DISTRIBUTION, ABUNDANCE, AND FEEDING HABITS OF SEABIRDS OFF THE COLUMBIA RIVER, MAY-JUNE, 1982

by

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TABLE OF CONTENTS

INTRODUCTION

The University of Oregon Institute of Marine Biology conducted 6 cruises offshore of the Columbia River during May and June, 1982 to study the distribution, abundance, and feeding habits of Sooty Shearwaters (Puffinus griseus) and Common Murres (Uria aalge). The principal purpose of the study was to determine whether, and to what degree, shearwaters and murres forage upon juvenile coho salmon (Oncorhynchus kisutch) emanating from the Columbia River. This report contains the results of our field research, a discussion of our findings, and recommendations for future research.

METHODS

Six cruises were conducted offshore of the Columbia River in May and June, 1982 aboard the National Marine Fisheries Service vessel Egret (Table 1). The study area extended along the main channel of the Columbia River, from navigation buoy No. 14 to No. 7, and offshore of the river mouth over an area of approximately 125 km^2 (Figure 1). Since hazardous sea conditions prevail at the river mouth during ebb tides, all sampling was carried out during the flood stage of the tidal cycle.

The censusing of seabirds was conducted along a series of strip transects located in the river channel and offshore of the river mouth (Appendix A, Figures A-1 to A-6). The transect segments were labelled alphabetically in the order in which they were traversed. Information regarding the vessel's course relative to the position of navigation buoys, prominent topographical features visible on the mainland, and fathometer depth readings was used to plot the location and determine the length of transects on U.S. National Ocean Survey Chart No. 1852. The width of all transects was 300 m; i.e., 150 m on each side of the vessel. While censusing, the vessel's

Table 1. Itinerary and information pertaining to environmental conditions during the 6 cruises conducted offshore of the Columbia River in 1982. Times (Pacific Daylight Time) are listed for departure from and return to the No. 14 navigation buoy in the Columbia River channel. Swell and tidal heights are in feet and wind speed is in knots.

DATE	START	END	CRUISE PERSONNEL	WEATHER	SEA STATE	TIDE[1]
24 May	1105	1445[2]	Matthews, Hansell, Durkin	Sky: clear Wind: NW, 10k	Swell: 3 ft. Seas: Large wavelets some cresting	L: -1.6 (0720) H: 6.8 (1403)
3 June	0655	1010	Matthews, Hansell, Durkin, Zorich	Sky: 60% overcast rain Wind: SW, 10k	Swell: 3-4 ft. Seas: Large wavelets no cresting	L: 0.5 (0420) H: 6.1 (1052)
4 June	0735	1025	Matthews, Hansell, Sharp, Zorich	Sky: 60% overcast clouds Wind: NW, 6k	Swell: 3 ft. Seas: Small wavelets, no cresting	L: 0.0 (0509) H: 6.2 (1139)
10 June	1140	1452	Matthews, Hansell, Emmett, Zorich	Sky: 100% overcast low fog Wind: NW, 6k	Swell: 3 ft. Seas: Small wavelets, no cresting	L: -0.2 (0854) H: 6.1 (1545)
11 June	1145	1441	Matthews, Hansell, Zorich	Sky: 100% overcast high fog Wind: SW, 3k	Swell: 3 ft. Seas: Ripples	L: 0.0 (0931) H: 6.2 (1627)
22 June	0923	1350	Matthews, Hansell, Emmett, McCabe, Zorich	Sky: 100% overcast high fog Wind: SW, 10k	Swell: 4-5 ft. Seas: Large wavelets, some cresting	L: -1.9 (0708) H: 6.8 (1356)

[1]Tidal data for the Columbia River entrance (north jetty) from tide tables published by the U.S. National Ocean Survey, Washington D.C.

[2]Time of arrival at No. 6 navigation buoy.

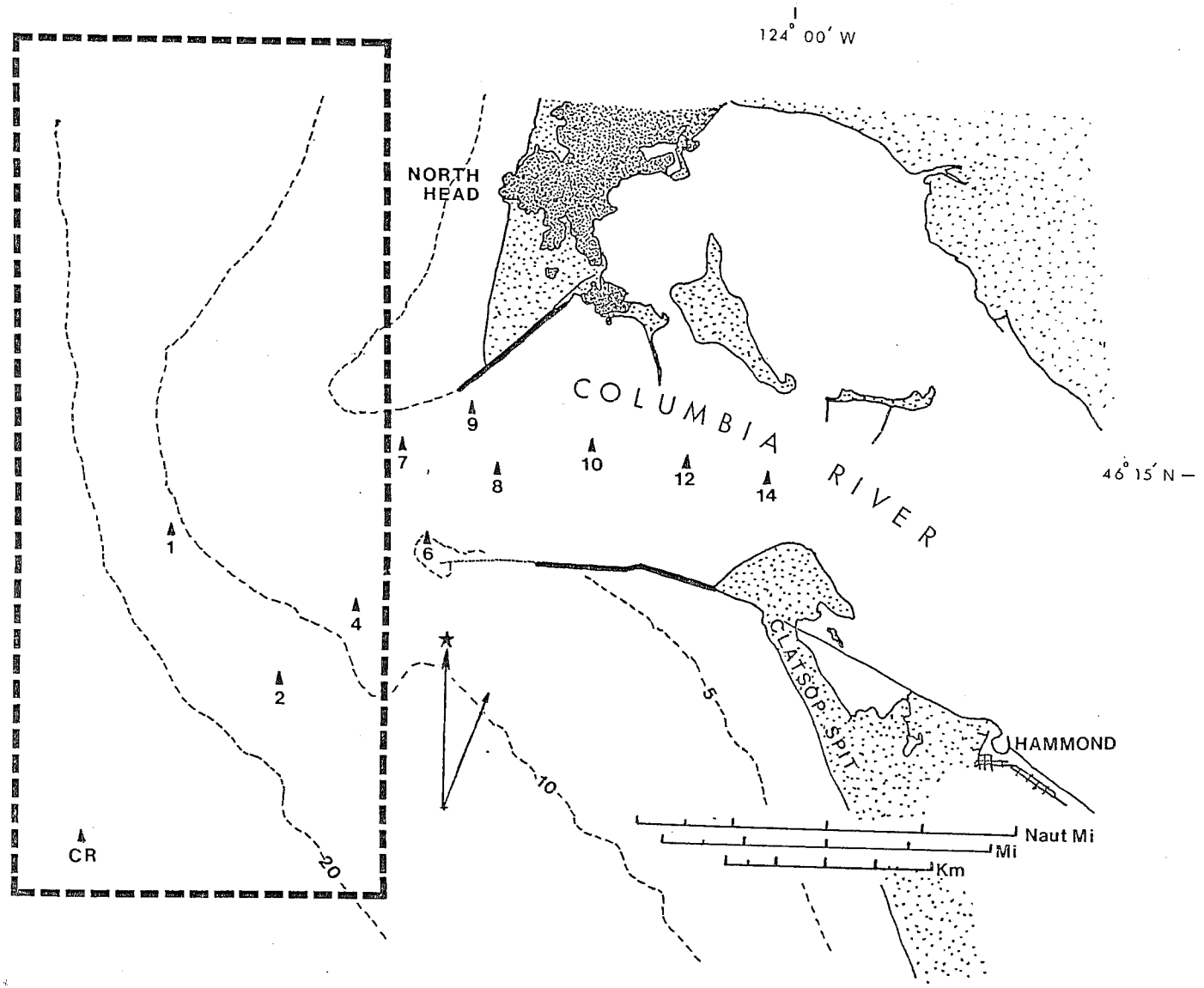

Figure 1. Study area, May-June, 1982. Sampling within the Columbia River channel was carried out between navigation bouys No. 14 and No. 7. Offshore sampling was carried out within a 125 km^2 area, which is approximated by the dashed-line rectangle. Depth contours are in fathoms (fathom = 1.8 meters). ▲ = location of navigation bouys.

speed was maintained at 10-15 knots (18-27 km/h). Observer height above the sea surface was 2 m. Numbers of swimming Common Murres were recorded, whereas both flying and swimming Sooty Shearwaters were counted.

