ICES C.M. 1995 C.M. 1995/G:7

THE OCCURRENCE OF 0-GROUP COD AND HADDOCK AS BY-CATCH IN THE INSHORE SHRIMP SURVEYS IN ICELANDIC WATERS 1978-1994

By

U. Skúladóttir, and G. S. Bragason
Marine Research Institute, Skúlagata 4,
P. O. Box 1390,121 Reykjavik Iceland.

ABSTRACT

The paper deals with the question whether the occurrence of 0-group cod and haddock in Icelandic shrimp surveys is indicative of the year class strength of cod and haddock in the period 1978-1994.

The by-catch of 0-group cod and haddock has been reccorded in the annual autumn shrimp surveys (SMR) of some Icelandic fjords since 1978. The indices of 0-group cod and haddock in the SMR were compared to the indices of 0-group cod and haddock in the annual 0-group survey of Icelandic and East Greenland waters, which are carried out in August every year. The relationsship was not significant for neither of these species.

The present Icelandic Groundfish Survey series (SMB) started in 1985, and covers a shorter time span than both the 0-group fish survey and the SMR. The catch in number of 0-group cod, taken in the SMR, was found to be signficantly related to the indices of 1, 2, 3 and 4 year old cod, of the same year classes in the SMB ($p<0.001$). In comparison, the abundance indices from the 0-group survey were somewhat less significantly related to the indices of the SMB ($p<0.01$). The same was not true for haddock where the relationssships were usually not significant both those from the SMR and the 0-group survey as compared to the SMB abundance indices.

The relationship between the SMR indices and VPA estimates of the abundance of year class 1982-89(90) was marginally significant ($p<0.02$). But when the 1978-81 year classes of cod were included the relationship was not significant. This is probably due to overestimation of 0-group cod in the years 1978-81 by the SMR. The 0-group survey also gave high estimates in the years 1978-80 indicating overestimates or higher juvenile mortality than later. As compared to VPA estimates, the SMR indices for haddock gave a slightly better fit than indices from the 0-group survey.

INTRODUCTION

The first survey to assess the abundance and distribution of 0-group fish in Icelandic and adjacent waters was initiated by ICES as a multinational project in 1970. Since 1976 the 0-group fish surveys have been carried out by two Icelandic research vessels in August (Helgason and Sveinbjörnsson 1987).

Since 1973, shrimp surveys of Icelandc coastal waters have been carried out on a regular basis. It soon became evident that small gadoids could at times be very numerous in all of the fjords surveyed. In the years prior to 1968, the shrimp trawls were small and less effective than they are now (Skúladóttir 1970). Nevertheless, the by-catch of juvenile gadoids had become noticeable in Ísafjardardjup by 1968. As early as 1908 Sæmundsson pointed out that

Ísafjardardjup is an important nursery area for some commercial fish species (Sæmundsson 1908). Pálsson (1976) studied the biology and occurrence of juvenile cod, haddock and whiting in 7 surveys during the shrimp season of 1974-75 and observed a decrease in number with time. Inevitably, there have been conflicts between the different interests in the fishing industry regardng the use of a small meshed trawl (36-38 mm open mesh) on a nursery area for cod and haddock. Therefore besides, measuring the occurrence and abundance of shrimp, one of the aims of the annual autumn shrimp surveys has been to assess the number of young fish mainly cod and haddock, in the by-catch. Since 1978 when a new management scheme was enforced, it became neccessary to age aggregate the catch of juvenile gadoids (Pálson and Thorsteinsson 1985). The number of cod and haddock and weight of shrimp in each tow were entered into a model which was used in a calculation of whether the fjord could be opened without causing excessive mortalites of cod and haddock. The effect of gadoid mortalities was also weighted against the long-term loss in value if the shrimp fishery in the fjord were during a large part of the season.

Lately it has been found that the shrimp surveys in the autumn, which take place in September or October shortly after the 0-group survey, appear to give an indication of the year class strength of cod and haddock. During the many shrimp surveys, carried out since 1978 it has been found that particularily 0-group cod and haddock are caught along with the shrimp. On the other hand, the 1-group gadoids do not occur together with the shrimp to the same extent within an area, but may be found in large concentrations in the fjord, just outside the shrimp concentrations. As it has been variable whether the area of 1-group gadoids was surveyed or not, this paper only deals with the by-catch of 0-group gadoids.

In the following it is contemplated whether the shrimp surveys might provide useful forecasts of year class strength of cod and haddock. Several relationsships are tested. One of these is the relationship between SMR abundance indces and VPA estimates of year class size. Another relationship is that between the SMR and the SMB which has been run since 1985 in the same manner (Pálsson *et al* 1989). The SMB records the occurrence of all age groups of cod and haddock including one year olds.

Using bottom trawl, Pálsson (1984) attempted to assess the occurrence of juvenile cod at ages 1-4 in the years 1976-1984. Since these investigations were based on short series of data and the indices could not be linked easily to the SMB, no attempt has been made to link the indices of SMR to Pálson's series.

Other authors have reanalyzed the calculation of the original 0-group indices using the method of Randa (1983), (Helgason and Sveinbjörnsson, 1987; Ásthorsson *et al* 1994). The resulting indices were not much different from those using the original assessment method and are not considered in this paper.

MATERIAL AND METHODS

SHRIMP SURVEYS (SMR)

The gear used was a shrimp trawl of 1000 meshes, the so called Vestfirdingur. The codend had diamond mesh and the mesh size was about 37 mm open mesh. In the SMR the cod and haddock were first measured to determine which of the fish belonged to age group 0-, 1- and 2-group. The numbers per tow of each age group were then reccorded along with the towing time. The average number of cod per trawling hour (No./tr.hr.) was calculated by summing the total number of 0-group cod/haddock for the complete survey of a fjord and divided by trawling hours (*i.e.* pooled mean). The trawling speed was approximately 2 nautical. miles per hour. It would have been possible to calulate indices by using the area swept method, but this was not done. Instead, the area of each fjord was used to weigh together 2 and 4 fjords respectively. The area chosen was the area assessed after standarization of the SMR for Arnarfjordur, Ísafjardardjup, Hunafloi and Axarfjordur in 1988.

0-GROUP SURVEYS

The 0-group indices were taken from the annual 0-group survey reports (pelagic trawl) since 1978 (ICES. 1979, ICES. 1980, Vilhjálmsson et al 1980, Vilhjálmsson and Magnússon 1981, 1982, 1983, 1984, 1985 and 1986, Magnússon *et al* 1987, 1988 and 1989. Magnússon and Sveinbjörnsson 1990, 1991, 1992, 1993 and 1994). The indices were calculated by using stratified catch in number per nautical mile towed as described by Vilhjálmsson and Fridgeirsson (1976). In this paper the total index for Icelandic waters and East Greenland combined has been used.

GROUNDFISH SURVEY (SMB)

The indices are from the annual SMB survey in March and are calculated by two different methods. The cod indices (Gamma Bernoulli, Stefánsson, 1991) for the years 1985-1995 are from Pálsson (pers. comm.). The haddock indices (Cochran) for the years 1985-1994 are from Jónsson *et al.* (1994) and the haddock index of 1995 is from Pálsson (pers. comm.).

VIRTUAL POPULATION ANALYSIS (VPA)

The VPA indices are from Anon. (1995). These are back-calculated numbers of 3 year old cod and 2 year old haddock, using the VPA method.

RESULTS

The shrimp surveys considered in this paper were carried out annually in the four fjords shown in Figure 1. The results of these surveys are listed in Table 1. Sometimes two surveys were carried out in the same autumn especially of Ísafjardardjup, *i.e.* in 1978, 1979, 1981, 1983, 1984 and 1985. In these cases only the first survey was used.

The number of 0-group cod per tr. hr in the SMR is listed in Table 2 for each area, together with the area of each fjord in km^2. Table 2 also gives the results when two or four fjords are combined, presented as mean number of cod per hour, weighted by area. In 1986 there was no survey of Axarfjordur and that area was therefore omitted in the combination of all fjords in that year.

Noteworty is the large number of 0-group cod in the years 1978 through 1981. Of these, 1978 is of special interest since there were large numbers of cod in all 4 fjords. Furthermore, there were large numbers of cod, both in Arnarfjordur and Axafjordur, in 1980. Table 3 is similar to Table 2, but gives data on 0-group haddock instead of cod. With the exception of 1985 the occurrence of haddock has been rather sporadic in Arnarfjordur. In Axarfjordur there is also considerable variation in the numbers of haddock. In 1990, there were high numbers of haddock in all four fjords, and the average No./tr. hr. was 706 for two areas combined and 605 for all 4 areas combined.

The number of cod taken in other surveys and the number of three year olds from the VPA are listed in Table 4. The annual distribution and relative density of cod in the 0-group surveys of 1978-1993 are shown in Figures. 5, 6, 7, and 8. The distribution and relative density of haddock in the years 1978-1993 is shown in Figures. 9, 10, 11 and 12.

As in the SMR, the number of 0-group cod was high in the years 1978-1980. However the highest number of cod was taken in the 1984 0-group survey, or 1772 per naut. mile towed. Numbers were also very high in 1985, or 812 cod per naut. mile. Table 4 also gives the results of the VPA assessment of the abundance of 3 year old cod (Anon, 1995). The 1983 and 1984 year classes appear the strongest, numbering 335 and 277 million cod respectively. Finally, Table 4 gives the number of cod assessed by the SMB as 1, 2, 3 and 4 year olds respectively. The SMB assessments are given for the northern area as well as the northern and southern

areas combined. Usually, most of the cod is found in the northern area until age 4. in comparison, a smaller proportion of haddock is found in the northern area in the SMB surveys. Table 5 gives similar results for haddock as given in Table 4 for cod.

In order to investigate whether the SMR could be used as an early assessment of the year class strength of either cod or haddock, a number of regressions were fitted comparing results of the SMR to those of other surveys and finally to the number of three/two year old cod/haddock as assessed by VPA (see Tables 6, 7 and Fig. 3 for cod and Tables 8, 9 and Fig. 4 for haddock). These tables also give the correlation coefficient r as well as the numer of years used. The comparison of 0-group cod in the SMR with the number of cod in the SMB as either 1, 2, 3 or 4 year olds (same year classes) was always highly significant, ($p<0.001$). This was irrepective of whether there were 2 or 4 areas combined in the shrimp surveys, or whether just the northern area in SMB or the number of cod in all of the SMB was used (*e.g.* Fig. 3, D).

A comparison of the 0-group survey results with the SMB estimate for cod was slightly less significant ($p<0.01$) in most cases, despite the fact that the 0-group survey covers a much larger area than the SMR (*e.g.* Fig. 3, B). Table 7 gives the results of fitting regressions between the SMR results and the year class strength of cod from VPA. The relationships were not significant when anywhere from 10 to 13 year classes were fitted (e.g. Fig. 3, C). It was only when data on the year classes from 1982 onwards were compared, that the results were marginally significant, *i.e.* using 8 or 9 year classes only (Fig 3, E). The 0-group survey did not give a better prognosis of the year class strength of cod as estimated by the VPA than the SMR for the same period (e.g. Fig. 3, A). Finally, the 0-group survey (pelagic trawl), which takes place about a month before the shrimp survey (bottom trawl), did not show a significant relationship when the year classes 1978-81 were included (Fig. 3, F). However a shorter series of between 10 and 13 years was significant.

The distribution of cod in the 0-group survey is shown in Figures 5, 6, 7 and 8 for the years 1978-1993. Usually, the highest densities of 0-group cod are found in the north Icelandic area near to the coast. In Figure 3 F there are noteable outliers, *e.g.* the 1978 year class of cod which was very rich in the SMR but not in the 0-group survey. The case of the 1980 year class is even worse. This is the largest year class in the SMR but simlar to the 1978 estimate of the 0-group survey. Figure 5 shows that there are large densities near 3 of the fjords where the SMR takes place both in 1978 and 1980. Furthermore the 1984 year class of cod was vastly overestimated in both the SMR and the 0-group surveys (Fig. 3 F). In the 1984 0-group survey the highest densities of 0-group cod were recorded quite near Hunafloi and Axarfjordur (Fig. 6) and these fjords were also very rich in cod in the SMR of that year (Table 1). The 1983 year class appears to be better estimated by the SMR than by the 0-group survey, althouh it was much less numerous than the year classes of 1978, 1980 and 1981 as estimated by the SMR (Fig 3, A and C).

