International Council for the
Exploration of the Sea

C.M.1968/H:13
Pelagic Fish (Northern) Committee

Final Report of Working Group on the Establishment of an International Herring Research Scheme

1. Introduction

At the Symposium on "Herring Population Studies" held by the Council in September 1961, when the current state of knowledge on the ecology and population dynamics of the herring stocks in the north-east Atlantic, and especially on the changes in the herring fisheries and the factors governing them, was reviewed, it was recognised that many of the present difficulties facing scientists in elucidating the causes of the observed, long and short-term changes in the abundance and composition of the herring stocks in this area stem from a lack of a clear understanding of many of the basic ecological and dynamic processes involved. This is largely due to the great size and complexity of the exploited resources and the fisheries exploiting them and the associated difficulties of investigating them. It was also recognised that many of these difficulties would be overcome if the investigations of these processes could be carried out on small, well defined stocks of herring, as were known to exist in the coastal waters of at least one member country. The Symposium accordingly adopted the following recommendation:-

> "In view of their size and great complexity of the biological, ecological and other processes governing the population dynamics of herring stocks, and of the extent and complexity of the scientific problems involved in understanding them, the Symposium recognises the need for setting up intensive and comprehensive studies on a small, self-contained, easily accessible herring population. It further recognises that such populations are known to exist in at least one member country. It therefore recommends that the Herring Committee of ICES should explore the possibilities of such investigations being initiated".

This recommendation was subsequently considered by the Herring Committee at the 1961 Annual Meeting of the Council and as a first step in examining the possibilities of implementing it, the Committee members in each country were requested to undertake surveys of the herring stocks in their coastal waters to determine whether suitable, self-contained stocks for these studies were available within the ICES area.

Information presented by the Norwegian members of the Herring Committee at its 1962 Annual Meeting indicated clearly that there are localities within the Norwegian Fjord system which may be suitable to meet the requirements for these studies. Following further endorsement at that meeting, of the need for establishing such a scheme of research, on an international basis, and of the sorts of long and short-term research projects which it might embrace it was recommended that the Council should appoint a small group of four or five experts to make a survey of possible localities in Norway, with a view to determining whether the essential requirements for a research scheme are available in the Norwegian Fjord system.

This Working Group was duly established and held its first meeting at the Institute of Marine Research, Bergen in August 1963, at which it prepared a report, which was presented to the Herring Committee meeting in 1963 (C.M.1963 Doc.No. 121), on its preliminary assessment of the basic requirements for the establishment of the research scheme and on the features and suitability of three localities near Bergen. Further meetings of the Working Group were held in Bergen in April 1964, March-April 1965, and April 1966, at each of which reports were prepared and presented to an approved by the Herring Committee at its Annual Meeting (C.M.1964 Doc.No. 7; C.M.1965 Doc.No. 135; C.M.1966 Doc.No. H:20). This report presents a summary of the results of the Working Group's acitivities during this period, as presented in these reports.

2. Membership of the Working Group

The following experts served as members of the Working Group during the period.

Mr. B.B. Parrish (Chairman)	- all four meetings
Prof. G. Hempel	" " "
Mr. K. Popp Madsen	" " "
Mr. Finn Devold	1st and 2nd meeting
Mr. O.J. Østvedt	2nd and 3rd meeting
Mr. O. Dragesund	4th meeting
Dr. Á. Friðriksson	2nd meeting

In addition, Mr. O. Dahl of the staff of the Institute of Marine Research, Bergen who was responsible for organising and running the routine herring sampling programme in the "polls" during the whole of the experimental period participated in all of the meetings of the Working Group.

3. Main Tasks

In the course of its activities, the Working Group undertook the following main tasks:-

A) To consider the types of research projects suitable for study in a small, self-contained herring stock.

B) To define the basic requirements of the locality and fish stock for conducting these research projects.

C) To examine the suitability of selected localities within the Norwegian Fjord system in satisfying the requirements in B).

D) To specify the minimum facilities and operational requirements for implementing such a research scheme on an international basis.

A. Types of research project

The Working Group considered the types of research project which might be undertaken in a research scheme based on a small, self-contained herring stock mainly in the light of biological problems encountered by the North Sea and Atlanto-Scandian Herring Working Groups in their assessments of the population dynamics of the exploited herring stocks and the factors governing the observed, post-war changes in their abundance and composition. Such projects can be divided into relatively long-term studies of biological or ecological processes governing changes in the abundance and structure of the herring stocks and shorter-term studies of specific biological processes and experimental work on methods of investigation and features of the physiology and behaviour (including learning) of the herring. Some important examples of both types of study which the Working Group considers to be of major relevance to the present herring research problems in the ICES area and which might be pursued within the proposed scheme are as follows:-

a) Long-term biological and ecological studies

(i) Rates of survival throughout the life-span (egg and larval stages; juvenile stages and adult phase) and the factors governing them, including the relation between survival rate and population density.

(ii) The gonad maturation cycle in spring and autumn spawning herring, its variations from year to year and the factors governing it.

(iii) Studies of egg and larval production, dispersal and survival in relation to spawning stock size and composition and their variations with environmental factors.

(iv) Studies of fecundity and egg size, their variations from year to year and throughout the maturation cycle and their relations with environmental factors, including the endocrine system.

(v) Growth studies, including zone formation in scales and otoliths; predatory-prey relationships and the relation between food, population density and growth at different life-history stages.

(vi) Serological and blood-group studies.

b) Short-term biological and experimental studies

(i) Behaviour studies of different life-history stages including diurnal variations in behaviour, responses to natural and artificial stimuli (including fishing gears), schooling behaviour, spawning behaviour, etc.

(ii) Experimental studies of the efficiency of tags and tagging methods (internal and external), including estimation of tagging mortality and tag shedding rates and observations on differences in behaviour and growth between tagged and untagged herring.

(iii) Experimental work with sonar equipment for estimating fish abundance, target strength measurement etc.

(iv) Genetical studies, including cross-fertilisation and hybridisation of different spawning groups of herring.

This list of research projects is in no sense meant to cover all possible investigations which might be conducted under the research scheme. In particular, it is confined to research projects on herring and takes no account of investigations of, for example, other fish species which might be present in the locality (except in relation to herring, predator-prey relationships) or basic environmental and productivity studies. It seems likely from the interest expressed by scientists in the fields during the course of the Working Group's investigations that in the event of the herring research scheme being implemented, and the basic facilities provided for its continuation on a long-term basis, appropriate research programmes in these other research fields would arise.

B. Basic requirements for locality and fish stock

Consideration was given by the Working Group at its first meeting to the desired features of a locality and fish (herring and other species) stocks to permit investigations along these lines to be carried out. These were considered to be as follows:-

(1) The water mass must be small, not exceeding 10 km^2 and containing a herring stock, or clearly identifiable stocks - e.g. spring and autumn spawners, of not less than 200,000-400,000 adult individuals (500-1000 hectolitres).

(2) The herring stock(s) must be self-contained with all life-history stages present and with little or no exchange of adult individuals with other localities.

(3) The stock(s) of herring should, if possible, be unexploited in the locality and certainly not heavily exploited commercially, but statistics of the catches taken, if any commercial fishing does take place, should be available. The stock(s) must, however, be readily available to capture by standard and experimental fishing gears throughout the year.

(4) The water mass should contain other fish species, especially predators of herring.

(5) The physical, chemical and biological properties of the water mass should be as similar to the open sea as possible (e.g. temperature salinity, O_2, nutrients and plankton production). It should be mostly free from severe icing in water, and free from serious pollution.

(6) The entrance(s) to the locality should be narrow and shallow to allow, if necessary, the erection of temporary or permanent barriers to the emigration or immigration of fish (at least of adults).

(7) The bottom topography of the area should be as regular as possible and the depth not too great (i.e. not exceeding 60-80 metres) over the main part of it. Small, narrow mouthed bays, suitable for isolating small groups for experimental work (e.g. tagging and behaviour studies), leading off the main water mass would be highly desirable.

(8) The locality should have easy access by road or sea transport from a research centre (e.g. from Bergen).

(9) The locality should be one in which the amount of sea traffic is small.

(10) The shores of the area should have sites suitable for the erection of temporary or permanent buildings (laboratory accommodation, stores, landing stage, boat house etc.) close to a road and within easy reach of fresh water and electricity supplies.

In its subsequent assessment of the availability and characteristics of localities and fish stocks, meeting these requirements within the Norwegian Fjord system, the Working Group recognised that the relative importance of the different basic requirements outlined above depends on specific investigations actually being conducted. For example, requirement (2) is an important one for those investigations listed in the preceding section involving studies of the total dynamics of the herring stock, covering all life-history stages and therefore is, clearly, a very desirable feature of the system. However, the failure of the system to meet this requirement completely does not necessarily preclude others of the listed types of project being pursued effectively. Thus, a substantial incidence of immigration or emigration of one life-history stage (e.g. larvae) to and from the locality might severely complicate or indeed preclude some detailed studies of the population dynamics of that stage but this would not invalidate some other investigations of that stage or studies of the dynamics of other life-history stages. Similarly, requirement (4) is essential for studies of predation on herring and, of course, for studies on the predators themselves, but it is not essential for the other types of investigation; indeed for some of them the absence of substantial predation on herring would be advantageous. Such factors were borne in mind throughout the assessment of the potentialities of the proposed research scheme.

In addition to these "physical" and "biological" requirements, it is clear that a number of important legal, social and thechnical requirements have to be fulfilled. Important amongst these is the reaction of the local community (fishermen, landowners, etc.) towards any restrictions on their activities demanded by the scheme, including, for example, the closure of entrances to the water mass. It was agreed that these factors would have to be considered in the light of the results of the assessment of the other requirements outlined above.

