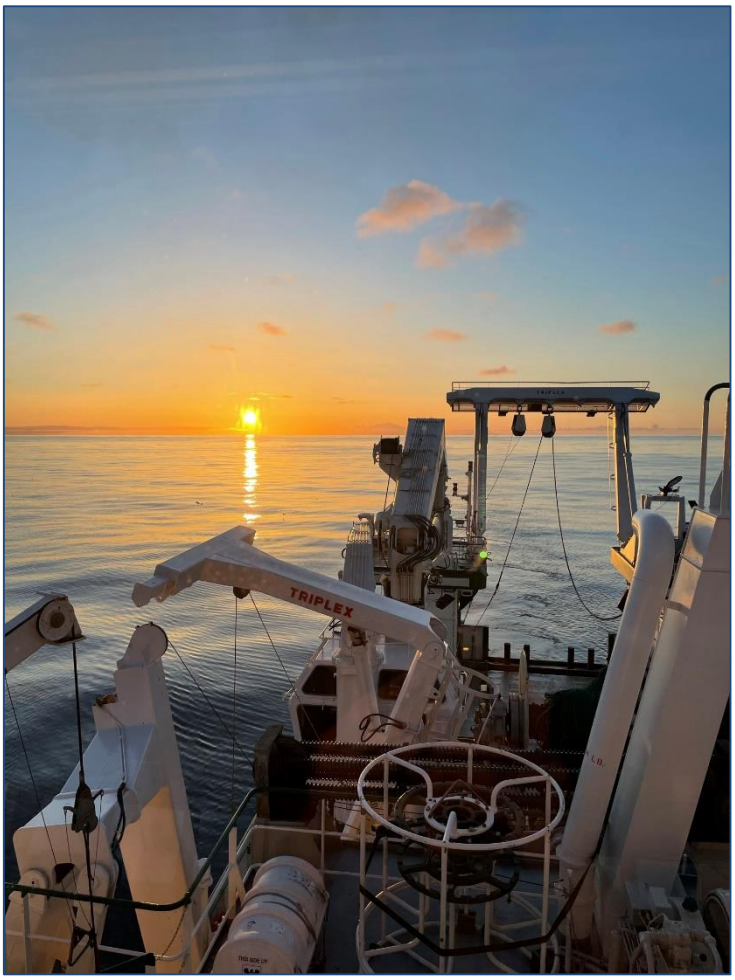
Cruise report:
Irish Anglerfish & Megrim Survey 2021



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Cláir Chistí Eorpacha Struchtúrtha agus Infheistíochta na hÉireann 2014–2020
Cómhaoinithe ag Rialtas na hÉireann agus ag an Aontas Eorpach

An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

European Union EMFF

Contents

Cover Photo credit: 'Flat calm on the shelf edge' by Eoghan Kelly Marine Institute

Introduction

The 2021 Irish Anglerfish and Megrim Survey (IAMS) took place from 8th February to 4th March (area 7bcjk) and 10-21st April 2021 (area 6a) on RV *Celtic Explorer*.

The main objective of the survey is to obtain biomass and abundance indices for anglerfish (*Lophius piscatorius* and *L. budegassa*) and megrim (*Lepidorhombus whiffiagonis* and *L. boscii*) in areas 6a (south of 58°N) and 7 (west of 8°W).

Secondary objectives are to collect data on the distribution, relative abundance and biology of other commercially exploited species.

For the third year, additional sampling took place in deep water (up to 1,500m) in order to monitor the recovery of exploited deep-water species following the decline of the deep-water fisheries in Irish waters. In addition two extra days of fishing were allocated to target Marine Scotland stations north of 58°.

The IAMS survey is coordinated with the Scottish Anglerfish and Megrim Survey (SIAMISS) and uses the same gear and fishing practices.

Methods

Stratification

The stratification is based on the following considerations:

- Depth: 0-200m; 200-500m; and 500-1,000m
- Clearly defined fishing grounds (from VMS-logbook data: Gerritsen and Lordan, 2011; Gerritsen *et al*., 2012) were identified as separate strata; an area with high fishing intensity surrounded by low fishing intensity signify that the bottom type and ecology on the fishing ground is different from that of the surrounding area. Examples include the Porcupine, Aran and Labadie *Nephrops* grounds, the Stanton Banks and Stags grounds.
- Catch rates of the target species (anglerfish and megrim) from VMS-logbook data as well as IBTS and previous Anglerfish and Megrim surveys were also taken into account in determining the boundaries of the strata.
- Rocky bottom types are excluded from the survey area which implies an assumption that the densities of the target species are zero in those areas.
- Regions 6a and 7bcjk are treated separately because they comprise different assessment and TAC areas.
- In addition to the main survey strata, additional deep water transects were added in deep water areas 4 and 5 (north of the Porcupine Bank and West of Donegal).
- IAMS 2021 completed five additional Marine Scotland stations that were located north of the main survey area in 6a.

The density of sampling stations in each stratum was either low, medium (twice the low density) or high (four times the low density). These station densities were assigned to each stratum so that the number of stations in each stratum would be roughly proportional to the expected standard deviation of the biomass estimate in the stratum.

Three small sampling strata with expected low abundance of the target species (Aran and Porcupine *Nephrops* grounds and the area of coarse sediment on the Porcupine Bank) were combined into a single stratum ('VII_Shelf_L') for estimation purposes, despite the differences in depth and bottom

type. The naming of the strata reflects the region (VIa or VII), area (continental shelf or slope) and density of stations (Low, Medium, High). The final sampling strata and stations are shown in Figure 1.

Station selection

Sampling stations were selected at random in the following way:

1. Add a 30nm buffer around the survey area (to avoid edge effects)
2. Select 10,000 random points within the (buffered) survey area
3. Identify the pair of points that are closest to each other (nearest neighbour)
4. Remove the point of this pair that is closest to its second-nearest neighbour
5. Repeat steps 3. and 4. until only one point remains
6. Rank the stations in each stratum based on the order in which they were removed – giving stations removed last the highest priority – this ensures that regardless of how many stations are selected in a stratum, they will always be distributed approximately evenly (but randomly) in space

After selecting the random points, suitable tow tracks are identified that go through the random point. Where it was impossible to do so (owing to underwater cables, unsuitable bottom etc.) it was attempted to find a tow track that came within 1nm of the selected point.

As a result of Covid-19 restrictions on staff numbers, due to single cabin occupancy, fishing operations were reduced from 24 to 12 hours per day. This meant that the maximum number of stations achievable was approximately four per fishing day. The target number of stations for area 7bcjk was 65 stations and for area 6a it was 40 stations with an additional 10 deep water stations and 8 Marine Scotland stations. This meant that stations with priority number 1-40 for area 6a and 1-65 for area 7bcjk respectively would be selected to be trawled. In practice some of the high priority stations may have to be dropped (in cases where it was impossible to achieve a valid tow) and replaced by the 'spare' stations with priority numbers >40 for area 6a and >65 for area 7bcjk respectively. In addition to the regular sampling strata there were also two 'deep water' transects included for the first time in 2019. These transects were each composed of 5 stations extending from 500-1,500m using the methodology of previous Marine Institute deep water surveys that were carried out between 2005 and 2009 (O'Hea *et al*., 2009).

Four to six weeks prior to the departure a Marine Notice was issued (www.dttas.ie) to advise seafarers and fishermen about the survey. This document included a brief description of the survey methods and objectives including a list and map of the location of the proposed stations.

