CAPELIN AND SEABIRDS IN THE NORTHWEST ATLANTIC[1]

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ABSTRACT

Capelin Mallotus villosus are central to the food-webs of fish, marine mammals and seabirds in low arctic waters in the northwest Atlantic. A major international commercial fishery for this species developed there in the 1970s, and by the end of the decade it was clear that the populations on the Grand Banks, where the fishery takes adult fish before they can spawn, had collapsed. This has had significant effects on capelin-dependant species. For example, Atlantic Puffins Fratercula arctica in southeastern Newfoundland, where more than 70% of the North American population reproduces, failed to breed successfully in 1981, apparently because capelin availability was low and the nutrient content of the only alternative prey, small gadoids, was inadequate for chick growth. [This situation is compared with that on the colony at Røst, northern Norway, where similar breeding failure has followed overfishing of the immature herring Clupea harengus populations, and on St. Kilda, Scotland, where the birds have apparently been able to find alternative prey of suitable quality and thus buffer the effects of fluctuations of prey availability.] Other capelin feeders such as the two murre species and Razorbill Alca torda were probably similarly affected by the collapse of capelin spawning both inshore and offshore. In general, it appears that the seabirds most vulnerable to pressure from over-fishing are the specialized pursuit divers, [as opposed to birds which feed on the surface or by plunge diving in from the air.]

INTRODUCTION

The Capelin Mallotus villosus is a small smelt (Osmeridae) which, as an adult, reaches a length of ca. 170 mm (Jangaard 1974). It is widely distributed in the low arctic zones of both the North Atlantic and the North Pacific. The Pacific population is apparently not very large, but the fish is extremely abundant in the Atlantic, especially off eastern and southeastern Newfoundland, southeast Labrador, Greenland, Iceland and in the Barents Sea.

Capelin is the key organism in the food-webs of fish, marine mammals and seabirds in low arctic waters of the northwest Atlantic. These higher vertebrates depend, directly or indirectly, on capelin for their food (Fig. 1). Because of this central position in the northwest Atlantic food-web, much concern and attention have been focused recently on the major international commercial fishery for this species developed there in the early 1970s (Winters and Campbell, in Pinhorn 1976), and its impact on capelin-associated species (e.g., Nettleship 1977). This concern has grown considerably over the last few years (since 1978) as it became clear that the capelin populations on the Grand Banks, where the fishery takes adult fish before they can spawn, had collapsed. The continued decline offshore from 1978 to 1981 combined with the collapse of the beach spawning stocks inshore along the eastern Avalon Peninsula in 1981 will most certainly affect levels of abundance and patterns of distribution of capelin for a considerable period. These changes have already had significant effects on capelin-dependant species. The urgency to monitor threatened species and reassess techniques and analytical models for determining harvest quotas of capelin is obvious and likely

to become even more evident in the future as capelin-dependent species continue to decline in numbers.

The purpose of this paper is to review the importance of capelin to other marine organisms in the northwest Atlantic, particularly populations of breeding seabirds in southeast Newfoundland which are most vulnerable to pressure of over-fishing by man.

THE DISTRIBUTION OF CAPELIN IN THE NORTHWEST ATLANTIC

Several discrete capelin populations are known to exist in the northwest Atlantic (Campbell and Winters 1973, Winters and Carscadden 1978, Carscadden 1982 - this volume). There are at least five of these in the Newfoundland region (Fig. 2):

A, a population on the banks off southeast Labrador and northeast Newfoundland, which migrates south or southwest in summer to spawn on beaches from Groswater Bay to Cape Freels -- meristic differences suggest that there are differences between the Labrador and Newfoundland segments of this population;

B, fish from the northern Grand Bank migrate west to spawn on the beaches of the eastern Avalon Peninsula;

C, fish from the southern and central Grand Bank migrate south to spawn on the shallows (ca. 50 m deep) of the South East Shoal on the southern tip of the Bank;

D, fish from the western Grand Bank and Green Bank migrate north to spawn on beaches from the southern Avalon Peninsula to the Burin Peninsula; and

E, fish from the eastern Gulf of St. Lawrence migrate northeast to spawn on beaches on both sides of the Strait of Belle Isle.

The capelin found in the lower St. Lawrence (e.g., Bailey et al. 1977),

and those in James Bay and off west Greenland (Jangaard 1974) presumably also represent discrete population units.

In Newfoundland and Labrador these spawning migrations take place in June and July - earlier in the south than off Labrador (Jangaard 1974). The spawning schools consist mainly of 3-4 year old fish, though younger, immature fish also migrate inshore. The mortality of the spawning fish is high. The survivors, along with the younger fish, move back offshore again in August and as a rule winter out on the banks. However, at least some fish winter inshore in deep-water fjords such as Trinity Bay (Winters 1970).

