

Cruise Report ZDLV-10-2018

Skate mesh trial survey



**Alexander Arkhipkin, Ludovic
Goyot, Toni Trevizan, Cian
Derbyshire, Jack Hall**

**Falkland Islands Government
Directorate of Natural Resources
Fisheries Department
Stanley, Falkland Islands**



Participating Scientific Staff

Alexander Arkhipkin	(Introduction, text of the report, biological sampling)
Ludovic Goyot	(Biological sampling, Maps, Skate length frequencies)
Toni Trevizan	(Biological sampling, Bycatch length-frequency graphs)
Cian Derbyshire	(Biological sampling, bycatch analysis)
Jack Hall	(Biological sampling)

Acknowledgements

We thank Captains Jose Antonio Vilar Marcote, Alfonso Garcia Juncal and the crew of the *F/V Petrel* for all of their help.

© Crown Copyright 2018

No part of this publication may be reproduced without prior permission from the Falkland Islands Government Fisheries Department.

For citation purposes this publication should be referenced as follows:

Arkhipkin et al. (2018). Scientific Report, Fisheries Cruise ZDLV-10-2018. Stanley, Fisheries Department, Directorate of Natural Resources, Falkland Islands Government.

Introduction

The Patagonian Large Marine Ecosystem (LME) is a hotspot of skate biodiversity and abundance in the world's oceans. An important feature of this LME is a diverse species radiation of the genus *Bathyraja* with at least eleven species occurring in various habitats from coastal waters (*B. magellanica*) to the shelf and shelf break (*B. brachiurops*, *B. griseocauda*, *B. albomaculata*) and deep continental slope (*B. meridionalis*, *B. papilionifera*). Four species of *Zearaja*, four species of *Amblyraja* and at least three species of *Psammobatis* complete the assemblage of Falkland skates to at least 22 species. Four large abundant skates (*Z. chilensis*, *B. brachiurops*, *B. griseocauda* and *B. albomaculata*) constitute the main target species by commercial fisheries. An annual average catch of between 4 to 5 thousand tonnes is reported within the Falkland Island waters. A majority of these skates are taken by a licensed trawl fishery that is assessed and managed under the policy of a multi-species complex.

Currently, there are no specific gear requirements for the specialized skate fishery in the Falkland Islands. The 110 mm diamond mesh regulation applies to all trawlers regardless of their targeted species. However, skate-licensed trawlers are permitted to use one or several tickler chains in front of their ground rope to 'lift' the skates from the bottom, increasing the effectiveness of their catches.

The relatively small mesh size of the cod-end of the specialized skate fishery in the Falkland Islands raised concerns regarding the high proportion of bycatch in terms of finfish species caught, as well as the unwanted bycatch of small and undersized skates. Elsewhere (for example in the northern Atlantic), the minimum cod-end mesh size in skate fishery is 280 mm diamond mesh¹.

In the beginning of 2018, a skate-licensed fishing company (Fortuna Ltd) approached the Falkland Islands Fisheries Department (FIFD) with a proposal to test a variety of cod-ends comprised of differing mesh sizes as a means to optimise their catches of skate. The present report describes the results obtained during a sea trial research cruise that took place in October 2018 on board the F/V *Petrel*.

¹ <https://archive.nafo.int/open/fc/2017/fcdoc17-01.pdf>

Cruise objectives

1. To assess the impact different cod-end mesh sizes have on the composition and quantities of finfish by-catch caught within the specialized skate fishery.
2. To investigate species composition and skate size distribution by species in the catches of trawls utilising different cod end mesh sizes.
3. To make recommendations on the optimal mesh size to be used in the cod-end of bottom trawls for the specialized skate fishery.

Vessel

The cruise was conducted on the F/V *Petrel* (ZDLV), registered in the Falkland Islands.

Personnel and responsibilities

The following FIFD personnel participated in the cruise:

Alexander Arkhipkin	Chief Scientist
Ludovic Goyot	Trawl survey
Toni Trevizan	Trawl survey
Cian Derbyshire	Trawl survey
Jack Hall	Trawl survey

Cruise plan and key dates

The vessel departed from Stanley at 6 p.m. on October 8, 2018 and proceeded overnight to the first station. Trawling was performed in three areas (Figure 1). Area 1 is in the north of the *Loligo* Box and represented the southernmost part of the skate fishing area, at a depth of around 200 m. It was trawled for three consecutive days: the first day with 300 mm mesh size (4 trawls), the second day with 110 mm (3 trawls) and the third day with 400 mm (3 trawls). All trawls with different cod-ends were fished in the same area, but slightly apart from each other to avoid a possible effect of resource depletion. On October 12, the vessel moved further north to Area 2, which is in the north-eastern part of the Patagonian Shelf edge (220-320 m depths) and situated within the common commercial area for skate (Skate Box). The same sampling protocol was applied, but an additional trawl was performed on the second day (*i.e.* 4 trawls with the 110 mm mesh net). The vessel then moved on October 15 to Area 3, where the same protocol as in Area 2 was applied. This last area is located in the north-western part of FICZ (northwest of Jason Islands) at depths of 220-250 m, and is also sometimes fished by commercial F-licensed trawlers. The cruise was successfully finished on October 18, 2018. Despite two days of rough weather with strong winds (30-50 knots), the vessel managed to fish with no day lost.

Trawling

A regular commercial bottom trawl net (120 m horizontal opening) equipped with three entwined tickler chains in front of the ground rope and two Oval-Foil doors was used for the survey.

Three interchangeable cod-ends were used:

1. Standard 110 mm diamond mesh
2. Special 300 mm diamond mesh (net space clearance 275 mm)
3. Special 400 mm diamond mesh (net space clearance 375 mm)
- 4.

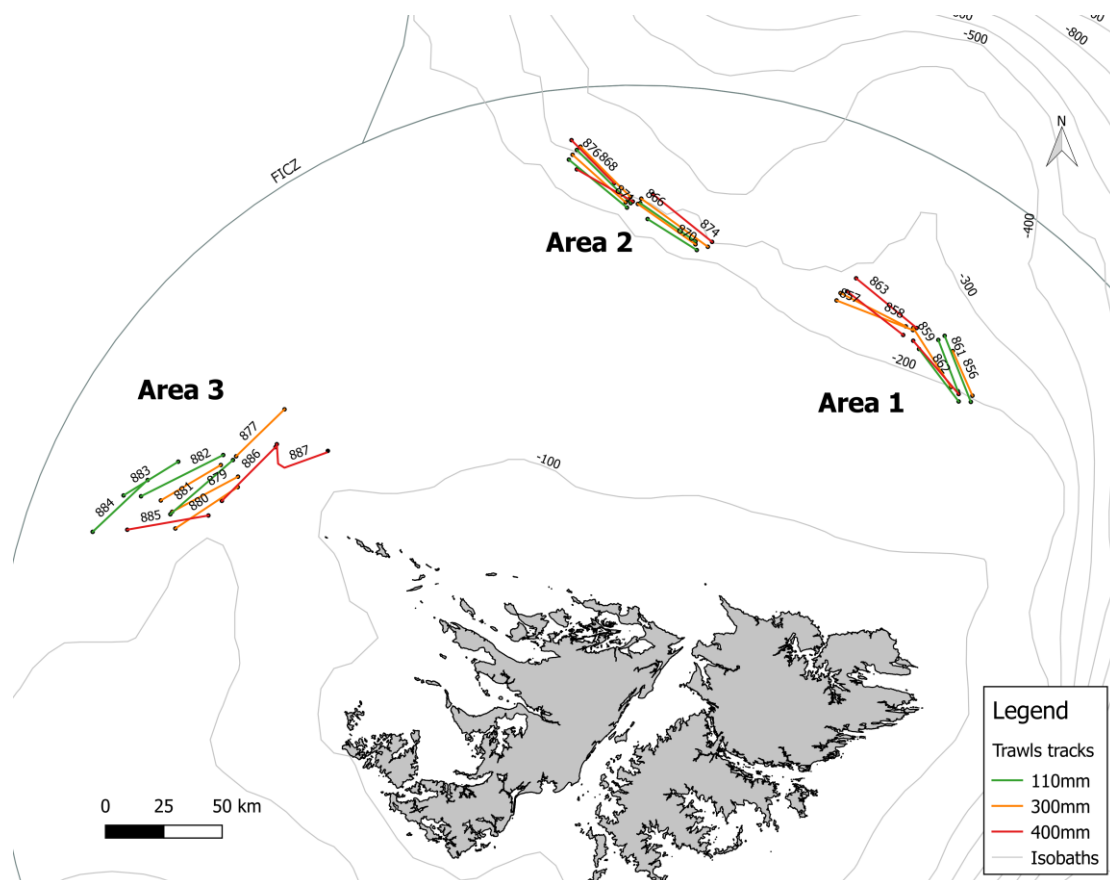


Figure 1 - Trawl tracks with three different cod ends performed in three different areas of the survey.

Sampling

Trawl stations and biological sampling

During the ZDLV-10-2018 research cruise, a total of 32 trawls were conducted with corresponding station numbers ranging from 856 to 887. The total catch of each station was not weighed due to the commercial quantities of the main catch. Instead, for all commercial species which were retained onboard, the product weight was taken and green weights of each species were calculated by applying corresponding conversion factors. All discarded species (rock cod *Patagonotothen ramsayi*, dogfish *Squalus acanthias* etc), as well as minor bycatch were weighed either with an electronic spring balance (up to 50 kg), or using an electronic marine-adjusted balance (Marel, up to 15 kg). From every trawl, all skates were identified, sexed (male and female without assigning maturity stage) and measured individually (disc width). All major commercial bycatch species were sampled (random samples of up to 100 individuals) and were measured, sexed and their maturity stages were identified as of standard biological analyses. During otolith collection, individual weights were measured to the nearest gram. Some fish and squid specimens were frozen for analysis ashore.

Table 1 - Total catches of various species by bottom trawl during the cruise.

Species Code	Species Name	Total Catch (kg)	Proportion (%)
AUL	<i>Austrolycus laticinctus</i>	1.3	<0.01
BAC	<i>Salilota australis</i>	1857.1	3.95
BDU	<i>Brama dussumieri</i>	3.7	0.01
BLU	<i>Micromesistius australis</i>	2.5	0.01
BUT	<i>Stromateus brasiliensis</i>	0.5	<0.01
CGO	<i>Cottoperca gobio</i>	52.0	0.11
COP	<i>Congiopodus paeruvianus</i>	0.4	<0.01
COT	<i>Cottunculus granulatus</i>	186.2	0.40
DGH	<i>Schroederichtys bivius</i>	384.0	0.82
DGS	<i>Squalus acanthias</i>	323.4	0.69
EEL	<i>Iluocoutes/Patagolyicus sp.</i>	1.7	<0.01
GRC	<i>Macrourus carinatus</i>	428.7	0.91
HAK	<i>Merluccius hubbsi</i>	6680.9	14.22
ILF	<i>Iluocoetes fimbriatus</i>	0.9	<0.01
ILL	<i>Illex argentinus</i>	0.8	<0.01
ING	<i>Moroteuthis ingens</i>	65.7	0.14
KIN	<i>Genypterus blacodes</i>	138.4	0.29
LAR	<i>Lampris immaculatus</i>	27.5	0.06
LOL	<i>Doryteuthis gahi</i>	374.9	0.80
LYB	<i>Lycenchelys bachmanni</i>	<0.1	<0.01
MXX	<i>Myctophid spp.</i>	<0.1	<0.01
NEM	<i>Neophyrnichthys marmoratus</i>	15.5	0.03
OCT	<i>Octopus spp.</i>	166.4	0.35
PAR	<i>Patagonotothen ramsayi</i>	1118.4	2.38
PAT	<i>Merluccius australis</i>	7.5	0.02
POE	<i>Pogonolycus elegans</i>	<0.1	<0.01
RAL	<i>Bathyraya albomaculata</i>	2805.9	5.97
RBR	<i>Bathyraya brachyurops</i>	10558.1	22.47
RBZ	<i>Bathyraya cousseauae</i>	1366.2	2.91
RDA	<i>Zearaja argentinensis</i>	47.5	0.10
RDO	<i>Amblyraja doellojuradoi</i>	1366.5	2.91

Species Code	Species Name	Total Catch (kg)	Proportion (%)
RED	<i>Sebastes oculatus</i>	0.4	<0.01
RFL	<i>Zearaja chilensis</i>	9177.4	19.53
RGR	<i>Bathyraya griseocauda</i>	2405.3	5.12
RMC	<i>Bathyraya macloviana</i>	2356.9	5.02
RMU	<i>Bathyraya multispinis</i>	2104.5	4.48
RPX	<i>Psammobatis sp.</i>	436.8	0.93
RSC	<i>Bathyraya scaphiops</i>	1352.2	2.88
SEC	<i>Seriolella caerulea</i>	1.1	<0.01
SEP	<i>Seriolella porosa</i>	1.2	<0.01
SPN	Porifera	200.0	0.43
TOO	<i>Dissostichus eleginoides</i>	969.7	2.06
WHI	<i>Macruronus magellanicus</i>	2.6	0.01

RESULTS

Catch composition

Catch volume and composition of skate and finfish differed between the sample areas (Table 2). The largest skate catch was observed in Area 2 – which was not surprising given the location of this area within the ‘Skate Box’, where F-licensed Korean and Spanish trawlers usually catch skates. However, even in this area, skate catches were not impressive, averaging 1-2 t per trawl (200-250 kg per hour). In the other two areas, catches were even lower, amounting to roughly half of those observed in Area 2.

