

# Ringing recoveries of Razorbills *Alca torda* and Guillemots *Uria aalge* in Danish waters

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(Med et dansk resumé: *Genfund af ringmærkede Alke Alca torda og Lomvier Uria aalge i Danmark*)

## Introduction

Several hundred thousand Razorbills *Alca torda* and Guillemots *Uria aalge* have been reported to frequent the seas around Denmark in recent years. Between 200 000 and 400 000 Razorbills were estimated in the winters 1987 and 1988, and 200 000 Guillemots moulted in the Skagerrak during late summer, with peak numbers in late autumn being about 300 000 (Jensen 1993, Durinck et al. 1994, Skov et al. 1995). Danish waters are thus of international importance for these auks. Since a full evaluation of this importance requires that the populations and age-classes involved are known we here analyse the ringing recoveries of Razorbills and Guillemots in Denmark.

## Material and methods

Data on ringed birds recovered up to January 1993 were supplied by the Zoological Museum, Copenhagen, Denmark; National Environmental Research Institute, Kalø, Denmark; British Trust for Ornithology (Joint Nature Conservation Committee), U. K.; Institut für Vogelforschung (Vogelwarte Helgoland), Germany; Museum of Natural History, Stockholm, Sweden; and Zoological Museum, Helsinki, Finland. In addition, all published lists of recoveries from Norway, Great Britain, Russia, Finland and Sweden were scanned for relevant information. Supplementary data on auks ringed in Iceland were supplied by Æ. Petersen and I. K. Petersen. Breeding-season recoveries from the mixed colony at Græsholmen, central Baltic Sea, Denmark, were not used (for an analysis of these, see Lyngs 1992).

The 640 recoveries (135 Razorbills and 505 Guillemots, Tab. 1-2 and Fig. 1-2) were broken down according to area of origin, cause of recovery (found dead, shot, caught in fishing gear) and age-class (immature: birds recovered in their first to third year of life; adult: birds ringed as adults or recovered as older than three years). In some cases we took a more detailed look at the recovery patterns of first-year birds.

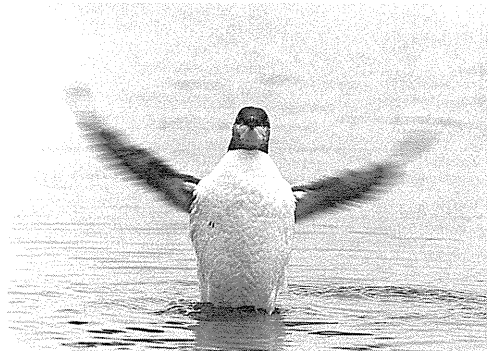


Photo: John Larsen

The Danish waters were divided into five areas (Fig. 3): the North Sea (NOS), the Kattegat (KAT), the Belt Sea (BEL), the inner Danish waters (IDW), and the Baltic Sea around Bornholm (BOR).

While the ringing recoveries tell which populations visit Denmark, they say little of the quantitative composition of the winter populations. To approach this question we need to take account of ringing effort and population size. A coarse index of numerical abundance of birds from a given region might be the magnitude  $P \times DR/N$ , where  $P$  = population size,  $DR$  = number of Danish recoveries, and  $N$  = number ringed; but since a break-down into subregions, age at ringing, and subperiod of recovery has not been possible owing to lack of detailed information, the results should, at best, be regarded as semiquantitative indicators of relative abundance. The data used in these comparisons are given in Tab. 3.

## Sources of bias

All recovery materials are influenced by various sources of bias, of which some are general to all data sets of this kind and some are specific. The most important sources of bias in the present case are:

*Changes in hunting legislation and variation in hunting traditions.* Both species had an open

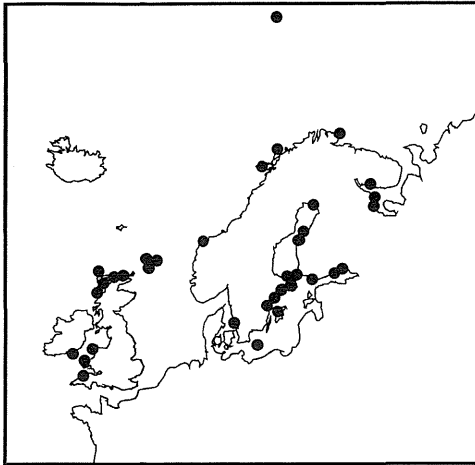


Fig. 1. Ringing localities of Razorbills recovered in Denmark.  
Mærkningsteder for Alke genfundet i Danmark.



Fig. 2. Ringing localities of Guillemots recovered in Denmark.  
Mærkningsteder for Lomvier genfundet i Danmark.

Tab. 1. Recoveries of Razorbills in Denmark.  
Genfund af Alke i Danmark.

Ringing place Mærkningssted	Immature <sup>a</sup>	Adult <sup>a</sup>	Adult <sup>b</sup>	Total
Britain and Ireland <i>Storbritannien</i>	33	5	16	54
Norway <sup>c</sup> <i>Norge<sup>c</sup></i>	6	3	3	12
Russia <i>Rusland</i>	2	1	3	6
Western Sweden <i>Vestsverige</i>	3	0	1	4
Baltic Sea <i>Østersøområdet</i>	51	7	1	59
Total	95	16	24	135

a) Ringed as chick *Mærket som redeunge*

b) Ringed as adult *Mærket som adult*

c) Includes one bird ringed on Bear Island (Svalbard) *Omfatter en fugl mærket på Bjørnøya (Svalbard)*

Tab. 2. Recoveries of Guillemots in Denmark.  
Genfund af Lomvier i Danmark.

Ringing place Mærkningssted	Immature <sup>a</sup>	Adult <sup>a</sup>	Adult <sup>b</sup>	Total
Heligoland <i>Helgoland</i>	57	15	3	75
Britain and Ireland <i>Storbritannien</i>	166	11	10	187
Faeroe Islands <i>Færøerne</i>	0	0	2	2
Russia <i>Rusland</i>	1	3	0	4
Western Sweden <i>Vestsverige</i>	1	0	0	1
Baltic Sea <i>Østersøområdet</i>	171	44	21	236
Total	396	73	36	505

a) Ringed as chick *Mærket som redeunge*

b) Ringed as adult *Mærket som adult*

season of five months (October-February) until the late 1970s. The Guillemot was fully protected in 1978, the Razorbill in 1980. After this, only very few birds have been reported as shot. In 1975/76 the total kill was roughly estimated at 1200 Razorbills and 400 Guillemots, but was thought to have been higher in former years (Joensen 1978). Before the protection there was a tradition for auk-hunting in BEL (especially in Lillebælt), whereas in other areas auks were mostly shot incidentally. In NOS and BOR there was very little offshore hunting, and consequently only few auks were bagged.

