EFCA
European Fisheries Control Agency

ANALYSIS FOR THE WEIGHING PROCESS OF FISHERY PRODUCTS IN THE MEMBER STATES AND STRATEGY

FINAL REPORT

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Subject: Analysis for the weighing process of fishery products in the Member States and strategy

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For more information about this study, please contact:

EUROPEAN COMMISSION

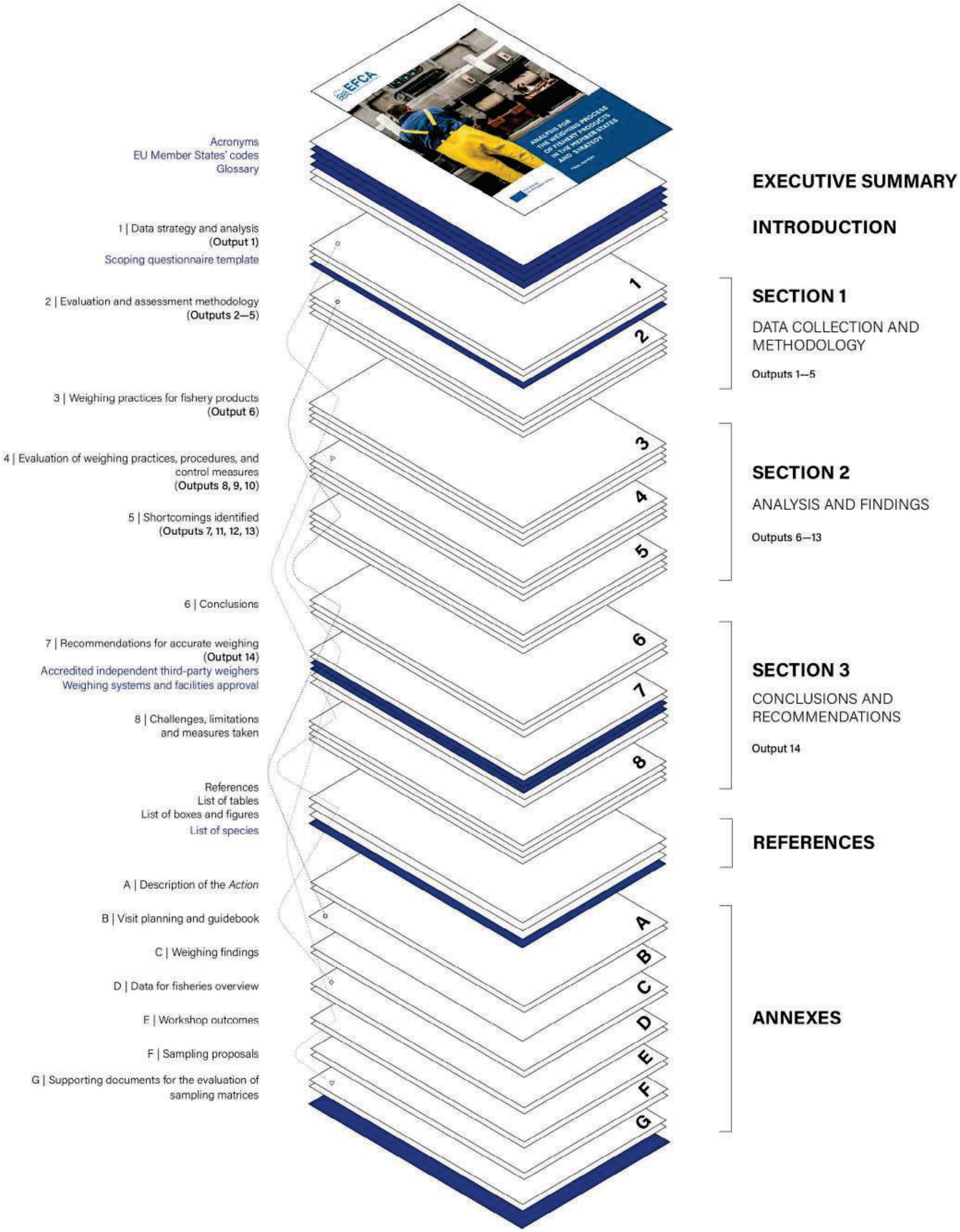
Directorate-General for Maritime Affairs and Fisheries (DG MARE)

