ICES CM 1991 C.M. 1991/H:9
Ref.B
Pelagic fish Committee/
Ref. Fish Capture Committee

SWIMMING SPEED OF SPENT NORWEGIAN SPRING SPAWNING HERRING

by

Ingolf Røttingen and Jostein Røttingen
Institute og Marine Reseach
P.O.Box 1870 Nordnes, 5024 Bergen

ABSTRACT

In March 1990 spent Norwegian spring spawning herring were tagged on the spawning grounds off Karmøy in southwestern Norway. 37 of these tagged herring were recaptured approximately 40 hours later. The recapture took place west of Bergen, some 60 nautical miles north of the tagging position. The herring seemed to move in schools in the upper water masses, and were appearently carrying out a migration to the feeding grounds in the Norwegian Sea. The herring moved in a northward flowing coastal current (salinity less than 35 ‰) with temperatures of 5-6^{0}C.

A minimum swimming speed (sustained for at least 40 hours) can be estimated to 1.4 knots. With reference to the length (BL) of the herring the speed is 2.2BL x sec^{-1}. Although obtained under different environmental conditions, this result is in agreement with earlier estimates obtained from echo sounding records, of the swimming speed of migrating Norwegian spring spawning herring.

Further, the present report gives details of the tagging, the recapture and of the biology of the herring.

INTRODUCTION

In 1989 Norwegian spring spawning herring reappeared for the first time in 30 years on the traditional spawning grounds off Karmøy in southwestern Norway (Røttingen 1989). Spawning also took place in this area in 1990 and 1991.

In March 1990 spent herring were tagged off Karmøy. Approximately 40 hours later a purse catch of herring was taken 60 nautical miles further north. This catch was screeened by a tag detector and 37 of the herring in this catch contained tags from the tagging at Karmøy. Thus a speed of migrating herring could be calculated.

The aim of this paper is to describe details on the tagging and recapture, and to discuss the estimated swimming speed in relation to other observations on swimming speed of Norwegian spring spawning herring.

METHOD

A tagging prosject on Norwegian spring spawning herring using internal steel tags was initiated in 1975 and since then herring have been tagged and released annually on various localities on the Norwegian coast in April-May (Hamre 1990). The herring are caught by purse seine and are then brailed from the seine to the RSV-tanks onboard the seiner and tagged and released from the tanks.

Several schools of herring were located west of Karmøy on the morning of 29.3-1990 in position 59^0 23'N, 05^0 06'E. This is within the area where the traditional spawning and "Spring herring fishery" took place (Runnstrøm 1941). A purse seine catch was made at 1235 hours local time at the above position (Fig 1). Length and age distribution of a sample taken from the catch is given in Fig 2. The catch consisted almost entirely of spent herring (Table 1). The brailing of the herring to the RSV-tanks was finished at 1440 hours. Approximately two tonnes of herring were taken on board. Due to a southwest strong breeze (force 6) and rather heavy seas, the seiner steamed to a sheltered location at Føyno for tagging (approximately 3.5 nautical miles from the catch location, Fig 1).

The tagging experiment commenced at 1615 hours. The herring were taken from the RSV-tanks with a small brail, tagged and then released into one of two tanks (each 1.6 m^3, filled with sea water) placed on the deck of the seiner. 600 tagged herring were released at 1730 hours, 700 at 1830 hours and 700 at 1930 hours. The releasing of the herring was done by lowering the two tanks into the sea. The tagging continued next day (terminated at 1400 hours).

After the termination of the the tagging at Karmøy the purse seiner steamed northwards via Bergen to the areas west of the island Sotra The seiner carried out a sonar search, and at 1240 hours on the 31.3 several herring schools were detected in position 60^0 50.1'N, 4^0 50.5' E (Fig 3). The schools seemed to be of approximate equal size, although no definte estimation of the different school sizes were made. The purse seine was shot at one of these schools at 1250, and 296 tonnes of herring were caught. The entire catch was screened by an internal tag detector and 43 tags were recovered. 37 of the recoveries were relased at Karmøy 29.3 in the tagging experiment described above. The remaining 6 recoveries were from herring tagged at Møre and northern Norway in the years 1986-1989. Of the 37 herring recovered from the Karmøy tagging, 29 belonged to the 1983 year class.

