

Scottish Marine and Freshwater Science

Volume 6 Number 7

Collection of bycatch data for spurdog (*Squalus acanthias*)
in the North Minch fishery

Report of Fishing Industry Science Alliance (FISA)
Project 02/13

C Fox

© Crown copyright 2015

Scottish Marine and Freshwater Science Vol 6 No 7

**Collection of bycatch data for spurdog (*Squalus acanthias*) in the
North Minch fishery**

Report of Fishing Industry Science Alliance (FISA) Project 02/13

C Fox

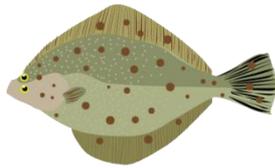
Published by Marine Scotland Science

ISSN: 2043-7722

DOI: 10.7489/1617-1

Marine Scotland is the directorate of the Scottish Government responsible for the integrated management of Scotland's seas. Marine Scotland Science (formerly Fisheries Research Services) provides expert scientific and technical advice on marine and fisheries issues. Scottish Marine and Freshwater Science is a series of reports that publishes results of research and monitoring carried out by Marine Scotland Science. It also publishes the results of marine and freshwater scientific work that has been carried out for Marine Scotland under external commission. These reports are not subject to formal external peer-review.

This report presents the results of marine and freshwater scientific work carried out for Marine Scotland under external commission.



ISLANDER SHELLFISH



Collection of Bycatch Data for Spurdog (*Squalus acanthias*) in the North Minch Fishery

Final report

Prepared by:-

Dr Clive Fox
Scottish Association for Marine Science
Scottish Marine Institute
Dunstaffnage, Oban, PA37 1QA

Summary

Stock assessments by ICES and others (De Oliveira et al. 2013, ICES 2014) suggest that the north-eastern Atlantic stock is at a historically low level and in consequence a zero TAC has been set (European Commission 2015). The project was proposed to FISA after discussion with fishers from Barra and Stornoway who fish for *Nephrops* in the Minches and Sea of Hebrides using single or twin-rig otter trawls. According to the fishers the majority of the spurdog caught in this area are predominantly small to medium-sized male fish. Pawson et al. (2009) suggested that controlled fisheries for small male spurdog (i.e. avoiding the mature female components of the stock) might not be damaging to the stocks overall so the industry are keen to explore whether a controlled by-catch fishery could be allowed.

The fishers also stated that patches of spurdog are encountered only occasionally and are hard to avoid (that is they do not occur in predictable locations). Prior to the zero TAC being introduced, spurdog represented a small but valuable by-catch for the *Nephrops* trawl sector fishing around the western Isles at certain times of the year. Because the spurdog entangle the nets the fishers state that they would normally move away from the area and try to avoid such encounters but they do object to having to discard a saleable product when it is accidentally caught. A further important issue is that under the new 'landings obligation', spurdog could act as a choke species for the *Nephrops* fisheries.

Discussions with the fishers elicited a range of opinions on whether discarded spurdog survive. A literature search suggested that there have not been any specific scientific studies on the survival of spurdog after capture in *Nephrops* trawls. Post-trawl survival has been examined on the east coast of the USA but the tow durations, less than 90 minutes, were relatively short compared with typical tow lengths in the west of Scotland *Nephrops* fisheries (Mandelman & Farrington 2007, Rulifson 2007).

The aims of the present project were to collect new data on the levels of spurdog by-catch, locations of by-catch and to collect biological information in terms of the sizes and sex of the fish caught in order to inform the debate on whether a controlled incidental by-catch (i.e. not targeted) fishery could be considered. The project was funded to run over the winters of 2013/14 and 2014/15. Because not all the available budget for sampling in 2013/2014 was spent, sampling was extended to cover the spring and summer 2014.

A methodology was designed, discussed and agreed with industry representatives and Marine Scotland Science (**Appendix I**). A number of vessels fishing from Barra and Stornoway volunteered to take part in collecting samples and recording their by-catches, additional vessels agreed to make records of spurdog discards available from their electronic landings returns.

A kick-off meeting was held in Stornoway on 5th Nov 2013 with representatives from Western Isles Council, Barratlantic, Islander Shellfish and the skipper of Astra III where the methodology was agreed. Following this meeting derogations for landing spurdog for scientific purposes were requested for the vessels, methodology instructions and logsheets were sent to participating skippers via Barratlantic and Islander Shellfish to be passed on to the vessels.

The winter of 2013/14 had a run of severe gales which disrupted fishing but samples were returned from three of the participating vessels, Astra III, Brighter Morn and Cheerful. These were measured 17-18th Feb 2014. Spines were also taken from a sub-set of the fish to see if they could be used to age the fish following Ketchen (1975), Holden and Meadows (1962), McFarlane and King (2009) and Bublely et al. (2011).

