FIELD FEEDING BY *CYGNUS COLUMBIANUS COLUMBIANUS* IN MARYLAND

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Introduction

Cygnus cygnus cygnus, Cygnus columbianus bewickii and *Cygnus olor,* all Eurasian, are known to utilize agricultural fields for feeding (Owen and Kear 1972). The spread of potato eating by *C. c. cygnus* in England (Pilcher and Kear 1966) apparently began in the 1940s in response to severe winters. According to Anderson (1944), heavy rainstorms during February 1943 raised water levels such that *C. c. cygnus* could not reach aquatic vegetation, its normal food resource. It subsequently moved to flooded grass fields but remained there after all traces of floodwaters disappeared.

Cygnus columbianus columbianus of North America was found to be generally herbivorous in Utah waters (Sherwood 1960) and in fresh estuarine areas of Chesapeake Bay (Stewart and Manning 1958), although the latter authors found it to be omnivorous in brackish waters of the Bay. Sincock and Kerwin (unpubl data 1969) reported similar results in their study of swan food habits in the Back Bay, Virginia/Currituck Sound, North Carolina area.

In western areas of the United States, swans use agricultural fields as well as aquatic areas for feeding. Moffitt (1939) indicated that swans in California were rarely responsible for crop depredations on rice and barley. Nagel (1965) described as 'atypical' a movement of swans into harvested corn fields during the spring of 1964 in northern Utah. Field feeding by swans was considered rare and localized in Washington (C A Rieck pers com) and Oregon (R U Mace pers com), and emergency-oriented in parts of Montana (D Witt pers com).

Swans on spring migration from the Atlantic Flyway have been using agricultural fields in some areas since the early 1950s. Gunn (1973) reported that half the eastern population of swans had begun using corn fields east of Lake St Claire in southern Ontario 'within the past five years'. Field feeding by all swans migrating through Ohio began about 1962 (J R Frye pers com). Up to 70% of swans migrating in spring through Saginaw County, Michigan, utilized fields for resting and feeding since the early 1960s (E J Mikula pers com). Spring field feeding has involved 50% of swans in Wisconsin since the early 1950s (J R March pers com), but is uncommon among swans in North Dakota (R E Stewart pers com).

Branta canadensis wintering in Maryland began field feeding 25 to 30 years ago. These populations have continued to increase and during the 1970s averaged over half a million birds, nearly twice the previous long-term average (unpubl data,

USFWS Migratory Bird Management Office MBMO, Laurel, Maryland). Their movement to fields was largely responsible for most of this increase.

There are no published accounts of swan field feeding in wintering areas of the Atlantic Flyway or records of this behaviour until the late 1960s. According to V D Stotts (pers com), significant numbers of swans began utilizing agricultural fields in Maryland during the late winter of 1969/70. Field feeding was noted in Delaware in 1972 (C A Lesser pers com), Virginia in 1968 (C P Gilchrist pers com) and North Carolina in 1971 (D M Connelly pers com). Although not necessarily representing the initiation of field feeding in these areas, the years cited represent noticeable or significant field feeding by *C. c. columbianus.*

From 1955 until 1971 swans wintering in Maryland, Virginia and North Carolina comprised 99.8% of the Atlantic Flyway population, which averaged about 53 000 birds or 54% of the continental population (unpubl data, MBMO, Laurel, Maryland). During this period, Maryland wintered 65% of the Atlantic Flyway swan population.

The primary objective of the present study was to document the increase of field feeding by swans in Maryland. Field work began in November 1969 and continued through March 1972. Subsequent observations of neck-banded birds that accumulated through the 1975/76 winter have been included in this report.

Description of the Chesapeake Bay and specific study areas

The Chesapeake Bay is the largest estuarine system along the Atlantic coast of North America. The upper Bay (that portion of the Bay north of the Maryland-Virginia state line and including the Potomac River) is or was one of the most important wintering areas in the Atlantic Flyway for up to 30 species of waterfowl.

Habitat quality

Although data are scarce, aquatic habitat quality has deteriorated in the Chesapeake Bay. Submerged aquatic vegetation, the most important aquatic food resource for waterfowl, has decreased in the upper Bay since 1971, according to Kerwin *et al* (1976). Over the upper Bay, frequency occurrence of submerged aquatic vegetation decreased from about 28% to about 15% of sampled stations from 1971 through 1974. Additional data (unpubl, USFWS Migratory Bird and Habitat Research Laboratory, Laurel, Maryland) indicate a continued reduction in submerged aquatic vegetation through 1979.

