Final Report

Spurdog, Porbeagle and Common Skate Bycatch and Discard Reduction

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In memory of "Coxy the Shark Hunter"



We dedicate this report to the memory of Anthony Cock ("Coxy"), an experienced fisherman and supporter of scientific endeavour, and a respected crew member of the FV "Charisma", who passed away in June 2012

Spurdog, Porbeagle and Common Skate Bycatch and Discard Reduction 2011–2012

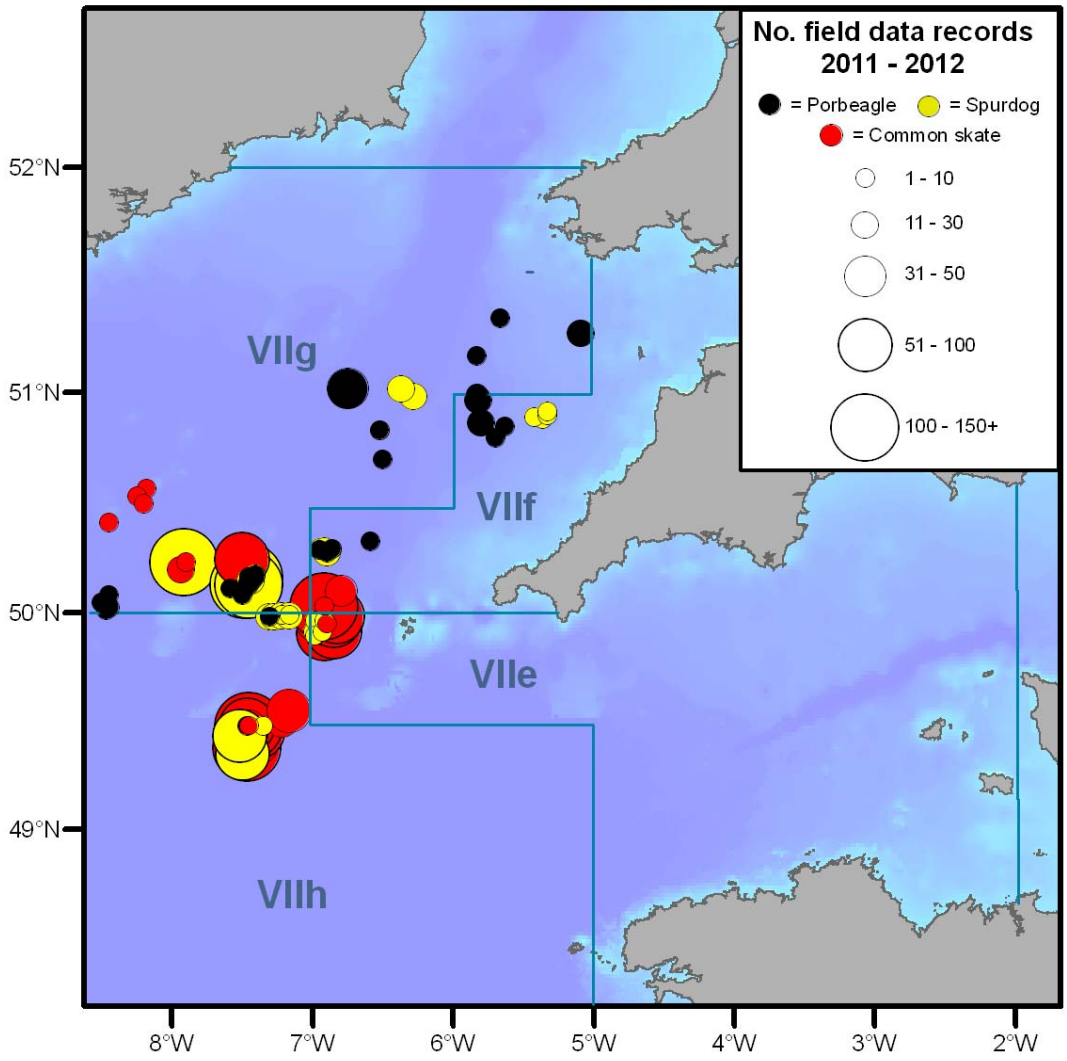
Executive Summary

The primary aim of this project was to collect field data on the numbers of elasmobranchs of both commercial and conservation interest (porbeagle *Lamna nasus*, common skate *Dipturus batis* 'complex' and spurdog *Squalus acanthias*) taken as bycatch in commercial net (gill, trammel and tangle) fisheries off Cornwall (ICES Division VIIe-h), and their survivability (health condition prior to discarding). Two commercial netters (FV "Charisma" and FV "Govenek of Ladram") were chartered to undertake field studies between August 2011 and March 2012. In all, field data were collected for 389 spurdog (135 females, mean length 79 ± 14 cm; 249 males, mean length 76 ± 7cm; 5 unknown), 20 porbeagle (seven females, mean length 183 ± 45 cm; ten males, mean length 174 ± 25 cm; and three which were lost in hauling) and 1206 common skate *D. batis* 'complex' (608 females, mean length 118 ± 20 cm; 598 males, mean length 114 ± 17 cm).

Survival rates were consistently high for common skate (1154 alive; 92%) and spurdog (283 alive; 73%) prior to discarding. Survival rates of porbeagle were lower, with only four (20%) recorded alive prior to discarding. Of the recorded live bycatch, 195 spurdog (63 females and 132 males), three porbeagle (two males and one female) and 423 common skate (219 females and 204 males) were tagged with external marker ID tags (button sure-tags and roto-tags) prior to release. Additionally, 58 spurdog (26 females and 32 males), one male porbeagle and 11 common skate (seven males and six females) were tagged externally with electronic data storage tags (DSTs). To date (30 April 2012), seven external identification tags have been returned from common skate (five by French trawlers and two by English gillnetters), all captured between 10 and 46 km from the original area of release. Four electronic tags have also been returned (three from spurdog and one from a porbeagle), from fish captured between 10 and 251 km from the original area of release, and collecting over 220 days of seasonal depth and temperature data.

In addition to chartered field studies, FV "Charisma", FV "Govenek of Ladram" and FV "Berlewen" voluntarily trialled a shark bycatch recording scheme during October and November 2011. A total of 23 record cards was returned providing information for individual and multiple shark bycatch incidents during normal commercial fishing operations. Bycatch recordings of individual porbeagle were widely distributed throughout ICES Divisions VIIf-g during October and November 2011, although large quantities were recorded of between 5 and 50 individuals during October 2011. Large-quantity catches were also recorded for common skate (up to 40 individuals) in October and for spurdog (150–200 individuals) in November 2011.

The figure below summarises field data collected during the study, showing the numbers of spurdog, porbeagle and common skate recorded overall.



Spatial distribution and quantity of spurdog, porbeagle and common skate bycatch recorded in FSP trips (May 2011 to March 2012).

Spurdog, porbeagle and common skate bycatch and discard reduction

1. Introduction

In January 2003, the Government announced a package of funding for the fishing industry, which included £1 million in that financial year for fishers and scientists to work in partnership. Following the announcement, industry and Cefas developed a programme to improve knowledge of our fish stocks. The Fishery Science Partnership (FSP) has successfully undertaken work on a variety of fish stocks and fisheries (see Armstrong *et al.*, 2005, 2008), including three previous studies specifically addressing elasmobranch fish (Catchpole *et al.*, 2007; Ellis *et al.*, 2008a, 2010).

Elasmobranchs are susceptible to overfishing, because they are long-lived and slow-growing, typically with low fecundity, late age at maturity and prolonged gestation period. Further, many species aggregate, rendering them vulnerable to various fishing gears.

Fishers off SW England have historically had important target and non-target fisheries for various elasmobranchs, including spurdog, porbeagle and common skate. However, because of their vulnerability to fishing and slow recovery from population depletion, spurdog *Squalus acanthias*, porbeagle *Lamna nasus* and common skate *Dipturus batis*-complex are now all listed as Critically Endangered in the Northeast Atlantic by the International Union for Conservation of Nature (IUCN).

European Commission (EC) regulations have recently been put in place to conserve these stocks, resulting in the closure of their target fisheries, but also preventing the landing of bycatch. The total allowable catches (TACs) for some elasmobranchs of conservation interest are currently set to zero, as in the case of porbeagle and spurdog, and that of some other elasmobranchs are now listed on the TAC and quota regulations as 'Prohibited species' (e.g. common skate); this has resulted in these species being discarded in commercial fisheries. However, these species can be sufficiently locally and/or seasonally common in the Celtic Seas that bycatch can be significant. Some local fishers feel that current regulations on these stocks are not fully effective, and that scientific knowledge and data are too limited. There is therefore a need to gain better understanding of current shark bycatch off SW England with the aim of reducing bycatch mortality and its potential impact on the stocks.

ICES advice and current regulations for spurdog

The International Council for the Exploration of the Seas (ICES) first established a Study Group on Elasmobranch Fisheries (SGEF) in 1989 and, although SGEF considered that there were insufficient data to undertake a formal stock assessment for spurdog, they did recommend "*that ACFM (the Advisory Committee on Fishery Management) consider the introduction of a precautionary TAC (total allowable catch) in order to inhibit any excessive expansion of directed fisheries*" (ICES, 1989). It was not until 2000 that a TAC was established, and this only covered EC waters in the North Sea (ICES Division IIa and subarea IV), despite the fact that there was considered to be a single stock in the Northeast Atlantic (Vince, 1991),

The ICES Working Group on Elasmobranch Fishes (WGEF) started to report to ACFM in 2005, and has gradually provided advice for a greater range of elasmobranch stocks, with most advice biennial and, pending comments by the STECF (the European Union's Scientific, Technical and Economic Committee of Fisheries) informing on TAC and quota regulations. A summary of ICES advice for spurdog is given in Appendix 1.

The work of the ICES WGEF included several exploratory assessments (Pawson *et al.*, 2009; ICES, 2011). One of these (Hammond and Ellis, 2005) suggested that the spurdog stock may have declined by up to 95%. Despite the assumptions and caveats in such models, this decline was used by the International Union for Conservation of Nature (IUCN) to justify listing the Northeast Atlantic spurdog stock as 'Critically Endangered' (Fordham *et al.,* 2006), although it should also be acknowledged that the IUCN listing for spurdog worldwide is 'Vulnerable'.

More recent biological studies on spurdog suggest that fecundity may have increased over time (Ellis and Keable, 2008). Subsequently, assessment models have been developed for spurdog that use these data, and include an increase in pup production as the stock decreases. These models indicate that the total biomass in 2011 relative to 1905, probably ranged from 13–18% (De Oliveira *et al.*, 2010; ICES, 2011). This model has now been benchmarked by ICES and the decline suggested (about 85%) would justify an IUCN listing of 'Endangered', but would not support a listing of 'Critically Endangered'. Additionally, forward projections of the model suggest that restricted spurdog landings (e.g. 1000 t) should still allow some population growth. In contrast, the magnitude of landings reported from the 1980s (when there were still target fisheries) would reduce the stock further still.

A management plan for spurdog is clearly required, and the biological characteristics of the species indicate that rebuilding the stock will take considerable time. Although the target fishery for spurdog has now ceased, the zero TAC has resulted in bycatch, including dead bycatch, having to be discarded.

ICES advice and current regulations for common skate

The ICES advice for demersal elasmobranchs has consistently held the position that common skate is depleted, as evidenced by its loss from former range. A summary of ICES advice for common skate is given in Appendix 2. Although ICES has advised that common skate should not be subject to target fisheries, in response to a question from the EC as to whether or not common skate should be included on the list of Prohibited Species, ICES (2010) advised that "*There is no basis in the current or previous ICES advice for the listing of the common skate (*Dipturus batis*) as a prohibited species*".

In terms of common skate, it should be noted that what was once considered to be a species is now viewed as a species complex. Although early ichthyologists differentiated between blue or common skate and flapper skate, a taxonomic revision of European skates in the 1920s combined these species as common skate *Raja batis.* Subsequent taxonomic work differentiated the rajids into various genera, and the common skate was renamed *Dipturus batis.* Scientists have found genetic differences in specimens of "*Dipturus batis*", and subsequently gave distinguishing characteristics for the two nominal species (Iglésias *et al.*, 2010). The nomenclature of the 'common skate complex' is still being updated, so the scientific name '*Dipturus batis'* may soon be an invalid synonym. Taxonomists working on the problem have proposed that former scientific names should be resurrected for these two species:

Dipturus cf. *flossada* and *D.* cf. *intermedia*, but this proposed change needs to be validated by the International Commission on Zoological Nomenclature (Iglésias *et al.*, 2010). A second study undertaken independently confirmed the genetic differences (Griffiths *et al.*, 2010), and also highlighted geographical differences in the current distributions of the two species. The larger flapper skate was reported mostly off Scotland, whereas the smaller blue skate was more abundant on the Rockall Bank and in the Celtic Sea.

ICES advice and current regulations for porbeagle

Porbeagle is known to be susceptible to overfishing, as evidenced by the crash in the Norwegian fishery. Porbeagle is a long-lived species that produces very few young (Francis and Stevens, 2000; Jensen *et al.*, 2002; Natanson *et al.*, 2002; Cassoff *et al.*, 2007). This biological vulnerability and the documented crash in the Norwegian fishery were used by the IUCN to list Northeast Atlantic porbeagle as 'Critically Endangered' (Stevens *et al.*, 2006).

ICES advice (summarised in Appendix 3) is based largely on the precautionary approach, and has generally advised along the lines of "*Given the state of the stock, no targeted fishing for porbeagle should be permitted and bycatch should be limited and landings of porbeagle should not be allowed*". ICES, however, also advised that "*It is recommended that exploitation of this species should only be allowed when indicators and reference points for stock status and future harvest have been identified and a management strategy, including appropriate monitoring requirements, has been decided upon and is implemented".*

In order to better assess and advise on the status of porbeagle stocks in the Atlantic, a joint meeting was held of the ICES WGEF and the ICCAT shark subgroup (ICCAT, 2009; ICES, 2009). During that meeting, analyses of the catch per unit effort (cpue) in the French longline fishery were examined, and exploratory assessments were undertaken using a Bayesian Surplus Production (BSP) model and an age-structured production model.

From this work, ICES (2009) noted that "*The projections (using the BSP model) were that sustained reductions in fishing mortality would be required if there is to be any stock recovery. Recovery of this stock to B_{MSY} under zero fishing mortality would take ca. 15–34 years. Although model outputs suggested that the current TAC (436 t) may allow the stock to remain stable, at its current depleted biomass level, under most credible model scenarios, catches of 200 t or less resulted in higher probabilities of recovery to B_{MSY} within 25–50 years under nearly all model scenarios*."

Despite attempts to assess the stock, there are fundamental problems in that (a) available catch data were considered underestimates, (b) the projections were based on the BSP model, and this model was generally more optimistic than the age-structured production model, and (c) the index of cpue for the French fleet was for a target fishery actively seeking areas of high catch rates, so may not reflect true stock abundance. Hence, model outputs were considered highly uncertain (ICES, 2009). The absence of any fishery-independent data on the status of the stock and the lack of recent fishery-dependent information restricts further options for assessing it.

Aims of the present study

The primary objective of this project was to collect field data on the numbers of elasmobranchs of conservation interest (porbeagle, common skate and spurdog) taken as bycatch in offshore gillnet fisheries, and their survivability (i.e. health prior to discarding).

In all, five main project aims were set to deliver the following:

- conduct seasonal fishery-dependent surveys of ICES areas VIIe-j to improve our knowledge and understanding of catches of spurdog, porbeagle and common skate in relation to target species, and their survival;
- undertake biological sampling of spurdog, porbeagle and common skate bycatch, to enhance the biological understanding of the species (e.g. sex ratio, size composition, age and growth, reproductive state, and stock structure) which can inform on stock assessments and management;
- assess options for reducing the impact of discarding;
- initiate a tag-and-release programme for the three species of interest, including the training of vessel crew in shark handling, tagging and release procedures to maximize the chances of live discarding and survival;
- trial simplistic logbooks/self-sampling schemes to collect information on the quantities (sizes and sex ratio) of the three species, with the potential of creating preliminary fishery-dependent indices of relative abundance.

To achieve this, three survey components were advanced:

(1) to monitor porbeagle bycatch with commercially rigged gillnets under commercial conditions in August/September 2011;
(2) to monitor common skate bycatch with commercially rigged trammel-/tanglenets under commercial conditions in August/September 2011.
(3) To monitor spurdog bycatch with commercially rigged gillnets under commercial conditions between October 2011 and March 2012

This report focuses on the percentage bycatch of sharks and their survival prior to discarding during commercial fishing operations together with external mark ID tag and data storage tag (DST) releases during the study and preliminary returns to date.

The Detailed Operational Plans (DOP) prior to each survey were finalized between Cefas and the skipper of the FV “Charisma”, John Walsh, and the skipper of the FV “Govenek of Ladram”, Phillip Mitchell (Appendix 4.)

2. Methods

2.1 Seasonal fishery-dependent surveys of ICES areas VIIe-j

Three field studies were designed to collect data on current levels of spurdog, porbeagle and common skate bycatch in relation to commercial target species in offshore net fisheries off Cornwall (ICES Division VIIe-j), and to assess their survival prior to discarding. In all, 20 days at sea were split between three commercial fishing trips to coincide with the seasonal abundance of common skate, porbeagle and spurdog bycatch, as shown Table 1.

Table 1. Summary of vessels and gears used for each of the three field studies.

Field study	Vessel	Port	Gear	Dates of fieldwork	No. days
Common skate bycatch	FV "Govenek of Ladram"	Newlyn	Trammelnet	19–26 August 2011	7
Porbeagle Bycatch	FV "Charisma"	Padstow	Gillnet/hake net	19–25 September 2011	7
Spurdog Bycatch	FV "Charisma"	Padstow	Gillnet/hake nets	26 February–2 March 2012	6

Areas fished for the three field studies were based upon years of local knowledge and the experience of the skippers in relation to seasonal occurrence of the three species in relation to commercial target fisheries within the Celtic Sea (Figure 1).

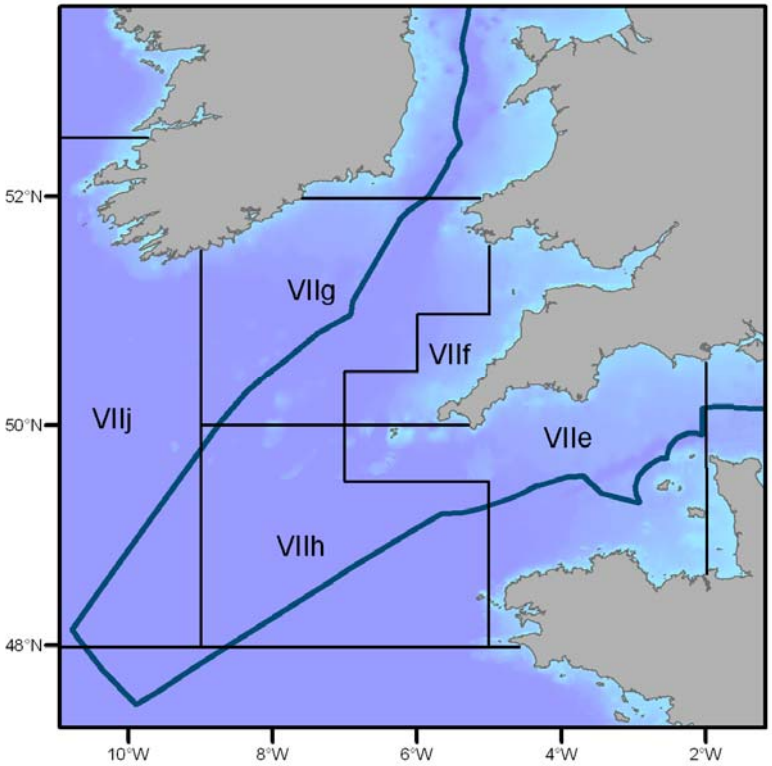


Figure 1. Fishing area of operation showing ICES Divisions VIIe-j (black boundary lines), with UK fisheries boundary limits as a blue line.

Fishing vessels and gears

FV “Charisma” (Figure 2a) is a 16.6 m gillnetter operating out of Newlyn and Padstow, Cornwall. The skipper John Walsh, has fished the grounds within the southwest approaches and off the north and south Cornish coasts for the plast 20 years and has considerable experience and knowledge of porbeagle, spurdog and common skate seasonal bycatch in relation to targeted species of commercial whitefish. The fishing gear used throughout both the porbeagle and spurdog bycatch field studies was 150 gillnets of 120 mm mesh size and 3600–4800 m in length. Fishing activity per day was aimed to allow for approximately five variable soak times, to assess the survival of porbeagle and spurdog bycatch in relation to soak time.

FV “Govenek of Ladram” (Figure 2b) is a 22.7 m long gillnetter operating out of Newlyn, Cornwall. The skipper, Phillip Mitchell, has fished the grounds within the southwest approaches and off the north and south Cornish coasts for the past 20 years and has considerable experience and knowledge of porbeagle, spurdog and common skate seasonal bycatch in relation to targeted species of commercial whitefish. The fishing gears used throughout the common skate bycatch field study were 400 trammelnets (250–300 mm mesh size inners), 150 gillnets (120 mm mesh size) and 50 wrecknets (140 mm mesh size). Fishing activity per day was aimed to allow for approximately five variable soak times, to better understand the survivability of common skate and spurdog bycatch.



Figure 2. Vessels used during the project, a) FV “Charisma”, b) FV “Govenek of Ladram”.

Seasonal common skate bycatch study in ICES Divisions VIIe-h aboard FV "Govenek of Ladram" (August 2011)

A seasonal common skate bycatch field study was undertaken aboard FV "Govenek of Ladram" for 7 days between 19 and 26 August 2011. During the field study, a total of 33 locations was fished (Figure 3) with a mixture of gears, including 12 wrecknets, two fixed gillnets and 18 trammelnets, which were shot during the day and night and left to soak for 12–60 h before being hauled.

During normal commercial practice, the vessel would typically undertake a mixed target fishery for anglerfish *Lophius piscatorius*, hake *Merluccius merluccius,* pollack *Pollachius pollachius* and cod *Gadus morhua,* for 8–10 days during neap tides in an area bounded by 48º30'−51º20'N 04º00'−10º00'W. For the purpose of the field study, a wide area was fished within these grounds, following normal commercial practice with some shortened soak times to address the survivability of common skate bycatch prior to discarding.

Prior to the scheduled seasonal field study an additional observer bycatch trip was also undertaken between 1 and 5 May 2011 to record the numbers of common skate bycatch and survival rates within ICES Division VIIg, during normal commercial fishing operations. Numbers and survival rates of common skate during this additional trip are included within the results of this study.

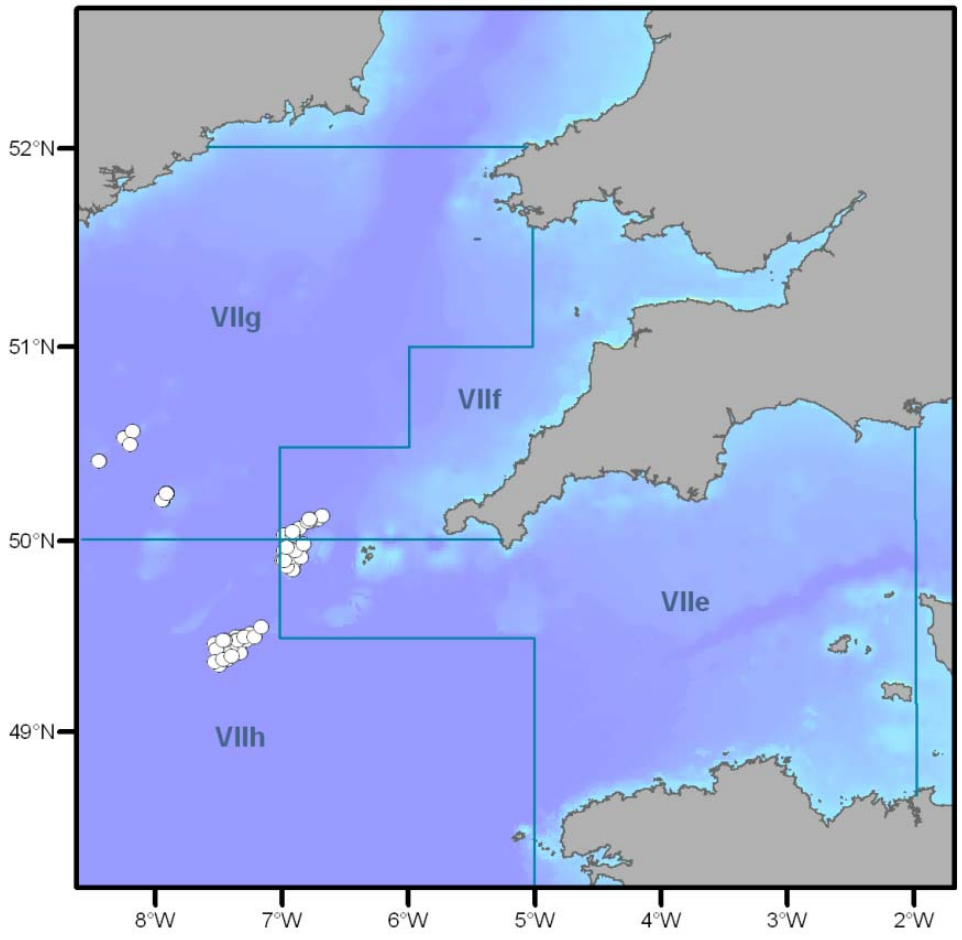


Figure 3: Location of fixed trammel-, gill- and wrecknet studies undertaken off Cornwall in ICES Division VIIe-h aboard FV "Govenek of Ladram" in May and August 2011.

Seasonal porbeagle bycatch study in ICES Divisions VIIf-h aboard FV "Charisma" (September 2011)

A seasonal porbeagle bycatch field study was undertaken aboard FV "Charisma" for 7 days between 19 and 25 September 2011. During the field study, a total of 21 locations was fished with fixed gillnets (Figure 4), which were all shot at night and left to soak for 12–21 h before being hauled.

During normal commercial practice the vessel would typically undertake a mixed target fishery for hake, Pollack and cod, for 6–7 days during neap tides in an area bounded by 48º30'−51º20'N 04º00'−10º00'W. For the purpose of the field studies, a wide area was fished within these grounds, under normal commercial operations, with shortened soak times to address the survivability of porbeagle bycatch prior to discarding.

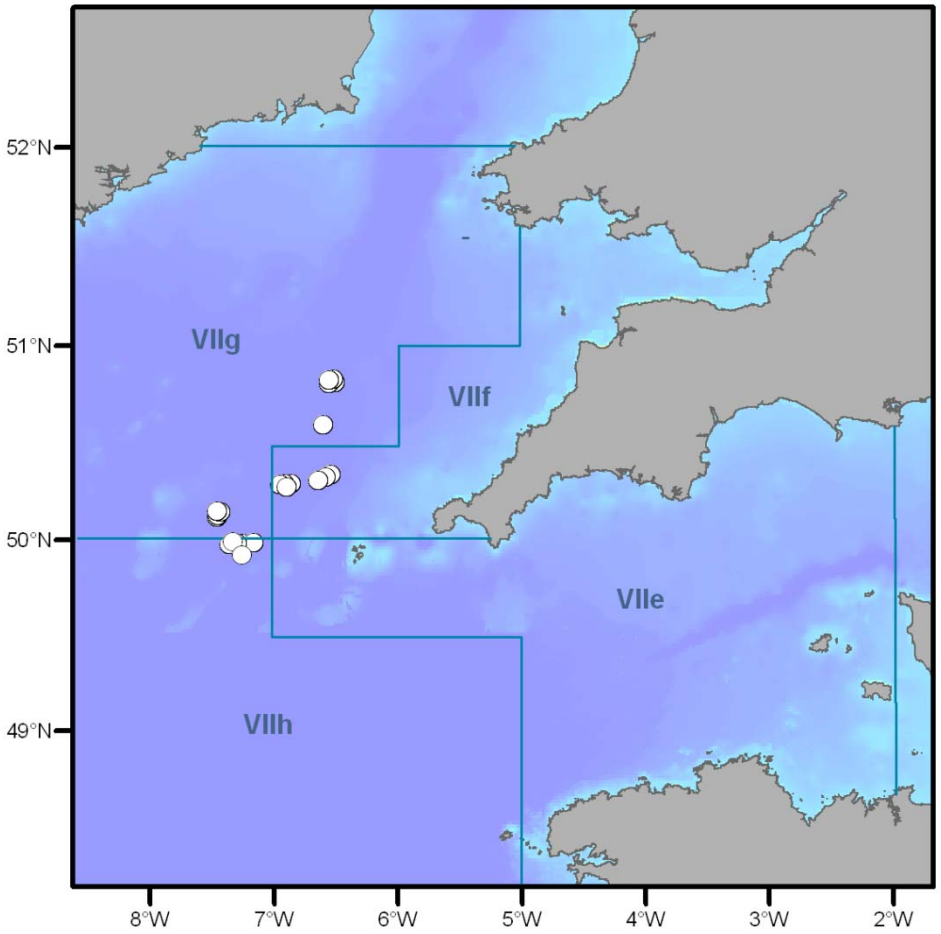


Figure 4. Location of fixed gillnet studies undertaken off Cornwall in ICES Divisions VIIf-h, aboard FV "Charisma" (September 2011).

Seasonal spurdog bycatch study in ICES Divisions VIIf-g aboard FV "Charisma" (February–March 2012)

A seasonal spurdog bycatch field study was undertaken aboard FV "Charisma" for 6 days between 26 February and 2 March 2012. During the field study, a total of 17 locations was fished with fixed gillnets (Figure 5), which were all shot at night and left to soak for 12–45 h before being hauled.

During normal commercial practice the vessel would typically undertake a mixed target fishery for hake, Pollack and cod for 6–7 days during neap tides in an area bounded by 48º30'−51º20'N 04º00'−10º00'W. For the purpose of the field studies, a wide area was fished within these grounds, under normal commercial practice with shortened soak times to address the survivability of spurdog bycatch prior to discarding.