The estimates of 0-group haddock in the SMR have also been compared to the results of the SMB (Table 8, Fig. 4 D). In contrast to the cod, there is a much lower proportion of young haddock found in the northern area (Table 5). The relationsship between the 0-group haddock in the SMR and SMB is rarely significant. The results of the 0-group survey do not fare much better and the relationship is only occasonally significant. It appears that the strong 1990 year class of haddock is better estimated by the SMR than the 0-group survey (Fig. 4, B and D).

Judging by the relationship between haddock abundance in the SMR and VPA estimates, SMR appears to give a better forecast than the 0-group survey (Table 9, Fig. 4, A and C). We especially note the underestimate in the 0-group survey of both the strongest year classes of 1985 and 1990, and the possible overestimate of the 1978 year class. From Figure. 10 it is evident that the largest concentration of haddock was recorded near the northwest coast in the 0-group surveys. It is, therefore, not surprising that there were large numbers of haddock in Arnarfjordur and Ísafjardardjup in the SMR (Table 1 and 3). The absence of

large concentrations of 0-group haddock in the 1990 0-group survey (Fig. 12) is more surprising since there were large numbers of 0-group haddock in all 4 fjords in the SMR. Is it possible, however, that the 0-group haddock had left the pelagic state at an early date in that year.

The SMB is extremely well suited for forecasting the size of haddock year classes if the VPA estimates are considered to be the best estimates. The relationships were always highly significant when comparing indices of 1, 2, 3 or 4 year olds to 2 year olds from the VPA (Table 9). Finally, the 0-group survey indices were fitted against the 0-group indices of SMR (Table 9, Fig 4, E and F). There was no significant relationsship whatever number of years was used. It would appear, however, that when the years 1978-1984 were omitted, and only the year classes of 1985-1994 were used, there was an improved, although not significant, fit ($r = 0.586$).

DISCUSSION

First of all, one may speculate whether just one index per fjord should be used from the SMR when there were two surveys carried out. According to Pálsson (1976), when studying the occurence of 0-group gadoids in Ísafjardardjup during the shrimp season (7 surveys), it seemed that most of the cod would be in shallower waters than the shrimp survey covered (< 20 fm) until late in October. On the other hand, the haddock in Pálsson's study were at all times at the same depth as the shrimp. In the present study it was variable whether numers per trawling hour for cod and haddock increased or decreased from the first to the second survey in the SMR. This seemed to be irrespective of whether the survey took place in early September or early October. The variation seems to be subject to different catchability or movement of the gadoids.

At first sight, the SMR would seem to give a reasonable forecast for the year class strength of cod, especially if one looks at the relationship between 0-group cod in the SMR and indices from the SMB. On the other hand, if the indices of cod from the SMR are regressed against the indices of VPA for all the year classes 1978-1990 there was no fit. The SMB indices appear to be best suited for forecasting year class strength of cod as calculated by the VPA. But it should be pointed out that the results of the SMB have been used along with catch/effort data from the trawler fleet to tune the VPA (ICES, 1994). Therefore the 1990 and 1989 year classes should probably not be used in the relationship. Although a comparison of the 0-group survey against the VPA for the period 1978-1990 does not show a significant relationship, the relationship for the whole period 1970-1991 shows a highly significant relationship $p<0.001$ (Asthorsson, 1994).

Apparently the 0-group cod were particularily abundant in all 4 fjords in the years 1978-1981. The high indices in the SMR in the years 1978-1981 could be due to a bias, induced by the dispersion of the 0-group cod. In that case, the densities in the four fjords investigated may be representative of a more general distribution of 0-group cod in shallow water in later years, but not in the period 1978-1981 where there could have been high densities of cod in those four fjords and lower elsewhere. It must be pointed out that the number of stations in Axarfjordur were comparatvely few in the years 1978-1983. Thus, the high density of 3572 0-group cod per tr. hr. in Axarfjordur in 1980 may have been an overestimate. On the other hand, a high density of 0-group cod was also found in the neighbourhood of Axarfjordur during the 0-group survey of the same year (Fig 5). The occurrence of high densities of 0-group cod in those years in the SMR, is supported by fairly high indices in the 0-group surveys in 1978-1980. However, it is possible that there were mass mortalites of juvenile cod in those years.

It can be speculated whether the inshore shrimp fishery took a large toll of the 0-group cod in the early years. Pálsson (1976) calculated that there were 636 0-group cod per trawling hour in the first survey in late September 1974 in all of Isafjardardjup. In the second survey (first week of October) there were 957 0-

group cod per tr. hr. After that, the codlings gradually moved from the inner to the outer reaches of the fjord. By December, their numbers had decreased greatly and in the 7th survey in the second week of February 1975, the 0-group cod had been reduced to 179 per tr. hr. Pálsson also calculated the number of 0-group cod caught by the shrimp trawl in the shrimp season 1974/75 and estimated how much this cod would weigh if allowed to grow to an average fishable size. This was found to be equivalent to 1250 tonnes of cod some years later. Pálsson also calculated that in Ísafjardardjup the shrimp fishery of 2300 tonnes during the season 1974/75 reduced the 1974 year class of cod by 4.7% and the 1974 year class of haddock by 8.6%. For comparison the shrimp catch was 4900-6400 tonnes per annum durng the years 1978-1981 (5400 tonnes on average) in the four fjords. The shrimp fishery can, therefore, not explain this large reduction in year class strength. Because of the apparent migration of 0-group cod and haddock away from the distribution area of shrimp in the fjord by December-January, it was considered possible that these juvenle fish could be largely spared if there was no shrimp fishery untill in the beginning of January. While the shrimp fishery was banned in Arnarfjordur and Ísafjardardjup in October-December in the season 1978/79, the shrimp fishery was still unlimited in Hunafloi and Axarfjordur where just as many 0-group cod were found. The reason for this was that according to the management scheme the much higher shrimp catches in Hunafloi and Axarfjordur counterbalanced the high numbers of 0-group cod, *i.e.* resulted in acceptable number of cod and haddock (0-group, 1-group and eventual 2-group) per 1000 kg of shrimp. During the following three winters there was quite often a months delay in opening the fjords to the shrimp fishery, or a fjord was opened for fishery while areas containing the highest densities of 0-group cod within that fjord were closed for considerable time. During the 1980/81 season Arnarfjordur was thus closed untill January. In later years, closures of limited areas were also practised , *i.e.* in the autumn of 1983, 1985 and finally in 1988, usually because of 0-group cod but occasionally because of 0-group haddock.

In the 1988/89 season the square mesh was introduced in the shrimp fishery. Fishing gear experiments had shown that this lowered the number of haddock in the catch substantially, or by 63% (Thorsteinsson, 1992). The 0-group cod were almost absent durng the fishing trials and, consequently, the escape of 94% in autumn 1988 is possbly not representative. There was an escape of 72% of the 1-group cod in an experiment in March 1990 but none of haddock, which is generally larger than cod at this age. A later trial in October 1992, when 0-group cod were more numerous than in 1990, showed that 72% of 0-group cod escaped through the square mesh as compared to the diamond mesh and 67% of the haddock (Thorsteinsson, pers. comm.). Since the introduction of square mesh in 1989, the mortalites of juvenile cod and haddock in the inshore shrimp fishery is thus considered to have been greatly reduced.

The SMB is by far the most important survey in forecasting year class strength of haddock as calculated by the VPA. The SMR shows a significant relationship for the whole period (13 years). whereas the 0-group survey alone is of little use. In the 0-group survey data the worst outliers are the indices of the 1985 and 1990 year classes of haddock. Since the SMR gave high indices for these year classes, it is quite possible that a combination of these 2 surveys might improve the forecast for year class stength of haddock. This should be studied further in the future.

ACKNOWLEDGEMENTS

The surveys in the period 1978-1987 were mainly conducted by Ingvar Hallgrímsson. In later years the scientists in charge were, besides the authors, Jónbjörn Pálsson and Stefán Brynjólfsson. The authors also wish to the thank the crew of the research vessel Dröfn for their assistance in the field work as well as the crews of several local shrimp boats who have given us use of their boats and

time to do surveys when r/s Dröfn could not cover all the inshore area. Among those are f/v "Jörundur Bjarnason" of Arnarfjordur, "Haukur Bödvarsson" of Ísafjardardjup, "Hafrun" of Hunafloi and "Skálaberg", "Thingey" and "Thorsteinn" of Axarfjordur.

REFERENCES

Anon., 1995. State of marine stocks in Icelandic waters 1994/95. (Prospects for the quota year 1995/96. In Icelandic, English summary). Fjölrit No. 43.

Ásthórsson, Ó. S., Á. Gíslason and Á. Gudmundsdóttir 1994. Distribution, abundance, and length of pelagic juvenile cod in Icelandic waters in relation to environmental conditions. ICES mar. Sci. Symp., 198: 529-541.

Helgason, V., and Sveinbjörnsson, S. 1987. Revised indices of cod abundance in 0-group surveys in the Iceland-East Greenland area 1970-1986. ICES C.M. Doc., No. G:59. 12 p. mimeo.

ICES, 1979. Report on the 0-group survey in Iceland and East Greenland waters, August-September 1979. ICES C.M. Doc., No. H: 31. 9 p. mimeo.

ICES, 1980. Report on the 0-group survey in Iceland and East Greenland waters, August-September 1978. Annls biol., Copenh., 32: 258-267.

ICES, 1994. Report on the North-Western working group. ICES C.M. Doc., No. Assess: 19. 337 p. mimeo.

Jónsson, E., Steinarsson, B. AE. , Jónsson, G., Stefánsson, G. Pálsson, Ó. K. and Schopka, S. A. 1994. Stofnmæling botnfiska á Íslandsmiðum 1994. (Icelandic groundfish survey 1994. In Icelandic). Fjölrit No. 42. 107 p.

Magnússon, J., and Sveinbjörnsson, S. 1990. Report on the 0-group survey in Iceland and East Greenland waters, August-September 1990. ICES C.M. Doc., No. G:68. 7 p. mimeo.

Magnússon, J., and Sveinbjörnsson, S. 1991. Report on the 0-group survey in Iceland and East Greenland waters, August-September 1991. ICES C.M. Doc., No. G:80. 20 p. mimeo.

Magnússon, J., and Sveinbjörnsson, S. 1992. Report on the 0-group survey in Iceland and East Greenland waters, August-September 1992. ICES C.M. Doc., No. G:50. 19 p. mimeo.

Magnússon, J., and Sveinbjörnsson, S. 1993. Report on the 0-group survey in Iceland and East Greenland waters, August 1993. ICES C.M. Doc., No. G: 67: 18 p. mimeo.

Magnússon, J., and Sveinbjörnsson, S. 1994. Report on the 0-group survey in Iceland and East Greenland waters, August 1994. ICES C.M. Doc., No. G: 45. 19 p. mimeo.

Magnússon, J., and Sveinbjörnsson, S. and Helgason, V. 1987. Report on the 0-group fish survey in Iceland and East Greenland waters, August 1987. ICES C.M. Doc., No. G: 60. 17 p. mimeo.

Magnússon, J., and Sveinbjörnsson, S. and Helgason, V. 1988. Report on the 0-group fish survey in Iceland and East Greenland waters, August 1988. ICES C.M. Doc., No. G: 69. 17 p. mimeo.

Magnússon, J., and Sveinbjörnsson, S. and Helgason, V. 1989. Report on the 0-group fish survey in Iceland and East Greenland waters, August-September 1989. ICES C.M. Doc., No. G: 52. 6 p. mimeo.

