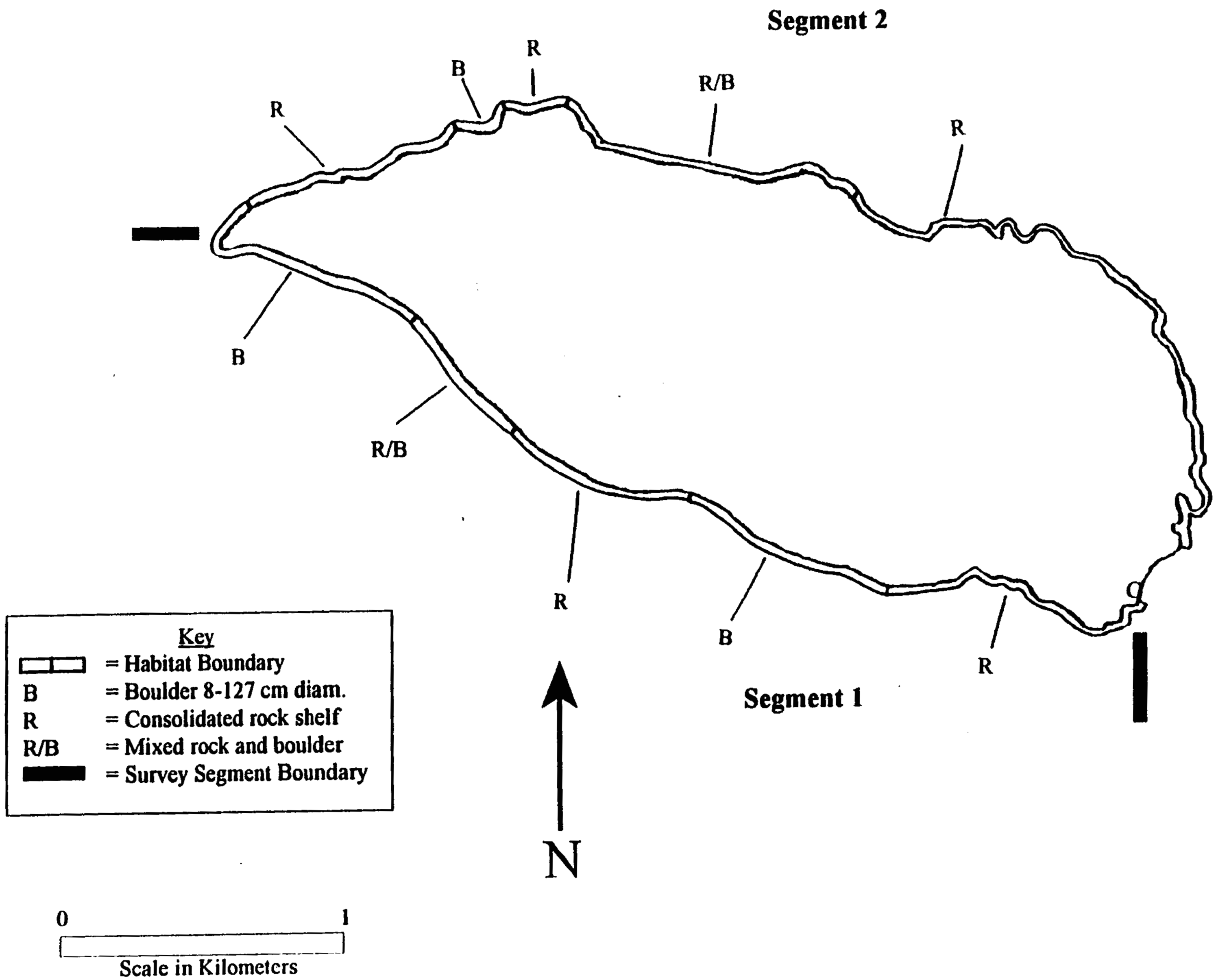

Figure B2. Delineation of habitat types and survey segments for black oystercatchers at Atkins Island, Shumagin Islands, Alaska, 1994.