THE CAPELIN FISHERY

The fishery for capelin off Newfoundland was until recently an inshore one, the spawning fish being taken on the beaches for food, bait and fertilizer (Templeman 1948, Jangaard 1974). It was never very intensive. Templeman (1967) has estimated that the annual catch at the beginning of this century was in the region of 23,000 tonnes, declining to about 18,000 tonnes by 1950. The impact of this upon the harvested populations must have been negligible, since most of the fish would have been taken from the beaches after they had spawned, at a time when natural mortality is high. However, Templeman recognized the potential of capelin as a fishery resource, and the species is now being intensively exploited over most of the North Atlantic, mainly for conversion into fishmeal. The exploitation first began in the Barents Sea, where the Russians began to take capelin ca. 1960 (ICES 1963-78; ICNAF 1963-79; Carscadden 1982 - this volume, see also Fig. 3). This fishery rapidly

expanded until it was taking some 500,000 tonnes a year by the end of that decade, and exceeding 1 million tonnes by the early 1970s. The fishery expanded to the waters off Iceland and northern Norway by ca. 1965 and quickly reached comparable levels there. The waters off east Greenland are the most recent parts of the eastern Atlantic to be exploited, the fishery starting there in the late 1970s.

For most of this period the harvest of Newfoundland capelin, by Newfoundland fishing boats mainly working inshore, remained low and well below the 10,000 tonne level, and has remained so up to the present. However, from 1972 onwards, foreign trawlers, again led by the Russians, began a very intensive fishery offshore, and this reached the 300,000 tonne mark by the middle of the decade (Figs. 3 and 4). The principal populations being exploited were those on the northern and southern Grand Banks, taken just before spawning, and those off southeast Labrador and northeast Newfoundland, taken late in the fall. In retrospect it is obvious that fishing pressure was far too intensive, especially when it was directed at the pre-spawning fish on the Grand Banks. In the spring of 1978 it became clear that spawning on the Grand Banks had collapsed, and the offshore fishery by the foreign fleets was terminated by regulation (Carscadden 1982 - this volume). The population on the northern Grand Banks also collapsed, as indicated by ~~either~~ reduced levels ~~of spawning~~ or ~~the~~ failure of beach spawning on the eastern Avalon Peninsula from 1978 through 1981 (Lien and Gray 1980, D.N. Nettleship, unpubl.). So far, however, the populations off northeast Newfoundland and southeast Labrador have not collapsed, presumably because the fishery there is a winter one and thus directed at both mature and immature fish, and not more or less exclusively at pre-spawning adults as it is on the Grand Banks.

THE EFFECTS OF THE FISHERY ON OTHER MARINE ANIMALS

Capelin appear to be as crucial to the marine food-webs of Newfoundland waters as, for example, sandlance Ammodytes spp. are in the North Sea (e.g., Pearson 1968), arctic cod Boreogadus saida in the high arctic (e.g., Gaston and Nettleship 1981), and krill Euphausia superba in the antarctic (e.g., Bierman and Voous 1950, Marr 1962, El-Sayed and McWhinnie 1979). Figure 1 shows this in a simplified way. Capelin are, for example, a primary food for finback Balaenoptera physalus, minke B. acutorostrata and humpback Megaptera novaeangliae whales and harbour porpoise Phocoena phocoena (Sergeant 1963, Banfield 1974, Whitehead et al. 1980), harp seals Phoca groenlandica (Sergeant 1973), cod Gadus morhua (Leim and Scott 1966), short-finned squid Illex illecebrosus (Squires 1957), and many species of seabirds, including important populations of breeding Black-legged Kittiwake Rissa tridactyla, Herring Gull Larus argentatus, Razorbill Alca torda, Common and Thick-billed Murres Uria aalge and U. lomvia, and Atlantic Puffin Fratercula arctica (Tuck 1961, Maunder 1971, Nettleship 1972, Mahoney 1979) and the non-breeding ~~summer~~ transequatorial ~~migrants~~ visitors, the Greater and Sooty Shearwaters Puffinus gravis and P. griseus (Brown et al. 1981). For example, capelin occurred in over 90% and 84% of the meals brought, respectively, to young Common Murres and Atlantic Puffins in the Witless Bay area of southeast Newfoundland (Nettleship 1972, Mahoney 1979, see also Table 1), as well as in 60% of a sample of Greater Shearwater proventriculi collected in Placentia Bay, Newfoundland (Brown et al. 1981), in summer. Furthermore, capelin ~~was~~ were also present in the stomachs of over 90% of Common and Thick-billed Murres collected in winter off Newfoundland (Tuck 1961). Capelin are also of indirect importance to such predators as the shearwaters and porpoise, which feed on squid as well as take

capelin directly, and harbour seals Phoca vitulina and grey seals Halichoerus grypus, which feed on cod (Banfield 1974).

It now seems clear that these higher predators have been affected by the collapse of the capelin population following over-fishing. In the late 1970s, for example, there was a sharp increase in the numbers of incidents in which finback and humpback whales became entangled in inshore fishing gear off eastern Newfoundland in summer (e.g., Lien and Gray 1980). It is likely that this in part reflects a greater tendency for the whales to forage inshore, for lack of capelin offshore. The South East Shoal of the Grand Bank, for example, normally has a large population of humpback whales during the capelin spawning season (R.G.B. Brown, personal observation).