Some problems were encountered during the first season of sampling. The labels supplied to identify the fish boxes proved inadequate during freezer storage so that a number of the samples could not be matched back to the returned log-sheets. However, sufficient samples were identifiable to provide useful information. One of the vessels did not return log-sheets with the samples although their date of capture and location were provided verbally. None of the vessels provided details of tows where dogfish were not caught although this had been requested.

Overall 17 samples comprising around 40-50 fish per sample were returned to Barratlantic. Lengths were measured for 345 fish, all of which were males. No female spurdog were found in these samples. The sizes of the fish were very consistent with an overall mean of 77.1 +/- 4.0 cm (mean +/- standard deviation) for the North Minch and 73.9 +/- 4.8 cm from Sea of Hebrides.

An attempt was made to age these fish based on marks on the spines. The number of spines with markings considered to be readable was very low (31 out of 300 examined) and there was considerable variation in the spine mark patterns. A tentative ageing was made suggesting the average age of the fish sampled was around 6 years. However, this implies a higher growth rate than reported for other areas. The most likely reason for this discrepancy was under-ageing. Because age determination from spines did not appear very reliable for fish from the west of Scotland, vertebrae were also collected from subsequent samples.

Un-spent funds allowed sampling to continue during spring 2014. Overall seven sets of samples were returned from a single vessel participating in the scheme comprising around 50 to 70 fish per sample. Lengths of 517 fish were recorded of which 87% were males, 13% were small females and a single larger female (102 cm SL) with pups. The sizes of the male fish were 74.0 +/- 6.6 cm (mean +/- standard deviation). One sample contained a higher proportion of small immature females and a few similar sized fish were recorded in other samples (mean size 52.6 +/- 4.8 cm).

Some problems with sample collection persisted despite efforts to rectify them. Labelling of boxes in a manner which would survive freezing and handling remained an issue. None of the participating vessels provided details of tows where dogfish were not caught although this had been requested.

A meeting was held with the Western Isles Fishermen's Association at Stornoway on 29th Nov 2014 to report on the findings of the project to date and to discuss the problems encountered (this was originally planned for 9th Nov but had to be deferred the original meeting was still held to discuss other issues and it was emphasised by the chair (Duncan Macinnes) that all skippers should fill in details of any spurdog discarded using the e-logs). Following the meeting of the 29th, new sampling instructions, paper logsheets and plastic fish-box tags were distributed to all vessels who had indicated a willingness to participate in sample collection.

A number of samples of spurdog caught during the summer had been returned to Barratlantic and had been defrosted in anticipation of a measuring visit from Clive Fox on 10th & 11th November. Regrettably this had to be cancelled due to a vehicle breakdown close to Ullapool. It was not possible to re-arrange the visit quickly because of few alternate ferry sailings and these samples had to be dumped but anecdotal evidence suggests they contained quite a high proportion of small fish.

During winter 2014/2015 vessels Cheerful, Joanna, Sheigra and Heather Isle all returned samples to Barratlantic (Nordic Way returned one sample but the vessel then withdrew from the project following engine problems). Detailed logsheets were received from two of these vessels including information on tows where spurdog were not caught, other vessels only provided details of tows where spurdog were caught. A site visit to Barra was conducted from 14th – 19th February and 980 fish were measured and sexed. Of these 96.2% were males, 3.6% were females and 0.2% were females with pups. The sizes of the male fish were 77.9 +/- 4.0 cm (mean +/- standard deviation) from the North Minch and 76.9 +/- 4.2 cm from Sea of Hebrides. Samples of spines and vertebrae were also taken for future age determination.

As mentioned above, only two vessels returned full details of their fishing including tows where spurdog were not caught. Extraction of e-log records also showed very small catches of spurdog being recorded. The lack of detailed reporting of spurdog discards by a larger number of vessels makes it difficult to say how typical the detailed reports from two vessels are of the wider fleet. This in turn makes it difficult to estimate the potential economic losses being incurred. However, based on the limited data available it was estimated that economic losses could be up to £40,000 per vessel in the Sea of Hebrides but appear to be much lower for vessels operating in the North Minch. Recording of spurdog discard rates was also recommended when the North Minch *Nephrops* trawl fisheries applied for Marine Stewardship certification. A certain amount of work was undertaken in 2008 to 2010 in association with that application although full certification was not pursued (Milligan et al. 2013). Lengths of 100 spurdog were recorded and are largely in agreement

with values reported here (winter samples being dominated by males of 60-70 cm with smaller males and some females being more common in the summer). Some fish were also aged using spines and ages estimated to be somewhat higher than in this report – again the authors emphasised the great uncertainty in age determination using this method and recommended that inter-calibration work be undertaken before these results were accepted. It is not clear whether the Young's Trace System mentioned in Milligan et al. (2013) is still being used and whether spurdog by-catch has been recorded but this should be explored in view of the difficulties in estimating the total amounts of spurdog being discarded in this *Nephrops* fishery.

