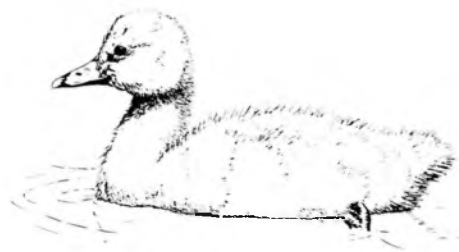

SECTION 3: BREEDING

Breeding performance of an Irish Mute Swan *Cygnus olor* population

RICHARD COLLINS

Mute Swans breeding in Dublin, Ireland, were studied from 1983 to 1989. Only 46% of birds bred in the season in which they were five years old. The mean clutch size was 6.7. About 80% of clutches hatched. The mean brood size was 4.2 per nest at hatching and 2.7 per 'nest' at the age of three months. A shortage of suitable territories seemed to limit recruitment to the breeding population and to promote the use of inadequate territories, especially on estuaries, in (usually futile) breeding attempts. Urban breeders tended to be younger than rural ones.

Ireland, at the western edge of the palearctic range of the Mute Swan *Cygnus olor* (Cramp & Simmons 1977), has a milder climate than the species encounters elsewhere. Ringing has shown that this population is virtually closed (Spencer & Hudson 1978, Spray 1981a, Collins 1985). A study of the dynamics of the Mute Swan population in the Dublin region commenced in March 1983. This paper gives the results to date on the age at which birds begin to breed and on breeding productivity. It examines breeding performance in various habitat types and compares breeding productivity in urban and rural environments.

Methods and Materials

The study area of 1,350 sq km (Fig. 1), a coastal location, included all of County Dublin and small portions of adjoining counties. The area enclosed Dublin city in which one million people live and rural communities with low population densities. Coarse fishing is not popular and blood lead levels in swans in the region are low (O' Halloran & Myers 1988).

The terms 'breeding' 'breeder' and 'nesting attempt' as used here denote the production of at least one egg. (Pairs which held territories or built nests but did not produce eggs are not classified as 'breeders'). The term 'urban' denotes a location inside or within 500m of the boundaries of Dublin city or of a town or village. 'Rural' denotes a location outside such areas and at least 500m from the boundaries of the city, a town or village.

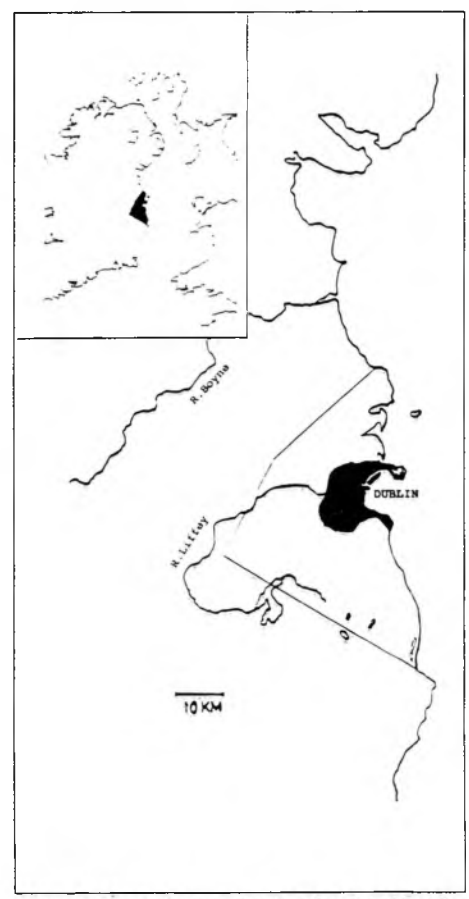

Figure 1. The study area showing the city of Dublin. The coordinates of the northern tip of the area are 53° 36'N., 6 °12'W.

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Table 1 Age at which birds first bred; number in each age cohort known to be breeding for the first time and number known not to have bred.