*Prevailing wind directions and surface currents.* In Denmark the prevailing wind directions are from the southwest and west, generally giving an eastward surface current. This implies that the chance of finding a dead bird on the beach is much larger on, e.g., the west coast of Jutland than on the east coast.

*Reporting of ringed birds.* The chance of a ringed bird being reported differs between the areas, depending on the level of human activity and people's attitude towards reporting killed birds. For example, it is known that in some areas (e.g. most of BEL) fishermen are reluctant to report ringed birds, while in other areas (e.g. BOR) a large proportion of the ringed birds caught in fishing gear are (or were until recently) reported.

*Type of fishing gear used in the different areas.* Most of the auks reported as caught in fishing gear

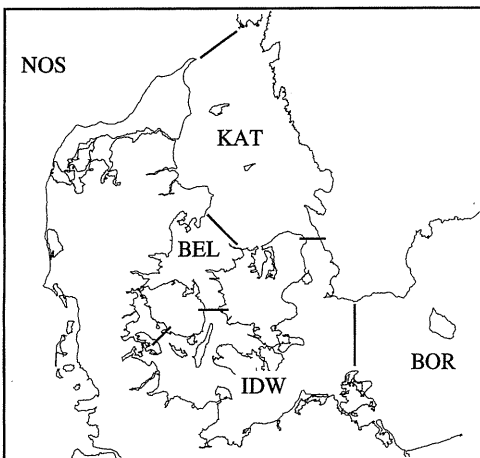


Fig. 3. The subdivision of Danish waters used in this paper: NOS = North Sea, KAT = Kattegat, BEL = the Belt area, IDW = inner Danish waters, BOR = Baltic Sea around Bornholm.  
*Inddelingen af de danske farvande brugt i denne artikel.*

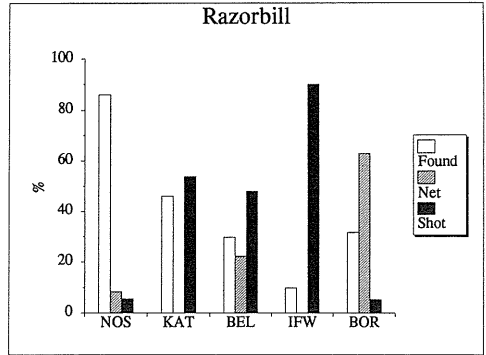


Fig. 4. Razorbill. Causes of recovery. Found = found dead (n=55), net = caught in fishing gear (n=21), shot = shot during hunting (n=59).

*Fordeling af genfindsårsager hos Alke genfundet i Danmark. Found = fundet død, net = fanget i fiskeredskab, shot = skudt.*

were taken in either gillnets or driftnets. Offshore gillnets are widely used in all areas except for the southernmost part of NOS. Driftnets are almost exclusively used in BOR.

*Variation in ringing effort.* Generally, the ringing effort has been very high in Great Britain, the Baltic and Heligoland, relatively high in Russia, moderately high in Norway and Faeroes, and very low in Iceland (Tab. 3).

**Statistical analyses**

Two-way contingency tables were analysed by the common  $\chi^2$ -test, applying Yates' correction in case of 2x2 tables. Three-way contingency tables were analysed according to Sokal & Rohlf (1981: 747-765); the procedure is referred to as a three-way analysis or test in the text.

**Results**

**Razorbill**

*Recovery causes*

The recovery causes vary markedly from area to area (Fig. 4), and the association between recovery cause and recovery area is statistically highly significant (Tab. 4). Less extreme but still significant associations are also found between age and recovery area, and between age and recovery cause (Tab. 4). The interdependence between age-cause and area-cause pose a problem in interpreting the apparent age-area dependence. There seems to be a relative preponderance of adults

Tab. 3. Breeding populations (P; pairs) of Razorbills and Guillemots in the Northeast Atlantic region. Also shown are number of birds ringed (N), and number of these subsequently recovered in Denmark (DR). Population estimates are from Golovkin (1984), Bakken & Mehlum (1988), SOF (1990), Lloyd et al. (1991), Lyngs (1992), and Gardarsson (1995).

*Ynglebestande (P; par) af Alke og Lomvier i det nordøstatlantiske område. Desuden er vist, hvor mange fugle, der i tidens løb er blevet ringmærket (N), og hvor mange af disse, der siden er genfundet i Danmark (DR).*

	<i>Alca torda</i>			<i>Uria aalge</i>		
	P	N	DR	P	N	DR
Heligoland	5-10	–	0	2400	4368 <sup>a</sup>	62
U.K.	120000	75912 <sup>b</sup>	54	806100	166094 <sup>b</sup>	187
Faeroes	1000-5000	60 <sup>c</sup>	0	175000	6054 <sup>c</sup>	2
Iceland	380000	2342 <sup>d</sup>	0	990000	1800 <sup>d</sup>	0
Svalbard	50	–	1	40000-100000	–	0
Russia	3700-4200	–	6	4750	–	4
Norway	30000	1737 <sup>e</sup>	11	100000-120000	8053 <sup>e</sup>	0
Stavanger		1563 <sup>f</sup>	8		10264 <sup>f</sup>	0
W Sweden	42	–	4	10	–	1
Baltic	10000	17706 <sup>g</sup>	35	13000	–	236
Denmark	375	–	–	1500	2574 <sup>h</sup>	31
Sweden	–	–	–	10000	33788 <sup>i</sup>	186

a) 1909-79; Wijs 1985

b) until 1992 incl.; Mead et al. 1994

c) 1962-92; Jensen 1994

d) until 1993 incl.; Æ. Petersen in litt.

e) until 1983 incl.; Røv et al. 1984

f) 1914-87; Anon. 1994

g) 1968-91; Ringing Centers of Copenhagen, Stockholm, Helsinki

h) 1960-88; Ringing Center of Copenhagen

i) 1960-88; Stolt et al. 1991

among the Razorbills recovered in the NOS (43% of adults recovered, vs 20% of immatures), but more of the adults (60%) than of the immatures (33%) are found dead, and most (56%) of the 55 birds found dead are from the NOS. So, do relatively more adults than immatures occur in the NOS, as the age-area distribution suggests, or is

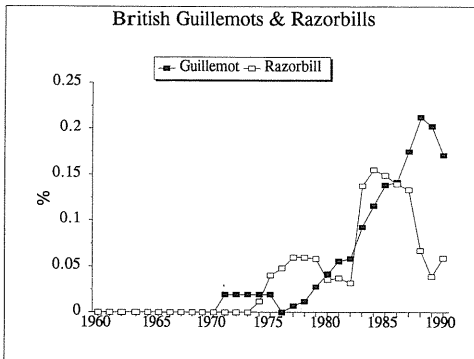


Fig. 5. Recoveries in Denmark 1960-90 as percent of number ringed (moving 5-year averages) of British Guillemots and Razorbills. Birds recovered as shot are excluded.

