Papers

Radar Observations of Bird Migration at Cape Prince of Wales

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ABSTRACT. Observations of bird movements at Cape Prince of Wales, Alaska, were made by means of radar during the spring migration seasons of 1969 and 1970. Between 10 and 15 May 1970, flocks of sandhill cranes *(Grus canadensis)* made huge radar targets and were tracked easily as they flew westwards across the Bering Strait. It is believed that lesser snow geese *(Chen caerulescens)* were also followed by radar, *en route* to Wrangel Island, U.S.S.R., on 19 May 1970. On later dates in May and early June 1969 extensive westward and northward flights and some eastward movements were recorded by radar. Automatic camera data obtained from the Cape Prince of Wales radar site also show extensive eastward migration from Siberia to Alaska by 24 July 1969.

RÉSUMÉ. *Migrations des oiseaux observées au radar au cap du Prince-de-Galles.* Au cours des migrations printanières de 1969 et 1970, on a observé au moyen du radar les mouvements des oiseaux au cap du Prince-de-Galles. Alaska. Entre le 10 et le 15 mai 1970, les voiliers de Grues du Canada (*Grus canadensis*) formaient d'énormes cibles radar et pouvaient être suivies facilement dans leur vol vers l'ouest à travers le détroit de Behring. De même, on croit avoir pu suivre au radar la migration de l'Oie bleue (*Chen caerulescens*) vers l'île de Wrangel en URSS, le 19 mai 1970. En 1969, on avait enregistré au radar d'importants mouvements vers le Nord et l'Ouest et quelques-uns vers l'Est plus tard en mai et au début de juin. Les données recueillies par caméra automatique à la base du cap du Prince-de-Galles avaient aussi indiqué d'importantes migrations vers l'Est, de la Sibérie vers l'Alaska, dès le 24 juillet 1969.

РЕЗЮМЕ. *Радиолокационные наблюдения миграций птиц на мысе Принца Уэльсского.* Во время весенних миграций 1969-70 гг. были выполнены радиолокационные наблюдения передвижений птиц вблизи мыса Принца Уэльсского. Между 10 и 15 мая 1970 года легко были прослежены стаи журавлей (Grus canadensis), пролетавших через Берингов пролив в западном направлении. Предполагается, что 19 мая 1970 г. радиолокатором были также прослежены стаи гусей (Chen caerulescens) на их пути к острову Врангеля (СССР). В последние дни мая и в начале июня 1969 г. были зарегистрированы интенсивные передвижения стай в западном и северном направлениях, а также некоторое движение в восточном направлении. Данные автоматической радиолокационной установки, полученные на мысе Принца Уэльсского, показывают также интенсивные миграции в восточном направлении из Сибири на Аляску к 24 июля 1969 г.

INTRODUCTION

Cape Prince of Wales, Alaska, at the edge of the Bering Strait between Alaska and Siberia and at the tip of the Seward Peninsula west of Nome (Fig. 1), is a unique and extremely interesting locality from the standpoint of bird migration (Bailey 1943, 1948). Certain species of birds, including the sandhill crane (*Grus canadensis*) and lesser snow goose (*Chen caerulescens*), and perhaps some shorebirds, winter in the United States and migrate across the Bering Strait in spring

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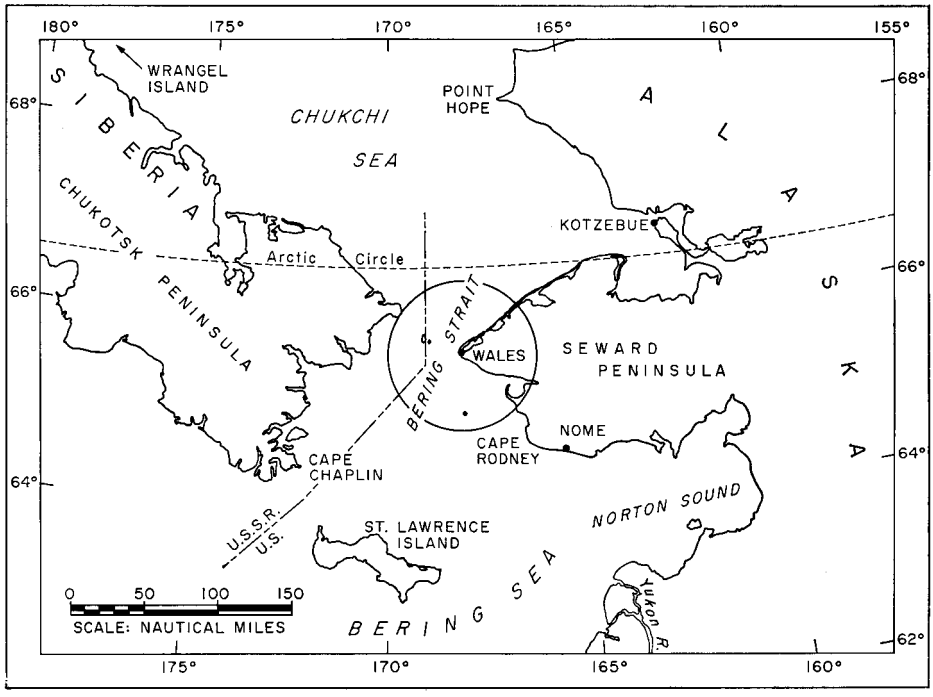

FIG. 1. Map of Bering Strait area and nearby portions of Alaska and Siberia. The circle centred at Cape Prince of Wales is 50 nautical miles (92.6 km.) in radius and corresponds to the outer circles of Figs. 2, 3, 7 and 11.

to breed in Siberia. Some small passerine song birds, such as the wheatear (*Oenanthe oenanthe*), yellow wagtail (*Motacilla flava*), and white wagtail (*Motacilla alba*), make the migration in the reverse direction from Asia to breed in Alaska. Eiders, shorebirds, murres, jaegers, etc., migrate north past Cape Prince of Wales to breed in northern Alaska and arctic Canada.

