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Jón Jónsson

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and
Tagging of haddock *(Gadus aeglefinus)* in Icelandic waters 1953-1965

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1. Introduction

The old Icelandic Annals record the yearly lots of fishermen engaged in the spawning fishery. Furthermore, the annalists also remark on the condition of the cod, *i.e.* low fat content of the liver, fish being very lean and so on. Such notes indicate immigrations by cod from Greenland. This may for example have occurred around the middle of the 18th century, when there were also reports of cod occurring at West-Greenland (*e.g.* Buch *et al.* 1994).

The spawning migrations of the Icelandic cod were vividly described by Skúli Magnússon (1785). He noted the two main routes which are followed by the mature fish to the spawning grounds. On the first one, westwards along the southeast and south coasts, Magnússon describes the cod as boisterous and vigorously chasing the herring (capelin) all the way into Faxaflói. The other route is southwards along the west coast. According to Magnússon's description, the fish taking this route are more tranquil, since they have yet to encounter the great schools of herring and capelin off the south coast.

Numerous tagging experiments have confirmed this 200 years old description by Skúli Magnússon and shown that at that time people had a fairly good knowledge about the movements of the cod. However, there were different views as to where these fish came from. In his diaries from 1791-1794, the naturalist and physician Sveinn Pálsson maintained that the cod came from the Faroes, since Dutch fishermen were reporting large cod catches in that area in the 1780s (Pálsson 1791-1794).

In a report to the Danish Govenment for the year 1902, regarding proposals of marine research in Icelandic waters, Sæmundsson (1905) stressed *i.a.* the importance of cod tagging in order to ascertain the seasonal movements of the fish around Iceland. When Danish fisheries investigations at Iceland commenced in 1903, under the auspicies of the newly founded International Council for the Exploration of the Sea (ICES), Sæmundsson's recommendations for experimental tagging of cod were duly accepted as described in the next section..

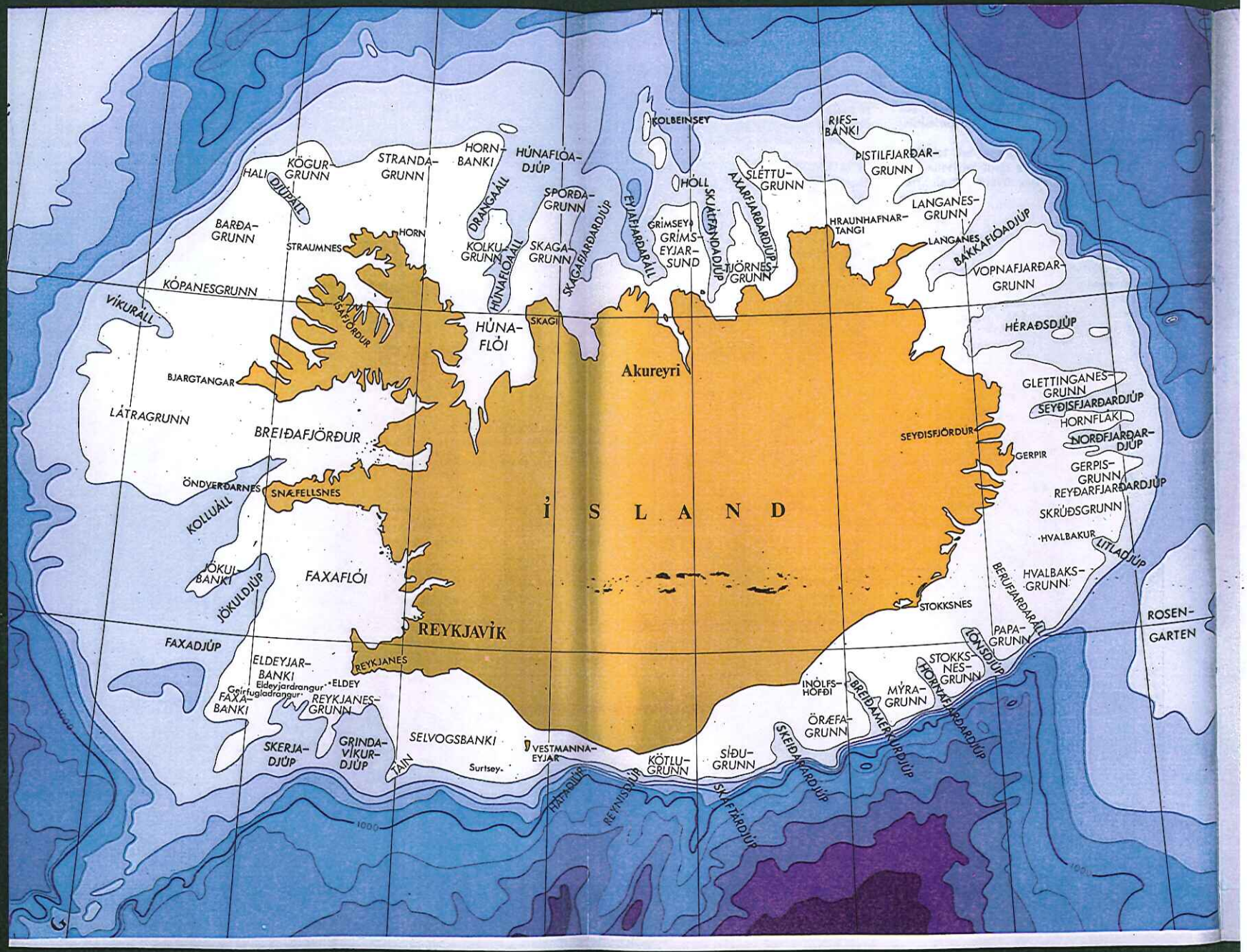
In the years 1948-1986 a total of 84,578 cod were tagged, of which 10,969 or 13% were recovered (Appendix Table I.1). Preliminary reports on cod migrations, based on these taggings and mostly written in Icelandic, are quoted in the list of references (Jónsson 1949, 1950, 1951). For various reasons the writing of a comprehensive report, describing *i.a.* changes in mortalities due to fishing and other causes, derived from the results of these tagging experiments, had to be postponed time and again. In the following this author has attempted to amend this situation.

One might ask if the results from tagging experiments, some of which commenced more than forty years ago, are of anything but historic interest. However, there is no reason to believe that the cod have radically changed their migrations and behaviour during this biologically short period, or even in historic times for that matter. The old Icelandic and foreign fisheries for cod at Iceland were conducted under similar hydrographic and biological features as today. The distribution of the old fishing stations along the Icelandic coastline clearly reflects that the main winter and spring cod fishery was based upon concentrations of cod at and on their way to or from the spawning grounds off the south and west coasts. On the other hand, the summer

and autumn fishery was more concentrated in the main feeding area, in the mixed waters off the east, north and northwest coasts – just like today.

Unless otherwise stated, all the fish to be tagged were caught by trawl and then placed in a container with running sea water. In the present paper, a selection of these taggings has been used to analyze tag losses, mortalities and migrations of cod in Icelandic waters.

All of the tagging data are archived in a computerized form at the Marine Research Institute, Reykjavík and available for further examination.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2. Results of previous investigations

For orientation, the names of the different places and fishing banks referred to in this paper are shown in Figure 2.1.

Cod were first tagged at Iceland in Loðmundarfjörður on the east coast in July 1904 (Schmidt 1907). The tags were of the Petersen type (cf. section 3). The fish were caught with longlines using small hooks baited with herring. Immediately after being detached from the hooks the cod were placed in a well with seawater and kept for a day or so before they were marked and released. A total of 297 cod were thus tagged in this experiment, of which 25 fish or 8.4% were recaptured, all by open Icelandic or Faroese boats.

Three days later, 194 cod were tagged in the nearby Héraðsflói. This time the fish were caught with a trawl and taken through a hole which was cut in the codend and tagged from a boat alongside. The rate of recapture was 2.1% or substantially lower than in the first experiment. Sæmundsson (1913) does not ascribe this to the method of catching the fish, but rather to a much lower fishing effort in the Héraðsflói area.

Tagging in Skagafjörður on the central north coast in mid August 1905 only yielded a return rate of 3.8% from a total of 391 cod tagged. All the returns were from open Icelandic fishing boats (Sæmundsson 1913). It is interesting to compare this with an experiment carried out forty three years later in the same locality, using the same type of tag and with a similar length distribution of the tagged fish, at the end of May 1948, (see page 38). In the latter case, 14.0% of the 691 fish tagged were returned, undoubtedly due to the greatly increased fishing effort as compared to that at the beginning of the century. One third of these recaptures were from catches taken by foreign vessels.

◊ Figure 2.1. Bathymetrical features and main fishing areas around Iceland.

However, tagging carried out in June 1909 in Faxaflói at Southwest Iceland, indicated a much larger fishing effort in that area than east and north of Iceland. Out of 200 cod tagged, 30 (15%) were recovered, all but one inside Faxaflói. English trawlers recovered 16 tags and Icelandic trawlers 11, in spite of the fact that an Icelandic trawl fishery for cod had just begun 4 years earlier. Only 3 tags were returned by open vessel fishermen (Sæmundsson 1913).

Most of the fish tagged at the north and east coasts were recaptured in the same locality, but a few of the tags were recovered in the warm water area south and west of Iceland, showing the typical spawning migration.

The tagging of cod at Iceland was resumed in 1924 (Appendix Table I.2). From that time until 1938, a total of 7,925 fish were liberated. All of these cod were caught in trawls and marked with a Petersen disc. Appendix Table I.3 shows the number of cod tagged in each statistical square in this period, together with the percentage recaptured. Most of the fish were tagged in Subarea 9 in January-May under the auspices of Fiskifélag Íslands (The Icelandic Fisheries Association).

The results of the tagging experiments at Iceland in 1924-1938 have not been published in detail, but Dr. Vedel Tåning placed all the material at the disposal of the present author for analysis. The apparent total instantanous mortality coefficient, Z' (cf. section 4), calculated on the basis of returns from taggings in the years 1931 to 1938, is given in Table 2.1. The values of Z' range from 0.73 to 1.86 with

Table 2.1. Returns from cod taggings in Subareas 1 and 9 in January - May 1931-1938.

Year	*Number tagged*	*Number returned*	*% returned*	*1st year No*	*2nd year No*	*3rd year No*	*4th year No*	*Total 1-4*	*Z'*
1931	1459	197	13.5	68	33	14	8	123	0.73
1932	1163	115	9.9	71	25	10	4	110	0.96
1933	381	35	9.2	13	4	2	1	20	0.84
1934	975	89	9.1	47	13	1	–	61	1.86
1937	974	117	11.0	56	17	5	7	85	0.75
1938	400	44	11.0	25	7	1	1	34	1.86
Total	5352	597	11.2	280	99	33	21	433	0.89

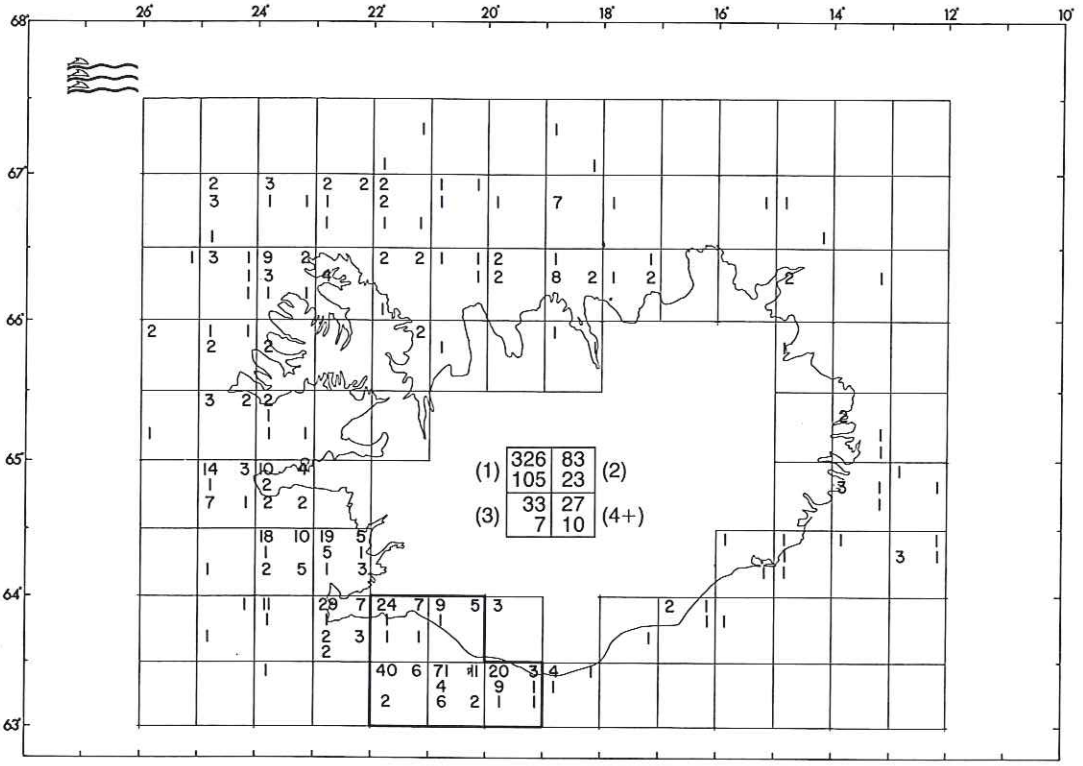


Figure 2.2. Recaptures of cod tagged on the spawning grounds in 1925-1938. The uppermost figures in the left hand corner of each square give the number of recaptures in the first year (1) in the months January - May and the figures below the number of recaptures in June - December. The figures in the uppermost right hand corner denote in the same way the recaptures in the second year (2) and so on. Tagging area in bold lines. The numbering system is illustrated in the centre square, where the total recaptures are also given.

an average of 1.13. This is considerably lower than the Z' values, calculated from the post World War II taggings, which are discussed in section 4.

Schmidt (1931) reported on the results of the cod tagging experiments up to 1929. The most interesting recaptures were those of a cod in the stomach of a Greenland shark in the middle of the Greenland Strait (between Northwest Iceland and Greenland), and another near Frederikshaab at Southwest Greenland, 17 months after tagging. Three and a half years prior to the last mentioned recapture, a cod tagged at West-Greenland had been caught in Faxaflói on 23 March 1927. This was the first indication of the large migrations of cod from Greenland to Iceland, observed in the years to come.

Tåning (1934, 1937) reported on several instances of long distance cod migrations between Iceland and other areas. Of the 4,939 cod which were tagged on the spawning grounds off the southwest coast in 1924-1935, a total of 443 fish were recaptured at Iceland and 23 elsewhere. Of the latter, two cod were taken at the Faroes, two off northern Norway, one in the middle of the Greenland Strait as mentioned above, one off Newfoundland and 17 at West-Greenland. A remarkable feature was that six of the fish, marked at Southwest Iceland during 7-24 May 1931, were all caught near each other at West-Greenland 99-116 days after liberation, indicating that the fish had left together immediately after spawning. Similarly, three fish were caught in August 1932 at West-Greenland, 476-491 days after tagging and, finally, one in mid August 1935 after 52 months at liberty, showing that the tagging itself was quite successful. These fish were 81-96 cm at tagging and thus all sexually mature. Most likely, they were of Greenlandic origin, or had drifted across to Greenland as 0-group, since immature fish tagged at Iceland have very seldom been found outside Icelandic waters.

In the period 1924-1939 a total of 12,800 cod were tagged at West-Greenland, and until 1940, 1,067 had been recaptured or 8.3%. Of these, 616 were taken at Greenland, 449 at Iceland, one at the Faroes and one in the Barents Sea. The immigration of cod from Greenland was highly important to the cod fisheries at Iceland. In the years 1924-1928, 10% of the recaptures of cod tagged at Greenland were taken at Iceland, 56% in 1928-1933 and 40% in 1934-1939. However, the high proportion of recaptures at Iceland does not give a true picture of the magnitude of these migrations. At Greenland the recapture rate was 4.4% and 4.2% at Iceland in 1930-1934, whereas the total landings of cod at Greenland were 48 thous. tonnes compared to 485 thous. tonnes at Iceland in the same period (Hansen 1941; Hansen *et al.* 1935).

Recaptures in the periods January-May and June-December, from tagging on the spawning grounds (Subarea 9) in the years 1925-1938, are shown in Figure 2.2.

The largest part of the recaptures was taken in Subarea 9 in the season of tagging and the remainder was fairly evenly distributed over Subareas 2, 3 and 4. Only a very few fish seem to have taken the route east along the south coast. The recaptures in June-December are mainly from the northern part of Subarea 3 and from Subareas 4 and 5. These results are in conformity with those which will be discussed in section 5.1.

3. Tags, tagging techniques and returns

3.1. Tags and tagging methods

Four types of tags were used for marking the cod: the Petersen disc, the Lea hydrostatic tag, the Alcathene tag and the plastic flag tag (Fig. 3.1.). Detailed descriptions of these types of tags and their mounting are given by Jakobsson (1970).

The Petersen disc was used exclusively in the years 1948 to 1953 as well as in the tagging experiments conducted before World War II. This type of tag consists of two black ebonite plates connected through the operculum with a wire of silver or stainless steel. The identification number together with one or more letters is stamped on the surface.

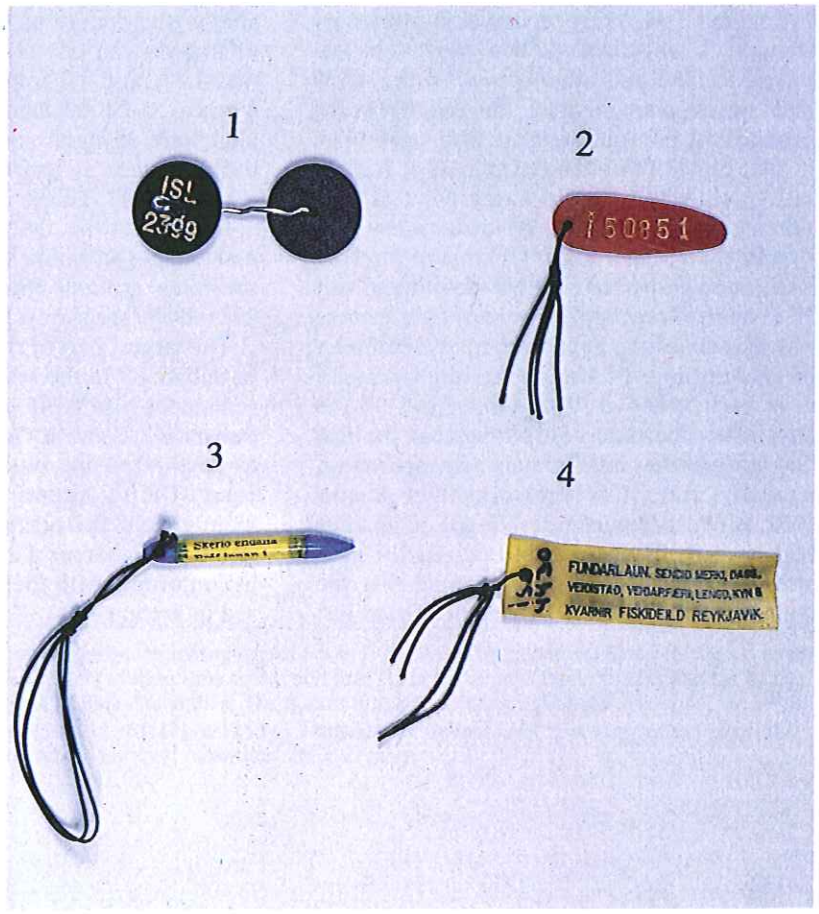


Figure 3.1. Types of fish tags used in experiments in 1948-1986.
1) Petersen disc;
2) Alcathene tag;
3) Lea's hydrostatic tag;
4) Plastic flag.

The Lea hydrostatic tag is a hollow tube of celluloid. Inside the tube is a slip of paper with printed instructions to the finder and an identification number. The Lea tag was fastened to the fish in front of the first dorsal fin with a bridle of stainless steel or with a soft, braided nylon twine.

The Alcathene tag is of oval shape with an identification number and one or more letters stamped on the surface. In the Icelandic tagging experiments it was always fastened with a soft, braided nylon twine.

The plastic flag tag is a long rectangle made of thin plastic with a message as well as the identification number printed on the surface. It was fastened to the fish in the same way as the two last mentioned types.

3.2. Rates of return of the various types of tags

It is well known that the various types of tags, which have been used to mark fish, are not equally effective. Not only is the tag itself of importance but also the method of attachment to the fish and the colour of the tag. A comparison of the yearly returns of the various types of tags used is given in Appendix Table I.4.

The Petersen disc was fastened to the fish with a silver wire in all experiments during 1948-1956. In the 1957 experiments part of the tags were fastened with a stainless steel wire, and in 1958 and 1959 the attachment was exclusively with wire of stainless steel.

In the 1957 experiments the silver wire fastening gave 5.2% returns compared to 12.8% for the attachment with a wire of stainless steel. Taking all the experiments together, the silver wire attachment in the years 1948-1957 yielded 9.1% returns on the average, whereas a fastening with stainless steel in the years 1957-1959 resulted in an average return rate of 12.7%. However, it should be kept in mind that there was a large increase in fishing effort in 1957-1959 as compared to the former period.

The Lea hydrostatic tag was mainly attached to the fish with a soft, braided nylon twine. However, a bridle of stainless steel was used in the 1960 experiments. The stainless steel bridle experiments yielded a return rate of 20.5%, whereas the rate for the braided nylon attachment was 14.2-14.9%. One experiment, using monofilament nylon as attachment for the Lea hydrostatic tag, was carried out in 1954 and gave a return rate of 29.5%.

Two colours were used for the Alcathene tag, red and blue. Data from four years are available for direct comparison, *i.e.* from the years 1954-1956 and from 1958. The average return rate for the red Alcathene tag was 7.4% and 11.4% for the blue one. There are, however, considerable variations within the different experiments and also between years.

Table 3.1. Summary of experiments with various types of tags in 1954-1967.

Period	*1954-1957*		*1958-1960*		*1964-1967*	
Type of tag	*Tagged N*	*Returned %*	*Tagged N*	*Returned %*	*Tagged N*	*Returned %*
Petersen disc	2550	7.5	–	–	–	–
Lea's hydrostatic . .	–	–	2525	14.7	–	–
Red Alcathene . . .	2580	9.7	1748	11.4	4843	14.4
Blue Alcathene . . .	1581	11.3	–	–	–	–
Yellow plastic flag .	–	–	–	–	2718	18.4

Due to differences in return rates and in order to facilitate a direct comparison from one period to another, the returns from different types of tags within comparable periods have been summarized in Table 3.1.

The returns of tags have been adjusted using the red Alcathene tag as a reference. On the average, the red Alcathene tag gave re-

Figure 3.2. Subareas and statistical squares used in fisheries and fishery research at Iceland.

turn rates which were 1.3 times higher than those of the black Petersen disk, 0.8 times the return rates of Lea's hydrostatic tag, 0.9 times those of the blue Alcathene tag and 0.8 times the return rates of the plastic flag.

There was a marked increase in fishing effort in the late 1950s and in the 1960s, when the red Alcathene tag was mainly in use.

3.3 Returns of tags by the different fleets fishing for cod at Iceland

The area around Iceland has, for statistical purposes, been divided into a number of squares, each spanning half a degree of latitude and one degree of longitude. These squares are again divided into four equal parts (a,b,c and d). The numbering system of these squares is shown in Figure 3.2. Furthermore, the total area around the island is divided into nine subareas (Fig. 3.2), four of which (subareas 4-7) comprise the "cold water" area and the remaining the "warm water" area, as they are traditionally referred to in Iceland. The total number of cod tagged in each square is shown in Figure 3.3.

The number of returns per 1000 tonnes landed by the various fleets fishing for cod at Iceland in 1949-1965 are given in Appendix Table I.5. In all periods, except for the Faroes in 1948-1952, the returns per unit landed are by far the highest for the Icelandic vessels. However, experience has shown that some of the tags, recovered by the Icelandic fishing fleet, have gone unreported. Nevertheless, since the Icelandic returns seem to be the most complete, they are used as a standard with which to compare those from other fleets. The results of using the values given in Appendix Table I.5 to calculate the returns

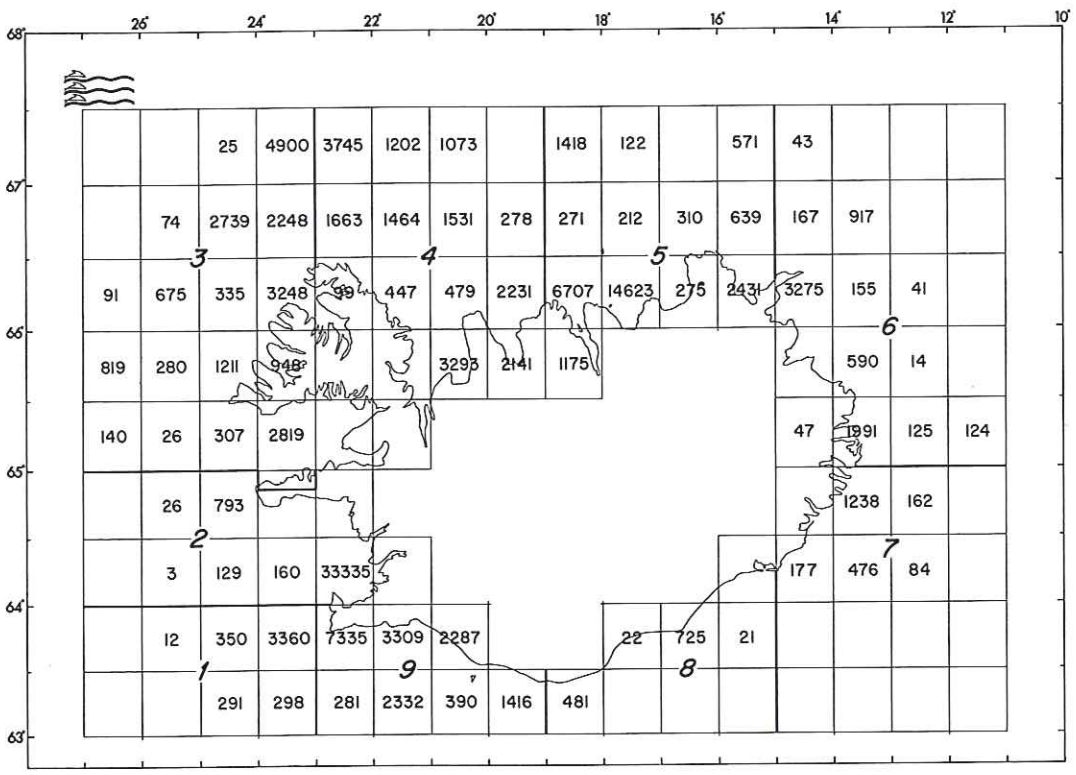


Figure 3.3. Total numbers of cod tagged in each statistical square in 1948-1986.

per unit landed of other nations as percentages of the Icelandic values, are given in Table 3.2.

Until 1965, most of the taggings were carried out inside the Icelandic fishing limits. This is probably the reason for the higher Icelandic returns per unit landed as compared to other fleets. The high Faroese returns in the years 1948-1952 confirm this. At the time, the Faroese could fish with handlines in the same areas as the Icelandic vessels. However, after the extension of the Icelandic fishing limit in 1952 and again in 1958, there was a conspicious decline in the Faroese returns of tags per unit of catch landed. This is most likely because the Faroese vessels were then obliged to fish farther offshore than prior to the extension.

In 1968 a total of 5,314 cod were tagged, mainly in deep waters of the then interna-

Table 3.2. Returns of cod tags by foreign fleets relative to that of Iceland. The return rate of the Icelandic fishing fleet is set at 100.

Period	*Iceland*	*England*	*Faroes*	*W. Germany*	*Norway*
1948-52	100	24	100	34	63
1953-58	100	37	50	37	34
1959-65	100	29	15	81	47
1948-65	100	31	47	52	41

Table 3.3. The total number of tags returned from the 1968 tagging and average returns/1000 tonnes landed by the main fleets fishing for cod at Iceland.

	Iceland	*England*	*Faroes*	*W. Germany*
Number returned	502	144	4	15
Tonnes landed in 1969	281,680	95,386	2,579	19,368
Number returned per 1000 tonnes	1.78	1.51	1 .55	0.77

tional fishing grounds in Subareas 4 and 5. The returns until November 1970 are given in Table 3.3.

The main tagging area was an important fishing ground for English trawlers but not so much frequented by German vessels, as can clearly be seen by the lower returns per unit of catch landed. In comparison with the taggings before 1965, the English and Faroese returns of tags derived from this experiment were higher and the German returns lower.

As will be shown later, there was a fairly rapid dispersion of the tagged fish into the international fishing area. Therefore, the location of the taggings can hardly be the main cause of the variations between fleets in numbers of returns per unit landed. The more numerous Icelandic returns are most likely due to the fact that a large part of the Icelandic catch is taken with other gear than trawl, *i.e.* handlines, longlines and gillnets.

Furthermore, each individual fish passes through the hands of many persons. As a rule, the fish is brought ashore just a few hours after it has been caught. Marked fish, which were not detected on deck are likely to be spotted in the factories where light conditions are much better than on a trawler in the darkness of night or under adverse weather conditions.

On the other hand, we do not have reason to believe that there were any drastic changes in the efficiency of tag reporting among the various countries fishing for cod at Iceland during the period, which would invalidate our estimate of the apparent total mortality as calculated from the tag returns.

4. Estimation of mortality

The use of tagging data to estimate mortality in a population of fish is based on the assumption that the tagged fish are subjected to the same fishing effort and natural mortality as the population at large. Furthermore, it is presumed that the tagged fish are uniformly mixed with the untagged population.