Skate catch totals were comparable for both 110 and 300 mm cod-end mesh sizes. In contrast, 400 mm mesh size was observed to produce less total skate catch, particularly in sample areas 1 and 3. However, the catch weight of discarded skates (because of their small size) was the greatest for 110 mm mesh and lowest for 400 mm mesh. The total catch of skates retained onboard as commercial product was the highest for 300 mm mesh (Table 2). The size grading of skate product was drastically different among mesh sizes. Both 110 mm and 300 mm had the majority of catch classed as RY1 (below 300 g), whereas larger grades (RY3 and RY4), *i.e.* > 500 g were more prevalent in 400 mm mesh trawls.

Overall, when only considering skate catches from the most productive area (Area 2) it is evident that the large catch totals obtained from the 300 mm mesh is due to the high abundance of small skate inflating catch totals. Catches of larger skates were the same, even at times higher, when 400 mm mesh was applied to the same area when compared to that of 300 mm mesh (Table 3).

The reported catch figures for Area 3 do not follow the trends in skate size by mesh category as observed in Areas 1 and 2. A possible reason for this is that all 400 mm trawls were performed slightly to the south of those conducted with 300 mm and 110 mm in Area 3 (Figure 1), and hence this may be a reflection of differences in geographical factors.

The amount of finfish and cephalopod bycatch was strikingly different between cod-ends of different mesh sizes in all three areas. Trawling with the 110 mm cod-end harvested substantial bycatch – varying from as much as 68 % in Area 3, to 22 % in Area 2. In Areas 1 and 2, the smallest bycatch was observed with the 400 mm cod-end, whereas it was with the 300 mm cod-end for Area 3.

Table 2 - Catch composition by area and mesh size

Skate catch vs By-catch									
	Area 1			Area 2			Area 3		
	110 mm	300 mm	400 mm	110 mm	300 mm	400 mm	110 mm	300 mm	400 mm
Skate Catch Total (kg)	2746	3027	1225	6134	6351	4856	4019	4113	1503
Skate Catch Kept (kg)	1705	1657	940	3494	4480	3644	1859	2582	1139
CPUE for Retained Skate (kg/h)	118	91	61	176	227	249	97	143	77
Discarded Skates Proportion	39.9%	43.5%	25.8%	43.0%	28.5%	24.9%	53.7%	37.2%	24.2%
By-catch (kg)	1811	26	89	1721	220	87	8461	259	140
Skate Catch	60.3%	99.2%	93.7%	78.1%	96.7%	98.2%	32.2%	94.1%	91.5%
By-catch	29.7%	0.8%	0.7%	21.9%	3.3%	1.8%	67.8%	5.9%	8.5%

Table 3 - Catch of skate by size categories in different areas and mesh size

Skate catch vs By-catch									
	Area 1			Area 2			Area 3		
	110 mm	300 mm	400 mm	110 mm	300 mm	400 mm	110 mm	300 mm	400 mm
Skate Catch Total (kg)	2746	3027	1225	6134	6351	4856	4019	4113	1503
Skate Catch Kept (GW) (kg)	1705	1657	940	3494	4480	3644	1859	2582	1139
Skate Product weight (kg)	533	518	294	1092	1400	1139	581	807	356
RY1 (0-300g) (kg)	270	274	80	656	692	320	368	480	192
RY2 (300-500g) (kg)	96	144	64	172	352	336	162	208	96
RY3 (500-1000g) (kg)	119	68	102	136	174	323	51	119	68
RY4 (1000g+) (kg)	48	32	48	128	182	160	0	0	0

Skate catch composition

Area 1

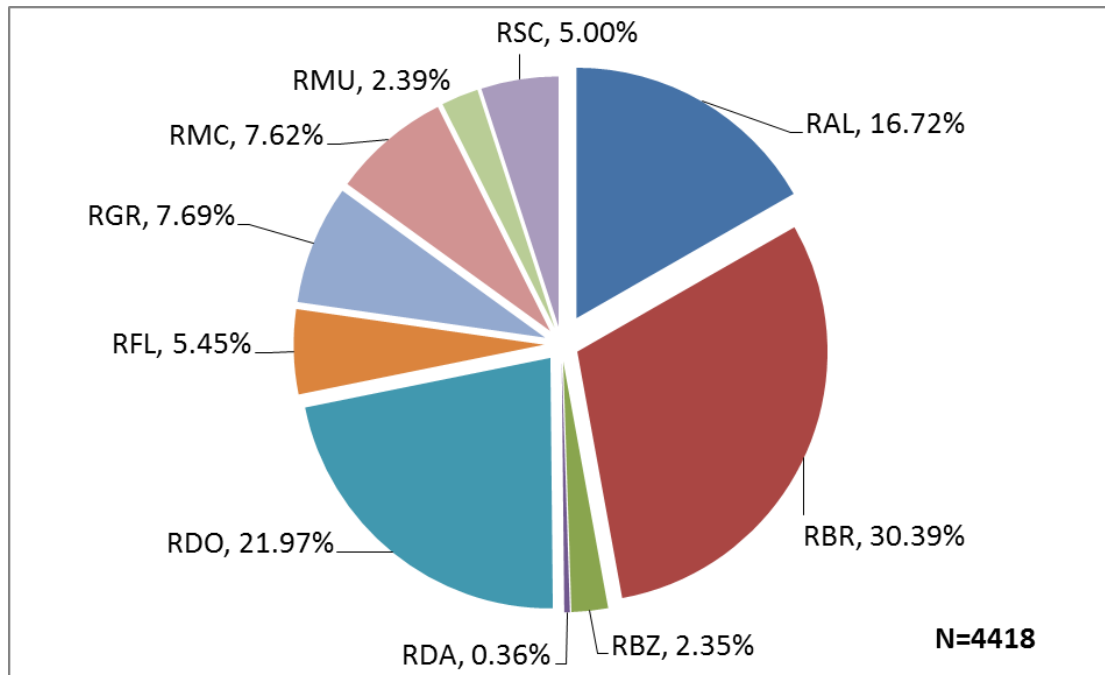


Figure 2 - Skate catch composition by number, all trawls combined, in Area 1.

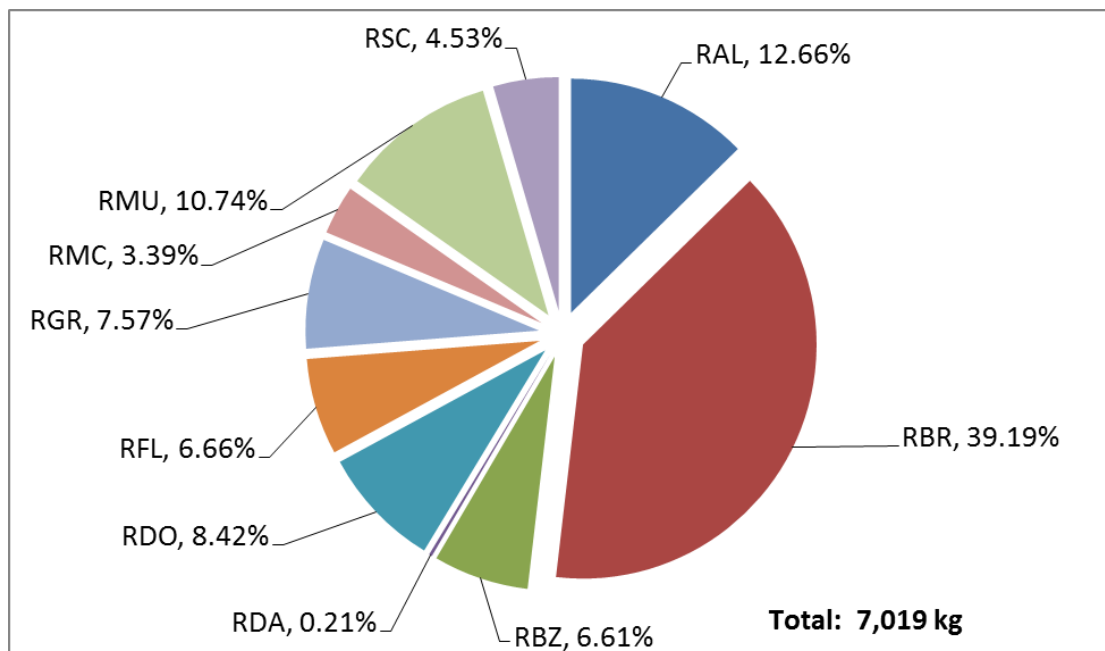


Figure 3 - Skate catch composition by weight, all trawls combined, in Area 1

The most abundant skates in terms of number and weight in Area 1 were the commercial RBR and RAL species. About a fifth of the catch was composed of small non-commercial RDO, which constituted less than 10 % of catch by weight. Notably, slightly more than 10 % of the catch by weight was represented by large RMU. RFL and RGR were not abundant.

Area 2

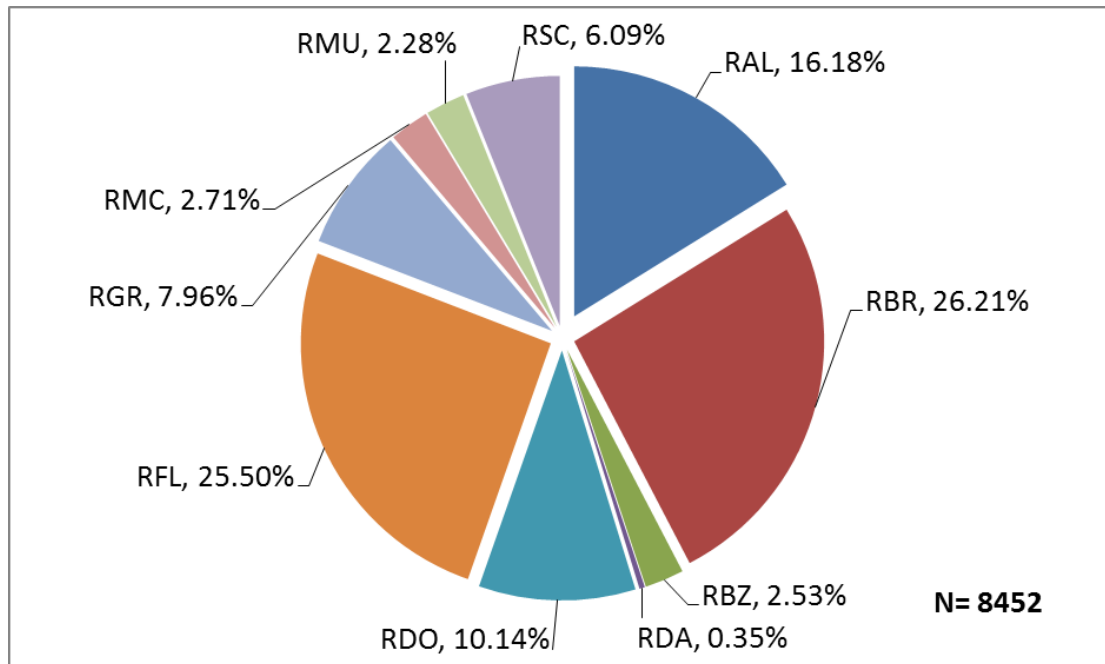


Figure 4 - Skate catch composition by number, all trawls combined, in Area 2.