Pálsson, Ó. K. 1976. Um líffræði fiskungviðis í Ísafjarðardjúpi. (On the biology of juvenile fish in an Icelandic fjord. In Icelandic, English summary). Hafrannsóknir, 8: 5-56.

Pálsson, Ó. K. 1984. Studies on recruitment of cod and haddock in Icelandic waters. ICES C.M. Doc., No. G: 6. 18 p. mimeo.

Pálsson, Ó. K., and Thorsteinsson, G. 1985. The management of juvenile fish by-catch in an Icelandic shrimp fishery. ICES C.M. Doc., No. K: 47. 19 p. mimeo.

Pálsson, Ó. K., Jónsson, E., Schopka, S. A., Stefánsson, G. and Steinarsson, B.Æ. 1989. Icelandic groundfish survey data used to improve precision in stock assessments. J. Northw. Atl. Fish. Sci. 9: 53-72.

Skúladóttir, U., 1970. The deep-sea (Pandalus borealis) fisheries in Icelandic waters. ICES C.M. Doc., No. K: 15. 11 p. mimeo.

Stefánsson, G. 1991. Analysis of groundfish survey data: Combining the GLM and delta approaches. ICES C.M. Doc., No. D: 9. 11 p. mimeo.

Sæmundsson, B. 1908. Fiskirannsóknir 1908. Rannsóknir á Vesturlandi 1908. Andvari, 43:114-148.

Thorsteinsson, G. 1992. The use of square mesh codends in the Icelandic shrimp (*Pandalus borealis*) fishery. Fisheries Research, 13: 255-266.

Vilhjálmsson, H., and Fridgeirsson, E. 1976. A review of 0-group surveys in the Icelandi and East Greenland waters in the years 1970-1975. Coop. Res. Rep. 54 ICES.

Vilhjálmsson, H., and Magnússon, J. 1981. Report on the 0-group survey in Iceland and East Greenland waters, August 1981. ICES C.M. Doc., No. H: 41. 11p. mimeo.

Vilhjálmsson, H., and Magnússon, J. 1982. Report on the 0-group survey in Iceland and East Greenland waters, August 1982. ICES C.M. Doc., No. H: 63. 26p. mimeo.

Vilhjálmsson, H., and Magnússon, J. 1983. Report on the 0-group survey in Iceland and East Greenland waters, August 1983. ICES C.M. Doc., No. H: 38. 26p. mimeo.

Vilhjálmsson, H., and Magnússon, J. 1984. Report on the 0-group survey in Iceland and East Greenland waters, August 1984. ICES C.M. Doc., No. H: 66. 26p. mimeo.

Vilhjálmsson, H., and Magnússon, J. 1985. Report on the 0-group survey in Iceland and East Greenland waters, August 1985. ICES C.M. Doc., No. H: 75. 22p. mimeo.

Vilhjálmsson, H., and Magnússon, J. 1986. Report on the 0-group survey in Iceland and East Greenland waters, August 1986. ICES C.M. Doc., No. H: 74. 19p. mimeo.

Vilhjálmsson, H., and Magnússon, J., and Fridgeirsson, E. 1980. Report on the 0-group fish survey in Iceland and East Greenland waters, August 1980. ICES C.M. Doc., No. H: 64. 11p. mimeo.

Table 1. The mean number of cod and haddock per trawling hour in the autumn shrimp surveys are listed by area along with other useful data.

	Arnarfjordur		Ísafjardardjup		Hunafloi		Axarfjordur	
	Cod	Haddock	Cod	Haddock	Cod	Haddock	Cod	Haddock
22/9-4/10 1978								
Number of stations	14	14	27	27	20	20	5	5
Trawling hours Σ	9.64	9.64	20.53	20.53	9.75	9.75	2.75	2.75
Mean number per tr. hour	1769.9	74.0	1201.8	347.7	1235.5	236.0	1876.4	1296.4
14/10-23/10 1978								
Number of stations			37	37	21	21		
Trawling hours Σ			26.98	26.98	15.84	15.84		
Mean number per tr. hour			1572.7	682.1	1685.2	157.4		
12/9-28/9 1979								
Number of stations	14	14	34	34	30	30	7	7
Trawling hours Σ	10.58	10.58	26.17	26.17	15.08	15.08	5.58	5.58
Mean number per tr. hour	3.0	0.1	324.5	249.8	984.2	13.9	93.9	10.0
26/10-6/11 1979								
Number of stations			30	30				
Trawling hours Σ			19.42	19.42				
Mean number per tr. hour			93.2	71.9				
9/9-28/9 1980								
Number of stations	13	13	35	35	21	21	9	9
Trawling hours Σ	9.92	9.92	25.90	25.90	15.92	15.92	6.75	6.75
Mean number per tr. hour	7693.1	5.0	1297.0	346.3	156.4	42.0	3572.4	452.9
6/9-3/10 1981								
Number of stations	11	11	37	37	20	20	6	6
Trawling hours Σ	7.58	7.58	28.80	28.80	14.30	14.30	5.00	5.00
Mean number per tr. hour	86.7	12.4	1482.4	570.7	346.7	195.7	3.8	36.8
7/10-10/10 1981								
Number of stations			24	24				
Trawling hours Σ			18.80	18.80				
Mean number per tr. hour			786.9	540.5				
9/9-30/9 1982								
Number of stations	11	11	35	35	20	20	7	7
Trawling hours Σ	9.20	9.20	27.80	27.80	14.90	14.90	5.30	5.30
Mean number per tr. hour	8.3	0.0	96.8	64.6	1.1	2.3	171.0	266.3
10/9-29/9 1983								
Number of stations	13	13	35	35	22	22	7	7
Trawling hours Σ	7.80	7.80	27.75	27.75	23.30	23.30	6.60	6.60
Mean number per tr. hour	44.4	0.0	703.5	59.8	586.1	10.6	14.3	9.9
30/10-9/11 1983								
Number of stations			27	27				
Trawling hours Σ			21.67	21.67				
Mean number per tr. hour			1283.3	79.4				
1/9-3/10 1984								
Number of stations	7	7	33	33	23	23	30	30
Trawling hours Σ	4.90	4.90	27.75	27.75	16.60	16.60	25.40	25.40
Mean number per tr. hour	124.8	0.0	414.3	206.8	910.9	109.7	107.2	55.1

Table 1 continued

	Arnarfjordur		Ísafjardardjup		Hunafloi		Axarfjordur	
	Cod	Haddock	Cod	Haddock	Cod	Haddock	Cod	Haddock
21/10-27/10 1984								
Number of stations			42	42				
Trawling hours Σ			39.25	39.25				
Mean number per tr. hour			65.0	415.5				
6/9-4/10 1985								
Number of stations	7	7	58	58	25	25	27	27
Trawling hours Σ	6.50	6.50	48.67	48.67	14.17	14.17	13.67	13.67
Mean number per tr. hour	883.1	1631.4	708.9	640.8	123.2	51.4	5.9	64.7
14/10-23/11 1985								
Number of stations	19	19	40	40			50	50
Trawling hours Σ	15.60	15.60	35.83	35.83			30.83	30.83
Mean number per tr. hour	479.8	240.1	441.6	621.4			25.3	93.7
2/10-16/10 1986								
Number of stations	14	14	45	45	22	22		
Trawling hours Σ	11.00	11.00	32.00	32.00	15.25	15.25		
Mean number per tr. hour	18.1	22.4	148.2	317.8	123.4	211.6		
1/10-30/10 1987								
Number of stations	16	16	52	52	45	45	6	6
Trawling hours Σ	12.00	12.00	38.80	38.80	33.33	33.33	6.67	6.67
Mean number per tr. hour	16.4	199.1	371.0	855.6	183.7	51.6	8.8	35.5
28/9-3/11 1988								
Number of stations	22	22	54	54	55	55	20	20
Trawling hours Σ	20.75	20.75	52.42	52.42	15.55	15.55	14.08	14.08
Mean number per tr. hour	30.4	52.3	149	951.3	118.8	175.5	96.9	76.3
6/9-18/10 1989								
Number of stations	22	22	54	54	37	37	10	10
Trawling hours Σ	20.33	20.33	51.75	51.75	30.30	30.30	11.50	11.50
Mean number per tr. hour	46.3	39.6	309.1	746.7	102.0	269.5	8.6	2.3
27/9-24/10 1990								
Number of stations	22	22	54	54	38	38	18	18
Trawling hours Σ	20.35	20.35	49.38	49.38	24.63	24.63	13.90	13.9
Mean number per tr. hour	45.9	229.5	70.6	837.4	43.9	543.2	4.1	415.2
1/10-27/10 1991								
Number of stations	22	22	54	54	38	38	17	17
Trawling hours Σ	20.48	20.48	50.13	50.13	31.06	31.06	11.00	11.00
Mean number per tr. hour	7.8	29.3	14.8	155.3	7.9	348.5	3.0	197.7
18/9-17/10 1992								
Number of stations	22	22	54	54	38	38	18	18
Trawling hours Σ	20.22	20.22	47.77	47.77	27.55	27.55	13.28	13.28
Mean number per tr. hour	38.1	35.8	568.3	196.5	35.6	10.2	0.0	0.0
21/9-12/10 1993								
Number of stations	22	22	54	54	38	38	17	17
Trawling hours Σ	20.07	20.07	49.47	49.47	29.76	29.76	13.95	13.95
Mean number per tr. hour	36.1	0.7	584.4	795.7	532.3	201.8	4.0	48.7
13/9-16/10 1994								
Number of stations	22	22	54	54	38	38	17	17
Trawling hours Σ	20.07	20.07	51.78	51.78	33.92	33.92	14.38	14.38
Mean number per tr. hour	0.2	0.2	8.8	14.5	154.9	79.6	238.5	295.0

Table 2. The number of cod per trawling hour by areas from the first shrimp survey in autumn every year. Also presented are the weighted averages by area of two or four areas respectively. The area for each fjord is presented at the bottom of the table.

	Arnarfjordur	Ísafjardardjup	Hunafloi	Axarfjordur	Isafjardard. & Hunafloi weighted together	All fjords weighted together
1978	1769.9	1201.8	1235.5	1876.4	1216.8	1392.5
1979	3.0	324.5	984.2	93.9	618.6	461.2
1980	7693.0	1297.0	156.4	3572.4	788.6	1988.0
1981	86.7	1482.4	346.7	3.8	976.1	709.7
1982	479.8	96.8	1.1	171.0	54.1	118.1
1983	44.4	703.5	586.1	14.3	651.2	474.3
1984	124.8	414.3	910.9	107.2	635.7	488.1
1985	883.1	708.9	123.2	5.9	447.8	410.9
1986	18.1	148.2	123.4		137.1	122.7
1987	16.4	371.0	183.7	8.8	287.5	209.5
1988	30.4	149.0	118.8	96.9	135.5	118.0
1989	46.3	309.1	102.0	8.6	216.8	161.7
1990	45.9	70.6	43.9	4.1	58.7	47.5
1991	7.8	14.8	7.9	3.0	11.7	9.7
1992	38.1	568.3	35.6	0.0	330.8	241.2
1993	36.1	584.4	532.3	4.0	561.2	407.0
1994	0.2	8.8	154.9	238.5	73.9	96.5
Square km	94	373	300	171	673	938

Table 3. The number of haddock per trawling hour by areas from the first shrimp survey in autumn every year. Also presented are the weighted averages by area of two or four areas respectively. The area for each fjord is presented at the bottom of the table.