Estimates of the overall levels of spurdog discarding thus still remain somewhat uncertain but may be up to a few tens of tonnes per vessel per annum in the Sea of Hebrides. Discard levels appear to be much lower in the North Minch although the relative rates may be influenced by gear as single rig rather than twin rig gear was being used in that area. Furthermore the survival rates of spurdog caught in *Nephrops* tows, which can last up to 5 hours, appear to be unknown. These two areas of uncertainty will probably need to be addressed if options for a limited by-catch fishery are to be pursued further.

Overall the project established a good working relationship with a number of vessels operating in the Minch and Sea of Hebrides, has generated new biological data on the sizes and sex ratios of the spurdog being discarded, has generated some new estimates of discarding rates and has collected samples of spines and vertebrae which can be used to test age determination in future.

Acknowledgements

The author would like to acknowledge the assistance of skippers and crew of the participating vessels, the support of Cllr Donald Manford for acting as project secretary; Islander Shellfish and Barratlantic for co-ordination and sample storage; to the Western Isles Fishermen's Association for their support; Donald Morrison (Marine Scotland) for assistance with e-log records and to Francis Neat (Marine Scotland Science) who provided useful advice to the project.

Introduction

The north-eastern Atlantic stock of spurdog (*Squalus acanthias*) is assessed as being at a historical low by ICES and others (De Oliveira et al. 2013, ICES 2014). In consequence landing spurdog has been banned via a zero Total Allowable Catch limit set throughout EU waters (European Commission 2015). The present project was proposed to FISA after discussion with fishers from Barra and Stornoway who fish for *Nephrops* in the Minches and Sea of Hebrides using single or twin-rig otter trawls. According to the fishers the majority of the spurdog caught in this area are predominantly small to medium-sized male fish. Pawson et al. (2009) suggested that controlled fisheries for small male spurdog (i.e. avoiding the mature female components of the stock) might not be damaging to the stocks overall so the industry are keen to explore whether a controlled by-catch fishery could be allowed.

The fishers also stated that patches of spurdog are encountered only occasionally and are hard to avoid (that is they do not occur in predictable locations). Prior to the landing ban, spurdog represented a small but valuable by-catch for the *Nephrops* trawl sector fishing around the western Isles at certain times of the year. Because the spurdog entangle the nets the fishers state that they would normally move away from the area and try to avoid such encounters but they do object to having to discard a saleable product when it is accidentally caught. A further important issue is that under the new 'landings obligation', spurdog could act as a choke species for the *Nephrops* fisheries.

The aims of the present project were to collect new data on the levels of spurdog by-catch, locations of by-catch and to collect biological information in terms of the sizes and sex of the fish caught in order to inform the debate on whether a controlled incidental by-catch (i.e. not targeted) fishery could be considered. The project was funded to run over the winters of 2013/14 and 2014/15. Because not all the available budget for sampling in 2013/2014 was spent, sampling was extended to cover the spring and summer 2014.

Materials and Methods

Catches of spurdog are unpredictable rendering the use of observers on vessels as impractical. A fisher self-sampling scheme was therefore devised with the industry representatives. Derogations were obtained allowing skippers of interested vessels to retain spurdog on board for the purpose of sampling. Derogated vessels were issued with instructions, logsheets and asked to record tow details, amounts of spurdog caught and each week to retain a random sample to be shipped to Barratlantic for subsequent measurements (**Appendix I**). If only small quantities of spurdog were being caught then all the fish were to be returned to Barratlantic (up to around 50 fish per vessel per week). Tows to the north of latitude 57.5°N were nominated as being in the North Minch and to the south of latitude 57.5°N as being

in the Sea of Hebrides. The lead scientist visited Barratlantic periodically to measure the samples. The frozen samples were defrosted and individuals examined to determine sex (based on presence or absence of male claspers) and stretched fish lengths (tip of snout to end caudal fin) recorded to the nearest cm. Female fish were also examined internally for the presence of pups.

Non-derogated vessels operating in the area were also asked, via their local associations, to record any spurdog caught using the e-log system.

Age determination was not included in the original project proposal but was added as an additional parameter which could be sampled relatively easily. Dorsal spines were taken from around 30 fish per sample landed from the winter 2013/2014 season. These were air dried, cleaned with ethanol and examined under a low-power microscope with top illumination (Olympus SZX-16). Spine marks were interpreted following Holden and Meadows (1962). Interpretation of age from dogfish spines is complicated by the fact that these structures are external to the fish and can become worn in older animals. Holden and Meadows (1962) suggested that wear can begin in fish as small as 45 cm although wear above 5 mm was only noted in fish larger than 90 cm. Several workers have attempted to correct spine readings for wear based on changes in the width of the spine. However, Bubleby et al. (2011) suggested that such an approach can lead to over-estimation of ages so wear correction was not attempted.

