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## **SCIENTIFIC COUNCIL MEETING –SEPTEMBER 2024**

### **Protocol of the Faroese longline survey of Flemish Cap (Div. 3M)**

by

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#### **Abstract**

This document provides insight and guidance to the operational procedures of the Faroese long line survey on Flemish Cap NAFO Regulatory Area (NRA, Division 3M) with the methodologies adhered to during the planning and execution phases of the survey being described in detail. The objective of publishing the protocol is to achieve clarity and transparency of the results derived from survey data, and to ensure continuity of unaltered procedures. The protocol was developed by Faroe Marine Research Institute.

#### **Introduction**

Flemish Cap is an isolated bank on the American continental shelf covering approximated 17 000 squared nautical miles within the 1460 m depth isobath and 10 555 within the 730 m. Flemish Cap is separated from the Newfoundland Grand Bank by the Flemish Pass, an area deeper than 1000 m.

The general circulation in the vicinity of the Flemish Cap consists of the offshore branch of the Labrador Current which flows through the Flemish Pass on the Grand Bank side and a jet that flows eastward north of the Cap and then southward east of the Cap. To the South, the Gulf Stream flows to the northeast to form the North Atlantic Current and influences waters around the southern areas of the Cap. In the absence of strong wind forcing, the circulation over the central Flemish Cap is dominated by a topographically induced anti-cyclonic (clockwise) gyre (Akenhead 1986, Stein 1996).

The survey was initiated in 2021 as a collaboral investigation between the Faroese Association of Longliners and the Faroe Marine Research Institute (FAMRI), with the latter being the governing body. The survey has been subjected to several planned and ad-hoc adjustments which are described below:

- The survey conducted in 2021 from 14/6 to 10/7 by the longline vessel “Klakkur” (KG 9, LOA 51.3 m) covered the 3M area shallower than 600 m isobaths. The number of sets was established at 100 with approximately 6000 hooks on each longline set.
- The 2022 survey was led by the smaller vessel “Eivind” (VA 132, LOA 41.3 m). A total number of 54 (of 100 planned) sets of 4400 hooks each were employed covering mostly the western region of Division 3M. Fishing operations were carried out in the month of June (1/6 – 13/6).
- In May 2023 (2/5 – 15/5) the vessel “Stapin” (FD 32, LOA 42 m) conducted the survey employing 3600 hooks on each of the total 28 (of 52 planned) sets.

The following protocol is based on the experience from the Faroese longline survey in 2021 to 2023 and on experience, guidelines and manuals from already accepted protocols for other research surveys carried out in the NRA.

### **Objective**

The main objective of the survey is the study of abundance, biomass and composition structure of the target species, i.e., Atlantic cod in Division 3M. In addition, also biological samples of other fish species should be conducted in every longline set as well as oceanographic compilation of data consisting of water temperatures and depth measurements recorded from haphazardly selected sets.

### **Significance of the longline survey**

The aim of the survey is to investigate the Flemish Cap Atlantic cod stock employing an alternative gear to that used in the EU trawl survey, which may potentially be incorporated into and supplement the analytical stock assessment as a fishery independent index. Importantly, the longline survey catches fish larger than 60 cm, i.e. the part of the stock that is not well covered in the EU trawl survey.

A further motivation for the inclusion of a longline survey in the assessment framework is the distinct perception of the stock dynamics among Faroese fishermen. Since 2017 the Faroese fishery in 3M is conducted exclusively by longliners.

Given the nature of longline fishing it is not possible to collect samples of invertebrates, sponges and corals. However, an advantage of longlining over more traditional methods of groundfish trawl surveys is that impact on ecological structures and negative effects on the sea floor are kept to a minimum.

### **Survey design and area coverage**

The stratified random survey design in the Flemish Cap follows the methodological specifications of NAFO which were presented and adopted in 1981 (Doubleday 1981). Flemish Cap is divided into 39 strata of which 32 are surveyed by the EU research vessel *Vizconde de Eza*. Each stratum is divided in rectangles of equal area and thus the number of rectangles is proportional to the stratum area. A total of 478 rectangles are considered in the current survey design. Each rectangle is in turn divided in 10 fishing units of equal area, leading to 4780 possible bottom trawl fishing hauls or longline sets (Figure 1). The number of selected hauls in the EU survey is 181.

The scope of the Faroese survey is limited to 62 longline stations (Table 1); this adjustment is based on the relatively high catches observed the first three years. In order to accomplish the objective, the 62 random stations are to be selected from the sampling strata in NAFO Division 3M. The Faroese survey will cover strata 1-20, 24 and 28 of Flemish Cap (Table 1).