	Arnarfjordur	Ísafjardardjup	Hunafloi	Axarfjordur	Isafjardard. & Hunafloi weighted together	All fjords weighted together
1978	74.0	347.7	236.0	1296.4	297.9	457.5
1979	0.1	249.8	13.9	10.0	144.6	105.6
1980	5.0	346.3	42.0	452.9	210.7	234.2
1981	12.4	570.7	195.7	36.8	403.5	297.5
1982	0.0	64.6	2.3	266.3	36.8	75.0
1983	0.0	59.8	10.6	9.9	37.9	29.0
1984	0.0	206.8	109.7	55.2	163.5	127.4
1985	1631.4	640.8	51.4	64.7	378.1	446.5
1986	22.4	317.8	211.6		270.5	240.1
1987	199.1	855.6	51.6	35.5	497.2	383.2
1988	52.3	951.3	175.5	76.3	605.5	453.6
1989	39.6	746.7	269.5	2.3	534.0	387.5
1990	229.5	837.4	543.2	415.2	706.3	605.4
1991	29.3	155.3	348.5	197.7	241.4	212.2
1992	35.8	196.5	10.2	0.0	113.5	85.0
1993	0.7	795.7	201.8	48.7	531.0	389.9
1994	0.2	14.5	75.6	295.0	41.7	83.7
Square km	94	373	300	171	673	938

Table 4. The assessed number of cod per nautical mile by the 0-group survey. Results from the virtual population analysis (VPA) and the results from the groundfish survey (SMB). The SMB indices are calculated by Gamma Bernoulli method. The indices are allways numbers in millions except for the 0-group survey. All results are put on the year of hatching although estimated up to 4 years later.

	ALL AREAS						NORTH AREA			
Year/Survey, VPA	0-group survey	VPA Age 3	SMB Age 4	SMB Age 3	SMB Age 2	SMB Age 1	SMB Age 4	SMB Age 3	SMB Age 2	SMB Age 1
1978	551.6	143.3								
1979	369.6	133.6								
1980	557.7	226.3								
1981	78.0	139.1	57.21				54.83			
1982	10.3	144.0	23.87	35.35			22.07	34.53		
1983	152.6	335.5	85.42	86.2	36.99		79.75	82.61	36.31	
1984	1772.0	277.5	103.95	95.66	55.60	17.11	90.56	91.88	53.93	16.78
1985	812.0	168.3	79.87	68.60	25.66	13.55	69.56	65.64	25.22	13.29
1986	50.0	81.5	9.85	17.86	5.63	2.70	8.06	16.74	5.47	2.65
1987	81.0	130.3	25.20	19.11	15.81	1.91	21.72	18.15	15.07	1.70
1988	20.0	98.1	17.82	17.25	11.82	2.05	16.06	15.94	11.63	1.93
1989	41.0	176.9	40.98	37.57	15.25	3.75	33.63	34.87	14.54	3.50
1990	37.0	182.8	23.99	31.81	22.09	1.95	18.00	26.85	20.69	1.75
1991	6.0		6.10	6.96	2.98	0.30	4.17	5.78	2.33	0.23
1992	42.0			20.12	12.25	1.69		17.39	10.97	1.32
1993	155.0				29.75	9.52			28.64	8.58
1994	74.0					0.64				0.49

Table 5. The assessed number of haddock per nautical mile by the 0-group survey. Results from the virtual population analysis (VPA) and the results from the groundfish survey (SMB). The SMB indices are calculated by Cochran method. The indices are allways numbers in millions except for the 0-group survey. All results are put on the year of hatching although estimated up to 4 years later.

	ALL AREAS						NORTH AREA			
Year/Survey, VPA	0-group survey	VPA Age 3	SMB Age 4	SMB Age 3	SMB Age 2	SMB Age 1	SMB Age 4	SMB Age 3	SMB Age 2	SMB Age 1
1978	116.2	36.3								
1979	11.1	9.7								
1980	63.8	41.7								
1981	11.8	29.8	23.2				7.6			
1982	2.0	19.7	15.6	20.8			9.5	11.0		
1983	24.6	41.3	54.6	66.3	41.4		30.8	35.7	24.9	
1984	71.0	88.3	95.7	163.9	131.5	39.9	57.5	114.0	74.8	25.4
1985	50.0	165.7	156.0	186.3	233.9	122.7	45.7	89.9	103.7	34.4
1986	19.0	46.7	44.5	46.4	45.8	24.9	13.2	20.3	20.6	12.0
1987	4.0	26.4	18.9	31.6	25.3	16.1	5.3	16.9	10.6	9.5
1988	19.0	23.0	36.0	43.6	33.2	14.2	20.0	22.3	24.9	11.2
1989	23.0	84.8	102.1	133.6	161.5	83.7	42.4	94.6	90.7	36.1
1990	21.0	170.6	183.2	305.3	245.9	105.3	78.8	160.2	146.6	55.6
1991	5.0		26.8	43.3	43.0	22.5	13.3	20.2	18.1	10.8
1992	5.0			53.1	64.1	31.4		13.6	10.3	5.8
1993	20.0				81.6	67.0			16.2	14.5
1994	3					39.3				7.6

Table 6. The results of simple regressions for the assessed number of cod in various surveys. In the shrimp surveys only the o-group cod is used. The number of cod of the same year-class is put as x- and y-value from the respective surveys each year where the x -value comes from the survey stated in the first column and the y-value from the survey in the second column. The two areas combined in the shrimp surveys are Ísafjardardjup and Hunaflói (Fig.1).

cod

Survey	Survey	year-classes	Number of years	Correlation r	Significant at
Shrimp survey 4 areas	SMB north area1 year old	84-94	11	0.902	p=0.001
Shrimp survey 4 areas	SMB all areas 1 year old	84-94	11	0.913	p=0.001
Shrimp survey 4 areas	SMB north area 2 year old	83-93	11	0.840	p=0.001
Shrimp survey 4 areas	SMB all areas 2 year old	83-93	11	0.834	p=0.001
Shrimp survey 4 areas	SMB north area 3 year old	82-92	11	0.903	p=0.001
Shrimp survey 4 areas	SMB all areas 3 year old	82-92	11	0.898	p=0.001
Shrimp survey 4 areas	SMB north area 4 year old	81-91	11	0.832	p=0.001
Shrimp survey 4 areas	SMB all areas 4 year old	81-91	11	0.802	p=0.01
Shrimp survey 2 areas	SMB north area1 year old	84-94	11	0.859	p=0.001
Shrimp survey 2 areas	SMB all areas 1 year old	84-94	11	0.873	p=0.001
Shrimp survey 2 areas	SMB north area 2 year old	83-93	11	0.843	p=0.001
Shrimp survey 2 areas	SMB all areas 2 year old	83-93	11	0.838	p=0.001
Shrimp survey 2 areas	SMB north area 3 year old	82-92	11	0.866	p=0.001
Shrimp survey 2 areas	SMB all areas 3 year old	82-92	11	0.864	p=0.001
Shrimp survey 2 areas	SMB north area 4 year old	81-91	11	0.802	p=0.01
Shrimp survey 2 areas	SMB all areas 4 year old	81-91	11	0.770	p=0.01
0-group survey	SMB north area1 year old	84-94	11	0.908	p=0.001
0-group survey	SMB all areas 1 year old	84-94	11	0.897	p=0.001
0-group survey	SMB north area 2 year old	83-93	11	0.797	p=0.01
0-group survey	SMB all areas 2 year old	83-93	11	0.797	p=0.01
0-group survey	SMB north area 3 year old	82-92	11	0.760	p=0.01
0-group survey	SMB all areas 3 year old	82-92	11	0.758	p=0.01
0-group survey	SMB north area 4 year old	81-91	11	0.733	p=0.01
0-group survey	SMB all areas 4 year old	81-91	11	0.766	p=0.01

Table 7. The results of simple regressions for the assessed number of cod in three types of surveys against the VPA indices. Also there is the comparison between the 0-group surveys and the shrimp surveys. The regressions are carried out in the same manner as in Table 6 as regards x- and y-values.

Cod

Survey	VPA/ survey	year-classes	Number of years	Correlation r	Significant at
Shrimp survey 4 areas	VPA 3 year old	78-90	13	0.254	no
Shrimp survey 4 areas	VPA 3 year old	79-90	12	0.349	no
Shrimp survey 4 areas	VPA 3 year old	80-90	11	0.360	no
Shrimp survey 4 areas	VPA 3 year old	81-90	10	0.450	no
Shrimp survey 4 areas	VPA 3 year old	82-90	9	0.764	p=0.02
Shrimp survey 4 areas	VPA 3 year old	83-90	8	0.760	p=0.02
Shrimp survey 4 areas	VPA 3 year old	84-90	7	0.661	no
0-group survey	VPA 3 year old	78-90	13	0.462	no
0-group survey	VPA 3 year old	79-90	12	0.484	no
0-group survey	VPA 3 year old	80-90	11	0.495	no
0-group survey	VPA 3 year old	81-90	10	0.481	no
0-group survey	VPA 3 year old	82-90	9	0.470	no
0-group survey	VPA 3 year old	83-90	8	0.454	no
0-group survey	VPA 3 year old	84-90	7	0.805	p=0.02
SMB all areas 4 year old	VPA 3 year old	81-90	10	0.804	p=0.01
SMB all areas 3 year old	VPA 3 year old	82-90	9	0.888	p=0.001
SMB all areas 2 year old	VPA 3 year old	83-90	8	0.854	p=0.01
SMB all areas 1 year old	VPA 3 year old	84-90	7	0.745	p=0.05
0-group survey	Shrimp survey 4 areas	78-94	17	0.367	no
0-group survey	Shrimp survey 4 areas	79-94	16	0.339	no
0-group survey	Shrimp survey 4 areas	80-94	15	0.337	no
0-group survey	Shrimp survey 4 areas	81-94	14	0.447	no
0-group survey	Shrimp survey 4 areas	82-94	13	0.656	p=0.02
0-group survey	Shrimp survey 4 areas	83-94	12	0.647	p=0.02
0-group survey	Shrimp survey 4 areas	84-94	11	0.761	p=0.01
0-group survey	Shrimp survey 4 areas	85-94	10	0.691	p=0.02

Table 8. The results of simple regressions for the assessed number of haddock in various surveys. In the shrimp surveys only the o-group haddock is used. The regressions are carried out in the same manner as described in Table 6 as regards x- and y-values.

Haddock

Survey	Survey	year-classes	Number of years	Correlation r	Significant at
Shrimp survey 4 areas	SMB north area1 year old	84-94	11	0.656	p=0.05
Shrimp survey 4 areas	SMB all areas 1 year old	84-94	11	0.551	no
Shrimp survey 4 areas	SMB north area 2 year old	83-93	11	0.553	no
Shrimp survey 4 areas	SMB all areas 2 year old	83-93	11	0.537	no
Shrimp survey 4 areas	SMB north area 3 year old	82-92	11	0.529	no
Shrimp survey 4 areas	SMB all areas 3 year old	82-92	11	0.585	p=0.05
Shrimp survey 4 areas	SMB north area 4 year old	81-91	11	0.395	no
Shrimp survey 4 areas	SMB all areas 4 year old	81-91	11	0.560	no
Shrimp survey 2 areas	SMB north area1 year old	84-94	11	0.550	no
Shrimp survey 2 areas	SMB all areas 1 year old	84-94	11	0.378	no
Shrimp survey 2 areas	SMB north area 2 year old	83-93	11	0.425	no
Shrimp survey 2 areas	SMB all areas 2 year old	83-93	11	0.377	no
Shrimp survey 2 areas	SMB north area 3 year old	82-92	11	0.474	no
Shrimp survey 2 areas	SMB all areas 3 year old	82-92	11	0.493	no
Shrimp survey 2 areas	SMB north area 4 year old	81-91	11	0.316	no
Shrimp survey 2 areas	SMB all areas 4 year old	81-91	11	0.415	no
0-group fish survey	SMB north area1 year old	84-94	11	0.460	no
0-group fish survey	SMB all areas 1 year old	84-94	11	0.411	no
0-group fish survey	SMB north area 2 year old	83-93	11	0.505	no
0-group fish survey	SMB all areas 2 year old	83-93	11	0.513	no
0-group fish survey	SMB north area 3 year old	82-92	11	0.626	p=0.05
0-group fish survey	SMB all areas 3 year old	82-92	11	0.542	no
0-group fish survey	SMB north area 4 year old	81-91	11	0.644	p=0.05
0-group fish survey	SMB all areas 4 year old	81-91	11	0.577	p=0.05

Table 9. The results of simple regressions for the assessed number of haddock in three types of surveys against the VPA indices. Also there is the comparison between the 0-group surveys and the shrimp surveys. The regressions are carried out in the same manner as in Table 6 as regards x- and y-values.

