CONTINUING INVESTIGATIONS OF OLDSQUAWS (CLANGULA HYEMALIS L.) DURING THE MOLT PERIOD IN THE ALASKAN BEAUFORT SEA

by

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INTRODUCTION

Tundra regions along the central Beaufort Sea coast of Alaska have been rapidly developed for oil and gas over the past decade; exploration and drilling in adjacent nearshore waters have recently begun and no doubt will follow a similar pattern of rapid development. Scientific investigations of broad scale biological and physical processes have also been carried out along this portion of the coast of Alaska, and much new information has been reported (OCSEAP 1978, 1979, SAI 1980, Norton and Sackinger 1981). Several reports have documented the importance of Beaufort Sea barrier island-lagoon systems to large numbers of fishes and birds and their invertebrate prey resources (Craig and Haldorson 1981, Johnson and Richardson 1981, Griffiths and Dillinger 1981).

This report presents the results of research conducted in 1980 and 1981; these results supplement information presented by Johnson and Richardson (1981) concerning the oldsquaw duck (*Clangula hyemalis*), one of the dominant and most visible vertebrate species using barrier island-lagoon habitats along the Beaufort coast during the open water period. Some attention also has been given in this report to several other species of marine birds. Prior to the initiation of our 1980 field program, emphasis was placed on studies in and near the Beaufort Lease Sale 71 area, including the area near Harrison Bay. Consequently, investigations that we had proposed to conduct in the Flaxman Island-Leffingwell lagoon region were redirected to Harrison Bay, near the Lease Sale 71 area. Thetis Island was chosen as the focal point for our investigations in 1980 because (1) an all-weather shelter (small cabin) was available on the island, (2) it was in Harrison Bay and close

to Lease Sale 71, (3) it was known (Johnson and Richardson 1981) to support several thousand oldsquaws during the molt period, and (4) because of its presumed isolation from man-made disturbances. This last characteristic was important because of our need to make detailed observations of normal oldsquaw behavior, distribution and movements in a relatively undisturbed barrier island environment.

The major objectives of our field programs were the following:

1) Conduct the fourth (1980) and fifth (1981) annual aerial surveys of molting oldsquaw habitat along 22 coastal transects from the Colville Delta eastward toward the Alaska-Canada border during the peak of the oldsquaw molt period (early August). These surveys provide useful comparative information on the numbers of oldsquaws and other birds using specific coastal locations and habitats over a broad area of the Alaskan Beaufort.

2) Conduct a census of the birds nesting on Thetis Island. On the basis of limited data (Divoky 1978, Johnson and Richardson 1981), Thetis Island has been classified as one of the three or four most productive bird nesting islands along the Alaskan Beaufort coast. Since this island lies close to the Lease Sale 71 area, it was important to conduct another census of the island during 1980.

3) Collect and prepare a series of reference specimens of male oldsquaws during the peak of their molt period. Few museums in North America have specimens of oldsquaws during summer molt plumage. This material provides important documentation of the timing of flightlessness and condition of the birds during the molt period in this part of Alaska.

4) Initiate a study of habitat use and behavior of oldsquaws during their molt period. Several important questions concerning oldsquaws remained unanswered throughout our work with this species in Simpson Lagoon (Johnson and Richardson 1981). Of particular concern were questions relating to the normal patterns of distribution and abundance during the period of molt when they are flightless and therefore thought to be most vulnerable to disturbance and to water borne contaminants. Until presently, it has been unknown whether the large concentrations of flightless male oldsquaws, documented to occur in the barrier island-lagoon complexes (Spindler 1979, Johnson and Richardson 1981), move from one lagoon to the next during the molt period (i.e., whether there is a turnover of birds within a concentration or flock at a particular location) or whether the birds are relatively sedentary and do not make use of adjacent lagoons for feeding, resting, etc. during the molt period. An understanding of the patterns of oldsquaw behavior and habitat use is important to ensure their proper management. These important questions relate directly to the fate of oldsquaws as various barrier island-lagoon habitats are altered during industrial development.

STUDY AREA

Thetis Island (70"33'N, 150°10'W; Figure 1) is the most westerly of the Jones Island group and is the only barrier island in Harrison Bay. It lies about 14 km N 01' the Colville River delta, and about 7 km W of Simpson Lagoon. The island is approximately 5 km long by 0.5 km wide and is comprised almost exclusively of sand and gravel, however, there are patches of *Puccinellia* sp., and sparse clumps of *Arenaria* sp. and *Mertensia* sp. at several locations on the islands. It lies downstream of the E to W nearshore flow of marine and brackish water that moves through Simpson Lagoon; it is oriented in a SE to NW direction, perpendicular to prevailing northeasterly winds.

Driftwood from both the Mackenzie River in Canada and from the nearby Colville River is littered across much of the approximately 3 km^2 surface of the island. One particularly large accumulation of driftwood at the center of the island supports a dense concentration of nesting common eiders (*Somateria mollissima v-nigra*). About 4-8 pairs of brant (*Branta bernicla nigricans*) nest and rear their broods in association with the sparse growth of *Puccinellia* sp., and 8-10 pairs of glaucous gulls (*Larus hyperboreus*) and 3-6 pairs of arctic terns (*Sterna paradisaea*) nest along the length of the island. Thetis Island supports several hundred pre-migratory staging juvenile red and northern phalaropes (*Phalaropus fulicarius* and *Lobipes lobatus*, respectively) during August and also provides shelter for thousands of oldsquaws during mid-July to mid-August, the male molt period.

Flocks of oldsquaws are normally distributed along the leeward (SW) side of the island; most birds are concentrated in the embayments

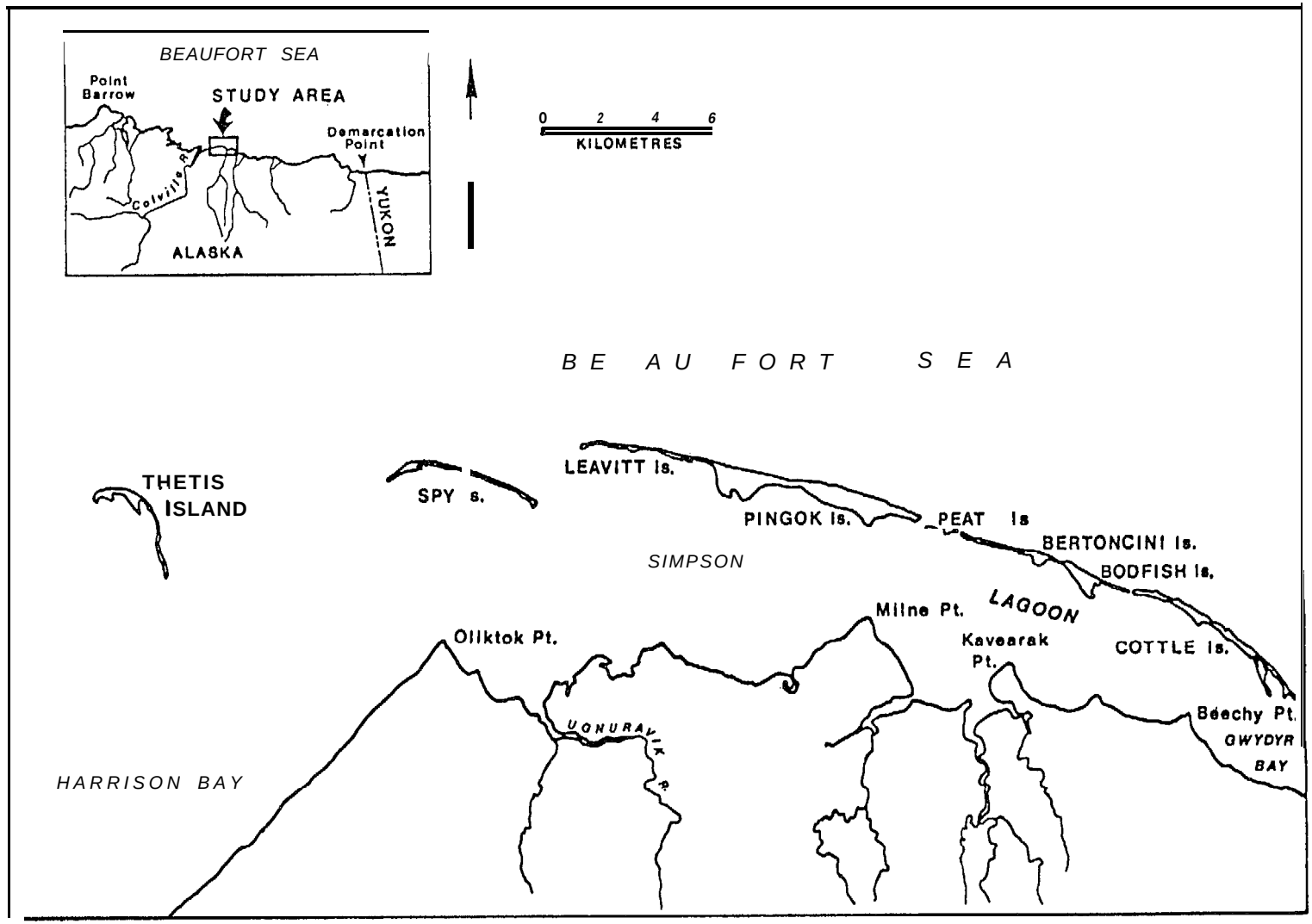


Figure 1. Location of Thetis Island, Alaska.

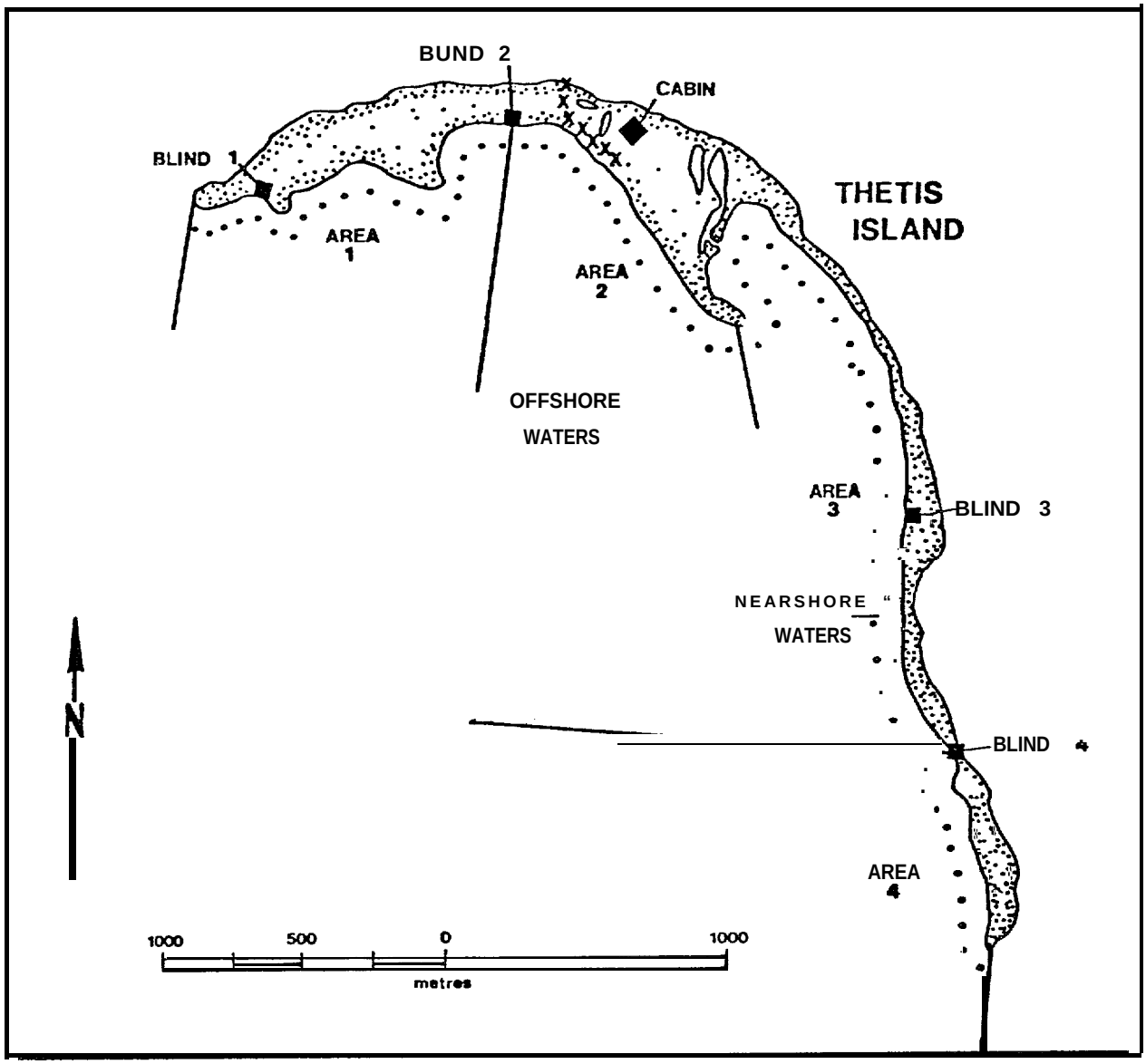


Figure 2. Thetis Island, Alaska, with locations of observation blinds and subdivision of the leeward waters. Nearshore waters were <100 m from the shoreline. X's denote an area of driftwood very important to nesting birds.

at the NW end (Area 2) and along the southern end of the island in Area 4. Figure 2 shows our subdivisions of the leeward waters and the locations of our four observation blinds used in 1980.

METHODS

Aerial Surveys

Aerial surveys were conducted on 2 August 1980 and 1981, using identical procedures and along identical routes described by Johnson and Richardson (1981) for aerial surveys conducted in 1978 and 1979. During 1980, transects 15 and 16 and small portions of transects 14 and 17 were not surveyed because of dense fog and poor visibility encountered near the west end of Arey Island. The area east of Arey Island, as far as the Alaska-Canada border was surveyed by USFWS personnel on 1-3 August 1980 (Spindler 1981). The 1981 aerial surveys included the Beaufort coast from Atigaru Pt. in the west to Brownlow Pt. in the east.

Nesting Bird Census

The census of birds nesting on Thetis Island generally followed procedures used by us in 1978 (see Johnson and Richardson 1981). On 21 July 1980, four individuals slowly walked from NW to SE along the island, recording all potentially nesting birds, all nest scrapes, all active (eggs present} nests and all apparently destroyed nests. Clutch sizes were recorded only if the nest was unattended. The approximate location of each nest or concentration of nests was sketched on a map and obvious habitat relationships were recorded (nest near driftwood, old oil drums, etc.). Special care was taken not to flush female common eiders from their nests.

Oldsquaw Collections

Oldsquaws were collected near Thetis Island between 27 July and 9 August 1980. One bird was salvaged from a gill net set about 600 m SE of the cabin on Thetis Island, and a small sample were collected while feeding among ice chunks (brash) 75 m N of the cabin and the rest were collected from flocks of molting males concentrated along the south end of the island. Birds collected along the south end were approached from a speeding boat and were shot as they moved from loafing areas on and near the leeward beach. Aside from the birds collected while feeding among brash N of the island, no attempt was made to determine if birds were feeding prior to their collection. However, stomachs (and gonads) of all birds were inspected and preserved for later analysis.

Oldsquaw Behavior

Four burlap observation blinds were erected at locations (see Figure 2) where major concentrations of oldsquaws were observed during the nesting bird census on 21 July. Each blind was 4-sided with no roof and was "slit on each side for placement of a variable power (20-45x) spotting scope. Blinds of this type were not weatherproof and were used until 27 July when below freezing and wet weather forced us to use a weather-proof tent. The tent limited our visibility to 180° (leeward direction only) and was used continuously until our intensive observations terminated on 5 August.

Continuous but preliminary observations of flocks of oldsquaws were initiated at 2200 ADT on 21 July 1980 at Blind 4, near the south end of Thetis Island. These preliminary observations were discontinued after

48 h in order for the three observers to discuss problems and to standardize observation and recording procedures. Continuous observations were reinitiated at Blind 4 at 2200 ADT on 24 July and continued there for another 48 h after which all observations were made from Blind 2 (see Figure 2).

The four prescribed areas of observation are shown on Figure 2. Some important initial observations of oldsquaw movements were made from Blind 4, but the majority of all the intensive observations were of Areas 2 and 1 from Blind 2. The largest concentration of oldsquaws near the north end of the island was in Area 2 and that portion of Area 1 in the bay adjacent to Blind 2. Most of our observations and almost all of our results relate to our intensive observations made in these two areas from 2200 h on 26 July (hour 120 of the study) to 2200 h on 5 August (hour 360 of the study).

Each of the 4 areas were further subdivided into 4 habitats: beach, interface, nearshore and offshore. Beach habitat included the area above waterline to the limits of the area washed by storm surfs. The beach slope extended about 10 m from the water line at high tide and about 12 mfrom the water line at low tide.

Interface habitat consisted of an area that extended approximately 0.15 m (6″) either side of the waterline. This habitat initially was thought to be important because birds often stopped at the interface when leaving or entering the water. We later pooled birds in interface habitat with those in beach habitat: all analyses of birds using beach habitat include those in interface habitat.

Nearshore habitat includes the area from waterline out to 100 m. The limits of this area were standardized by using local landmarks, but along portions of the area it was necessary to estimate the 100 m distance.

Offshore habitats were those greater than 100 m from shore. Birds often moved beyond the limits of visibility in this habitat, depending on the presence of fog, rough water, disturbances or other factors.

A typical day of observations involved three individuals, each conducting hourly counts and classifications during one of the following three periods: 2201-0600, 0601-1400, 1401-2200. At the beginning of each hour, a census was conducted of all birds within each habitat in a prescribed area. The behavior of oldsquaws was recorded in each habitat. If the total number of birds present in beach or nearshore habitats did not exceed approximately 150 birds, the behavior of each bird was recorded; if the total number exceeded 150 birds, the behavior of 5 subsamples of 25-30 birds each was recorded. In offshore habitats, behavior was based on observations of 25-30 individual oldsquaws. We seldom observed birds longer than 30 seconds before assigning a behavior code. Birds that were diving were considered to be feeding. Those floating idly on the water, those sitting or standing on the beach or those apparently sleeping were considered to be resting. Birds making deliberate directional movements either in the water or on the beach were considered to be traveling or moving and birds manipulating or cleaning their plumage or bathing were considered to be preening. All disturbances that were natural (predators, autopanics) and man-caused (aircraft, boat, human presence) were recorded when they occurred; the reactions of oldsquaws to these disturbances *were* also recorded.

Aside from habitat and behavioral classifications, the distance from the observation blind to the closest bird in a particular habitat was recorded; we used this measurement as a subjective index of the possible effects on the birds of the blind and movements of the observer and spotting scope. As often as possible, observers recorded the total number of females or the proportion of females in each subsample in each habitat.

The total number of oldsquaws present seaward (N) of Thetis Island were counted when it was possible (from Blind 4 only). However, other than during the observations from 21 through 26 July, no systematic information was recorded concerning oldsquaw behavior seaward (N) of Thetis Island.

For seven of the total 19 days of observations on Thetis Island, total counts of oldsquaws visible both seaward and leeward of the island were recorded after morning and evening watch periods (after 0600 h and after 2200 h ADT, respectively). On 10 additional days, only the morning (~0600 h) or the evening (~2200 h) count was conducted.

Prior to their watch, or in the event of a noticeable change in the weather, each observer recorded the ambient temperature, wind direction and speed, percent cloud cover, wave height, precipitation (fog, rain or snow), visibility and percent ice cover seaward (N) and leeward (S) of the island.