C. Assessment of suitability of localities and fish stocks

Following the initial definition of the types of research project and the consequent, principal requirements of the locality and fish stock, the activities of the Working Group were concerned principally with a detailed study of possible localities and the fish (principally herring) stocks in them to meet these requirements. From the outset, the Working Group attached considerable importance to the desirability of the research scheme being conducted within easy reach of an existing, major, marine and fishery research centre. Therefore, although it was known from earlier, Norwegian investigations (e.g. Aasen 1952) that local populations of herring occur within a number of Norwegian fjords, the study was confined to localities in the vicinity of Bergen. Three such localities, each of which is a small arm (termed "Poll" in Norway) of an open fjord, with one or more narrow entrances, were selected for detailed study, from information supplied by the Institute of Marine Research, Bergen. The location of these "polls", Fjellspollen (Fjeldspollen), Lindåspollen, and Heiamarkpollen (Heidemarkpollen), each of which was known to contain herring for at least part of the year, is shown in Figure 1. Following surveys by the members of the Working Group at its first meeting in August 1963, of the general features and physical characteristics of the three polls, in which the suitability of each was assessed principally in relation to the "physical" requirements, as the next step the Working Group drew up a sampling programme on the herring stocks in each of the three localities, aimed at determining whether they also fulfill the main "biological" requirements, especially concerning the size, composition and unity of the herring stock and its availability to capture throughout the year. It was planned to obtain a sample of around 100 herring per month from each of the polls to provide detailed information on especially the length, weight, age and maturity compositions but also data on scale and otolith types, vertebral number, intestinal fat, fecundity and egg size. In addition, the programme included:-

(1) Echo-surveys, to provide further information on depth and bottom topography and the distribution and schooling behaviour of herring and other species in the polls;

(2) studies of the hydrographic and other environmental characteristics of the water masses, including their general plankton content, as food for herring, and the incidence of ice cover in winter;

(3) surveys of spawning herring and spawning products in and in the vicinity of the polls, to provide additional information on the occurrence of spawning in the polls, estimates of the size of the spawning stock and the movement of spawners and spawning products in and out of the polls;

(4) fishing experiments with types of gear not commonly used in the local fisheries;

(5) experiments with netting barriers to determine the feasibility of confining a group of herring in small narrow mouthed bays within the main water mass, for use especially in ad hoc experimental work.

Arrangements were made, by kind permission of the Norwegian authorities, for a herring sampling programme to be run by Mr. O. Dahl, to whom the Council has paid a small annual honorarium for its duration. Fishing was conducted mainly by local fishermen, using set gill-nets, provided by the Institute of Marine Research, Bergen. Sampling in Fjellspollen commenced in September 1962 (prior to the Working Group being set up) and continued through to March 1966. Sampling in Lindåspollen and Heiamarkpollen, on the other hand, was terminated in July and August 1964 following two and one year's sampling respectively.

The additional items of study were conducted on an ad hoc basis by the staff of the Institute of Marine Research and by the members of the Working Group during the course of their second, third and fourth meeting in Bergen. As an important, initial contribution to this additional work the Institute staff conducted echo-surveys of the three polls and their immediate vicinities, and detailed bathymetric charts at a scale of 1:10,000 were prepared by Mr. O. Bostram. Small reproductions of the most relevant parts of these charts are given in Figures 2-4.

D. Results of assessments of localities and fish stocks

(a) Physical features of polls

The principal "physical" features of the three polls are summarised in Appendix I. This shows that all of them fulfil most of the "physical" requirements listed in Section 3B. For example, all of them are small, having narrow entrances through which there is water exchange with the open sea; they are close to and are quite easily reached by road and/or sea transport from Bergen, and they each possess shore sites suitable for the erection of buildings etc. However, the Working Group concluded that of the three localities, the Fjellspollen possesses a number of "physical" advantages over the other two. These are:-

(1) It is smaller than the Lindåspollen and Heiamarkpollen and has a single, narrow, shallow entrance.

(2) It is the closest to Bergen and can be reached directly by road transport.

(3) Its shores are less densely populated and the amount of sea traffic is smaller than in either of the others.

(4) It possesses small, narrow necked bays, suitable for isolating groups of herring for ad hoc experimental work.

(5) Depths in the poll are less than in Lindåspollen and Heiamarkpollen, the main basin reaching 40-50 m. Sand and gravel areas, suitable for herring spawning occur in the shallow areas along its sides.

(6) The general, environmental features in the poll (temperature, salinity, O_2, plankton content) are amenable for herring.

(b) Biological features of the herring stocks

The data collected during the survey period on the occurrence, length, age and maturity stage composition, mean length at age and numbers of vertebrae of the herring stocks in the three polls were presented in the second, third and fourth report of the Working Group (C.M.1964 Doc.No.7; C.M.1965 Doc.No.135; C.M.1966 Doc.No.H:20). They are summarised here on a monthly basis for the Fjellspollen (September 1962 to March 1966) in Tables 1-5; the Lindåspollen (November 1962 to July 1964) in Tables 6-10 and the Heiamarkpollen (August 1963 to August 1964) in Tables 11-15.

The results of the analysis of these data indicate that:-

(1) Herring are present in each of the three polls throughout the year and are available to capture by gill net, the only fishing method used in the routine sampling survey (small catches of herring were also taken in the Fjellspollen by purse-seine in March, April and May 1965 - see later).

(2) Numbers of herring in the polls probably vary seasonally, but they probably exceeded 100 hl in most of the months sampled.

(3) Herring in spawning condition were present in spring in all three polls and in the Fjellspollen also in the autumn. Although the actual occurrence of spawning in the polls was not confirmed (e.g. by sampling of eggs or yolk-sac stage larvae), it seems likely from the maturity stage observations that it did take place in all of them.

(4) The length and age composition of the herring in the polls varied seasonally. This, and irregularities in the occurrence of certain maturity stages suggest that in none of them are the herring stocks self-contained; instead, the data for each poll suggest that there is some movement of herring into and out of the polls. The data for the Fjellspollen suggest that the spring spawners enter the poll as three-year-old first-time spawners from outside. The faster growing members of a year-class may invade the poll in winter but leave it again during February-March, immediately after spawning or to spawn outside. They are replaced by smaller members of the year-class, most of which probably remain in the poll after spawning, for the remainder of the year, some of them spawning there a second time, as four-year olds. However, few members of a year-class remain, or return to spawn in the poll after age four. The data also suggest that members of more than one spring spawning group were present in the poll. The autumn spawners appear to enter Fjellspollen in September as three- and four-year-old recruits, immediately prior to the spawning season, but they move out again immediately after spawning and do not return in strength as older fish. The data for the spring spawning populations in the Lindåspollen and Heiamark-pollen point to a somewhat similar situation as in the Fjellspollen, with a substantial seasonal movement of herring to and from the polls.

(5) No 0-group herring were recorded in the Fjellspollen, and only occasional, very small numbers in the Lindåspollen and Heiamarkpollen during the sampling period. However, owing to the unsuitability of the routine sampling gear for catching this age-group, it was not possible to determine whether substantial concentrations of juvenile herring were present in the three polls during the whole or part of the year.

It is evident from the above that while herring are available in the three polls throughout the year, none of them meet the requirement of possessing a self-contained herring stock. Instead, it seems that, in each, there is immigration and emigration of adult herring prior to and after the spawning season. However, it is also evident that members of the same year-classes of a stock are present in the polls (especially in Fjellspollen) for a large part of the year and can be sampled there. It seems clear, therefore, that the biological features of the herring stocks in all three polls would probably preclude the study of some of the research projects outlined in section 3A, especially those concerning some aspects of the population dynamics of the herring stock (e.g. the relations between stock and recruitment; predator-prey relations etc.), but they would be suitable for others (e.g. studies of annual biological processes within separate year-classes such as maturation rates, growth-rates etc.). It was also evident to the Working Group, however, that for some of the biological, experimental studies specified in Section B, which would necessitate frequent, repeat observation and sampling of the same body of fish, a group of fish in a smaller body of water than the open poll would be required. Therefore, as part of its appraisal, the Working Group investigated the possibility of establishing a group of herring in a small, narrow-necked bay, using a barrier of netting at the entrance to retain the herring but allowing free exchange of water and plankton between the poll and the bay.

(c) Establishment of herring in a small bay

The site chosen for this study was a small bay, Selvåg in the Fjellspollen (shown in Figure 2), which has a narrow entrance (35 m wide and 10-15 m deep at the centre). A detailed survey of the entrance to the bay indicated that it had a relatively smooth, sandy botton, with rocky sides, which would allow a netting barrier to be erected.

At the third meeting of the Working Group in 1965, arrangements were made for a commercial purse-seiner to fish in Fjellspollen, to provide herring in good condition for transfer to the bay. Fishing was conducted on three nights (27/3 1965, 31/3 1965 and 2/4 1965), using artificial lights to aggregate the fish and on the second of these about 1,000 herring were caught in the poll, just north of the entrance. The herring were transferred from the purse-seine into two keep-nets (each 4x4x2 m) which were then towed slowly into the bay using the 35 ft vessel "Olav" of the Bergen Aquarium. During their transfer, in the keep-nets, the herring exhibited no panic or flight reactions and on arrival appeared to be in excellent condition. In the fishing carried out on the other two occasions, less than 100 herring were caught and these were not transferred to the bay. In addition to herring small catches were made of the following species on the three occasions - sandeel, sprat, saithe, whiting, cod, lumpsucker and tusk. This established that some predator species of herring occur in the poll.

Following the transfer of the herring into the bay, a small-meshed netting barrier weighted at the botton and buoyed at the surface was placed across its entrance. Subsequent inspection showed that it had been satisfactorily closed. Subsequent inspections in the following months, carried out by the staff of the Institute of Marine Research, Bergen, showed that the barrier remained intact throughout the summer. However, later inspection in the spring of 1966, following a period when access to Selvåg was impossible due to ice, showed that the closure had become incomplete due to the headline of the netting being drawn below the surface at high tide as a result of the weight of debris and marine growth which had accumulated on it. While this led to the escape of some herring from the bay on this occasion, the Working Group considers that such occurrences could be readily avoided by more regular maintenance, cleaning and replacement of the barrier than was feasible in the course of this experiment, and is confident that the closure of the bay can be satisfactorily achieved in this way. It was also shown during the third meeting of the Working Group that the presence of the barrier does not prevent the passage of small craft into and out of the bay.