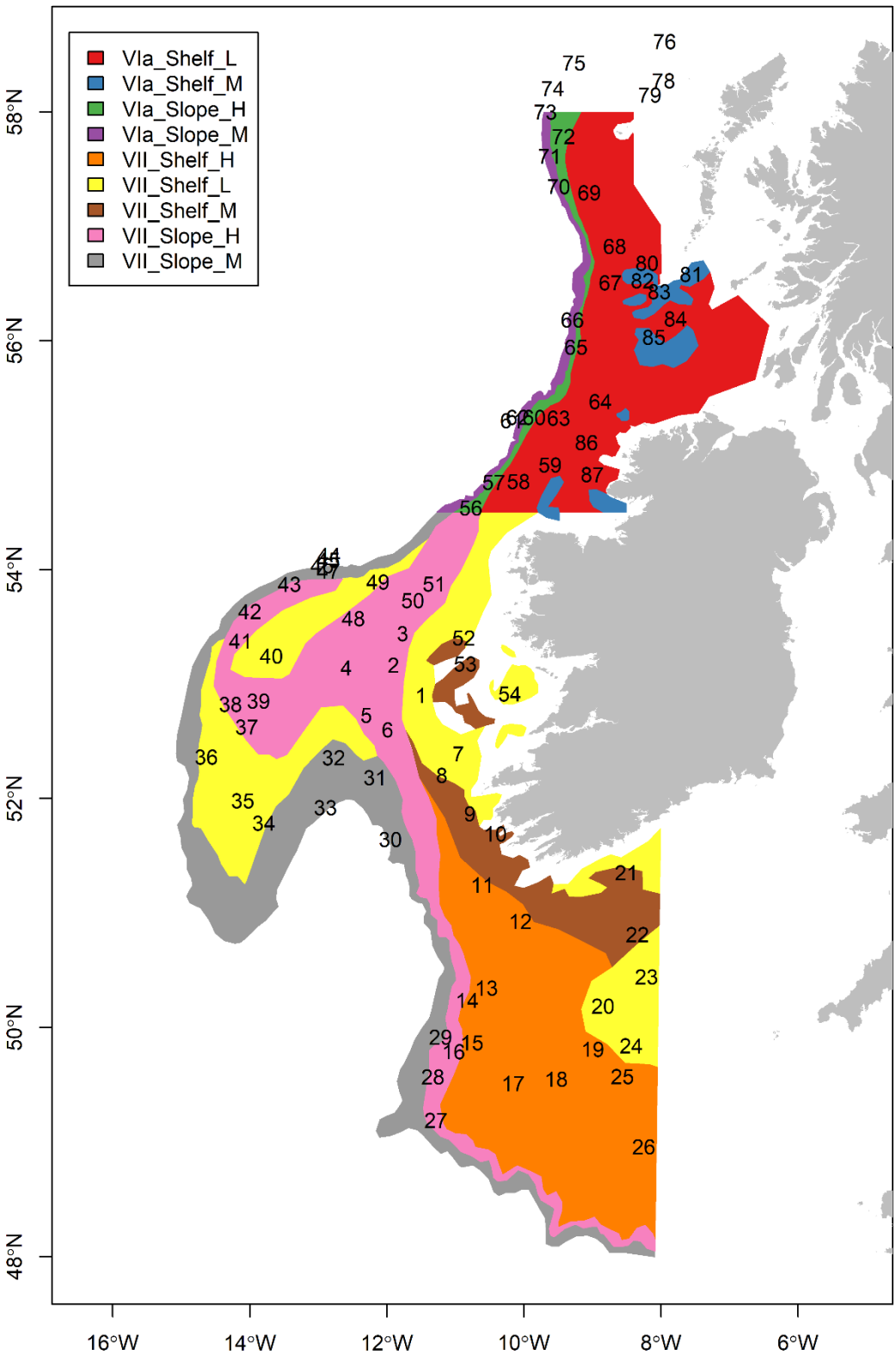

Figure 1*: Valid tow positions (the numbers refer to the haul number).*

Fishing operations

The trawl design is based on a standard commercial otter trawl used in the anglerfish fishery and is described in detail in Reid *et al*. (2007). The mesh size varies from 200mm in the wings gradually reducing to 100mm in the cod-end. The ground gear is fitted with 16'' rock hopper disks and a 19mm tickler chain is mounted between the wings, rigged to run ahead of the ground gear. The trawl doors used were 5.45m^2 Thyboron Type 16 straight oval doors.

The gear was trawled at 3kn for one hour at each station. The warp to depth ratio was 3:1 for depths up to 200m, and 2:1 plus 200m in deeper water.

Door spread, wing spread, headline height and bottom contact were monitored using Scanmar and Marport trawl sensors (distance sensors in the doors and wing-ends, headline sensor and a trawl-eye sensor positioned on the top sheet directly over the footrope).

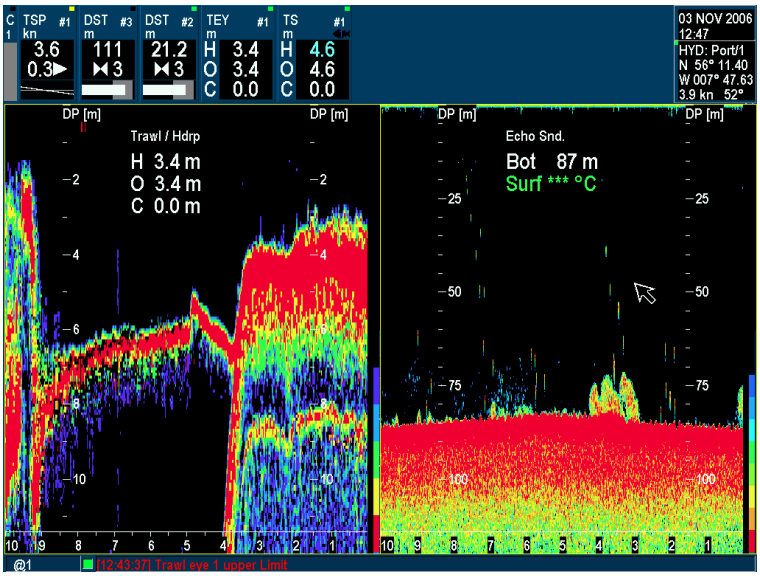

Figure 2: Screengrab of Scanmar display showing trawl geometry, water depth and fish marks

Wet lab protocol

All fish and invertebrate species were sorted and weighed (Table 1). Biological data were collected for the species listed in the Table 2 below. Occurrence of the following vulnerable or sentinel invertebrate species was noted if present: corals, sea pen, fan mussel and ocean quahog.

Table 1: General sampling protocols

Priority	Task
1	If you are under extreme pressure only sort and sample anglerfish and megrim For monkfish, record the gutted weight in the 'comments' box ; collect otoliths as well as illica. Inform SIC so they can flag the station with validity code 'T' (target species only)
2	Sort and weigh all fish and squid species, *Nephrops* and rubbish. Sort and enter benthos only for indicator species (see table above) record weights & count as per IGFS. Record unsorted benthos as total weight using spp code "BEN" and comment on main ingredients in Notes. Take picture or preserve sample if unsure about ID and record as comment
3	Measure fish species listed in table above.
4	Take biological samples for the demersal listed in the table below.
Note: If you can't complete all the work, drop tasks in reverse order as listed above. Never record sample weights for a few species; record all or just anglerfish and megrim. On invalid hauls you can still collect biological data.	

Table 2: Detailed sampling protocols by species

	Species	Sort by sex	OTO box	Catch weight	Can you subsample	Bio target	Live weight	Sex	Mat	Age	Gutted weight
Aged demersal species	COD	U	100-149	yes	yes	1pcm	yes	yes	yes	yes	**yes**
	HAD	U	150-249	yes	yes	100%	yes	yes	yes	yes	no
	LIN	U	250-299	yes	yes	1pcm	yes	yes	yes	yes	no
	MEG	F/M	300-364 / 365-399	yes	**Preferably not**	1pcm	yes	yes	yes	yes	no
	MON*	U	400-499	yes	**never**	100%	yes	yes	yes	yes	**Yes**
	WAF*	U	500-599	yes	**never**	100%	yes	yes	yes	yes	**Yes**
	PLE	F/M	600-649 / 650-699	yes	yes	1pcm	yes	yes	yes	yes	no
	POK	U	700-749	yes	yes	1pcm	yes	yes	yes	yes	no
	POL	U	750-799	yes	yes	1pcm	yes	yes	yes	yes	no
	SOL	F/M	800-849 / 850-899	yes	yes	1pcm	yes	yes	yes	yes	no
	WHG	U	900-989	yes	yes	100%	yes	yes	yes	yes	no
Biological teleo	BLL	U	Spp#	yes	yes	1pcm	yes	yes	yes	no	no
	HKE	U	Spp#	yes	yes	1pcm	yes	yes	yes	no	no
	JOD	U	Spp#	yes	yes	1pcm	yes	yes	yes	no	no
	LBI	U	990-999	yes	yes	1pcm	yes	yes	yes	no	no
	LEM	F/M	Spp#	yes	yes	1pcm	yes	yes	yes	no	no
	TUR	U	Spp#	yes	yes	1pcm	yes	yes	yes	no	no
	WIT	U	Spp#	yes	yes	1pcm	yes	yes	yes	no	no
Bio elasmo	BLR	F/M	Spp#	yes	yes	1pcm	yes	yes	yes**	no	no
	CUR	F/M	Spp#	yes	yes	1pcm	yes	yes	yes**	no	no
	DGS	F/M	Spp#	yes	yes	1pcm	yes	yes	yes**	no	no
	DFL	F/M	Spp#	yes	yes	1pcm	yes	yes	yes**	no	no
	DII	F/M	Spp#	yes	yes	1pcm	yes	yes	yes**	no	no
	SDR	F/M	Spp#	yes	yes	1pcm	yes	yes	yes**	no	no
	THR	F/M	Spp#	yes	yes	1pcm	yes	yes	yes**	no	no
Others	NEP	U	-	yes	nemesys	nemesys	nemesys	nemesys		no	no
	Most other demersal fish species***			yes	Yes	Measured-only, no need to sort by sex					
	All pelagic fish species, squid; common demersals ***			yes	No length or biological samples						
	Invertebrates: Corals, sea fans, sea pens, fan mussels, Arctica islandica			Count & weight. If unsure about ID, take pic or freeze with haul label. For coral and A. islandica include comment on whether dead or alive							
	Other invertebrates			Total weight in comment field							
	Rubbish			As IGFS							
	CTD			As IGFS							

Key

Sex — F/M: record catch weight by sex (flatfish and elasmobranchs); U: do not sort by sex.

Spp# — use number allocated by Spp/Sex when prompted for otolith box. We use otolith process to ensure we get the maturity QC plots

subsample — these species can be subsampled for length and biological data, if necessary

1pcm — biological sampling target of one fish per cm size class (otolith target 1)

100% — biological sampling target set per length group, i.e. targets vary by size class (otolith target 100%)

*
- Monk <20cm that are not clearly black should be id'd using dorsal fin ray counts: WAF 9-10; MON 11-12
- Cut illicia to around 1cm so they fit flat in the otolith box and clean them so they don't stick to the tissue
- When taking gutted weight, also remove the liver
- COLLECT OTOLITHIS FOR MON AND WAF in area 6!

** Only determine the maturity of female elasmobranchs if they are already dead, otherwise record as stage 9.

*** Do measure:
- All deep water species
- Large gadoids like ling, blue ling tusk
- All elasmobranchs except LSD
- Any demersal species that is not very common

Don't measure:
- Any pelagics (including boarfish, blue-mouth, argentines)
- Squid, octopus etc
- LSD (no need to record weight by sex either)
- Any flatfish not listed in the biological sampling table above
- Common demersal species of no or limited commercial value like gurnards, pout, poor cod, dragonets

Data collection and storage

Station positions, heading and bottom depth were recorded at the moment the gear settled on the bottom and when the gear lifts off on haul-back. Tide and wind direction and speed, barometric pressure, pitch and roll were recorded at the mid-point in the tow. The median values of the door spread, wing spread and headline height were recorded at the end of the tow. The CEFAS software FSS (Fishing Survey System) was used to enter station data and import catch data. These data are stored in a SQL database (FSS_SURVEY) on a local server.