Common Murres were collected with a 12 gauge shotgun; we did not have the opportunity to collect Sooty Shearwaters. Censusing was interrupted for the collection and processing of specimens. All the murres collected were taken along or within 50 m of the census transects. Once the collected specimen was on board the stomach (from mid-esophagus to the pylorus) was immediately removed, tagged, bagged and placed on ice. The birds were then labelled, bagged, and, once ashore, placed on ice.

In the laboratory the murre carcasses were weighed to the nearest gram (g), and measurements to the nearest millimeter (mm) were made of various anatomical features, including the gonads and brood patch. Determination of murre breeding status was based on data pertaining to the size of the gonads and oviduct, and the state of brood patch development in both males and females.

The stomachs were dissected and the contents of the proventriculus and gizzard were examined separately. Relatively intact fish and cephalopods were identified to species, weighed, measured and stored for future reference. Fish otoliths (sagittae) and cephalopod beaks resist digestion and mechanical breakdown, and can be used to identify prey species (Clarke, 1962; Fitch and Brownell, 1968). Identification of the stomach contents was accomplished by comparisons with cephalopod beaks and fish otoliths in the Oregon Institute of Marine Biology reference collection. The minimum number of fish, represented in a stomach sample by otoliths, was taken to be the greatest number of right or left sagittae. When the sagittae were too badly deteriorated to determine right or left, the total number was divided by two to estimate the minimum number of fish represented. Furthermore, when only fragments

of identified otoliths were found, the number of prey consumed of that species was listed as 1. The minimum number of individuals of species represented by cephalopod beaks was taken to be the greatest number of upper or lower beak halves.

RESULTS

Transect locations and census data are presented in Appendix A. During the study period abundance of Common Murres along the census transects offshore of the Columbia River mouth ranged from 195 to 852 birds (Table 2). Over this same period the estimate of mean murre density was 51 birds/km^2 (range = 18-123 birds/km^2). On each sampling day the distribution of murres on the offshore transects was patchy, as evidenced by the difference between the lowest and highest density estimates for the various transect segments (Table 3). Common Murre abundance within the river channel ranged from 1 to 213 birds, and the estimate of mean density is 24 birds/km^2 (range = 1-101 birds/km^2).

Sooty Shearwater abundance offshore of the river mouth ranged from 0-295 birds. The mean density estimate is 25 birds/km^2 (range = 0-866 birds/km^2).

During the study period 77 Common Murres were collected, 12 from the channel and 65 offshore of the river mouth. Specimens were collected from various transect segments on each sampling day (Refer to the data base in Appendix B, Table B-1). Thirty of the 37 males and 29 of the 40 females collected were classified as reproductively active.

The stomachs of all the murres collected were examined. Five were found to be empty, and an additional 43 were found to have no relatively intact prey items in the proventriculus portion of the stomach. Table 5 contains a summary of the stomach contents analysis (Refer to data base in Appendix B, Table B-2).

Table 2. Abundance and density estimates of Common Murres off the Columbia River mouth in 1982. Transect width = 0.3 km. (Refer to data base in Appendix A, Tables A-1 to A-6)

DATE	TOTAL TRANSECT LENGTH (km)	TRANSECT AREA (km^2)	NUMBER OF MURRES		MURRES/km^2
24 May	23.0	6.9	852		123
3 June	35.5	10.7	195		18
4 June	42.0	12.6	659		52
10 June	36.0	10.8	478		44
11 June	38.5	11.6	751		65
22 June	40.5	12.2	344		28
totals	215.5	64.8	3,279	mean	51

Table 3. Density estimates of Common Murres offshore of the Columbia River. Highest and lowest density estimates, and corresponding transect segment, are presented for each sampling day.

DATE	MURRE DENSITY (birds/km^2)			
	LOW	SEGMENT	HIGH	SEGMENT
24 May	27	C	254	E
3 June	8	G	37	C
4 June	9	F	111	G
10 June	5	B	297	G
11 June	11	F	111	E
22 June	0	D	170	F

Table 4. Abundance of Common Murres along the Columbia River channel census transect, May and June 1982, between navigation buoys No. 14 and No. 7. In all cases transect area was the same: area = 2.1 km^2; length = 7.0 km, width = 0.3 km

DATE	TIME (No. 14 to No. 7)	NUMBER OF MURRES	TIME (No. 7 to No. 14)	NUMBER OF MURRES
24 May	1105-1118	23	-	-
3 June	0655-0707	19	-	-
4 June	0735-0755	16	1005-1025	213
10 June	1140-1200	3	1440-1452	17
11 June	1145-1200	71	1425-1441	135
22 June	0923-0937	1	1335-1350	15

Table 5. Prey items of Common Murres collected in and offshore of the Columbia River estuary, May-June, 1982. Presented are the total number of each prey species, percentage of total individuals by number, and the frequency of occurrence of prey species. (n=77 , including five empty stomachs).

Prey Species	Number	Percent	Frequency
northern anchovy (Engraulis mordax)	215	46.7	74.0
Pacific tomcod (Microgadus proximus)	136	29.5	44.2
whitebait smelt (Allosmerus elongatus)	35	7.6	24.7
longfin smelt (Spirinchus thaleichthys)	17	3.7	3.9
night smelt (Spirinchus starksi)	11	2.4	9.1
coho salmon (Oncorhynchus kisutch)	9	2.0	10.4
eulachon (Thaleichthys pacificus)	8	1.7	2.6
Pacific herring (Clupea harengus)	7	1.5	9.1
rockfish juveniles (Sebastes spp)	7	1.5	6.5
unidentified fish	7	1.5	7.8
Pacific sandlance (Ammodytes hexapturus)	3	0.7	2.6
chinook salmon (Oncorhynchus tshawytscha)	2	0.4	2.6
market squid (Loligo opalescens)	2	0.4	2.6
Pacific lamprey (Lampetra tridentata)	1	0.2	1.3
topsmelt (Atherinops affinis)	1	0.2	1.3
TOTAL	461		

Thirteen species of fish and the market squid (Loligo opalescens) constituted the diets of murres collected during this study. Numerically, the most important prey species was the northern anchovy (Engraulis mordax), which composed 46.7% of all the prey consumed and were found in 57 (74.0%) of the stomachs examined. The Pacific tomcod (Microgadus proximus) was also an important part of the diet, representing 29.5% of the prey consumed and present in 34 (44.2%) of the stomachs examined. Juvenile coho salmon represent 2.0% of the prey consumed, and were found in 8 (10.4%) of the stomachs examined. The presence of juvenile coho salmon was documented by the identification of partially eroded otoliths found only in the gizzard portion of 8 stomachs examined.