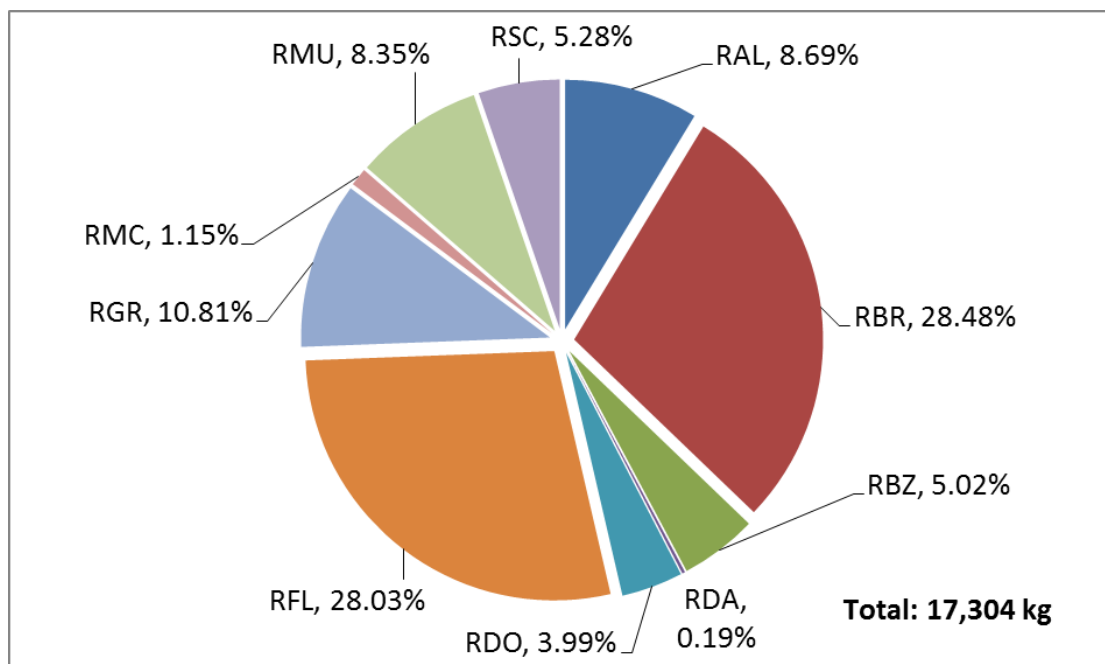


Figure 5 - Skate catch composition by weight, all trawls combined, in Area 2.

In Area 2, RBR was the dominant species, this being comparable to that of Area 1 in this regard. RAL caught were significantly smaller in size, constituting only 8.69 % in terms of weight. Two other commercial species, RFL and RGR, were significantly more abundant in this area, with RFL being the second most abundant species in terms of both number and weight (Figure 4, Figure 5). The proportion of RGRs increased to more than 10 %. In respect to non-commercial species, RDO were the most abundant (> 10 % by number), but again constituted only ~4 % by weight. The proportion of large RMU by weight was still significant (8.35 %).

Area 3

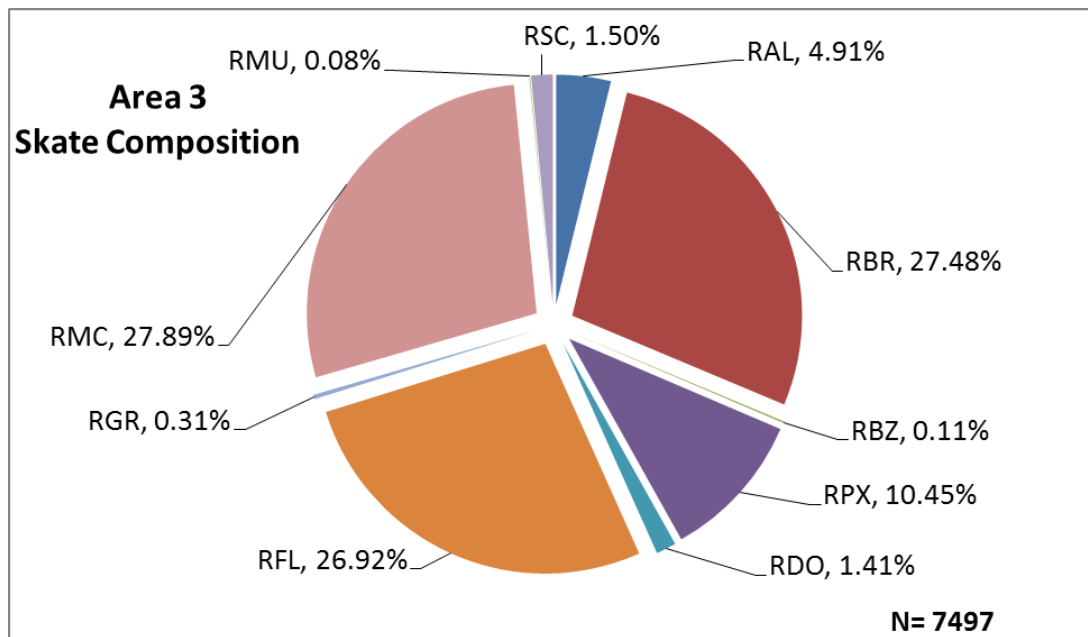


Figure 6 - Skate catch composition by number, all trawls combined, in Area 3.

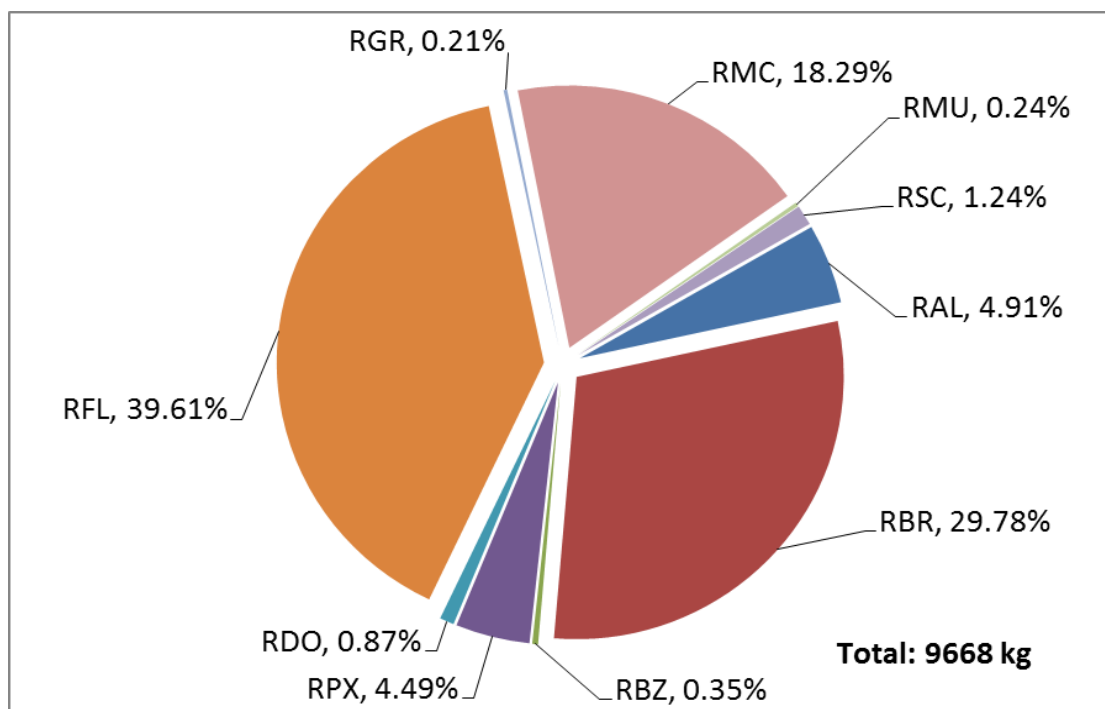


Figure 7 - Skate catch composition by weight, all trawls combined, in Area 3.

Skate composition differed in the northwest (Area 3) when compared to the north-eastern areas (Areas 1 and 2). Among the commercial species, the most abundant species were RBR and RFL, with RFL dominating the overall catch by weight. Proportions of RAL, and especially RGR decreased dramatically (Figure 6, Figure 7). Among non-commercial species, RMC was the most abundant species, constituting roughly a quarter of all skates by number. This area was also characterised by the presence of the small sand skate species, RPX (around 4.5 % in terms of weight). The amount of RDO recorded was considerably smaller compared to the first two areas.

Skate catch composition, skate size ≥ 40 cm Disc Width

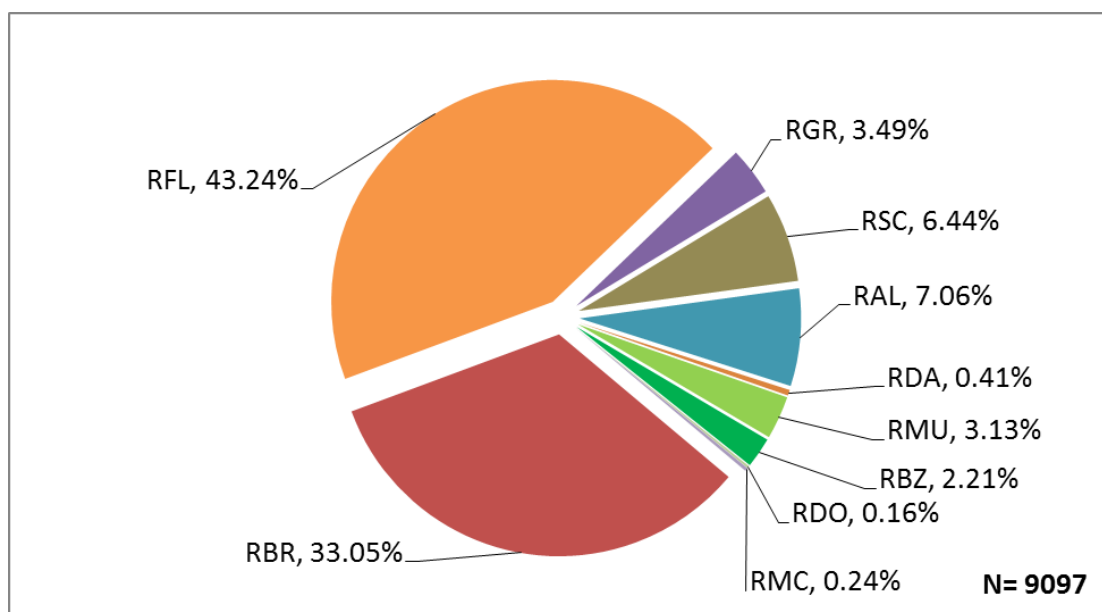


Figure 8 - Skate catch composition by number, all trawls combined, for skates ≥ 40 cm DW.

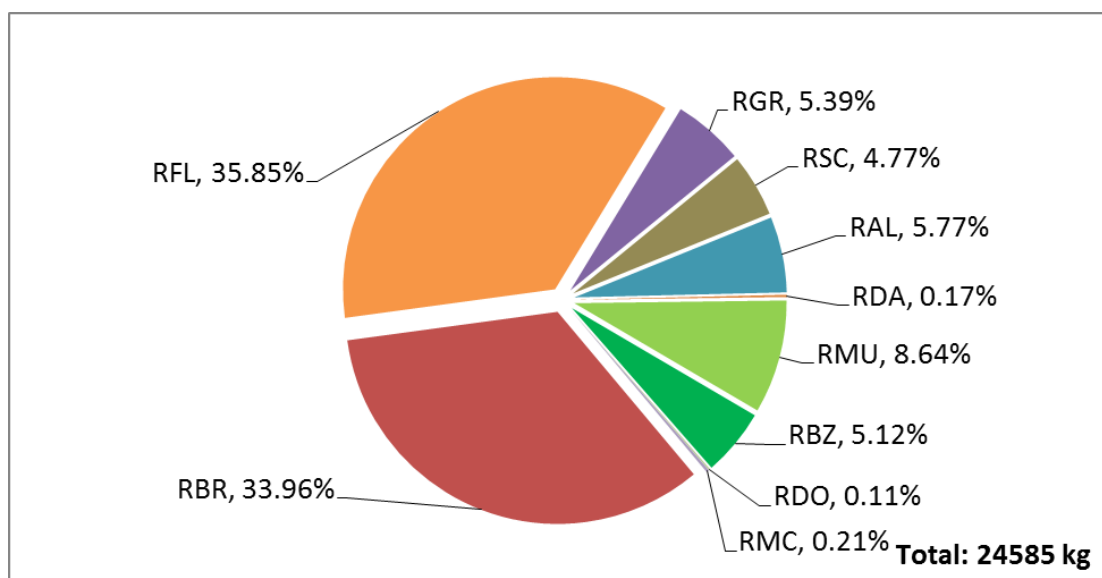


Figure 9 - Skate catch composition by weight, all trawls combined, for skates ≥ 40 cm DW.

It was estimated that the minimum disk width of skates to be processed and retained onboard was ~ 40 cm DW. Almost all animals smaller than this size were discarded by the crew. These discarded individuals were unlikely to survive, as caught skates spend a significant amount of time both in fish bins, and then on conveyer belts whilst the catch is sorted. Figure 8 and Figure 9 show the numbers and weights of all skates retained onboard. RFL had the largest proportion, closely followed by RBR. Three other commercial species (RGR, RAL and RSC) constituted $\sim 15\%$ of the total catch by both weight and number. $> 10\%$ of weight was represented by by-catch skates such as RMU and RBZ. Non-commercial species (RMC and RDO) were rarely retained on-board.