The Alaskan Air Command of the U.S. Air Force operates an AC&W surveillance radar whose transmitter is located on the top of Cape Mountain, elevation 2,289 feet (698 m.), a few miles from the tip of Cape Prince of Wales where the village of Wales is located. The principal operational and support facilities of this radar station are at Tin City at the base of Cape Mountain (Fig. 2). On the basis of experience with Federal Aviation Administration radars in the lower 48 states (Flock 1968; Flock and Bellrose 1970) and literature concerning other radar studies of bird movements (Eastwood 1967; Myres 1970) it was judged that the Tin City radar facility would be able to monitor bird migration in the vicinity of Cape Prince of Wales. A brief visit was made to the radar site from 14 to 17 August 1967 for the purpose of investigating this possibility. Longer visits were made from 17 May to 2 June 1969 and 9 to 19 May 1970 to observe and record features of the spring migration.

Eurasia and North America are separated by as little as 52 statute miles (84 km.) at the Bering Strait, and East Cape of Siberia can be seen from Cape Mountain and Wales on a clear day. Little Diomede Island, belonging to the U.S.A.,

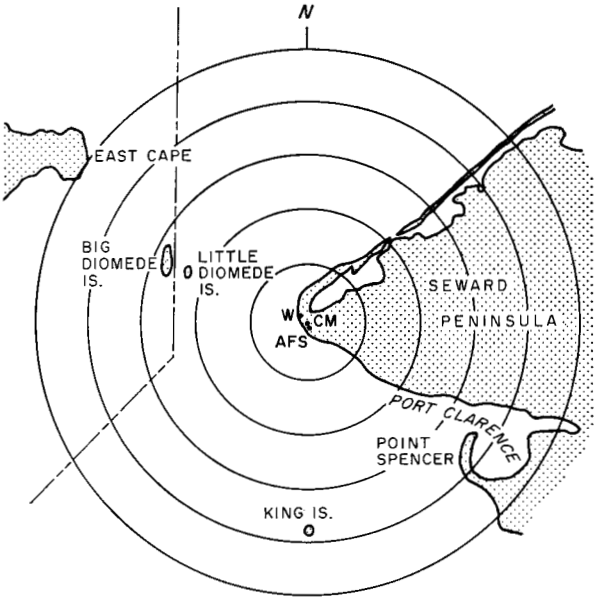

FIG. 2. Map of Cape Prince of Wales area superimposed on circles spaced 10 naut. mi. (18.5 km.) apart. The circles correspond to those of Figs. 3-11. The abbreviations W, CM, and AFS stand for Wales, Cape Mountain, and Tin City Air Force Station, respectively.

and Big Diomede Island, belonging to the U.S.S.R., are roughly halfway between the two coasts. The weather at and near the cape is characterized by prevailing strong winds from the north, and it was much colder as well as windier in the cape area than at Nome during the times of the visits. The average wind speed for the entire year at Wales is 25 knots (46.5 km./hr.), and at Tin City the corresponding figure is 20 knots. During the spring migration, a shift to a south wind may result in a major bird movement through the strait. The birds are forced sometimes, however, to move without the benefit of a favourable wind.

For practical reasons, a complete radar record of bird movements at Cape Prince of Wales has not yet been obtained. But, as no radar data about bird movements in the area have been available previously, it seems desirable to report on the observations made to date. Interesting records of radar echoes, believed to be caused by sandhill cranes, lesser snow geese, waterfowl, shorebirds, and passerines, have been obtained, mostly in the spring migration season. Similar observations made by using DEW radars at Point Barrow and adjacent sites will be reported separately. The work in Alaska has been part of a larger project having as its major purpose analysis of the role that radar can play in reducing the hazard of collisions between birds and aircraft.

Located adjacent to the shortest portion of the former Bering land bridge, the Cape Prince of Wales area is of much interest from anthropological, biological, and geological viewpoints (Hopkins 1967).

PROCEDURE

The Tin City L-band surveillance radar has standard PPI (plan-position-indicator) displays, and these were observed visually and photographed. MTI (moving-target-indicator) video signals were used. Long-range surveillance radars give a

general picture of bird movements taking place within the beam of the antenna out to a range of approximately 50 naut. mi. or 92.6 km., the exact distance varying with circumstances, and radar displays with radii of 25 or 50 naut. mi. were most commonly viewed. Photographs were generally 5-minute time exposures. Echoes produced by migrating birds showed on the photographs as streaks having lengths consistent with distances flown by birds in 5 minutes. Visual inspection of the PPI displays commonly sufficed to tell when significant bird movements were taking place, so photographs could be taken when especially interesting bird movements were observed. Automatic photographic recording is the best way to obtain complete, continuous coverage of bird movements in the vicinity of a radar, but there is considerable advantage in having an interested person on the spot who can adjust video levels, vary sweep lengths, etc. to fit the prevailing ornithological situation. Furthermore it was not possible to obtain a complete automatic record in 1969, and no automatic data were obtained at all in 1970. Thus reliance had to be placed mainly on photographs taken manually and on visual observations of the radar screen. For manual photography a model 180 Polaroid camera, with a portrait kit consisting of an auxiliary lens and viewfinder for focusing to shorter distances than otherwise, was used. The camera used for automatic operation in 1969 was part of the Air Force installation. Automatic camera data were obtained from 25 May to 2 June 1969, while the investigator was at the site, and for all or parts of the following additional days: 2-3, 5-8, 11-13, 17 June; 17, 18, 24-26 July; and 1-11 August. By 1970 the function of the automatic camera was carried out by more sophisticated magnetic-tape equipment.

