Olson report ?

A STUDY OF GOOSE AND BRANT NESTING ON THE YUKON-KUSKOKWIM DELTA.

INTRODUCTION

The Yukon-Kuskokwim Delta, (fig. 1), a vast marshy coastal tundra regio 20,000 square miles in extent, provides some of the finest waterfowl breeding grounds in Alaska. Aerial surveys (1949-50) indicated a population of 17 birds per square mile over the entire area, however the 800 square mile coast strip running from Igiak Bay to the south shore of Nelson Island supports a breeding population (principally Black Brant and Cackling Geese) of 130 per square mile. Preliminary studies on this strip disclose that many nests are at an elevation below the line of high, on-shore storm tides as indicated by driftwood deposits. In addition, severe nesting and brood losses from gulls, jaegers, and foxes have been reported. During June and July of 1951 an inves gation of the nesting conditions in the lower Kashunuk River region was dondu ed by Sigurd T. Olson, Wildlife Management Biologist, with the assistance of two Eskimo helpers, Matthew Peterson of Mt. Village, and Jack Paniyak of Chev Patticular emphasis was placed on the effects of gull predation and the effec of abnormally high, on-shore storm tides in addition to the collecting of nes ing data.

On June 12th, Olson was flown to Chevak by Fish and Wildlife Widgeon ai craft where an 18 foot boat, motors, and camping equipment had been stored by the Fish and Wildlife Service after the 1950 waterfowl banding season. Durin the next three days the services of the two native assistants were procured, supplies and additional equipment purchased, and the boat and motors readied for the season's work. On June 16th, the party left Chevak and proceeded to the lower Kashunuk River where a base camp was established 10 air-miles from the mouth of the river. Except for preliminary observations made enroute,

the study proper was begun on June 17th, and was terminated on July 10th. After July 10th, a waterfowl banding program was initiated. However information pertinent to the continuation of certain phases of the study was recorded during this period also.

METHODS

Initial reconnaissance of the lower Kashunuk area by motorboat June 16th and 17th revealed that the brant and goose nesting season was well underway. The study originally was designed to encompass the entire breeding season from the onset of nesting through its completion, however, unavoidable delays in transportation to the study area, coupled with an early spring (10-14 days) made this impossible. Incubation was generally found to be in its later stages for nearly all waterfowl.

Three study areas were set up with the intention of sampling the nesting population of the three fairly distinct topographic zones found to occur here, with regard to species composition, production, nesting and breed mortality due to predation and tidal action, (fig. 2). Each area was systematically searched for nests by three persons walking abreast approximately 60 yards apart and traveling back and forth until the entire study area had been covered. During the early stages of the study, vegetation had not grown tall enough to furnish adequate cover to conceal the incubating birds, (fig. 3), thus it is believed that no less than 90% of all nests on each area were located. In order to check the effect of marking nests for later reference, nests were not marked on Areas 1 and 3 during the initial survey of the three areas. Nests marked on Area 2 did not suffer any increased predation over those found and left unmarked on Areas 1 and 3, therefore on subsequent checks, all nests were marked on all areas. The nests were marked in the following manner: a small driftwood marker 8 to 10 inches high was placed not closer than 20 feet from a nest. If no stake was available, a

small hummock of mud or sod was substituted. Nests later found hatched or destroyed were further marked by driving a stake in the center of the nest in order that it would not be recounted in later checks.

Each study area was checked completely at approximately weekly intervals and as many nests relocated as possible. Records were kept on a quantitative basis rather than on individual nests because it was not always possible to relocate every nest each time. Also, because of the uniformity of the area's physical features, it was seldom possible to know which nest was which each time it was found. As little nest checking as possible was done during cold or stormy weather because of the adverse effects it might have on the eggs or young deserted even temporarily by the adults under such conditions.

Brood counts were made by boat along an established transect route extending from base camp to the mouth of the Kashunuk River and return. Only those broods that could definitely be recorded as single broods were tallied.

DESCRIPTION OF AREA 1

Area 1, one-half mile by one mile in extent, is characterized by a multitude of shallow brackish lakes and ponds ranging from tiny ponds only a few feet in diameter to sizable lakes of two or three acres area, (fig. 4.) Shorelines are vastly irregular and fow no set pattern as to size or configuration. The average water depth is two to three feet and their levels remained relativel constant during the summer. No tidal sloughs run through this area although it is touched on the southeast corner by a slough which was used to gain access to the area.

With exception of the northeastern fourth of the area, the low, wet sedge flats and meadows lie interspersed among the ponds and lakes. Occasional raised mossy hummocks or hillocks lie above the common level of the sedge flats

and vary in size from a few feet across to nearly an acre. The northern quarter and the northeastern corner in particular is somewhat raised above the elevation of the rest of the area approximately three to five feet. Here the raised mossy hummocks and hillocks are numerous and extensive, interspersed with low wet sedge flats and ponds. The vegetation on these hummocks is chief club moss, crow and salmon berry, caribou moss and lichens, dwarf birch and sedges. Along the slough banks and in the semi-raised areas scattered over the area, a species of rye-grass 10 to 20 inches tall is found growing in rather rank clumps and patches. An irregular deposit of driftwood left by a high storm tide during the fall of 1950 marks the high ground on this area, otherwise it is not regularly subject to tidal action.