Before the group of herring, transferred into the bay were released, 200 of them were tagged, 105 with Scottish "spaghetti" tag and 95 with "Gundersen" internal-external sprat tags. Close observation of them before being released showed that very few scales had been lost during the tagging operation and revealed no difference in behaviour between the tagged and untagged individuals, although it was noticed that a few of the knots tied in the spaghetti tags had become loose, suggesting that there might be a subsequent shedding of tags. A rough count of the total number of tagged and untagged fish released gave an estimate of about 1200. In an echo-survey conducted over the bay about 30 minutes after the release of the body of fish, two small "plume" traces were recorded close to the surface, less than 200 m. from the release point; no other echo-traces characteristic of herring were recorded in the bay on this occasion and none were recorded in a survey carried out prior to the transfer and closure.

Subsequent to the third meeting of the Working Group a further fishing experiment was made on 14th May 1965 in the Fjellspollen and an additional 80 herring were transferred to Selvåg and tagged (30 with the "spaghetti" and 50 with an internal steel tag).

Arrangements were made at the third meeting of the Working Group for periodic fishing trials with gill-nets and/or purse-seine to be carried out in the bay by staff of the Institute of Marine Research, Bergen during the summer of 1965, to provide information on the distribution of the different types of tag in the catches and on the condition and survival of the tagged and untagged herring.

On 8th June, 1965, two months after the main liberation, sampling was carried out in the bay by purse-seine but sampling by a small fleet of anchored gill-nets was also conducted in all months in which circumstances permitted, between the times of liberation and March 1966.

Purse-seine sampling

The purse-seine haul taken in early June 1965 gave a catch of about 1,200 herring of which 76 were tagged with the spaghetti tag and 69 with the sprat tag. All but 51 untagged and 1 tagged herring were then reliberated alive.

The catch taken in this haul was approximately the same as the estimated number of herring transferred to the bay two months previously. This suggests that the mortality of the body of fish following their initial capture and transfer had been small (bearing in mind that at the time of their transfer, a detailed echo-survey of the bay had provided no evidence of any substantial numbers of herring already in the bay). However, of the population of tagged fish only 73% of those liberated with sprat tags and 57% with spaghetti tags were recaptured. This suggests that some tag shedding and/or mortality of tagged fish had taken place since liberation. On the assumption that the mortality of fish as a result of the transfer was negligibl , these figures indicated that 1/3rd to 1/2 of the fish with spaghetti tags and 1/5th of those with sprat tags had either died or lost their tags since liberation.

While no information is available to allow these two sources of tag loss - mortality and tag shedding - to be estimated separately, it is considered that the observed difference between the recovery rates of the two tag types is due to a higher initial rate of shedding of the spaghetti tags, due to the knots becoming untied. This was observed to have happened in a few cases between the time of tagging and liberation from the keep net at the time of the tagging experiment. It is also likely that for both tag types the above estimates of the rates of tag loss are over-estimates because:-

(a) some herring may have been present in the bay prior to the experiment

(b) it cannot be excluded that a few tags, especially the inconspicuous sprat tags were overlooked when counting the herring in the purse-seine catch.

Gill-net sampling

The numbers of recaptures of the different tag types in the total catches taken by gill-net during the period May 1965 - March 1966 were as follows:-

	Tag types		
	Internal Steel Tag	Gundersen Tag	Spaghetti Tag
Liberation of untagged fish = c. 1100			
Liberation of tagged fish = 280	50	95	135
Catch of untagged fish = 262			
Catch of tagged fish in Selvåg = 60 incl. 14/4/66	8(16%)	16(16.5%)	36(26.7%)
Total catch of tagged fish = 62	8(16%)	16(16.5%)	38(28.1%)
Total catch of untagged/total liberation of untagged 23.8%			
Total catch of tagged/total liberation of tagged 23.1%			

These data show that a total of 322 fish were caught in Selvåg, of which 60 were tagged. Thus, the overall ratio of tagged (all types) to untagged fish in the total catch (c. 19%) was approximately the same as in the original population (c. 20%) when liberated.

The recapture rate of the spaghetti tag for the sampling period as a whole, at 26%, was considerably higher than for the sprat and internal, steel tags, for both of which it was 16%. Moreover difference in recapture rates between the tag types increased somewhat in favour of the spaghetti tag with time after liberation; whereas in the period April-June 1965 the spaghetti tag made up about half the total recaptures, in the later months it contributed up to two-thirds of them. The interpretation of these observed differences is not clear, but the following are possible contributory causes:-

(a) a higher "long-term" tag shedding or mortality of internally than of externally tagged herring

(b) a greater vulnerability to capture by gill-net of the fish tagged with spaghetti tags, due to the tags becoming entangled in the netting.

Observations were made throughout the sampling period of the condition factors of the tagged and untagged fish caught in the Selvåg. These data for fish of the same size and maturity stages are given below.

	Spaghetti tag	Sprat tag	Internal steel tag	Untagged
April-June 1965	0.76(4)	0.79(3)	0.78(1)	0.80(14)
Aug.-Sept. 1965	0.68(21)	0.79(11)	0.74(2)	0.82(35)
Nov.-Dec. 1965	0.64(7)	-	0.74(3)	0.78(10)
Feb.-Mar. 1966	0.59(4)	0.66(1)	0.78(1)	0.71(5)

These results show that the condition factors of herring tagged with the spaghetti tag were considerably lower than of those tagged with either the sprat or internal, steel tag, and that those of herring tagged with all three tag types were lower than those of untagged herring. However, length and age observations taken during the sampling period showed that the rates of growth (in length) did not differ significantly between the three tag types or between the tagged and untagged fish in Selvåg.

During the period December 1965 - March 1966, when the netting barrier at the entrance to the bay was not complete some movement of herring out of the bay was possible. Evidence that this occurred was provided by the subsequent recapture in the Fjellspollen and the open sea of a number of the herring tagged and released in the bay.

The analysis of samples taken in the bay subsequent to their transfer showed that almost all of them were 2 ringers. A comparison of the biological features of the herring in the bay and the Fjellspollen must be confined to the 1963 year-class. By September 1965, the average total lengths of this year-class in the two localities were as follows:-

Fjellspollen (sampled on 30/8 and 1/9) 30.8 cm (85 fish)
Selvåg (sampled on 15/9) 29.4 cm (113 fish)

Thus, the herring in Selvåg were on average 1.4 cm smaller than the Fjellspollen herring; also, their growth increment during the year was only 64% of that of the Fjellspollen herring.

Analysis of the fat content was carried out on herring from both localities. The most comparable data are those obtained for September. In this month, the average fat contents of the herring in the Fjellspollen and Selvåg were 22.4% and 13.9% respectively. The condition factors ($= \frac{W_3}{L^3}$) of 2 ringers in the two localities were also determined. The average values for fish in maturity stages IV and V were as follows:-

	Whole fish	Without gonads	Gonads alone
Fjellspollen (sampled on 1/9/65)	1.05	0.87	0.18
Selvåg (untagged herring)(sampled on 15/9/65)	0.87	0.76	0.11

The fat analysis and condition factor data show that as well as having slower growth, the herring in Selvåg were in generally poorer overall condition than those in the open waters of the Fjellspollen.

Observations on stages suggest that the herring in Selvåg completed a normal maturation cycle during the year. Although no herring in maturity stage VI were sampled there, (unfortunately no sampling was possible in October), a number of late stage V fish were taken in September, and by November the majority of the adult fish were recovering spents. The data suggest therefore, that spawning took place in the bay during the period September-October. The maturity data also suggest that some spawning also took place in spring.

In the Working Group's view, these observations on the body of herring introduced into the bay are of major importance in relation to its main assessment. Despite abnormally cold weather conditions and persistent ice-cover in the bay during the period mid-December 1965 to late March 1966, which prevented regular sampling of herring in the bay and proper inspection and maintenance of the netting barrier (which was known to be in need of cleaning and resetting), these observations show that

(a) members of the group of tagged and untagged herring were present in the bay and were available to capture by gill-net and purse-seine throughout the period April-December 1965 and again in March-April 1966

(b) the recapture rate for tagged fish was approximately the same as for the untagged ones, suggesting that their survival rates were approximately the same and that the tag shedding rate after the first month at liberty was small

(c) the tagged and untagged fish in Selvåg appeared to follow a "normal" maturation cycle, and probably spawned in the bay in autumn 1965, although their growth and general condition was inferior to that of the herring sampled in the Fjellspollen.

(d) Overall conclusions from assessments

The Working Group is satisfied from the results of the surveys of the herring stocks in the three polls and of the observations on the small group of herring in the enclosed bay, Selvåg, that the Fjellspollen is the most suitable of the three localities in meeting the basic requirements set out in Section 3B. It considers that, despite its lack of a self-contained herring stock, the available supplies of herring in the poll and the practicability of establishing a small well-defined group of herring in the bay make it possible to investigate there many of the experimental and biological projects specified in Section 3A, more effectively than in the open sea or in aquaria. These include:-

(i) tagging studies (e.g. survival of tagged fish, tag shedding, relative efficiencies of tag types, effects of tags on behaviour and metabolism on the fish),

(ii) biological studies (e.g. maturation cycles of spring and autumn spawners, fecundity and egg size, growth and feeding, and egg development),

(iii) experimental studies (e.g. fish behaviour studies, including shoaling habits, diurnal variations in behaviour, reactions to stimuli; acoustic target strengths; gear selectivity).

E. Minimum facilities and operational requirements

During its investigations, the Working Group considered the essential requirements for the efficient conduct of investigations at Fjellspollen. On the understanding that the specific research projects would be undertaken by scientists from the countries, including Norway, participating in the research scheme the minimum requirements would be as follows:-

(a) Facilities for sampling herring (and perhaps other species) in the Fjellspollen or Selvåg. This necessitates the provision of a small 10-12 m motor vessel as required, equipped with a winch for plankton and hydrographic sampling and for fishing. Fishing by purse-seine when required, e.g. for transferring herring in good condition to Selvåg would need to be arranged by hiring a commercial fishing vessel locally.