Visual observations of birds were made by walking to lookout points a little to the west of the site or by walking along the beach area to the southeast. Direct correspondence between particular radar echoes and flocks of birds could not be established. However, at times, a certain species of bird was the only one migrating in significant numbers and its movements continued over a period of hours. On such occasions identification of radar targets could be made with reasonable certainty.

Drawings (Figs. 3 to 11) are used in this paper to illustrate bird echoes as they appeared in the 5-minute time-exposure photographs. True geographic north is indicated by a short line extending outward from the top of the outer circle. This presentation results after rotation of the original photographs through 20 degrees, as the radar displays are oriented with geomagnetic north (20 degrees east of geographic north) at the top. All times of day in this paper are given in terms of Alaska Daylight Time (ADT). It should be remembered, however, that because the International Date Line passes through Bering Strait the dates recorded in the paper must be advanced by one day to obtain the corresponding date on the Siberian side of the strait.

OBSERVATIONS

The spring seasons of 1969 and 1970 were quite similar and both were rather early. The peak sandhill crane migration took place near 10 May in both years.

The peak crane movement was missed in 1969, because of a 17 May arrival date, but the arrival on 9 May 1970 allowed monitoring the main crane movement. Because the two spring seasons appeared to be very similar, the observations for both years will be described chronologically by day of the month, starting with the 1970 observations (9 to 19 May) and continuing with the 1969 observations (17 May to 2 June).

1970

The 1970 visit to the Tin City radar site began on 9 May 1970. People at the radar site and at Wales reported that eiders had passed by in large numbers on about 2 May, on which date there was a shift to a favouring south wind. From 3 to 7 May inclusive the wind was consistently from the north, but during the afternoon of 8 May, most of 9 May, and all of 10 May it was generally from the south. Some eiders were observed to fly past after arrival on 9 May, but the numbers were smaller than on 2 May. Visibility was low to moderate in May until 1200 ADT, 10 May. From then until 1300, 12 May, excellent visibility of 35 naut. mi. (65 km.) was reported. This visibility allows seeing King Island clearly to the south.

These comments provide the background for the first observation of migrating sandhill cranes at 1300 ADT, 10 May, when the wind was 12 knots from 170°, visibility was 35 naut. mi., and the temperature was 31°F. (−0.5°C.). At that time, two flocks of sandhill cranes containing 30 and 35 birds were seen approaching Cape Mountain, flying over the land from the east. The first flock appeared to become confused as it neared the still fog-shrouded crags of Cape Mountain, and it circled and gained altitude. Later, near 1700 ADT, two flocks of 35 and 50 cranes were seen flying over the land, followed by flocks of 120 and 60 cranes flying over the water south of Tin City. By about 1815, when 1,200 cranes flew by over the water it was becoming apparent that a major movement of cranes was under way. Five minutes later another 1,200 passed by over the water, and at 1830, 500 flew by. Then 1,600 were seen over Cape Mountain. A little before 1900, a huge group, estimated at 4,000, and apparently consisting of several flocks flying close together, was seen some distance out over the water. A total of about 9,000 birds was estimated to have been seen on 10 May, and these were certainly not all that moved past the Cape.

The sandhill cranes flew northwest across the Bering Strait at speeds between 30 and 50 knots, and they made huge radar echoes which could be followed all the way across the strait to near East Cape on the Siberian mainland, about 60 naut. mi. away in the direction the birds were flying. Figs. 3 and 4 show the radar screen during the evening of 10 May, 1970. In Fig. 3 the birds are following along the south coast of the Seward Peninsula as they approach Wales, and then continuing directly across the Bering Strait. Fig. 4 (for 2008 ADT) depicts an offset PPI display that was set up so that the Bering Strait extended across the entire screen, and the huge echoes beyond 40 naut. mi. from the radar may be from the tremendous group that was observed visually over an hour earlier at Tin City. Observations of the radar screen continued until 2330, ADT, 10 May, by which time the intensity of movement had diminished considerably.

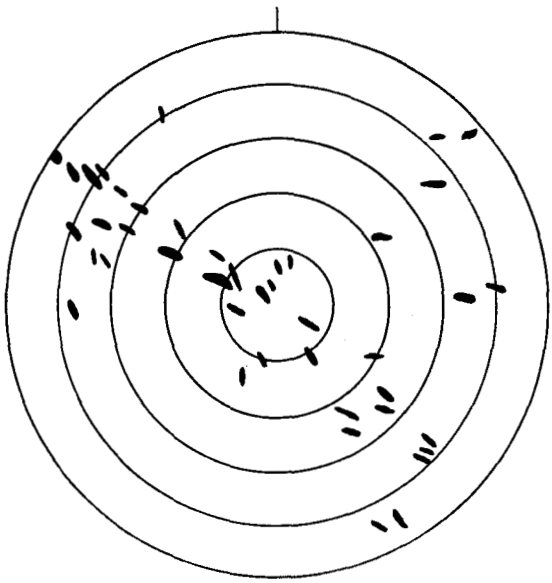

FIG. 3. 10 May 1970, 2000 ADT. Radar echoes caused by sandhill cranes, which are approaching mainly along the south coast of the Seward Peninsula and continuing directly NW-WNW across the Bering Strait. Wind southerly. On this and subsequent figures 5-minute time-exposure photographs of the Tin City radar PPI are illustrated and range circles spaced 10 nautical miles apart are shown.

