Cruise report
Irish Beam trawl Ecosystem Survey 2018

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Cláir Chistí Eorpacha Struchtúrtha agus Infheistíochta na hÉireann 2014–2020
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Contents

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Introduction

The third annual Irish Beam trawl Ecosystem (IBES) took place from 9-19th March 2018 on *RV Celtic Explorer* in the western Celtic sea.

The main objective of IBES is to extend the geographic range of the CEFAS Q1 South-west Ecosystem Survey (Q1SWECOS), with the purpose of providing a swept-area biomass estimate for anglerfish (*Lophius piscatorius* and *L. budegassa*) in the Celtic Sea (ICES area VII).

Secondary objectives are to collect data on the distribution and relative abundance of commercially exploited species as well as invertebrates and by-catch species, particularly vulnerable and indicator species. The survey also collects maturity and other biological information for commercial fish species in the western Celtic Sea.

The IBES survey uses the same gear, methods and stratification as the Q1SWECOS.

The IBES survey is formally coordinated by the ICES Working Group on Beam Trawl Surveys

Methods

Stratification

An ecosystem-based spatial stratification for the Celtic Sea and western Channel was developed by WGMSFDEMO (2015). These strata are used by IBES as well as Q1SWECOS which covers the area as far west as stratum G (Figure 1). The IBES covers strata Ia, Ib, IV and A as well as stratum G (to allow a comparison between the IBES and Q1SWECOS).

Station selection

Each stratum is divided into 15 hexagons. Random hexagons are selected sequentially in each stratum. Inside each hexagon a random station position is then selected. The sequence in which the station is selected will be considered the priority of the station; so if the target number of stations in a stratum was 5, then only the first 5 randomly selected stations would be sampled. If, during the survey, it becomes clear that the targets will not be met (e.g. due to bad weather) then the stations with the highest sequence numbers will be dropped first. For example in a stratum with 5 stations, only the first 4 will be sampled (where feasible).

The target number of stations in each of the strata is given in Table 1. A tow track was picked to go through the randomly selected points. Where it was impossible to do so (e.g. underwater cables or other obstacles, unsuitable bottom, etc.) it was attempted to find a tow track that came within 1nm of the selected point. The target number of stations in each stratum was chosen to be proportional to the stratum area.

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

Fishing operations

Two steel 4m beam trawls are towed directly from the warps off the stern of the vessel. The beam trawls are similar to those used by the fishing industry and identical to those used by the CEFAS Q1

South-west Ecosystem Survey (Q1SWECOS). The trawls are fitted with a chain mat and single flip-up rope and 80mm mesh size in the cod-end. The starboard trawl was fitted with a 40mm cod-end liner. Further gear specifications are given in the 2016 cruise report.

The gear was trawled at 4kn over a distance of 2nm (approx. 30min). The warp to depth ratio was 3/1. On very soft or hard ground the warp may be shortened a bit to make the gear lighter on the bottom. No trawl sensors are used; the fishing master judges from the speed of the vessel when the gear is on the bottom.

The gear was inspected on daily basis by suspending it from the A-frame. The gear was checked for any missing linker chains, worn fly meshes (which tie the net to the fishing line), the shape (too slack or tight) of the chain mat, footrope, fishing line and flip-up as well as any other damage.

Fishing operations took place 24 hours per day.

Wetlab protocol

The catches from the (starboard) trawl with the 40mm liner are sorted first. All fish and invertebrate species are sorted and weighed. All fish and squid species as well as *Nephrops* and *Cancer pagurus* are measured and biological data are collected for the species listed in the table below. The catches from the (port) trawl without the liner are treated in the same way except for the invertebrate species, which are only weighed if they do not occur in the catches from the first trawl.

	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	300-349 / 350-399	yes	yes	1pcm	**yes**	**yes**	**yes**	**yes**	**yes**
	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	**yes**
	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
Ot	NEP	U	-	yes	nemesys	nemesys	nemesys	nemesys		no	no
	All other demersal fish species			yes	Yes	none	no	no	no	no	no

All pelagic fish species and squid	yes No length samples 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
Litter	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 workstaton 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
**	Only determine the maturity of female elasmobranchs if they are already dead, otherwise record as stage 9.

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 was hauled back. Tide and wind direction and speed, barometric pressure, heave, pitch and roll were recorded at the mid-point in the tow. Bottom depth and GPS position are also recorded in a SQL database at intervals of approximately 1 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 a central SQL database. The CEFAS software FSS (Fishing Survey System) was used to enter station data and import catch data.

Estimation

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

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

v_i is the swept area of tow i in stratum s.
I_s is the number of tows in stratum s.
A_s is the surface area of stratum s.

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

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

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.

Because this estimate is based on the assumption that catchability is 100%, it can be treated as a lower bound of the actual abundance.

Changes in gear, protocols or estimation

No changes since the previous survey.

Results

Cruise narrative

A total of 42 valid tows were completed (out of a target of 58). There were six invalid hauls but no gear damage. The weather was mostly good but there were nearly 2 days of weather downtime.