(b) Facilities and manpower for the setting and strict maintenance of a netting barrier at the entrance to Selvåg. This would necessitate frequent inspection (preferably by divers) and periodic lifting and cleaning.

(c) The employment of a qualified technical officer in Norway who would be responsible for organising and running routine fish and environmental sampling, participating in the field projects conducted in the specific research programmes and supervising the inspection and maintenance of the netting barrier.

In this specification of minimum requirements, no provision is made for laboratory or other accommodation for the scientists undertaking the research projects. While the establishment of an international research station, including the provision of laboratory and living accommodation at Fjellspollen for visiting scientists would have some definite advantages, it would clearly involve high capital and running costs and raise legal, ownership problems. The Working Group considers that such provisions are not essential for the efficient conduct of the research projects at Fjellspollen if laboratory accommodation for visiting workers can be made available at the Institute of Marine Research in Bergen. This would, however, necessitate the provision of facilities for transporting equipment and personnel by road between Bergen and the Fjellspollen.

As indicated in Section B, in the course of its assessment, the Working Group recognised that important social, legal and technical problems arise in the implementation of the research scheme on an international basis. These would clearly be greater if a full research station was established on the site than on the basis of the minimum requirements outlined above.

F. Acknowledgements

The Working Group wishes to express its thanks to the Director and staff of the Institute of Marine Research in Bergen for the generous facilities made available to the Working Group during its meetings and the generous help provided in fulfilling its programme of herring sampling and other investigations during the course of its work. It wishes also to express its appreciation of the important part played by Mr. O. Dahl of the Institute's staff in following through this part of its work.

APPENDIX I

Physical Features of the Fjellspollen, Lindåspollen and Heianarkpollen

a) Fjellspollen

Geographical situation

The Poll is situated on the island Sotra 20 km south-west of Bergen. To reach the Poll from Bergen one may go by bus to Alvøen (40 min. drive) and from here by ferry to Bratholmen (10 min., about 10 connections per day) and further on by bus either to Nessjøen (30 min.) or to Dalseide (30 min.). This latter spot is directly situated at the Poll, whereas from Nessjøen one has to undertake a 10 min. trip by motor-boat to the pollen. Except in the southernmost branch of the poll where a few farmers live, only two small farms are situated on the shore, one at Dalseide and the other one just inside the entrance. There are a number of sites along the shore suitable for the erection of buildings.

Topography

The entrance from the sea is divided by a small island, the one on the northern side of the island being 10 m broad and 2 m deep, and the southern one 10 m broad and 2 m deep. The average speed of the stream going in and out is roughly estimated to be 3-4 knots. The tidal range being 1 m. The poll itself is 5 km long with a breadth ranging from 200 to 400 m, the maximum depth being 50 m with an average depth of approximately 20-30 m. At the western side of the northern branch a small bay is situated, which is connected to the main poll by an entrance of 15 m breadth and 2-3 m depth. Into the northernmost part of the poll a narrow stream brings fresh water from small lakes of a moorland valley.

The underwater topography of this poll is in the form of a U-shaped valley; the steep rocky mountains at the shore continue under water until the rather flat botton of the fjord is reached at about 40-50 m depths. The botton of the northern end of the poll and at least some of its deeper central parts is muddy. The sides are either rocky or, where shallow, consist of sand and gravel. In the neighbourhood of the entrance, several sills with a sill depth of about 20 m separate the poll into a northern and southern part. The narrow entrances have a minimum depth of about 1 m. Between the entrance of the poll and the outer skerry region there is a sheltered basin with narrow outlets and shallow arms which have gravel bottoms. This basin is a steep bowl, more than 90 m deep.

Hydrography

The water has the lowest salinity in the northern branch, where most of the fresh water comes into the poll. The poll is mainly covered by ice in this part during the winter, whereas in the area inside the main entrance ice is found in extremely cold winters.

b) Lindåspollen

Geographical situation and traffic

The Lindåspoll is a landlocked fjord systen situated on the mainland 35 km northof Bergen. It can be reached by car (and ferry-boat) in 1 1/2 hours or by boat, 3 hours from Bergen. The surroundings of the poll are farmland and forests. The community of Lindås is situated at the northern side of Spjeldnesosen. Several huts for summer holidays are scattered all round the poll. No industry except a saw-mill at Fjellangervåg in the vicinity of the poll.

The main population centre, Lindås, in Spjeldnesosen, has no longer a regular service by boat from Bergen. Most of the traffic goes over land.

No commercial fishery occurs regularly, but occasionally a purse-seiner fishes there.

The Lindås area is a favourite holiday centre and during summer time several sportsfishermen used to come there.

Topography

The poll is divided into three basins, Fjellangervåg, Spjeldnesosen and Straumsosen.

Fjellangervåg is the innermost basin and is connected with Spjeldnesosen through a narrow channel (Haukenaesstrømmen), 30-40 m broad and 1500 m long with a depth of about 4 m. Maximum depth of the Fjellangervåg is 81 m.

Spjeldnesosen is the largest basin, 3-4 km long and 1 1/2 km broad. Maximum depth is 89 m. It is separated from Straumsosen by two small islands and the connection is about 200-300 m at the most, with depth less than 10 m.

Straumsosen is connected with the fjord outside, Lurefjord by three narrow entrances. Two of them can only be passed by small boats on high tide. In the third one is a sluice with a depth of 3 m. The maximum depth in Straumsosen is 55 m.

Both in Spjeldnesosen and Straumsosen there are several smaller islands, bays, and narrow "arms". Especially should be mentioned Kvalvåg, about 2 km long, and only 30-100 m broad, connected with Straumsosen.

The botton of the polls consist mainly of rocks, the profile as shown by echo-sounding is rather irregular.

Hydrography

There is considerable inflow of fresh water at the eastern side of Fjellangervåg. This part has a surface layer of low salinity, which is stained by humus at least in summer time.

Temperature measurements on 14th August show a sharp thermocline at 10 m depth with a temperature of 19.3°C at the surface and 4.9°C at the botton (49 m). Near the botton a considerable amount of H_2S was observed.

In the other parts of Lindåspollen the salinity at the surface is higher than in Fjellangervåg. No hydrographical data are available for these parts.

In most winters the Fjellangervåg is covered by ice and also in the two other parts ice conditions are often severe preventing all traffic by boat during longer or shorter parts of the winter.

c) Heianarkpollen

Geographical situation

The Heianarkpoll is a landlocked fjord on the island Hufterøy, 35 km south of Bergen. It can be reached by car going to Hjellestad or Espegrend (Biological Station), 40 min. from Bergen, and then by boat (2 hours).

Part of the route has to cross waters open to the sea and may be difficult to pass for small boats under very bad weather conditions. In this case the island can be reached on a more sheltered route from the southern end of the Fana-peninsula.

The public transportation to the poll by ferry and road is poor and time consuming at the present time, but is expected to improve in the course of the next five years. At the island itself only one small road leads to the poll.

The poll is surrounded by hilly forests and some open landscape. At the western coast of the poll the small community of Heianark and some isolated houses are situated. At the end of different bays at the eastern side several huts and a saw-mill are situated. Heianark is the home port for several small vessels serving as a ferry to Bergen three times a week. Within the poll motor-boats and rowing boats are used for fishing and transport.

Topography

The Heianark poll is very irregularly shaped. Its largest diameter is 3 km, and its surface area about 3 km^2. The coast line shows several bays of different size and shape, some of them are also nearly landlocked. Its deepest central basin is 116 m deep and the basins in the surrounding bays are 50-80 m deep with rather steep sides. The profile of the bottom is very irregular the seafloor seems to consist of rock except the entrance where a wide area of smooth shallow sand was observed.

The access to the poll is a loch about 3 km long and 1 km wide with several islands in its middle part. The entrance to the poll is mainly blocked by three islands. The westerly by-pass round the westerly island is like a shallow stream, at the east side of this island is the main entrance, about 50 m wide and 6 m deep and narrowed by a mole constructed of block stones. The current in the entrance was estimated to be about 2-3 knots. Eastwards two very narrow and shallow inlets are separated by another small island. The tidal range is about 1 m.

Hydrography

The amount of fresh water coming into the poll for most of the year is small compared with the surface of the poll and the tidal exchange of water. In the south-eastern part of the main body the water temperature was found on this visit to be 15.5°C at the surface, 14.6°C at 10 m, 10.0°C at 20 m. No H_2S was recorded at 20 m depth. The water of the poll is extremely clear. Due to its salinity and close connection to the open sea the Heiamark-pollen will not usually have a considerable coverage by ice during winter.

Table 1. Fjellspollen: Percentage length-composition by months. September 1962 - March 1966.