Results

Some problems with self-sampling did occur. In particular incomplete log records were returned from most vessels e.g. only in the second season were tows reported where spurdog were not caught. Problems with skippers accurately labelling fish boxes returned to Barratlantic were also encountered (for example a number of boxes had the vessel name but no date whilst others lacked both vessel name or date) but this did improve as the project progressed. Not all the samples returned could therefore be matched with logsheet records. All fish which could be unequivocally matched with logsheet records were measured and sexed. Remaining fish which could only be allocated to vessel (but not catch date) were also measured and these data are included in the overall comparisons of lengths. Because a large number of measurements were taken it was felt that the data on size and sex ratio are robust and there was also no visual evidence that the sizes of the remaining unallocated and un-measured fish were different to those measured.

Quantities of Spurdog Discarded

All tows were made using commercial twin-rig or single-rig *Nephrops* trawls with nominal 80 mm mesh cod-ends. Reported tow durations ranged from 3.75 h to 7 h (mean 290 mins based on 221 tows). Towing speed was generally between 2.2 and

2.5 knots. During winter one or two tows were usually completed per day but in summer up to four tows were made per day.

In the winter 2013/2014 season nearly all the reported spurdog catches were from the Sea of Hebrides but this may reflect fishing patterns that season (Figure 1). Bad weather meant that little fishing took place in the Northern Minch and only Cheerful reported a significant number of tows. In total the reported amount of spurdog caught (discards plus samples returned to shore for measurement) was 19,210 kg (from the three participating vessels although the majority of records and samples received were from the Cheerful). Other vessels operating in the area had been asked to record spurdog discards via the local fisheries officers but verbal reports were received that some vessels had problems recording spurdog using the electronic log system - the total amount being discarded across the whole fleet is therefore unknown.

The total amount reported discarded during spring (March to May) 2014 was 4,000 kg but this was from a single derogated vessel, the Cheerful, which returned logsheets for that period (Figure 2).

The total amount reported from June to Sept. 2014 was 7,200 kg but this was again from a single vessel, the Cheerful (Figure 3). Anecdotal comments suggest that at this time a large number of the fish were under market size. Unfortunately measurements on these samples were not obtained due to logistical problems.

In the following winter season renewed efforts were made to engage more vessels in the project. From Nov 2014 to Feb 2015 the total amount of spurdog reported caught by the four vessels supplying samples during was 25,469 kg. The majority of the catches were in the Sea of Hebrides (98% by weight) but again this will be influenced by relative fishing effort. Two locations where spurdog were not caught were supplied by two of the participating vessels during the winter 2014/2015 season (one operating in the North Minch and one in Sea of Hebrides) so that the distribution of fishing effort versus spurdog catches can be better judged for this period (Figure 4). However, caution is advised in interpreting Figure 4 because the southern vessel was using twin-rig gear and the northern vessel single rig gear so this might also have contributed to higher spurdog by-catch levels in the Sea of Hebrides (on the assumption that the twin-rig gear may have had a wider swept area).

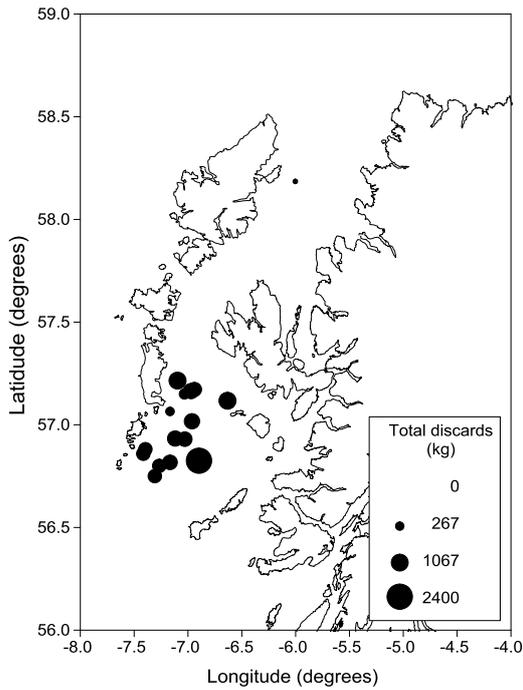


Figure 1: Reported locations and quantities of spurdog caught from Nov. 2013 – Feb. 2014.