Skate catch composition, skate size ≥ 60 cm Disc Width

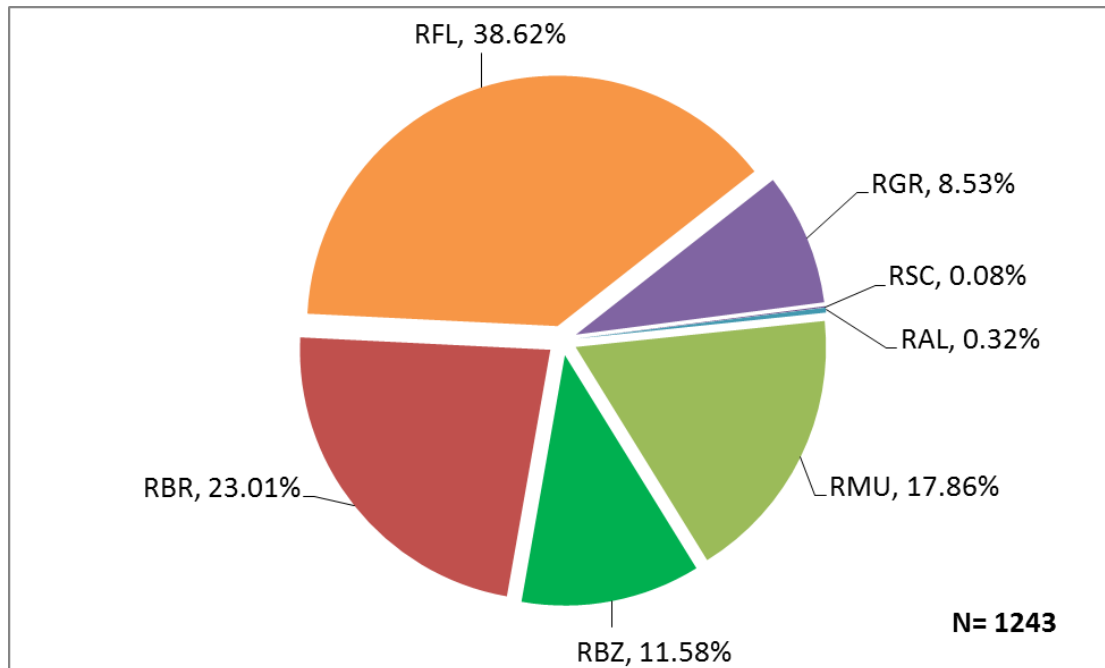


Figure 10 - Skate catch composition by number, all trawls combined, for skates ≥ 60 cm DW

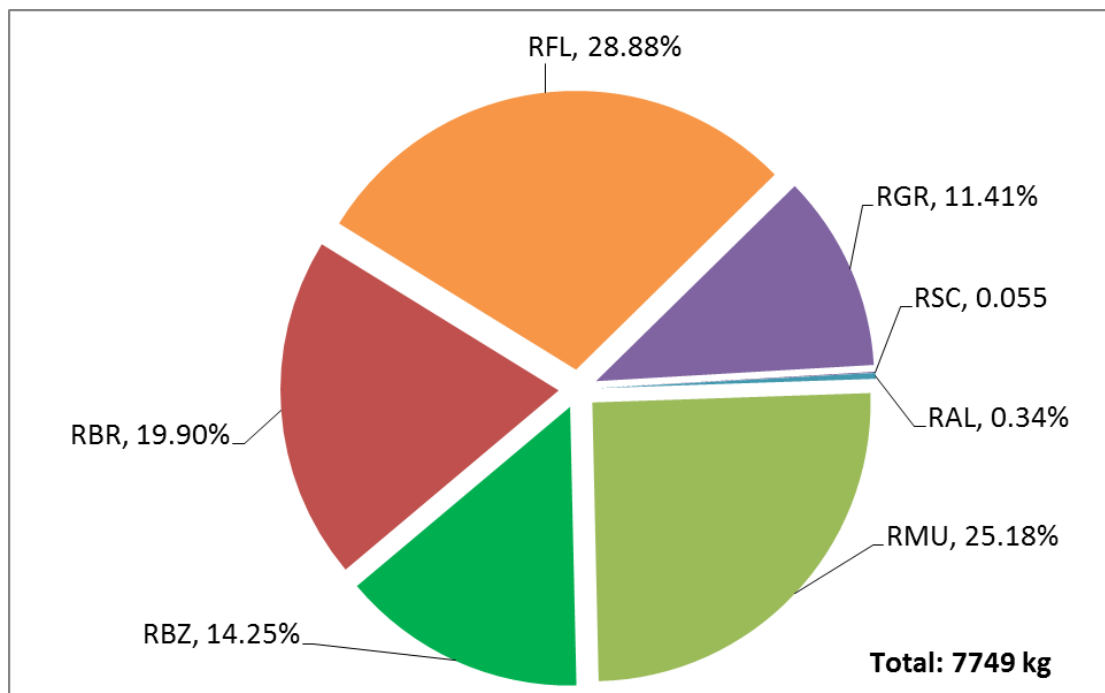


Figure 11 - Skate catch composition by weight, all trawls combined, for skates ≥ 60 cm DW.

When considering larger animals (> 60 cm DW), the proportion of skates in the catch changed compared to that of the previous disk width class section. Quite surprisingly, by-catch species such as RMU constituted a quarter of the whole catch of large skates in terms of weight, with another bycatch species (RBZ) totalling almost 15 % (Figure 11). RFL and RBR were the most abundant albeit constituting smaller proportions than skates among > 40 cm DW size class.

Size composition of skates by area

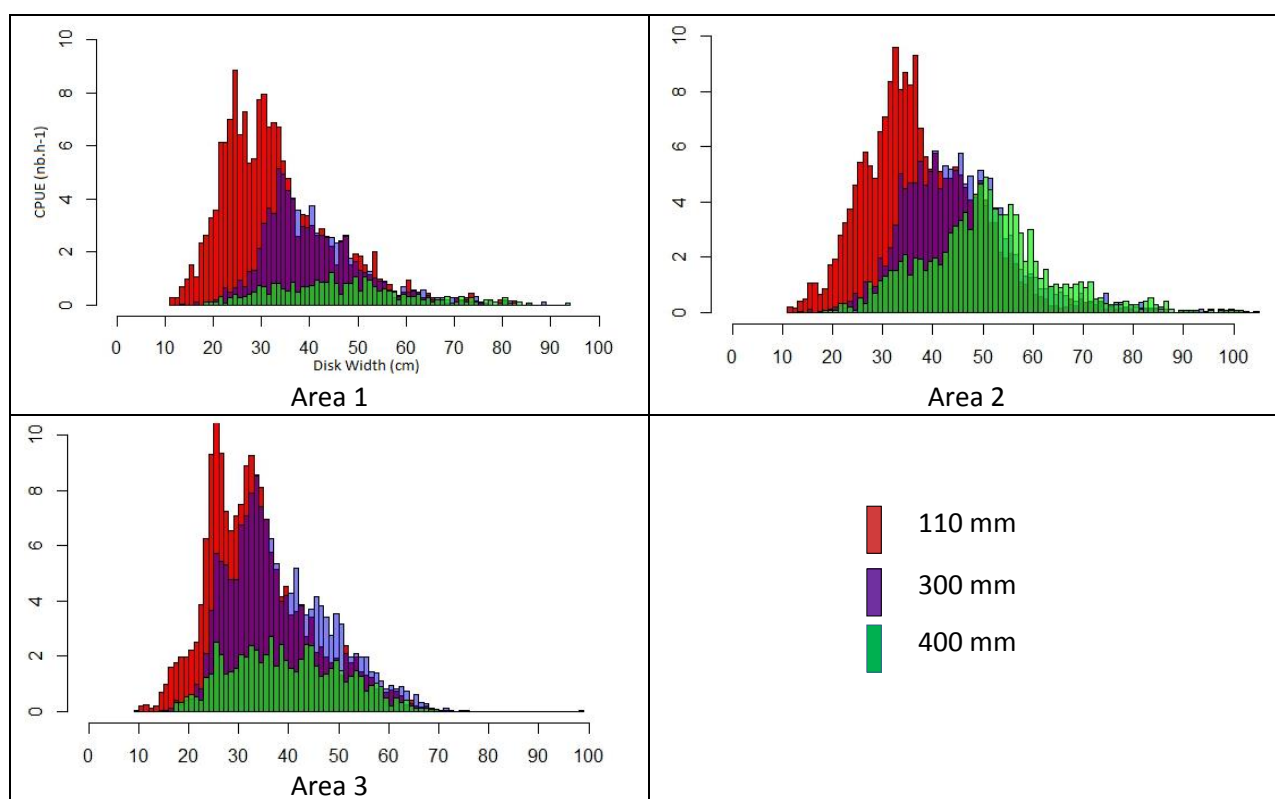


Figure 12 - Catch per unit effort (Number per h-1) of skate per mesh size and areas.

Figure 12 shows the size composition of skates in the three sample areas, ‘normalized’ by effort (in numbers per hour fishing). This was done as total effort varied between the different trawls. The main aim of these graphs is to show the selectivity of the fishing gear using cod-ends with different mesh size, therefore all species are combined.

Regardless of the area, the 110 mm and the 300 mm mesh size cod-ends showed similar efficiency in catching skates > 35 cm DW. It was not the case for 400 mm mesh size, for which catch efficiency for individuals wider than 40 cm was dependant on the area fished (*i.e.* dependent on the species assemblage). Even in the most productive area, Area 2, skates of 40-50 cm DW were caught more effectively by 300 mm mesh than 400 mm mesh. Skates > 50 cm DW seemed to be unable to escape the three different nets. Small individuals (< 30 cm) escaped the 300 mm mesh size net very efficiently when compared to the 110 mm mesh size net. These small skates represented either non-commercial species such as RDO, RMC and RPX, or were juveniles of commercial species that were discarded because of no commercial value

Size composition of skates by species and mesh size

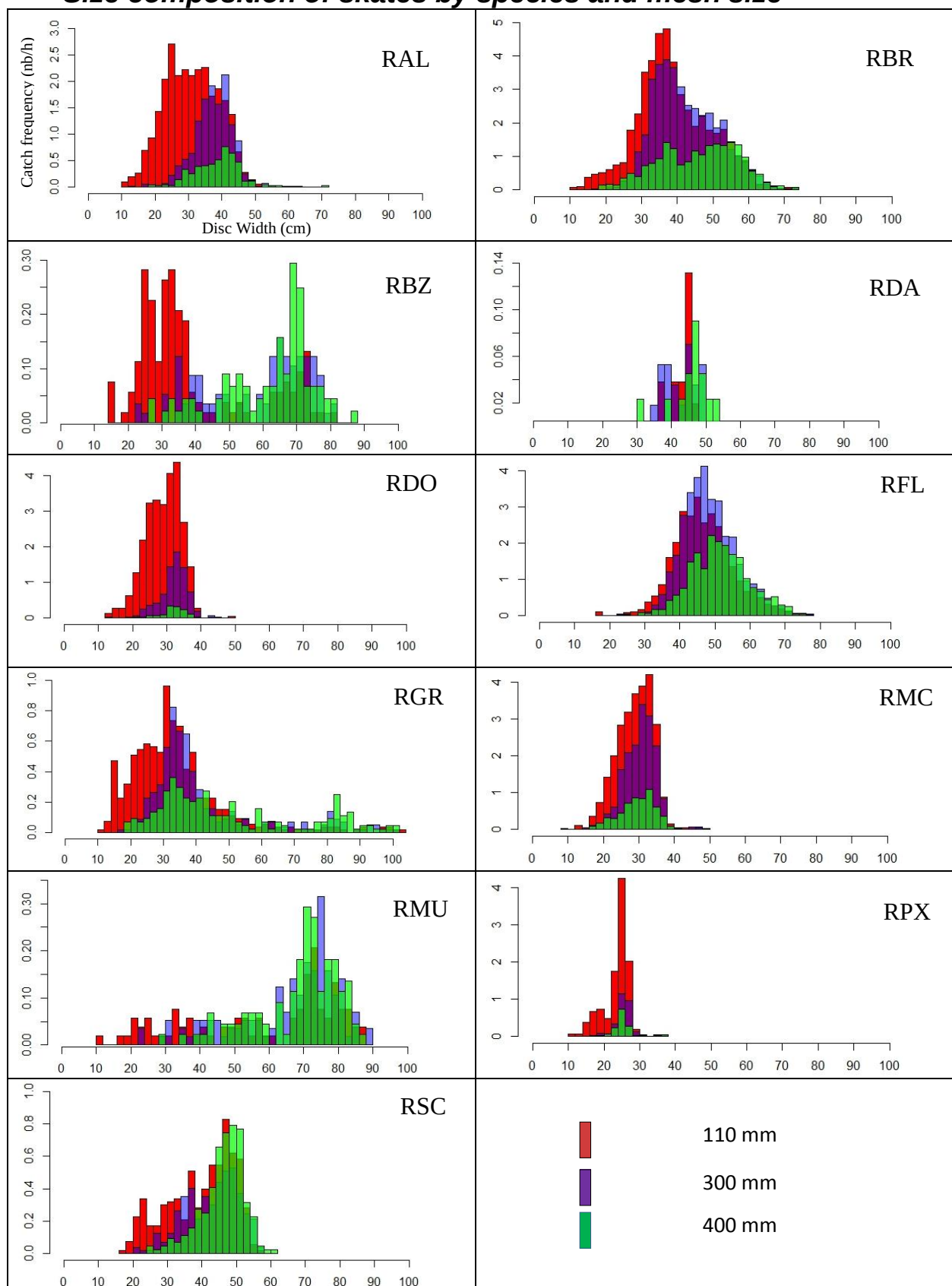


Figure 13 - Size composition (adjusted by CPUE) per species and mesh size for all areas.