On an opportunistic basis throughout the study period, individual feeding oldsquaws were watched and the duration of dives and recovery periods on the surface were recorded in various habitats. Also, in order to more closely examine the relationship between wind direction and speed, wave height and oldsquaw distribution, wind speeds and

directions at 22 locations along both the N and S sides of the island were measured under varying weather conditions. Wind direction was measured with a compass, wind speed (mi/hr) was measured at 2 m and 0.2 m heights above the beach/water interface with a Dwyer hand-held " wind meter; wave height (ft) at the waterline was estimated.

Analysis Procedures

Throughout this report, analysis procedures involved simple parametric and nonparametric statistical comparisons (Siegel 1956, Sokal and Rohlf 1969). Methods and descriptions of the autocorrelation procedures that were used in the analysis of the oldsquaw behavior time series are described in Davis (1973], Kendall (1973), and Miller and Kahn (1962); Sokal and Oden (1978a, b) also give a good discussion of autocorrelation procedures.

RESULTS AND DISCUSSION

Aerial Surveys of Molting Oldsquaws

A total of 42,195 oldsquaws were recorded along 314.4 km^2 of coastal habitat between Atigaru Pt. and Arey Island on 2 August 1980. On 2 August 1981, a total of 16,493 oldsquaws were seen along 256.5 km^2 of coastal habitat between Atigaru Pt. and Brownlow Pt. Areas where major concentrations of oldsquaws were recorded are given in Table 1 and Appendix 1. Appendix 2 gives the total numbers of oldsquaws seen on- and off-transect during the 2 August 1980 and 2 August 1981 aerial surveys.

A summary of results of aerial surveys during the peak of the oldsquaw molt in 1978, 1979, 1980 and 1981 is given in Table 2. During all four years, but especially in 1980 and 1981, the density of oldsquaws in Harrison Bay was one order of magnitude less than in either Simpson Lagoon or in areas east of Simpson Lagoon, and in each year the density of oldsquaws in Simpson Lagoon was higher than in areas east or west of there. Simpson Lagoon, Gwydyr Bay and Leffingwell Lagoon continue to support the largest numbers of molting oldsquaws along the central Alaskan Beaufort coast. Detailed information on the distribution of oldsquaws in Simpson Lagoon on 2 August 1980 and 1981 is given in Appendices 3 and 4. Results of aerial surveys in Simpson Lagoon in 1980 and 1981 were similar to those given by Johnson and Richardson (1981) for the three preceding years (Appendix 3).

The number of birds recorded on- and off-transect on all transects was markedly lower in 1981 than during the preceding years, especially

Table 1. Locations of major oldsquaw concentrations recorded in 1980 and 1981 during the period of summer molt in areas west* and east** of Simpson Lagoon, Alaska.

2 August 1980	# of Oldsquaws
Barrier Island Locations	
S Thetis Island	38830
S of W end of Long Island	4343
S of E end of Long Island	2505
S of Challenge Island	1500
S of W end Flaxman Island	1800
S of E end Flaxman Island	1882
Mid Lagoon Locations	
Canning Lagoon	1070
Prudhoe Bay	997
N Tigvariak Island	1610
Camden Bay	2145
Mainland Shoreline Locations	
W of Anderson Point	2603
E of Konganevik Point	1120
2 August 1981†	
Barrier Island Locations	
S Thetis Island	1482
SE Spy Island	1811
SE Pingok Island	1031
S Jeanette Island	1050
S Flaxman Island	3203

*Surveys W of Simpson Lagoon in 1980 and 1981 extended to Atigaru Pt., on the west side of Harrison Bay.

**Surveys E of Simpson Lagoon in 1980 extended to Arey Island, approximately 30 km W of Kaktovik.

'Surveys E of Simpson Lagoon in 1981 extended beyond the U.S. Canada border, but data in this table are only for coastal habitats as far E as Brownlow Pt.

Table 2. Densities of oldsquaws recorded during the peak of the summer molt in Harrison Bay compared with Simpson Lagoon and areas east of Simpson Lagoon, 1978-1981.

	5-6 August 1978	28 July 1979	2 August 1980	2 August 1981	All Years ($\bar{x} \pm 1$ s.d.)*
Harrison Bay					
km² surveyed	65.5	65.5	65,5	65.5	65.5 ± 0
oldsquaws/km²	27.7	45.1	36.4	12.7	30.5 ± 13.8
Simpson Lagoon					
km² surveyed	39.9	39.9	39.9	39,9	39.9 ± o
oldsquaws/km²	142.6	247.8	355.3	155.8	225.4 ± 98,5
E of Simpson Lagoon					
km² surveyed	315.1	222.3	197*1	151.1	221.4 ± 69.1
oldsquaws/km²	103.7	219,2	142.4	57.2	130.6 ± 68.5

*Unweighed mean for all four years.

in the area E and W of Simpson Lagoon. However, even in Simpson Lagoon the number of birds recorded during 1981 was lower than the preceding two years (1979 and 1980) and only slightly higher than in 1978.

Thetis Island Nest Census

A total of 52 active nests, 181 inactive nests or scrapes and 5 destroyed nests were recorded on Thetis Island during the nest census in 1980 (Table 3). The majority of all nests or scrapes found were of common eiders, with far fewer black brant, glaucous gulls and arctic terns. Thirty-six of the 52 active nests and 124 of the 176 scrapes or inactive nests of common eiders were found on the west half- of the island (N of the cabin), and a significant proportion of the 41 active common eider nests (13 nests; 31%) were found in the dense pile of driftwood immediately W of the cabin (Figure 2).

Very few nests (5) were positively recorded as having been destroyed and the majority (4) of those were nests of common eiders abandoned by incubating females because of disturbance by humans.

The total number of active nests and the number of common eider nests on Thetis Island has remained relatively constant during 1976, 1978 and 1980 (Table 4) and is relatively high compared with the total number nesting on other barrier islands in the Alaskan Beaufort Sea (see OCSEAP 1978). In fact, after Cross and Pole islands, Thetis Island supports the third largest number of nesting common eiders along the Alaskan Beaufort coast.

Table 3. Total number of nests found on Thetis Island, Beaufort Sea, Alaska, during 1980.

	# Active Nests	# Nest Scrapes or Inactive Nests	# Destroyed Nests
Common Eider	41	176	4
Arctic Tern	1	0	0
Glaucous Gull	5	5	1
Black Brant	5	0	0
Total	52	181	5

Table 4. A comparison of the numbers of nests found on Thetis Island, Alaska, in 1976, 1978 and 1980. (Data for 1976 provided by James W. Helmericks.)

	# Active Nests	# Inactive Nests or Nest Scrapes*	# Destroyed Nests
Common Eider			
1976	38		-
1978	34	198	0
1980	41	176	4
Arctic Tern			
1976	1		
1978	2	8	
1980	1	0	
Glaucous Gull			
1976	4	-	-
1978	5	4	0
1980	5	5	1
Black Brant			
1976	3	-	-
1978	9	1	0
1980	5	0	0
Total			
1976	46		
1978	50	211	0
1980	52	181	5

*Nest scrapes are depressions in the sand or gravel and designate an early stage of nest establishment.

Oldsquaw Collections

We collected 26 oldsquaws near Thetis Island between 27 July and 9 August 1980. Nine (8 males; 1 female) were collected on 27 July, 8 (3 males; 5 females) during 3-5 August and 9 (5 males; 4 females) during 7-9 August. Although the main objective in making this collection was to provide documentation of molt classification, other information was recorded also. Whole body weights, length of the right wing and right tarsus, subcutaneous fat thickness and gonad size for the three collection periods are given in Table 5; Appendix 5 gives details for each bird. Even though body weights of males tended to be greatest during the 3-5 August period, they were not significantly different from those during the other two periods. Female oldsquaw body weights remained about the same during the latter two collection periods; only one very light-weight bird was collected during the first period. Lengths of right wings of male oldsquaws tended to increase (regrowth of primaries) throughout the 27 July to 9 August collection period while those of females tended to decrease (loss of primaries); none of these differences were statistically significant ($p > 0.05$). Subcutaneous fat thickness in male oldsquaws tended to be greatest during the mid (3-5 August) period but this tendency was not significantly different from the early or late collection period ($p > 0.05$). In general, too few birds were collected over too short a time period to provide detailed information for comparison of this sample of oldsquaws with much larger samples collected in earlier years (see Johnson and Richardson 1981).

Table 5. Summary of weights and measurements of oldsquaws collected during the peak of the male molt period at Thetis Island, Alaska, 1980.*

	27 July ($\bar{x}$ ± s.d.)	N	3-5 August ($\bar{x}$ ± s.d.)	N	7-9 August ($\bar{x}$ ± s.d.)	N
Weight (gms)						
M	832.9 ± 65.9	8	883.3 ± 60.1	3	843.0 ± 70.9	5
F	590	1	711.0 ± 46.0	5	716.8 ± 60.5	4
Rt. Wing (mm)						
M	127.8 ± 20.5	8	134,7 ± 15.2	3	166.4 ± 34.2	5
F	192	1	181.6 ± 45.5	5	157.5 ± 63.7	4
Rt. Tarsus (mm)						
M	45.3 ± 1.3	7	46, 46	2	42.4 ± 0.5	5
F	43	1	42.4 ± 1.3	5	40.7 ± 1.6	3
Sub Q Fat Thickness (mm)						
M	4.3 ± 1.8	7	4.9 ± 1.3	3	3.6 ± 1.3	5
F	3.5	1	3.5 ± 1.3	5	2.7 ± 1.2	4
Gonads (mm)**						
M Rt.	9.9 ± 1.9 x 4*7 ± 1	7	11.3 ± 1.5x 5.3 ± 0.6	3	10.2 ± 1.9x 3.8 ± 0.6	5
L.	10.1 ± 2.0 x 4.6 ± 1.1	7	13.0 ± 0 x 5.7 ± 0.6	3	10.8 ± 0.4 4.6 ± 2.2	5
F	1.5	1	1.9 ± 0.6	5	2.0 ± 0.1	4

*Appendix Table gives individual weights and measurement of all oldsquaws collected.

**Measurements of testes are length x width; measurements of ova are largest dimension of largest ovum.

Because little time was available to determine if birds were feeding prior to their collection, they were collected arbitrarily and few had significant amounts of food in their stomachs (Appendix 6). The 2 birds observed to be feeding N of Thetis Island prior to their collection on 7 August 1980, had stomachs of fullness 8 and 9 (about half full, see Johnson and Richardson 1981 for procedures). These birds were both males and had consumed relatively large amounts of the amphipod *Apherusa* sp. Another bird with a relatively full stomach was a male collected on 5 August 1980 whose stomach was about half full of a mixture of *Mysis* sp. and *Onisimus* sp.

Mysis relicta and *M. littoralis* and *Onisimus glacialis* were the most common prey consumed by oldsquaws farther east, in Simpson Lagoon (Johnson 1982), similarly *Apherusa* was taken from the stomachs of a small sample of oldsquaws collected while feeding among ice flows north of Pingok Island (~12 km NE of Thetis Island) during August 1978 (Johnson 1978, Griffiths and Craig 1978:53).

Oldsquaw Behavior

Movements

One of the major objectives of this program of near continuous oldsquaw observations was to determine if molting birds move between major molting locations (e.g., move between barrier islands). On two occasions when exceptionally calm weather prevailed (on 23 and 24 July; see Figure 3 and Appendix 7) two groups of oldsquaws were watched with a telescope as they swam eastward from the SE tip of Thetis Island (Area 4) at least 5 km toward 01 iktok Pt. (Figure 1). They were

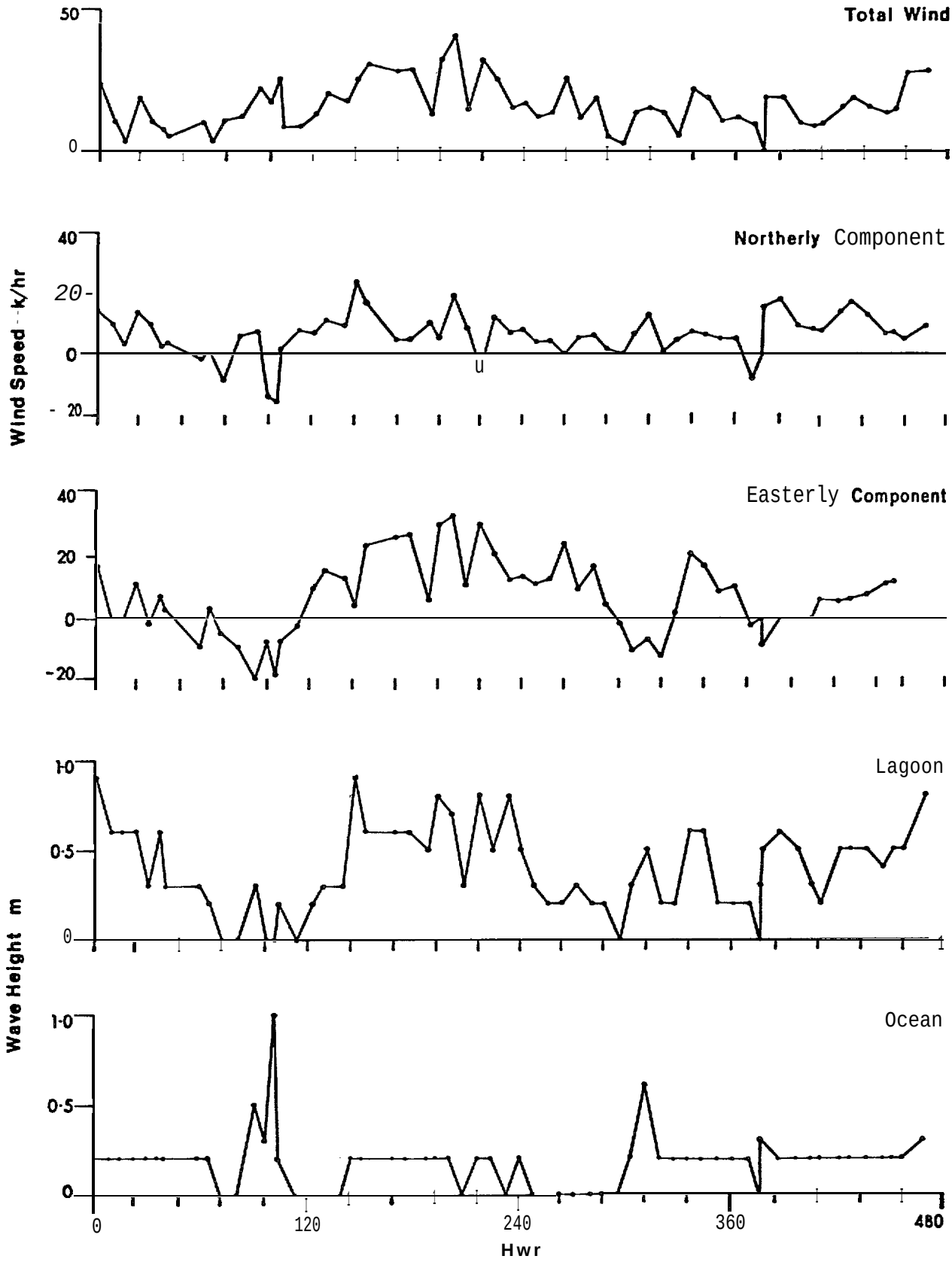


Figure 3. Relationship between wind speed and direction (component) and wave height adjacent to oceanside beaches (generally windward) and lagoonside beaches (generally leeward) along Thetis Island, Alaska.

eventually lost in the surface haze and myriad of other oldsquaws. Oliktok Pt. is also a major molting area for several thousand oldsquaws (Johnson and Richardson 1981 :250). In total, about 800 birds (one group of about 300 and another of about 500) left Thetis Island in these two movements. It is not known whether these birds eventually returned to Area 4 after winds from the NE began again on 25 July.

We recorded no other movements of oldsquaws to other potential molting areas away from Thetis Island. Although Area 2 was monitored nearly continuously from hour 120 of the study through hour 360, dense fog on some occasions made it impossible to watch birds as they moved from beach or nearshore habitats to offshore habitats. Furthermore, without a large sample of marked birds it was uncertain whether the same individuals or the same flocks were under observation in an area from one hour to the next, especially after some birds disappeared into the fog for periods of time.

Daily censuses of birds around Thetis Island at locations away from the area under continuous observation were thought to provide further indication of immigration to or emigration from the general Thetis Island area by oldsquaws, or of major movements of birds from one end of the island to the other. However, because of inconsistencies in our count procedures, the island censuses provided little additional information. On the seven days when evening counts were conducted between 1930 h and 2230 h ADT, total numbers away from the Blind 2 area fluctuated between 3905 and 1066 birds ($\bar{x}$ ± s.d.=2450 ± 1002.2, n=7 days between 29 July and 5 August; see Appendix 8). The evening counts fluctuated much less radically than those conducted in morning (0900 to 1300 h ADT; range= 3083 birds on 28 July to 442 birds on 2 August; $\bar{x}$ ± s.d.=1489 ± 1323.6; n=5 days between 28 July and 2 August).

Influences of Weather

As indicated in Figure 3 and Appendix 7, winds from the northeast prevailed throughout most of our studyon Thetis Island. We showed earlier (Johnson and Richardson 1981:275) that during the molt, oldsquaws appear to seek shelter on the leeward sides of barrier islands and spits, away from wind and rough water. We conducted more detailed investigations of surface winds in this study and found that even the relatively low profile of Thetis Island (1.2 ± 0.29 m above waterline; n=13 locations along the islands total length) had a highly significant influence on wave height. On the morning of 9 August, measurements of wind speed and wave height were taken at 11 windward and 11 leeward locations along the length of Thetis Island and at a location at the W and E tip of the island. Winds during the several hour period when the measurements were taken averaged from 66.9° ± 14.20° magnetic (range=45° to 90°; n=24). Average wave height at the 11 windward locations was 0.32 ± 0.072 m, which was significantly higher than at the 11 immediately adjacent leeward locations (0.05 ± 0.048 m, $p < 0.005$, n=11 pairs of comparisons). However, one remarkable result of these morning measurements was that windspeed (as measured with the relatively crude Dwyer wind guage) was little affected by island relief at either the 0.2 or 2.0 m height above water level at the shoreline. Wind speeds 0.2 m (~6 in} above the water 1 ine on the windward side of the island averaged 9.1 ± 0.52 km/hr compared with 8.3 ± 1.21 km/hr on the leeward side where oldsquaws commonly concentrated ($p > 0.05$; n=11 pairs of comparisons).

Similarly, measurements at the 2.0 m (~6 ft) level were not significantly different (windward=13.4 ± 1.58 km/hr; leeward=12.4 ± 1.21 km/hr; $p > 0.05$; n=11 pairs of comparisons).

Similar measurements taken under a slightly different wind regime (mean direction= 78.8° ± 11.35°) on the evening of 9 August, gave different results than those taken earlier in the morning. Wind speeds at the same 11 windward locations 0.2 m above the water line averaged 13.6 ± 1.27 km/hr, which was almost double the average 8.2 ± 2.97 km/hr at the 11 immediately adjacent leeward locations ($p < 0.05$; n=11 pairs of comparisons). However, at the 2.0 m level differences in windspeed at windward vs. adjacent leeward locations (24.1 ± 2.23 km/hr vs. 20.7 ± 4.91 km/hr, respectively) were not significant ($p > 0.05$; n=11 pairs of comparisons). As one might expect, in all comparisons both for the morning and evening measurements, wind speeds at the 2.0 m level were significantly greater than those at the 0.2 m level (9.8 ± 3.40 km/hr at 0.2 m *vs.* 17.7 ± 5.66 at 2.0 m; n=44 comparisons; $p < 0.05$).

