Cruise report:
Irish Anglerfish & Megrim Survey 2020

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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
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Introduction

The 2020 Irish Anglerfish and Megrim Survey (IAMS) took place from 23rd February to 18th March (area 7bcjk) and 12-21st April 2020 (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 second 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.

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 7 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).

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.

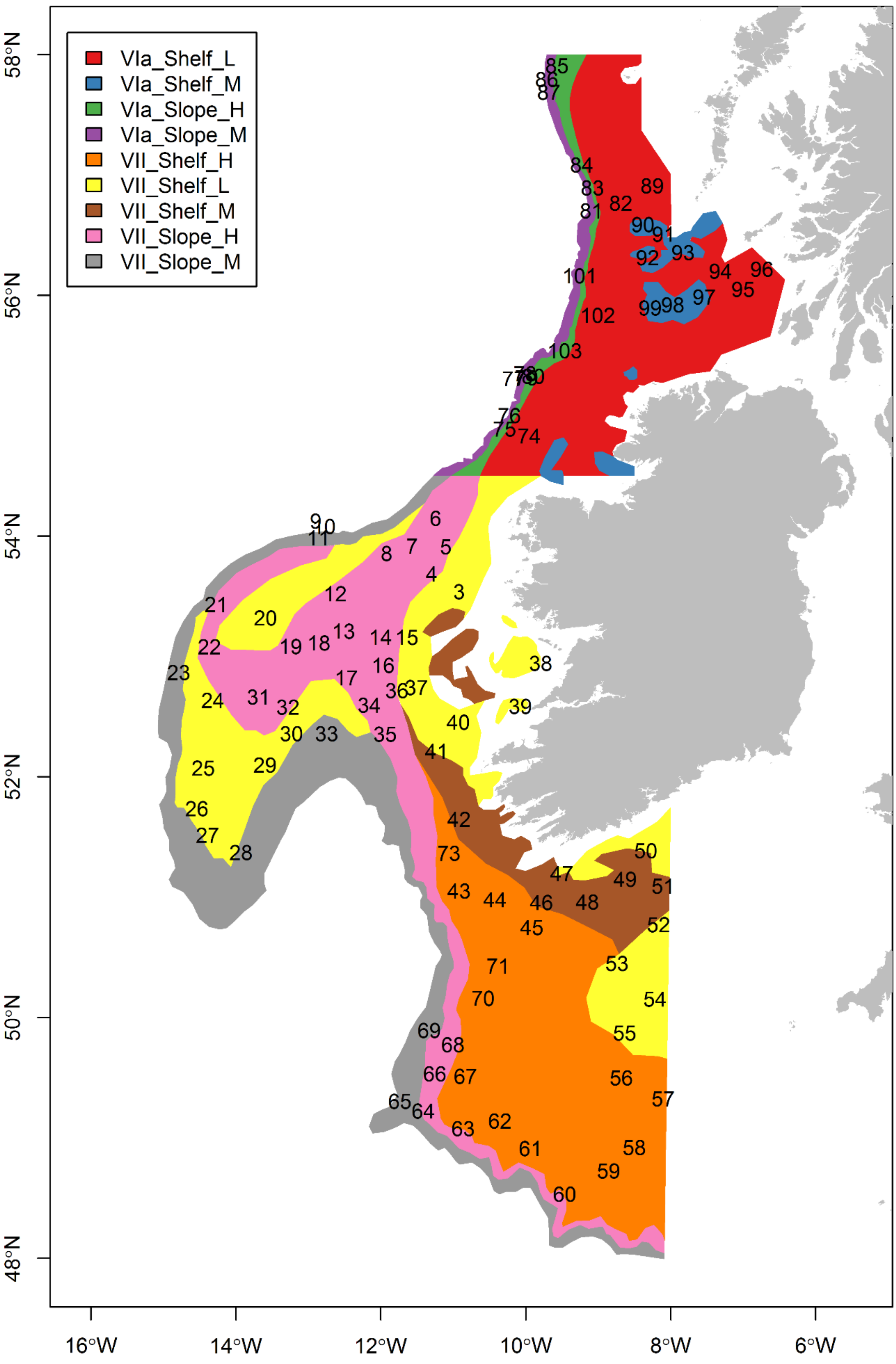

Figure 1*: Valid tow positions, the numbers refer to the haul number.*

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.

The target number of stations is usually 40 in area 6a, however, with Covid-19 restrictions on staff numbers this was reduced to 21 stations this year. The target for area 7bcjk is 65 stations. This means that stations with priority number 1-21 for area 6a and 1-65 for area 7bcjk respectively will be selected to be trawled. In practice some of the high priority stations may to be dropped (in cases where it was impossible to achieve a valid tow) and replaced by the 'spare' stations with priority numbers >21 for area 6a and >65 for area 7bcjk respectively. In addition to the regular sampling strata there were also two 'deep water' transects included in 2019 for the first time. 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 2005-2009 (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 location of the proposed stations.

Fishing operations

The trawl 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 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).

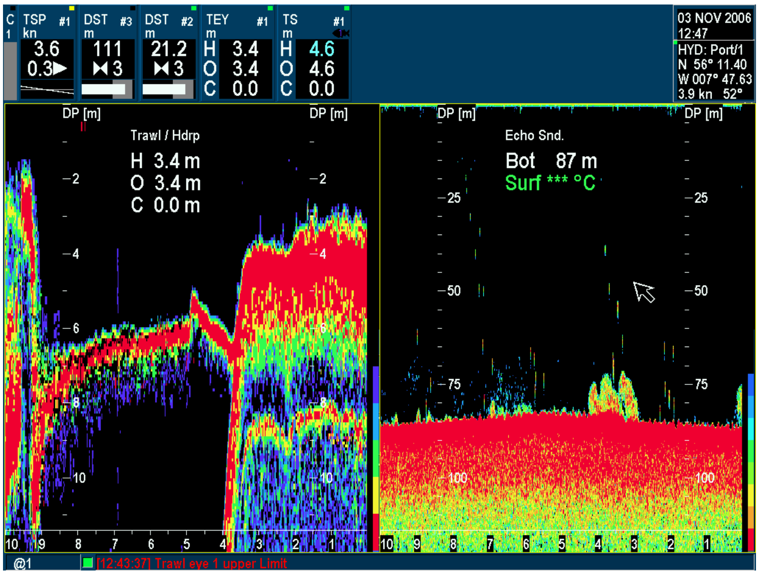

Figure 2: Screengrab of Scanmar display showing trawl geometry, water depth and fish marks

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 'serial number' 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. Record the total weight of benthos as a comment. Sort benthos only for indicator species (see table above) record weights. 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	F/M	wkstn	yes	yes	1pcm	yes	yes	yes	no	no
	HKE	U	wkstn	yes	yes	1pcm	yes	yes	yes	no	no
	JOD	U	wkstn	yes	yes	1pcm	yes	yes	yes	no	no
	LBI	F/M	990-999	yes	yes	1pcm	yes	yes	yes	no	no
	LEM	F/M	wkstn	yes	yes	1pcm	yes	yes	yes	no	no
	TUR	F/M	wkstn	yes	yes	1pcm	yes	yes	yes	no	no
	WIT	F/M	wkstn	yes	yes	1pcm	yes	yes	yes	no	no
Bio elasmo	BLR	F/M	wkstn	yes	yes	1pcm	yes	yes	yes**	no	no
	CUR	F/M	wkstn	yes	yes	1pcm	yes	yes	yes**	no	no
	DGS	F/M	wkstn	yes	yes	1pcm	yes	yes	yes**	no	no
	DFL	F/M	wkstn	yes	yes	1pcm	yes	yes	yes**	no	no
	DII	F/M	wkstn	yes	yes	1pcm	yes	yes	yes**	no	no
	SDR	F/M	wkstn	yes	yes	1pcm	yes	yes	yes**	no	no
	THR	F/M	wkstn	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.
wkstn	use workstation number when prompted for otolith box
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, heave, 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 CEFAS Electronic Data Capture (EDC) system and stored into local Access '97 databases 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 Scottish 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.