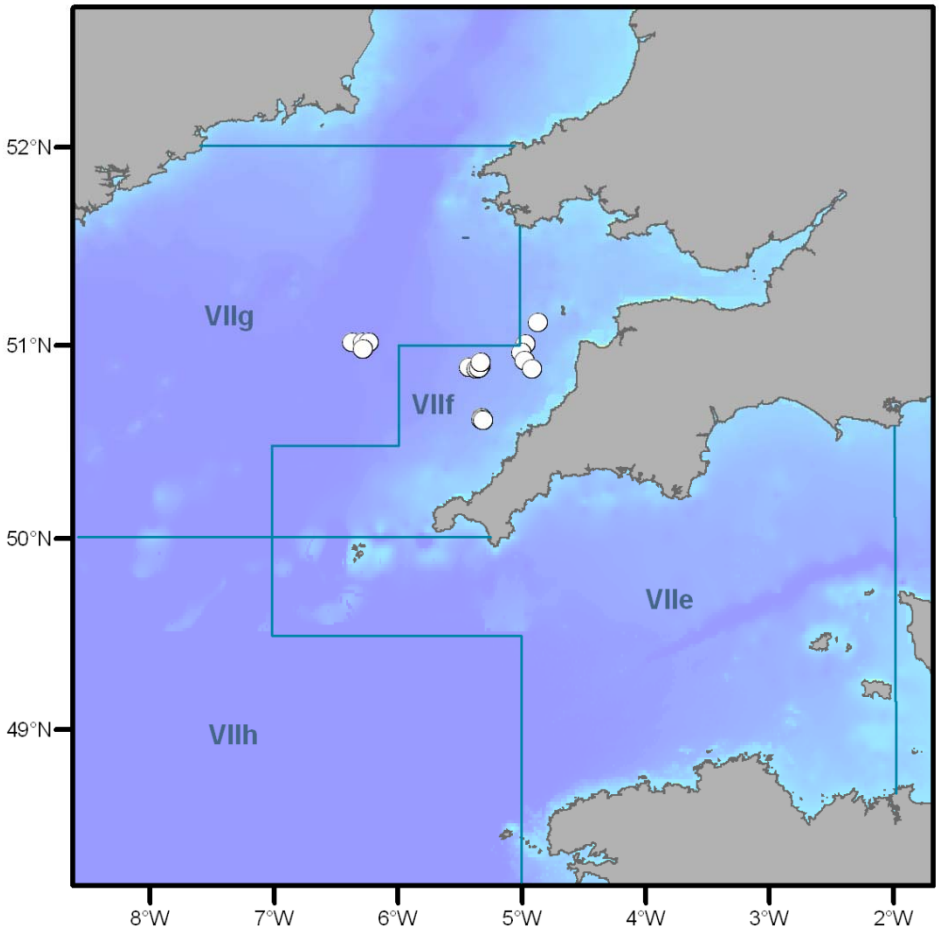


Figure 5. Location of fixed gillnet studies undertaken off Cornwall in ICES Divisions VIIf-h, aboard FV "Charisma" (February–March 2012).

Collecting field data

In order to improve knowledge and understanding of catches of spurdog, porbeagle and common skate in relation to commercial target species, entire catches for each fished location during field studies were recorded by species and measured (total

length, to the cm below), before either being retained as commercial catch or classed as discarded bycatch.

All bycaught porbeagle, spurdog and common skate were additionally measured (by total length; fork length / wing width; pre-dorsal girth), sexed (maturity recorded, where possible) and scored on health state condition (i.e. lively, sluggish, very sluggish, dead, or scavenged), before being returned to sea. Where possible any dead porbeagle, spurdog or common skate were sampled biologically in order to determine sexual maturity, stomach content, age (by obtaining a section of vertebral column for future age determination studies) and stock identity (by obtaining a finclip for future genetic studies).

For common skate (*D. batis*), identification by subspecies − blue skate (*D.* cf. *flossada*) and flapper skate (*D.* cf. *intermedia*) − was undertaken using the guidelines detailed in Appendix 5.

Tag-and-release programme

Additionally, porbeagle, spurdog or common skate considered to be lively and in good condition were tagged with either an external mark ID tag or electronic data storage tag (DST). Individuals suitable for tagging were measured and sexed, before being placed onto a foam block where their gills and head were covered with a towel (kept wet with seawater). In the case of porbeagle, a seawater hose was placed into the mouth for continuous flow of seawater over the gills. External roto-tags were placed directly into the dorsal fin for porbeagle and spurdog, while external DSTs were attached by a dart tag just below the dorsal fin through the dorsal muscle. For common skate, button suretagsand DSTs were placed directly onto the wing. Where possible, tag training of vessel crew in shark handling, tagging and release procedures was undertaken to maximize the chances of future live commercial discarding and survival of shark bycatch.

Reward scheme

In order to encourage the recovery of information on the recaptured tagged porbeagle, spurdog and common skate, a reward scheme was established throughout the commercial fisheries of the UK and the EU, with the intention of raising the profile of Cefas' shark-tagging work within the local fishing industry and detailing how to return tags back to the Cefas Laboratory. Reward posters were distributed widely to the local offices of the Marine Management Organization (MMO) and Inshore Fisheries and Conservation Authorities (IFCAs). Tag-return information can be supplied via the tag-reporting hotline, by post, or on the internet (see www.cefas.co.uk/fishtagreturns).

Tag returns

For all tags returned, as much recapture information as possible was obtained, including the receiving port, tag number, vessel name and nationality, gear type, date, capture position (latitude and longitude), and any other relevant information.

When all the recapture information had been processed, a reward of £10, any postage costs, a promotional T-shirt, posters and project summary were sent to the

returnee with a letter of thanks. If a DST-tagged shark was returned, a reward of €100 was paid along with entry into the Cefas Annual Tag Lottery prize draw of £1000.

2.2 Trial of simplistic self-sampling scheme: shark bycatch record cards

Shark bycatch record cards (Figures 6, 7) were designed specifically for this study in order to collect information on the quantities (sizes and sex ratio) of porbeagle, spurdog and common skate bycatch taken during normal fishing operations in October and November 2011. Record cards were distributed to three fishing vessels operating off the SW coast (FV “Charisma”, FV “Berlewen” and FV “Govenek of Ladram”). The trial aimed to demonstrate the potential of creating preliminary fishery-dependent indices of relative abundance based on voluntary recorded information from SW fishers.

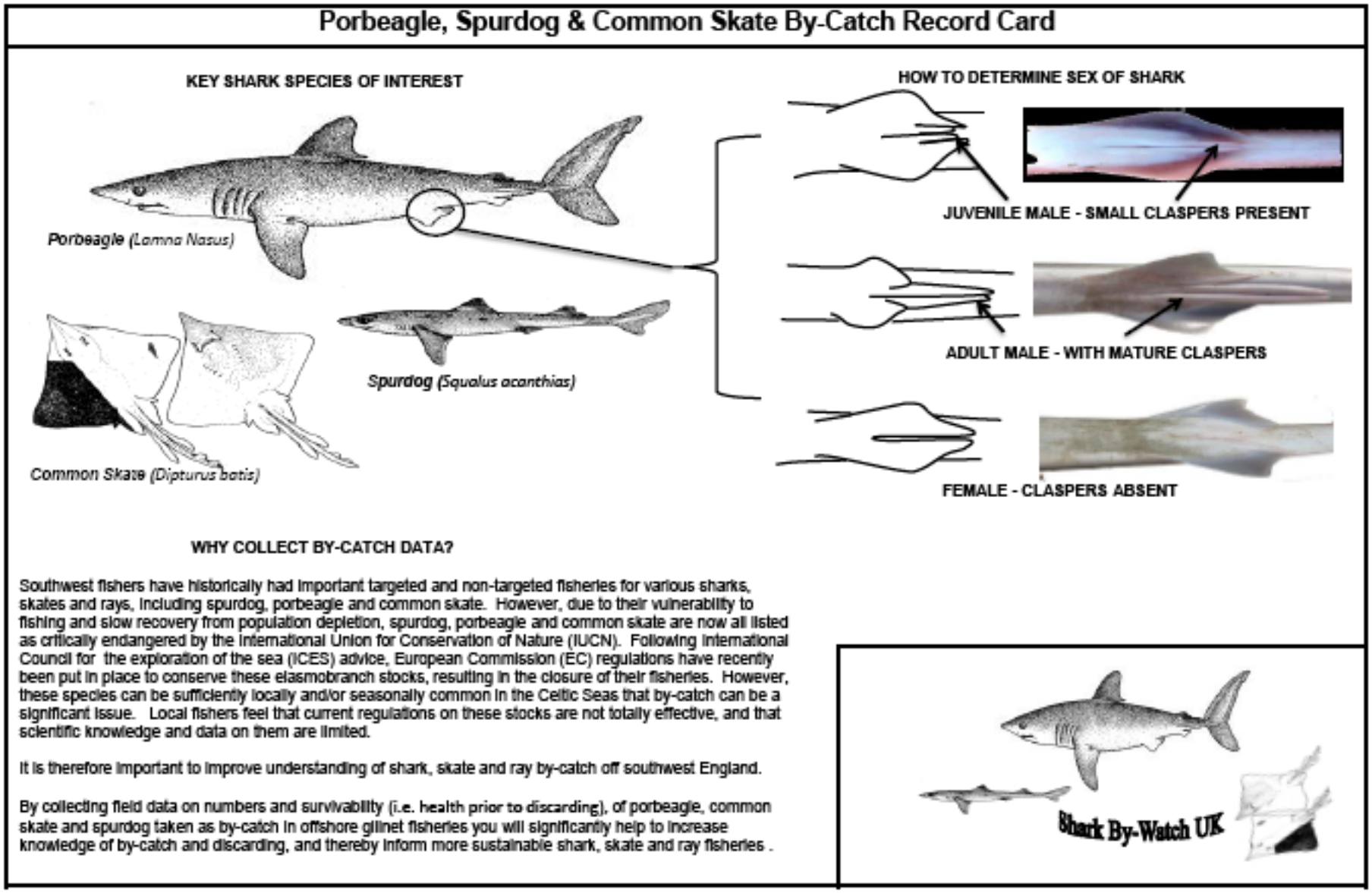


Figure 6. Front of shark bycatch record card design

a)

Date of trip:	Vessel Name / Number	Position: (ICES rectangle / lat & long)
	CHARISMA / BA45	

Fishing gear used (Circle):	Size of mesh:	Please specify soak time of gear (e.g. 24hr)
Gill Trammel Tangle		

Species (Circle)	Sex of catch (Circle)	Discarded (circle)
Common Porbeagle Spurdog Skate	Mostly males Mostly females Mixed catch	Mostly dead Mostly alive Mix of dead & alive

Approx number of fish under 1 metre in total length (Circle)	Aprox number of fish over 1 metre in total length (Circle)	Approx time of discard after hauling
5-10 10-50 50-100 100+	5-10 10-50 50-100 100+	

Any additional comments: (e.g. Exact numbers of sharks, condition, parasites, in pup etc)

b)

Date of trip:	Vessel Name / Number:	Skipper:
	CHARISMA / BA45	JOHN WALSH

Position: (ICES rectangle / lat & long)	Fishing gear used (Circle):	Size of mesh:-
	Gill Trammel Tangle	

Species (Circle)	Sex	Total Length (Circle)
Common Porbeagle Spurdog Skate	Male Female Unknown	<50cm <1 metre >1 metre >2 metres

Any additional comments: (e.g. condition of shark, parasites, exact total length, in pup etc)

Please specify soak time of gear (e.g. 24hr)	Discarded (circle)	Approx time of discard after hauling
	Alive Sluggish Dead	

Figure 7. Example of shark bycatch record designs (a) for recording large quantities of shark bycatch and (b) for recording individual shark bycatch.

3. Results

3.1 Seasonal common skate bycatch study in ICES Divisions VIIe-h aboard FV "Govenek of Ladram" (August 2011)

Overall target and bycatch species composition

The number and percentage of the total catch hauled aboard FV "Govenek of Ladram" from 19 to 26 August 2011 is shown in Table 2. Detailed target and bycatch species compositions by gear type (gill nets & trammel nets) are given in Appendix 6.

In all, 1201 common skate, *D. batis* 'complex' (1193 *Dipturus* cf. *flossada*; eight *Dipturus* cf. *intermedia*) made up 40% of the total number of fish captured during the survey and accounted for 77.6% of the total number of discarded bycatch. In addition 149 spurdog (accounting for ~5% of the total catch and 9.6% of total discarded bycatch) and one porbeagle shark (accounting for 0.03% of total catch and 0.06% of total discarded catch) were also captured during the 7-day field study.

Overall a total of 1529 elasmobranchs was captured during the trip, accounting for 51% of the total number of fish caught Of these, 1462 individuals were discarded, accounting for 94% of the total discarded bycatch (by numbers). Roundfish (*n* = 74, 5%), shellfish (*n* = 9, 0.7%) and flatfish (*n* = 3, 0.2%) accounted for the remainder of discarded bycatch (shown in Figure 8).

The species composition of discarded elasmobranch bycatch was predominantly common skate (*n* = 1201, 81%), followed by spurdog (*n* = 149, 10%) and lesser-spotted dogfish (*n* = 100, 7%). The remaining 2% consisted of a wide variety of elasmobranchs, such as cuckoo ray and six-gill shark. It should be noted that most of the discarded elasmobranchs were returned to sea alive.

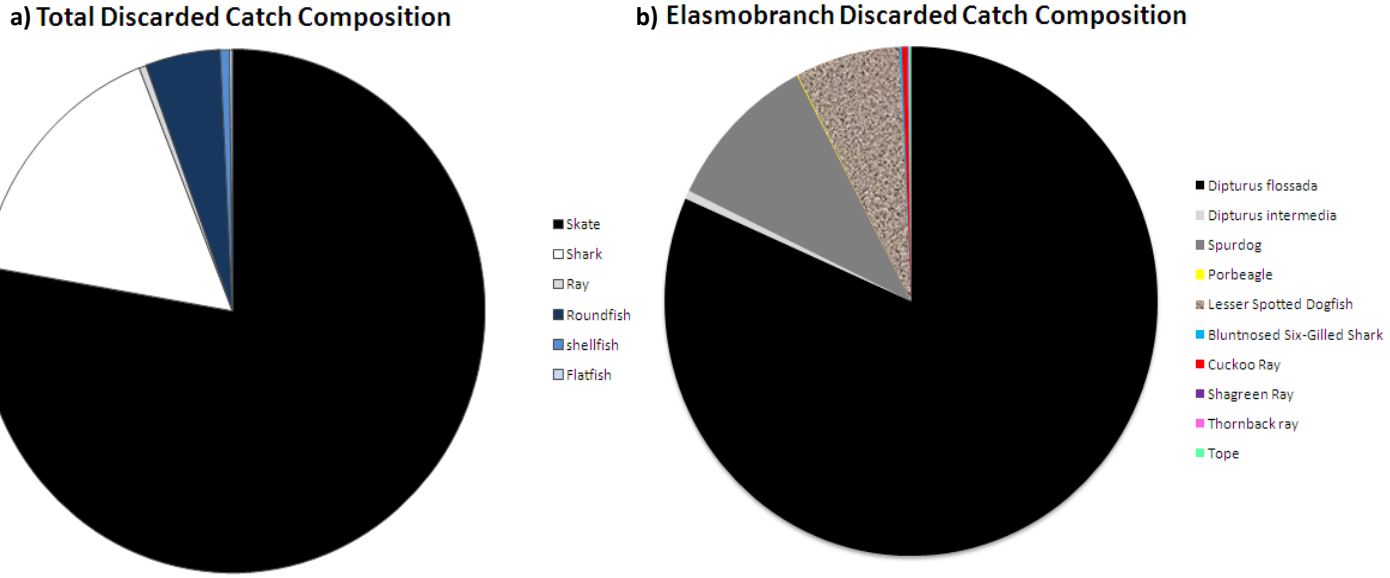


Figure 8. Discarded catch composition for 33 fixed net locations over the field study aboard FV "Govenek of Ladram", showing (a) total discarded catch composition by species group and (b) species composition of discarded elasmobranchs.

Table 2. Species composition (numbers and %) for total catches, and retained/discarded parts of the catch, observed for 33 sites fished with fixed nets during a field study aboard FV "Govenek of Ladram". Grey shading highlights shark species of interest and yellow shading the most abundant target species captured and retained.

Species	Total catch			Retained catch			Discarded catch		
	N°	%	Length range (cm)	N°	%	Length range (cm)	N°	%	Length range (cm)
Anglerfish	**90**	**3.02**	**29–135**	**90**	**6.28**	**29–135**			
Anglerfish, black-bellied	**39**	**1.31**	**39–92**	**39**	**2.72**	**39–92**			
Bib	6	0.20	37–42	5	0.35	37–42	1	0.06	42
Blue shark	1	0.03	210	1	0.07	210			
Bluntnosed six-gill shark	2	0.07	120–133				2	0.13	120–133
Brill	1	0.03	63	1	0.07	63			
Cod	268	8.98	37–109	251	17.50	44–109	17	1.10	37–102
Conger eel	5	0.17	35–151	2	0.14	35–151	3	0.19	36–111
Crayfish	2	0.07	13.7–16.0	2	0.14	13.7–16.0			
Cuckoo ray	33	1.11	48–71	28	1.95	61–71	5	0.32	48–57
Dipturus* cf. *flossada	**1193**	**39.99**	**53–182**				**1193**	**77.07**	**70–148**
Dipturus* cf. *intermedia	**8**	**0.27**	**79–230**				**8**	**0.52**	**79–230**
Edible crab	**111**	**3.72**	**12.8–23.4**	**105**	**7.32**	**15.8–23.4**	**6**	**0.39**	**12.8–22.5**
Greater forkbeard	3	0.10	47–57	2	0.14	51–57	1	0.06	47–47
Grey gurnard	2	0.07	22–22				2	0.13	22–22
Haddock	**110**	**3.69**	**24–77**	**97**	**6.76**	**32–77**	**13**	**0.84**	**24–63**
Hake	**234**	**7.84**	**43–109**	**222**	**15.48**	**43–109**	**12**	**0.78**	**47–91**
John Dory	3	0.10	35–38	3	0.21	35–38			
Lesser-spotted dogfish	100	3.35	51–78				100	6.46	51–78
Ling	45	1.51	36–119	44	3.07	36–119	1	0.06	63
Lobster	16	0.54	10.2–14.9	14	0.98	10.2–14.6	2	0.13	10.4–14.9
Mackerel	6	0.20	28–32	2	0.14	30–32	4	0.26	28–32
Megrim	21	0.70	33–53	20	1.39	33–53	1	0.06	48
Plaice	1	0.03	59	1	0.07	59			
Pollack	**445**	**14.92**	**38–88**	**435**	**30.33**	**38–88**	**10**	**0.65**	**52–72**
Poor cod	10	0.34	16–20				10	0.65	16–20
Porbeagle	**1**	**0.03**	**206**				**1**	**0.06**	**206**
Red gurnard	1	0.03	40	1	0.07	40			
Shagreen ray	14	0.47	73–100	13	0.91	73–100	1	0.06	94
Spider crab	1	0.03	12.9				1	0.06	12.9
Spotted ray	16	0.54	51–74	16	1.12	51–74			
Spurdog	**149**	**4.99**	**56–107**				**149**	**9.63**	**56–107**
Thornback ray	9	0.30	75–116	8	0.56	75–116	1	0.06	107
Tope	2	0.07	63–78				2	0.13	63–78
Tub gurnard	2	0.07	50–54	2	0.14	50–54			
Turbot	32	1.07	40–117	30	2.09	40–67	2	0.13	83–117
Grand total	**2982**	**100.00**		**1434**	**100.00**		**1548**	**100.00**	

Variable soak time durations

During the 7-day field study, soak times were shortened wherever possible to 12–26 h from the typical commercial fishing operations of the vessel (typically between 36–48 h and 58–60 h). The species composition of the catches for 12–26 h, 36–48 h and 58–60 h soak times are shown in Tables 3–5. The numbers of roundfish, porbeagle, spurdog and other elasmobranch species caught during the field study are shown in Figure 9.

Overall, the total catch of common skate increased considerably with soak time, from 19% of total catch between 12 and 26 h, to 72% between 36 and 48 h and to 63% between 58 and 60 h. The total catch of preferred commercial species, such as anglerfish, also increased with soak time, from 3% of total catch between 12 and 26 h, to 6% between 36 and 48 h and to 7% between 58 and 60 h.

Table 3. Target and bycatch species composition for 12–26 h soak time of fixed nets, showing the number and percentage of species captured, retained and discarded, for 20 fixed net locations fished over the 7-day field study aboard FV "Govenek of Ladram".

12-26 h soak time	Total catch			Retained catch			Discarded catch		
Species	N°	%	Length range	N°	%	Length range	N°	%	Length range
Anglerfish	**32**	**1.79**	**29–117**	**32**	**2.83**	**29–117**	**10**	**1.53**	**52–72**
Anglerfish, black-bellied	**22**	**1.23**	**39–88**	**22**	**1.95**	**39–88**			
Bib	6	0.34	37–42	5	0.44	37–42	1	0.15	42–42
Blue shark	1	0.06	210	1	0.09	210			
Cod	**230**	**12.89**	**37–109**	**221**	**19.56**	**44–109**	**9**	**1.38**	**37–102**
Conger eel	4	0.22	35–151	2	0.18	35–151	2	0.31	36–41
Crayfish	2	0.11	13.7–16.0	2	0.18	13.7–16.0			
Cuckoo ray	8	0.45	48–69	6	0.53	63–69	2	0.31	48–52
Dipturus* cf. *flossada	**346**	**19.45**	**70–148**				**346**	**52.99**	**70–148**
Edible crab	**39**	**2.19**	**12.8–21.8**	**37**	**3.27**	**16.2–21.8**	**2**	**0.31**	**12.8–16.1**
Greater forkbeard	3	0.17	47–57	2	0.18	51–57	1	0.15	47–47
Grey gurnard	1	0.06	22				1	0.15	22–22
Haddock	**107**	**6.00**	**24–77**	**95**	**8.41**	**32–77**	**12**	**1.84**	**24–63**
Hake	**223**	**12.50**	**43–109**	**212**	**18.76**	**43–109**	**11**	**1.68**	**47–91**
John Dory	2	0.11	35–36	2	0.18	35–36			
Lesser-spotted dogfish	88	4.93	51–78				88	13.48	51–78
Ling	32	1.79	36–112	31	2.74	36–112	1	0.15	63–63
Lobster	7	0.39	10.4–14.9	5	0.44	10.7–13.2	2	0.31	10.4–14.9
Mackerel	4	0.22	28–32	1	0.09	30	3	0.46	28–32
Megrim	16	0.90	33–53	16	1.42	33–53			
Pollack	**427**	**23.93**	**38–88**	**417**	**36.90**	**38–88**	**10**	**1.53**	**16–20**
Poor cod	10	0.56	16–20						
Porbeagle	**1**	**0.06**	**206**				**1**	**0.15**	**206**
Red gurnard	1	0.06	40	1	0.09	40			
Shagreen ray	3	0.17	84–90	3	0.27	84–90			
Spotted ray	4	0.22	67–74	4	0.35	67–74			
Spurdog	**149**	**8.35**	**56–107**				**149**	**22.82**	**56–107**
Tope	2	0.11	63–78				2	0.31	63–78
Tub gurnard	2	0.11	50–54	2	0.18	50–54			
Turbot	11	0.62	42–65	11	0.97	42–65			
Grand total	**1783**	**100.00**		**1130**	**100.00**		**653**	**100.00**	

Table 4. Target and bycatch species composition for 36–48 h soak time of fixed nets, showing the number and percentage of species captured, retained and discarded, for 11 fixed net locations fished over the 7-day field study aboard FV "Govenek of Ladram".

36–48 h soak time	Total catch			Retained catch			Discarded catch		
Species	N°	%	Length range (cm)	N°	%	Length range (cm)	N°	%	Length range (cm)
Anglerfish	**46**	**4.84**	**57–135**	**46**	**21.00**	**57–135**			
Anglerfish, black-bellied	**11**	**1.16**	**49–78**	**11**	**5.02**	**49–78**			
Bluntnosed six-gill shark	2	0.21	120–133				2	0.27	120–133
Cod	**16**	**1.68**	**48–93**	**12**	**5.48**	**48–92**	**4**	**0.55**	**51–93**
Conger eel	1	0.11	111				1	0.14	111
Cuckoo ray	19	2.00	52–71	16	7.31	61–71	3	0.41	52–57
Dipturus* cf. *flossada	**690**	**72.56**	**53–182**				**690**	**94.26**	**53–182**
Dipturus* cf. *intermedia	**7**	**0.74**	**79–163**				**7**	**0.96**	**79–163**
Edible crab	**64**	**6.73**	**14.2–23.4**	**60**	**27.40**	**15.8–23.4**	**4**	**0.55**	**14.2–22.5**
Grey gurnard	1	0.11	22				1	0.14	22
Haddock	2	0.21	59–67	1	0.46	67	1	0.14	59
Hake	10	1.05	49–73	9	4.11	49–73	1	0.14	69
Lesser-spotted dogfish	12	1.26	61–72				12	1.64	61–72
Ling	12	1.26	78–119	12	5.48	78–119			
Lobster	7	0.74	10.7–14.6	7	3.20	10.7–14.6			
Mackerel	1	0.11	32	1	0.46	32			
Megrim	3	0.32	42–52	2	0.91	42–52	1	0.14	48
Plaice	1	0.11	59	1	0.46	59			
Shagreen ray	8	0.84	73–100	7	3.20	73–100	1	0.14	94
Spider crab	1	0.11	12.9				1	0.14	12.9
Spotted ray	12	1.26	51–71	12	5.48	51–71			
Thornback ray	9	0.95	75–116	8	3.65	75–116	1	0.14	107
Turbot	16	1.68	40–117	14	6.39	40–67	2	0.27	83–117
Grand total	**951**	**100.00**		**219**	**100.00**		**732**	**100.00**	

Table 5. Target and bycatch species composition for 58– 60 h soak time of fixed nets, showing the number and percentage of species captured, retained and discarded, for 2 fixed net locations fished over the 7-day field study aboard FV "Govenek of Ladram".

58–60 h soak time	Total catch			Retained catch			Discarded catch		
Species	N°	%	Length range (cm)	N°	%	Length range (cm)	N°	%	Length range (cm)
Anglerfish	**12**	**4.84**	**52–120**	**12**	**14.12**	**52–120**			
Anglerfish, black-bellied	**6**	**2.42**	**46–92**	**6**	**7.06**	**46–92**			
Brill	1	0.40	63	1	1.18	63			
Cod	**22**	**8.87**	**52–102**	**18**	**21.18**	**52–96**	**4**	**2.45**	**52–102**
Cuckoo ray	6	2.42	61–70	6	7.06	61–70			
Dipturus* cf. *flossada	**157**	**63.31**	**74–141**				**157**	**96.32**	**74–141**
Dipturus* cf. *intermedia	**1**	**0.40**	**230**				**1**	**0.61**	**230–230**
Edible crab	8	3.23	18.1–22.5	8	9.41	18.1–22.5			
Haddock	1	0.40	59	1	1.18	59			
Hake	1	0.40	85	1	1.18	85			
John Dory	1	0.40	38	1	1.18	38			
Ling	1	0.40	119	1	1.18	119			
Lobster	2	0.81	10.2–11.0	2	2.35	10.2–11.0			
Mackerel	1	0.40	31				1	0.61	31–31
Megrim	2	0.81	39–40	2	2.35	39–40			
Pollack	**18**	**7.26**	**58–76**	**18**	**21.18**	**58–76**			
Shagreen ray	3	1.21	83–91	3	3.53	83–91			
Turbot	5	2.02	43–53	5	5.88	43–53			
Grand total	**248**	**100.00**		**85**	**100.00**		**163**	**100.00**	

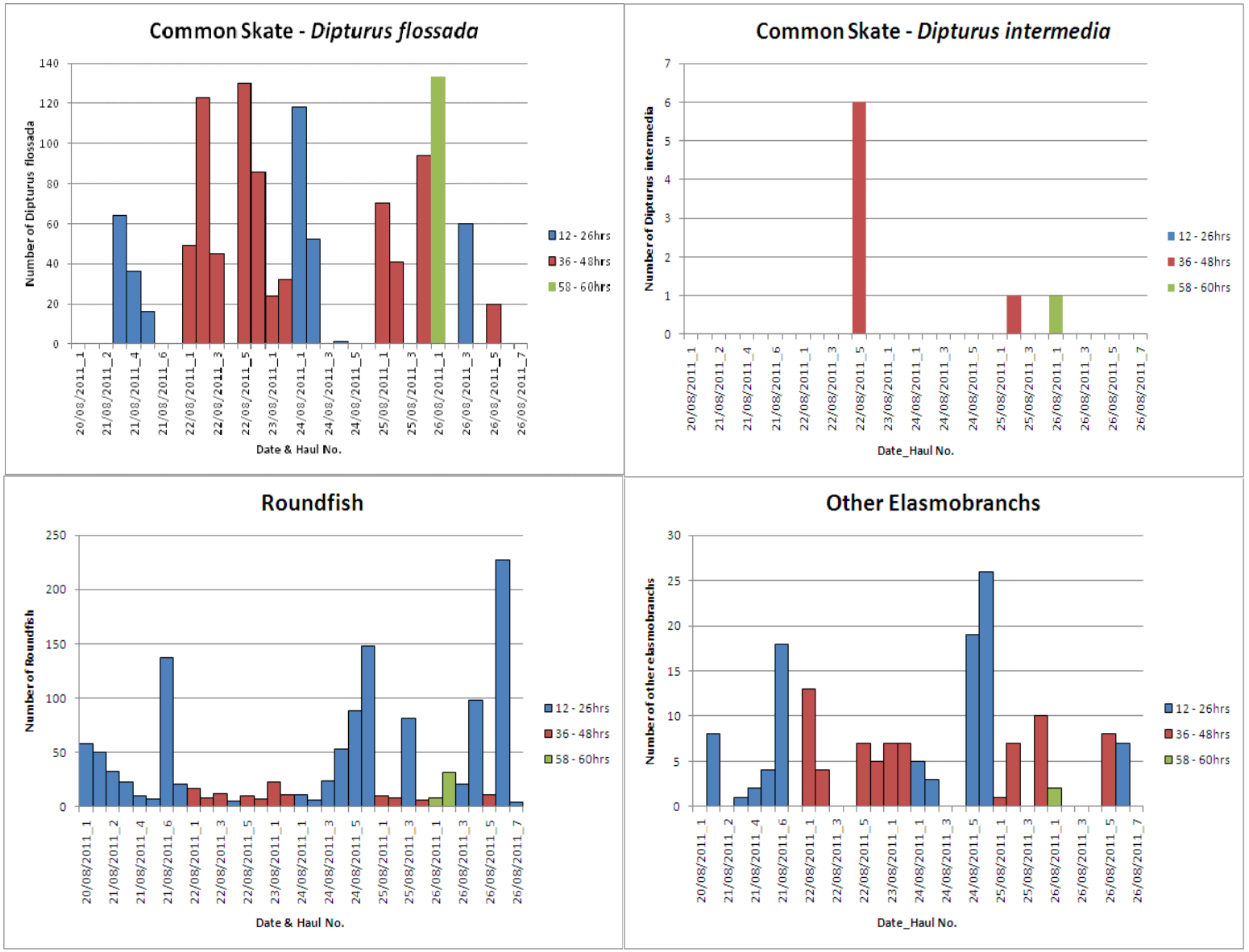


Figure 9. Numbers of common skate (a) *Dipturus* cf. *flossada,* (b) *Dipturus* cf. *intermedia*, and (c) roundfish and (d) other elasmobranchs for 20 fixed net positions (12–26 h soak time), 11 fixed net positions (36–48 h soak time) and 3 (58–60 h soak time) fished over the 7-day field study aboard FV "Govenek of Ladram".