*Genfundsprocenten (antal genfundne fugle som procent af antal fugle mærket) vist som fem års rullende gennemsnit for britiske Lomvier og Alke genfundet i Danmark 1960-90. Skudte fugle er ikke medtaget.*

this merely an effect of the age-cause and area-cause interdependence?

A three-way analysis gives a partial answer, in that the removal of the area-cause interaction yields a highly significant model ( $P \ll 0.001$ ), whereas removal of either the age-area or the age-cause term is not quite significant ( $P = 0.07$  and  $P = 0.19$ , respectively), although the removal of both is ( $P = 0.014$ ). Thus, there is a strong interdependence between area and cause, with "too many" found dead (and few shot) in the NOS, too many taken in fishing gear (and few shot) in BOR, and too many shot in the other areas. There is a much less pronounced (but probably real) tendency that immatures are more likely to be shot than adults (both age-classes appear to be equally vulnerable to fishing nets); and that relatively more immatures occur in the KAT, IDW and BOR areas, and adults in the NOS and BEL.

#### *Change over time*

The first recovery in Denmark was of a Finnish bird shot in October 1926. The average number of recoveries did not exceed one per year until, by the early 1960s, it increased to 3-4 recoveries annually (Tab. 5). Part of the reason is that an increasing number of auks were being ringed; this is the case for the Baltic birds, for which nothing suggests a

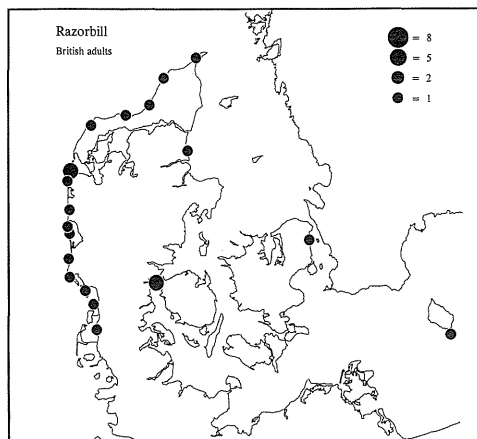


Fig. 6. Geographical distribution of adult British Razorbills recovered in Denmark.

*Geografisk fordeling af genfund af adulte britiske Alke.*

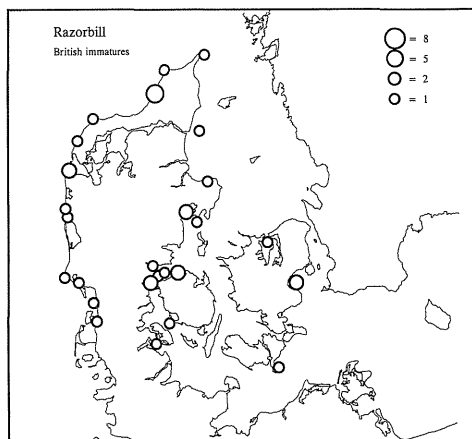


Fig. 7. Geographical distribution of immature British Razorbills recovered in Denmark.

*Geografisk fordeling af genfund af immature britiske Alke.*

change in occurrence within the Danish waters. However, a change in area utilization by British Razorbills set in during the mid-1970s and continued throughout the 1980s (Fig. 5). For the remaining populations there are too few recoveries to draw any conclusions.

#### *Recoveries of birds ringed in Britain and Ireland*

Of the 54 recoveries (Tab. 1), 42 were ringed in northern Scotland (19 of them in Shetland) and 12 in the Irish Sea (see also Fig. 1). Recoveries came from all the areas considered here (Fig. 6, 7). In autumn recoveries were reported from NOS, KAT and BEL in October, and from IDW in November; an adult was recovered in BOR in late February. After February all British recoveries were from NOS (all found dead).

First-year birds constituted 28% (15) of the recoveries, adults 39% (21). The proportion of adults

Tab. 4. Associations between area, recovery cause and age at recovery of Razorbills recovered in Denmark. *Sammenhænge mellem genfundsområde, genfundsårsag og genfundsalder hos Alke genfundet i Danmark.*

	$\chi^2$	df	P
area - cause	224.3	8	<<0.001
område - årsag			
area - age	13.7	4	0.009
område - alder			
age - cause	8.7	2	0.013
alder - årsag			

(Tab. 1) was the same as the proportion of adults among Baltic birds (chick-ringed birds only;  $\chi_1^2 = 0.02$ , n.s.) and among Norwegian/Russian birds ( $\chi_1^2 = 1.33$ , n.s.). Adults were recovered later in the winter than immatures (Fig. 8): in October-December 4% of the recovered birds were adults, compared with 74% in January-March ( $\chi_1^2 = 22.1$ ,  $P < 0.001$ ).

Adults were mainly recovered in NOS (76% vs 45% of the immatures;  $\chi_1^2 = 3.78$ ,  $P = 0.05$ ), but this was apparently caused solely by the above-mentioned interdependence between area and cause, and between age and cause. A three-way analysis with only two areas (NOS vs all other)

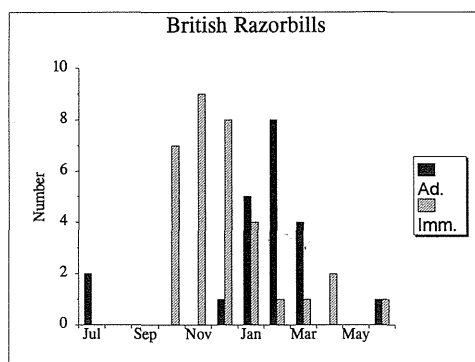


Fig. 8. Temporal distribution of British Razorbills recovered as adults and immatures.