For calculations of mortality rates the method described in Beverton and Holt (1957) is used. First, the apparent mortality rate Z', is computed from:

$$Z' = \ln(N_t/N_o) \qquad (1)$$

where N_o denotes the number of fish tagged at a certain time, and N_t denotes the number of fish recaptured t units of time later. This, Z', of apparent removal from population during a certain period of time, is affected by fishing, natural mortality, tagging mortality, loss of tags from living fish, non-reporting of captured tags and emigration of tagged fish. Thus:

$$Z' = F+M+X \qquad (2)$$

where F is the instantaneous fishing mortality rate, M denotes the natural mortality rate and X is the sum of all the other causes mentioned above.

4.1. The spawning population

A summary of all liberations and returns from tagging experiments in the period January-May on the spawning grounds off the south and southwest coasts of Iceland (Subareas 1, 8 and 9, see Fig. 3.2), is given on an annual basis as well as by 5 year periods from 1948 to 1967 (Appendix Table I.6). However, the five years periods prior to 1963 are incomplete, since before that time taggings were not performed annually in Subareas 1, 8 and 9. There was a steady rise in the value of Z', from 1.26 in the period 1948-1952 to 1.64 in 1963-1967, the average for all the years being 1.49.

As mentioned before, these values of Z' include F, M and X as defined by (2). It is possible to estimate the magnitude of X by comparing the values for Z' with estimates of the total mortality rate, Z, in the spawning population. Such estimates were obtained in the study of spawning zones in otoliths collected during the years 1930-1964 (cf. Jónsson 1960).

Rollefsen (1933, 1935) described spawning zones in the otoliths of the skrei (mature cod) in Lofoten and demonstrated how these could be used to estimate the total mortality in the mature part of the stock. According to the spawning zones, the spawning stock could be divided into spawning classes. Thus, first time spawners had no visible spawning zone in their otoliths. Maturing or mature second time spawners had one visible spawning zone and so on. The number of fish in each spawning class decreased fairly regularly, and this reduction was assumed to be caused by the total mortality.

Among the Icelandic cod, spawning zones are easily distinguished in the otoliths of the mature fish and seem to be formed annually after maturity is reached. The spawning population was thus divided into spawning classes as mentioned above. The yearly mortalities were expressed as the average mortalities evaluated from the first six spawning classes in year n and compared to the estimated fishing effort in year n-1. In this way, the total instantanous mortality rate, Z, for the spawning

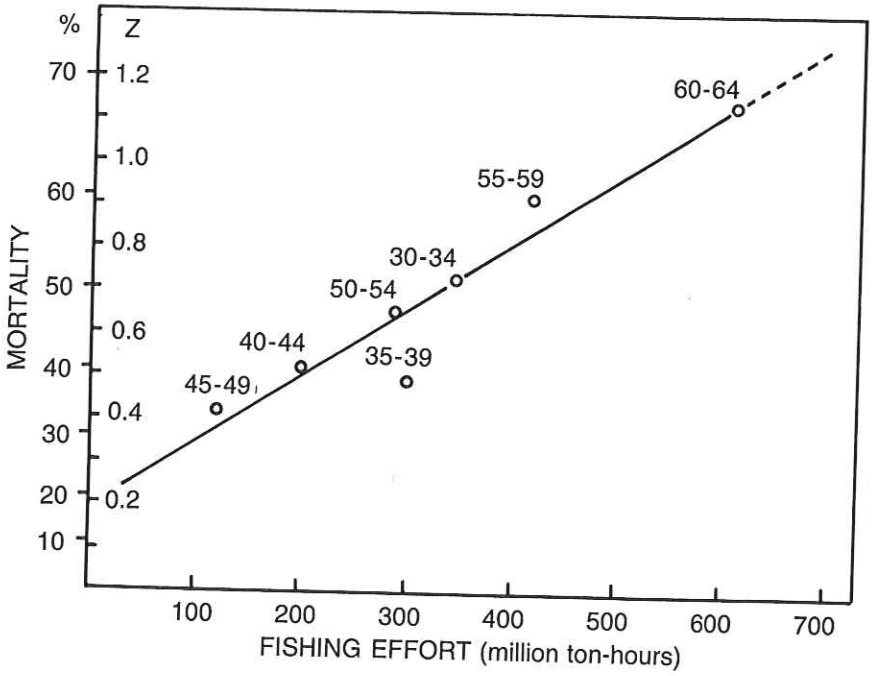


Figure 4.1. Comparison of Z, as calculated from spawning zones, and the international fishing effort in Icelandic waters in 1930-1964.

population of the Icelandic stock of cod could be estimated for the years 1930-1959 (Jónsson 1960).

Estimates of the fishing effort on cod in Icelandic waters are given in Appendix Table I.7 (Anon. 1971). A comparison of the Z values with the international fishing effort in Icelandic waters (Jónsson 1960) gave an M value of 0.17 (Fig. 4.1). These estimates depend on the assumption that fishing mortality remains stable within each group of years for which Z is computed. In cases when effort increases, the resulting estimates of Z may become underestimates.

A comparison of the average values of Z and Z' with the international fishing effort in the same periods is given in Table 4.1 and Figure 4.2. The high positive correlation between these two sets of data and changes in total mortality, caused by variations in fishing effort, are reflected in the same way. The difference between the two estimates of mortal-

Table 4.1. Comparison of Z' as calculated from tagging experiments in Subareas 1, 8 and 9 in January-May. Z calculated from determinations of spawning cod (spawning zones) in the same area and the total fishing effort. VPA: Virtual population analysis.

Years	*Z' Taggings*	*Z Spawning zones*	*VPA*[1)]	*Average total fishing effort*
1948, 51, 52	1.26	0.70	0.59	292
1953, 56, 57	1.42	0.85	0.68	408
1960, 61	1.62	1.32	0.82	667
1963-1967	1.49	1.44	1.07	660
Average	1.64	1.08		

[1)] Age groups 7-12 years. (Schopka, pers. comm.)

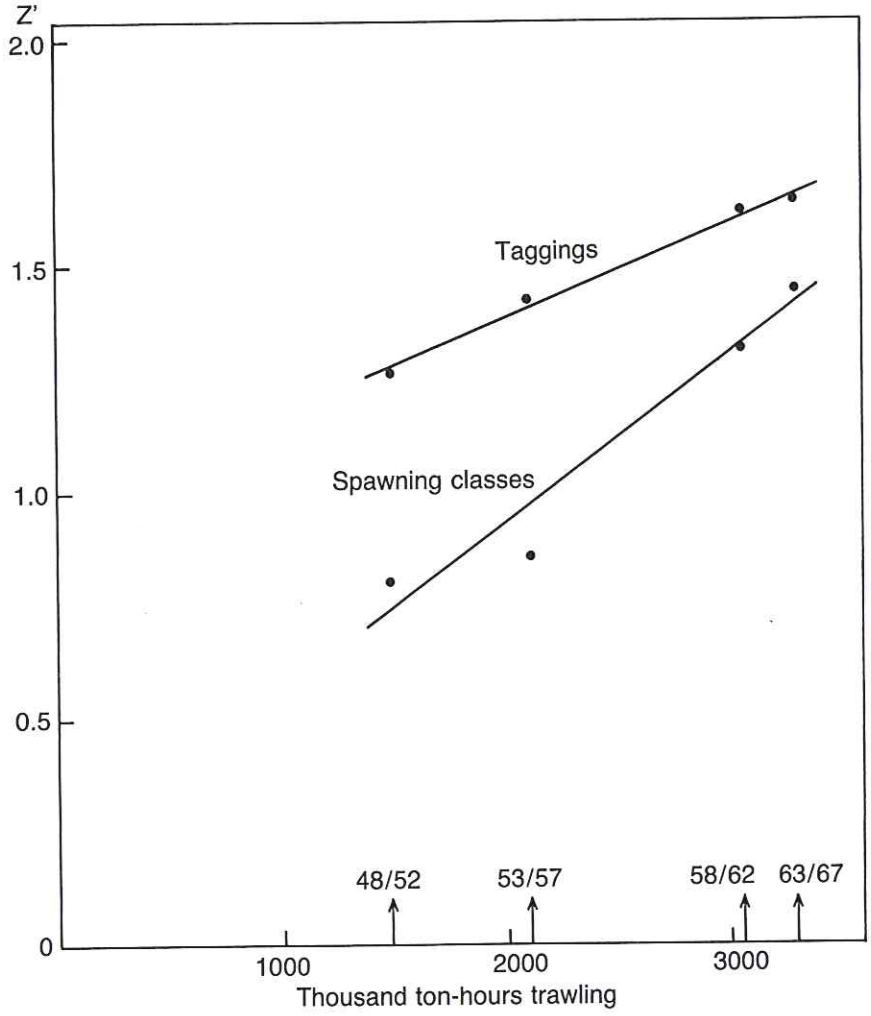


Figure 4.2. Comparison of the apparent total instantaneous mortality rate, calculated from tagging experiments (Z'), and the total instantaneous mortality rate, as calculated from spawning zones in the otoliths (Z).

ity varies from 0.56 in the years 1948-52 to 0.20 in 1963-67. The average value of Z in the years 1948-67 was 1.08 and the average for Z' in the same period was 1.64. The difference, $X = (F + M + X) - (F + M) = Z' - Z = 1.64 - 1.08 = 0.56$, is an estimate of X alone and does not include M. This is somewhat lower than the value of 0.63 found by Jones (1966) for X + M among Faroese cod.

4.2 The immature population

Values of Z' from tagging experiments in some north Icelandic fjords during May to September 1948-1970 are given in Appendix Table I.8. The wide range of Z' is consistent with annual and local variations in fishing effort. The lowest mean values of Z' were found in Þistilfjörður and Bakkaflói on the northeast coast of Iceland, 0.54-0.71, but in the other fjords the average Z' values varied from 0.97 to 1.12.

The tagging in Skjálfandi was the most comprehensive and, therefore, considered representative for the main fishing areas in the coastal waters off North Iceland. The annual number of recaptures from tagging experiments, carried out in May - August during the

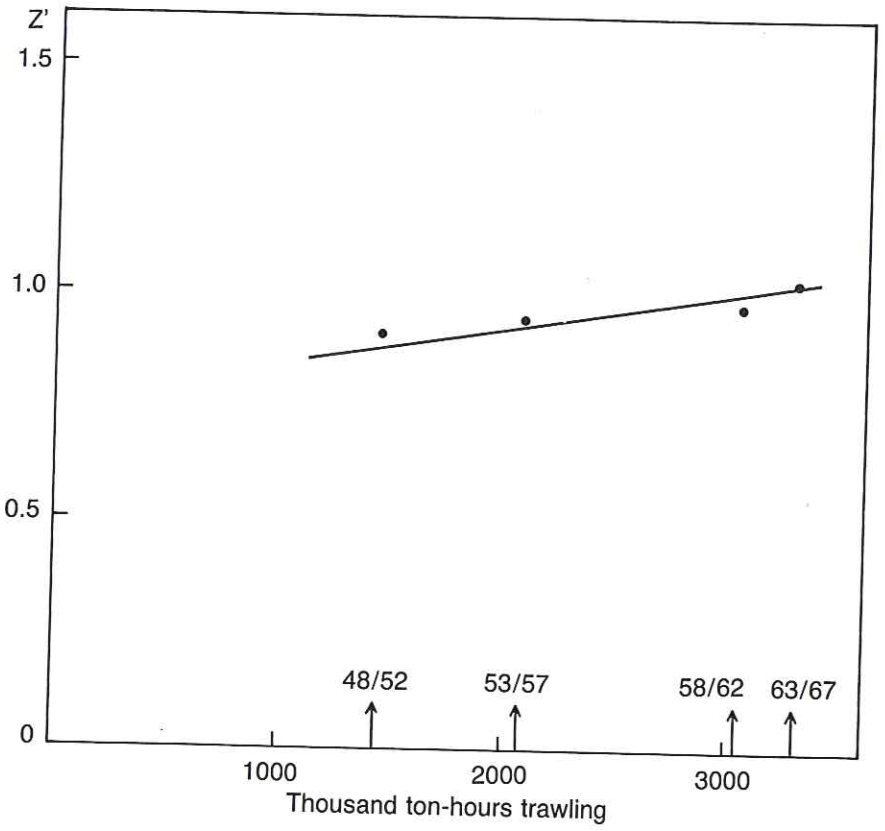


Figure 4.3. Comparison of Z' as calculated from tagging experiments in Skjálfandi and the international fishing effort.

period 1950-1970, are given in Appendix Table I.9. The values of Z' are calculated as previously described. There was a conspicuous increase in Z' during this period, from 0.91 in 1950-1952 to 1.06 in 1963 and 1.33 in 1968-1970. This is clearly correlated to the increased international fishing effort during this period (Fig. 4.3). However, the slope of the regression line for the immature cod is not as steep as that for the spawning population. Furthermore, these results must be qualified. A part of the recaptured fish was caught on the spawning grounds and were thus sexually mature.

In order to assess the values of X from these experiments, it is possible to compare them to the estimates of F from a virtual population analysis of the immature part of the Icelandic cod stock, based on data from 1960-1969 (Anon. 1971). With an M estimate of 0.2, a mean value of F was found to be 0.46. The mean average value of $Z' = F + M + X$ from the tagging experiments, carried out in 1960-1969, was 1.20. The value of X, the tagging mortality alone, is therefore estimated from $X = Z' - (F + M)$ as $1.20 - 0.66 = 0.54$, which is almost the same as the value of 0.56 for X, as estimated earlier for the spawning stock.

4.3 Mortality among the various size groups

Values of Z' for 10 cm length groups at tagging, over five year periods during 1948-1986 are given in Table 4.2. The average values of Z' are lowest for the smallest fish, *i.e.* 0.85 for the 40-49 cm length group, increasing to a maximum of 1.80 for the 80-89 cm length group and declining again to 1.22 among the 100-109 cm length group.

Table 4.2. Mortality and length at tagging. Z' values for the various length groups by five year periods.

Length (cm) at tagging	*Periods when tagged*								
	1948-50	*1951-55*	*1956-60*	*1961-65*	*1966-70*	*1971-75*	*1976-80*	*1981-86*	*1948-1986*
40-49	0.82	–	0.68	1.24	1.03	0.79	0.61	0.79	0.85
50-59	1.11	1.26	1.15	1.41	1.19	1.32	1.39	0.72	1.19
60-69	1.29	1.29	1.13	1.19	1.08	1.44	1.32	1.41	1.27
70-79	1.40	1.40	1.34	1.36	1.80	1.15	1.44	2.12	1.50
80-89	1.52	1.15	1.23	1.95	2.18	2.10	1.88	2.35	1.80
90-99	–	1.29	1.37	1.25	1.90	1.42	1.49	–	1.45
100-109	–	1.25	0.88	1.43	1.16	1.47	1.15	–	1.22
110-119	–	–	1.60	–	1.10	–	–	–	–
120-129	–	–	–	–	–	–	–	–	–
70-89	1.43	1.32	1.42	2.00	1.95	1.93	1.26	2.19	

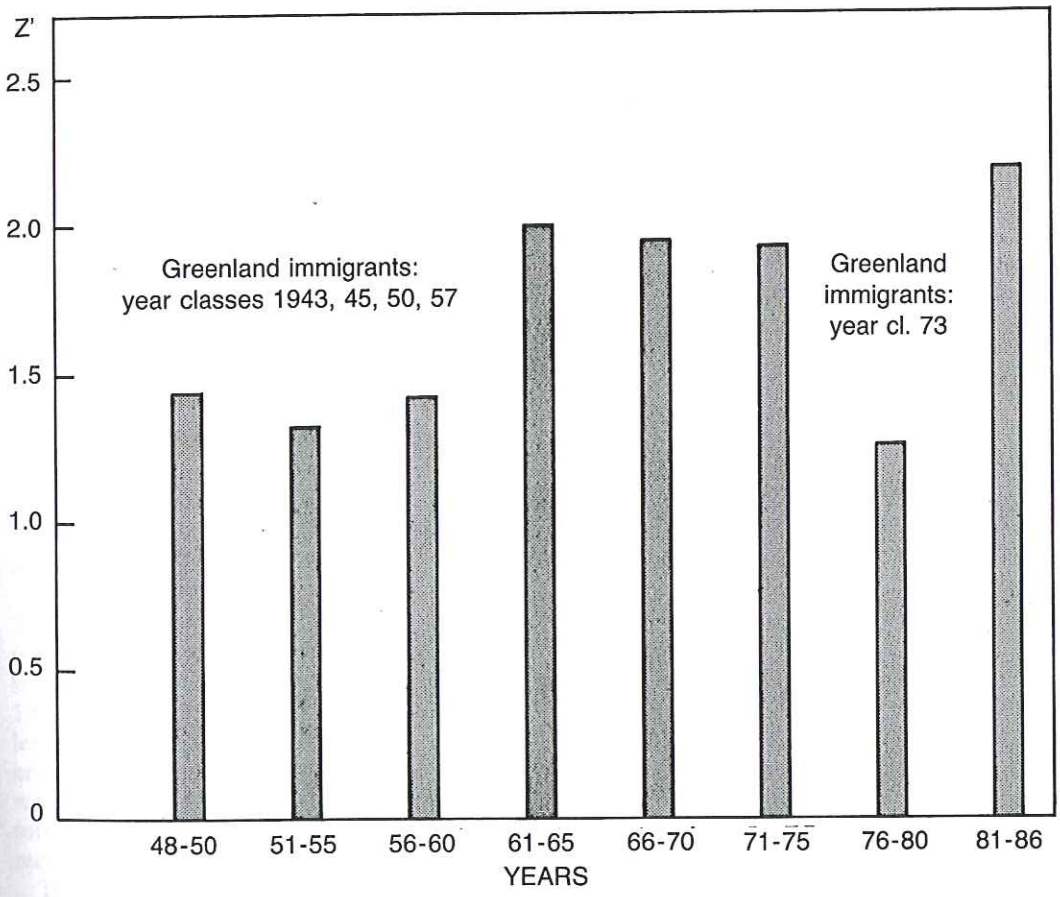


Figure 4.4. Z' values calculated from returns of 70-89 cm cod at tagging. In five year periods.

Figure 4.4 shows the Z' values for the 70-89 cm length groups in five year periods. The Z' values are clearly lower in the 1950s than later on. This is not only due to a reduced fishing effort, but also coincides with a large scale immigration of the very large 1945 year class from Greenland to the Icelandic spawning grounds in 1953. This year class was very abundant in the Icelandic and West-German trawl fisheries at West- and South-Greenland in 1952 and 1953 as well as in the Greenland fishery (Jónsson 1957, 1958). By 1955 cod of the 1945 year class had become scarce in the West-German catches at South-Greenland, but together with the 1947 and 1949 year classes it constituted, on the other hand, the main part of the East-Greenland cod stock in 1956 (Bückmann 1956).

Schopka (1993) pointed out that although the 1945 year class was of an average size at Iceland, it nevertheless dominated completely the Icelandic fishery of spawning cod in 1953-1956. According to revised estimates of fishing mortalities, two thirds of this year class, caught in Icelandic waters, were immigrants from Greenland. If no fish of the 1945-year class had immigrated in 1953, the expected biomass of 8 years old cod at Iceland would have been around 200,000 tonnes. In actual fact, the biomass of this year class at Iceland was more than 900,000 tonnes in 1953. This addition to the spawning population was bound to lower the fishing mortality as shown in Figure 4.4.

The average biomass of the spawning stock of cod at spawning time in 1956-1960 is estimated at 1,094 thousand tonnes, but had been reduced to 565,000 tonnes in the 1966-1970 period (Anon. 1993). There was a simultaneous rise of Z' in the 70-89 cm length group from 1.42 to 1.95 (Table 4.2 and Fig. 4.4).

Other Greenlandic immigrants to the Icelandic fishing grounds belong to the year classes 1950, 1953, 1956, 1961, 1962, 1963, 1973 and 1984 (Schopka 1993, 1994; Buch *et al.* 1994). Thus, the reduction of Z' in the 1970s may, in part, be explained by immigration of cod from Greenland.

5. Migrations

The length distribution of tagged cod, described in the following sections, is given in Appendix Tables I.10a, 10b, 10c, 10d, and I.11a, 11b. The tables also show the mean length and age of the tagged cod and the mean length (and age) of the recovered fish at tagging. A comparison of such data is informative of the possible variability in tagging mortalities among size and/or age groups. In general, there is little variation of this nature in the data. Exceptions are noted in the text.

A selection from the taggings in the years 1948-1986 will be considered below. In the following illustrations, the tagging area is designated by a square, while each recapture is represented by a black dot. The figures accompanying each dot denote number of months at liberty. If the number of days at liberty was between 15 and 30, the fish were assumed to have been at liberty for a whole month.

5.1 Taggings on the spawning grounds

In 1949-1968 a total of 7,772 cod were tagged in 69 different experiments during the spawning season, mainly in the area between Vestmannaeyjar and Reykjanes (Subareas 9 and 1).

The returns from several taggings made during the height of the spawning season in the second half of April and the first week of May 1951 are shown in Figure 5.1. The average length of the tagged fish was 83.8 cm. The average length of the recaptured fish at tagging was 77.8 cm, indicating a somewhat higher return rate of the smaller fish. Most of the recovered fish were 7-8 years old at tagging.

The single two years old fish tagged was recaptured in Faxaflói about 4½ years after tagging. Otherwise, out of a total of 94 returns from the Vestmannaeyjar tagging, 48 were taken south of Reykjanes in Subareas 1 and 9. All but two of the fish were recaptured in the year of tagging, most of them within one month. There were two returns in the second year and none thereafter.

Sixteen fish were returned from Subarea 2, most of them having spent from two weeks to three months at liberty. However, there was one return every year in this area up to the fourth spawning season after tagging.

The 15 returns from Subarea 3 may be divided into two groups. The first contains recaptures from near the coast as well as several fish taken inside Ísafjarðardjúp (square 623). The other group of returns came from deeper waters, mainly in square 674. Most of the returns were from the year of tagging. One return was obtained in square 674, 23 days after tagging indicating a minimum speed of 10.6 naut. miles per day. This fish was caught by an Icelandic trawler. It was 4 years old and 71 cm when tagged.

Another notable return was from square 664 after 23 days at liberty. This fish was tagged in the same area as the fish mentioned above but three days later. No otoliths are available, but the length at tagging was 82 cm. The minimum speed of this fish was 15.9 naut. miles per day.

Most of the returns obtained from east of the tagging area, off the south and east coasts, are from a single tagging of relatively small fish, carried out on May 5, 1951. All the returns from Ísafjarðardjúp came from this experiment as well as those recaptured off the central north coast (square 619) at the end of January in the following year.

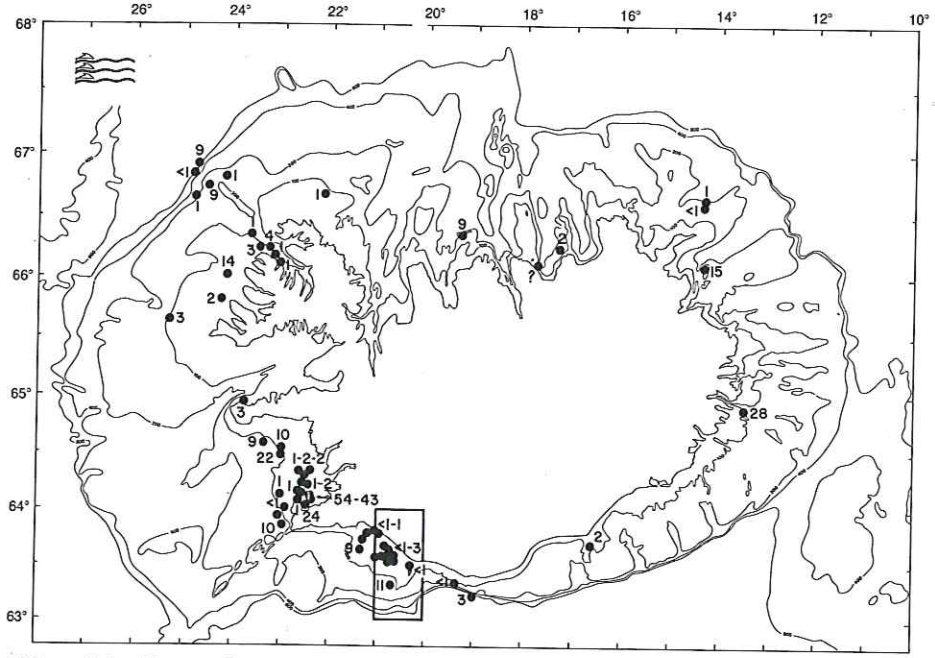


Figure 5.1. Returns from tagging experiments 27-30 and 34-35. Locality: Off Loftstaðahóll and west of Vestmannaeyjar. Squares 370 and 320. April 16-20 and May 5-6, 1951. Depth 51-100 m. Type of tag: Petersen disc (silver wire). Total tagged 934, recaptured 94 (10.1%).

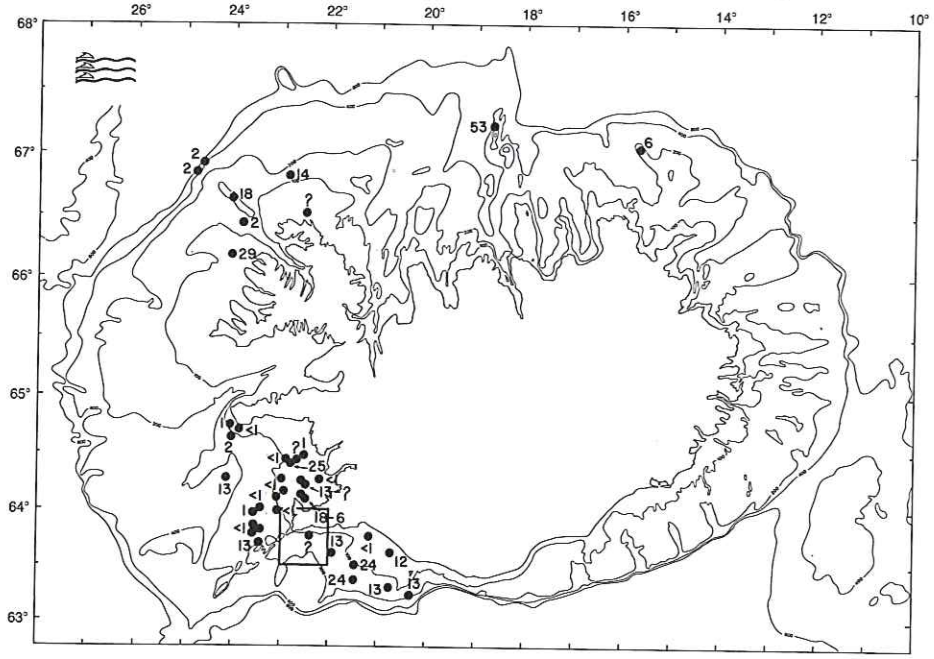


Figure 5.2. Returns from tagging experiment 162. Locality: Miðnessjór. Square 372 a, March 22, 1958. Depth 114 m. Types of tags: Petersen disc (stainless steel), 100 tagged, 8 recaptured (8%). Alcathene red (braided nylon), 100 tagged, 18 recaptured (18%). Alcathene blue (braided nylon), 99 tagged, 25 recaptured (25.3%). Total tagged 299, recaptured 51 (17.1%).

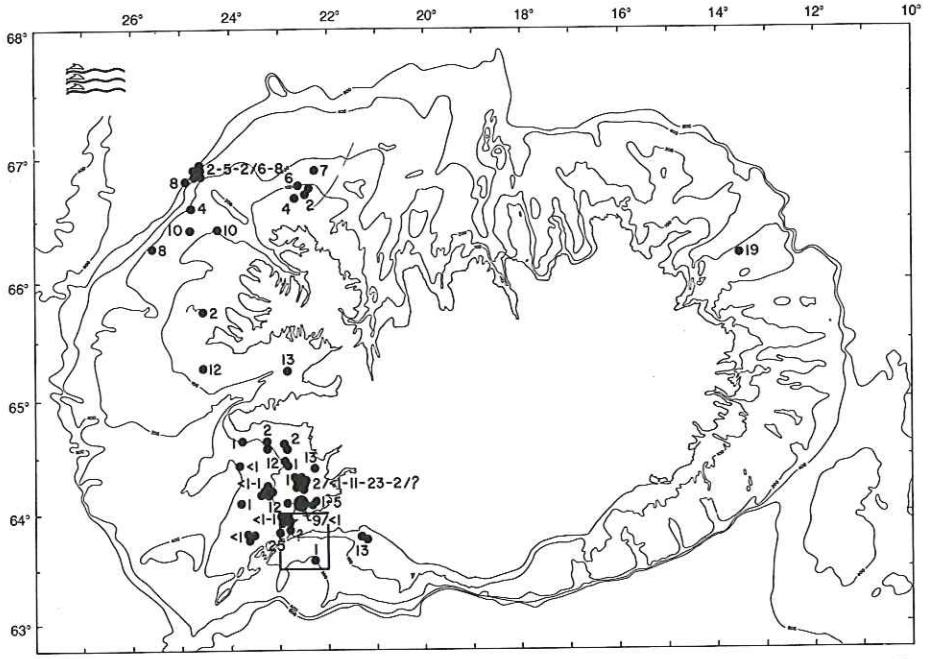


Figure 5.3. Returns from tagging experiment 250. Locality: Miðnessjór. Square 372 a, March 19, 1963. Depth 105 m. Type of tag: Alcathene red (braided nylon). Total tagged 442, recaptured 73 (16.5%).