Year	Month	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	Average Size	N.
1962	Sept.					7.5	7.5		5.0	17.5	7.5	17.5	20.0	17.5					29.65	40
	Oct.			2.7	2.7	2.7			2.7		16.2	21.6	27.0	24.3					30.45	37
	Nov.	3.1				3.1	6.2	9.4	12.5	6.2	12.5	15.6	21.9	6.2	3.1				29.12	32
1963	March									1.3	11.8	22.2	27.5	16.3	15.0	5.9			31.36	153
	April								8.6	31.4	20.0	17.1	8.6	2.9	8.6			2.9	29.99	35
	Sept.			2.0	7.0	3.0	1.0	1.0	2.0		5.0	14.0	31.0	21.0	12.0	1.0			30.63	100
	Oct.	0.7	2.6	0.7	9.3	12.6	5.3	7.9	7.3	5.3	11.3	21.2	6.6	7.3	1.3	0.7			27.66	151
1964	Jan.								0.7		2.0	4.0	6.0	8.7	20.7	36.7	16.0	5.3	33.90	150
	Feb.			2.7				2.7		8.1	5.4	13.5	35.1	13.5	8.1	8.1	2.7		31.56	37
	March								2.0	5.2	20.9	24.2	22.2	11.8	7.2	5.2	1.3		31.08	153
	April						0.4	1.8	9.2	29.8	36.0	19.7	2.6	0.4					29.21	228
	May		1.2				0.6	0.6	8.2	21.6	36.8	24.0	5.8	1.2					29.38	171
	June							1.1	1.1	9.9	12.1	28.6	39.6	5.5	1.1		1.1		30.70	91
	July							1.1	1.1	1.1	11.9	33.7	39.1	10.9		1.1			30.93	92
	Aug.									3.6		10.8	28.9	38.5	14.5	3.6			32.07	83
		(<20)																	30.25	
	Sept.	(1.4)					6.5	3.6	5.8	4.3	13.0	31.2	14.5	12.3	6.5	0.7			(30.01)	138
	Oct.						7.1	7.1	7.1	7.1	25.0	14.3	7.1	10.7	14.3				29.96	28
	Nov.							2.4	0.6	0.6	1.8	1.8	5.4	35.3	40.1	11.4	0.6		32.81	167
	Dec.								1.4			2.1	7.0	23.1	46.9	18.2	1.4		33.19	143
1965	Feb.										1.0	2.0	6.0	29.5	40.5	17.0	4.0		33.23	200
		(<20)																	28.45	
	March	(0.8		0.8	0.8		3.1	20.8	28.5	9.2	10.0	13.1	9.2	1.5	1.5	0.8			(28.35)	130
	April						1.6	15.6	9.4	9.4	9.4	10.9	23.4	17.2	3.1				29.91	64
	May								1.4	8.0	10.8	23.5	34.7	16.9	4.7				31.02	213
	July								12.5		75.0		12.5						29.50	8
	Aug.										16.0	40.0	40.0	2.0		2.0			30.86	50
	Sept.									2.0	8.0	38.0	36.0	10.0	4.0	2.0			31.14	50
	Oct.								1.4	11.0	24.8	35.2	21.4	4.1	1.4	0.7				145
1966	Feb.										1.1	1.1	6.6	23.3	44.4	12.2				90
	March										1.9	2.8	9.3	22.2	47.2	15.7	0.9			108

Table 2 Fjellspollen: Percentage age-composition by months.
September 1962 - September 1965
(birthday taken as 1st January)

Age (winter-rings)		0	1	2	3	4	5	6	7	8	8+	Nos.
Year	Month											
1962	Sept.		15.4	71.8	10.3	2.6						39
	Oct.			55.9	41.2	2.9						34
	Nov.		9.4	71.9	12.5	3.1				3.1		32
1963	Mar.			0.7	67.7	25.6	2.3		1.5	0.7	1.5	133
	Apr.			23.3	50.0	23.3					3.3	30
	Sept.		13.3	28.6	52.0	6.1						98
	Oct.		30.0	39.3	28.7	1.3	0.7					150
1964	Jan.				29.3	60.7	10.0					150
	Feb.			2.9	35.3	52.9	5.9	2.9				34
	Mar.				63.3	32.4	3.6		0.7			139
	Apr.				96.8	2.7	0.4					223
	May			1.9	91.0	6.4	0.6					156
	June			9.2	75.0	14.5			1.3			76
	July			9.6	83.1	7.2						83
	Aug.			10.7	81.3	6.7	1.3					75
	Sept.	1.5		62.3	33.8	0.8	0.8	0.8				130
	Oct.		3.8	42.3	50.0	3.8						26
	Nov.		1.9	5.8	81.2	7.8	2.6	0.6				154
	Dec.		1.5	0.7	82.8	13.4	1.5					134
1965	Feb.				6.0	80.0	12.0	1.5		0.5		200
	Mar.		0.8	48.5	24.6	23.1	0.8	1.5			0.8	130
	Apr.			29.7	15.6	51.6	1.6	1.6				64
	May			3.7	10.3	74.6	7.5	3.3	0.5			213
	July			87.5		12.5						8
	Aug.			90.0	8.0	2.0						50
	Sept.			80.0	12.0	6.0			2.0			50

Table 3 Fjellspollen: Percentage maturity stage composition (all age groups combined) by months. September 1962 - March 1966

Year	Month	Maturity Stage								N.
		I	II	III	IV	V	VI	VII	VIII	
1962	Sept.		33.3	23.1	12.8	23.1			7.7	39
	Oct.		5.7	62.9	17.1	14.3				35
	Nov.			6.3	6.3	34.3	50.0		3.1	32
1963	Mar.		0.7	2.6	26.8	40.5	28.1		1.3	153
	Apr.		14.7	14.7	2.9		61.8		5.9	34
	Sept.	11.6	18.9	48.4	3.2	4.2			13.7	95
	Oct.	19.3	11.7	6.9	8.3	32.4	21.4			145
1964	Jan.			2.0	56.0	42.0				150
	Feb.		2.8		2.8	36.1	58.3			36
	Mar.		0.7	0.7		36.6	61.4	0.7		153
	Apr.				0.9		97.4	1.3	0.4	228
	May	1.2	1.2	2.4			80.6	2.4	12.4	170
	June					100.0				6
	July		1.1	80.4	12.0	3.3			3.3	92
	Aug.		2.4	79.5	12.0	1.2			4.8	83
	Sept.	1.4	0.7	19.6	35.5	39.1	4.3			138
	Oct.			10.7	25.0	64.3				28
	Nov.		1.8	13.8	72.4	10.8	1.2			167
	Dec.		1.4	0.7	78.3	19.6				143
1965	Feb.			1.4	20.5	75.2	2.9			210
	Mar.	0.8	41.4	8.6		1.6	32.0		15.6	128
	Apr.		29.0	1.6		1.6	64.5	1.6	1.6	62
	May			0.9	0.5	1.9	91.2	1.9	3.7	215
	July		12.5	50.0	25.0			12.5		8
	Aug.		2.0	2.0	58.0	30.0			8.0	50
	Sept.			16.0	44.0	28.0			12.0	50
	Oct.		1.4	11.0	7.6	42.8	31.0	5.5	0.7	145
1966	Feb.		1.1	11.1	73.3	14.4				90
	Mar.			2.8	38.0	52.8	6.5			108

Table 4 Fjellspollen: Mean length (cm) at age, by month.
September 1962 - September 1965

(Values in brackets are averages based on less than 10 fish)

Year	Month	0	1	2	3	4	5	6	7
1962	Sept.		(25.3)	30.7	(29.8)				
	Oct.			29.9	30.9				
	Nov.		(24.1)	29.2	(29.8)				
1963	Mar.				31.6	31.6	(32.9)		
	Apr.			(28.9)	29.6	(30.9)			
	Sept.		23.9	31.2	31.8	(33.3)			
	Oct.		24.0	28.3	30.2				
1964	Jan.				33.2	34.3	33.9		
	Feb.			(22.3)	31.6	31.6	(32.0)	(32.3)	
	Mar.				30.2	32.4	(31.7)		(32.3)
	Apr.				29.1	(31.3)	(30.3)		
	May			(25.1)	29.3	30.7	(32.3)		
	June			(30.2)	30.6	31.0			(31.3)
	July			(29.7)	31.1	(31.3)			
	Aug.			(30.4)	32.3	(32.5)	(32.8)		
	Sept.	(14.0)		29.4	31.5	(31.8)	(34.3)	(30.3)	
	Oct.		(25.8)	28.9	30.7	(33.3)			
	Nov.		(26.3)	(29.9)	33.1	33.1	(34.0)	(34.8)	
	Dec.		(27.5)	(30.3)	33.2	33.9	(34.5)		
1965	Feb.				32.4	33.2	34.1	(32.5)	
	Mar.		(15.5)	26.9	29.8	29.9	(33.5)	(30.5)	
	Apr.			27.0	30.0	31.3	(33.5)	(32.5)	
	May			(28.2)	30.0	31.2	32.1	(31.4)	(32.5)
	July			(29.2)		(31.5)			
	Aug.			30.8	(30.8)	(34.5)			
	Sept.			30.8	(32.0)	(32.5)			(34.5)

Table 5. Fjellspollen. Number of vertebrae by maturity stage and month. Sept. 1962 - March 1966.

Month	Group	54	55	56	57	58	59	60	Mean	N.
Sept. 1962	VIII, II-II			1	16	8			57.23	25
	IV-V		1	7	6				56.31	13
Oct. 1962	II-III			2	13	9			57.29	24
	IV-V		1	1	2					4
Nov. 1962	III			1	1					2
	IV-VI		1	15	13	1			56.47	30
Mar. 1963	all mats.		1	21	82	48			57.16	152
Sept. 1963	IV-V				3					3
	I-III, VIII			4	33	19	1		57.30	57
Oct. 1963	I-III S.			7	9	13	1		57.27	30
	I-III A.			9	7	3			56.68	19
	IV-VI		3	51	28	5			56.40	87
Jan. 1964	III-V			19	78	47	4		57.24	148
Feb. 1964	IV-VI			7	18	8			57.03	33
March 64	V-VI			20	74	42			57.16	136
Apr. 1964	VI		1	11	74	28	2		57.16	116
May 1964	I-III		1	3	3				56.3	7
	VI-VIII		2	12	90	53	3		57.27	160
June 1964	Mat.non det.			12	57	22			57.11	91
July 1964	VIII, II-III			11	43	22	1		57.17	77
	IV-V			9	5				56.36	14
Aug. 1964	VIII, II-III			11	36	21	1	1	57.21	70
	IV-V		1	7	3				56.18	11
Sept. 1964	I-III			4	20	6			57.07	30
	IV-V		8	47	36	7	1		56.45	99
	VI			1	2	1			-	4
Oct. 1964	III				2	1			-	3
	IV-V		1	11	8	4			56.62	24
Nov. 1964	II			1	1	1			-	3
	III-V			15	83	53	6		57.32	157
	VI			2					-	2
Dec. 1964	II			1	1				-	2
	III-V			13	65	51			57.29	129
Feb. 1965	III			1	2				-	3
	IV-VI			16	120	69	2		57.27	207
March 1965	I-III			22	29	6			56.72	57
	V-VI			7	16	4			56.89	27
	VIII	1	1	6	8	2			56.50	18

Table 6. Lindåspollen. Percentage length-composition by months, November 1962 - July 1964.