Many invertebrate species used by waterfowl for food are associated with submerged aquatic vegetation. Unfortunately, no data comparable to those on vegetation are available for invertebrate populations.

Nevertheless, some changes in invertebrate numbers have been recorded. In 1971 the soft-shelled clam *Mya arenaria,* a species of considerable commercial importance to Atlantic coastal states, was estimated to occupy less than 20% of its 1957 distribution in Maryland waters (F Hammons pers com). There is evidence, therefore, that both plant and animal aquatic food resources for waterfowl were less abundant in the upper Bay by the mid-1970s.

Recent agricultural trends

A general crop summary is provided annually by the Maryland Crop Reporting Service, as well as county statistics on crops planted and harvested. Agricultural plantings in Kent, Queen Anne's, Talbot and Dorchester Counties on Maryland's Eastern Shore have not changed over the ten year period ending in 1973. There was also no change in total land cultivated. Corn was the major crop planted, followed by soybeans.

Specific study areas

Primary criteria for selection of five study areas were the general distribution of swans in Maryland (Stewart 1962), landowner co-operation and accessibility to swans. The areas (Fig 1) are briefly described in Munro (1981). All are within slight to moderately brackish areas of the Bay in the 5—15 parts per thousand salinity range. For a thorough description of Maryland's Chesapeake Bay, see Lippson (1973).

Methods and materials

Plastic neck-bands were used as the principal marker. A standard USFWS band was placed on one tarsus and a plastic band, engraved with the same numerals as the neck-band, was placed on the other tarsus. Unless otherwise specified, all records of individually marked swans reported in this study were based on observations of neck-banded birds. For methods of construction, application and a description of the marking protocol, see Sladen (1973).

Swans were baited with corn and captured in either topless funnel traps set in water or under cannon nets in fields. Three hundred and forty swans were captured and marked at Bay study areas during the winter of 1969/70.

Birds were observed with 15 to 60x spotting scopes that enabled positive identification up to 150 m under ideal conditions. Banding records and subsequent sightings of members of the original marked sample were coded and punched on cards or keyed on magnetic tape either by the author or personnel of the USFWS Migratory Bird Management Office. Data reduction and summarization procedures were also provided by that Office. Statistical analysis was as detailed in Munro (1981).