The scarcity of capelin has also had significant effects on at least part of the Newfoundland Atlantic Puffin population. Capelin are normally an important part of this species' diet (Table 1), and indeed the majority of its colonies in North America are in areas where there is a large capelin population (Nettleship 1972, 1973; Brown et al. 1975; Nettleship 1977, 1980; see also Fig. 2). The timing of the hatch of young puffins in southeast Newfoundland, in the last week of June and the first week in July, coincides with the arrival of spawning capelin, which usually occurs ca. 20 June (Nettleship 1972, unpubl.). The largest colonies are in Witless Bay, southeast Newfoundland, where some 225,000 pairs (70% of the North American population) breed on Gull, Green and Great Islands. Table 1 shows that in prime, slope habitat on Great Island in 1968/69 the chicks had a high (60.3%) fledging success, fledging at an average body weight of 261.6 g, and of the unsuccessful chicks only 15.7% were found dead, of starvation, in the nesting burrows. In 1981 by contrast the capelin failed to spawn in the Witless Bay area; fewer than 45% of

the chicks fledged and at a significantly reduced weight of 217.0 g, and no less that 44.4% of the unsuccessful chicks were found dead of starvation (Table 1). Table 1 also shows that the chicks were receiving smaller and fewer meals in 1981 than in 1968/69, and that they were being fed mainly small gadoids instead of capelin. Nutritional analyses are still in progress but, following Harris and Hislop (1978), it is probable that gadoids are a nutritionally inferior food, so the meals brought to the young puffins were insufficient in quality as well as quantity. By contrast, puffins breeding on the Gannet Clusters, southeast Labrador, in 1981 had chicks with a significantly higher fledging success and fledging weight than did those on Great Island as well as a significantly lower incidence of chick mortality from starvation (Nettleship, in prep.). Fishing pressure on the Labrador capelin population has not been as severe as it has been on those on the Grand Banks, and the Labrador puffins were feeding their young mainly on capelin.

The situation on Great Island in 1981 has an exact parallel with the events on Røst in the Lofoten Islands, a colony which contains ca. 55% of the Norwegian puffin population (Brun 1979). The principal food species here were not capelin but small herring Clupea harengus (Mills 1981). Since 1969 this fishery has collapsed through the overfishing of both the young and spawning adult herrings along the Norwegian coast (Anon. 1972-79). At Røst, as on Great Island, the adults are instead bringing mainly small gadoids to their young (Mills 1981). With the exception of the 1974 season, no chicks have fledged from this colony since 1969. No recent population estimates for Røst puffins have been published, though the colony was apparently already declining in the early 1970s (Brun 1979). We would expect that this decline would have accelerated sharply in the late 1970s, in the absence of recruits from the year-classes of 1969

onwards.

We do not as yet have comparable information for the other capelin-feeding seabird species breeding in the Witless Bay area. However, we predict that the scarcity of capelin will have similar effects on species such as the Common Murre and Razorbill, and perhaps even on less specialised feeders such as the Black-legged Kittiwake. As with the puffin, the eastern North American breeding distributions of the Common Murre and Razorbill, and the non-arctic segment of the kittiwake population, closely coincide with the distribution of capelin (Nettleship 1973; Brown et al. 1975; Nettleship 1977, 1980). Again comparable declines elsewhere in at least one of these species have been associated with overfishing. Common Murres in the Faeroes have declined greatly in numbers along with the decline of the herring population there since the 1950s (Dyck and Meltofte 1975, Salomonsen 1979), and there is some evidence that these Faeroese birds have reduced breeding success when they feed on an alternative diet of gadoids (Reinert 1976).

The other seabirds which rely heavily on capelin for food in Newfoundland waters are the shearwaters. These birds breed in the southern hemisphere, and a relatively small proportion of the Sooty Shearwater population, but almost all of the Greater Shearwater, spend the southern winter in the North Atlantic (Phillips 1963, Voous and Wattel 1963, Brown et al. 1975). The arrival of both species, in late May and early June, coincides with the start of the spawning migrations of the capelin, and the birds apparently follow the fish northwards up the coast to Labrador. The Southeast Shoal of the Grand Bank, along with Georges Bank off the New England coast, seem to be the first stopping points for Greater Shearwaters in the northern hemisphere; presumably the birds use both these rich fishing banks as places to feed up and moult after their

breeding season and migration. It would be very difficult to assess the effects of the capelin fishery on these birds because neither species has been properly censused and so there is no way of knowing whether their populations have declined. It is possible that these birds are less seriously affected by the scarcity of capelin than are the puffins and other Newfoundland seabirds. Since they are not breeding, the shearwaters are less restricted in the areas where they go to feed, unlike puffins, for example, which can only forage within a fairly short distance from their colonies. The Greater Shearwater's food on Georges Bank is sandlance and saury Scomberesox saurus (K.D. Powers, pers. comm.), and so the birds could, in theory, go there and feed on these fishes as an alternative to capelin on the Grand Bank. Moreover, the shearwaters are more omnivorous than the alcids, and at times feed by scavenging (Brown et al. 1981), and so presumably have more feeding options. It is even possible that, in the very short run, the shearwaters have benefitted from the capelin fishery insofar as they can scavenge fish spilled from the nets or dumped after capture (e.g., Rowe and Collins 1982) rather than having to dive in pursuit of their prey. These are, however, only speculations.