Year	Month	20	21	22	23	24	25	26	27	28	29	30	31	32	33	Mean	No.
1962	Nov.	0.6	0.6	6.0	9.5	7.3	6.3	8.9	18.9	23.2	12.9	4.8	1.1	0.3	0.6	26.8	349
	Mar.		1.9	5.7	15.0	17.0	9.5	13.1	20.7	9.5	3.8	3.8	-	-	-	25.7	53
	Sept.			0.7	14.5	51.6	22.5	5.3	2.7	2.0	0.7	-	-	-	-	24.6	151
1963	Oct.		2.8	2.9	15.7	20.0	11.5	12.8	11.5	8.6	9.9	4.3	-	-	-	25.7	70
	Nov.		0.8	3.0	18.5	30.7	16.9	12.3	10.0	1.6	1.5	1.6	1.5	0.8	-	25.0	130
	Dec.			0.9	8.9	18.7	5.4	16.9	24.1	10.7	6.3	4.5	3.6	-	-	26.5	112
	Jan.		0.8	-	21.3	32.0	14.0	11.6	12.3	2.4	0.8	3.2	1.6	-	-	25.2	122
	Feb.			2.3	11.6	20.9	7.0	2.3	16.3	14.0	7.0	4.7	11.6	2.3	-	26.6	43
	Mar.				2.7	9.8	11.6	8.9	18.7	17.9	15.2	8.9	3.6	0.9	1.8	27.3	112
1964	April	0.7		1.5	2.9	25.0	25.7	8.8	9.6	9.6	5.9	6.6	2.2	1.5	-	26.0	136
	May				6.4	36.9	40.5	9.9	1.4	2.1	1.4	1.4	-	-	-	24.8	141
	June				3.6	31.7	54.7	8.6	1.4	-	-	-	-	-	-	24.7	139
	July	1.9	15.4	21.2	5.8	7.7	21.1	17.3	5.8	1.9	-	1.9	-	-	-	23.9	52

Table 7. Lindåspollen. Percentage age-composition, by months.
November 1962 - July 1964.

(Birthday taken as 1st January)

Age (winter rings)		0	1	2	3	4	5	6	7	8	9	10	>10	No.
Year	Month													
1962	Nov.			3.9	28.5	4.1	13.4	17.0	11.8	11.3	6.4	2.1	1.5	389
1963	March April					44.3	9.8	14.8	21.3	4.9	3.3	1.6	-	61
	Sept.			1.2	12.8	71.9	4.3	4.3	4.9	0.6	-	-	-	164
	Oct.		15.5	9.9	9.9	40.8	5.6	8.5	5.6	1.4	2.8	-	-	71
	Nov.	0.8	9.0	23.3	7.5	50.3	3.0	1.5	2.2	0.8	0.8	0.8	-	133
	Dec.	-	11.1	47.0	10.2	28.2	2.6	0.9	-	-	-	-	-	117
1964	Jan.	-	-	36.6	29.3	11.4	21.9	-	-	0.8	-	-	-	123
	Feb.	-	-	27.9	20.9	25.6	20.9	4.7	-	-	-	-	-	43
	Mar.	-	-	1.0	38.1	23.8	29.5	1.0	2.9	2.9	1.0	-	-	105
	April			6.6	11.7	18.2	38.0	5.8	10.9	6.6	0.7	0.7	0.7	137
	May			3.5	4.3	21.3	65.2	0.7	3.5	0.7	-	0.7	-	141
	June			11.2	2.8	10.5	73.4	1.4	0.7					143
	July			70.2	5.3	10.5	8.8	1.8	-	1.8	-	1.8	-	57

Figures for 1959 year-class underlined.

Table 8. Lindåspollen: Percentage maturity stage composition (all age-groups combined) by months. November 1962 - July 1964.

Year	Month	I	II	III	IV	V	VI	VII	VIII	No.
1962	Nov.	-	4.4	29.0	62.5	3.9	-	0.2	-	389
1963	March-April	-	-	-	-	-	96.7	3.3	-	61
	Sept.	-	11.0	84.1	3.7	-	-	-	1.2	164
	Oct.	12.7	8.5	50.7	23.9	2.8	-	-	1.4	71
	Nov.	17.3	6.8	41.3	27.1	6.8	-	-	0.7	133
	Dec.	7.7	20.5	40.2	27.3	4.3	-	-	-	117
1964	Jan.	3.3	37.4	13.0	38.2	7.3	-	-	0.8	123
	Feb.	2.3	25.6	16.3	25.6	30.2	-	-	-	43
	Mar.	-	4.5	14.3	15.2	39.3	25.9	0.9	-	112
	April	-	12.1	0.7	-	0.7	49.3	37.1	-	140
	May	0.7	84.1	2.8	-	-	7.6	-	4.8	145
	June	-	No data available					-	-	
	July	5.9	72.1	22.1	-	-	-	-	-	68

Table 9. Lindåspollen: Mean lengths (cm) at age by months November 1962 - July 1964.
(Values in brackets for samples less than 10 fish)

Year	Month	1	2	3	4	5	6	7	8	9	10	All Ages
1962	Nov.	-	25.9	25.1	27.3	26.7	27.4	27.8	27.4	28.3	(28.9)	26.8
1963	March	-	-	-	24.3	(25.0)	(26.4)	27.4	(27.3)	-	-	25.7
	Sept.	-	(25.8)	24.0	24.4	(25.6)	(25.8)	(27.7)	-	-	-	24.6
	Oct.	23.0	(27.1)	(26.8)	24.9	(27.2)	(28.0)	(28.3)	-	-	-	25.7
	Nov.	22.8	25.5	26.7	24.8	(25.0)	(26.5)	(26.5)	-	-	-	25.0
	Dec.	23.8	27.2	29.1	25.6	(26.5)	-	-	-	-	-	26.5
1964	Jan.	-	23.8	26.3	26.2	25.4	-	-	-	-	-	25.2
	Feb.	-	23.6	(27.4)	(30.0)	(26.9)	-	-	-	-	-	26.6
	Mar.	-	-	27.1	29.3	25.7	-	-	-	-	-	27.3
	April	-	(24.0)	27.3	27.4	24.8	(28.1)	26.8	-	-	-	26.0
	May	-	(23.3)	(27.0)	24.6	24.7	-	-	-	-	-	24.8
	June	-	25.1	-	24.3	24.7	-	-	-	-	-	24.7
	July	-	23.3	-	(25.6)	-	-	-	-	-	-	23.9

Figures for 1959 year-class underlined.

Table 10 Lindåspollen: Mean V.S. for age-groups, by months.
November 1962-July 1964

(No. of observations in brackets. Values not given for samples of less than 10 fish)

Year	Month	1	2	3	4	5	6	7	8	9
1962	Nov.	-	57.09 (11)	56.78 (109)	57.13 (16)	56.62 (52)	56.69 (65)	56.73 (45)	56.70 (43)	56.38 (26)
1963	Mar.	-	-	-	56.96 (24)	-	-	56.92 (12)	-	-
	Sept.	-	-	56.70 (19)	56.40 (107)	-	-	-	-	-
	Oct.	-	-	-	56.50 (28)	-	-	-	-	-
	Nov.	56.84 (13)	57.13 (30)	57.00 (10)	56.55 (67)	-	-	-	-	-
	Dec.	57.08 (13)	57.25 (55)	57.25 (12)	56.59 (32)	-	-	-	-	-
1964	Jan.	-	57.35 (34)	57.10 (30)	57.00 (13)	56.78 (23)	-	-	-	-
	Feb.	-	57.33 (12)	-	-	-	-	-	-	-
	Mar.	-	-	57.36 (11)	-	56.46 (24)	-	-	-	-
	Apr.	-	56.90 (10)	56.94 (16)	56.65 (20)	56.44 (55)	-	56.62 (13)	-	-
	May	-	-	-	-	56.26 (19)	-	-	-	-
	June	57.27 (15)			56.87 (15)	56.64 (104)				
	July	No V.S. readings available								

Values for 1959 year-class underlined.

Table 11. Heiarmarkpollen: Percentage length-composition by months. August 1963 - August 1964.

Year	Length (cm) / Month	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	Mean	No.
1963	Aug.	1.5	16.4	16.4	41.8	19.4	-	-	1.5	-	-	1.5	1.5	-	-	-	-	23.2	67
	Sept.	-	3.1	6.2	32.3	32.3	6.2	1.5	-	4.6	1.5	7.7	4.6	-	-	-	-	24.8	65
	Oct.	-	-	2.8	41.7	44.4	5.5	-	2.8	-	-	2.8	-	-	-	-	-	24.7	36
	Nov.	-	-	-	4.7	31.3	32.2	15.6	3.4	1.3	1.3	5.1	3.4	1.7	-	-	-	25.7	236
	Dec.	-	-	3.0	10.4	40.3	37.3	4.5	3.0	1.5	-	-	-	-	-	-	-	24.7	67
1964	Jan.	-	-	-	9.7	24.2	32.2	24.2	6.5	1.6	-	-	1.6	-	-	-	-	25.8	62
	Feb.	-	-	-	1.0	4.0	28.0	45.0	17.0	4.0	-	1.0	-	-	-	-	-	26.1	100
	March	-	-	-	-	-	3.7	4.6	6.5	30.6	24.1	25.0	5.5	-	-	-	-	28.8	108
	April	-	-	-	2.5	5.0	8.3	21.7	23.3	9.2	15.0	14.2	0.8	-	-	-	-	27.2	120
	May	-	-	-	2.0	6.0	2.0	24.0	8.0	18.0	20.0	16.0	4.0	-	-	-	-	27.7	50
	June	-	-	-	-	-	10.6	17.0	21.3	29.8	17.0	4.3	-	-	-	-	-	27.4	47
	Aug.	-	-	-	-	1.0	1.0	2.0	5.0	13.0	22.0	25.0	20.0	7.0	3.0	-	1.0	29.7	100

Table 12. Heiarmarkpollen: Percentage age-composition by months. August 1963 - August 1964 (birthday taken as 1st January).