The gear sensor data as well as bottom depth and GPS position were also recorded in a SQL database (FSS_NMEA) at intervals of approximately one per second.

Catch weights, length frequency distributions and biological data were captured using the EFDAQ (Electronic Fisheries Data Acquisition) system and stored into a local database in wet laboratory before being imported into the central SQL database (FSS_SURVEY).

Estimation

Catchability corrections for the two anglerfish species were applied following the methods described by the ICES working group WKAGME (2009). The equations were re-written to express the estimates in terms of capture probabilities (see also Yuan, 2012).

Footrope selectivity at length l, ($\hat{e}_{1l}$) was estimated using a 3-parameter logistic model:

$$\hat{e}_{1l} = \frac{1}{1 + \exp(-\beta_0 - \beta_1(l - \beta_2))}$$

$\beta_0 = 0.82257$, $\beta_1 = 0.11386$ and $\beta_2 = 35.5$

A herding coefficient ($\hat{h} = 0.017$) was applied to estimate herding in the area between the doors and wings (sweeps). The herding selectivity ($\hat{e}_{2li}$) was estimated as follows:

$$\hat{e}_{2li} = \frac{v_{1i} + \hat{h}v_{2i}}{v_{1i} + v_{2i}}$$

v_{1i} is the area swept by the footrope on tow i.
v_{2i} is the area covered by the sweeps on tow i.

The capture probability for a fish at length l in tow i in stratum s, (p_{lis}) is then given as:

$$p_{lis} = \hat{e}_{1l}\,\hat{e}_{2li}\frac{(v_{1i} + v_{2i})\,I_s}{A_s}$$

I_s is the number of hauls in stratum s.
A_s is the surface area of stratum s.

For megrim, no catchability correction is applied, so the capture probability is simply:

$$p_{is} = \frac{v_i\,I_s}{A_s}$$

The estimated number of fish ($\hat{N}$) or biomass (B) in the survey area are then:

$$\hat{N} = \sum_{i \in I} \frac{n_i}{p_{lis}} \qquad \hat{B} = \sum_{i \in I} \frac{n_i w_i}{p_{lis}}$$

n_l is the catch numbers-at-length in tow i
w_l is the mean weight-at-length, obtained from the length-weight relationship for the whole survey.

Changes in gear, protocols or estimation

During the 2016 survey:

- The tickler chain was fitted with a weak link that broke regularly. It was replaced with a G13 connector (not-so-weak link) at the end of the first leg.

Before the 2017 survey:

- The tickler chain was shortened so it is now well ahead of the footrope (approx. 3m) last year it was about 1.5-2m ahead of the footrope).
- The doors were modified by fitting a new top-end in order to increase their surface area from 5.25m^2 to approx. 5.45m^2 resulting in an additional 6% spreading power (estimated by supplier). This resulted in 4-5m extra door spread.
- The head rope was replaced and the floats were tidied up (tied on tighter and more regularly spaced). This resulted in an additional 60cm headline height, on average.
- The netting at the tips of the wings was replaced with stronger netting to avoid damage when it is pulled onto the drum on top of the floats.
- This was the first year a CTD was mounted on one of the trawl doors.

During the 2017 survey:

- The cod end was replaced after the area 7 part of the survey was completed (legs 1 and 2) but before the 6a part of the survey took place.

Before the 2018 survey:

- 1.2m length of chain added to the headline bridles. This chain was part of the design of the gear but was omitted from the gear plans. Fitting the chains resulted in an increase in the headline height of round 75cm and an increase in door spread of around 5m compared to 2017. There were no indications that fitting the chains changed the bottom contact or the amount of digging-in of the ground gear.

Before the 2019 survey:

- Additional deep water transects (500-1,500m) were added to survey protocols (3 additional days have been added to legs 1 and 2 to facilitate this work).
- In the middle of the Porcupine Bank there is some very soft ground. This may cause the gear to dig in (you see the door sensors getting unstable), reduce the warp to lift the gear a bit more. If this doesn't work, increase the speed a bit, e.g. up to 3.4-3.5 knots. (Soft ground can be quite dangerous if trawl belly fills up with mud!).
- The duration of leg 3 (6a) has been reduced due to over-sampling relative to the Marine Scotland effort; the target has been reduced from 50 to 40 stations.
- In case of extreme work pressure, there is an option to only process target species (MON, WAF, MEG; no catch weights or samples for other species). These stations will be flagged with validity code 'T' (This did not occur during IAMS 2019).
- There has been some inconsistency in recording the end of the tow in the past. Some SiCs recorded the end of the tow as the time when the gear is being hauled back, others as the time the gear lifts off the ground. It will be necessary to analyse the sensor data and apply corrections to the historic data in terms of tow length. From 2019 onwards, the end of the tow is being recorded as the time at lift-off.

Before the 2020 survey:

- Operational working hours on Leg III were reduced from 24 to 12 hours due to comply with Covid-19 restrictions. Staffing levels and targets were reduced proportionally.

Before the 2021 survey:

- Additional Marine Scotland stations in 6a (North of 58°) were added to survey plan.
- EFDAQ (Electronic Fisheries Data Acquisition) system used in wet lab (replaced the CEFAS EDC system)

Results

Cruise summary

Weather was poor for leg I and II, with 6 days lost due to storms during the period from 11th to 23rd February (Table 3). Conditions improved during leg III (10-21st April) with no downtime due to weather (see Appendix 2: Cruise narrative for details). A total of 80 valid tows were completed (out of a target of 115), including 4 additional deep water tows (Table 4). There two invalid hauls with substantial damage to gear (at the beginning and end of leg III). The five additional Marine Scotland stations that were conducted north of 58° are not included in Table 4 and

Table 5 as they were located outside the main survey area. Summary statistics by stratum for four main target species are provided in

Table 5.

Downtime

Table 3: Details of downtime during survey (Weather, technical and/or gear damage)

Date	Hours downtime	Reason
11/02/2021	24	Weather
12/02/2021	24	Weather
13/02/2021	24	Weather
14/02/2021	24	Weather
19/02/2021	24	Weather
23/02/2021	24	Weather
11/04/2021	6	Net mending
18/04/2021	10	Net mending

Summary statistics

Table 4: Target and achieved stations by stratum (excluding 5 Marine Scotland stations)

Stratum	Target	Valid	Invalid
DeepArea4	5	1	0
DeepArea5	5	3	0
VIa_Shelf_L	14	11	0
VIa_Shelf_M	7	4	0
VIa_Slope_H	10	5	0
VIa_Slope_M	9	5	1
VII_Porc_L	4	3	0
VII_Shelf_H	16	10	0
VII_Shelf_L	7	8	0
VII_Shelf_M	5	5	0
VII_Slope_H	22	17	0
VII_Slope_L	2	2	0
VII_Slope_M	9	6	0
Total	115	80	1

Table 5: Summary statistics by stratum. Stratum area is given in Km^2, 'Num hauls' is the is the number of valid hauls in each stratum and 'Swept Area' is the total area swept between the doors in each stratum (in Km^2), catch numbers ('Catch Num') are given for *L. piscatorius* (MON), *L. budegassa* (WAF), *L. whiffiagonis* (MEG) and *L. whiffiagonis* (LBI).

Stratum	Stratum Area	Num Hauls	Swept Area	Catch Num Mon	Catch Num Waf	Catch Num Meg	Catch NumLbi
VIa_Shelf_L	37,003	11	5.1	75	7	63	0
VIa_Shelf_M	4,746	4	2.4	49	31	59	0
VIa_Slope_H	3,114	5	2.8	58	26	117	0
VIa_Slope_M	3,044	5	3.4	114	1	129	4
VII_Shelf_H	50,764	10	5.4	24	108	168	34
VII_Shelf_L	42,034	13	7.1	69	66	151	105
VII_Shelf_M	14,621	5	2.4	54	27	64	0
VII_Slope_H	35,768	17	8.7	94	100	360	179
VII_Slope_M	29,406	6	3.7	35	0	1	0
Total	220,500	76	40.9	572	366	1,112	322

Abundance and Biomass estimates

Estimated numbers and biomass for the survey area are given in Table 6. Note that it is likely that the selectivity correction does not account for all the fish encountered by the gear; therefore, these estimates should not be treated as absolute.

Table 6: Estimated numbers (millions; NumMln) and biomass (kT; BiomKT) in the survey area, with CV (relative standard error) and 95% confidence intervals (low:CiLo and high:CiHi). Only fish >500g live weight (approximately 32cm) were included in the estimate.

	VIa MON	VII MON	VIa WAF	VII WAF
NumMln	3.104	9.726	0.632	16.126
NumCV	17.669	14.988	28.768	19.226
NumCiLo	2.029	6.869	0.276	10.049
NumCiHi	4.179	12.583	0.989	22.203
BiomKT	4.752	15.901	0.564	8.300
BiomCV	18.977	13.302	27.938	12.555
BiomCiLo	2.985	11.756	0.255	6.258
BiomCiHi	6.520	20.047	0.873	10.342

Gear and fishing details

Figure 3 gives details of fishing net geometry of valid tows: distance towed, depth / warp length, warp length / door spread and door spread / wing spread. These show expected distributions and ranges.

Catch

The length-weight relationship for *L. piscatorius* and *L. budegessa* over the course of the survey followed expected relationships (Figure 4).