DISCUSSION

Up to a point, seabird populations are able to adjust to periodic natural fluctuations in the availability of their food supply. Vermeer et al. (1979) and Vermeer (1980) report an example for two puffin species breeding in British Columbia, the Tufted Puffin Lunda cirrhata and the Rhinoceros Auklet Cerorhinca monocerata, whose normally preferred food is sandlance. These fish were unavailable for some reason during one breeding season. The Rhinoceros Auklets, nocturnal feeders, were able to switch to sauries and myctophids, fish which only come up into the surface layers at night, and bred fairly successfully, though neither substitute food was completely satisfactory, as chick growth rates and fledging success rates showed. The Tufted Puffins, diurnal feeders, were unable to make this switch, and their breeding failed completely. Similarly, Atlantic Puffins breeding in Scotland make minor adjustments in their diet, depending on what foods were available in the vicinity of their colonies in any given breeding season (Harris and Hislop 1978). Perhaps the best known examples of such adjustments come from the guano birds of Peru - the Peruvian Booby Sula variegata, Peruvian Pelican Pelecanus thagus and Guanáy Cormorant Phalacrocorax bougainvillei (Murphy 1936). The principal food of these birds is the anchoveta Engraulis ringens, in the cool upwelling along the west coast of South America. Every few years the Peru upwelling becomes overlain by an intrusion of warm tropical water from the north - the El Niño phenomenon. The anchovetas become unavailable and the guano birds populations drop catastrophically, with the Guanáy Cormorant which specialises the most on anchovetas being the species worst affected. However, their numbers normally come back again very rapidly once the cool upwelling and the anchoveta population are reestablished.

Unfortunately, seabirds usually have a low reproductive rate and are fairly specialized feeders, and they are ill-adapted to coping with prey scarcity when this occurs more or less permanently, as it does when their food is the target of a very intensive fishery. The Peruvian anchoveta population has been very intensively harvested since the 1960s and it has failed to recover from the El Niño events of the 1970s, possibly because of overfishing at a time when numbers were at their lowest (Walsh 1978). As a result the guano bird population has become drastically and apparently permanently reduced and the guanáy, formerly the commonest of the three species, is now the rarest (Schaefer 1970; Brown 1981; J.R. Jehl, pers. comm.). This clearly illustrates how vulnerable seabirds with specialized feeding habits may be when they depend on a single very abundant prey species when man is competing with them for it.

Atlantic Puffins are further examples of this, even though they are not as specialized in their feeding habits as are the guano birds. It is not clear to what extent the variations in the prey species taken by birds at Scottish colonies are related to the fishery (Harris and Hislop 1978), but the birds there are at least able to exploit a variety of prey species of high nutritional quality - sandlance, young herring, sprat Sprattus sprattus - and in most years one or more of these is available to them. But the birds on Great Island and Røst have no such options open to them. Sprats do not occur in the western Atlantic (Leim and Scott 1966). The distribution of sandlance off Newfoundland is not well known, but to judge from the frequency with which they are found in cod stomachs, they are probably commonest in the shallows of the Grand Banks (Leim and Scott 1966; G.R. Lilly, pers. comm.). These, at least 75 km away from Great Island at their nearest point, are presumably beyond the range for economical foraging by breeding birds. The fact that Great Island puffins did not increase their catch of sandlance when capelin were ~~absent~~ scarce (Table 1) also points to a scarcity

of these fish inshore. Herring also occur off Newfoundland but their principal spawning area is along the south coast (Anthony and Waring 1980), again, almost certainly out of range for Witless Bay puffins. Moreover, herring larvae and young herring tend to move with the current (e.g., Dragesund et al. 1980); this sets westwards along that coast and would tend to carry them into the Gulf of St. Lawrence and not eastwards past Witless Bay. The small herring populations of eastern Newfoundland, in Trinity and Bonavista Bays, are apparently resident in these bays at all ages (Pinhorn 1976), and so never come closer than 100 km of Witless Bay. In short, the Great Island puffins have no high-quality alternative prey to capelin. In just the same way, the colony on Røst is south of the area where capelin are sufficiently abundant to support a fishery off northern Norway, but well north of the areas where sprat and sandlance are fished (Anon. 1972-79). In their case they have no acceptable alternative to young herring.

The general point to be made, for puffins and for many other seabirds, is that it is easy to be misled by long published lists of prey which they have been known to take into overestimating the amount of choice which they actually have. Their basic requirements are to obtain more energy from eating their food than they expend in catching it, so the ideal prey must be:

(1) predictably abundant at the appropriate season.

(2) locally abundant in dense concentrations, so that it may be caught with the minimum of effort. This may be especially important to species like the alcids which forage by pursuit-diving (Ashmole 1971) in the dense medium of the water; there is evidence that they and other seabirds may fly considerable distances to feed at dense local concentrations of prey (Hartley and Fisher 1936, Brown 1976). (If

the prey is a commercially harvested species, it is just these local concentrations which will be the target of the fishermen, too.)