RESULTS

Of the 37 herring recovered from the Karmøy tagging, 21 were released to the sea at approximately 1730 hours, 8 were released at approximately 1830 hours, and 8 were released at approximately 1930 hours on 29.3. The detection of the school west of Sotra occured at 1240 hours on 31.3. This gives approximately 43, 42 and 41 hours in liberty for the tagged herring. The direct ("as the crow flies") distance between posistions of tagging and recapture is 59.5 nautical miles (Fig 3). This gives an estimated swimming speed of 1.38, 1.42 and 1.45 nautical mile x $hour^{-1}$ (i.e. knots) for the respective releases. Using the herring with shortest time in liberty, the speed with reference to the length of the herring (33.5 cm, Table 1) will be:

$$2.2BL \times sec^{-1}$$

(BL = length of herring)

BIOLOGICAL DATA

Length and age data from samples taken from the herring catches at Karmøy (29.3) and Sotra (31.3) are given in Fig 2 and Table 1. The stomachs of all the herring were empty.

DISCUSSION

Along the west coast of Norway there is a coastal current (salinities less than 35 ‰ and the temperatures of the upper water masses in March are in the order of 5^0 - 7^0C) flowing in a northward direction. Referring to the situation in March, the average propagation velocity of the water masses in this current in the Karmøy - Bergen area has been estimated to approximately 0.2 $msec^{-1}$ (i.e. 0.4 knots) (Aure and Sætre 1981). When migrating from Karmøy and northwards the Norwegian spring spawning herring is thus "helped" by the coastal current.

The direct distance between the tagging and recapture localities is 59.5 nautical miles. The actual swimming distance will certainly be longer. Due to wind and rather heavy sea the tagging had to be carried out in sheltered areas at the island of Føyno (Fig 1). The outlet to open sea NW of the tagging locality consists only of very shallow water, thus the herring must therefore have travelled in a WSW-direction before the northward migration could begin. But of course, the nature of the actual swimming route between release and recapture can only be guessed.

The swimming speed of interest in this connection is the maximum sustained or cruising speed. Cruising speed of herring has been estimated using a variety of techniques including tanks, flumes and towed cages. However, it is not certain that the speeds measured in tanks are relevant to what happens in natural conditions, especially as the clupeoids are difficult to tame and often never really acclimatize to tank conditions. Blaxter and Hunter (1982) are of the opinion that mean speeds measured from tagging or echo surveys of schools may give more meaningful values.

For the Norwegian spring spawning herring, Devold (1963), on basis of echo sounding records, reported that during the spawning migration from the wintering areas east of Iceland (which this stock utilized prior to the stock collapse in the late 1960s) to the Norwegian west coast, the herring travelled first (in the East Icelandic current) at a speed of 5-7 nautical miles in 24 hours. At a later stage in the spawning migration, in Atlantic water and nearer the spawning areas, the speed was much greater, 20-40 nautical miles in 24 hours. Unfortunately, no details are given as to how these speeds were measured.

The present estimated speed of 2.2BL x sec^{-1} (35 nautical miles in 24 hours) is in agreement with Devold's figures for the herring migration in Atlantic waters.