Thus, even though oldsquaws apparently favor the leeward sides of barrier islands during their molt period, windspeeds may or may not be profoundly different there from adjacent windward sides. Wind fetch and wave height may be more of a factor influencing oldsquaw distribution than windspeed; certainly, oldsquaws seeking roosting locations would find it easier to leave the water on a leeward beach with no waves.

In general, throughout the first 120 h of observations in Area 4 (where oldsquaws had easy access to the seaward side of Thetis Island) there was a significant negative correlation ($r=0.384$; $p < 0.01$; df=94) between the numbers of birds on the windward vs. the leeward side of the

island, further indicating an apparent preference for sheltered waters. Only during a rare period of calm and/or very slight southwesterly winds around hour 96 of this study, did oldsquaws move around the SE tip of Thetis Island from Area 4 to the seaward and (at that time) the leeward side of the island (Figure 4). Figures 5 and 6 show a similar remarkable movement of oldsquaws from the area SE of Blind 2 (Area 2) to the leeward beach SW of Blind 2 (Area 1). This movement occurred shortly after a major shift in the wind direction and a significant increase in the wave height along the beach east of Blind 2 (Area 2) around hour 288 of this study (Figure 3). As discussed later, a significant increase in the level of human disturbance occurred almost simultaneous to the change in weather in the area near Blind 2; these disturbances also may have influenced the distribution and movement patterns of the oldsquaws under observation.

Periodicity of Habitat Use

Oldsquaw use of barrier island-lagoon habitats followed a regular cycle of abundance and activity with a period of about 24 h (Figures 5 and 6). Results of the autocorrelation analyses (Figure 7A) give the most clear picture of the cyclic nature of oldsquaw behavior. Peak numbers of birds counted in all habitats were during the late evening (~2100 h) through early morning (~0300 h) hours (Figures 5 and 6). This result does not agree with that given by Gollop *et al.* (1974) for molting oldsquaws at Herschel Island, Y.T. They found peak abundance of birds on beach and nearshore habitats between 1300 and 1500 h YDT, during the warmest part of the day. However, their counts were not over a 24 h period, but only over the 7 h period 1100 to 1800 h ADT. Ward and Sharp (1974) watched oldsquaws at Herschel Island, Y.T., over a longer portion of the day

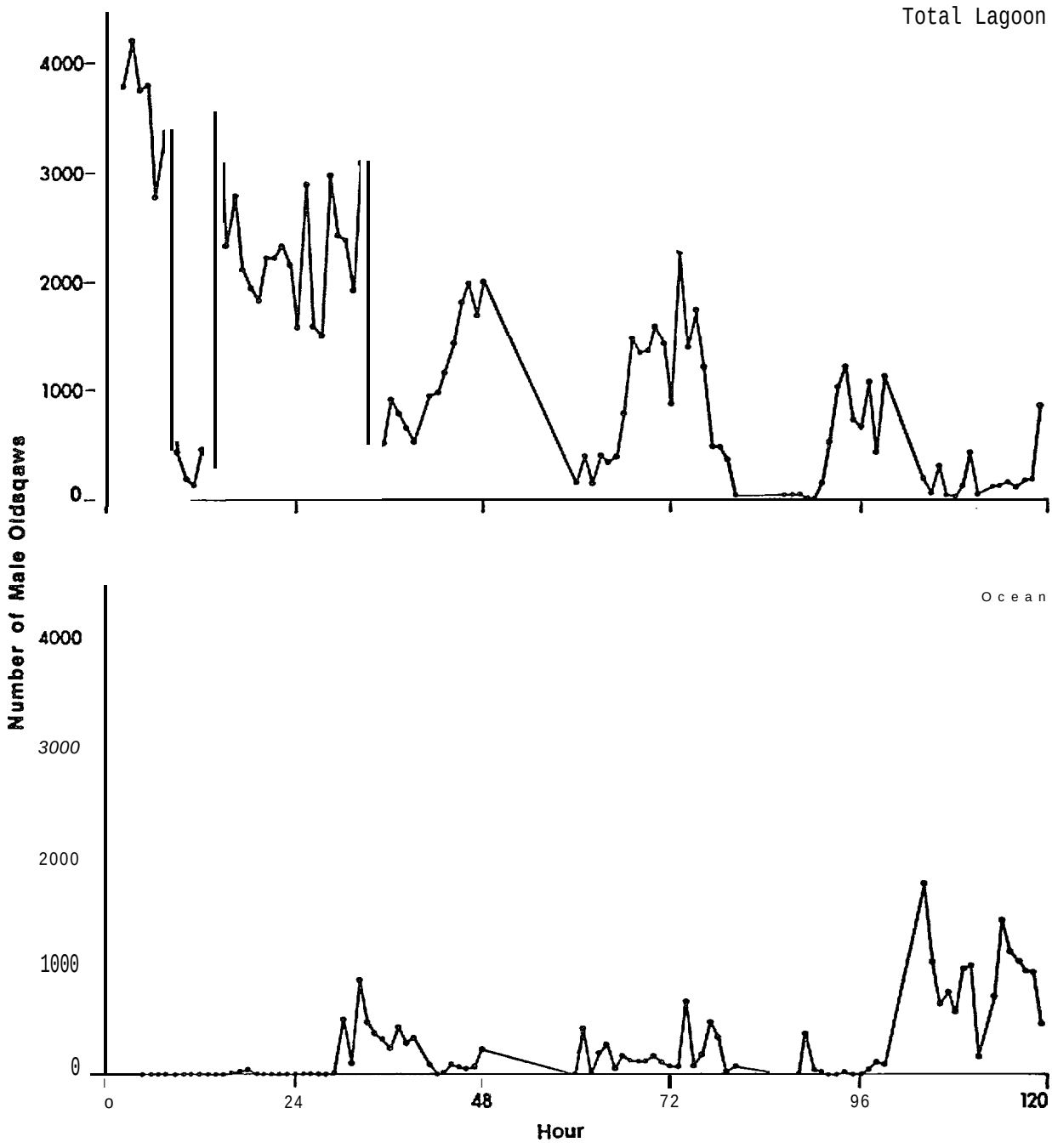


Figure 4. Numbers of molting male oldsquaws near the SE tip (Area 4) of Thetis Island, Alaska, 21 to 26 July 1980.

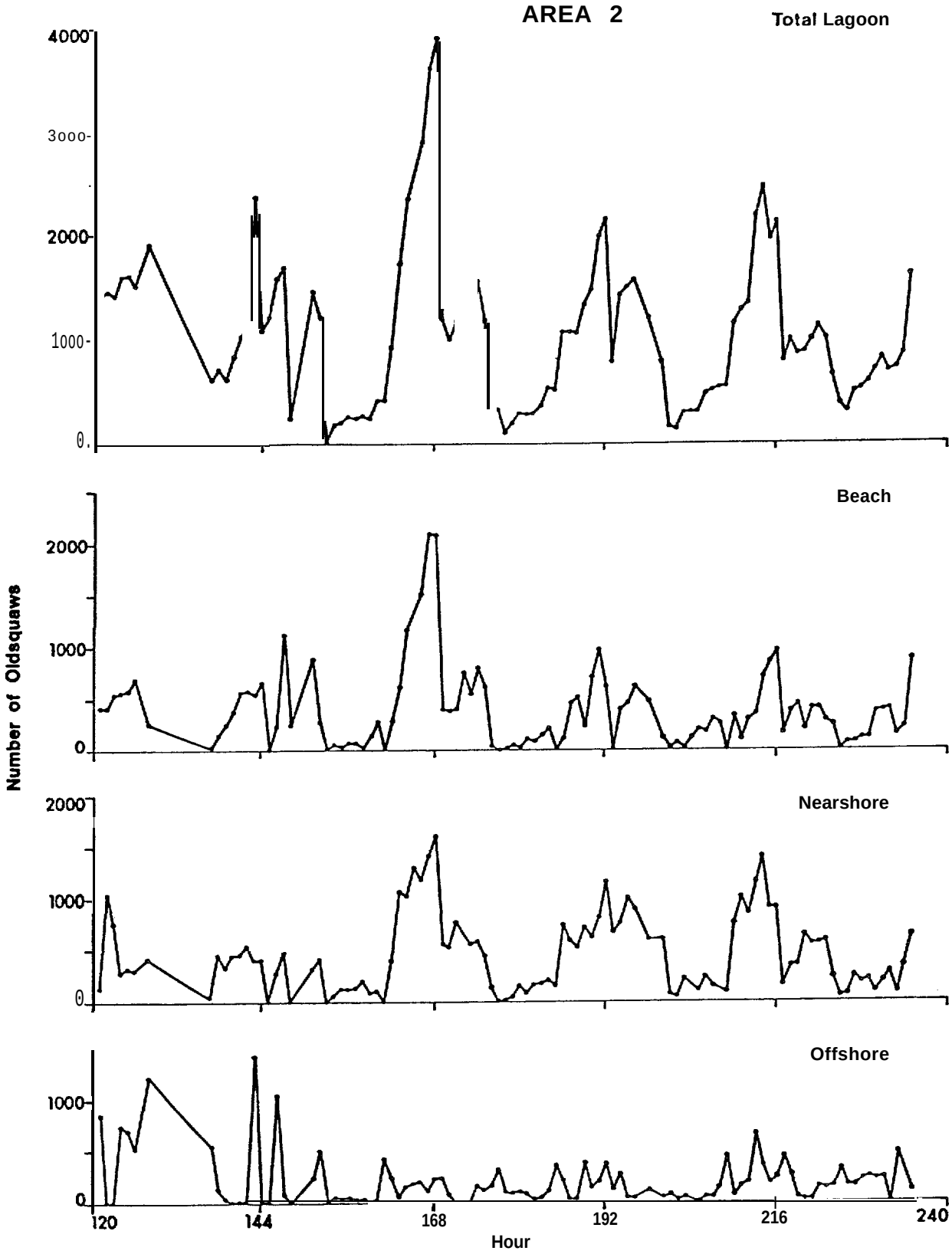


Figure 5. Numbers of oldsquaws in barrier island-lagoon habitats in Area 2 (see Figure 2) during the 240 h period of intensive observations from Thetis Island, Alaska. (See next page for hours 240 to 360.)

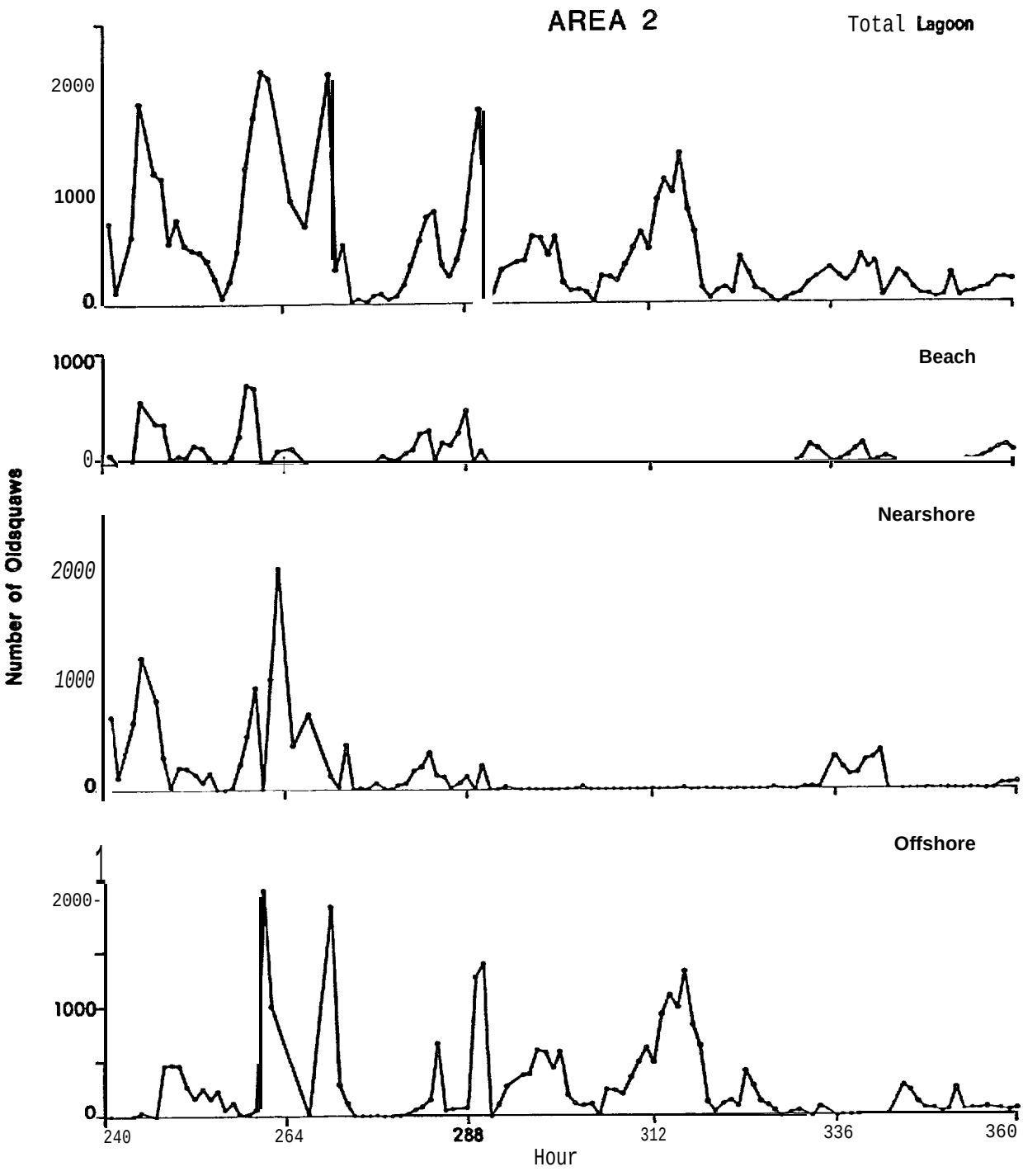


Figure 5. Continued.

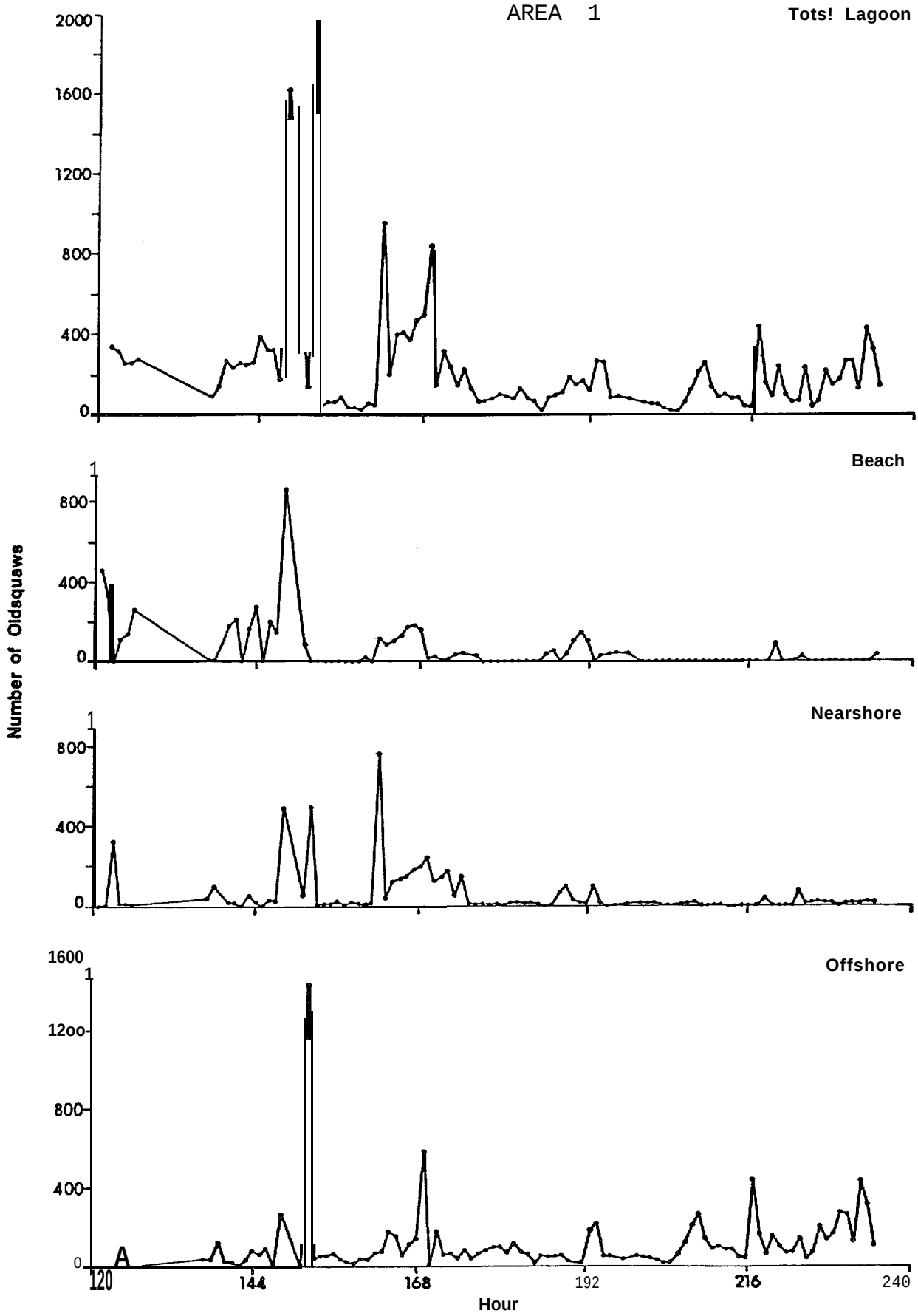


Figure 6. Numbers of oldsquaws in barrier island-lagoon habitats in Area 1 (see Figure 2) during the 240 h period of intensive observations from Thetis Island, Alaska. (See next page for hours 240 to 360.)