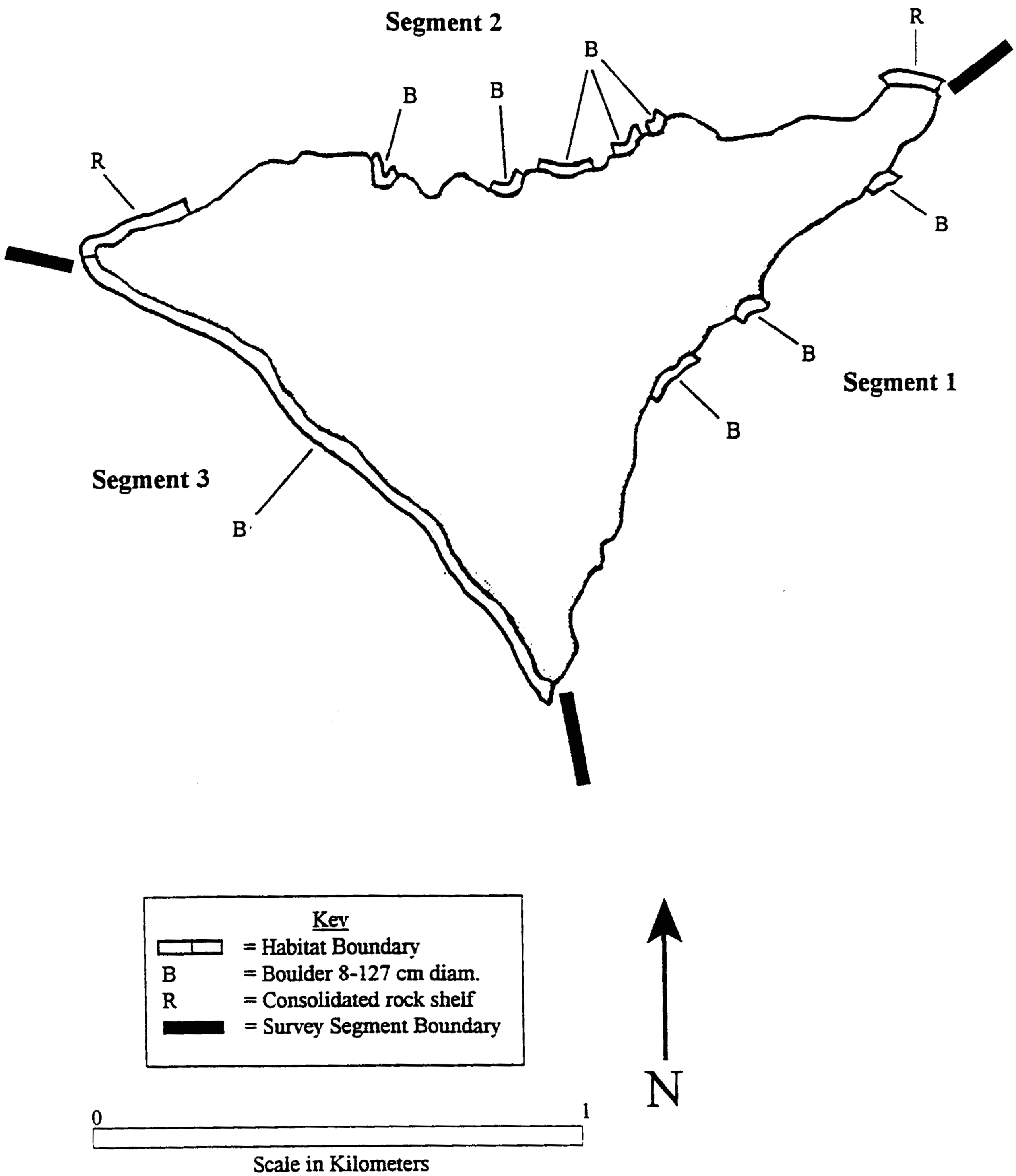

Figure B3. Delineation of habitat types and survey segments for black oystercatchers at Herendeen Island, Shumagin Islands, Alaska, 1994.