Unit D.4 — Fisheries Control and Inspections

Contact: MARE-D4@ec.europa.eu

European Commission B-1049 Brussels

Belgium



Acronyms
EU Member States' codes
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Scoping questionnaire template
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3 | Weighing practices for fishery products
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Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Institutionen för akvatiska resurser
Havsfiskelaboratoriet

SLUID: SLU.aqua.2024.5.5-110
2024-03-29

Annica de Groote, Nuno Prista

Kontroll - Bestämning av stickprovsstorlek för provtagning vid landning av pelagisk fångst

Frågeställning/Beställning

Analysera minsta stickprovsstorlekar för att fastställa artsammansättning (i vikt) vid landningsprovtagning av mixade industrifångster utifrån finska och irländska kontrolldata för olika acceptabla felmarginaler (3%, 5%, 7% och 10%) och olika landningsstorlekar.

Bakgrund

Europeiska fiskerikontrollbyrån (EFCA) har uppmärksammat ett tidigare kunskapsunderlag från SLU Aqua till HaV (de Groote m fl 2023; SLUID: SLU.aqua.2023.5.5-356), som bl a analyserade provtagningsdesign och osäkerheter I skattningar av artsammansätting vid kontroll av osorterade pelagiska landningar från Österjön. EFCA vill ha hjälp med att utföra en liknande analys av landningsdata från den irländska och finska fiskerikontrollen.

Format

Resultaten presenteras i tabellform, såsom i kunskapsunderlaget baserat på svenska data från Östersjön (de Groote m fl 2023; SLUID: SLU.aqua.2023.5.5-356), i form av separata tabeller för de två dataseten. Rapporten skall vara skriven på engelska.

-Irländska data: gruppera efter landningsvolymerna t <25; t>25 and t<200, and t ≥ 200 och fokusera på arterna taggmakrill (HOM), makrill (MAC) och blåvitling (WHB)

-Finska data: Gruppera efter landningsvolymerna t < 25 and t>25 och fokusera på sill/strömming (HER) och skarpsill (SPR)

Datum för leverans

2024-03-29

Kunskapsunderlaget skickas till Malin Hultgren, med kopia till Karin Linderholm och Malin Wilhelmsson.

Determination of sample size needed for sampling unsorted pelagic landings from Finland and Ireland

Annica de Groote, Nuno Prista

1 Background

The European Fisheries Control Agency (EFCA) was informed of previous work done by SLU Aqua for HaV (de Groote et al. 2023[1]) in which, among other things, the sampling design, sample size and uncertainties in estimates of species composition from unsorted pelagic landings from the Baltic Sea were analyzed. EFCA requested HaV and SLU assistance for carrying out a similar analysis of landing data collected from the Irish and Finnish Fisheries control programmes. According to the request, the results were to be presented in tabular form (similar to de Groote et al. 2023) and separately for the countries. The Finish results should be grouped by the landing volumes (less than 25 tonnes, equal or above 25 tonnes) and have focus on herring and sprat. The Irish results should be grouped by landing volumes (less than 25 tonnes, 25 to 200 tonnes, and equal or above 200 tonnes) and have focus on horse mackerel, mackerel, and whiting.

2 Methodology

The tables reported in sections 3 and 4 display calculations of minimum sample sizes needed to estimate the weight proportions of different fish species when sampling unsorted landings from Finnish and Irish pelagic catches. Data analyzed consisted of species composition in weight in buckets taken from a selection of anonymized landings sampled in each country during 2023.

Separate calculations of sample sizes were made for four predefined margins of error (e): 3 %, 5 %, 7 % and 10 %. All calculations were based on a significance level of 5 %. It was assumed that in each landing, buckets of fish are selected randomly or systematically from the entire catch. In our calculations, systematic sampling was approximated by simple random sampling.