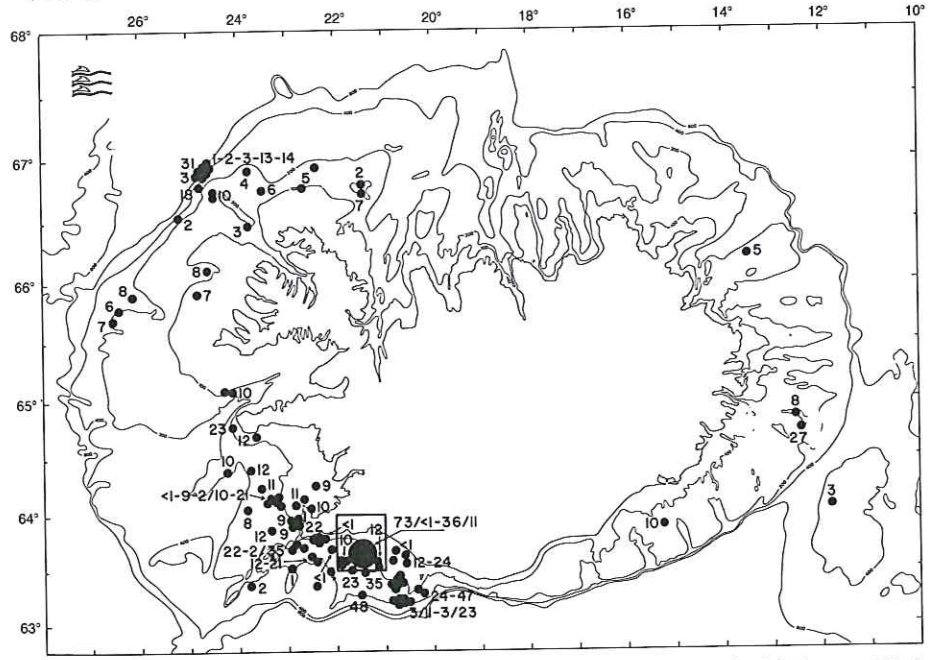


Figure 5.4. Returns from tagging experiments 285-290. Locality: Selvogsbanki. Square 371 d. April 24-28, 1965. Types of tag: Alcathene red (braided nylon). Total tagged 500, recaptured 95 (19.0%). Plastic flag (braided nylon). Total tagged 475, recaptured 124 (26.1%).

A tagging experiment was carried out in Subarea 1, in the near shore fishing area Miðnessjór late in March 1958 (Fig. 5.2). The average length of the tagged fish was 88.9 cm and the average length of the recaptures at tagging 90.1 cm. The main part of the recoveries consisted of 7-9 years old fish.

The distribution of returns was fairly similar to that of the 1951 experiment just described. However, in the season of tagging there was only one return from Subarea 9, which suggests that very few of the tagged fish migrated to this area to spawn or were perhaps on their way back from spawning. The fish spent the usual time in Faxaflói and there were also the familiar returns in Subarea 3.

From the Miðnessjór tagging there are, however, two interesting returns from Subareas 5 and 6. The return from square 718 came from a Faroese handline vessel. The fish had been 53 months at liberty. It was 102 cm at tagging and 117 cm when recaptured, but the age could not be read. Another return was from square 665. This fish was caught in September in the year of tagging by a Norwegian longliner and was 104 cm when released. Finally, one was recaptured by a German trawler on the Dohrn Bank at the end of January 1959. The fish was nine years old and 100 cm at tagging, but the length at recapture was given as 101 cm.

Another tagging of 7-10 years old cod in Miðnessjór in mid-March 1963 showed a similar pattern (Fig. 5.3). The returns were mainly concentrated in Subareas 2 and 3 and the adjacent square 672 in Subarea 4. The 34 returns in Subareas 9, 1 and 2 in the season of tagging were all taken within the first two months, 19 during the first month and 15 during the second. The average number of days at liberty was 25. Six fish were returned in the next spawning season and two in the third one.

The returns from Subareas 3 and 4 were from every month of 1963 during May-November. There were also some returns as late as April 1964 from the southern part of Subarea 3.

The fish tagged during an experiment on Selvogsbanki in late-April 1965, were taken with a purse seine. The cod, caught with this type of gear in the 1965 season, were considerably larger than those caught by gillnets and longlines. The fish were in excellent condition, which is reflected in the high recovery rate (Fig. 5.4). The average length of the tagged fish was 92.8 cm. The age ranged from 4-15 years but the majority was 6-10 years old.

In April and May 1965, all returns but one came from Subarea 9. During the remaining months, most of the recoveries were from Subarea 3 and the westernmost part of Subarea 4. The returns had a fairly even temporal distribution throughout the year apart from a maximum in November. Of the 15 returns from Subareas 3 and 4 in 1965, the majority, or 11 recaptures, were taken by German trawlers. Three were returned by British trawlers and one by an Icelandic vessel. The recoveries from Subareas 6 and 7 were taken in July, October and December.

In the first two months of 1966 most recoveries still came from Subarea 3, but in March the majority were taken in Subarea 9, and a few in Subareas 2 and 3. The highest number of recoveries was obtained in Subarea 9 in April, but after May 1966 there were no recoveries from that area. There were very few recoveries from Subarea 3 during the latter part of 1966, only one in May, two in June and one in November. In 1967 only one fish was recaptured in March in Subarea 3. There were 11 returns from Subarea 9, all but two in April. Furthermore, two returns were obtained in Subarea 9 in 1968, three in 1969 but none after that.

5.2 The post-spawners

5.2.1 Distribution according to area and depth

The migrations and distribution of the Icelandic cod after spawning have not been studied in detail. Where exactly do the large schools of spawning fish go after spawning? Nowhere in their distribution area are they subjected to such concentrated fishing as on

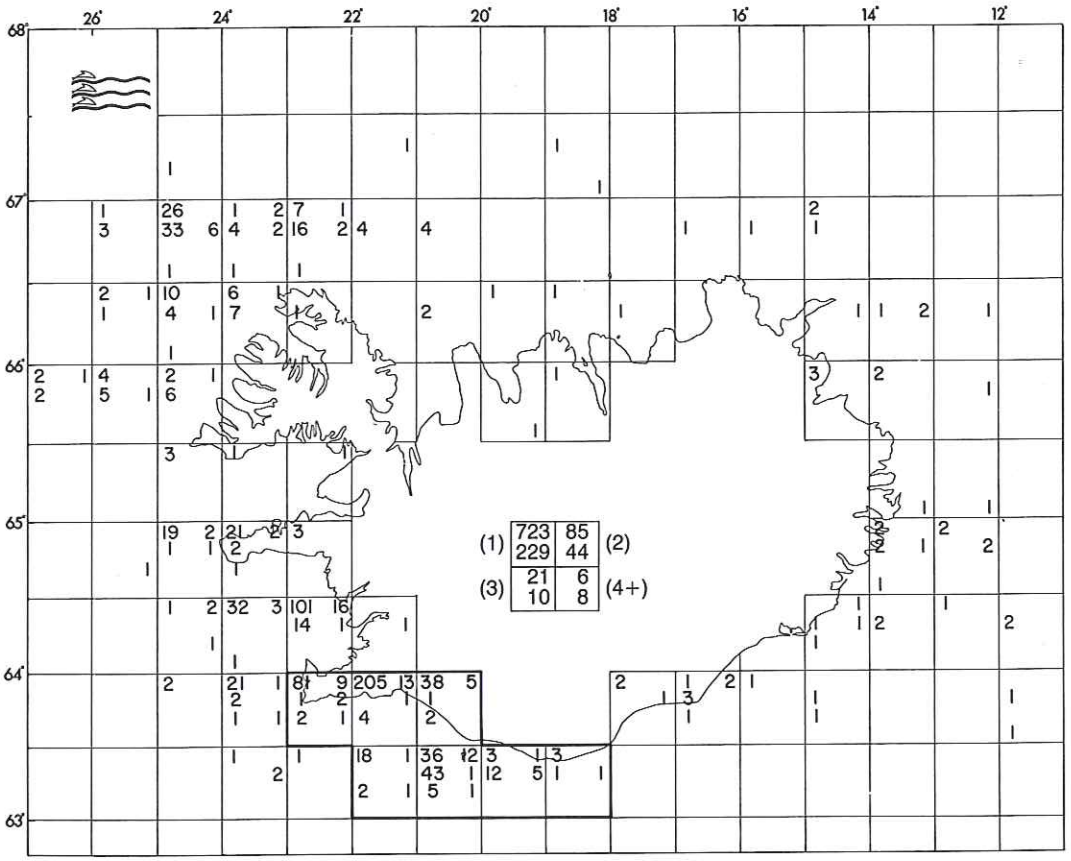


Figure 5.5. Recaptures of cod tagged on the spawning grounds in 1948-1969. The uppermost figures in the left hand corner of each square give the number of recaptures in the first year (1) in the months January - May and the figures below the number of recaptures in June - December. The figures in the uppermost right hand corner denote in the same way the recaptures in the second year (2) and so on. Tagging area in bold lines. The numbering system is illustrated in the centre square, where the total recaptures are also given.

the spawning grounds. From fisheries data it is clear that the cod disperse after spawning and for that reason it has been difficult to follow their subsequent migrations. However, some of them are caught on their way back to the colder waters off Northwest, North and East Iceland, where they mix with concentrations of immature fish during the feeding season.

In the previous description of the results of tagging experiments, carried out on the spawning grounds, the migration of the post-spawners was described in some detail. The overall distribution of recaptured cod tagged on the spawning grounds, mainly in the area between Vestmannaeyjar and Reykjanes in the years 1948-1969, is shown in Figure 5.5. A total of 7,979 fish were tagged and 1,102 tags were returned. The recaptures are given for statistical squares, and the returns in the first, second, third and fourth year after tagging are listed in each square. The details of the arrangement are given in the legend to Figure 5.5.

Most of the recaptures were taken in the spawning area (Subareas 9, 1 and 2) during the last part of the spawning season in late

May. Most of the fish captured inside Faxaflói, *i.e.* in Subarea 2, were actually on their way north after having completed spawning.

The distribution of returns outside the spawning area is distinctly concentrated in the area west and north of the spawning grounds. However, a few fish seem to have headed back along the south and east coasts. The number of returns gradually decreases as we proceed clockwise around Iceland. Thus, the highest number of returns, outside the spawning areas, were obtained in Subarea 3, *i.e.* 145 fish out of a total of 247. In Subarea 3 most of the recaptures were taken in square 674 which includes the famous fishing ground Hali. From this square and the adjoining squares 673 and 672 there were a total of 103 returns, *i.e.* 71% of all tags recovered in Subarea 3.

The data given in Appendix Table I.12 indicates that the main fishing effort with respect to the post-spawners in Subarea 3 was generated in May-June, but there were also returns in other months of the year. The months of September and October as well as February-April yielded the least frequent returns, while there was an increase in the period November-January. In January-March most recoveries were from fish on their way to the spawning grounds in the first or second year after tagging. There were very few recoveries off the central north coast, but a certain increase southwards along the east coast.

The distribution of returns by depth is given in Appendix Table I.13. Most of the returns from the spawning grounds came from depths between 51 and 150 meters. Similarly, most of the returns from Subarea 3 during January-May were from waters shallower than 200 meters, mainly in the depth range 100-150 meters. However, in the latter part of the year the fish were taken in deeper waters. Thus, about half of the returns in the months June-December came from depths in excess of 200 meters and 15% of the returns came from waters deeper than 300 meters, compared to an average of 2% from that depth for all post-spawners. The returns from the remaining Subareas 4-7 came from depths between 50 and 350 meters, whereas the recaptures from Subarea 8 were all from within the 51-150 m depth range.

The tag returns just described are given by fleets (nations) in Appendix Table I.14. By far the highest number of recaptures were taken by Icelandic, German and British vessels. German vessels were responsible for the bulk of the recaptures in square 674 (Subarea 3), while British trawlers fished more intensively in Subareas 4, 6 and 7.

5.2.2 The age of the recaptured post-spawners

The age distribution of the recaptured post-spawners is given in Appendix Table I.15. The returns in Subarea 3 cover an age range of 3 to 17 years. The majority of the 86 returns, of which the age could be read, were 8-11 years old fish. In Subarea 4 the age distribution of the fish was from 7 to 15 years and in Subarea 6 the returns also had a wide age range of 4-15 years.

It is well known that there is a distinct dominance of older fish in the Icelandic spawning fishery in Subarea 7 and the easternmost part of Subarea 8. The average length of the spawning fish also decreases as we move clockwise around Iceland from the southeast coast. Thus, the average age of the fish recaptured in Subarea 7 was 10.9 years as compared to a mean age of 8.9 years for the recaptures in Subareas 3-6.

Table 5.1. Returns within the first four months after tagging in Subareas 3-7 of cod tagged in Subareas 1 and 9 in 1948-1968. Distance from square of tagging to square of return in naut. miles.

Distance	*Number of returns*
51-100	1
101-150	7
151-200	28
201-250	35
251-300	15
301-350	2
351-400	5
Total number	93
Average distance	220.9

Table 5.2. Returns of cod tagged in 1948-1960 in Subareas 1 and 9 in the spawning season and days at liberty in square of tagging or in adjacent squares.

Days at liberty	*1-7*	*8-14*	*15-21*	*22-28*	*29-35*	*36-42*	*Average no. of days at liberty*
N recaptured in Feb.-Mar.	19	21	15	15	9	4	16.8
Percentage	22.9	25.3	18.1	18.1	10.8	4.8	
N recaptured in April-May	83	61	17	21	3	6	11.3
Percentage	43.5	31.9	8.9	11.0	1.6	3.1	
N recaptured in Feb.-May	102	82	32	26	12	10	12.0
Percentage	37.2	29.9	11.7	9.5	4.4	3.7	

5.2.3 The apparent speed of the returning fish

The apparent speed of the cod returning from the spawning grounds can be estimated by the distance travelled in a known number of days between the localities of tagging and recapture.

The distance covered by the post spawners within the first four months after tagging is given in Table 5.1. The table refers to returns, obtained in Subareas 3 to 7, from taggings in Subareas 1 and 9 during the spawning season. The average distance was about 221 naut. miles, with a range of 70-395 naut. miles. Most of the fish had migrated between 150 and 250 miles when caught.

However, there may be many sources of uncertainty in such calculations. First, we do not know how many days the tagged fish spent in the tagging area before the beginning of the return migration. Secondly, the exact route is not known and, third, we do not know how many days the fish had been in the area of recapture before they were caught.

An indication of the number of days spent in the locality of tagging is given in Table 5.2. Returns from tagging experiments in the years 1948-1960 in Subareas 1 and 9 have been grouped in periods of seven days at liberty. The returns are those from the square of tagging as well as from adjacent squares.

Furthermore, the returns have been divided according to periods, *i.e.* whether the taggings were carried out in the months of February-March or April-May. As expected, the average number of days at liberty is smaller in the latter period, since this is the main time of spawning. In the first period the average number of days at liberty was 16.8 as compared to 11.3 in the second. In April-May 75% of the returns were obtained within the first two weeks after tagging, whereas only 48% were returned in the first two weeks of February-March.

Since the rate of returns is correlated to availability as well as to fishing effort, we can

Table 5.3. Returns in Subareas 3-7 of cod tagged in Subareas 1 and 9 in 1948-1968. The apparent speed of fish from square of tagging to square of recapture.

	Number of fish Period of tagging		
Nautical miles	*16 Mar. - 15 Apr.*	*16 Apr. - 15 May*	*16 Mar. - 15 May*
2.0-2.9	2	1	3
3.0-3.9	11	1	12
4.0-4.9	3	3	6
5.0-5.9	5	7	12
6.0-6.9	2	5	7
7.0-7.9	–	2	2
8.0-8.9	–	–	–
9.0-9.9	–	1	1
10.0-10.9	–	1	1
11.0-11.9	–	1	1
12.0-12.9	–	–	–
13.0-13.9	–	–	–
14.0-14.9	–	1	1
15.0-15.9	–	1	1
Total	23	24	47
Average	4.10	6.10	5.02

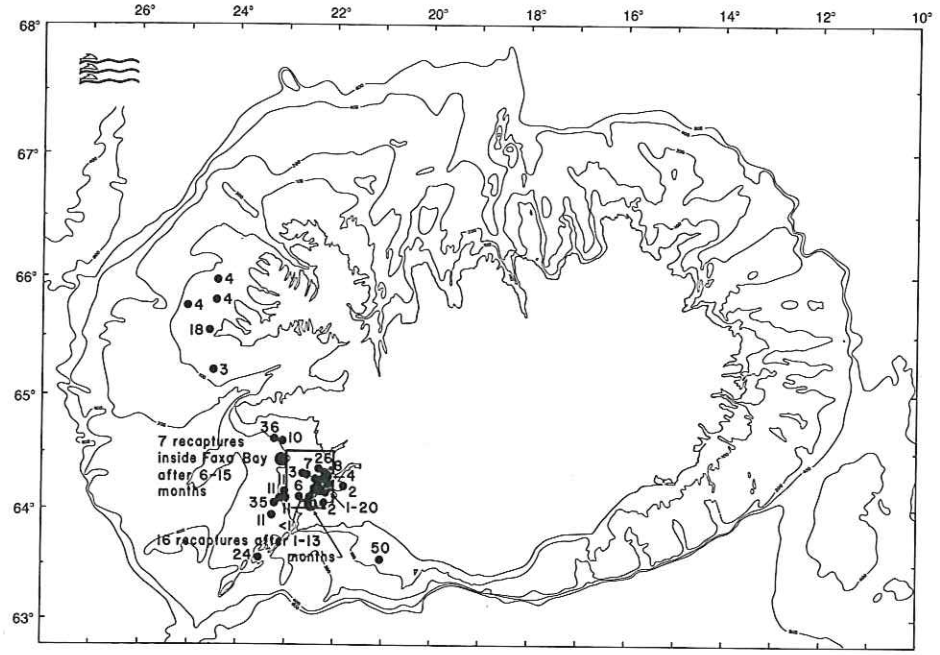


Figure 5.6. Returns from tagging experiment 69. Locality: Faxaflói. Square 422 d, February 28, 1954. Depth 35 m. Type of tag: Lea's hydrostatic (monofilament nylon). Total tagged 200, recaptured 59 (29.5%).

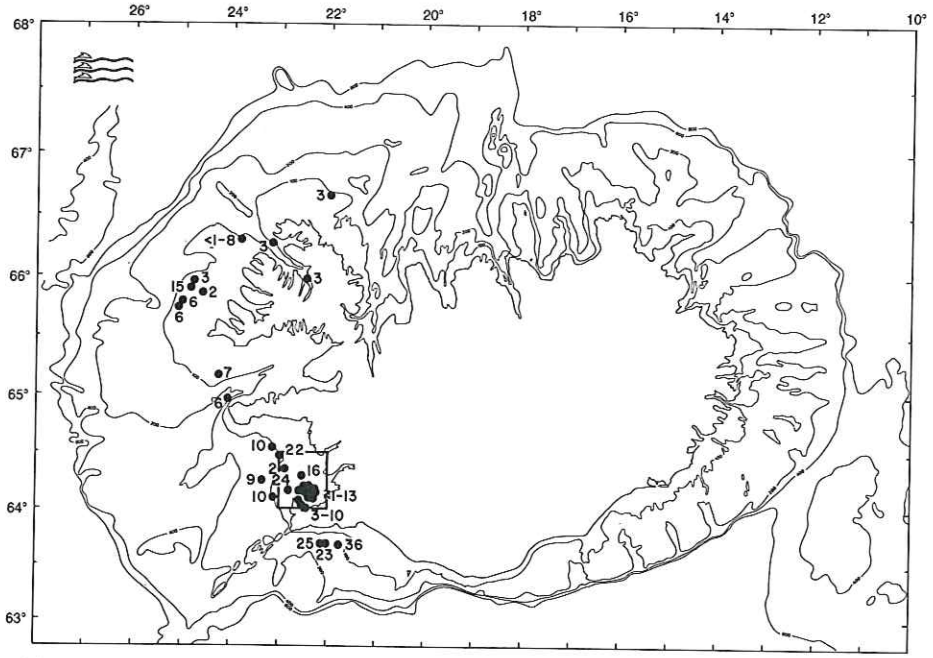


Figure 5.7. Returns from tagging experiment 60. Locality: Faxaflói. Square 422 d, May 6, 1953. Depth 28 m. Type of tag: Petersen disc (stainless steel). Total tagged 460, recaptured 34 (7.4%).

presume that on the average the tagged fish stayed on the spawning grounds for 12 days after tagging, and that the earlier in the spawning season the tagging was performed, the longer did the fish remain at or near the location of tagging.

This is further illustrated in Table 5.3, which gives the calculated apparent speed of cod migrating from the location of tagging to that of recapture. These cod were tagged in Subareas 1 and 9 in the years 1948-1968 and returned from Subareas 3 to 7 outside the spawning season. There is a correlation between the calculated apparent speed and the time of tagging during the spawning season. The average speed of the cod, tagged in the period April 16-May 15 was about 6 naut. miles per day or 0.25 naut. miles per hour. Taking into consideration that the fish may have spent an average of 12 days on the spawning grounds after tagging, we get an apparent minimum speed of 8.6 naut. miles per day or 0.36 naut. miles per hour (Jónsson 1986).

5.3 Tagging in Faxaflói (Subarea 2)

A large number of cod have been tagged in Faxaflói, which is an important fishing area at the southwest coast, between Reykjanes and the Snæfellsnes peninsula (see Fig. 2.1). A few experiments will be described in detail in order to illustrate seasonal variations in the distribution of fish tagged in these waters.

The results of a tagging experiment in Faxaflói at the end of February 1954 are shown in Figure 5.6. All but seven recaptures were taken in the subarea of tagging. There were recaptures within Faxaflói in every month of 1954 and in most months of 1955. The last recoveries in the bay were obtained three years after tagging, showing that most of the fish were stationary. There was one recapture of a spawning fish on Selvogsbanki in the fifth year after tagging. The recoveries in Subarea 3 are from May-July in the year of tagging and one was taken in August of the following year. All of these fish had taken the customary route north and most of them were 5-8 years old at tagging.

From taggings in the same area in February 1955 and 1956, only two fish were recovered outside Faxaflói. Taggings in March and April 1951, 1954, 1958 and 1960 show a similar picture. Of the 441 fish tagged in Faxaflói during these years, a total of 97 were recaptured. Only eight recoveries were taken outside the bay proper.

As indicated by the tagging experiments mentioned in section 5.1, the cod enters Faxaflói on its way back north and feeds heavily on sandeel and capelin which are abundant in this area in late winter and spring. This is illustrated in Figure 5.7, which shows the results from a tagging in the beginning of May 1953. Of the 34 returns, nine were taken in Subareas 3 and 4, most of them in the latter half of the year of tagging. There were 3 fish recovered in Subarea 9, up to 3 years after tagging. These fish could have been on a return migration from the north. The age at tagging of the recaptured fish was 6-11 years. However, most of them were seven and eight years old and thus sexually mature.

Other tagging experiments in Faxaflói in May 1952 and during 1954-1958 show the same general picture (Fig. 5.8).

A tagging in mid-August 1959 indicates a stationary population as shown in Figure 5.9. All recaptures but three were taken inside Faxaflói up to two years after tagging. Most of the fish were immature at tagging, two were 3 years old, 13 were 4 years, one was 5 years and finally one was seven years old when tagged.

Only a few tagging experiments are available from June-July, but they all show a similar picture as that illustrated by Figure 5.9, *i.e.* mostly stationary fish of local origin.

Most of the fish tagged in Faxaflói early in November 1954 were also of local origin as shown in Figure 5.10. All recaptures except 3 were taken inside Faxaflói during the next

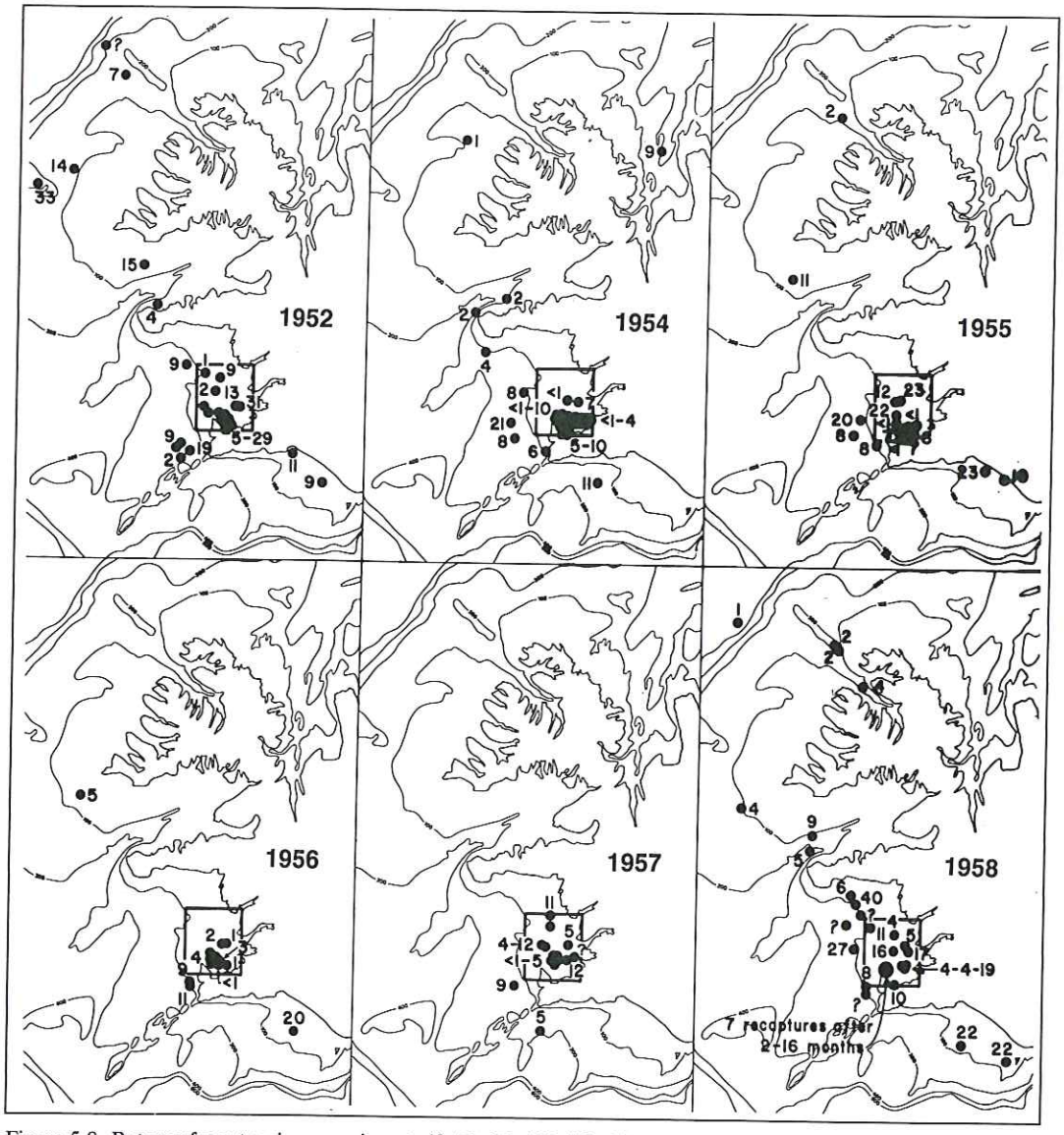


Figure 5.8. Returns from tagging experiments 40, 71, 82, 110-113, 141 and 164. Locality: Faxaflói. May 1952, 1954, 1955, 1956, 1957 and 1958.

three years, but irregularly with regard to time. The fish were mainly 4-8 years old when released, but the average size of the recaptured fish indicates a higher survival rate of the larger individuals.

A summary of the results of the 1948-1965 taggings in Faxaflói is given in Figure 5.11, which shows all returns in the months January-May on one hand and in June-December on the other. Of the recaptures from January-May, 62% were taken inside Faxaflói. The remainder were mainly taken in Sub-

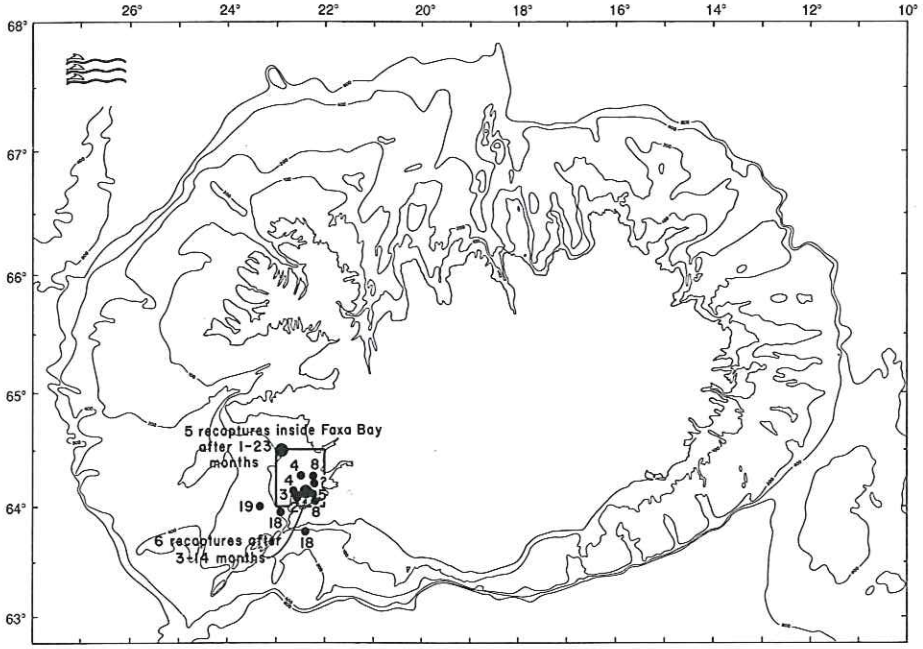


Figure 5.9. Returns from tagging experiment 187. Locality: Faxaflói. Square 422 c. August 14, 1959. Depth 36 m. Type of tag: Lea's hydrostatic (braided nylon). Total tagged 264, recaptured 28 (10.6%).