*Tidsmæssig fordeling af britiske Alke genfundet som adulte og immature.*

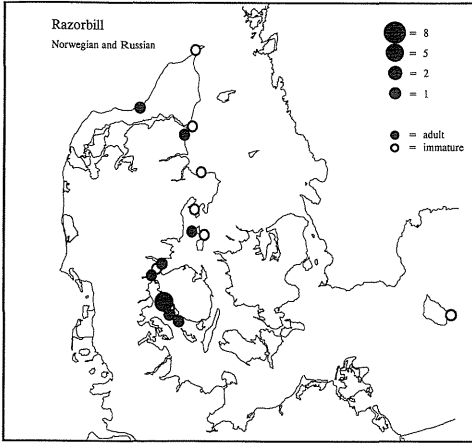


Fig. 9. Geographical distribution of Norwegian and Russian Razorbills recovered in Denmark.  
*Geografisk fordeling af genfund af norske og russiske Alke.*

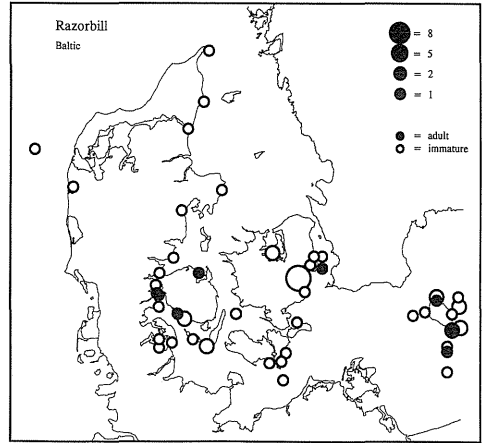


Fig. 10. Temporal distribution of Norwegian and Russian Razorbills recovered as adults and immatures.  
*Tidsmæssig fordeling af norske og russiske Alke genfundet som adulte og immature.*

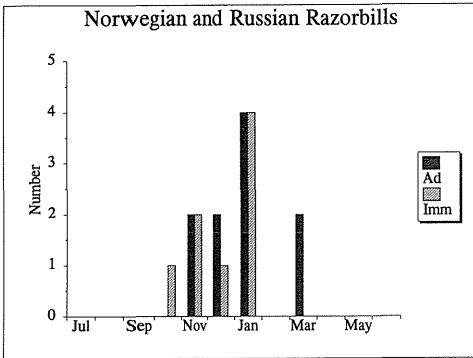


Fig. 11. Geographical distribution of Baltic Razorbills recovered in Denmark.  
*Geografisk fordeling af genfund af Alke fra Østersøområdet.*

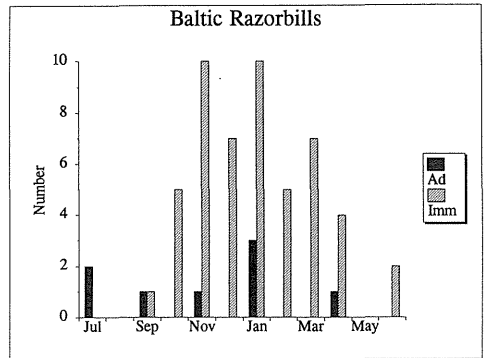


Fig. 12. Temporal distribution of Baltic Razorbills recovered as adults and immatures.  
*Tidsmæssig fordeling af genfund af adulte og immature Alke fra Østersøområdet.*

Tab. 5. Recoveries per decade of Razorbills from selected ringing areas.  
*Genfund pr dekade af Alke fra udvalgte mærkningsområder.*

Decade <i>Dekade</i>	Britain and Ireland <i>Storbritannien</i>	Russia <i>Rusland</i>	Norway <i>Norge</i>	Baltic Sea <i>Østersøen</i>	Total
1921-30	1	0	0	1	2
1931-40	1	0	1	5	7
1941-50	2	0	1	1	4
1951-60	2	2	1	3	8
1961-70	8	3	5	14	30
1971-80	29	1	0	9	40
1981-90	11	0	4	15	32
Total	54	6	12	48	123

gave much the same result as for the entire Razorbill material summarized previously: the area-cause interaction was strongly significant ( $P < 0.001$ ), and even the age-cause interaction was significant in this case ( $P < 0.05$ ), whereas the age-area interdependence was unimportant ( $P = 0.29$ ). An alternative area combination NOS+KAT vs all other led to the same conclusion.

*Recoveries of birds ringed in Norway and Russia*  
 Norwegian and Russian Razorbills (Tab. 1, Fig. 9) were recovered during October-March, with 83% of the recoveries in November-January (Fig. 10). The earliest recovery was from 9 October (first-year bird from Vedøy, Norway, shot in KAT). There were no recoveries from IDW, but an immature from northern Norway was recovered in BOR in January (fishing gear). Both recoveries in March were of birds found dead.

First-year birds constituted 28% (5) of the recoveries, adults 56% (10; including a bird from Bear Island found newly dead in NOS).

*Recoveries of birds ringed in western Sweden*  
 All four birds (Tab. 1) were ringed on Hallands Väderö and recovered in BEL; two in October (shot) and two in November (found dead).

*Recoveries of birds ringed in the Baltic*  
 Of the 59 recoveries (Tab. 1, Fig. 11, 12) 19 were ringed in Sweden, 24 in Finland and 16 in Denmark (Græsholmen).

Baltic Razorbills were recovered in all areas (Fig. 11). In autumn, the first recoveries outside BOR were from October, including two found in the NOS (a Finnish bird shot near Torsminde and a Danish found freshly dead near Skagen). Fresh corpses of immatures were found as late as April and June (including a one year old bird caught in fishing gear off Hvide Sande, NOS, in late June).

Relatively more adults were recovered in area BOR (50%) than immatures (25%), but the difference is not statistically significant (BOR vs all other areas,  $\chi_1^2 = 1.01$ , n.s.). There were too few recoveries for a three-way analysis to be meaningful.

First-year birds constituted 64% (38) of the recoveries, adults 14% (8). In BOR 4 out of 17 (24%) birds recovered were adults.

*Composition of the winter population*

Based on the numbers given in Tab. 3, the winter population in Denmark is comprised of Razorbills from Britain, Norway, and the Baltic in proportions 33:59:8, with small contributions from Rus-

Tab. 6. Associations between area, recovery cause and age at recovery of Guillemots recovered in Denmark. *Sammenhænge mellem genfundsområde, genfundårsag og genfundsalder hos Lomvier genfundet i Danmark.*

	$\chi^2$	df	P
area - cause	198.5	8	<<0.001
område - årsag			
area - age	43.8	4	<0.001
område - alder			
age - cause	7.4	2	0.025
alder - årsag			

sia and western Sweden. However, this may be a poor estimate of the actual distribution (see Discussion).

**Guillemot**

*Recovery causes*

As with the Razorbill, the recovery causes vary from area to area (Fig. 13), but for the Guillemot even the age-area interaction is highly significant (Tab. 6). A three-way analysis confirms this conclusion (area-cause:  $P < 0.001$ ; age-area:  $P < 0.001$ ; age-cause:  $P < 0.05$ ). Adults are predominantly recovered in the NOS and BOR areas, with few in KAT and BEL, whereas immatures show the opposite pattern. Adults are slightly more liable to be shot and immatures to be caught in fishing nets. Shooting mainly takes place in BEL (rarely in NOS and BOR), net entanglement mainly in KAT and BOR (rarely in BEL and IDW), whereas "found dead" is a particularly common recovery cause in NOS and BOR but uncommon in KAT and BEL.