DISCUSSION

The calculation of a mean daily abundance estimate for Sooty Shearwaters that could be applied to the entire study period would be inappropriate, because the day to day abundance of shearwaters was highly variable.

The results can, however, be applied to a determination of daily Common Murre abundance for May and June, 1982. Common Murre abundance in a 125 km^2 area offshore of the Columbia River is estimated to be 6,374 birds, during flood tides. This calculation is based on a mean density of 51 birds/km^2. In the river channel where the mean density equalled 24 birds/km^2, murre abundance in a 7 km^2 area (1 km wide strip extending between navigation buoys No. 14 and No. 7) is estimated to be 168 birds.

These abundance estimates can in turn provide a basis for estimating the overall number of murres that daily frequent the waters of the Columbia River plume, if one knows how rapidly murre numbers turnover during the day. During the breeding season, April through July, large numbers of Common Murres are flying to and from colony

sites and feeding areas. By monitoring the number of murres on the water in a feeding area, and the number flying to and from the area, an estimate of the turnover rate in murre numbers can be calculated. This turnover rate can then be multiplied times the mean daily abundance estimate for the area to obtain an estimate of Common Murre total daily abundance. Information about murre movements in and out of feeding areas off Coos Bay and Newport, Oregon indicates that the turnover in murre numbers in these areas is accomplished in every 4-6 hours; i.e., during the breeding season murre numbers in these two feeding areas turnover about 3 times a day (Varoujean, unpublished data). If this turnover rate is applied to the abundance estimates for the Columbia River during flood tides, approximately 19,500 (3 x 6,543) Common Murres a day were feeding in the study area during May and June, 1982.

Three important assumptions are made when applying the Common Murre turnover rate of 3 times/day to the determination of total daily abundance in the Columbia River study area. First, it is assumed that Common Murres from breeding colonies were foraging off the Columbia River. This is a relatively sound assumption, since 77% of the murres collected during the study were breeding birds.

The second assumption is that a relatively large number of breeding Common Murres were within foraging distance of the Columbia River. The census results of a 1979 Oregon seabird colony survey by Varoujean and Pitman (1980) showed that approximately 15,600 Common Murres were on breeding colonies between Tillamook Head and Cape Falcon, from 35 km to 55 km south of the Columbia River, and an additional 80,000 murres were on or near Three Arch Rocks, about 80 km south. Potentially then, the Columbia River is within the foraging range of 95,600 murres. This conclusion is based on observations off of Coos Bay which indicate that murres, in search of food along the coast, range as far as 150 km from their colony sites (Varoujean, unpublished data).

Third, by using mean abundance estimates during flood tides as a mean daily abundance estimate for murres in the Columbia River study area, it is assumed that murre abundance during ebb tides is the same as it is during the flood. But murre abundance may be higher in feeding areas during ebb tides (Slater, 1976; and Varoujean, unpublished data). Consequently, 19,500 birds may be an underestimate of the total daily abundance of Common Murres in the Columbia River study area.

What impact could Common Murre predation have on juvenile coho salmon, given a total daily abundance of 19,500 murres? Evidence of 9 juvenile coho salmon was found after 77 murre stomachs were examined. Applying this ratio to the abundance estimate of 19,500 birds, murres may have consumed approximately 2,300 juvenile coho salmon a day in the study area. This means Common Murres could have consumed 138,000 juvenile coho in a 60 day period extending through May and June.

Three important factors pertaining to our sampling regime may have influenced the estimate of juvenile coho salmon consumption by murres. First, as already mentioned, the daily abundance of Common Murres may be an underestimate, this would in turn result in an underestimate of the impact of murre predation on juvenile coho salmon.

A second factor is that in 8 Common Murres we found partially eroded coho salmon otoliths in only the gizzard portion of the stomach. This indicates that these juvenile salmon were consumed 4-6 hours before the murres were collected (Varoujean, unpublished data). In other words, murres were actually feeding on juvenile coho salmon when we were not out sampling, i.e. during the ebb flow of the tide.

Third, our sampling began on 24 May, about the time (21-27 May) that purse seine catches of juvenile coho salmon reached a maximum 75 km up river at Jones

Beach (Dawley, 1982). Juvenile coho salmon may remain in the Columbia River estuary after reaching Jones Beach for as few as 3 days (Dawley, et al., 1981, p. 26). Therefore, there is the possibility that by the time we began sampling a substantial portion of the juvenile coho salmon population had already dispersed offshore.

Biases associated with our sampling regime aside, the estimated number of juvenile coho salmon consumed by murres in May-June, 1982 is small as compared to the nearly 30 million coho juveniles that were released into the Columbia River in Spring 1982. This could be explained in the following way. Off the Columbia River, sea surface temperatures within 46 km of shore were substantially colder during the 1982 study period than in May and June of the previous 3 years (Fisher, et al., 1983; and Pearcy, personal communication). Moreover, the catches of juvenile coho salmon offshore of the Columbia River in May and June were smaller in 1981 than in 1982 (calculated from data in Wakefield, et al., 1981; and Fisher, et al., 1983). We suggest that the smaller catches in 1982 may be the result of juvenile coho salmon dispersing rapidly over a wide expanse of cold, upwelled water. If this is the case, then the availability of juvenile coho salmon to Common Murres, and presumably other seabird species, may have been reduced.

RECOMMENDATIONS

Based on our findings, several recommendations can be formulated pertaining to the course of future research.

1. Research on the abundance, distribution and feeding habits of seabirds off the Columbia River should be continued. The sampling regime and oceanographic conditions in May-June, 1982 may have led to an underestimate of the potential magnitude of juvenile coho salmon consumption by seabirds, principally the Common Murre.

2. Continued research should include the sampling of seabirds while juvenile coho salmon are emanating from the Columbia River during a period of weak upwelling.

3. Furthermore, the censusing and collection of seabirds should begin in early May, and the sampling regime should include the censusing and collection of seabirds during both the ebb and flood stages of the tidal cycle.

4. Research that incorporates the above recommendations will lead to a better understanding of the relationship between natural predation and the survival of coho salmon.