Figure 13 shows size compositions of all 11 species of skates caught during the survey, respective of number per hour per mesh size. The selectivity trends are quite similar – small skates of < 30 cm DW occur mainly in 110 mm mesh. Skates between 30 and 45 cm occur both in 300 mm and 400 mm mesh, but the number caught averages about two times more in 300 mm mesh compared to 400 mm mesh. Skates over 50 cm DW occur in all mesh sizes in similar numbers and weights. This is to be compared with the data on size at 50 % maturity of main commercial species, which averaged between 1994 and 2013:

RAL, *Bathyraja albomaculata*: 43.12 ± 6.50 cm

RBR, *Bathyraja brachyurops*: 49.15 ± 3.16 cm

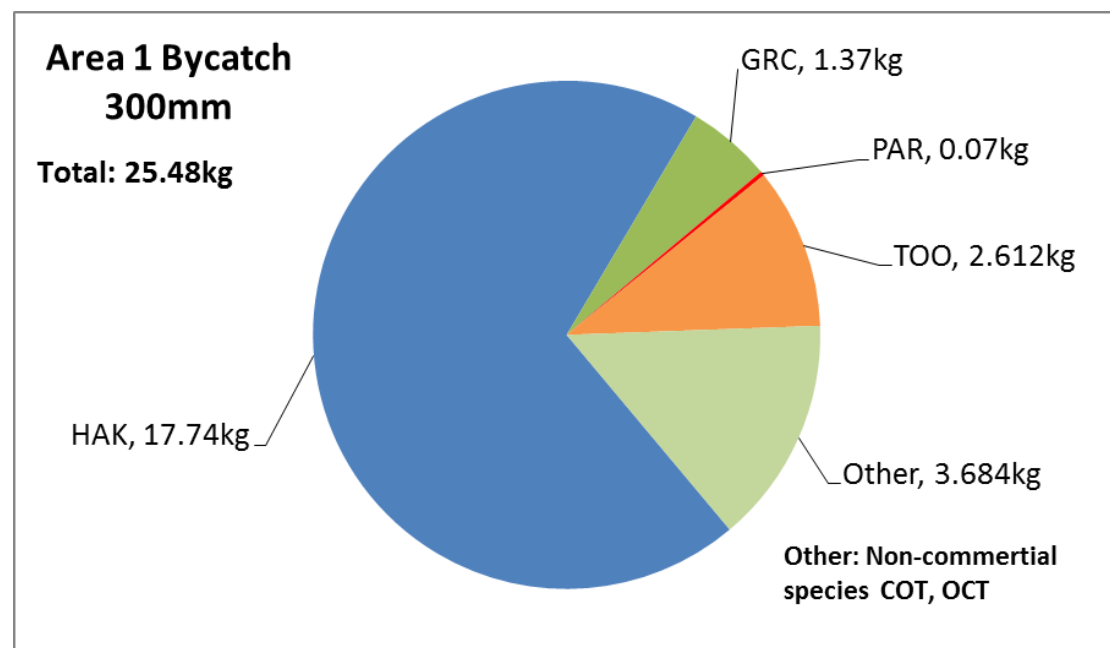
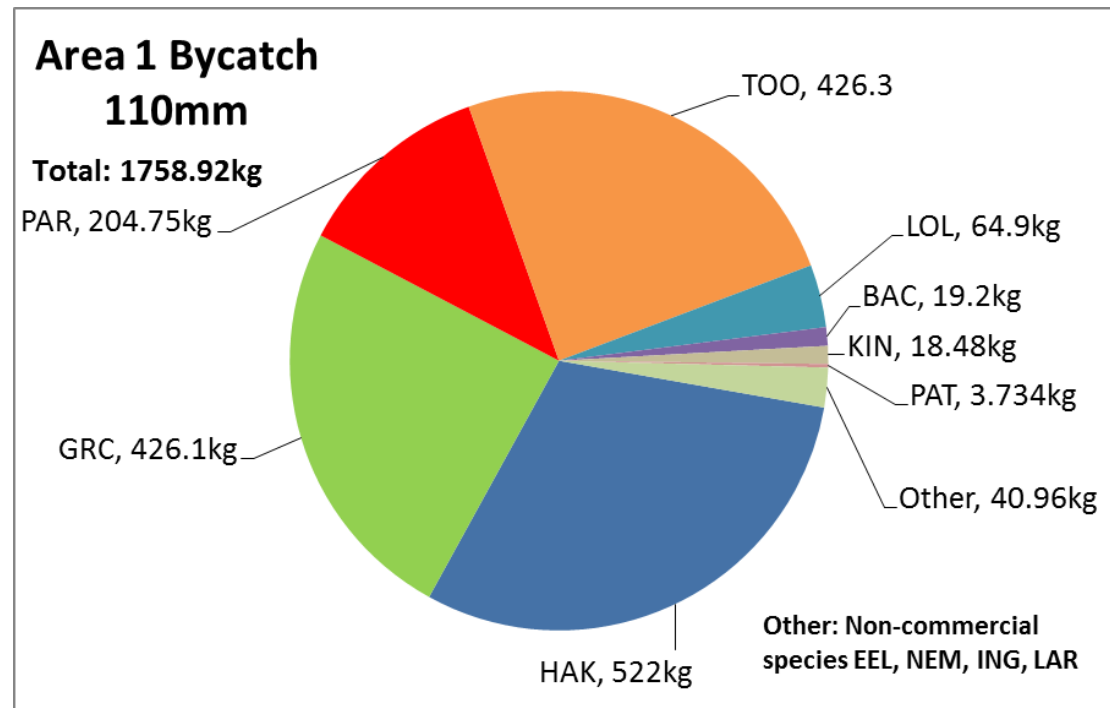
RFL, *Zearaja chilensis*: 62.88 ± 4.56 cm

RGR, *Bathyraja griseocauda*: 75.71 ± 5.58 cm

Catches of juvenile and young sub-adults which did not reach their first maturity were substantially (by half) larger in 300 mm mesh size cod ends than those of 400 mm ones. Among them, two commercial skate species are of particular concern (a consequence of results obtained via this cruise), those being the RFL and RGR species. Both species are slow-growing and late to mature, resulting in the majority being fished before reaching their potential reproduction size.

Bycatch composition

Area 1



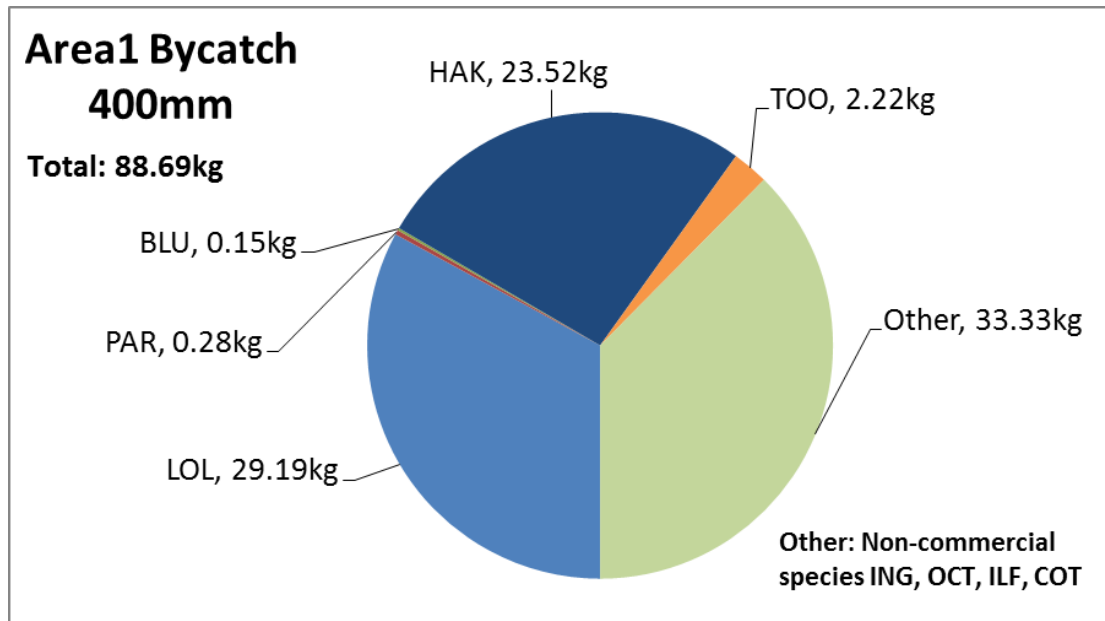
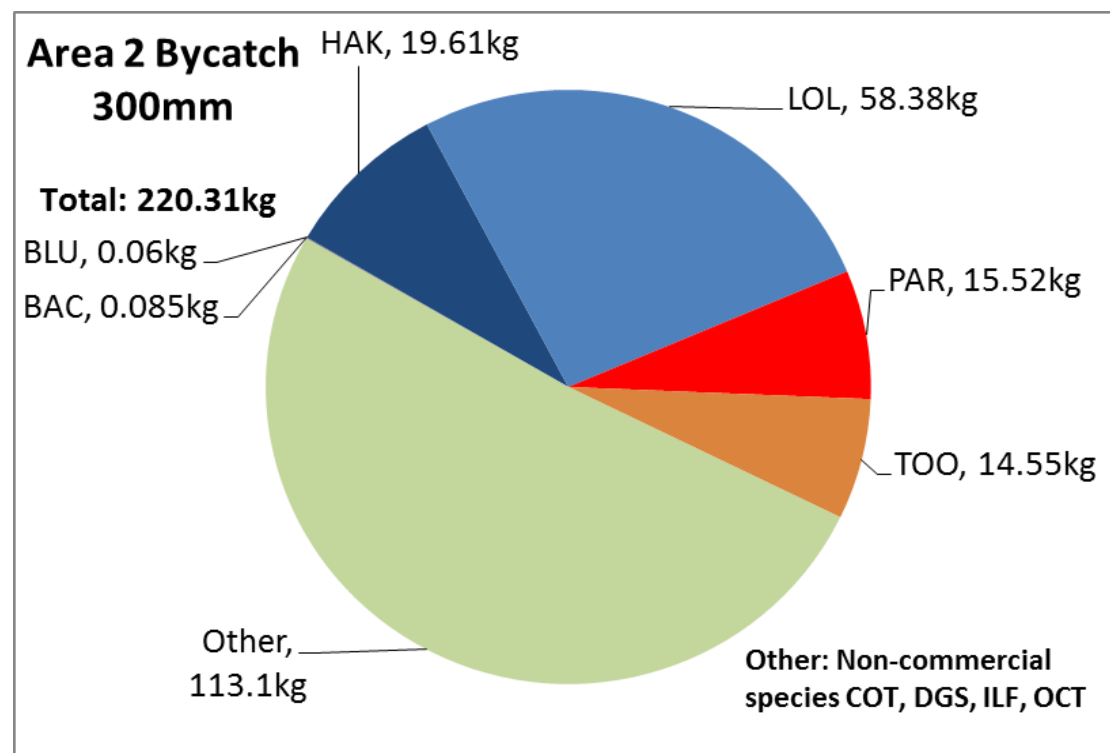
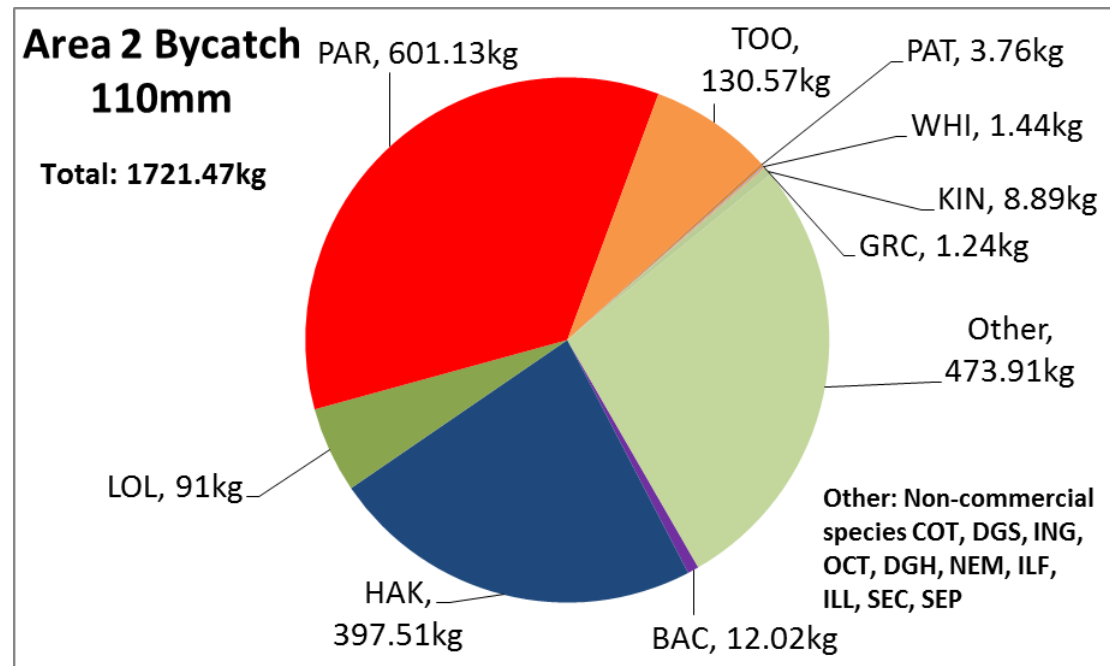