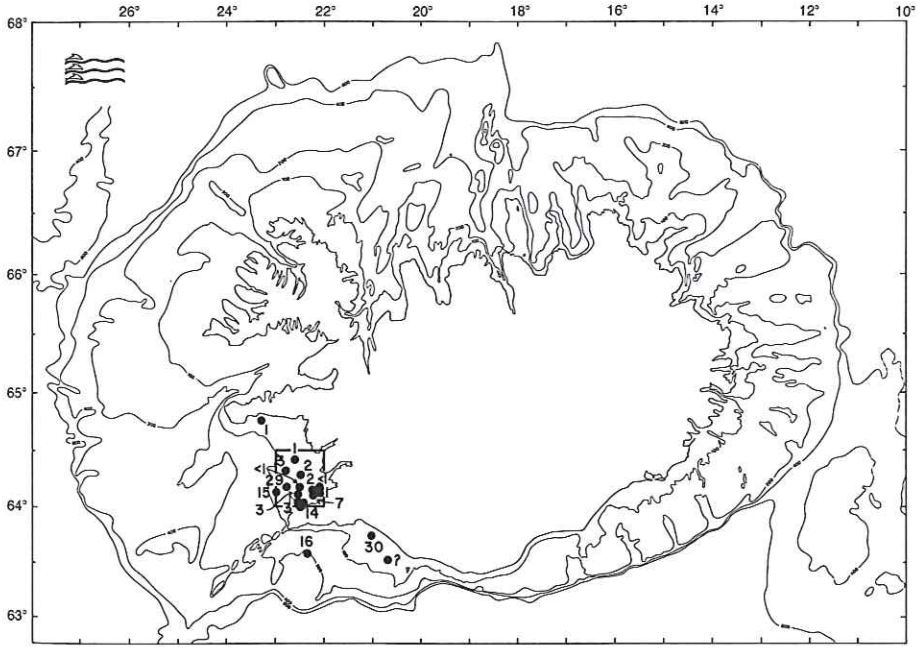


Figure 5.10. Returns from tagging experiment 75. Locality: Faxaflói. Square 422 d, November 6, 1954. Depth 39 m. Type of tag: Alcathene red (braided nylon). Total tagged 150, recaptured 22 (14.7%).

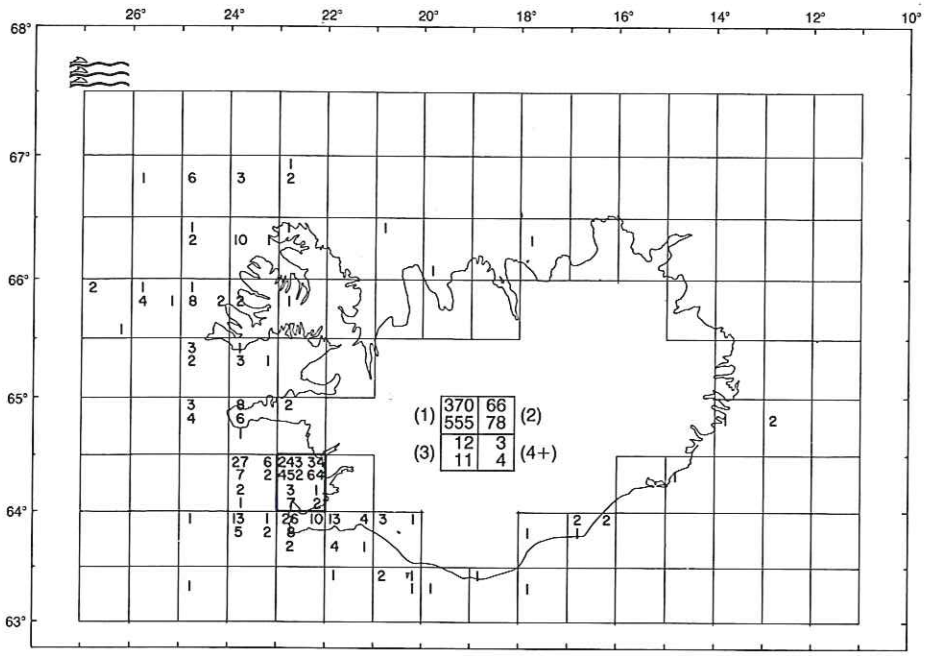


Figure 5.11. Recaptures of cod tagged in Faxaflói during 1948-1965. Returns in January-May and June-December. Figures in each square give total number of recaptures in first, second, third and fourth + year after tagging. The uppermost figures in the left hand corner of each square give the number of recaptures in the first year (1) in the months January-May, and the figures below the number of recaptures in June-December. The figures in the right hand corner denote in the same way the recaptures in the second year (2) and so on. Tagging area in bold lines. The numbering system is is illustrated in the centre square, where the total recaptures are also given.

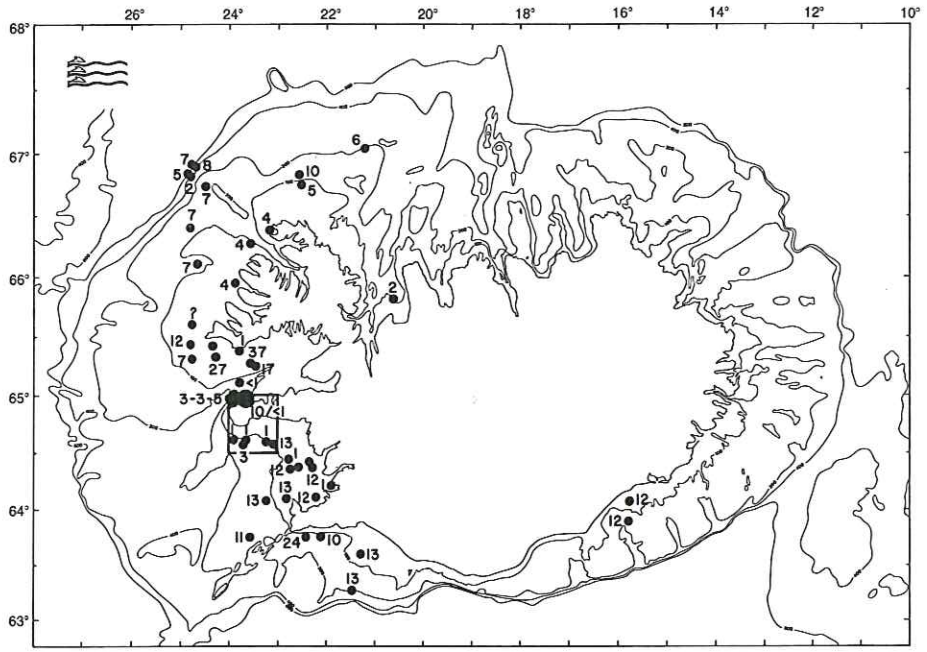
areas 1 and 9, most of them in the year of tagging, but a few were caught much later, or until the fourth year after release. Over 80% of the fish recaptured in June-December were taken inside the Faxaflói proper and the remainder in Subarea 3.

5.4. Tagging in Subarea 3

Most of the tagging in Subarea 3 in the 1950s and 1960s was carried out in coastal waters and inside some of the the numerous fjords on the Vestfirðir peninsula and in the region of Breiðafjörður. After the acquisition of r/s Bjarni Sæmundsson in the beginning of the 1970s, a number of tagging experiments were also conducted in deeper waters farther off the coast.

As illustrated by returns from taggings on the spawning grounds, most of the post-spawners migrate to, and then remain in, the northern part of Subarea 3 and the westernmost part of Subarea 4 during the latter part of the year, whereupon they begin the return migration to the spawning grounds in the beginning of the following year. Presently, we shall discuss the results of some nearshore tagging experiments.

A tagging in Ólafsvík on the north shore of the Snæfellsnes peninsula (square 473 a) at the end of March 1963 is particularly illustrative (Fig. 5.12). The location of this tagging site is in the coastal area off the northwestern part of the Snæfellsnes peninsula. Clearly, this is an area which the cod traverse, either on their



Figue 5.12. Returns from tagging experiment 256. Locality: Ólafsvík. Square 473 a, March 30, 1963. Depth 70 m. Type of tag: Alcathene red. Total tagged 397, recaptured 70 (17.6%).

way south for spawning or north again after spawning has been completed. Most of the recovered fish were 5-10 years old when tagged. The average length of the tagged fish was 75.9 cm, but the average length of the recovered fish at tagging was 79.5 cm. This is a substantial difference, indicating a higher return rate of the larger fish.

The length of the tagged fish shows that they were in part immature. This is also reflected in the distribution of the recoveries. Most of the returns from within the square of tagging were taken in April of the same season, but there were some recoveries as late as August.

The returns from the northern part of Subarea 2 were mainly taken in April/May in the year of tagging, whereas the returns from the southern part of that subarea and from Subareas 1, 9 and 8 were all from March and April in the spawning season of 1964. The returns from Subareas 3 and 4 were fairly evenly distributed in time, covering all months of the year until March 1964.

Most of the fish, tagged in square 574 off Patreksfjörður on the Vestfirðir peninsula in the last week of June 1968, were 4-5 years old and recaptured within the subarea of tagging or in the adjoining squares of Subarea 4 as shown in Figure 5.13. The returns from this tagging, taken in Subareas 2 and 9, were from spawning migrations, and were all obtained during the 1969 spawning season. The returns taken within the subarea of tagging, as well as in Subarea 4, were fairly evenly distributed throughout the year up to 24 months after tagging. This indicates that most of the tagged fish was stationary in the area.

The tagging in Aðalvík (square 623) at the end of August 1959 (Fig. 5.14) showed an almost identical picture to that from the Patreksfjörður tagging just described. All of

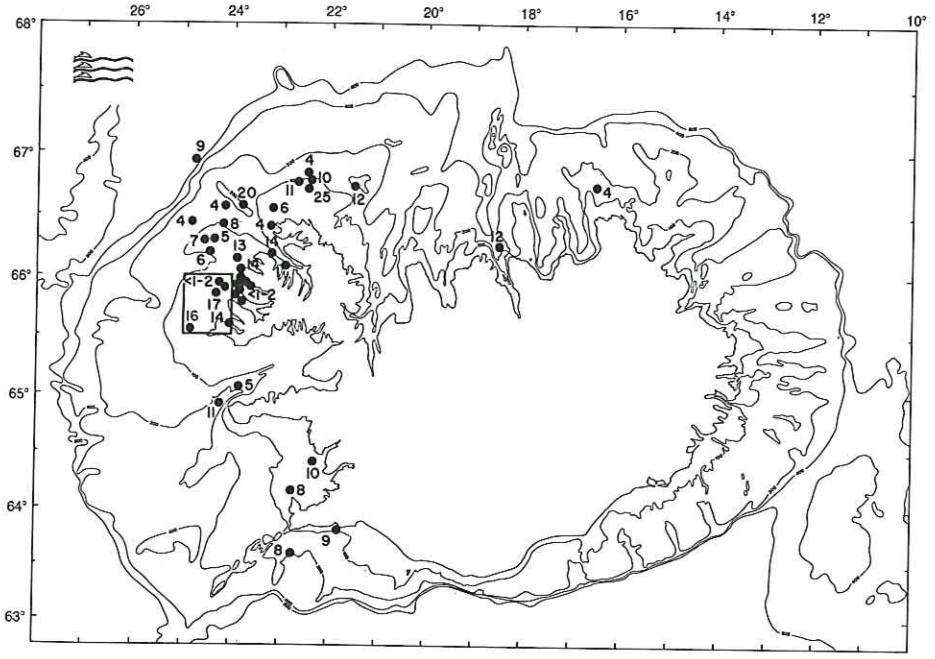


Figure 5.13. Returns from tagging experiment 351. Locality: Off Patreksfjörður. Square 574, June 25, 1968. Depth 48 m. Type of tag: Alcathene red (braided nylon). Total tagged 227, recaptured 41 (18.1%).

the fish which were returned had been 3-5 years old when tagged. Most of the recoveries were from the subarea of tagging and in the adjacent squares of Subarea 4. The fish seem to have left the tagging locality fairly soon. There were five recoveries in the year of tagging, all of them in the first half of November. Then there were no more returns from this area until March of the following year, and in the period March-May six fish were recaptured.

At that time of year there appears to be a certain segregation of the tagged fish depending upon length and age. The fish recaptured in the southermost part of Subarea 3 were of sufficient length and age to be on a spawning migration, whereas the one fish recaptured in square 674 was only 53 cm and 5 years old and, therefore, most likely immature. One fish was recovered at Kolbeinsey (square 718) in the beginning of April of the year after tagging. It was four years old. Furthermore, there were two recaptures off the east coast. The one from square 562, after only 49 days, was of dubious validity because of the short time at liberty. The fish caught in square 412 was taken by a British trawler in the beginning of August 1961. This fish was 5 years when caught and most probably immature.

The fish tagged on Barðagrunn (square 624) in mid-November 1969 yielded a wider dispersion of returns (Fig. 5.15). Compared to previous experiments in this area, a relatively large part of the recoveries came from Subareas 2, 1 and 9. These fish were all taken during the 1970 spawning season (March-April) and were 6-8 years of age. In Subarea 3 there were returns up to 19 months after tagging. In 1970 most of the recovered fish were taken during the first half of the year. The fish were mainly 5-7 years old at tagging.

Judging by the length distribution, part of the cod tagged on the fishing bank of Hali (Squares 673 and 674) in mid-February 1980

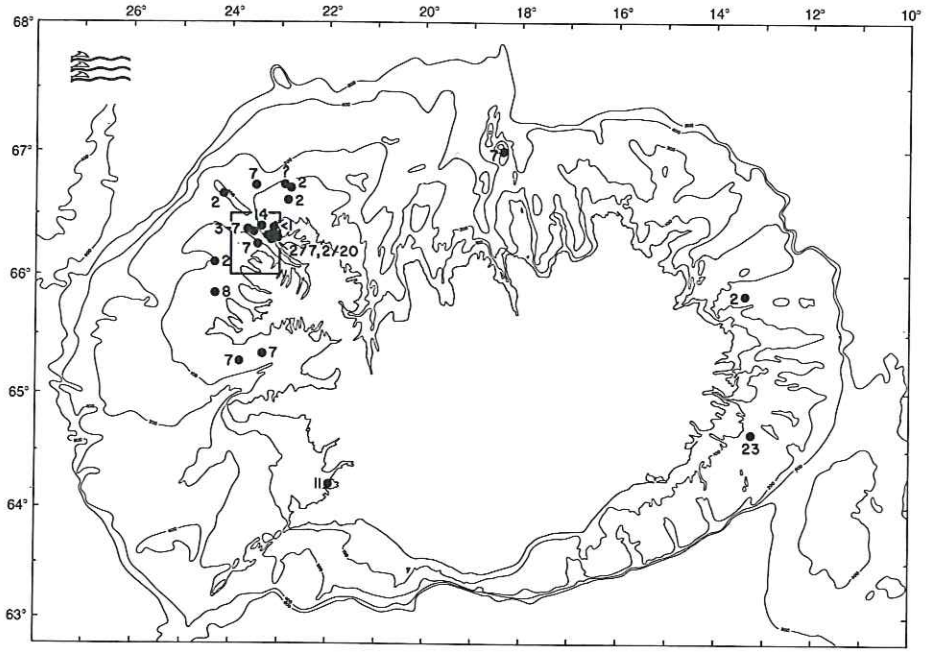


Figure 5.14. Returns from tagging experiment 197. Locality: Aðalvík. Square 623, August 31, 1959. Depth 22 m. Type of tag: Lea's hydrostatic (braided nylon). Total tagged 187, recaptured 23 (12.3%).

(Fig. 5.16) was mature. Most of the recoveries were from the area of tagging. However, there were returns from the southern Breiðifjörður (squares 523 and 524) during February-April and June-July in the year of tagging, indicating spawning migrations. One fish was recaptured in the northernmost part of Faxaflói in the second spawning season after tagging. Finally, there were three recoveries in the third spawning season, *i.e.* in Subareas 1, 9 and 8. The last mentioned fish was recovered at the southeast coast, which suggests a counterclockwise migration.

The results of the tagging experiments in squares 722 and 723 in the last week of July 1980 have been combined and the recaptures are shown in Figure 5.17. These fish were mainly 5-7 years old at tagging. It is remarkable that from this experiments there were no recaptures off the northeast-, east- and southeast coasts. Nevertheless, a certain eastward movement of the fish along the north coast is clearly indicated, mostly in Subarea 4 and in the western part of Subarea 5. The numerous recaptures in Subarea 3 show a southward spawning migration. There was a cluster of recaptures just off the tip of the Snæfellsnes peninsula (square 474), all taken in the course of two and a half week during the latter half of March of the following year. Judging by their age and size, these fish were sexually mature. The three recaptures in the southern part of Faxaflói (square 422) in March-April were clearly related to those taken off Snæfellsnes. The route of the spawning migration is further indicated by the recaptures in Subareas 1, 9 and 8 in April. There were additional recoveries from these areas in the next 4 spawning seasons.

Recaptures from taggings in squares 722 and 723 in late November 1976 are shown in Figure 5.18. Most of the fish were immature, but of the same age as those in the previous experiment and there were only few recap-

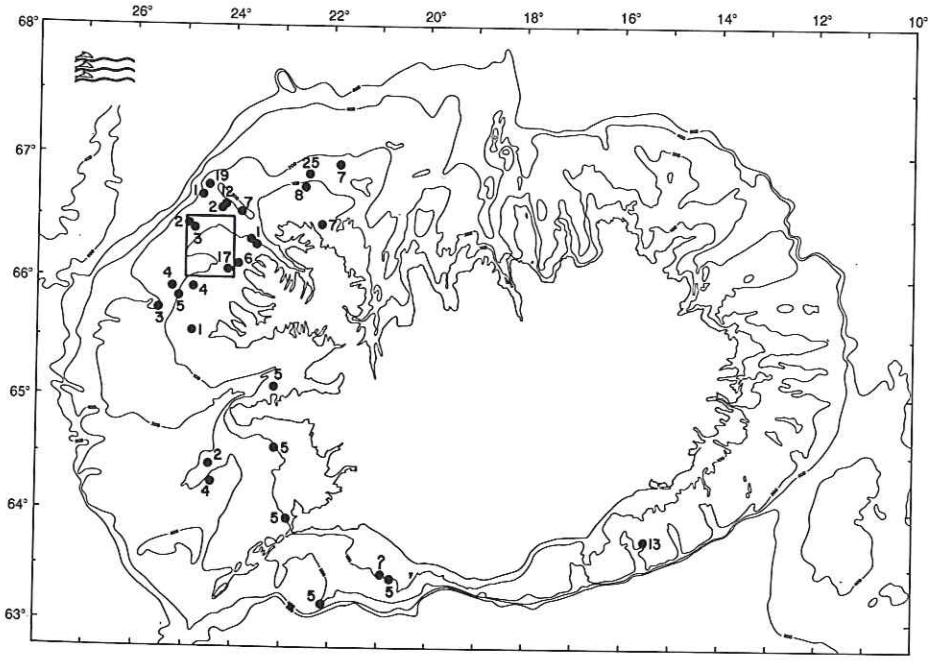


Figure 5.15. Returns from tagging experiment 416. Locality: Barðagrunn. Square 624, November 16, 1969. Depth 128 m. Type of tag: Alcathene red (braided nylon). Total tagged 194, recaptured 35 (18.0%).

tures during the next spawning seasons in Subareas 2, 1 and 9. The bulk of the recoveries from this tagging were from Subarea 3, and to a lesser degree from Subarea 4, showing a distinct movement of the fish to the southwest as well as eastward from the tagging area. Only one return is reported from Subarea 5, and none from Subareas 6 and 7. The single fish caught in Subarea 8 was probably making a round trip after spawning. This tagging area was subjected to a large fishing effort and 56% of the total number recaptured were taken during the first six months at liberty.

5.5. Tagging in Subareas 4 and 5

The first tagging experiment in north Icelandic coastal waters after World War II was carried out in Skagafjörður on the central north coast (square 619) in late May 1948. The experiment was quite successful as shown in Figure 5.19, which highlights the main features of the movements of the juvenile cod in this area. The average length at tagging was 65.3 cm and the tagged fish were 4-7 years old.

Although the returns are distributed all around Iceland, the main part was taken in Subareas 4 and 5. There was a distinct eastward movement of the tagged fish into the nearby Eyjafjörður and Skjálfandi as well as into deeper waters. There were recaptures in the tagging area up to 18 months after tagging. Except for one recapture after two months, most of the recaptures in the nearby Húnaflói were taken 8 to 16 months after tagging. These returns came from all months of 1948 and 1949. In the year of tagging, most fish were returned in July and August, but in 1949 the returns were mainly in April-June. There were three returns taken in May-September 1950.

The returns from Subareas 3, 2, 1, 9, 8 and 7 represent spawning migrations. The first recaptures in the 1949 spawning season came from the northern part of Faxaflói (squares 473 and 422). One fish was taken on March 11

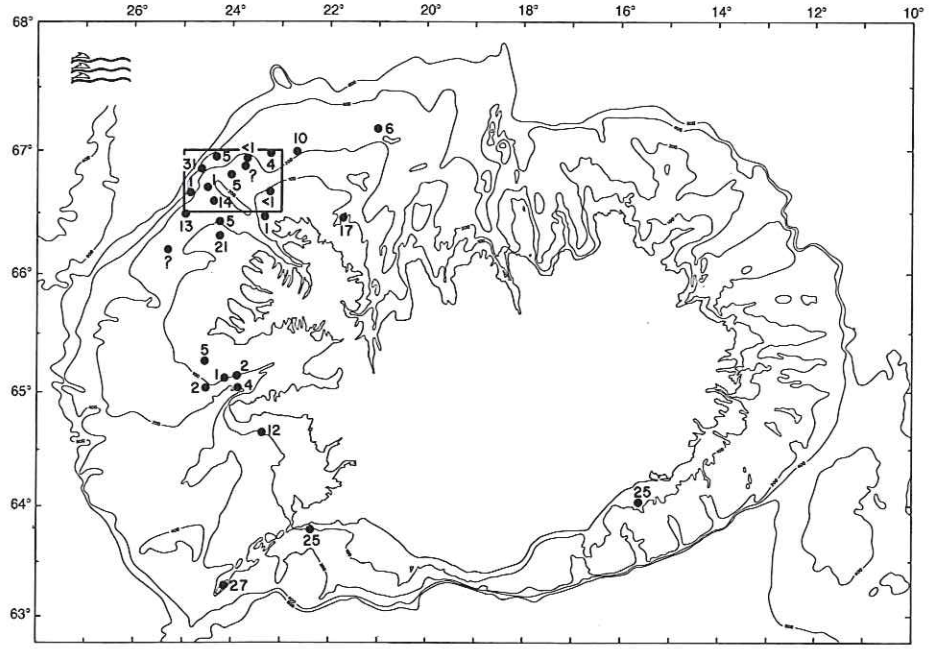


Figure 5.16. Returns from tagging experiments 1043, 1044, 1047 and 1048. Locality: Halamið. Squares 673 and 674. Depth 218-239 m. February 10 and 17, 1980. Type of tag: Alcathene yellow (braided nylon). Total tagged 412, recaptured 44 (10,7%).

and two were recaptured on the following day. These fish were 7, 8 and 10 years old. There were also three returns from Subarea 9 in the same season, all from the latter half of April. These fish were 8 and 10 years old. The returns from Subarea 3 mainly represent fish on their way to or from the spawning areas in the 1949, 1950 and 1951 spawning seasons.

Furthermore, there were returns from Subareas 2, 1 and 9 in the spawning seasons of 1950 and 1951 as well as from Subareas 8 and 7. These recoveries indicate that some of the fish migrated in a counterclockwise direction along the south and east coasts on their way back from spawning. A total of 15 fish from this experiment were taken on the spawning grounds off the southwest and south coast.

As mentioned in section 4.2.2, the taggings in Skjálfandi (square 617) comprise the most comprehensive experiments carried out in the north Icelandic coastal area. Therefore, we will consider some of them together with taggings from some other fjords and bays in this area.

The results of the first tagging in Skjálfandi in mid-May 1952 are shown in Figure 5.20. The average length at tagging was 71.2 cm and most of the fish were 5-8 years old. Compared to the tagging experiment in Skagafjörður in 1948, a much smaller part of the returns came from Subareas 4 and 5. There was a conspicuous lack of returns from Subarea 4, but a considerable number of returns from Subareas 3, 2, 1 and 9. There were also several returns from Subareas 6 and 7.

The returns from Subareas 4 and 5 were all from May-December in the year of tagging and in the following year. Furthermore, one fish was returned from the tagging location in August 1956 and another in August 1961 after respectively four and nine years at liberty. The first of these was 95 cm at recapture and had grown by 41 cm. The length at recapture of the second one is not known.

The returns from Subarea 3 were mainly

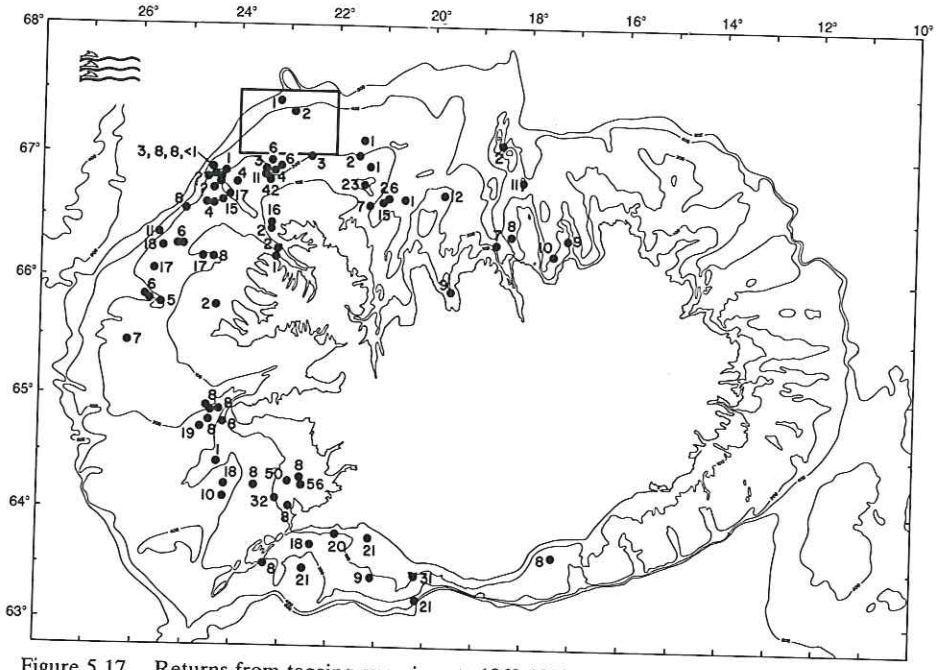


Figure 5.17. Returns from tagging experiments 1062-1070, 1076-1079 and 1083-1085. Locality: Þveráll-Þverálshorn. Squares 722, 723, July 24-29, 1980. Depth 206-260 m. Type of tag: Alcathene yellow (braided nylon). Total tagged 1457, recaptured 119 (8,2%).

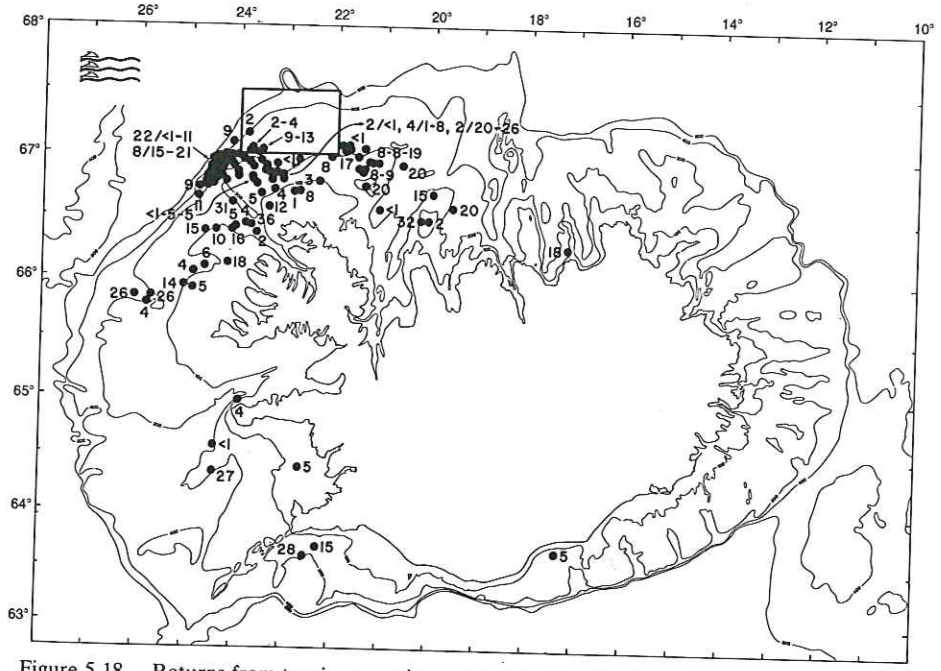


Figure 5.18. Returns from tagging experiments 937-939 and 941-942. Locality: Hornáll-Þveráll. Squares 722-723, November 21-27, 1976. Depth 200-244 m. Type of tag: Alcathene red (braided nylon). Total tagged 1479, recaptured 179 (12.1%).