Survivability of common skate bycatch

A total of 1242 common skate (*D.* cf. *flossada* = 1234 and *D.* cf. *intermedia* = 8) was caught by FV "Govenek of Ladram" between 1 and 5 May 2011 and 20 and 26 August 2011. Catches were mainly *D.* cf. *flossada*, including large mature skates, whereas catches of *D.* cf. *intermedia* were lower and mostly immature fish. Both species showed an even composition of males and females (sex ratio 1 : 1.03; Table 6, Figure 10).

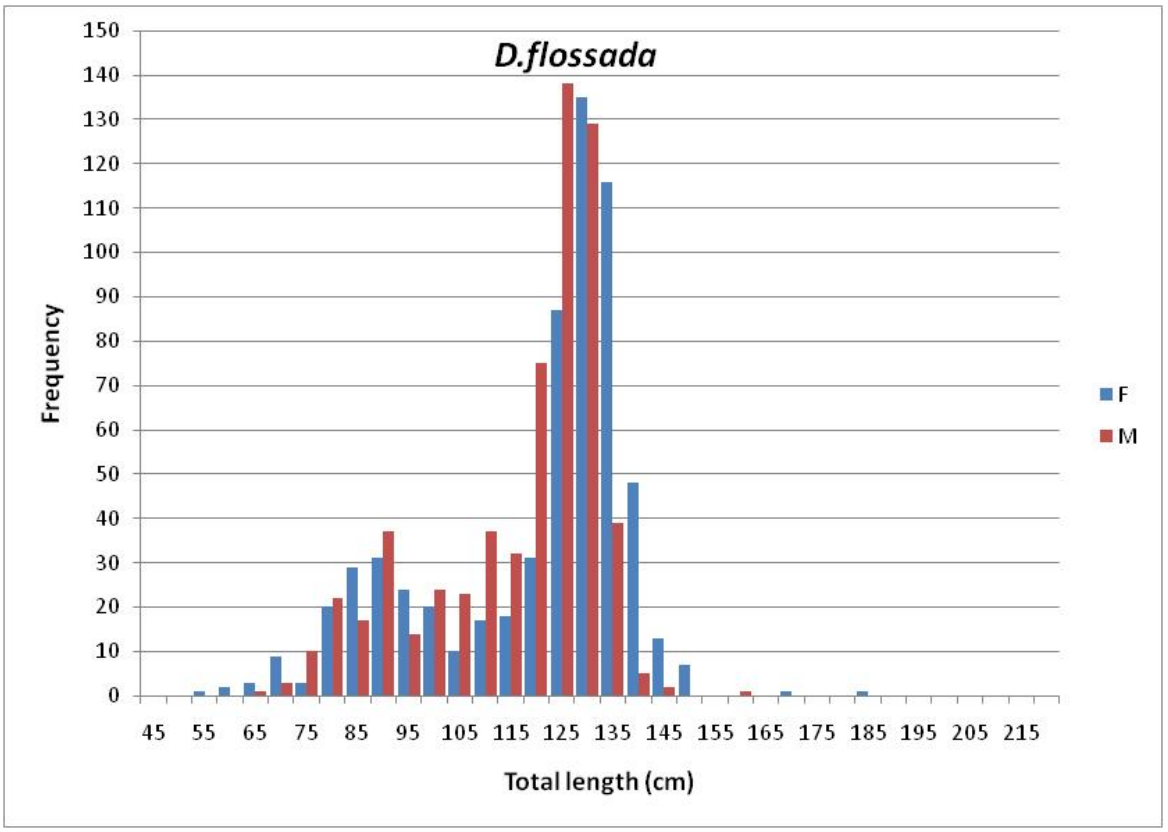
Of the1234 *D.* cf. *flossada* captured, 1076 (86%) were considered to be in good condition (i.e. lively), 65 (6%) were recorded as sluggish, 63 (5%) as dead and 31 (3%) as dead and scavenged by "lice" (predominantly isopods). Survival rates appeared to be consistently better for males and females regardless of soak time (Table 7). All eight *D* cf*. intermedia* captured (four females, length 119–128 cm; four males, length 79–230 cm) were considered in good condition (caught in soak times of 36–48 h).

Table 6. Species composition, sex ratio and length range of *D.batis* 'complex' while trammel- and tanglenetting aboard FV "Govenek of Ladram".

Species	Species composition %	No.	Males		Females		Sex ratio F:M
			Length range (cm)	No.	Length range (cm)	No.	
*D.*cf. *flossada*	99.3	1234	65–158	608	53–110	626	1.03:1
D. cf. *Intermedia*	0.7	8	79–230	4	119–128	4	1:1
Total	**100%**	**1242**	**65–230**	**612**	**53–128**	**630**	**1:1.03**

Table 7. Sex composition, length range and survivability of common skate *D.* cf. *flossada* bycaught in fixed nets within ICES Divisions VIIe-h, on FV "Govenek of Ladram".

					Survivability							
Soak time (h)	Sex	No.	Sex composition %	Total length range (cm)	Lively		Sluggish		Dead		Dead and scavenged	
					No.	%	No.	%	No.	%	No.	%
12–26 h	**Males**	164	47%	76–138	140	85	8	5	9	6	7	4
	Females	182	53%	70–148	173	95	2	2	6	3	1	1
	Total	**346**	**100%**	**70–148cm**	**313**	**90%**	**10**	**3%**	**15**	**5%**	**8**	**2%**
36–48 h	**Males**	326	47%	65–138	263	80	25	8	25	8	13	4
	Females	364	53%	53–182	325	90	18	5	13	3	8	2
	Total	**690**	**100%**	**53–182cm**	**588**	**85%**	**43**	**6%**	**38**	**5%**	**21**	**4%**
58–60 h	**Males**	118	60%	74–158	109	93	3	2	5	4	1	1
	Females	80	40%	69–168	66	82	9	11	5	7		
	Total	**198**	**100%**	**69–168cm**	**175**	**88%**	**12**	**6%**	**10**	**5%**	**1**	**1%**
All catches	**Males**	**608**	**49%**	**65–158**	**512**	**84**	**36**	**6**	**39**	**7**	**21**	**3**
	Females	**626**	**51%**	**53–182**	**564**	**90**	**29**	**5**	**24**	**4**	**10**	**2**
	Total	**1234**	**100%**	**53–182cm**	**1076**	**86%**	**65**	**6%**	**63**	**5%**	**31**	**3%**



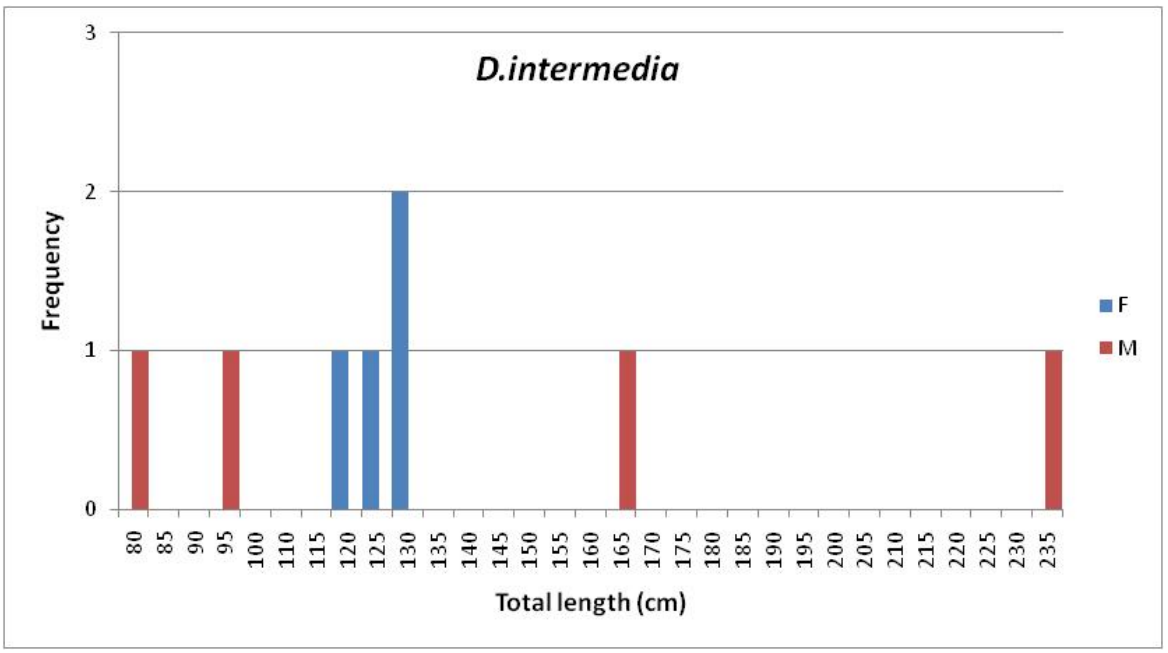


Figure 10. Length frequency distributions of *Dipturus* cf. *flossada* (top) and *Dipturus.* cf. *intermedia* (bottom) caught in fixed nets within ICES Divisions VIIe-h on FV "Govenek of Ladram".

Mark ID and electronic (DST) tagged common skate

Of the 1084 common skate *D. batis* considered lively and in good condition, 418 were tagged externally with button sure-tags placed on the wing. This sample included 413 *D.* cf. *flossada* (201 males, 212 females) and five *D.* cf. *intermedia* (one male, four females).

Electronic DSTs, set to record depth and temperature at 1-min intervals, were attached to the wing of 13 exceptionally lively common skate, including both *D.* cf. *flossada* (five males, six females) and two male *D.* cf. *Intermedia.* Figures 11 and 12 illustrate the distribution and numbers of common skate tagged and released.

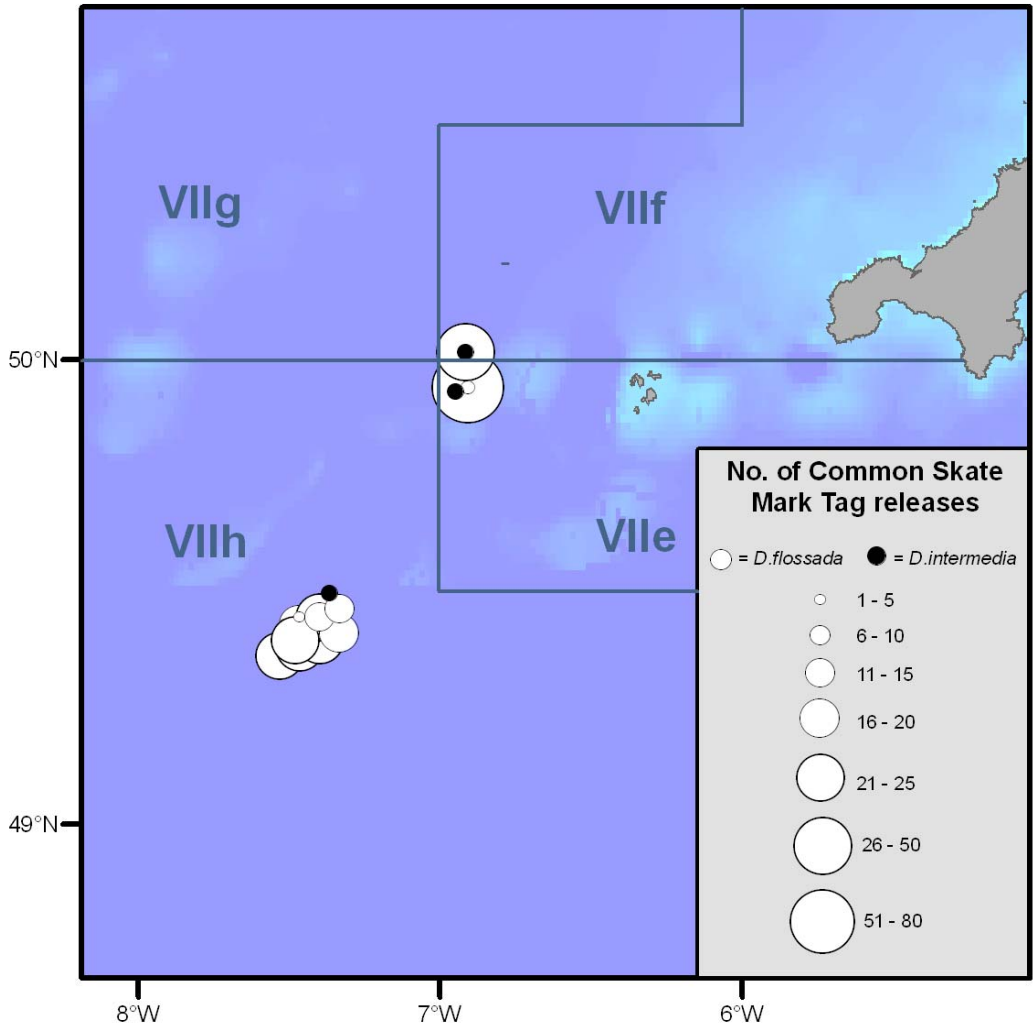


Figure 11. Map showing the number of mark ID tagged common skate by release area. Black circles depict *D.* cf. *intermedia* and white circles depict *D.*cf. *flossada*.

To date (30 April 2012), seven mark ID tagged common skate (*D.* cf. *flossada*) have been recaptured, at liberty between 36 and 236 days (mean = 127 ± 88 days) and travelled between 10 and 46 km (mean = 26 ± 12 km). Summary details are given in Table 8. The distributions of release and recapture positions are shown in Figure 12. In all, five of the recaptured skate were reported by French trawlers, and two by English netters.

Table 8. Details for recaptured common skate (*D.* cf. *flossada*) tagged and released with external mark ID tags in August 2011 aboard FV "Govenek of Ladram". Distance (km) relates to the straight-line distance between release and recapture positions.

Tag ID	Release date	Recapture date	Days at liberty	Total length (cm)	Sex	Distance (km)	ICES area of release	ICES area of recapture
E016804	21/08/2011	01/11/2011	72	113	F	22	VIIh	VIIh
E016850	21/08/2011	21/03/2012	213	102	M	23	VIIh	VIIh
E016915	22/08/2011	27/09/2011	36	106	M	16	VIIh	VIIh
E017012	24/08/2011	10/11/2011	78	129	F	39	VIIe	VIIe
E017015	24/08/2011	16/04/2012	236	129	F	46	VIIe	VIIf
E017058	24/08/2011	19/03/2012	208	128	F	10	VIIe	VIIf
E017095	24/08/2011	06/10/2011	43	128	M	26	VIIe	VIIe
		Mean days at liberty:	**127**	**Mean distance (km) :**		**26**		

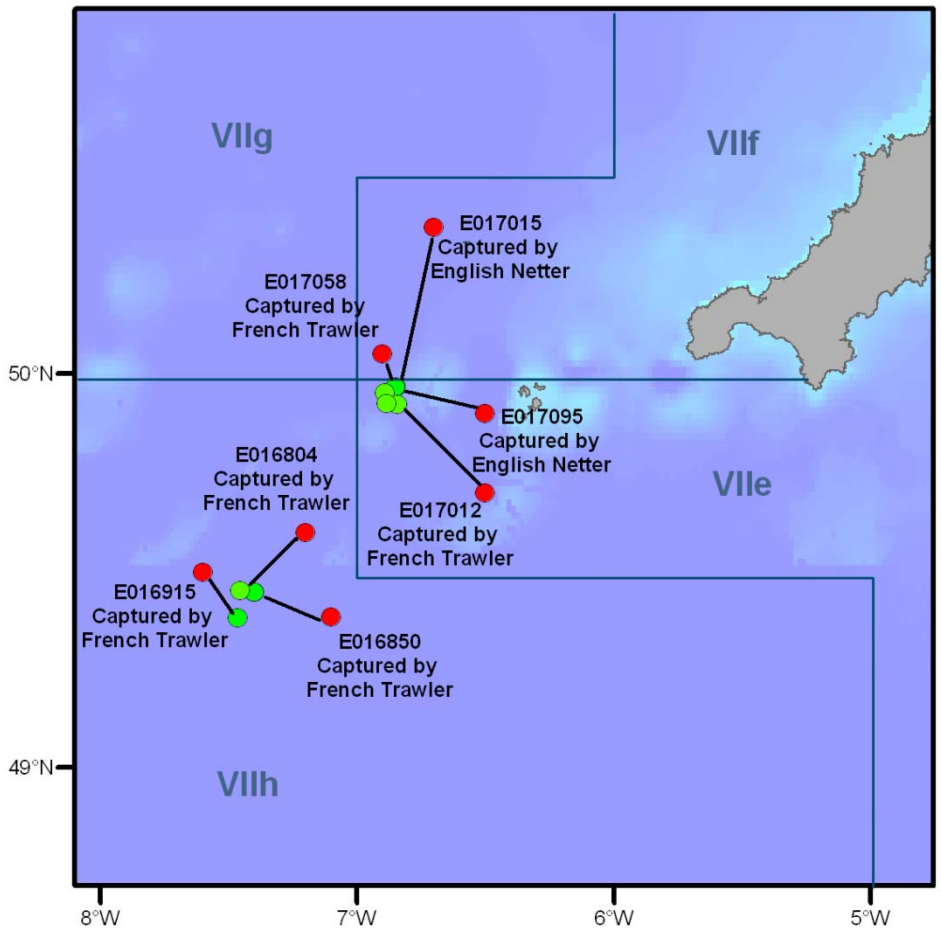


Figure 12. Release positions (green circles) of seven mark ID tagged common skate (*D.* cf. *flossada*) captured by the FV "Govenek of Ladram" (August 2011). Recapture positions (red circles) are shown for each tag ID together with vessel of capture.

Biological sampling of common skate

In all, 89 dead bycaught common skate *D.* cf. *flossada* were sampled biologically aboard FV "Govenek of Ladram". Of these, 57 were male with a mean total length of 123 cm (± 16 cm), of which 34 (60%) were mature/active, nine (16%) maturing, and 14 (24%) immature. Of the 32 females, with a mean total length of 115 cm (± 17 cm), 11 (34%) were immature, 14 (44%) maturing, and seven (22%) active, with egg cases present.

Of the 90 dead bycaught common skate, 31 (35%) had been heavily scavenged by lice (Figure 13). These lice appeared to enter internally into the skate via the cloaca and eat away the tissue to the extent that entire body cavities had been eaten and cleaned out of all organ tissue and gut contents. Early stages of internal lice damage was also evident on some live bycaught skate.



Figure 13. Examples of (a-c) the extent of lice damage after 24 h soak duration upon dead bycaught common skate captured by the FV "Govenek of Ladram", and (d) scavenging isopods.

Spurdog bycatch and survivability

In all, 149 spurdog were caught as bycatch by FV “Govenek of Ladram” between 20 and 26 August 2011 (summarized in Table 9). Of these, 73 (50%) were considered to be in good condition (lively), 18 (12%) sluggish, 54 (36%) were dead and three (2%) dead and scavenged by lice. The sex ratio was relatively even between males and females (M : F sex ratio 1.3 : 1). The mean total lengths of males (73 ± 7 cm) and females (74 ± 11 cm) were similar, although females exhibited a wider length range than males (Figure 14).

Table 9. Sex composition, length range and survivability of spurdog bycaught in fixed nets in ICES Divisions VIIe-h by FV “Govenek of Ladram”.

					Survivability							
Soak time (h)	**Spurdog**	**No.**	**Sex composition %**	**Total length range (cm)**	**Lively**		**Sluggish**		**Dead**		**Dead and scavenged**	
					No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
12–26 h	**Males**	84	56%	56–84	37	44	11	13	33	40	2	2
	Females	65	44%	57–107	36	55	7	10	21	32	1	1
Total Catch		**149**	**100%**	**56–107cm**	**73**	**50%**	**18**	**12%**	**54**	**36%**	**3**	**2%**

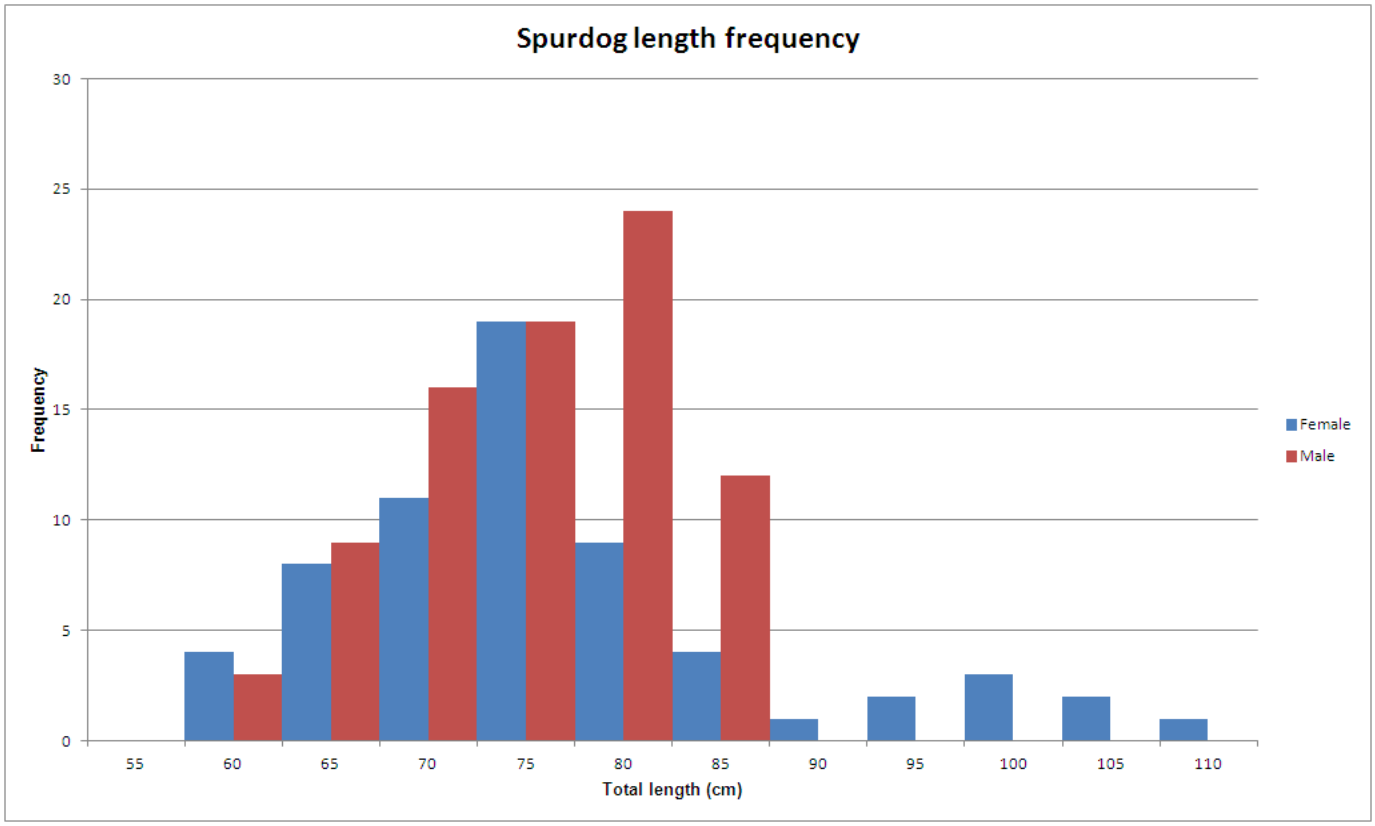


Figure 14. Length frequency distributions of spurdog bycaught in fixed nets in ICES Divisions VIIe-h by FV “Govenek of Ladram”.

Mark ID and electronic (DST) tagged spurdog

In all, 74 spurdog considered lively and in good condition were tagged and released over the field study aboard FV “Govenek of Ladram”. A total of 60 (32 males, 28 females) were tagged externally with simple mark ID tags placed on the dorsal fin, and 14 spurdog (six males, eight females) were tagged externally with an electronic DST into the dorsal musculature (to record depth and temperature at 1-min intervals). Figures 15 and 16 illustrate the distribution and numbers of spurdog tagged and released.

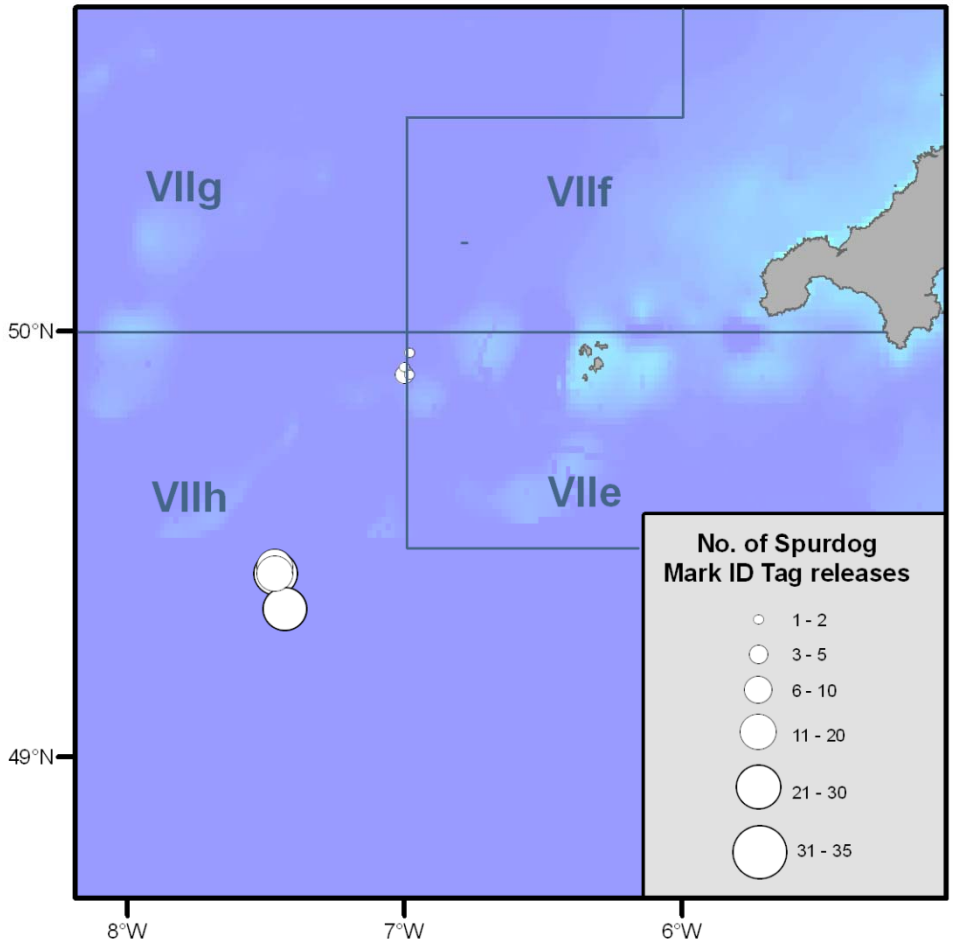


Figure 15. Map showing the number of mark ID tagged spurdog by release area.

Up to 30 April 2012, one electronic data storage float tags had been returned (see Figure 16). Tag (ID A07159) released on a male spurdog (71 cm total length) bycaught in a gillnet (soak duration 21 h) in VIIe, became detached after 61 days. Thanks to the tag's float jacket, the tag popped to the surface where it was washed ashore onto a beach off Wales and recovered by a member of the public. The depth data recorded by the tag shows that despite being scored as lively and in good condition, the spurdog survived for just 10 days after being tagged and released, before coming to a complete rest on the seabed, where it appears to have died (Figure 17).

