

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

A. Participation

The fourth meeting of the Working Group took place at the Institute of Marine Research, Bergen, from 13th-15th April 1966. The following members participated:-

B. B. Parrish (Chairman)  
G. Hempel  
K. Popp Madsen  
O. Dragesund  
O. Dahl

Mr. O. J. Østvedt, who had participated in the previous work of the Group, was unable to take part in this meeting owing to his absence from Bergen.

During the meeting, discussions were also held with Dr. Finn Devold on aspects of the possible future development of the Scheme.

B. Subject Matter

In accordance with the recommendation passed at the 1965 meeting of the Herring Committee, the main tasks undertaken by the Working Group at this meeting were as follows:-

- (1) To assess the results of the sampling programme carried out since its last meeting on the group of tagged and untagged herring introduced into an enclosed bay (Selvåg).
- (2) To study further biological data collected in the Fjellspollen, especially for comparison with data collected from the enclosed bay.

C. Tagging Experiment in Selvåg

At the time of the third meeting of the Working Group, in April-May 1965, about 1,100 live herring, in good condition, were transferred from the open waters of the Fjellspollen into the narrow-necked bay, Selvåg, the mouth of which was closed by small-meshed netting (see Third Report of Working Group, C.M.1965, Doc. No.135). Of these 280 were tagged, 135 with an external "Spaghetti" tag, 95 with an internal-external "sprat" tag and 50 with an internal steel tag.

At intervals thereafter, fishing was carried out in this bay by the staff of the Fisheries Research Institute, Bergen, to provide information on the distribution of the different kinds 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, between the times of liberation and the present meeting, in which circumstances permitted.

Purse-seine Sampling

The purse-seine haul taken in early June 1965 gave a catch of 1,200, 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 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 (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 negligible, these figures indicate that  $\frac{1}{3}$  to  $\frac{1}{2}$  of the fish with Spaghetti tags and  $\frac{1}{5}$ th 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 overestimates 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 number of recaptures of the different tag types in the total catches taken by gill-net are given in Table 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.

#### Condition of Tagged Fish

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 in Table 2. These results show that the condition factors of herring tagged with the Spaghetti tag were considerably lower than 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.

### Observations on Emigration from Selvåg

During the period December 1965 - March 1966, when access to Selvåg was impossible due to ice, the netting barrier at its mouth was not complete; at high tide its head-line was about one metre below the surface. Therefore, some exchange of herring with the Fjellspollen and the open sea was possible. Evidence that there was some emigration from Selvåg was provided by the recapture of two tagged herring, one on 1st February from the Fjellspollen and the other on 2nd February from coastal waters 30 miles to the south of it.

While this experiment was of a preliminary, exploratory nature, the results obtained show clearly that it has already provided useful information on the relative efficiencies of different tag types and their effects on conditions and survival of herring. The Group considers that the results of further experimental tagging work on such a group of herring in confinement would be of value to the major open-sea tagging experiments on Atlanto-Scandian and North Sea herring, especially with regard to the choice of tag type, tag shedding, etc.

### Sampling of Herring in Fjellspollen and Selvåg

In the period February 1965 - March 1966 a total of 29 samples, comprising 1071 herring were collected by anchored gill-net in the Fjellspollen, while a further 9 samples, totalling 321 herring, were taken from Selvåg. The results are shown in Tables 3-7.

Some conclusions concerning the biology of the herring in the Fjellspollen, based on monthly sampling throughout 1964 were presented in the Third Report of the Working Group (C.M.1965, Doc.No.135). The main object of the further sampling in 1965 and 1966 was to compare the biological development in the Fjellspollen and in the batch of herring transferred to the Selvåg, in order to determine the possible effects of confinement on growth and maturation.