Haddock

Survey	VPA/survey	year-classes	Number of years	Correlation r	Significant at
Shrimp survey 4 areas	VPA 2 year old	78-90	13	0.534	p=0.05
Shrimp survey 4 areas	VPA 2 year old	79-90	12	0.600	p=0.05
Shrimp survey 4 areas	VPA 2 year old	80-90	11	0.559	no
Shrimp survey 4 areas	VPA 2 year old	81-90	10	0.551	no
Shrimp survey 4 areas	VPA 2 year old	82-90	9	0.565	no
Shrimp survey 4 areas	VPA 2 year old	83-90	8	0.490	no
Shrimp survey 4 areas	VPA 2 year old	84-90	7	0.429	no
0-group fish survey	VPA 2 year old	78-90	13	0.177	no
0-group fish survey	VPA 2 year old	79-80	12	0.419	no
0-group fish survey	VPA 2 year old	80-90	11	0.380	no
0-group fish survey	VPA 2 year old	81-90	10	0.539	no
0-group fish survey	VPA 2 year old	82-90	9	0.514	no
0-group fish survey	VPA 2 year old	83-90	8	0.435	no
0-group fish survey	VPA 2 year old	84-90	7	0.430	no
SMB all areas 4 year old	VPA 2 year old	81-90	10	0.985	p=0.001
SMB all areas 3 year old	VPA 2 year old	82-90	9	0.942	p=0.001
SMB all areas 2 year old	VPA 2 year old	83-90	8	0.980	p=0.001
SMB all areas 1 year old	VPA 2 year old	84-90	7	0.943	p=0.001
0-group survey	Shrimp survey 4 areas	78-94	17	0.277	no
0-group survey	Shrimp survey 4 areas	79-94	16	0.266	no
0-group survey	Shrimp survey 4 areas	80-94	15	0.079	no
0-group survey	Shrimp survey 4 areas	81-94	14	0.092	no
0-group survey	Shrimp survey 4 areas	82-94	13	0.134	no
0-group survey	Shrimp survey 4 areas	83-94	12	0.050	no
0-group survey	Shrimp survey 4 areas	84-94	11	0.076	no
0-group survey	Shrimp survey 4 areas	85-94	10	0.586	no

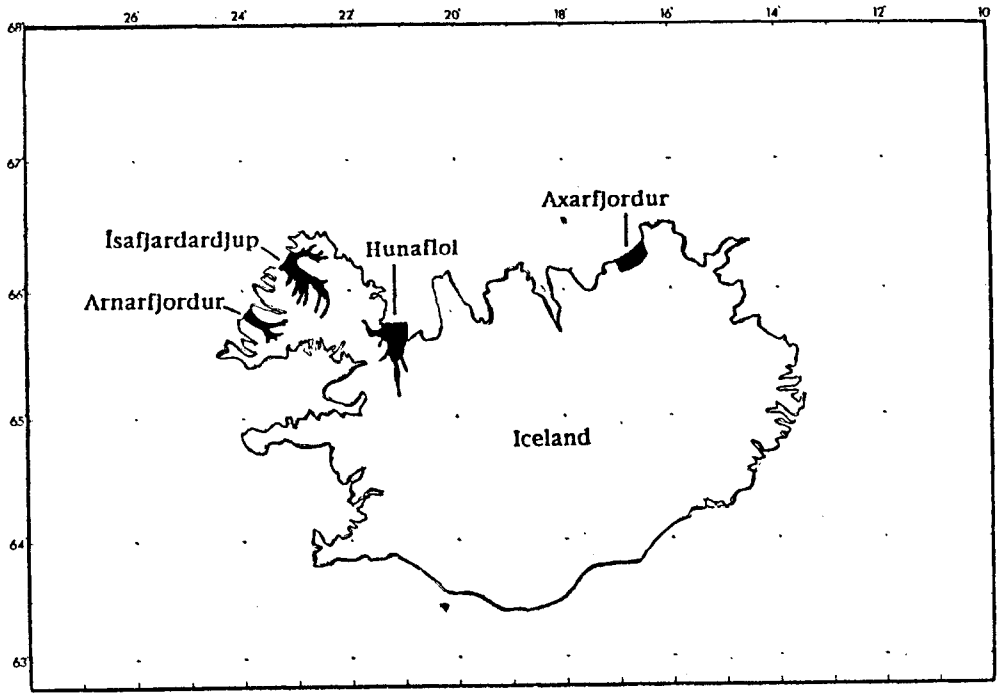

Fig. 1. The four fjords studied in this paper where shrimp surveys (SMR) are carried out every autumn.

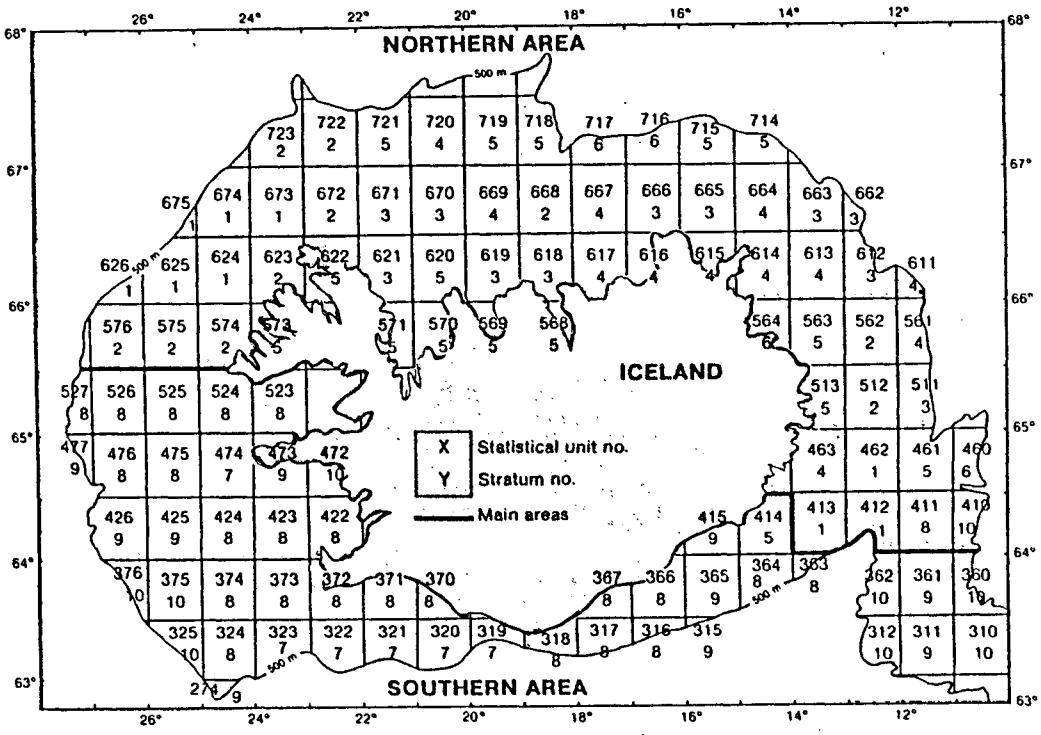

Fig. 2. The survey area of the annual groundfish survey (SMB). The area is divided into northern and southern area by heavy lines. From Pálson *et al* 1989.

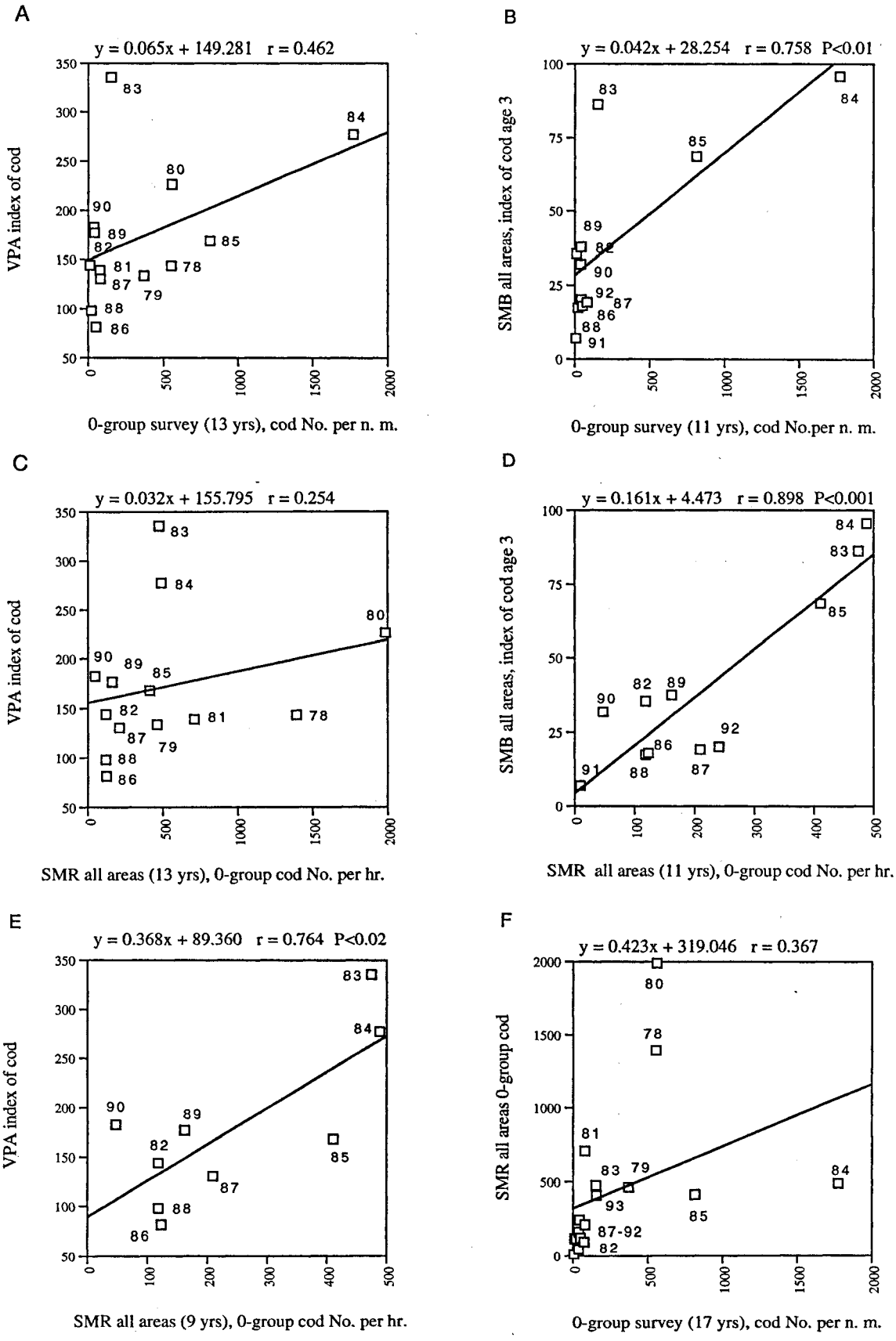

Fig. 3. Some examples of relationships between the assessed number of cod in various surveys or as calculated by virtual population analysis (VPA) as 3 year olds (Tables 6 and 7). Numbers in the figures denote year-classes.