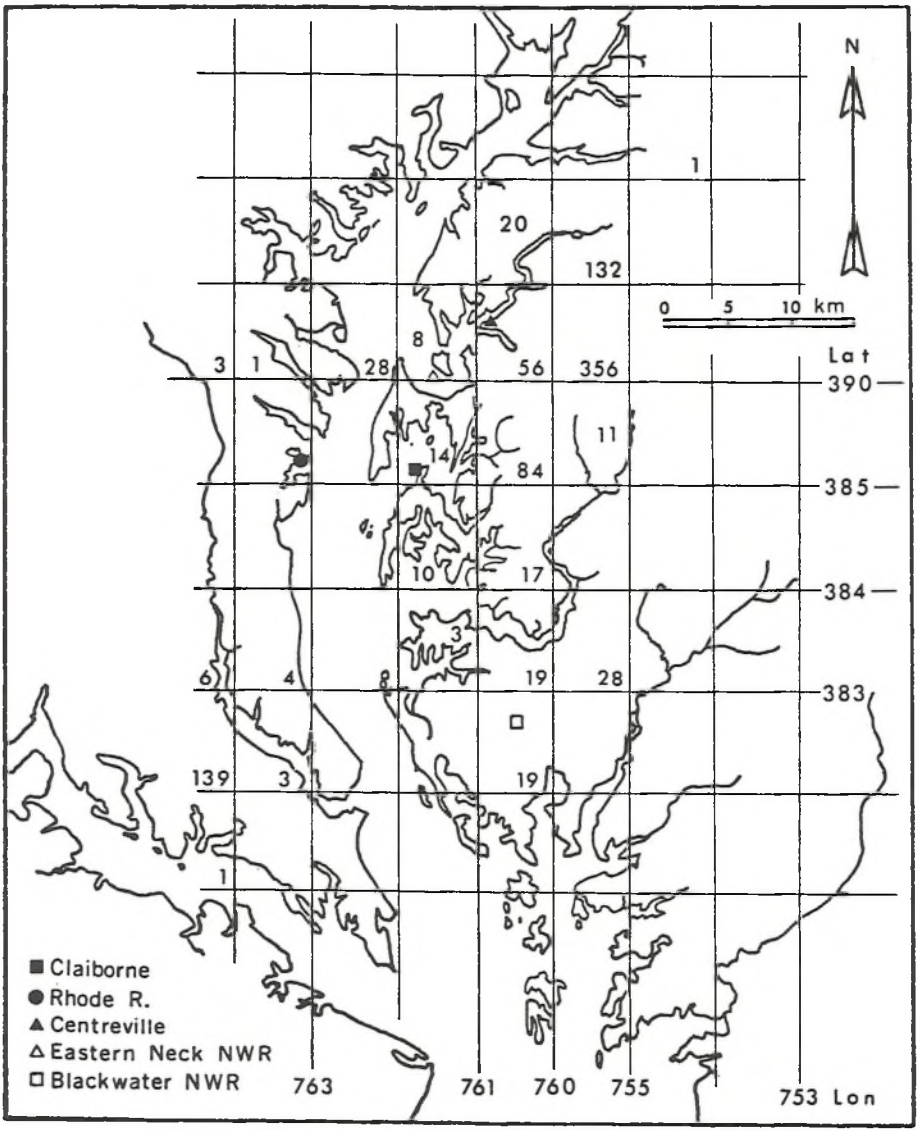

Fig 1. Locations of study areas in the upper Chesapeake Bay of Maryland, and ten-minute block locations of field feeding by neck-banded swans, winters 1970/71 to 1975/76 and study areas combined. (Multiple observations (different days) per individual included).

Results

The recent increase in field feeding

According to V D Stotts (pers com), the movement of swans into agricultural fields in Maryland during the late winter of 1969/70 was in response to six weeks of freezing weather. Concern was also expressed for apparent decreases in submerged aquatic plants and some shellfish in recent years. The decrease in submerged aquatic vegetation (Kerwin *et al* 1976) was followed by a smaller proportion of the Atlantic Flyway swans wintering in Maryland (Fig 2); see also Munro (1981). Although swans had been observed in Maryland fields prior to 1969, their numbers were probably under some stress such as disease.

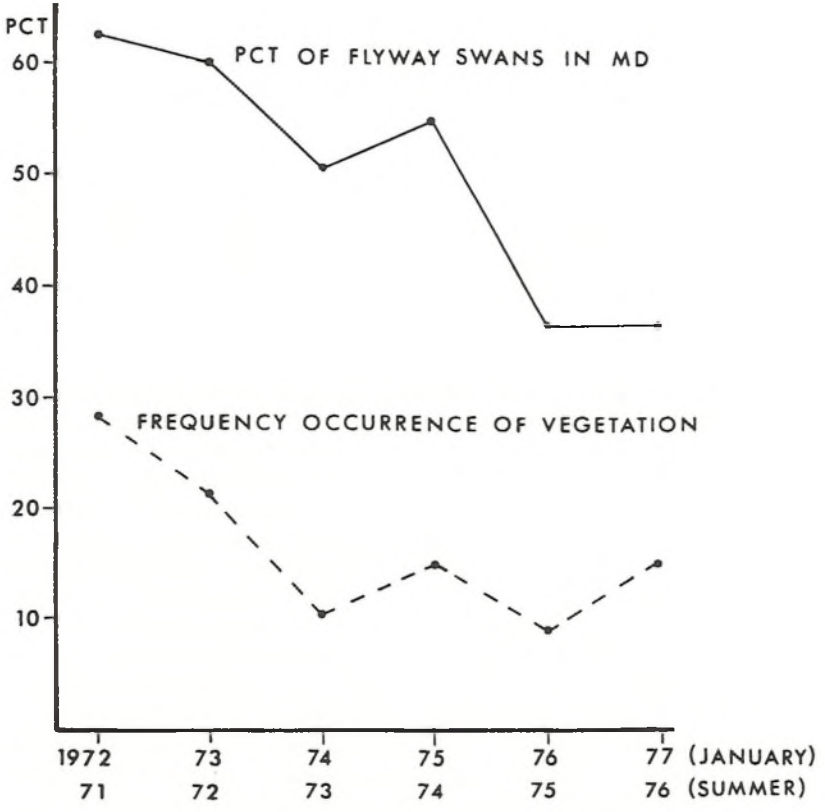

Fig 2. Percentage of Atlantic Flyway swans in Maryland and frequency of occurrence of vegetation.