Cruise narrative

Date	Comments
Friday 09/03/18	Scientific crew joined for 17:00 with the vessel sailing at 22:00.
Saturday 10/03/18	Arrived on station at 09:00 and the beams were swung out. The first tow started at 09:30. It was decided to head south and carry out stations in strata 1a and 1b. Five valid tows carried out.
Sunday 11/03/2018	Eight valid tows were carried out. Weather good.
Monday 12/03/2018	Three valid tows were carried out. Fifteen hours were lost due to poor weather, winds were gusting up to 50 knots. As a result of the lost time, and a poor weather forecast for Wednesday it was decided to drop three stations in the south of 1b and six stations in the south of area G. It was hoped that CEFAS might be in a position to pick up some of these stations, particularly those in G, during their beam trawl survey.
Tuesday 13/03/2018	Weather much improved. Ten valid hauls carried out. In order to facilitate the preparation for the next survey it was decided to return to Galway on the morning tide on the 19th, rather than the evening tide as originally planned. This led to the loss of three to four stations. Due to a poor weather forecast it was decided to fish northwards with a plan for the vessel to shelter in Bantry Bay.
Wednesday 14/03/2018	One valid station carried out. Into Bantry Bay for 04:00.
Thursday 15/03/2018	Back on station at 09:30. Nnea logger not working so BridgeQC not logging the tow. Nmea logger was fixed before the next tow. Wind levels have dropped but there is still a large southerly swell. 8 stations carried out.
Friday 16/03/2018	The swell continuing to drop and weather improving. Six stations carried out.
Saturday 17/03/2018	Seven stations were carried out. The final tow was completed at 16:15. Due to time availability it was decided to carry out a CTD transect from the coast to the 200m contour line, with stations spaced six miles apart. Grab samples were also collected for seabed sediment analysis. Eight CTD stations were carried out and successful grad samples were collected at seven of these.
Sunday 18/03/2018	Final CTD and grab samples were collected at 03:30, at which stage the vessel turned for home. The weather disimproved during the day and progress was slow.
Monday 19/03/2018	Arrived back in Galway at 06:00. The vessel was demobbed and all scientists departed the vessel by 11:00.

Downtime, damage

Weather downtime	**15hrs on 12th March and 29hrs on 15th March**
Technical downtime	None
Gear damage	None

Summary statistics

Target and achieved number of stations per stratum

Stratum name	Target	Achieved	Area (km^2)	Swept area (km^2)	Swept area (%)
StratumA	9	5	6,832	0.1474	0.0022%
Stratum_Ia	2	2	2,502	0.0600	0.0024%
Stratum_Ib	16	13	20,065	0.3928	0.0020%
Stratum_IV	17	8	17,970	0.2403	0.0013%
StratumG	14	14	17,309	0.4109	0.0024%
Total	58	42	64,678	1.2514	0.0019%

Catch rates of target species

Species	CatchNum	CatchNumHr	CatchWtKgHr
Megrim	3459	163.8	10.40
Black-bellied angler	593	28.1	12.98
Four-spot megrim	465	22.0	0.98
White-bellied angler	97	4.6	4.46

Catch rates of the top 10 species (by number); 57 species of fish were caught.

Species	CatchNum	CatchNumHr	CatchWtKgHr
Megrim	3,459	163.8	10.4
Black-bellied Angler	593	28.1	13.0
Four-spot Megrim	465	22.0	1.0
Hake	352	16.7	5.3
Lemon Sole	170	8.1	1.0
Plaice	127	6.0	0.6
White-bellied Angler	97	4.6	4.5
Sole	97	4.6	0.6
Dab	79	3.7	0.1
Cuckoo Ray	49	2.3	0.5

Catch weights of the top 10 invertebrates (by occurrence); 141 species and genera of invertebrates were caught.

Species	Catch Weight (Kg)	Number of Hauls
ACTINAUGE RICHARDI	88.8	42
HYALINOECIA TUBICOLA	1.3	40
MACROPIPUS TUBERCULATUS	1.9	37
STICHASTRELLA ROSEA	5.8	37
HYDROIDA (order)	0.4	35
LUIDIA SARSI	5.9	30
PORANIA PULVILLUS	5.6	28
LUIDIA CILIARIS	32.8	26
ELEDONE CIRRHOSA	40.9	26
OPHIURA OPHIURA	1.7	25

Number of biological samples taken.

	Species[1]	Sex[2]	Sex/Mat	Age
Aged demersal spedies	COD	U	1	1
	HAD	U	51	51
	LIN	U	4	4
	MEG	F/M	990	990
	MON	U	106	106
	WAF	U	445	445
	PLE	F/M	63	63
	POK	U	1	1
	POL	U	3	3
	SOL	F/M	64	64
	WHG	U	53	53
Biological teleo	BLL	F/M	5	
	HKE	U	294	
	JOD	U	10	
	LBI	F/M	173	
	LEM	F/M	91	
	TUR	F/M	4	
	WIT	F/M	193	
Bio elasmo	BLR	F/M	0	
	CUR	F/M	29	
	DGS	F/M	0	
	DFL	F/M	11	
	DII	F/M	0	
	SDR	F/M	29	
	THR	F/M	9	