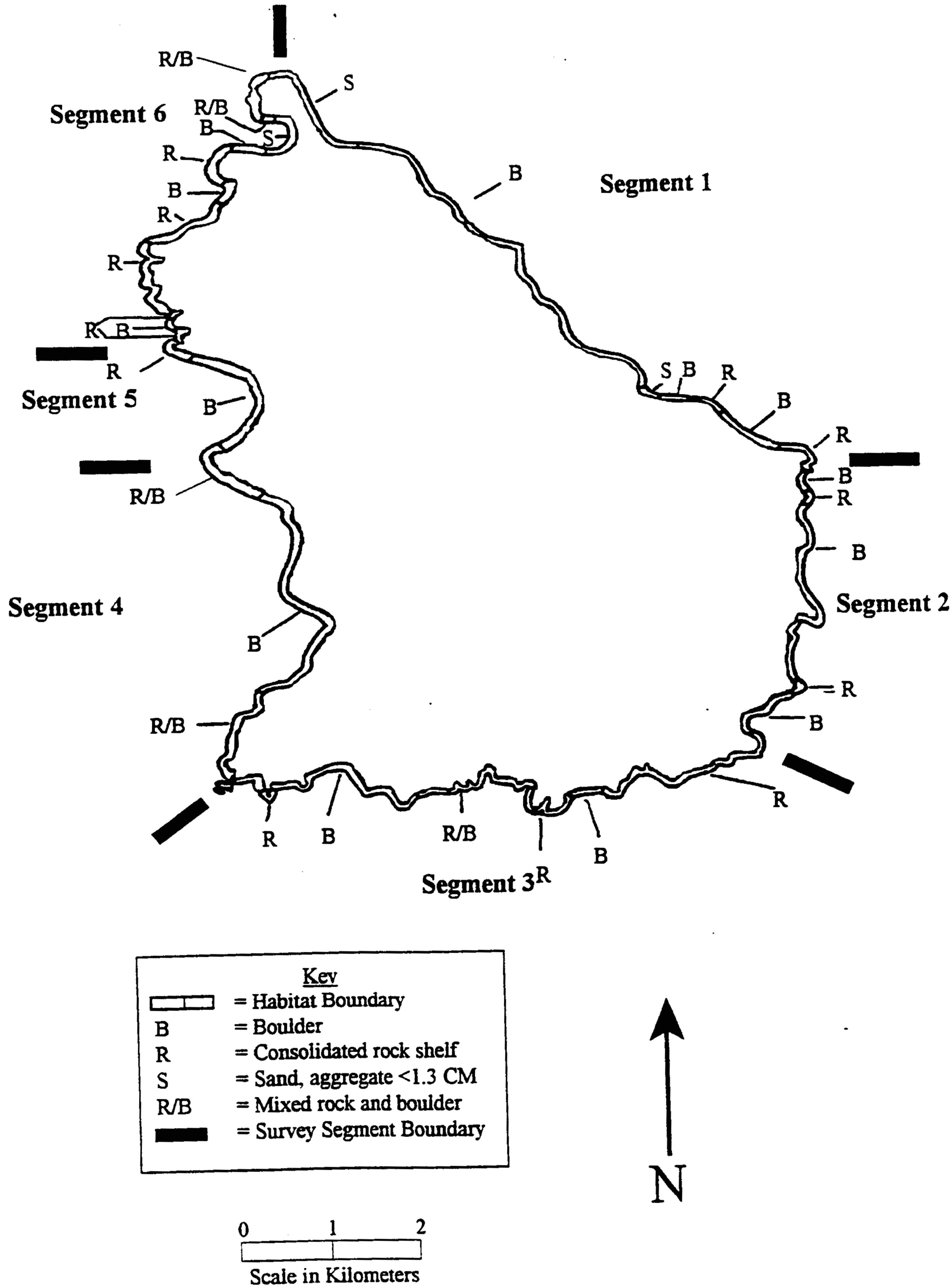

Figure B4. Delineation of habitat types and survey segments for black oystercatchers at Chernabura Island, Shumagin Islands, Alaska, 1994.

