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SCIENTIFIC COUNCIL MEETING - JUNE 1993

Diet of Harp Seals (*Phoca groenlandica*) in 2J3KL During 1991-93

by

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The following changes (underlined and boldfaced) are to be made:

1. Page 2, Introduction, para. 5, 2nd line: ".... although seals are known to feed some ...." (**and the "n"**)

2. Page 2, Methods, para, 1, 1st line: "examined from animal collected in offshore ...." (the word **"recovered"**, originally following "collected", should be deleted).

3. Figure 2, Legend: "... cod-directed trawls, in harp seals caught in nets .... and in harp seals caught in inshore areas ..." (add two **"in"**s)

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Abstract

An understanding of geographical and seasonal variations in diet and distribution is necessary before we can estimate the impact of seals on commercial fish species. The diet of harp seals in 2J3KL was determined by reconstructing the contents of 540 prey-containing stomachs recovered from 1991-1993. Although preliminary, this study shows that there is considerable seasonal, geographical and interannual variation in the diet of harp seals in 2J3KL. Geographical differences were observed among inshore harp seals; based on wet weight, sculpins (Cottidae) were the major component of the diet of seals in 2J (although prevalence was small), whereas Arctic cod (*Boreogadus saida*), Atlantic herring (*Clupea harengus*), *Pandalus* shrimp and squid were the major prey in harp seals from3KL. While Arctic cod was the major prey consumed in both summer and winter, herring and squid gained importance for harp seals during the summer as these prey species moved inshore. There was also evidence of interannual variation in the diet, with harp seals depending more heavily on crustacean prey in 1992 than in 1991. Atlantic cod was not a major component of the diet in these areas.

Except for two stomachs collected during April, 1992, Atlantic cod was not found in the stomachs of offshore seals collected independently from commercial cod trawls during summer 1992 and winter 1993. While cod were the predominant prey of harp seals caught in the nets of cod-directed trawls, the size classes of cod found in the stomachs were similar to, or smaller than, cod discarded by the trawlers.

Introduction

Pinnipeds are among the largest carnivores in marine ecosystems and therefore may be significant predatory components of marine ecosystems (e.g. Laws, 1977). In spite of this potential importance in marine ecosystems relatively little quantitative data are available on the diets of many marine mammals.

In Canada, harp seals inhabit coastal and offshore waters from the Gulf of St. Lawrence to the southern Arctic (Finley *et al.*, 1990; Sergeant, 1965). Based on estimates of pup production Shelton *et al.* (1992) estimated that the total population in the Northwest Atlantic in 1990 was approximately 3.1 million. Thus, the harp seal is likely the predominant mammalian piscivorous predator in NAFO zones 2J3KL.

Assessing the potential impact of harp seals as predators is difficult since they possess a broad diet which varies seasonally and geographically. To date, our knowledge of the diets of harp seals in eastern Canada has been based on stomach content analyses (for a review of the literature on harp seal diet see Wallace and Lavigne, 1992). Most studies used a variety of noncomparable methods, most commonly frequency of occurrence. This has been calculated as either the proportion of stomachs which contain a particular prey or the overall numbers of each prey species present. Although frequency of occurrence has the advantage of computational simplicity, it does not provide information about the amount of each species in a stomach or the size of the prey consumed (Bowen *et al.*, 1993). Length and weight provide the best means to determine which prey are satisfying the energy requirements of the seals since simple frequencies may overestimate the importance of numerous small prey in the diet while underestimating the contribution of larger, less common items (Bigg and Fawcett, 1985). Further, since studies have often reported diet composition in different seasons or locales using dissimilar measures, it has been difficult to estimate the relative significance of different prey items in the seasonal intake of harp seals (e.g. Finley *et al.*, 1990).

In this paper we have begun to assess the relative contributions of prey species by estimating their sizes as reconstructed from otoliths and other hard parts recovered from harp seal stomachs. We present preliminary analyses of harp seal diets in 2J3KL from 1991 to 1993, in summer and winter for inshore and offshore areas.

Previous studies have primarily relied upon samples collected in inshore areas. Little is known about the diet of harp seals in offshore areas, although seals are know to feed some distance from shore, particularly during the winter and spring (Sergeant, 1973b; Stenson and Kavanagh, unpublished data). Stomach samples taken in offshore areas are difficult to obtain and have not produced data used in most previous diet reconstructions (e.g. Finley *et al.*, 1990; Murie and Lavigne, 1991; Ni *et al.*, 1991; Sergeant, 1973b). In addition to samples taken from nearshore areas, in this study we were able to perform a preliminary reconstruction of the stomach contents of seals collected in offshore areas as well.

Methods

The stomachs of 636 harp seals were examined from animals collected recovered in inshore and offshore waters around Newfoundland and Labrador (NAFO zones 2J, 3K and 3L) from 1991 through spring 1993. Seals were obtained using five methods: inshore net, inshore shot, offshore net by-catch, offshore trawl and offshore shot. Seals were collected during most months of the year, although fewer stomachs were recovered during the summer reflecting these seals' annual migratory pattern. Stomachs from seals collected between April and September were designated as "summer" samples and those taken between October and March as "winter" samples. No effort was made to restrict the sex or age of seals killed, or the time of day at which they were collected. Two age groups were used in analyses: pups and seals aged 1 year and older (1+).