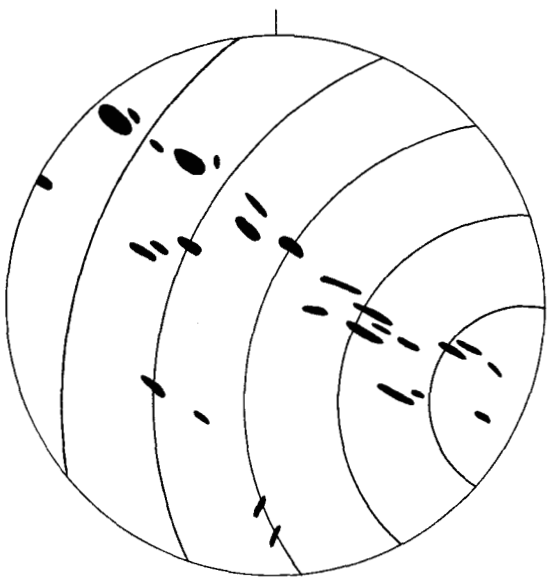

FIG. 4. 10 May 1970, 2008 ADT. Radar echoes from huge flocks of sandhill cranes crossing the Bering Strait in a NW-WNW direction. Wind southerly. Offset PPI displays are shown in Figs. 4, 5, and 6.

Flying at heights of up to perhaps 2,000 feet (610 m.) near Cape Prince of Wales, and uttering their loud, characteristic calls, the cranes made their presence readily evident, visually, audibly, and on the radar screen, when they flew near Tin City. The number of radar echoes that showed on the radar screen at the time of the peak crane movement at Cape Prince of Wales was not, of course, as great as that observed in the migration season at other places such as the Great Plains and Midwest (for example see Flock and Bellrose 1970). But only one species was involved, and one echo might represent more than a thousand birds so the radar record is impressive.

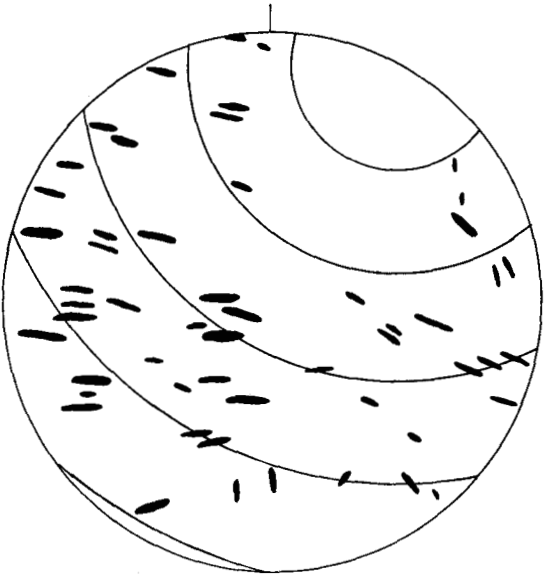

FIG. 5. 11 May 1970, 1950 ADT. Echoes from sandhill cranes, in the area west of King Island, moving W-WNW towards Siberia. Wind northerly.

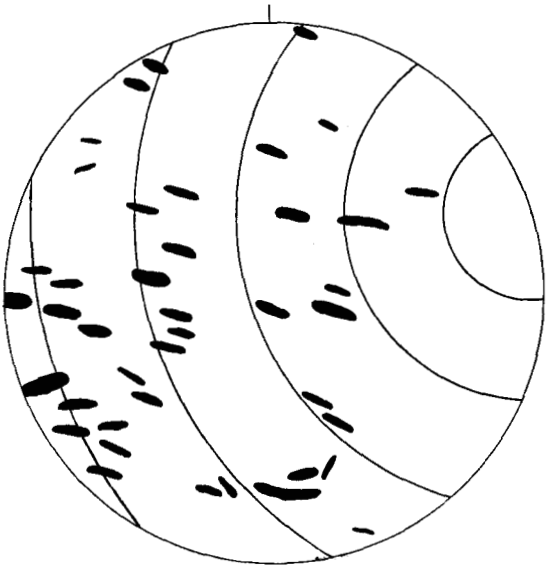

FIG. 6. 11 May 1970, 2050 ADT. Echoes from sandhill cranes moving W-WNW towards Siberia. Wind northerly.

At 0730 ADT, 11 May, no migrating birds were seen outside and only a few bird targets showed on the radar screen. By 1510, birds were still invisible to the naked eye. But, upon hearing faint calls of cranes, binoculars were raised and 3 flocks of cranes, of about 120, 100, and 120 birds, were seen on the southern horizon. This experience was repeated on several occasions and during the hour from 1500 to 1600 10 flocks containing a total of about 1,500 cranes were observed. On the previous day, the cranes had been flying over land, or over water but close to land, but on 11 May they were flying significantly farther out over the water to the south. By the time of these 11 May observations the

wind had shifted to the north but was moderate (7 to 16 knots) and visibility was still excellent. Upon returning to the radar room, numerous radar targets flying considerably to the south of Cape Prince of Wales were seen heading towards Siberia. By about 1950 ADT, 11 May, a considerable number of echoes were proceeding W-WNW as compared with WNW-NW of the previous day. Fig. 5 illustrates movement which was taking place in the area west of King Island at that time. In Fig. 6, taken at 2050, strong echoes can be seen at extreme ranges to the southwest of Tin City. The sandhill cranes migrating on 11 May may have been heading purposely for a more southerly area on the Siberian coastline than on 10 May, and they may have also been influenced by the change to a north wind. The continuing excellent visibility allowed the cranes to make the longer crossing to Siberia from the stretch of Alaskan coastline between Cape Rodney and Point Spencer, instead of following the coast from Nome to Wales.