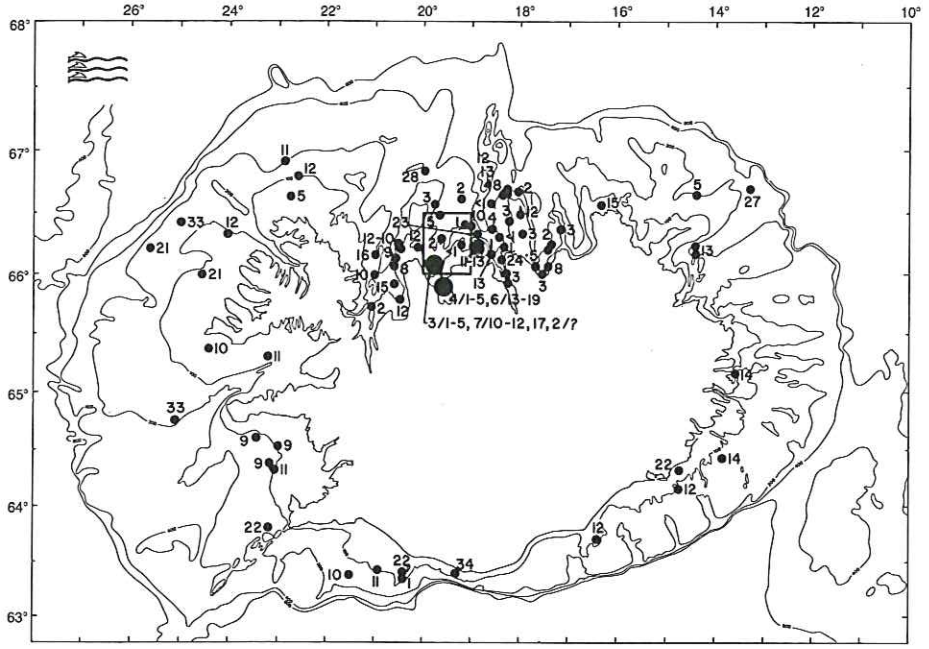


Figure 5.19. Returns from tagging experiment 4. Locality: Skagafjörður. Square 619 c, May 27, 1948. Depth 110 m. Type of tag: Petersen disc (stainless steel). Total tagged 691, recaptured 99 (14.3%).

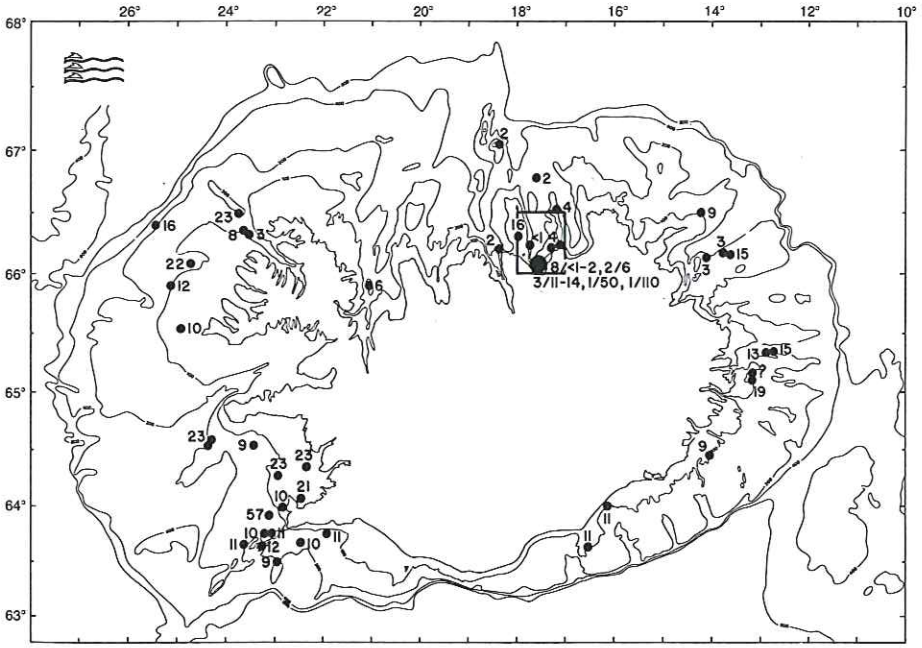


Figure 5.20. Returns from tagging experiment 49. Locality: Skjálfandi. Square 617 c, May 19, 1952. Depth 66 m. Type of tag: Petersen disc (silver wire). Total tagged 467, recaptured 68 (14.5%).

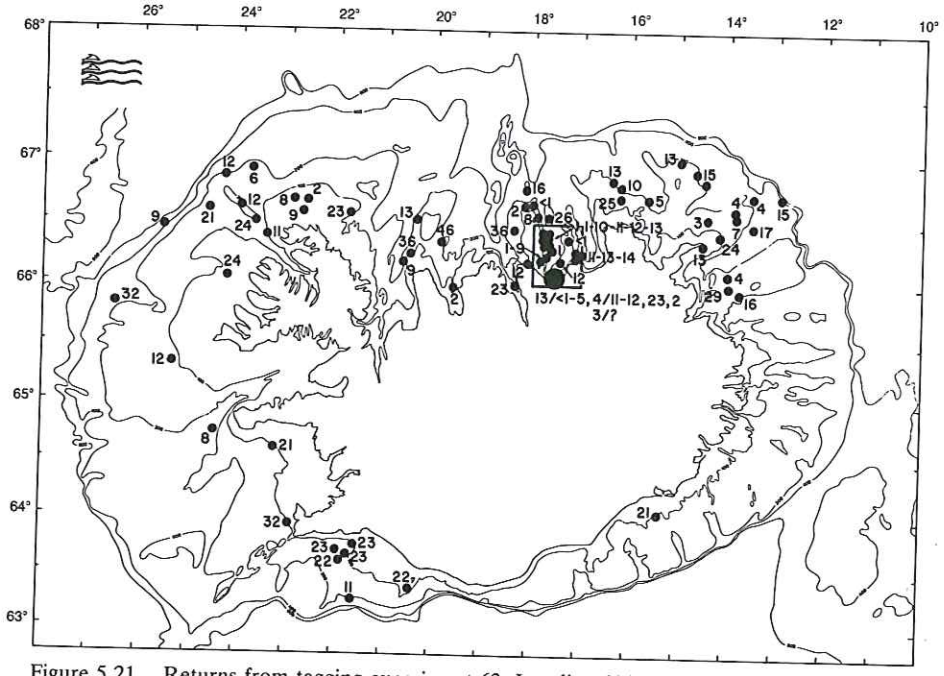


Figure 5.21. Returns from tagging experiment 63. Locality: Skjálfandi. Square 617 c, May 12, 1953. Depth 100 m. Type of tag: Petersen disc (silver wire). Total tagged 1026, recaptured 109 (10.9%).

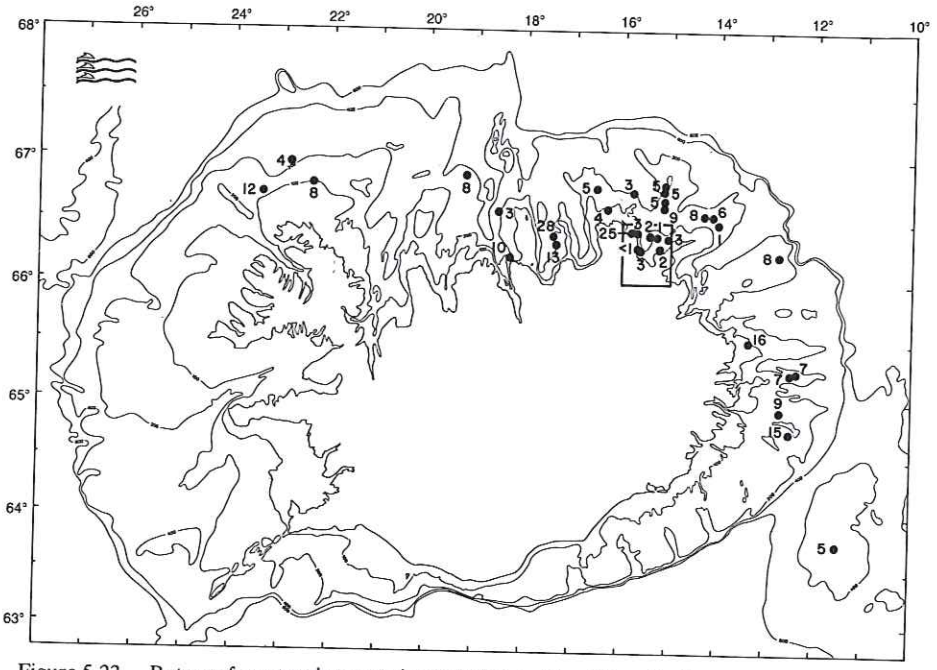


Figure 5.22. Returns from tagging experiment 560. Locality: Viðarvík. Square 615, May 2, 1971. Depth 57 m. Type of tag: Alcathene red (braided nylon). Total tagged 178, recaptured 41 (23.0%).

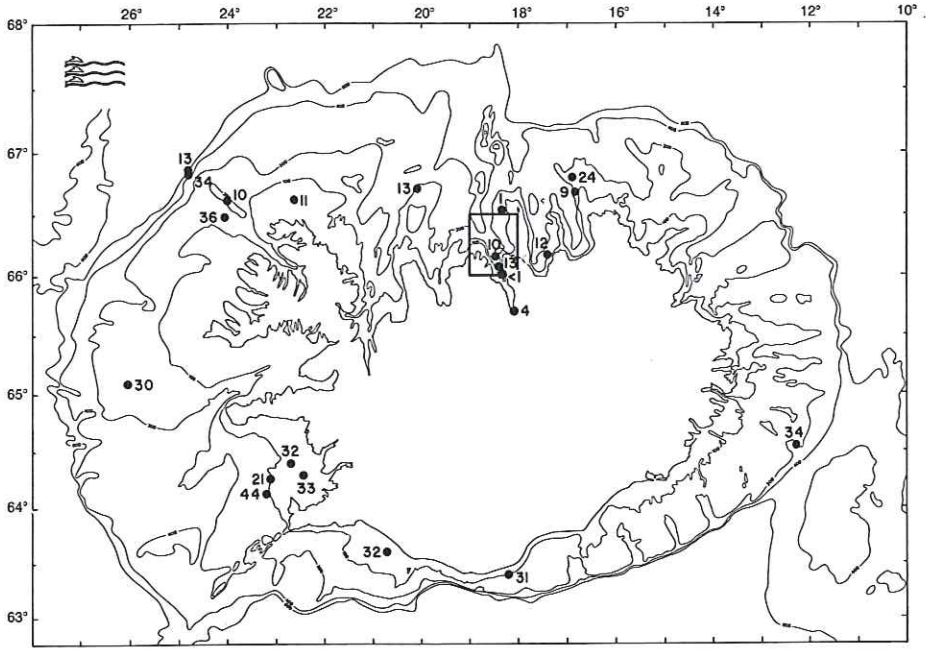


Figure 5.23. Returns from tagging experiment 95. Locality: Eyjafjörður. Square 618 d, July 18, 1955. Depth 122 m. Types of tag: Alcathene red (braided nylon). Total tagged 100, recaptured 6 (6%). Alcathene blue (braided nylon). Total tagged 200, recaptured 25 (12.5%).

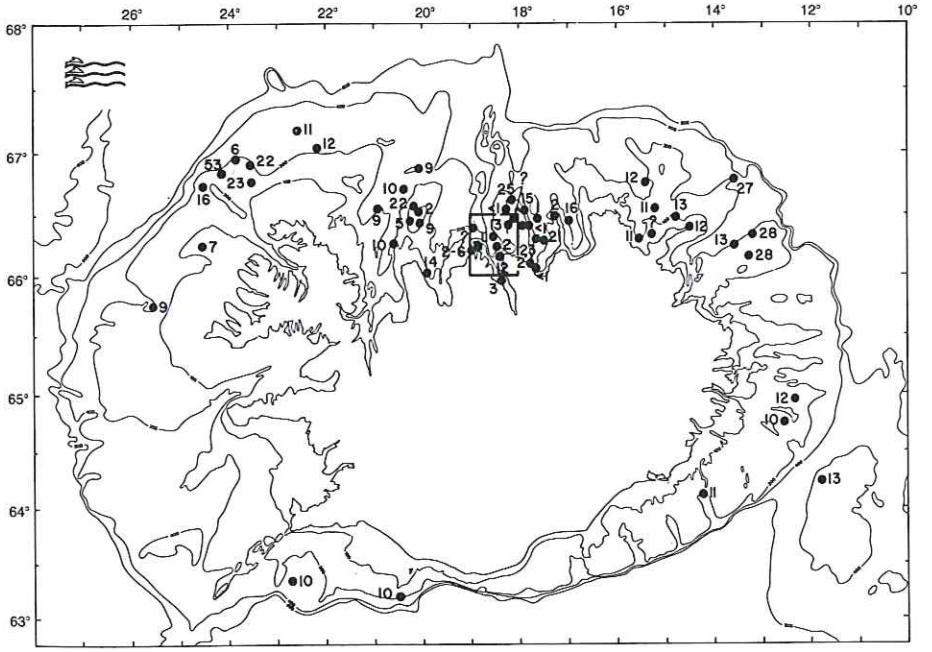


Figure 5.24. Returns from tagging experiment 359. Locality: Grímseyjarsund. Square 618, July 2, 1968. Depth 144 m. Type of tag: Alcathene red (braided nylon). Total tagged 322, recaptured 67 (20.8%).

from the months of March to May. The fish were 7-10 years old and some were probably returning after spawning.

The returns from Subarea 2, 1 and 9 were all from February-May, with the majority taken in April. There were nine returns in 1953 and six in 1954, and finally one in April 1957. That fish was 59 cm at tagging but had grown to 110 cm and was 11 years old when recaptured.

There were several recaptures from Subareas 6, 7 and 8, evenly distributed throughout 1953 along the northeast, east and southeast coasts. The returns from Subareas 7 and 8 were certainly from spawning migrations. The time of recapture indicates that these fish actually took the route southward off the east coast for spawning. Of the 58 returns for which the location of capture is known, 18 or 31% were taken on the spawning grounds at the southwest, south and southeast coasts during the spawning season. Furthermore, there was a distinct concentration of returns in the westernmost part of Subarea 9 and in Subarea 1.

In 1953 cod were again tagged in Skjálfandi at almost the same time as in the year before (Fig. 5.21). In contrast to the 1952 experiment, there were several returns in Subarea 4. The tagged fish were mainly 4-6 years old.

Of the 109 recaptures from the 1953 experiment, 51 came from the subarea in which the fish were tagged. Other returns were fairly evenly distributed in other subareas, with the exception that there was no recapture from Subarea 7 and only one from Subarea 8. There was an obvious concentration of returns in the northern part of Subarea 6 and the eastern part of Subarea 5. The returns from Subareas 4, 5 and 6 were mainly from the months of April, May and June. Most of the returns from these areas were taken in the year of tagging. After that, there was a gradual yearly decline of returns. A total of 33 fish were recovered in 1953, 27 were taken in 1954, 9 in 1955, 4 in 1956 and, finally, 2 in 1957.

The returns from Subarea 3 were mainly from the months of January-May and there were returns until May 1957. The returns from Subareas 1 and 9 were from the months of February to April exclusively, most of them taken in the 1955 season.

A total of 13% of the returns from this tagging experiment was taken in Subareas 2, 1, 9 and 8 during the spawning season.

A tagging of mainly 5 years old cod in Viðarvík (square 615) in the beginning of May 1971, revealed an almost equal dispersion of recaptures along the north and east coasts (Fig. 5.22). The fish from the Viðarvík tagging remained up to 3 months in the area and one was caught there in May two years later. There was a striking absence of any recaptures on the main spawning grounds at the southwest coast, which could be due to the fact that usually there is some spawning of cod at the north and east coasts.

The returns from a tagging experiment in Eyjafjörður (square 618) in mid-July 1955 are shown in Figure 5.23. The age of the tagged fish was 4-7 years, and the recaptures were fairly evenly distributed. However, there was only one return from the southeast and east coasts.

The first returns from the spawning grounds in Subareas 2 and 9 were taken in April 1957, but most of the returns from these areas were from February-May 1958. The same is true of the returns from Subarea 3, indicating that most of the tagged fish became mature in 1958.

Most of the returns from a tagging experiment on Grímseyjarsund (squares 617-618) in the beginning of July 1968 were taken off the central north coast (Fig. 5.24). The average length at tagging was 56.8 cm, whereas the average length of the recaptured fish was 60.3 cm at tagging. The returns from Subareas 3 and 9 show the typical spawning migrations, and returns in Subareas 7 and 6 indicate a circumnavigation after spawning.

The cod tagged at Kolbeinsey (square 718) in the beginning of July 1973 mainly consisted of

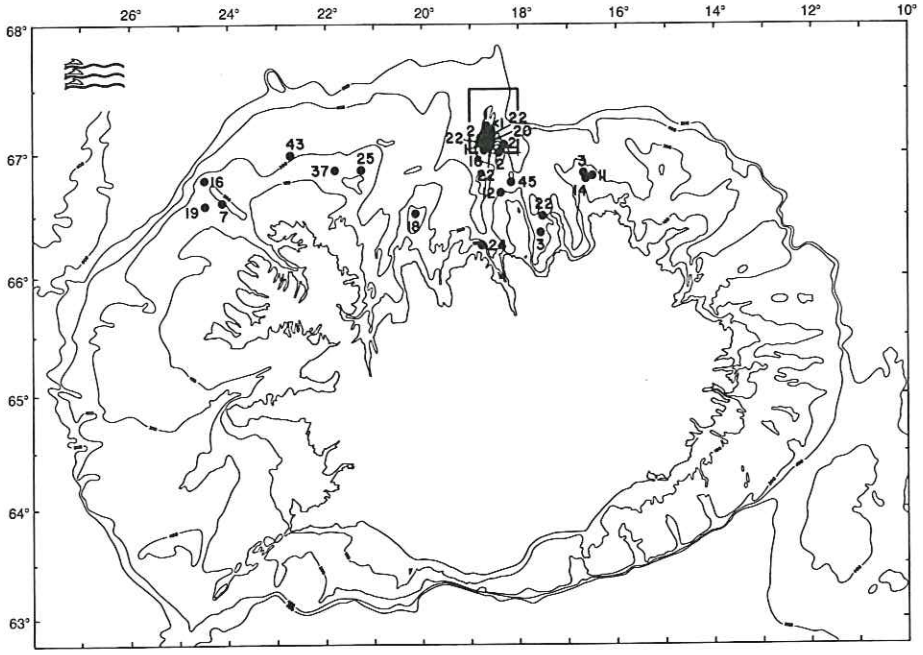


Figure 5.25. Returns from tagging experiments 751 and 752. Locality: Kolbeinsey. Square 718, July 5, 1973. Depth: 130-220 m. Type of tag: Alcathene red (braided nylon). Total tagged 398, recaptured 48 (12.1%).

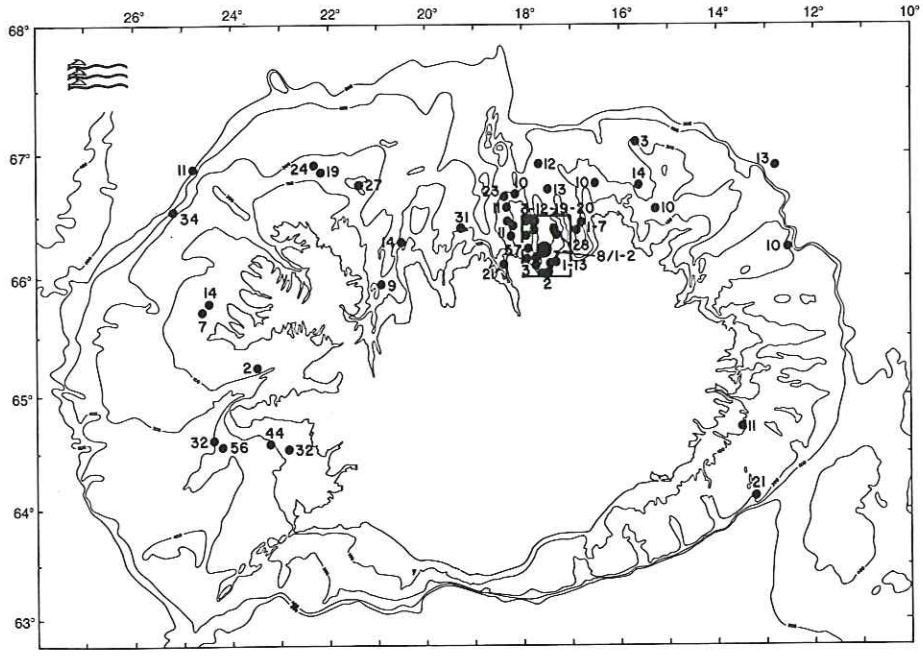


Figure 5.26. Returns from tagging experiment 215. Locality: Skjálfandi. Square 617c, July 22, 1960. Depth 135 m. Types of tag: Lea's hydrostatic (stainless steel). Total tagged 222, recaptured 45 (20.3%). Lea's hydrostatic (braided nylon). Total tagged 178, recaptured 22 (12.4%).

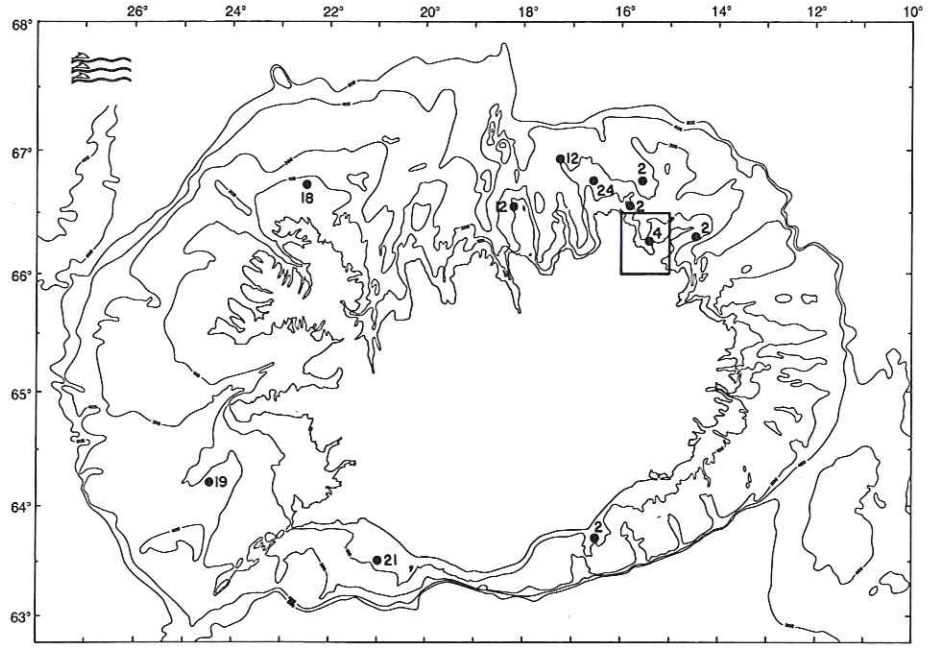


Figure 5.27. Returns from tagging experiment 240. Locality: Viðarvík. Square 615, July 28, 1962. Type of tag: Alcathene red (braided nylon). Total tagged 91, recaptured 12 (13.2%).

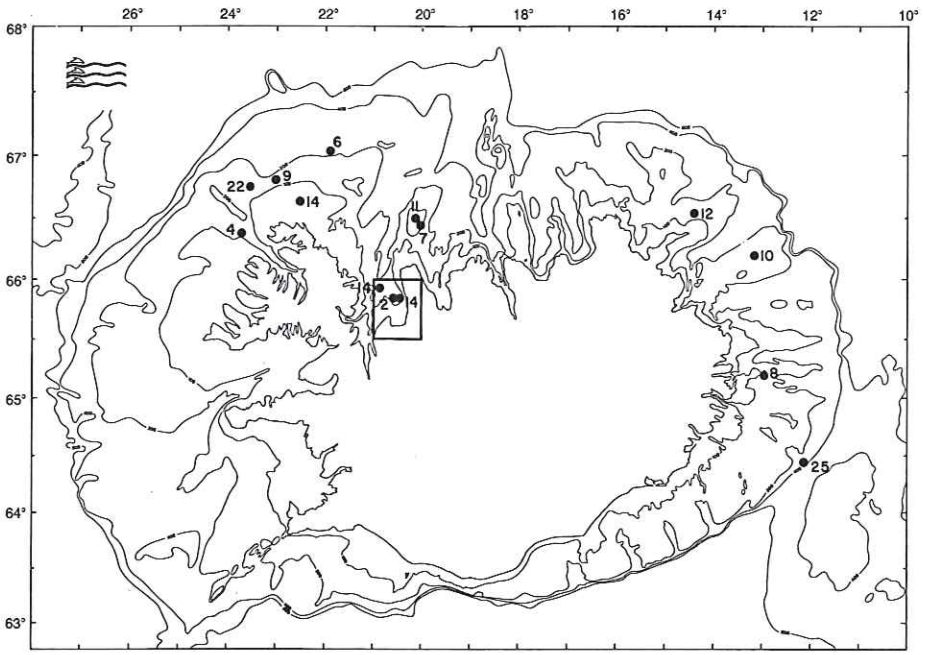


Figure 5.28. Returns from tagging experiment 129. Locality: Húnaflói. Square 570 a, August 10, 1956. Depth 125 m. Type of tag: Petersen disc (silver wire). Total tagged 118, recaptured 15 (12.7%).

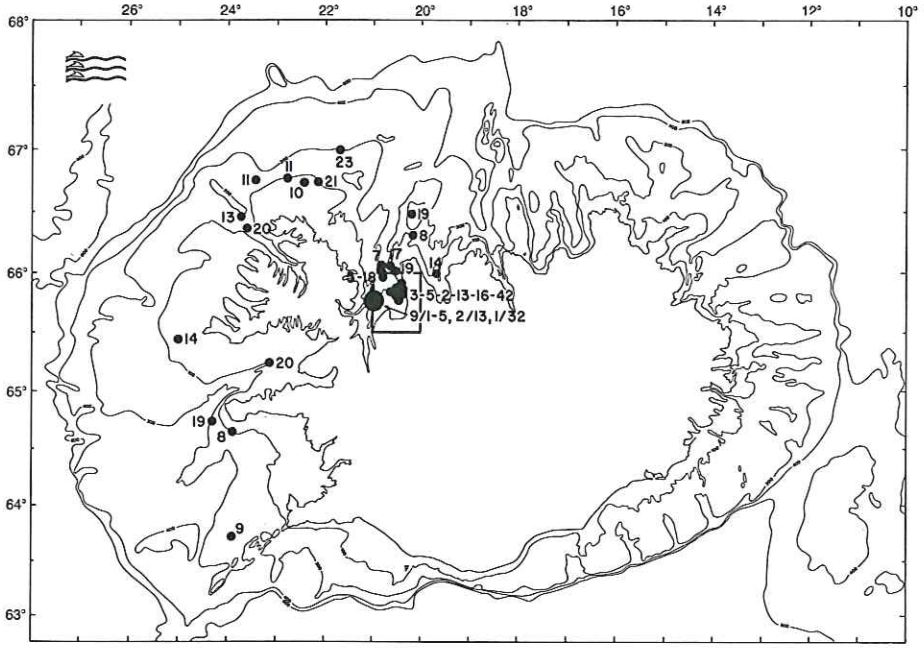


Figure 5.29. Returns from tagging experiment 147. Locality: Húnaflói. Square 570 a, July 31, 1957. Depth 112 m. Types of tag: Petersen disc (stainless steel). Total tagged 100, recaptured 28 (28%). Alcathene red (braided nylon). Total tagged 104, recaptured 16 (15.4%).

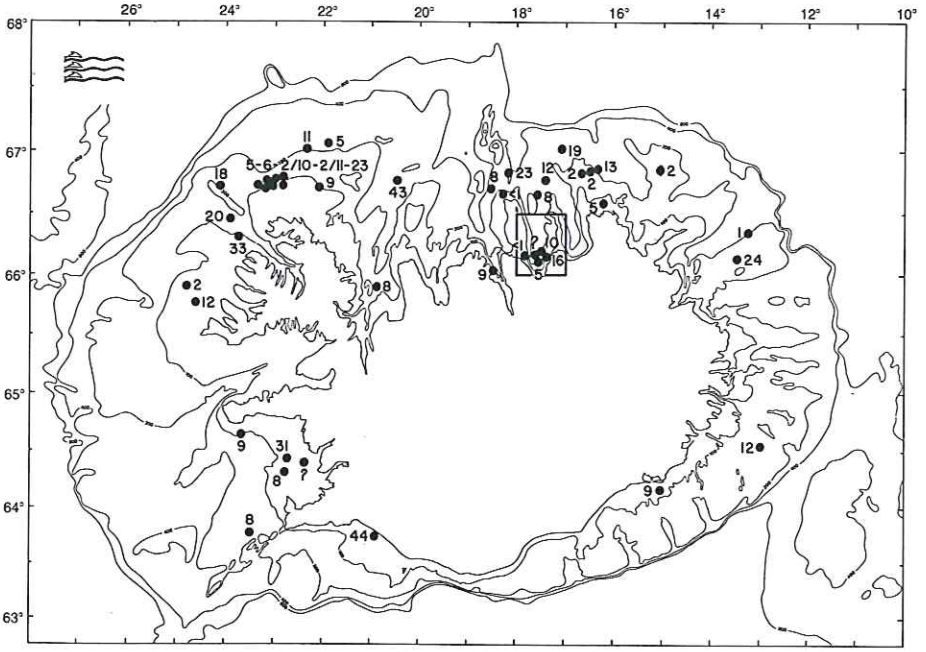


Figure 5.30. Returns from tagging experiment 151. Locality: Skjálfandi. Square 617 c, August 5, 1957. Depth 132 m. Type of tag: Petersen disc (stainless steel). Total tagged 200, recaptured 19 (9.5%). Alcathene red (braided nylon). Total tagged 200, recaptured 28 (14.0%).

small fish, mostly 3-4 years old, with an average length of 45.2 cm. Most of the recaptures were taken in Subareas 4 and 5 as shown in Figure 5.25. To a certain extent, these fish appear to have migrated to the shallower waters off the central north coast and westward into Subarea 3. The three recaptures in that area were from January-March in the first and second year after tagging. Only one of them was old enough (7 years) to be sexually mature. There were no recoveries from other areas.