(3) Within certain size limits. These limits will be narrower in species like the alcids which ingest their prey whole, than in shearwaters which can tear at the larger items and break them up. The importance of size is shown by Vermeer's (1980) observations on Rhinoceros Auklets; the sauries which the parent birds brought back to the colony in lieu of sandlance were in several cases too big, and choked the chicks to which they were fed. Size is also a determinant of foraging efficiency, since large fish are faster than small ones (Beamish 1978), and thus require more effort to catch, and to handle once they are caught.

(4) Of acceptable nutritional quality. Little is known of the nutritional aspects of seabird diets, but it is likely that they vary with the season and the birds' age, and no doubt with much else. For example, Thick-billed Murres at the colony on Prince Leopold Island in Lancaster Sound fed their chicks almost exclusively on fish, while themselves eating both fish and crustaceans (Gaston & Nettleship 1981). This is presumably adapted to the greater energetic requirements of the growing chick. The calorific value of crustaceans is lower than that of fish (e.g., Brown et al. 1981), and there is some evidence that an all-crustacean diet is inadequate for a Thick-billed Murre chick (Tuck and Squires 1955).

Given requirements such as these, it is obvious that there will only be a very limited number of acceptable prey species within range of any colony. For the Great Island puffins, for example, sandlance are presumably nutritionally satisfactory but insufficiently abundant. Small gadoids are the right size and probably abundant enough, but they seem

to be inadequate as a source of nutrition for the chicks. They probably also do not occur in schools as dense as those of spawning capelin. In fact, despite the variety of species of fish in the waters off eastern Newfoundland, and the variety of foods which puffins have been known to take, the diet of Newfoundland puffins during the breeding season is essentially a single-species one, with the birds extremely dependant on capelin. To a greater or lesser extent this is undoubtedly also true of other capelin predators - seabirds, marine mammals and the larger fish. We cannot emphasise too strongly the need to include realistic estimates of the consumption of capelin by these predators in the models used to calculate Total Allowable Catch by the fishery (e.g., Winters and Carscadden 1978, Carscadden 1982 - this volume). To put it simply, we can plan for a small capelin fishery off Newfoundland, along with a cod fishery and an abundance of seabirds and the other higher predators, or we can plan for a major capelin fishery. But we cannot have both, and if the calculations are wrong we may very well end up with neither. The possible consequences of such a miscalculation on Newfoundland marine ecosystems are frightening.

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Table 1. Comparison of breeding performance in Atlantic Puffins in Witless Bay, Newfoundland, in 1968/69 and 1981[1].

Measure		1968/69[2]		1981[2]
Fledging success		60.3% (126/209)	*	45.0% (45/100)
Chick mortality:				
(a) found dead in burrow (i.e., starvation)		15.7% (13/ 83)	*	44.4% (24/ 54)[3]
(b) disappeared prematurely (i.e., gull predation/ early departure)		84.3% (70/ 83)	*	55.6% (30/ 54)[3]
Chick condition at fledging:		(n = 126)		(n = 45)
(a) body weight (g)		261.6 ± 34.07 (159-323)	*	217.0 ± 38.22 (145-276)
(b) wing length (mm)		142.1 ± 14.19 (127-154)	NS	140.0 ± 6.36 (126-152)
Chick diet:	n			n
(a) meal size (g)	155	12.4 ± 5.33	*	101 5.86 ± 4.95
(b) composition:	208 (1969)			101
-capelin	175	84.13%	*	13 12.9%
-immature Gadus	7	3.36%	*	65 64.3%
-sandlance	26	12.50%	NS	14 13.9%
-total fish	208	100.00%	*	92 91.1%
-invertebrate	0	0.00%	*	9 8.9%
(c) $\bar{x}$ feeding rate (meals/chick/d)[4]	17 (1969)	3.6 ± 1.08	NS	20 2.3 ± 2.65
(d) $\bar{x}$ chick food/c/d (g) [(a)·(c)]	17	44.64	*	20 13.47

NOTES:
[1] same study plots and habitats (slope) used in 1981 as base years 1968-69.
[2] period 1968/69 prior to international capelin fishery; 1981 - 9 years after beginning of fishery plus 1981 was 3rd consecutive year of capelin spawning failures in SE Newfoundland waters.
[3] fate of 1 chick uncertain though known not to have fledged.
[4] chicks watched for 3 days and therefore 1969 = 51 chick days, and 1981 = 60 chick days.
* $P<0.001$
NS $P>0.05$