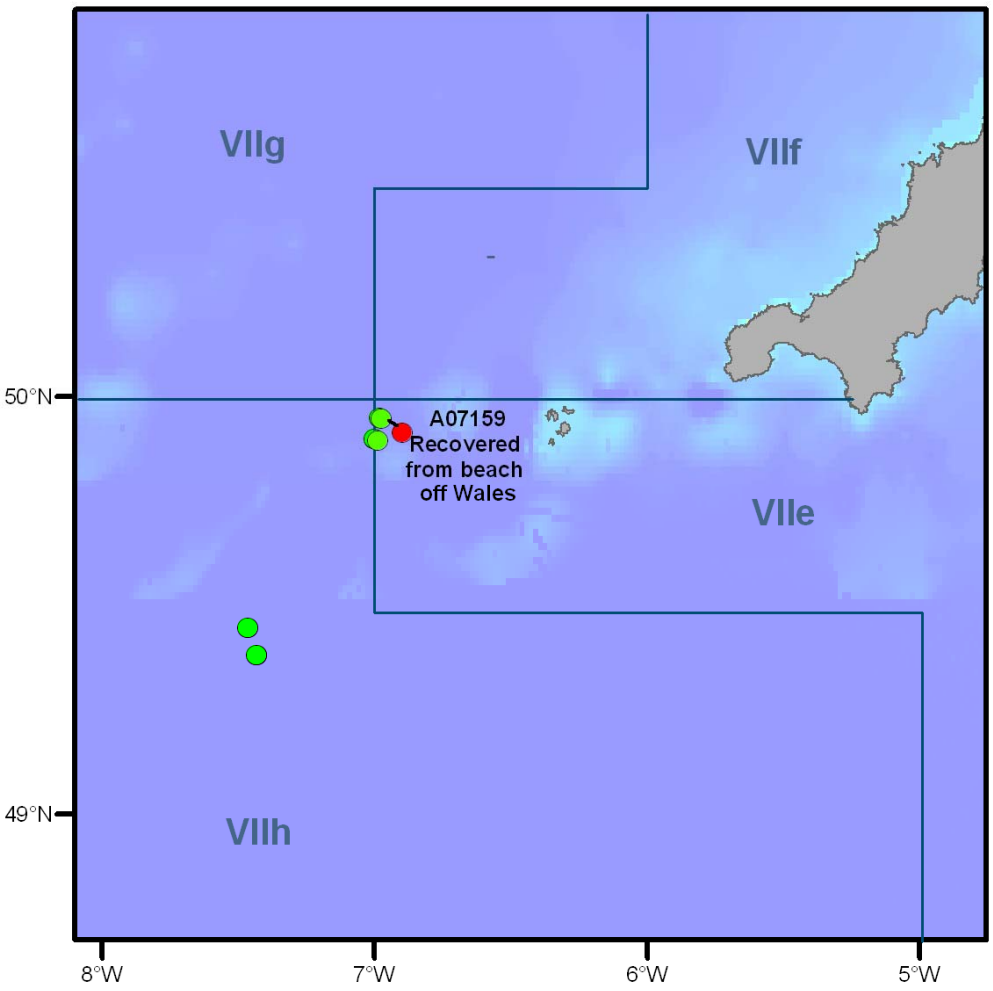


Figure 16. Release positions (green circles) of 14 electronically tagged spurdog captured aboard FV "Govenek of Ladram" during August 2011. Pop-up position (red circle) shown for float tag ID A07159, before being washed up and recovered off Borth beach, Wales.

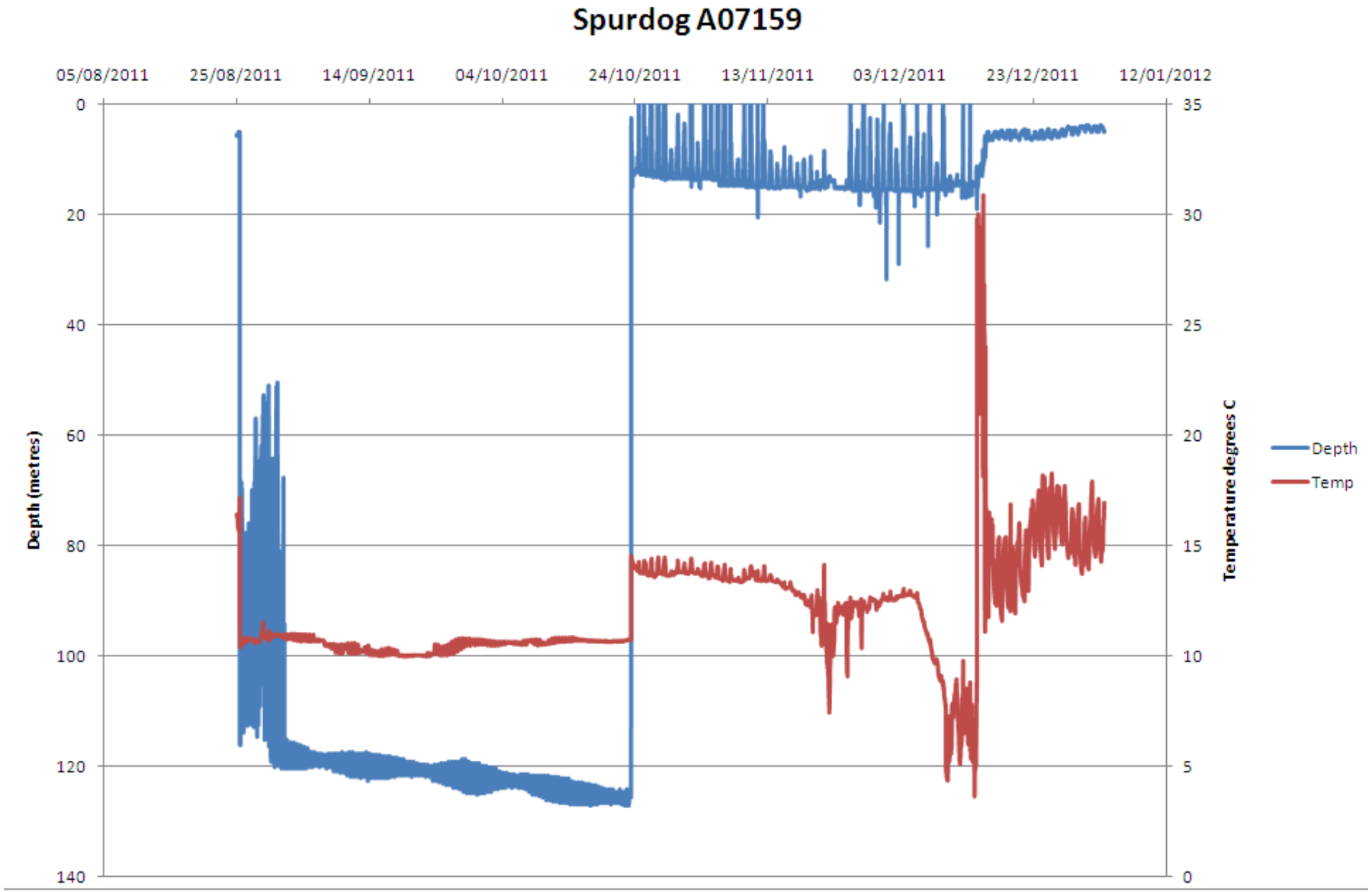


Figure 17. Depth and temperature plot for spurdog A07159 tagged and released on 24/08/2011 and recovered on 14/12/2011. Depth in m (blue line), temperature in °C (red line), recorded at 1-min intervals throughout the time at liberty.

Biological sampling of spurdog

In all, 57 dead spurdog were recorded on board FV “Govenek of Ladram” during the field study. Of these, 36 were male (mean total length = 73 ± 9 cm), and 22 were female (mean total length = 70 ± 9 cm). Three of the females contained pups (2–6 pups per female).

Overall for the 57 dead bycaught spurdog, external net damage was mainly around the gills (*n* = 24, 42%), gill and body (*n* = 7, 12%) or all over the body (*n* = 6, 10%), with 16 (28%) showing no visible external signs of net damage (Figure18).

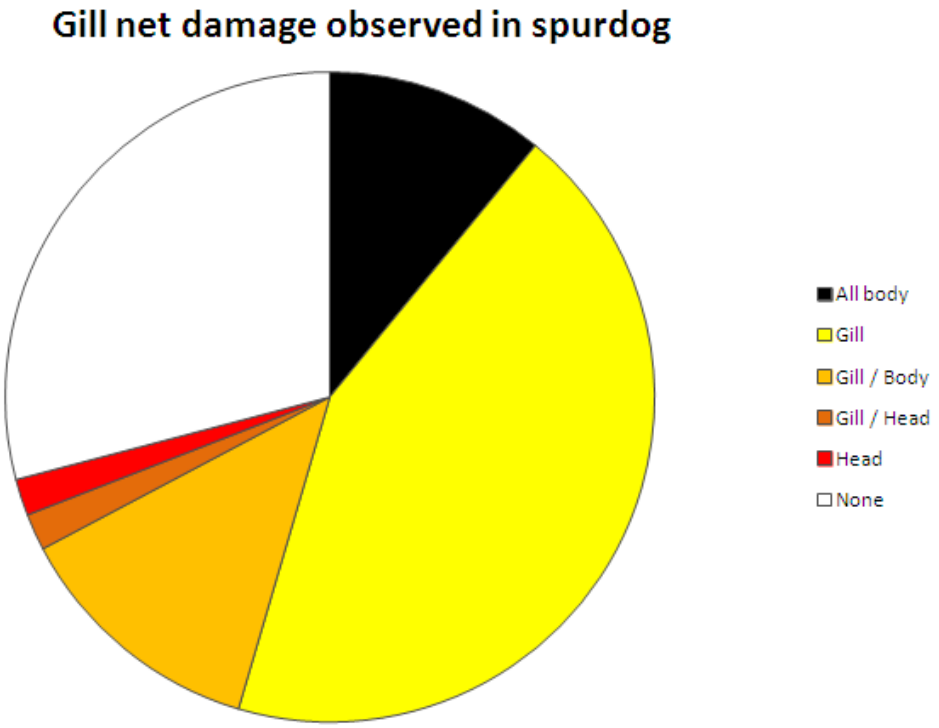


Figure 18. Net damage observed in 75 dead spurdog bycaught in fixed gillnets within ICES Divisions VIIf-h on FV “Govenek of Ladram” during August 2011.

3.2 Seasonal porbeagle bycatch study within ICES Divisions VIIf-h aboard FV Charisma (September 2011).

Overall target and bycatch species composition

The number of fish (and percentage of total catch and their size range) caught by FV "Charisma" during the period 19–25 September 2011 is shown in Table 10.

Table 10. Species composition (numbers and %) for total catches, and retained/discarded parts of the catch, observed for 21 sites fished with fixed nets during a field study aboard FV "Charisma". Grey shading highlights shark species of interest and yellow shading the most abundant target species captured and retained.

	Total catch			Retained catch			Discarded catch		
Species	**N°**	**%**	**Length range**	**N°**	**%**	**Length range**	**N°**	**%**	**Length range**
Allis shad	2	0.11	55–58				2	0.39	55–58
Anglerfish	6	0.32	29–57	3	0.22	46–57	3	0.59	29–31
Anglerfish, black-bellied	1	0.05	50	1	0.07	50–50			
Bib	4	0.21	18–36				4	0.79	18–36
Black mouth dogfish	2	0.11	66–67				2	0.39	66–67
Blue shark	6	0.32	104–235				6	1.18	104–235
Blue whiting	5	0.27	22–31				5	0.98	22–31
Cod	**516**	**27.37**	**46–99**	**506**	**36.77**	**46–99**	**10**	**1.96**	**50–85**
Common skate	**5**	**0.27**	**113–132**				**5**	**0.98**	**113–132**
Crayfish	1	0.05	8				1	0.20	8
Dab	1	0.05	26				1	0.20	26
Dover sole	1	0.05	31	1	0.07	31–31			
Edible crab	15	0.80	16–21				15	2.95	16–21
Greater-spotted dogfish	1	0.05	38				1	0.20	38
Grey gurnard	8	0.42	22–37				8	1.57	22–37
Haddock	126	6.68	30–69	99	7.19	30–69	27	5.30	30–63
Hake	**650**	**34.48**	**29–110**	622	45.20	50–110	**28**	**5.50**	**29–96**
Herring	1	0.05	25				1	0.20	25
Lemon sole	1	0.05	31	1	0.07	31–31			
Lesser-spotted dogfish	139	7.37	42–76				139	27.31	42–76
Ling	56	2.97	63–105	54	3.92	63–105	2	0.39	87–96
Mackerel	15	0.80	24–36				15	2.95	24–36
Megrim	16	0.85	30–49	14	1.02	33–49	2	0.39	30–34
Pollack	29	1.54	54–66	29	2.11	54–66			
Poor cod	1	0.05	20				1	0.20	20
Porbeagle	**19**	**1.01**	**117–250**				**19**	**3.73**	**117–250**
Red gurnard	2	0.11	26–29				2	0.39	26–29
Saithe	18	0.95	44–64	16	1.16	44–63	2	0.39	52–64
Shagreen ray	1	0.05	82				1	0.20	82
Spurdog	**187**	**9.92**	**60–123**				**187**	**36.74**	**60–123**
Stone crab	1	0.05	8				1	0.20	8
Whiting	46	2.44	31–56	30	2.18	36–56	16	3.14	31–52
Witch	3	0.16	33–35				3	0.59	33–35
Grand total	**1885**	**100.00**		**1376**	**100.00**		**509**	**100.00**	

In all, 19 porbeagle sharks were caught, 1% of the total number of fish caught and 3.7% of the total number of discarded bycatch. In addition 187 spurdog were captured (9.9% of the total catch; 36.7% of the total number of discarded fish) and five common skate *Dipturus* cf. *flossada*, (ca. 0.3% of the total catch and 1% of total discarded catch).

Overall a total of 360 elasmobranchs were captured during this field study (19% of the total catch; 71% of the discarded bycatch). The remaining discarded bycatch (Figure 19) included roundfish (*n* =126, 25%), shellfish (*n* =17, 3%) and flatfish (*n* = 6, 1%).

Of the discarded elasmobranch bycatch, 187 spurdog (52%) and 138 lesser-spotted dogfish (39%) were observed. The remaining bycatch included 19 porbeagle and five common skate, accounting for 5% and 1%, respectively, of the total discarded elasmobranch bycatch. It should be noted that these discarded elasmobranchs were mainly returned to sea alive.

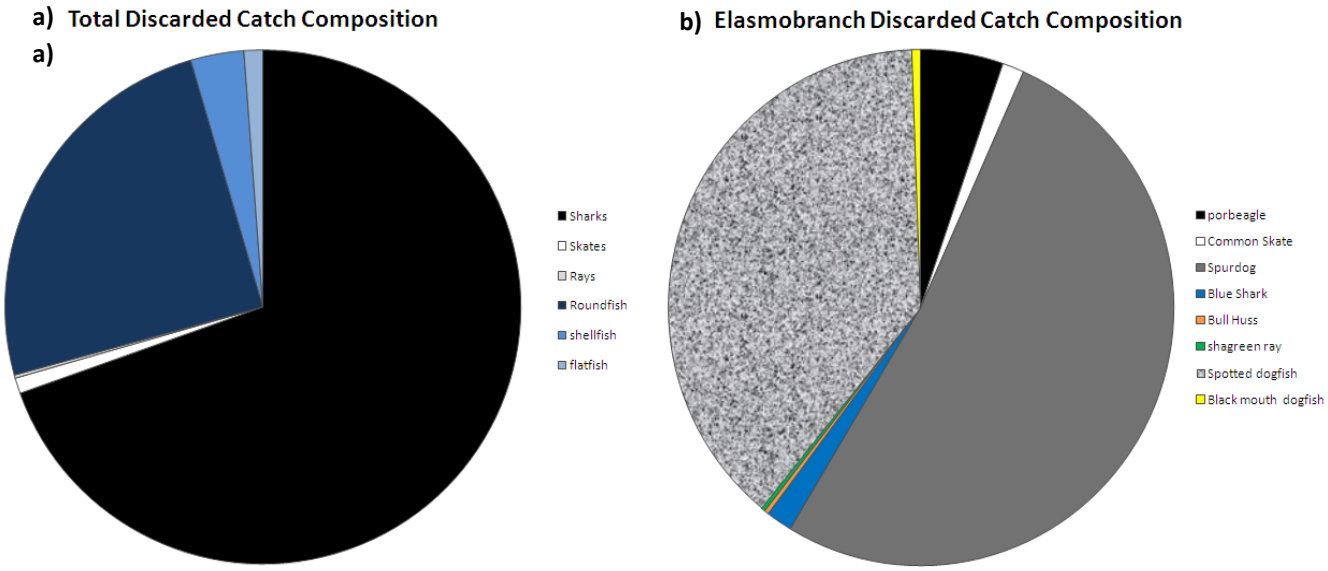


Figure 19. Discarded catch composition for 21 fixed gill net locations over the 7-day field study aboard FV "Charisma": (a) total discarded catch composition by species group; (b) elasmobranch (sharks, skates and rays) discarded species catch composition.

Variable soak times

During the 7-day field study, fixed gillnet soak times were shortened wherever possible from typical commercial fishing operations. Tables 11 and 12 show the species composition of catches for 12–15 h and 16–21 h soak times, respectively, and Figure 20 shows the distribution of the numbers of roundfish, porbeagle, spurdog and other elasmobranch species caught during the field study.

Table 11. Target and bycatch species composition for 12–15 h soak time of fixed gillnets, showing the number and percentage of species captured, retained and discarded, for 13 fixed gillnet locations fished over the 7-day field study aboard FV "Charisma".

11–15 h soak time	Total catch			Retained catch			Discarded catch		
Species	N°	%	Length range	N°	%	Length range	N°	%	Length range
Anglerfish	5	0.59	29-57	3	0.54	46–57	2	0.69	29–31
Anglerfish, black-bellied	1	0.12	50	1	0.18	50–50			
Bib	4	0.47	18-36				4	1.37	18–36
Black mouth dogfish	1	0.12	66				1	0.34	66
Blue shark	2	0.24	104-235				2	0.69	104–235
Blue whiting	3	0.36	22-31				3	1.03	22–31
Cod	88	10.41	46-99	83	14.98	46–99	5	1.72	54–70
Common skate	**2**	**0.24**	**113-120**				**2**	**0.69**	**113–120**
Crayfish	1	0.12	8				1	0.34	8
Dab	1	0.12	26				1	0.34	26
Dover sole	1	0.12	31	1	0.18	31–31			
Edible crab	8	0.95	16-21				8	2.75	16–21
Greater-spotted dogfish	1	0.12	38				1	0.34	38
Grey gurnard	6	0.71	22-37				6	2.06	22–37
Haddock	61	7.22	31-69	44	7.94	32–69	17	5.84	31–56
Hake	386	45.68	29-110	365	65.88	50–110	21	7.22	29–94
Herring	1	0.12	25				1	0.34	25
Lemon sole	1	0.12	31	1	0.18	31			
Lesser-spotted dogfish	77	9.11	48-76				77	26.46	48–76
Ling	30	3.55	63-105	29	5.23	63–105	1	0.34	87
Mackerel	7	0.83	24-34				7	2.40	24-34
Megrim	7	0.83	30-39	5	0.90	33–39	2	0.69	30–34
Pollack	4	0.47	58-63	4	0.72	58–63			
Porbeagle	**10**	**1.18**	**117-250**				**10**	**3.44**	**117–250**
Red gurnard	1	0.12	26				1	0.34	26
Saithe	2	0.24	45-56	2	0.36	45–56			
Spurdog	**107**	**12.66**	**60-118**				**107**	**36.77**	**60–118**
Stone crab	1	0.12	8				1	0.34	8
Whiting	25	2.96	31-56	16	2.89	36–56	9	3.09	31–52
Witch	1	0.12	34				1	0.34	34
Grand total	**845**	**100.00**		**554**	**100.00**		**291**	**100.00**	

Table 12. Target and bycatch species composition for 16–21 h soak time of fixed gillnets, showing the number and percentage of species captured, retained and discarded, for 8 fixed gillnet locations fished over the 7-day field study aboard FV "Charisma".

16–21 h soak time	Total catch			Retained catch			Discarded catch		
Species	N°	%	Length range	N°	%	Length range	N°	%	Length range
Allis shad	2	0.27	55–58				2	0.92	55–58
Anglerfish	1	0.14	29				1	0.46	29
Black mouth dogfish	1	0.14	67				1	0.46	67
Blue shark	4	0.55	167–170				4	1.83	167–170
Blue whiting	2	0.27	22–24				2	0.92	22–24
Cod	**282**	**38.52**	**46–92**	**277**	**53.89**	**46–92**	**5**	**2.29**	**50–85**
Common skate	**3**	**0.41**	**124–132**				**3**	**1.38**	**124–132**
Edible crab	7	0.96	16–19				7	3.21	16–19
Grey gurnard	2	0.27	23–29				2	0.92	23–29
Haddock	49	6.69	30–65	39	7.59	38–65	10	4.59	30–63
Hake	**180**	**24.59**	**51–104**	**173**	**33.66**	**51–104**	**7**	**3.21**	**63–96**
Lesser-spotted dogfish	62	8.47	42–72				62	28.44	42–72
Ling	12	1.64	75–105	11	2.14	75–105	1	0.46	96
Mackerel	8	1.09	28–36				8	3.67	28–36
Megrim	7	0.96	34–49	7	1.36	34–49			
Pollack	1	0.14	59	1	0.19	59			
Poor cod	1	0.14	20				1	0.46	20
Porbeagle	**9**	**1.23**	**156–245**				**9**	**4.13**	**156–245**
Red gurnard	1	0.14	29				1	0.46	29
Saithe	5	0.68	45–64	3	0.58	45–54	2	0.92	52–64
Shagreen ray	1	0.14	82				1	0.46	82
Spurdog	**80**	**10.93**	**64–123**				**80**	**36.70**	**64–123**
Whiting	10	1.37	32–53	3	0.58	42–53	7	3.21	32–47
Witch	2	0.27	33–35				2	0.92	33–35
Grand total	**732**	**100.00**		**514**	**100.00**		**218**	**100.00**	

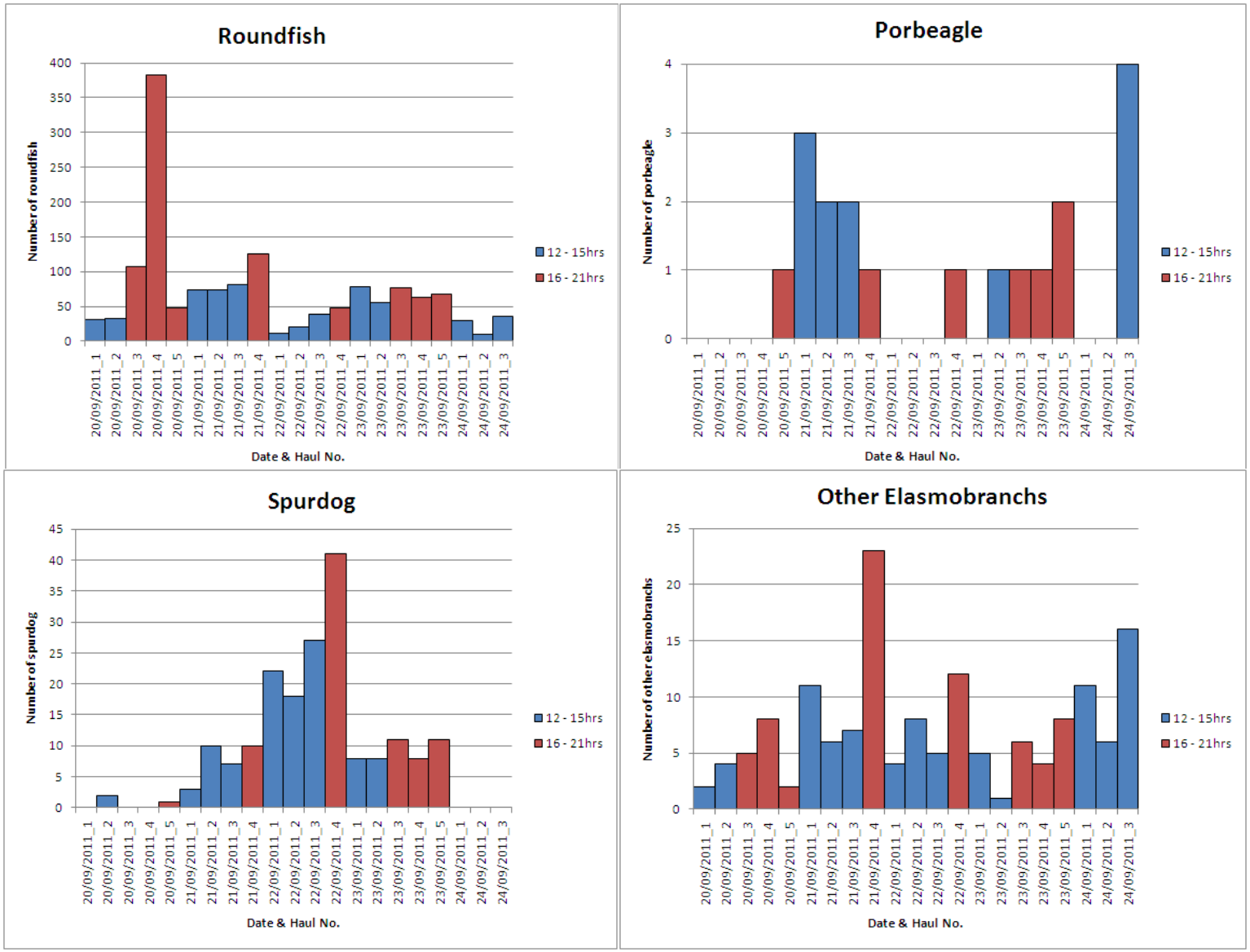


Figure 20. Distribution in number of (a) roundfish, (b) spurdog, (c) porbeagle and (d) other elasmobranchs for 13 fixed gillnet positions (12–15 h soak time) and 8 fixed gillnet positions (16–21 h soak time) fished over the 7-day field study aboard FV “Charisma”.

Porbeagle bycatch

Of the 19 porbeagle caught, 3 (16%) were thought to be in good condition (lively), one (5%) was recorded as very sluggish, 14 (74%) were considered dead and one (5%) as dead and scavenged by lice (Table 13). There was an even catch composition of males and females (sex ratio 1.3 : 1).

Length distributions varied widely for males and females, with mean total lengths of 170 ± 24 cm for males and 183 ± 45 cm for females. However, females covered a considerably broader length range than males.

Table 13. Sex composition, length range and survivability of porbeagle sharks bycaught in fixed gillnets within ICES Divisions VIIf-h by FV "Charisma" in September 2011.

					Survivability							
Soak time (h)	**Porbeagle**	**No.**	**Sex composition %**	**Total Length Range (cm)**	**Lively**		**Sluggish**		**Dead**		**Dead and scavenged**	
					No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
11–15 h	Male	1	10%	117	1	100						
	Female	6	60%	144–250	1	17			4	66	1	17
	Unknown	3	30%						3	100		
	Total	**10**	**100%**	**117–250**	**2**	**20%**			**7**	**70%**	**1**	**10%**
16–26 h	Male	8	89%	156–194	1		1		6			
	Female	1	11%	245					1			
	Unknown											
	Total	**9**	**100%**	**156–245**	**1**	**12%**	**1**	**12%**	**7**	**76%**		
All catches	Male	9	47	117–194	2	33	1		6	67		
	Female	7	37	144–250	1	14			5	72	1	14
	Unknown	3	16						3	100		
	Total	**19**	**100%**	**117–250**	**3**	**16%**	**1**	**5%**	**14**	**74%**	**1**	**5%**

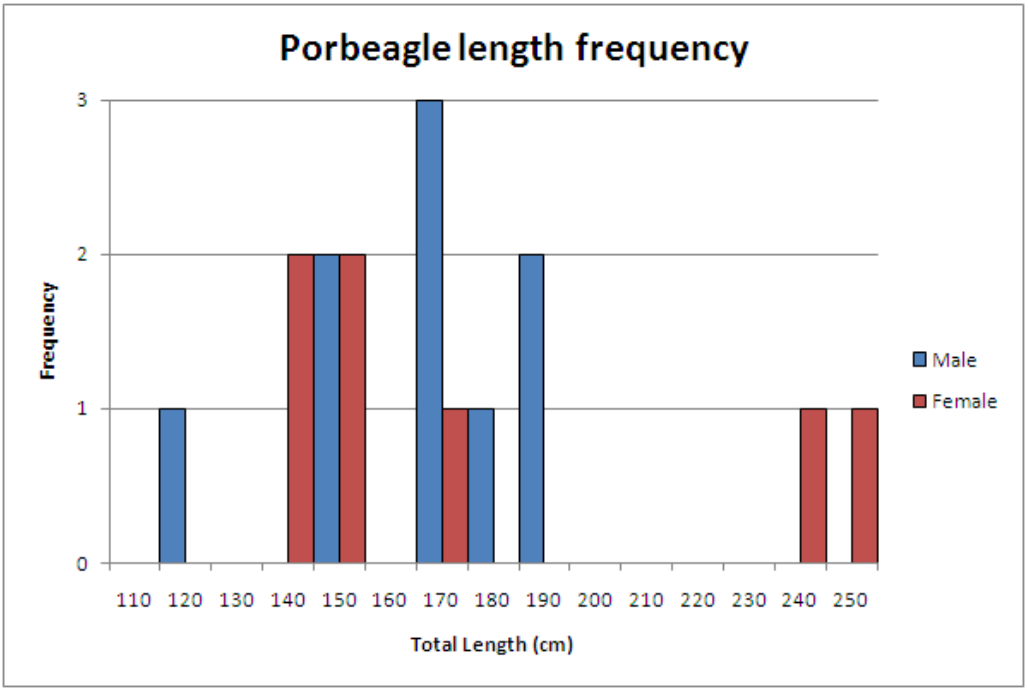


Figure 21. Length frequency distribution of male and female porbeagle bycaught in fixed gillnets within ICES Divisions VIIf-h on board FV "Charisma" during September 2011.

Mark ID and electronic (DST) tagged porbeagle

Of the four porbeagle considered lively and in good condition, three (two males and one female) were tagged externally with roto-tags placed on the dorsal fin, and one exceptionally lively male porbeagle was tagged externally with an electronic DST tag into the dorsal musculature (to record depth and temperature at 1-min intervals), before being released back to sea. Summary details are shown in Table14, and the distribution of released fish is shown in Figure 22.

Table 14. Summary details of porbeagle tagged on FV "Charisma" during September 2011. Yellow shading highlights electronic data storage tagged porbeagle.

Date	Tag ID	Total length (cm)	Fork length (cm)	Girth (cm)	Sex	ICES area of release
21/09/2011	E015519	177	151	88	Female	VIIf
21/09/2011	E015509	120	99	70	Male	VIIg
21/09/2011	E015493	192	163	90	Male	VIIf
23/09/2011	A07206	172	150	93	Male	VIIg

Up to 30 April 2012, one tag had been returned; electronic float tag A07206 at liberty 66 days before becoming detached from the porbeagle on 24 November 2011, 251 km from the release position, floating ashore and washed up on Guisseny beach, North Brittany on 20 January 2012, where it was recovered by a member of the public and returned to Cefas (Figure 23). Depth data recorded from the electronic tag showed the porbeagle to have been incredibly lively and mobile with active vertical movements up into the water column during darkness before returning closer to the seabed by day.