### **Temporal coverage**

The recommended time-frame to conduct the survey is during the four-week period from mid-May to mid-June. In any given year, the survey should be completed within three weeks.

### **Longline station selection methodology**

The number of sets in each stratum is fixed and distributed proportionately to the area of the stratum, as in the EU trawl survey (Table 1). A minimum of two sets are surveyed in each stratum to ensure statistically valid estimates and deviations.

Only one fishing station will be selected randomly in each stratum in a given rectangle. Additionally, two stations are not be selected in adjacent fishing units.

### **Rejection of survey sets**

Rejected sets are not to be used in the compilation of survey indices although sampled individuals can be retained for further investigations.

Criteria for rejecting sets:

- Deviations from the standard soaking time and the number of hooks employed in all sets

- Damages caused in the longline gear
- Unjustified change in the geographical position of selected units

### **Vessels**

Due to operational and financial limitations, it is not possible to employ the same vessel every year to conduct the survey. The survey may either be conducted by one single vessel or up to three vessels in each year. If more than one vessel conducts the survey all vessels must carry an observer (see below) and the stations (see below) are distributed among the vessels prior to survey start. Potential vessels to conduct the survey are listed in Table 2. The Faroese Association of Longliners appoints which vessel/vessels conduct(s) the research trip prior to the annual survey preparations.

### **Personnel**

A fishery independent scientific observer will be present during the duration of the survey. The task of the observer is to carry out the sampling procedure and ensure that crew members follow the scientific standards established in the protocol. Crew members are obliged to help and facilitate the operational requirements of the survey.

### **Data collection**

Data collected will be delivered to the FAMRI for quality check and error filtering. Validation of all the input data will be completed by scientists at FAMRI and stored in the institutes database. The observer is responsible to ensure all data and samples collected during the survey as well as institute's equipment used is delivered to FAMRI upon port return.

### **Fishing gears**

The fishing gear employed is longline from various gear providers. In order to standardize equipment in the survey among the vessels and years, obligated specifications of equipment used is listed in Table 3. These specifications are based on experience from the investigations in 2021-2023 and from the protocols for DFO's halibut longline survey in Canada.

Main adjustments to the protocol with regard to gear specification compared to the surveys in 2021-2023 consist of lowered number of hooks per longline set and decreased and standardized soak time. Based on the Canadian halibut survey, the number of hooks per longline-set is fixed at 1000. Fishing activity is standardized by limiting the soak time, aiming at a range from 6 to 10 hours. For optimisation of vessels operational time, setting and retrieving can be conducted throughout the day. To account for potential bias due to diurnal catch variation, all effort within reason should be made to distribute sets evenly throughout the day. Particularly, planning of the survey should safeguard that not all stations within a stratum are set within few hours. If statistical analyses of diurnal catch variation after ~2 years of sampling suggest the survey index biased, then this protocol needs to be updated accordingly.

### **Station data**

The station data form (see Annex 1) is to be filled in for each longline set. The information gathered at beginning and completion of the set-procedure includes: geographical position, date, time, temperature, depth, and TD-recorder ID. At set retrieving, date and time and catch information by species is to be recorded on same station data form. The observer is responsible for logging the catches in the data form. Catches of non-targeted species are also to be recorded.

### **Fish species**

Since the survey design utilizes a passive gear aimed at free-swimming fish, benthic fauna is not caught to any significant degree, and such species are not included in the non-target species list.

Target species:

- Atlantic cod (*Gadus morhua*)

By-catch/non-target species e.g.:

- Redfish (*Sebastes marinus*, *S. mentella* and *S. fasciatus*)
- Tusk (*Brosme brosme*)
- Greenland halibut (*Reinhardtius hippoglossoides*)
- Atlantic halibut (*Hippoglossus hippoglossus*)
- Wolf fish (*Anarhichas lupus*)
- Spotted wolffish (*Anarichas minor*)
- Grenadier (*Coryphaenoides rupestris*)

(This list is not exhaustive, merely a list of previously encountered species – all caught species in the subsample are to be sampled).

### **Hook occupancy**

Sampling power for a set or line of hooks is diminished if hooks are broken, bait is lost or the hook is already occupied by another fish. Standardising catch by the condition of the hooks yields a better index of local density of cod.