NEWFOUNDLAND CAPELIN: A SIMPLIFIED FOOD-WEB

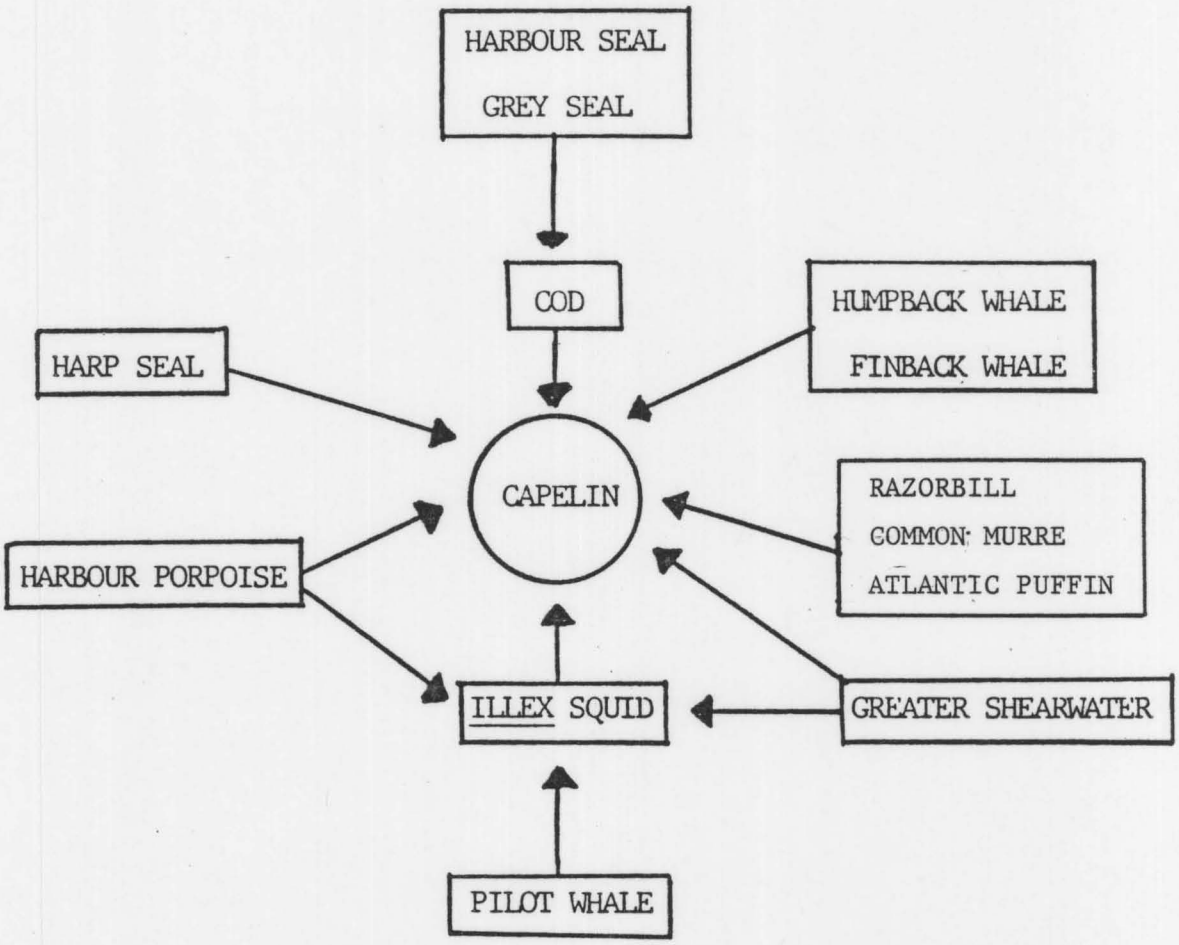

Figure 1. Simplified food-web illustrating the central position of the capelin in Newfoundland marine trophic relationships. (Data from the authorities cited in the text, see section 'Effects of the fishery on other marine animals'.)