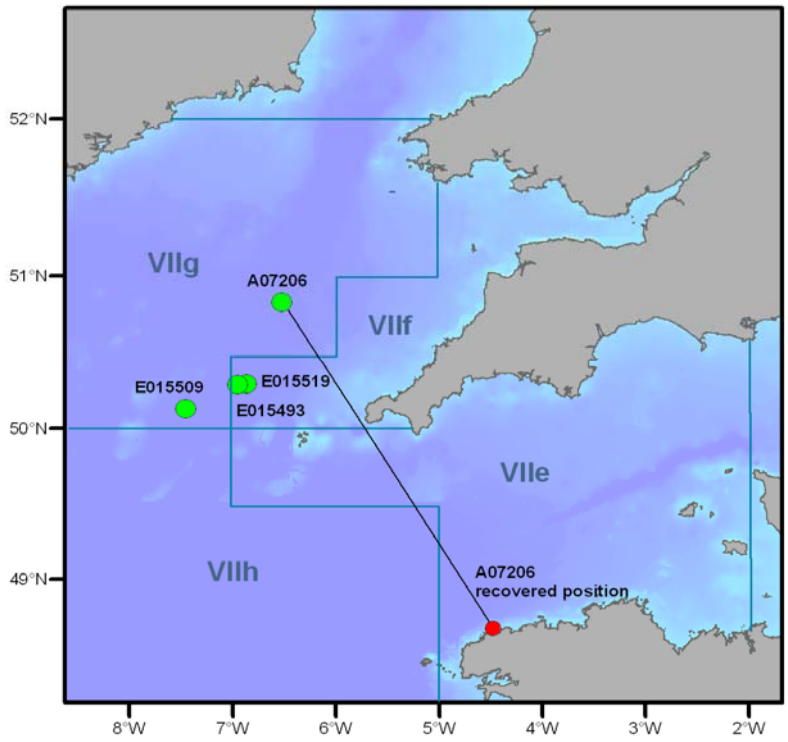


Figure 23. Release positions (green circles) of four porbeagle sharks tagged aboard FV "Charisma" during September 2011. Recapture position (red circle) shown for electronic tag A07206 recovered off Guisseny, North Brittany.

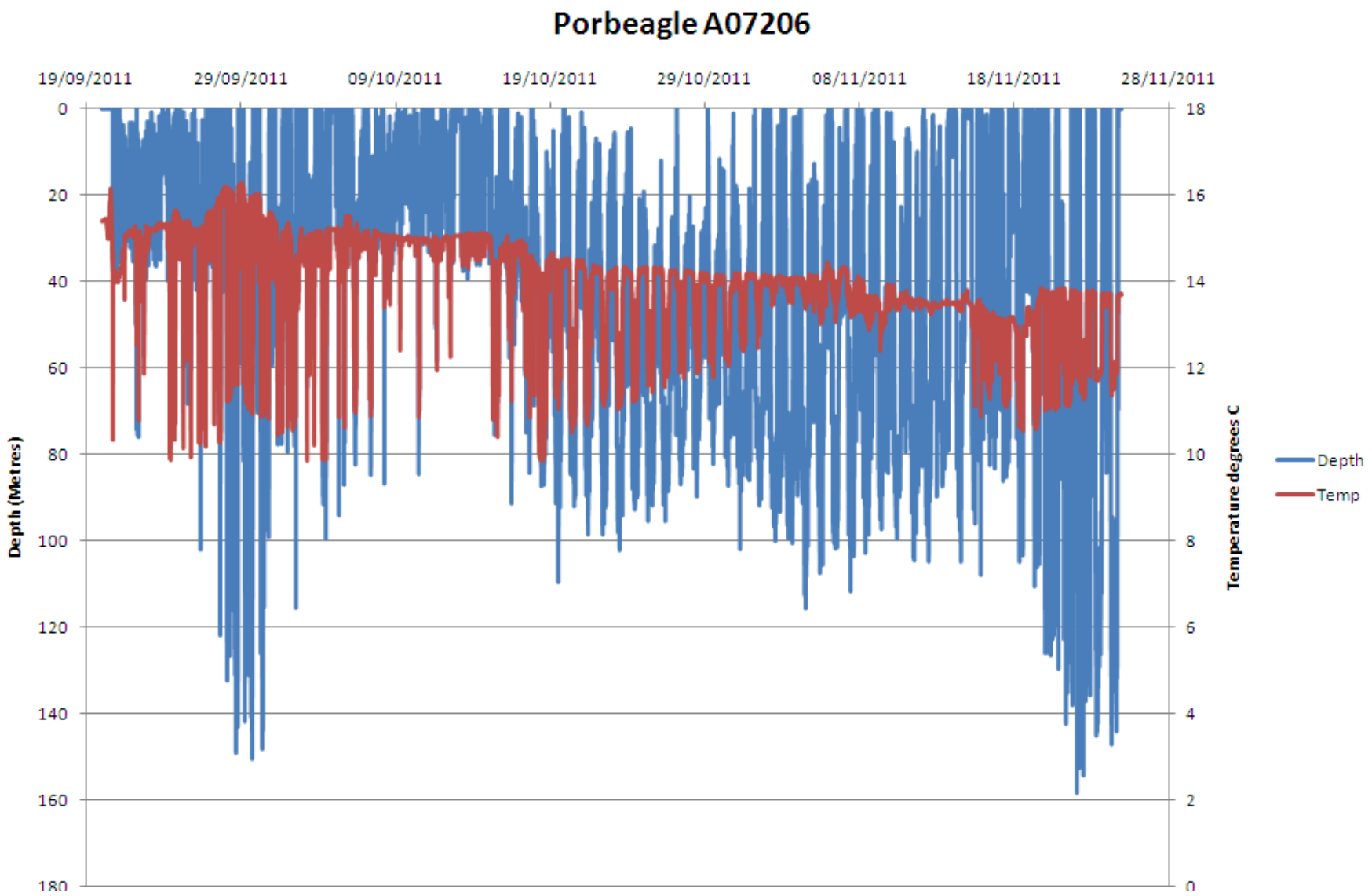


Figure 24. Depth and temperature plot for porbeagle A07206 tagged and released on 20/09/2011 and detached on 24/11/2011, before being washed ashore at Guisseny (North Brittany), France. Depth in m (blue line) and temperature in °C (red line) recorded at 1-min intervals throughout the time at liberty.

Biological sampling of porbeagle

In all, 11 dead porbeagle sharks were transported back to the Cefas Laboratory to be sampled biologically. Details for each individual are summarized in Table 15. Of the 11, seven were males with a mean total length of 167 ± 26 cm and mean body weight of 33 ± 12 kg; four of the males were mature (57%), one in early stages of maturing (14%) and two were immature (29%). Of the four dead female porbeagle (mean total length = 174 ± 48 cm; mean body weight = 41 ± 36 kg), three were considered immature and the largest female (245 cm total length) was in the early stages of maturing.

Table 15. Summary details of biosampled porbeagle bycaught in fixed gillnets on FV "Charisma".

Date	Total length (cm)	Fork length (cm)	Girth (cm)	Sex	Maturity	Body weight (kg)	ICES area of capture
24/09/2011	144	119	65	Female	Immature	20.8	VIIf
24/09/2011	149	126	72	Female	Immature	23.6	VIIf
24/09/2011	157	130	62	Female	Immature	25.5	VIIf
21/09/2011	245	203	99	Female	Maturing	94.2	VIIh
21/09/2011	117	98	69	Male	Immature	12.1	VIIg
21/09/2011	156	130	72	Male	Maturing	30.2	VIIg
21/09/2011	157	128	66	Male	Immature	23	VIIg
21/09/2011	178	151	82	Male	Mature	40.3	VIIg
23/09/2011	179	153	86	Male	Mature	41.2	VIIg
20/09/2011	185	153	78	Male	Mature	44.2	VIIf
23/09/2011	194	161	80	Male	Mature	40.2	VIIg

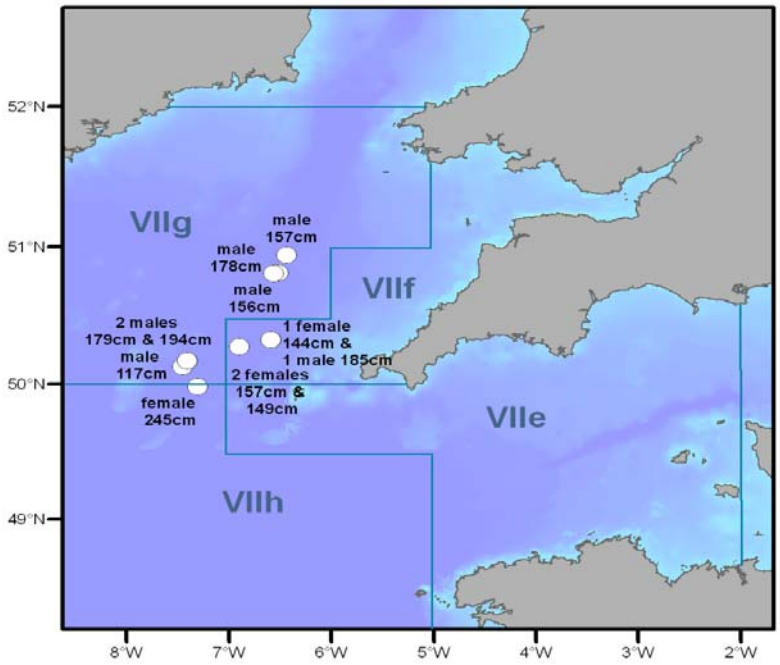


Figure 25. Spatial distribution of biosampled porbeagle bycaught in fixed gillnets on FV "Charisma".

Spurdog bycatch

Of the 187 spurdog (summarized in Table 16), 135 (72%) were considered to be in good condition (lively), 10 (5%) were recorded as sluggish, 30 (16%) were dead and 12 (7%) were dead and scavenged by lice. Five of the dead spurdog could not be sampled biologically because of the severe extent f damage by lice. The sex ratio significantly favoured males (sex ratio 1.7 : 1, Chi-squared test $p < 0.001$).

The spurdog bycatch was mainly males, and the total mean lengths were 79 ± 5 cm for males and 86 ± 15 cm for females. Females attained a larger size than males overall, with a maximum observed length of 123 cm.

Table 16. Sex composition, length range and survivability of spurdog bycaught in fixed gillnets within ICES Divisions VIIf-h by FV "Charisma" during September 2011.

					Survivability							
Soak time (h)	**Spurdog**	**No.**	**Sex composition %**	**Total length range (cm)**	**Lively**		**Sluggish**		**Dead**		**Dead and scavenged**	
					No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
11–15 h	Male	68	64%	64–91	57	84	1	1.5	9	13	1	1.5
	Female	35	33%	60–118	26	74			8	23	1	3
	Unknown	4	3%								4	100
	Total	**107**	**100%**	**60–118**	**83**	**78%**	**1**	**1%**	**17**	**16%**	**6**	**5%**
16–26 h	Male	47	59%	67–89	27	58	6	12	9	19	5	11
	Female	32	40%	66–123	25	78	3	9	4	13		
	Unknown	1	1%								1	100
	Total	**80**	**100%**	**66–123**	**52**	**65%**	**9**	**11%**	**13**	**16%**	**6**	**8%**
All Catches	Male	115	61%	64 –91	84	73	7	6	18	16	6	5
	Female	67	36%	60–123	51	77	3	4	12	18	1	1
	Unknown	5	3%								5	100
	Total	**187**	**100%**	**60–123**	**135**	**72%**	**10**	**5%**	**30**	**16%**	**12**	**7%**

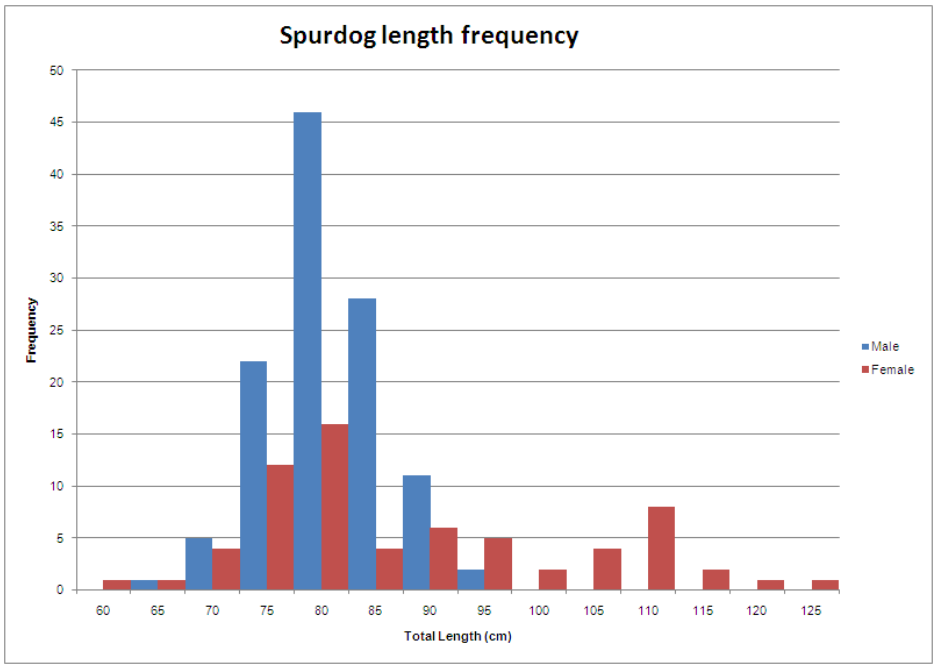


Figure 26. Length frequency distribution of male and female spurdog bycaught in fixed gillnets within ICES Divisions VIIf-h by FV "Charisma" during September 2011.

Mark ID and electronic (DST) tagged spurdog

In all, 132 spurdog considered lively and in good condition were tagged and released during the field study aboard FV “Charisma”. A total of 108 individuals (76 males and 32 females) was tagged externally with roto-tags placed on the dorsal fin, and 24 (seven males and 17 females) were tagged externally with an electronic DST into the dorsal musculature. Figures 27 and 28 illustrate the distribution and numbers of spurdog tagged and released.

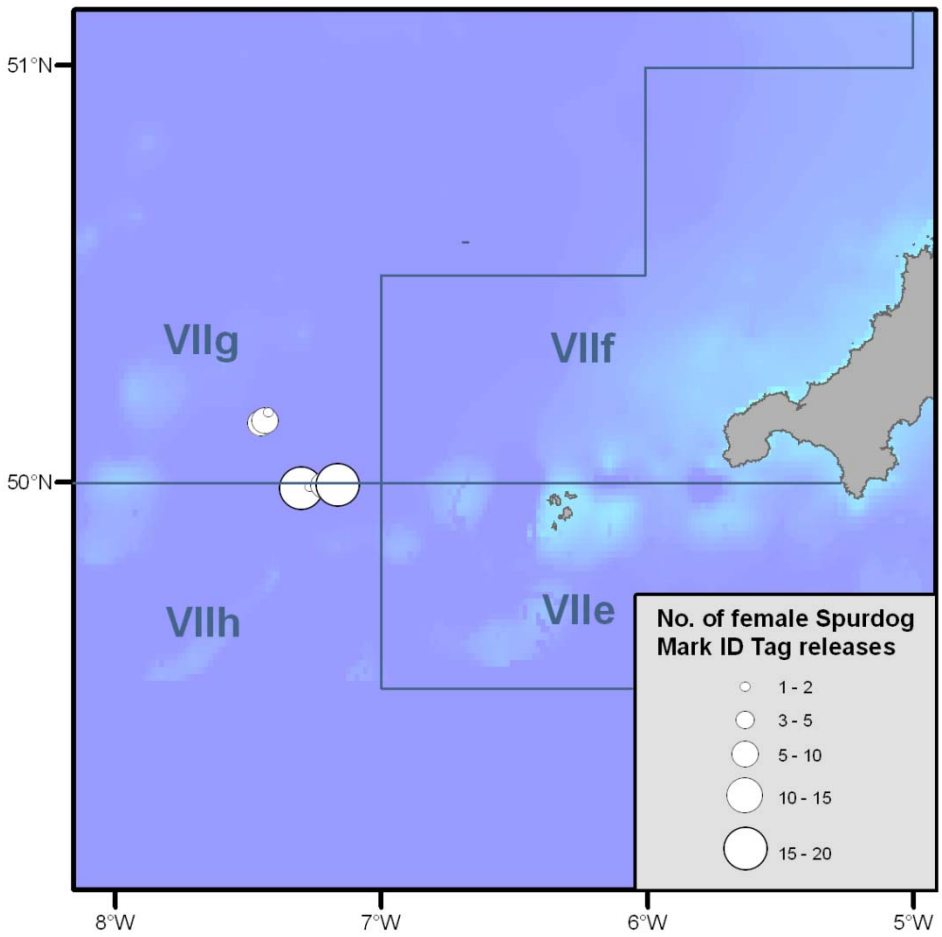


Figure 27. Map showing the number of mark ID tagged spurdog, bycaught in fixed gillnets within ICES Divisions VIIf-h, on FV “Charisma” during September 2011.

Up to 30 April 2012, two electronic data storage float tags had been returned (see Figure 28):

Tag ID A07204: a female spurdog (total length 76 cm), released on 21 September 2011 in ICES area VIIh and at liberty 25 days was recaptured by a French trawler 161 km south of the release position on 16 October 2011. Depth and temperature data recorded from release to recapture are shown in Figure 29.

Tag ID A06747: a male spurdog (total length 88 cm), released on 21 September 2011 in ICES area VIIg and at liberty 72 days was recaptured by a French trawler 50 km northwest of its release position on 2 December 2011. Depth and temperature data recorded are shown in Figure 30.

Depth data recorded from both electronic tags showed spurdog behaviour movements up into the water column during darkness before returning closer to the seabed by day.

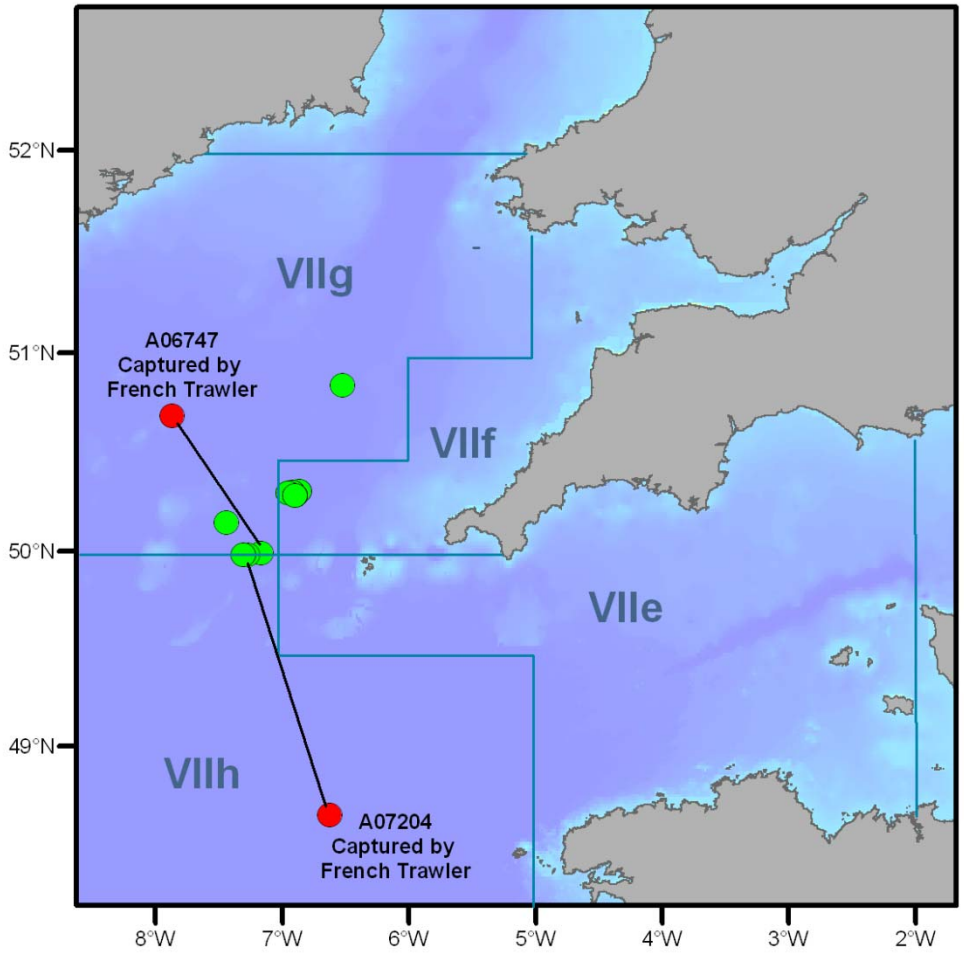


Figure 28. Release positions (green circles) of 24 electronically tagged spurdog captured aboard FV "Charisma" during September 2011. Recapture positions (red circles) are shown for two spurdog recaptured by French trawlers.

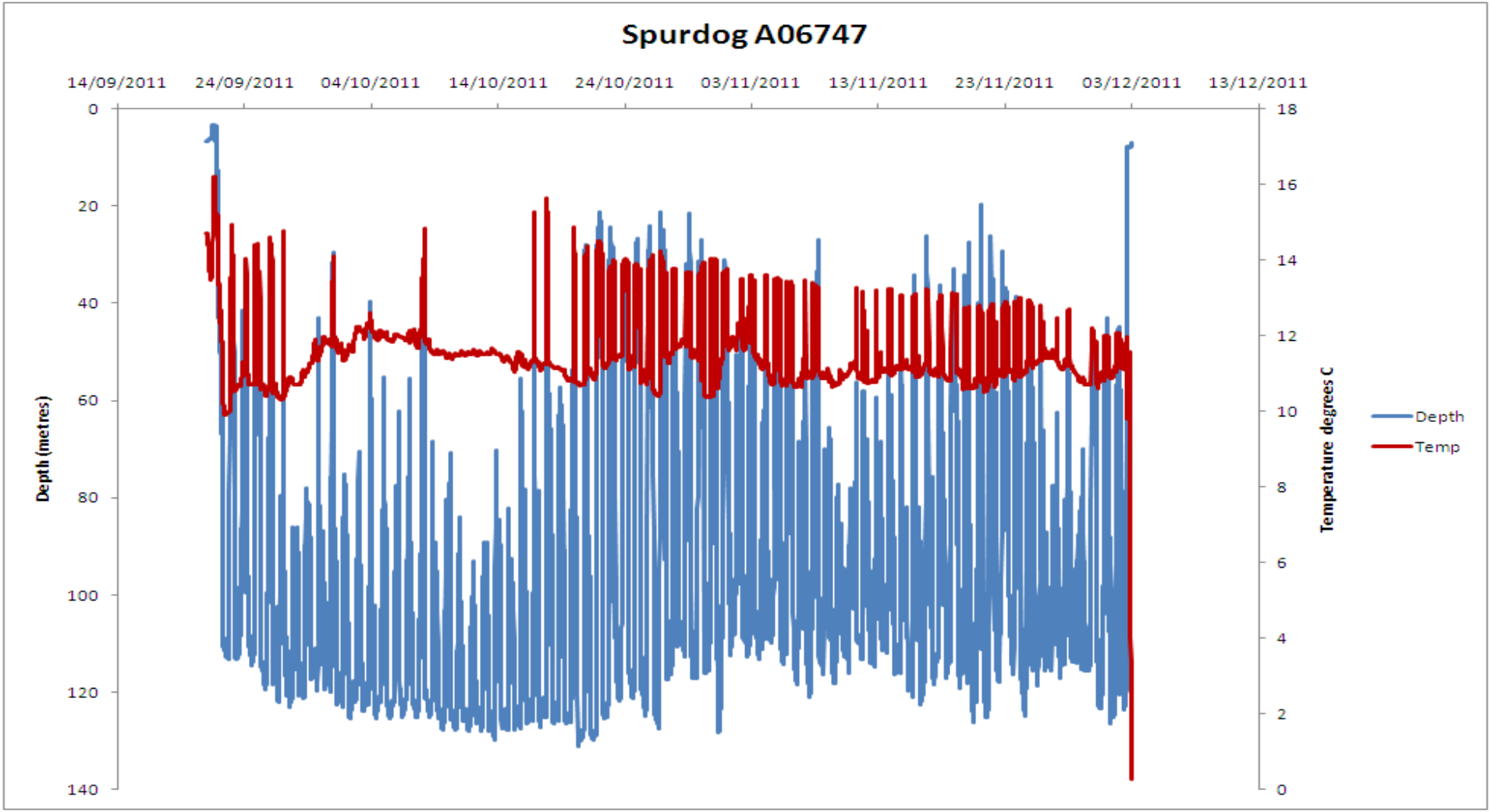


Figure 29. Depth and temperature plot for spurdog A06747 tagged and released on 21 September 2011 and captured by a French trawler on 02 December 2011. Depth in m (blue line) and temperature in °C (red line) were recorded at 1-min intervals throughout the time at liberty.

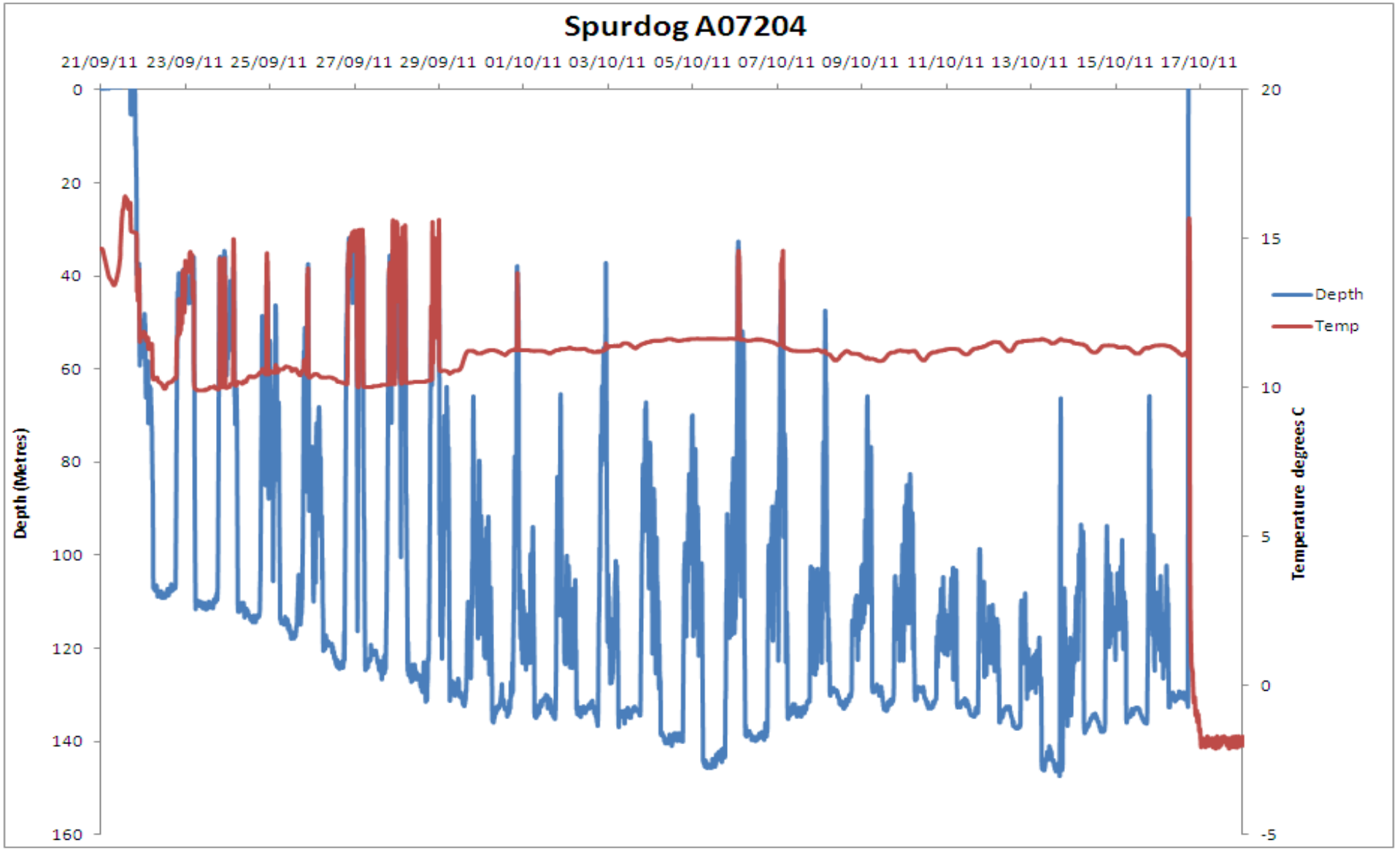


Figure 30. Depth and temperature plot for spurdog A07204 tagged and released on 21 September 2011 and captured by a French trawler on 16 October 2011. Depth in m (blue line) and temperature in °C (red line) were recorded at 1-min intervals throughout the time at liberty.

Biological sampling of spurdog

In all, 38 of the 42 dead spurdog were sampled biologically on board FV “Charisma” during the field study. Of these, 25 were males (mean total length 80 ± 5 cm), 20 (84%) of which were considered mature/active and four (16%) as maturing. Of the 13 females (mean total length 86 ± 15 cm), two (15%) were immature, five (39%) were maturing and six (46%) were active and in pup (with 1–14 pups present).

Overall, external body net damage was found to be mainly around the head and gills in 25 spurdog (66%), over the body for seven spurdog (18%), and six (16%) showed no external signs of damage (Figure 31).