On the morning of 12 May 1970, visibility was still good but relatively few migrating birds were seen. During the day the north wind became stronger (to 26 knots). On 13 May the wind was still stronger from the north (to 34 knots), the temperatures had dropped from the 30's to the 23-26°F. (−3.3°C.) range, and visibilities were from ½ to 2½ miles (0.8 to 4 km.), with fog. Few migrating cranes or waterfowl were seen on these days, either visually or on the radar, but the first lapland longspurs (*Calcarius lapponicus*), short-eared owls (*Asio flammeus*), Baird's sandpipers (*Erolia bairdii*), semipalmated sandpipers (*Ereunetes pusillus*), western sandpipers (*Ereunetes mauri*), and semipalmated plovers (*Charadrius semipalmatus*) were seen on 12 or 13 May. On 14 May new crane movements were observed, again far out over the water to the south, and considerable bird movement, presumably that of cranes, was evident on the radar. The weather did not show much improvement on that date, at least locally near the weather station. Moderate crane movement also took place on 15 May; by then the weather had improved to the point that 35 naut. mi. visibility, low winds (even zero wind at 1200, ADT), and warm temperatures (to 30°F.; 3.9° C.) were reported. Robins (*Turdus migratorius*) (1 pair), varied thrushes (*Ixoreus naevius*) (1 pair), fox sparrows (*Passerella iliaca*), and water pipits (*Anthus spinoletta*) were seen on that date. After 15 May, some cranes were seen now and then, but the main movement had passed on 10 and 11 May, with a secondary peak on 14 and 15 May.

Following a short visit to the village of Wales, about 5 miles (8 km.) away, on 16 and 17 May, walking over and back under conditions of poor visibility, 5 flocks of snow geese, ranging in size from 17 to 40, were observed between 1445 and 1620 ADT, 18 May 1970. That number did not cause very prominent radar echoes. However, upon arising early on 19 May, under conditions of zero visibility due to fog and snow, a stream of radar echoes was observed travelling in a NW-NNW direction along a course which may have originated from Port Clarence behind Point Spencer and which would pass to the north of East Cape (Fig. 7). The main movement came no closer than about 10 naut. mi. (18.5 km.) to the northeast of the radar station. This movement was observed and photographed from about 0500 to 0800 ADT, 19 May. Although the evidence is not as conclusive as in the case of the echoes attributed to sandhill cranes, it appears

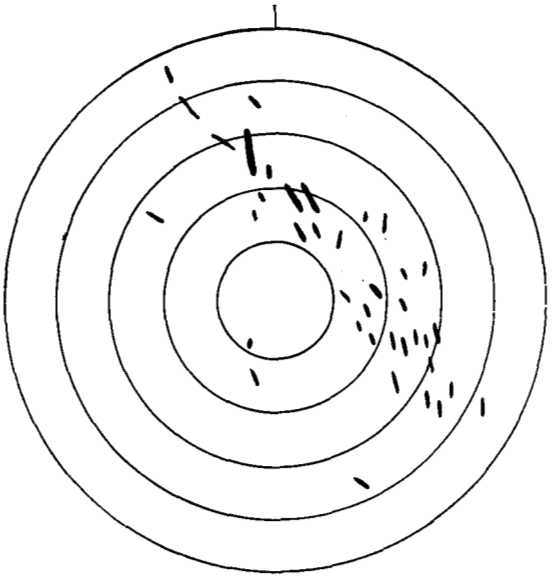

FIG. 7. 19 May 1970, 0730 ADT. Radar echoes believed to be caused by lesser snow geese that are crossing the Seward Peninsula from the Port Clarence area and continuing NW-NNW across the Chukchi Sea.

very likely that these echoes were caused by lesser snow geese that were heading for Wrangel Island where a quarter million breed (Uspenski 1965). If this interpretation is correct, it follows that the migration of lesser snow geese past Wales takes place at times under conditions of poor visibility and thus goes unnoticed.

1969

In 1969, when the arrival date was 17 May and the departure date was 2 June, major crane and snow goose movements were not seen, but much bird activity was detected on the radar screen and the number of species actually seen was considerably greater than in the following year, 1970. Tundra flowers were blooming well upon arrival and thereafter. Strong north winds prevailed, however, during most of the 1969 visit.

A major impression gained in examining the 1969 radar data is that of complexity. Bird movements were in different directions at different times, and sometimes they were in several different directions at the same time. It is not feasible to try to describe or list all of the movements in detail in this paper. In contrast to the situation in 1970, the radar targets were probably caused by several species.

Only a few radar echoes from birds had been seen during the first three days, 17-19 May of the 1969 visit, and no radar observations were made during a visit to Wales on 20-22 May. On 23 May 1969 near 1600 ADT, the radar screen showed that birds were approaching the Cape along the south coast of the Seward Peninsula and some of these followed the coast northeastwards after rounding the Cape. Others headed almost directly north after passing the Cape. It was not until the evening of 25 May 1969, that the first impressive bird movement was seen on the radar screen. The scarcity of bird echoes up until 25 May, may have been due in part to imperfect adjustment of the MTI circuitry, as the MTI

video signals were poorer in 1969 than in 1970, but there probably were few migrating birds during most of that period.