DESCRIPTION OF AREA 2

Area 2, also a mile long and a half mile wide, is characterized by many small 1/10 to 1/2 acre brackish ponds 18 to 24 inches deep, which are interspe with sedge and grass flats, (fig. 6). The low wet sedge flats extend from the river bank inland approximately a fourth mile and comprise about 95 percent of the cover on that strip. The remaining 5 percent consists of isolated clumps and patches of tall grass. The sedge flat zone gradually merges into a zone of mixed sedge and grass occurring in nearly equal proportions. Toward the eastern boundary of the area however, the sedges give way to the grass in a ratio of 25 to 75 percent respectively. The grass also is found in dense stan along the banks of the sloughs and their tributaries, (fig.5). Thus it is fou along the north and south boundaries of the area. On the southwest corner of the area is a small tidal mudflat of one and one-half or two acres. This area is subject to some daily tidal action, for it borders the river and has severa small sloughs running through it.

DESCRIPTION OF AREA 3

Area 3 was the largest of the three study areas, being one square mile in extent. Located on the coast of the Bering Sea at the mouth of the Kashunuk River, it occuppied the lowest site in relation to sea level of any of the three areas under observation, figs. 7 and 8, since its extensive mud flats were subject to daily tidal action. The mosaic pattern of extensive tidal mud and sedge flats drained somewhat radially by numerous sloughs serves to characterize this area. A very slight plateau between 1 and 2 feet higher than the rest of the area lies nearly at the center of the area and is perhaps 1/3 mile squares in extent. A large open tidal flat runs nearly into the center of the area from the coast on the southwest, and another from Rankin Slough to the south. Several lesser mud flats indirectly connected with the coastal flats lie scattered over the entire area except for the slight plateau. These flats in their entirety occuppy almost half of the surface of the area. The sedge flats, raised 10 to 20 inches above the level of the mudflats grow smaller and smaller as the coast is approached, and finally become mere hummocks or tussocks a few feet in diameter studding the tidal zone in a narrow coastwise band, (fig. 9.)

The vegetation on the area is fairly uniform consisting for the most part of short sedges. Occasional patches and tussocks of tall grasses and sedges are found along the banks of the sloughs or in isolated clumps and patches. The entire area is subject to daily tidal action, and on the highest daily tide, most of the mud flats are inundated. Tidal mudflats extend seaward from the last fringe of vegetation more than a mile at this point to form a wide point.

SPECIES COMPOSITION

Cackling Geese and Black Brant, the predominant species found breeding on the lower Kashunuk River Study Area comprised 81% of the breeding population. Table 1 presents the species composition as found on the three study areas as well as for the area as a whole. The variation in species composition on the three study areas is believed to correspond to the change of habitat in relation to tidal action, elevation, and vegetation from the sea coast inland. The outstanding example of this is presented by the occurance of brant and cacklers, the former becoming ever more numerous toward the coast and the latter becoming more numerous inland. There is no definite delimiting line between the species, for they are both found utilizing the area in the vicinity of Area 2. This, however, marks the inland limit for brant for they were not found nesting on Area 1, near base camp or even as far downstream as the old fish camp above Area 2. Whitefronted Geese and Emperor Geese were known to nest inland from Area2. Pacific and Spectacled Eiders were found nesting on all three areas, but were more common towards the coast. Stellers Eiders were found nesting only on Area 2, but were also observed nesting further inland between Areas 2 and 1.

This same general pattern was true of non-breeding birds also, although scattered flocks of all species inhabiting this entire area were observed on all the study areas at various times. For example small flocks and pairs of Whitefronts and Emperors were noted feeding on Areas 2 and 3 although they were not found nesting. The same was true of brant which were occassionally seen in the vicinity of Area 1 and even inland as far as Chevak. Swans were noted in fairly large flocks (24 to 30 birds) between Chevak and the old fish camp, but were seldom seen below that point.

Table 1. Species Composition

Species	Area 1 No.	Area 1 %	Area 1 Nests/ Sq. mi	Area 2 No.	Area 2 %	Area 2 nests/ Sq. mi	Area 3 No.	Area 3 %	Area 3 nests/ Sq. mi	Total Area No.	Total Area %
Brant	--	--	--	74	54	148	49	66	49	123	40.3
Cackler	73	79	146	49	36	98	2	3	2	124	40.7
Whitefront	9	10	18	--	--	--	--	--	--	9	3.0
Emperor	2	2	4	--	--	--	--	--	--	2	.7
Whistling Swan	1	1	1	--	--	--	--	--	--	1	.3
Spec. Eider	3	3	6	8	6	16	12	16	12	23	7.5
Pacific Eider	--	--	--	2	1	4	11	15	11	13	4.2
Steller's Eider	--	--	--	3	2	6	--	--	--	3	1.0
Pintail	--	--	--	2	1	4	--	--	--	2	.7
Pacific loon	5	5	10	--	--	--	--	--	--	5	1.6
	93	100	186	138	100	376	74	100	74	305	100.0