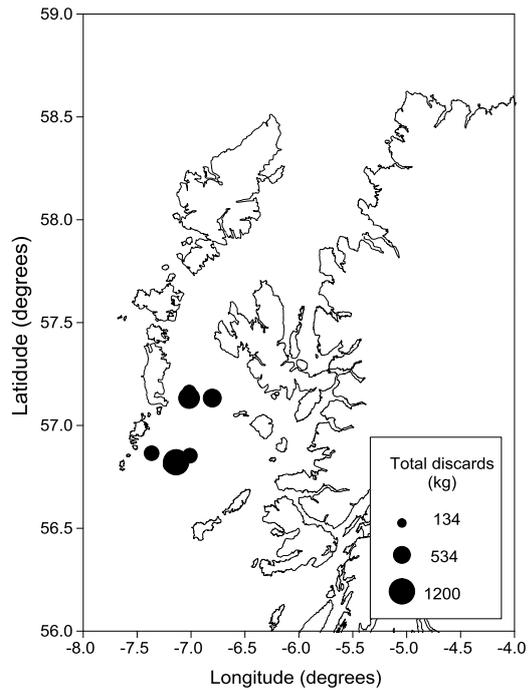


Figure 2: Reported locations and quantities of spurdog caught from Mar. – May 2014.

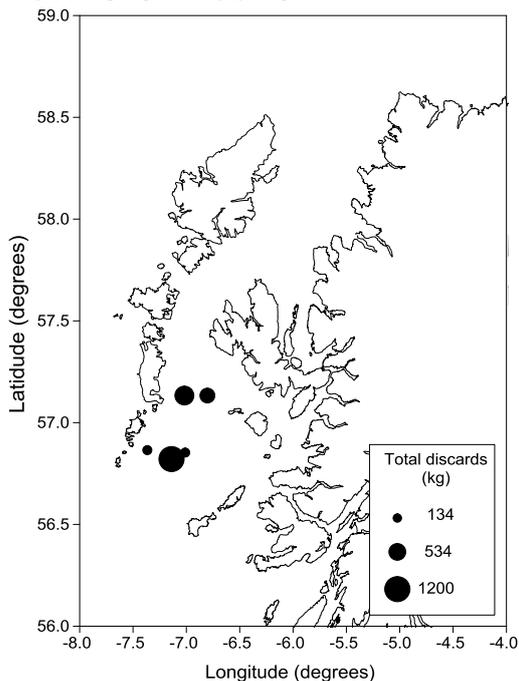


Figure 3: Reported locations and quantities of spurdog caught from June – Sept. 2014.

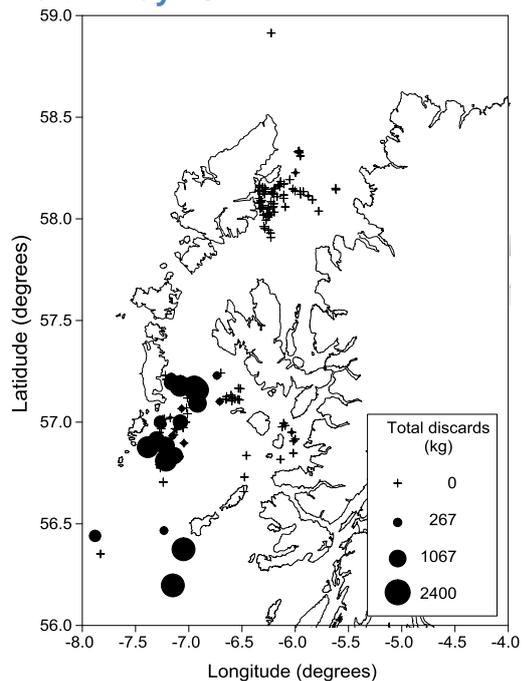


Figure 4: Reported locations and quantities of spurdog caught from Nov. 2014 – Feb. 2015.

The total quantities reported caught per vessel were very variable (Table 1). It is not clear if this reflects incomplete reporting or if by-catch levels were really lower in the North Minch compared with the Sea of Hebrides. However, of the two vessels which filled in logsheets fully (including details of tows with zero spurdog catches in winter 2014/2015), one was fishing in the north and one in the south.

Table 1: Total reported spurdog bycatch in tonnes based on logsheets returned to Barratlantic

Vessel	2013/2014	Winter 2014/2015
Cheerful (Oct to Sept),(Nov to Feb)	26.3	24.0
Astra III (Oct)	3.2	No data
Joanna (Oct, Nov & Dec)	No data	0.5
Sheigra (Nov, Dec & Feb)	No data	0.304
Heather Isle (Nov & Dec)	No data	0.235

An extraction of e-log discard records covering the whole area showed very low levels of by-catch (Table 2).

Table 2: Total reported spurdog bycatch in tonnes based on e-logs returned to Marine Scotland excluding vessels which participated in returning paper logsheets (see Table 1). E-log data from winter 2014/2015 were not available at time of writing.

Vessel	2013/2014
Ardent II	0.05
Brighter Morn	0.1
Aquarius	0.500
Northern Star	0.05
Sharon Rose	0.32
Sincerity	0.337

Samples Returned for Length and Sex Measurement

From the winter 2013/2014 season 17 samples of around 50 fish each were returned to Barratlantic for measurement. From the winter 2014/2015 season around 30 samples of about 50 fish each were returned. The fish were stored frozen for up to two months and defrosted prior to the site visits.