Figure 14 - . Bycatch composition from trawls with various mesh size at the cod end in Area 1.

The largest bycatch in Area 1 was observed with 110 mm mesh cod end (40 %), consisting of HAK, GRC, TOO and PAR. By-catch of other species in 300 mm and 400 mm mesh cod-ends was close to zero (0.7-0.8 %), and consisted of HAK, GRC and LOL, that became enmeshed in the body of the net before the cod-end. Quite unexpectedly, 400 mm mesh cod-end had significant numbers of *Benthoctopus* spp. in the mesh.

Area 2



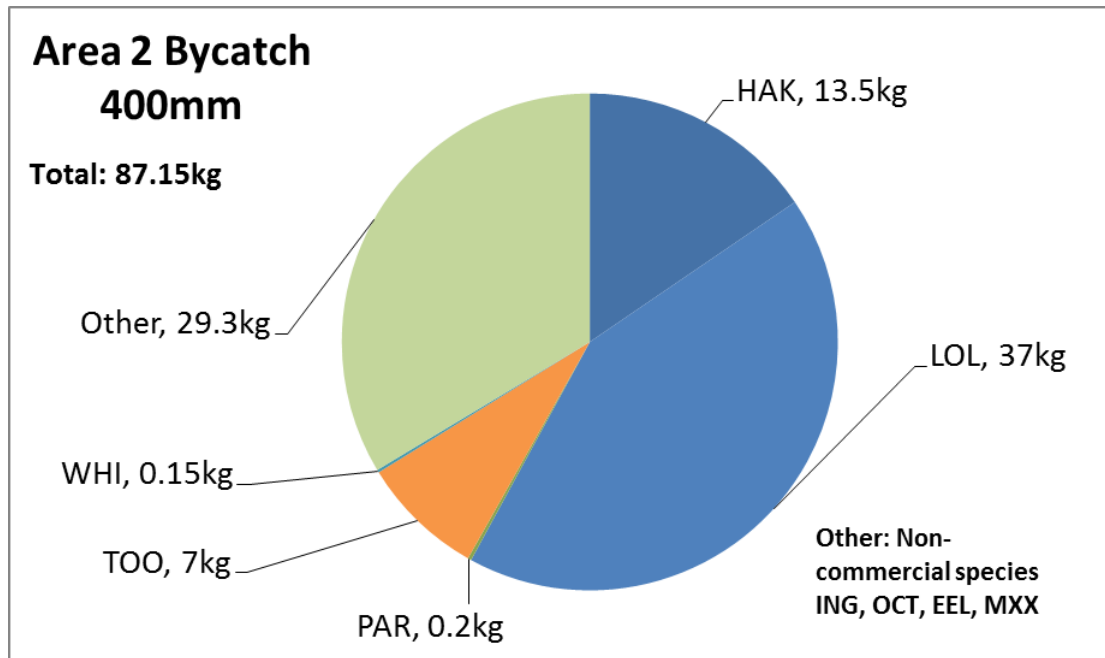
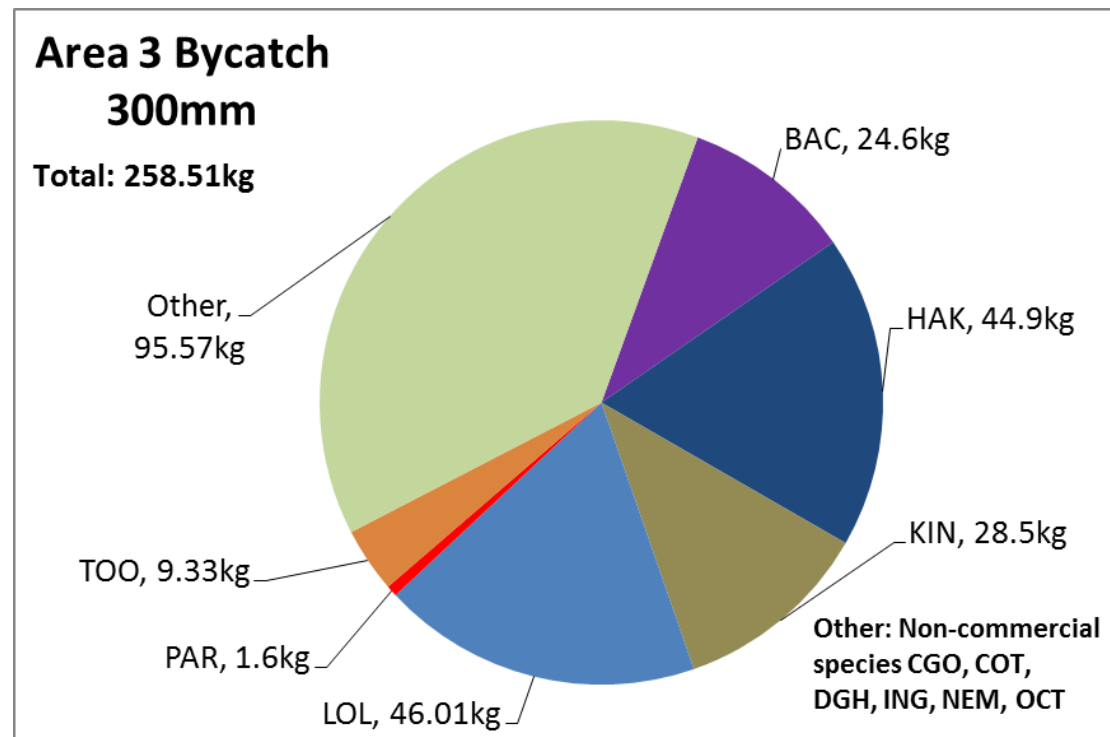
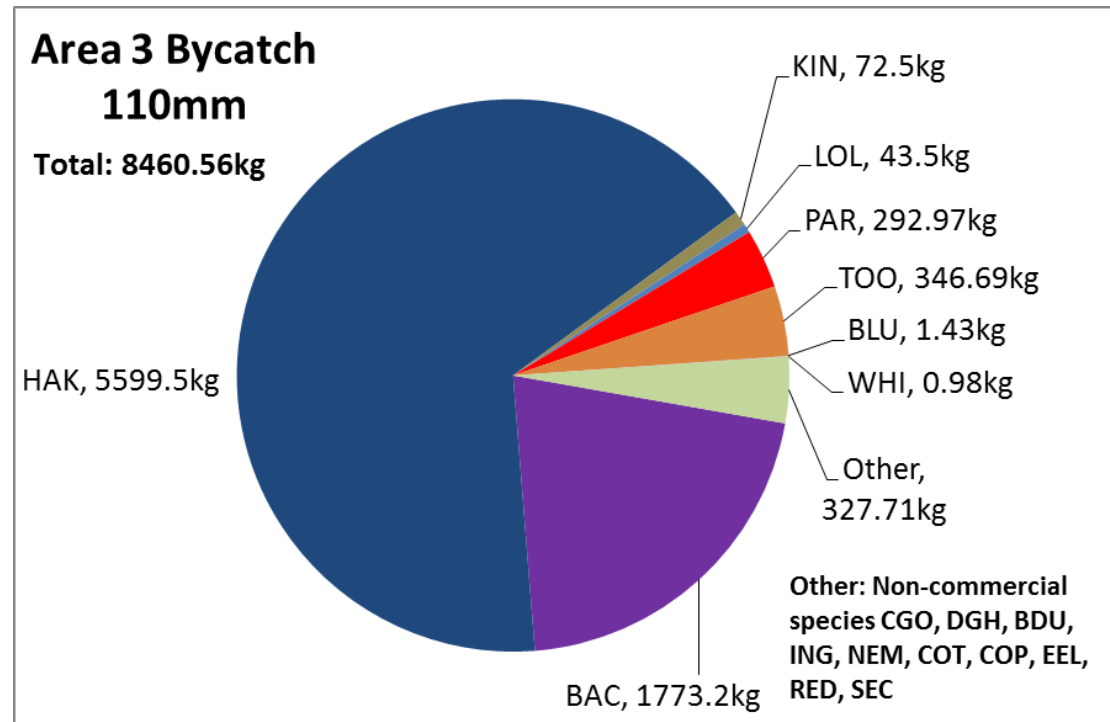


Figure 15 - Bycatch composition from trawls with various mesh size at the cod end in Area 2.

Similar to Area 1, the largest bycatch in Area 2 was taken with 110 mm mesh cod-end, but in reduced amount (21.9 %). The largest proportion of bycatch consisted of PAR, followed then by HAK and TOO (Figure 15). By-catch of other species in 300 mm and 400 mm mesh cod-ends were slightly larger (1.8 to 3.3 %). Again, the main part of the bycatch in these cod-ends originated from entrapment in the body of the net located before the cod-end (LOL, OCT and HAK).

Area 3



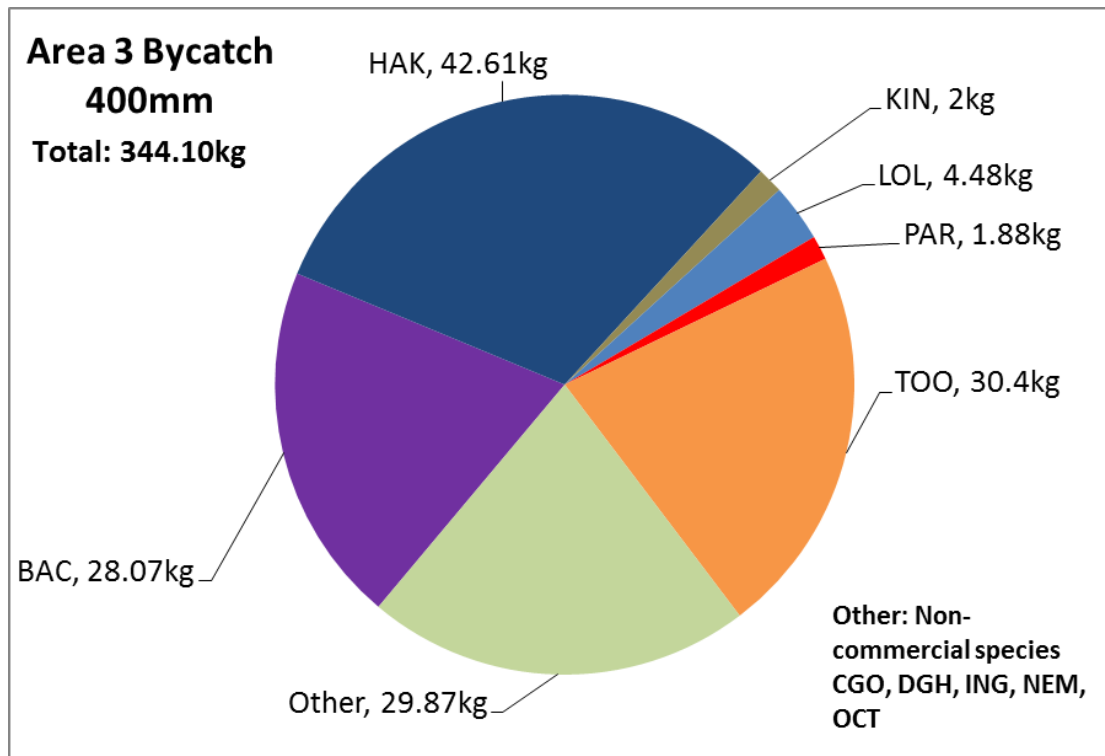


Figure 16 - Bycatch composition from trawls with various mesh size at the cod-end in Area 3.