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APPENDIX A

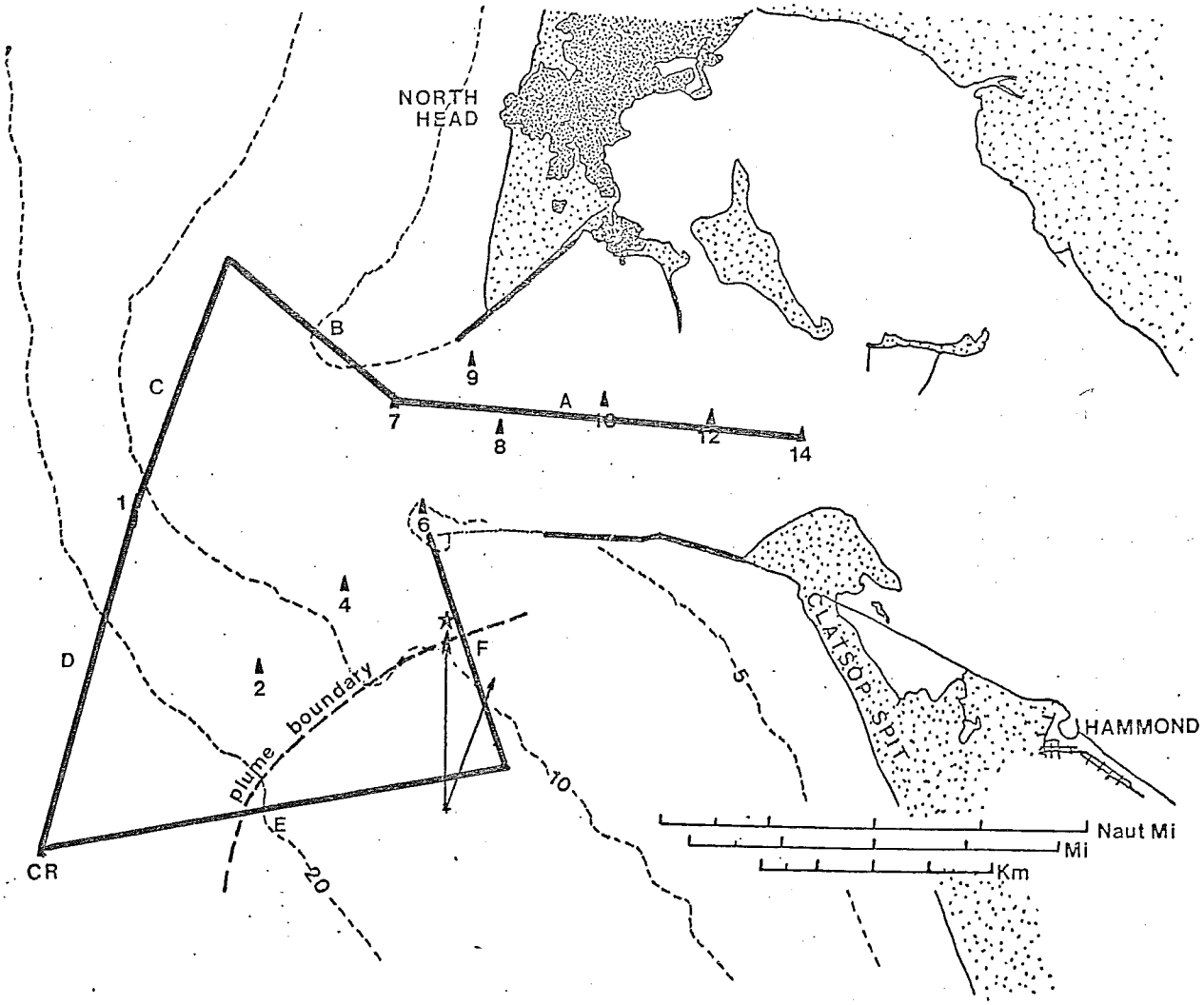

Figure A-1. Transect locations in and offshore of the Columbia River, 24 May, 1982. Sampling began at 1105 hrs (Transect A) and ended at 1445 hrs (Transect F). Depth contours are in fathoms (fathom = 1.8 meters).

Table A-1. 24 May 1982 census results. Listed are the number and estimated density (in parentheses) of Common Murres and Sooty Shearwaters in the Columbia River study area. Lengths of the transect segments are also listed; all transects were 0.3 km wide.

	TRANSECT SEGMENT						
Species	A 7.0 km	B 3.8 km	C 4.4 km	D 6.4 km	E 8.3 km	F 4.4 km	TOTAL NUMBER
Common Murre	23 (11)	60 (53)	36 (27)	60 (31)	633 (254)	63 (48)	875
Sooty Shearwater	0	0	0	0	0	0	0