INTERSPECIFIC RELATIONSHIPS

The various species of waterfowl breeding on the three study areas displayed a marked degree of tolerance towards one another. The nesting pattern showed a thorough interspersion of species on all areas studied, the only governing factor seeming to be site and cover. Brant and Cackler nests were found on 23 recorded instances to be within 25 feet of one another, and it was common to find them within 10 feet. One cackler was found nesting within 10 feet of a Brant on one occasion. Whitefronts, Emperors, and the eiders were scattered indescriminately over the areas wherever the site and cover met their requirments.

The only recorded instance of actual resentment toward another species of waterfowl was noted with regard to swans and Pacific loons. One of the adult swans on Area 1 was seen in vigorous pursuit of a loon which had the misfortune to have its nest on one of the ponds that the swan family had moved into after hatching. The loon desperately tried to avoid the swan's attacks but finally after 10 futile minutes of diving and evasive actions gave up and flew off, leaving the pond to the swans.

NESTING

Site and Cover Relationships

The various species of waterfowl exhibited definite preferences for certain types of nesting site and cover, see Table 2. Brant preferred the short sedge cover over tall grass, fig. 9. Fifty-five nests were situated in the sedge as opposed to only 19 in the tall grass on area 2. Thirty-eight nests were found on sedge flats, 8 on points, 2 on islets, and 5 on shores of ponds, 18 on in tall grass clumps or patches, and 1 on a tall grass islet. Note: the majority of of brant nests on Area 2 were located in the short sedge zone paralleling the river, and became less common with the increase of tall grass further inland. On Area 3,47 out of 49 brant nests were located in short sedge

cover. Choice of site was almost equally divided, 17 nests found on sedge flats, 21 on tussocks or hummocks, 4 on points, 3 on the shores of ponds, and 2 on islets. Two nests were found utilizing tall grass sites.

Cacklers on Area 1 definitely preferred short sedge cover and sites adjacent water, fig. 4; 25 sites occuppying points, 36 on islets, and even on sedge fe flats. Only 7 nests were found in the tall grass, and these too were along the edges of ponds and lakes. On Area 2 however, 34 sites were found in tall grass, only 4 of which were immediately adjacent to water, despite the fact that there were many small ponds available. Fifteen were found in the short sedge, 8 of which were adjacent to water. Seven were located on sedge flats, some as far as 75 feet from the nearest water.

Whitefronts definitely preferred clumps or patches of tall grass, usually at a distnce from water, fig. 10. Six nests were located in tall grass clumps 2 on tall grass flats adjacent to sloughs. Six of the 9 nests noted were situated in a dense clump of dead grass from the previous seasons growth while the other 2 were found in new current growths of tall grass.

Both Emperor nests were found on sites adjacent to water, one in short sedge, the other in a tall grass clump, Fig. 11.

The single Whistling Swan's nest was located on one of the higher tundra areas midway between two ponds approximately 200 feet apart, fig. 12.

Spectacled and Pacific Eiders were found nesting in a variety of situations on all three areas. They were seldom found nesting on points or islets however, seeming to prefer sedge flats or tussocks instead (3 on points, 15 on sedge flats, 12 in sedge tussocks or hummocks). The Steller's Eiders favored tall dense stands of grass in the cases of the three nests on Area 2, fig. 13.

WATERFOWL NEST PRODUCTION

On the two square miles of study area (Areas 1, 2, and 3) a total of 306 active brant, goose, duck, and loon nests were found giving an overall nesting density of 153 per square mile. This however, does not present an entirely valid picture, as nesting density varied on the three study areas both in regard to the species and area. Table 1 presents a breakdown of the nest density by species and area. It can readily be seen that Area 2 was by far the most productive of the three (276 nests per square mile), Area 3 the least productive (74 per square mile), and Area 1 about midway between (188 per square mile).

While all the reasons for the variation in density are not known, it is thought that the extensive tidal mud flats on Area 3 cut down available breeding ground by nearly half, and thus limits nesting. In a similar manner, the higher dryer mossy mounds and hummocks on Area 1 were little used as nest sites and thus the preferred nesting ground available was lessened. With the exception of a few very small mud flats, the majority of Area 2 was available as nesting site, and thus had a higher nesting population.

The extremely high nest production as indicated by the above figures more than confirms the tremendous importance of this Area as a key breeding ground, particularly in regard to cackling geese and brant. The very fact that nearly all goose, brant nesting is concentrated on this relatively limited area practically dictates that if future production is to be safeguarded and properly managed, recognition of all possible factors influencing production is necessary.