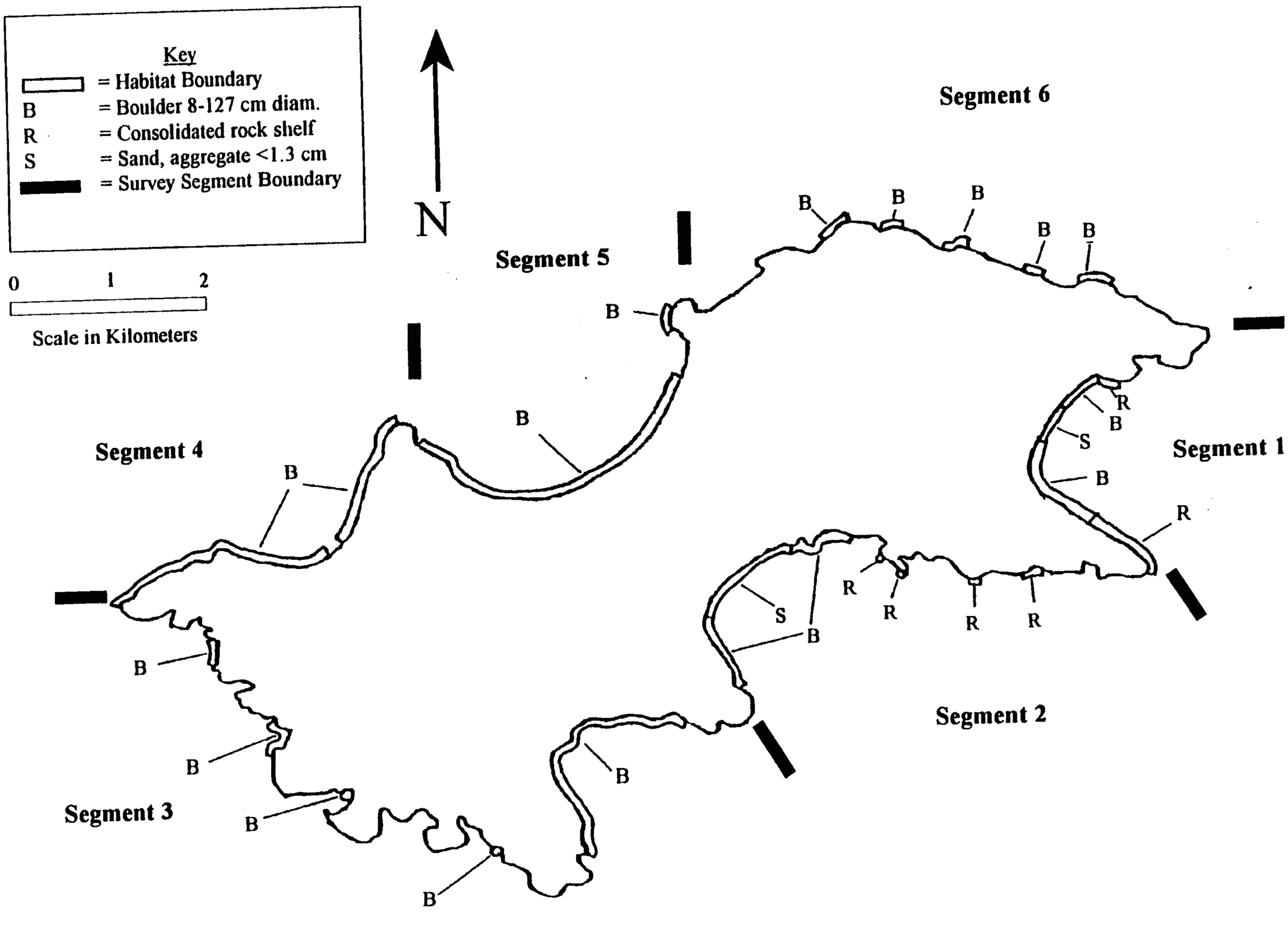

Figure B5. Delineation of habitat types and survey segments for black oystercatchers at Bird Island, Shumagin Islands, Alaska, 1994.