Figures

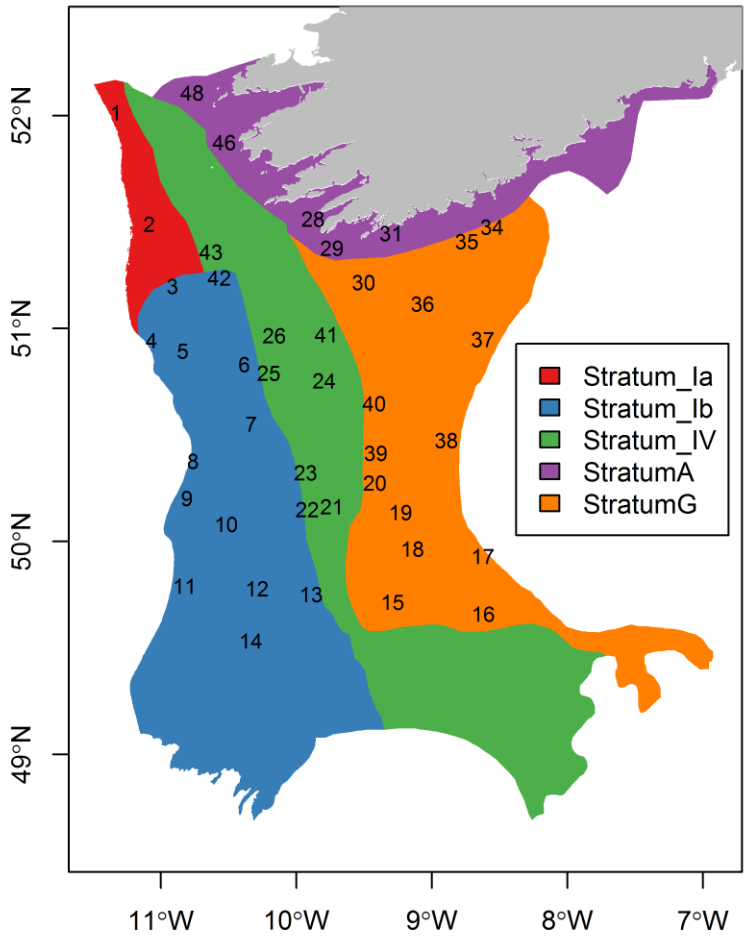

Figure 1. Valid tow positions, the numbers refer to the haul number.

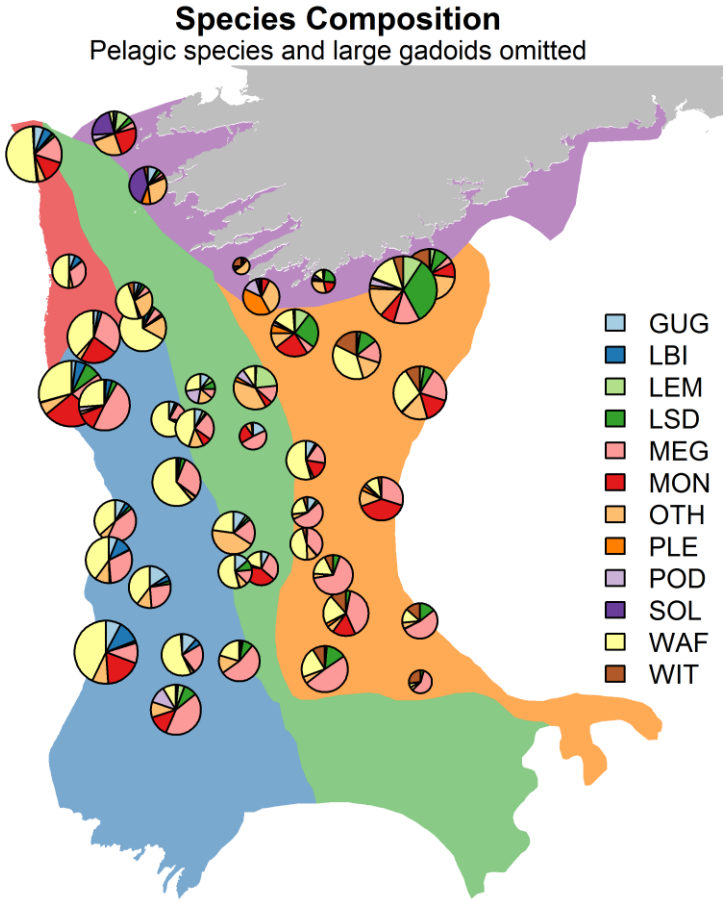

Figure 2. Fish species composition of the catches. The size of the pies is proportional to the catch weight per km^2 swept area. Pelagic species and gadoids were removed.