Results

Cruise summary

Weather was poor for leg I and II, with 7 days lost due to storms during the period from 23rd February to 18th March (Table 3). Conditions improved during leg III (12-21st April) with no downtime required (see Appendix 2: Cruise narrative for details). A total of 98 valid tows were completed (out of a target of 95), including 6 additional deep water tows (Table 4). There were 5 invalid hauls although there was no major damage to gear. 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
23/02/2020	24 Hours	Bad weather
24/02/2020	24 Hours	Bad weather
29/02/2020	24 Hours	Bad weather
01/03/2020	24 Hours	Bad weather
08/03/2020	24 Hours	Bad weather
09/03/2020	24 Hours	Bad weather
12/03/2020	24 Hours	Bad weather
16/03/2020	3 Hours	Hydraulic pipe on winch

Summary statistics

Table 4: Target and achieved stations by stratum

Stratum	Target	Valid	Invalid
Test	NA	0	3
DeepArea4	5	3	0
DeepArea5	5	3	0
VIa_Shelf_L	7	7	0
VIa_Shelf_M	4	7	0
VIa_Slope_H	5	6	1
VIa_Slope_M	5	5	0
VII_Porc_L	4	4	0
VII_Shelf_H	16	15	1
VII_Shelf_L	7	14	0
VII_Shelf_M	5	5	0
VII_Slope_H	22	21	0
VII_Slope_L	2	3	0
VII_Slope_M	9	5	0
Total	95	98	5

Table 5: Summary statistics by stratum. Stratum area is given in Km², '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 Km²), 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	CatchNum Mon	CatchNum Waf	CatchNum Meg	CatchNum Lbi
VIa_Shelf_L	37,003	7	3.0	28	3	18	0
VIa_Shelf_M	4,746	7	4.2	55	99	76	0
VIa_Slope_H	3,114	6	3.7	183	43	349	10
VIa_Slope_M	3,044	5	3.1	89	1	14	0
VII_Shelf_H	50,764	15	8.2	67	136	188	25
VII_Shelf_L	42,034	21	11.2	128	71	55	75
VII_Shelf_M	14,621	5	2.7	25	34	22	0
VII_Slope_H	35,768	21	12.5	171	118	169	111
VII_Slope_M	29,406	5	3.0	18	1	5	2
Total	**220,500**	**92**	**52**	**764**	**506**	**896**	**223**

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	3.043	7.489	0.968	10.581
NumCV	20.722	10.471	22.887	20.442
NumCIlo	1.807	5.952	0.534	6.342
NumCIlo	4.278	9.026	1.402	14.821
BiomKT	3.647	17.802	0.665	7.314
BiomCV	20.269	11.947	25.482	12.247
BiomCIlo	2.198	13.634	0.333	5.558
BiomCIlo	5.096	21.971	0.997	9.069

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* caught over the course of the survey followed expected relationships (Figure 4). Figure 5 and Figure 6 summarise the catch distribution across the survey area, and by areas (VIa and VII) of *L. piscatorius* and *L. budegessa* respectively. *L. piscatorius* tended to show higher densities in the VIa Slope and VIa High strata, and lower densities in the VII Shelf High and VIa Shelf Low strata. *L. budegessa* showed highest densities on VII Shelf High and VIa Slope High, and lowest on VIa Slope Medium and VII Porcupine Low and were absent on VII Slope Low and VII Slope Medium strata.

Figure 7 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 2020 are shown in Figure 8. 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 7). Catch rates for white anglerfish (*L. piscatorius*) in area 7 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 have also been declining since 2017 although there was a slight increase in 2019. Catch rates of black anglerfish in area 6.a have been more or less flat since 2016 with very slight increases in 2017 and 2019. Catch rates for megrim (*L. whiffiagonis*) in area 7 have been declining since 2016, while in area 6a they have been more or less flat. It is important to note that for all species the variability between years is within the uncertainty bounds, so there is no strong evidence of a trend.