To describe the hook occupancy, registration of 50 hook condition will be recorded for each set at retrieval (Annex 4). Bycatch species are to be noted under “viðmerking”. Due to the increased possibility of entanglement at the beginning of the line, registration of hook condition is to begin after first 100 hooks are retrieved. Possible hook conditions are:

- Bait only
- Cod
- Bycatch/other species
- Hook empty
- Hook missing
- Damaged/broken hook

### **Biological sampling**

#### ***Cod***

For each station full biological sampling of cod is done. The biological sampling includes:

- length in cm
- round weight in kg
- sex
- maturity
- otolith collection

As a rule, 100 individuals of the target species taken randomly from the catch are to be sampled in each station, all to be measured in both length and weight. Sample weight of the 100 individuals is to be recorded as well as the total catch from each set. Length measurements are made on the total length measured in centimeters (cm) to the nearest lower cm. Weight measurements are recorded in kg. Biological data for cod are to be recorded in the target specie’s registration form (Annex 2).

From the cod sample, 20 individuals are to randomly be subsampled for investigation of gender and gonad maturity. Inspection of gonad maturity is conducted by observer and is based on a seven-step identification scheme (Table 4).

A further subsample there of containing 10 individuals will have otolith samples taken. Otoliths are upon sampling temporarily stored in paper envelopes marked by pencil with following information:

- Set number (station number)
- Fish number
- Sex
- Maturity stage

All otolith envelopes from one set (station) will be gathered into larger envelope marked with date and set number (station number). Otoliths will be processed by established otolith processing protocols developed by and for FAMRI.

It is necessary to ensure that by the completion of survey, the biological sampling of the survey covers all lengths measurements, i.e. minimum one otolith sample per length (cm) measurements.

### ***Bycatch/non-target species***

At each set (station), 20 random individuals of non-target species will be registered with length and weight, conditioned on fish availability, following same technical measures as mentioned above for individual cod length and weight sampling. Measurements are to be recorded in bycatch registration form (Annex 3). Specimens whose classification is dubious should be labelled and frozen for further scrutiny at FAMRI.

### **Oceanographic and environmental data sampling**

Due to availability of equipment, oceanographic data collection is limited to hap-hazardly deployments amongst the survey sets. Standard equipment used, but not limited to, is Star-Oddi's Starmon TD loggers in titanium housing. Depth and temperature loggers are to be attached to the long line's main line close to the anchor when ever a logger is available during the survey, i.e. not occupied in other deployment. Every three minutes, depth is to be measured in meters with two decimals and temperature in celcius degrees with three decimals. Loggers are to be preset by FAMRI staff prior to the vessles departure ensureing recordings to be active prior to reaching first station and first long line deployment. Loggers will be de-activated upon port return at FAMRI where data retrival and filtering will also occure.

### **Data analyses**

The calculation of the survey indices will follow the standard stratified average method:

$$\bar{x} = \frac{1}{N} \sum_{h=1}^L N_h \bar{x}_h$$

$$s_{\bar{x}}^2 = \sum_{h=1}^L \left(\frac{N_h}{N}\right) \left(\frac{N_h - n_h}{N_h - 1}\right)^2 \frac{s_h^2}{n_h}$$

where

L = number of strata

N = sum of all stratum sizes

N<sub>h</sub> = size of stratum h

$\bar{x}_h$  = sample mean of stratum h

n<sub>h</sub> = number of observations in stratum h

s<sub>h</sub> = sample standard deviation of stratum h

### **Future recommendations**

The longline survey is over time intended to develop a fishery independent catch-at-age index based upon an age length key (ALK) to support the 3M cod stock assessment framework. In order for the incorporations of such index, a comparative age reading workshop (e.g. via SmartsDots platform) including Faroese, EU and Canadian otolith samples would be highly beneficial to ensure transparency between age-readings of the Atlantic cod stocks in NAFO regulatory areas. This has been requested for at the Scientific Council's June meeting 2024.