	Age (years old)				
	2	3	4	(5	6)
breeding for 1st time: cobs	0	5	4	(2	1)
„ „ pens	1	6	6	(2	0)
not yet breeding: both sexes	202	98	44	(16	3)
total known status	203	109	54	(20	4)
% 1st breeders	0.5	10	19	(20	25)

'breeding' = pair with eggs.

Swans in the study area were given individually coded plastic leg rings and British Trust for Ornithology (BTO) metal leg rings. By the end of 1985 over 90% of swans in the study area had been ringed. A marked population has been maintained since then in which all swans, with a few exceptions, could be recognised in the field. Any swan known to have been in the study area at any time during the study period was deemed to be a member of the population. The mates and young of birds marked within the study area but subsequently nesting outside it were also ringed. Up to December 1989 1,047 swans had been ringed.

All locations frequented by swans within the study area were visited regularly. The ring codes of swans in flocks were recorded at least twice a week. A swan recorded in a flock in both April and May was considered to be a non-breeder that year. Locations outside the study area were visited to find 'missing' birds. Life history data were collected from sightings of plastic rings and recoveries of BTO rings. The collection of breeding data commenced in 1985. It is believed that some nests may have remained undetected in 1985 but that virtually all nesting attempts in the study area from 1986 to 1989 were recorded. Where possible, nests were visited during egg-laying, immediately before and after completion of the clutch and before and after the predicted hatching date. Brood sizes were recorded one week, two weeks, four weeks and three months after hatching. All known nesting attempts outside the study area which involved marked birds were treated similarly, where possible. Figures given here for clutch and brood sizes refer only to nesting attempts where these data were known precisely. Pairs nesting within 5km of their previous nest location on the same canal or river are not regarded as having moved to a different territory. The 5km figure was chosen because the length of the largest territory was 5.2km.

Results

One hundred and seventy four nests with eggs were recorded within the study area from 1983 to 1989. A further 40 nests of marked birds were recorded outside the study area.

Age profile of breeding birds

The age at first breeding is known for 27 swans (Table 1). Only ten out of 54 swans which were known not to have bred, did so for the first time at age four. The breeding status of birds during each of their early years is shown in Table 2. Here the samples for the older categories are larger. The table is not an exact representation

Table 2 Breeding status of birds in each of their early years.

	Age (years old)					
	2	3	4	5	(6	7)
known to be alive	270	151	98	56	(17	5)
breeding status unknown	67	31	25	21	(9	1)
breeding status known	203	120	73	35	(8	4)
known breeders (eggs laid)	1	14	19	16	(4	1)
known non-breeders	202	106	54	19	(4	3)
% breeding (of breeding status known total)	0.5	12	26	46	(50	25)

Table 3 Numbers of recorded nests with eggs in each habitat type; hatching rates and mean young raised to three months per nest, related to habitat type.

	habitat				
	pond	gravel pit	river	canal	estuary
nests (with eggs)	91	10	42	34	35
hatched	82	10	34	26	18
not hatched	8	0	8	8	16
% hatched	91	100	81	76	53
'nests' with young at 3 months	67	9	28	21	10
'nests' with no young at 3 months	19	0	10	13	25
broods of known size at 3 months	64	7	21	19	9
mean young at 3 months per 'nest'	3.4 (83)	4.0 (7)	2.7 (31)	2.9 (32)	0.6 (34)

() = sample size. Two pairs found with cygnets could not be assigned to a habitat type. In the case of one pond and one estuarine nest it was not possible to say whether the eggs hatched or not. The data on 25 'nests' at 3-months were incomplete.

of breeding recruitment since some birds which have bred will fail do so in a subsequent year. However, the numbers of such birds (mainly widowed or injured individuals) were small and Table 2 should resemble the breeding recruitment pattern fairly closely. Again, failure to breed during the early years is evident with only 46% breeding when five years old. In the 1989 breeding season, only 24% of breeding birds were of known age. Taking into account birds of unknown age and estimating their minimum ages (these were adults when ringed and were at least eighteen months old then), 46% of all breeding swans were at least six years old and 26% were at least seven in 1989.