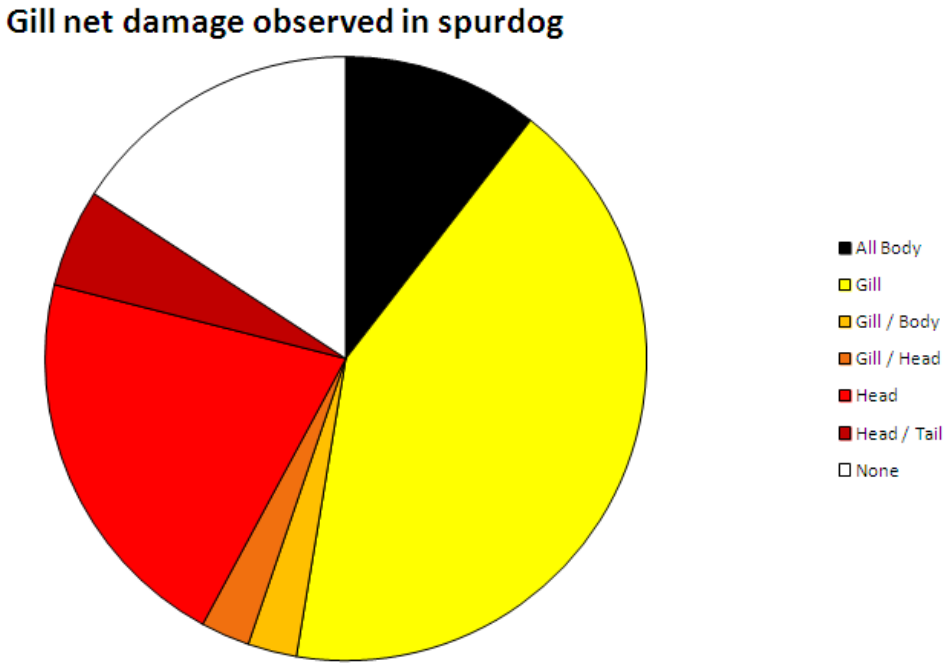


Figure 31. Net damage observed in 38 dead spurdog bycaught in fixed gillnets within ICES Divisions VIIf-h on FV “Charisma” during September 2011.

Common skate (*D.* cf. *flossada*) bycatch, survivability and mark ID

In all, five common skate were captured aboard FV "Charisma" (Table 17, Figure 32), and all were considered to be in good condition (lively) so were tagged externally with a button sure-tags directly onto the wing prior to release.

Table 17. Summary details of common skate (*D.* cf. *flossada*) tagged after being bycaught in fixed gillnets in ICES Divisions VIIf-h by FV "Charisma" during September 2011.

Release date	Tag ID	Sex	Total length (cm)	Wing width (cm)	Health state	Soak time (h)	ICES area of release
21/09/2011	E016593	Male	120	86	1	12	VIIf
22/09/2011	E016584	Female	127	91	1	17	VIIh
23/09/2011	E016542	Male	113	80	1	14	VIIg
23/09/2011	E016785	Female	132	93	1	19	VIIg
23/09/2011	E016801	Female	124	84	1	19	VIIg

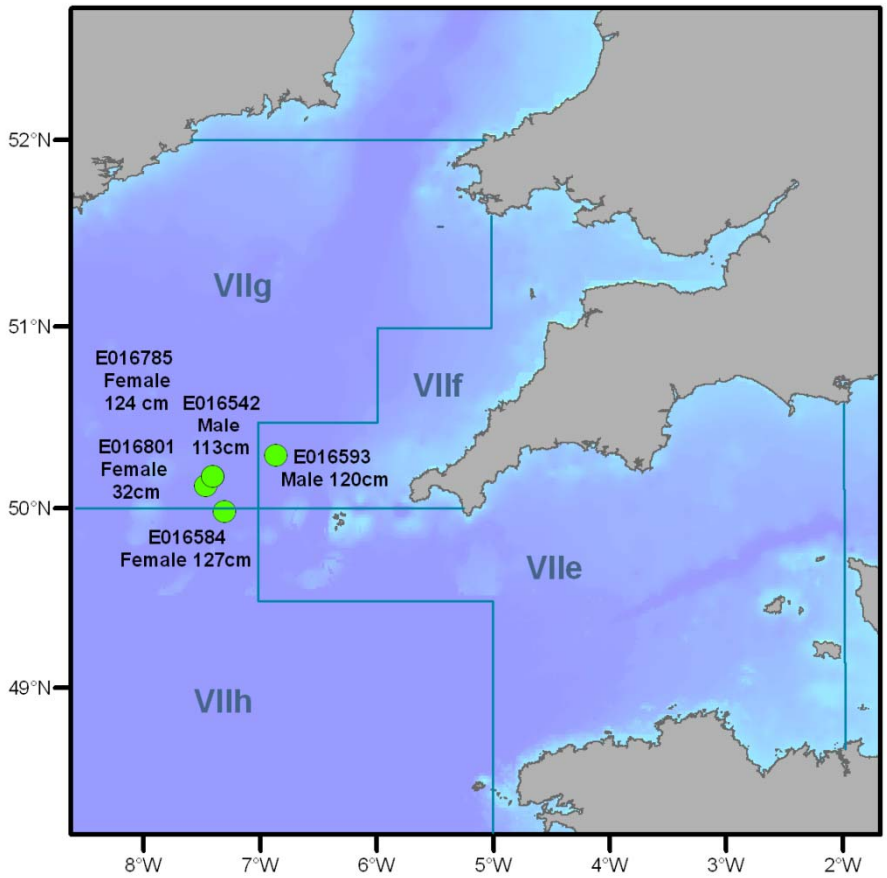


Figure 32. Release positions (green circles) of mark ID tagged common skate captured aboard FV "Charisma" during September 2011.

3.3. Seasonal spurdog bycatch study within ICES Divisions VIIf-g aboard FV "Charisma" (February–March 2012).

Overall target and bycatch species composition

The number of fish (and percentage of total catch and their size range) caught by FV "Charisma" between 26 February and 2 March 2012 is shown in Table 18.

In all, 53 spurdog made up 1% of the total number of fish caught during the survey, and 4% of the total number of discarded bycatch. In addition 179 lesser-spotted dogfish were captured, accounting for 3% of the total catch and just over 12% of the total number of fish discarded.

Overall, 337 elasmobranchs (5% of the total catch) were captured during the field study, which together accounted for 22% of discarded bycatch. Remaining discarded bycatch (Figure 33) consisted of various roundfish (*n* =1048, 70%), shellfish (*n* = 79, 5%) and flatfish (*n* = 32, 2%).

The most abundant discarded elasmobranch bycatch species were lesser-spotted dogfish (*n* = 179, 53%), spurdog (*n* = 53, 16%), nursehounds (*n* = 56, 17%) and starry smoothhound (*n* = 39, 12%). These discarded elasmobranchs were mainly returned to sea alive.

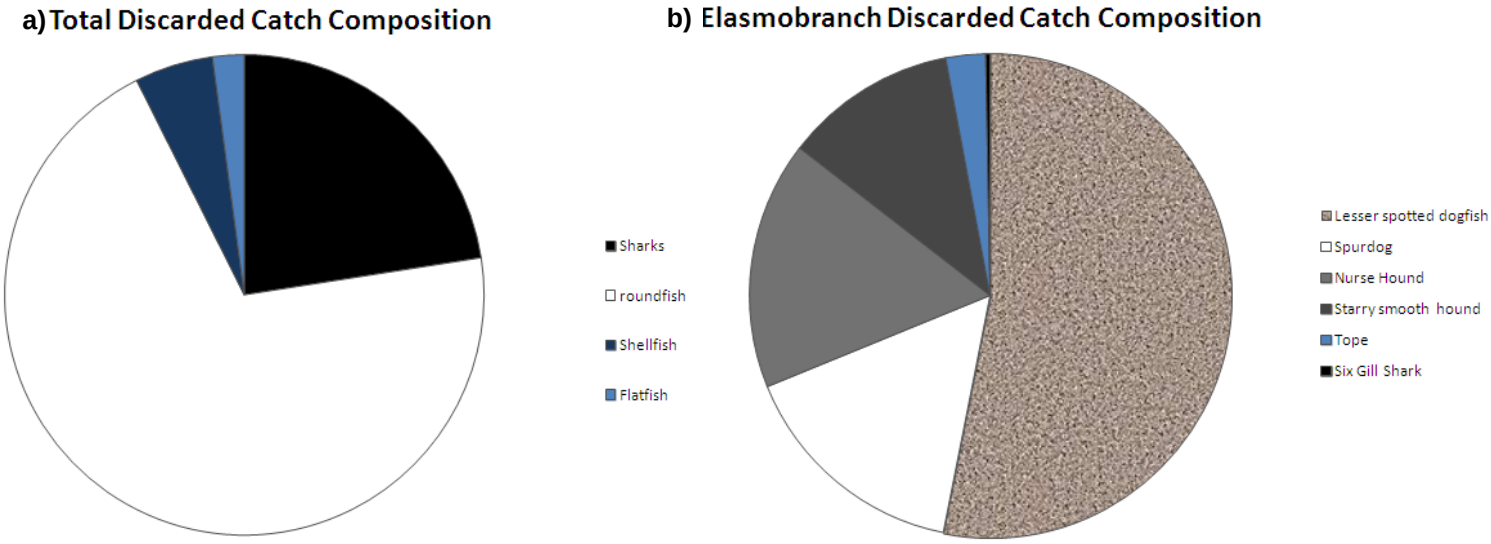


Figure 33. Discarded catch composition for 17 fixed gillnet locations over the 6-day field study aboard FV "Charisma": (a) total discarded catch composition by species group and (b) elasmobranch (sharks, skates and rays) discarded species catch composition.

Table 18. Species composition (numbers and %) for total catches, and retained/discarded parts of the catch observed for 17 sites fished with fixed nets during a field study aboard FV "Charisma". Grey shading highlights shark species of interest and yellow shading the most abundant target species captured and retained.

	Total catch			Retained catch			Discarded catch		
Species	**N°**	**%**	**Length range**	**N°**	**%**	**Length range**	**N°**	**%**	**Length range**
Anglerfish	1	0.01	32				1	0.07	32
Ballen wrase	2	0.03	33 - 36				2	0.13	33 - 36
Bass	29	0.43	42 - 60	29	0.55	42 - 60			
Bib	14	0.21	26 - 43				14	0.94	26 - 43
Blunt nosed six gill shark	1	0.01	85				1	0.07	85
Cod	**4564**	**67.52**	**46 - 110**	**3845**	**73.06**	**46 - 110**	**719**	**48.06**	**55 - 73**
Dab	3	0.04	24 - 26				3	0.20	24 - 26
Edible crab	4	0.06	13.5 - 20.1				4	0.27	13.5 - 20.1
Flounder	2	0.03	31 - 33				2	0.13	31 - 33
Grey gurnard	44	0.65	20 - 43				44	2.94	20 - 43
Haddock	**823**	**12.18**	**26 - 77**	**663**	**12.60**	**28 - 77**	**160**	**10.70**	**26 - 56**
Hake	6	0.09	70 - 105	6	0.11	70 - 105			
Herring	2	0.03	27.5 - 28				2	0.13	27.5 - 28
John Dory	12	0.18	27 - 46	12	0.23	27 - 46			
Lesser spotted dogfish	179	2.65	35 - 75				179	11.97	35 - 75
Lemon sole	3	0.04	31 - 72				3		31 - 72
Ling	223	3.30	67 - 108	223	4.24	67 - 108			
Lobster	1	0.01	13				1	0.07	13
Mackrel	2	0.03	25 - 31				2	0.13	25 - 31
Megrim	4	0.06	32 - 46	4	0.08	32 - 46			
Nurse hound	56	0.83	66 - 114				56	3.74	66 - 114
Pollack	**223**	**3.30**	**41 - 84**	**221**	**4.20**	**41 - 84**	**2**	**0.13**	**55 - 64**
Poor cod	1	0.01	21				1	0.07	21
Red gurnard	14	0.21	24 - 39				14	0.94	24 - 39
Sole	17	0.25	28 - 37	17	0.32				
Spider crab	75	1.11	10 - 16	1	0.02		74	4.95	Oct-16
Spurdog	**53**	**0.78**	67 - 86				**53**	**3.54**	67-86
Starry smooth hound	39	0.58	69 - 105				39	2.61	69 - 105
Tope	9	0.13	106 - 162				9	0.60	106-162
Tub gurnard	1	0.01	41				1	0.07	41
Whitting	342	5.06	27 - 75	242	4.60	28 - 75	100	6.68	27 - 55
Witch	10	0.15	25 - 43				10	0.67	25 - 43
Grand total	**6759**	**100.00**		**5263**	**100.00**		**1496**	**100.00**	

Variable soak times

Tables 19 and 20 show the catch composition for 12–27 h and 36–45 h, respectively, and Figure 34 shows the distribution by numbers of spurdog, roundfish and other elasmobranch species caught during the field study.

Table 19. Target and bycatch species composition for 12–27 h soak time, showing the number and percentage of species captured, retained and discarded, for 15 fixed gillnet locations fished over the 6-day field study aboard FV "Charisma". Grey shading highlights shark species of interest and yellow shading the most abundant target species captured and retained.

12 – 27h soak time	Total catch			Retained catch			Discarded catch		
Species	N°	%	Length range	N°	%	Length range	N°	%	Length range
Ballen wrase	2	0.04	33 - 36				2	0.33	33 - 36
Bass	25	0.55	45 - 59	25	0.64	45 - 59			
Bib	14	0.31	26 - 43				14	2.31	26 - 43
Bluntnosed six-gill shark	1	0.02	85				1	0.16	85
Cod	2799	61.94	46 - 104	2778	71.01	46 - 104	21	3.46	55 - 67
Dab	2	0.04	24 - 26				2	0.33	24 - 26
Edible crab	2	0.04	17 - 20.1				2	0.33	17 - 20.1
Flounder	2	0.04	31 - 33				2	0.33	31 - 33
Grey gurnard	22	0.49	25 - 39				22	3.62	25 - 39
Haddock	668	14.78	26 - 77	550	14.06	39 - 77	118	19.44	26 - 56
Hake	6	0.13	70 - 105	6	0.15	70 - 105			
Herring	2	0.04	27.5 - 28				2	0.33	27.5 - 28
John Dory	12	0.27	27 - 46	12	0.31	27 - 46			
Lemon sole	2	0.04	31 - 32				2	0.33	31 - 32
Lesser spotted dogfish	137	3.03	35 - 75				137	22.57	35 - 75
Ling	127	2.81	67 - 108	127	3.25	67 - 108			
Lobster	1	0.02	13				1	0.16	13
Mackerel	2	0.04	25 - 31				2	0.33	25 - 31
Megrim	4	0.09	32 - 46	4	0.10	32 - 46			
Nurse hound	38	0.84	66 - 114				38	6.26	66 - 114
Pollack	201	4.45	41 - 79	199	5.09	41 - 79	2	0.33	55 - 64
Poor cod	1	0.02	21 - 21				1	0.16	21 - 21
Red gurnard	9	0.20	27 - 39				9	1.48	27 - 39
Sole	5	0.11		5	0.13				
Spider crab	65	1.44	9.9 - 15.7	1	0.03		64	10.54	9.9 - 15.7
Spurdog	**49**	**1.08**	67 - 86				**49**	**8.07**	67 - 86
Starry smooth hound	29	0.64	69 - 105				29	4.78	69 - 105
Tope	7	0.15	106 - 162				7	1.15	106 - 162
Whiting	276	6.11	27 - 75	205	5.24	37 - 75	71	11.70	27 - 42
Witch	9	0.20	25 - 43				9	1.48	25 - 43
Grand total	**4519**	**100.00**		**3912**	**100.00**		**607**	**100.00**	

Table 20. Target and bycatch species composition for 36–45 h soak time; showing the number and percentage of species captured, retained and discarded, for 2 fixed gillnet locations fished over the 6-day field study aboard FV "Charisma". Grey shading highlights shark species of interest and yellow shading the most abundant target species captured and retained.

36 – 45h soak time	Total catch			Retained catch			Discarded catch		
Species	N°	%	Length range	N°	%	Length range	N°	%	Length range
Anglerfish	1	0.04	32				1	0.11	32
Bass	4	0.18	42 - 60	4	0.30	42 - 60			
Cod	**1765**	**78.79**	**55 - 110**	**1067**	**78.98**	**56 - 110**	**698**	**78.52**	**55 - 73**
Dab	1	0.04	26				1	0.11	26
Edible crab	2	0.09	13.5 - 13.7				2	0.22	13.5 - 13.7
Grey gurnard	22	0.98	20 - 43				22	2.47	20 - 43
Haddock	**155**	**6.92**	**28 - 69**	**113**	**8.36**	**28 - 69**	**42**	**4.72**	**28 - 45**
Lemon sole	1	0.04	32				1	0.11	32
Lesser spotted dogfish	42	1.88	45 - 67				42	4.72	45 - 67
Ling	96	4.29	73 - 99	96	7.11	73 - 99			
Nurse hound	18	0.80	72 - 104				18	2.02	72 - 104
Pollack	**22**	**0.98**	**54 - 84**	**22**	**1.63**	**54 - 84**			
Red gurnard	5	0.22	24 - 38				5	0.56	24 - 38
Sole	12	0.54	28 - 37	12	0.89				
Spider crab	10	0.45	10.5 - 15				10	1.12	10.5 - 15
Spurdog	**4**	**0.18**	69 - 81				**4**	**0.45**	69 - 81
Starry smooth hound	10	0.45	82 - 94				10	1.12	82 - 94
Tope	2	0.09	152 - 155				2	0.22	152 - 155
Tub gurnard	1	0.04	41				1	0.11	41 - 41
Whiting	66	2.95	27 - 60	37	2.74	28 - 60	29	3.26	27 - 55
Witch	1	0.04	37				1	0.11	37 - 37
Grand total	**2240**	**100.00**		**1351**	**100**		**889**	**100.00**	

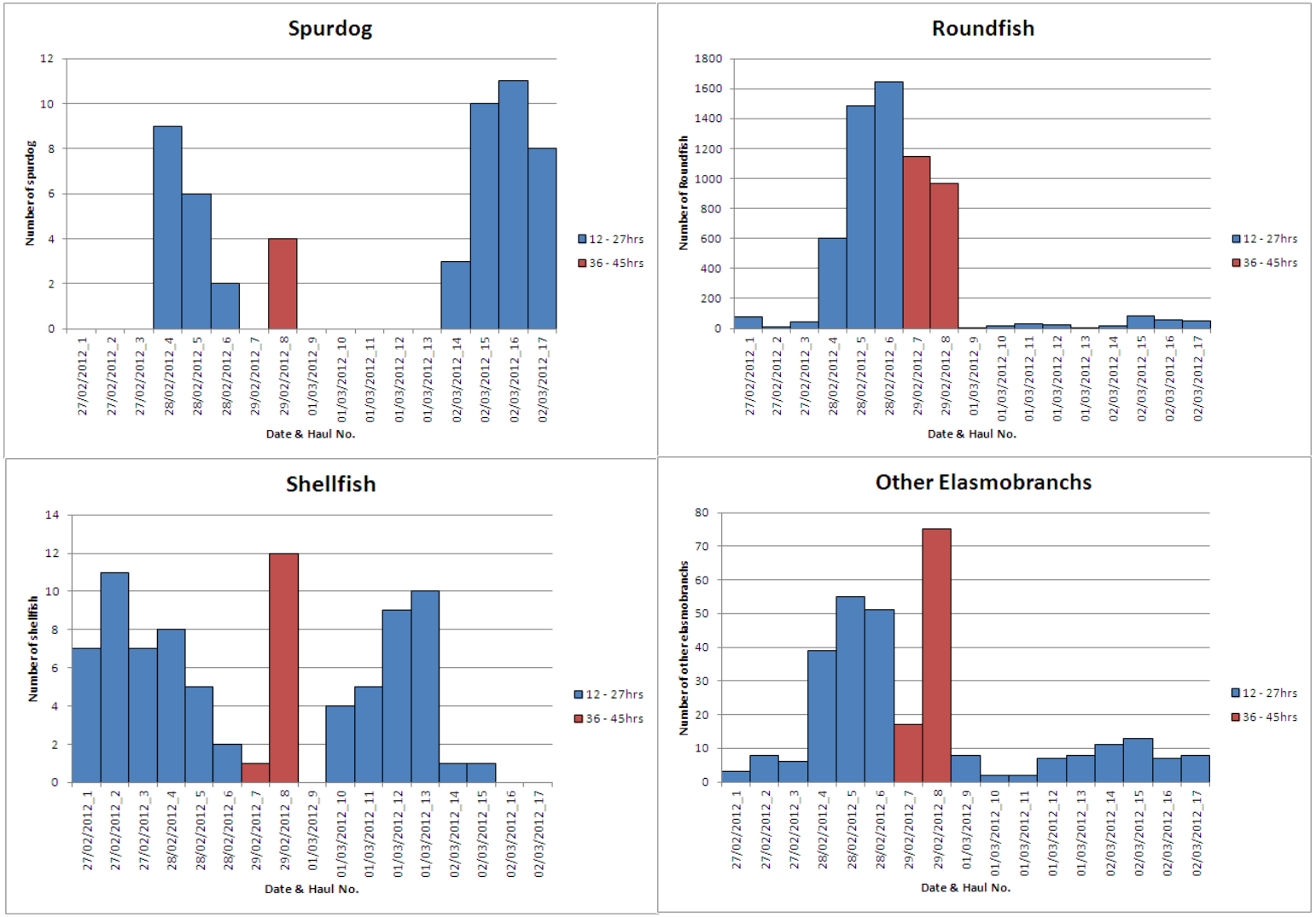


Figure 34. Distribution by number of (a) spurdog, (b) roundfish, (c) shellfish and (d) other elasmobranchs for 15 fixed gillnet positions (12–27 h soak time) and 2 fixed gillnet positions (36–45 h soak time) fished over the 6-day field study aboard FV “Charisma”.

Spurdog bycatch and survivability

Of the 53 spurdog caught (summarized in Table 21), 40 (75%) were considered to be in good condition (lively), seven (13%) were recorded as sluggish and six (12%) were considered dead. Catches were dominated significantly by males (sex ratio 16.7 : 1, Chi-squared $p < 0.001$).

The mean total lengths of spurdog were 78 ± 5 cm and 76 ± 6 cm for males and females, respectively.

Table 21. Sex composition, length range and survivability of spurdog bycaught in fixed gillnets in ICES Divisions VIIf-g by FV "Charisma" (February–March 2012).

					Survivability					
Soak time (h)	**Spurdog**	**No.**	**Sex composition %**	**Total length range (cm)**	**Lively**		**Sluggish**		**Dead**	
					No.	**%**	**No.**	**%**	**No.**	**%**
12–27 h	Males	46	94%	67–86	36	78	6	13	4	9
	Females	3	6%	69–82	2	66	1	46		
	Total	**49**	**100%**	**67–86**	**38**	**78%**	**7**	**14%**	**4**	**8%**
36–45 h	Males	4	100%	69–81	2	50			2	50
	Females	0	0%							
	Total	**4**	**100%**	**69–81**	**2**	**50%**			**2**	**50%**
All catches	Males	50	94%	67–86	38	76	6	12	6	12
	Females	3	6%	69–82	2	66	1	46		
	Total	**53**	**100%**	**67–86**	**40**	**75%**	**7**	**13%**	**6**	**12%**

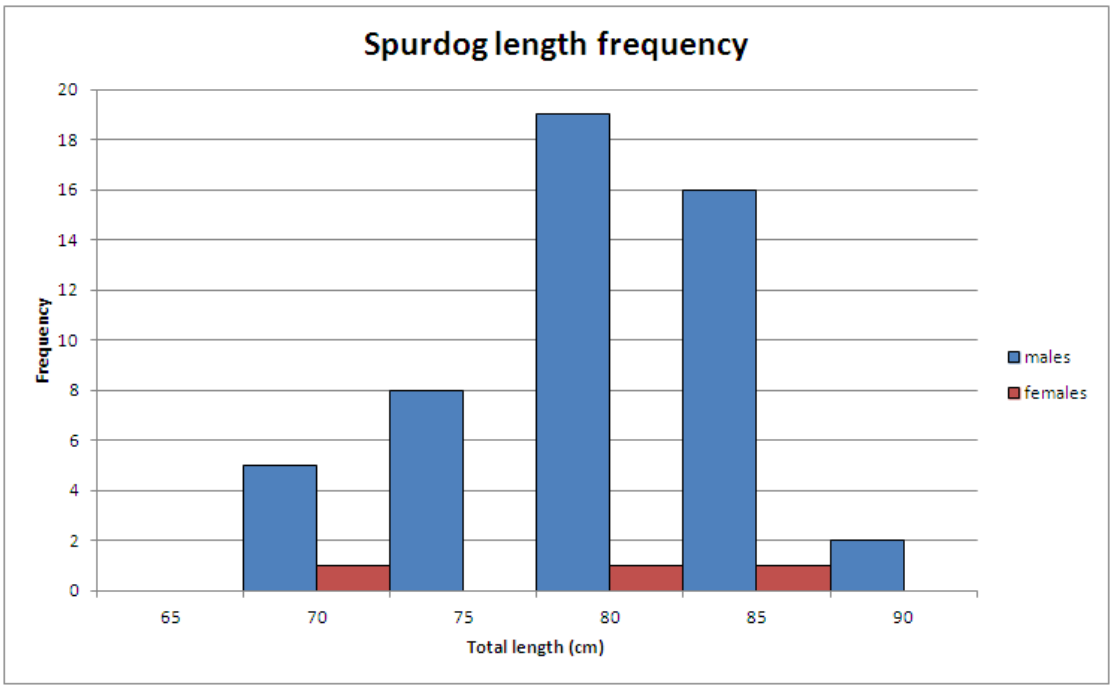


Figure 35. Length frequency distribution of male and female spurdog bycaught in fixed gillnets in ICES Divisions VIIf-g by FV "Charisma" (February−March 2012).

Mark ID and electronic (DST) tagged spurdog

In all, 47 spurdog considered to be in good condition were tagged and released during the field study. A total of 27 spurdog (25 males and two females) was tagged externally with roto-tags placed on the dorsal fin, and 20 (19 males and one female) were tagged externally with DSTs, into the dorsal musculature. Figure 36 illustrates the distribution and numbers of spurdog tagged and released. There had been no returns up to 30 April 2012.

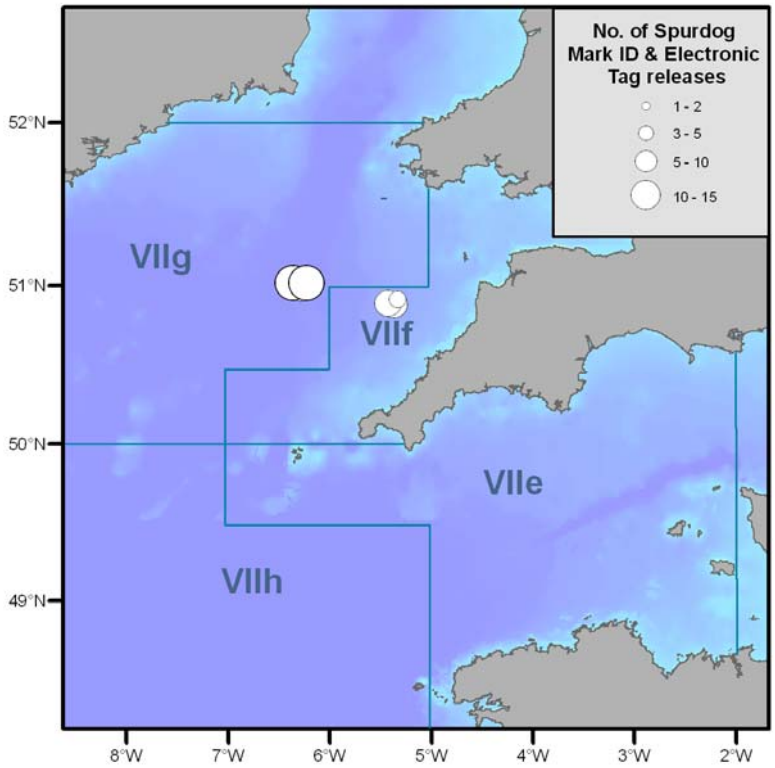


Figure 36. Map showing the number of mark ID and electronically tagged spurdog, by release area.

Biological sampling of spurdog

In all, six dead spurdog were captured during the field study and transported back to the Cefas Laboratory to be sampled biologically. All six were males (mean total length 77 ± 3 cm). Details for each fish are summarized in Table 22.

Table 22. Summary details of biosampled spurdog bycaught in fixed gillnets on FV "Charisma".

Date	Total length (cm)	Fork length (cm)	Girth (cm)	Sex	Body weight (kg)	Soak time (hrs)	ICES Division
28/02/2012	76	67	23	Male	2.3	15	VIIg
28/02/2012	76	66	22	Male	1.9	19	VIIg
28/02/2012	83	74	23	Male		19	VIIg
28/02/2012	75	67	21	Male		27	VIIg
29/02/2012	75	65	21	Male		45	VIIg
29/02/2012	78	69	25	Male	2.3	45	VIIg

3.4. Voluntary trial of simplistic logbook/self-sampling scheme: shark bycatch record cards

A total of 23 bycatch cards was returned in October and November 2011 from three fishing vessels operating off the SW coast (FV “Charisma”, FV “Berlewen” and FV “Govenek of Ladram”). The distribution of recorded bycatch is illustrated in Figure 37, and the full recorded bycatch card details are listed in Table 23.

Individual porbeagle recordings were widely distributed throughout ICES Divisions VIIf-g during October and November 2011, although large quantities, of 5–50 fish, were recorded during October 2011. Large quantity catches were also recorded for common skate in October and for spurdog in November 2011.