The present distribution areas and migration routes for Norwegian spring spawning herring is shown in Fig 4. The spawning migration from northern Norway to Møre takes place in January - February, and an approximate cruising speed for the herring during this migration can be estimated from data from the Winter herring fishery. There is a time span of 2 - 3 weeks from the time the herring leaves the wintering areas of Ofotfjorden and enters Vestfjord, and the first catch of winter herring at Møre. The migration distance is approximately 450 nautical miles, indicating sustained cruising speeds of 1.3 - 0.9 knots (31 - 22 nautical miles in 24 hours). These values are also within Devold's estimate of a migration of 20-40 nautical miles pr day. It should however, be kept in mind that the environmental conditions during the spawning migration of the Norwegian spring spawning herring have changed. Prior to the stock collapse, when Devold made his observations, the herring migrated throught the East Icelandic current into Atlantic water, and finally into coastal water, (salinity less 35 ‰) before reaching the spawning areas. Today the entire spawning migration takes place in coastal waters, against the prevailing currents.

REFERENCES

Aure, J. and R. Sætre, 1981. Wind effects on the Skagerrak outfolow. in. the Norwegian Coastal Current, (eds. R. Sætre and M. Mork). Bergen University, pp. 263 -294.

Blaxter, J.H.S. and J.R. Hunter, 1982. The biology of the clupoid fishes. Adv. Mar. Biol. 20: 1-223.

Devold, F., 1963: Life history of the Atlanto-Scandian herring. Rapp.P.-v. Reun.Cons.int.Explor.Mer 154, 98-108.

Hamre, J. 1990. Life history and exploitation of the Norwegian spring-spawning herring. pp 5-39 in Monstad, T. (ed) Proceedings of the fourth Soviet-Norwegian Symposium, Bergen 12-16 Ju 1989. Institute of Marine Research, Bergen.

Runnstrøm, S. 1941. Quantitative investigations on herring spawning and its yearly fluctuations at the west coast of Norway. FiskDir.Skr.Ser. 6(8): 1-71.

Røttingen, I., 1989. Reappearance of Norwegian spring spawning herring on spawning grounds south of 60°N. ICES C.M. 1989/H:22, 8 pp.

Røttingen. I., 1990. A review of variability in the distribution and abundance of Norwegian spring spawning herring and Barents Sea capelin. Polar Research, 8, 33-42.

Table 1 Biological data of herring from Karmøy and Sotra, March 1990.

Location	Sample	Mean length	Mean weight	Maturation stage (%)			
size	(N)	(cm)	(grammes)	V	VI	VII	VIII
Karmøy	100	33.6	285	1	1		98
Sotra	100	33.5	235		2	6	92