Pair bonds

In seven pairs the partners were the same age. Six cobs were older than their mates. Four pens were older than their cobs. For all nesting attempts where the age of a bird was known, the mean age of cobs was 4.2 years (n = 25, range 3 to 6), and the mean for pens was 4.3 years (n = 29, range 2 to 7).

When birds nested in consecutive years and their mates of the first year were known to be still alive in the second, 97% of the pair bonds had remained intact (n = 100), an annual divorce rate of 3%.

Territories

Sixty-three urban and 150 rural nests with eggs were recorded. (The urban/rural status of one pair found with cygnets could not be determined). Forty-three per cent of nests were on ponds, 20% on rivers, 16% on estuaries, 16% on canals and 5% on gravel-pits (Table 3).

Territorial fidelity was high. Only one pair was recorded breeding on a territory different from the one on which it had bred the previous year, compared to 115 instances of pairs nesting on the territory of the previous year.

Eggs

The largest clutches were laid earliest in the season, clutches decreasing in size the later laying commenced (Table 4). There was no significant variation in laying dates between years.

The mean clutch size was 6.7 (n = 132, range 1 to 12). Mean clutch sizes were similar for all years except 1985 (Table 5) when a lower figure

Table 4 Week of first egg related to clutch size.

Week no.	11	12	13	14	15	16	17	18	19	20	21
mean clutch size	9.1	8.8	7.8	6.7	6.2	5.9	6.8		5	5	4
(n)	(10)	(9)	(13)	(19)	(13)	(8)	(6)		(1)	(1)	(1)

Table 5 Nesting performance.

Year	nests				clutches/broods						
	all	study area only	mean clutch size	(n)	h	hatching f	%h	mean young per nest hatching	(n)	12 weeks later	(n)
83	2	2			1	1				0	1
84	13	13	6.7	3	13	0		5.8	4	4.0	9
85	31	29	5.9	16	23	8	74	2.7	19	2.4	26
86	39	31	6.8	28	29	10	74	4.1	30	2.5	33
87	38	31	6.6	30	33	5	87	5.0	28	2.7	35
88	46	35	6.9	28	38	7	84	4.4	36	3.2	41
89	45	33	6.9	27	35	9	80	3.8	27	2.5	42
Total	214	174	6.7	132	172	40	81	4.2	144	2.7	187

h = number of broods hatched, f = clutches failing to hatch, *n* = sample size (clutches or broods for which the size was known). There were two nests of unknown hatching status; one in 1988 and one in 1989.

was recorded. It is thought that the small 1985 sample may be biased as some early nests (the larger clutches) were not found in time to be certain of the clutch size. No data were collected for clutches in 1983 and the 1984 data were incomplete. The mean clutch size for the 1986 to 1989 seasons was 6.8 (n = 113).

Eggs were lost from 26% of clutches from which young subsequently hatched.

Young

Eighty-one per cent of clutches hatched (n = 212, Table 5). The data for 1983 and 1984 are limited. The hatching rate for the years 1985 to 1989 was 80% (n = 197). The proportion of clutches hatching did not vary significantly with season from 1985 to 1989. The mean brood size at hatching, was 4.2 (n = 144) per nest and 5.9 (n = 102) per clutch hatched. In 1985 only 2.7 young per nest were recorded. Freak rainstorms, which flooded several nests at or near the hatching stage, and vandalism were largely responsible for this.

Pairs succeeded in raising young to the age of three months from 67% of nests (n = 204). The average brood size was 4.2 at three months (n = 120), 3.5 at three months per clutch hatched (n = 145) and 2.7 at three months per 'nest' (n = 187).

Breeding performance related to habitat type

Half of all clutches on canals had commenced by the end of the 13th week of the year. Half of pond, river and gravel-pit clutches had commenced by the end of the 14th week. Estuarine clutches were later. Half of these had commenced by the end of the 16th week.