In the field, each stomach was ligated and removed from the seal soon after death and either frozen at -20° C, or frozen and later stored in 70% ethanol, until analysed. Whole stomachs were thawed, or removed from the ethanol, and then weighed on an electronic balance to the nearest 0.1 g. Each stomach was then placed in a large tray to prevent loss of contents. If present, whole prey items were removed, weighed to the nearest 0.1 g and measured to the nearest 1.0 mm (fork length in teleosts, or pen length in cephalopods). Saggital otoliths were removed from intact skull cases. Cephalopod beaks were removed from the buccal capsules of whole squids. All hard parts were stored dry. Free otoliths, squid beaks, and smaller invertebrate prey were recovered by visual inspection after washing each stomach's contents through a stack of five sieves of decreasing mesh sizes with fresh water. Previous work has demonstrated that over 90 percent of otoliths are recoverable using this method (Murie and Lavigne, 1985). After the contents were removed, the empty stomach was again weighed to determine the wet weight of the contents.

Fish species were identified by examining whole specimens or by comparing recovered otoliths to reference material collected in waters around Newfoundland, or to a published otolith identification key (Härkönen, 1986). The total number of recovered otoliths of each species was used to calculate the number of individual prey in each stomach. If left and right otoliths could be distinguished, the side with the greater number was used to determine the number of prey eaten. Where it was not possible to distinguish between left and right otoliths, the number of individuals consumed was estimated by dividing the total number of otoliths by two. Squid were identified by comparing either intact individuals, if present, or upper beaks to published descriptions (Dawe, 1988; Lilly and Osborne, 1984). The number of squid consumed was assumed to be equal to the number of the more numerous beak halves.

Only otoliths with minimal or no erosion were used to estimate the size of prey consumed. Degree of erosion was determined by comparing the surface and edge features of the recovered otolith with those in the reference collections. Otoliths which had complete surface detail, and whose margins displayed a similar degree of topography to reference material were measured to the nearest 0.1 mm using vernier calipers (otoliths longer than 5 mm) or a Apple Macintosh™-based image analysis system (otoliths shorter than 5 mm). In most species measurements were taken from the rostrum to the posterior edge of the otolith, parallel to the sulcus. Greenland halibut (*Reinhardtius hippoglossoides*) otoliths were measured across the widest chord. Whole squid beaks were measured if they were intact and showed no erosion. Squid beaks were measured from the tip of the beak to the base of the hood (*Illex* sp.) or from the tip to the margin angle (*Gonatus* sp.).

Length and wet weight of fish prey and squid were estimated from regressions relating these two measures to otolith or beak dimensions. To estimate total biomass of prey in a stomach, we summed the estimated wet weights of all prey items found therein. To estimate the biomass represented by eroded otoliths, we assumed that eroded otoliths of each species were originally the same size as the average of the uneroded measured otoliths in that stomach. We multiplied the number of prey items with eroded otoliths in each stomach by the average length and weight determined from uneroded otoliths of the same species. Estimated energy density (J/g wet weight) values for each prey was taken from the literature (Anonymous, 1969; Croxall and Prince, 1982; Griffiths, 1977; Hislop *et al.*, 1991; Hodder *et al.*, 1973; Liem, 1943; Montevecchi and Piatt, 1984; Steimle and Terranova, 1985), obtained from proximal content analyses performed in St. John's, or derived using published estimates of the proportions of fat and protein in the prey (assuming the fat yielded 39.3 MJ/g and protein yielded 23.6 MJ/g wet weight).

Results

A) Inshore Diet

1) Proportion of Food-Containing Stomachs

Most (86.5%) of the 356 inshore harp seal stomachs contained prey remains. This proportion was not significantly different between 1991 (83.9%) and 1992 (90.9%; χ^2=0.26, df=1, p=0.6) or between summer (93.6%) and winter (81.8%; χ^2=0.78, df=1, p=0.38).

Seals recovered from area 2J (67.2%) had a statistically similar proportion of prey-containing stomachs to 3KL (90.7%; χ^2=3.5, df=1, p=0.06). A similar proportion of female harp seals (88.5%) had stomachs containing prey as males (84.0%; χ^2=0.12, df=1, p=0.73), and the suites of prey they consumed were similar. All four 0 group seals (pups) had prey in their stomachs in comparison to 86.3% of 1+ aged seals.

There was little difference in the mean number of prey types which we found in prey-containing stomachs from inshore areas between years (1991=2.53 species/stomach; 1992=2.58 species/stomach), seasons (summer=2.61 species/stomach; winter=2.52 species/stomach) or age classes (O group=2.25 species/stomach; 1+=2.57 species/stomach).