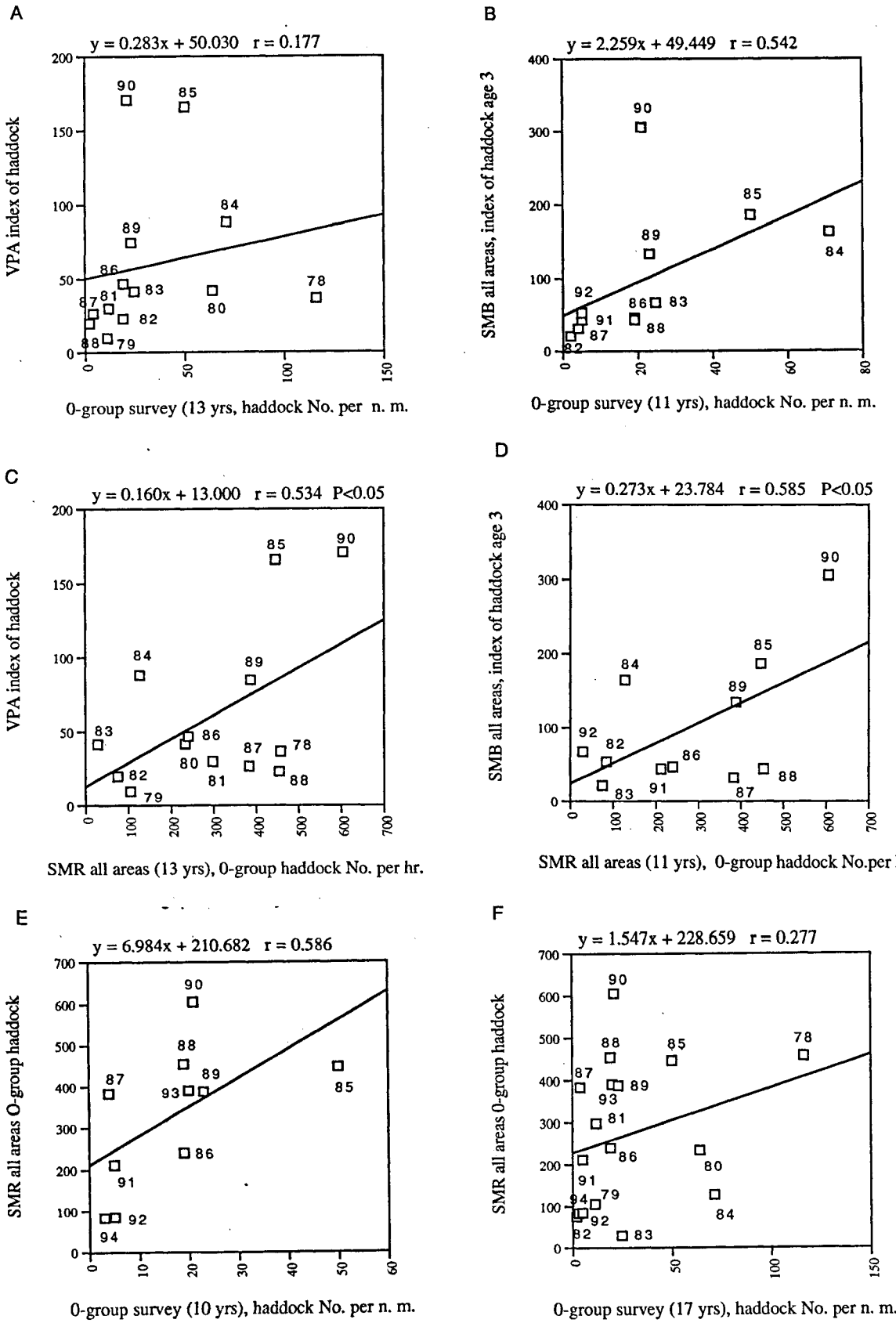

Fig. 4. Some examples of relationships between the assessed number of haddock in various surveys or as calculated by virtual population analysis (VPA) as 2 year olds (Tables 8 and 9). Numbers in the figures denote year-classes.

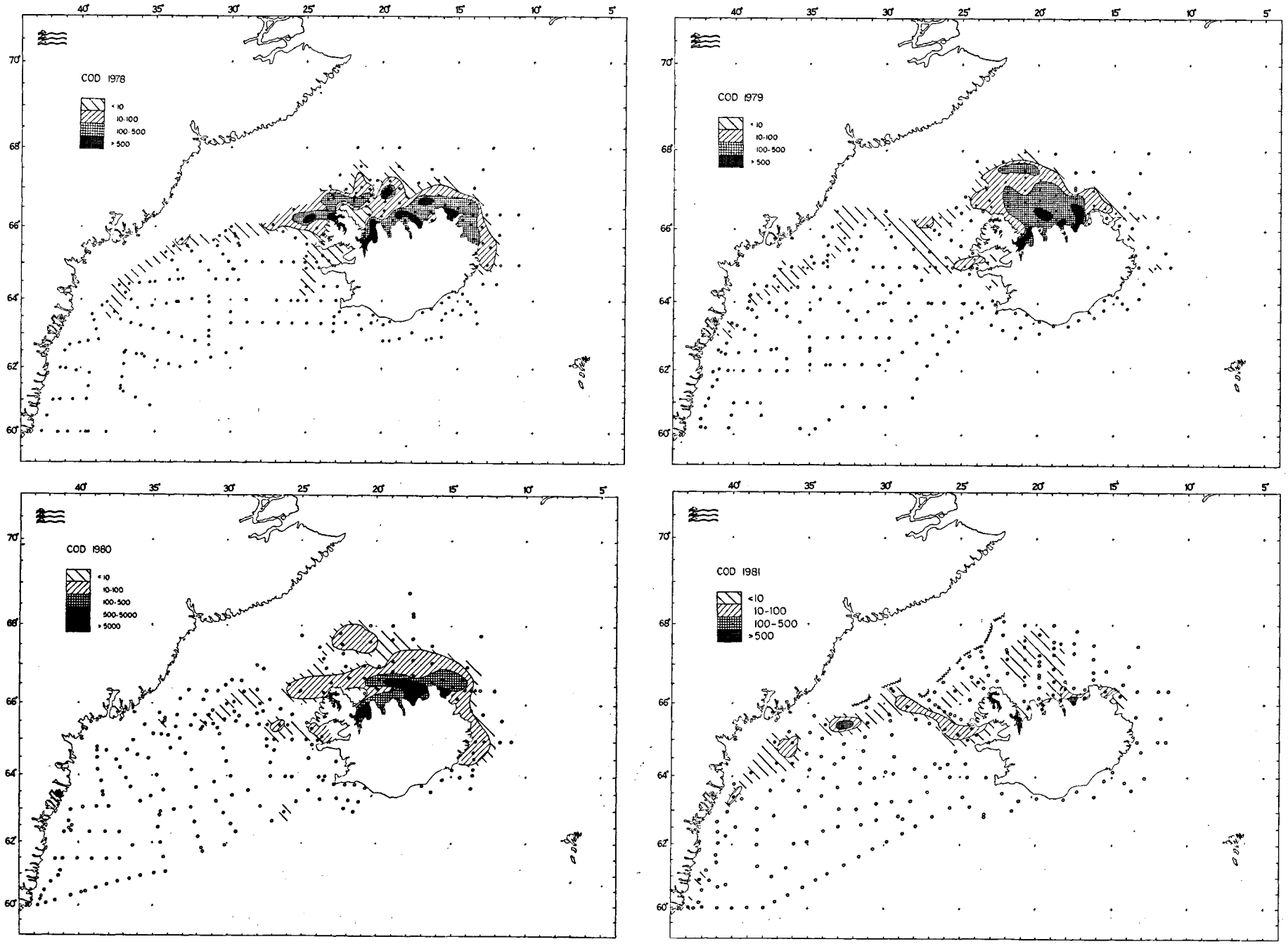

Fig. 5. Distribution and density of 0-group cod in the 0-group fish survey in August in the years 1978 through 1981. From ICES. 1979, ICES. 1980, Vilhjálmsson et al 1980, Vilhjálmsson and Magnússon 1981.

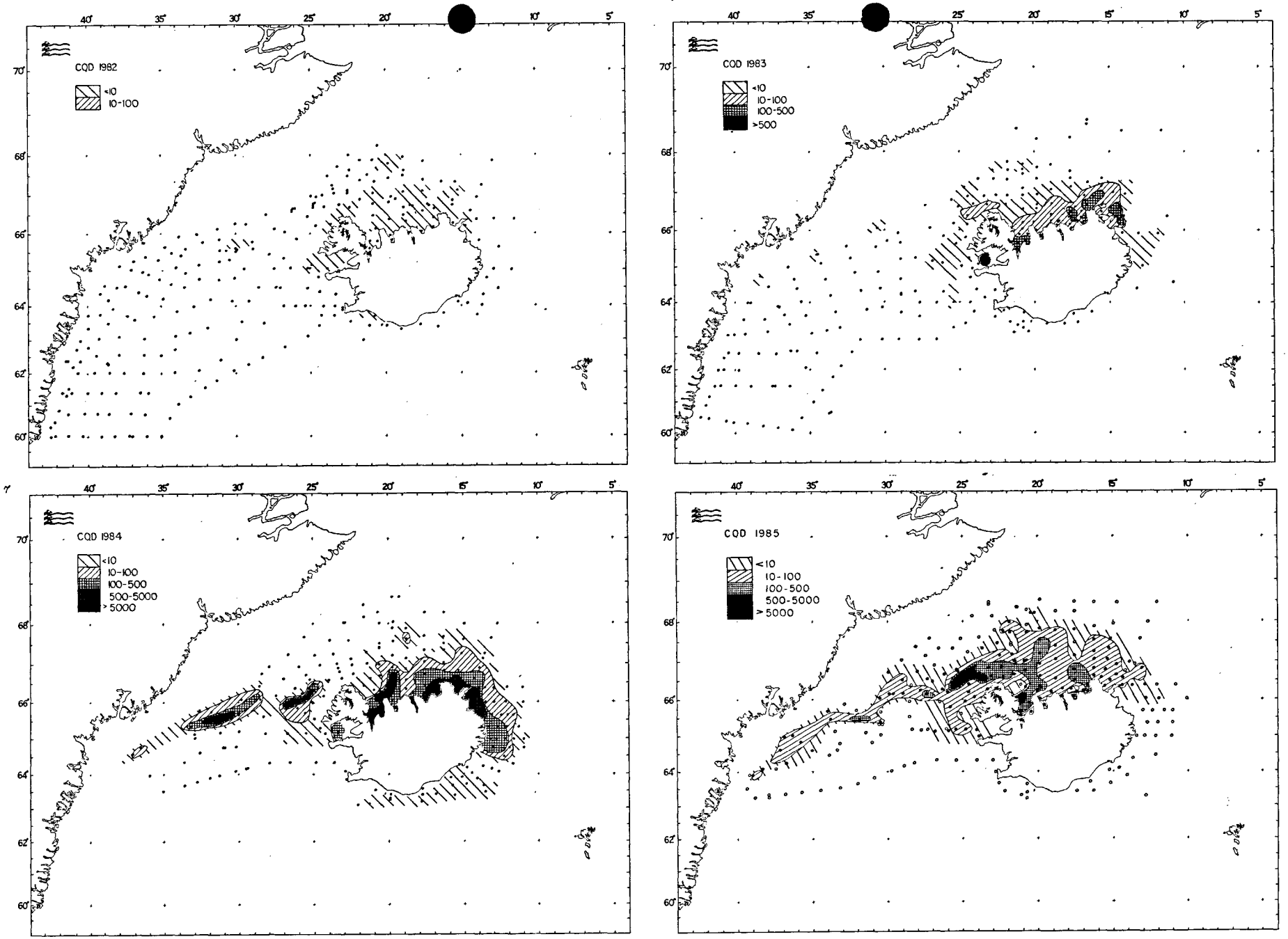

Fig. 6. Distribution and density of 0-group cod in the 0-group fish survey in August in the years 1982 through 1985. From Vilhjálmsson and Magnússon 1982, 1983, 1984 and 1985.