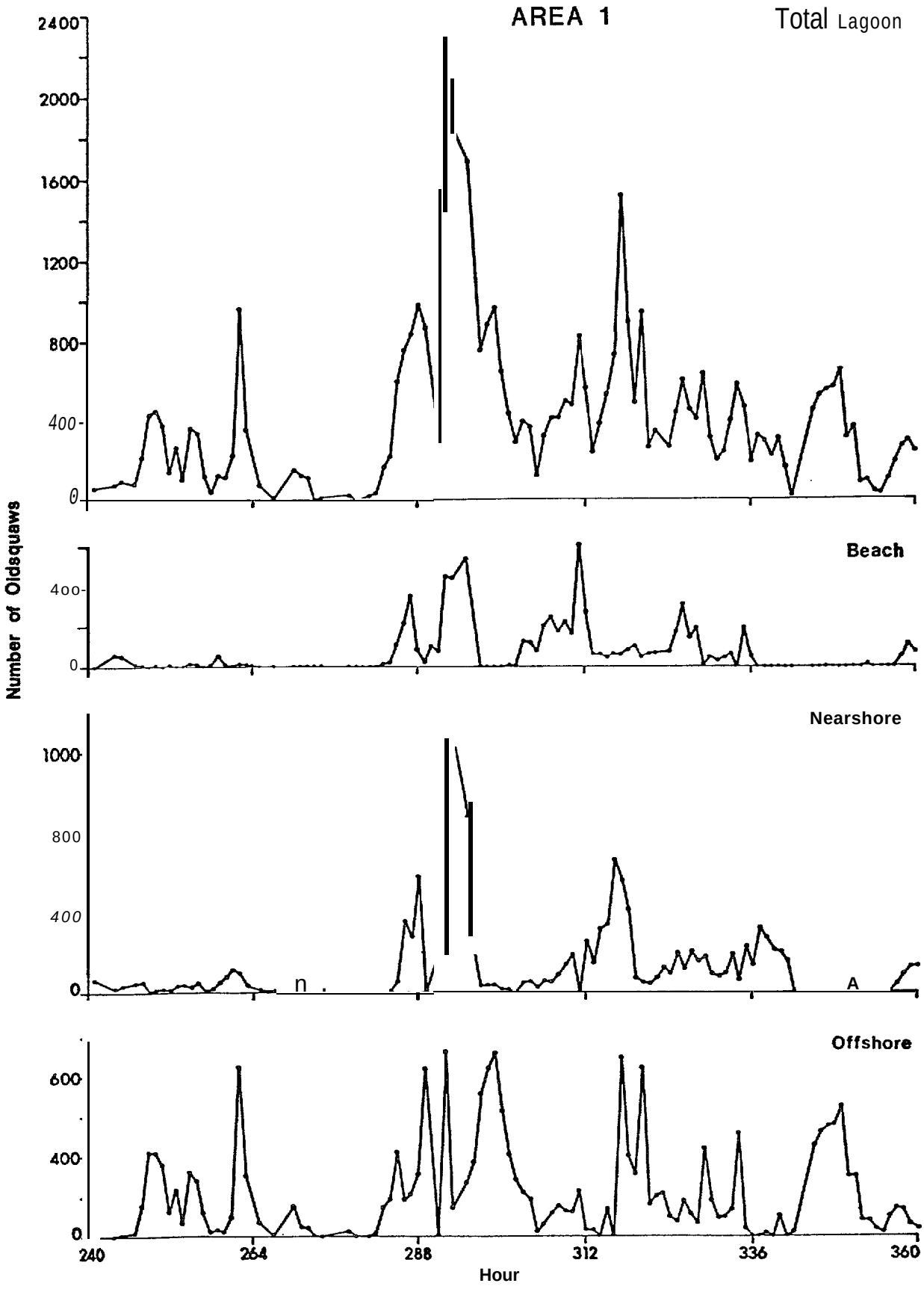
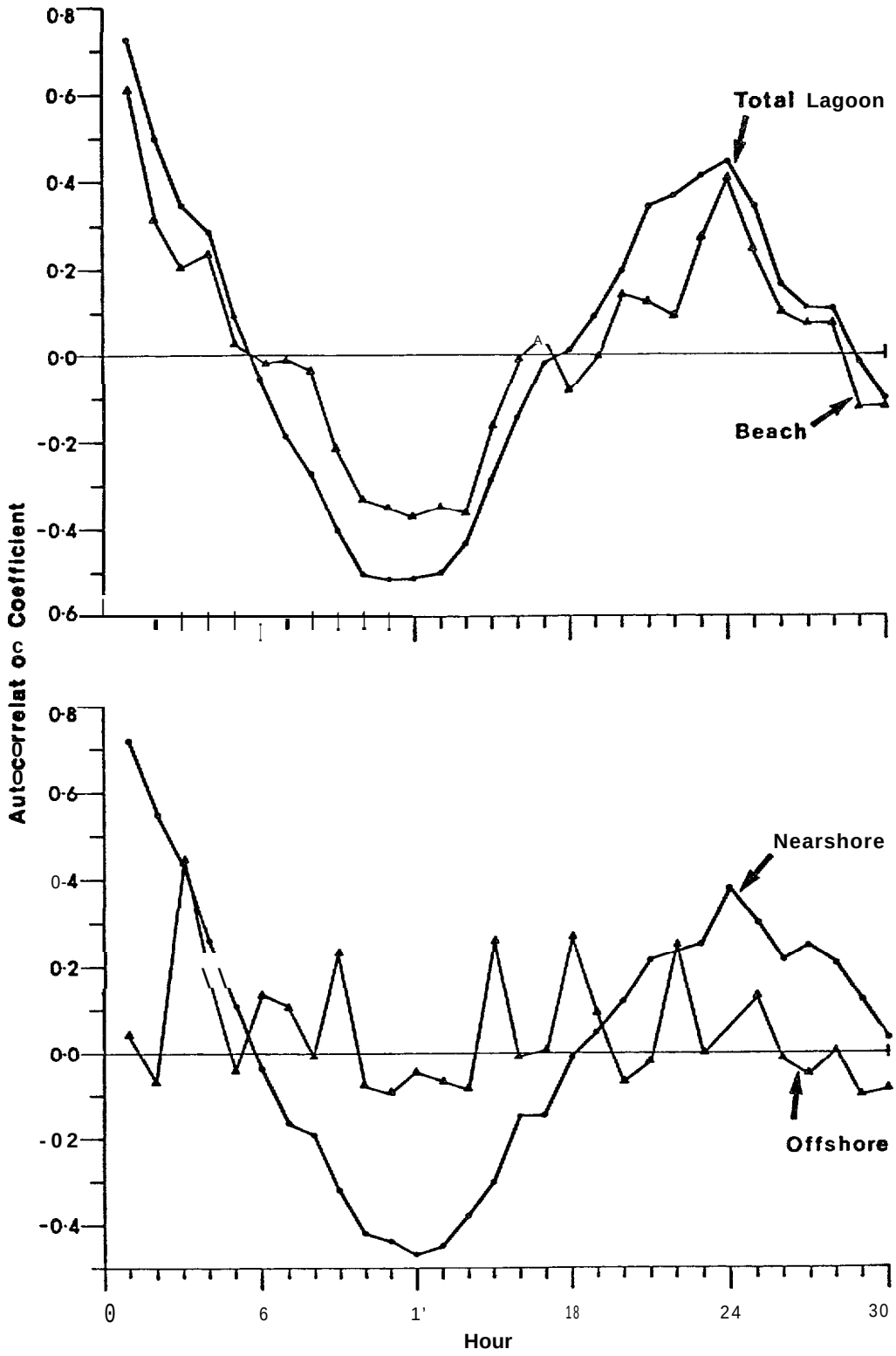


Figure 6. Continued.

Figure 7A. Results of autocorrelation analyses of numbers of birds in various barrier island-lagoon habitats in Area 2 during four 30-h cycles (120 hrs) of activity when oldsquaws were relatively undisturbed and when waters were calm. Peak to peak or O to O lag correlation of numbers in beach, nearshore and total lagoon habitats showed a 24-h period; numbers in offshore habitats showed little periodicity.

Figure 7B. Results of autocorrelation analyses of numbers of birds in various barrier island-lagoon habitats in Area 2 during four 30-h cycles (120 hrs) of activity when oldsquaws were subjected to disturbance and rough water. Peak to peak or O to O lag correlation of numbers in beach, nearshore and total lagoon habitats showed a 24-h period; use of offshore habitats showed little periodicity.


0·8
0·6
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0·0
-0·2
-0·4
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Total Lagoon
Beach
Autocorrelat oc Coefficient
0·8
0·6
0-4
0·2
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-02
-0·4
Nearshore
Offshore
0
6
1'
18
24
30
Hour

Figure 7A.

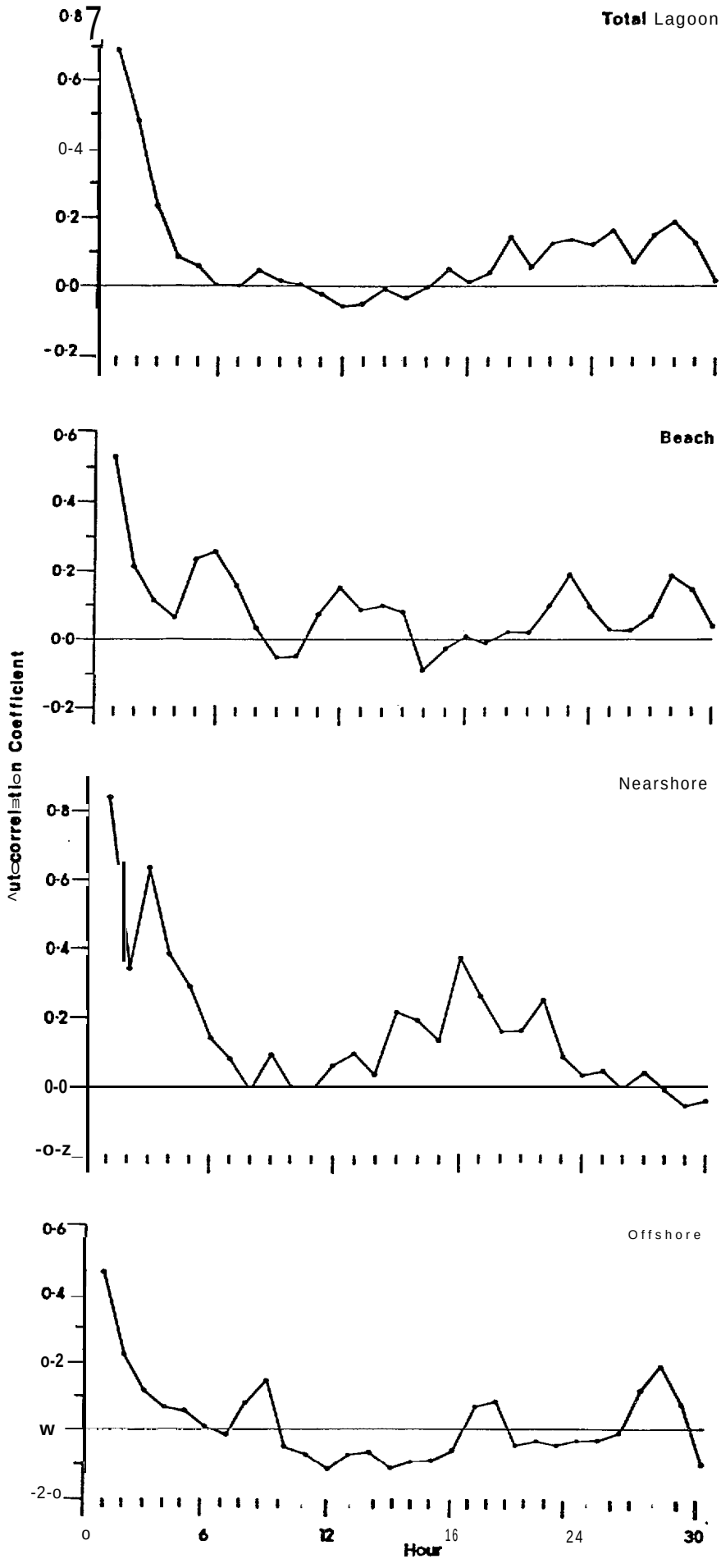
Total Lagoon
Beach
Nearshore
Offshore
Autocorrelation Coefficient
0·8
0·6
0·4
0·2
0·0
-0·2
0
6
12
16
24
30
Hour

Figure 7B.

(0600 through 2000 h YDT) during the following year (1973), however, and found a significant increase in the number of birds moving toward land from offshore waters during the evening. Our results indicate that peak numbers of birds occur on and near roosting sites during the two to three hour period either side of midnight.

The most notable cyclic rhythms of habitat use and changes in bird numbers were on the beaches and in adjacent nearshore habitats in Area 2 during hours 120 to 240 (Figure 7A) and in Area 1 during hours 288 to 336 (Figures 6 and 7B). However, there were indications of cyclic behavior by oldsquaws early in the study in Area 4 (Figure 8).

The southern limits of offshore habitat near Thetis Island were not defined, i.e., we did not place an outer limit on this habitat. No doubt for this reason, the recorded increases in numbers of birds on beach and nearshore habitats did not correspond to decreases in numbers in offshore habitats, and *visa versa.* Birds normally moved beyond our limits of clear vision (not countable) when they moved offshore. Also, movements by birds to offshore habitats were often rapid; on many occasions (see Figure 5) a large proportion of the total number of birds on the beach or in nearshore waters had moved out of sight to offshore waters within one count period (1 h). Similarly, often times birds clearly visible in offshore habitats disappeared farther offshore from one count period to the next (Figure 5).

As mentioned in the preceding section, the cyclic use by oldsquaws of Area 2 was abruptly discontinued around h 288 when rough weather (Figure 3) and the level of disturbance (Figure 9) coincidentally increased markedly. As the number and rhythmicity of' birds using habitats in Area 2 became less marked, a corresponding increase in rhythmicity

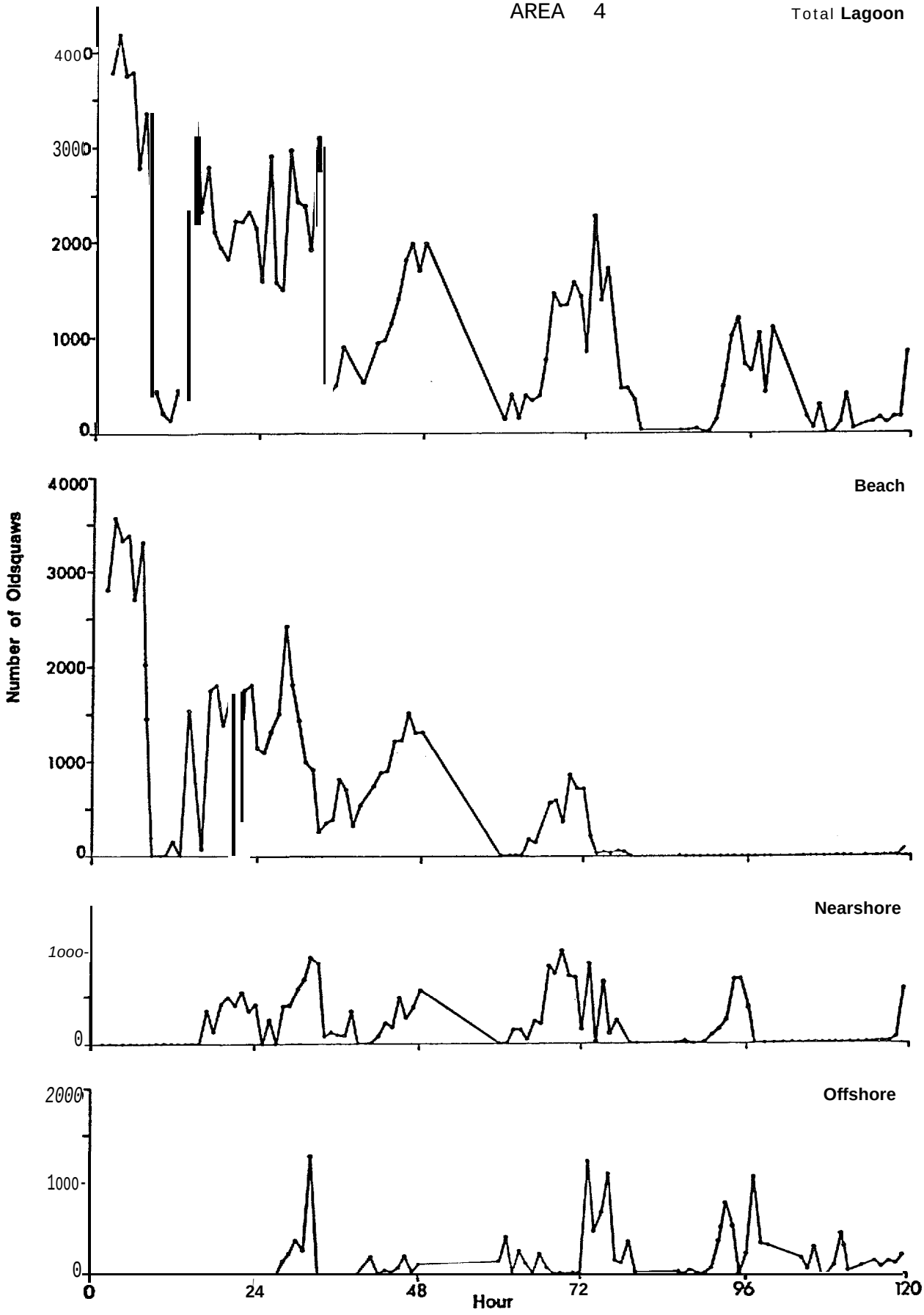

Figure 8. Numbers of oldsquaws in barrier island-lagoon habitats in Area 4 (see Figure 2) during the initial 120 h period of intensive observations from Thetis Island, Alaska.

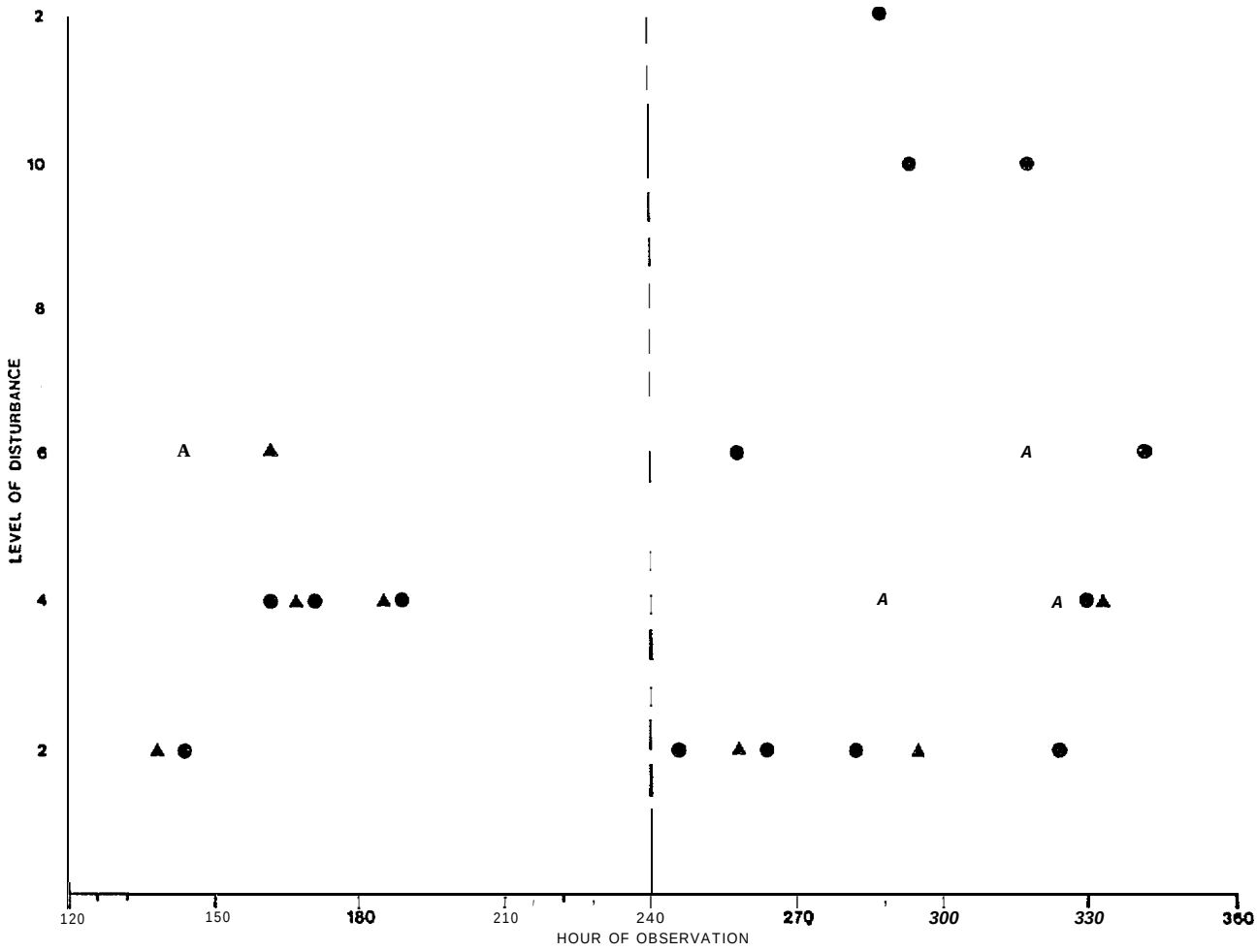

Figure 9. Level of disturbance to oldsquaws throughout the 240-h period of intensive observations. (A represent data from Area 1; ● represent data from Area 2.)

and use occurred on the opposite side of the bay in Area 1, which under the new wind regime (Figure 3) was the leeward side of the bay.