Sex and Size of Fish Sampled

345 fish were measured from the winter 2013/2014 season, 518 from spring 2014 and 979 from the winter 2014/2015 season¹ (Table 3). The size of the male fish was rather consistent ranging from 57 to 87 cm the first winter season and 57 to 91 in the second winter.

¹ A larger number of vessels returned samples in 2014/2015

Female fish were not found in the samples from the first winter but some were present in the spring 2014 samples. These were mainly smaller individuals (41 to 63 cm length) with a single larger pup-bearing female. Females were a little more common in samples collected during the winter 2014/2015 fishing season but still only represented <4% of the catch overall (in terms of numbers).

Table 3: Summary of fish sizes based on samples returned to Barratlantic

Season	Region	Males			Females (not pregnant)		
		n	Mean (cm)	Std dev (cm)	n	Mean (cm)	Std dev (cm)
Winter 2013/2014	North Minch	66	77.1	4.0	0	-	-
	Sea Hebrides	279	73.9	4.8	0	-	-
Spring 2014	North Minch	0	-	-	0	-	-
	Sea Hebrides	449	74.0	6.6	68	52.6	4.8
Winter 2014/2015	North Minch	343	77.9	4.0	9	93.7	11.3
	Sea Hebrides	600	76.9	4.2	26	84.6	15.8
Total	North Minch	409			9		
	Sea Hebrides	1328			94		

Summer 2014: No length data available

Females with pups: spring 2014 Sea of Hebrides one at 102 cm; winter 2014-15 North Minch one at 104 cm; winter 2014-15 Sea of Hebrides one at 99 cm.