The heavy movement of the evening of 25 May (Fig. 8) was W-WNW across the Bering Strait. Although it passed overhead at Tin City, no significant bird movements could be seen visually at the same time. Some of the streaks on the time-exposure photograph were about 5 naut. mi. in length indicating a speed of about 60 knots. Migration westward across the Bering Strait continued on 26 May, though at a somewhat reduced rate. As on 25 May, the heaviest movement took place after 1800 ADT. There was another interesting movement observed

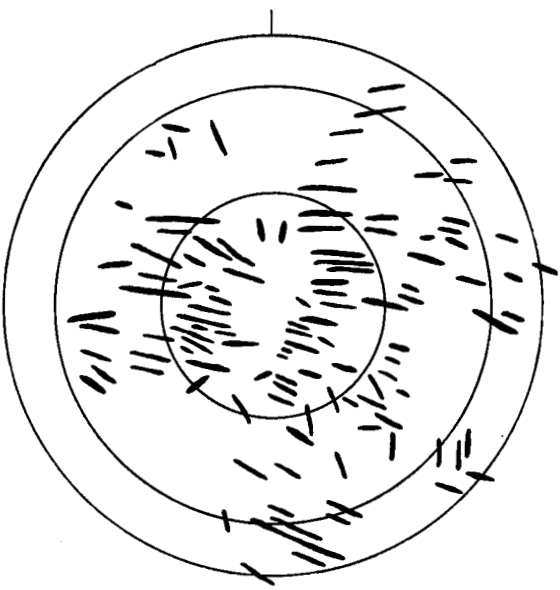

FIG. 8. 25 May 1969, 2150 ADT. Movement W-WNW towards the Chukotsk Peninsula, possibly of shorebirds. The outer circles in Figs. 8, 9, and 10 are at a range of 25 naut. mi.

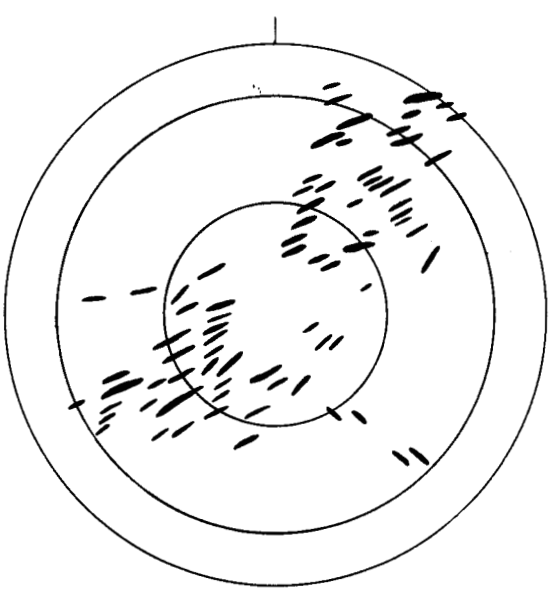

FIG. 9. 27 May 1969, 2155 ADT. Birds are approaching Cape Prince of Wales along the north coast of the Seward Peninsula and continuing in the same SW direction across the sea towards Cape Chaplin.

near 2200 on 26 May, again on the evening of 27 May (Fig. 9), and also, to a lesser degree, on the evenings of 30 and 31 May; this was of birds which followed the north coast of the Seward Peninsula, from the direction of Kotzebue Sound, and continued on in the same direction towards Siberia. If these birds maintained the southwest track shown in Fig. 9, they would strike the Siberian coastline near Cape Chaplin (Fig. 1). These birds were flying in the presence of a north wind. The birds involved could not be seen from Tin City.

On 27 and 28 May 1969, weak echoes were noted moving eastwards across the strait towards Alaska from Siberia. A wheatear was observed near the radar site on the evening of 27 May and white wagtails were seen on 30 May and thereafter, these being birds that winter in the Old World but breed in Alaska.

After 28 May 1969, the bird movements became even more complex than previously. On 29 May, bird traffic leaving Cape Prince of Wales was directed more towards the north than the west. Moderate movement to the west occurred on 30 and 31 May. (On the morning of 31 May, most of the birds were approaching the Cape along the south coast of the Seward Peninsula, and in the afternoon most were approaching along the north coast.) On 1 June movement past the Cape was almost entirely to the north for much of the day, as shown in Fig. 10 which refers to 1550 ADT on that date. The birds were flying N-NNE and passing directly over the Cape, rather than following along the coastline. By shortly before midnight on 1 June 1969, conditions had changed again, and the automatic camera showed movement to both the west and the northeast. Birds in the northeast movement came from the direction of Asia and could be followed from 30 to 40 naut. mi. to the northeast of Cape Prince of Wales. Twenty-four hours later there was some additional movement eastwards. From 5 to 8 June and from 11 to 13 June, movements were mostly towards the west or north, with a slight amount of eastward movement on 11 June.

The shore ice at Tin City was blown away by strong winds on 30 May, and ice in the lagoon a short distance east of Tin City had largely melted by about the same time. After these occurrences more birds were present in the local area than previously, in spite of strong winds from the north (as high as 35 knots). The very attractive red phalarope (*Phalaropus fulicarius*), in full breeding plumage, was abundant in the water a few feet from shore after the ice moved out. The lagoon then harboured a number of interesting birds including, on 2 June, 6 whistling swan (*Olor columbianus*), 2 emperor geese (*Philacte canagica*), 1 male oldsquaw (*Clangula hyemalis*) in full breeding plumage, many pintail (*Anas acuta*), many arctic terns (*Sterna paradisaea*), and a few Sabine's gulls (*Xema sabini*). Migrating birds seen flying by the site in 1969, mostly in small flocks, included the sandhill crane, lesser snow goose, emperor goose, black brant (*Branta nigricans*), common eider (*Somateria mollissima*), oldsquaw, and pintail. After the ice went out the black brant and common eider were the most obvious and these occurred in larger flocks of up to a hundred birds. At this time some flocks were observed to fly north across the rather low land east of Cape Mountain, rather than going around the Cape. These flocks raised and lowered and twisted and turned as if seeking the path of least resistance as they fought the strong wind from the north.