Influences of Disturbance

Although there was clear documentation on numerous occasions of oldsquaws fleeing from one habitat to another in response to observed aircraft, boat and human disturbances, as well as natural disturbances,

the fact that they did not abandon the bay adjacent to Blind 2, suggests some level of tolerance by oldsquaws to these perturbations. However, the gradual decline (from near 4000 to near 2000, see Figures 5 and 6) in the total number of oldsquaws in Areas 2 and 1 from hour 120 to 360 may in fact indicate that some birds did abandon this part of Thetis Island. Only a few male oldsquaws normally have regrown their wing feathers sufficient for flight by 5 August (see Johnson and Richardson 1981), thus, although some birds may have flown away from Thetis Island during the latter half of the study, the number doing so would have been small compared to the number still flightless (far too few to account for a loss of nearly 2000 birds). Furthermore, the total counts of birds in the Thetis Island area (see Appendix 8), although incomplete, indicated no overall decline in numbers of birds. The decline in percent males in Area 2 (Figures 5 and 10 to 12 and Appendices 9 to 11) after hour 288 can be explained in part by their movement to Area 1 (Figure 6 and Appendices 12 to 14). Female oldsquaws are still flying during early August, the peak of their molt and flightless period is later in the month (Johnson and Richardson 1981); those few birds present in the large flocks of males near barrier islands were therefore able to fly the short distance to the beach in Area 2 after hour 288 (Figures 10 to 12).

Another indication of the possible effects of bad weather and disturbance on oldsquaws was the markedly greater proportions of birds occupying offshore habitats from Area 2 between hours 288 to 300 and 301 to 324 (Figures 5 and 6 and Tables 6 and 7); prior to this time, the combined number of birds occupying nearshore and beach habitats

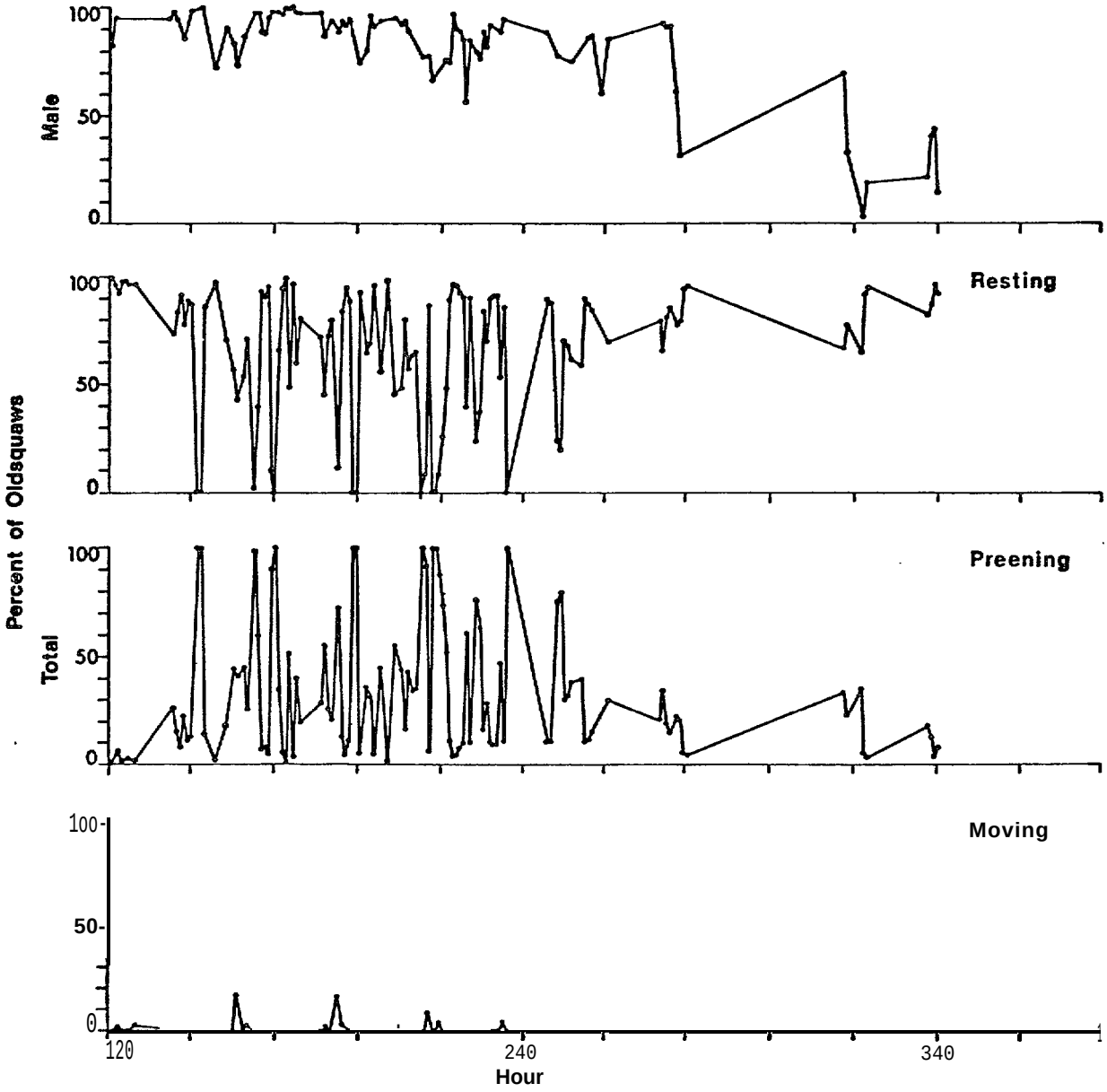

Figure 10. percent male oldsquaws and their observed behavior on beach habitats during hours 120 to 360 in Area 2 (see Figure 2), Thetis Island, Alaska.

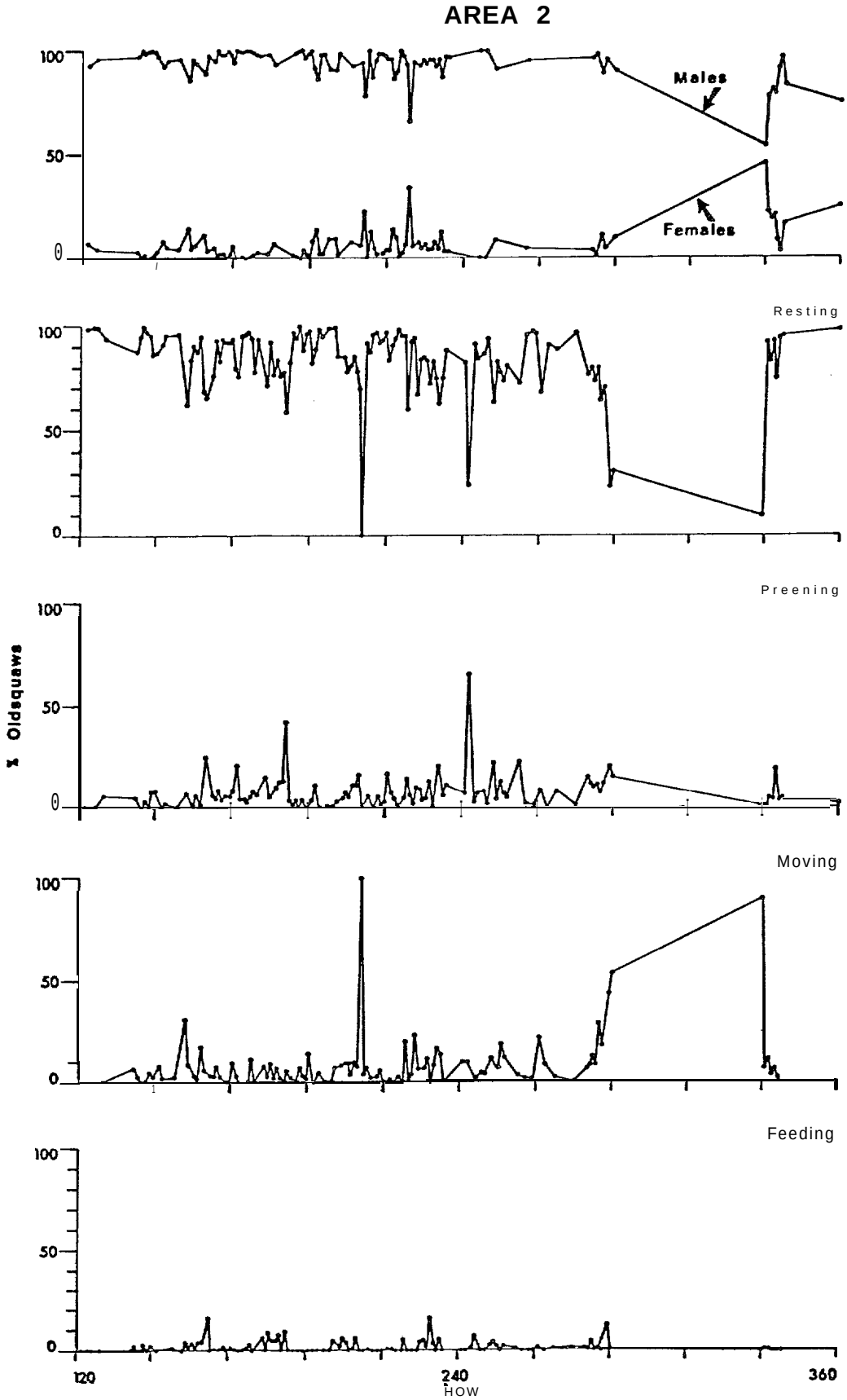

Figure 11. Percent male oldsquaws and their observed behavior in nearshore habitats during hour 120 to 360 in Area 2 (see Figure 2), Thetis Island, Alaska.

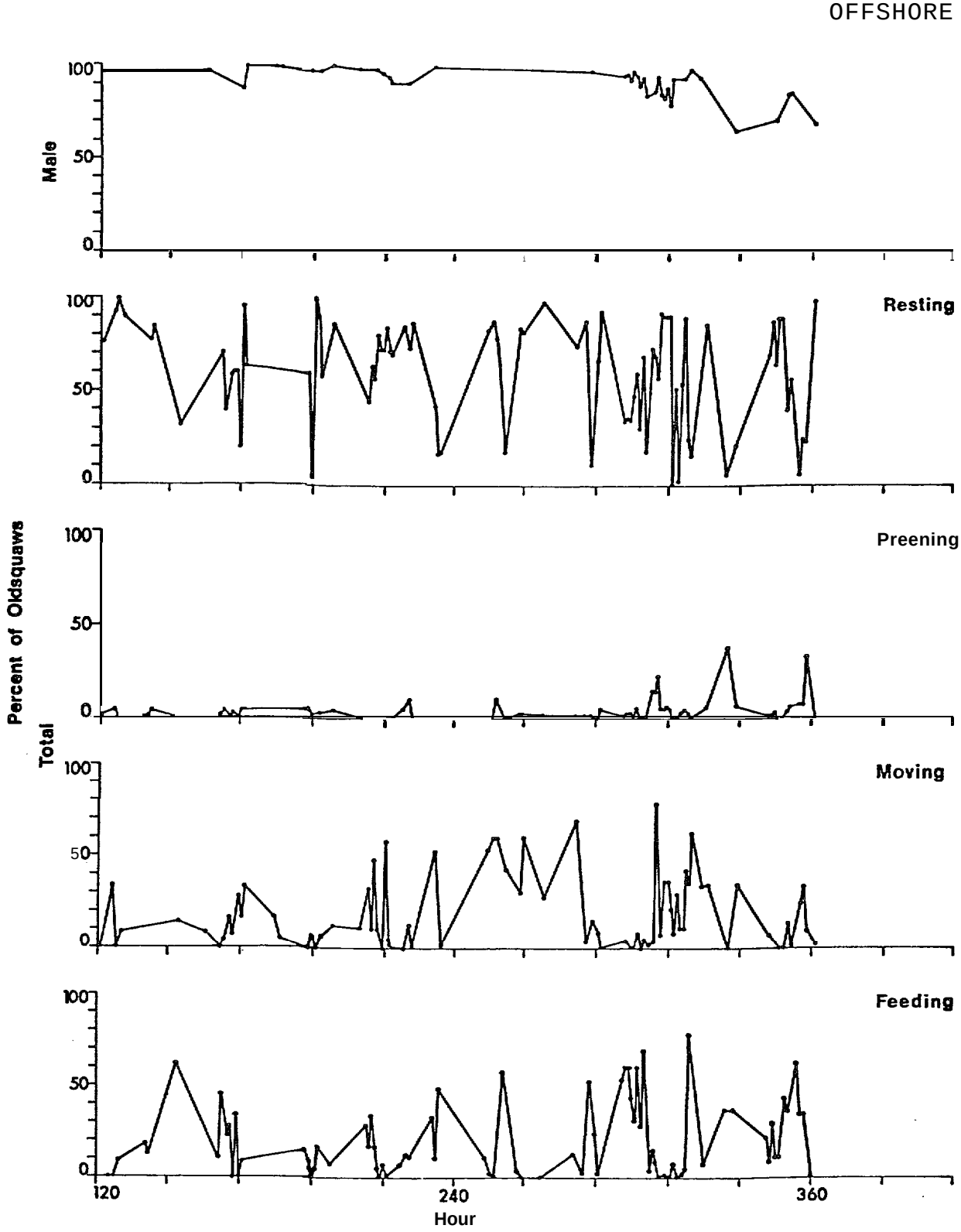

Figure 12. Percent male oldsquaws and their observed behavior in offshore habitats during hours 120 to 360 in Area 2 (see Figure 2), Thetis Island, Alaska.

was much greater than those occupying offshore habitats (Tables 6 and 7). In fact, the 24-cycle when the largest proportion of oldsquaws were recorded in offshore habitats (99.3%; Table 6B), was during hours 301 to 324, simultaneous with the peaks of disturbance and rough water in Area 2 (Figure 3). Similarly, Gollop *et aZ.* (1974) found that molting seaducks spent more time away from shore in open water on days when they were disturbed by aircraft than on days when they were not. They also found that swimming and feeding activities and population levels of seaducks appeared to be unaffected by aircraft disturbance. Furthermore, Ward and Sharp (1974) found that disturbance during one molting season (year), had little effect on the numbers and behavior of molting seaducks using the same location the next year.

Although wind regimes at Thetis Island returned to normal by hour 336, few oldsquaws returned to the beach at Area 2; most remained in beach, nearshore and offshore habitats in Area 1 until hour 360, the end of intensive observations (see Appendices 12 to 14).

Oldsquaw Behavior in Area 2

In beach habitats - The average proportion of oldsquaws on beach habitats in Area 2 that were resting was well over 70% (see Figure 10 and Appendix 9). Preening behavior on the beaches averaged about 25%; many birds preened their feathers while pausing at the beach/water interface during movements from nearshore to beach habitats. Very little time was spent moving once birds reached the beach (<2% average) and virtually no birds were recorded feeding on the beaches.

Table 6A. Summaries of I-cycle* subtotals, subtotal percentages, means, standard deviations and sample sizes of all birds classified in Area 2 during hours 121 through 240.

Hours	Beach	Nearshore	Offshore	Total
121 to 132				
subtotals	3456	3281	4059	10906
%	32.0	30.4	37.6	100.0
$\bar{x}$	439.7	468.7	577.9	1558.0
s.d.	143.6	370.4	450.6	175.25
n	7	7	7	7
133 to 156				
subtotals	5998	4884	4282	16364*
%	39.6	32.2	28.2	100.0
$\bar{x}$	333.2	271.3	237.9	909.1
s.d.	324.1	192.7	406.9	624.4
n	18	18	18	18
157 to 180				
subtotals	12196	12975	3050	26778
%	43.2	46.0	10.8	100.0
$\bar{x}$	530.3	540.6	127.1	1164.2
s.d.	628.4	490.1	108.0	1092.7
n	23	24	24	23
181 to 204				
subtotals	6315	10995	2831	20141
%	31.4	54.6	14.1	100.1
$\bar{x}$	287.0	499.8	128.7	915.5
s.d.	271.8	333.4	119.8	601.7
n	22	22	22	22
205 to 228				
subtotals	7158	11777	4719	23654
%	30.3	49.8	20.0	100.1
$\bar{x}$	298.3	490.7	136.6	985.6
s.d.	243.8	386.3	160.8	619.5
n	24	24	24	24

. ..continued

Table 6A. Continued.

Hours	Beach	Nearshore	Offshore	Total
229 to 240				
subtotals	2472	1861	1589	5922
%	41.7	31.4	26.8	99.9
$\bar{x}$	353.1	265.9	227.0	846.0
s.d.	253.6	191.8	153.9	343.5
n	7	7	7	7
121 to 240				
subtotals	37595	45778	20530	103765
%	36.1	44.1	19.8	100.0
$\bar{x}$	372.2	448.8	201.3	1027.4
s.d.	386.0	370.5	256.0	730.9
n	101	102	102	101

*1-cycle=24 hours; see Figure 7.

Table 6B. Summaries of l-cycle* subtotals, subtotal percentages, means, standard deviations and sample sizes of all birds classified in Area 2 during hour 241 through 360.

Hours	Beach	Nearshore	Offshore	Total
241 to 252				
subtotals	1045	4267	1890	7802
%	21.1	54.7	24.2	100.0
$\bar{x}$	164.5	426.7	189.0	780.2
s.d.	190.5	373.3	214.2	469.1
n	10	10	10	10
253 to 276				
subtotals	2161	6590	6678	13304
%	14.0	42.7	43.3	100.0
$\bar{x}$	108.1	329.5	351.5	700.2
s.d.	207.6	501.7	620.2	728.5
n	20	20	19	19
277 to 300				
subtotals	2084	1508	7280	10872
%	19.2	13.9	67.0	100.1
$\bar{x}$	90.6	65.6	316.5	472.7
s.d.	125.3	91.9	392.7	405.4
n	23	23	23	23
301 to 324				
subtotals	4	61	9695	9760
%	0.0	0.6	99.3	99.9
$\bar{x}$	0.2	2.5	404.0	406.7
s.d.	0.6	6.6	376.6	377.0
n	24	24	24	24
325 to 348				
subtotals	678	1793	1939	3864
%	17.5	46.4	36.1	100.0
$\bar{x}$	30.8	81.5	63.3	175.6
s.d.	50.1	119.7	86.7	118.2
n	22	22	22	22

. ..continued

Table 6B. Continued.

Hours	Beach	Nearshore	Offshore	Total
349 to 360				
subtotals	467	195	836	1498
%	31.1	13.0	55.8	
$\bar{x}$	38.9	16.3	69.7	124.8
s.d.	52.2	21.3	58.8	77.2
n	12	12	12	12
241 to 360				
subtotals	7039	14414	27772	47110
%	14.3	29.3	56.4	100
$\bar{x}$	63.4	129.9	252.5	428.3
s.d.	130.0	284.4	386.1	469.1
n	111	111	111	111

*1-cycle=24 hours; see Figure 7.

Table 7A. Summaries of l-cycle* subtotals, subtotal percentages, means, standard deviations and sample sizes of all birds classified in Area 1 during hours 121 through 240.