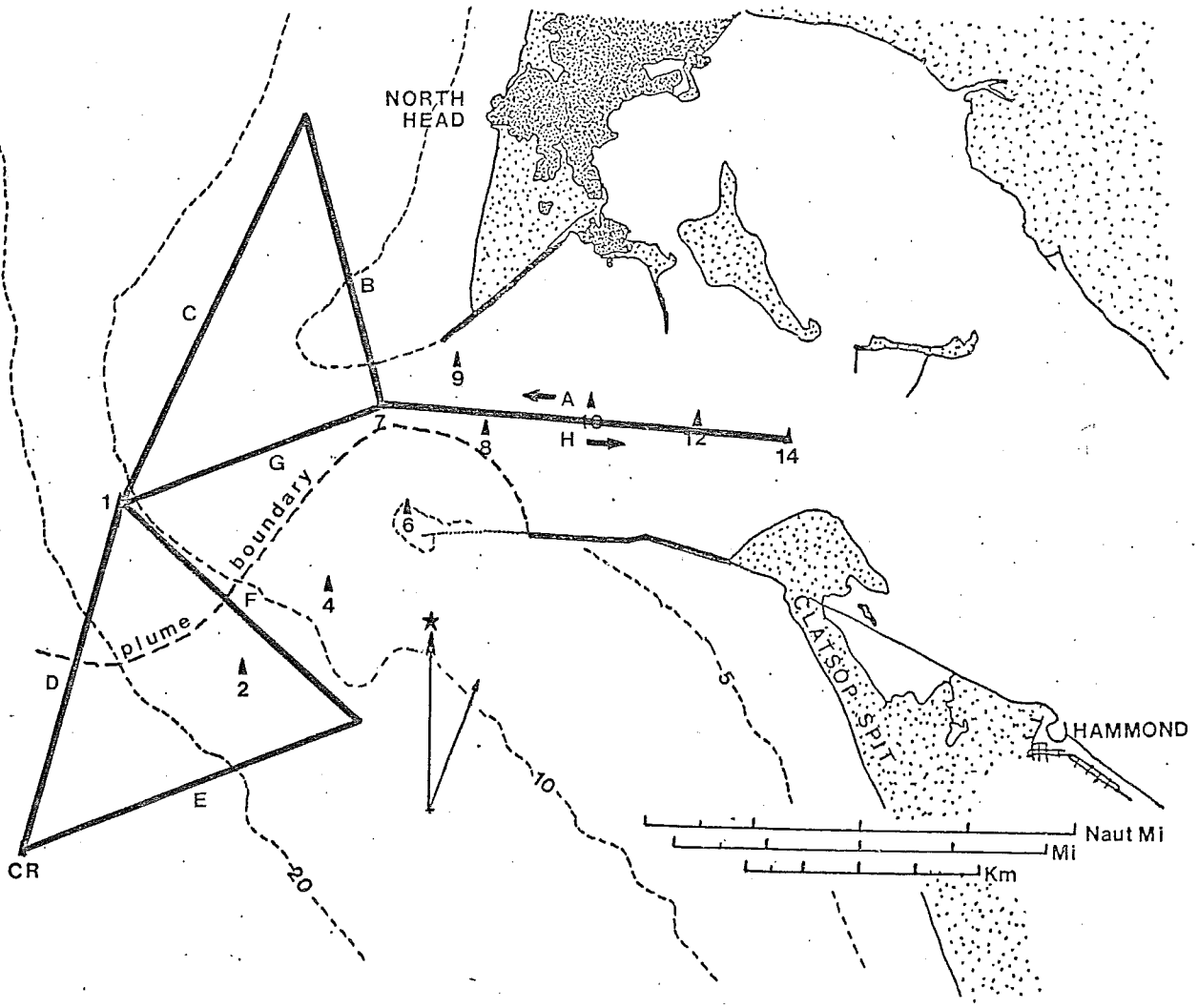

Figure A-2. Transect locations in and offshore of the Columbia River, 3 June, 1982. Sampling began at 0655 hrs (Transect A) and ended at 1010 hrs (Transect H). Depth contours are in fathoms (fathom = 1.8 meters).

Table A-2. 3 June 1982 census results. Listed are the number and estimated density (in parentheses) of Common Murres and Sooty Shearwaters in the Columbia River study area. Lengths of the transect segments are also listed; all transects were 0.3 km wide.

	TRANSECT SEGMENT							
Species	A 7.0 km	B 5.2 km	C 7.4 km	D 6.4 km	E 6.3 km	F 5.6 km	G 4.8 km	TOTAL NUMBER
Common Murre	19 (9)	23 (15)	81 (37)	34 (18)	23 (12)	23 (14)	11 (8)	214
Sooty Shearwater	0	0	1 (<1)	1 (<1)	0	0	0	2

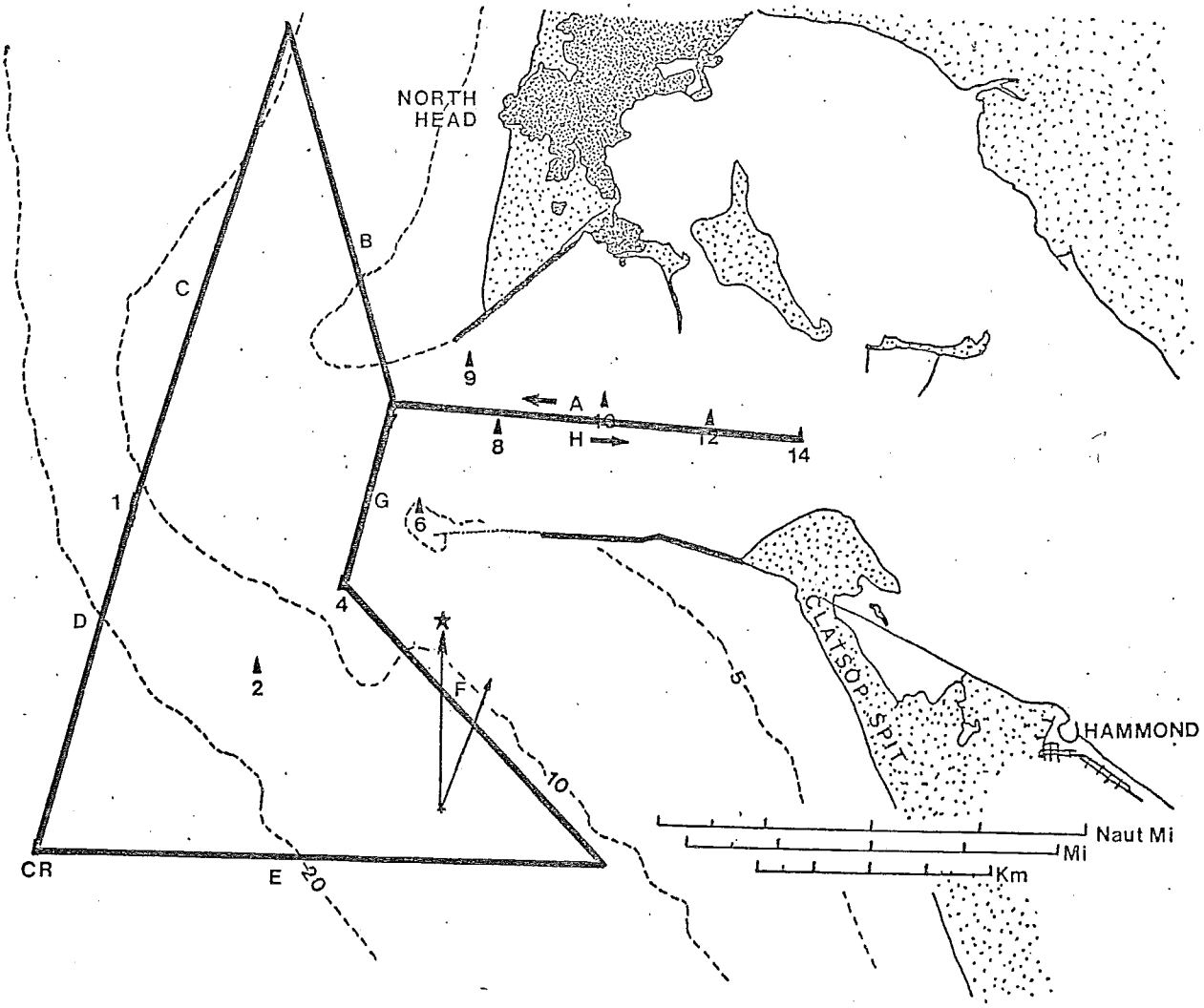

Figure A-3. Transect locations in and offshore of the Columbia River, 4 June, 1982. Sampling began at 0735 hrs (Transect A) and ended at 1025 hrs (Transect H). Depth contours are in fathoms (fathom = 1.8 meters).

Table A-3. 4 June 1982 census results. Listed are the number and estimated density (in parentheses) of Common Murres and Sooty Shearwaters in the Columbia River study area. Lengths of the transect segments are also listed; all transects were 0.3 km wide.