Figure 5 and Figure 6 summarise the catch weights of *L*. *piscatorius* and *L*. *budegessa* at each station across the survey area, and the size distribution of each species for assessment areas 6a and 7bcjk. Figure 7 displays the density of each species by stratum and associated standard error. *L*. *piscatorius* showed highest densities (kg/km^2) in the 'VIa Slope M' stratum and lower densities in the 'VII Shelf H' and 'VII Shelf L' strata. *L*. *budegessa* showed highest densities on 'VIa Shelf M' and lower densities on 'VIa Shelf L' and 'VIa Slope M' and were absent on the 'VII Slope M' stratum.

Figure 8 shows that the relative influence each of the stations had on the final density estimate was generally equitable (i.e. no single tow had a disproportionally large influence on the biomass estimates).

The trends in catch weights per swept area (Kg/Km^2) for anglerfish (*L*. *piscatorius*, *L*. *budegassa*) and megrim (*L*. *whiffiagonis*) from IAMS 2016 to 2021 are shown in Figure 9. For the anglerfish, the footrope and sweep selectivity were estimated as outlined in the Methods section. For megrim, no selectivity figures are available; 100% footrope selectivity was assumed and 0% sweep selectivity. Both species of anglerfish recorded the highest catch rates in 2017 for both assessment areas (6a and 7bcjk). Catch rates for white anglerfish (*L*. *piscatorius*) in area 7bcjk peaked in 2017 and have

been declining since then, while catch rates of black anglerfish (*L. budegassa*) have also been declining in this area but at a lesser rate. In area 6a the catch rates of white anglerfish had also been declining since 2017 although there was a slight increase in 2021. Catch rates of black anglerfish in area 6a have been declining at a low rate since 2017. Catch rates for megrim (*L. whiffiagonis*) in area 7bcjk have been declining since 2016, while in area 6a they have been more or less flat. It is important to note that for all three species the variability between years is within the uncertainty bounds, so there is no strong evidence of a trend.

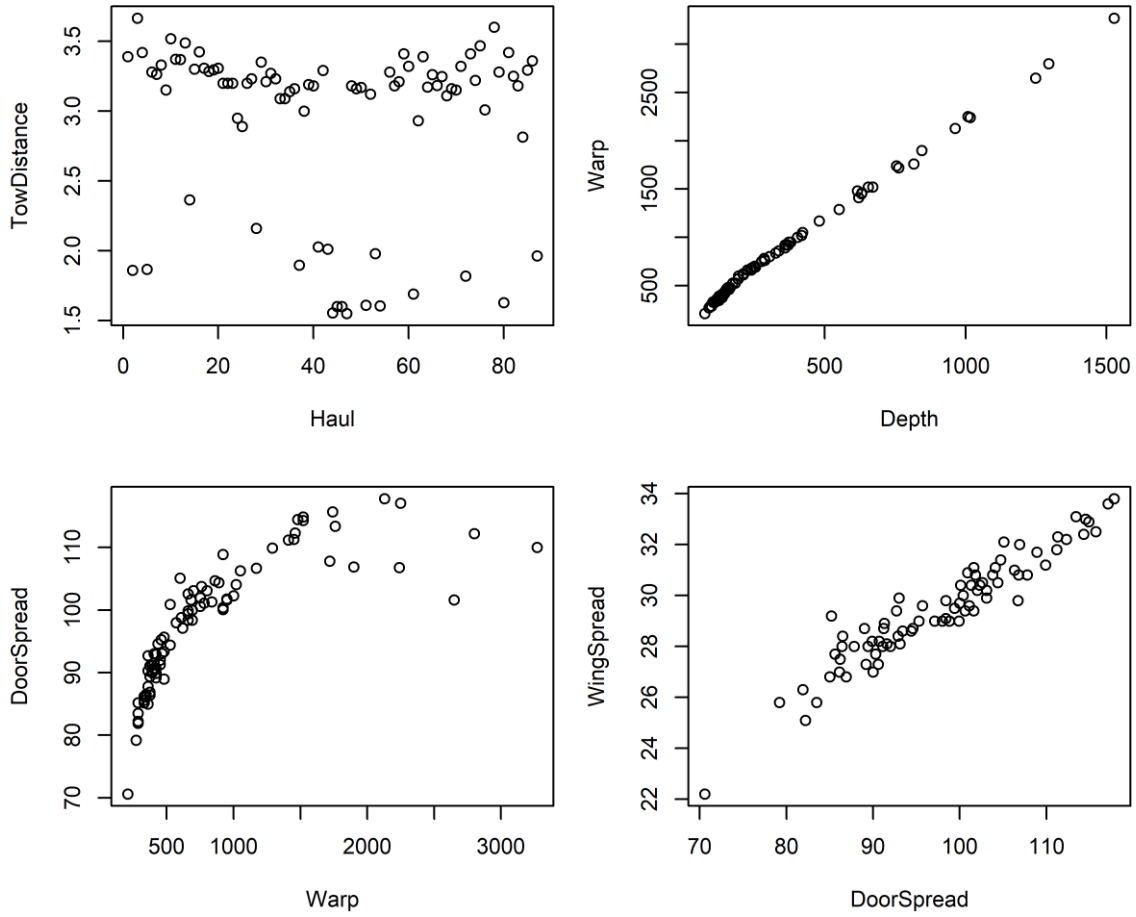

Figure 3: Gear parameters for the valid hauls. Haul is the haul number; tow distance in nautical miles; warp, depth door spread and wing spread in meters

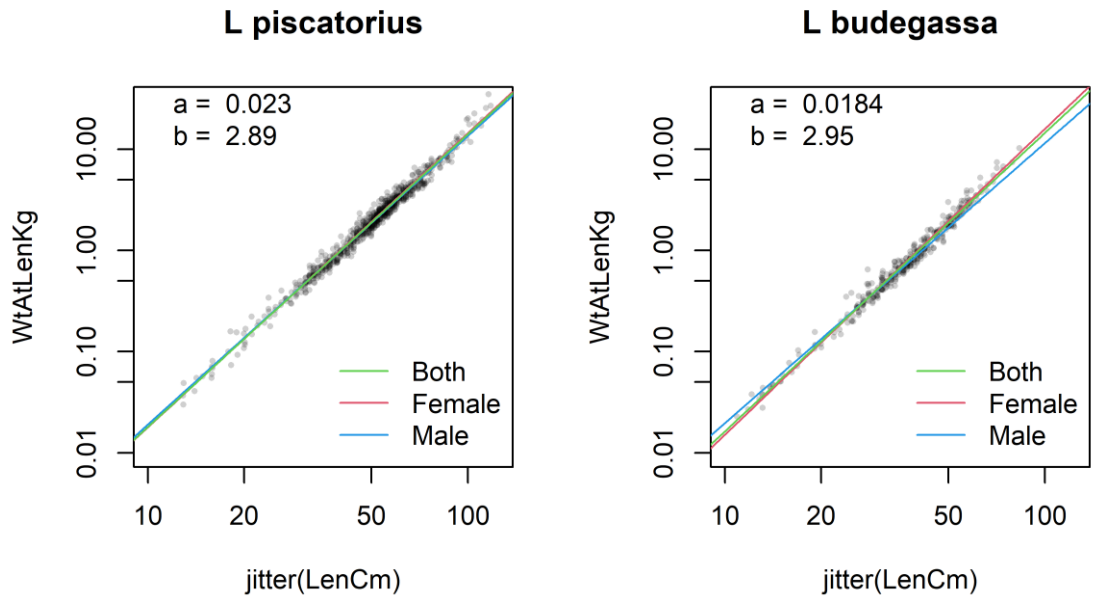

Figure 4: *Length-weight parameters. Total length in cm and live weight in kg. Note the log scale.*