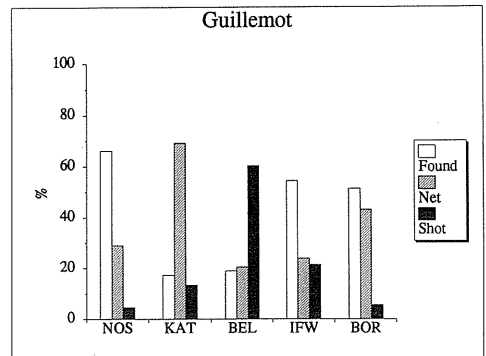


Fig. 13. Guillemot. Causes of recovery. Found = found dead (n=245), net = caught in fishing gear (n=181), shot = shot during hunting (n=78).

*Fordeling af genfundårsager hos Lomvier genfundet i Danmark. Found = fundet død, net = fanget i fiskerredskab, shot = skudt.*

Tab. 7. Recoveries per decade of Guillemots from selected ringing areas.  
*Genfund pr dekade af Lomvier fra udvalgte mærkningsområder.*

Decade <i>Dekade</i>	Heligoland <i>Helgoland</i>	Britain and Ireland <i>Storbritannien</i>	Russia <i>Rusland</i>	Baltic Sea <i>Østersøen</i>	Total
1911-20	0	0	0	1	1
1921-30	6	0	0	0	6
1931-40	16	0	0	3	19
1941-50	2	0	2	5	9
1951-60	5	1	0	2	8
1961-70	27	0	0	30	57
1971-80	4	14	2	140	160
1981-90	13	169	0	38	220
Total	73	184	4	219	480

*Change over time*

The first recovery in Denmark was of a Swedish Guillemot shot in January 1915. From the late 1920s and until the 1960s the number of recoveries was approximately one per year and then increased to more than 20 per year in the 1980s (Tab. 7). Recoveries of British Guillemots began to increase around 1978 (only five are earlier), and during the 1980s they made up 76% of all recoveries. Since the fraction of British ringed Guillemots subsequently recovered in Denmark has shown a similar growth (Fig. 5), this must reflect an increased occurrence of British Guillemots in Danish waters. The many recoveries of Baltic birds after 1960, on the other hand, are due to an increased ringing effort, especially at Stora Karlsö during the 1970s (Hedgren 1981), and an increas-

ed occurrence in Denmark is not suggested. The recovery pattern of Heligoland birds has remained fairly stable since ringing of this population began in the 1920s.

*Recoveries of birds ringed on Heligoland*

Guillemots ringed on Heligoland (Tab. 2) were recovered in all months (Fig. 14) and in all areas except BOR (Fig. 15, 16). First-year birds constituted 37% (21) of the recoveries, adults 24% (18).

All except two of the 18 adults (89%) were recovered in NOS, mainly in the southern part and in July-September (Fig. 14, 15); of the 57 immatures 30 (53%) were from NOS. The difference between age-classes was statistically significant ( $\chi_1^2 = 6.13$ ,  $P = 0.013$ ). The cell frequencies are too low to permit a three-way analysis of age, area and cause effects.

Immature birds were recovered in the inner waters (KAT-IDW) from September/October to April (the latest was a first-year bird caught in fishing gear on 3 April). The earliest recovery of a first-year bird was from Fanø (southern NOS) on 14 July, two weeks after ringing. The recoveries show that some first-year birds move northwards along the west coast of Jutland in July-August, reaching the southern parts of KAT in early September (bird caught in fishing gear off Hesselø on 9 September) and the IDW by mid-October. Not all young birds travel this far, however: recoveries exist of newly dead birds in the southern part of NOS in late August and early October.

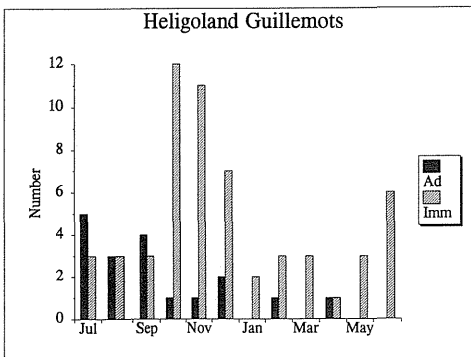


Fig. 14. Temporal distribution of Heligoland Guillemots recovered as adults and immatures.

*Tidsmæssig fordeling af Lomvier fra Helgoland genfundet som adulte og immature.*

*Recoveries of birds ringed in Britain and Ireland*

Of the 187 recoveries (Tab. 2) 185 were ringed in Scotland (here including Farne Islands in England) and two in Ireland (Fig. 2). British Guillemots



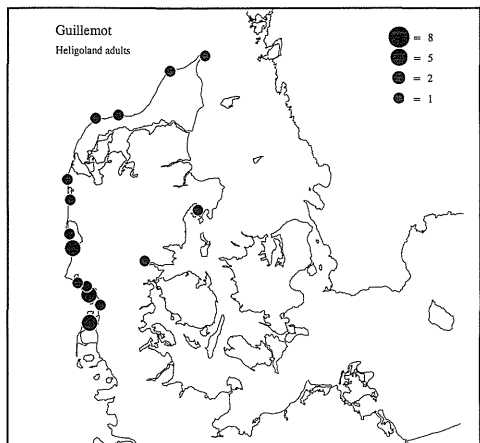


Fig. 15. Geographical distribution of adult Heligoland Guillemots recovered in Denmark. *Geografisk fordeling af genfund af adulte Lomvier fra Helgoland.*

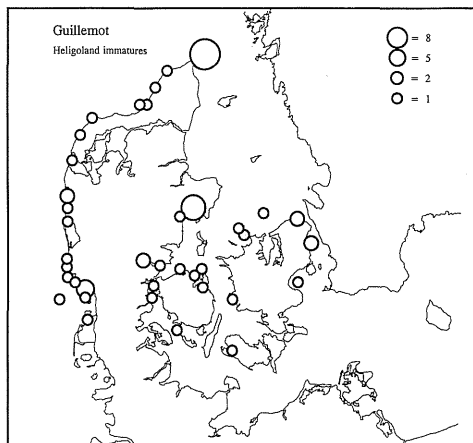


Fig. 16. Geographical distribution of immature Heligoland Guillemots recovered in Denmark. *Geografisk fordeling af genfund af immature Lomvier fra Helgoland.*

were recovered in all areas (Fig. 17, 18) and in all months except July (Fig. 19).

First-year birds constituted 74% (138) of the recoveries, adults 11% (21). Compared with Baltic and Heligoland birds (which had equal proportions of adults), there were much fewer adults among the British Guillemots (Tab. 2, chick-ringed birds only:  $\chi_1^2 = 16.5$ ,  $P < 0.001$ ).