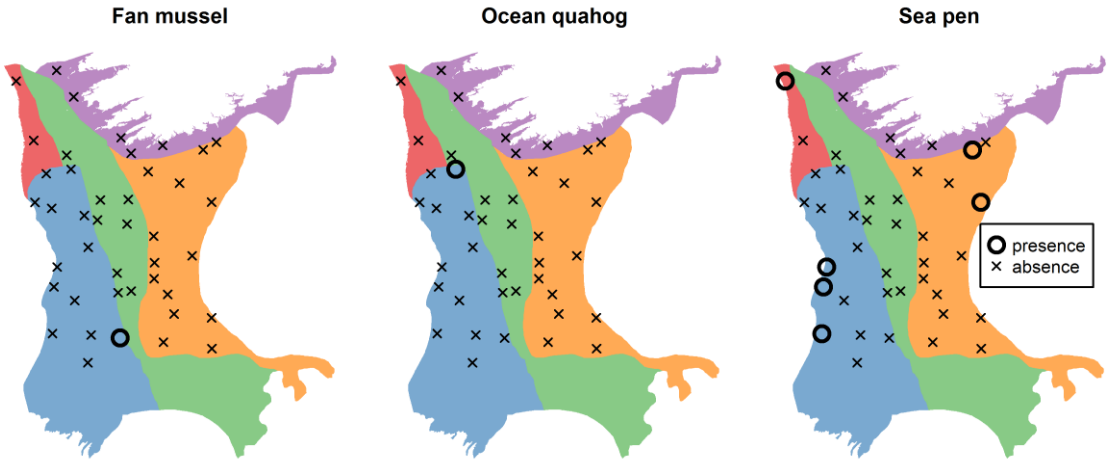

Figure 3. Presence/absence of vulnerable and sentinel species.

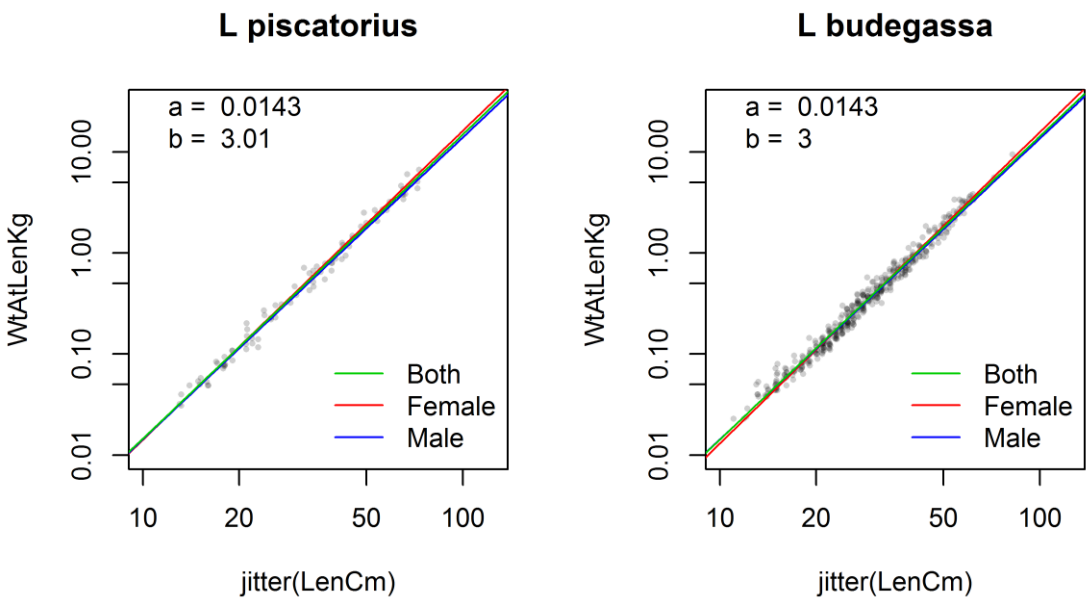

Figure 4. Length-weight parameters for L. piscatorius *and* L. budegassa.

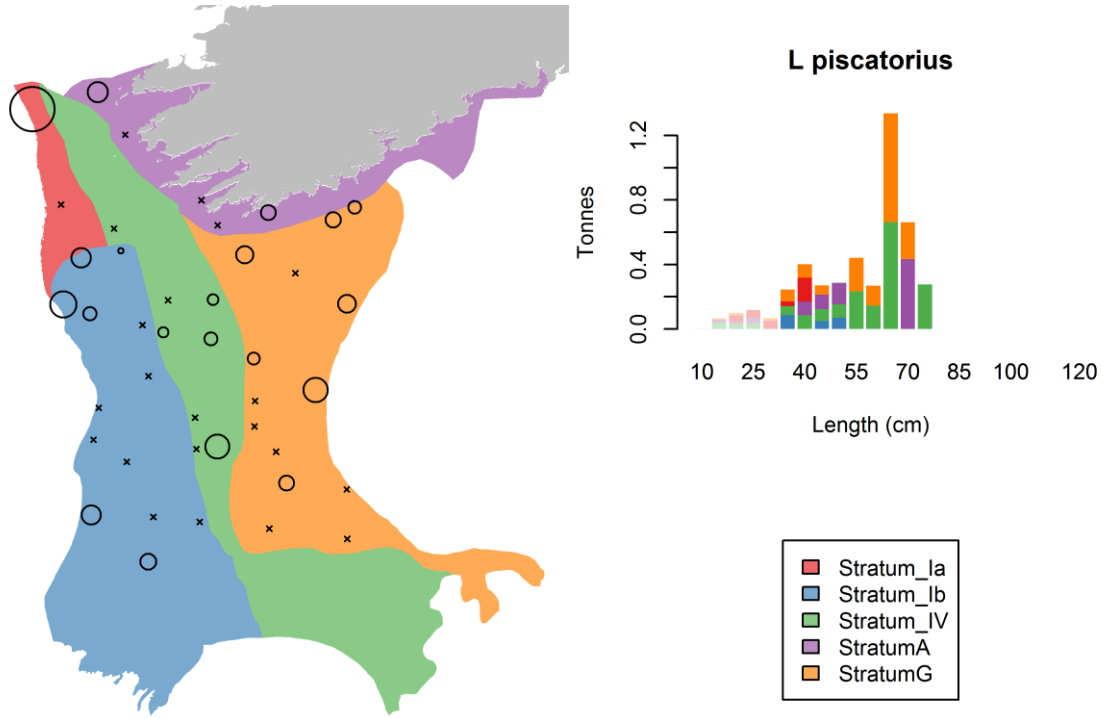

Figure5. Bubble size is proportional to the biomass of L. piscatorius *per swept area at each sampling station (left; >500g fish only) and biomass per size class and stratum (right; fish <500g in pale shades).*