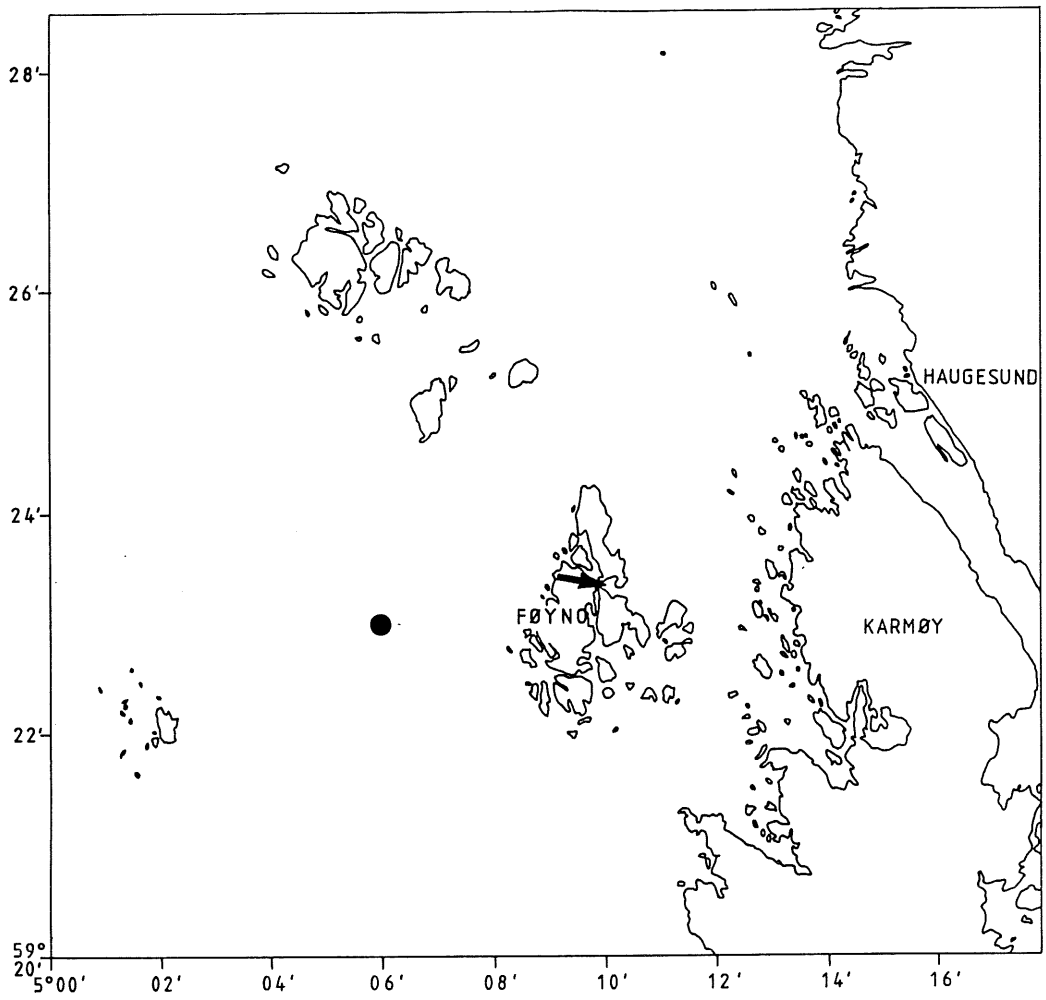

Fig. 1 Locations for catch (filled circle) and tagging (filled arrow) of herring 29.3.

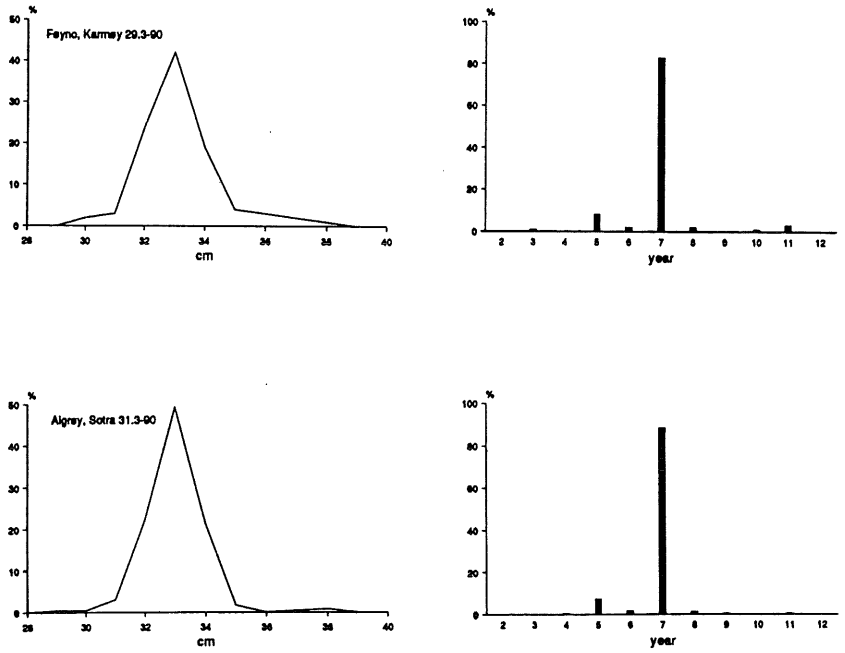

Fig. 2 Length and age distributions of herring from Karmøy (29.3) and Sotra (31.3).