Calculations of sample size were made separately by country (Finland and Ireland) and by anonymized landing ID. In the case of Ireland, two landing IDs (ID 15 and 17) were removed from analysis because they had only one bucket sampled and uncertainty could not be estimated. Different fish species were analysed for the two countries. For Finland the predefined focus was herring (HER) and sprat (SPR); for Ireland the predefined focus was horse mackerel (HOM), mackerel (MAC) and blue whiting (WHB). Results were grouped into a set predefined classes of landing weight in ton (t). For Finland the groups were $t < 25$ and $t \geq 25$. For Ireland, the groups were only $t < 200$, and $t \geq 200$ since no landing existed with < 25 t. To support interpretation of results, the species composition of each landing was summarized as a set of dominance classes: HighDomX (≥ 90% of one species X), DomX (≥ 60 % but < 90% of species X)

[1] Annica de Groote, Nuno Prista, Katja Ringdahl (2023). Bestämning av stickprovsstorlek för provtagning av pelagisk fångst. PM SLU.aqua.2023.5.5-356. 5 pp + Annex.

and noDom (no species ≥ 60%). The latter case, that represents a very even species composition, was not observed in the data.

The sample sizes provided in the tables were calculated as follows. Consider one landing and one fish species d. For this landing there are n_s sampled buckets of fish numbered $1, \dots, i, \dots, n_s$. We want to estimate the weight proportion of fish species d, R_d, in the landing. The approximate sample size n needed to do this with a margin of error e is calculated as

$$n = \frac{1}{\bar{y}_s^2}\left(\frac{1.96 \times S_{t_E s}}{e}\right)^2$$

where $\bar{y}_s$ is the average weight of the catch in sampled buckets (irrespective of species), $S_{t_e s}^2 = \sum_{i=1}^{n_s}\left(t_{y_d i} - \hat{R}_d t_{yi}\right)^2 / (n_s - 1)$, $t_{y_d i}$ is the total weight of species d in bucket i, t_{yi} is the total weight of all species in bucket i, and $\hat{R}_d$ is the estimated weight proportion of species d (based on all sampled buckets).

Summaries of sample size results by landing weight classes were calculated as averages and medians of sample size determinations obtained from individual landings of each country. Considering that, even when individual landings are close to 100% dominated by one species, a sample size of at least two is always needed to estimate variance, landings with a required sample size n < 2 in were set to n = 2 in those calculations.

When deciding on which sample size should be selected for a given sampling programme, it should be kept in mind that results are always dependent on the question at hand, the representativeness of the data available to analyze and the statistical methodologies that were used. In section 5, we provide an outlook into some of these issues alongside a few cautionary notes on the interpretation of our results.

3 Results for Finland

Table 3.1. The number of sampled buckets (n), observed dominance, point estimates of weight proportion, and the associated margin of error, for HER and SPR, by landing ID. Margins of error are calculated using the t distribution. The landings are sorted by landed weight.