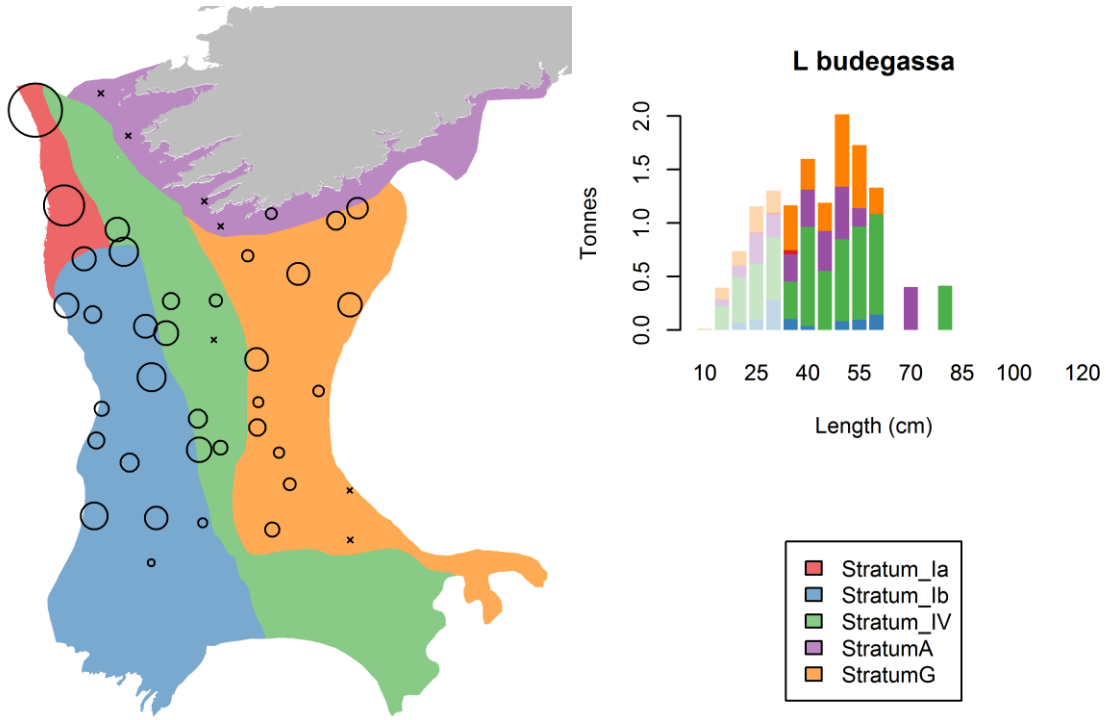

Figure 6. Bubble size is proportional to the biomass of L. budegassa *per swept area at each sampling station (left; >500g fish only) and biomass per size class and stratum (right; fish <500g in pale shades).*

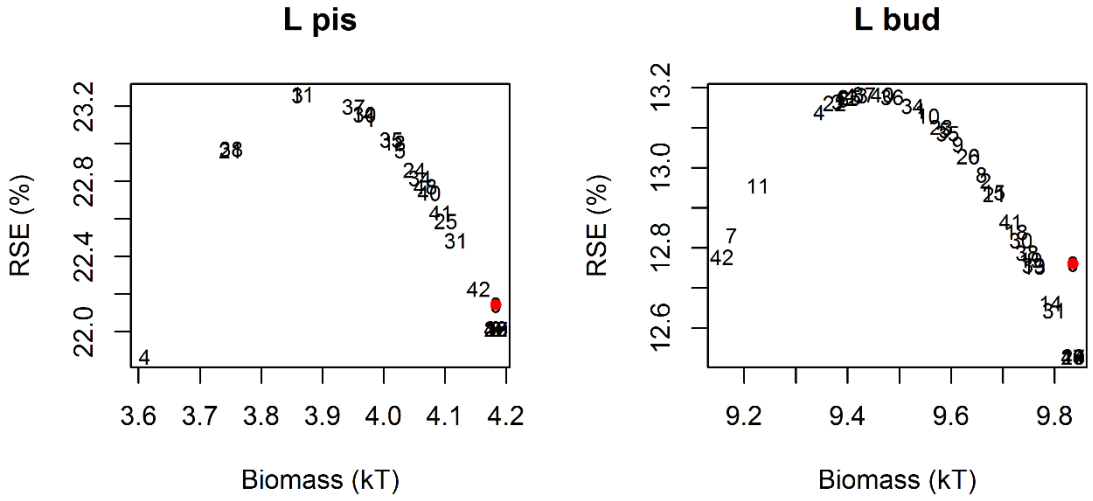

Figure 7. Influence that each tow had on the final biomass estimate (excluding fish <500g). Estimates were obtained by sequentially removing each of the tows from the analysis.