2) Composition of the Diet

More than 37 prey types were identified from the 308 food-containing harp seal stomachs collected in 2J3KL (Table 1). Most numerous were capelin, Arctic cod, Teuthoid squid, *Pandalus* shrimp and cod species. Prey species found in more than ten percent of prey-containing stomachs included Arctic cod (57.1% of stomachs), capelin (28.9%), *Pandalus* sp.(24.0%), Atlantic herring (17.9%), Hyperiid crustaceans (16.2%), *Thysanoessa* sp. (euphausiids, 14.9%), Atlantic cod (11.4%) and *Liparis* sp. (10.1%).

Six prey species (Arctic cod, herring, *Pandalus* shrimp, sculpin sp., Teuthoid squid and capelin) accounted for almost 90% of the estimated wet weight of food eaten in both 1991 and 1992 (Table 2). Atlantic cod contributed only 2.8% of the total wet weight and 2.4% of the total energy intake of these seals.

Contributions by energy were similar to those for wet weight (Table 2), although herring, with its high energy density, was relatively more important in terms of energy provided than weight.

3) Annual Variation in the Diet

There was little difference between 1991 and 1992 in the weight of major prey items consumed by these harp seals (Table 2). Arctic cod was the most important prey species in both years, but contributed almost 20% less in 1992 than in 1991. In its place *Pandalus* shrimp, *Thysanoessa* sp. (euphausiid) and capelin contributed relatively more to the total weight of prey consumed in 1992, whereas sculpin sp. and squid contributed less.

4) Seasonal Variation in the Diet

Relative contributions, by wet weight, of prey consumed by harp seals in 2J3KL during summer and winter were different. Arctic cod was the major component in both seasons, but was more important during the winter (Table 3), as were *Pandalus* shrimp and sculpins. In contrast, herring, capelin and squid were more important to the diet during the summer.

5) Age and Geographic Variation in the Diet

There were differences in the relative amounts of major prey species consumed in different geographic regions. 1+ harp seals consumed different relative masses of prey species in 2J and 3KL. Sculpins were the major prey item in seals from 2J, with cod sp. providing a smaller proportion of total prey weight. Cod sp. accounted for 11.4% of prey weight, but were small (mean length=15.6 cm). Despite their contribution to the total weight of prey consumed, sculpins were found in only 1.6% of prey-containing stomachs (Table 1)

Arctic cod provided most of the prey mass eaten by 1+ seals in 3KL (57%). These seals consumed herring, *Pandalus* shrimp and squid to a lesser extent. Atlantic cod represented less than 0.1% of the total weight of prey consumed.

Small sample size (n=4) necessitates caution when examining 0 group diet (Table 4). These pups consumed small prey (capelin and invertebrates).

B) Offshore Diet

We examined 232 prey-containing stomachs recovered from harp seals in offshore areas of 2J3KL (Table 5). Samples were divided into four groups: seals shot during directed research cruises (Brandal and Offshore Shot Recoveries), offshore gillnets and from seals caught during commercial trawling operations.

Although the location of these samples was similar, the timing of the samples varied; the Brandal samples were collected from NAFO zones 326, 330 and 346 in February, the offshore trawl samples from zones 325, 330, 332, 343 and 346 in January and February, the offshore shot samples from zones 330, 343, 345, 346, 347 in April and the gillnet samples from zones 328, 330, 333, and 346 in April to July.

1) Proportion of Food-Containing Stomachs

As for the inshore samples, most (80.6%) of the 232 offshore harp seal stomachs contained prey remains. This proportion was not significantly different between Brandal (64.1%), offshore gillnet (87.7%), offshore trawl (92.4%) or offshore shot recoveries (61.5%; χ^2=4.98, df=3, p=0.17).

On average, there were fewer prey types found in prey-containing stomachs from offshore areas than inshore (Brandal=1.8 species/stomach; offshore gillnet=2.1 species/stomach; offshore trawl=1.24 species/stomach; offshore shot=1.4 species/stomach).

2) Composition of the Diet

Capelin were by far the most important component of harp seals taken on the Brandal cruise (85.8% of weight; Table 5). Sand lance, righteye flounder and capelin accounted for most of the prey weight consumed by harp seals recovered from offshore gillnets. No Atlantic cod were found in either of these recovery methods.

In contrast, harp seals caught in the nets of offshore trawls directed towards cod in 2J3KL consumed Atlantic cod almost exclusively, by weight (97%).

Figures 1 and 2 illustrate the length-frequency distributions of *G. morhua* caught by commercial trawlers originating from Newfoundland ports during January and February 1991 and 1992 (Figure 1A and 2A), and the length of cod in the stomachs of harp seals caught by these vessels (Figures 1C and 2C). Catches contained cod between 31 and 88 cm long; discards consisted of cod between 41 and 55 cm in length.

In both 1991 and 1992 the Atlantic cod found in harp seal stomachs (Figures 1C and 2C) were similar in size to those discarded by the trawlers, or smaller (Figures 1B and 2B). While there were few cod found in inshore harp seals, their sizes were smaller than those taken in the commercial fishery (Figure 2D).