In Area 3, the largest biomass of bycatch was in 110 mm mesh (67.8 %), consisting mainly of HAK and BAC (Figure 16). By-catch of other species in 300 mm and 400 mm were the largest among all three Areas, 5.9 % and 8.5 % respectively. As in the other two areas, this bycatch consisted mainly of fish and squid stuck in the mesh just before the attachment area of the cod-end to the trawl. Generally, it was more finfish and less *D. gahi* (LOL) in these catches.

Size composition of bycatch

Hakes

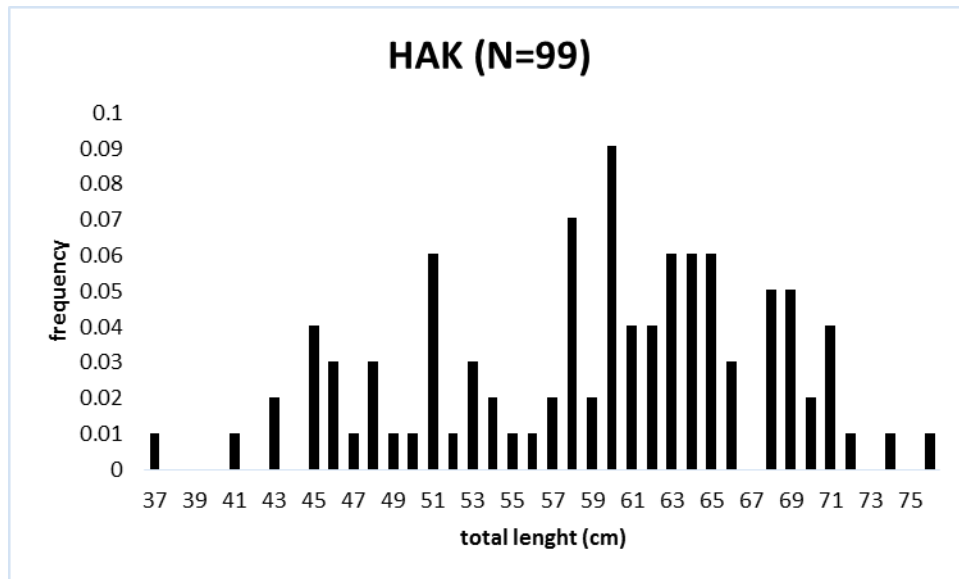


Figure 17 - Hake length frequency composition, Area 1.

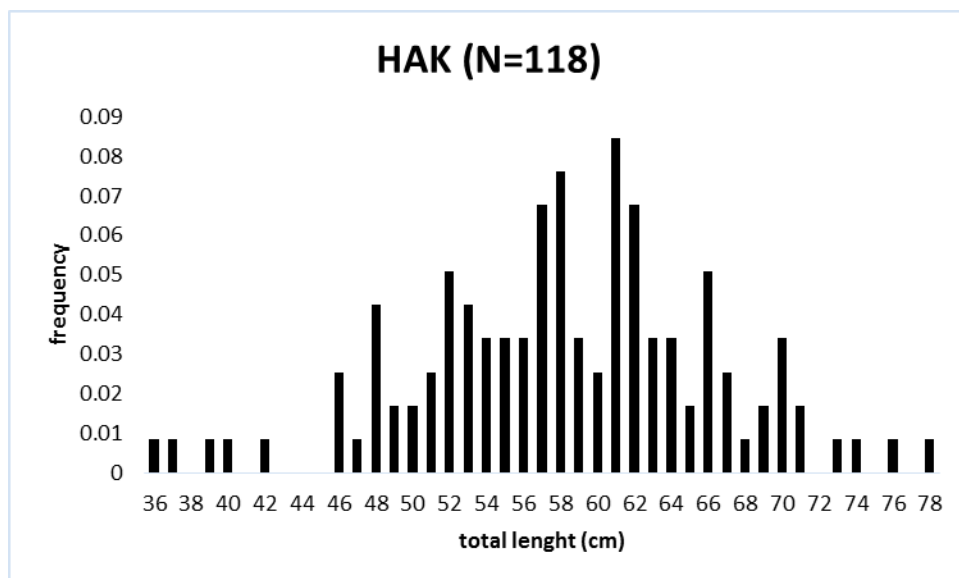


Figure 18 - Hake length frequency composition, Area 2.

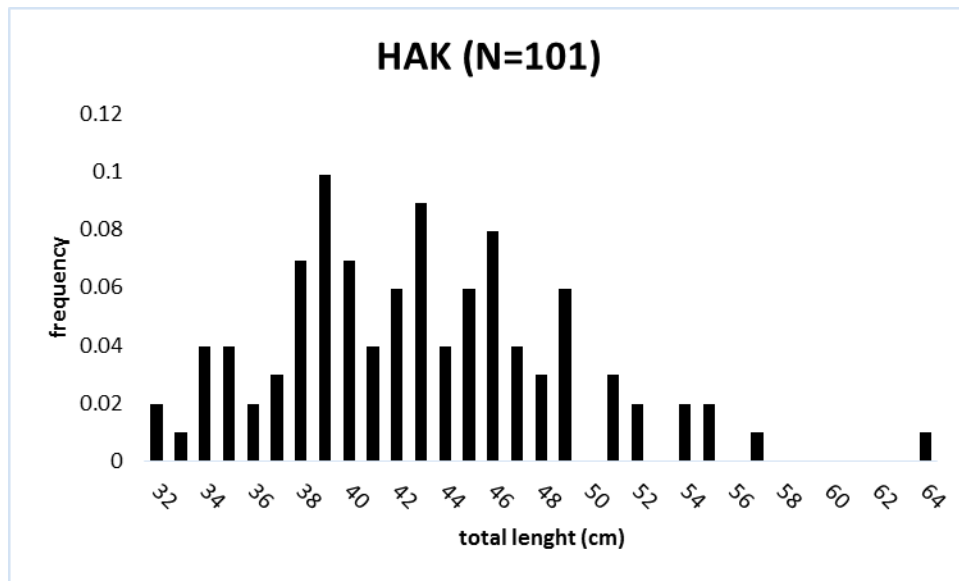


Figure 19 - Hake length frequency composition, Area 3.

Figure 17, Figure 18 AND Figure 19 show size compositions of the main bycatch species, Common Hake *Merluccius hubbsi*, at the time of the survey. Hakes of larger sizes (> 60 cm TL) occurred mainly in the southern part of their distribution areas, albeit in smaller quantities. In Area 2, hakes of 50-60 cm TL occurred in larger proportions, however the modal size of hakes was the same in both areas (60-62 cm TL). In Area 3, the hakes were much smaller than in the northeast, with the majority of them being < 50 cm TL. These hakes were about to migrate to their spawning grounds in the Argentine EEZ.

Rock cod

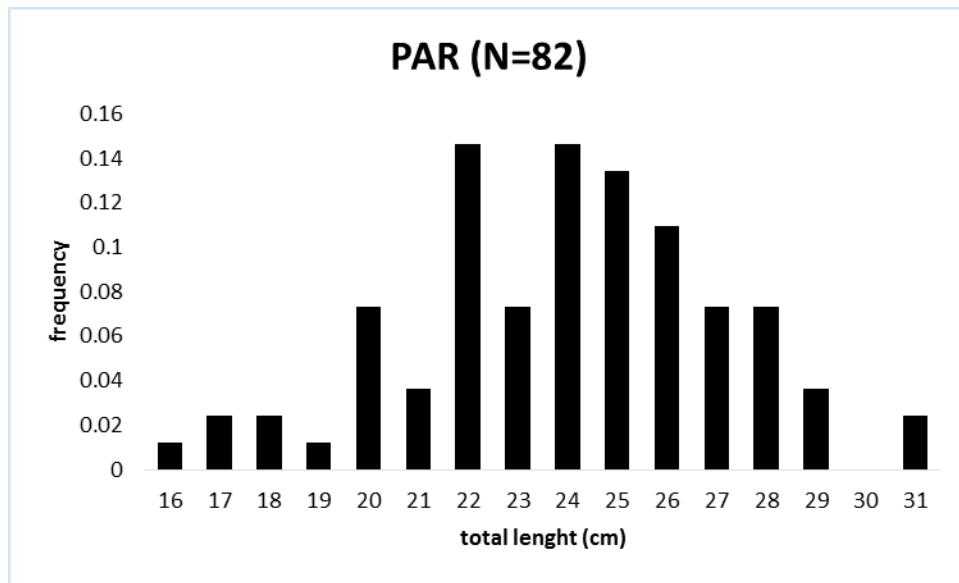


Figure 20 - . Rock cod length frequency composition, Area 1.

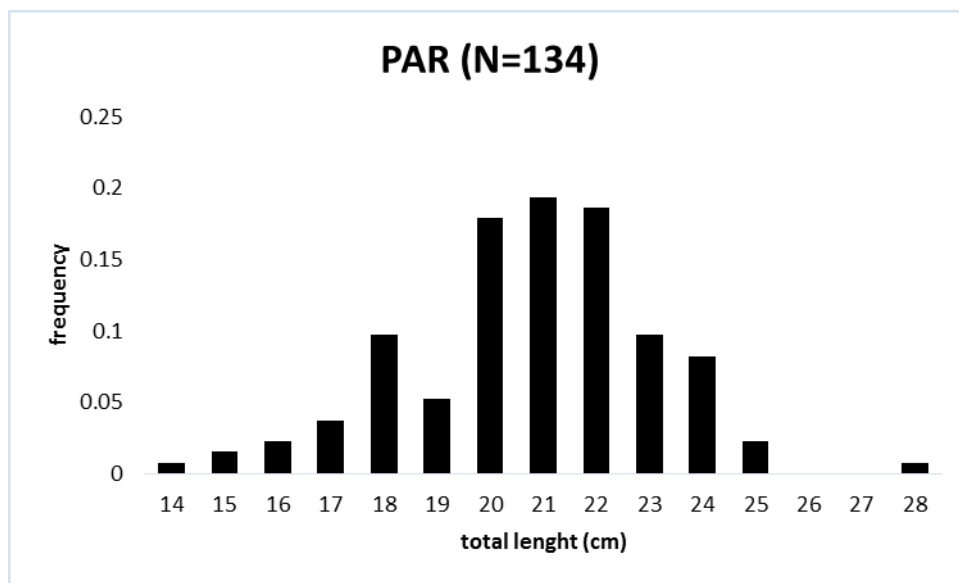


Figure 21 - Rock cod length frequency composition, Area 2 (enmeshed, from 300-mm trawl).

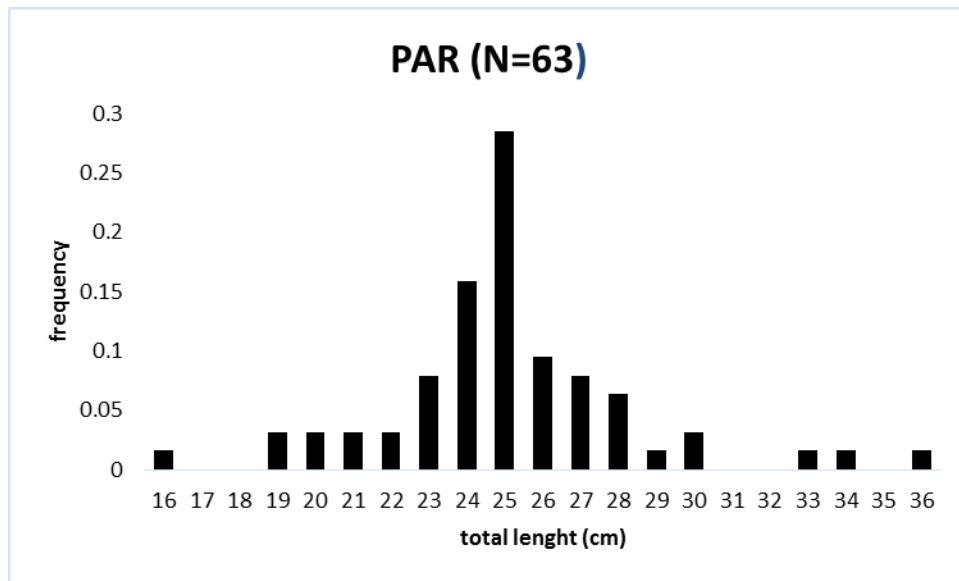


Figure 22 - Rock cod length frequency composition, Area 3.