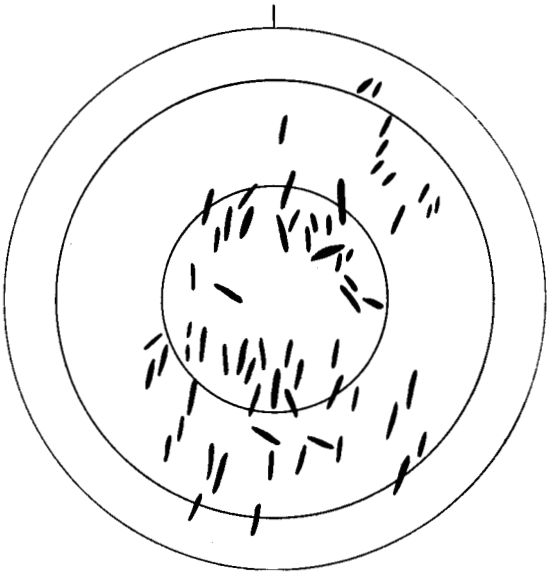

FIG. 10. 1 June 1969, 1550 ADT. Radar echoes moving N-NNE from direction of central Pacific Ocean.

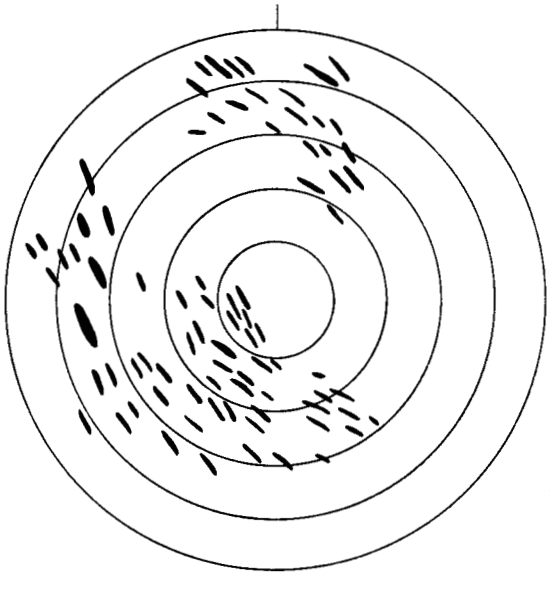

FIG. 11. 24 July 1969, 2335 ADT. Movement SE-SSE from Siberia towards Alaska, possibly of Steller's eiders.

The return or fall migration was already under way on 17 and 18 July 1969, when automatic camera data on bird movements were again obtained. On 17 and 18 July, and also from 24 to 26 July and 1-11 August 1969, movements were to the southeast, south, or east. Near midnight on 24 July an especially interesting movement over a rather broad front was approaching Alaska in a SE-SSE direction from Siberia, as shown in Fig. 11. Some very large echoes, which could be tracked for distances of 20 naut. mi. or more on successive camera frames, can be seen in the figure.

DISCUSSION

The migration of sandhill cranes from Siberia to Alaska was noted as early as 1880 by Bean (1882) who reported such a migration on 18 August 1880. Jacques (1929) also commented briefly on the late summer flight of cranes from Siberia to Alaska. Bailey (1925, 1926, 1943, 1948) described the spring migration of sandhill cranes from Alaska to Siberia in May 1922 and he noted that Captain Joe Bernard of the schooner *Teddy Bear* (which was frozen in the ice about thirty miles below East Cape when Bailey was at Wales) had reported cranes crossing Bering Strait to the Siberian shore and then heading south. Gabrielson and Lincoln (1959) mention the report of a noticeable flight of sandhill cranes from Alaska to Siberia. Breckenridge and Cline (1967) observed an estimated 15,000 to 20,000 cranes flying from Alaska to Siberia in May 1964, with the peak movement on 23 May. In the case of the present observations, no reliable total count can be supplied, but it seems likely that the number in 1970 was at least 20,000 and probably more than that. Site personnel reported that the peak crane movement in 1969 took place on about 10 May, and the peak movement in 1970 was also on that date. Seward Peninsula dates for the crane migration supplied by John Burns when he was at the Nome office of the Alaska Department of Fish and Game, are as follows (Burns, private communication): 13 May 1962; 12 May 1963; 7-30 May 1964 (largest numbers 19-23 May).

Lesser snow geese breed on Wrangel Island, U.S.S.R. and Dement'ev *et al.* (1952) mention a first arrival date there of 22 May (Siberian calendar as west of the International Date Line). Uspenski (1965) lists the same arrival date for 1957 and also reports first arrival dates of 21 May, in 1963 and 1964 and the "start of mass arrival" as 25 May in 1957 and 1963 and 4 June in 1964 when the weather was very bad. Migrating lesser snow geese were observed at Tin City on 18 and 19 May 1970. Lesser snow geese cross the land at the base of the Alaska Peninsula during the spring migration (Gabrielson and Lincoln 1959). Gabrielson and Lincoln also state that a large concentration usually forms at Point Spencer on the Seward Peninsula. Bailey (1925) recorded large numbers at Wales on 31 May 1922, that "followed along the coast, rounded Cape Prince of Wales, and cut to the northward, working along the high land." The observations of 1970 imply that such a flight may not be typical, either as regards the route upon leaving Point Spencer, or the date.