To determine if the lack of Atlantic cod in the Brandal stomachs was due to the unavailability of cod to the seals, we compared the intestinal contents of harp and hooded seals recovered in the same area and found that the latter species were finding Atlantic cod to eat (Table 6). In fact, *G. morhua* accounted for a major percentage of the total weight of prey consumed (37.4%) by hooded seals (and to a lesser extent witch flounder, *Illex* squid and blue hake). Harp seals taken in the same area were relying almost exclusively on capelin (89%) as food (Table 6).

Squid (47.4%) and Atlantic cod (45.2%) were the most important prey types, by weight, in seals shot as part of other offshore recoveries (Table 5).

Discussion

We must assess the degree of variation in diet and distribution of harp seals before we can estimate their effect on commercial fish species. This preliminary study shows that there is seasonal, geographical and interannual variation in the diet of harp seals in 2J3KL.

While most harp seals in this study had prey remains in their stomachs, this should not be extrapolated to include the entire year. Samples were not taken during breeding or moulting periods when harp seals normally fast (Ronald and Healey, 1981) as stomach samples taken during these times are more likely to be empty. We did not include all of the moulting animals in the offshore shot analyses which had empty stomachs.

As has been found in previous studies of seals (e.g., Ni *et al.*, 1991; Wallace and Lavigne, 1992), harp seals taken in inshore 2J3KL had consumed a variety of prey (Table 1). By far the most important prey species by prevalence, weight or energy was Arctic cod, *Boreogadus saida* (Tables 1, 2 and 3). This is similar to studies of harp seals in the northeast Canadian Arctic (Finley *et al.*, 1990), northwest Greenland (Kapel and Geisler, 1979) and the southeast Canadian Arctic (Sergeant, 1973b; Sergeant, 1991). Atlantic herring was also a significant component of the diet, but primarily during the summer (see below).

There was some difference between 1991 and 1992 in the importance of major prey items consumed by harp seals in inshore areas (Table 2). Arctic cod was the most important prey species in both years, but contributed almost 20% less in 1992 than in 1991. *Pandalus* shrimp, *Thysanoessa* sp. (euphausiid) and capelin contributed relatively more to the total weight of prey consumed in 1992, while sculpin sp. and squid contributed less. Atlantic cod and herring were of similar importance in both years. Larger sample sizes, data from more years and better information of fish populations will be necessary before we can determine if these dietary changes are based on alterations of prey stock abundance or distribution.

While Arctic cod was the major prey consumed in both summer and winter, herring and squid gained importance for harp seals during the summer as these prey species moved inshore to spawn. This may represent a shift by harp seals to locally abundant, schooling prey or prey which are more energy rich (in the case of herring).

Although geographical differences were observed among harp seals recovered from inshore areas, the preponderance of sculpins (Cottidae) by weight in 2J should be viewed with caution. The 34 large sculpins which accounted for 67% of the prey weight consumed, were recovered from only four 1+ seals (9.5% of the prey-containing stomachs). This discrepancy between the relative frequency and weight measures in 2J illustrates a weakness in diet reconstruction from stomach contents: small sample size can produce deceptive results. Thus, while Arctic cod, herring, *Pandalus* shrimp and squid were the major prey in harp seals from 3KL, more samples should be analysed before credible comparisons can be made between 2J and 3KL.

Similarly, with only four O group harp seals, it is not feasible to make firm conclusions about age differences in harp seal diet at this time. It appears (Table 4) that pups were eating smaller prey than older seals, with a greater reliance on invertebrates, as documented previously by Sergeant (1973b).

Our results suggest that Atlantic cod was a relatively minor component of the diet of harp seals in inshore 2J3KL areas. This is similar to the findings of other studies which also examined seals caught primarily in inshore areas (e.g., Foy *et al.*, 1981; Murie and Lavigne, 1991; Ni *et al.*, 1991; Sergeant, 1973b; Sergeant, 1991; Wallace and Lavigne, 1992). The cod in these stomachs were generally small (Figure 2D).

For the first time, we were able to examine seals from offshore areas. The importance of cod to seals in offshore areas is difficult to estimate due to the small sample sizes and variation in diet among seasons, and/or method of recovery. For example, seals taken in offshore trawls contained almost exclusively cod (Table 5), while seals collected in the same area during the winter of 1993 (Brandal cruise) contained none. The distribution of size classes of cod found in seals caught by trawlers (Figures 1C and 2C), and anecdotal reports of harp seals feeding on discarded cod, suggests that the high prevalence of cod in these stomachs may, in part, be due to harp seals feeding on discarded fish (Figures 1B and 2B). This would overemphasise the importance of cod if applied to the population as a whole.

The absence of cod in the Brandal samples does not appear to be due to the unavailability of cod in the area. Hooded seals were feeding on Atlantic cod in this area while harp seals were more likely to be eating other species (Table 6). Surveys of offshore waters indicated that harp seals were abundant in this area (3KL border) during the winters of 1992 and 1993, whereas groundfish hydroacoustic surveys indicated that high densities of cod were present in this area only in 1992 (Stenson and Kavanagh, unpublished data). Therefore harp seals may not be present in this area simply to feed on pre-spawning concentrations of Atlantic cod.