The average size of rock cod *Patagonotothen ramsayi* in catches was relatively small, barely passing the minimum commercial size of 25 cm TL. In Area 1, the largest number of rock cod was recorded, with about a third of individuals being > 25 cm TL. A strict unimodal distribution of rock cod was observed in Area 3, this being one of the main fishing grounds for this species several years prior. The modal size of rock cod there was 25 cm TL. A large quantity of fish occurred in the mesh just before the cod-end attachment to the trawl – a typical example of such event with smaller enmeshed fish was in Area 2 (Fig. 21), with modal sizes 20-22 cm TL. Almost all fish sampled were at resting maturity stages (8 and 2), however several females were found to be at stage 7 indicating the end of their spawning season.

Kingclip

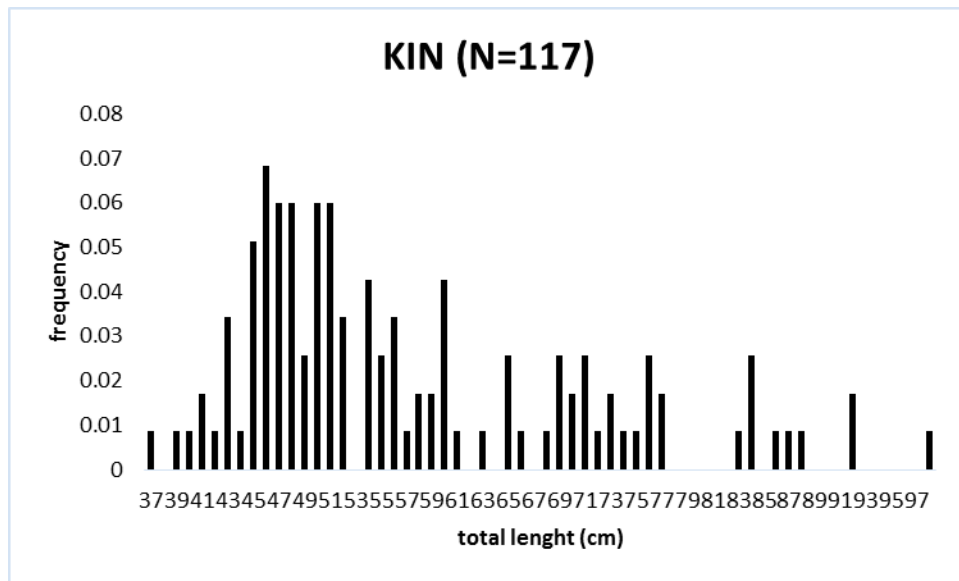


Figure 23 - Kingclip length frequency composition, Area 3.

Sizes of kingclip *Genypterus blacodes* were much smaller than those observed a few years ago, with modal lengths ranging between 45 and 51 cm TL. Surprisingly, these fish were still kept as a product on the ship. The abundance of larger fish (over 85 cm TL) was low. Kingclip were practically absent in the areas 1 and 2.

Grenadier (*M. carinatus*)

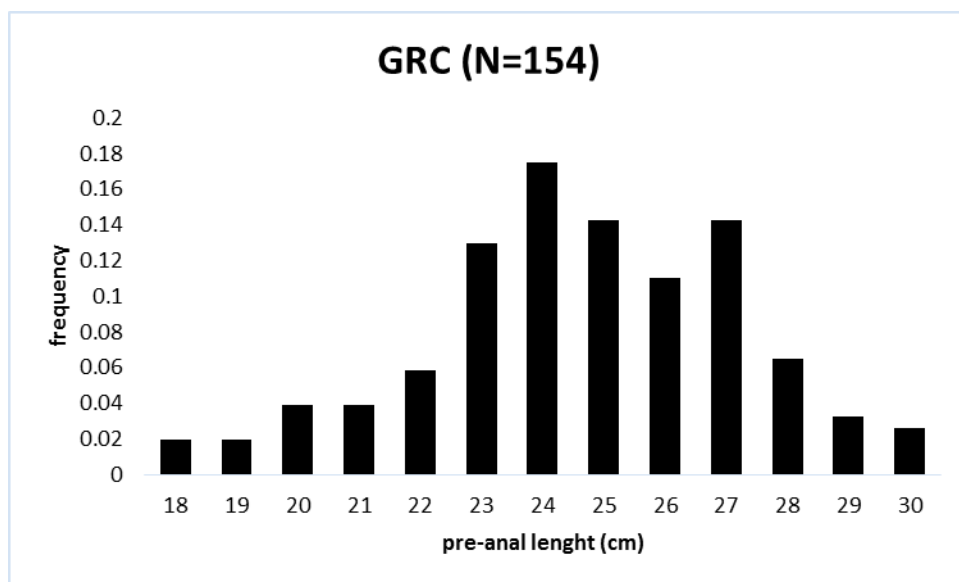


Figure 24 - Grenadier length frequency composition, Area 1.

Grenadiers of the species *Macrourus carinatus* were mainly present in catches from Area 1. A majority of them were females of 23-27 cm pre-anal length. This bycatch was processed and kept onboard.

Toothfish

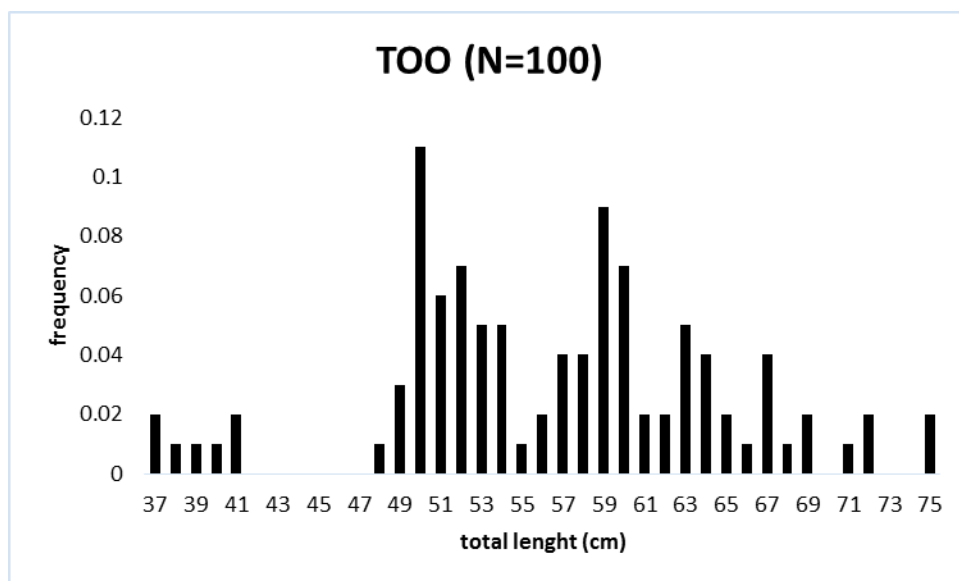


Figure 25 - Toothfish length frequency composition, Area 1.

Substantial catches of toothfish *Dissostichus eleginoides* were observed in Area 1. Size composition was multimodal with two main modes of 50 cm and 59-60 cm TL. At this time of the year, medium-size toothfish concentrate near the shelf edge before migrating to deeper water.

Red cod

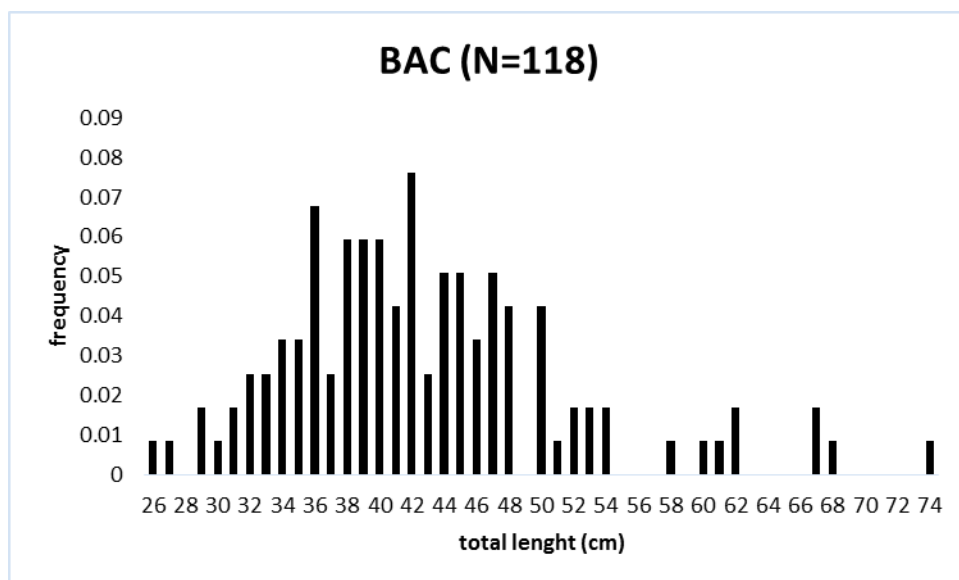


Figure 26 - . Red cod length frequency composition, Area 3.

Red cod *Salilota australis* were mainly caught in Area 3. The bulk of the catches consisted of immature fish of 36 and 42 cm TL modal lengths, with some larger post-spawning fish > 60 cm TL.

Conclusions

1. The usage of different sized meshes (110 mm, 300 mm, 400 mm) in the cod-end of the bottom trawl resulted in similar catches of both commercial and by catch species for three sample areas of the FICZ that currently allows skate fishing (north of 51°S) subject to licence conditions.
2. 110 mm mesh cod-ends kept between 22 to 73 % of commercial by-catch species in the net (hake, grenadier, rock cod, red cod and toothfish). The by-catch of these species drastically decreased in 300 mm and 400 mm mesh, down to 1-8 %. In the latter case, a large proportion of bycatch originated from fish enmeshed in the trawl area close to the attachment of the cod end.
3. 110 mm mesh cod-end took a large proportion of small undersized commercial (< 35 cm disc width) and non-commercial species of skates such as RMC, RDO and RPX, accounting for 40 to 50 % of catch by weight (and up to 80 % by number). Such skates were discarded, with unlikely survival rates.
4. 300 mm mesh retained significantly larger proportions of small skates (40-50 cm DW), approximately 30-40 % more than those of 400 mm mesh. These were processed and kept onboard as low value product (category RY1 – 0-300 g). A significant proportion of these skates were at length below 50% maturity – *i.e.* never given the opportunity to reproduce.
5. When all mesh sizes are considered, skate numbers and weights remained consistent in terms of larger individuals (>50 cm DW). However, in Areas 1 and 2 the effectiveness of the 400 mm mesh was higher than that of 300 mm, as the reported weight for the product RY3 and RY4 (+500 g) was significantly larger when the 400 mm mesh was utilised.
6. The skate Box (Area 2) was the most productive area in terms of skate catch. However, it was surprising to see among large mature skates relatively small quantities of common skate species such as RBR, RFL, and in particular RGR, but relatively large proportions of typical bycatch species such as RMU and RBZ. This phenomenon needs further investigation, but it is **likely** that large commercial skate (RGR, RBR and RFL) decreased in abundance due to **extensive exploitation** in recent years, and have started to be substituted by RMU and RBZ.

Recommendations

1. 110 mm mesh size cod end is **NOT** recommended for the specialized skate fishery as it catches large quantities of commercial by-catch finfish species, as well as large quantities of undersized and non-commercial small skates.
2. 300 mm mesh size reduces by-catch of finfish species but retains a significant proportion of small sized skate (<45-50 cm DW) that have yet to attain their 50 % maturity size. Thus, for the sustainability of the skate assemblage, the 300 mm mesh is not recommended for the F-licensed fishery.
3. 400 mm mesh size cod end is recommend to be used in the F-Licensed fishery as it produces the same (or greater) amounts of large commercial sizes skates as both 110 mm and 300 mm mesh cod ends. Furthermore, 400 mm mesh dramatically decreases the number and volume of fin fish by-catch caught and also limits the catch of immature commercial and non-commercial skate species.