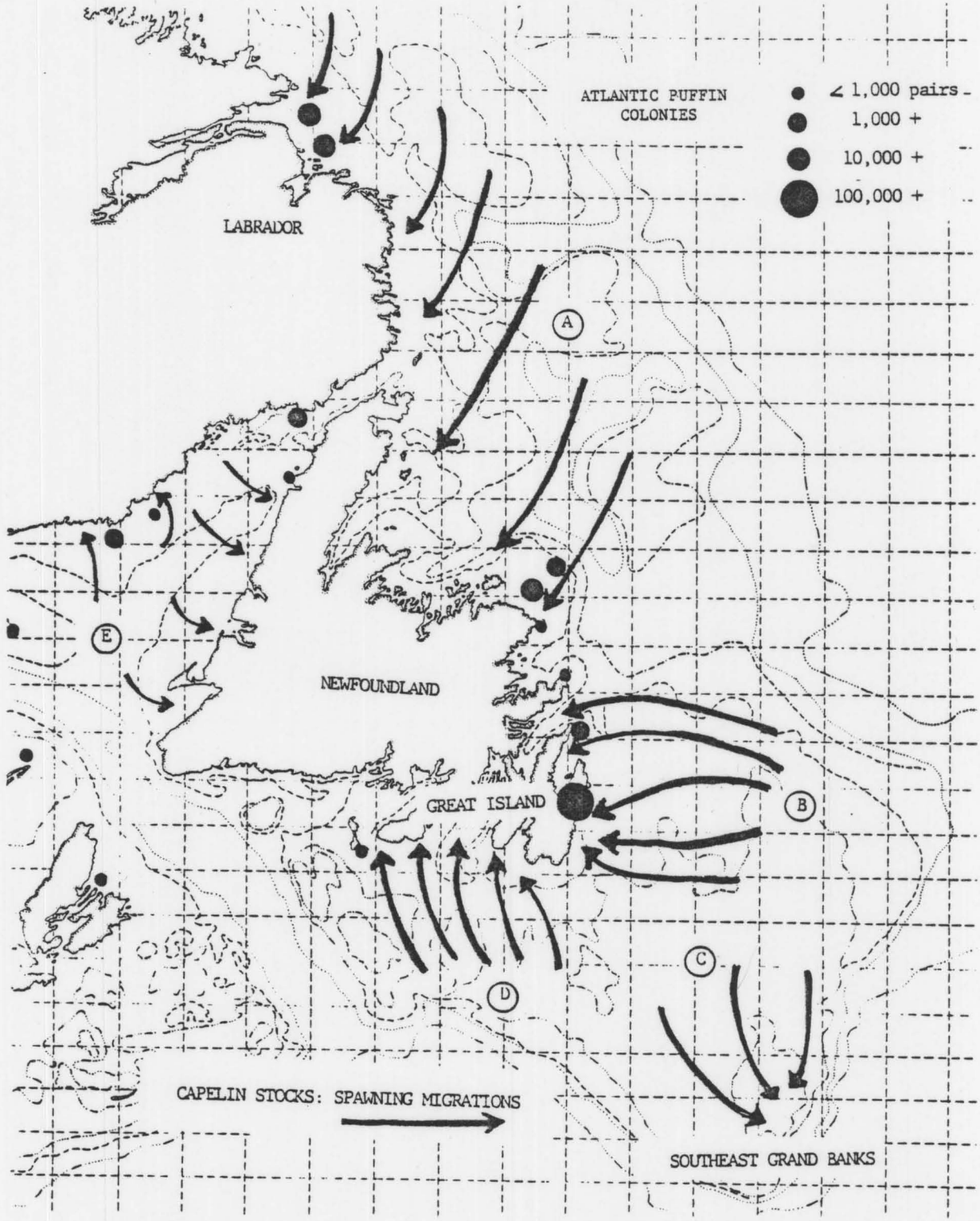

Figure 2. Distributions of capelin Mallotus villosus stocks (after Carscadden 1982) and Atlantic Puffin Fratercula arctica colonies (Nettleship 1980) in the Newfoundland region. A-E indicate the separate capelin stocks described in the text; arrows indicate their migrations, and point towards the spawning areas.