No *G. morhua* were found in the stomachs of harp seals taken in gill nets while cod comprised a major portion of the diet of seals shot during April (Offshore Shot; Table 5). However, these cod were present in only two adult females which represented a small proportion (5%) of the stomachs recovered using this means. This again points out the potential effect that sample variation can have within a small sample. Further offshore samples will permit us to determine if these two females, like the four sculpin-containing seals from 2J (Table 4) accurately represent the diet of the population.

Although reconstruction of stomach contents allows us to estimate the size of prey consumed, there are limitations. Stomach content reconstruction assumes that seals eat the heads (and therefore otoliths) of their prey; if this is not the case then the size range of prey will be underestimated. While this may be happening, harp seals can and do eat whole, large cod up to at least 53cm long. Also, digestion of otoliths may correlate with their size; smaller otoliths may be eroded proportionately more than those from larger fish. This effect would tend to yield a skewed size distribution with the lengths of smaller fish being underestimated to a greater degree than those of larger fish. Sampling of seals in areas where there are fish of known size, may indicate if there is a prey size preference.

Although preliminary, these studies show that there is seasonal, geographical and interannual variation in the diet of harp seals. In light of this variation, in conjunction with the relatively small sample sizes from 2J and offshore areas, our limited knowledge concerning spatial overlap between seals and their prey, and the ongoing nature of these studies, we cannot make a clear assessment of the harp seal's impact in Atlantic cod stocks at this time.

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Table 1: Estimated numbers and percent frequency of occurrence of prey in harp seal stomachs (n=308) recovered from inshore areas of 2J3KL in1991 and 1992.

Prey Species	Number	Percent Frequency of Occurrence [1]
Atlantic Herring (*Clupea harengus*)	273	17.9
Capelin (*Mallotus villosus*)	1628	28.9
Lanternfish (Myctophidae)	1	
Gadoid Sp.	24	3.6
Gadus Sp.	106	6.5
Atlantic Cod (*Gadus morhua*)	123	11.4
Rock Cod(*Gadus ogac*)	12	
Arctic Cod (*Boreogadus saida*)	3268	57.1
Sand Lance (*Ammodytes dubius*)	88	3.9
Fourline Snakeblenny (*Lumpenus medius*)	3	
Blenny Sp.	1	
Shanny(*Lumperus maculatus*)	8	
Eelpout Sp.	88	8.8
Arctic Eelpout (*Lycodes reticulatus*)	10	
Redfish Sp. (*Sebastes marinus*)	1	
Sculpin Sp. (Cottidae)	37	1.6
Shorthorn Sculpin (*Myoxocephalus scorpius*)	1	
Long-horned Sculpin (*M. octodecemspinosus*)	3	
Liparis Sp.	75	10.1
Righteye Flounder (Pleuronectidae)	17	3.2
American Plaice (*Hippoglossoides platessoides*)	13	
Greenland Halibut (*Reinhardtius hippoglossoides*)	12	1.3
Unknown Fish	41	6.2
Illex Sp. (squid)	14	1.3
Teuthoidea (squid)	331	9.7
Gonatus fabricii (squid)	1	
Hyperiidae (crustacean)	37	16.2
Mysidae Sp. (mysid)	2	
Mysis Sp. (mysid)	1	
Euphausiacea (euphausiid)	5	
Meganyctiphanes norvegica (euphausiid)		
Thysanoessa Sp. (euphausiid)	24	14.9
Natantia (shrimp)	19	4.5
Hippolytidae (shrimp)	1	
Eualus Sp. (shrimp)	1	
Eualus fabricii (shrimp)	14	
Eualus macilentus (shrimp)	51	6.5
Spirontocaris spinus (shrimp)	5	
Lebbeus polaris (shrimp)	1	
Pandalus Sp. (shrimp)	87	8.4
Pandalus borealis (shrimp)	34	1.3
Pandalus montagui (shrimp)	61	14.3
Crangonidae (shrimp)	1	
Argis dentata (shrimp)	11	3.2
Hyas Sp. (crab)	7	
Bird Sp.	1	
	6542	800

[1] As a percentage of the 308 prey-containing stomachs.

Table 2: Estimated minimum, total wet weight (g) and energy (kJ) of prey accounting for 95 percent of the total weight in prey-containing harp seal stomachs recovered in inshore 2J3KL areas during 1991 (n=188) and 1992 (n=120).