	TRANSECT SEGMENT								
Species	A 7.0 km	B 6.8 km	C 8.7 km	D 6.4 km	E 10.0 km	F 6.7 km	G 3.4 km	H 7.0 km	TOTAL NUMBER
Common Murre	16 (8)	91 (45)	136 (52)	37 (19)	265 (88)	17 (9)	113 (111)	213 (101)	888
Sooty Shearwater	0	0	0	0	0	0	0	0	0

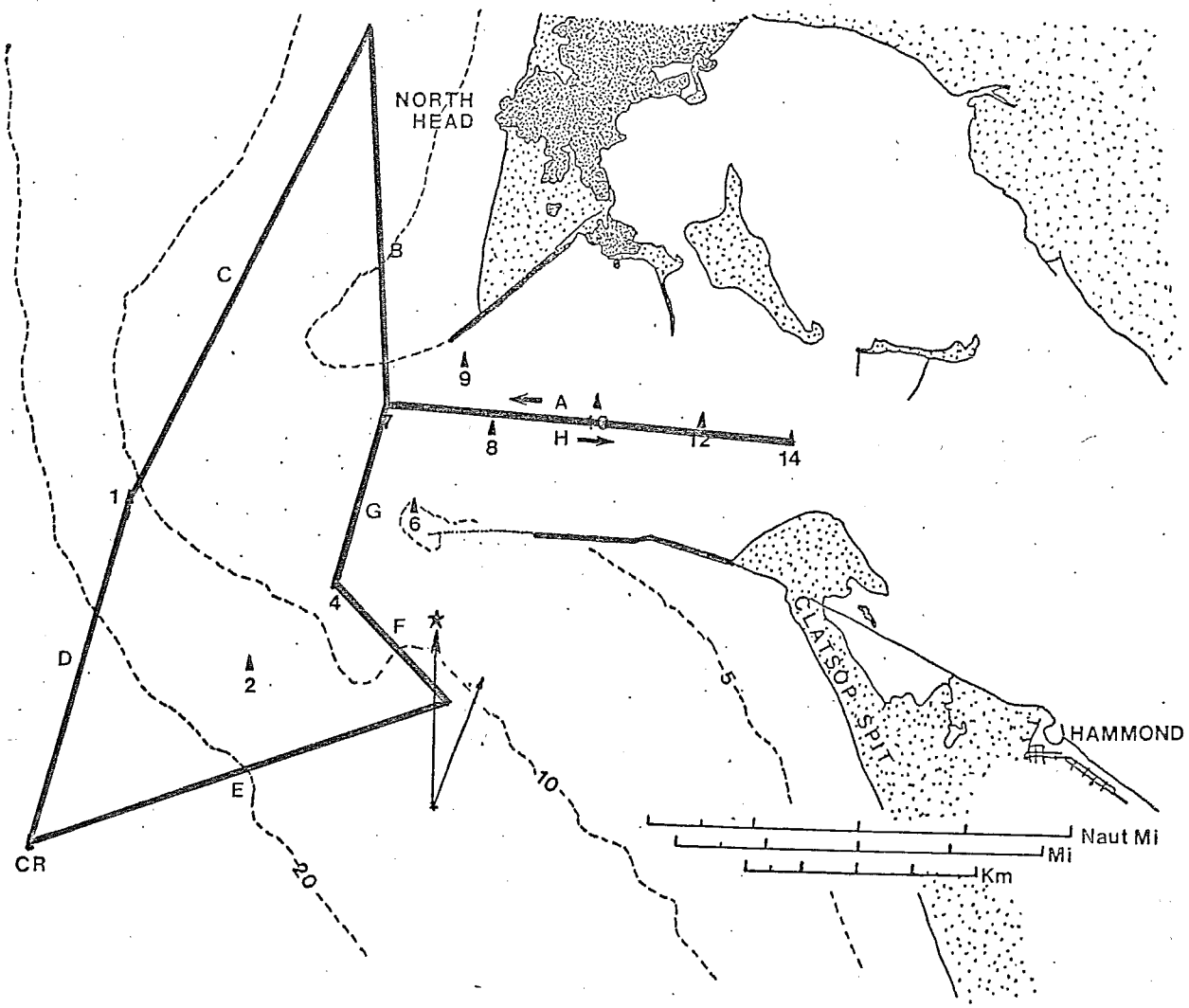

Figure A-4. Transect locations in and offshore of the Columbia River, 10 June, 1982. Sampling began at 1140 hrs (Transect A) and ended at 1452 hrs (Transect H). Depth contours are in fathoms (fathom = 1.8 meters).

Table A-4. 10 June 1982 census results. Listed are the number and estimated density (in parentheses) of Common Murres and Sooty Shearwaters in the Columbia River study area. Lengths of the transect segments are also listed; all transects were 0.3 km wide.

	TRANSECT SEGMENT								
Species	A 7.0 km	B 6.5 km	C 9.2 km	D 6.4 km	E 7.8 km	F 2.8 km	G 3.4 km	H 7.0 km	TOTAL NUMBER
Common Murre	3 (1)	10 (5)	13 (5)	28 (15)	60 (26)	64 (76)	303 (297)	17 (8)	498
Sooty Shearwater	300 (143)	350 (180)	390 (141)	0	0	140 (166)	45 (44)	0	1225