Year	Month	Age (winter rings)							No. of fish
		1	2	3	4	5	6	7	
1963	Aug.	-	97.0	3.0	-	-	-	-	67
	Sept.	-	83.2	10.8	3.0	3.0	-	-	65
	Oct.	-	97.2	2.8	-	-	-	-	36
	Nov.	-	88.9	11.1	-	-	-	-	235
	Dec.	3.0	97.0	-	-	-	-	-	67
1964	Jan.	-	-	98.4	1.6	-	-	-	62
	Feb.	-	-	100	-	-	-	-	95
	March	-	-	76.2	21.9	1.9	-	-	105
	April	-	0.8	91.4	7.8	-	-	-	116
	May	-	2.0	87.0	11.0	-	-	-	50
	June	-	6.8	88.7	4.5	-	-	-	47
	Aug.	-	4.4	86.7	7.8	-	-	1.1	90

Table 13. Højemarkpollen. Percentage maturity stage composition by months. August 1963 - August 1964.

Year	Maturity stage / Month	All age-groups									2 and 3-years-old, year-class 1961								
		I	II	III	IV	V	VI	VII	VIII	Fish Total	I	II	III	IV	V	VI	VII	VIII	Fish Total
1963	August	59.4	37.7	2.9	-	-	-	-	-	69	61.2	38.8	-	-	-	-	-	-	67
	September	70.1	19.5	3.9	-	-	-	-	6.5	72	81.8	18.2	-	-	-	-	-	-	66
	October	27.8	66.7	5.5	-	-	-	-	-	36	28.6	68.6	2.8	-	-	-	-	-	35
	November	22.6	54.0	19.8	2.4	1.2	-	-	-	248	25.2	60.4	12.6	0.9	0.9	-	-	-	222
	December	19.0	61.8	16.2	1.5	1.5	-	-	-	68	16.9	64.6	16.9	1.6	-	-	-	-	65
1964	January	-	50.8	42.6	6.6	-	-	-	-	61	-	51.7	43.3	5.0	-	-	-	-	60
	February	-	28.0	49.0	21.0	2.0	-	-	-	100	-	28.4	48.4	21.1	-	-	-	-	95
	March	-	1.0	1.0	-	-	94.0	4.0	-	101	-	3.5	3.1	-	-	73.7	13.7	-	95
	April	-	18.2	4.5	-	-	62.1	15.2	-	66	-	20.0	3.3	-	-	61.7	15.0	-	60
	May	-	32.0	6.0	-	-	34.0	28.0	-	50	-	31.7	7.3	-	-	39.0	22.0	-	41
	June	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	August	1.0	17.0	78.0	2.0	-	-	-	2.0	100	1.2	17.2	78.0	2.4	-	-	-	1.2	82

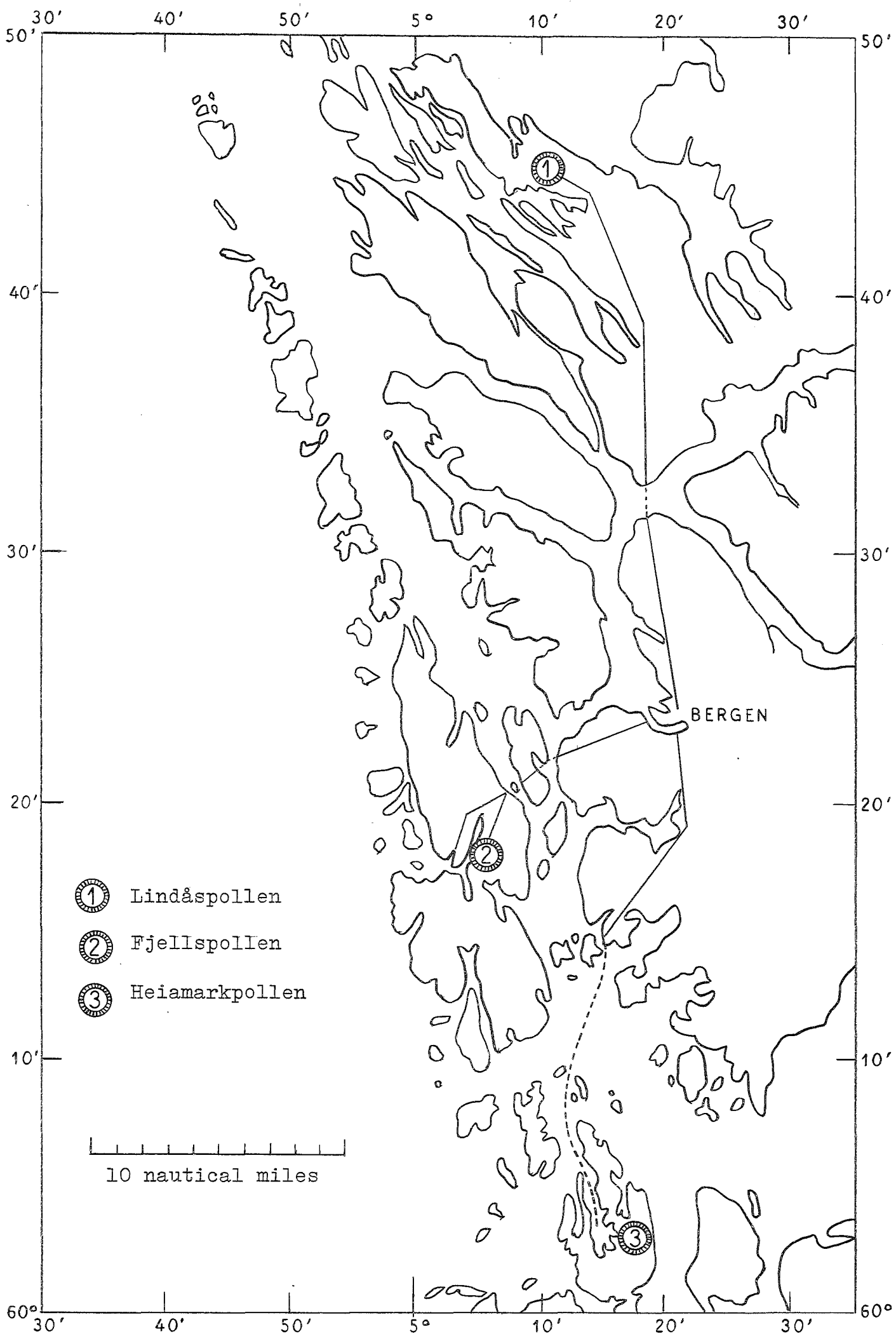
Table 14. Heiarmarkpollen. Mean length at age by months.
August 1963 - August 1964.

Year	Month	1	2	3	4	5
1963	Aug.	-	22.9	-	-	-
	Sept.	-	23.7	(29.9)	(30.5)	(30.8)
	Oct.	-	23.9	-	-	-
	Nov.	-	25.1	31.0	-	-
	Dec.	-	24.7	-	-	-
1964	Jan.	-	-	25.2	-	-
	Feb.	-	-	25.9	-	-
	March	-	-	28.3	29.8	-
	April	-	-	27.1	(29.6)	-
	May	-	-	27.6	-	-
	June	-	-	27.4	-	-
	Aug.	-	-	29.5	-	-

Table 15. Heiarmarkvollen. Mean V.S. at age-groups by months. August 1963 - August 1964.

(Number of observations in brackets. Values are not given for samples of less than 10 fish.)

Year	Month	2	3	4	Total
1963	Aug.	57.16 (64)			57.18 (66)
	Sept.	57.32 (64)			57.30 (92)
	Oct.	57.26 (35)			57.25 (36)
	Nov.	57.15 (94)			57.17 (117)
	Dec.	57.19 (64)			57.16 (67)
1964	Jan.		57.32 (31)		57.31 (22)
	Feb.		57.22 (94)		57.23 (98)
	March		-		-
	April		57.16 (106)		57.15 (120)
	May		57.43 (40)		57.32 (50)
	June		57.28 (39)		57.30 (47)
	Aug.		57.12 (78)		57.13 (96)


30′
40′
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BERGEN
1 Lindåspollen
2 Fjellspollen
3 Heiamarkpollen
10 nautical miles