PROGRESS OF NESTING AND HATCHING

Incubation for nearly all waterfowl species was found to be in its later stages by the end of the third week in June. The first evidence of hatching was noted on June 19th when a brood of newly hatched brant were noted. On June 20th, four broods of cacklers, two of brant, and one of spectacled eider were observed. (By figuring an inclusive incubation period for all species ranging between 23 and 28 days, the onset of nesting occured between May 25 and 30.) Thereafter, the entire area appeared to explode young brant, geese and ducks. The peak of hatch came during the last week of June and the 1st week of July. Table summarizes the progress of hatching as based on approximately weekly area checks.

Table Progress of Nesting and Hatching (all species)

Period	Incubation		Hatched		Unsuccessful	
	No.	%	No.	%	No.	%
June 17-21	207	90.0	19	8.0	6	2.0
June 22-26	128	75.0	35	21.0	8	5.0
June 27-July 2	56	27.0	130	64.0	25	12.0
July 3-9	4	7.5	44	85.0	4	7.5
			227		43	

By July 10th, no known incubation was in progress on Area 1. Cackler nest was observed hatching. The final check on Area 2, July 11th revealed one brant nest and 1 pintail nest still under incubation. Both nests were in the late stages however. Two brant nests, also late in incubation remained on Area 3 at the time of the last nest check July 8th.

There appeared to be noldifference in chronology of hatching between the various species of waterfowl, with the exception of loons and oldsquaws which appeared to be approximately a week or 10 days later. Although no nesting oldsquaws were located on the study areas, the native assistants both asserted

that they were late nesters in comparison to the geese, brant, and eiders.

After July 10th, a check during banding operations of the occurrance of young less than a week old was made. By July 15th, 25 percent of young birds banded were of this group. A check made on July 20th indicated that this age class comprised not more than 5 percent. On August 1st, only 1 percent of the juveniles were less than a week old. Whether or not these late young were the result of late nesting or renesting was not determined. Inquiry of local natives in regard to renesting produced no evidence of a positive nature. There were no nests located during the last two weeks of the study that were not well along in incubation. (All new nests not previously located after the first two checks on an area were checked by floating the eggs in water to get an idea of the stage of incubation). In the future, this particular phase of nesting should be more thoroughly investigated.

NEST SUCCESS

During the study, nest histories were completed on 123 Brant nests, 124 Cackler nests, 9 Whitefront nests, 2 Emperor nests, 1 Swan nest, 39 eider nests, 2 Pintail nests, and 2 Pacific loon nests. Table summarizes the nesting data by study areas and total areas.

Brant and Cacklers, the two most important species of the coastal delta area enjoyed nesting success ratios of 79 and 73 percent respectively. The 54 percent success of the Spectacled eider is undoubtedly low due to the relatively large number of nests of unknown fate. The better success of Pacific eiders is probably more nearly correct, since both species were found nesting under similar conditions, and have practically the same nesting habits, it is very probable that their nesting sucesses should be somewhat similar.

Success data for those species for which only a few nests were found is included also, but the numbers are not large enough to be significant, and are merely presented for their face value.

Unknown fates in the case of cacklers and spectacled eiders is relatively high and could affect the success ratios in either direction. The majority of these nests were "lost" due the rapid growth of the tall grass which tended to hide the nest markers. This was especially true of cacklers which utilized the tall grass for nesting to a great extent.

No previous data on nesting success for this area is available, therefore it is impossible to know whether or not the current season was normal or not. I will however serve as a basis of comparison for the future and also furnish an index to the probable nesting success in future seasons.

Table Nest Success

Species	Area	Total nests	Successful nests	Unsuccessful nests	Fate unknown	Percent nest success
Brant	1	[illegible]	--	--	--	--
	2	74	60	13	1	81
	3	49	37	7	5	75
	total	123	97 (79%)	20 (16%)	6 (5%)	79%
Cackler	1	73	57	9	7	78
	2	49	32	4	13	65
	3	2	1	1	0	50
	total	124	90 (73%)	14 (11%)	20 (16%)	73 %
Whitefront	1	9	8	1	0	89
	2	--	--	--	--	--
	3	--	--	--	--	--
	total	9	8	1	0	89%
Emperor	1	2	1	1	0	50
	2	--	--	--	--	--
	3	--	--	--	--	--
	total	2	1	1	0	50
Swan	1	1	1	0	0	100
	2	--	--	--	--	--
	3	--	--	--	--	--
	total	1	1	0	0	100
Spectacled Eider	1	4	3	1	0	75
	2	8	4	3	1	50
	3	12	6	1	5	50
	total	24	13 (54%)	5 (21%)	6 (25%)	54%
Pacific Eider	1	--	--	--	--	--
	2	2	2	0	0	100
	3	11	9	1	1	82
	total	13	11 (85%)	1 (7.6%)	1 (7.5%)	85%
Steller's Eider	1	--	--	--	--	--
	2	3	1	1	1	33.3
	3	--	--	--	--	--
	total	3	1	1	1	33.3%
Pintail	1	--	--	--	--	--
	2	2	1	0	1	50
	3	--	--	--	--	--
	total	2	1	0	1	50%
Pacific Loon	1	5	4	0	1	80
	2	--	--	--	--	--
	3	--	--	--	--	--
	total	5	4	0	1	80%

Average clutch sizes for the various species of waterfowl found nesting on the study area are presented in Table 4-a. Averages for brant and cacklers are lower than the averages given by Kortright (1945), (5 for brant and 4 for cacklers). Averages for all other species, however, compare favorably. The reason for the smaller clutch size of brant and cacklers is not known.