No survey data have been published on numbers of swans using fields. Although boundaries of areas surveyed during co-operative State-USFWS January inventories are generally oriented around river systems, they include vast tracts of agricultural land. Current procedures continue to combine survey results (except for swans during recent years – V D Stotts pers com) from estuarine and agricultural habitats.

Observations from the original sample of 340 neck-banded swans were examined to determine numbers that returned to the Bay area each winter (Munro 1981). Numbers and proportions of these birds that were observed field feeding were tabulated and analysed by study area of banding (Table 1). The analysis was con-

Table 1. Numbers of neck-banded swans, by area of banding, field feeding around Chesapeake Bay, expressed as the percentage of the number available (see Munro 1981).

RHO = Rhode River, ENR = Eastern Neck, CEN = Centreville, BLK = Blackwater, CLA = Claiborne

Banded	1969/70	1970/71		1971/72		1972/73		1973/74		1974/75		1975/76	
Area		N	%	N	%	N	%	N	%	N	%	N	%
RHO	48	2	6	11	46	1	8	2	25	3	60	3	60
ENR	42	10	36	14	70	7	70	7	70	4	100	1	60
CEN	19	11	85	12	92	2	67	3	100	1	50	2	100
BLK	168	17	24	29	64	8	31	4	44	4	44	3	37
CLA	63	7	19	14	61	6	35	4	40	3	75	4	100
Total	340	47	26.0	80	64.0	24	35.3	20	50.0	15	62.5	13	61.9

structed to test for differences in the combined data and between the proportions of birds field feeding from each study area population, both at the start of the study period (intercept) and across years (slope or trend). Differences among area intercepts were indicated ($p = 0.0057$), as well as an overall trend ($p = 0.0194$). Study areas were compared by testing one arbitrarily chosen sample, Rhode River (RHO), for zero intercept and slope, followed by tests between this and each of the remaining areas. The estimated proportion of Rhode River birds that were field feeding during the band year was 1.5%, which was not different from zero. A large difference (82.5%) was found between the estimated proportions of Rhode River and Centreville (CEN) birds that were field feeding during the band year. That this difference was easily detected ($p = 0.005$) was comforting, since all Centreville birds were captured while feeding in a corn field. The estimated trend in field feeding by Rhode River birds was an increase of 9.4 percentage points per year, which was marginally significant ($p = 0.0629$); nevertheless, it was an indication of a yearly increase in swan field feeding. Tests for slope or trend differences between study area populations were all non-significant.

A similar analysis by age and sex class of percentages or proportions of neck-banded

swans feeding in fields yielded uniformly non-significant results. This was affected by the initially high percentage of Centreville birds that were field feeding and the six-year study.

To examine better the extent and trend in field feeding by swans, the Centreville birds were removed from the data set, as were young birds and those of unknown age or sex (Table 2). Using a similar model, an analysis of variance indicated no

Table 2. Numbers of adult male (AM) and female (AF) neck-banded swans field feeding around Chesapeake Bay, expressed as the percentage of the number available.

Banded	1969/70	1970/71		1971/72		1972/73		1973/74		1974/75		1975/76	
		N	%	N	%	N	%	N	%	N	%	N	%
AM	118	9	15	20	62	6	37	5	42	1	50	2	50
AF	138	18	23	37	61	11	30	9	43	10	71	8	73
Total	256	27	19.4	57	61.3	17	32.1	14	42.4	11	68.8	10	66.7

intercept or slope differences among adults; however, the year effect in the combined data was significant ($p = 0.0504$). The estimated intercept or proportion of birds feeding in fields during the band year was 20.8% for adult females, which was not significantly different from zero ($p > 0.2$). Of greater importance, the estimated slope for adult females was +8.4 percentage points per year, which was marginally significant ($p = 0.0529$). Therefore, observations of neck-banded swans indicate the incidence of field feeding among birds banded as adults was between 0 and 21% during the 1969/70 winter, and increased to between 50.4% and 71.2% (0 or 20.8% + [8.4%/year * 6 years]) by the 1975/76 winter.