				HER		SPR	
ID	**Landed weight (t)**	**n**	**Dominance**	**Point estimate**	**Margin of error**	**Point estimate**	**Margin of error**
62	13.9	3	HighDomHER	0.972	0.117	0.028	0.117
66	16.1	4	HighDomHER	0.966	0.024	0.006	0.004
54	21.2	4	HighDomHER	0.985	0.010	0.004	0.002
49	27.3	5	HighDomHER	0.969	0.004	0.030	0.005
50	31.5	3	DomHER	0.847	0.050	0.153	0.050
59	31.8	3	HighDomHER	0.984	0.026	0.016	0.026
61	34.8	5	HighDomHER	0.994	0.016	0.003	0.009
57	42.7	4	HighDomHER	0.996	0.005	0.004	0.005
48	42.8	5	DomHER	0.634	0.167	0.363	0.169
51	53.6	8	DomHER	0.895	0.022	0.105	0.022
63	60.4	8	HighDomHER	0.956	0.023	0.038	0.023
58	63.0	4	DomHER	0.621	0.086	0.379	0.086
56	77.4	4	HighDomHER	0.935	0.023	0.062	0.024
46	78.2	4	DomHER	0.757	0.049	0.238	0.042
60	78.4	5	HighDomHER	0.926	0.049	0.072	0.051
52	83.2	3	HighDomHER	0.961	0.024	0.025	0.020
53	89.6	12	DomHER	0.827	0.083	0.163	0.086
47	112.7	9	HighDomHER	0.981	0.005	0.017	0.005
65	113.1	8	HighDomHER	0.954	0.025	0.044	0.024
45	117.8	6	DomHER	0.893	0.150	0.104	0.152
55	213.2	15	HighDomHER	0.930	0.012	0.067	0.012
64	255.5	8	DomSPR	0.248	0.047	0.752	0.047

Table 3.2. The number of buckets needed to estimate the proportion of HER and SPR, respectively, for different margins of error (0.03, 0.05, 0.07, 0.10), by landing ID. All sample sizes are rounded up to the nearest integer. The landings are sorted by landing weight class and landed weight.

		HER				SPR			
Weight class (t)	**ID**	**0.03**	**0.05**	**0.07**	**0.10**	**0.03**	**0.05**	**0.07**	**0.10**
< 25	62	10	4	2	1	10	4	2	1
< 25	66	1	1	1	1	1	1	1	1
< 25	54	1	1	1	1	1	1	1	1
≥ 25	49	1	1	1	1	1	1	1	1
≥ 25	50	2	1	1	1	2	1	1	1
≥ 25	59	1	1	1	1	1	1	1	1
≥ 25	61	1	1	1	1	1	1	1	1
≥ 25	57	1	1	1	1	1	1	1	1
≥ 25	48	78	28	15	7	80	29	15	8
≥ 25	51	4	2	1	1	4	2	1	1
≥ 25	63	4	2	1	1	4	2	1	1
≥ 25	58	13	5	3	2	13	5	3	2
≥ 25	56	1	1	1	1	1	1	1	1
≥ 25	46	4	2	1	1	3	2	1	1
≥ 25	60	7	3	2	1	8	3	2	1
≥ 25	52	1	1	1	1	1	1	1	1
≥ 25	53	74	27	14	7	78	28	15	7
≥ 25	47	1	1	1	1	1	1	1	1
≥ 25	65	4	2	1	1	4	2	1	1
≥ 25	45	88	32	17	8	90	33	17	9
≥ 25	55	3	1	1	1	3	1	1	1
≥ 25	64	14	5	3	2	14	5	3	2

Table 3.3. The average sample size (in number of buckets) needed to estimate the weight proportion of HER and SPR, respectively, for different margins of error (0.03, 0.05, 0.07, 0.10), by landing weight class. All sample sizes are rounded up to the nearest integer. *Landings with a required sample size <2 in Table 3.2 are replaced with 2 in the calculations.*

	HER				SPR			
Weight class (t)	**0.03**	**0.05**	**0.07**	**0.10**	**0.03**	**0.05**	**0.07**	**0.10**
< 25	5	3	2	2	5	3	2	2
≥ 25	17	7	5	3	17	7	5	3

Table 3.4. The median and (third quartile) of sample size (in number of buckets) needed to estimate the weight proportion of HER and SPR, respectively, for different margins of error (0.03, 0.05, 0.07, 0.10), by landing weight class. *Landings with a required sample size <2 in Table 3.2 are replaced with 2 in the calculations.*

	HER				SPR			
Weight class (t)	**0.03**	**0.05**	**0.07**	**0.10**	**0.03**	**0.05**	**0.07**	**0.10**
< 25	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)
≥ 25	4 (13)	2 (5)	2 (3)	2 (2)	3 (13)	2 (5)	2 (3)	2 (2)

4 Results for Ireland

Table 4.1. The number of sampled buckets (n), observed dominance, point estimates of weight proportion, and the associated margin of error, for HOM, MAC and WHB, by landing ID. Margins of error are calculated using the t distribution. The landing IDs are sorted by landed weight.