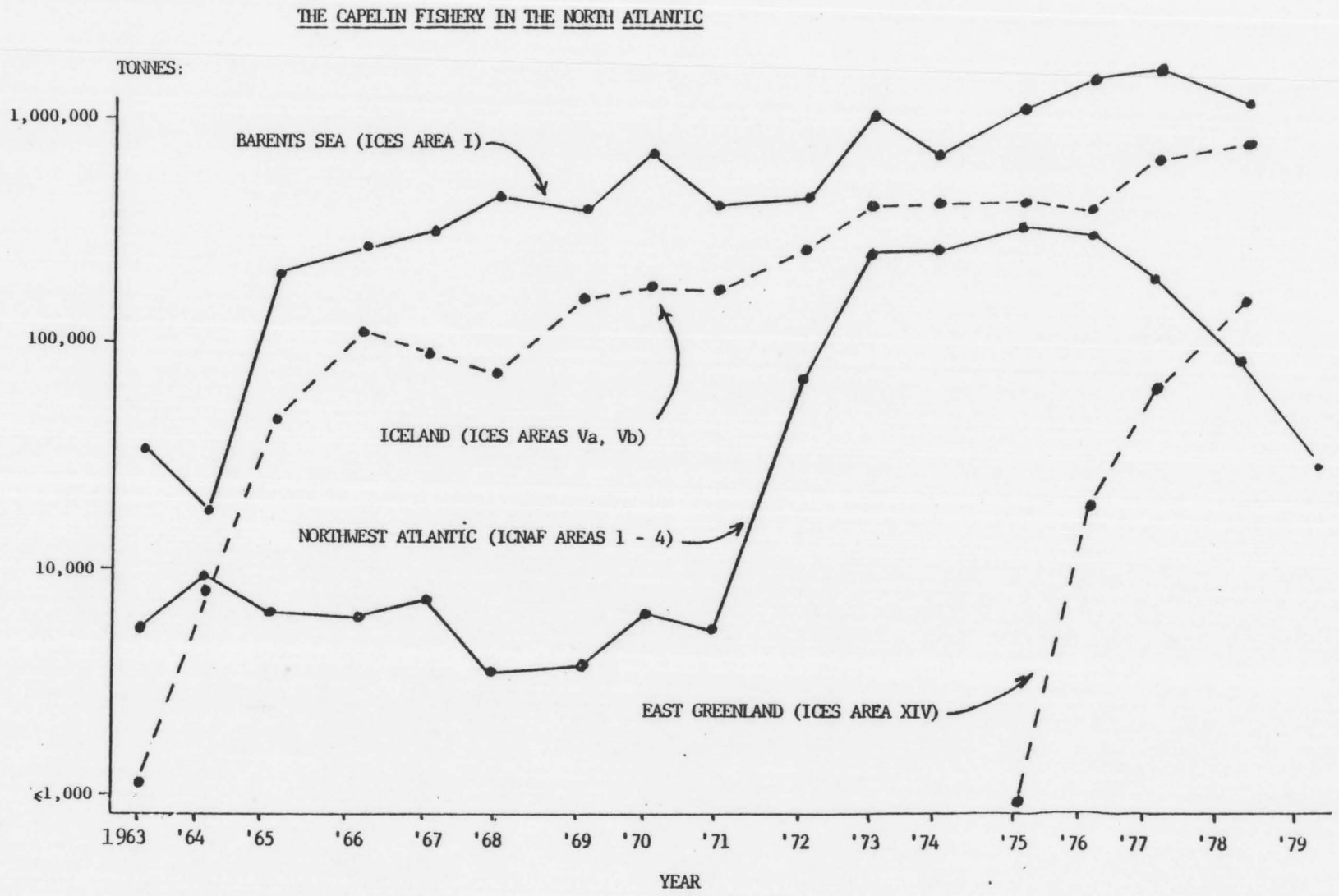

Figure 3. Annual harvest of capelin in selected zones in the north Atlantic (based on ICES 1963-78 and ICNAF 1963-79).

TOTAL FOREIGN CATCH, 1972-1979

AREA	TONNES	% MAY + JUNE + JULY
LABRADOR (2J)	532,000	4.9
NE NEWFOUNDLAND (3K)	400,000	3.0
SE NEWFOUNDLAND (3L)	154,000	69.5
SE GRAND BANKS (3N)	414,000	95.5

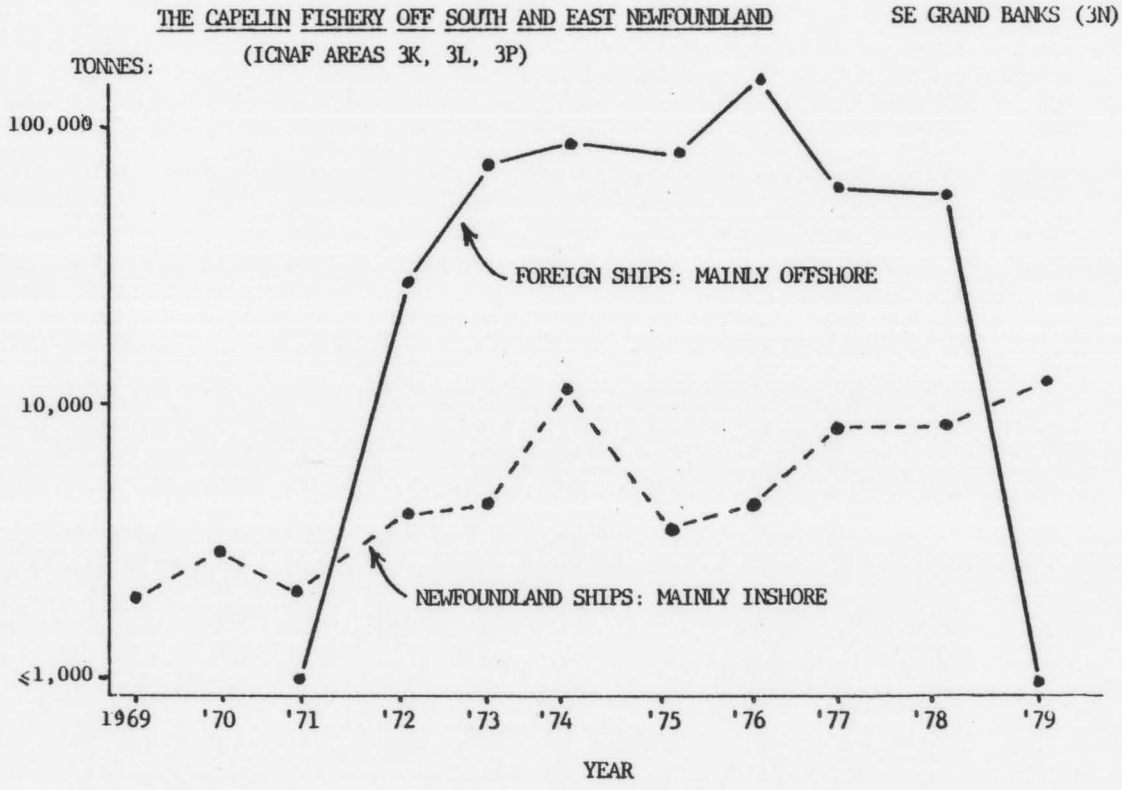

Figure 4. Annual harvest of capelin by Newfoundland and foreign fishing boats off northeast (3K), southeast (3L) and southern Newfoundland (3P), and the proportion harvested in or just before the spawning season (May-July). (From ICNAF 1963-79.)