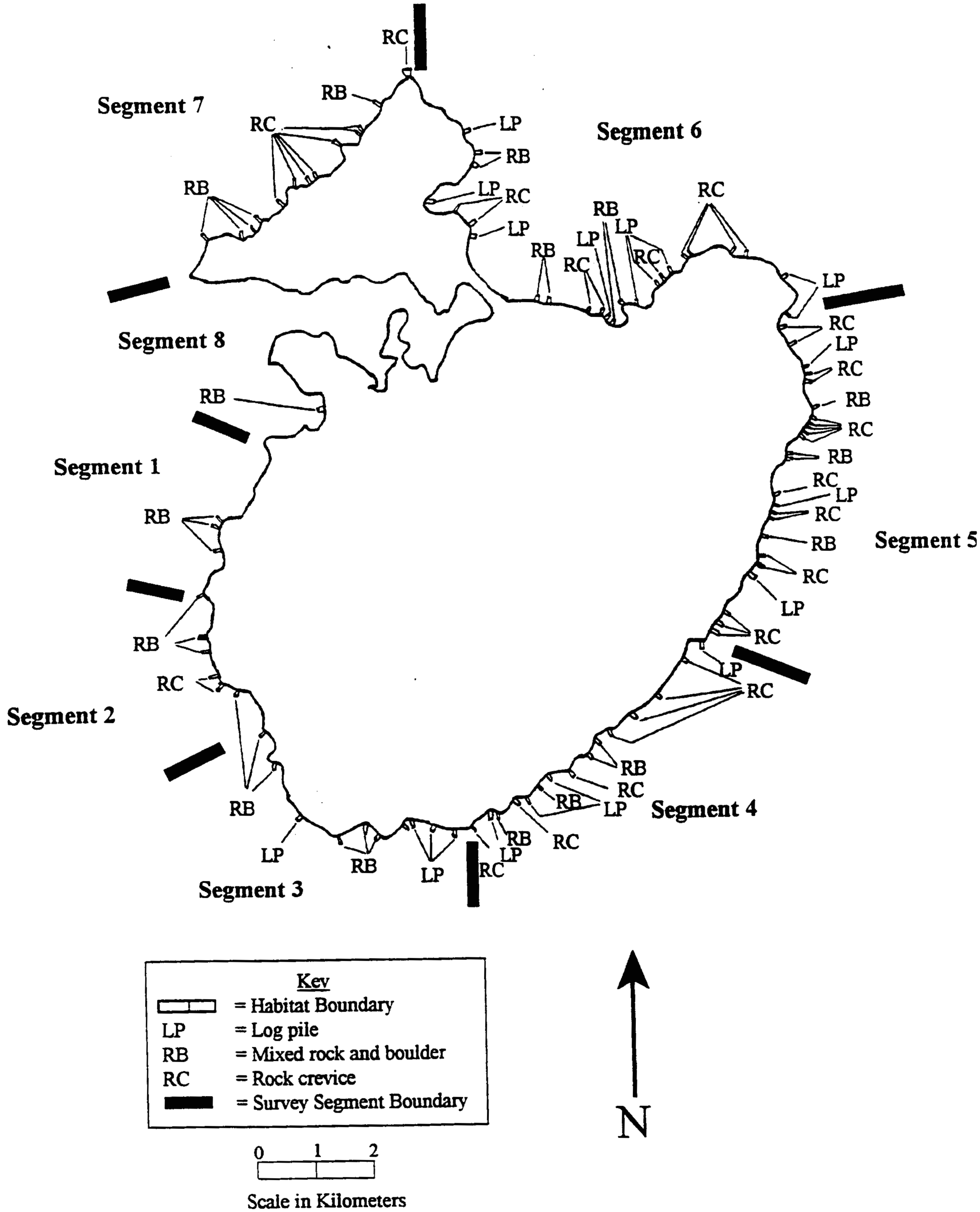

Figure B6. Delineation of habitat types and survey segments for pigeon guillemots at Simeonof Island, Shumagin Islands, Alaska, 1994.

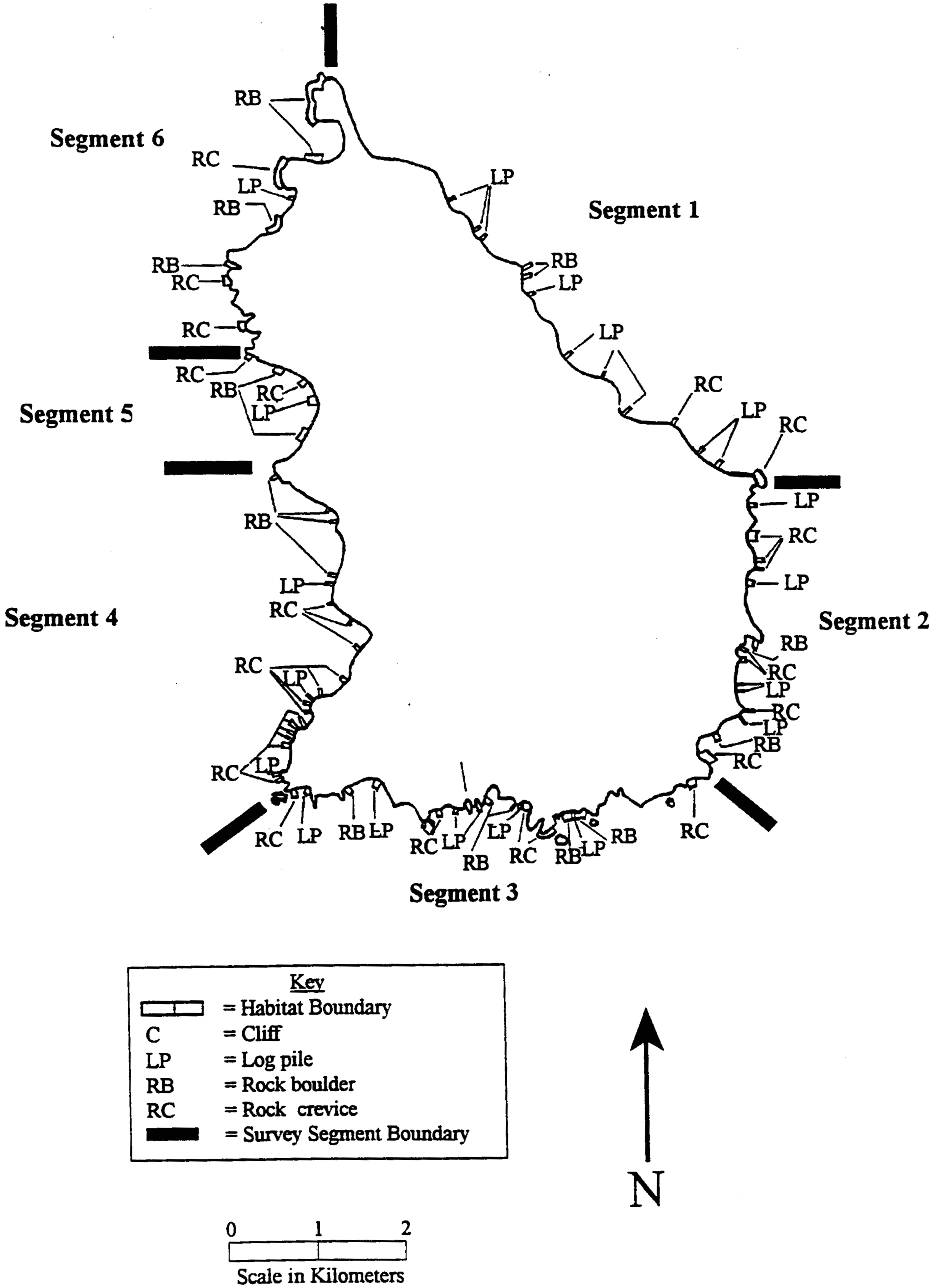

Figure B7. Delineation of habitat types and survey segments for pigeon guillemots at Chenabura Island, Shumagin Islands, Alaska, 1994.