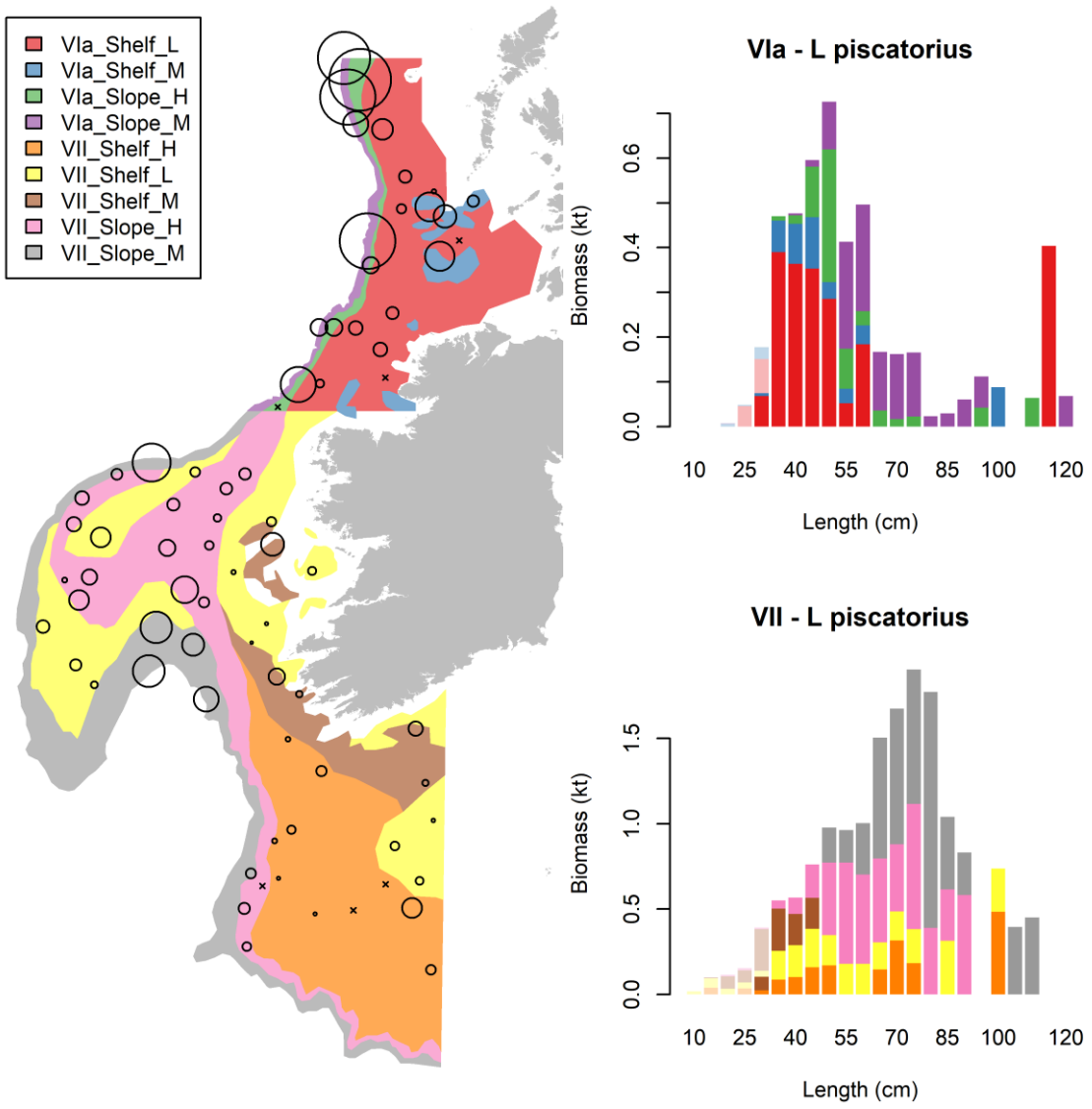

Figure 5: *Bubble size is proportional to the biomass of* L. piscatorius *per swept area at each sampling station (left; >500g fish only) and biomass per size class and stratum (right; fish <500g in pale shades).*

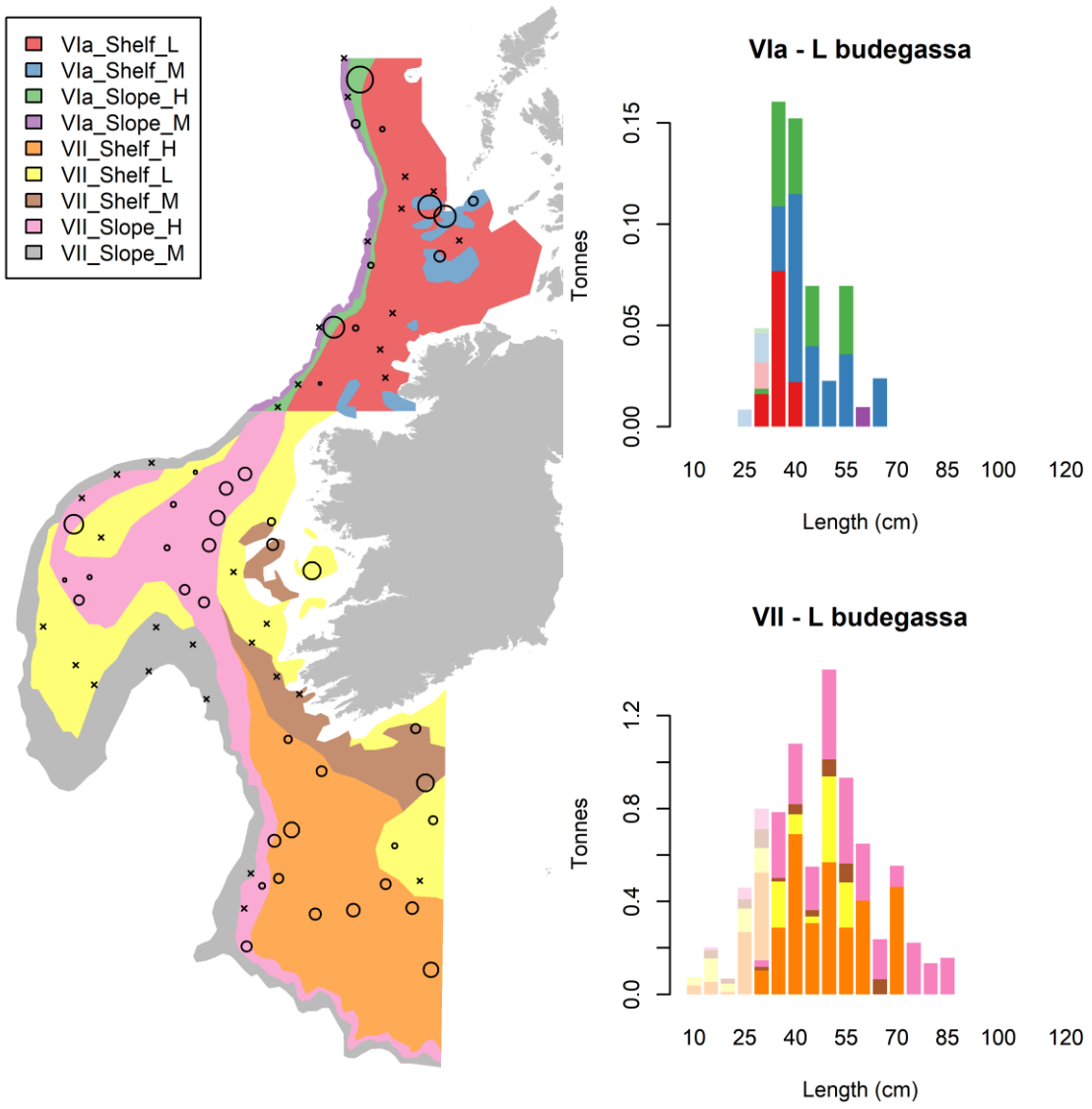

Figure 6: *Bubble size is proportional to the biomass of* L. budegassa *per swept area at each sampling station (left; >500g fish only) and biomass per size class and stratum (right; fish <500g in pale shades).*

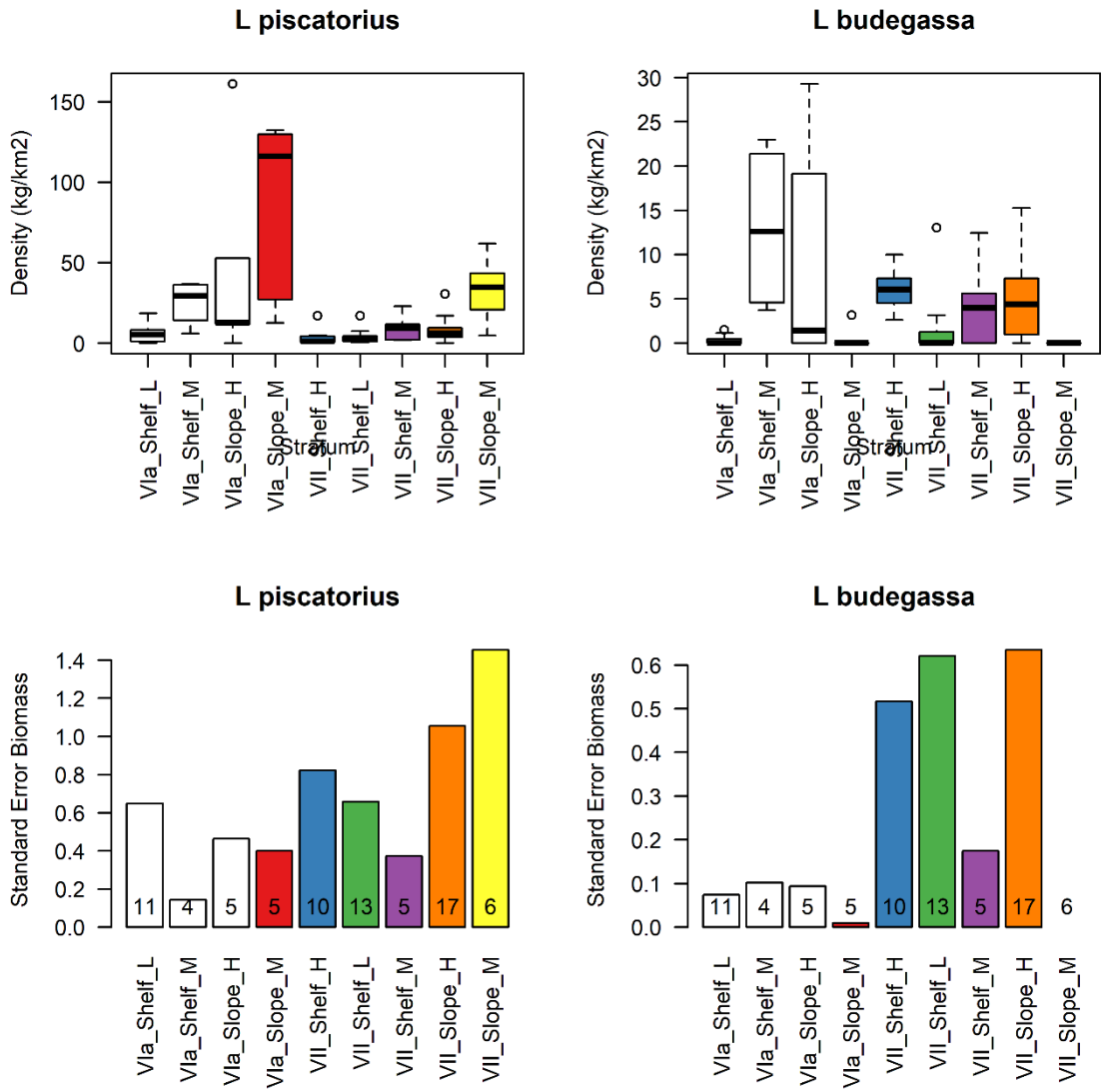

Figure 7: ***Density (kg/km²) of*** **L. piscatorius** ***(Top Left) and*** **L. budegassa** ***(Top Right) and standard error of*** **L. piscatorius** ***and (Bottom Left)*** **L. budegassa** ***(Bottom Right) catches by stratum Note: Numbers in SE bar charts represent the total number of stations in each stratum***