Hours	Beach	Nearshore	Offshore	Total
121 to 132				
subtotals	1314	368	105	1912
%	73.5	20.6	5.9	100.0
$\bar{x}$	219.0	61.3	17.5	318.7
s.d.	165.7	126.8	42.9	76.5
n	6	6	6	6
133 to 156				
subtotals	2256	1493	2351	6658
%	37.0	24.5	38.5	100.0
$\bar{x}$	125.3	82.9	130.6	369.9
s.d.	206.6	151.9	327.0	529.2
n	18	18	18	18
157 to 180				
subtotals	1177	2615	2173	5965
%	19.7	43.8	36.4	99.9
$\bar{x}$	49*O	109.0	90.5	248.5
s.d.	62.1	160.1	113.8	247.2
n	24	24	24	24
181 to 204				
subtotals	645	523	1131	2299
%	28.1	22.7	49.2	100.0
$\bar{x}$	29.3	27.8	51.4	104.5
s.d.	40.5	23.8	51.1	68.2
n	22	22	22	22
205 to 228				
subtotals	120	256	2638	3014
%	4.0	8.5	87.5	100.0
$\bar{x}$	5.0	10.7	109.9	125.6
s.d.	18.8	15.4	89.6	94.8
n	24	24	24	24

. ..continued

Table 7A. Continued.

Hours	Beach	Nearshore	Offshore	Total
229 to 240				
subtotals	34	93	1563	1690
%	2.0	5.5	92.4	
$\bar{x}$	4.9	13.3	223.3	241.4
s.d.	12.0	5.7	114.4	107.9
n	7	7	7	7
121 to 240				
subtotals	5546	5348	9961	21538
%	26.6	25.6	47.8	100.0
$\bar{x}$	54.9	53.0	98.6	213.2
s.d.	115.7	111.7	163.2	274.9
n	101	101	101	101

*1-cycle=24 hours; see Figure 7.

Table 7B. Summaries of I-cycle* subtotals, subtotal percentages, means, standard deviations and sample sizes of all birds classified in Area 1 during hours 241 through 360.

Hours	Beach	Nearshore	Offshore	Total
241 to 252				
subtotals	164	282	1479	1925
%	8.5	14.6	76.8	99.9
$\bar{x}$	18.2	31.3	164.3	213.9
s.d.	22.9	20.6	183.1	158.9
n	9	9	9	9
253 to 276				
subtotals	127	722	2612	3461
%	3.7	20.9	75.5	100.1
$\bar{x}$	7.1	40.1	145.1	192.3
s.d.	12.7	34.2	206.3	223.3
n	18	18	18	18
277 to 300				
subtotals	2409	4901	7131	13749
%	16.7	33.9	49.4	100.0
$\bar{x}$	114.7	245.1	339.6	723.6
s.d.	173.0	367.2	333.8	641.0
n	21	20	21	19
301 to 324				
subtotals	2937	3842	5224	11663
%	24.5	32.0	43.5	100.0
$\bar{x}$	127.7	160.1	217.7	507.1
s.d.	126.1	177.7	230.4	303.7
n	23	24	24	23
325 to 348				
subtotals	1234	2917	4143	8294
%	14.9	35.2	50.0	100.1
$\bar{x}$	56.1	132.6	188.3	377.0
s.d.	85.9	95.4	207.4	164.3
n	22	22	22	22

...continued

Table 7B. Continued.

Hours	Beach	Nearshore	Offshore	Total
349 to 360				
subtotals	258	458	1943	2659
%	9.7	17.2	73.1	100.0
$\bar{x}$	21.5	38.2	161.9	221.6
s.d.	36.4	50.3	179.7	176.3
n	12	12	12	12
241 to 360				
subtotals	7129	13122	22532	41751
%	16.7	30.7	52.7	100.1
$\bar{x}$	67.9	125.0	212.6	405.3
s.d.	114.8	199.7	242.7	385.0
n	105	105	106	103

*1-cycle=24 hours; see Figure 7.

The proportion of male oldsquaws in beach habitats averaged well above 80% until after hour 288. After that period most of the males (most of the birds) moved offshore and to the leeward nearshore waters on the opposite side of the bay (see Figures 5 and 6). There was, however, a general declining trend in the proportion of males from over 90% early in the study to about 35% in the final stages (Figure 10 and Appendix 9).

In nearshore habitats - The average proportion of oldsquaws that were resting in nearshore waters in Area 2 was near 85% during hours 120 to 288 (Figure 11 and Appendix 10). After that period, the number of birds counted in the nearshore in Area 2 decreased markedly and a much higher proportion of the birds remaining were females and were birds that were moving, especially during hours 287 and 288 and hour 336. After hour 336, the average proportion of birds resting on the nearshore waters of Area 2 increased, as did the proportion of males. Although a significant proportion of feeding and preening oldsquaws were recorded in this habitat, the average proportion that were moving was greater. Appendix 15) provides a summary of information on diving (feeding) behavior of oldsquaws in nearshore habitat.

The general trend in the proportion of males on this habitat declined from over 90% early in the study, to about 77% in the final stages (Figure 11 and Appendix 10).

In offshore habitats - The average proportion of birds recorded resting and moving fluctuated much more markedly in offshore habitats than was recorded on either beach or nearshore habitats (Figure 12 and Appendix 11). Although a relatively high proportion of birds in offshore habitats were classified as resting, the proportion feeding was notably greater than in either of the previous two habitats considered. The cyclic trend of oldsquaws feeding in offshore habitats is also

evident from Figure 12. It was often difficult to isolate a diving oldsquaw in offshore habitats therefore it was not possible to record information on diving behavior. The summary of diving (feeding) behavior in Appendix 15 constitutes our only information on this subject, and this was collected only in nearshore habitats.

The proportion of birds moving in offshore habitats was quite variable, especially during hours 216 to 288 and from hour 312 through the end of the study. A very small proportion of the birds classified in offshore habitats in Area 2 were recorded preening. In part, this may have been because of the greater distances over which birds were observed in offshore habitats and the difficulty in discerning this more subtle behavior; birds that were diving and moving were much more easily classified in offshore habitats.

As on the beaches and in the nearshore habitats, the average proportion of male oldsquaws that were classified in offshore habitats in Area 2 gradually declined from over 90% in the early stages of this study, to around 75% during the final stages (Figure 12 and Appendix 11).

Oldsquaw Behavior in Area 1

Few birds were present in the portion of Area 1 adjacent to Blind 2 prior to hour 288 of the study, therefore little can be said about their behavior. However, as mentioned earlier, after hour 288 the number of birds in this area increased markedly (Figure 6). Their behavior patterns in Area 1 were essentially identical to those recorded and discussed for Area 2 (see Appendices 12 through 14).

SUMMARY AND CONCLUSIONS

Aerial Surveys

Aerial surveys along the entire central Alaskan Beaufort coast have been conducted during the peak of the oldsquaw molt (late July to early August) for the past four years (1978-1981). Certain locations such as Simpson Lagoon, Gwydyr Bay and Leffingwell Lagoon (S of Flaxman Island) have consistently supported very large numbers of molting oldsquaws, and the highest densities consistently have occurred along transects immediately south of barrier island shorelines. This habitat appears to be particularly important to the flightless males that comprise over 90% of the birds in these molting concentrations. The barrier islands provide protection from wind and rough water, they afford easy access to roosting areas along leeward beaches and are close to the very abundant prey resources in the nearby lagoons.

Thetis Island

Thetis Island lies about 12 km N of the Colville River delta and about 7 km W of Simpson Lagoon. There is about 5 acres of private land on this small (~2.5 km^2) barrier island in Harrison Bay. Thetis Island supports one of the largest colonies of common eiders in the Alaskan Beaufort Sea (~50 nests). The rows of driftwood along the top of the island appear to be particularly attractive to nesting eiders; these areas should be avoided during the nesting season (mid-June to late July).

The leeward waters and beaches of Thetis Island support the only significant molting concentrations of oldsquaws (~4000 birds) in Harrison Bay.

Oldsquaw Collections

The 26 oldsquaws collected during the period 27 July to 9 August were primarily males (65%; 17 birds). Because we wanted to document that females were not flightless near Thetis Island at this time, we selectively collected a relatively higher proportion of females that were present in the area. All but 2 of the 17 males were flightless; the two that were barely able to fly were taken late in the collection period. All of the seven females were able to fly, although one bird had dropped an outer primary (one wing feather) from each wing and was obviously in the early stages of her wing molt.

Twenty-five specimens of oldsquaws were deposited in the vertebrate collection at the University of Alaska Museum, Fairbanks. The one specimen taken from a gillnet was too badly decomposed to prepare as a study skin.

Oldsquaw Behavior

During the molt period (mid-July to mid-August) male oldsquaws shed their wing feathers and are unable to fly for about two weeks. Birds collected at Thetis Island during this period in 1980 conformed to this pattern of molt and flightlessness. Molting oldsquaws typically cycled through a 24-h period of activity, with peak numbers of birds resting and preening in the leeward nearshore and beach habitats during late evening and early morning (~2100 to 0300 h ADT*). During mid-day they typically moved farther offshore to feed.

*Alaska Daylight Time.

On two occasions when the waters around Thetis Island became very calm, oldsquaws moved 5 km toward an adjacent molting location at Oliktok Pt. (~7 km E of Thetis Island), thus suggesting that under some conditions, flightless oldsquaws do make long-distance movements from one molting location to another.

On one occasion during our 360 h period of intensive observations of oldsquaws, the level of man-made disturbance doubled from the background of natural and biologist-induced disturbances. This period of disturbance coincidentally occurred during a period when the normal patterns of wind and waves changed. Although it was impossible to distinguish between the effects of these two perturbations, oldsquaws responded by moving to another location which provided better protection from wind and waves, thus suggesting a more significant functional response to weather, rather than disturbance.

However, the fact that the total number of male oldsquaws in the bay adjacent to Blind 2 declined from near 4000 birds early in the study to near 2000 birds later in the study may indicate a general movement by oldsquaws away from the sources of disturbance near Area 2. It is unlikely that the general attrition of birds throughout the study was the result of some males regrowing flight feathers and leaving the Thetis Island area; it is more likely that they moved to another sheltered bay on the west end of the island.

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Appendix 1. Locations of major oldsquaw concentrations recorded during the period of summer molt in Simpson Lagoon, Alaska, 1980 and 1981.

2 August 1980	# of oldsquaws
Barrier Island Shoreline Locations	
SW of Spy Island	2455
SW of Leavitt Island	3957
SW of Bertoncini Island	1163
SE Shore Cottle Island	980
Mid Lagoon Locations	
NW of Milne Point	3459
S of Leavitt Island	2617
Mainland Shoreline Locations	
NE of Kavearak Point	1891
2 August 1981	
Barrier Island Shoreline Locations	
SE Spy Island	1811
SE Pingok Island	1031

Appendix 2. Total numbers and densities of oldsquaws on all transects and during the 2 August 1980 and 2 August 1981 aerial surveys along the Alaskan Beaufort Sea coast.*

Transect Number	Density #/km²		# on-transect		# off-transect	
	1980	1981	1980	1981	1980	1981
1	0.0	0.0	0	0	0	0
2	645.8	284.7	9,558	4,214	160	184
3	168.3	128.9	2,010	1,578	5,294	74
4	197.9	38.2	2,557	421	2,179	43
5	0.0	0.6	0	8	8	30
6	327.9	113.0	1,810	629	0	1,109
7	44.1	0.9	319	6	1,175	0
8	7.7	5.7	175	128	0	88
9	0.0	1.4	0	17	15	0
10	0.1	0.0	2	0	0	0
11	0.8	10.3	4	50	1,220	40
12	568.6	86.1	7,915	1,204	30	174
13-1	7.8	0.0	51	0	0	
13-2	168.8	143.7	8,364	6,883	95	1,64:
14	54.3	-	1,916		0	
17	216.5	-	7,500		280	
18	2.8	9.4	92	298	1,635	50
19	0.0	2.5	0	17	0	0
20	0.0	6.2	0	16	0	0
21	150.1	56.8	2,222	1,026	35	0
overall/total	128.1	49.1	42,195	16,495	12,095	3,432

*See Johnson and Richardson (1981) for transect locations and descriptions.

Appendix 3. Densities of oldsquaws during the peak of the male molt period in Simpson Lagoon, Alaska, 1977-1981.

Survey Date	01dsquaws/km^2		
	Transect 2	Transect 3	Transect 4
28/29 July 1977	401.7	501.1	516.4
25 July 1978	284.7	73.0	19.1
28 July 1979	520.5	123.6	31.2
2 August 1980	645.8	168.3	197.9
2 August 1981	284.7	128.9	33.2
Unweighed mean density ± 1 s.d.	427.5 ± 156.3	198.9 ± 172.3	159.6 ± 212.7

Appendix 4. Estimates of the total number of oldsquaws present in Simpson Lagoon, Alaska, during the peak of the molt period on 2 August 1980 and 2 August 1981.

Transect Number	Location	Approximate Lagoon Area Represented (km′)	Lagoon Area Surveyed (km′)	Estimated Number of Oldsquaw	
				1980	1981
2	North Lagoon (<1.82 m deep)	22	14.80	10,223 (9,558)	4,400 (4,214)
3	Mid Lagoon (>1.82 m deep)	102	12.24	17,080 (2,060)	13,084 (1,578)
4	South Lagoon (<1.82 m deep)	36	12.88	4,233 (2,557)	1,928 (421)
Total		160	39,92	31,536 (14,175)	19,412 (6,213)

Mean 1980 Density (weighted) = 197.1 oldsquaws/km²
Mean 1981 Density (weighted) = 121.3 oldsquaws/km²

Appendix 5. Weights and measurements of 26 oldsquaws collected* during the peak of the male molt period (27 July to 9 August) in the vicinity of Thetis Island, Alaska, 1980.

Date	Sex	Wt. (g)	Rt. Wing (mm)	Longest Primary on Rt. Wing (mm)	Rt. Tarsus (mm)	Sub Q Fat Thickness (mm)	Gonads (mm)				
							Male				Female
							Rt.		L.		
							L	W	L	W	Largest Ovum
27 July	M	825	140	0	46	2.5	11	5	11	6	
	M	950	145	49	44	4.0	12	G	12	5	
	M	870	103	15	45	4.5	9	5	9	5	
	M	830	113	17	44	7*9	12	5	13	5	
	M		99	7	44		-	-	-	-	
	M	785	140	51	47	2.5	9	4	8	3	
	M	740	154	57	45	4.0	7	3	8	3	
	M	830	128	32	47	4.7	9	5	10	5	
	F	590	192	127	43	3.5					1.5
3 Aug.	M	880	132	39	46	5.5	11	5	13	6	
	F	749	219	139	43	4.8					2.5
5 Aug.	F	765	218	140	43	3*0					1.5
	M	945	151	56	46	5.8	10	6	13	6	
	M	825	121	34		3.5	13	5	13	5	
	F	695	132	0	40	4.0					1.0
	F	700	132	0	43	4.0					2.0
	F	650	207	127	43	1.5					2.3
7 Aug.	M	910	121	28	43	4.1	9	4	11	8	
	M	790	216	131	42	1.0					2.0
	F	720	209	136	40	3.0					200
	M	725	143	64	42	1.7	8	3	10	2	

. ..continued

Appendix 5. Continued.

Date	Sex	Wt. (g)	Rt. Wing (ml)	Longest Primary on Rt. Wing (mm)	Rt. Tarsus (ml)	Sub Q Fat Thickness (mm)	Gonads (mm)				
							Male				Female
							Rt.		L,		
							L	W	L	W	Largest Ovum
7 Aug.	M	880	177	88	42	4.0	11	5	13	5	
	M	860	184	96	43	5.0	11	4	11	4	
9 Aug.	F	715	108	22	-	4.0					1.8
	F	642	97	8	40	2.8					2.0
	M	840	207	133**	42	3.0	10	3	11	4	

*All 26 specimens have been deposited in the vertebrate collection of the University of Alaska Museum, Fairbanks, Alaska.

**Longest primary on this bird was #9; on all other birds was #10.

Appendix 6. Fullness of 25 oldsquaw stomachs collected in the vicinity of Thetis Island, Alaska, during 27 July to 9 August 1980.

Bird #	Hynes Point Fullness Classification	Stomach Contents*
1	2	
2	2	
3	1	
4	1	
5	1	
6	1	
7	1	
8	1	
9	1	
10	1	
11	1	
12	1	
13	12	*Mysis* sp. and *Onisimus* Sp.
15	1	
16	2	
17	3	
18	9	*Apherusa* sp.
19	10	*Apherusa* sp.
20	2	
21	2	
22	3	
23	2	
24	1	
25		
26	-	
27	3	

*See Griffiths *et al.* 1975 for a description of the Hynes Pt. method of assessing stomach fullness. See Johnson and Richardson 1981 for descriptions of modification of this technique as we have applied it to oldsquaw stomachs.

Appendix 7. Thetis Island weather, 2200 h ADT 21 July 1980 to 1000 h ADT 9 August 1980.

1*	2	3	4	5	6	7	8	9	10	11
1	0.9	0.2	-0.6	1.0	22.5	14.5	17.3	50.	10	Fog
10	0.6	0.2	-1.1	0.8	9.7	9.7	-0.0	360.	10	Fog
16	0.6	0.2	2.2	21.0	3.2	3.2	-0.0	360.	00	Clear
24	0.6	0.2	0.3	21.0	17.7	13.6	11.4	40.	08	Clear
37	0.6	0.2	1.1	21.0	7.2	2.5	6.8	70.	09	From SW
40	0.3	0.2	3.3	21.0	4.8	3.7	3.1	40.	08	
31	0.3	0.2	0.6	21.0	9.7	9.5	-1.7	350.	10	Ovrcst
59	0.3	0.2	4.4	0.2	9.7	-1.7	-9.5	260.	10	Fog
64	0.2	0.2	5.6	11.2	3.2	0.0	3.2	90.	04	Pt Cldy
71	0.	0.	11.7	21.0	10.1	-8.8	-5.1	210.	10	Ovrcst
80	0.	0.	5.6	0.1	11.3	5.6	-9.8	300.	10	Fog
90	0.3	0.5	3.4	21.0	20.9	7.2	-19.7	290.	00	Clear
96	0.	0.3	4.4	1.6	16.1	-13.9	-8.0	210.	10	Fog
101	0.	1.1	2.8	1.0	24.1	-15.5	-18.5	230.	10	Ovrcst
103	0.2	0.2	1.7	21.0	8.0	1.4	-7.9	280.	10	Ovrcst
113	0.	0.	5.0	21.0	8.0	7.6	-2.8	340.	10	Ovrcst
122	0.2	0.	2.8	11.2	12.1	6.9	9.9	55.	10	Ovrcst
128	0.3	0.	1.7	14.4	19.3	11.1	15.8	55.	10	Ovrcst
139	0.3	0.	0.6	21.0	16.1	9.2	13.2	55.	999	Cld Lat
145	0.9	0.2	0.0	21.0	24.1	23.8	4.2	10.	999	
151	0.6	0.2	-0.6	14.4	29.0	16.6	23.7	55.	09	
168	0.6	0.2	-0.6	21.0	26.6	4.6	26.2	80.	10	Ovrcst
176	0.6	0.2	-1.1	14.4	27.4	4.8	26.9	80.	10	Ovrcst
187	0.5	0.2	1.1	11.2	12.1	10.5	6.0	30.	10	
192	0.8	0.2	0.6	16.0	30.6	5.3	30.1	80.	10	Lt Prcip
200	0.7	0.2	0.6	3.2	38.6	19.3	33.4	60.	10	Fog
208	0.3	0.	2.2	11.2	13.7	8.8	10.5	50.	999	
216	0.8	0.2	1.6	8.0	30.6	-5.3	30.1	100.	10	
224	0.5	0.2	1.1	11.2	24.1	12.1	20.9	60.	999	
240	0.5	0.2	-0.6	0.8	16.1	8.0	13.9	60.	10	Fog
233	0.8	0.	-0.6	3.2	14.5	7.2	12.5	60.	10	Ovrcst
248	0.3	0.	-0.6	11.2	11.3	3.9	10.6	70.	10	Ovrcst
256	0.2	0.	1.1	1.6	12.9	4.4	12.1	70.	07	Fog
264	0.2	0.	1.1	1.6	24.1	0.0	24.1	90.	10	Fog
272	0.3	0.	1.1	0.4	10.5	5.2	9.1	60.	10	Fog
281	0.2	0.	2.2	1.6	17.7	6.1	16.6	70.	10	Fog

. ..continued

Appendix 7. Continued.