	1991	1992	Overall	
	Weight (%)	Weight (%)	Weight (%)	Energy (%) [1]
Arctic Cod	99169 (57.8)	23556 (38.0)	122724 (52.6)	687254 (52.7)
Atlantic Cod	4824 (2.8)	1615 (2.6)	6439 (2.8)	30908 (2.4)
Atlantic Herring	19137 (11.2)	8627 (13.9)	27764 (11.9)	249875 (19.2)
Capelin	5116 (3.0)	5235 (8.4)	10352 (4.4)	77639 (6.0)
Gadus Sp.	4079 (2.4)	68	4147 (1.8)	19908 (1.5)
Greenland Halibut	526 (0.3)	2466 (4.0)	2992 (1.3)	17951 (1.4)
Pandalus Sp. (shrimp)	4096 (2.4)	11143 (18.0)	15239 (6.5)	60957 (4.7)
Righteye Flounder	1354 (0.8)	1245 (2.0)	2599 (1.1)	10914 (0.8)
Sculpin Sp.	12919 (7.5)	14	12933 (5.5)	69840 (5.4)
Teuthoidea (squid)	13490 (7.9)	518 (0.8)	14007 (6.0)	58831 (4.5)
Thysanoessa Sp. (euphausiid)	775 (0.4)	4438 (7.2)	5213 (2.2)	17724 (1.4)
	171513.3	61894.2	233407.5	1301801.2

[1] Energy percentage values are calculated using only those species listed.

Table 3: Estimated minimum, total wet weight (g) of prey accounting for 95 percent of the total weight in prey-containing 1+ harp seal stomachs (n=303) recovered in inshore 2J3KL areas in summer (n=132) and winter (n=176).

	Summer	Winter
	Weight (%)	Weight (%)
Arctic Cod	39054 (41.1)	83670 60.4)
Atlantic Cod	944 (1.0)	5495 (4.0)
Atlantic Herring	20717 (21.8)	7047 (5.0)
Capelin	5686 (6.0)	4643 (3.3)
Gadus Sp.	1764 (1.9)	2383 (1.7)
Greenland Halibut	2466 (2.3)	526 (0.4)
Pandalus Sp. (shrimp)	2006 (2.1)	13231 (9.6)
Sculpin Sp.	12	12921 (9.3)
Teuthoidea (squid)	12137 (12.8)	1870 (1.3)
Thysanoessa Sp. (euphausiid)	3717 (3.9)	1495 (1.1)
	94957.9	138403.7

Table 4: Number and estimated wet weight (g) of prey species accounting for 95 percent of total, reconstructed wet weight of prey-containing harp seals (n=307)[1] recovered in inshore 2J3KL areas.

	1+ Seals				0 Group Seals	
	2J		3KL		3KL	
	N	Weight (%)	N	Weight (%)	N	Weight (%)
Arctic Cod	77	794 (4.1)	3167	121930 (57.0)		
Atlantic Cod	6	895 (4.7)	117	5544		
Atlantic Herring			273	27764 (13.0)		
Capelin	192	1087 (5.7)	1417	9243 (4.3)	1	22.0 (48.4)
Cod Sp.	14	2187 (11.4)	92	1960 (0.9)		
Eelpout Sp.					1	2.4 (5.3)
Euphausiacea (euphausiid)						14.9 (32.7)
Hyperiidae (crustacean)					1	4.3 (9.4)
Pandalus montagui (shrimp)	8	7.4	53	14841 (6.9)	5	1.9 (4.2)
Righteye Flounder	1	113	16	2486 (1.2)		
Sculpin Sp.	34	12919 (67.2)	3	14.0		
Teuthoidea (squid)			331	14007 (6.5)		
Other Fish		610 (3.2)		12878 (6.0)		
Other Invertebrates		263 (1.4)		8589 (4.0)		
	42 stomachs	19215.3	261 stomachs	213899.4	4 stomachs	45.5

[1] The age of one seal was undetermined.

Table 5: Number, estimated wet weight (g) and mean length (cm) of prey species accounting for 95 percent of total, reconstructed wet weight of prey-containing harp seals (n=232) recovered from offshore areas, 1991 to 1993 (n equals the number of stomachs containing prey).

	Brandal Cruise (n=25)		Offshore Gillnet Recoveries (n=57)		Offshore Trawl Recoveries (n=110)		Offshore Shot (n=40)	
	Weight (%)	Length (SE)	Weight (%)	Length (SE)	Weight (%)	Length (SE)	Weight (%)	Length (SE)
Atlantic Cod					377511 (97.0)	35.2 (0.3)	4730 (45.2)	40.8 (1.1)
Capelin	24003 (85.8)	13.0 (0.1)	8540 (21.0)	9.5 (0.1)	335 (0.1)	9.7 (0.1)	83	12.9 (1.0)
Redfish					1191 (0.3)	26.6 (1.1)		
Righteye Flounder	1483 (5.3)	23.1 (3.6)	11003.1 (27.1)	19.2 (1.2)	556 (0.1)	19.6 (1.6)	107 (1.0)	27.3 (-)
Sand Lance			19668 (48.4)	13.2 (0.4)		13.2 (0.2)		
Teuthoidea (squid)	299 (1.1)	21.3 (2.9)			4163 (1.1)	20.4 (4.7)	4963 (47.4)	30.3 (4.6)
Hyperiidae (Crustacean)	16		1		210 (0.05)		489 (4.7)	
Other Fish Sp.	1935 (6.9)		384 (0.9)		4072 (1.0)		8.9	
Other Invertebrates	230 (0.8)		27 (0.07)		176 (0.04)		80 (0.8)	
	27965.0		40638.0		388213.6		10469.6	

Table 6: Estimated number (N), frequency of occurence and wet weight (g) of prey in the diets of harp and hooded seals reconstructed using intestine contents recovered during Brandal offshore cruise, February 1993.