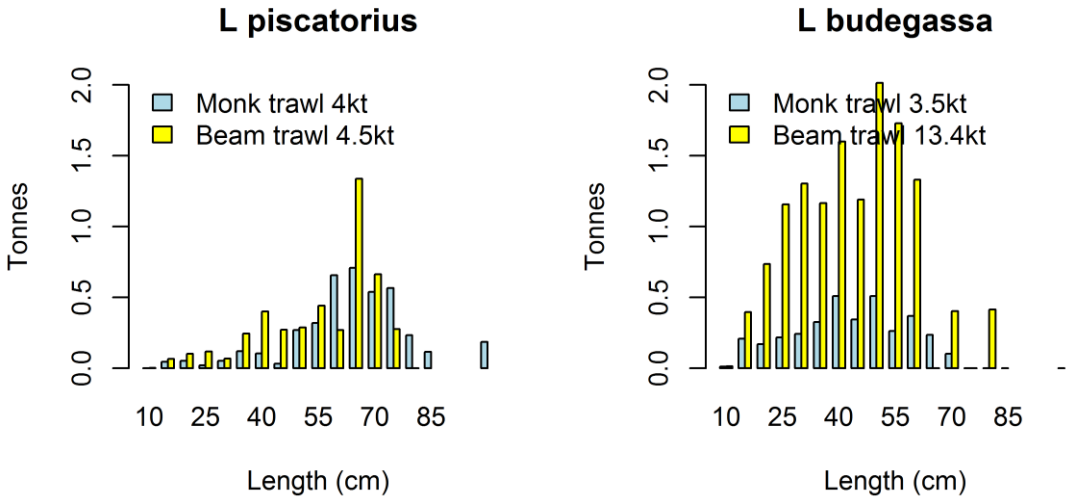

Figure 8. Comparison between the biomass estimates-at-length of the beam trawl and Irish Anglerfish and Megrim Survey (IAMS) 2018 in the area where the two overlapped. The IAMS survey took place from 20th February to 9th March and used a commercial anglerfish trawl.

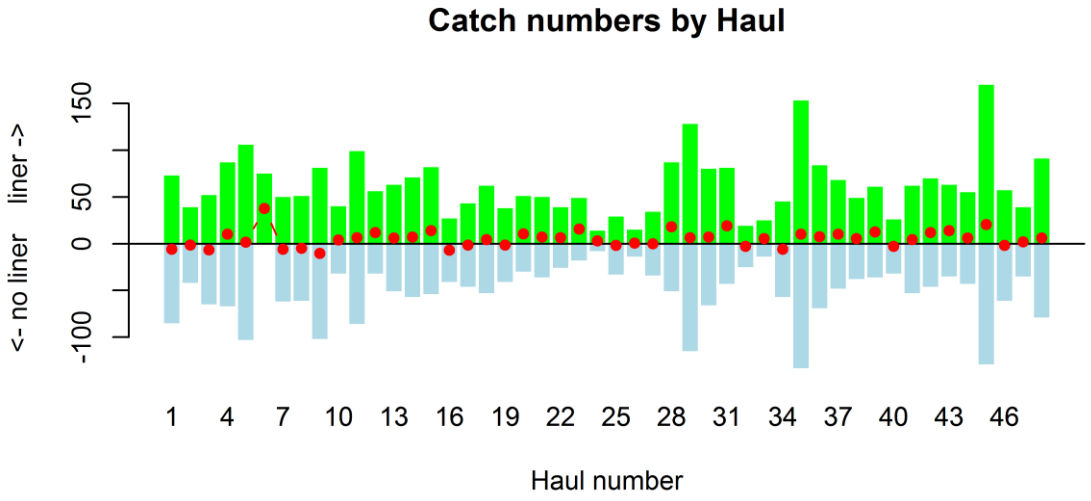

Figure 9a. Comparison between the catch numbers in the trawl with the liner (green) and without the liner (blue). The red dots signify the difference between the two trawls.

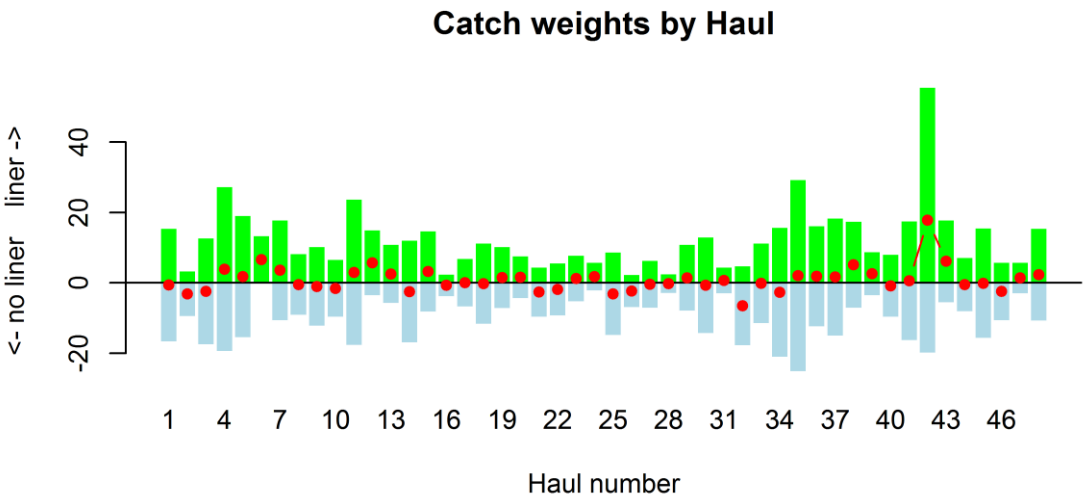

Figure 9b. Comparison between the catch weights in the trawl with the liner (green) and without the liner (blue). The red dots signify the difference between the two trawls.