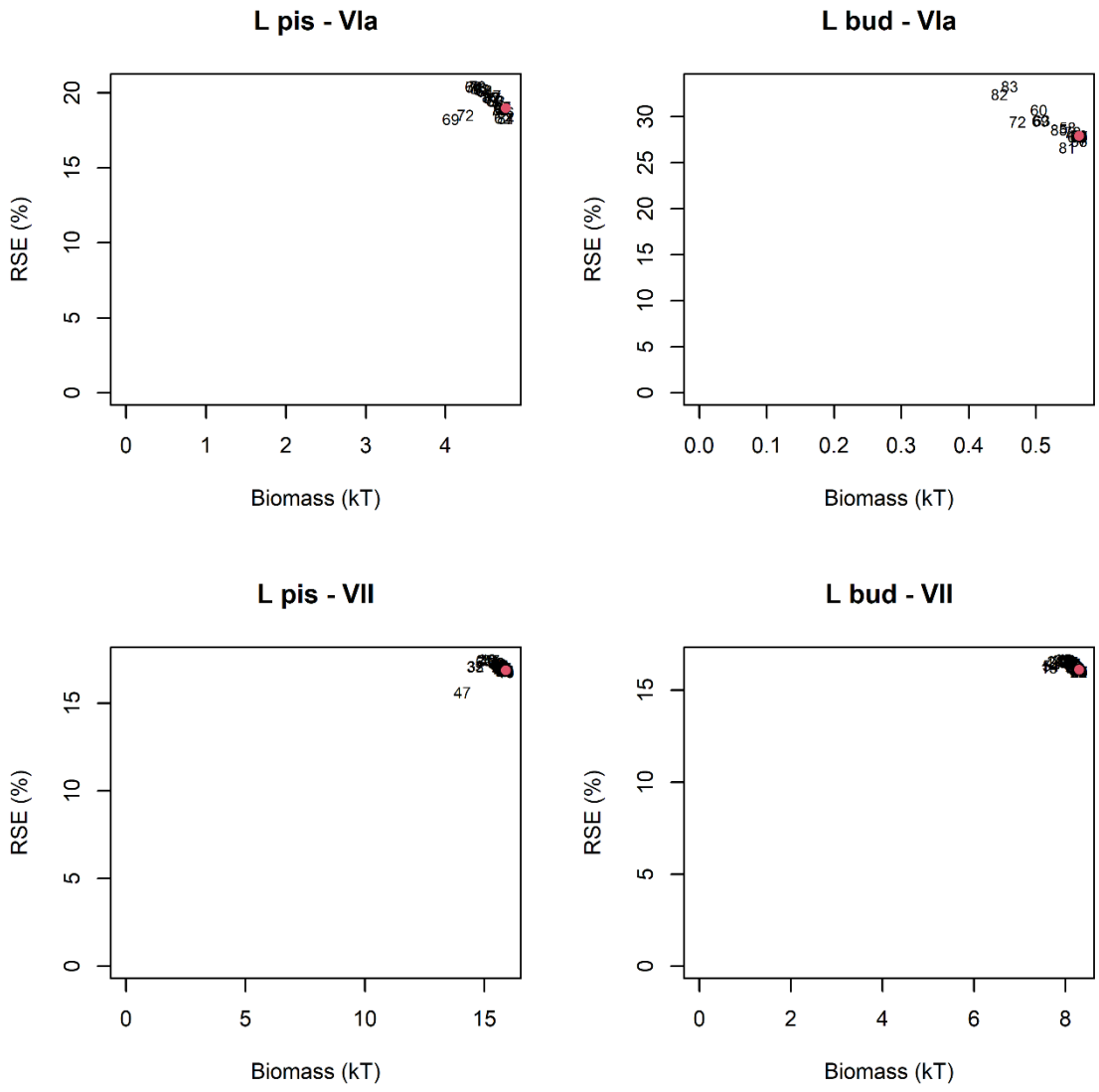

Figure 8: *Influence that each tow had on the final biomass estimate. Estimates were obtained by sequentially removing each of the tows from the analysis. The red dot indicates the final estimate (with all the valid tows included).*

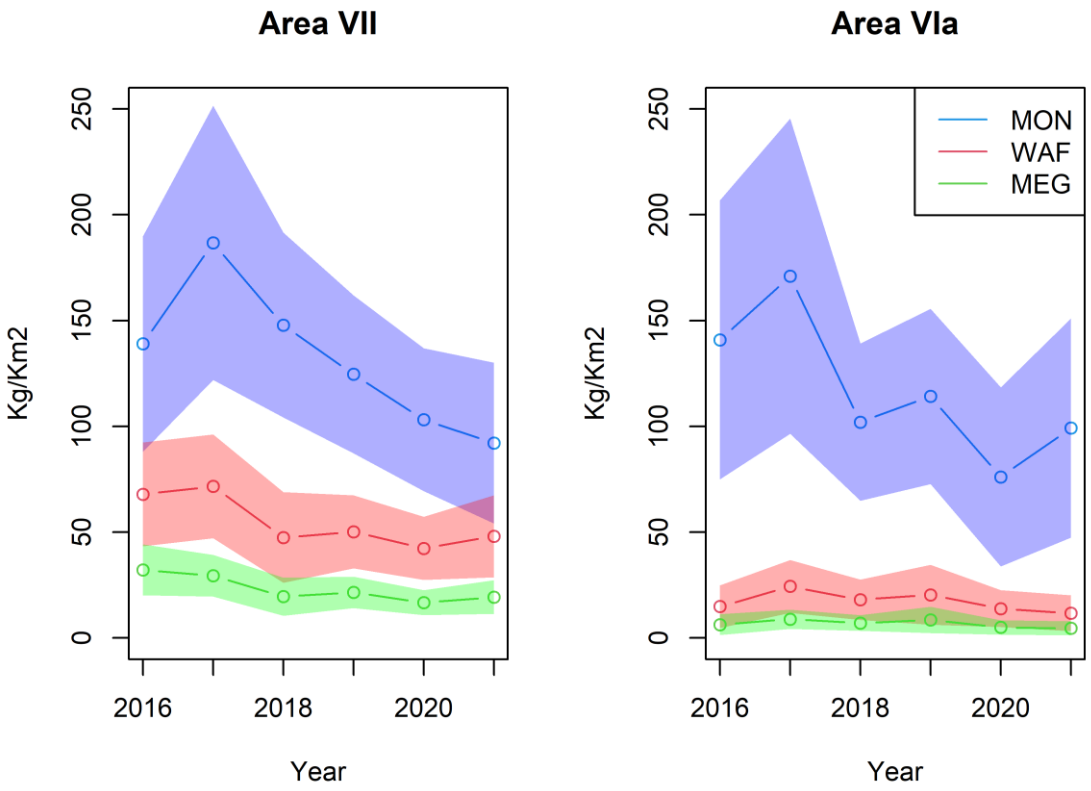

Figure 9: *Trends in catch weights per swept area for white anglerfish (MON); black anglerfish (WAF) and megrim (MEG).*

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Appendix 1: List of IAMS 2021 survey staff

First Name	Surname	Organization	Survey Role	Participation Dates
Dave	Stokes	Marine Institute	Chief Scientist	8/2/21 - 20/2/2021
Robert	Bunn	Marine Institute	Deckmaster	8/2/21 - 20/2/2021
Sinéad	O'Brien	Marine Institute	Wetlab Scientist	8/2/21 - 20/2/2021
Tobi	Rapp	Marine Institute	Wetlab Scientist	8/2/21 - 20/2/2021
Ross	Fitzgerald	Marine Institute	Deckmaster	8/2/21 - 20/2/2021
Helen	McCormick	Marine Institute	Wetlab Scientist	8/2/21 - 20/2/2021
Leanne	Oliver	Survey Contractor	Wetlab Scientist	8/2/21 - 20/2/2021
Stephen	Brennan	Survey Contractor	Wetlab Scientist	8/2/21 - 20/2/2021
Bartley	Hernon	P&O Maritime	Gear Technologist	8/2/21 - 20/2/2021
Sara-Jane	Moore	Marine Institute	Chief Scientist	20/02/2021 - 4/3/2021
Turloch	Smith	Marine Institute	Wetlab Scientist	20/02/2021 - 4/3/2021
Sean	O'Connor	Marine Institute	Deckmaster	20/02/2021 - 4/3/2021
Gary	Robinson	Survey Contractor	Wetlab Scientist	20/02/2021 - 4/3/2021
Dave	Tully	Marine Institute	Survey Support/Deckmaster	20/02/2021 - 4/3/2021
Karl	Bentley	Marine Institute	Wetlab Scientist	20/02/2021 - 4/3/2021
Brendan	O'Hea	Marine Institute	Wetlab Scientist	20/02/2021 - 4/3/2021
Laurence	Manning	Survey Contractor	Wetlab Scientist	20/02/2021 - 4/3/2021
Nicoletta	Perrella	Smart Sea School	Wetlab Scientist	20/02/2021 - 4/3/2021
Ger	Dougal	Survey Contractor	Gear Technologist	20/02/2021 - 4/3/2021
Eoghan	Kelly	Marine Institute	Chief Scientist	10/4/21-21/4/21
Sean	O'Connor	Marine Institute	Deckmaster	10/4/21-21/4/21
Gráinne	Ní Chonchuir	Marine Institute	Wetlab Scientist	10/4/21-21/4/21
Dermot	Fee	Marine Institute	Wetlab Scientist	10/4/21-21/4/21
Dave	Tully	Marine Institute	Survey Support/Deckmaster	10/4/21-21/4/21
Karl	Bentley	Marine Institute	Wetlab Scientist/Deckmaster	10/4/21-21/4/21
Ross	O'Neill	Marine Institute	Wetlab Scientist	10/4/21-21/4/21
Gráinne	Ryan	Marine Institute	Deckmaster	10/4/21-21/4/21
Cian	Derbyshire	Smart Sea School	Wetlab Scientist	10/4/21-21/4/21
John	O'Regan	Survey Contractor	Gear Technologist	10/4/21-21/4/21