	Number of Prey				Frequency of Occurrence		Wet Weight of Prey			
	Harp		Hooded		Harp	Hooded	Harp		Hooded	
Prey Species	N	%	N	%			Weight	%	Weight	%
Arctic Cod	3	0.4			6.9		15.0	0.2		
Atlantic Cod			12	18.2		33.3			2420.7	37.4
Blue Hake			2	3.0		11.1			490.0	7.6
Capelin	639	89.0	4	6.1	93.1	55.6	5473.9	89.6	52.0	0.8
Common Grenadier			8	12.1		11.1				
Greenland Halibut	12	1.7	3	4.5	17.2	22.2	450.9	7.4	85.2	1.3
Hookear Sculpin	13	1.8			3.4		35.3	0.6		
Liparis sp.	1	0.1			3.4		1.2	0.02		
Redfish	1	0.1	4	6.1	3.4	22.2	11.5	0.2	454.5	7.0
Righteye Flounder	2	0.3	1	1.5	6.9	11.1	3.3	0.1	209.0	3.2
Scaled Lancetfish	2	0.3			6.9					
Vahl's Eelpout	1	0.1			3.4		51.0	0.8		
Witch Flounder			12	18.2		22.2			1771.6	27.4
Unknown Fish			1	1.5		11.1				
Hyperiidae (crustacean)	10	1.4			24.8					
Illex Sp. (squid)	14	1.9	19	28.8	17.2	44.4	66.3	01.1	988.8	15.3
Natantia	2	0.3								
Pandalus Sp. (shrimp)	18	2.5			34.5					
	718		66		29 Intestines	9 Intestines	6108.6		6472.0	