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**Table 1.** Survey design and stratification of 3M EU-survey and Faroese longline survey

EU 3M survey					Faro 3M survey
Stratum	Depth interval (fathoms)	Area (sq miles)	Possible hauls	Selected hauls	Selected sets
<b>1</b>	<b>70-80</b>	342	100	4	<b>3</b>
<b>2</b>	<b>81-100</b>	838	250	10	<b>4</b>
<b>3</b>	<b>101-140</b>	628	180	7	<b>3</b>
<b>4</b>	"	348	100	4	<b>3</b>
<b>5</b>	"	703	200	8	<b>3</b>
<b>6</b>	"	496	150	6	<b>3</b>
<b>7</b>	<b>141-200</b>	822	240	9	<b>4</b>
<b>8</b>	"	646	190	7	<b>3</b>
<b>9</b>	"	314	90	3	<b>2</b>
<b>10</b>	"	951	280	11	<b>4</b>
<b>11</b>	"	806	240	9	<b>4</b>
<b>12</b>	<b>201-300</b>	670	200	8	<b>3</b>
<b>13</b>	"	249	70	3	<b>2</b>
<b>14</b>	"	602	170	7	<b>2</b>
<b>15</b>	"	666	200	8	<b>3</b>
<b>16</b>	<b>301-400</b>	634	190	7	<b>3</b>
<b>17</b>	"	216	60	2	<b>2</b>
<b>18</b>	"	210	60	2	<b>2</b>
<b>19</b>	"	414	120	5	<b>2</b>
<b>20</b>	<b>401-500</b>	525	160	6	<b>2</b>
<b>24</b>	"	253	80	3	<b>2</b>
<b>28</b>	"	530	160	6	<b>3</b>
<b>33</b>	"	98	30	2	-
<b>21</b>	501-600	517	160	6	-
<b>25</b>	"	226	70	3	-
<b>29</b>	"	488	150	6	-
<b>32</b>	"	238	70	2	-
<b>34</b>	"	486	150	5	-
<b>22</b>	601-700	533	160	6	-
<b>30</b>	"	1134	350	11	-
<b>23</b>	701-800	284	90	3	-
<b>31</b>	"	203	60	2	-
<b>Total (strata 1-34)</b>		16070	4780	181	
<b>Total (Longline survey)</b>		11863	3490	135	<b>62</b>

**Table 2.** List of potential vessels to conduct the survey

Vessel name	Call name	Official number	Length (m) LOA	Power System (kW)	BRT
Klakkur	OW2046	KG9	51.3	1 800	1 737
Eivind	XPQE	VA132	41.3	749	656
Stapin	OW2065	FD32	42.0	745	703
Jákup B	XPPR	KG7	44.95	698	726
Jógvan I	OW2049	FD710	44.85	749	1 001
Sandshavið	XPRK	SA499	47.7	735	765
Vesturhavið	OW2009	VN700	37.6	687	522
Pison	OW2132	KG476	40.6	736	593

**Table 3.** Fishing gear specifications of the longline Faroe survey in NAFO Division 3M.

Gear Type		Longline
Total Length		Ca 0.85 Nm
Hooks:	Number	1000
	Average spacing (m)	1.5
	Hook type	EZ
	Hook size	12
Buoys	Marked yes/no	YES
Anchors	Number	2
Main line material	50/50 pol/ter	
Bait line material	ter	
Bait type	Squid	
Soak time	6-10 hours	

**Table 4.** Gonad maturity identification scheme

Stage	Description	Links between stages
1	Immature	
2	Developing, early stage	
3	Developing, mid stage	
4	Developing, late stage	
5	Mature	
6	Spawning	
7	Spent/restorative stage	