Appendix 2: Cruise narrative

Date	Comments
8/02/2021	Mobilised in Galway. Scanmar NMEA output issues: Scanbas box and cable to dry lab both had problems. Replaced Scanbas with Scancheck.
9/02/2021	Sailed 01:25, first station 10:00. Three hauls done, first had 8+ ton boarfish, had to slip, just took some otolith species and tested systems.
10/02/2021	3 hauls today, weather ok, but deteriorating
11/02/2021	Sheltering – Brandon Bay
12/02/2021	Sheltering – Brandon Bay
13/02/2021	Sheltering – Brandon Bay
14/02/2021	Sheltering – Brandon Bay
15/02/2021	3 valid hauls, 4th was too far and weather building fast even for a short tow. Remained on station overnight.
16/02/2021	3 valid hauls off SW and weather building again. Attempted to test Trawlsounder over the side and it got caught under the hull and was lost. Made slow passage south to next station in very poor weather.
17/02/2021	4 hauls in southern area of survey, working north east as forecast showing heavy seas for 19th.
18/02/2021	4 hauls and a lot of net sensor testing. Weather building by tonight so making passage north towards Cork to decide in morning if workable.
19/02/2021	Heavy seas, c.7m so decision made to berth in Cork.
20/02/2021	End of leg 1 – Handover leg 2 scientists joined at 13:00hrs
21/02/2021	3 hauls carried out. Depths shallow at 90-120 m. Weather good. Sediment sample for Infomar today.
22/02/2021	3 hauls carried out in depths of 130-150 m. Weather good.
23/02/2021	Downtime today. Dodging ~170km South West of Kinsale
24/02/2021	3 hauls carried out. Depths shallow at 200-600 m. Weather good. Big catch of large prawns.
25/02/2021	3 hauls carried out in deeper waters ranging from 600m-800m. Day grab to collect sediment samples for GMIT micro plastics project and Infomar.
26/02/2021	Weather freshening. Deep tow first thing. Made slow passage west to second station. 3 hauls done today. Attempted grab but swell too big and day grab came back empty.
27/02/2021	Weather fine. 4 stations carried out. Grab sample done for GMIT Micro plastics project and Infomar sediment sample taken.
28/02/2021	4 hauls today, weather fine, no grabs.
01/03/2021	4 Deepwater Stations done today. No sensor readings, 30 mins tows, Weather fine. Grab sample carried out at Haul 47.
02/03/2021	4 hauls today, One grab.
03/03/2021	3 hauls today, first two had big catches of boarfish.
04/03/2021	Arrived in Galway -0700 hrs. Scientists disembarked at 10am.
10/04/2021	IAMS Leg III: sailed from Kilybegs at 19:00. 10 hour steam to first station.
11/04/2011	Net came fast on first tow - 6 hours mending. One successful haul.
12/04/2021	4 hauls today.
13/04/2021	2 deep water stations (1,200m and 1,000m) and 2 “VIa_Shelf_L” stations.
14/04/2021	4 hauls today.
15/04/2021	4 hauls today.
16/04/2021	3 hauls today (incl additional tows for Marine Scotland) and glider deployment.
17/04/2021	4 hauls today, 1 foul (all additional Marine Scotland tows).
18/04/2021	2 hauls today (one foul haul with 4 hours’ damage).
19/04/2021	4 hauls today.
20/04/2021	2 hauls today. Net came fast on station after 32 minutes with substantial damage.
21/04/2021	End of Survey. Demob in Galway 10:00hrs.

Appendix 3: Additional Sampling

Request	Details	Requested by	Target
Nephrops	Nemesis catch sampling	Marine Institute	All
Litter	Litter log per tow	OSPAR	All
CTD on trawl door	Mini CTD	Oceanography Marine Institute	Mini CTD unavailable
CTD transects	Main CTD	Oceanography Marine Institute	Opportunistic
Grab samples	Sub sample from Day grab	INFOMAR Marine Institute	Opportunistic
Grab samples	Sub sample from Day grab	GMIT Microplastics	Opportunistic
Elasmobranch Tagging	Tag & record elasmobranchs	FEAS Marine Institute	Opportunistic
RTE Request	Unusual fish species	RTE	Opportunistic
Hake and Anglerfish	Ethanol for DNA analysis	AZTI Technalia	90 from 6a and 7b-k
Monkfish Genetics	Ethanol for DNA analysis	IMR Bergen	30 from 6a south
Herring Morphometrics	Frozen	FEAS Marine Institute	100 from 6a

Appendix 4: Summary of station location, gear geometry and catch

Haul	Stratum	LonDeg W	LatDeg N	Depth mtr	Dist nm	Door mtr	Wing mtr	Mon Num	Waf Num	Mon Kg	Waf Kg	Mon $KgKm^{-2}$	Waf $KgKm^{-2}$	Mon Tons	Waf Tons
1	VII_Shelf_L	-11.5035	52.9050	144	3.4	90.6	27.3	1	0	1.4	0.0	0.9	0.0	37.3	0.0
2	VII_Slope_H	-11.9045	53.1695	211	1.9	97.1	29	3	8	5.1	11.0	3.5	7.3	124.7	261.4
3	VII_Slope_H	-11.7685	53.4430	227	3.7	99.4	29.5	5	21	8.3	31.3	2.6	9.1	99.7	349.0
4	VII_Slope_H	-12.5925	53.1445	373	3.4	101.6	31.1	10	2	37.4	5.1	11.6	1.3	422.0	46.6
5	VII_Slope_H	-12.3010	52.7275	363	1.9	100.4	30	15	5	54.0	8.3	30.5	4.4	1091.3	156.6
6	VII_Slope_H	-11.9880	52.6025	241	3.3	101.6	29.4	8	9	13.6	14.5	4.9	4.8	174.5	181.5
7	VII_Shelf_L	-10.9545	52.3920	127	3.3	89.4	28	5	0	1.7	0.0	0.6	0.0	59.6	0.0
8	VII_Shelf_L	-11.1995	52.2050	141	3.3	92.9	28.4	2	3	1.1	1.2	0.4	0.0	29.4	37.4
9	VII_Shelf_M	-10.7900	51.8685	126	3.2	90.3	27.7	23	7	10.6	1.6	11.5	0.0	316.5	61.2
10	VII_Shelf_M	-10.4160	51.6930	91	3.5	79.2	25.8	1	0	1.5	0.0	1.9	0.0	28.3	0.0
11	VII_Shelf_H	-10.6055	51.2470	164	3.4	93.4	28.6	2	6	1.9	6.0	1.0	2.6	68.1	181.4
12	VII_Shelf_H	-10.0545	50.9295	127	3.4	87.8	28	7	8	7.2	6.5	4.8	4.5	263.7	248.2
13	VII_Shelf_H	-10.5475	50.3475	161	3.5	95.3	29	3	23	6.4	18.9	3.3	10.0	177.8	653.1
14	VII_Shelf_H	-10.8280	50.2385	194	2.4	98	29	1	18	1.3	11.5	1.2	6.6	61.7	639.8
15	VII_Shelf_H	-10.7575	49.8680	158	3.3	89	28.7	2	11	0.9	6.9	0.6	4.0	40.3	301.5
16	VII_Slope_H	-11.0280	49.7915	305	3.4	103.1	29.9	0	5	0.0	4.7	0.0	1.6	0.0	66.5
17	VII_Shelf_H	-10.1555	49.5150	123	3.3	86.4	28	1	6	0.7	8.4	0.6	5.8	31.1	293.9
18	VII_Shelf_H	-9.5280	49.5510	154	3.3	92	28	1	16	0.1	11.4	0.0	7.3	10.2	440.2
19	VII_Shelf_H	-8.9985	49.8100	133	3.3	90	27	0	10	0.0	8.6	0.0	4.6	0.0	291.6
20	VII_Shelf_L	-8.8450	50.1880	134	3.3	91.2	28.7	3	9	8.8	3.8	3.4	1.3	146.0	106.4
21	VII_Shelf_M	-8.5030	51.3540	95	3.2	83.5	25.8	14	9	7.8	4.2	9.1	4.0	224.1	112.6
22	VII_Shelf_M	-8.3445	50.8155	112	3.2	85.6	27.7	2	9	1.4	9.5	1.9	12.5	35.8	213.2
23	VII_Shelf_L	-8.2105	50.4435	121	3.2	92.7	29.4	9	21	1.7	8.5	0.7	3.2	64.3	251.2
24	VII_Shelf_L	-8.4350	49.8435	135	3.0	93	29.9	4	9	6.8	1.5	2.9	0.0	130.3	81.9
25	VII_Shelf_H	-8.5625	49.5735	144	2.9	89.9	28.2	5	5	22.0	9.7	16.9	6.3	866.6	344.1
26	VII_Shelf_H	-8.2500	48.9595	150	3.2	91.3	28.9	2	5	7.0	21.0	4.3	9.6	218.6	507.7
27	VII_Slope_H	-11.2830	49.1920	286	3.2	101.1	29.6	2	14	10.3	13.3	3.6	4.9	128.3	207.2
28	VII_Slope_H	-11.3260	49.5700	404	2.2	102.3	30.4	3	0	11.7	0.0	5.7	0.0	205.4	0.0