Table 4-a Average clutch sizes of waterfowl found nesting on the Yukon-Kuskokwim Delta - 1951

Species	No. nests with eggs	Total no. eggs	Average clutch
Brant	116	408	3.5
Cackler	97	390	4.0
Whitefront	9	41	4.6
Emperor	2	14	7.0
Swan	1	6	6.0
Spectacled eider	19	97	5.1
Pacific eider	11	66	6.0
Stellers eider	3	21	7.0
Pintail	2	13	6.5
Pacific loon	5	10	2.0

NESTING LOSSES

Losses due to nesting failure were found to be surprisingly low during the 1951 nesting season as indicated below in Table . The possible sources of nest mortality are as follows in order of their importance:

1. Avian predation - glaucous gulls, jaegers, and shortbilled gulls
2. Flooding due to tides and storms
3. Human predation - egg collecting by natives
4. Mammalian predation - fox, mink, and weasle

Table Nesting Losses on Areas 1, 2, and

Area	Total nests found	Nests failed
1.	94	12 (13%)
2.	138	21 (15%)
3.	74	10 (13%)
Total	306	43 (14%)

Effects of Avian Predation

The majority of nesting failures were found due to glaucous gulls and jaegers. To what extent each is responsible, was not determined, however in all cases where enough evidence remained to furnish a clue to the reason for failure, avian predation was apparent. In the light of the percentages presented in Table above, it is felt that avian predation accounts for at least 10 or 12 percent of nest failures in this area. Table indicates that predation increased during the first three weeks of the study and then decreased sharply during the fourth week. The decline is probably due to the fact that by this time, the majority of nests had hatched off. It must be remembered however, that predation can at times mask desertion in that deserted nests are more liable to predation since they are unattended. It is entirely possible that some nests were deserted first and their eggs plundered later, to be eventually

checked off as predation. To what extent this actually occurred was not determined during this study.

For a detailed discussion of gull predation see the separate report covering this phase of the study.

The Effect of Tides and Storms on Nesting

The entire coastal nesting area under observation could feasibly be subject to great losses from abnormal raises in the water levels due to severe high tides, especially if driven by strong storm winds. During the 1951 season however, no such losses occurred, despite the occurrence of several abnormal tides during the first half of July.

The three study areas became progressively vulnerable towards the coast with regard to nesting losses from raises in water level. Measurements taken on Area 1 revealed that rises of two to three feet above the highest recorded high tide on June 27th would be necessary to flood the lower sedge and grass flats where mostof the nesting took place. Areas 2 and 3 however, being lower in elevation would be nearly entirely cvered by a rise in water level of two or three feet, above the highest recorded June tide in that area, fig. 14.

Inquiry made of natives with reference to the flooding of nesting areas produced a stock reply as follows: "It is an old saying that the nesting grounds of the birds are never flooded during nesting time." No native of the area could ever remember seeing the nesting grounds flooded during May, June or early July. They all agreed, however, that storm tides, usually beginning aboutthe middle of July and on through the fall created flood conditions at times. During the early fall of 1950, a severe southwest windstorm created the highest tide of the last 15 or 20 years. It flooded the entire coastal area inland as far as Chevak, leaving only the highest ground above the water. This accounts for

for the "driftwood line" that coincides roughly with the high ground just east of Area 1, fig. 15, and also accounts for the fact that all driftwood lines found on the lower areas nearer the coast in previous years were obliterated, leaving merely miscellaneous scatterings on the higher ground that followed no particular pattern of distribution.

No abnormally high tides were noted during June, but four occured during July 1951. Over July 4th and 5th, two very high night tides took place, induced by a two day windstorm from the southwest. At the base camp, between Areas 1 and 2, the water rose 10 vertical inches over the previous high recorded for the season on June 27th. A check of Areas 1 and 2 revealed no flooding or even proximity to flood conditions, as the river and sloughs remained well within their banks. Since Area 3 was the lowest of the three, it was checked most thoroughly for flooding. Debris (vegetative, driftwood, molted feathers etc.) and water marks revealed that although the mudflats and sloughs had over flowed slightly none of the nesting sites on even the lowest sedge flats and tussocks were affected, fig. 16. Eleven nests (7 brant and 4 eider), because of their proximity to tidal and coastal mudflats (all within 100 yards) were considered to be on key areas. None of these had been affected. A brant nest within 50 feet of the lar mudflat directly connected to the east flats, was still 12 inches above the high tid mark. Four nests located in the hummock and tussock zone along the coastal mud flats were all 8 to 12 inches above the high tide mark. Two days later, on the evening of July 7th, a still higher tide occurred, rising almost five inches higher than its predecessor. The key areas on Area 3 were again checked, but no evidence of flooding was found. Forty-nine additional nest sites were also checked, and all sites were still five to six inches above the highest tide marks. By this time however, only two of these nests were active, all others having either hatched or failed.