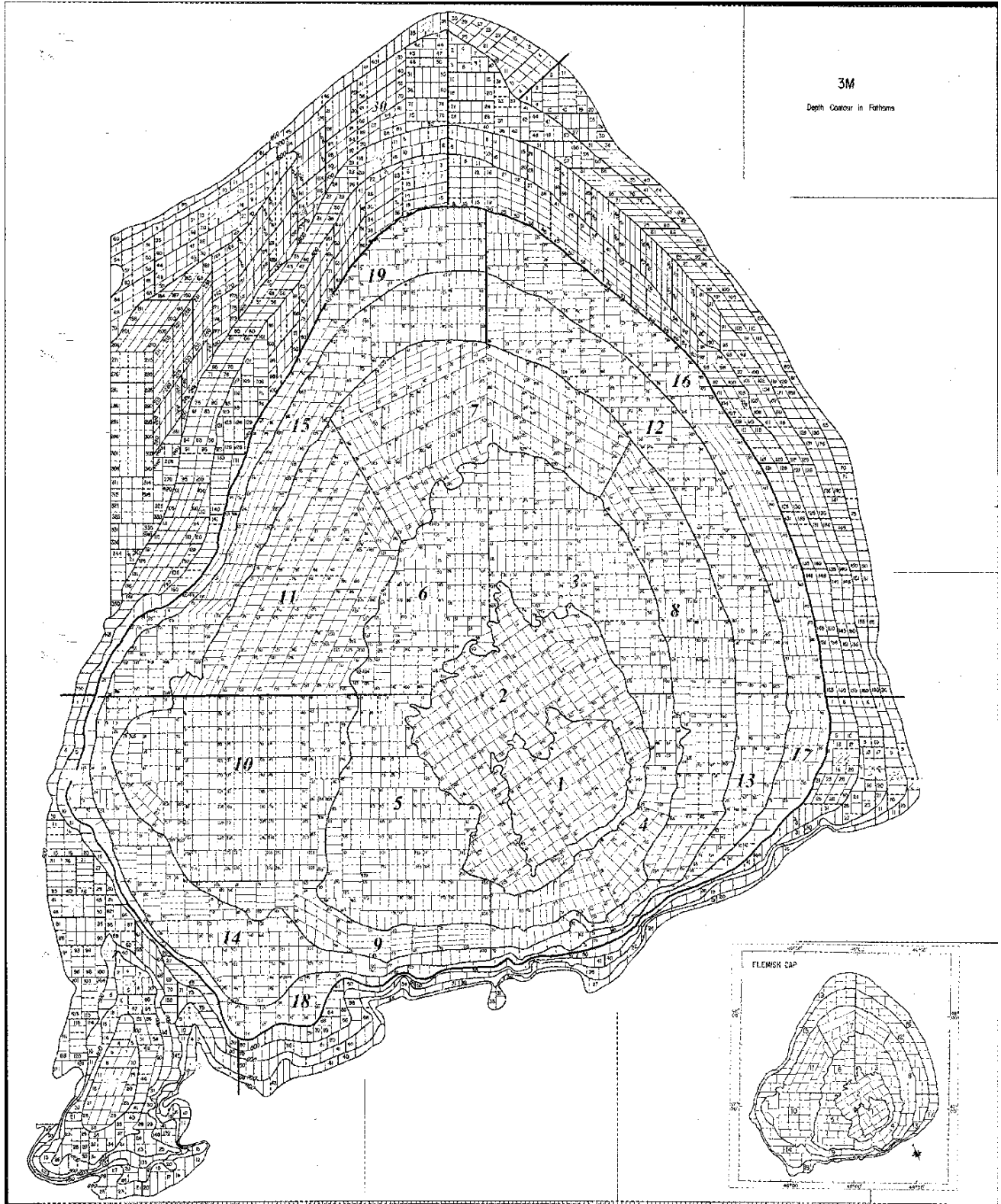


Figure 1. Stratification of the 3M Flemish Cap surveys.



## Annex 2 – Cod (target specie) registration form, page 1

FISKASLAG:

DATO:

STUBBI NR:

PRÖVATAKARI:

**TOSKUR**

	<i>Longd (cm)</i>	<i>Rund vekt (kg)</i>	<i>Kyn (rogn/sil)</i>	<i>Búningarstig</i>	<i>Nytrur (x)</i>
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
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14					
15					
16					
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25					
26					
27					
28					
29					
30					

Vend (31-100) →

## Annex 2 continued - Cod (target specie) registration form, page 2

<i>Longd (cm)</i>	<i>Rund vekt (kg)</i>	<i>Longd (cm)</i>	<i>Rund vekt (kg)</i>
31		66	
32		67	
33		68	
34		69	
35		70	
36		71	
37		72	
38		73	
39		74	
40		75	
41		76	
42		77	
43		78	
44		79	
45		80	
46		81	
47		82	
48		83	
49		84	
50		85	
51		86	
52		87	
53		88	
54		89	
55		90	
56		91	
57		92	
58		93	
59		94	
60		95	
61		96	
62		97	
63		98	
64		99	
65		100	



## Annex 4 – Hook occupancy registration form

<b>Skráseting av húkum - (hook occupancy)</b>																	
Prøvatakarí:							Reiðskapur:										
Setu nummar:							Stokkur nr:										
Dagfesting:				Kl.:			Tal húkar tils.:										
	Húkur nr	Bert agn	Toskur	Hjáveiða/annað fiskaslag	Omki agn	Óngin húkur	Útgerð oyðilögð/ófiskifør	Viðmerking		Húkur nr	Agn á húki	Toskur	Hjáveiða	Omki agn	Óngin húkur	Útgerð oyðilögð/ófiskifør	Viðmerking
1									26								
2									27								
3									28								
4									29								
5									30								
6									31								
7									32								
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25									50								

Viðmerking:

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