29	VII_Slope_M	-11.2175	49.9180	552	3.4	109.9	31.2	2	0	5.4	0.0	4.7	0.0	137.1	0.0
30	VII_Slope_M	-11.9470	51.6445	845	3.2	106.9	32	8	0	31.2	0.0	26.7	0.0	785.7	0.0
31	VII_Slope_M	-12.1700	52.1860	672	3.3	114.3	32.4	4	0	23.4	0.0	20.8	0.0	611.0	0.0
32	VII_Slope_M	-12.7765	52.3580	631	3.2	111.3	32.3	10	0	48.7	0.0	42.7	0.0	1255.9	0.0
33	VII_Slope_M	-12.8965	51.9220	963	3.1	117.8	33.8	5	0	51.4	0.0	43.5	0.0	1278.9	0.0
34	VII_Shelf_L	-13.7935	51.7875	482	3.1	106.7	29.8	2	0	5.8	0.0	2.2	0.0	90.6	0.0
35	VII_Shelf_L	-14.1015	51.9835	360	3.1	108.9	31.7	3	0	12.7	0.0	5.7	0.0	239.6	0.0
36	VII_Shelf_L	-14.6345	52.3640	419	3.2	104.1	31.1	3	0	17.1	0.0	7.3	0.0	308.6	0.0
37	VII_Slope_H	-14.0420	52.6265	289	1.9	103.8	30.8	5	1	28.1	10.5	17.0	4.4	609.2	156.8
38	VII_Slope_H	-14.2825	52.8245	338	3.0	104.7	31.4	1	1	3.9	3.0	1.2	0.7	43.7	23.6
39	VII_Slope_H	-13.8710	52.8540	212	3.2	98.8	29	11	2	33.4	3.3	10.5	0.9	374.3	37.7
40	VII_Shelf_L	-13.6825	53.2485	184	3.2	94.4	28.6	17	0	28.1	0.0	17.0	0.0	722.1	0.0
41	VII_Slope_H	-14.1320	53.3780	236	2.0	99.9	29	7	7	17.9	31.6	9.3	15.3	343.7	551.8
42	VII_Slope_H	-13.9990	53.6385	371	3.3	100.1	30.4	6	0	27.3	0.0	8.5	0.0	304.1	0.0
43	VII_Slope_H	-13.4190	53.8740	422	2.0	106.3	31	1	0	13.7	0.0	5.4	0.0	193.6	0.0
44	DeepArea5	-12.8400	54.1295	1527	1.6	110	NA	0	0	0.0	0.0	NA	NA	NA	NA
45	DeepArea5	-12.8535	54.0850	1295	1.6	112.2	NA	0	0	0.0	0.0	NA	NA	NA	NA
46	DeepArea5	-12.9455	54.0365	1017	1.6	106.8	30.8	4	0	54.6	0.0	NA	NA	NA	NA
47	VII_Slope_M	-12.8505	53.9880	763	1.6	107.8	30.8	6	0	32.5	0.0	62.0	0.0	1823.3	0.0
48	VII_Slope_H	-12.4885	53.5735	327	3.2	101.3	30.4	6	2	17.7	4.0	6.6	1.3	242.6	46.8
49	VII_Shelf_L	-12.1310	53.8945	380	3.2	101.8	30.8	2	1	9.7	1.3	4.4	0.7	183.7	28.7
50	VII_Slope_H	-11.6195	53.7320	277	3.2	100.6	29.4	8	13	16.3	20.3	6.4	7.5	230.2	276.0
51	VII_Slope_H	-11.3100	53.8760	248	1.6	98.4	29.1	3	10	9.8	9.2	6.0	7.5	215.1	297.0
52	VII_Shelf_L	-10.8765	53.4055	146	3.1	89.2	27.3	11	7	9.3	5.1	4.1	2.6	241.8	134.7
53	VII_Shelf_M	-10.8565	53.1785	137	2.0	86.9	26.8	14	2	9.6	3.4	22.9	5.6	401.2	100.1
54	VII_Shelf_L	-10.2065	52.9160	115	1.6	86.5	28.4	7	16	3.6	13.9	3.1	13.0	209.6	612.3
56	VIa_Slope_H	-10.7730	54.5410	360	3.3	104.4	30.5	0	0	0.0	0.0	0.0	0.0	0.0	0.0
57	VIa_Slope_H	-10.4380	54.7655	278	3.2	102	30.2	7	0	48.0	0.0	52.7	0.0	164.2	0.0
58	VIa_Shelf_L	-10.0810	54.7730	114	3.2	86.2	27.5	7	1	4.4	0.5	2.9	0.5	135.0	17.3
59	VIa_Shelf_L	-9.6200	54.9165	99	3.4	85.2	NA	7	0	3.5	0.0	NA	NA	NA	NA
60	VIa_Slope_H	-9.8495	55.3325	240	3.3	98.4	29.8	3	13	13.2	13.5	12.5	19.1	39.0	59.6
61	DeepArea4	-10.1750	55.3030	1248	1.7	101.6	NA	0	0	0.0	0.0	NA	NA	NA	NA
62	VIa_Slope_M	-10.0920	55.3320	1009	2.9	117.1	33.6	2	0	10.0	0.0	12.5	0.0	38.0	0.0
63	VIa_Shelf_L	-9.4935	55.3255	126	3.4	86.1	27	8	3	13.9	1.8	8.2	1.5	305.3	55.5
64	VIa_Shelf_L	-8.8835	55.4710	96	3.2	82.2	25.1	7	0	11.0	0.0	6.5	0.0	259.8	0.0

65	VIa_Slope_H	-9.2410	55.9460	253	3.3	103.1	30.2	7	1	10.4	1.2	11.8	1.4	36.7	4.5
66	VIa_Slope_M	-9.2915	56.1840	816	3.2	113.4	33.1	27	0	140.7	0.0	132.1	0.0	402.1	0.0
67	VIa_Shelf_L	-8.7370	56.5080	146	3.2	94.6	28.7	8	0	7.0	0.0	4.0	0.0	165.2	0.0
68	VIa_Shelf_L	-8.6745	56.8260	127	3.1	85	26.8	10	0	10.5	0.0	7.0	0.0	275.7	0.0
69	VIa_Shelf_L	-9.0475	57.2955	143	3.2	90.7	28.2	10	3	37.4	1.9	18.5	1.1	686.2	57.3
70	VIa_Slope_M	-9.4935	57.3495	617	3.2	114.5	33	11	1	27.1	4.0	27.1	3.1	83.7	9.6
71	VIa_Slope_M	-9.6220	57.6155	655	3.3	114.9	32.9	42	0	137.8	0.0	129.7	0.0	395.0	0.0
72	VIa_Slope_H	-9.4205	57.7875	256	1.8	100	29.7	41	12	76.2	11.7	161.1	29.3	501.7	91.2
73	VIa_Slope_M	-9.6845	58.0010	755	3.4	115.7	32.5	32	0	127.0	0.0	116.0	0.0	353.1	0.0
74	Marine Scotland	-9.5775	58.2045	633	3.2	112.3	32.2	58	0	266.0	0.0	NA	NA	NA	NA
75	Marine Scotland	-9.2705	58.4280	621	3.5	111.2	31.8	15	0	61.2	0.0	NA	NA	NA	NA
76	Marine Scotland	-7.9480	58.6170	236	3.0	102.6	30.5	98	3	286.2	6.6	NA	NA	NA	NA
78	Marine Scotland	-7.9630	58.2735	118	3.6	90.3	NA	1	0	0.8	0.0	NA	NA	NA	NA
79	Marine Scotland	-8.1640	58.1485	131	3.3	91.1	28	6	0	6.2	0.0	NA	NA	NA	NA
80	VIa_Shelf_L	-8.2045	56.6800	140	1.6	91.6	28.1	2	0	0.9	0.0	1.0	0.0	57.8	0.0
81	VIa_Shelf_M	-7.5550	56.5815	195	3.4	105.1	32.1	5	2	5.3	3.1	6.1	3.7	34.6	17.6
82	VIa_Shelf_M	-8.2710	56.5260	166	3.3	95.7	29.6	10	15	30.4	15.0	36.0	23.0	170.9	118.5
83	VIa_Shelf_M	-8.0230	56.4315	175	3.2	100.9	30.9	9	10	16.3	15.4	22.5	19.8	111.8	103.0
84	VIa_Shelf_L	-7.7860	56.1930	104	2.8	85.2	29.2	0	0	0.0	0.0	0.0	0.0	0.0	0.0
85	VIa_Shelf_M	-8.1025	56.0335	153	3.3	93.1	28.1	25	4	21.8	3.2	36.7	5.4	193.8	29.8
86	VIa_Shelf_L	-9.0860	55.1125	99	3.4	81.9	26.3	16	0	13.3	0.0	8.5	0.0	342.9	0.0
87	VIa_Shelf_L	-9.0025	54.8325	76	2.0	70.6	22.2	0	0	0.0	0.0	0.0	0.0	0.0	0.0

Notes:

Valid stations only.

LonDegW and LatDegW are the mid-point positions of each haul.

Depth mtr is the average depth of the haul.

Dist nm is the tow distance in nautical miles.

Door mtr and Wing mtr are the median door and wing spread.

Mon/Waf num/kg are the catch numbers and weights of *L. piscatorius* and *L. budegassa*.

Mon/Waf kg/km^2 are the catch weights per swept area.

Mon/Waf tons are the contribution that each station makes to the total biomass estimate in the survey area.