The highest tide of the 1951 season occurred on July 15th as a result of a severe windstorm which blew for two days from the southern quarter. The post-storm check of the three study areas indicated that Area 1 had not been flooded appreciably, but that Areas 2 and 3 had been partially and almost entirely flooded respectively. Check of Area 2 revealed new tidal debris forming a tide mark 150 yards inland from the river bank. Had this tide taken place three weeks earlier it would have destroyed at least 30 to 40 percent of the nesting here. Check of Area 3 showed all signs of nesting (even the nest markers) to be completely obliterated by the tide. It is estimated that 90 to 100 percent of the nests would have been lost on this Area. Conclusive evidence of the extent of flooding was furnished by a marked 55 gallon fuel oil drum originally located on Area 3 at a point a half mile inland from the Kashunuk River and a fourth mile from the coast. This same barrel was found after the high tide on Area 2, 150 yards inland on the new tide mark.

The foregoing data thus discloses that a catastrophic flooding of these important nesting grounds is not improbable. While there is little that could be done from a management standpoint to forestall such a happening, it's immediate possibility sould be kept in mind in the event that it ever does occur and consequent regulations devided to safeguard breeding stock in the future.

Effect of Human Predation

The actual effect of the human predation on nesting is not accurately known, however it is believed that with the exception of those areas surrounding native villages and fish camps, nesting suffers little as a whole. Some egg collecting is practiced according to the Eskimo assistants, but not on the scale [illegible] In recent years canneries and government constructions projects have taken a large portion of the male population of Eskimos in this area during the summer months, and with the increased income, waterfowl are not in as great demand as formerly.

Effect of Mammalian Predation

Nest failure due to fox, mink, and weasel predation in this area was neglible. Only one instance of possible fox predation on a cackler nest was noted. The only fox sign recorded during the study was found in the vicinity of an old, long abandoned Eskimo village a half mile north of Area 1. Although fox tracks were found in the mud, intensive search of the old mounds and hummocks in the vicinity failed to produce any evidence of dens. Elsewhere, searches of the raised drier sites, thought by the native assistants to be potential denning sites, produced no results. The Eskimos stated the the fox is rarely seen during the summer months on the lower wet coastal tundra, seeming instead to prefer the drier inland country. The numerous streams, tidal sloughs, and lakes tend to limit their movements according to observations made in 1950.

Mink sign was noted along the banks of the Kashunuk River and its tributary sloughs, but was not common. There is a possibility of some nest predation form this source, but none was recognized. Failure due to mink is believed to be of minor import. No weasel sign was observed.

Other

Although small, there are two factors which contribute to partial nest failure in addition to the major ones discussed above, the occurrence of of infertile eggs and eggs with embryos either too weak to pip out or too late in hatching to join the rest of the brood when the nest is abandoned doned. Seven cackler nests, 6 brant nests, and 2 eider nests were found containing infertile eggs (usually 1, rarely 2) after the successful hatch of the rest of the eggs in the clutch. Similarly, 3 brant nests, 5 cackler nests, 2 eider nests, and 1 swan nest were found containing eggs (usually 1, rarely 2) with fully developed embryos (often still alive) either partially hatched or still unhatched. These findings do not accurately represent the degree to which these phenomena occur since gulls are known to utilize the abandoned eggs as food. On several occassions gulls were found to contain rotten eggs.

BROODS

Table is a compilation of brood data arranged on an approximate weekly basis. In addition to miscellaneous brood records, kept on a daily basis, a brood transect was run by boat once during each period in an attempt to establish brood sizes as well as areas. The transect route ran from base camp to the mouth of the Kashunuk River, via Hock Slough, and return. It also included a side trip into Connection Slough, and Rankin Slough. Only those broods attended by [illegible] adults were tallied. The total number of broods for each period is a rough index to the progress of hatching, but cannot be considered an index to production since many broods could not be accurately counted for the following reasons:

1. Brant broods tended to band together in several family groups (fig.).
2. Cackler, whitefront and emperors are more wary than brant and many were totally missed or a complete tally of the entire brood was not possible.
3. Weather often governed brood activity, (on very windy days the broods stayed off the larger sloughs and rivers, remaining in the smaller sloughs and grass flats inaccessible by boat.

Brood Size

Brood sizes for the most part declined only slightly as the season progressed and in one instance, increased (cacklers). This is believe not to indicate low mortality, but is rather a function of brood behavior wherein several families often combine forces or stray goslings merely attach themselves to the first family group that they encounter. This behavior is particulary true of brant, and to a somewhat lesser extent of cacklers. The largest family group encountered consisted of 21 brant. Within this group, at least three distinct age groups (one week, two week, and three week old) were

distinguishable). Groups from [illegible] were common. Out of 93 brant broods tallied on June 27th, 13 were in groups consisting of two or more families and ranging in size from 5 to 21.