The adults were mainly recovered in NOS (86% vs 47% of the immatures;  $\chi_1^2 = 9.7$ ,  $P < 0.01$ ). A

three-way test (NOS vs all other areas) showed a highly significant area-cause interaction ( $P = 0.0002$ ), but a not quite significant age-area interaction ( $P = 0.06$ ) and a nonsignificant age-cause interaction ( $P = 0.16$ ). Removal of both age-area and age-cause interactions gave a significant model ( $P = 0.002$ ). So, again, the apparently different recovery areas of adults and immatures was caused by a strong area-cause interdependence, combined with much weaker age-area and age-

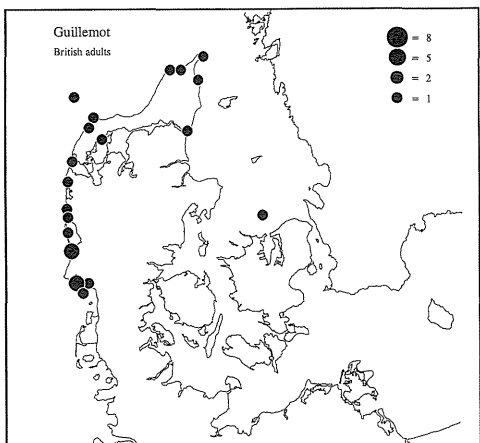


Fig. 17. Geographical distribution of adult British Guillemots recovered in Denmark. *Geografisk fordeling af genfund af adulte britiske Lomvier.*

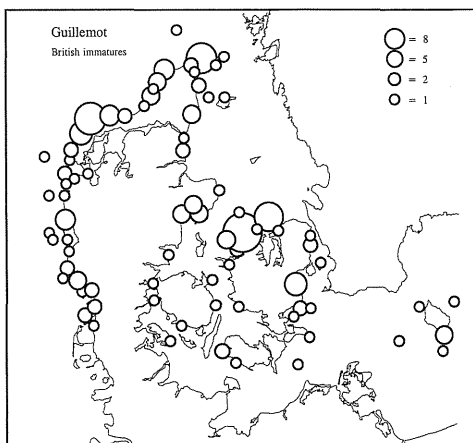


Fig. 18. Geographical distribution of immature British Guillemots recovered in Denmark. *Geografisk fordeling af genfund af immature britiske Lomvier.*

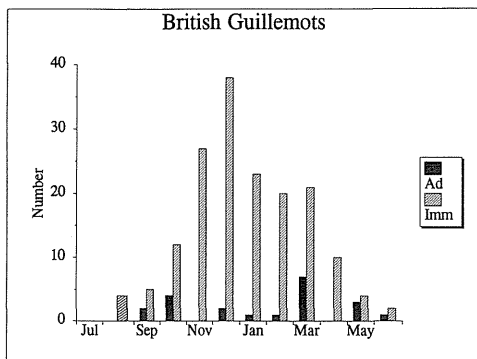


Fig. 19. Temporal distribution of British Guillemots recovered as adults and immatures.

*Tidsmæssig fordeling af britiske Lomvier genfundet som adulte og immature.*

cause associations. The test confirmed that adults were more likely than immatures to be found in the NOS, and showed that "found dead" was a particularly common cause of recovery in the same area (NOS), and that adults were less likely than immatures to get entangled in fishing gear.

The temporal distribution of recoveries of adult Guillemots did not show any clear tendencies (Fig. 19). The recoveries from March-June were mostly of birds reported as found dead (7 of 11), but three of the recoveries from March and one from May were of birds reported as caught in fishing gear. Immature birds were recovered from August to June (Fig. 19), with the highest numbers in October-April. All six recoveries in May-June were of first-year birds and half of these were reported as caught in fishing gear. The earliest recovery of a first-year bird was from Nymindégab (NOS) on 4 August, 44 days after ringing. Some first-year birds had reached KAT by early September and BOR by mid-September (a bird caught in fishing gear off Dueodde on 15 September).

#### *Recoveries of birds ringed on the Faeroe Islands*

The two recoveries (Tab. 2) are of adults ringed on Stóra Dímun in 1970 and found dead in NOS in March 1979 and December 1990, respectively.

#### *Recoveries of birds ringed in Russia*

The four Russian Guillemots (Tab. 2) were ringed as chicks on the Kola peninsula and recovered in NOS (an adult shot in January), KAT (a first-year bird shot in February) and BEL (two adults shot on 5 October and in February, respectively).

#### *Recoveries of birds ringed in western Sweden*

The single recovery (Tab. 2) concerns a Guillemot ringed as a chick on Hallands Väderö in 1986 and caught in fishing gear in KAT in March 1988.

#### *Recoveries of birds ringed in the Baltic*

Of the 236 recoveries (Tab. 2) 35 were ringed in Denmark (Græsholmen) and 201 in Sweden (195 on Stora Karlsö). Baltic Guillemots were recovered in all areas (Fig. 20, 21) and in all months (Fig. 22).

First-year birds constituted 43% (101) of the recoveries, adults 28% (65). Relatively more adults than immatures were recovered in BOR (86% and 58%, respectively;  $\chi^2 = 8.29$ ,  $P < 0.01$ ). A three-way test (BOR vs all other areas) confirmed this difference (significance of interactions: age-area  $P = 0.0009$ ; area-cause  $P \ll 0.001$ ; age-cause  $P = 0.40$ ). Shooting was a more likely cause of recovery outside BOR and entanglement in fishing nets within BOR, while "found dead" was an equally likely cause in both areas.

The only recovery of an adult outside BOR-IDW was from KAT in February. Immature birds were recovered outside BOR-IDW in August-February (omitting two birds found in NOS in July, both reported as long dead), with most of the recoveries in October-January (Fig. 22). The earliest recoveries of first-year birds were from IDW on 27 August and BOR on 28 August, respectively, 53 and 46 days after ringing. A first-year bird was recovered in KAT in late September.

#### *Composition of the winter population*

The autumn/winter population of Guillemots in Denmark and surrounding seas is comprised of birds from Heligoland, Britain, the Faeroes, and the Baltic in proportions 3:85:5:7, when estimated as for the Razorbill. The 7% from the Baltic can be broken down to 2% from Christiansø (Denmark) and 5% from Sweden.

## Discussion

### **Razorbill**

Razorbills frequenting Danish waters come from Britain (including the Irish Sea), Norway, Russia, West Sweden, and the Baltic Sea. Ringed birds were generally recovered in October-February (March). Adult British Razorbills were recovered from December onwards and thus arrive two months later than the immatures, coinciding with a marked drop in numbers of Razorbills staging along the east coast of Scotland (Skov et al. 1995).