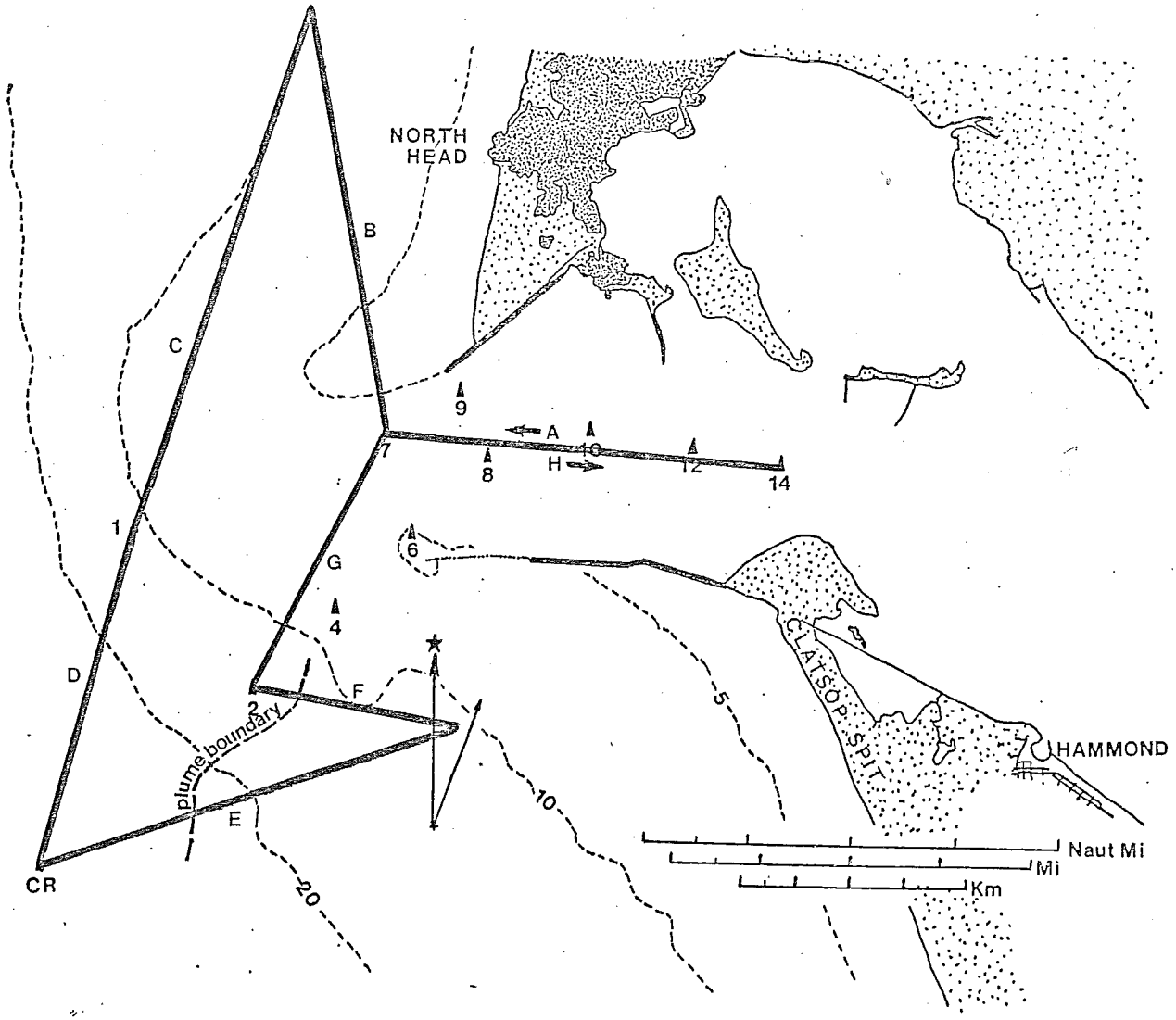

Figure A-5. Transect locations in and offshore of the Columbia River, 11 June, 1982. Sampling began at 1145 hrs (Transect A) and ended at 1441 hrs (Transect H). Depth contours are in fathoms (fathom = 1.8 meters).

Table A-5. 11 June 1982 census results. Listed are the number and estimated density (in parentheses) of Common Murres and Sooty Shearwaters in the Columbia River study area. Lengths of the transect segments are also listed; all transects were 0.3 km wide.

	TRANSECT SEGMENT								
Species	A 7.0 km	B 7.6 km	C 9.9 cm	D 6.4 km	E 7.8 km	F 3.6 km	G 5.2 km	H 7.0 km	TOTAL NUMBER
Common Murre	71 (34)	211 (93)	133 (45)	79 (41)	259 (111)	12 (11)	57 (37)	135 (64)	957
Sooty Shearwater	10 (5)	440 (193)	115 (39)	55 (29)	10 (4)	0	0	0	630

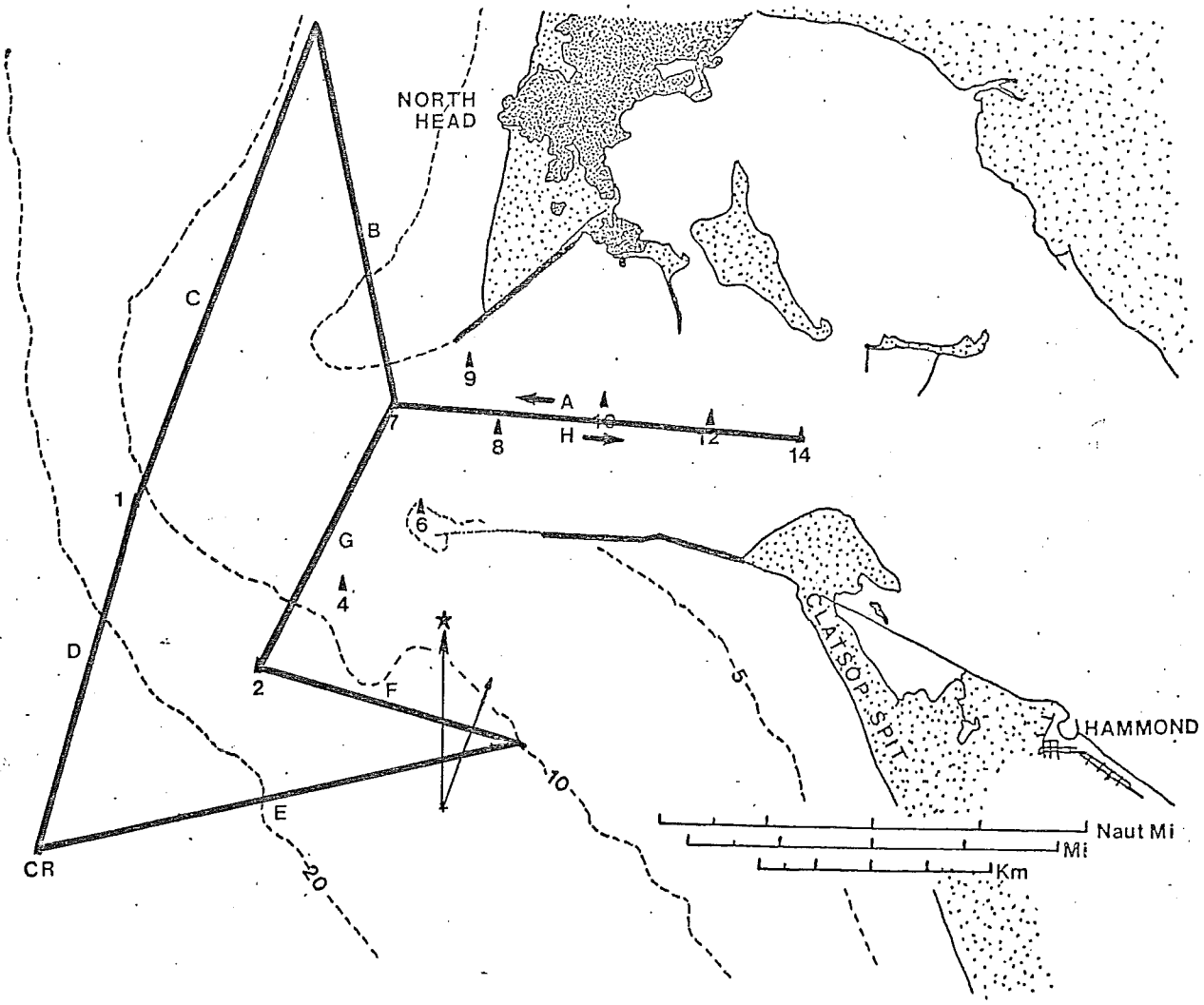

Figure A-6. Transect locations in and offshore of the Columbia River, 22 June, 1982. Sampling began at 0923 hrs (Transect A) and ended at 1350 hrs (Transect H). Depth contours are in fathoms (fathom = 1.8 meters).

Table A-6. 22 June 1982 census results. Listed are the number and estimated density (in parentheses) of Common Murres and Sooty Shearwaters in the Columbia River study area. Lengths of the transect segments are also listed; all transects were 0.3 km wide.

	TRANSECT SEGMENT								
Species	A 7.0 km	B 6.7 km	C 8.9 km	D 6.4 km	E 8.6 km	F 4.8 km	G 5.2 km	H 7.0 km	TOTAL NUMBER
Common Murre	1 (1)	12 (6)	14 (5)	0	53 (21)	245 (170)	20 (13)	15 (7)	360
Sooty Shearwater	0	0	0	0	0	40 (28)	0	0	40

APPENDIX B

Table B-1. Common Murres collected in and offshore of the Columbia River in 1982. For location of transect segments refer to figures in Appendix A. Depths are in meters (m); weights are in grams (g). Sex: F = female; M = male; * = specimen categorized as a breeding bird. + = birds collected outside off Columbia River plume.