Figure 1

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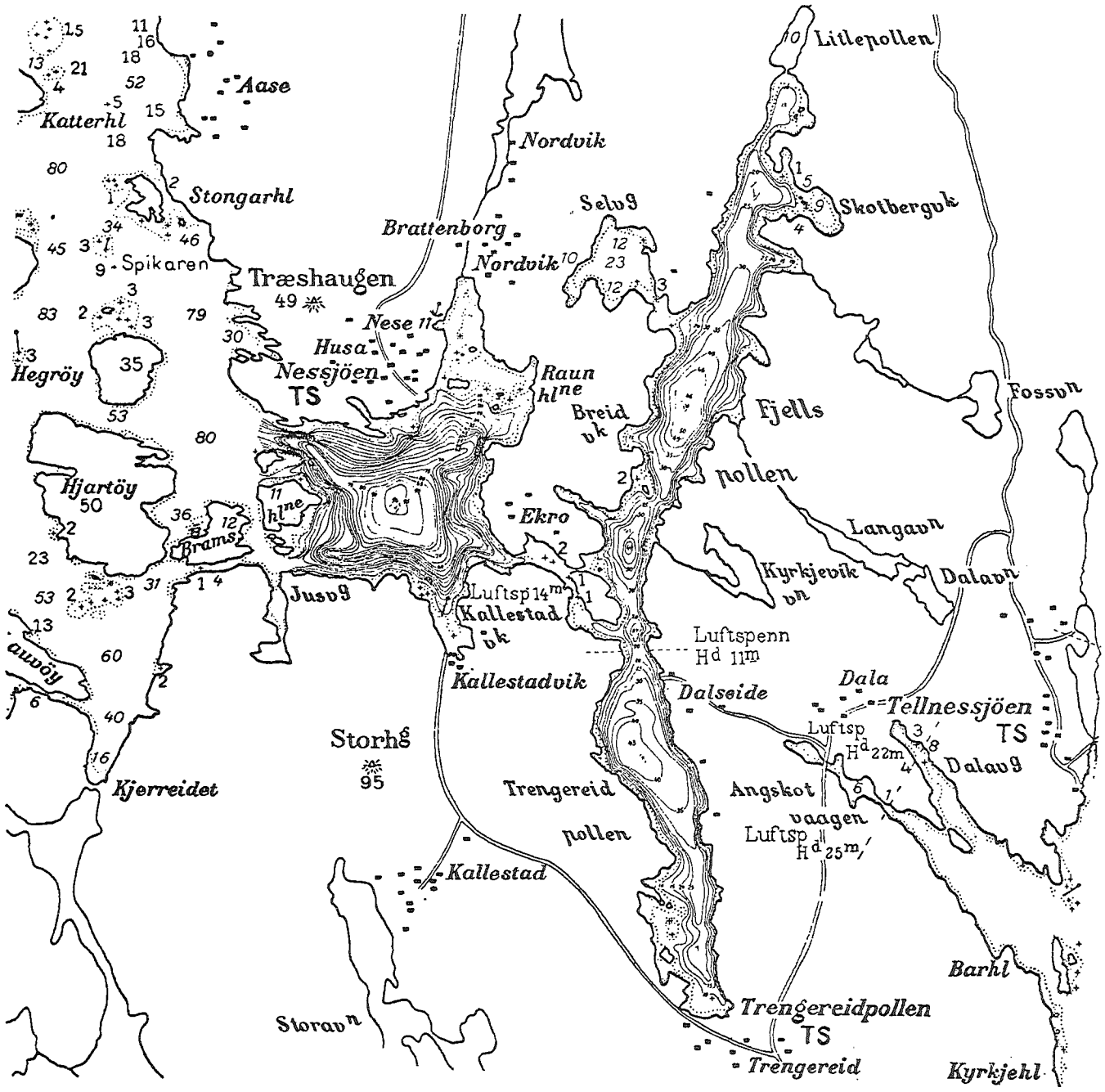

FIGURE 2 .FJELLSPOLLEN

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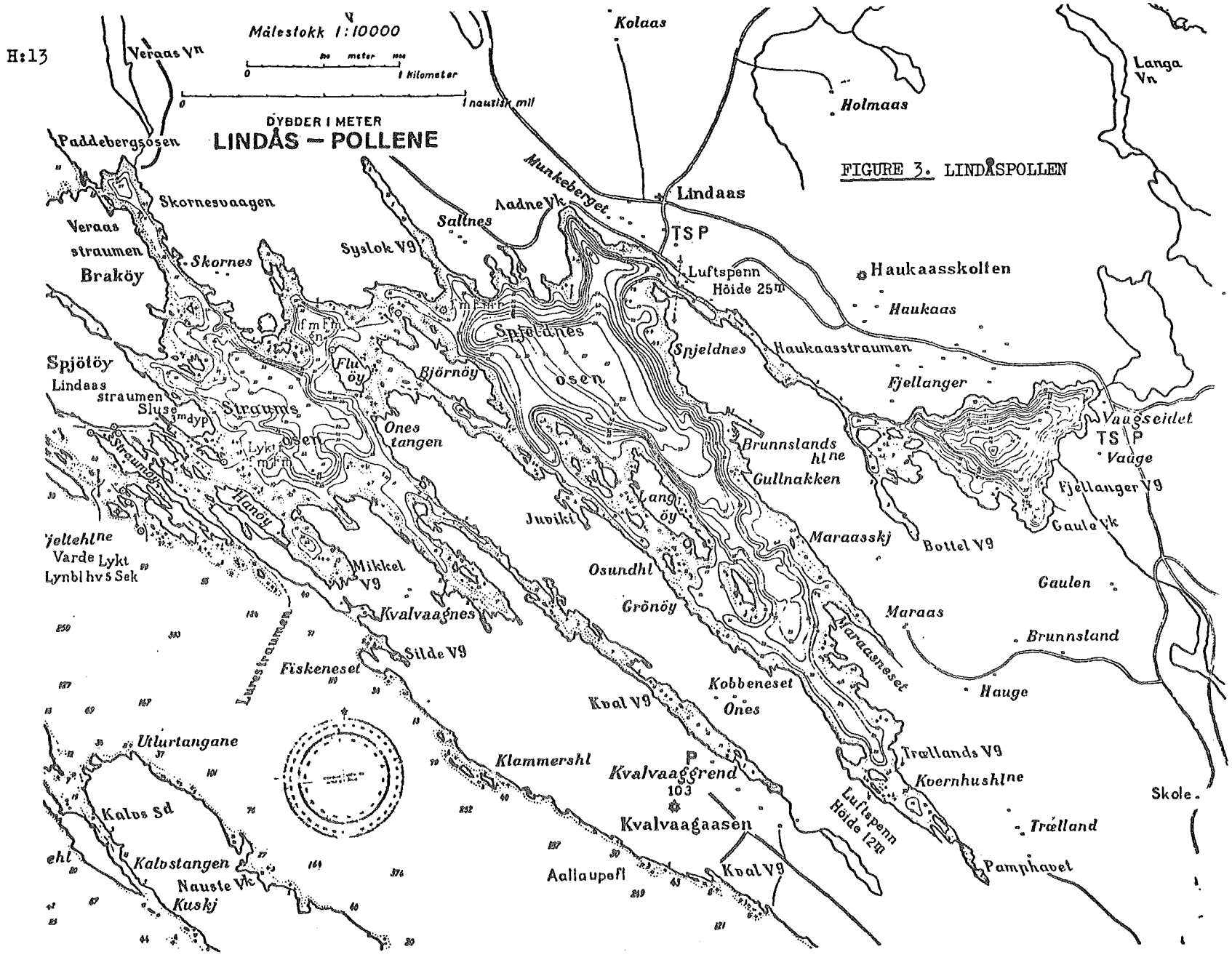

FIGURE 3. LINDÅSPOLLEN

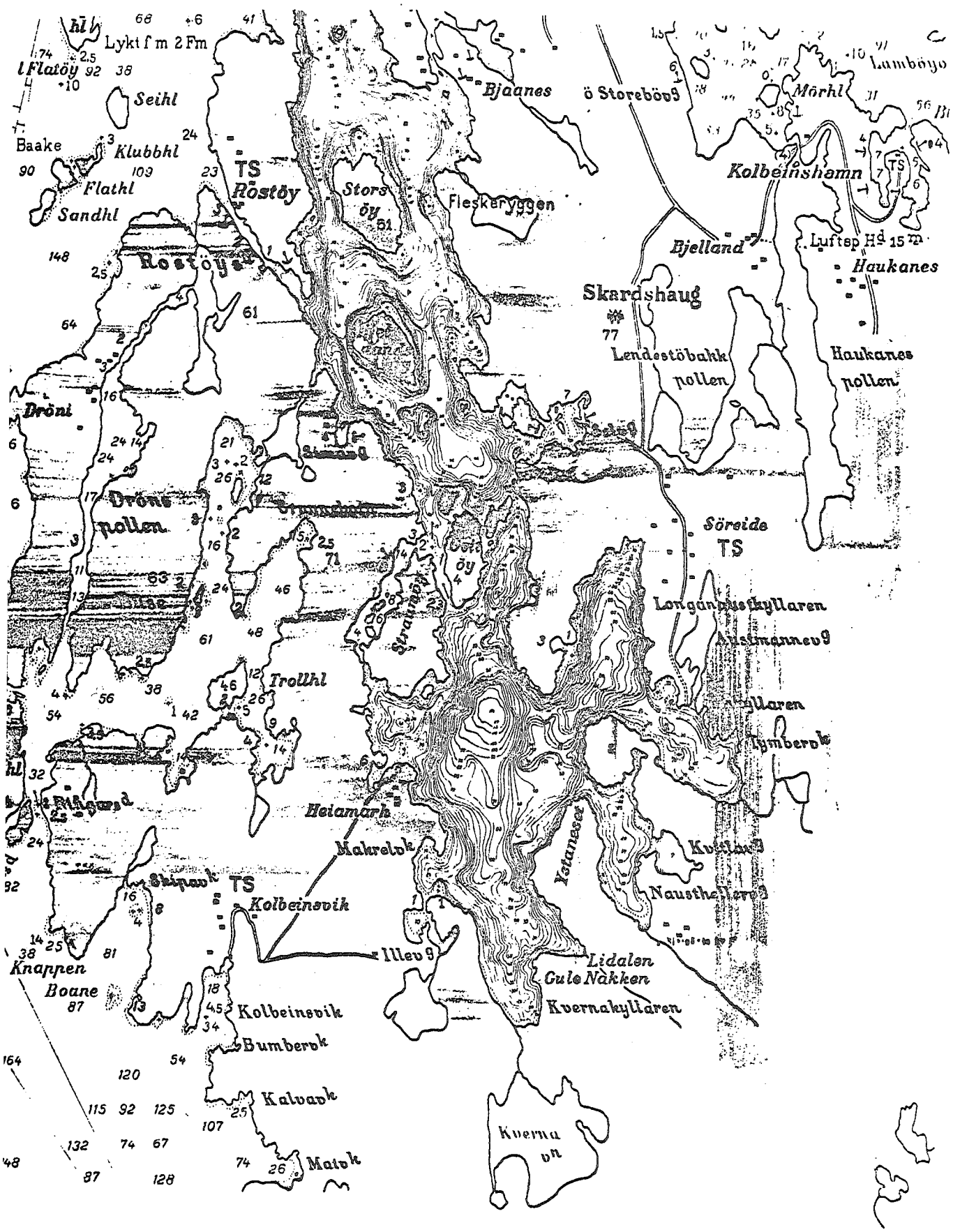

FIGURE 4. Heiamarkpollen.

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