Brood Mortality

Because of the brood behavior described above, it was not possible to determine either the actual decrease in production or an index to the decrease. It is known however, that several mortality factors operate jointly to decimate the current production, as follows:

1. Avian predation
2. Climatic factors
3. Weakness and straying
4. Human interference

It is believed that glaucous gulls create the greatest depredations on the young geese, brant and ducks in this region. Stomach analysis of 149 glaucous gulls showed that 67 percent of gulls examined had duck, goose, or brant, or avian remains (unidentifiable as to species) in them. To a lesser extent shortbilled gulls and perhaps jaegers contribute. See separate report on gull predation in this area.

Climatic factors such as severe wind and rain storms undoubtedly contribute to brood losses, particularly just at hatching, and during the week following. Although no losses were actually recorded due to these factors it is conceivable that if the adult bird were in someway caused to desert the young temporarily at this crucial time, some mortality could ensue. It is further possible that strayed young caught out in a severe rain could perish before finding another brood and protection.

Straying is a definite mortality factor, exerting its influence on those young scattered either by human disturbance, predators, or merely the lack of innate ability for the weaker ones to keep up. Once alone, the strays become easy game for gulls, or, as mentioned above, the weather. During nest checks, banding activities, and gull hunting, 33 young were found dead. All of these were downy young and appeared not to be over a week or ten days old. After this critical period they apparently were better able to manage since none of this age group were ever found.

As stated earlier, the infrequent occurrence of mammalian predators such as fox, mink, and weasels renders this mortality factor one of minor importance.

General Notes on Behavior

Soon after hatching (usually within a day or two) the parent brant and geese usually moved their new families to the nearest slough or river, deserting the nesting sites. As a consequence, the nesting areas were almost completely deserted after the peak of hatching had passed. The main body of the brant and goose population was then to be found along the waterways after the first week in July, fig.

For the most part, the broods usually remained in the same vincinity until they learned to fly. This was shown by recapture of currently banded broods. These recpatures, sometimes as long as a week afterwards, usually found the birds in the same genreal vicinity as when first caught. Some broods were however noted to be capable of rather extended movement early in life. Brant families were noted as far inland as the mouth of the slough leading into Area 1, with young less than a week old. Note: brant were not found breeding any further inland than Area 2. The tendency to remain near the home area disappeared after flight was achieved by the young and the molted adults.

It is interesting to note that for the most part, the species composition remained relatively the same throughout the area despite some brood movement. A striking illustration of this was provided when traversing Hock Slough. At the upper end of the slough, whitefronts, emporers and cacklers were predominant. From the middle of the slough to the last half mile, mostly cacklers were seen. On the lower fourth of the slough and thence on to the coast, brant predominated with only a few cacklers here and there.

FLIGHT

Juvenile brant and cacklers were first observed in flight on July 26 and by August 1 nearly all young were flying. Nearly all juvenile whitefronts and emperors were also flying by August 1.

MOLT

The postnuptial molt of brant and geese began the third week in June and continued through July, the peak occuring approximately July 15-25. Nearly 95 percent of the birds were through molting by August 1.

The first flightless brant was seen on June 20th, however, no more flightless birds were seen till June 27th, when the first molting cacklers were seen. By July 1st flightless adults of all species were fairly common. Fifty percent of all adult geese and brant were flightless by July 10th. The first adults to regain flight status were noted July 26th and by August 1 nearly all were on the wing again.

There was no recognizable difference in the time of molt between breeding and non-breeding birds. Flightless adults with young were noted simultaneously along with flightless non-breeders, and were often found in the same groups. Brant non-breeders forsook their flocks and joined the family groups when their molt commenced, thus the majority of the population was found close to the larger coastal sloughs, rivers, and along the sea coast. Cacklers, whitefronts, and

emperors did not form the large molting flocks but instead remained more or less as before the molt. They did however, tend to move toward the waterways for the duration of their molt.

Table Brood data, Yukon-Kuskokwim Delta, 1951

Date	Brood Size 1	2	3	4	5	6	7	8	Total No. broods	Ave. brood size
Brant										
June 17-24	1	3	10	18	8	2	-	-	42	3.8
June 25-July 1	4	21	26	40	17	2	-	-	110	3.5
July 2-11	12	25	44	36	13	4	2	-	136	3.2
									288 (983 yg)	3.4
Cackler										
June 17-24	2	2	4	5	4	1	-	-	18	3.6
June 25-July 1	-	9	11	15	13	2	-	-	50	3.8
July 2-11	1	7	11	20	14	2	-	-	55	3.8
									123 (464 yg)	3.7
Whitefront										
June 17-24	-	-	1	-	1	1	-	1	4	5.5
June 25-July 1	-	-	-	-	1	-	-	-	1	5.0
July 2-11	-	-	-	-	-	-	-	-	-	-
									5 (34 yg)	5.4
Emperor										
June 17-24	-	-	-	-	-	-	1	-	1	7.0
June 25-July 1	-	-	2	-	-	2	-	-	4	4.5
July 2-11	-	-	-	-	-	-	-	-	-	-
									5 (25 yg)	5.0
Swan										
June 17-24	-	-	-	-	-	-	-	-	-	-
June 25-July 1	-	-	-	-	1	-	-	-	1	5.0
July 2-11	-	-	-	1	-	-	-	-	1	4.0
									2 (9 yg)	4.5