In previous spring seasons, herring samples from the Fjellspollen were composed principally of spring spawners, belonging to two distinctly different growth types; fast-growing 3 year-old recruit spawners were present in the poll in January and February and were replaced by a slower-growing component of the same year-class in March and April. However, it appears from Table 4 that in March-April 1965, autumn spawners constituted a considerable part of the sampled stock, and about 80% of the herring transferred to Selvåg belonged to this spawning group. The small purse-seine catches taken at the time of the transfer and the small number of herring shoals recorded on echo-surveys made by the Working Group in late March - early April suggest that the high proportion of autumn spawners was due to a scarcity of spring spawners rather than a high abundance of autumn spawners.

The Tables show that, apart from the scarcity of spring spawners, the features of the biology of the herring in Fjellspollen in 1965 followed the pattern of previous years. The presence of those different groups of herring, a fast-growing early spring-spawning component, a slow-growing late spring-spawning component and an autumn-spawning component was again observed.

Almost all of the herring transferred to the Selvåg were 2-ringers, so that a comparison of the biological features of the herring in the two areas 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  $( = \frac{W}{L^3} )$

of 2-ringed fish in the two localities were also determined. The average values for fish in maturity stages IV and V were as follows:-

	<u>Whole fish</u>	<u>Without gonads</u>	<u>Gonads alone</u>
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.

The maturity-stage data in Table 4 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.

### Conclusions

In the Working Group's view, the observations made since its last meeting on the body of herring introduced into the small, netted bay "Selvåg" are of major importance. 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 re-setting), 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.

The Working Group is satisfied that it has completed the main task assigned to it. The results reported above indicate that it is feasible to investigate a well-defined group of herring in a small artificially closed bay. It is clearly possible to carry out, at least in Selvåg, experimental and biological investigations which cannot be pursued as easily and effectively in the open sea or in aquaria. Examples of such investigations are as follows:-

- (a) tagging studies; including the survival of tagged fish; tag shedding; the relative efficiencies of tag types; the effects of tagging on behaviour and metabolism of the fish
- (b) biological studies, especially of (i) maturation cycles of spring- and autumn-spawners, (ii) fecundity and egg-size, (iii) growth and feeding, (iv) spawning and egg development
- (c) experimental studies; measurement of acoustic target strengths; gear selectivity experiments etc., fish behaviour studies; shoaling habits in relation to external factors; reactions to stimuli (light, sound, chemicals etc.).

It is considered that the essential, minimum requirements for the efficient conduct of such investigations are as follows:-

- (a) the strict maintenance of the netting barrier in a clean and efficient state. This necessitates frequent inspection and periodic lifting for cleaning.
- (b) facilities, as required, to catch herring by purse-seine, in the Fjellspollen or neighbouring areas for transfer to the Selvåg in good condition.
- (c) sampling facilities in the Fjellspollen and Selvåg. This necessitates the provision of a small motor vessel as required, equipped with a winch and davit for plankton and hydrographic sampling and fish sampling. Fish sampling by purse-seine would need to be arranged by hiring a commercial fishing vessel, locally.
- (d) laboratory accommodation for visiting workers at the Marine Research Institute in Bergen and facilities for transporting equipment and personnel by road from the Institute to the Fjellspollen.

The Working Group considers that for the efficient operation of the research programmes, it would be necessary for a qualified technical officer in Norway to organise and run the routine fish- and environmental-sampling, and to participate in the specific field programmes carried out.

During the four years since the programme of herring sampling in the three polls started, many data concerning the composition and biology of the herring in them have been collected. While preliminary results of analyses of these data have been presented in the reports of the Working Group, a full account of all the results is being prepared for publication.

#### Acknowledgements

Again the Working Group wishes to express its thanks to the Director and staff of the Fisheries Research Institute in Bergen for the generous facilities made available to it during the meeting, and for the generous help provided in fulfilling its programme of sampling and other work during the year. It wishes to express its appreciation of the important part played by Mr. O. Dahl in following through this part of the Group's work.

Table 1. Recaptures of tagged and untagged herring by gill-net sampling in Selvåg (April 1965 - March 1966).