				HOM		MAC		WHB	
ID	**Landed weight (t)**	**n**	**Dominance**	**Point estimate**	**Margin of error**	**Point estimate**	**Margin of error**	**Point estimate**	**Margin of error**
35	36.7	2	HighDomWHB	0.000	0.000	0.000	0.000	1.000	0.000
22	53.9	2	HighDomHOM	0.995	0.072	0.005	0.072	0.000	0.000
37	64.5	4	HighDomWHB	0.000	0.000	0.000	0.000	1.000	0.000
26	88.9	5	HighDomMAC	0.008	0.013	0.970	0.050	0.000	0.000
16	97.6	3	HighDomMAC	0.004	0.016	0.969	0.133	0.000	0.000
12	101.0	3	HighDomMAC	0.000	0.000	0.989	0.025	0.004	0.017
18	116.8	4	HighDomMAC	0.015	0.019	0.961	0.023	0.000	0.000
27	118.6	4	HighDomMAC	0.000	0.000	1.000	0.000	0.000	0.000
25	124.2	4	HighDomMAC	0.027	0.031	0.973	0.031	0.000	0.000
20	133.6	5	HighDomMAC	0.002	0.005	0.993	0.019	0.000	0.000
28	141.5	5	HighDomMAC	0.000	0.000	0.997	0.009	0.000	0.000
10	144.7	5	HighDomMAC	0.000	0.000	1.000	0.000	0.000	0.000
19	149.9	5	HighDomMAC	0.000	0.000	1.000	0.000	0.000	0.000
36	160.2	6	HighDomWHB	0.000	0.000	0.000	0.000	1.000	0.000
21	170.2	6	HighDomMAC	0.000	0.000	1.000	0.000	0.000	0.000
31	196.8	6	HighDomWHB	0.000	0.000	0.000	0.000	1.000	0.000
44	266.8	22	HighDomHOM	0.980	0.012	0.000	0.000	0.001	0.001
8	340.7	13	HighDomMAC	0.000	0.000	0.997	0.003	0.000	0.000
5	356.8	12	HighDomMAC	0.000	0.000	0.999	0.002	0.000	0.000
38	380.6	12	HighDomWHB	0.000	0.000	0.000	0.000	1.000	0.000
3	428.9	14	HighDomMAC	0.000	0.000	0.992	0.007	0.000	0.000
1	569.6	18	DomMAC	0.000	0.000	0.867	0.026	0.000	0.000
40	571.5	18	HighDomMAC	0.000	0.000	1.000	0.000	0.000	0.000
41	584.7	19	HighDomMAC	0.000	0.000	0.998	0.002	0.000	0.000
7	588.0	19	HighDomMAC	0.000	0.000	0.997	0.003	0.000	0.000
2	623.6	21	HighDomMAC	0.000	0.000	0.951	0.013	0.000	0.000
14	624.9	20	HighDomMAC	0.001	0.002	0.999	0.002	0.000	0.000
4	627.5	20	HighDomMAC	0.000	0.000	1.000	0.000	0.000	0.000
9	645.7	10	DomMAC	0.298	0.340	0.697	0.346	0.000	0.000
23	657.1	19	HighDomWHB	0.000	0.000	0.000	0.000	1.000	0.000
11	698.7	22	HighDomMAC	0.000	0.000	0.998	0.002	0.000	0.000
39	751.5	24	HighDomMAC	0.000	0.000	0.989	0.016	0.000	0.000
32	765.1	27	HighDomWHB	0.000	0.000	0.000	0.000	1.000	0.000
43	771.1	21	HighDomMAC	0.000	0.000	0.996	0.004	0.000	0.000