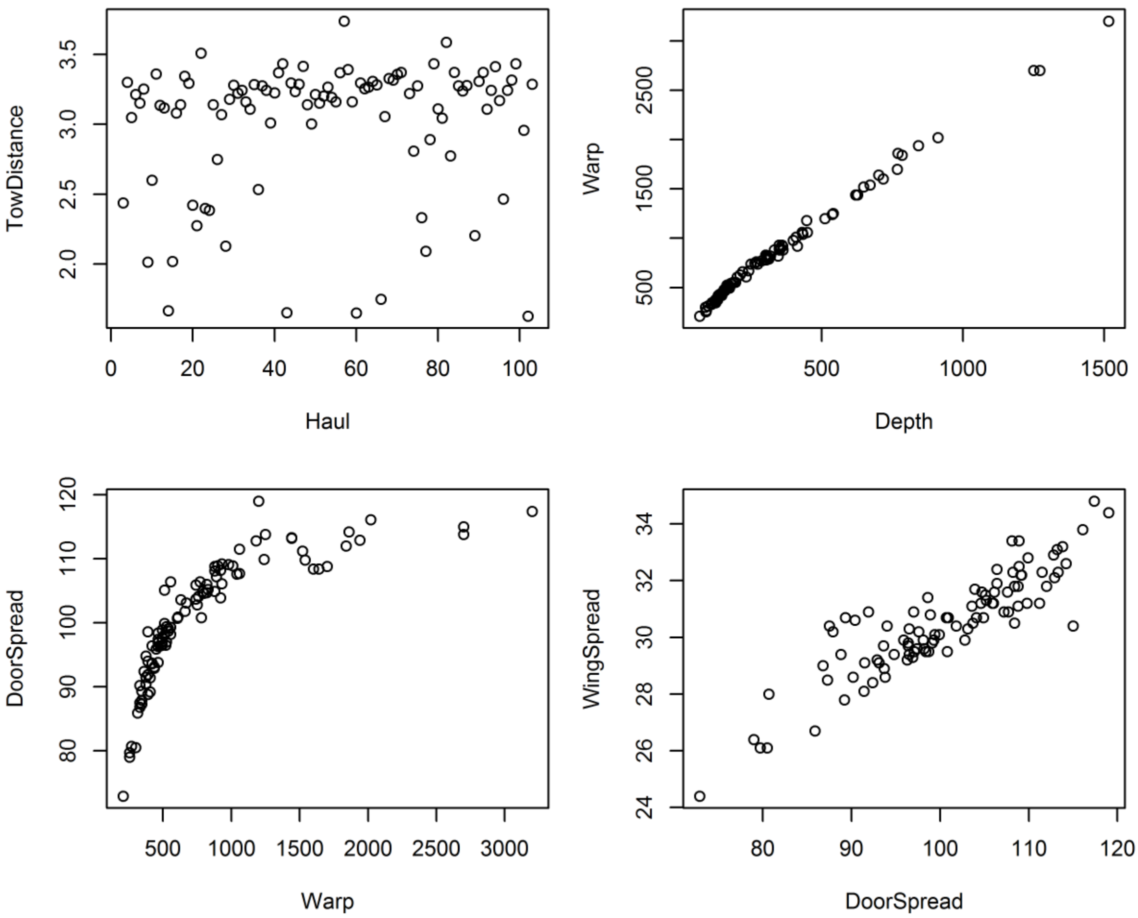

Figure 3: Gear parameters for the valid hauls. Haul is the haul number; tow distance in nautical miles; warp, depth door spread and wing spread in meters

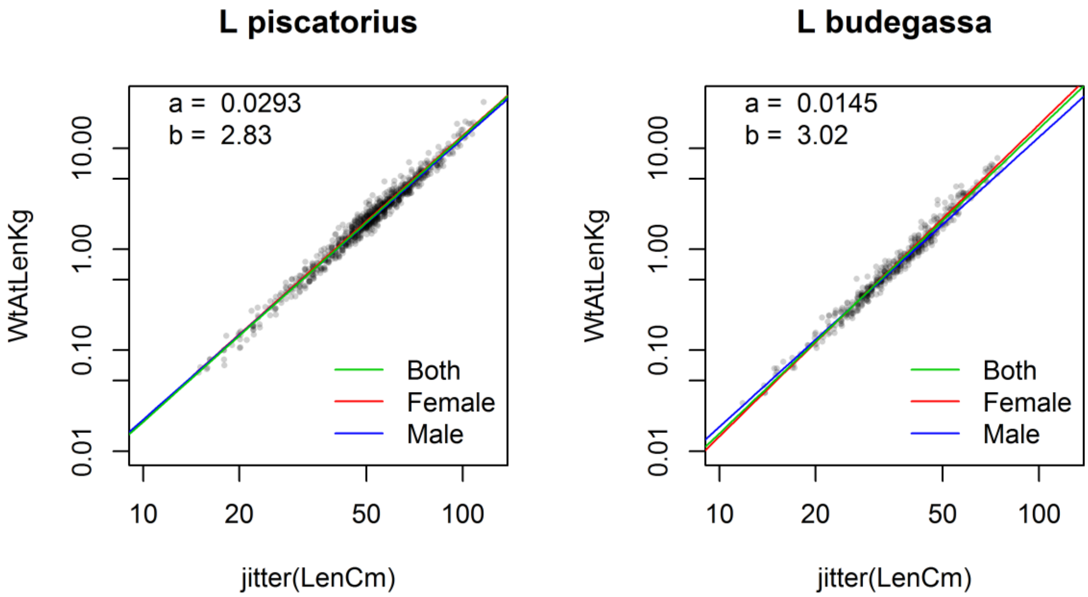

Figure 4: ***Length-weight parameters. Total length in cm and live weight in kg. Note the log scale.***

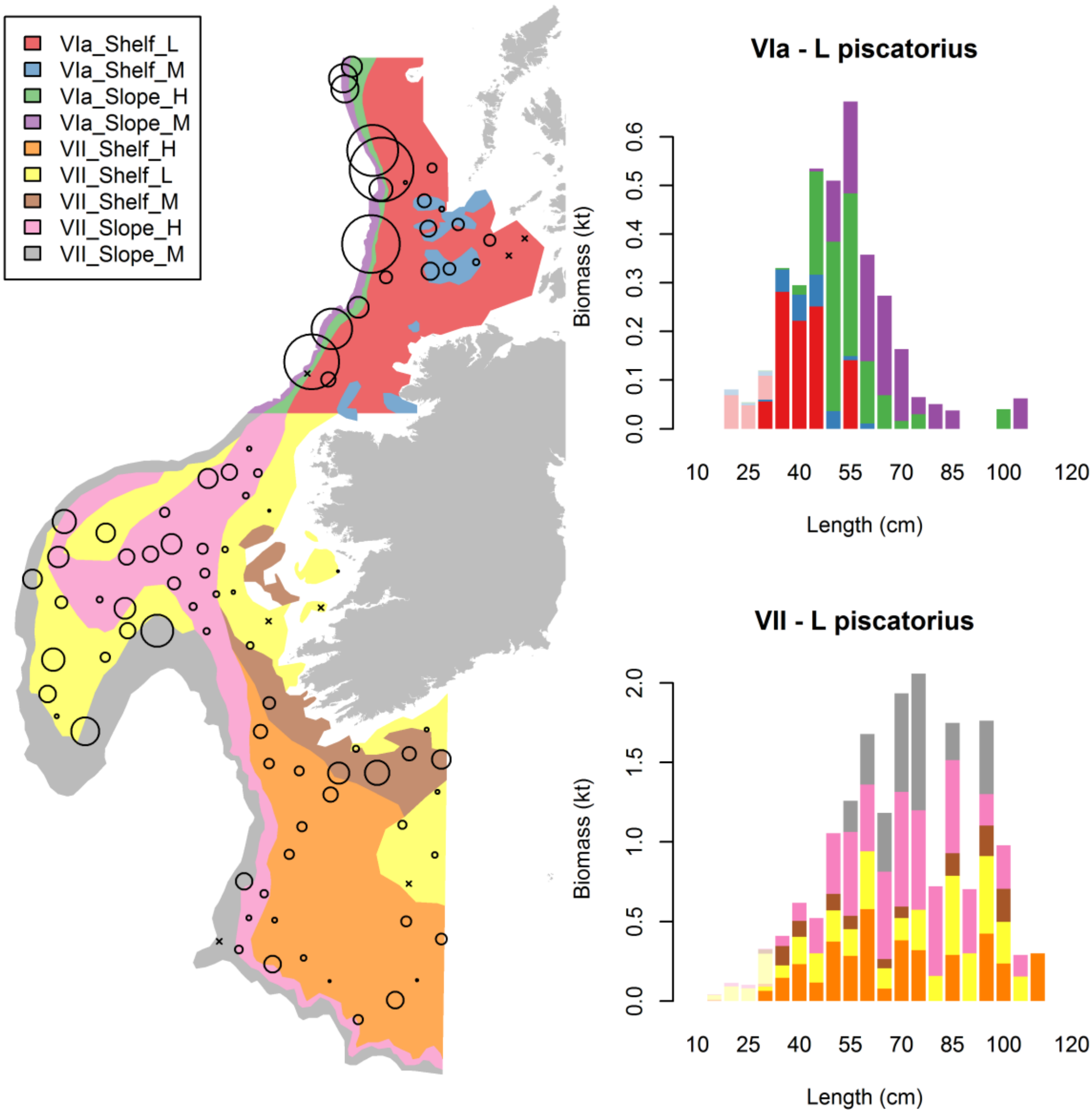

Figure 5: ***Bubble size is proportional to the biomass of*** **L. piscatorius** ***per swept area at each sampling station (left; >500g fish only) and biomass per size class and stratum (right; fish <500g in pale shades).***