There was a striking absence of returns in Subareas 1, 9 and 8 from a tagging in Skjálfandi (square 617) late in July 1960 (Fig. 5.26). Furthermore, the recaptures from Subarea 2 were all from the northernmost part of Faxaflói. By far the most numerous returns came from the subarea of tagging in the same year and in the next. The returns were distributed throughout the year. In 1961, however, most of the returns were obtained in the period June-September. The returns from Subarea 3 were from February, June and July. The average length of the tagged fish was 50.4 cm and most of them were 3-4 years old.

The recaptures from a tagging experiment in Viðarvík (square 615) in late July 1962 were few but fairly evenly distributed (Fig. 5.27). There were recaptures in Subarea 5 up to 2 years after tagging. The recaptures in Subareas 2 and 9 in March-April 1964 both represent a spawning migration, whereas the fish caught off the cape of Horn (square 672) was only 5 years old and most probably immature. The single fish recaptured in Subarea 8 (square 366) only 64 days after tagging was 55 cm and 4 years of age.

The recaptures from the tagging in Húnaflói (square 570) early in August 1956 showed a somewhat unusual distribution pattern (Fig. 5.28). The returns were divided into two distinctly separate groups, one off the western part of the north coast and another off the east coast. There were no recaptures from the west and south coasts, but one remarkable return was obtained in the area south of Cape Farewell, the southernmost promontory of Greenland. The fish was caught by a British trawler on July 4, 1957. Most of the fish recovered were 3-4 years old at tagging.

The result of another tagging experiment in the same area at the end of July 1957 was more in conformity with the usual migration pattern as shown in Figure 5.29. Thus, most of the recaptures were taken in the immediate area of tagging. There were returns in every month of 1957 and in most months of 1958. In 1959 there were only returns in January-June. There was still one return in Húnaflói at the end of January 1961 which indicates that a part of the tagged fish, which were mainly 3-5 years old, resided in the bay until that time.

Most of the returns in Subareas 3, 2 and 1 were from the months of March and April. The fish were 5 and 6 years at recapture, but one fish caught in Subarea 1, was only 3 years and 51 cm when recaptured. There were no recaptures, whatsoever, in Subareas 5 to 9. Of the 42 returns from a known locality, three were returned from Subareas 2 and 1. If we add to these the recaptures from squares 524 and 523, about 12% out of all recaptures were recovered on the spawning grounds.

The returns from a tagging in Skjálfandi early in August 1957 were much along the same lines as those from the 1952 experiment (Fig. 5.30). The returns, representing 4-7 years old fish at tagging, were fairly evenly distributed all around Iceland, with the exception that there were no recoveries from the central south coast. There was a concentration of returns in the outer part of Subarea 5 as well as in the area of tagging. The returns were also evenly distributed throughout 1958 with no apparent maximum with regard to time. Another concentration of returns was obtained in squares 674, 673, 672 and 623. Most of these returns were from the months of May to August and some also from January. The length and age of the recaptured fish indicated that they were either on their way to or from the spawning grounds farther south. There

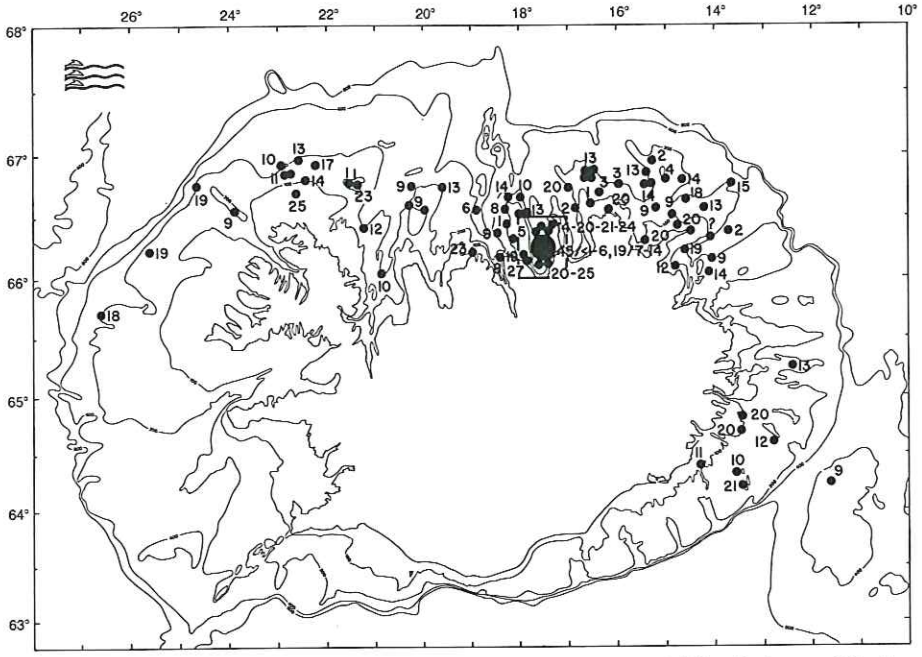


Figure 5.31. Returns from tagging experiments 395-398. Locality: Skjálfandi. Square 617, August 7-9, 1969. Depth 96-150 m. Type of tag: Alcathene red (braided nylon). Total tagged 1032, recaptured 196 (19.0%).

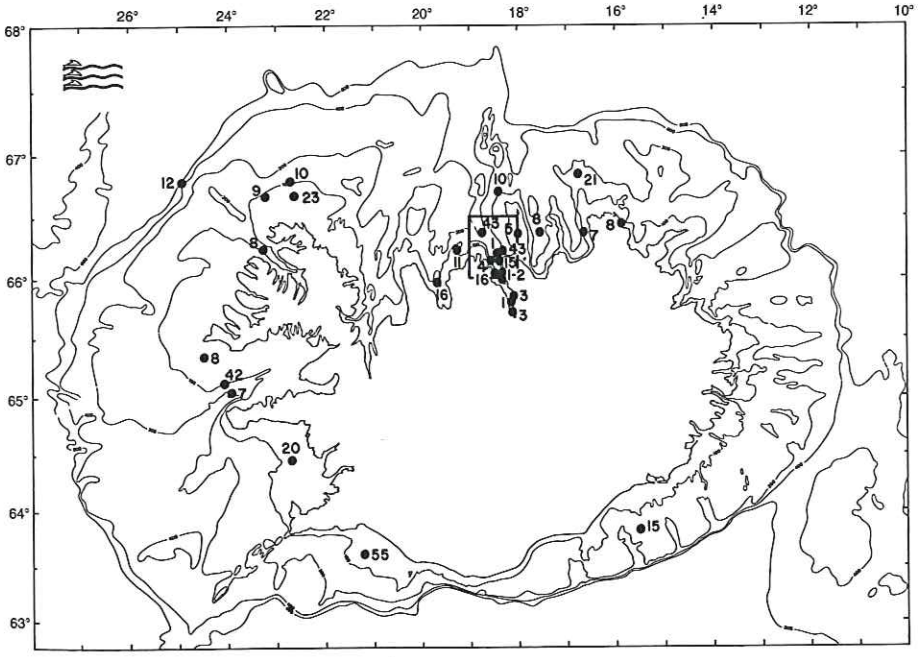


Figure 5.32. Returns from tagging experiment 195. Locality: Eyjafjörður. Square 618, August 28, 1959. Depth 108 m. Type of tag: Lea's hydrostatic (braided nylon). Total tagged 100, recaptured 18 (18%).

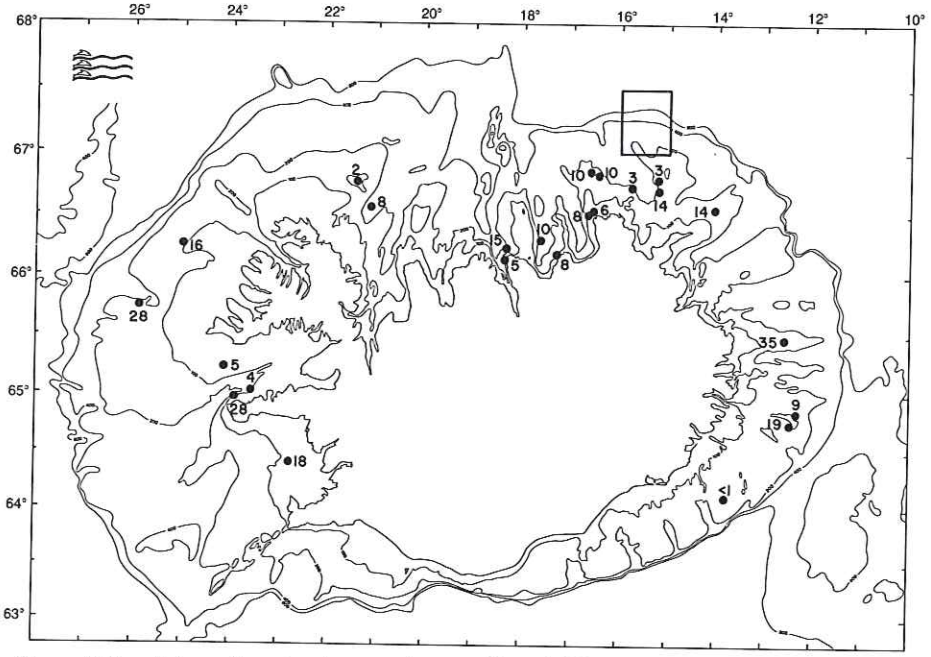


Figure 5.33. Returns from tagging experiments 659 and 660. Locality: Rifsbanki. Square 715, November 17, 1972. Depth 205-210 m. Type of tag: Alcathene red (braided nylon). Total tagged 225, recaptured 34 (15.1%).

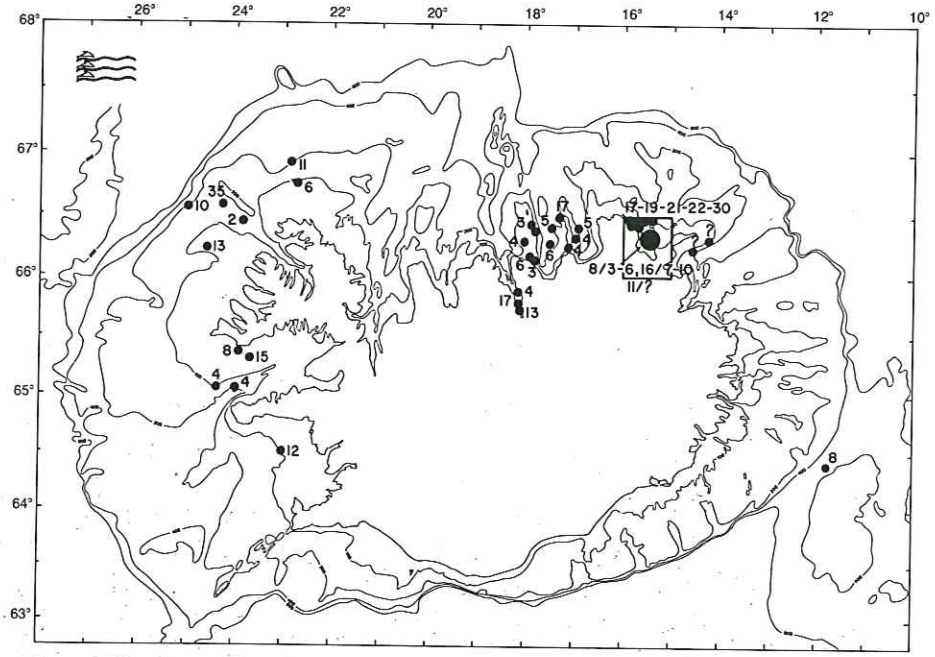


Figure 5.34. Returns from tagging experiment 425. Locality: Viðarvík. Square 615, December 14, 1969. Depth 101 m. Type of tag: Alcathene red (braided nylon). Total tagged 587, recaptured 77 (13.1%).

were six returns from Subareas 2, 1 and 9, representing 13% of the total recovered, all taken in the months of March and April before 1961.

Another tagging in Skjálfandi early in August 1969 gave no returns in Subareas 2, 1, 9 and 8. This is unusual (Fig. 5.31). The recaptures were taken all along the north coast, with the highest concentrations in the subarea of tagging. There were a few returns from Subarea 3 and the northernmost part of Subarea 6. Furthermore, there was a cluster of recaptures in Subarea 7. The recaptured fish were 3-9 years old when tagged and this group thus consisted of fairly many year classes.

The tagging in Eyjafjörður in late August 1959 gave a result similar to those of tagging in the same area in 1955 (Fig. 5.32). The much higher mean length at tagging of the recovered fish indicates higher tagging mortality of the smallest fish. The majority of the returns came from the subarea of tagging, most of them taken in April of the following year. However, there were two recoveries in the area in March 1963, showing that some fish stayed near the locality of tagging over a period of three and a half years.

All but two of the 6 returns from the southernmost part of Subarea 3 were from the period March-May of 1960. There was one return from square 524 in 1963 and one in 1961 and 1964 from Subareas 2 and 9 respectively.

A tagging on Rifsbanki (square 715) in mid-November 1972 gave no returns in the square of tagging. Otherwise, there were recaptures in all subareas, except 1, 9 and 8 (Fig. 5.33). The recaptures in Subareas 4, 3 and 2 represent spawning migrations. There was a recapture from the Hornbanki (square 671) around mid-January 1973 (length 99 cm, age 9 years), and 2 from Breiðafjörður (squares 523 and 524) in March and April, 8 and 9 years old respectively. Furthermore, there were two recaptures in 1974 and another two in 1975. The recaptures in Subarea 5 were taken throughout the year and were most probably immature fish. The age at tagging was 3-10 years, and the average length of all the tagged fish was somewhat lower than that of those recovered.

The December tagging in Viðarvík (square 615) in 1969 (Fig. 5.34) yielded results fairly similar to those of previous taggings in the same area in May and June. By far the highest number of recoveries were taken in the square of tagging, or 39 out of a total of 77 recaptures, up to 2.5 years after tagging. The recaptures were mainly from the months of April, August and October 1970. The largest fish were taken in April and were 8 cm larger than the average of those taken in the square of tagging. These fish were mainly 7 and 8 years old. This confirms that a limited spawning takes place in this area in April and May.

From this tagging there were several recaptures in the area between Grímsey and Rauðinúpur (western part of Subarea 5). The age and length of the fish recovered in Subareas 3 and 2 indicated a spawning migration. There was a striking absence of any recoveries from Subareas 1, 9, 8, and 7.

5.6. Tagging in Subareas 6 and 7

The recaptures from tagging, carried out in Bakkaflói on the northeast coast (Subarea 6, square 614) on May 25, 1948 and July 25, 1960, are shown in Figures 5.35 and 5.36. Although there was an interval of 12 years between these taggings, the migration pattern was similar.

The recaptures from the 1948 experiment were taken off the northeast and east coasts. On the other hand, apart from recaptures in the general area of tagging, there were three recaptures in Subareas 4 and 5 from the 1960 experiment. Two of these latter could have been from spawning migrations.

Tagging experiments in Reyðarfjörður on the east coast (square 513) and the neighbouring Fáskrúðsfjörður (square 463) all gave similar results. Most of the fish were 4-6 years old at tagging and of local origin as judged by their

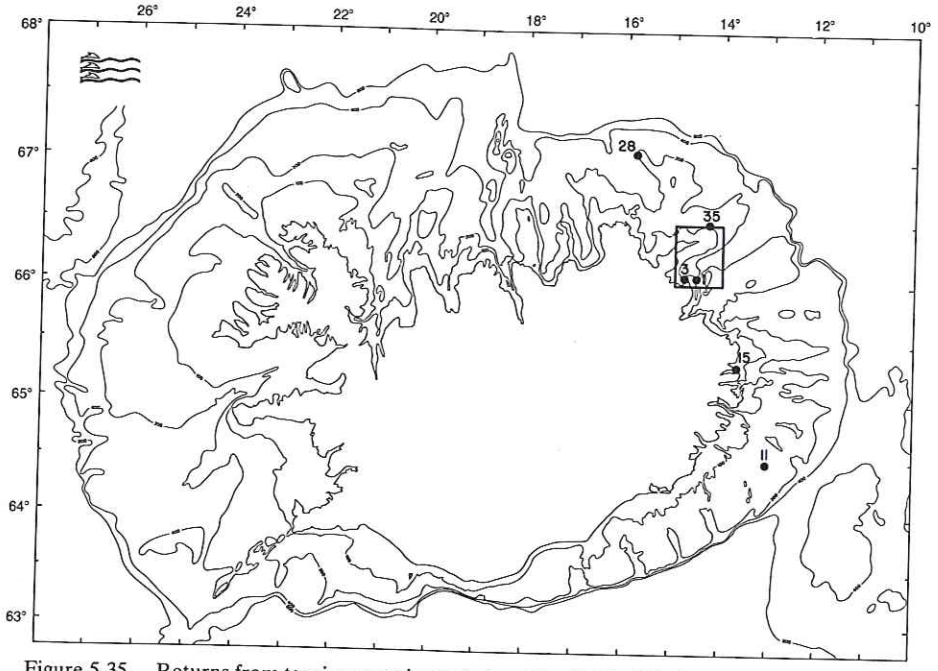


Figure 5.35. Returns from tagging experiment 3. Locality: Bakkaflói. Square 614, May 25, 1948. Depth 70 m. Type of tag: Petersen disc (silver wire). Total tagged 118, recaptured 6 (5.1%).

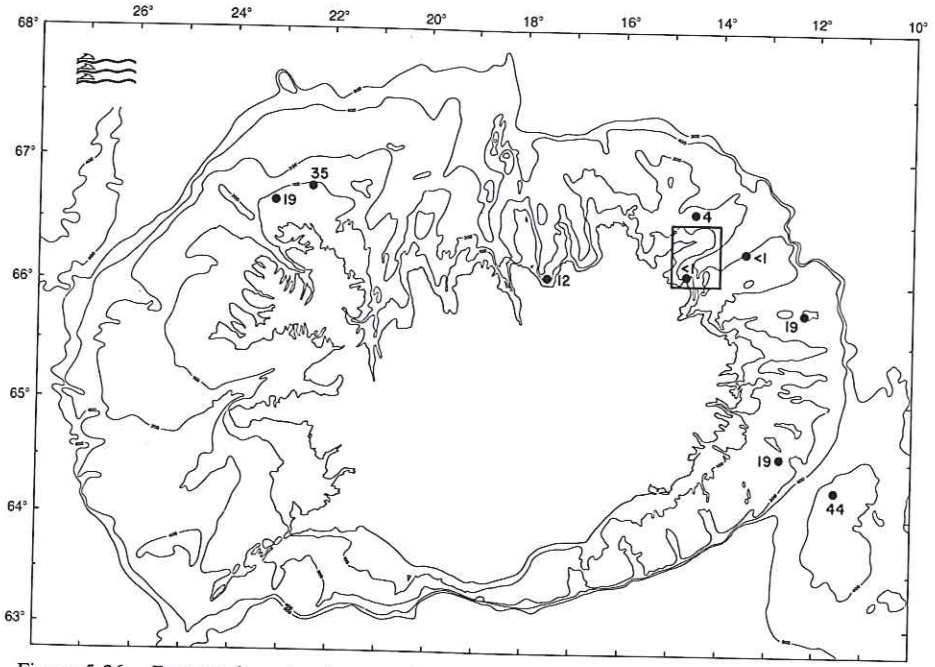


Figure 5.36. Returns from tagging experiment 217. Locality: Bakkaflói. Square 614, July 25, 1960. Depth 72 m. Type of tag: Lea's hydrostatic (braided nylon). Total tagged 69, recaptured 9 (13.0%).

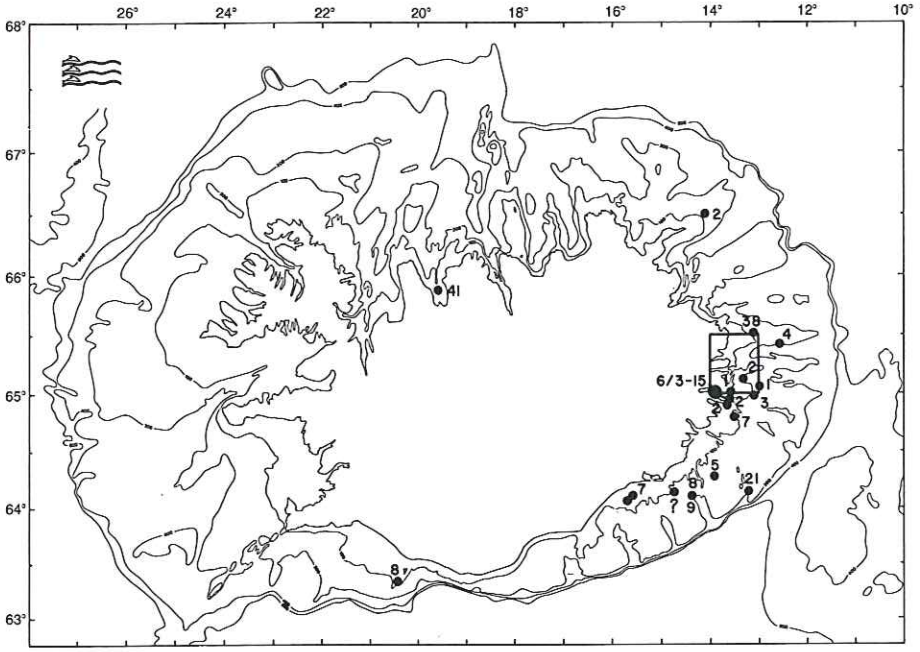


Figure 5.37. Returns from tagging experiment 155. Locality: Reyðarfjörður. Square 513, August 10-11, 1957. Depth 152 m. Type of tag: Petersen disc (stainless steel). Total tagged 111, recaptured 26 (23.4%).

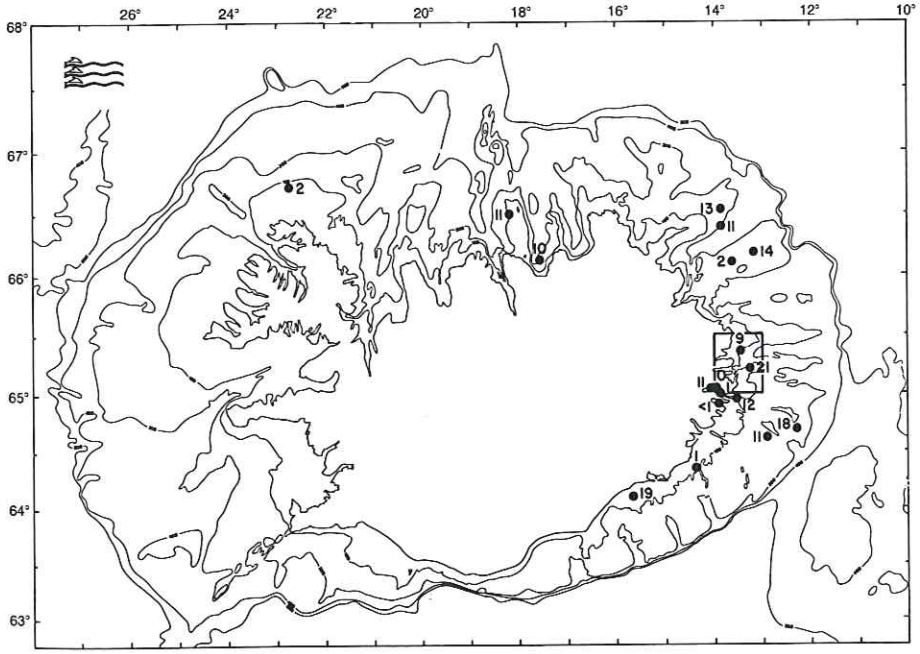


Figure 5.38. Returns from tagging experiment 191. Locality: Reyðarfjörður. Square 513, August 22-23, 1959. Depth 154 m. Types of tag: Petersen disc (stainless steel). Total tagged 44, recaptured 12 (27.3%). Alcathene red (braided nylon). Total tagged 51, recaptured 9 (17.6%).

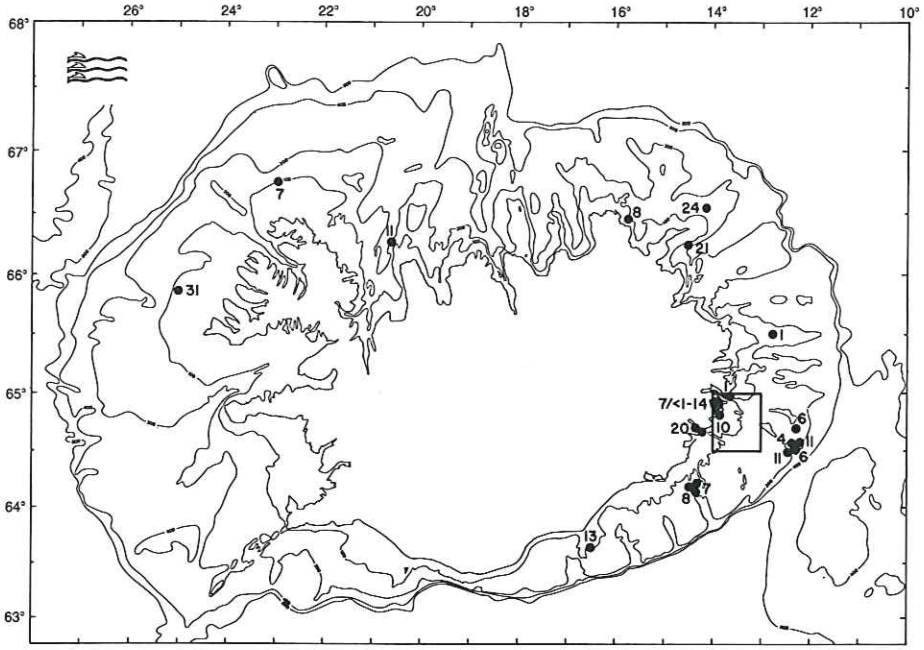


Figure 5.39. Returns from tagging experiment 156. Locality: Fáskrúðsfjörður. Square 463, August 11, 1957. Depth 90 m. Type of tag: Petersen disc (stainless steel). Total tagged 100, recaptured 27 (27%).

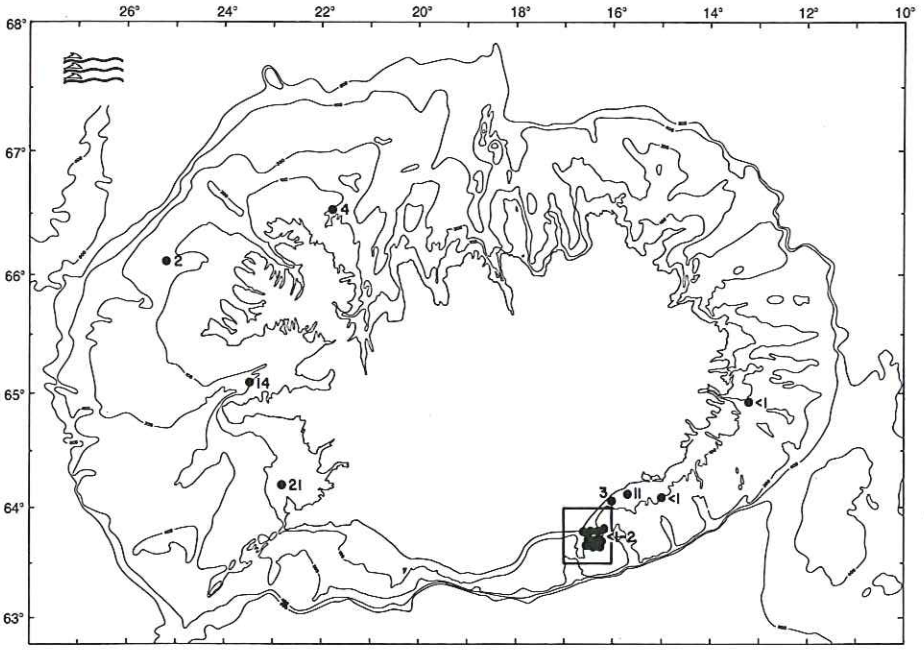


Figure 5.40. Returns from tagging experiment 58. Locality: Ingólfshöfði. Square 366, April 30, 1953. Depth 25-60 m. Type of tag: Petersen disc (silver wire). Total tagged 231, recaptured 19 (8.2%).