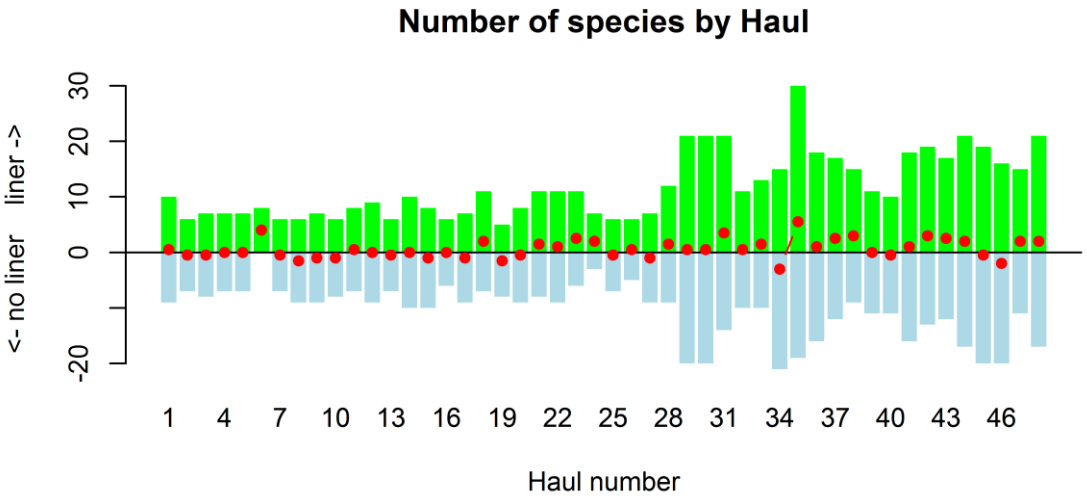

Figure 9c. Comparison between number of fish species in the trawl with the liner (green) and without the liner (blue). The red dots signify the difference between the two trawls.

References

WGMSFDemo 2015. Interim Report of the Working Group to Demonstrate a Celtic Seas wide approach to the application of fisheries related science to the implementation of the Marine Strategy Framework Directive (WGMSFDemo), 28-30 April 2015, Dublin, Ireland. ICES CM 2015\SSGIEA:12. 32 pp.

Appendix 1: List of survey staff

Name	Organisation	Role
Brendan O'Hea	Marine Institute	Scientist In Charge
Gráinne Ní Chonchuir	Marine Institute	Scientist In Charge
Macdara Ó Cuaig	Marine Institute	Wetlab Deckmaster
Claire Moore	Marine Institute	Wetlab Deckmaster
Ian Murphy	Marine Institute	Wetlab Assistant
William Hunt	Survey Contractor	Wetlab Assistant
Darren Craig	Survey Contractor	Wetlab Assistant
Alina Wieczorek	NUIG	Wetlab Assistant
Sharon Sugrue	Marine Institute	Wetlab Assistant
Leigh Barnwall	NUIG	Wetlab Assistant
Ghassen Halouani	GMIT	Wetlab Assistant
Paula Silvar	GMIT	Wetlab Assistant
Bartley Hernon	P&O	Master Fisherman

Appendix 2: Additional sampling

Request	Details	Requested by	Target	Number collected
Nephrops Sampling	Nemesis catch sampling	Jennifer Doyle (MI)	All	All
Litter	Litter log per tow	OSPAR	All	All
Genetics Mon	96 fish from 7bcjk	AZTI	96	83
MON otoliths	All MON from 7gjk	Hans Gerritsen (MI)	All	All
Elasmo Tagging	Tag and record elasmos	Macdara O'Cuaig (MI)	All	All
Genetics WAF/MON	Green boxes in fridge	Edward Farrell (UCD)	50 WAF 50 MON	50 WAF 50 MON