All gravel-pit clutches hatched, and gravel-pits had the highest production of young. However, the data refer only to two pits occupied each year by the same two pairs. The hatching rates on ponds, rivers, and canals did not vary significantly (Table 3). The 53% hatching rate recorded on estuaries was significantly lower than those recorded on the other habitats (χ^2 = 26.17, df = 4, P < 0.01).

The mean number of young per 'nest' at three months was 0.6 on estuaries and 3.2 for the other habitat types combined. Pairs succeeded in raising young to the age of three months from 29% of estuarine nests. This was significantly lower than the 75% success rate recorded for the other habitats combined (χ^2 = 33.63, df = 4, P < 0.01). There were no significant differences

Table 6 Territorial breeding productivity related to habitat type.

habitat	total	A	% of total	B	% of total	C	% of total
pond	29	16	55	9	31	4	14
canal	14	4	29	3	21	7	50
river	11	7	64	1	9	3	27
estuary	13	2	15	1	8	10	77
all types	67	29	43	14	21	24	36

A: territory fledging young in more than one season. B: territory fledging young in only one season. C: territory from which no young fledged.

Table 7 Numbers of nests with eggs in urban and rural areas; hatching rates and mean number of young at three months per nest in urban and in rural locations.

	habitat			
	urban	urban excl. estuary	rural	rural excl. estuary
nests	63	61	150	117
hatched	52	51	119	102
not hatched	11	10	29	14
% hatched	83	84	80	88
'nests' with young at 3 months	47	46	89	80
'nests' with no young at 3 months	15	14	52	28
known size broods at 3 months	44	43	76	68
mean young at 3 months per 'nest'	3.4 (59)	3.4 (57)	2.4 (128)	3.1 (96)

( ) = sample size. The urban/rural status of one pair with cygnets was not known. There were two nests of unknown hatching status. The data on 26 'nests' at '3 months' were incomplete.

between the success rates for the other habitats up to the three month point. The mean size of broods surviving to three months on estuaries was 2.2 (n = 9). This was also significantly lower than the 4.4 (n = 111) recorded for the other habitats combined ($F = 3.66$, df = 4 & 115, $P < 0.01$). There were no significant differences between the means for the other habitats.

Table 6 compares fledging success rates for territories in the different habitat types. No young fledged at 36% of locations where eggs were laid in at least one season from 1985 to 1989, while at 21% of locations young fledged in one season only. The most successful habitat type was ponds with young fledging from 86% of territories on at least one occasion during the study period. Estuaries appear to offer mainly marginal and non viable territories.

Urban/rural comparisons

The mean age of birds breeding in urban locations, for all nesting attempts where the age of at least one bird was known, was 3.9 (n = 27, range 2 to 6). In rural locations the mean was 4.6 (n = 27, range 3 to 7). Thus urban breeders tended to be younger than rural breeders ($z = 2.84$, $P < 0.01$).

Egg loss was higher for urban than for rural nests ($\chi^2 = 5.3$, $P < 0.05$, df = 1). Of 34 urban clutches of known size from which young subsequently hatched, 14 (41%) lost at least one egg compared to nine recorded losses from 54 rural clutches (17%).

There were no significant differences between the numbers of urban and rural clutches hatching (Table 7), between the numbers of urban and rural pairs raising young to the age of three months, or between the mean brood sizes at three months.

Discussion

The swans in this study were older when starting to breed than those studied in England by Perrins & Reynolds (1967) Minton (1968) Coleman & Minton (1979) or Perrins & Ogilvie (1981) but not as old as recorded in Denmark by Andersen-Harild (1981) or in the Hebrides by Spray (Birkhead & Perrins 1986). Almost all viable breeding territories appeared to be occupied each year in Dublin. Many young adults failed to get territories and had to postpone breeding. About half of all territories seemed to be inadequate or marginal. Though inadequate territories were recorded in all habitat types (except gravel-pits), estuarine territories were predominantly so. With limited fresh-water territories available, birds may have resorted to nesting on estuaries, the coastline serving as a conduit for moving swans. Irish swans may be more mobile than British swans (O'Halloran & Collins 1985). Such mobility could result from a shortage of suitable breeding habitat, with young adults, 'unemployed' for several years, moving about in search of territories or food.