1*	2	3	4	5	6	7	8	9	10	11
288	0.2	0.	2.2	21.0	4.8	1.7	4.5	70.	07	
297	0.	0.	3.3	21.0	2.4	-0.4	-2.4	260.	10	Ovrcst
304	0.3	0.2	4.4	2.2	12.9	6.4	-11.1	300.	999	Fog
312	0.5	0.6	1.7	999	14.5	12.5	-7.2	330.	10	Fog
320	0.2	0.2	0.6	1.6	12.9	-0.0	-12.9	270.	10	Mist
328	0.2	0.2	2.8	21.0	4.8	4.5	1.7	20.	09	
336	0.6	0.2	2.2	11.2	20.9	7.2	19.7	70.	08	
344	0.6	0.2	3.99	999	17.7	6.1	16.6	70.	08	
352	0.2	0.2	8.3	999	9.7	4.8	8.4	60.	09	
361	0.2	0.2	7.8	999	11.3	4.8	10.2	65.	06	Endwatch
370	0.2	0.2	10.0	999	8.9	-8.3	-3.0	200.	10	
376	0.	0.	7.8	21.0	0.	0.	0.	0.	10	Calm
376	0.5	0.3	5.6	0.2	17.7	15.3	-8.9	330.	10	Fog
386	0.6	0.2	4.4	16.0	17.7	17.7	-0.0	360.	10	Fog/Rain
396	0.5	0.2	3.9	0.2	8.9	8.9	-0.0	360.	10	Fog/Mist
404	0.3	0.2	3.3	21.0	8.0	8.0	-0.0	360.	999	
409	0.2	0.2	2.2	16.0	8.9	6.8	5.7	40.	10	Lt Rain
420	0.5	0.2	2.2	1.6	14.5	13.6	5.0	20.	999	
426	0.5	0.2	2.8	0.4	17.7	16.6	6.1	20.	10	Fog
435	0.5	0.2	1.7	0.8	14.5	12.5	7.2	30.	10	
445	0.4	0.2	3.9	21.0	12.6	6.3	10.9	60.	999	
450	0.5	0.2	3.3	21.0	13.7	6.8	11".8	60.	999	
456	0.5	0.2	2,8	0.1	25.7	4.5	25.4	80.	10	F o g
468	0.8	0.3	3.7	1.0	26.6	9.1	25.0	70.	10	Fog

*1=hour of study; 2=wave ht (m} on seaward side of Thetis Island; 3=waveht (m) on leeward side of Thetis Island; 4=Temp (“C); 5= visibility (miles); 6=wind speed (km/hr); 7=N component of wind; 8=E component of wind; 9=wind direction (° origin); 10=cloud cover or opacity (%); 11=comments; 999=not recorded or unknown.

Appendix 8. Total counts of oldsquaws around Thetis Island, Alaska, 22 July to 9 August 1980.

Date	Total Number of Birds					
	Morning*			Evening**		
	E†	W	Total	E	W	Total
July 22	2916	475	3391			
23	1958	1630	3588			
24	-	-	-			
25	1748	870	2618			
26	1903	1911	3814			
27	1106	-				
28	1033	2050	3083			
29	633		-	2530	1080	3610
30	275	215	490	2560	1345	3905
31	577	75	652	601	1130	1731
August 1	1982	800	2782	1023	1668	2691
2	310	132	442		1100	
3		1270		706	360	1066
4		-		1700	941	2641
5		460		872	1270	2142
6	2945	2775	5720	1245	1600	2845
7	2301	724	3025	1675	2975	4650
8	669	510	1179	1941	2172	4113
9	575	385	980	626	1212	1838
$\bar{x}$	1397	952	2443	1407	1404	2839
±s.d.	911.7	804.6	1593.9	724.2	660.7	1120.4

*0530 h ADT to 1300 h ADT.

**1930 h ADT to 2330 h ADT.

†E=east half of island, W=west half.

Appendix 9. Relative proportion of male and female oldsquaws and those birds classified as resting, preening, moving and feeding in beach habitat in Area 2.

1*	2	3	4	5	6	7
121	100.0	0.0	0.0	0.0	82.4	17.6
122	96.6	2.3	1.1	0.0	94.9	5.1
123	92.8	5.6	1.6	0.0		
124	98.4	0.8	0.8	0.0		
125	98.4	1.6	0.0	0.0		
126	96.8	2.4	0.8	0.0		
128	96.8	0.8	2.4	0.0		
138					94.5	5.5
139	73.3	26.0	0.8	0.0	97.7	2.3
140	83.8	14.9	1.4	0.0	94*4	5.6
141	91.9	8.1	0.0	0.0	-	
142	77.9	22.1	0.0	0.0	85.7	14.3
143	88.7	10.7	0.7	0.0		
144	87.5	12.0	0.5	0.0	98.2	1.8
146	0.0	100.0	0.0	0.0		
147	0.0	100.0	0.0	0.0	100.0	0.0
148	86.1	13.9	0.0	0.0		
151	97.6	1.6	0.8	0.0	72.0	28.0
154	70.5	18.0	0.0	11.5	90.2	9.8
156	56.3	43.7	0.0	0.0	83.1	16.9
157	42.3	40.8	16.9	0.0	73.2	26.8
159	53.4	45.1	1.5	0.0	86.5	13.5
160	70.8	25.3	2.6	1.3		-
162	1.8	98.2	0.0	0.0	97.4	2.6
163	39.2	60.0	0.8	0.0	97.6	2.4
164	93.3	6.7	0.0	0.0	89.0	11.0
165	90.9	7.6	1.5	0.0	88.0	12.0
166	95.3	4.3	0.3	0.0	95.2	4.8
167	10.0	90.0	0.0	0.0	98.1	1.9
168	0.0	100.0	0.0	0.0		-
169	65.6	34.4	0.0	0.0	97.7	2.3
170	94.7	5.3	0.0	0.0	96.7	3.3
171	99.3	0.7	0.0	0.0	99.3	0.7
172	48.3	51.7	0.0	0.0	99.3	0.7
173	96.7	3.3	0.0	0.0	100.0	0.0
174	59.8	39.7	0.0	0.4	97.5	2.5
175	80.6	18.9	0.6	0.0	97.3	2.7

. ..continued

Appendix 9. Continued.

1*	2	3	4	5	6	7
181	71.7	28.3	0.0	0.0	97.2	2.8
182	45.1	54.9	0.0	0.0	86.6	13.4
183	72.3	25.5	2.1	0.0		
184	79.7	20.3	0.0	0.0	93.7	6.3
186	11.3	72.6	16.0	0.0	88.7	11.3
187	84.0	12.8	3.2	0.0	93.6	6.4
188	94".7	4.0	1.3	0.0	91.3	8.7
189	88.8	10.4	0.8	0.0	94.4	5.6
190	0.0	100.0	0.0	0.0		
191	0.0	100.0	0.0	0.0		-
192	92.7	4.7	2.7	0.0	74.4	25.6
194	64.1	35.9	0.0	0.0	80.0	20.0
195	68.9	31.1	0.0	0.0	95.8	4.2
196	95.8	4.2	0.0	0.0	91.1	8.9
198	55.4	44.6	0.0	0.0	93.8	6.3
200	98.5	1,5	0.0	0.0	-	-
202	45.0	55.0	0.0	0.0	95.0	5.0
204	48.2	43.9	3.5	4.4	91.9	8.1
205	80.0	15.9	0.5	3.6	93.8	6.2
206	57.0	43.0	0.0	0.0	89.0	11.0
207	63.3	34.0	0.0	2.7		
208	64.7	34.7	0.0	0.7		-
210	0.0	100.0	0.0	0.0	76.9	23.1
211	8.4	91.6	0.0	0.0		
212	86.4	5.6	8.0	0.0	77.6	22.4
213	0.0	100.0	0.0	0.0	66.5	33.5
214	0.0	100.0	0.0	0.0		
215	8.1	88.1	3.8	0.0		
216	25.9	74.1	0.0	0.0		
217	48.0	52.0	0.0	0.0	75.7	24.3
218	89.3	10.7	0.0	0.0	74.4	25.6
219	96.7	3.3	0.0	0.0	96.7	3.3
220	96.0	4.0	0.0	0.0	90.0	10.0
221	92.7	7.3	0.0	0.0	88.9	11.1
222	90.7	9.3	0.0	0.0	85.0	15.0
223	39.3	60.7	0.0	0.0	56.3	43.7
224	90.0	10.0	0.0	0.0	84.4	15.6
226	23.8	76.2	0.0	0.0	79.4	20.6
227	36.6	63.4	0.0	0.0	76.1	23.9

. ..continued

Appendix 9. Continued.

1*	2	3	4	5	6	7
228	84.0	16.0	0.0	0.0	88.7	11.3
229	69.9	28.3	1.8	0.0	81.4	18.6
230	89.7	10.3	0.0	0.0	91.9	8.1
231	91.3	8.7	0.0	0.0		
232	91.3	8.7	0.0	0.0		-
233	53.1	46.9	0.0	0.0	88.8	11.3
234	85.6	10.4	4.0	0.0	94.4	5.6
235	0.0	100.0	0.0	0.0	-	-
247	89.8	10.2	0.0	0.0	88.3	11.7
248	88.3	10.0	1.7	0.0		
250	23.9	76.1	0.0	0.0	77.5	22.5
251	20.0	80.0	0.0	0.0		
252	70.3	29.7	0.0	0.0		
253	68.3	31.7	0.0	0.0		
254	61.7	38.3	0.0	0.0	75.0	25.0
257	58.6	39.7	1.7	0.0		
258	90.0	10.0	0.0	0.0	-	-
259	87.5	10.8	1.7	0.0	85.6	14.4
260	85.3	14.7	0.0	0.0	86.7	13.3
263					60.0	40.0
265	70.1	29.9	0.0	0.0	85.2	14.8
280	79.5	20.5	0.0	0.0		
281	65.6	34.4	0.0	0.0	92.6	7.4
282	81.4	18.6	0.0	0.0	90.5	9.5
283	85.8	14.2	0.0	0.0	91.0	9.0
285	77.9	22.1	0.0	0.0	60.8	39.2
286	79.7	20.3	0.0	0.0	31.2	68.8
287	94.7	5.3	0.0	0.0		
288	96.0	4.0	0.0	0.0		
333	66.4	33.6	0.0	0.0	69.2	30.8
334	77.5	22.5	0.0	0.0	32.6	67.4
338	64.7	35.3	0.0	0.0		
339	91.9	5.1	3.0	0.0	3.0	97.0
340	95.5	3.2	1.3	0.0	18.7	81.3
357	82.5	17.5	0.0	0.0	21.3	78.7
358	87.4	12.6	0.0	0.0	40.5	59.5
359	96.6	3.4	0.0	0.0	43.8	56.2
360	92.5	7.5	0.0	0.0	14.0	86.0

*1=hour of study; 2=percent resting; 3=percent preening; 4=percent moving or traveling; 5=percent feeding; 6=percent males; 7=percent females.

Appendix 10. Relative proportion of male and female oldsquaws and those birds classified as resting, preening, moving and feeding in nearshore habitat in Area 2.

1*	2	3	4	5	6	7
122	98.4	0.8	0.8	0.0	92.8	7.2
124	99.2	0.0	0.8	0.0	-	
125	99.0	0.0	1.0	0.0	96.0	4.0
128	93.6	6.4	0.0	0.0	-	
138	87.5	5.7	6.8	0.0	97.0	3.0
139	94.9	2.1	2.4	0.6	99.5	0.5
140	99.3	0.4	0.2	0.0	98.5	1.5
141	96.4	3.3	0.2	0.0	99.3	0.7
142	95.3	0.7	1.3	2.7	100.0	0.0
143	86.1	8.2	5.2	0.4	99.1	0.9
144	86.7	8.7	2.7	2.0	97.3	2.7
146	91.0	1.0	8.0	0.0	92.0	8.0
147	95.2	2.4	1.6	0.8	95.0	5.0
151	96.0	0.8	2.4	0.8	96.0	4.0
154	61.8	7.3	30.9	0.0	85.5	14.5
155	83.5	3.9	8.7	3.9	95.3	4.7
156	90.3	1.6	6.5	1.6	94.4	5.6
157	87.1	6.8	3.0	3.0		
158	94.7	2.7	1.3	1.3		-
159	68.2	11.4	17.0	3.4	88.6	11.4
160	65.4	25.0	5.8	3.8	97.1	2.9
162	75.6	6.4	2.6	15.4	94.9	5.1
163	92.7	4.7	2.5	0.0	99.6	0.4
164	82.9	8.7	7.6	0.7	97.8	2.2
165	93.5	4.0	2.2	0.4	97.8	2.2
166	92.0	5.8	1.5	0.7	99.6	0.4
167	92.0	6.2	0.4	1.5	98.4	1.6
168	93.5	6.1	0.4	0.0	94.3	5.7
169	79.9	9.0	9.7	1.4	100.0	0.0
170	75.7	20.8	2.8	0.7	99.3	0.7
171	95.3	4.7	0.0	0.0	99.2	0.8
172	95.3	4.7	0.0	0.0	100.0	0.0
173	96.7	3.3	0.0	0.0	100.0	0.0
174	94.0	5.3	0.0	0.7	98.7	1.3
175	77.2	8.7	11.4	2.7	98.0	2.0
176	93.3	6.7	0.0	0.0	97.3	2.7
179	71.2	15.4	7.7	5.8	98.1	1.9

...continued

Appendix 10. Continued.

1*	2	3	4	5	6	7
180	92.0	5.3	2.7	0.0		
181	75.9	6.9	9.2	8.0	93.1	6.9
182	83.6	9.9	2.0	4.6		
183	76.0	12.7	6.7	4.7		
184	77.3	13.3	2.0	7.3		
185	58.6	41.4	0.0	0.0		
186	82.5	3.6	5.1	8.8		
187	96.8	1.6	1.6	0.0	98.7	2.3
188	94.4	4.0	1.6	0.0	99.2	0.8
189	100.0	0.0	0.0	0.0	100.0	0.0
190	88.0	4.8	7.2	0.0	96.0	4.0
191	96.0	0.8	3.2	0.0	98.4	1.6
192	97.3	0.0	1.3	1.3	100.0	0.0
193	82.0	4.0	14.0	0.0	91.3	8.7
194	88.7	11.3	0.0	0.0	86.1	13.9
195	98.7	1.3	0.0	0.0	98.0	2.0
196	94.7	0.7	4.7	0.0	98.0	2.0
198	98.7	1.3	0.0	0.0	90.7	9.3
200	99.3	0.7	0.0	0.0	90.5	9.5
201	85.3	2.9	7.4	4.4	98.5	1.5
203	85.3	4.7	8.0	2.0		
204	78.0	7.3	9.3	5.3		
205	80.6	5.8	9.7	3.9	92.2	7.8
206	85.3	11.3	3.3	0.0		
207	78.5	11.4	9.5	0.6	-	
208	69.6	16.3	8.1	5.9	94.1	5.9
209	0.0	0.0	100.0	0.0	77.7	22.3
210	92.0	4.0	4.0	0.0	100.0	0.0
211	87.2	5.6	6.8	0.4	86.8	13.2
212	96.0	1.6	1.6	0.8	95.2	4.8
213	96.8	1.6	1.6	0.0	98.4	1.6
214	92.0	5.6	2.4	0.0	98.4	1.6
215	92.8	1.6	5.6	0.0	97.6	2.4
216	96.8	3.2	0.0	0.0	96.0	4.0
217	83.3	16.7	0.0	0.0	96.0	4.0
218	90.7	7.3	1.3	0.7	86.0	14.0
219	94.0	4.7	0.7	0.7	90.0	10.0
220	98.7	1.3	0.0	0.0	100.0	0.0
221	95.3	2.0	2.7	0.0	97.8	2.2

. ..continued

Appendix 10. Continued.

1*	2	3	4	5	6	7
222	95.3	4.7	0.0	0.0	93.3	6.7
223	60.0	14.7	20.0	5.3	65.8	34.2
224	92.7	6.7	0.7	0.0	94.7	5.3
225	94.3	1.9	3.8	0.0	-	-
226	67.1	10.1	22.8	0.0	92.4	7.6
227	84.3	9.4	5.9	0.4	95.6	4.4
228	85.0	3.9	6.7	4.4	93.3	6.7
229	84.0	4.1	6.8	5.0	95.9	4.1
230	72.5	13.2	12.1	2.2	95.6	4.4
231	83.5	0.5	0.5	15.5	92.0	8.0
232	75.4	12.8	8.3	3.5	95.5	4.5
233	62.8	20.5	16.7	0.0	87.2	12.8
234	75.2	6.4	13.6	4.8	96.8	3.2
235	88.8	11.2	0.0	0.0	96.8	3.2
241	82.8	6.9	10.3	0.0		
242	25.0	64.8	10.2	0.0		
244	91.8	2.7	4.5	0.9		-
245	84.5	6.9	1.7	6.9	100.0	0.0
247	87.1	8.1	4.8	0.0	100.0	0.0
248	94.2	1.7	4.2	0.0		
250	63.3	22.4	11.9	2.4	91.0	9.0
251	83.4	4.0	8.5	4.0		
252	78.0	13.2	6.9	1.9		
253	73.9	7.2	18.8	0.0		
254	81.1	4.9	11.6	2.4		
258	72.6	22.6	3.6	1.2		
260	96.0	2.0	2.0	0.0	95.3	4.7
262	97.5	0.8	1.7	0.0		
263	96.7	2.0	1.3	0.0		
265	68.2	9.0	21.4	1.5		
267	91.5	0.0	8.5	0.0		
270	88.7	8.1	2.4	0.8		
276	96.9	1.6	0.0	1.6		
280	76.9	15.4	6.2	1.5		
281	80.1	11.4	7.8	0.6	96.4	3.6
282	73.5	9.5	12.8	4.3	98.1	1.9
283	80.3	11.3	8.4	0.0		
284	64.3	6.3	28.6	0.8	88.9	11.1
285	70.9	11.8	17.3	0.0	95.5	4.5

. ..continued

Appendix 10. Continued.

1*	2	3	4	5	6	7
287	**24.1**	20.7	43.1	**12.1**	-	
288	**31.3**	14.8	53.0	0.9	**90.4**	9.6
336	**9.7**	0.6	89.6	0.0	54.0	46.0
337	**92.3**	0.5	6.7	0.5	77.7	22.3
338	**82.8**	4.9	11.5	0.8	81.1	18.9
339	**92.6**	4.0	3.4.	0.0	79.2	20.8
340	**74.9**	19.0	6.1	0.0	91.3	8.7
341	**94.3**	3.9	**1.8**	0.0	96.8	**3.2**
342	**95.4**	4.6	**0.0**	0.0	83.4	**16.6**
360	**98.2**	1.8	0.0	0.0	75.0	25.0

*1=hour of study; 2=percent resting; 3=percent preening, 4=percent moving or traveling; 5=percent feeding; 6=percent males; 7=percent females.

Appendix 11. Relative proportion of male and female oldsquaws and those birds classified as resting, preening, moving and feeding in offshore habitat in Area 2.