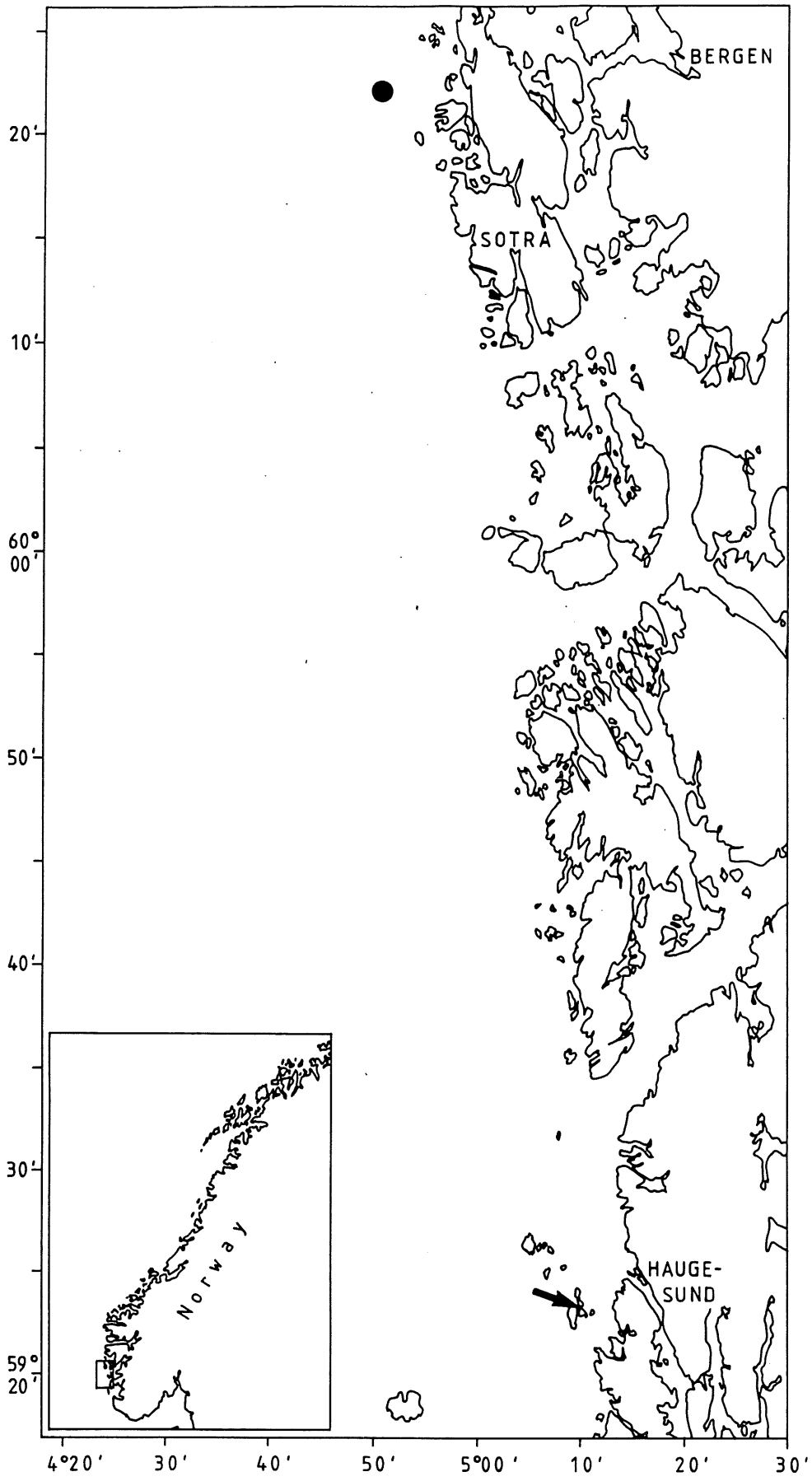

Fig. 3 Tagging locality 29.3 (arrow) and recapture locality 31.1 (filled circle).