Within-season changes in field feeding

The movement of swans to fields during the 1969 winter occurred in late January and February 1970, the marking period. Data therefore were arranged by 15-day periods beginning with 1970/71 (Table 3) to investigate changes in timing of field feeding within seasons. Birds from all study areas were combined, as were multiple observations (different days) of individuals. Most swans usually arrived in the Bay area during early to mid-November. Of 125 observations of neck-banded swans in fields during the 1970/71 winter, less than 5% occurred before February; this was consistent with the previous winter. However, almost 10% of 544 field feeding observations during the next winter (1971/72) occurred during November 1971 immediately upon the swans' arrival in the Bay area. Although numbers of observations during later years were small, a season-long pattern of field feeding was suggested.

Table 3. Winter time periods during which agricultural field feeding by neck-banded swans was recorded in the Chesapeake Bay area, all study areas combined.

Season (N. obs.)	Percent frequency by 15-day time period									
	1 Nov–15 Nov	16 Nov–30 Nov	1 Dec–15 Dec	16 Dec–30 Dec	31 Dec–14 Jan	15 Jan–29 Jan	30 Jan–13 Feb	14 Feb–28 Feb	1 Mar–15 Mar	16 Mar–30 Mar
1970/71 (125)	0.0	1.6	0.0	1.6	0.0	1.6	16.0	23.2	29.6	26.4
1971/72 (544)	1.1	8.5	14.5	1.5	20.2	20.2	4.2	10.9	17.8	1.1
1972/73 (68)	1.5	2.9	23.5	0.0	2.9	29.4	5.9	17.6	16.2	0.0
1973/74 (94)	1.1	1.1	0.0	6.4	10.6	25.5	25.5	23.4	6.4	0.0
1974/75 (81)	0.0	16.1	12.3	4.9	12.3	14.8	9.9	14.8	12.3	2.5
1975/76 (56)	0.0	0.0	16.1	7.1	17.9	19.6	14.3	8.9	14.3	1.8

Multiple observations (different days) per individual included.

Locations of field feeding

Locations of field feeding by neck-banded swans were summarized by 10 minute block of latitude-longitude (Fig 1). Observer effort was concentrated in the Chester River area in Kent and Queen Anne's Counties on Maryland's Eastern Shore. Within that area, attempts were made to observe all field feeding locations without regard to flock size. Three study areas (Centreville, Claiborne and Eastern Neck) are within 25 km of that area. Intensity of field feeding there, when compared with other Bay areas, is over-emphasized when based on observations of neck-banded swans. Nevertheless, about 37% of all field feeding by marked swans was observed in one 10 minute block (390–0755) in Queen Anne's County. That block and the one to the north comprised 50% of over 900 observations of neck-banded swans feeding in fields.

Swans tended to fly farther inland than *B. canadensis.* Since large numbers of geese arrive in the Bay area four to six weeks earlier than swans, perhaps geese deplete food resources in fields closer to water.

Daily patterns of field feeding

About 1800 swans in the Sassafras River area of Kent County on Maryland's Eastern Shore were intensively observed during late January and February 1972. Ice was an insignificant environmental factor in the Sassafras River area when observations began on 27 January. In 30 days, none of these birds was observed feeding in the river or adjoining creeks during daylight hours. Although night-time feeding in the river cannot be discounted, it was improbable since little vegetation was found in the river the previous summer (Kerwin *et al* 1976).

Daily movements by the entire flock to fields about 8 km south of the river commenced not earlier than half an hour after sunrise (about 0710 local time). It was usually 0800 before the first swans left the river, but after 1200 before the last swans departed. Observations of one swan (C955) equipped with a small radio transmitter suggested that temperature affected the timing of daily movement to fields. On seven mornings between 27 January and 11 February this bird left Turner Creek, a Sassafras River tributary, between 0814 and 1022. On four mornings when ice had formed in the creek overnight, departure times were between 1546 and 1733.

The flock's evening flight to water was usually triggered by approaching sunset (when the sun appeared to touch the horizon) and ended not later than one hour after sunset. Although adverse weather conditions such as high winds (>30 km/hr) or fog delayed the evening flight, no swans stayed in fields long after sunset when normal weather prevailed. The absence of nocturnal field feeding by swans was further demonstrated by the movements of C955. On the afternoon of 10 February, after resting on ice most of the day, this bird left water at 1733 to feed in fields

even though sunset was at 1738; he returned to water at 1809 after only 20 minutes of field feeding.

Undisturbed swans used the same fields and portions of fields day after day until food resources were apparently exhausted. For example, C955 was observed over the 30-day period in only five fields, all within a 3 km radius; his movements reflected those of the majority of birds in the flock.