1*	2	3	4	5	6	7
121	76.0	1.7	22.3	0.0	96.0	4.0
125	92.0	4.0	4.0	0.0		
126	99.2	0.0	0.8	0.0		
128	89.6	0.8	0.8	8.8		
137	76.8	1.1	4.2	17.9		
138	84.1	3.4	0.0	12.5		
147	31.7	0.0	6.7	61.7		
156					96.4	3.6
161	70.3	1.3	18.2	10.2		
162	39.6	3.8	11.3	45.3		
163					0.0	100.0
164	58.4	0.0	19.5	22.1		
165	59.9	2.0	10.5	27.6		
166	0.0	100.0	0.0	0.0		
166	60.0	0.0	40.0	0.0		
167	20.0	0.0	46.2	33.8		
168	95.2	4.0	0.8	0.0	87.2	12.8
169	63.2	3.7	24.3	8.8	99.1	0.9
179					98.9	1.1
181					98.8	1.3
190	59.1	4.4	21.9	14.6		-
191	4.2	1.4	85.9	8.5	97.1	2.9
192	99.1	0.9	0.0	0.0		
193	90.2	2.5	3.3	4.1		-
194	58.2	2.7	22.7	16.4	97.1	2.9
198	85.8	4.2	2.5	7.5	100.0	0.0
207					98.1	1.9
210	45.0	0.0	26.7	28.3		
211	63.8	1.3	18.1	16.9		
212	57.1	0.0	9.2	33.7		
213	80.2	1.6	1.6	16.7	98.4	1.6
214	72.6	1.1	21.3	5.0		
215	72.2	0.0	27.8	0.0	96.1	3.9
216	84.1	0.0	9.0	6.9		
217	71.7	1.7	26.7	0.0	94.2	5.8
218	69.7	0.0	28.7	1.6	91.0	9.0
222	84.7	5.3	3.3	6.7		

. ..continued

Appendix 11. Continued.

1*	2	3	4	5	6	7
224	73.6	9.9	4.1	12.4	90.8	9.2
225	86.7	1.1	1.1	11.1	-	-
233	42.7	0.0	24.5	32.7	100.0	0.0
234	17.0	0.0	72.3	10.6		
235	17.9	0.0	33.7	48.4		
251	82.8	0.0	6.5	10.8		
253	87.7	0.0	10.5	1.8		
254	78.9	10.6	9.9	0.7		
257	18.0	0.0	24.0	58.0		
262	83.9	2.8	10.0	3.3		
263	81.7	2.5	15.0	0.8		
270	98.0	2.0	0.0	0.0		
281	74.2	1.6	11.3	12.9		
284	87.4	1.9	8.9	1.7		-
286	11.1	1.4	34.7	52.8	97.2	2.8
288	66.7	0.0	9.8	23.5		
289	92.7	4.9	0.7	1.6		
297	34.4	1.6	10.4	53.6	95.2	4.8
298	36.0	3.0	1.0	60.0	96.0	4.0
299	35.2	3.2	1.6	60.0	92.8	7.2
300	48.0	1.6	7.2	43.2	97.6	2.4
301	60.0	5.6	4.0	30.4	95.2	4.8
302	30.6	0.0	9.3	60.2	89.8	10.2
303	68.9	0.0	3.3	27.8	94.4	5.6
304	18.3	1.0	11.5	69.2	84.6	15.4
306	73.2	14.8	8.6	3.3		-
307	68.8	14.6	1.5	15.1	87.0	13.0
308	57.5	22.8	11.4	8.4	94.8	5.2
309	92.2	5.2	2.1	0.5	85.2	14.8
310	90.7	5.3	0.0	4.0	83.3	16.7
311	90,4	6.3	1.9	1.4	88.8	11.2
312	90.6	5.0	3.9	0.6	79.6	20.4
313	0.0	0.0	100.0	0.0	93.6	6.4
314	51.6	0.0	40.5	7.9		
315	2.4	3.2	94.4	0.0		
316	54.4	2.4	38.4	4.8		
317	89.6	4.8	4.0	1.6	93.6	6.4
318	24.8	3.2	68.0	4.0		-
319	16.1	0.8	5.1	78.0	98.3	1.7

. ..continued

Appendix 11. Continued.

1*	2	3	4	5	6	7
322			-	-	94.1	5.9
324	86.0	5.8	1.2	7.0		
331	5.8	38.5	19.2	36.5		
334	21.6	6.8	35.2	36.4	65.7	34.3
345	69.8	1.6	7.1	21.4		
346	87.3	1.6	3.2	7.9		
347	64.3	3.5	2.6	29.6	71.0	29.0
348	89.2	0.0	0.0	10.8		
349	89.1	0.0	0.0	10.9		
351	40.4	3.8	13.5	42.3	84.6	15.4
352	56.4	6.4	1.6	35.6	85.2	14.8
355	5.7	7.5	24.5	62.3		
356	24.6	7.7	33.8	33.8		
357	23.4	32.8	9.4	34.4		
360	98.3	0.0	1.7	0.0	69.0	31.0
408	89.3	0.0	7.9	2.9		

*1=hour of study; 2=percent resting; 3=percent preening; 4=percent moving or traveling; 5=percent feeding; 6=percent males; 7=percent females.

Appendix 12. Relative proportion of male and female oldsquaws and those birds classified as resting, preening, moving and feeding in Area 1.

1*	2	3	4	5	6	7
121	80.0	9.0	11.0	0.0	44.3	55.7
122	98.3	0.6	1.2	0.0	66.3	33.7
124	97.4	2.6	0.0	0.0		
125	95.6	1.5	2.9	0.0		
126	87.9	7.9	4.3	0.0		
139	83.7	16.3	0.0	0.0	78.7	21.3
140	92.3	7.7	0.0	0.0		
141	96.3	3.7	0.0	0.0		
143	93.0	7.0	0.0	0.0		
144	72.5	27.5	0.0	0.0	86.8	13.2
147	87.1	8.6	4.3	0.0	50.7	49.3
148	94.4	2.4	3.2	0.0		
163	79.1	19.8	1.2	0.0	89.7	10.3
165	88.3	10.2	1.6	0.0		
166	88.2	11.8	0.0	0.0	-	
167	95.6	4.4	0.0	0.0	87.8	12.2
168	-	-	-	-	87.5	12.5
187	92.5	5.7	1.9	0.0	88.7	11.3
190	90.0	8.8	1.3	0.0	57.5	42.5
191	96.6	2.8	0.7	0.0	49.0	51.0
192	98.1	1.9	0.0	0.0	46.6	53.4
220	61.1	38.9	0.0	0.0	-	-
245	53.6	46.4	0.0	0.0	64.3	35.7
259	73.1	26.9	0.0	0.0		
285	89.9	10.1	0.0	0.0		
286	65.7	34.3	0.0	0.0	65.7	34.3
287	97.3	2.7	0.0	0.0	-	
288	27.9	72.1	0.0	0.0	64.0	36.0
290	81.0	19.0	0.0	0.0	10.8	89.2
291	16.5	81.0	1.3	1.3		-
292	92.6	7.4	0.0	0.0	40.4	59.6
293	0.0	100.0	0.0	0.0		
295	89.2	5.8	5.0	0.0	67.5	32.5
296	88.7	11.3	0.0	0.0	74.0	26.0
303	68.0	31.2	0.8	0.0	78.4	21.6
304	63.6	36.4	0.0	0.0		
306	96.8	3.2	0.0	0.0		

. ..continued

Appendix 12. Continued.

1*	2	3	4	5	6	7
307	94.9	4.5	0.6	0.0	88.1	11.9
308	92.5	7.5	0.0	0.0	94.3	5.7
309	100.0	0.0	0.0	0.0	90.1	9.9
310	79.6	20.4	0.0	0.0	74.5	25.5
311	90.0	8.6	1.5	0.0	75.8	24.2
312	94.4	5.6	0.0	0.0	67.8	32.2
313	56.9	41.4	1.7	0.0		
314	61.9	38.1	0.0	0.0		
318	56.6	43.4	0.0	0.0		
319	54.4	43.7	1.9	0.0	77.7	22.3
321	70.1	29.9	0.0	0.0	83.6	16.4
322	57.1	42.9	0.0	0.0	74.3	25.7
325	61.4	38.0	0.6	0.0	81.5	18.5
326	88.8	11.2	0.0	0.0	88.5	11.5
327	68.3	30.2	1.4	0.0	65.4	34.6
328	93.7	5.8	0.5	0.0	54.8	45.2
333	66.7	33.3	0.0	0.0	56.1	43.9
335	85.9	14.1	0.0	0.0	44.5	55.5
336	96.0	4.0	0.0	0.0	26.0	74.0
358	50.9	49.1	0.0	0.0	35.8	64.2
359	71.2	28.8	0.0	0.0	53.2	46.8
360	98.6	1.4	0.0	0.0	33.3	66.7
407	61.7	36.7	1.7	0.0	38.3	61.7
408	78.5	15.1	6.5	0.0	69.9	30.1

*1=hour of study; 2=percent resting; 3=percent preening, 4=percent moving or traveling; 5=percent feeding; 6=percent males; 7=percent females.

Appendix 13. Relative proportion of male and female oldsquaws and those birds classified as resting, preening, moving and feeding in nearshore habitat in Area 1.

1*	2	3	4	5	6	7
123	96.0	0.0	4.0	0.0		
138	85.4	2.4	0.0	12.2		
139	83.6	13.1	3.3	0.0		
143	34.0	13.2	22.6	30.2	-	-
148	94.7	0.0	4.0	1.3	92.8	7.2
151	94.2	0.0	3.8	1.9		
162	84.1	7.2	5.1	3.6	-	-
164	95.8	0.8	0.0	3.3	70.2	29.8
165	78.4	1.1	15.9	4.5		
166	89.3	5.4	1.3	4.0	-	
167	92.6	2.0	0.0	5.4		
169	0.0	2.3	96.6	1.1		-
171	86.9	6.2	6.2	0.7	98.6	1.4
172	93.3	5.0	0.8	0.8	98.3	1.7
174	94.0	1.3	4.7	0.0	96.0	4.0
189	97.0	0.0	3.0	0.0	97.0	3.0
193	97.0	0.0	2.0	1.0	35.6	64.4
241	86.2	1.5	4.6	7.7		
248	44.0	20.0	34.0	2.0	58.2	41.8
261	91.5	5.1	1.7	1.7		
271	84.0	8.0	2.7	5.3		
272	81.4	2.9	7.1	8.6		
285	26.7	0.0	68.3	5.0		
286	82.0	6.0	6.0	6.0		
287	82.7	4.0	6.7	6.7	100.0	0.0
288	57.6	1.5	40.9	0.0	-	
290	88.9	3.3	7.8	0.0	62.0	38.0
292	94.7	3.3	2.0	0.0	78.0	22.0
296	65.0	3.3	30.0	1.7	78.3	21.7.
303	13.7	3.9	3.9	78.4		
304	31.6	3.5	7.0	57.9		
306	43.3	21.7	30.0	5.0		-
308	87.5	4.5	2.3	5.7	95.5	4.5
309	82.3	6.4	4.3	7.1	95.7	4.3
310	87.3	5.6	2.0	5.1	91.8	8.2
312	98.3	0.8	0.0	0.8	99.2	0.8
313	7.9	7.2	84.9	0.0		

. ..continued

Appendix 13. Continued.

1*	2	3	4	5	6	7
314	74.7	0.6	14.4	10.3		
315	24.0	1.6	71.2	3.2		
316	84.9	0.8	12.7	1.6		
317	96.7	0.0	0.0	3.3	96.0	4.0
318	82.4	8.8	4.8	4.0	94.4	5.6
319	93.2	4.1	2.7	0.0	97.3	2.7
320	69.2	0.0	23.1	7.7	57.7	42.3
322	72.2	19.4	5.6	2.8	86.1	13.9
323	92.9	0.0	3.1	3.9	95*3	4*7
324	93.3	5.6	1.1	0.0	95.6	4.4
325	71.9	14.3	1.5	12.2	94.2	5.8
326	67.8	1.7	0.9	29.6	90..9	9.1
327	87.9	6.9	1.1	4.0	89.7	10.3
328	80.1	9.9	3.3	6.6		
329	74.0	17.3	0.7	8.0		
330	56.2	20.2	4.5	19.1		
331	50.0	15.4	15.4	19.2		
332	28.6	21.4	23.5	26.5		-
333	80.9	3.7	2.7	12.8	89.4	10.6
334	83.6	13.1	3.3	0.0	47.5	52.5
335	90.9	5.6	0.4	3.0	68.5	31.5
336	85.0	13.6	1.4	0.0	76.4	23.6
337	91.9	8.1	0.0	0.0	72.7	27.3
338	94.2	3.3	0.0	2.6	56.7	43.3
339	93.5	4.6	0.0	1.9	67.1	32.9
340	93.1	5.4	1.0	0.5	80.8	19.2
341	92.5	6.8	0.0	0.6	81.4	18.6
351	83.1	7.7	0.0	9.2	86.2	13.8
358	71.1	16.9	3.6	8.4	-	-
359	92.1	3.9	3.1	0.8	90.7	9.3
360	95.6	3.8	0.0	0.6	81.8	18.2

*1=hour of study; 2=percent resting; 3=percent preening; 4=percent moving or traveling; 5=percent feeding; 6=percent males; 7=percent females.

Appendix 14. Relative proportion of male and female oldsquaws and those birds classified as resting, preening, moving and feeding in offshore habitat in Area 1.

1*	2	3	4	5	6	7
125	-	-			52.4	47.6
146	78.2	0.0	17.2	4.6	-	
152	82.3	12.0	5.6	0.0	64.2	35.8
164	46.9	3.8	26.3	23.1		
165	24.3	0.0	41.2	34.6		
166	12.0	0.0	38.0	50.0		
167	77.9	1.0	4.8	16.3	93.4	6.6
168	9.2	0.0	18.5	72.3		-
169	82.6	3.4	8.1	6.0	98.7	1.3
175	0.0	0.0	96.8	3.2		
180					96.7	3.3
181	-	-	-	-	98.3	1.7
193	91.7	2.5	0.8	5.0	90.0	10.0
194	97.3	2.0	0.0	0.7	100.0	0.0
206					92.2	7.8
210	55.8	0.0	19.4	24.8		
211	30.7	1.3	2.7	65.3		
212	27.2	2.2	4.3	66.3		
213	78.4	1.4	5.4	14.9		
214	88.4	2.9	5.8	2.9		-
217	94.0	2.0	0.0	4.0	96.7	3.3
222	80.0	0.0	0.0	20.0		
223	87.7	4.6	0.0	7.7	-	-
226	-				93.1	6.9
227	22.0	6.0	4.0	68.0		
233	19.0	0.0	17.6	63.4		
234	52.8	1.9	26.4	18.9		
235	23.9	3.4	55.7	17.0		
249	36.8	10.3	2.9	50.0		
256	83.8	4*1	0.0	12.2		
257	79.1	4.5	4.5	11.8		
261	58.6	5.7	25.7	10.0		
285	54.2	0.0	45.8	0.0		
289	94.2	3.7	0.4	1.8		
290	78.3	6.7	14.2	0.8	75.8	24.2
297	32.8	4.8	8.0	54.4	94.4	5.6
298	29.6	3.2	12.8	54.4	94.4	5.6

. ..continued

Appendix 14. Continued.

1*	2	3	4	5	6	7
299	34.9	8.7	5.6	50.8		
300	52.8	4.0	7.2	36.0		
301	45.7	4.7	6.3	43.3	94.4	5.6
302	33.6	4.8	3.2	58.4	96.8	3.2
303	8.7	0.0	5.5	85.8		
304	17.3	0.0	8.1	74.6		
306	16.4	0.0	72.7	10.9		
307	0.0	2.6	91.3	6.1		
308	43.2	11.6	27.1	18.1	85.6	14.4
309	20.3	7.0	63.9	8.9	94.1	5.9
310	63.3	2.2	21.1	13.3	98.1	1.9
311	52.2	5.4	26.1	16.3	94.6	5.4
315	11.6	5.1	80.4	2.9		-
317	91.2	5.6	3.2	0.0	95.2	4.8
319	41.3	5.2	34.8	18.7		
320	16.7	3.1	9.4	70.8		
321	55.2	3.4	2.3	39.1		
323	56.9	3.9	13.7	25.5		
326	72.7	7.1	9.1	11.1		
327	50.5	18.7	1.9	29.0		
328	71.2	5.8	0.0	23.1		
329	19.5	1.3	55.7	23.5		
330	49.5	5.7	26.7	18.1		
331	67.9	11.5	3.8	16.7		
332	75.8	5.5	9.4	9.4		
333	60.6	2.1	14.1	23.2		
334	67.9	2.5	11.9	17.6	78.0	22.0
340	98.1	1.9	0.0	0.0		
345	71.2	1.6	9.6	17.6		
346	74.4	1.6	9.6	14.4		
347	50.4	1.6	12.8	35.2	56.0	44.0
348	58.5	0.0	4.4	37.0		
349	73.9	2.5	16.8	6.7	88.0	12.0
350	56.3	5.3	6.0	32.3	90.7	9.3
351	78.7	6.7	0.7	14.0	87.3	12.7
352	60.0	5.0	0.0	35.0		
353	46.9	18.5	6.2	28.4		
357	59.1	4.3	11.8	24.7		
358	25.4	15.7	52.2	6.7	72.4	27.6
359	76.3	20.3	1.7	1.7	87.5	12.5
407	68.4	2.7	6.6	22.3	70.9	29.1
408	39.2	0.0	8.1	52.8		

*1=hour of study; 2=percent resting; 3=percent preening; 4=percent moving or traveling; 5=percent feeding; 6=percent males; 7=percent females.

Appendix 15. Summary of information concerning diving (feeding) behavior of oldsquaws in nearshore habitats at Thetis Island, Alaska.

Sex	Number of Dives Recorded	Water Depth (m)	Time Submerged (Feeding) (s)	Time at Surface (s)
	1	-	19.6	
	5	-	27.7 ± 2.1	13.1 ± 2.6
	4	-	28.2 ± 2.0	14.6 ± 2.8
	1	-	28.7	8.4
	1	-	28.6	10.5
	1	-	28.4	11.2
	1	-	31.0	10.9
	1	-	29.1	14.7
	1	-	29.8	8.3
	1	-	28.8	8.3
	1	-	28.7	8.9
	6	-	28.3 ± 1.3	9.3 ± 1.2
F	8	~1	21.0 ± 2.1	7.9 ± 1.1
M	4	~4	25.6 ± 2.1	8.6 ± 1.1
F	1	~4	23.5	8.2
M	5	~4	26.8 ± 1.2	8.5 ± 0.9
M	1	~4	23.6	9.1
	5	-	23.2 ± 4.1	10
				14
	1	-	26.9	7
	1	-	24.4	14
	1	-	31.4	8
	1	-	30.2	7
	1	-	20.8	10
	1	-	25.9	7
	1	-	23.2	6
	1	-	25.2	20
M	3	shallow	27.5 ± 3.0	7.7 ± 1.2
M	6*	deep	29.7 ± 1.0	8.9 ± 1.5
	6	-	27.6 ± 0.8	10.5 ± 0.8
	1	-	29	8
-	1	-	31	10
F	1	-	19	21
F	5*	-	17.7 *3.9	9.8 ± 6.4
F	1	-	31	7

. ..continued

Appendix 15. Continued.

Sex	Number of Dives Recorded	Water Depth (m)	Time Submerged (Feeding) (s)	Time at Surface (s)
F	1		25	10
F	1		34	-
F	1		30	8
				10
F	3	-	26.7 ± 7.5	11.0 ± 7.9
M	1	-	39	25
M	5	-	23.8 ± 3.6	5.8 ± 1.6
Total M=6	25		27.4 ± 4.6	6.7 ± 3.1
Total F=8	22		21.3 ± 4.8	9.1 ± 3.7
Total=40	90		24.82 3.8	10.1 ± 3.9

*Same bird as in preceding row.