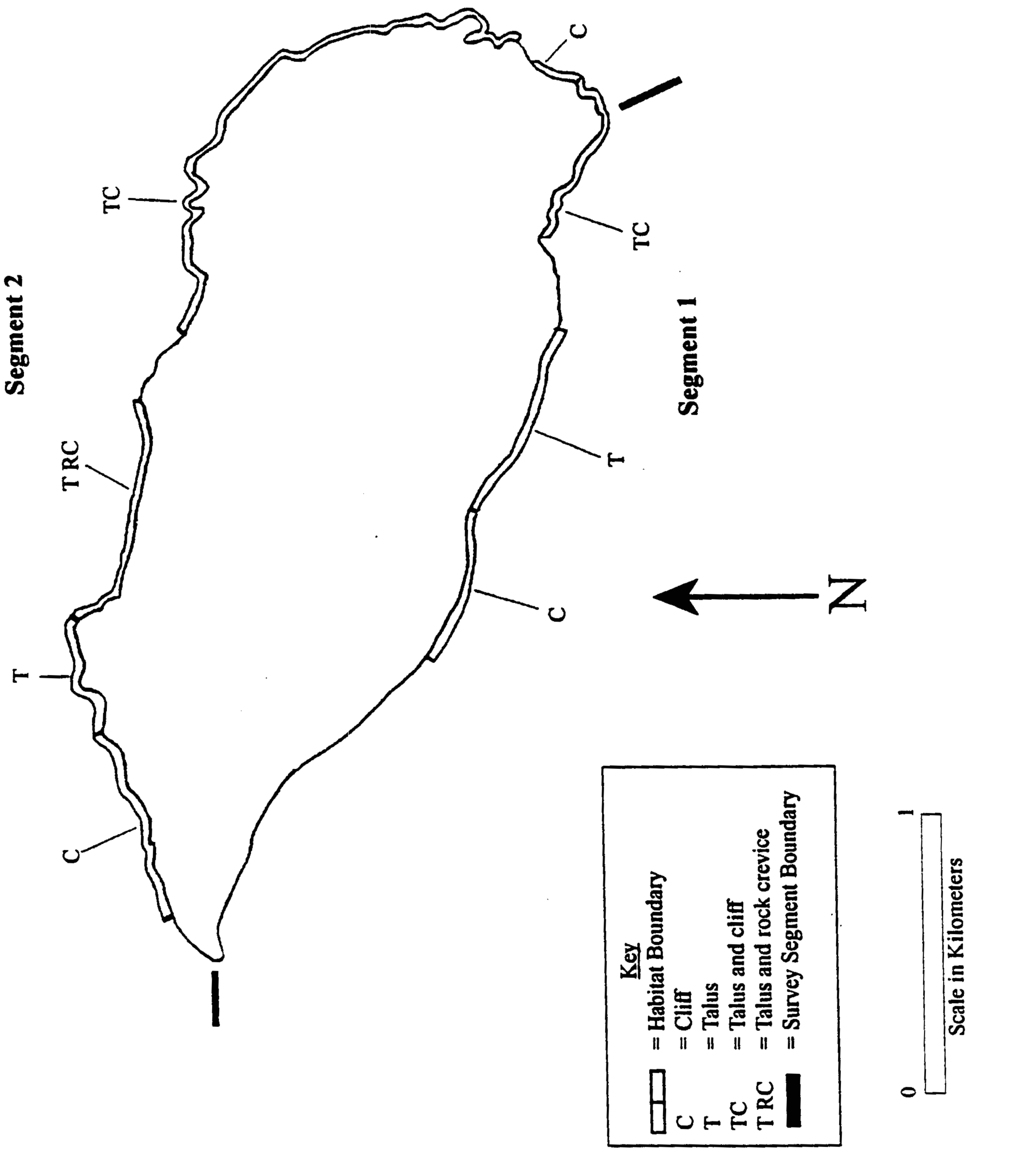

Figure B8. Delineation of habitat types and survey segments for pigeon guillemots at Atkins Island, Shumagin Islands, Alaska, 1994.