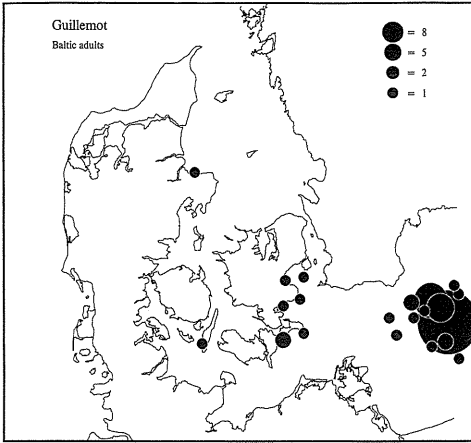


Fig. 20. Geographical distribution of adult Baltic Guillemots recovered in Denmark.  
*Geografisk fordeling af genfund af adulte Lomvier fra Østersøområdet.*

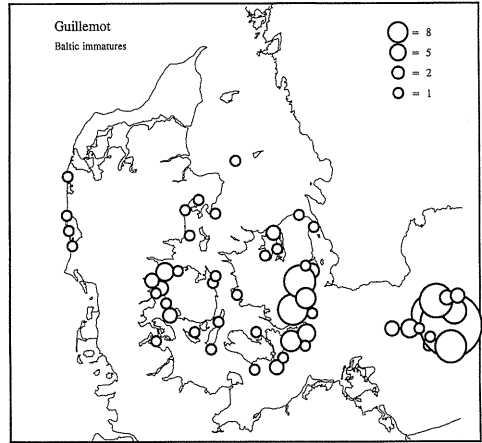


Fig. 21. Geographical distribution of immature Baltic Guillemots recovered in Denmark.  
*Geografisk fordeling af genfund af immature Lomvier fra Østersøområdet.*

Except for Baltic Razorbills, which mainly stay within the BOR and IDW areas, most recoveries are from NOS, KAT and BEL. The temporal distribution of the recoveries agrees with results from ship-based counts (Durinck et al. 1994, Skov et al. 1995) and observations from the northern tip of Jutland, showing that at least since 1974 large numbers of Razorbills enter KAT in October and leave in February (NOK 1977-1990).

If recent estimates of up to 395 000 Razorbills in the Danish waters (Jensen 1993) are approximately correct, Icelandic birds are likely to be involved. Otherwise, it seems difficult to account for this number, considering that many of the Razorbills from SW Britain (probably more than 100 000) move south to winter between the southern North Sea and the western Mediterranean (Lloyd 1974, Carboneras 1988, Silva & Castro 1991). According to Æ. Petersen (in litt.), foreign recoveries of Icelandic Razorbills have come from the Faeroes (35; cf. Jensen & Fritze 1992), Great Britain (13), Norway (2), the Netherlands (1) and Sweden (1). Our estimate of a 33:59:8 distribution of Razorbills originating in Britain, Norway and the Baltic, respectively, would change to 20:36:5 in the hypothetical case of a single Danish recovery from Iceland, the Icelandic Razorbills making up the remaining 39%. Even such a distribution appears unlikely, however, since 36% of the Danish winter population would seem to exceed the entire Norwegian population, and the composition according to origin, as here given, is probably a poor approximation.

### Guillemot

Although Guillemots from Britain, the Faeroes, Russia, Germany (Heligoland) and the Baltic Sea have been found in Denmark, ringing recoveries indicate that the great majority come from Britain, particularly Scotland. The suggested composition of the winter population in Denmark (3% Heligoland, 85% Britain, 5% Faeroes, 7% Baltic) may actually not be very far off in this case. There are no recoveries of Norwegian Guillemots which seem mainly to winter off Norway (Holgersen 1961, Baillie 1982, Bakken 1993), as do many Guillemots from the Faeroes (Olsen 1982). However, Guillemots from the small population in

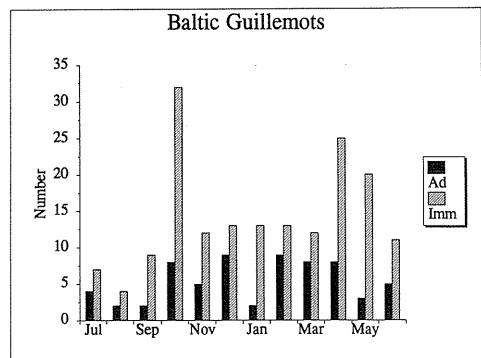


Fig. 22. Temporal distribution of Baltic Guillemots recovered as adults and immatures.  
*Tidsmæssig fordeling af Lomvier fra Østersøområdet genfundet som adulte og immature.*

southern Norway (Runde), and also a few from northern Norway, are known to winter in the Skagerrak, and two have been recovered on the Swedish west coast (Peterz & Oldén 1987).

The Baltic Guillemots are largely sedentary, and few are recovered outside the BOR, IDW and southern BEL areas (Stolt et al. 1991, Lyngs 1992). However, some immatures venture further and have been recovered as far away as Britain and northern Norway; also, the small colony on Hallands Väderö, W Sweden, was probably founded by birds from the Baltic (Lyngs 1993).

British Guillemots are mainly recovered in the outer Danish waters, but increasing numbers have been found in BOR (and in the Baltic proper, Stolt et al. 1991); recently, two birds were controlled in Baltic colonies (own observation, M. Peterz pers. comm.). Even a few Guillemots from Heligoland enter the Baltic (Schloss 1969, Schmidt 1983).

The first post-breeding recoveries of British Guillemots were in early August, corresponding with the arrival of up to 200 000 Guillemots in the Skagerrak, where they moult (Skov et al. 1992, Skov et al. 1995). After completing the moult, many adults must move back towards Britain, since birds start visiting the colonies in October (Taylor & Reid 1981, Harris & Wanless 1990), and many Guillemots occur in the western North Sea during winter (Skov et al. 1995). However, many Guillemots stay in Danish waters, and more arrive later in autumn, reaching peak numbers of up to 300 000 in October–November (Jensen 1993). The recoveries suggest that even these birds are mainly British, many of them immatures.

### Change over time

The Danish waters have probably "always" supported wintering Razorbills and Guillemots from the Northeast Atlantic and Baltic Seas (Salomonson 1931, Paludan 1947, Holgersen 1952, Schloss 1969, Mead 1974, Bianki 1977, Dybbro 1978), but the increasing number of British auks recovered in later years is noteworthy.