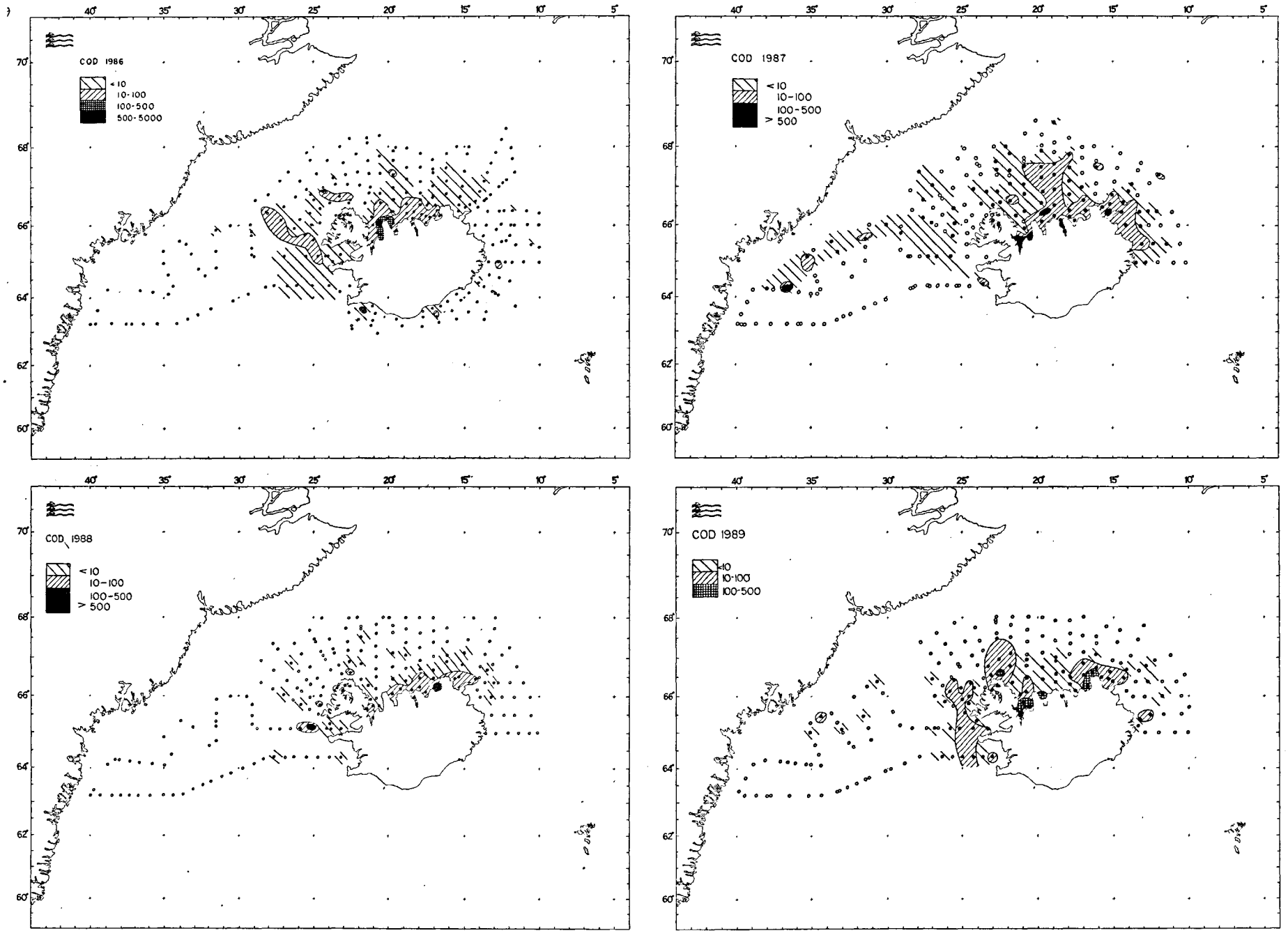

Fig. 7. Distribution and density of 0-group cod in the 0-group fish survey in August in the years 1986 through 1989. From Vilhjálmsson and Magnússon 1986, Magnússon et al 1987, 1988 and 1989.

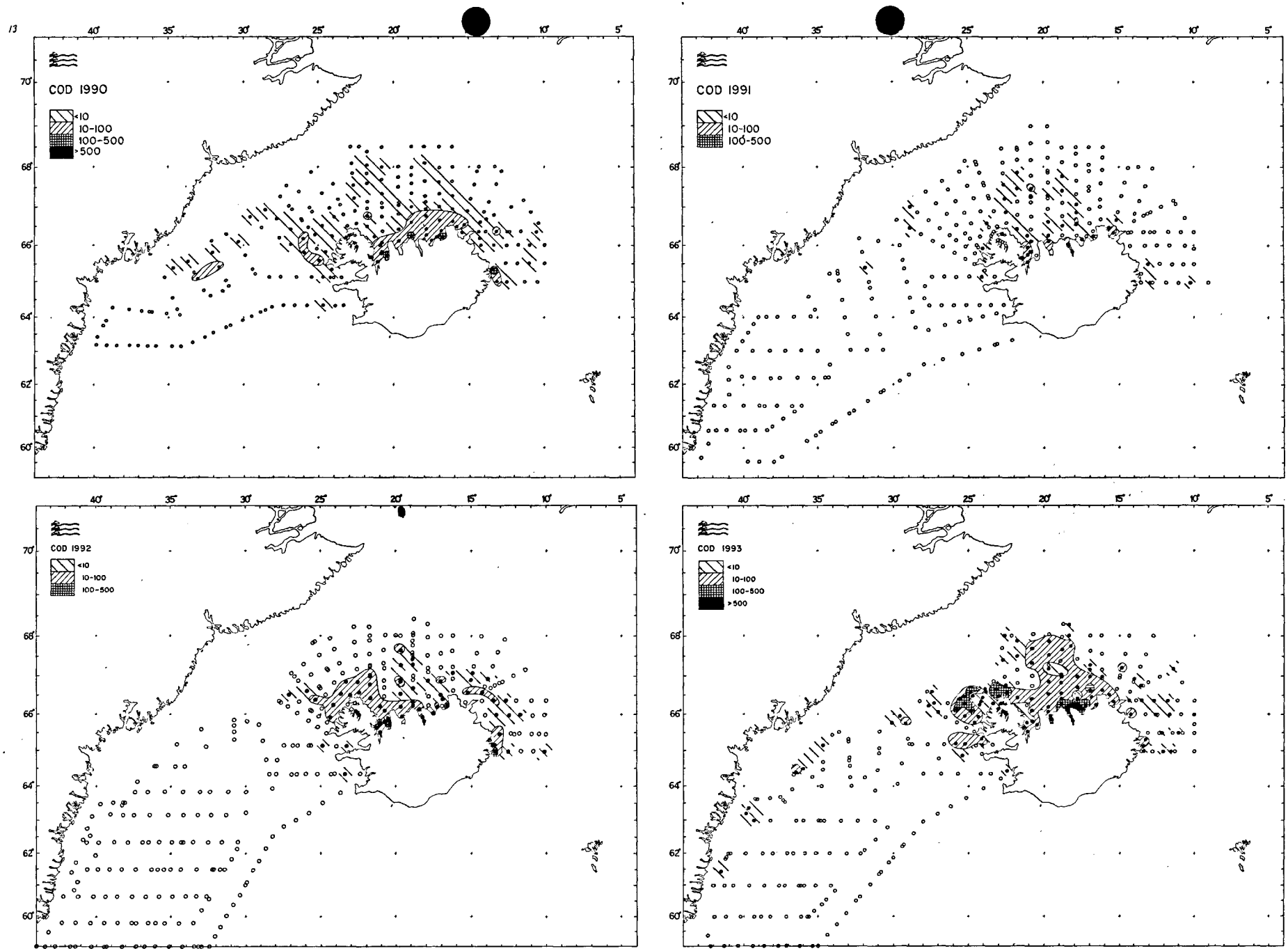

Fig. 8. Distribution and density of 0-group cod in the 0-group fish survey in August-September in the years 1990 through 1993. From Magnússon and Sveinbjörnsson 1990, 1991, 1992 and 1993.

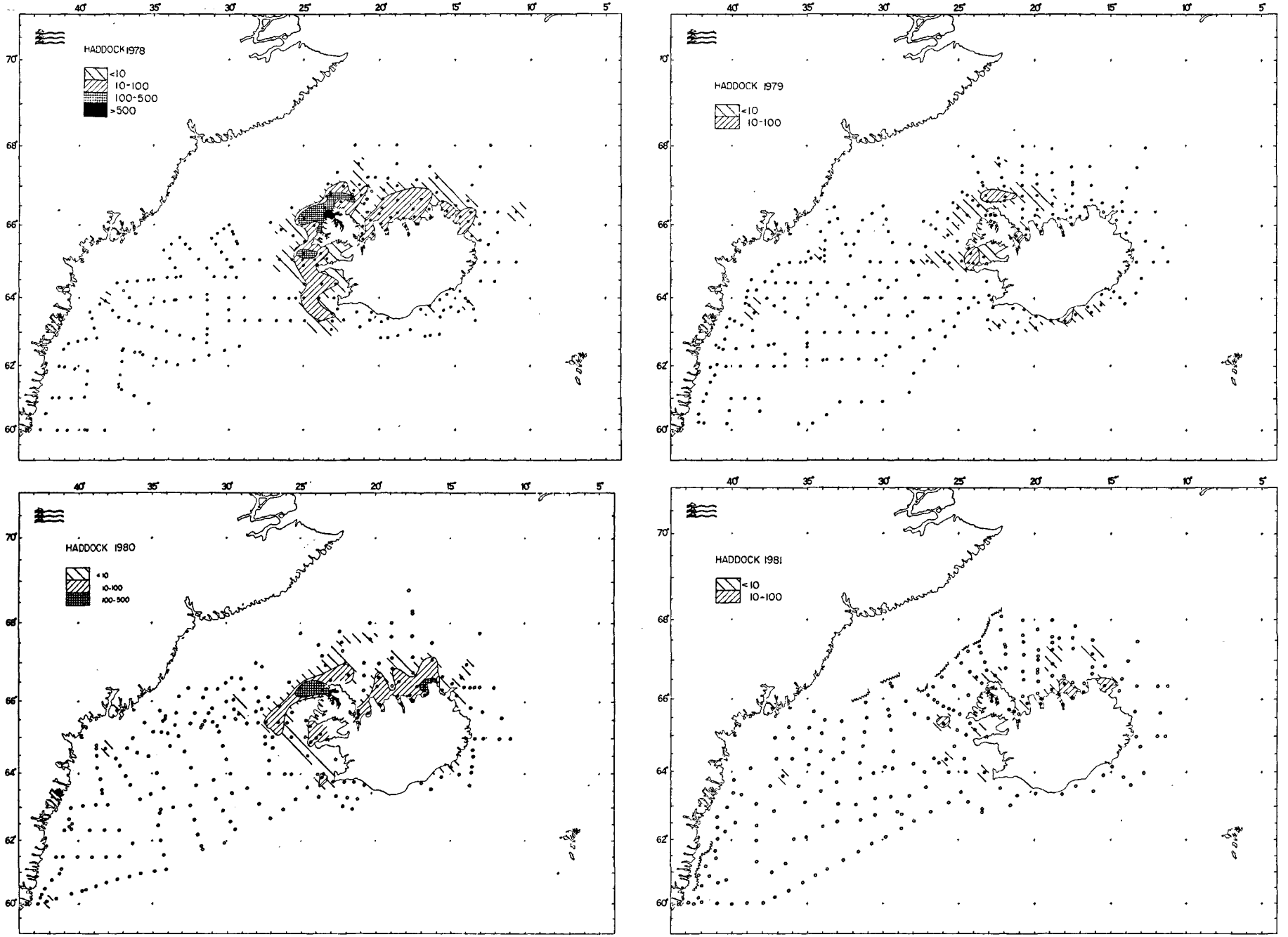

Fig. 9. Distribution and density of 0-group haddock in the 0-group fish survey in August in the years 1978 through 1981. From ICES. 1979, ICES 1980, Vilhjálmsson et al 1980, Vilhjálmsson and Magnússon 1981.