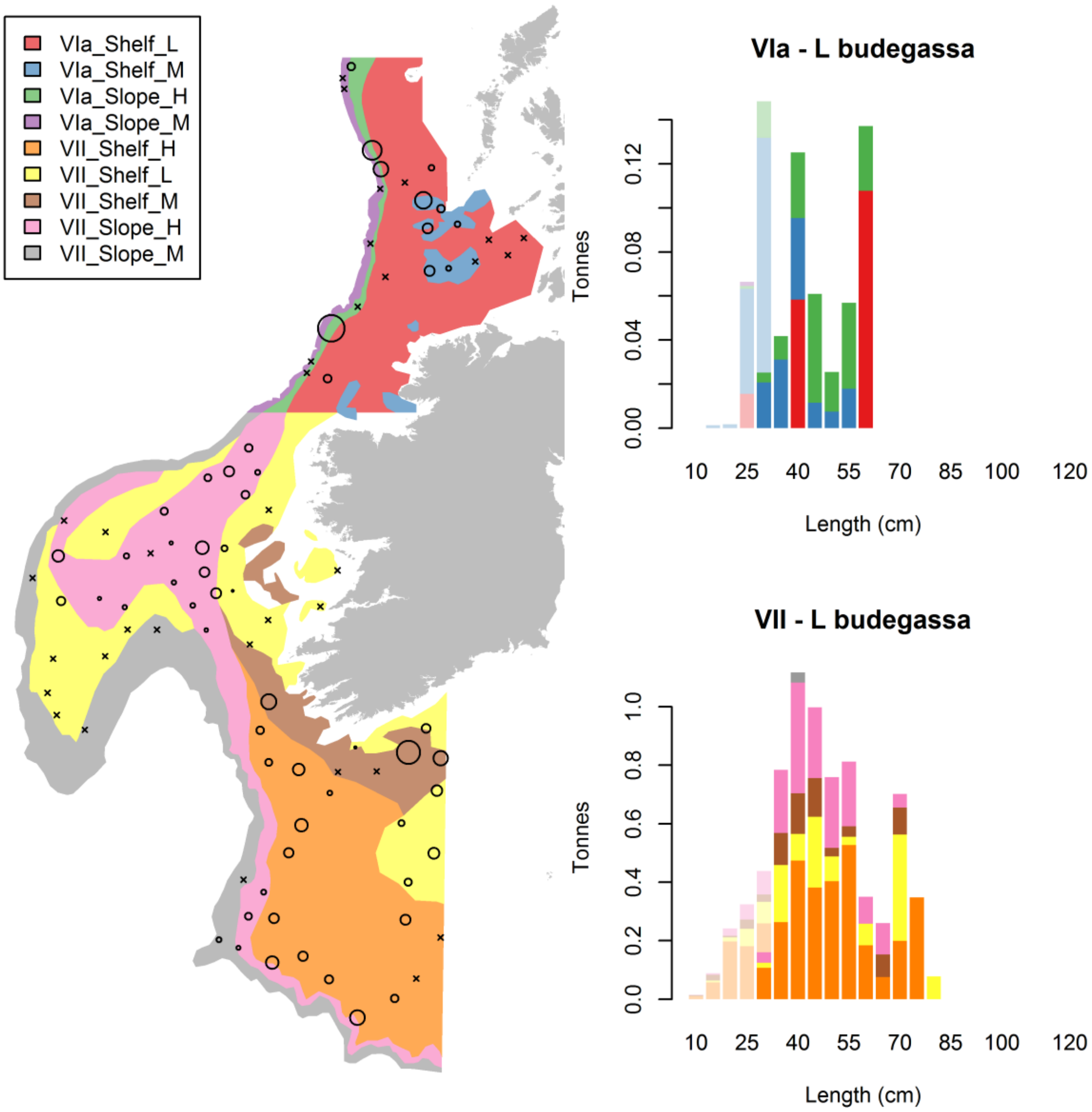

Figure 6: *Bubble size is proportional to the biomass of* L. budegassa *per swept area at each sampling station (left; >500g fish only) and biomass per size class and stratum (right; fish <500g in pale shades).*