6	868.5	28	HighDomMAC	0.000	0.000	0.998	0.003	0.000	0.000
42	887.5	26	HighDomMAC	0.009	0.005	0.988	0.006	0.000	0.000
30	894.8	28	HighDomWHB	0.000	0.000	0.000	0.000	1.000	0.000
33	925.8	38	HighDomWHB	0.000	0.000	0.000	0.000	1.000	0.000
24	938.1	30	DomWHB	0.135	0.131	0.000	0.000	0.865	0.131
13	991.9	36	HighDomMAC	0.000	0.000	1.000	0.000	0.000	0.000
29	1014.8	31	HighDomWHB	0.000	0.000	0.000	0.000	1.000	0.000
34	1072.3	35	HighDomWHB	0.000	0.000	0.000	0.000	1.000	0.000

Table 4.2. The sample size (in number of buckets) needed to estimate the proportion of HOM and MAC, respectively, for different margins of error (0.03, 0.05, 0.07, 0.10), by weight class and landing ID. All sample sizes are rounded up to the nearest integer. The sample size equals 0 if the species was not observed during the landing. The landing IDs are sorted by landing weight class and landed weight.

		HOM				MAC				WHB			
Weight class (t)	**ID**	**0.03**	**0.05**	**0.07**	**0.10**	**0.03**	**0.05**	**0.07**	**0.10**	**0.03**	**0.05**	**0.07**	**0.10**
< 200	35	0	0	0	0	0	0	0	0	0	0	0	0
< 200	22	1	1	1	1	1	1	1	1	0	0	0	0
< 200	37	0	0	0	0	0	0	0	0	0	0	0	0
< 200	26	1	1	1	1	7	3	2	1	0	0	0	0
< 200	16	1	1	1	1	13	5	3	2	0	0	0	0
< 200	12	0	0	0	0	1	1	1	1	1	1	1	1
< 200	18	1	1	1	1	1	1	1	1	0	0	0	0
< 200	27	0	0	0	0	0	0	0	0	0	0	0	0
< 200	25	2	1	1	1	2	1	1	1	0	0	0	0
< 200	20	1	1	1	1	1	1	1	1	0	0	0	0
< 200	28	0	0	0	0	1	1	1	1	0	0	0	0
< 200	10	0	0	0	0	0	0	0	0	0	0	0	0
< 200	19	0	0	0	0	0	0	0	0	0	0	0	0
< 200	36	0	0	0	0	0	0	0	0	0	0	0	0
< 200	21	0	0	0	0	0	0	0	0	0	0	0	0
< 200	31	0	0	0	0	0	0	0	0	0	0	0	0
≥ 200	44	3	2	1	1	0	0	0	0	1	1	1	1
≥ 200	8	0	0	0	0	1	1	1	1	0	0	0	0
≥ 200	5	0	0	0	0	1	1	1	1	0	0	0	0
≥ 200	38	0	0	0	0	0	0	0	0	0	0	0	0
≥ 200	3	0	0	0	0	1	1	1	1	0	0	0	0
≥ 200	1	0	0	0	0	12	5	3	2	0	0	0	0
≥ 200	40	0	0	0	0	0	0	0	0	0	0	0	0
≥ 200	41	0	0	0	0	1	1	1	1	0	0	0	0
≥ 200	7	0	0	0	0	1	1	1	1	0	0	0	0
≥ 200	2	0	0	0	0	4	2	1	1	0	0	0	0
≥ 200	14	1	1	1	1	1	1	1	1	0	0	0	0