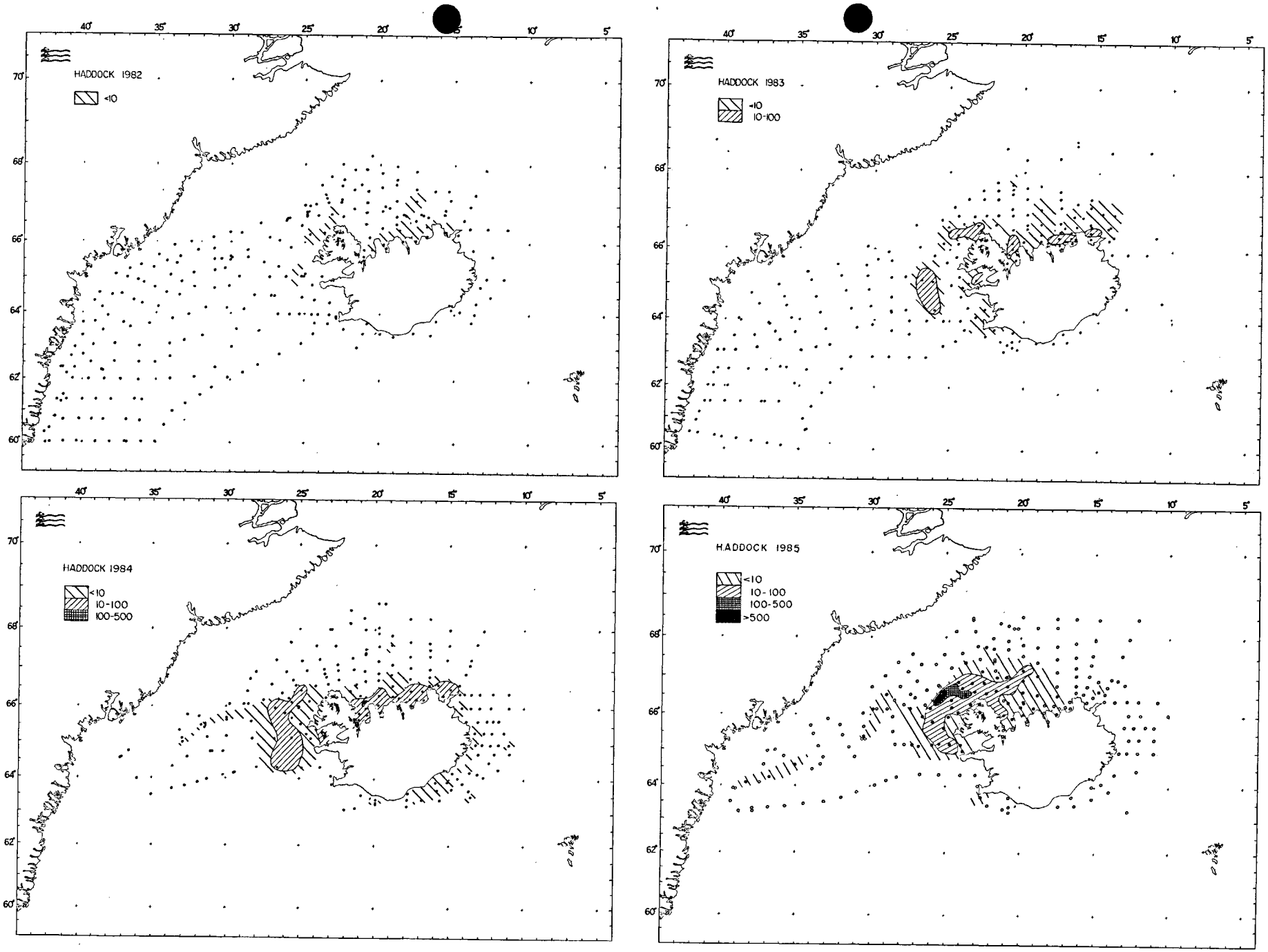

Fig. 10. Distribution and density of 0-group haddock in the 0-group fish survey in August in the years 1982 through 1985. From Vilhjálmsson and Magnússon 1982, 1983, 1984 and 1985.

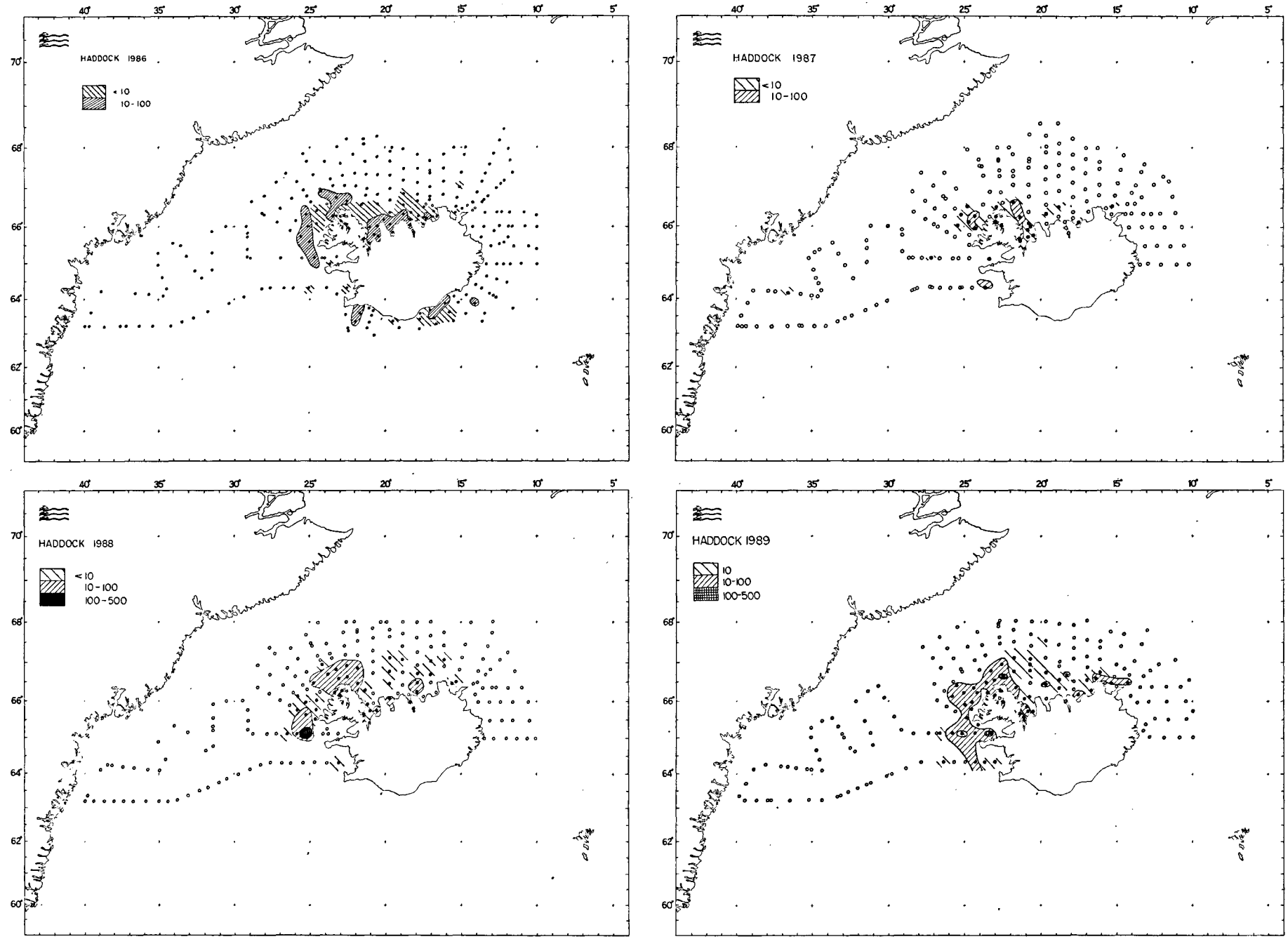

Fig. 11. Distribution and density of 0-group haddock in the 0-group fish survey in August in the years 1986 through 1989. From Vilhjálmsson and Magnússon 1986, Magússon et al 1987, 1988 and 1989.

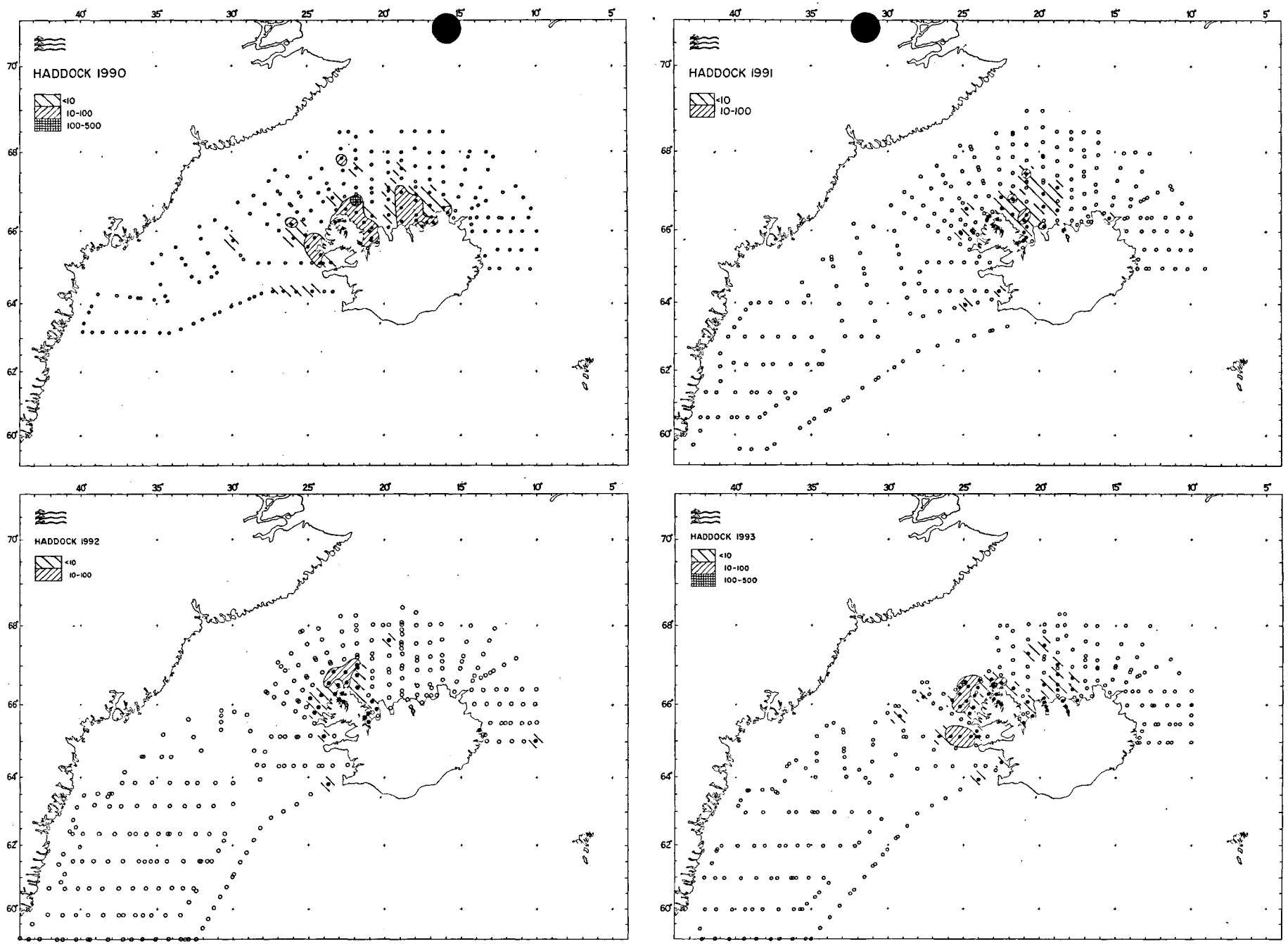

Fig. 12. Distribution and density of 0-group haddock in the 0-group fish survey in August-September in the years 1990 through 1993. From Magnússon and Sveinbjörnsson 1990, 1991, 1992 and 1993.