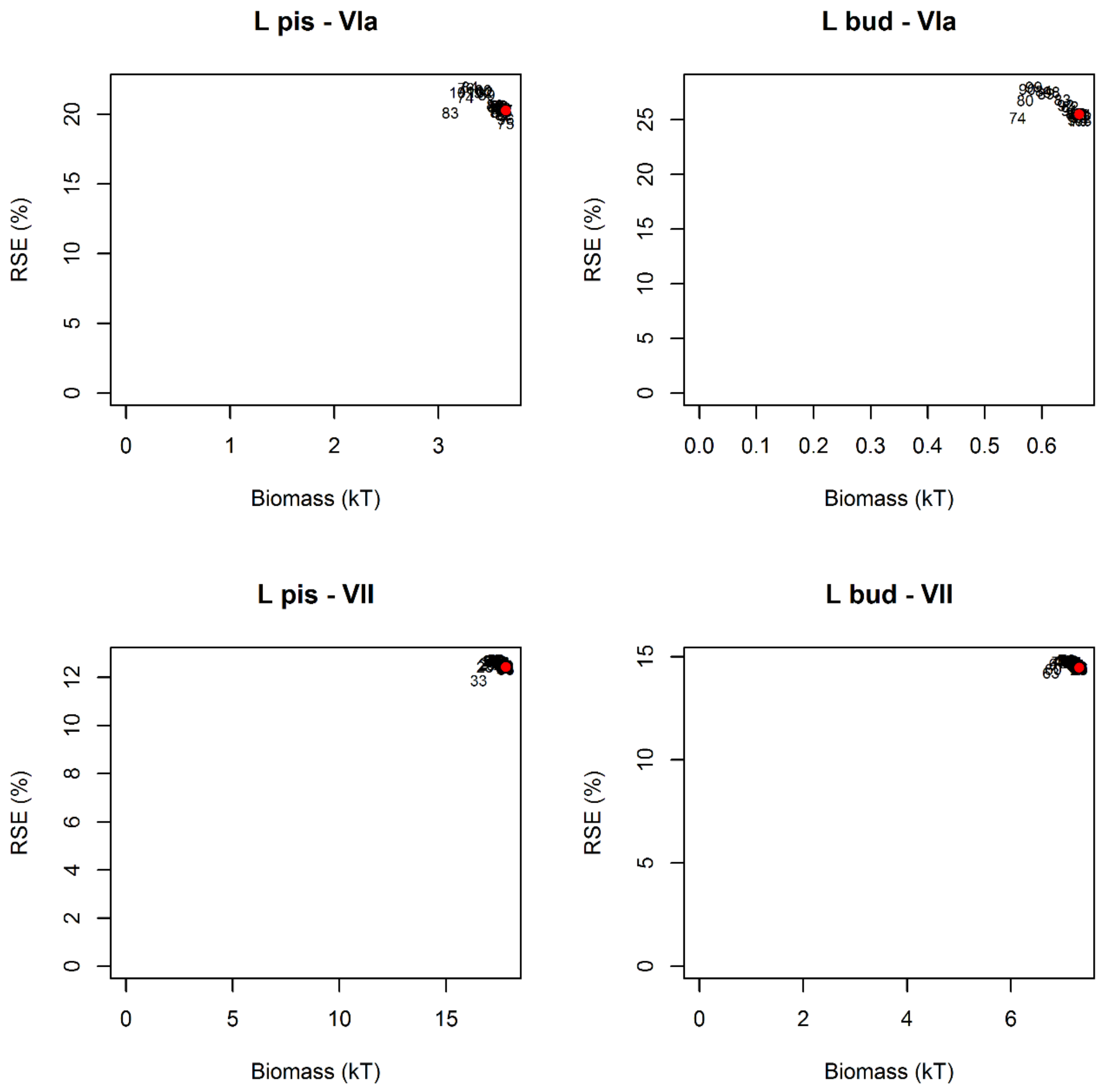

Figure 7: Influence that each tow had on the final biomass estimate. *Estimates were obtained by sequentially removing each of the tows from the analysis. The red dot indicates the final estimate (with all the valid tows included). For* **L. piscatorius** *in subareas VIa station 123 was most influential while in subarea VII station 28 was most influential; for* **L. budegassa** *in subarea VIa, stations 107 and 108 were particularly influential (without either of these stations the biomass estimate would have been considerably lower). For* **L. budegassa** *in subarea VII, station 54 and 33 were most influential.*

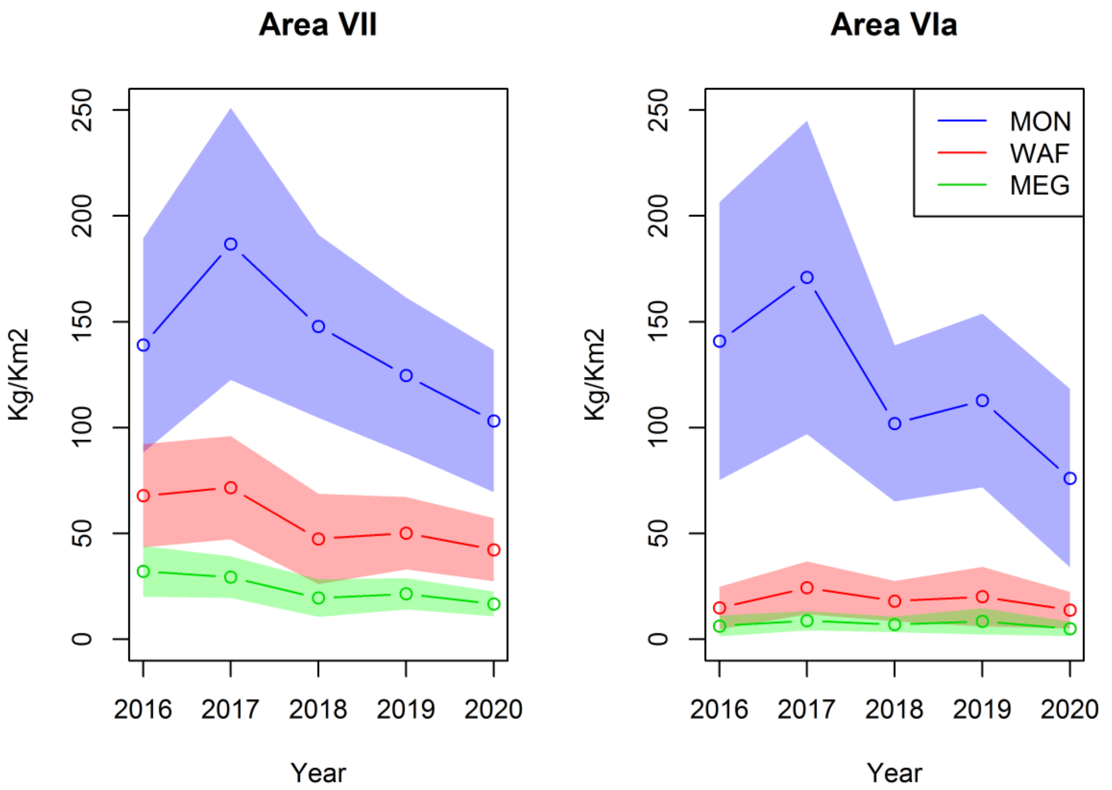

Figure 8: ***Trends in catch weights per swept area for white anglerfish (MON); black anglerfish (WAF) and megrim (MEG).***

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Appendix 1: List of survey staff in alphabetical order

First Name	Surname	Organisation	Role	Dates
Mikel	**Aristegui-Ezquibela**	Marine Institute	Scientist In Charge	6 - 8/3/2020
Sarah	**Ayres**	Smart Seaschool	Wetlab Scientist	6 - 18/3/2020
Leigh	**Barnwall**	NUIG	Wetlab Scientist	23/2 - 6/2/2020
Karl	**Bentley**	Survey Contractor	Wetlab Scientist	23/2 - 6/2/2020
Rachel	**Breslin**	Survey Contractor	Wetlab Scientist	23/2 - 6/2/2020
Robert	**Bunn**	Marine Institute	Deckmaster	23/2 - 6/2/2020
Rosemarie	**Butler**	Marine Institute	Wetlab Scientist	12 - 21/4/2020
Paul	**Coleman**	Marine Institute	Scientist In Charge	23/2 - 6/2/2020
John	**Cunningham**	Survey Contractor	Gear Technologist	12 - 21/4/2020
Liam	**Darcy**	Smart Seaschool (Exeter Uni.)	Wetlab Scientist	23/2 - 6/2/2020
Ger	**Dougal**	Survey Contractor	Gear Technologist	6 - 18/3/2020
John	**Enright**	Marine Institute	Wetlab Scientist	23/2 - 6/2/2020
Dermot	**Fee**	Marine Institute	Wetlab Scientist	23/2 - 6/2/2020
Ross	**Fitzgerald**	Marine Institute	Deckmaster	23/2 - 6/2/2020
Bartley	**Hernon**	P&O Maritime	Gear Technologist	23/2 - 6/2/2020
Frankie	**McDaid**	Survey Contractor	Wetlab Scientist	12 - 21/4/2020
Sinead	**O'Brien**	Marine Institute	Scientist In Charge	12 - 21/4/2020
Sinéad	**O'Brien**	Marine Institute	Scientist In Charge	6 - 18/3/2020
Jack	**O'Callaghan**	Smart Seaschool (UCC)	Wetlab Scientist	6 - 18/3/2020
Sean	**O'Connor**	Marine Institute	Deckmaster	6 - 18/3/2020
Sean	**O'Connor**	Marine Institute	Deckmaster	12 - 21/4/2020
Ross	**O'Neill**	Marine Institute	Wetlab Scientist	12 - 21/4/2020
Artur	**Opanowski**	Survey Contractor	Wetlab Scientist	23/2 - 6/2/2020
Michael	**Petroni**	NUIG	Wetlab Scientist	6 - 18/3/2020
John	**Power**	Survey Contractor	Wetlab Scientist	23/2 - 6/2/2020
Tobi	**Rapp**	Marine Institute	Wetlab Scientist	6 - 18/3/2020
Gráinne	**Ryan**	Marine Institute	Deckmaster	6 - 18/3/2020
Gráinne	**Ryan**	Marine Institute	Deckmaster	12 - 21/4/2020
Dave	**Stokes**	Marine Institute	Scientist In Charge	23/2 - 6/2/2020
Sharon	**Sugrue**	Survey Contractor	Wetlab Scientist	6 - 18/3/2020
Katie	**Thomas**	Marine Institute	Wetlab Scientist	6 - 18/3/2020
Dave	**Tully**	Marine Institute	Wetlab Scientist	6 - 18/3/2020
David	**Tully**	Marine Institute	Wetlab Scientist	12 - 21/4/2020
Jonathan	**White**	Marine Institute	Scientist In Charge	6 - 18/3/2020