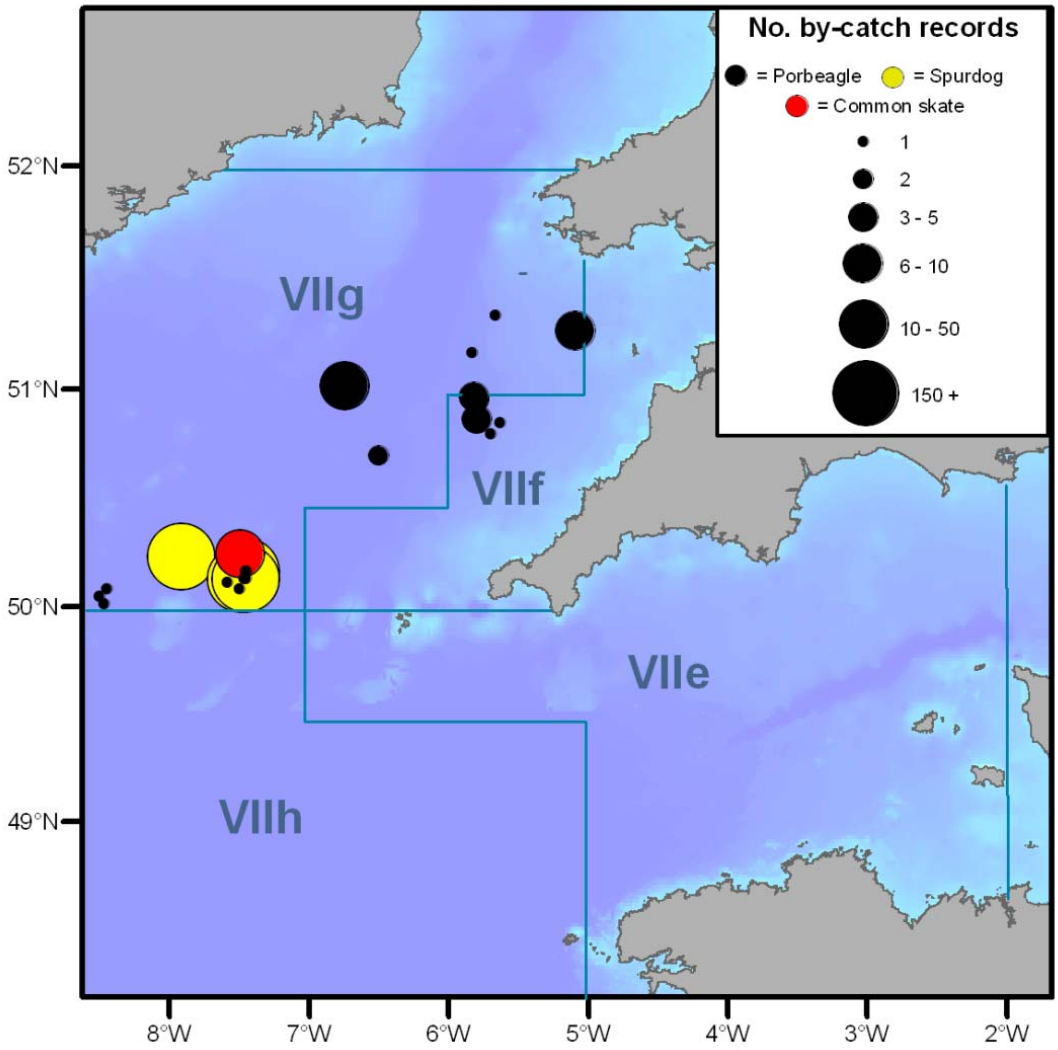


Figure 37. Spatial distribution of voluntary recorded bycatch of “shark species of interest” by FVs “Charisma”, “Berlewen” and “Govenek of Ladram” during October/November 2011.

Table 23. Summary details of voluntary bycatch card recordings by FVs “Charisma”, “Berlewen” and “Govenek of Ladram” during October/November 2011.

Date of trip	Species	No.	Sex	Total length	Discarded Condition	ICES Area	Fishing Vessel	Gear Type	Mesh size	Soak time (h)	Discard time after hauling
06/10/2011	Common skate	40	Mixed catch	>1 m	Mix of dead & alive	VIIg	Govenek of Ladram / PZ51	Trammel	4 7/8 inch	48–72	10 - 15 min
18/10/2011	Porbeagle	2	Female	>2 m	Dead	VIIg	Berlewen / PW1	Gill	120–220 mm	18	10 min
18/10/2011	Porbeagle	10–50	Mostly females	>1 m	Mostly dead	VIIg	Berlewen / PW1	Gill	140 mm	18	10 min
19/10/2011	Porbeagle	5	Mostly females	>1 m	Dead	VIIf	Berlewen / PW1	Gill	140 mm	20	10 min
20/10/2011	Porbeagle	1	Female	>2 m	Dead	VIIf	Berlewen / PW1	Gill	140 mm	18	10 min
20/10/2011	Porbeagle	1	Female	>1 m	Dead	VIIf	Berlewen / PW1	Gill	140 mm	18	5 min
20/10/2011	Porbeagle	5	Mostly males	>1 m	Mostly dead	VIIf	Berlewen / PW1	Gill	140 mm	18	5 min
20/10/2011	Porbeagle	1	Unknown	>1 m	Dead	VIIg	Berlewen / PW1	Gill	140 mm	18	5 min
21/10/2011	Porbeagle	1	Unknown	>2 m	Dead	VIIg	Berlewen / PW1	Gill	140 mm	16	5 min
22/10/2011	Porbeagle	5–10	Mixed catch	>1 m	Dead	VIIg	Berlewen / PW1	Gill	140 mm	18	10 min
16/11/2011	Spurdog	150	Mixed catch		Mix of dead & alive	VIIg	Charisma / BA45	Trammel	4 7/8 inch	18	1 min
17/11/2011	Porbeagle	1	Female	>1 m	Dead	VIIg	Charisma / BA45	Gill	4 7/8 inch	18	5 min
17/11/2011	Spurdog	200	Mixed catch		Mix of dead & alive	VIIg	Charisma / BA45	Trammel	4 7/8 inch	18	1 min
18/11/2011	Porbeagle	1	Male	>1 m	Dead	VIIg	Charisma / BA45	Gill	6 7/8 inch	20	5 min
18/11/2011	Spurdog	200	Mixed catch		Mix of dead & alive	VIIg	Charisma / BA45	Trammel	4 7/8 inch	18	1 min
18/11/2011	Porbeagle	1	Male	>2 m	Dead	VIIg	Charisma / BA45	Gill	5 7/8 inch	18	5 min
18/11/2011	Porbeagle	1	Unknown	<1 m	Dead	VIIg	Charisma / BA45	Gill	7 7/8 inch	18	5 min
19/11/2011	Porbeagle	1	Unknown	<1 m	Dead	VIIg	Charisma / BA45	Gill	10 7/8 inch	18	1 min
19/11/2011	Porbeagle	1	Male	>1 m	Dead	VIIg	Charisma / BA45	Gill	9 7/8 inch	18	2 min
19/11/2011	Porbeagle	1	Female	>2 m	Dead	VIIg	Charisma / BA45	Gill	8 7/8 inch	18	2 min
19/11/2011	Spurdog	200	Mixed catch		Mix of dead & alive	VIIg	Charisma / BA45	Trammel	4 7/8 inch	18	1 min
20/11/2011	Porbeagle	1	Unknown	>1 m	Dead	VIIg	Charisma / BA45	Gill	11 7/8 inch	18	Fell out of net
20/11/2011	Porbeagle	1	Female	>2 m	Dead	VIIg	Charisma / BA45	Gill	12 7/8 inch	18	2 min

4. Discussion

This Fisheries Science Partnership study on spurdog, porbeagle and common skate discard reduction successfully met its primary objectives with the collation of data for >2,000 elasmobranchs of both commercial and conservation interest. The combined release of 621 mark ID tags and 70 electronic tags on spurdog, porbeagle and common skate during the study will certainly help to improve our understanding of the spatial and temporal distribution of these species in relation to the environment and commercial fisheries within the region, and will feed directly into current and future Defra-funded research projects[1].

The aim of the study was to examine current levels of shark and skate bycatch in commercial offshore netfisheries (gill, trammel and tangle) off Cornwall (ICES Division VIIe-h), an area where spurdog, porbeagle and common skate are sufficiently common (locally and/or seasonally) that bycatch has become a real issue. Generally gill- and trammelnet bycatch compositions included large numbers of sharks, skates and rays. Lesser-spotted dogfish and spurdog were the main elasmobranch bycatch in gillnets, and common skate the main bycatch in trammelnets. Overall, the elasmobranch bycatch appeared to be distributed widely throughout the area, and most of the fish were returned to sea alive.

Spurdog bycatch

In all, 389 spurdog were captured throughout the three chartered field studies (Table 24) and were distributed widely throughout ICES areas VIIf-h. Sex composition varied between fishing locations, although males were more abundant throughout. Spurdog were mainly at early stages of maturing or fully mature, with biological sampling of dead bycatch indicating females to be mature and in pup.

Table 24. Summary details of spurdog caught during the FSP.

Vessel	Month	Males		Females		Unsexed	Surviving capture		
		No.	Length range	No	Length range		No.	%	No. tagged
Govenek of Ladram	Aug 2011	84	56 - 84	65	57 - 107		91	61.1%	74
Charisma	Sep 2011	115	64 - 91	67	60 - 123	5	145	77.5%	132
Charisma	Feb/Mar 2012	50	67 - 86	3	69 - 82		47	88.6%	47
Total		249		135		5	283	72.8%	253

Survival rates were consistently high for spurdog regardless of gillnet soak time, with 283 (73%) discarded to sea alive. Variation in length of soak time did not appear to have an impact upon the numbers of spurdog caught, with variable numbers captured in both short and long soaks.

From the results of recaptures up to 30 April 2012, the spatial distribution of three electronically tagged spurdog at liberty between 25 and 72 days were caught 25–161 km from their original area of release. Two of the spurdog were recaptured by French trawlers operating to the south and north of original release locations within VIIg and VIIh. Depth data recorded from the electronic tags showed that spurdog moved up

[1] See MB5201 and MB5202 on Defra's science and research projects, http://randd.defra.gov.uk/

into the water column during darkness before returning close to the seabed by day. Further studies would be useful to determine whether the bycatch of spurdog could be reduced notably by shooting and hauling nets during darkness and whether such activity would affect the levels of target catch.

One electronic tag (ID A07159) released on a male spurdog (71 cm total length) bycaught in a gillnet (soak duration 21 h) within VIIe, became detached after 61 days. Thanks to the tag's float jacket, the tag popped to surface where it was washed ashore onto a beach off Wales and recovered by a member of the public. The depth data recorded by the tag shows that despite being scored as lively and in good condition, the spurdog survived for just 10 days after being tagged and released, before coming to a complete rest upon the seabed, where it appears to have died. This underscores the possibility that fish that appear lively and do not show external signs of damage may not survive capture and may sustain injuries that compromise survival. That particular spurdog was captured in a gillnet with a reduced soak time and high standards of post-capture handling and welfare prior to release, so the result raises potential concerns in determining realistic survival rates for elasmobranchs that appear to be fit on release during normal commercial activities. Further field studies may help evaluate the longer-term survival of elasmobranch bycatch.

Porbeagle bycatch

In all, 20 porbeagle were captured during the chartered field studies (Table 25), distributed widely throughout the study area in September 2011. Sex composition appeared to be almost unity and most of the males were maturing or mature (64%). Biological sampling of the dead catch indicated that most females were immature (75%). One small juvenile male porbeagle just over a metre long was also captured.

Table 25. Summary details of porbeagle caught during the FSP.

Vessel	Month	Males		Females		Unsexed	Surviving capture		
		No.	Length range	No	Length range		No.	%	No. tagged
Govenek of Ladram	Aug 2011					1	0	0%	0
Charisma	Sep 2011	9	117 - 194	7	144 - 250	3	4	21%	3
Total		9		7		4	4	20%	3

Porbeagle survival rates throughout the study were consistently low, with just 4 (20%) recorded as alive prior to discard. Variation in the duration of soak time did not appear to have an impact upon the numbers of porbeagle captured nor the chances of survivability. The few live porbeagle encountered during the study appeared to be relatively fresh captures and it would appear that the chance of survival for porbeagle declines rapidly after capture in nets within a short period of time. Reducing the net soak time would therefore appear not to be a viable option for fishers wanting to avoid unwanted dead porbeagle bycatch.

From the results of recaptures up to 30 April 2012, one electronic tag (ID A07159) has been returned. The tag was released on a male porbeagle (172 cm total length) bycaught in a gillnet (soak duration 20 h) within VIIg and became detached after 66 days, some 251 km from the original release position. Thanks to the tag's float jacket, the tag popped to surface where it was washed ashore onto a beach off North Brittany and recovered by a member of the public. Depth data recorded from the

electronic tag showed the porbeagle to be incredibly lively and mobile, with active vertical movements up into the water column during darkness before returning close to the seabed by day. Further studies would be useful to determine whether the bycatch of porbeagle could be reduced by shooting and hauling nets during the hours of darkness and whether such activity would affect the levels of target catch.

During our studies there did not appear to be a discrete habitat or localized abundance of porbeagle, and the bycatch often consisted of a few individuals spread widely across ICES Divisions VIIf-g. This is a critical issue of concern for SW fishers, because porbeagle bycatch has become incredibly hard to judge and avoid, resulting in incidental catches of mainly dead porbeagle that have to be discarded.

Future sustainable management and stock recovery for these species appears to be incredibly complex, and further study is needed to help map spatial abundance and habitat use for porbeagle within the Celtic Sea, in order to understand and manage the stock better. Current measures may not be benefiting the stock, because the discards are often dead. As well as the impact to the fishery, such discarding also results in less fishery-dependent information being available for assessing the stock.

Common skate bycatch

During the study, captures of both species of the common skate *D. batis* 'complex' were observed (Table 26), blue skate (*D.* cf. *flossada*) and the larger flapper skate (*D.* cf. *intermedia*). *D.* cf. *flossada* was by far the more abundant, with 1239 captured during the study (compared with the eight *D.* cf. *intermedia*). *D.* cf*. flossada* were distributed widely throughout the study area during May and August 2011. *D.* cf*. flossada* bycatch yielded a sex ratio of virtually unity, including mature males in active breeding condition and females carrying egg cases ready to be deposited.

Table 26. Summary details of common skate caught during the FSP.

Species	Vessel	Month	Males		Females		Surviving capture		
			No.	Length range	No	Length range	No.	%	No. tagged
D. cf. *Flossada*	Govenek of Ladram	May/Aug 2011	608	65 - 158	626	53 - 110	1141	92%	413
D. cf. *Flossada*	Charisma	Sep 2011	2	113 - 120	3	124 - 132	5	100%	5
D. cf. *intermedia*	Govenek of Ladram	Aug 2011	4	79 - 230	4	119 - 128	8	100%	5
Total			614		633		1154	92.5%	423

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Survival rates were consistently high regardless of soak time for all common skate, with a total of 1154 skate discarded back to the sea alive (93%). However, the total bycatch of common skate increased considerably with soak time, from 19% of total catch at 12–26 h soak to 72% at 36−48 h and 63% at 58–60 h, with targeted commercial species such as anglerfish also increasing from 3% (12–26 h) to 7% (58–60 h) of the total overall catch. Reducing the soak time of trammelnets does not therefore seem to be a realistic commercial option to fishers in relation to their target species, although it does have potential implications for increased numbers of incidental bycatch of common skate. According to the skipper of FV "Govenek of Ladram", this has become a particular issue for concern, which is becoming increasingly more difficult to avoid.

The numbers of common skate (*D.* cf. *flossada*) appeared to be high and healthy in terms of breeding condition. and they were widely spread throughout the study area during the field studies. In order to avoid large incidental bycatch of common skate, which is costly in terms of net damage and time-consuming for clearing the nets of unwanted catch, fishing vessels such as the "Govenek of Ladram" are becoming increasingly more constrained to fishing grounds free from potential common skate bycatch. These fishing grounds are now being heavily impacted by English and French fleets wanting to avoid unwanted incidental catches of common skate.

Although the blue skate (*D.* cf. *flossada*) stock appeared to be relatively abundant in terms of the number caught, breeding conditions and broad size distributions, conservation concerns can be raised for the larger flapper skate (*D.* cf. *intermedia*), with just eight individuals captured during the study, all of which were immature. The flapper skate is not thought to reach 50% sexual maturity until it is 19–20 years of age, having grown to just under 2 m total body length. In contrast, blue skate are thought to reach 50% sexual maturity at 11 years of age, having grown to just over 1 m total body length (Iglesias *et al.*, 2009). Such slow growth to maturity renders the flapper skate particularly susceptible to overfishing, although it may be that they occur more to the north of the study area, including off NW Scotland (Griffiths *et al.*, 2010), and it is unclear whether flapper skate numbers have actually declined in the Celtic Sea. Further studies are needed to understand better the distribution of both forms of common skate, including the areas of local abundance, in order to manage both species better.

Lice damage was also particularly common, at all soak times. Overall, 35% of dead bycaught common skate were heavily lice-damaged externally and internally, with body cavities completely cleaned out in many cases. Further studies on scavenging isopods could be useful, including perhaps how the populations of such scavengers respond to discarding.

From the results of recaptures up to 30 April 2012, the seven common skate (at liberty for 36–236 days) had moved at least 10–46 km from their original area of release. Recaptures were mainly by French trawlers to the north, south and east of release locations within ICES Divisions VIIe-h.

Voluntary Bycatch Record Cards

In addition to chartered field studies, a voluntary shark bycatch record card scheme was undertaken in October and November 2011. Bycatch card recordings of individual porbeagle were widely distributed throughout the Celtic Sea during those months, although large quantities (of 5–50 individuals) were recorded during October 2011.

Large quantity catches were also recorded for common skate (up to 40 individuals) in October and for spurdog (150–200 individuals) in November 2011. The trial as a whole was successful and the fishers involved voluntarily undertook the scheme to help address their current situation with shark and skate bycatch. Further industry engagement is critical to widening our understanding and knowledge of the spatial abundance and distributions of elasmobranchs of management concern and to help determine practical and realistic ways forward to help address concerns of species and industry sustainability in the long term.

It is hoped that data from this study will be used to supplement management advice, but will also contribute important biological information that can be used to inform future stock assessments.

Conclusions

- Future management and stock recovery for all these target species appears to be complex, and further studies are needed to improve understanding of the spatial distribution and relative abundance for spurdog, porbeagle and common skate both within the Celtic Sea (ICES Divisions VIIe-j) and elsewhere in their areas of distribution.

- Current measures that result in discarding are not benefiting porbeagle, with discarding of dead porbeagle remaining a contentious issue for gillnetters in the southwest, impacting on porbeagle stocks and reducing the levels of data and knowledge to understand and manage the stock better.

- The common skate species known as blue skate (*D.* cf. *flossada*) appeared to be abundant (at least seasonally) and healthy in terms of the size composition and distribution. Only small numbers of flapper skate (D. cf. *intermedia*) were recorded, although it is not known whether this species would have been more abundant in the area prior to the expansion of offshore fisheries, or whether the Celtic Sea is simply the southern edge of their distribution (given that the species is better known from off Scotland and Northern Ireland).

- Increased knowledge of the distribution and behaviour of individual porbeagle, spurdog and common skate over appropriate spatial and temporal scales in the Celtic Sea and elsewhere in their stock distributions is needed to aid the development of more biologically realistic population models and to underpin robust advice. Further studies to examine diel (day/night) patterns in catch rates could be useful in this context.

- Data recorded from a DST placed on a spurdog that was considered ‘lively’ showed subsequent swift deterioration of health, so further studies to understand the longer term survival rates of discarded elasmobranchs better is required.

- Further studies on scavenging isopods could be useful, including on how the populations of such scavengers respond to discarding.

Potential for future work

- The data collected in this FSP study will be provided to the ICES Working Group on Elasmobranch Fishes, to supplement the data being collected to underpin the assessment and advisory process.

- As a direct result of this study, Cefas is using dead bycaught porbeagle and spurdog to increase knowledge of the spatial distribution, diet and age structure.

- A new Defra-funded research project will include a collaborative scientific/industry monitoring programme to collect data on the catches, distribution, biology and discards of elasmobranchs of commercial and conservation interest in southwest England. The research will be unique, in that fishing vessels taking part will

    - help develop and implement a code of conduct for the handling and live release of bycaught elasmobranchs;
    - collect data on catch composition, i.e. weight, length, sex, condition;
    - maximize the live return of threatened bycaught elasmobranch species;
    - tag and release a proportion of the live discards to determine both spatial distribution and monitor/enforce any total allowable bycatch for landing, under the scientific dispensation for biological sampling, to supplement stock assessment and further understanding of elasmobranch biology on an individual and stock level.

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Appendix 1. Chronology of ICES advice and technical regulations for spurdog

ICES advice		EC regulations	
2005	*The stock is depleted. All experimental assessments indicate that the stock is at a record low level … Target fisheries should not be permitted to continue, and* bycatch *in mixed fisheries should be reduced to the lowest possible level. A TAC should cover all areas where spurdog are caught in the northeast Atlantic. This TAC should be set at zero for 2006.*	2006	TAC for EC waters in IIa and IV reduced by ca. 7.5%
2006	*The stock is depleted and may be in danger of collapse. Targeted fisheries should not be permitted to continue, and* bycatch *in mixed fisheries should be reduced to the lowest possible level. The TAC should cover all areas where spurdog are caught in the northeast Atlantic and should be set at zero for 2007.*	2007	TAC for EC waters in IIa and IV reduced by ca. 20%, and allocated as a bycatch quota, whereby spurdog should not comprise more than 5% (by live weight) of the catch retained on board. Separate TAC established for other parts of the ICES area.
2007	*No new advice*	2008	TAC for EC waters in IIa and IV reduced by ca. 25%, and allocated as a bycatch quota, whereby spurdog should not comprise more than 5% (by live weight) of the catch retained on board. TAC for other parts of the ICES area reduced by ca. 30%
2008	*The only new information available for spurdog (Squalus acanthias) is landings data which does not offer any reason to change the advice from 2006… If a non-zero TAC would be set, ICES recommends the introduction of a* ***maximum*** *landing length (MLL). This is expected to deter fisheries targeting areas where large females occur. The maximum landing length should initially be set at 100 cm.*	2009	TAC for EC waters in IIa and IV reduced by 50%. TAC for other parts of the ICES area reduced by 45%. Maximum landing length (100 cm) introduced.
2009		2010	TAC set to zero. Bycatch (up to 10% of 2009 TAC) allowed.
2010	*There is no additional information to change the perception of the stock, consequently ICES reiterates its advice for 2007-2010*	2011	TAC set to zero.
2011	*ICES advises on the basis of the precautionary approach that there should be no targeted fishery and that catches in mixed fisheries should be reduced to the lowest possible level. A rebuilding plan should be developed for this stock… The stock currently appears stable at a low level, but the recent period of stability is short compared to the longevity of the species. Given this longevity, stock recovery will be slow.*	2012	TAC set to zero

Appendix 2: Chronology of ICES advice and technical regulations for common skate

ICES advice		EC regulations	
2005	*North Sea: The stocks of common skate … are depleted. Target fisheries should not be permitted, and* bycatch *in mixed fisheries should be reduced to the lowest possible level.*	2006	TAC only applies to skates and rays at a family level, and only to the North Sea (EC waters of IIa and IV)
2006	*As above*	2007	• North Sea: TAC for 'skates and rays' reduced by 20%, and these species were not to comprise more than 25% (by live weight) of the catch retained on board. • Celtic Seas: No regulations
2007	*No new advice*	2008	• North Sea: TAC for 'skates and rays' reduced by 25%, but catches of the main species, including common skate were to be reported separately • Celtic Seas: No regulations
2008 and 2009	*North Sea: Common skate is depleted. It was formerly widely distributed over much of the North Sea but is now found only rarely, and only in the northern North Sea. The distribution extends into the west of Scotland and the Norwegian Sea … Target fisheries (for commons skate) should not be permitted and measures should be taken to minimize bycatch.* *Celtic Seas: Common skate is depleted. It was formerly widely distributed in the Irish Sea (VIIa), but is now rarely found in this division. Now mostly found off Northwest Scotland (VIa), west of Ireland (VIIb,c), and in the deeper waters of the Celtic Sea (VIIg j), with occasional individuals in shallower areas (VIIe f) … Target fisheries for (common skate) should not be permitted and measures should be taken to minimize bycatch.*	2009	• North Sea: TAC unchanged • Celtic Seas (VIa,b, VIIa-c,e-k): TAC introduced • The TACs for 'skates and rays' did not apply to common skate (*Dipturus batis*). Catches of this species were not be retained on board and should be promptly released unharmed to the extent practicable. Fishers encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of the species
		2010	• North Sea: TAC reduced by 15%. 25% bycatch limit applied to vessels over 15 m • Celtic Seas: TAC reduced by 15% • Common skate listed as a Prohibited species
2010 and 2011	*North Sea: Zero catch. Retain on prohibited species list. Celtic Seas: No targeted fishery.* *Special request for advice on common skate (2010) "There is no basis in the current or previous ICES advice for the listing of the common skate (Dipturus batis) as a prohibited species. Therefore it should not appear on the prohibited species list in either the Celtic Seas or the Biscay/Iberia eco-region fisheries legislation. In the Celtic Seas eco-region, ICES considers that stocks of the common skate complex is depleted, and that protective management measures are required. There should be no target fishing on the common skate, and there should be a TAC set at 0. In the Biscay/Iberia eco-region ICES has no information on stock status. In view of the vulnerability of these species to fishing ICES advises, on the basis of the precautionary approach, that there be no directed fishing unless studies are available on sustainable harvest rates.*	2011	• North Sea: TAC unchanged. 25% bycatch limit applied to vessels over 15 m • Celtic Seas: TAC reduced by 15% • Common skate retained on list of Prohibited Species

Appendix 3: Chronology of ICES advice and technical regulations for porbeagle shark

<table>
<tr><th colspan="2">ICES advice</th><th colspan="2">EC regulations</th></tr>
<tr><td>2005</td><td>• There is no information to evaluate stock status. The directed fishery for porbeagle stopped in the late 1970s due to very low catch rates. Sporadic small fisheries have occurred since that time. The high market value of this species means that a directed fishery would develop again if abundance increased. There are no indications of stock recovery. Given the apparent depleted state of this stock, no fishery should be permitted on this stock.</td><td rowspan="2">2006–2007</td><td rowspan="2">No management measures</td></tr>
<tr><td>2006 and 2007</td><td>• Available information from Norwegian and Faroese fisheries shows that landings declined strongly and these fisheries ceased in the ICES area. These fisheries have not resumed, implying that the stock has not recovered, at least in the areas where those fisheries took place.
• The available information from the French fishery suggests that CPUE reached a peak in 1994 and afterwards has declined. The CPUE has been stable at a much lower level since 1999, despite a relatively constant number of vessels involved.
• No targeted fishing for porbeagle should be permitted on the basis of their life history and vulnerability to fishing. In addition, measures should be taken to prevent bycatch of porbeagle in fisheries targeting other species, particularly in the depleted northern areas.</td></tr>
<tr><td>2008 and 2009</td><td>• Available information from Norwegian and Faroese fisheries shows that landings have declined strongly and have almost ceased. The stock is considered to be depleted. The directed fisheries have not been resumed.
• While the CPUE indices for a targeted fishery may not reflect trends in relative abundance, CPUE data have been relatively stable since 1996. CPUE of the French fishery has declined since a peak in 1994 and has been stable at a lower level since then.
• Given the state of the stock, no targeted fishing for porbeagle should be permitted and bycatch should be limited and landings of porbeagle should not be allowed.
• It is recommended that exploitation of this species should only be allowed when indicators and reference points for stock status and future harvest have been identified and a management strategy, including appropriate monitoring requirements has been decided upon and is implemented.
• A maximum landing length (MLL) in longline fisheries may be a useful precautionary management measure to afford protection to the mature female part of the stock. Although there are no studies to define an MLL that would be most beneficial to the stock, the length at first maturity of females may serve as a precautionary MLL, which would be about 210 cm fork length</td><td>2008</td><td>TAC of 581 t</td></tr>
<tr><td rowspan="2">2010 and 2011</td><td rowspan="2">• There is no assessment available to alter the perception of the depleted nature of the stock. Therefore there is no non-zero catch option that is compatible with the ICES MSY framework.
• ICES reiterates the precautionary advice it gave in 2008, for 2009 and for 2010 that given the state of the stock, no targeted fishing for porbeagle should be permitted and bycatch should be limited and landings of porbeagle should not be allowed.</td><td>2009</td><td>TAC of 436 t (25% reduction)
A maximum landing size of 210 cm (fork length) shall be respected</td></tr>
<tr><td rowspan="2">2010–2012</td><td rowspan="2">Zero TAC in EC waters; Prohibited species in international waters</td></tr>
</table>

Appendix 4. Detailed Operation Plans

Fisheries Science Partnership: FSP 2011-2012
Spurdog, Porbeagle and Common Skate By-Catch and Discard Reduction

Detailed Operations Plan (DOP)

Survey component 1 (porbeagle bycatch)

Jointly developed between Stuart Hetherington & John Walsh
4th August 2011

Main aims and objectives of the FSP Porbeagle By-catch and Discard reduction

Aims

- Seasonal fishery-dependent survey of ICES areas VIIe-j to improve knowledge and understanding of catches of porbeagle in relation to target species, and their survival;
- Biological sampling of porbeagle by-catch, to enhance the biological understanding of the species (e.g. sex ratio, size composition, age and growth, reproductive state, and stock structure) which can inform on stock assessments and management;
- Assess options for reducing the impact of discarding;
- Initiate a tag-and-release programme for porbeagle, including the training of vessel crew in shark handling, tagging and release procedures to maximise the chances of live discarding and survival;
- Trial self-sampling schemes to collect information on the quantities (sizes and sex ratio) of the species of interest throughout seasonal occurrence, with the potential of creating preliminary fishery-dependent indices of relative abundance.

Objectives

- The primary objective of this project will be to collect field data on the numbers of elasmobranchs of conservation interest (porbeagle, common skate and spurdog) taken as by-catch in offshore gillnet fisheries and their survivability (i.e. health prior to discarding).

- To build relationships between UK fishermen and scientists and to involve fishermen in the co-commissioning of science.

To achieve these objectives, the programme will: -

(a) provide information from commercial fishing catches on key stocks to supplement data sources traditionally used in ICES assessments;

(b) investigate concerns raised by fishermen on scientific assessments or on stocks not currently assessed;

(c) investigate innovative scientific methods and or more-selective/ environmentally friendly fishing methods; and,

(d) support the work of Regional Advisory Councils.

1) Location and method of fishing activity

The fishing location of interest will be within the British territorial limits of the ICES rectangles 29E1, 29E2, 30E2, 30E3 & 31E4

The precise fishing locations within this area remains purposeful undetermined at this time. This reflects typical fishing practice, being responsive to weather conditions, sea state and abundance of the target fishery across the area defined above, for which there is known porbeagle by-catch.