Minton (1968) studying swans in Staffordshire, showed that pens tended to breed at a younger age than cobs. There was little evidence of pens breeding at a younger age in Dublin though a slight tendency to earlier

breeding may not be detectable with the sample sizes available. The decline of clutch size with date of laying was similar to that found by Reynolds (1972) in the Oxford area. The mean clutch size in the Dublin study was within the range recorded in several studies in Britain (Reynolds 1965, Perrins & Reynolds 1967, Bacon 1980, Spray 1981b). In Reynolds' (1965) study 16 broods hatched from 17 nests, but the hatching rates in Dublin were higher than recorded by Perrins & Reynolds (1967), Coleman & Minton (1980), Spray (1981b) or Leach (1988). Lower incidences of flooding and of vandalism in Dublin may account for this. Almost all water bodies in the Dublin area are controlled by weirs and sluices and few nests were flooded. People are fond of swans and take a keen interest in them. Vigilance is high and few nests were vandalised.

In most British studies swans had surplus territories available to them and presumably few marginal territories were used. With many poor territories in use in Dublin, a lower overall production of young might be expected than recorded in British studies. But in fact the mean of 2.7 per nesting pair at three months was high compared to most British results. It was, however, very close to the mean of 2.6 recorded by Andersen-Harild (1981) for solitary nesters in his study in Denmark. This is interesting since both the Dublin and Danish populations appeared to have shortages of territories and postponed breeding by younger birds. The exceptionally high survival of clutches to the hatching stage partly explained the high productivity in Dublin and compensated for the poorer performance on marginal habitats but it was not the whole story. The average brood size of 3.5 at three months per hatching clutch in Dublin was high compared to levels recorded in British studies. Reynolds (1965) recorded 3.0 young at three months per hatching clutch and Perrins & Reynolds (1967) recorded 3.1. Minton (1968) recorded an average brood size of 3.5 at fledging. Coleman & Minton (1980) recorded an average brood size of 3.8 at fledging for the period 1961 to 1967 and 4.0 for 1975 to 1978. In Dublin the average brood at three months was 4.2. Allowing for some deaths between the three month and fledging stages, the brood size at fledging in Dublin was probably similar to Coleman & Minton's figures. Nests in the Dublin study fared better up to the hatching stage than their counterparts in British studies and appeared to fare equally well after hatching.

The lower mean age of urban swans compared to rural birds was a curious finding. Perhaps this resulted from a higher death rate in urban areas. Collisions with aerial cables may be more frequent in the city than in the country. The urban waterways are festooned with cables and the ensuing collision deaths would make territories available more frequently in built-up areas than in the country. The recruitment rate to the urban breeding population would be higher.

Parent birds were known to have broken eggs in defending nests from intruders (four cases). Eggs occasionally fell out of poorly constructed nests, but the higher rate of egg loss in built-up areas suggests that thefts by people were responsible for most egg losses. This is odd considering that total destruction of clutches was rare and hatching rates were similar in urban and rural areas. Perhaps people stole the occasional egg from vulnerable nests but without malicious intent to the swans.

The Mute Swan seems to breed productively in Dublin city and county, optimising largely man-made habitats and subject to human influences both favourable and unfavourable.

The work was done under the supervision of Dr. John Whelan at University College Dublin. Dr. Malcolm Ogilvie advised on capturing and ringing swans. Mr. Brian Madden gave valuable assistance in capturing and subsequently tracking ringed birds. Mr. Padraig Farrelly and Mr. John Marsh monitored remote nests. Mr. Hugh Brazier commented on an earlier draft of the paper.

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