Appendix 2: Cruise narrative

Date	Number Valid	Number Invalid	Comments	Gear Damage
25/02/2020	0	2	Test Tows	NA
26/02/2020	3	0	Small bag, mixed	NA
27/02/2020	5	0	NA	Lost all sensors except TS about 2/3 way down. Doors intermittent. Burst Hydraulic Pipe @ 1600m warp, Trawl Eye intermittent, still pinging, was in agreement with TS when displaying values.
28/02/2020	4	0	A lot of heavy marks on TEY and TE, storm Jorge on the way so hauled at 31min to process this and argue for another haul en route to shelter.	NA
02/03/2020	4	0	NA	NA
03/03/2020	6	0	Doors narrowed significantly, after 32min, decided to haul, ship came fast, towed over coral, no damage to net.	Came fast after 42 mins - coral. No damage
04/03/2020	6	0	NA	NA
05/03/2020	7	0	Increased warp from 880-1,020m at 15:40	Came fast after 46 mins, no damage
06/03/2020	2	0	NA	NA
07/03/2020	2	0	NA	NA
10/03/2020	4	0	Fishing blind. No Scanmar (video card/ fan issue / data still collected) or Marport sounder (flat battery), may have missed started line by 7 mins due to Sodena issues. | Hauled after 30mins as a lot of fish marks. Hydraulics failed. Net dangling for 40 mins. Count as valid.	NA
11/03/2020	6	0	NA	NA
13/03/2020	6	0	Marport software back up and running, no Marport sensors. Battery reporting 50% but no readings trawl explorer, doors or wings, no Marport sensors. Battery reporting 50% but no readings trawl explorer, doors or wings. Battery going to be charged and software rebooted	NA

14/03/2020	6	0	Bit of difficulty getting door spread sorted. Hauled back for a minute and it sorted itself so continued once settled again on bottom. First 10 minutes NOT settled - Doors , wings, TEY - stable for the rest of the hour, except Trawl sounder which remained erratic, hauled back after 30mins as a lot of fish marks.	NA
15/03/2020	4	0	Planned line laying half way over seafloor cable. Towed second half of the line, cutting short after 32 minutes owing to uneven seafloor	NA
16/03/2020	5	1	Extra station added as Extra 1 to make up numbers for this strata. Went over a bump in the seafloor at around 19:32. Port door angle in correct, out approx. -70 degrees, did not recover. Called at 35 minutes. No net damage apparent, hydraulic pipe to winch blew again on hauling. Bag in water for >3hrs. Still counted as valid. Trawl path crossed seafloor cable, so started early to compensate. Spanish fishing boats crossing path so direction altered to the east. Full hour achieved.	Door fallen over?
13/04/2020	3	0	Hauled back at 40 mins. Getting late and ~700m haul back. Hauled back at 53 minutes as wings spread was giving incorrect feedback. No comments for haul 3.	NA
14/04/2020	4	0	Called it at 30mins as not getting read back correctly at this depth from Marport or Scanmar. No comments for haul 4.	NA
15/04/2020	4	0	Had to travel faster revs up for 3knt as tide. Hard ground, some strange read backs throughout but kept stabilising, hauled back at 46 mins as was a lot of marks and again sudden changes in gradient. Hauled back at 53 mins as sudden change in gradient. Scanmar trawl screen on left wasn’t reading back for about 25mins. Batteries getting charged for everything tonight	NA
16/04/2020	3	1	No comments on hauls 1. Haul 2 was let go as 4-5 ton of mackerel and as IAMS not processing pelagics.	NA

17/04/2020	4	0	Called it at 40 mins as the doors and wings were varying a lot. Very bumpy and hard ground and worried for damage. No comments for haul 4.	NA
18/04/2020	4	0	Called it back at 50 mins as wreck ahead that had previously snagged so being cautious. No comments for haul 4.	NA
19/04/2020	3	1	Had to haul back at 20 mins as pots in the water and short line of 2.8 miles so not enough to redo. No comments for haul 3.	NA
20/04/2020	3	0	Depth variation of 50m! Hauled back at 30mins as a lot of marks so don't want invalid haul as similar marks to the previous mackerel invalid haul. No comments for haul 3.	NA

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	All
CTD transects	Main CTD	Oceanography Marine Institute	One per leg if possible
Grab samples	Sub sample from Day grab	INFOMAR Marine Institute	Opportunistic
Cephalopods	Complete biological sampling	Ryan Institute NUIG	All
Elasmobranch Tagging	Tag & record elasmobranchs	FEAS Marine Institute	Opportunistic
Halargyreus johnsonnii	Frozen for DNA analysis	Spanish Institute of Oceanography (IEO)	Opportunistic
Hake and Anglerfish	Ethanol for DNA analysis	AZTI Technalia	90 from 6a and 7b-k
Cod	Age, sex, maturity and DNA	Marine Scotland	Opportunistic
Shark specimens	Shark species (0.5-1m)	UCD	Opportunistic
Skate specimens	DNA samples and specimens	QUB	Opportunistic