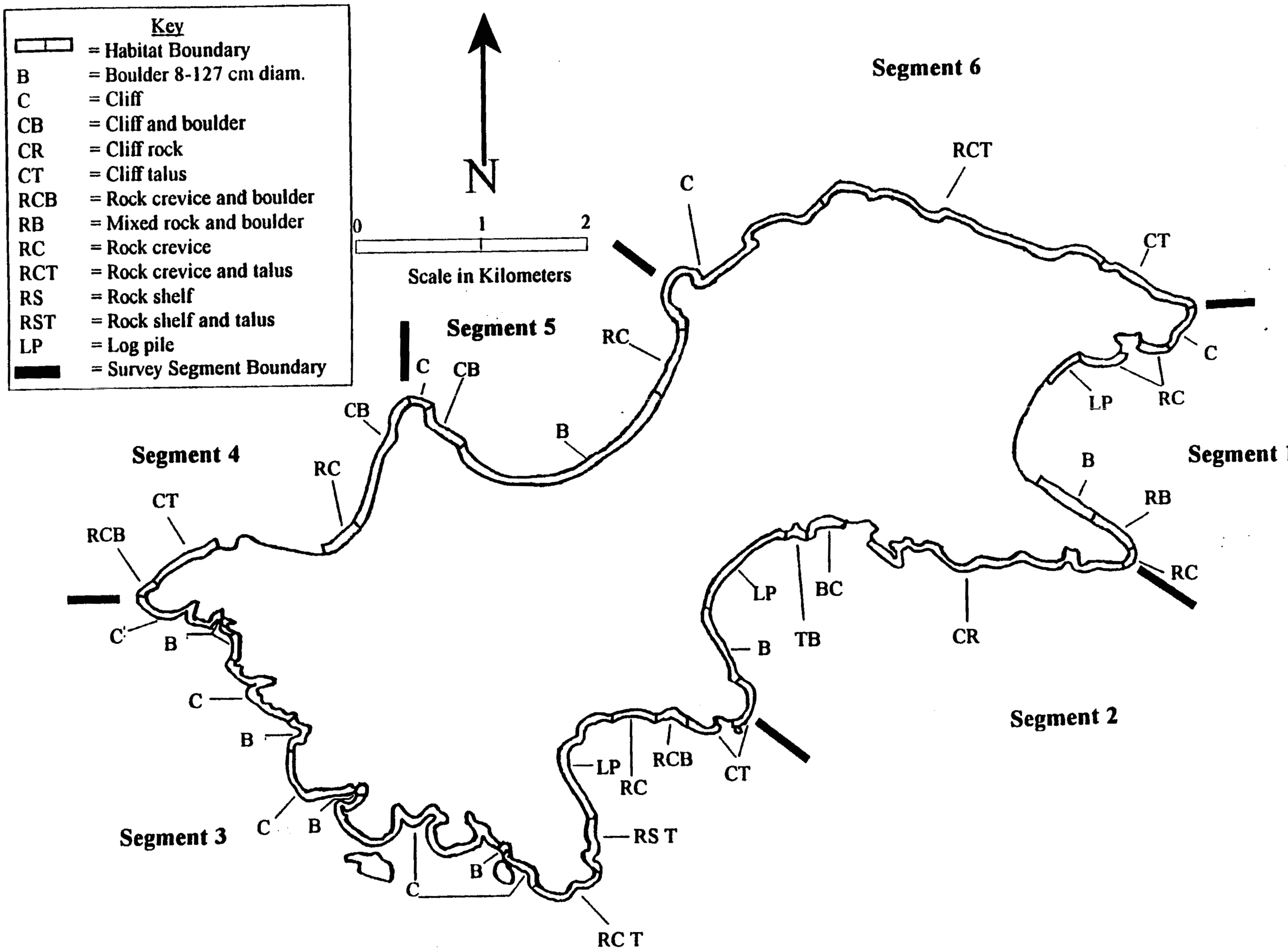

Figure B9. Delineation of habitat types and survey segments for pigeon guillemots at Bird Island, Shumagin Islands, Alaska, 1994.