≥ 200	4	0	0	0	0	0	0	0	0	0	0	0	0
≥ 200	9	968	349	178	88	1001	361	184	91	0	0	0	0
≥ 200	23	0	0	0	0	0	0	0	0	0	0	0	0
≥ 200	11	0	0	0	0	1	1	1	1	0	0	0	0
≥ 200	39	0	0	0	0	7	3	2	1	0	0	0	0
≥ 200	32	0	0	0	0	0	0	0	0	0	0	0	0
≥ 200	43	0	0	0	0	1	1	1	1	0	0	0	0
≥ 200	6	0	0	0	0	1	1	1	1	0	0	0	0
≥ 200	42	1	1	1	1	1	1	1	1	0	0	0	0
≥ 200	30	0	0	0	0	0	0	0	0	0	0	0	0
≥ 200	33	0	0	0	0	0	0	0	0	0	0	0	0
≥ 200	24	524	189	97	48	0	0	0	0	524	189	97	48
≥ 200	13	0	0	0	0	0	0	0	0	0	0	0	0
≥ 200	29	0	0	0	0	0	0	0	0	0	0	0	0
≥ 200	34	0	0	0	0	0	0	0	0	0	0	0	0

Table 4.3. The average sample size (in number of buckets) needed to estimate the weight proportion of HOM, MAC and WHB, respectively, for different margins of error (0.03, 0.05, 0.07, 0.10), by landing weight class. All sample sizes are rounded up to the nearest integer. *Landings with a required sample size <2 in Table 4.2 are replaced with 2 in the calculations.*

	HOM				MAC				WHB			
Weight class (t)	**0.03**	**0.05**	**0.07**	**0.10**	**0.03**	**0.05**	**0.07**	**0.10**	**0.03**	**0.05**	**0.07**	**0.10**
< 200	2	2	2	2	3	3	3	2	2	2	2	2
≥ 200	60	23	13	8	42	16	10	6	23	10	6	4

Table 4.4. The median and (third quartile) of sample size (in number of buckets) needed to estimate the weight proportion of HOM, MAC and WHB, respectively, for different margins of error (0.03, 0.05, 0.07, 0.10), by landing weight class. *Landings with a required sample size <2 in Table 4.2 are replaced with 2 in the calculations.*

	HOM				MAC				WHB			
Weight class (t)	**0.03**	**0.05**	**0.07**	**0.10**	**0.03**	**0.05**	**0.07**	**0.10**	**0.03**	**0.05**	**0.07**	**0.10**
< 200	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)
≥ 200	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)

5 Notes on the interpretation of sample size results

The tables presented in section 3 and 4 are based on well-established statistical estimation procedures. Similar techniques have previously been applied in analysis of Swedish data from other fisheries (de Groote m fl 2023; SLUID: SLU.aqua.2023.5.5-356). Still, it should be emphasized that a) the selection of analysis methods was guided by the specific framing of the question at hand which sets a frame to the applicability of the results, b) the interpretation of the results, and particularly their extrapolation to fleet-level, may be limited by issues of representativeness of the data with respect to present and future populations of interest and c) the results on sample sizes estimated for each individual landing (tables 3.2 and 4.2) and the overarching summaries provided from them (tables 3.3, 3.4, 4.3 and 4.4) have strong underlying assumptions. These aspects should to be considered when evaluating the results and when deciding on their applicability to routine monitoring or control programmes.

a) Framing of the question and objectives of the study

The objectives originally set for the present report were similar to those of a previous study carried out in Swedish fisheries. Specifically it was requested the determination of the sample sizes needed to achieve a specific margins of error in the proportions of target species in individual landings for a given set of landing weight classes. Since the aim was to estimate proportions, the provided sample sizes tend to be somewhat independent of the volume landed being larger or smaller (compare some small and large landings in tables 3.1 and 4.1 with the results in table 3.2 and 4.2)[2]. If, alternatively, the study objectives were set around, e.g., determining the sample size needed to estimate the total amount of a certain species in the landing with a pre-specified margin of *absolute* error (e.g., in tonnes), different calculations would be involved. In such case, the outcomes would be much more dependent on the size of the population being sampled, i.e., volume of the catch.

b) Representativeness of the data available and extrapolation to other populations of interest (present and future)

In this study we analyzed a selection of landings from two pelagic fisheries of two different countries. That selection was reported to us as being representative of the landings occurring in those fisheries. The representativeness of the data (alongside some statistical assumptions, discussed below), allows the results in tables 3.3, 3.4, and 4.3 and 4.4, to be seen as an indication of the minimum sample size that may be needed for an effective monitoring programme on species proportions of these fisheries. Still, two aspects are important to consider.