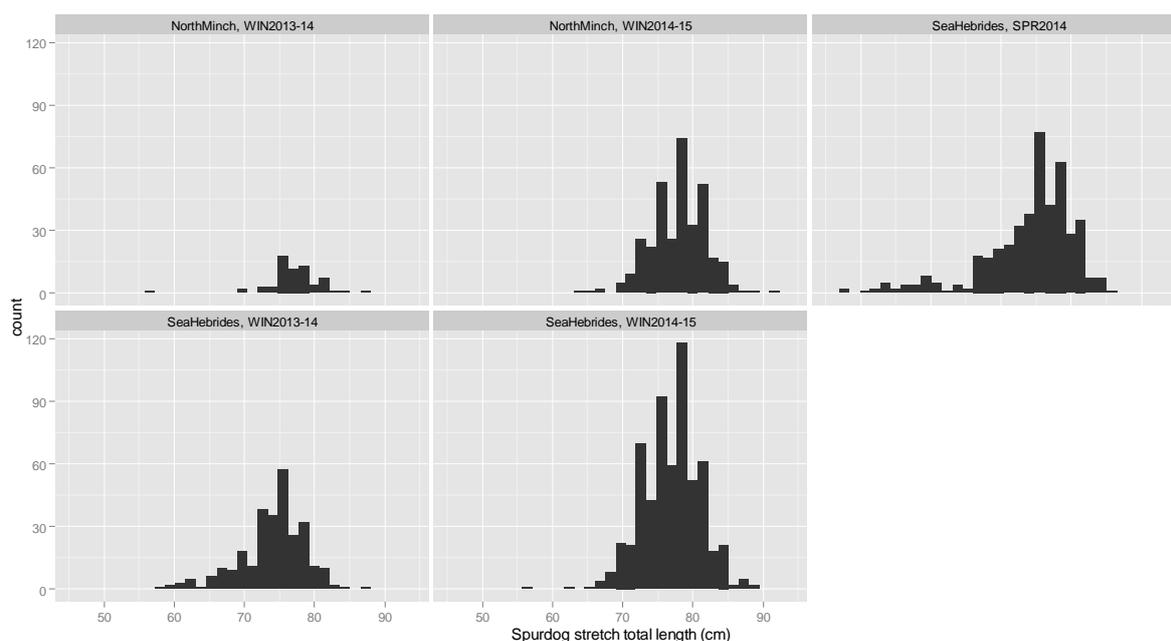


Figure 5: Length distributions of male spurdog returned to Barratlantic

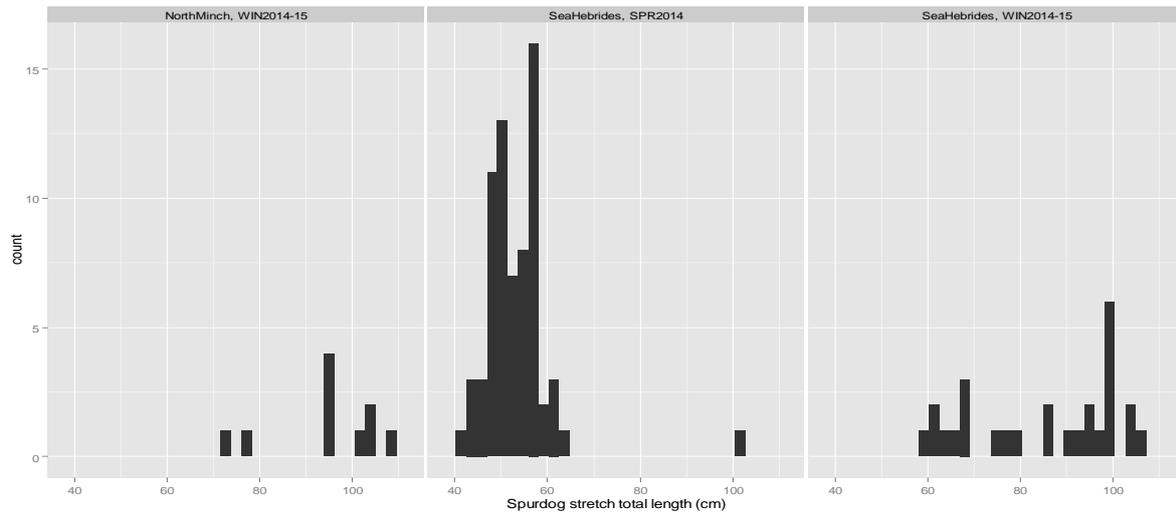


Figure 6: Length distributions of female spurdog returned to Barratlantic

Age of Fish Sampled

A variety of the spine markings are shown in Figure 7. Very few of the spines examined showed the clear markings (Figure 7a) illustrated in Holden and Meadows (1962) and which could be used to age the fish with any confidence. Nearly all of the spines also showed at least some wear at the tips. A few examples of double banding were also observed (Figure 7d). The few spines showing readable marks suggested fish might be between 3 and 8 years of age (mean 6.2, std dev. 1.4, $n=31$). Comparing data from the North Sea in Sosiński (1978) with growth estimates from the American east coast does suggest that growth rates might be higher in the eastern Atlantic. Despite this if fish from west Scotland have been aged correctly then the growth rates in the Minch and Sea of Hebrides would be considerably higher than reported from other areas, including the North Sea (Figure 8).



Figure 7: First dorsal spines of *S. acanthias*. Collected from samples landed by (a) Astra III, 63 cm long fish, this spine shows the clear pigmentation banding reported to be useful for age determination, estimated age was 7 (b) Astra III, 72 cm long fish, this spine shows only faint and diffuse pigment banding (c) Astra III, 75 cm long fish, this spine shows bands in lower portion of spine but upper two-thirds do not contain clear patterns (d) Cheerful, 75 cm long fish, this spine shows apparent double-banding, especially towards the base in the portion beneath the skin surface (e) Astra III, 80 cm long fish, this spine shows heavy ridges at the base in the below skin portion but little patterning in the exposed portion.