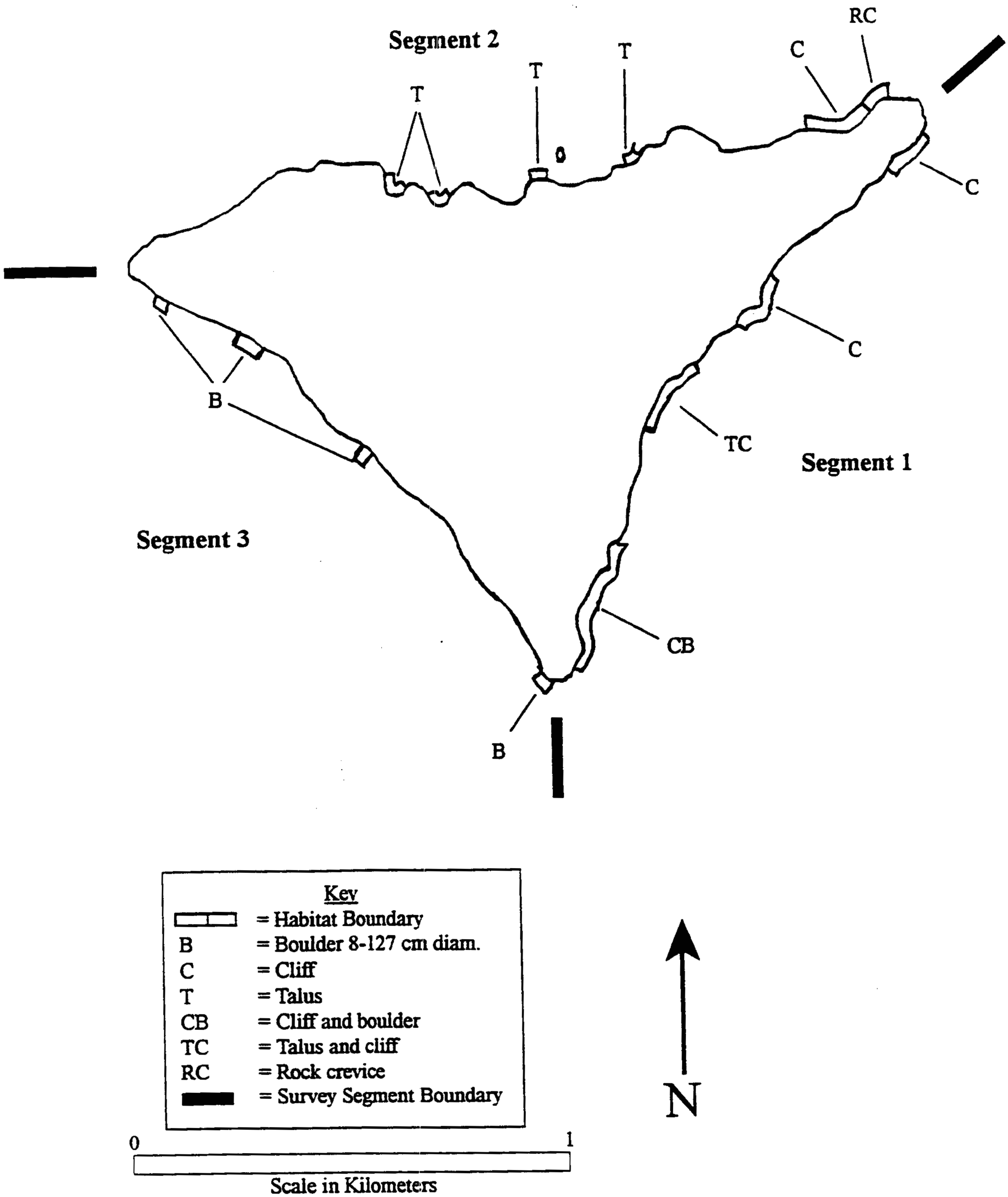

Figure B10. Delineation of habitat types and survey segments for pigeon guillemots at Herendeen Island, Shumagin Islands, Alaska, 1994.

REVIEW COMMENTS FOR *EXXON VALDEZ* TRUSTEE COUNCIL
"Introduced predator removal from islands": Restoration Project #94041 - Final Report

This project is unique among the many funded by the Trustee Council in that restoration is actually being implemented in the field. The idea of using fox eradication (from islands where they were never native) to replace seabirds lost from the oil spill is directly related to the Council's long-term goals. That these sorts of projects are relatively inexpensive (but apparently effective), is yet another strength.

I would like to see some stronger statistical rigor and design in future studies of this type, mainly in terms of replicating the counts of oystercatchers and guillemots so as to obtain more precise estimates when comparing the sizes of the pre- and post-removal populations. In addition, there are biometric methods for determining population size through "trapping to extinction", even if not all foxes are actually trapped. There are wonderful opportunities here to measure the response of species after predator removal. Statistically-rigorous results can be used to better justify future restoration efforts that employ similar methods, as well as offer a unique chance to conduct manipulative experiments of island ecosystems.

Numbered comments below correspond to locations numbered throughout the text of the report. Elsewhere I have also suggested minor changes marked in red pen directly on the text.

1) Neither Murie (1959) nor Jones and Byrd (1989) are listed in the "Literature Cited" section.

2) Bailey (1994) is not listed in the "Literature Cited" section; is Bailey (1993) intended here?

3) Neither Ainley and Boekelheide (1990) nor Vermeer et al. (1993) are listed in the "Literature Cited" section.

4) There is some consensus, however, that counting guillemots is best accomplished during high tides and/or during morning hours. Did you use this protocol?

5) Evaluation of the efficiency of fox removal will be facilitated if you use a sample design which allows statistical comparison of pre- and post-fox removal populations of the birds. (Two to four replicates are unlikely to be sufficient sample sizes, for example). Can and will you construct such a sample design? It is important to do this, particularly if more fox removals are slated for future restoration projects.

6) How did you accomplish the delineation? Is this adequately spelled out in the appendices?

7) This and similar exercises will be important for judging the eventual success, if any, of the fox eradication program.

8) It is not necessary to mention the authors twice; it is already understood from their authorship that they made material contributions to the project.

9) I could find no reference in this Final Report to the USFWS 1991 report on the Aleutian Canada goose recovery plan.

10) I like the fact that the field data collected are attached with these appendices within the report, thus enabling direct access.