	N	Tag types	
		G.T.	Spaghetti
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/ <sup>t</sup> total liberation of untagged	23.8%		
Total catch of tagged/ <sup>t</sup> total liberation of tagged	23.1%		

N = Norwegian internal steel tag  
 G.T. = Gundersen internal-external, sprat tag  
 Spaghetti = Spaghetti tag

Table 2. Condition factors of tagged and untagged fish of the same sizes and maturity stages in Selvåg.

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

Table 3. Percentage length-composition by months. 1965

FJELLSPOLLEN																					
Year	Month	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	Average size	N.	
1965	February	< 20 (0.8)									1.0	2.0	6.0	29.5	40.5	17.0	4.0		33.23 28.45	200	
	March		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
	August										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
October									1.4	11.0	24.8	35.2	21.4	4.1	1.4	0.7				145	
1966	February										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	
SELVAG																					
1965	April							60.0	40.0										26.90	5	
	May							11.1	66.7	22.2									27.61	9	
	June					2.0			24.5	51.0	18.4	4.1							28.44	49	
	August								7.2	37.7	31.9	17.4	5.8						29.27	69	
	Sept.								5.6	29.0	33.9	21.0	5.6	4.0		0.8			29.58	124	
	November								11.1	11.1	44.4	33.3									9
December							6.7		6.7	13.3	26.6	33.3	13.3							15	
1966	March						9.7		3.2	9.7	19.4	12.9	12.9	3.2	25.8	3.2				31	

Table 4. Average length by age and month. 1965

FJELLSPOLLEN

Year	Month	0	1	2	3	4	5	6	7	8	8+
1965	Febr.				32.4	33.2	34.1	(32.5)			(34.5)
	March		(15.5)	26.9	29.8	29.9	(33.5)	(30.5)			(31.5)
	April			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)		
<u>SELVAG</u>											
1965	April			(26.9)							
	May			(27.6)							
	June			28.5	(24.5)						
	Aug.			29.2	(29.5)	(31.5)					
	Sept.			29.4	31.5		(34.5)				

Table 5. Percentage maturity composition by months. 1965.

FJELLSPOLLEN

Year	Month	I	II	III	IV	V	VI	VII	VIII	N
1965	Febr.			1.4	20.5	75.2	2.9			210
	March	0.8	41.4	8.6		1.6	32.0		15.6	128
	April		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	Febr.		1.1	11.1	73.3	14.4				90
	March			2.8	38.0	52.8	6.5			108
<u>SELVAG</u>										
1965	April		100.0							5
	May		22.2					77.8		9
	June		50.0	36.5				11.5	1.9	52
	Aug.		8.7	50.7	18.8				21.7	69
	Sept.		10.3	4.1	43.2	21.6		1.0	19.6	97
	Nov.		22.2		11.1				66.7	9
	Dec.		33.3	60.0			6.7			15

Table 6. Percentage age-composition by months. 1965

FJELLSPOLLEN

Age (winter-rings)	0	1	2	3	4	5	6	7	8	8+	N
Year Month											
1965 Febr.				6.0	80.0	12.0	1.5		0.5		200
March		0.8	48.5	24.6	23.1	0.8	1.5			0.8	130
April			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
<u>SELVAG</u>											
1965 April			100.0								5
May			100.0								9
June			97.9	2.0							49
Aug.			95.7	1.4	2.0						69
Sept.			91.1	8.1		0.8					124

Table 7. Number of vertebrae by maturity stage and month. 1965

FJELLSPOLLEN

Month	Maturity stages	54	55	56	57	58	59	60	Mean	N
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
<u>FJELLSPOLLEN - 2-ringers</u>										
March 1965	I-III			19	25	3			56.66	47
	V-VI									0
	VIII	1			3	1			-	5
<u>SELVAG</u>										
Aug. 1965	II, VIII			6	8	7			57.05	21
	III-IV		2	23	21	2			56.48	48
Sep. 1965	II			2	3	5			57.30	10
	III-V		2	27	28	10			56.69	67
	VII-VIII		1	4	9	6			57.00	20