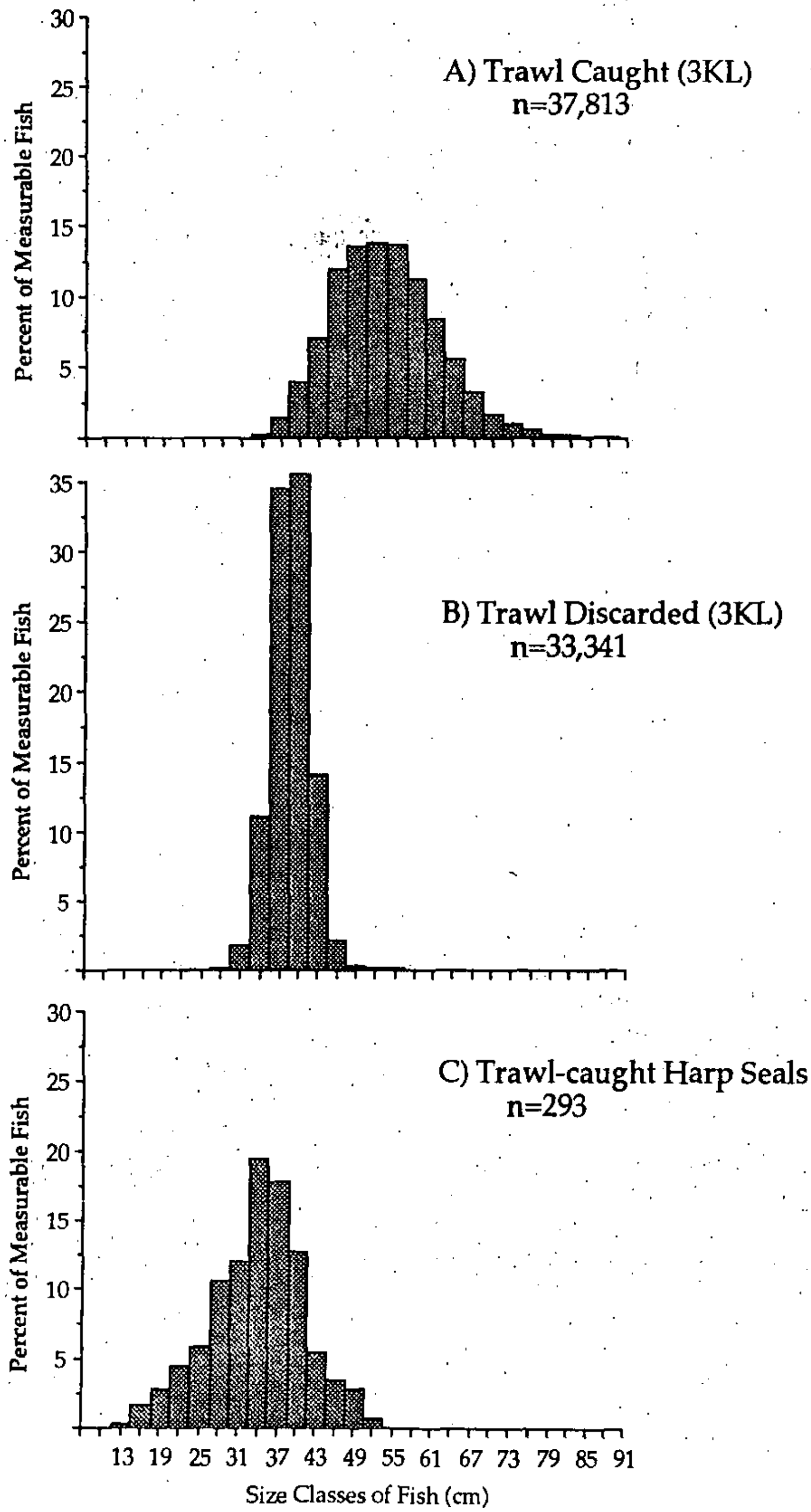

Figure 1: Length-frequency distributions of Atlantic cod caught in commercial, cod-directed trawls and in harp seals caught in the nets of offshore, cod-directed trawls in 2J3KL during 1991. n equals the number of cod measured.

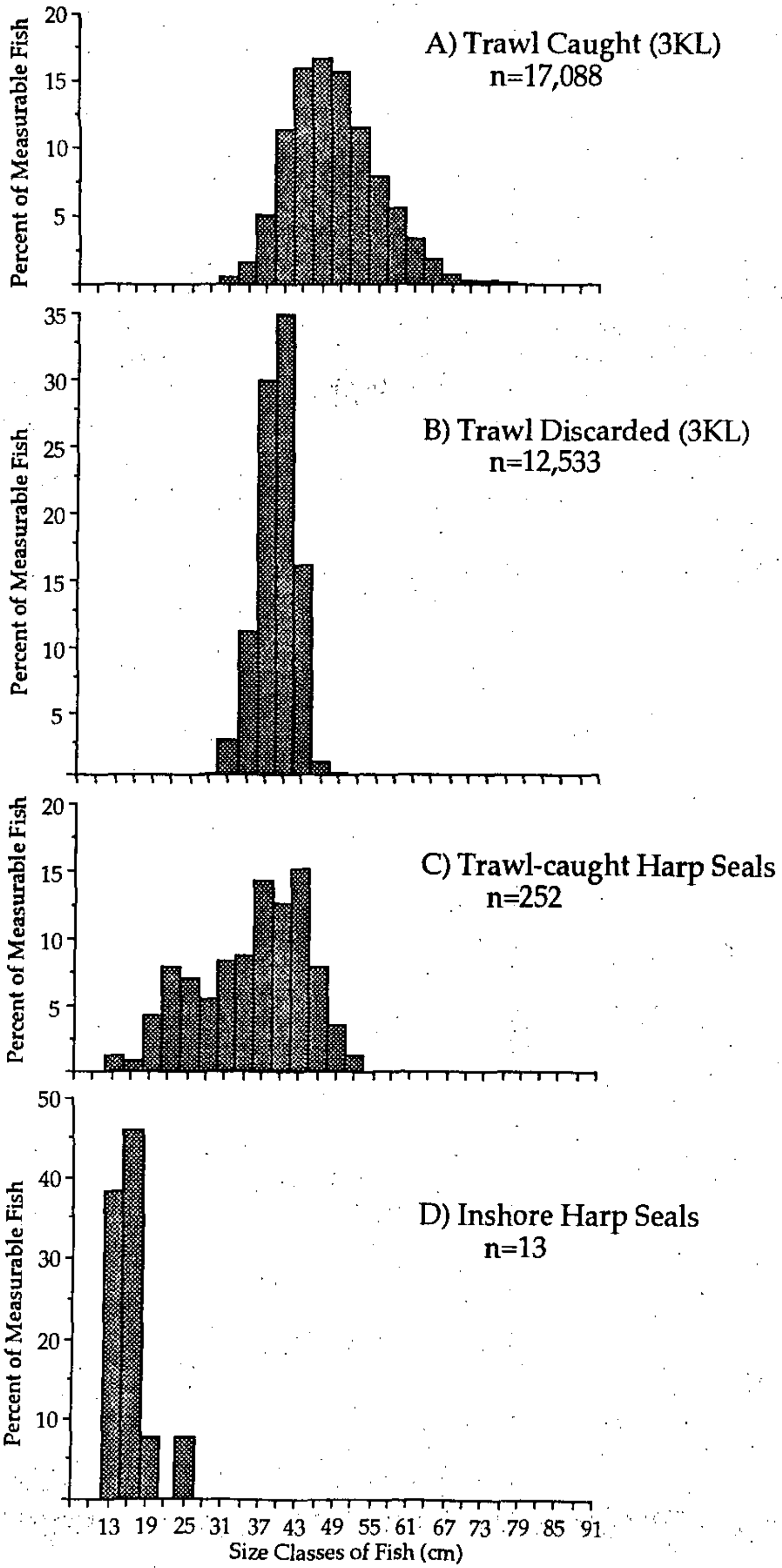

Figure 2: Length-frequency distributions of Atlantic cod caught in commercial, cod-directed trawls, harp seals caught in the nets of offshore, cod-directed trawls and harp seals caught in inshore areas in 2J3KL during 1992. n equals the number of cod measured.