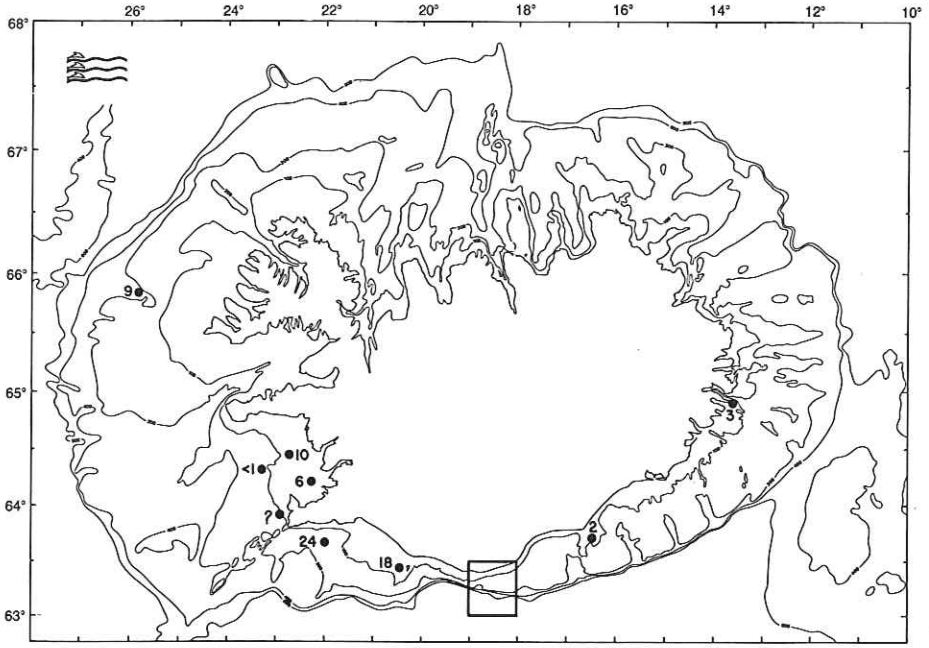


Figure 5.41. Returns from tagging experiment 57. Locality: Kötlugrunn. Square 318, April 29, 1953. Depth 45-110 m. Type of tag: Petersen disc (silver wire). Total tagged 129, recaptured 9 (7,0%).

growth. Part of the fish, tagged in Reyðarfjörður in mid-August 1957, stayed in the fjord until mid-November (Fig. 5.37). After that, there were no returns from the fjord proper until in August of the following year. Furthermore, one fish was recovered in September and another in October of that year. Outside of Reyðarfjörður, seven fish were recovered well to the south of the tagging locality. They were all taken in March-May 1958 and 1959, and at least some of them on a spawning migration. The recovery of one fish in Skagafjörður (square 569) in the beginning of January 1961 is most interesting. The fish was 11 years old at recapture.

The recoveries from another experiment in Reyðarfjörður in late August 1959 are shown in Figure 5.38. Three fish were caught in the fjord of tagging within the first year, and one, three years old, in the neighboring Fáskrúðsfjörður after 23 days. However, most of the recoveries came from Subareas 6 and 7, and to the north of the square of tagging. Of the three recoveries from the north coast, the westernmost one (square 673) is quite interesting. It indicated a minimum speed of 6.4 naut. miles per day. Judging from the length (72 cm) and age (7 years), the fish could have been on their way to spawn in the warm water area off the southwest coast.

The recaptures from a tagging in Fáskrúðsfjörður in mid-August 1957 showed a distribution very similar to that found for the 1959 Reyðarfjörður experiment (Fig. 5.39). There were four returns from the fjord in August-October. From then on there were no recoveries in Fáskrúðsfjörður until two fish were taken in April and one in June of the following year. Thus, the tagged fish seem to have stayed in the fjord for about two months, *i.e.* until the beginning of October, and then they left for deeper waters. There was a cluster of recoveries by British trawlers off the southern part of the east coast in square 462

(Flákinn). Another group of recoveries was obtained on Papagrunn farther to the southeast (square 414), all taken by British trawlers in March-May in the year after tagging.

There were some interesting recoveries from the northeast and northwest coasts, showing a certain westward movement of the fish along the north coast. Some of these indicated a spawning migration, whereas others consisted of fish which were not yet mature.

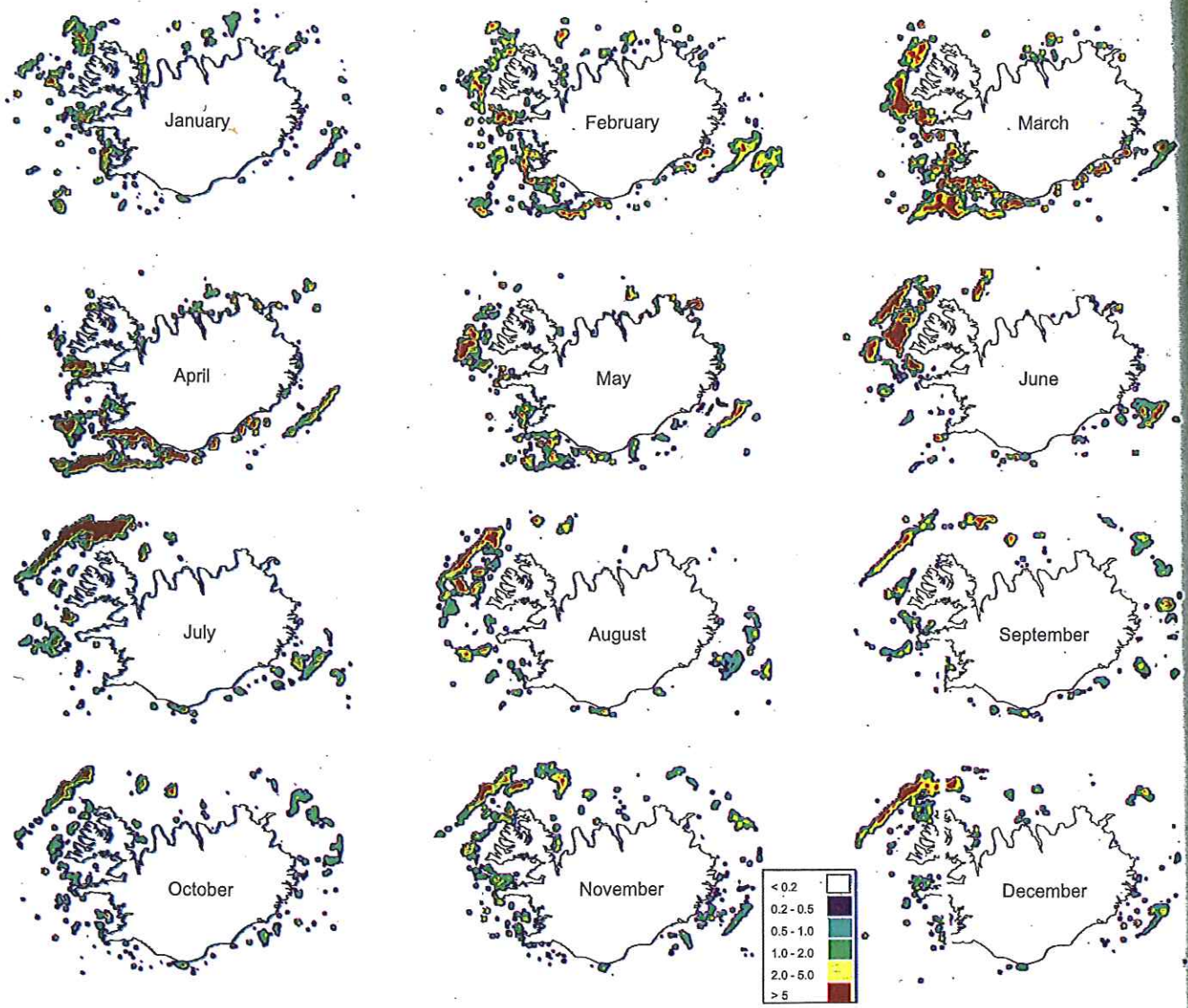
5.7. Tagging in Subarea 8

The two tagging experiments in Subarea 8 were both carried out at the end of April 1953 and show a similar dispersion pattern (Figs. 5.40 and 5.41).

From the first experiment, 8 fish were caught within 2 months by Belgian trawlers in the square of tagging (366). Most of these fish were sexually mature. There were some recaptures indicating both an eastward and a westward migration. One remarkable recapture was obtained from square 625 after only 73 days.

Most of the recaptures from the second experiment were from Subareas 9 and 2, and only one was taken in the spawning season during the year of tagging. There was also an interesting recapture from the important fishing ground of Víkuráll, west of the Vestfirðir peninsula (square 575).

To the east of the tagging site, two fish were recovered in squares 366 and 463. This was respectively two and three months after liberation, showing the typical eastward migration which takes place in this area after spawning.


January
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0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
2.0 - 5.0
> 5

6. Seasonal displacement of the commercial fishery

An example of the present day migrations of cod in Icelandic waters is provided by the 1991 fishery. The catches of cod in January-May and June-December 1991 in all gears combined are shown in Figure 6.1.

In the period January-May 1991, the densest concentrations of fish were found on the banks off Southwest Iceland, representing the main spawning population. The concentration off the southern part of the Vestfirðir peninsula consisted mostly of fish on their way to or from the spawning grounds farther to the south. Furthermore, there were smaller concentrations of cod off the north coast as well as off the eastern south coast.

In June-December 1991, the densest concentrations of cod were found to the west and north of the Vestfirðir peninsula, within a section approximately following the 200 m isobath, representing all the main fishing banks in this area. There was also a considerable fishery in shallower waters off Látrabjarg (Bjargtangar), as well as off the Snæfellsnes peninsula. The fishery in the area northeast, east and southeast of Iceland was also conducted at depths near the 200 m isobath. During the period June-December the cod tend to concentrate near warm/cold water boundaries, *i.e.* in areas which are rich in food.

About 80% of the handline catches were landed in spring and summer, mostly in June and July, and two thirds of the longline catches were landed in November-December and January-February. Most of these catches were taken off the Vestfirðir peninsula. On the other hand, some 90% of the gill-net landings were taken in February-May on or near the spawning grounds off the south and west coasts.

However, the fleet of trawlers is in the best position to follow the migrations of the cod. The trawl fishery of 1991 clearly demonstrates the seasonal migration of the cod (Fig. 6.2). In February, there appear to be several concentrations of cod, mainly northwest and southeast of Iceland. In March, the main spawning migration had reached the area off Southwest Iceland, but two concentrations are still visible off the Vestfirðir peninsula. In April, the trawlers mainly fished off Southwest Iceland, while in May the fishery had again shifted to the banks off the Vestfirðir peninsula, where good catches were obtained until August. In the remaining months of the year, the trawlers mainly fished for cod in this area.

There was an increase in the monthly cod landings from 8.0 thous. tonnes in January to 18.7 thous. tonnes at the beginning of the spawning season in March. This was followed by a decrease to 9.6 thous. tonnes with the dispersal of the spawners in May. After that, catches culminated in the feeding areas northwest and north of the Vestfirðir peninsula with over 26 thous. tonnes in June and July. The lowest catch, 7.2 thous. tonnes, was taken in October, whereafter the catch increased to 13.3 thous. tonnes in December.

◊ Figure 6.2. The Icelandic cod fishery in 1991. Monthly catches landed per square naut. mile by commercial trawlers.

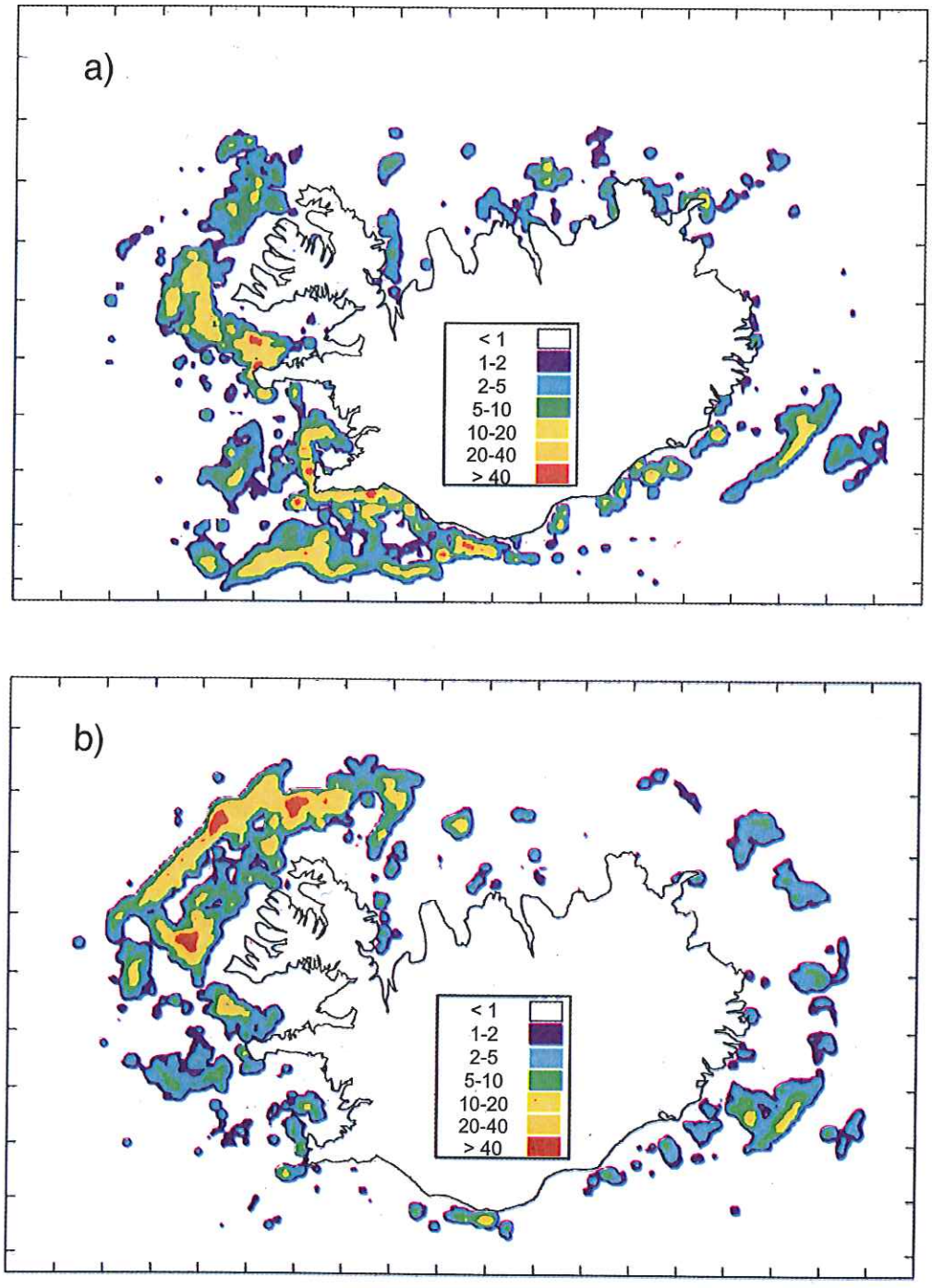

Figure 6.1. The Icelandic cod fishery in 1991. Tonnes landed per square naut. mile in a) January - May and b) June - December. All fishing gears combined.

7. Long distance migrations

Table 7.1 lists 38 cod recovered outside Icelandic fishing grounds but tagged in Icelandic waters during 1948-1986. Eighteen of these recoveries were taken off East Greenland, thirteen of them by West German trawlers, two by Icelandic trawlers and one by a British trawler. Eleven fish were caught on the Dohrn Bank and in neighboring areas, one on the Jónsbank and one on the Heimland Ridge. The length at tagging varied from 47 to 100 cm, and the age at recapture ranged from 5 to 11 years, but mostly from 7 to 11 years. The recaptures were distributed throughout most of the year (Jónsson, 1958a).

As shown in Table 7.1, fourteen of the fish recaptured were tagged in Subareas 9, 1, 2 and 3 in March and April. The length at tagging was from 59 to 100 cm and the age from 4 to 11 years, while most of the cod were 8-11 years old at tagging. Thus, these fish were sexually mature. Finally, four recaptures were obtained from fish liberated at the north coast of Iceland in July-August. These fish were 47-83 cm at tagging.

Of the four recaptures from West Greenland, two of the fish had been tagged on 22 March 1958 in square 372 of Subarea 9. One of these fish was reportedly caught after only 39 days at liberty. The shortest distance, between the tagging location to Cape Farewell, is about 640 naut. miles, indicating a minimum speed of 16.4 naut. miles per day. Therefore, this fish was most likely caught off East-Greenland. The second recovery, 83 cm at tagging, had grown by 4 cm in 403 days. The findings from this experiment are in conformity with those of the 1931 taggings mentioned in Chapter 2, when a group of cod, tagged on the spawning grounds, migrated almost simultaneously to West-Greenland. The third recapture was from a tagging off the Snæfellsnes peninsula (square 473) on 30 March 1963, whereas the last one represents a fish tagged in Skagafjörður on the central north coast in mid-May 1953.

The only recovery of an Icelandic cod tag from the Barents Sea proper is a cod tagged in Arnarfjörður (square 573) in July 1965. This fish was 49 cm at tagging but had grown to 76 cm and was 4 years old when caught by an English trawler after 457 days at liberty.

One recapture is listed as taken from the coast of Norway, another specifically from the Lofoten area and a third from the Vardø-Andenes area. The last one was taken by an English trawler after 504 days at liberty, having been tagged in Skjálfandi on the eastern north coast (square 617). This fish was 62 cm long and 7 years old when recaptured. The two first mentioned fish were tagged near each other in squares 618 and 569 (central north coast) in the first week of September 1949 and recovered on February 19 and March 16, 1951, respectively. Therefore, there are compelling reasons to believe that they crossed the Norwegian Sea together (Jónsson 1953, 1954, 1954a). There were two additional recaptures from Norway, where a more definite location is given. The first of these fish was caught in a Danish seine off Ålesund in mid-June 1969, 335 days after it was tagged off central North Iceland (square 618), only 43 cm long. The second was captured south of Stadt (61°55′N, 04°48′E) by a Norwegian longliner. It was 90 cm when tagged in square 576, about 50 naut. miles off Arnarfjördur on the Vestfirðir peninsula on 28th February 1971. The date of recapture is listed as February-April 1973 and the length 93 cm.

Three recaptures were recorded from the North Sea, all taken by German trawlers. The first of these was a 57 cm cod which had been tagged in Faxaflói (square 422) in May 1952. The recapture was reported from the Bløden Ground only 97 days later. A fairly fast traveller indeed! The second had been tagged in Skjálfandi (square 617) only nine days later than the fish from Faxaflói. This fish was 72 cm long and recaptured 260 days later in a location given as approximately 61°N, 3°W (Jónsson 1954). Finally, the third recapture

Table 7.1. Long distance migrations of cod tagged at Iceland in 1948-1986.

Tagging				*Recapture*				
Date	*Square*	*Length cm*	*Location*	*Date*	*Length cm*	*Age*	*Nation*	*Gear*
10/8/56	570	47	E-Greenland	4/7/57	60	–	Br.	Trawl
22/3/58	372	100	Dohrnbank	30/1/59	101	9	Ge.	Trawl
30/7/58	617	49	Dohrnbank	2/5/60	5	5	Ge.	Trawl
24/3/60	422	59	Dohrnbank	March'62	78	6	Ge.	Trawl
26/3/60	372	77	E-Greenland	8/6/60	76	8	Ge.	Trawl
28/3/60	320	99	W-Dohrnbank	3/10/60	99	10	Ge.	Trawl
2/4/60	372	86	W-Dohrnbank	26/2/61	90	11	Ge.	Trawl
19/3/63	372	89	Dohrnbank	24/8/63	90	11	Ge.	Trawl
30/3/63	473	76	Dohrnbank	14/10/63	79	7	Ge.	Trawl
21/4/64	371	77	Dohrnbank	August'64	87	6	Ge.	Trawl
28/4/65	371	–	E-Greenland	19/2/66	93	5	Ge.	Trawl
4/4/67	422	68	Jónsbank	1/6/67	–	–	Icl.	Trawl
25/3/68	372	73	Heimland Ridge	3/3/69	–	8	Ge.	Trawl
15/3/73	474	72	E-Greenland	16/5/74	89	6	Icl.	Trawl
30/3/78	321	71	Dohrnbank	2/11/79	–	–	–	–
20/7/79	721	51	Dohrnbank	23/12/82	85	9	Ge.	Trawl
20/7/79	721	83	Dohrnbank	12/11/81	84	6	Ge.	Trawl
24/7/80	723	61	East-Greenland	12/5/81	–	–	–	–
11/5/53	569	70	W-Greenland	1/10/53	68	8	Br.	Trawl
22/3/58	372	75	W-Greenland	1/5/58	73	7	Ge.	Trawl
22/3/58	372	83	W-Greenland	5/5/59	87	10	Ge.	Trawl
30/3/63	473	72	W-Greenland	15/1/64	82	7	Ge.	Trawl
3/9/49	618	61	Norway	19/2/51	74	8	Ge.	Trawl
7/9/49	569	69	Lofoten-Norway	16/3/51	70	–	Ge.	Trawl
22/8/50	617	62	Vardø-Andenes	15/1/52	–	7	Br.	Trawl
24/7/65	574	49	35 n.m. off Bear Isl.	25/10/66	76	4	Br.	Trawl
13/7/68	618	43	Off Ålesund	18/6/69	41	–	Nor.	Dan.seine
28/3/71	576	90	61°55'N-04°48'E	Feb-Ap'73	93	–	Nor.	Longline
14/4/73	321	102	White Sea	Jan.Feb.'74	107	11	Br.	Trawl
10/5/52	422	57	North Sea (Fladen)	15/8/52	–	–	Ge.	Trawl
19/5/52	617	72	North Sea (61N - 3W)	3/2/53	77	–	Ge.	Trawl
12/12/68	672	75	North Sea	16/12/69	80	6	Ge.	Trawl
26/5/55	422	95	Faroes	19/4/56	–	–	Far.	Gillnet
18/7/55	618	68	150 n.m. NNA off Faroes	15/5/57	85	8	Far.	?
22/8/59	617	52	Faroe Bank	28/8/62	84	7	Br.	Trawl
15/7/66	473	63	Faroes	2/10/67	95	6	Ger.	Trawl
30/3/68	372	76	Faroes	8/8/68	78	7	Far.	?
17/1/78	723	46	Faroes	8/7/82	94	–	–	–

was taken in the North Sea 364 days after the fish had been tagged when 75 cm long off Horn (square 672) in mid-December 1968. At that time it was customary for West German trawlers, returning from fishing at Iceland, to take some hauls in the North Sea on their return journey. Consequently, the present author feels that these recaptures are subject to considerable doubt.

There are four recaptures from the Faroe grounds and one taken some 150 naut. miles to the NNE of the Faroes. Three of these were taken by Faroese fishermen, but the remaining two by British and German trawlers. Of these recaptured fish, one 95 cm long, had been tagged in Faxaflói (square 422) in late May 1955 eleven months earlier. Another cod, 76 cm long, was tagged in square 372 near the end of March 1968, and recaptured at the Faroes only four months later. The remaining fish were all tagged in July-August, one off Snæfellnes (square 473) and two off the central north coast. They were 52-68 cm and 6-8 years old at recapture.

8. Discussion and conclusions

There is a fairly good agreement between mortality values for the spawning population of the Icelandic cod, as calculated from tag returns and by the spawning zones method. Comparison between the mortality estimates, obtained by these two methods, makes it possible to evaluate the tagging mortality. Changes in mortality rates are also duly reflected in known temporal and spatial changes in fishing effort. Similarly, the variations in Z (see Fig. 4.4) for cod that were in the 70-90 cm size range at tagging, follow the estimated variation in immigration by Greenland cod. Thus, the Z values are lowered when large numbers of cod from outside are added to the local population.

Tagging experiments also show large variations in Z for the immature population, according to local and annual variations in fishing effort. Furthermore, a comparison of fishing mortality from tagging experiments and VP-analysis also makes it possible to estimate the tagging mortality for the immature part of the stock.

For centuries, the winter fishery for spawning cod took place in the area between Vestmannaeyjar and the Snæfellsnes peninsula. Ever since the 15th century, the most important fishing stations have been situated in places where the cod come nearest to the shore on their way to or from spawning. Many of those stations later became the modern fishing communities of today. As mentioned in section 1, people were pretty well aware of the spawning migrations of cod along the south and west coasts already in the 18th century. However, combined Danish and Icelandic taggings of spawning cod, first carried out in the late 1920's and in the 1930's, gave a much more detailed information on these migrations.

The main spawning occurs at the boundary between the warm Atlantic water with a salinity of about 35.1 units and the near-shore coastal water of lower salinity and temperatures in the range 5-7 °C. In these areas, spawning takes place in the course of six weeks, *i.e.* during the fourth week of March, in April and in the first week of May. As a rule, the maximum spawning occurs in the fourth week of April. On the average, the spawning of each fish takes 3-4 weeks. There are, however, some variations with regard to the time and the area of maximum spawning. Usually, spawning starts about one week earlier south of the Reykjanes Ridge than north of it (Sæmundsson 1926; Jónsson 1982). The oldest fish are the first to appear on the spawning grounds, the young fish come later (Jónsson 1954).

After spawning, most of the post-spawners follow a route north along the west coast, leading to the rich feeding grounds off the northwest and north coasts. There are, however, some indications of circumnavigation, *i.e.* fish coming along the western route from the north, and after spawning continuing to the east along the south coast, sometimes at a considerable speed. As an example, a 71 cm cod was tagged in square 371 in April 1951 and caught by an English trawler 23 days later in square 664, suggesting an apparent minimum speed of 15.9 naut. miles per day.

On their way from the spawning grounds to the feeding area in the north, the cod may make a detour into Faxaflói, where they feed on sandeel and capelin. However, these fish stay there only for a short while. The cod then

proceed north along the west coast and can move quite fast. Thus, a cod which was tagged in mid-April 1951 in square 371, was recovered 23 days later in square 674, implying an apparent minimum speed of 10.6 naut. miles per day. As shown in Table 5.1, the post-spawners have arrived in square 674 (Hali) and neighboring squares by May, and seem to stay there for the remainder of the year. In this area, about half of the returns were taken from depths of more than 200 meters and 15% from more than 300 meters depth. Table 5.3 gives the apparent minimum speed of the returning fish. The minimum average speed is estimated at 8.6 naut. miles per day or 0.36 naut. miles per hour.

Figure 5.5 shows that only a few recaptures of post-spawners have been recorded from the central and eastern part of the north coast, but recoveries from the northeast and southeast coasts indicate the presence of post-spawners in these areas.

The fishery for cod in Faxaflói is partly based upon migratory fish, but the bay has also an endemic population. The recaptures outside Faxaflói are nearly all from experiments carried out during the spawning season, and either represent migratory fish which have entered the area or fish which have left the bay to spawn on the main spawning grounds in Subareas 1 and 9. As shown in Figures 5.9 and 5.10, which describe the results of taggings in August and November, there were no recaptures whatsoever from other areas. The cod in Faxaflói also grows much faster than elsewhere at Iceland (Jónsson 1965) and some fishermen even claim these cod can be identified by their shape.

As illustrated in Figure 6.1, a very important fishery for cod takes place in Subarea 3. In addition to a population of local origin, this is a transition area through which large numbers of fish, growing up at the north coast, must pass on their way to the spawning grounds in the south.

The Snæfellsnes peninsula marks the southern boundary of Subarea 3. The fishing station in Dritvík, at the tip of the peninsula, was for centuries among the most important ones in Iceland. Although this fishing station is certainly much older, it is first mentioned in the early 16th century. Figure 5.12 shows the results of a tagging experiment in the vicinity of Dritvík and clearly illustrates how it was possible for the Icelanders to conduct their fishing from small, open rowboats for almost thousand years.

The fish which grow up in Subarea 3 seem to stay there until they are sexually mature, whereupon they leave for the spawning grounds in the south. This is clearly demonstrated in Figures 5.13 and 5.15, which represent results from nearshore taggings in June and November when most of the fish were 4-5 years old. Most of the recaptures south of the tagging area are from spawning migrations.

There is an important fishery for cod in the northernmost part of Subarea 3, but Figures 5.17 and 5.18 show a clear-cut dispersion of the fish east along the north coast with recaptures up to 32 months after tagging. The southward migrations along the west coast are very conspicuous, with recaptures evenly distributed up to 4 1/2 years after tagging. The recaptures in the spawning seasons after tagging are illustrative and show how the fish are taken by the fishery on their way south.

The same time sequence is also obvious when considering various experiments carried out in Subareas 4 and 5. This is especially apparent in Figure 5.19, where the sexually mature fish seem to have left simultaneously for the spawning grounds in the south. Some of them evidently completed a round trip, whereas others returned along the same route as they came. The recaptures in the second and third spawning season show a similar picture.

The numerous tagging experiments in Subareas 4 and 5 confirm these results. There are, however, some exceptions. Thus, there were no returns in subareas 8, 9, 1 and 2 from the tagging in Skjálfandi (square 617) in August 1969 (Fig. 5.31), in spite of a quite successful operation (19% recaptured out of 1032 fish tagged). The same can be seen in Figures 5.25

and 5.34. A possible explanation is that most of these fish actually spawned at the north coast. The large concentration of returns in Subarea 6 tends to confirm this.

Figures 5.19-5.34 also show the movement of the fish within Subareas 4, 5 and 6. The fish disperse fairly rapidly in search of food, especially in the rich area off the northwest coast, where they stay until they leave for spawning in the south. There is also an eastward migration, and some of these fish actually follow the route south along the east coast for spawning, in all probability mainly those which grow up in Subareas 5, 6 and 7.

The relatively few taggings in Subareas 6 and 7 show a northward feeding migration in summer and spawning migrations along the southeast and south coasts in winter.

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Appendix

Table I.1. Cod tagged at Iceland in 1948-1986.

Year	Tagged N	Recaptured N	%	Year	Tagged N	Recaptured N	%
1948	1185	140	11.8	1966	1898	352	18.6
1949	1547	178	11.5	1967	1829	216	11.8
1950	1065	102	9.6	1968	5614	875	15.6
1951	1103	110	10.0	1969	4573	729	15.9
1952	2029	167	8.2	1970	4423	817	18.5
1953	2694	216	8.0	1971	3581	641	17.9
1954	1641	197	12.0	1972	3236	457	14.1
1955	2267	208	9.2	1973	3082	392	12.7
1956	2277	241	10.6	1974	2008	159	7.9
1957	2819	334	11.9	1975	1824	190	10.4
1958	2305	318	13.8	1976	3075	408	13.3
1959	1642	215	13.1	1977	1080	104	9.6
1960	2668	471	17.7	1978	1885	187	9.9
1961	1560	247	15.8	1979	4105	365	8.9
1962	1770	270	15.3	1980	3658	334	9.1
1963	2675	398	14.9	1981	2587	186	7.2
1964	1204	154	12.8	1986	814	72	8.9
1965	2853	519	18.2				

Table I.2. Cod tagged at Iceland in 1904-1938.