For the Guillemot, the increase, starting around 1978, was dramatic: in ten years the accumulated number of recoveries in West Sweden (Peterz & Oldén 1987, Stolt et al. 1991) and Denmark grew from 10 to almost 400. The increase was caused by an actual increase of British Guillemots frequenting these waters, not merely by more birds being ringed. This change in wintering area was probably caused by changes in stocks of herring *Clupea harengus* and sprat *Sprattus sprattus* which are among the most important prey for Guillemots

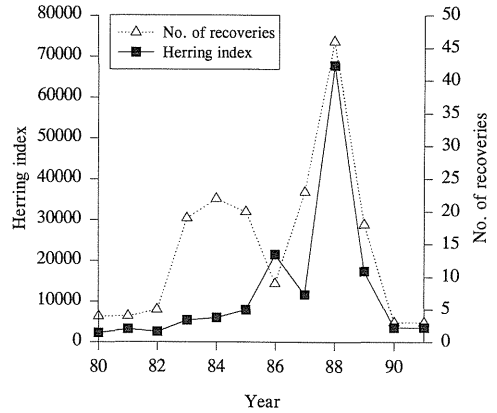


Fig. 23. The IBTS index of young herring (Skagerrak/Kattegat; Anon. 1995) and number of British-ringed Guillemots recovered in Danish waters during 1980–1991.

*IBTS indeks for ungsild i Skagerrak/Kattegat og antal genmeldte britiske Lomvier i Danmark i årene 1980–91.*

during winter (Madsen 1957, Blake 1984, Durinck et al. 1991). During the late 1970s, a decline in the North Sea stock of sprat paralleled an increase of young herring in Kattegat/Skagerrak (Peterz & Oldén 1987, Heubeck et al. 1991, Harris & Bailey 1992, Knijn et al. 1993), and the IBTS herring index (International Bottom Trawl Survey; Anon. 1995) and numbers of British Guillemots recovered in Denmark during 1980–91 are well correlated (Fig. 23;  $r^2 = 0.66$ ,  $P < 0.01$ ).

The recoveries of British Razorbills began to increase in the mid-1970s. Although less pronounced than for Guillemots (only in 1983 were there more than five recoveries), it also reflected increased numbers of British birds visiting Danish waters, also evidenced by observations at the north tip of Jutland of increasing numbers of Razorbills entering the Kattegat during the second half of the seventies (NOK 1977–1990).

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## Resumé

### Genfund af ringmærkede Alke *Alca torda* og Lomvier *Uria aalge* i Danmark

I alt 135 Alke og 505 Lomvier er genmeldt fra danske farvande frem til januar 1993 (Tab. 1-2); fugle mærket på Græsholmen (Danmarks eneste yngleplads) og genfundet i yngletiden er ikke medregnet i disse tal.

Alkene var mærket i Storbritannien (især Skotland; Fig. 6-8), Norge og Rusland (Fig. 9-10), Vestsverige samt Østersøen (Danmark, Sverige og Finland; Fig. 11-12). Østersø-Alkene er fortrinsvis genfundet i Østersøen og bælteerne, mens kun et mindre antal har nået Kattegat og Nordsøen. Alkene fra de øvrige mærkningsområder er hyppigst fundet i de ydre farvande, Kattegat og bælteerne, men sjældent i Østersøen. Der er ikke den store forskel mellem ungfugle (3 år eller yngre) og "adulte" (ældre end 3 år) hvad angår den geografiske fordeling af genfundene, bortset fra at adulte britiske Alke sjældnere end ungfuglene er genmeldt fra Kattegat og bælteerne. Denne forskel afspejler dog ikke nødvendigvis en tilsvarende forskel i de to aldersklassers opholdssteder, men kan i stedet skyldes en sammenhæng såvel mellem genfundsmåde og geografisk område som mellem genfundsmåde og alder: før fredningen i 1980 blev mange Alke skudt i de indre danske farvande, mens næsten alle genfund fra Nordsøen er dødfundne fugle; samtidig var næsten alle de skudte Alke ungfugle. At udrede årsagssammenhængen i sådan en situation er vanskeligt, men statistisk er genfundsmåde-område og genfundsmåde-alder sammenhængene signifikante, mens område-alder sammenhængen ikke er det.

Alkene er fortrinsvis genfundet i vinterhalvåret, fra oktober til marts. For de britiske Alke gælder, at de adulte ankommer et par måneder senere end ungfuglene. De britiske Alke blev først almindelige i Danmark fra midt i 1970'erne (Fig. 5), og tages størrelsen bestand×genfund/mærkningstal som et mål for vinterbestanden i Danmark, udgør de 33% af de overvintrende Alke i Danmark; 59% skulle tilsvarende stamme fra Norge og 8% fra Østersøen, mens bidragene fra Rusland og Vestsverige er ubetydelige. Det er dog sandsynligt, at også Alke fra den meget store islandske bestand optræder i danske farvande, idet det ellers er svært at forstå hvordan den danske vinterbestand kan nå op på de 200 000-400 000 fugle, som blev registreret sidst i 1980'erne (Jensen 1993). Kun få islandske Alke er blevet ringmærket, så at ingen er dukket op i Danmark kan skyldes tilfældigheder; enkelte er genmeldt fra vore nabolande. Selv hvis islandske Alke er involveret, synes den ovenfor anførte fordeling efter oprindelsesland imidlertid at give en urimelig høj andel af norske Alke, sammenholdt med den formodede ynglebestand. Den anførte fordeling lider formentlig under, at forskellige bestande er mærket og genmeldt i forskellige perioder, og at det ikke har været muligt at underpele mærkningstillene fra de forskellige lande på delbestande.

De genmeldte Lomvier stammede fra Helgoland (Fig. 14-16), Storbritannien (næsten udelukkende Skotland; Fig. 17-19), Færøerne, Rusland, Vestsverige og Øster-

søen (Fig. 20-22). Generelt er adulte Lomvier fra Østersøen genmeldt i Østersøen og adulte fra andre områder i Nordsøen, mens langt størsteparten af genfundene i de indre farvande (bortset fra Østersøen) har været ungfugle. Modsat Alken er sammenhængen mellem alder og genfundsområde ligesom genfundsmåde-område sammenhængen stærkt signifikant, mens signifikansen af genfundsmåde-alder sammenhængen er betydeligt svagere. Genfundene er ikke indskrænket til vinteren i samme grad som hos Alken, bl.a. kommer mange Lomvier fra Helgoland og Skotland til landet i sensommeren og efteråret. Ligesom for Alken er de skotske Lomviers masseoptræden i danske farvande af ny dato, idet der skete en dramatisk stigning sidst i 1970'erne (Fig. 5). Et sådant skift kan formodes at hænge sammen med en ændret fødetilgang i forskellige havområder, i det aktuelle tilfælde tilsyneladende en nedgang for Nordsøens brislinger og en samtidig stigning i mængden af ungsild i Skagerrak og Kattegat.

Fordelingen efter oprindelsesområde af Lomvierne i de danske farvande, beregnet som for Alken, er 85% fra Skotland, 7% fra Østersøen (2% danske, 5% svenske), 5% fra Færøerne og 3% fra Helgoland. Ligesom for Alken kan tallene på ingen måde anses for nøjagtigt at afspejle de faktiske forhold; men der er ingen tvivl om, at hovedparten af Lomvierne i Danmark er af skotsk oprindelse.

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