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
3	VII_Shelf_L	-10.921	53.541	133.0	2.4	96.4	29.8	3	0	1.2	0.0	0.4	0.0	32.7	0.0
4	VII_Slope_H	-11.299	53.690	231.5	3.3	100.9	30.7	6	14	8.1	9.4	1.7	2.8	68.5	123.9
5	VII_Slope_H	-11.104	53.913	200.0	3.1	100.7	30.7	8	13	9.6	5.4	2.8	1.2	101.3	87.4
6	VII_Slope_H	-11.246	54.151	306.0	3.2	104.6	31.2	2	7	3.5	7.6	0.9	2.5	32.2	89.7
7	VII_Slope_H	-11.570	53.920	318.5	3.2	104.7	31.6	12	10	35.7	14.0	10.4	4.5	372.2	162.2
8	VII_Slope_H	-11.919	53.858	345.5	3.3	104.7	31.6	20	7	60.8	7.2	16.0	2.2	575.2	87.0
9	DeepArea5	-12.899	54.127	1516.0	2.0	117.4	34.8	0	0	0.0	0.0	NA	NA	NA	NA
10	DeepArea5	-12.784	54.084	1272.0	2.6	113.8	33.2	0	0	0.0	0.0	NA	NA	NA	NA
11	DeepArea5	-12.865	53.989	767.0	3.4	108.8	31.8	10	0	66.4	0.0	NA	NA	NA	NA
12	VII_Slope_H	-12.632	53.526	306.5	3.1	106	31.2	5	4	13.7	8.6	4.0	2.4	142.6	84.8
13	VII_Slope_H	-12.517	53.213	361.0	3.1	108.2	32.3	13	2	66.0	2.4	17.0	0.6	614.7	23.1
14	VII_Slope_H	-12.005	53.166	219.5	1.7	101.8	30.4	3	12	10.3	14.7	4.9	7.5	176.1	275.9
15	VII_Shelf_L	-11.643	53.162	159.5	2.0	98.9	30.8	6	3	3.8	3.6	1.5	1.6	95.4	76.7
16	VII_Slope_H	-11.971	52.928	210.5	3.1	103.6	31.1	7	11	13.5	15.0	3.8	4.4	137.1	168.8
17	VII_Slope_H	-12.476	52.826	409.5	3.1	108.9	32.5	9	1	24.7	3.7	6.6	0.9	239.8	32.8
18	VII_Slope_H	-12.856	53.114	359.5	3.3	109.2	32.2	7	0	40.5	0.0	10.5	0.0	375.2	0.0
19	VII_Slope_H	-13.247	53.085	249.0	3.3	105.9	31.2	19	3	42.9	5.4	10.3	1.4	379.1	49.0
20	VII_Shelf_L	-13.593	53.323	169.0	2.4	97	30.9	21	0	55.1	0.0	15.1	0.0	673.2	0.0
21	VII_Slope_H	-14.273	53.437	349.0	2.3	107.2	30.9	11	0	73.9	0.0	23.4	0.0	843.5	0.0
22	VII_Slope_H	-14.367	53.084	241.0	3.5	103.1	30.3	21	8	79.1	26.5	18.0	6.0	648.7	214.2
23	VII_Slope_M	-14.790	52.870	648.5	2.4	111.2	31.2	3	0	10.3	0.0	15.5	0.0	455.0	0.0
24	VII_Shelf_L	-14.320	52.640	351.5	2.4	108.1	33.4	3	2	18.2	12.8	6.3	3.2	264.1	135.1
25	VII_Shelf_L	-14.451	52.074	352.0	3.1	108.9	33.4	10	0	87.6	0.0	21.5	0.0	903.5	0.0
26	VII_Shelf_L	-14.541	51.738	414.0	2.8	103.9	31.7	6	0	41.9	0.0	12.1	0.0	510.6	0.0
27	VII_Shelf_L	-14.391	51.519	449.0	3.1	111.5	32.3	1	0	2.8	0.0	0.9	0.0	36.4	0.0
28	VII_Slope_M	-13.931	51.373	541.0	2.1	113.8	33.2	3	0	20.4	0.0	33.2	0.0	977.3	0.0

29	VII_Shelf_L	-13.600	52.100	446.5	3.2	112.8	32.9	3	0	16.0	0.0	3.9	0.0	164.2	0.0
30	VII_Shelf_L	-13.233	52.361	510.5	3.3	119	34.4	7	0	48.5	0.0	10.3	0.0	431.3	0.0
31	VII_Slope_H	-13.688	52.665	286.0	3.2	106.4	32.4	2	2	6.1	2.0	1.6	0.6	58.4	21.3
32	VII_Slope_H	-13.282	52.581	399.0	3.2	109.1	32.2	15	2	74.7	3.7	18.8	1.0	677.1	34.6
33	VII_Slope_M	-12.750	52.361	626.5	3.2	113.2	33.1	9	0	39.5	0.0	43.4	0.0	1276.2	0.0
34	VII_Slope_H	-12.161	52.597	332.0	3.1	104.9	30.7	3	3	8.9	3.5	2.4	1.1	87.4	40.4
35	VII_Slope_H	-11.942	52.357	362.5	3.3	108.8	31.1	4	2	6.3	2.9	1.8	0.7	67.9	26.6
36	VII_Shelf_L	-11.781	52.718	176.0	2.5	99.1	29.8	4	11	4.8	12.6	1.7	4.6	71.7	201.2
37	VII_Shelf_L	-11.508	52.743	146.0	3.3	93.7	28.9	7	3	3.8	1.6	0.7	0.2	69.0	25.3
38	VII_Shelf_L	-9.794	52.946	90.5	3.2	79	26.4	12	0	2.7	0.0	0.3	0.0	81.1	0.0
39	VII_Shelf_L	-10.075	52.588	89.0	3.0	79.7	26.1	5	0	1.1	0.0	0.0	0.0	36.6	0.0
40	VII_Shelf_L	-10.930	52.456	131.0	3.2	91.5	29.1	4	0	0.5	0.0	0.0	0.0	21.1	0.0
41	VII_Shelf_L	-11.231	52.215	145.0	3.4	93.6	29.7	10	1	10.7	0.2	2.1	0.0	120.9	5.5
42	VII_Shelf_M	-10.921	51.650	166.5	3.4	97.6	30.2	7	7	5.0	10.5	6.4	10.0	104.9	157.7
43	VII_Shelf_H	-10.920	51.053	180.5	1.7	98.7	29.5	3	5	6.3	2.6	4.4	2.3	222.7	147.9
44	VII_Shelf_H	-10.426	50.981	153.5	3.3	96.4	29.7	8	11	8.5	18.0	3.7	6.1	187.8	330.0
45	VII_Shelf_H	-9.918	50.750	121.0	3.2	92.4	28.4	16	3	23.6	4.0	9.4	1.0	504.8	66.0
46	VII_Shelf_M	-9.785	50.958	127.5	3.3	91.9	30.9	4	0	23.1	0.0	19.3	0.0	282.8	0.0
47	VII_Shelf_L	-9.501	51.199	109.0	3.4	86.8	29.0	10	1	8.4	1.9	1.9	0.4	117.9	15.4
48	VII_Shelf_M	-9.151	50.963	123.0	3.1	90.4	30.6	5	0	24.2	0.0	25.0	0.0	366.0	0.0
49	VII_Shelf_M	-8.628	51.151	107.0	3.0	90.2	28.6	6	17	5.6	16.8	8.2	22.9	133.8	388.6
50	VII_Shelf_L	-8.344	51.387	91.0	3.2	80.7	28.0	5	6	3.8	12.9	0.9	3.5	59.3	154.6
51	VII_Shelf_M	-8.104	51.095	107.5	3.2	87.5	30.4	3	10	12.3	6.5	14.9	9.1	217.8	153.3
52	VII_Shelf_L	-8.167	50.775	112.5	3.2	87.9	30.2	3	16	3.1	18.9	0.8	5.0	43.9	236.6
53	VII_Shelf_L	-8.741	50.451	128.5	3.3	94.8	29.4	4	6	10.9	5.9	3.1	1.7	133.2	78.1
54	VII_Shelf_L	-8.216	50.154	131.5	3.2	98.6	31.4	4	12	6.2	24.9	1.5	5.5	69.0	256.9
55	VII_Shelf_L	-8.636	49.872	132.5	3.2	94	30.4	0	10	0.0	8.2	0.0	2.3	0.0	126.0
56	VII_Shelf_H	-8.682	49.501	149.5	3.4	95.9	29.9	4	2	13.6	11.5	4.6	4.6	233.0	231.2
57	VII_Shelf_H	-8.105	49.327	144.0	3.7	92.9	29.2	4	0	16.1	0.0	5.3	0.0	267.7	0.0