Types of fields used

During the winters of 1970 and 1971, swans were observed feeding in 78 fields in Kent, Queen Anne's and Talbot Counties. Fifty-nine of these (75.6%) were harvested corn fields, 13 (16.7%) were other cereal grains (winter wheat, rye or barley) and 6 (7.7%) were harvested soybean fields. During the 1971 winter, availability of Eastern Shore crops was 52.0% corn, 15.4% wheat/barley and 32.6% soybeans (Maryland Crop Reporting Service 1974: Tables 29 to 32). These data indicated a definite preference for corn over soybeans, and a use of wheat/barley cropland in relation to abundance. Aside from crop preferences, swans tended to select large, poorly-drained fields located farther inland than those utilized by *B. canadensis.*

Likely future developments

That Maryland's Chesapeake Bay was less suitable as a wintering area for swans (and non-terrestrial waterfowl) from 1972 to 1977 was indicated by significant shifts in populations from Maryland to North Carolina and reductions in Bay aquatic food resources. Birds that moved to North Carolina, traditionally the southern end of the winter range, must have initially done so to obtain preferred foods, primarily submerged aquatic vegetation. Nevertheless, field feeding increased there as well. This is a strong indication that the flyway distribution of swans will return to the traditional pattern regardless of the abundance of Bay vegetation. Fewer swans will continue to add 350 km to their migration to winter in North Carolina only to feed in fields when Maryland's Chesapeake Bay area offers the same opportunity.

The eastern swan population will in all certainty increase in the future as a result of its adaptation to field feeding in flyway wintering areas. Such has been the result of adaptation to field feeding by other waterfowl species.

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Summary

Historically, field feeding by large numbers of swans while on spring migration from Atlantic Flyway wintering areas began in the early 1950s. But in all wintering areas of the Flyway, swan field feeding was insignificant until the early 1970s. In contrast, *B. canadensis* in these same areas began field feeding perhaps 25 to 30 years earlier.

The initial movement of a substantial number of swans into agricultural fields during the late winter of 1969/70 apparently was stimulated by six weeks of cold weather that froze over most shallow water areas in Maryland's portion of the Chesapeake Bay. Field feeding during the 1970/71 winter was again prevalent in February. However, swans moved into fields upon arrival in the Bay area in November 1971. Thus began a season-long pattern of field feeding that continues to date.

Analysis of observations of swans neck-banded from January to March 1970 indicated a positive trend in field feeding. Although the proportion of Flyway swans wintering in Maryland decreased substantially over the 1972 to 1977 period, field feeding by swans increased at an estimated rate of 8% per year. Between 50% and 70% of the Maryland swan population were feeding in fields by the winter of 1975/76.

Swans fed in fields on a daily basis with movement beginning within one to three hours after sunrise. Unless disturbed, swans usually remained in fields until sunset when they returned to water. Swans were not observed in fields after sunset except during inclement weather. The same fields were used on successive days until food resources were apparently exhausted.

During the winters of 1970/71 and 1971/72, 75% of fields utilized by swans were harvested corn fields. Harvested soybean fields were infrequently used by swans. Winter wheat and barley crops, which are normally harvested in late spring, were used more in relation to their availability than the other crops.

It is suggested that reductions in Bay submersed aquatic vegetation are responsible for continued field feeding and recent changes in winter distribution of swans. It is predicted that Maryland will remain the primary wintering area and that, as a result of expansion into agricultural habitats, the Atlantic Flyway population will increase regardless of trends in Bay vegetation.

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SUMMER BEHAVIOUR OF *CYGNUS CYGNUS CYGNUS* IN ICELAND

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A comparative study was made of breeding and non-breeding *Cygnus cygnus cygnus* in the Myvatn area of northeast Iceland.

Birds arrive in north Iceland, possibly via staging posts on the south coast. Breeders probably migrate paired, or may pair at staging posts, then move into the vicinity of breeding sites to commence nesting when waters become ice-free. Non-breeders first move to areas of spring grazing, then change to aquatic habitats.

Successful breeders moult at the breeding site. However, the remaining moulters can be found in two distinct flocks. Aspects of pairing and of quasi-territorial behaviour, and the time of build-up of the flocks suggest that the first flock, feeding on blanket weed *Cladophora,* is comprised of non-breeders. The second flock, feeding on pondweeds *Potamogeton spp,* is comprised of failed breeders and birds which have occupied breeding sites but have not produced eggs or young.