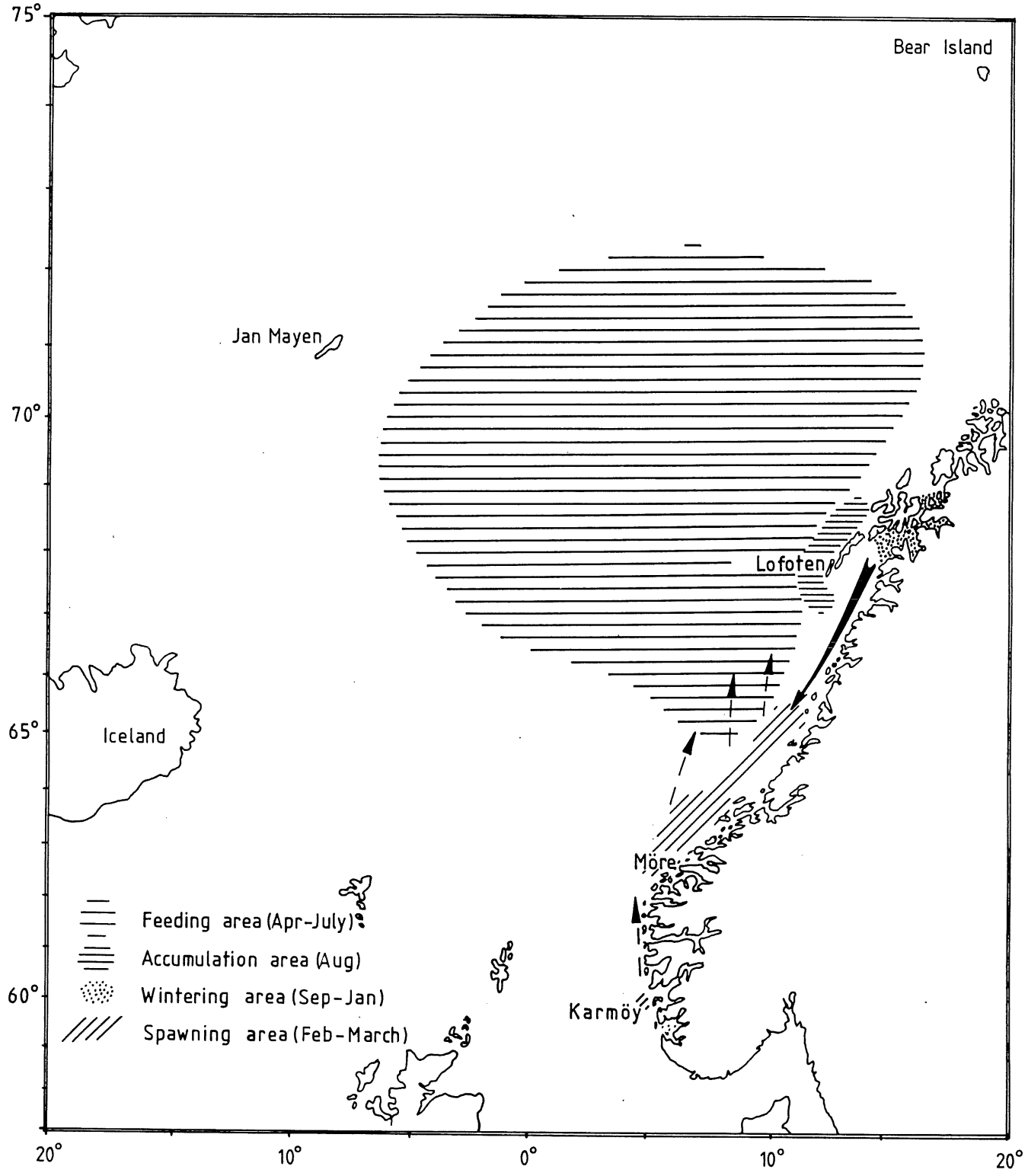

Fig. 4 Present distribution areas and migration routes (Modified from Røttingen 1990).