At the peak of the crane migration few other birds were moving and the radar echoes at that time were definitely caused largely by cranes. Identification was not quite as certain in the case of echoes attributed to snow geese, and at later dates it was not possible positively to identify the radar echoes, as eider, black brant, pintail, oldsquaw, shorebirds, passerines, etc. were all migrating then. It is reported by Chattin (1964) that pintail cross the Bering Strait to Siberia. Eiders migrate past Wales to breeding areas east of Point Barrow, Alaska. Black brant and oldsquaws also breed on the arctic coast and migrate past Cape Prince of Wales.

One good possibility for the birds that were moving to the west on 25 May (Fig. 9) is that they were shorebirds. They were flying at high speeds and at relatively high altitudes, as judged by the fact that they flew over the radar site

but could not be seen with the naked eye. The targets moving southwest on 27 May (Fig. 10) and north on 1 June (Fig. 11) may perhaps fall in the same general category. In the case of the 1 June record, it is of interest to note that the first jaegers, golden plovers, and phalaropes were seen near that time. Dates of first observations were 27 May for pomarine jaeger (*Stercorarius pomarinus*), 30 May for long-tailed jaeger (*Stercorarius longicaudus*), 2 June for parasitic jaeger (*Stercorarius parasiticus*), 28 May for golden plover (*Pluvialis dominica*), 31 May for red phalarope (*Phalaropus fulicarius*), and 31 May for northern phalarope (*Lobipes lobatus*). These birds might be expected to arrive from the general direction of the Hawaiian Islands and the central Pacific Ocean as was the case for the radar echoes, although it is not known, of course, how long the radar targets had maintained this same direction.

The targets moving east on 27 and 28 May were very likely wheatears, yellow wagtails, white wagtails, etc. as wheatears and white wagtails were first seen at Tin City at that time. It is more difficult to form an opinion about the eastward movement on 2 June as no pertinent visual observations were made on the same date. Other first observation dates which may be significant and are mentioned for completeness are 28 May for black brant, 25 May for emperor goose, 17 May 1969 and 18 May 1970 for pintail, 28 May for murres (*Uria*), 27 May for black-legged kittiwake (*Rissa tridactyla*), and 31 May for arctic tern.

The return migration from Siberia shown in Fig. 11 may be that of the Steller's eider (*Polysticta stelleri*) which breed mainly along the arctic coast of Siberia but moult at the end of the Alaska Peninsula in August (Jones 1965). A 24 July migration date is consistent with the habits of the king eider (*Somateria spectabilis*) and common eider (*Somateria mollissima*) which migrate past Point Barrow on the arctic coast of Alaska from mid-July through October. The return route of the king and common eider south of the arctic coast is not well established, and Bailey conjectured that they may fly down the Siberian side of Bering Strait.

As no data were obtained in 1969 or 1970 after 11 August, the flights of the sandhill cranes and lesser snow geese back from Siberia to Alaska were missed. John Burns (private communication) reported that the return flights of the cranes took place over the Seward Peninsula in late August and early September. He also stated that snow geese move through the Nome areas in early October.

Interest in Alaska, and in the Arctic in general, has increased in recent years, to a considerable extent because of the discovery of rich oil deposits on the north slope of Alaska. In view of this interest in the Arctic and its ecology it appears highly desirable that bird numbers and movements there be investigated more fully than in the past and that procedures be perfected for monitoring the bird migrations along and near the Alaskan coast line on a regular basis. The present Alaskan coastal radars could well be used for this purpose. In addition to bird movements, the Cape Mountain location may also be useful for studies of the sea ice and sea state of the Bering Strait area.

Research of various kinds in the area of the Bering Strait could benefit from cooperation and interchange of data between observers in the U.S.S.R. and the U.S.A. Accounts of movements of migratory waterbirds on the Siberian side of the strait would be particularly welcome.

CONCLUSION

Experience with the Tin City radar shows that the Alaskan AC&W radars are well suited for monitoring bird movements. Sandhill cranes cause intense radar echoes as they migrate across the Bering Strait. Evidence indicates that snow geese can be followed by radar even though they may pass Cape Prince of Wales under unfavourable visual conditions. Shorebirds and waterfowl, including black brant, eiders, pintail, and oldsquaw, are also surely detected by the Tin City radar. The Bering Strait is a region where birds from the Old World and the New World intermingle and their migrations cross over each other.

The study reported here was exploratory, small-scale, and somewhat informal in nature. A more continuous investigation at Tin City and at other AC&W and DEW sites could answer questions which remain. It seems desirable that bird migration in Alaska be monitored by radar on a regular basis, so that trends in bird numbers and habits can be recorded. Further work could probably be best carried out by setting up somewhat more formal arrangements, involving participation by the U.S. Air Force, the U.S. Bureau of Sport Fisheries and Wildlife, and other interested parties.

ACKNOWLEDGEMENTS

The cooperation of the Alaskan Air Command, Department of the Air Force, in making available the facilities of the Tin City Air Force Station, is gratefully acknowledged. Special thanks are due to Colonel John C. Keller, Jr., Deputy Chief of Staff for Operations and to Majors D. J. Malatesta and W. J. Daniels, Commanders of the 710th AC&W Squadron during the 1969 and 1970 seasons, respectively. I should like to express my appreciation to Dr. M. T. Myres for valuable comments and suggestions. The work has been supported by Research Grant 68-1377 from the Air Force Office of Scientific Research.

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