58	VII_Shelf_H	-8.504	48.922	128.5	3.4	88.8	29.4	1	2	0.4	0.4	0.3	0.0	15.4	18.6
59	VII_Shelf_H	-8.858	48.726	170.0	3.2	96.5	30.3	4	3	42.2	8.6	12.2	2.6	619.6	138.3
60	VII_Shelf_H	-9.465	48.535	194.5	1.7	98.2	29.6	1	10	8.0	11.3	4.0	9.5	203.0	498.8
61	VII_Shelf_H	-9.935	48.913	174.5	3.3	98.1	29.9	1	8	1.0	7.0	0.4	3.0	18.5	175.4
62	VII_Shelf_H	-10.357	49.142	156.0	3.3	98.4	29.5	2	6	4.4	11.7	1.4	4.0	73.5	214.9
63	VII_Shelf_H	-10.866	49.078	171.5	3.3	96.5	29.4	5	32	38.3	22.1	12.2	7.0	636.1	539.0
64	VII_Slope_H	-11.415	49.225	433.0	3.3	107.6	31.6	1	4	14.0	3.3	2.9	0.8	101.9	35.4
65	VII_Slope_M	-11.737	49.305	911.5	3.3	116.1	33.8	0	1	0.0	1.1	0.0	1.2	0.0	34.3
66	VII_Slope_H	-11.255	49.535	301.0	1.8	105.2	31.3	1	7	2.3	3.5	1.3	2.2	44.9	96.8
67	VII_Shelf_H	-10.833	49.513	164.0	3.1	99.4	30.1	2	28	3.4	15.0	1.2	4.4	68.0	417.0
68	VII_Slope_H	-11.005	49.775	268.0	3.3	104.1	30.7	2	6	12.1	5.0	2.7	1.2	96.4	54.6
69	VII_Slope_M	-11.333	49.895	620.0	3.3	113.3	32.3	3	0	13.2	0.0	11.9	0.0	349.6	0.0
70	VII_Shelf_H	-10.592	50.162	156.0	3.4	96.3	29.2	5	8	10.3	12.3	3.9	4.1	199.1	238.6
71	VII_Shelf_H	-10.384	50.432	153.5	3.4	96.9	29.3	5	10	12.2	22.9	4.1	7.1	205.8	370.4
73	VII_Shelf_H	-11.062	51.367	189.0	3.2	99.3	29.9	6	8	25.6	8.9	8.0	2.7	408.3	173.7
74	VIa_Shelf_L	-9.953	54.835	111.0	2.8	87.3	28.5	10	1	7.6	3.8	9.1	2.9	386.4	107.8
75	VIa_Slope_H	-10.296	54.891	348.5	3.3	106.1	31.6	0	0	0.0	0.0	0.0	0.0	0.0	0.0
76	VIa_Slope_M	-10.226	55.005	718.0	2.3	108.4	31.8	23	0	92.6	0.0	126.2	0.0	384.3	0.0
77	DeepArea4	-10.168	55.310	1250.5	2.1	115	30.4	0	0	0.0	0.0	NA	NA	NA	NA
78	DeepArea4	-10.008	55.353	701.5	2.9	108.4	30.5	48	0	188.0	0.0	NA	NA	NA	NA
79	DeepArea4	-9.989	55.319	537.0	3.4	109.9	32.8	46	0	135.4	0.0	NA	NA	NA	NA
80	VIa_Slope_H	-9.898	55.332	303.0	3.1	100.8	29.5	31	15	69.1	29.5	69.1	30.3	215.1	94.2
81	VIa_Slope_M	-9.094	56.706	770.0	3.0	114.2	32.6	6	0	19.3	0.0	22.6	0.0	68.7	0.0
82	VIa_Shelf_L	-8.690	56.769	124.5	3.6	89.3	30.7	1	1	0.5	0.3	0.6	0.0	22.8	15.5
83	VIa_Slope_H	-9.080	56.897	313.0	2.8	104.9	30.7	71	7	172.0	7.4	170.3	9.4	532.3	29.3
84	VIa_Slope_H	-9.228	57.087	262.5	3.4	102.8	29.9	66	19	125.0	17.4	109.8	15.7	344.1	62.3
85	VIa_Slope_H	-9.568	57.911	431.0	3.3	107.7	30.9	5	2	20.8	2.6	17.5	2.7	54.4	8.4
86	VIa_Slope_M	-9.711	57.797	842.5	3.2	112.9	32.1	9	1	32.7	0.3	34.0	0.0	103.5	1.9
87	VIa_Slope_M	-9.683	57.691	784.5	3.3	112	31.8	9	0	31.9	0.0	31.3	0.0	95.4	0.0

89	VIa_Shelf_L	-8.255	56.914	133.5	2.2	91.4	28.1	5	1	2.3	1.2	3.8	1.6	185.4	58.3
90	VIa_Shelf_M	-8.384	56.592	174.5	3.3	105.1	31.5	8	27	9.9	18.9	7.6	12.1	38.4	90.8
91	VIa_Shelf_M	-8.097	56.511	156.5	3.4	97.4	29.6	2	5	1.9	3.4	1.2	2.7	8.4	17.0
92	VIa_Shelf_M	-8.319	56.316	151.5	3.1	93.8	28.6	11	5	12.0	4.7	11.3	4.5	58.7	23.6
93	VIa_Shelf_M	-7.830	56.358	187.0	3.2	106.4	31.9	7	10	6.5	3.5	6.1	1.5	29.0	23.2
94	VIa_Shelf_L	-7.314	56.203	97.0	3.4	85.9	26.7	7	0	4.9	0.0	5.6	0.0	224.6	0.0
95	VIa_Shelf_L	-7.003	56.053	87.5	3.2	80.5	26.1	3	0	0.7	0.0	0.0	0.0	59.5	0.0
96	VIa_Shelf_L	-6.744	56.220	68.0	2.5	72.9	24.4	0	0	0.0	0.0	0.0	0.0	0.0	0.0
97	VIa_Shelf_M	-7.537	55.989	134.0	3.2	89.2	27.8	3	2	2.0	0.7	1.9	0.0	11.9	5.5
98	VIa_Shelf_M	-7.972	55.924	171.0	3.3	99.9	30.1	8	19	6.3	7.0	6.3	1.2	32.1	48.0
99	VIa_Shelf_M	-8.284	55.898	173.0	3.4	97.1	29.5	16	31	14.9	12.8	12.9	4.6	68.6	79.4
101	VIa_Slope_M	-9.256	56.166	670.5	3.0	109.8	31.2	42	0	123.2	0.0	139.4	0.0	424.3	0.0
102	VIa_Shelf_L	-9.009	55.838	138.5	1.6	93.1	29.1	2	0	4.0	0.0	6.5	0.0	241.9	0.0
103	VIa_Slope_H	-9.463	55.543	272.5	3.3	103.7	30.5	10	0	17.9	0.0	18.5	0.0	57.7	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 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/km2 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.