On the one hand, these sample sizes are quantities that on average/median are expected to perform well in the quantification of individual landings, *not* quantities that ensure that all landings, including the largest ones (see above) will be characterized at the desired precision level. A comparison of sample sizes in tables 3.3, 3.4, and 4.3 and 4.4 with per-trip sample sizes

[2] A simple evaluation of table 3.3 and 4.3 might induce a different conclusion but tables 3.4. and 4.4 and the larger number of zeros present in tables 3.2 and 4.2 reveal such interpretation to be driven by a only few extreme observations in the larger weight class.

indicated in tables 3.2 and 4.2 makes it clear that in the Irish case, the indicated sample sizes would not have provided precise estimates for some of the trips, leaving the two more atypical ones severely under-sampled.

On the other hand, when considering implementing programmes based on these results, users should keep in mind that even if the sample at hand is considered representative, extrapolating from it to the whole fleet and, particularly, to future developments of this fleet or different fleets, entails the strong assumption that the remainder of landing activity has similar characteristics. Considering the many aspects that affect the variability of species composition in landings[3] and the relatively small sample of landings at hand, it is likely that assumption does not fully hold, even if the data analyzed was obtained in a way that secures representation. Accordingly, if the objective is to establish a programme that has high chance of accurately determining the proportion of species of individual trips in the large variety of landings "out-there", both now and in the near future, the values provided are over-optimistic and a larger, more precautionary sample size is recommended. The samples sizes provided in tables 3.3 and 4.3, where cross-trip sample sizes were calculated, go some way towards such precaution. Still even such a sample size may be insufficient. To better encompass the possibility that the remainder of present landings from these two fisheries (and their future landings) may look different from the present sample (e.g., more like Irish landing ID 9 or 24), an analysis of a larger dataset (e.g., multi-year), would be beneficial. Without it, the current results are probably better approached with a focus on worst-case scenarios[4].

c) Statistical assumptions

The sample size indicated for a given margin of error in each individual landing assumes that the buckets sampled were taken randomly from the catch and only sampling error impacts their representation of the landing. We have information that samples were collected in a representative, frequently systematic, way. Systematic sampling is different from simple random sampling but in the present case, we don't think the difference in sampling strategy will represent a significant issue, i.e., the sample size calculations provided in table 3.2 and 4.2 assuming simple random sampling should still be relatively unbiased and conservative. Additionally, it is assumed that the underlying distribution of the species composition in buckets from a given landing is Gaussian. Formal testing of this assumption was not conducted but we have reasons to believe (from patterns we observed in the data) that in the vast majority of cases the Gaussian approximation should hold. Likely exceptions to this are the landings ID 9 and 24 where sharp sudden variations in the proportion of a series of buckets were observed. Those variations represent a violation of the Gaussian assumption and lead to large variances and less realistic Gaussian sample size estimates in those landings. Finally, it should be underscored that, albeit tempting, the consideration of the average sample size by weight class reported in table 3.3 and 4.3 as an indicator of sample size that should be adopted at fleet level (see further discussion above) would also imply a Gaussian assumption. As mentioned before, that assumption likely

[3] such as, e.g., choice of target species, fishing grounds, gears, number of hauls and their duration, vessel size and structure, arrival port and its facilities, on-board storage and unloading practices, …

[4] Such worst-case scenario approach would also be our suggestion to guide the choice of sample sizes where they differ substantially across target species even in the case of current fisheries (See Irish results on HOM, MAC and WHB).

does not hold, particularly on the Irish case where atypical landings were registered. Table 3.4 and table 4.4 that are based on medians and quartiles, provide alternative values that are more assumption-free and robust to extreme observations. It should be noted, however, that in the Irish case (that is characterized by very low variability in most of the landings sampled) the extreme robustness of the median and quartiles leads to very low sample sizes that, if implemented, would risk severe routine under-sampling.