Year	Tagged N	Recaptured N	%
1904	491	29	5.9
1905	417	17	4.1
1908	227	31	13.7
1924	225	23	10.2
1925	52	4	7.7
1928	686	173	25.2
1929	486	34	7.0
1931	1577	237	15.0
1932	1256	134	10.7
1933	381	35	9.2
1934	987	91	9.2
1935	655	120	18.3
1936	246	40	16.3
1937	974	107	11.0
1938	400	44	11.0
Total	9060	1119	12.4%

Table I.3. Cod tagged at Iceland in 1924-1938 in different areas (see Fig. 3.2).

Subarea	*Square*	*Tagged* *N*	*Recaptured* *N*	*%*
9	319	908	101	11.1
–	320	2846	301	10.6
–	321	363	43	11.8
–	370	1848	266	14.4
–	371	167	21	12.6
Total		6132	732	11.9
2	422	418	89	21.3
–	423	98	19	19.4
–	474	82	11	13.4
Total		598	119	19.9
3	524	14	1	7.1
–	574	9	2	22.2
–	623	93	17	18.3
Total		116	20	17.2
4	672	20	6	30.0
–	622	32	4	12.5
–	619	284	85	29.9
Total		336	95	28.3
5	618	267	69	25.8
Total		267	69	25.8
6	664	133	9	6.8
–	564	12	2	16.7
–	513	439	86	20.3
Total		584	97	16.6

Table I.4. Comparison of annual returns from various types of tags. T: numer tagged, R: number returned.

Type of tag	*Petersen disc 01*						*Leas hydrostatic tag 02*									*Alcathene tag 03 red*			*Alcathene tag 04 blue*			*Plastic flag 06*		
Fastening	*Silver wire*			*Stainless steel*			*Stainless steel*			*Bradided nylon*			*Monofilament nylon*			*Braided nylon*			*Braided nylon*			*Braided nylon*		
Year of tag.	*T*	*R*	*%R*	*T*	*R*	*%R*	*T*	*R*	*%R*	*T*	*R*	*%R*	*T*	*R*	*%R*	*T*	*R*	*%R*	*T*	*R*	*%R*	*T*	*R*	*%R*
1948	1183	142	12.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1949	1545	177	15.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1950	1109	106	9.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1951	1106	111	10.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1952	2028	166	8.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1953	2704	218	8.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1954	685	59	8.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1955	572	42	7.3	–	–	–	–	–	–	–	–	–	200	59	29.5	299	27	9.0	350	36	10.3	–	–	–
1956	1100	86	7.8	–	–	–	–	–	–	200	41	20.5	–	–	–	691	41	5.9	801	84	10.5	–	–	–
1957	193	10	5.2	1710	219	12.8	–	–	–	149	36	24.2	–	–	–	570	60	10.5	430	58	13.5	–	–	–
1958	–	–	–	455	58	12.7	–	–	–	–	–	–	–	–	–	1020	121	11.9	–	–	–	–	–	–
1959	–	–	–	299	36	12.0	–	–	–	698	99	14.2	–	–	–	850	109	12.8	299	49	16.4	–	–	–
1960	–	–	–	–	–	–	–	–	–	787	117	14.9	–	–	–	700	67	9.6	–	–	–	–	–	–
1961	–	–	–	–	–	–	1427	292	20.5	–	–	–	–	–	–	198	24	12.1	–	–	–	–	–	–
1962	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1560	248	15.9	–	–	–	–	–	–
1963	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1770	271	15.3	–	–	–	–	–	–
1964	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2674	385	14.4	–	–	–	–	–	–
1965	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1035	139	13.4	–	–	–	83	10	12.0
1966	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1541	247	16.0	–	–	–	1307	265	20.3
1967	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1050	167	15.9	–	–	–	860	178	20.7
1968	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1217	146	12.0	–	–	–	468	48	10.3
Total	12225	1117	9.1	2464	313	12.7	1427	292	20.5	2874	448	15.6	200	59	29.5	20489	2756	13.5	1880	227	12.1	2718	501	18.4

Table I.5. Comparison of number of tags returned per 1000 tonnes of cod landed by various nations fishing at Iceland in 1949-1965.

Nations	*Iceland*	*England*	*Faroes*	*W.Germany*	*Norway*
Thous. tonnes landed 1949-53	1.103	572	76	19	16
Number returned 1948-52	541	68	37	31	5
Returns pr. thous.tonnes landed . . .	0.49	0.12	0.49	0.17	0.30
Thous.tonnes landed 1954-59	1.730	840	97	220	39
Number returned 1953-58	1171	208	33	55	9
Returns pr. thous.tonnes landed . . .	0.68	0.25	0.34	0.25	0.23
Thous.tonnes landed 1960-66	1.715	794	53	171	19
Number returned 1959-65	1718	231	8	138	9
Returns pr. thous.tonnes landed . . .	1.00	0.29	0.15	0.81	0.47
Thous.tonnes landed 1949-66	4.548	2.205	23	578	75
Number returned 1948-65	3430	507	78	224	23
Returns pr. thous.tonnes landed . . .	0.75	0.23	0.35	0.39	0.31

Table I.6. Recaptures of cod tagged in Subareas 1, 8 and 9 in January-May 1948-1967. (Adjusted with reference to the red Alcathane tag. Time denotes number of instances with known date of recapture).

Year/ period	Tagged	Recaptured		Time	1 year		2 year		3 year		4 year		5+ year		
	N	N	%	Days	N	%	N	%	N	%	N	%	N	%	Z'
1948	219	18	8.2	13	8	61.5	4	30.8	1	7.7	–	–	–	–	1.04
1951	1006	155	15.4	132	118	89.4	5	3.4	3	2.3	3	2.3	3	2.3	1.37
1952	1016	61	6.0	57	43	75.4	12	21.1	1	1.8	1	1.8	1.37	–	–
48-52	2241	234	10.4	202	169	83.7	21	10.4	5	2.5	4	2.0	3	1.5	1.26
1953	388	40	10.3	38	33	86.8	5	13.2	–	–	–	–	–	–	1.88
1956	296	37	12.5	36	20	55.6	10	27.8	4	11.1	1	2.8	1	2.8	0.99
1957	138	15	10.9	15	12	80.0	3	20	–	–	–	–	–	–	1.39
53-57	822	92	11.2	89	65	73.0	18	20.2	4	4.5	1	1.1	1	1.1	1.42
1960	767	118	15.4	115	97	88.4	13	11.3	3	2.6	2	1.7	–	–	1.33
1961	220	31	14.1	29	24	82.8	5	17.2	–	–	–	–	–	–	1.91
58-62	987	149	15.1	144	121	84.0	18	12.5	3	2.1	2	1.4			1.62
1963	442	70	15.8	70	59	84.3	10	14.3	1	1.4	–	–	2.05	–	–
1964	648	99	15.3	92	73	79.4	14	15.2	3	3.3	1	1.1	1	1.1	1.44
1965	1142	204	17.9	198	166	83.8	26	13.1	6	3.0	–	–	–	–	1.66
1966	924	147	15.9	132	112	84.9	15	11.4	5	3.8	–	–	–	–	1.55
1967	364	29	8.0	28	20	71.4	7	25.0	1	3.6	–	–	–	–	1.49
63-67	3520	549	15.6	520	430	82.7	72	13.9	16	3.1	1	0.2	1	0.2	1.64

TABLE I.7. Estimates of effort in the fishery of Icelandic cod. English effort = thousand ton hours, motor and steam trawlers combined. Total effort = English effort × total catch/English catch.

Year	*England*	*Total effort*	*Year*	*England*	*Total effort*
1946	15 952	115 971	1958	153 601	519 171
1947	29 543	163 373	1959	137 455	551 744
1948	59 306	222 635	1960	157 309	668 563
1949	65 202	259 504	1961	171 282	664 745
1950	91 510	305 369	1962	177 962	653 832
1951	89 109	300 030	1963	210 897	688 157
1952	83 825	354 496	1964	234 447	823 612
1953	128 143	387 889	1965	225 425	694 095
1954	133 521	441 153	1966	181 784	591 717
1955	108 789	422 101	1967	184 548	503 088
1956	101 840	383 122	1968	127 965	437 063
1957	144 229	451 725	1969	91 571	390 156

TABLE I.8. Z' values (the removal rate of tagged fish) from cod tagging in North-Icelandic fjords 1948-1970.

Area	*Húnaflói*			*Skagafjörður*			*Eyjafjörður*			*Skjálfandi*			*Þistilfjörður*			*Bakkaflói*		
Square	*620, 570*			*619, 569*			*618, 568*			*617*			*615*			*614*		
Year	*N tagged*	*% recapt.*	*Z'*	*N tagged*	*% recapt.*	*Z'*	*N tagged*	*% recapt.*	*Z'*	*N tagged*	*% recapt.*	*Z'*	*N tagged*	*% recapt.*	*Z'*	*N tagged*	*% recapt.*	*Z'*
1948	–	–	–	692	14.3	1.15	–	–	–	–	–	–	–	–	–	118	5.1	0.20
1949	579	12.4	1.07	97	16.5	1.10	–	–	–	775	9.4	0.82	–	–	–	–	–	–
1950	–	–	–	92	8.7	0.89	–	–	–	–	–	–	–	–	–	–	–	–
1952	67	7.5	0.55	69	14.5	0.97	–	–	–	468	14.5	1.00	–	–	–	–	–	–
1953	–	–	–	252	7.1	0.77	–	–	–	1026	10.6	1.08	–	–	–	–	–	–
1955	259	7.4	0.41	–	–	–	300	10.3	0.46	300	11.0	0.83	197	3.6	0.35	163	8.6	0.61
1956	118	11.7	1.10	–	–	–	–	–	–	–	–	–	–	–	–	55	5.5	0.69
1957	279	19.4	1.17	–	–	–	251	6.8	1.18	400	11.6	0.91	127	6.3	1.10	–	–	–
1958	101	27.8	0.55	100	2.40	0.83	283	13.4	0.81	200	13.5	0.89	–	–	–	–	–	–
1959	–	–	–	–	–	–	–	–	–	283	12.0	0.40	–	–	–	–	–	–
1960	–	–	–	–	–	–	226	20.4	1.14	400	16.3	1.26	–	–	–	69	13.0	0.53
1961	68	16.2	1.95	–	–	–	87	10.3	0.69	97	24.7	1.03	–	–	–	333	8.1	0.66
1962	–	–	–	–	–	–	198	14.1	1.07	395	14.7	1.28	91	12.1	0.69	–	–	–
1963	–	–	–	–	–	–	112	16.1	1.40	172	213	1.06	–	–	–	–	–	–
1965	91	25.3	0.99	389	17.7	2.01	191	11.0	0.77	–	–	–	–	–	–	–	–	–
1966	–	–	–	–	–	–	35	20.0	0.35	–	–	–	–	–	–	–	–	–
1967	–	–	–	–	–	–	89	14.6	1.38	–	–	–	–	–	–	–	–	–
1968	–	–	–	39	2.31	1.25	387	12.7	1.27	200	19.5	1.22	67	16.4	0.69	229	11.4	0.48
1969	–	–	–	–	–	–	159	15.1	1.16	1000	19.2	1.33	–	–	–	–	–	–
1970	–	–	–	–	–	–	271	17.0	0.97	1000	17.8	1.40	–	–	–	103	17.5	0.63

TABLE I.9. Cod tagging in Skjálfandi (Square 617).

Years at liberty	*1*	*2*	*3*	*4*	*Total*	*Total*	*Total*	*%*	
Date	*N*	*N*	*N*	*N*	*1-4*	*tagged*	*recaptured*	*recaptured*	*Z'*
27/8-1950 . . .	49	6	3	4	62	775	73	9.4	0.82
19/5-1952 . . .	41	15	1	–	57	468	68	14.5	1.00
12/5-1953 . . .	62	32	6	3	103	1026	109	10.6	1.08
19/7-1955 . . .	11	6	2	1	20	300	33	11.0	0.83
5/8-1957 . . .	30	8	3	2	43	400	47	11.6	0.91
29/7-1958 . . .	12	8	2	1	23	200	27	13.5	0.89
7/8-1959 . . .	13	6	3	5	27	283	34	12.0	0.40
22/7-1960 . . .	30	15	7	1	53	400	65	16.3	1.26
29/7-1961 . . .	14	5	–	–	19	97	24	24.7	1.03
25/7-1962 . . .	25	22	1	1	49	395	44	14.7	1.28
1/8-1963 . . .	34	5	5	1	45	172	47	27.3	1.06
7/7-1968 . . .	23	12	2	–	37	200	39	19.5	1.22
7-8/8-1969 . . .	102	56	14	2	174	1000	192	19.2	1.33
1/5-1970 . . .	115	44	7	–	166	1000	178	17.8	1.40
1-2/8-1970 . . .	64	18	4	–	86	479	97	20.2	1.38

Table I.10a. Length distribution of tagged cod by experiments. Average length of all tagged and average length of recaptured fish at tagging.

	Tagging experiments (number)									
Length groups (cm)	*27-30 34-35*	*162*	*250*	*285-290*	*69*	*60*	*187*	*75*	*256*	*351*
21-30	–	–	–	–	–	–	–	–	–	–
31-40	1	–	–	1	–	–	–	–	4	–
41-50	13	–	1	–	–	–	–	–	19	4
51-60	24	1	–	–	4	–	19	–	27	37
61-70	52	6	3	1	11	–	115	9	53	103
71-80	247	43	60	76	53	6	112	42	142	69
81-90	338	115	144	421	80	135	14	69	105	12
91-100	196	104	159	275	39	262	3	22	38	–
101-110	55	28	59	106	10	54	–	5	7	–
111-120	7	1	7	56	1	2	–	1	1	–
121-130	1	1	8	30	–	–	–	–	–	–
131-140	–	–	1	4	–	–	–	–	–	–
Average length of all fish tagged	83.8	88.9	91.6	92.8	83.9	92.4	70.5	82.7	75.9	67.9
Average length of recovered fish at tagging	77.8	90.1	89.9	91.8	83.7	92.0	70.6	86.1	79.5	69.3

Table I.10b. Length distribution of tagged cod by experiments. Average length of all tagged and average length of recaptured fish at tagging.

Length groups (cm)	*Tagging experiments*									
	197	*416*	*1043-44 1047-48*	*1062-70, 1076-79 1083-85*	*937-39 941-42*	*4*	*49*	*63*	*560*	*95*
21-30	1	–	–	–	–	–	–	–	–	–
31-40	–	–	–	–	31	–	1	–	3	2
41-50	26	–	24	73	346	30	17	12	17	11
51-60	50	7	122	326	842	227	41	301	83	42
61-70	62	40	157	487	185	254	140	372	46	138
71-80	48	88	71	410	36	155	202	251	19	89
81-90	–	52	30	149	17	24	56	73	10	17
91-100	–	6	9	11	3	1	4	13	–	1
101-110	–	–	–	–	–	–	2	2	–	–
111-120	–	–	–	–	–	–	1	–	–	–
121-130	–	–	–	–	–	–	–	–	–	–
131-140	–	–	–	–	–	–	–	–	–	–
Average length of all fish tagged	62.2	76.5	65.0	65.9	54.8	63.5	71.2	66.7	60.7	67.4
Average length of recovered fish at tagging	64.8	74.9	67.0	67.4	55.0	65.5	71.9	67.5	61.5	67.3

Table I.10c. Length distribution of tagged cod by experiments. Average length of all tagged and average length of recaptured fish at tagging.

Length groups (cm)	*Tagging experiments (number)*									
	359	*751,52*	*215*	*240*	*120,124*	*129*	*147*	*151*	*395-98*	*195*
21-30	–	–	3	–	–	–	1	–	–	–
31-40	5	155	43	3	–	6	6	–	27	11
41-50	94	144	166	15	1	38	42	24	191	44
51-60	122	72	141	35	33	36	46	118	406	56
61-70	64	21	39	22	64	23	52	143	311	46
71-80	25	4	4	10	20	11	40	88	72	40
81-90	–	–	2	5	6	3	13	21	22	14
91-100	3	1	1	1	1	1	3	3	3	1
101-110	1	–	–	–	–	–	1	2	1	–
111-120	–	–	–	–	–	–	–	–	–	–
121-130	–	–	–	–	–	–	–	–	–	–
131-140	–	–	–	–	–	–	–	–	–	–
Average length of all fished tagged	56.8	45.2	50.4	59.8	65.4	56.8	61.5	65.1	58.1	60.1
Average length of recovered fish at tagging	60.3	47.1	51.6	58.4	65.1	55.0	60.8	66.3	60.3	67.9

Table I.10d. Length distribution of tagged cod by experiment. Average length of all tagged and average length of recaptured fish at tagging.

Length groups (cm)	*Tagging experiments (number)*								
	659,660	*425*	*3*	*217*	*155*	*191*	*156*	*58*	*57*
21-30	–	–	–	–	–	–	–	–	–
31-40	3	–	1	1	–	1	3	–	–
41-50	12	3	49	5	16	11	16	1	1
51-60	80	74	45	18	26	19	32	6	1
61-70	61	179	20	29	48	27	25	7	1
71-80	40	229	2	10	16	18	15	41	16
81-90	19	94	1	5	2	14	5	107	46
91-100	5	5	–	–	2	5	3	50	41
101-110	3	–	–	–	1	–	–	17	15
111-120	1	–	–	–	–	–	1	1	5
121-130	–	–	–	–	–	–	–	–	3
131-140	–	–	–	–	–	–	–	–	–
Average length of all fish tagged	65.3	71.4	53.6	64.0	63.1	67.6	62.1	86.5	91.3
Average length of recovered fish at tagging	68.2	72.3	55.8	59.3	64.6	64.9	65.6	84.4	90.9

Table I.11a. Age at tagging of recovered cod.

Tagging experiment (number)	*Age of recovered fish at tagging*													
	2	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
27-30, 34-35	1	4	3	3	2	8	7	3	2	–	–	–	1	–
162	–	1	–	–	2	6	8	7	2	–	–	–	–	–
250	–	–	–	–	1	20	10	5	23	2	1	2	–	–
285-290	–	–	4	2	11	44	36	90	15	9	–	3	4	3
69	–	–	4	17	8	–	21	2	1	1	–	–	–	–
60	–	–	–	–	4	5	5	3	–	1	–	–	–	–
187	–	2	13	1	–	1	–	–	–	–	–	–	–	–
75	–	–	1	4	2	–	3	–	–	–	–	–	–	–
256	–	–	–	5	7	19	7	1	7	1	1	–	–	–
351	–	1	11	17	4	1	–	–	–	–	–	–	–	–
197	–	3	2	9	–	–	–	–	–	–	–	–	–	–
416	–	–	3	12	3	7	–	–	–	–	–	–	–	–
1043-44, 1047-48	1	–	5	8	10	4	–	–	–	–	–	–	–	–
1062-70, '76-79,'83-85	1	–	11	19	25	26	1	1	–	–	–	–	–	–
937-39, 941-42	1	27	18	9	3	–	1	–	–	–	–	–	–	–
4	–	–	10	11	13	9	3	2	–	–	–	–	–	–
49	–	–	2	5	6	9	7	4	1	–	–	–	–	–
63	–	–	21	25	19	2	3	1	2	1	–	–	–	–
560	2	18	3	3	–	–	–	–	–	–	–	–	–	–
95	–	–	3	7	2	1	–	–	–	–	–	–	–	–

Table I.11b. Age at tagging of recovered cod

Tagging experiment (number)	*Age of recovered fish at tagging*													
	2	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
359	–	–	21	18	8	5	2	1	–	–	–	–	–	–
751, 752	5	15	9	4	–	–	–	–	–	–	–	–	–	–
215	4	21	20	3	–	–	–	–	–	–	–	–	–	–
240	–	1	5	1	1	–	–	–	–	–	–	–	–	–
120, 124	–	–	2	–	2	–	–	–	–	–	–	–	–	–
129	–	4	4	2	1	–	–	–	–	–	–	–	–	–
147	1	4	22	5	2	1	–	–	–	–	–	–	–	–
151	–	1	17	5	3	5	1	–	–	–	–	–	–	–
395-98	–	17	47	72	12	3	1	–	–	–	–	–	–	–
195	1	4	7	8	2	1	–	–	–	–	–	–	–	–
659-60	–	3	4	4	7	2	–	1	1	–	–	–	–	–
425	–	–	1	23	14	11	4	3	–	1	–	–	–	–
3	no otoliths													
217	–	–	2	1	–	–	–	–	–	–	–	–	–	–
155	–	–	3	4	6	1	–	–	–	–	–	–	–	–
191	–	2	6	2	1	1	–	–	–	–	–	–	–	–
156	–	3	5	3	4	3	–	–	–	–	–	–	–	–
58	–	–	–	2	2	1	3	–	–	–	1	–	–	–
57	–	–	–	–	–	–	2	–	–	–	–	–	–	–

TABLE I.12. Returns from cod tagging in Subareas 1 and 9 in 1948-1965.

		Month of recapture												
Subarea	*Square*	*Jan.*	*Feb.*	*March*	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Total*
	724	–	–	1	–	–	–	–	–	–	–	–	–	1
	675	–	–	–	–	1	3	–	–	–	–	–	–	4
	674	2	–	1	–	20	8	3	6	3	4	3	4	54
	673	–	–	–	–	1	1	–	–	2	–	2	–	6
	625	–	–	–	–	1	–	–	–	–	–	1	–	2
	624	5	2	–	1	1	1	–	2	–	–	–	–	12
3	623	1	1	–	1	3	2	–	3	–	–	–	1	12
	622	–	–	–	–	–	1	–	–	–	–	–	–	1
	576	1	–	–	–	–	–	–	–	–	–	1	1	3
	575	–	–	–	–	–	–	–	–	–	–	–	–	–
	574	–	–	–	–	1	1	1	–	–	–	–	2	5
	524	1	–	–	–	1	3	1	–	–	–	1	–	7
	523	–	1	2	–	1	–	–	–	–	–	–	–	4
	522	–	–	1	–	–	–	–	–	–	–	–	–	1
	473	–	–	–	1	–	–	–	–	–	–	–	–	1
Subtotal		10	4	5	3	30	20	6	11	5	4	8	8	114
	721	–	–	–	–	–	–	–	1	–	–	–	–	1
	672	–	–	–	–	6	1	–	1	5	–	1	–	14
4	671	–	–	–	–	–	2	1	–	–	–	1	–	4
	670	–	–	–	–	–	1	–	–	–	–	–	–	1
	620	–	–	–	–	–	–	1	–	1	–	–	–	2
	619	–	1	–	–	–	–	1	–	–	–	–	–	2
Subtotal			1			6	4	3	2	6		2		24
	718	–	–	–	–	–	–	1	1	–	–	–	–	2
5	665	–	–	–	–	–	–	–	–	1	–	–	–	1
	618	–	–	–	–	1	–	–	–	–	–	–	–	1
	617	–	–	–	–	–	1	–	–	–	–	–	–	1
Subtotal						1	1	1	1	1				5
	664	–	–	–	–	1	1	–	–	–	–	–	–	2
	614	–	–	–	–	–	–	1	–	–	–	–	–	1
	613	–	–	–	–	–	–	1	–	–	2	–	–	3
6	612	–	–	–	–	–	1	–	–	–	–	–	–	1
	562	–	–	–	–	–	–	1	–	–	–	–	–	1
	513	–	–	–	–	–	–	1	–	–	–	–	–	1
	512	–	–	–	–	–	–	–	1	–	–	–	–	1
Subtotal						1	2	4	1		2			10
	463	–	–	–	–	–	1	3	–	1	–	–	–	5
	462	–	–		1	–	–	1	–	–	–	1		3
7	414	–	–	–	–	1	1	–	–	–	–	–	–	2
	411	–	–	–	–	–	–	–	1	–	–	–	–	1
	360	–	–	–	–	–	1	–	–	–	–	–	–	1
Subtotal						2	3	3	1	2			1	12
Total		10	5	5	3	40	30	17	16	14	6	10	9	165

Table I.13. Returns by depth zones of cod tagged in Subareas 1 and 9 in 1948-1968 for recaptures where depth was recorded.

		Depth (m)								
Subarea	*Months*	*<50*	*51-100*	*101-150*	*151-200*	*201-250*	*251-300*	*301-350*	*351-400*	>400
9	Jan. - May	9	157	46	4	–	–	–	–	–
	June - Dec.	3	6	3	2	–	–	–	–	–
1	Jan. - May	1	15	13	1	3	–	–	–	–
	June - Dec.	1	–	1	–	–	1	–	–	–
2	Jan. - May	9	70	38	4	5	–	–	–	–
	June - Dec.	3	4	1	1	–	1	–	–	–
3	Jan. - May	1	6	19	7	7	4	1	1	1
	June - Dec.	2	6	5	4	6	5	2	3	–
4	Jan. - May	–	–	2	1	–	–	–	–	–
	June - Dec.	–	3	4	2	1	–	–	–	–
5	Jan. - May	–	–	1	–	–	–	–	–	–
	June - Dec.	–	–	2	–	1	1	–	–	–
6	Jan. - May	–	–	–	1	–	–	1	–	–
	June - Dec.	–	1	–	1	1	–	1	–	–
7	Jan. - May	–	1	1	–	1	–	–	–	–
	June - Dec.	–	–	3	1	3	–	1	–	–
8	Jan. - May	–	2	4	–	–	–	–	–	–
	June - Dec.	–	2	1	–	–	–	–	–	–
Total	Jan. - May	20	251	124	18	16	4	2	1	1
	June - Dec.	9	21	20	11	12	8	4	3	

Table I.14. Returns by fleets in Subareas 3-7 of cod tagged in 1948-1965 in Subareas 1 and 9.

		Nationality of fishing vessels					
Subarea	*Square*	*Iceland*	*England*	*Faroes*	*Germany*	*Norway*	*Total*
	724	–	–	–	1	–	1
	675	–	–	–	4	–	4
	674	14	2	–	40	–	56
	673	5	–	–	1	–	6
	625	2	–	–	–	–	2
	624	9	2	–	1	–	12
3	623	9	3	–	–	–	12
	576	–	–	–	3	–	3
	575	2	–	1	2	–	5
	574	3	3	1	–	–	7
	524	4	–	–	–	–	4
	523	1	–	–	–	–	1
	522	1	–	–	–	–	1
Subtotal		50	10	2	52		114
	721	–	–	–	–	1	1
	672	–	12	–	1	–	13
	671	–	4	–	–	–	4
4	670	–	1	–	–	–	1
	622	1	–	–	–	–	1
	620	–	1	–	–	–	1
	619	1	–	1	–	–	2
Subtotal		2	18	1	1	1	23
	718	–	–	2	–	–	2
5	665	–	–	–	–	1	1
	618	1	–	–	–	–	1
	617	1	–	–	–	–	1
Subtotal		2		2		1	5
	664	–	2	–	–	–	2
	614	–	–	–	–	1	1
	613	1	2	–	–	–	3
6	562	–	–	2	–	–	2
	513	–	–	–	–	1	1
	512	–	–	–	–	1	1
Subtotal		1	4	2		3	10
	463	1	4	–	–	–	5
	462	–	3	–	–	–	3
	460	1	–	–	–	–	1
7	414	–	2	–	–	–	2
	413	–	1	–	–	–	1
	360	–	–	–	1	–	1
Subtotal		2	10		1		13
Total		57	42	7	54	5	165

Table I.15. Returns by age of cod tagged in Subareas 1 and 9 in 1948-1965.

		Age at recapture												
Subarea	*Square*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*13*	*14*	*15*	*17*
	675	–	–	–	–	–	–	1	–	–	–	–	–	–
	674	1	1	2	3	2	11	12	8	6	–	–	–	–
	673	–	–	–	1	–	1	–	–	1	–	–	–	–
	625	–	–	–	–	–	–	–	–	–	–	–	–	1
	624	–	–	–	–	1	1	4	–	2	–	–	–	–
3	623	–	–	–	1	2	2	4	1	–	–	–	–	–
	576	–	–	–	–	–	2	–	–	–	–	–	–	–
	575	–	–	–	–	1	1	3	–	–	–	–	–	–
	574	–	1	–	1	–	–	2	2	–	–	–	–	–
	524	–	–	–	–	–	1	–	1	1	–	–	–	–
	523	–	–	–	–	–	–	–	–	–	–	–	–	–
	522	–	–	–	–	–	1	–	–	–	–	–	–	–
	473	–	–	–	–	–	–	–	–	–	–	–	–	–
Subtotal		1	2	2	6	6	20	26	12	10				1
	721	–	–	–	–	–	–	–	–	1	–	–	–	–
4	672	–	–	–	–	3	1	–	2	–	–	–	1	–
	671	–	–	–	–	1	1	1	–	–	–	–	–	–
Subtotal						4	2	1	2	1				
	664	1	–	–	–	–	–	–	–	–	–	–	–	–
	614	–	–	–	–	–	–	–	–	–	–	–	–	–
6	613	–	–	–	–	1	1	–	–	–	–	–	–	–
	562	–	–	–	–	–	–	–	–	1	–	–	–	–
Subtotal			1			1	1			1			1	
	463	–	–	–	–	–	1	–	3	–	–	–	–	–
	462	–	–	–	–	–	1	–	–	–	–	1	–	–
	460	–	–	–	–	–	–	–	–	1	–	–	–	–
7	414	–	–	–	–	–	–	–	–	–	1	–	1	–
	413	–	–	–	–	–	–	–	–	–	1	–	–	–
	411	–	–	–	–	–	1	–	–	–	–	–	–	–
Subtotal							3		3	1	2	1	1	
Total		1	4	2	6	11	25	28	18	13	2	1	3	1