The gear to be fished will be 4 $^{7/8}$" mesh gill nets, consisting of 150 – 180 nets, 30 nets to a tier with 5 to 6 tiers to be constantly fished. The soak time of the gear will typically be between 12 to 24 hours, with the gear laying overnight and hauled at first light, throughout the day before being shot away. The soak time will vary depending on the fishing activity (i.e. immediately shot away versus being shot away after steaming to a new ground), weather and the by-catch mitigation trails.

By-catch mitigation trails will be conducted during the 7 day survey, possibly investigating the effect of soak time, pingers and electropositive metals on reducing the by-catch and increasing survivability of porbeagle, without negatively impacting upon the catch of the target species.

2) Duration / timings & staffing of fishing operations

Weather permitting, one 7-day trip (consecutive days) will be conducted, embarking the vessel on 3rd September 2011, disembarking on the 10th September 2011, fishing the neap tide, as per typical fishing practice.

Embarkation and disembarkation will be at Padstow, Cornwall, with an exact sailing time agreed closer to the date of sailing. The vessel will then proceed to the fishing ground of choice, dependant on recent landings, whereby fishing will commence as soon as practicable possible.

Forty-eight hours notice will be given to Victoria Bendall/ Stuart Hetherington by John Walsh on whether sailing is to proceed as planned, taking into account the weather forecast, mechanical failure, etc.

Days at sea lost due to adverse weather conditions will be rescheduled for the following set of neap tides, but again weather dependant.

There will 2 Cefas scientists aboard which are likely to be Mr Stuart Hetherington and Mr David Peach. The vessel will be skippered by Mr John Walsh and crewed by Mr Trevor Broome, Mr Anthony Cock and Mr Luke Chaun

The main rest period will be between 8pm – 7am, with 30 minute breaks during the day as necessary for Cefas scientists aboard the vessel.

3) Requirements for collection of biological data, survival index trials and tagging of porbeagle

- Live porbeagles in suitable condition for tagging will be:

    - Measured (Total Length, Fork Length & Pre-dorsal Girth)
    - Sexed
    - Fin-clipped
    - Photographed
    - Mark ID tagged
    - Released to the wild

- Live porbeagles in unsuitable condition for tagging will be:

    - Measured (Total Length, Fork Length & Pre-dorsal Girth)
    - Sexed
    - Fin-clipped
    - Photographed
    - Scored on condition (e.g. net damage & survivability) prior to release

- Dead porbeagles will be:

    - Biologically sampled as above and dissected to determine sexual maturity, stomach contents and age (by obtaining spinal column section).

- There will be an open, engaged process between the Cefas scientists aboard the vessel and the crew to develop handling techniques to best aid the live return of discarded porbeagle in the best possible condition, aiding survival, with the aim of developing a code of best practice.

- Training of the crew by Cefas scientists in the tagging and release procedures of porbeagle with ID marker tags, with the purpose to continue tagging viable and suitable specimens, post survey, to enhance our understanding of movement and distribution.

- Co-development between the crew and Cefas scientists aboard the vessel of a suitability for release index, with a vision for it to be used by the whole SW netting fleet to assess and uniformly report on the condition of by-catch.

- Training of the crew by Cefas scientists in biological sampling techniques (i.e. fin clipping) with the purpose being for the crew to provide biological samples to Cefas for analysis, post survey, to enhance the biological understanding of the species.

- Trial of a simple By-Watch record card, by the crew, to collect information on the quantities (sizes and sex ratio) of by-caught porbeagle, with the crew able to provide by-catch data directly to Cefas, post survey. If successful it is envisaged that this self-recording scheme will be rolled out to the whole SW netting fleet in the lifetime of the project.

- A safe, uncluttered working space on deck of 4 metres^2 will be provided for biological sampling & tagging.

- The vessels crew will assist the Cefas scientists aboard in sorting the catch.

The Cefas tag reward scheme will be publicised by the distribution of posters throughout the local MMO offices, fish markets, mission halls and industry offices, as well as the Cefas website and possibly t-shirts.

Changes to the D.O.P may be necessary depending upon numbers of by-caught porbeagle and weather conditions.

Fisheries Science Partnership: FSP 2011-2012
Spurdog, Porbeagle and Common Skate By-Catch and Discard Reduction

Detailed Operations Plan (DOP)

Survey component 2 (Common skate bycatch)

Jointly developed between Victoria Bendall & Phillip Mitchell
12th August 2011

Main aims and objectives of the FSP Common skate Bycatch and Discard reduction

Aims

- Seasonal fishery-dependent survey of ICES areas VIIe-j to improve knowledge and understanding of catches of common skate in relation to target species, and their survival;
- Biological sampling of common skate bycatch, to enhance the biological understanding of the species (e.g. sex ratio, size composition, age and growth, reproductive state, and stock structure) which can inform on stock assessments and management;
- Assess options for reducing the impact of discarding;
- Initiate a tag-and-release programme for common skate, including the training of vessel crew in shark handling, tagging and release procedures to maximise the chances of live discarding and survival;
- Trial self-sampling schemes to collect information on the quantities (sizes and sex ratio) of the species of interest throughout seasonal occurrence, with the potential of creating preliminary fishery-dependent indices of relative abundance.

Objectives

- The primary objective of this project will be to collect field data on the numbers of elasmobranchs of conservation interest (porbeagle, common skate and spurdog) taken as bycatch in offshore gillnet fisheries and their survivability (i.e. health prior to discarding).

- To build relationships between UK fishermen and scientists and to involve fishermen in the co-commissioning of science.

To achieve these objectives, the programme will: -

(e) provide information from commercial fishing catches on key stocks to supplement data sources traditionally used in ICES assessments;

(f) investigate concerns raised by fishermen on scientific assessments or on stocks not currently assessed;

(g) investigate innovative scientific methods and or more-selective/ environmentally friendly fishing methods; and,

(h) support the work of Regional Advisory Councils.

4) Location and method of fishing activity

The fishing location of interest will be within the British territorial limits of the ICES rectangles 27 E2, 27 E3, 28 E2, 28 E3, 29 E2 & 29 E3.

The precise fishing locations within this area remains purposeful undetermined at this time. This reflects typical fishing practice, being responsive to weather conditions, sea state and abundance of the target fishery across the area defined above, for which there is known common skate bycatch.

The gear to be fished will be 400 trammel nets, 150 gill nets and 50 wreck nets to be constantly fished throughout the survey. The soak time of the gear will typically be between 12 to 72 hours, with the gear laying overnight and hauled at first light, throughout the day before being shot away. The soak time will vary depending on the fishing activity (i.e. immediately shot away versus being shot away after steaming to a new ground), weather and the bycatch mitigation trails.

Bycatch mitigation trails will be conducted during the 7 day survey, possibly investigating the effect of soak time on reducing the bycatch and increasing survivability of common skate, without negatively impacting upon the catch of the target species.

5) Duration / timings & staffing of fishing operations

Weather permitting, one 7-day trip (consecutive days) will be conducted, embarking the vessel on 19th August 2011, disembarking on the 26th August 2011, fishing the neap tide, as per typical fishing practice.

Embarkation and disembarkation will be at Newlyn, Cornwall, with an exact sailing time agreed closer to the date of sailing. The vessel will then proceed to the fishing ground of choice, dependant on recent landings, whereby fishing will commence as soon as practicable possible.

Forty-eight hours notice will be given to Victoria Bendall by Phillip Mitchell on whether sailing is to proceed as planned, taking into account the weather forecast, mechanical failure, etc.

Days at sea lost due to adverse weather conditions will be rescheduled for the following set of neap tides, but again weather dependant.

There will 2 Cefas scientists aboard which are likely to be Victoria Bendall and Samantha Smith. The vessel will be skippered by Mr Phillip Mitchell with a dedicated crew of six.

The main rest period will be between 8pm – 7am, with 30 minute breaks during the day as necessary for Cefas scientists aboard the vessel.

6) Requirements for collection of biological data, survival index trials and tagging of common skate

- Live common skate in suitable condition for tagging will be:

    - Measured (Total Length, Fork Length & Pre-dorsal Girth)
    - Sexed
    - Fin-clipped
    - Photographed
    - Mark ID tagged
    - Released to the wild

- Live common skate in unsuitable condition for tagging will be:

    - Measured (Total Length, Fork Length & Pre-dorsal Girth)
    - Sexed
    - Fin-clipped
    - Photographed
    - Scored on condition (e.g. net damage & survivability) prior to release

- Dead common skate will be:

    - Biologically sampled as above and dissected to determine sexual maturity, stomach contents and age (by obtaining spinal column section).

- There will be an open, engaged process between the Cefas scientists aboard the vessel and the crew to develop handling techniques to best aid the live return of discarded common skate in the best possible condition, aiding survival, with the aim of developing a code of best practice.

- Training of the crew by Cefas scientists in the tagging and release procedures of common skate with ID marker tags, with the purpose to continue tagging viable and suitable specimens, post survey, to enhance our understanding of movement and distribution.

- Co-development between the crew and Cefas scientists aboard the vessel of a suitability for release index, with a vision for it to be used by the whole SW netting fleet to assess and uniformly report on the condition of bycatch.

- Training of the crew by Cefas scientists in biological sampling techniques (i.e. fin clipping) with the purpose being for the crew to provide biological samples to Cefas for analysis, post survey, to enhance the biological understanding of the species.

- Trial of a simple By-Watch record card, by the crew, to collect information on the quantities (sizes and sex ratio) of bycaught common skate, with the crew able to provide bycatch data directly to Cefas, post survey. If successful it is envisaged that this self-recording scheme will be rolled out to the whole SW netting fleet in the lifetime of the project.

- A safe, uncluttered working space on deck of 4 metres^2 will be provided for biological sampling & tagging.

- The vessels crew will assist the Cefas scientists aboard in sorting the catch.

The Cefas tag reward scheme will be publicised by the distribution of posters throughout the local MMO offices, fish markets, mission halls and industry offices, as well as the Cefas website and possibly t-shirts.

Changes to the D.O.P may be necessary depending upon numbers of bycaught common skate and weather conditions.

Fisheries Science Partnership: FSP 2011-2012
Spurdog, Porbeagle and Common Skate ByCatch and Discard Reduction

Detailed Operations Plan (DOP)

Survey component 3 (spurdog bycatch)

Jointly developed between Stuart Hetherington & John Walsh
4th August 2011

Main aims and objectives of the FSP Spurdog By-catch and Discard reduction

Aims

- Seasonal fishery-dependent survey of ICES areas VIIe-j to improve knowledge and understanding of catches of spurdog in relation to target species, and their survival;
- Biological sampling of spurdog by-catch, to enhance the biological understanding of the species (e.g. sex ratio, size composition, age and growth, reproductive state, and stock structure) which can inform on stock assessments and management;
- Assess options for reducing the impact of discarding;
- Initiate a tag-and-release programme for spurdog, including the training of vessel crew in shark handling, tagging and release procedures to maximise the chances of live discarding and survival;
- Trial self-sampling schemes to collect information on the quantities (sizes and sex ratio) of the species of interest throughout seasonal occurrence, with the potential of creating preliminary fishery-dependent indices of relative abundance.

Objectives

- The primary objective of this project will be to collect field data on the numbers of elasmobranchs of conservation interest (porbeagle, common skate and spurdog) taken as by-catch in offshore gillnet fisheries and their survivability (i.e. health prior to discarding).

- To build relationships between UK fishermen and scientists and to involve fishermen in the co-commissioning of science.

To achieve these objectives, the programme will: -

(i) provide information from commercial fishing catches on key stocks to supplement data sources traditionally used in ICES assessments;

(j) investigate concerns raised by fishermen on scientific assessments or on stocks not currently assessed;

(k) investigate innovative scientific methods and or more-selective/ environmentally friendly fishing methods; and,

(l) support the work of Regional Advisory Councils.

7) Location and method of fishing activity

The fishing location of interest will be within ICES rectangles 30E4, 30E5 & 31E4.

The precise fishing locations within this area remains purposeful undetermined at this time. This reflects typical fishing practice, being responsive to weather conditions, sea state and abundance of the target fishery across the area defined above, for which there is known spurdog by-catch.

The gear to be fished will be a combination of 4 $^{7/8}$" mesh gill nets (90% of gear) and 5" gill nets (10% of gear), totalling 150 – 180 nets, with 30 nets to a tier, with 5 to 6 tiers to be constantly fished. The soak time of the gear will typically be between 12 to 24 hours, with the gear laying overnight and hauled at first light, throughout the day before being shot away. The soak time will vary depending on the fishing activity (i.e. immediately shot away versus being shot away after steaming to a new ground), weather and the by-catch mitigation trails.

By-catch mitigation trails will be conducted during the 7 day survey, possibly investigating the effect of soak time, pingers and electropositive metals on reducing the by-catch and increasing survivability of spurdog, without negatively impacting upon the catch of the target species.

8) Duration / timings & staffing of fishing operations

Weather permitting, there will be one 6-day trip (6 consecutive days at sea), during a period of neap tides, in January/ February 2011. Exact dates to be confirmed in December 2011 or January 2012.

Embarkation and disembarkation will be at Padstow, Cornwall, with an exact sailing time agreed closer to the date of sailing. The vessel will then proceed to the fishing ground of choice, dependant on recent landings, whereby fishing will commence as soon as practicable possible.

Forty-eight hours notice will be given to Victoria Bendall/ Stuart Hetherington by John Walsh on whether sailing is to proceed as planned, taking into account the weather forecast, mechanical failure, etc.

Days at sea lost due to adverse weather conditions will be rescheduled for the following set of neap tides, but again weather dependant.

There will 2 Cefas scientists aboard which are likely to be Mr Stuart Hetherington and Mr David Peach. The vessel will be skippered by Mr John Walsh and crewed by Mr Trevor Broome, Mr Anthony Cock and Mr Luke Chaun

The main rest period will be between 8pm – 7am, with 30 minute breaks during the day as necessary for Cefas scientists aboard the vessel.

9) Requirements for collection of biological data, survival index trials and tagging of spurdog

- Live spurdogs in suitable condition for tagging will be:

  - Measured (Total Length, Fork Length & Pre-dorsal Girth)
  - Sexed
  - Fin-clipped
  - Photographed
  - Mark ID tagged
  - Released to the wild

- Live spurdogs in unsuitable condition for tagging will be:

  - Measured (Total Length, Fork Length & Pre-dorsal Girth)
  - Sexed
  - Fin-clipped
  - Photographed
  - Scored on condition (e.g. net damage & survivability) prior to release

- Dead spurdogs will be:

  - Biologically sampled as above and dissected to determine sexual maturity, stomach contents and age (by obtaining spinal column section).

- There will be an open, engaged process between the Cefas scientists aboard the vessel and the crew to develop handling techniques to best aid the live return of discarded spurdog in the best possible condition, aiding survival, with the aim of developing a code of best practice.

- Training of the crew by Cefas scientists in the tagging and release procedures of spurdog with ID marker tags, with the purpose to continue tagging viable and suitable specimens, post survey, to enhance our understanding of movement and distribution.

- Co-development between the crew and Cefas scientists aboard the vessel of a suitability for release index, with a vision for it to be used by the whole SW netting fleet to assess and uniformly report on the condition of by-catch.

- Training of the crew by Cefas scientists in biological sampling techniques (i.e. fin clipping) with the purpose being for the crew to provide biological samples to Cefas for analysis, post survey, to enhance the biological understanding of the species.

- Trial of a simple By-Watch record card, by the crew, to collect information on the quantities (sizes and sex ratio) of by-caught spurdog, with the crew able to provide by-catch data directly to Cefas, post survey. If successful it is envisaged that this self-recording scheme will be rolled out to the whole SW netting fleet in the lifetime of the project.

- A safe, uncluttered working space on deck of 4 metres^2 will be provided for biological sampling & tagging.

- The vessels crew will assist the Cefas scientists aboard in sorting the catch.

The Cefas tag reward scheme will be publicised by the distribution of posters throughout the local MMO offices, fish markets, mission halls and industry offices, as well as the Cefas website and possibly t-shirts.

Changes to the D.O.P may be necessary depending upon numbers of by-caught spurdog and weather conditions.

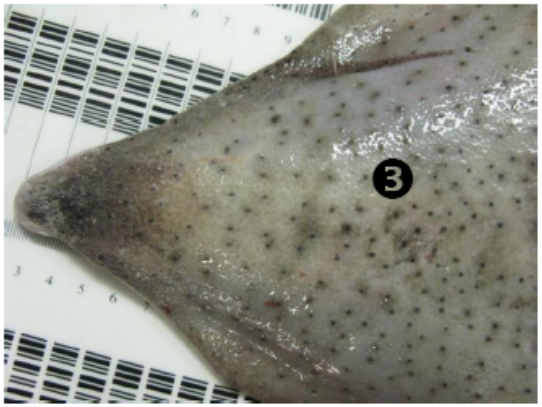
Appendix 5:- Identification guidelines for Common skate D.batis (courtesy Jim Ellis)

Common skate complex "*Dipturus batis*"

RAJIDAE

Length: 285 cm





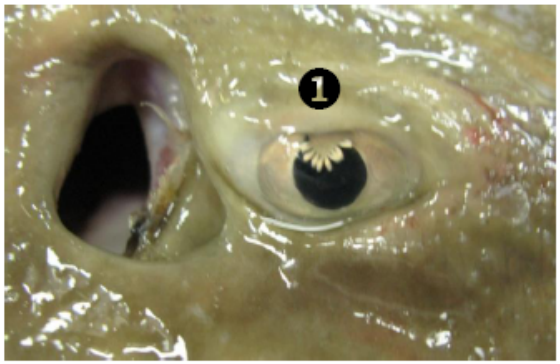


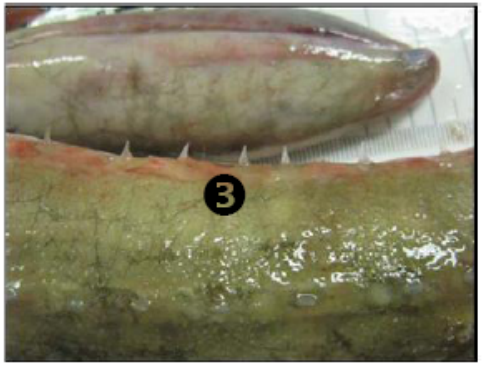
❶ Front margin of disc concave (an imaginary line from the wing tip to the snout does not touch anterior margin of disc)
❷ Dark grey ventral surface
❸ Ventral mucous pores black

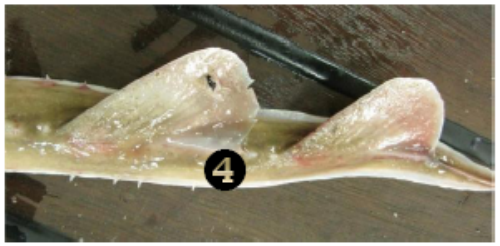
Also: 1-2 interdorsal spines, 12-28 median thorns on tail, 40-56 rows of teeth.

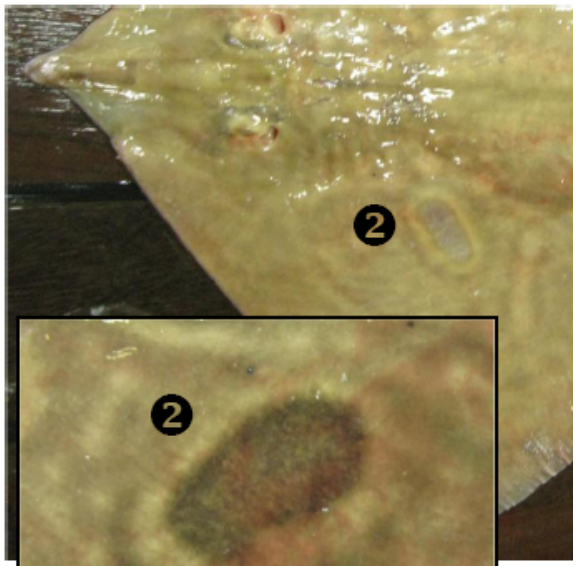
Common skate is now considered to be two species (see next page)

Common name	Blue skate (see images below)	Flapper skate
Proposed scientific name	*Dipturus* cf. *flossada*	*Dipturus* cf. *intermedia*
Range (in the UK)	Common in Celtic Sea. Also on Rockall Bank and parts of NW Scotland	NW Scotland
Eye	Pale yellow iris ❶	Olive-green iris
'Eye spots' on wing	Dark ocellus surrounded by a pale ring ❷	Blotch of pale spots in a group
Lateral thorns on the tail	Lateral thorns perpendicular to tail ❸	Lateral thorns angled
Inter-dorsal space	Short ❹	Long
Teeth	Base of teeth narrower	Base of teeth broader
Length at 50% maturity	115 cm (male); 123 cm (female)	186 cm (male); 198 cm (female)
Maximum length	ca. 150 cm	285 cm









Appendix 6: Skippers comments & recommendations:-

Comments and recommendations on the draft report received from Philip Mitchell, skipper FV "Govenek of Ladram", and John Walsh, skipper FV "Charisma", courtesy of Cornish Fish Producers Organisation Ltd (CFPO)

Phil Mitchell noted the professionalism of the Cefas scientists during the trip, and made three substantive comments on the draft report:

1) On the matter of how the discards by species are represented in pie charts in the report, he argued that although they were using trammelnets and gillnets during the study, discards for both mesh sizes should be illustrated in separate charts in the report rather than being shown as one chart for both gears. The scientists consulted agreed that from a scientific perspective there seemed to be little point in making these discard values cumulative, and that the approach could be misleading. It would be more useful and informative to have separate discard charts for each gear.
2) The pie charts do not specify the species of shark discarded.
3) To highlight the level of discards, it would be useful to include pie charts demonstrating the proportions of retained species (anglerfish, turbot, ray, brill. etc) and discarded skate to demonstrate relative abundance, supporting general fisher argument that a landings ban on skate should be lifted.

John Walsh was happy with the draft report as it stood and made no further comments.

Andy Wheeler
Cornish Fish Producers Organisation Ltd

Appendix 6.1 Skippers recommendations 1 – 3 addressed.

Overall target and bycatch species composition by gear type (trammelnet and gillnet) during the field study aboard FV "Govenek of Ladram" (August 2011)

Gill net bycatch composition

For target species, 1052 roundfish (including anglerfish, bib and cod), made up 77% of the total number of fish captured in gillnets, with 44 of them accounting for 13% of the discarded bycatch. In all, 11 shellfish (edible crab and crawfishes) made up 0.8% of the total number of fish captured in gillnets, with 3 (0.9%) discarded, and 16 flatfish (megrim) made up 1.2% of the total catch, all of which were retained aboard. A total of 226 sharks (spurdog, spotted dogfish and tope), made up 16% of the total number of fish captured in gillnets and accounted for 67% of the discarded bycatch. The total catch composition for gillnets by species groups is shown in Appendix 6 Figure 1a.

Overall a total of 286 sharks, skates and rays (elasmobranchs) was captured in gillnets, accounting for 21% of the total number of fish captured in that gear, and 285 individuals accounted for 86.8% of the total gillnet discarded fish bycatch. Roundfish (*n* = 44, 13%) and 3 shellfish (0.9%), accounted for the balance of the gillnet discarded bycatch (shown in Appendix 6 Figure 1b).

In all, 60 common skate (*Dipturus* cf. *flossada*), constituted 4.4% of the total number of fish captured in gillnets during the survey and accounted for 18% of the total number of discarded gillnet bycatch. In addition 148 spurdog (10.8% of the total catch and 44.6% of the total discarded bycatch), 75 spotted dogfish (5.5% of the total catch and 22.6% of the total discarded bycatch) and 2 tope (0.2% of the total catch and 0.6% of the total discarded bycatch) were captured in gillnets.

The elasmobranch species composition of gillnet discarded bycatch was mainly 148 spurdog (52%), 75 spotted dogfish (26.3%), 60 common skate (21%) and 2 tope (0.7%), depicted in Appendix 6 Figure 1c.

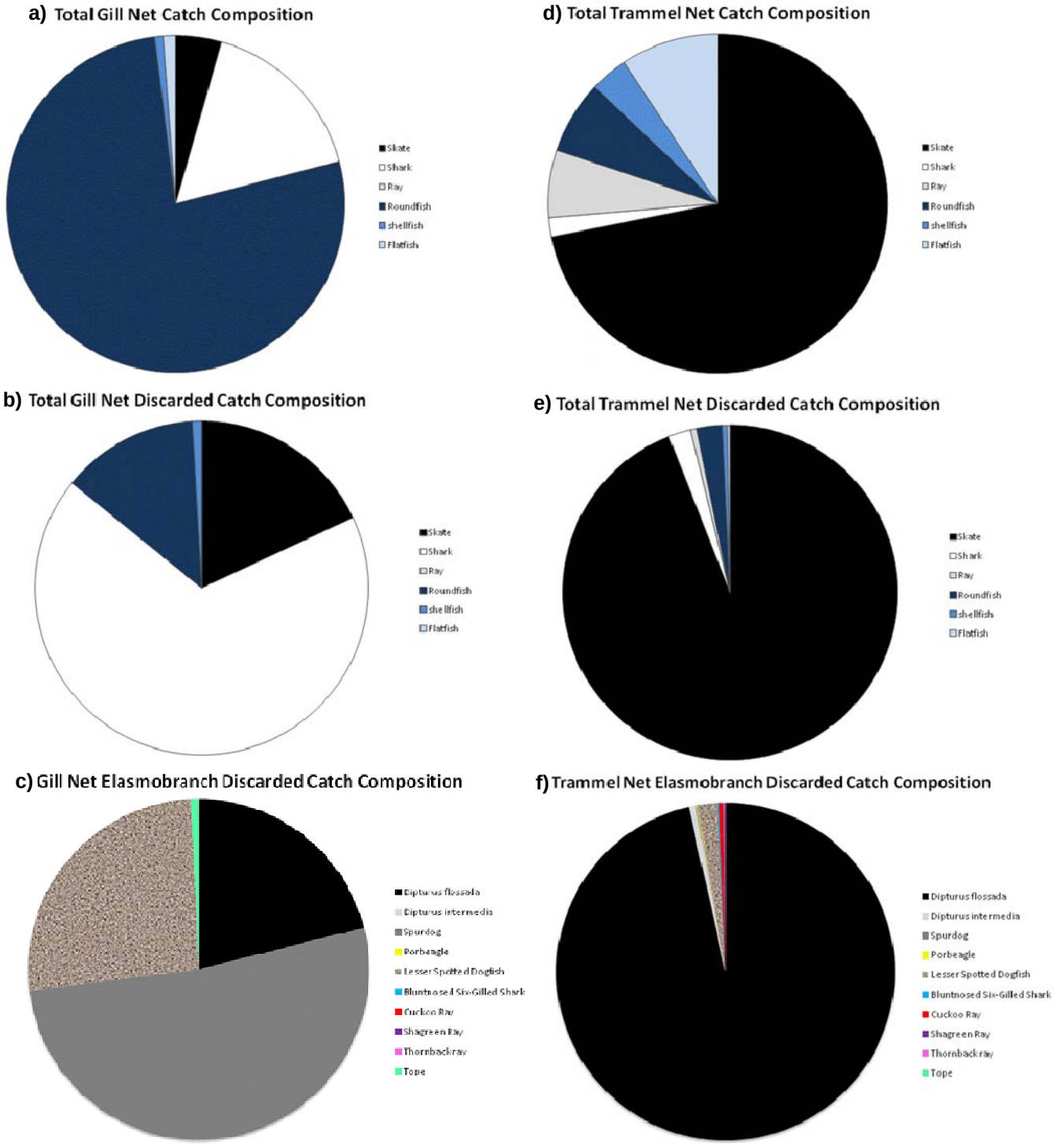
Trammelnet bycatch composition

For target species, 218 roundfish (such as anglerfish, bib and cod) constituted 13.5% of the total number of fish captured in trammelnets, with 30 of these accounting for 2.5% of the discarded bycatch. In all, 119 shellfish (such as edible crab and lobster) made up 7% of the total number of organisms captured in trammelnets, with 6 (0.5%) discarded. Of the fish, 72 rays (including cuckoo, shagreen, spotted and thornback rays) made up 4.5% of the total catch with 7 (0.6%) discarded, and 38 flatfish (including megrim, plaice and turbot) another 2.3% of the total catch with 3 (0.2%) discarded. The 29 sharks (spurdog, spotted dogfish, bluntnosed six-gill shark and porbeagle shark) made up 1.8% of the total number of fish captured in trammelnets and accounted for 2.1% of the discarded bycatch. Total catch composition for trammelnets by species group is shown in Appendix 6 Figure 1d.

Overall, a total of 1235 sharks, skates and rays (elasmobranchs) was captured in trammelnets during the 7-day field study, accounting for 76% of the total number of fish captured in those nets; of which 1174 fish accounted for 72% of the total discarded trammelnet fish by-catch (Appendix 6 Figure 1e).

In all, 1141 common skate, *D.batis* “complex” (1133 *Dipturus* cf. *flossada*; 8 *Dipturus* cf. *intermedia*) made up 70.6% of the total number of fish captured in trammelnets during the survey and accounted for 94% of the total number of fish in the discarded trammelnet bycatch. In addition 22 spotted dogfish (1.4% of the total catch and 1.8% of the total discarded bycatch), 5 cuckoo rays (0.4% of the total catch and 0.3% of the total discarded catch), 2 bluntnosed six-gill sharks (0.1% of the total catch and 0.2% of the total discarded catch), 1 thornback ray, 1 shagreen ray and 1 spotted ray (each accounting for 0.06% of the total catch and 0.08% of the total discarded catch), were also bycaught in trammelnets during the survey.

The elasmobranch species composition of trammelnet discarded bycatch was mainly common skate (1141 *D. batis*; 94%), leaving just 6% to account for a wide variety of elasmobranchs from cuckoo rays to six-gill sharks (shown in Appendix 6 Figure 1f).
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Appendix 6 Figure 1. Discarded catch composition for 14 gillnet and 19 trammelnet fixed locations over the field study aboard FV "Govenek of Ladram", showing the total and discarded catch composition by species group together with species composition of discarded elasmobranchs for gillnets (a, b and c) and trammelnets (d, e and f).