Appendix 3: Summary of station location and catch

Note: Valid stations only

Haul	Stratum	Lon DegW	Lat DegN	Depth mtr	Dist nm	Num Beams	Mon Num	Waf Num	Mon Kg	Waf Kg	Mon $KgKm^{-2}$	Waf $KgKm^{-2}$	Mon Tons	Waf Tons
1	Stratum_Ia	-11.3315	52.0145	184	2.0	2	8	39	4.7	18.1	81.9	117.6	214.2	668.2
2	Stratum_Ia	-11.0855	51.4920	183	2.1	2	0	12	0.0	6.4	0.0	67.3	0.0	243.1
3	Stratum_Ib	-10.9125	51.1995	173	2.0	2	4	21	7.4	12.1	16.1	22.7	340.7	586.6
4	Stratum_Ib	-11.0675	50.9455	179	2.2	2	6	17	14.1	14.5	28.6	24.4	581.5	615.7
5	Stratum_Ib	-10.8380	50.8945	183	2.1	2	5	24	3.5	7.8	7.8	12.3	167.4	394.2
6	Stratum_Ib	-10.3850	50.8315	146	2.0	2	3	25	0.2	9.8	0.0	22.1	9.1	525.8
7	Stratum_Ib	-10.3320	50.5515	155	2.0	2	3	35	0.2	16.4	0.0	32.9	7.5	800.2
8	Stratum_Ib	-10.7615	50.3775	188	2.1	2	0	20	0.0	7.3	0.0	8.8	0.0	341.1
9	Stratum_Ib	-10.8060	50.2030	179	2.1	2	1	42	0.2	9.9	0.0	11.1	12.9	486.0
10	Stratum_Ib	-10.5195	50.0820	145	2.1	2	0	15	0.0	8.0	0.0	13.9	0.0	368.8
11	Stratum_Ib	-10.8265	49.7915	158	1.9	2	9	43	8.4	19.7	15.7	30.3	343.6	850.2
12	Stratum_Ib	-10.2915	49.7795	139	2.0	2	2	14	0.1	11.0	0.0	21.8	6.8	520.3
13	Stratum_Ib	-9.8920	49.7525	130	2.0	2	0	14	0.0	3.9	0.0	3.7	0.0	197.8
14	Stratum_Ib	-10.3365	49.5345	137	2.1	2	1	11	3.9	2.5	10.8	2.1	215.8	128.5
15	StratumG	-9.2925	49.7160	139	1.9	2	0	14	0.0	5.3	0.0	8.9	0.0	239.2
16	StratumG	-8.6215	49.6595	140	2.0	2	0	4	0.0	0.3	0.0	0.0	0.0	15.2
17	StratumG	-8.6255	49.9310	133	1.9	2	1	13	0.1	1.9	0.0	0.0	3.1	79.5
18	StratumG	-9.1440	49.9650	134	2.0	2	1	17	3.9	4.9	9.6	6.3	166.4	211.9
19	StratumG	-9.2335	50.1370	129	1.9	2	0	9	0.0	3.0	0.0	4.7	0.0	132.1
20	StratumG	-9.4210	50.2755	108	2.1	2	1	9	0.1	5.5	0.0	11.7	3.4	239.8
21	Stratum_IV	-9.7380	50.1655	129	1.9	2	2	12	5.4	2.5	24.1	8.4	450.9	237.4
22	Stratum_IV	-9.9205	50.1520	121	2.0	2	0	5	0.0	7.0	0.0	25.6	0.0	518.0

23	Stratum_IV	-9.9320	50.3240	118	2.0	2	0	9	0.0	4.8	0.0	14.1	0.0	343.2
24	Stratum_IV	-9.7955	50.7560	116	2.1	2	1	1	2.0	0.2	7.4	0.0	132.9	16.0
25	Stratum_IV	-10.2050	50.7915	127	2.0	2	6	15	1.3	7.7	4.6	24.0	120.6	596.8
26	Stratum_IV	-10.1645	50.9675	118	2.0	2	0	6	0.0	2.7	0.0	11.3	0.0	226.2
28	StratumA	-9.8775	51.5155	57	2.1	2	1	0	0.2	0.0	0.0	0.0	6.1	0.0
29	StratumA	-9.7380	51.3785	75	2.0	2	5	0	1.1	0.0	0.0	0.0	43.2	0.0
30	StratumG	-9.5035	51.2165	100	2.0	2	4	10	6.0	3.9	12.4	5.8	230.4	159.0
31	StratumA	-9.3015	51.4470	62.3	1.5	2	1	1	1.2	0.8	9.6	5.3	65.3	36.5
34	StratumG	-8.5575	51.4775	88.4	2.0	2	4	15	2.8	8.9	7.2	17.9	130.0	343.9
35	StratumG	-8.7425	51.4090	90.6	1.9	2	5	11	3.6	7.3	9.9	14.0	183.2	293.6
36	StratumG	-9.0690	51.1165	112	2.0	2	0	29	0.0	9.6	0.0	20.2	0.0	444.6
37	StratumG	-8.6250	50.9490	110	2.0	2	2	12	5.1	9.2	13.4	23.3	232.3	418.9
38	StratumG	-8.8950	50.4760	120	2.0	2	3	4	8.6	2.2	24.9	5.1	431.8	108.3
39	StratumG	-9.4145	50.4150	130	2.0	2	0	17	0.0	2.4	0.0	4.4	0.0	116.7
40	StratumG	-9.4260	50.6485	129	2.0	2	1	8	2.8	9.5	6.3	21.3	108.7	376.3
41	Stratum_IV	-9.7790	50.9720	122	2.1	2	1	4	1.2	2.1	5.0	6.7	89.8	154.2
42	Stratum_Ib	-10.5690	51.2385	160	2.0	2	1	15	0.4	16.7	1.4	33.8	27.8	765.3
43	Stratum_IV	-10.6290	51.3605	157	2.0	2	0	18	0.0	7.4	0.0	23.3	0.0	606.7
46	StratumA	-10.5320	51.8750	86	2.1	2	2	0	0.4	0.0	0.0	0.0	15.2	0.0
48	StratumA	-10.7690	52.1075	123	2.2	2	13	3	5.3	0.7	16.8	0.0	193.9	30.2