Table (cont.) Brood data, Yukon-Kuskokwim Delta, 1951

Date	Brood Size 1	2	3	4	5	6	7	8	Total No. broods	Ave. brood size
Spectacled Eider										
June 17-24	-	-	-	2	-	2	-	-	4	5.0
June 25-July 1	-	-	2	4	3	2	-	-	11	4.5
July 2-11	2	-	2	4	3	5	-	-	16	4.3
									31 (138 yg)	4.5
Pacific Eider										
June 17-24	-	-	-	-	[illegible]	-	-	-	[illegible]	[illegible]
June 25-July 1	-	1	4	3	1	3	-	-	12	4.1
July 2-11	1	-	1	2	-	2	-	-	6	4.0
									19 (78 yg)	4.1

SUMMARY

1. A nesting study of the coastal breeding grounds of the Yukon-Kuskokwim Delta with particular emphasis on losses due to gull predation and tidal flooding was carried out between June 15th and July 10th. Gull predation studies were continued through August 1.

2. Brant and cackling geese, the two predominant species breeding on this area comprised 40.3 and 40.7 percent of the breeding population based on the occurrance of nests. Aerial transects of the area made in 1951 showed close agreement, brant and cacklers comprising 44 and 41 percent respectively, of the population.

3. Brant predominated along the coast and became less numerous inland away from areas not subject to tidal action. Conversely, the population density of cacklers increased inland. Whitefronts and emperors were not found along the coast but were found breeding inland several miles interspersed with cacklers, but in much lesser numbers. Spectacled and Pacific eiders were common over the entire area, but increased in numbers as the coast was approached. Steller's eiders and pintails were found inland, but were not common.

4. All water fowl displayed a marked interspecific tolerance and were well interspersed, cover and site seeming the only governing factor of nesting pattern.

5. Brant preferred short sedge cover; cacklers, emperors, spectacled and Pacific eiders preferred either tall or short grass cover; whitefronts preferred tall grass as did the Steller's eiders.

6. Nesting density for the entire coastal study area for all species was 152.5 per square mile. The inland areas, Area 1, somewhat higher in elevation had had a nesting density of 186 nests per square mile. Somewhat lower and inland

only 3 to 5 miles (Area 2) supported the highest density, 376 nests per square mile. The actual coastal nesting areas supported a nesting density of only 74 nests per square mile. The availability of suitable nesting site and cover is believed to govern the nesting density throughout the entire area.

7. Nesting for all species commenced the last week of May. The first nests hatched during the third week in June and the peak of hatching came during the last week of June and the first week of July. Chronology of nesting for all species of water fowl was the same except for loons and old squaw ducks which were 7 to 10 days later.

8. Brant and cacklers showed a good nesting success of 79 and 73 percent respectively.

9. Nesting losses were low during the 1951 season amounting to 14 percent for the entire area. Glaucous gulls and jaegers accounted for at least 10 percent of the nest failure. Some desertion took place, but was seldom recognized because predation undoubtedly masked it to some extent. No losses due to flood tides were recorded, but observations and measurements of abnormal raises in the tide levels during the 1951 season indicate that an abnormal tide driven by a wind storm from the southern quarter is capable of totally flooding the immediate coastal areas inland at least a mile, and partially flooding (30 to 40%) of areas inland 4 to 5 miles. Flood tides of this nature were recorded after the nesting season, but there is no insurance that such tides could not occur unseasonally three weeks or a month earlier and thus devastate the most important brant and cackling goose nesting grounds. Mammalian (fox, mink, and weasel) predation and human predation were found to be negligible.

10. Brood counts reveal that brood sizes did not decrease appreciably during the season in the case of brant and cacklers, due to the tendency for

families to combine forces and for strays t join the lst family they encounter. The average brood size for brant was 3.4 and for cacklers 3.7. Brood sizes decreased slightly during the season for nearly all species.

11. The extent of brood mortality was not determined beyond recognizing the mortality factors and their relative importance. Glaucous gulls are the chief decimating factor. Sixty-eight percent of gulls examined had duck, goose or brant, or avian remains in their gullets or stomachs. Straying during the first 7 to 10 days of life is another important factor; 33 young of this age group were found during the study. Mammalian predation is of little importance.

12. Soon after hatching (two or three days) broods are moved to the sloughs and rivers and the nesting grounds are virtually deserted. In the case of brant, the broods are soon joined by molting adults in the sloughs, rivers and near the coast as well as along thecoast itself. The cacklers, whitefronts, and emperors tend to remain more as family units, however molters of these species move to the waterways when their molt commences. The peak of the molt occurred July 15-25. By August 1, 95 percent of the birds were on wing.