Date	Specimen No.	Time	Transect Segment	Depth (m)	Sex	Body Wt. (g)	Stomach Contents (g)
24 May	DRM 077	1120	B	11	F*	1100	45
	078	1130	B	9	F	940	1
	079	1130	B	9	M*	1061	45
	080	1205	C	14	M*	1100	11
	081	1210	C	17	F*	1027	12
	082	1220	C	23	F*	1105	63
	083	1230	D	32	M*	1081	12
	084	1234	D	32	F*	1082	74
	085	1235	D	32	M	1021	64
	086	1249	D	61	F*	1122	40
	087	1300	E	60	M*	1119	1
	088	1300	E	60	F*	1037	60
	089	1325	E	43	M	1092	9
	090	1325	E	43	M	969	1
	091	1325	E+	43	M*	1193	45
	092	1340	E+	40	M*	969	10
	093	1340	E+	40	M*	948	7
	094	1355	E+	39	M*	1055	71
	095	1355	E+	39	F*	1019	57
	096	1355	E+	39	M*	1092	42
3 June	DRM 108	0820	E+	48	F*	1139	4
	109	0830	E+	41	F*	1015	12
	110	0840	E+	36	M*	1018	2
	111	0840	E+	36	M*	868	2
	112	0850	E+	28	M*	1064	26
	113	0850	E+	28	F*	1010	17
	114	0920	G	20	F*	1036	14
	115	0930	G	17	M*	975	3
	116	0940	G	14	M*	975	1
	117	1000	H	20	F	814	6
	118	1005	H	18	F*	1119	35
	119	1005	H	18	M*	1046	12
	120	1005	H	18	M*	1096	5
4 June	DRM 121	0750	A	20	M*	1024	79
	122	0800	A	13	M*	962	9
	123	0800	A	13	M*	1010	9
	124	0815	B	18	F*	924	4
	125	0825	B	20	M*	1016	15
	126	0825	B	20	M*	1112	22
	127	0850	D	26	F*	969	54
	128	0915	E	50	F*	966	28
	129	0930	E	35	F	864	1
	130	0930	E	35	F	926	0
	131	1000	G	18	M*	971	41
	132	1010	H	21	M	929	6

Table B-1 Continued.

Date	Specimen No.	Time	Transect Segment	Depth (m)	Sex	Body Wt. (g)	Stomach Contents (g)
10 June	DRM 133	1250	E	31	M	1070	12
	134	1250	E	31	M*	1127	28
	135	1305	E	60	F*	1024	8
	136	1330	F	36	F*	1024	13
	137	1335	F	30	F*	1049	15
	138	1350	F	20	F	1016	2
	139	1400	G	22	F	913	1
	140	1400	G	22	M*	969	33
	141	1425	G	17	F	978	0
	142	1425	G	17	F*	1114	103
	143	1425	G	17	F	--	84
	144	1425	G	17	M	999	54
11 June	DRM 145	1205	A	12	F*	879	28
	146	1210	A	8	F*	1018	30
	147	1210	A	8	M*	1022	27
	148	1245	C	18	F*	1013	16
	149	1300	C	18	M*	1027	12
	150	1315	D	52	M*	1008	5
	151	1325	E	65	F*	986	15
	152	1325	E	65	F	1008	5
	153	1345	E+	39	M*	1059	2
	154	1415	G	27	F*	1102	54
	155	1430	H	18	M*	1002	24
22 June	DRM 180	1005	C	18	F	1022	74
	181	1055	E	65	F*	1017	85
	182	1110	E	50	M	866	30
	183	1120	E	36	F*	967	70
	184	1140	E	20	F*	1033	83
	185	1140	E	20	F	1021	35
	186	1245	F	39	M*	1116	86
	187	1245	F	39	F*	1056	76
	188	1245	F	39	F*	968	52

Table B-2. Prey items of Common Murres collected in and offshore of the Columbia River estuary. The number and species of prey items were determined by an analysis of fish and squid remains (primarily otoliths and squid beaks) and whole fish removed from the stomach of collected birds. The contents of the anterior (proventriculus) and posterior (gizzard) portion of the stomach are listed separately.

		PROVENTRICULUS									GIZZARD										
DATE	SPECIMEN	Pacific lamprey	Pacific herring	northern anchovy	eulachon	whitebait smelt	night smelt	longfin smelt	Pacific tomcod	market squid	Pacific herring	northern anchovy	chinook salmon (smolt)	coho salmon (smolt)	eulachon	whitebait smelt	night smelt	longfin smelt	Pacific tomcod	topsmelt	rockfish (juv.)	Pacific sandlance	unidentified fish	market squid
24 May DRM	077			3								3			4									
	078		3									7				1			1					
	079											4	1										1	
	080		1									5												
	081											1									3			
	082		1									2			1	2								
	083																							
	084		2									6				1				1				
	085		1									3				1			2					
	086		4									10				1	1							
	087		1									6												
	088								3										6					
	089											1												
	090																		7					
	091		1									5				2			1					
	092											1				7								
	093											4		1		1								
	094		1									7												
	095										1	2							1					
	096											3												
3 June DRM	108													2			2		12					
	109											1												
	110											1							1					
	111																		7					
	112																1							
	113										1					3			4					
	114															1			2					
	115																		6					
	116																							
	117										1											2		
	118											4												
	119											2	1			1				1				
	120											2							1					

Table B-2 Continued.

DATE	SPECIMEN	PROVENTRICULUS										GIZZARD											
		Pacific lamprey	Pacific herring	northern anchovy	eulachon	whitebait smelt	night smelt	longfin smelt	Pacific tomcod	market squid		Pacific herring	northern anchovy	chinook salmon (smolt)	coho salmon (smolt)	eulachon	whitebait smelt	night smelt	longfin smelt	Pacific tomcod	topsmelt	rockfish (juv.)	Pacific sandlance	unidentified fish	market squid
4 June DRM	121			2								3													
	122											1					2			1					
	123											4								1					
	124											5			1									1	
	125											2								1					
	126											5			1					1					
	127			3								6													
	128	1																							
	129											2								13				1	
	130																								
	131																			1					
	132											1													
10 June DRM	133											1													
	134											2		1										1	
	135								3											20					
	136								1			3						3		1					
	137		1								1	1				1								2	
	138											1												1	
	139																								
	140				1							1							12	1					
	141																								
	142								3			1				2				1					
	143	1	1						1			1				4				1					
	144	1			1																				
11 June DRM	145		2									6		1											
	146											4													
	147											1													
	148											4		1											
	149											3													
	150																			16					
	151											1								1					
	152											1								3					
	153																			5					
	154								1	1		1													
	155											1								1					
22 June DRM	180		3									3													
	181						3					4				2		1	1	1					
	182											5					1				1				
	183		4									3								1					
	184		1			1						5				1	1				1				
	185											6		1		1		1	1		1	1			
	186		1								1	2							2						
	187		3									3													
	188		4									2													
TOTAL		1	2	40	3	2	1	3	12	1	5	175	2	9	5	33	10	14	124	1	7	3	7	1	