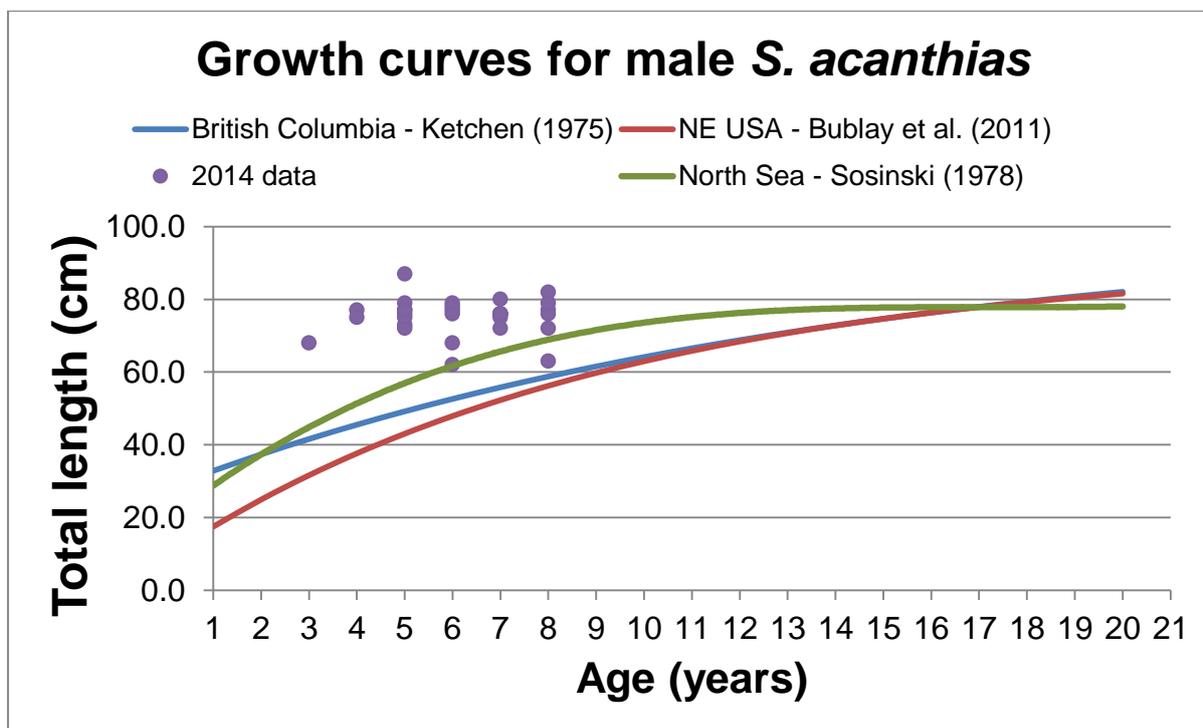


Figure 8: Growth curves derived from spine analyses for *S. acanthias* from British Columbia (Ketchen, 1975) and NE USA (Bublay et al., 2011).

Discussion

The figures in Table 1 were used to make a crude estimate of the possible economic losses from discarding of spurdog. Although the market price for small spurdog tends to be lower than for larger animals, verbal reports suggested that £70 a box² might be expected (http://ec.europa.eu/fisheries/cfp/market/proposed-guide-prices_2013_en.pdf give a lower guide price of 1,157 euros tonne⁻¹ in 2013). The amount of spurdog caught but not landed from 'Cheerful' in the Sea of Hebrides might therefore represent losses of up to £22,000 to £45,000 (using lower EU guide price and upper anecdotal price) per vessel over a year (winter to autumn inclusive). However, it is not known how typical the data reported from Cheerful are for other vessels fishing in the Sea of Hebrides. The economic losses due to discarding spurdog in the North Minch appear almost negligible (a few hundred pounds per vessel per year) based on reported discards from vessels operating in that area.

A by-catch landing trial for spurdog in the South-west of England gill net fishery is being proposed by Defra. The proposal states that only 'dead' spurdog would be retained and be allowed to be landed. An upper landing limit will be calculated based on the reported amounts being discarded * estimated post-discard mortality. For the gill net fishery the post-discard mortality has been estimated to be around 40%. As far as the author is aware post-discard survival of spurdog has not been

² A box holds roughly 40 kg

measured in *Nephrops* trawl fisheries. Post-trawl discard survival rates have been estimated at more than 50% by Mandelman and Farrington (2007) and Rulifson (2007) working in the north-western Atlantic but their tows were of relatively short duration (45-80 mins) in comparison with the typical *Nephrops* tow durations (3.5 to 5 hours). Although spurdog can appear healthy after trawling, increased mortality tends to manifest up to 72 h afterwards as a result of internal organ damage and stress responses. In addition, increased tow lengths and bulk of catch are acknowledged to be likely to increase mortality (Mandelman & Farrington 2007, Rulifson 2007). The post-trawl discard survival for spurdog discarded from *Nephrops* trawls is therefore likely to be lower than 50%, perhaps significantly so. A low survival rate would mean there is less conservation value in returning spurdog to the sea after *Nephrops* trawling and also raises the problem that spurdog could act as a 'choke' species under the new landings obligation of the Common Fisheries Policy.

Most papers on age determination using spurdog spines have reported a wide variety of patterning including the presence of double marks, spawning rings and other irregular patterns which can complicate interpretation, or spines with no obvious patterns (Holden & Meadows 1962, McFarlane & King 2009). Most papers have not reported the overall percentage of spines considered readable but rejection rates of between 30-50% can be inferred. Counts of increments on dorsal spines collected in this study were made attempting to interpret marks as annual marks following Holden & Meadows (1962), no corrections were applied for wear although where this was obvious the spine was excluded from further analysis. The ages determined from readable spines seemed low compared with reported size at age for spurdog from other studies. Although spurdog growth rates from different locations do show some variation (Figure 8) a more likely explanation for this result is that the spine-based age estimates were too low. Given the low numbers of readable spines, and the high uncertainty in interpretation of the spine marks, age determination from the vertebrae should be attempted in line with recommendations in Bubleby et al. (2011). Spines and vertebrae were thus collected from the spring 2014 and winter 2014/2015 fish to allow this to be attempted in the future.

Conclusions

By-catch levels of spurdog in the *Nephrops* trawl fisheries appear to be higher in the Sea of Hebrides compared with the North Minch. During winter the majority of the spurdog caught are males in the length range 70 to 85 cm stretched length. During spring and summer smaller male fish appear in the catches. Full evaluation of the amounts of spurdog being by-caught would need reliable data from a larger number of vessels. However, based on the limited data available <30 tonnes vessel⁻¹ year⁻¹ for the Sea of Hebrides can be suggested. Age determination on spurdog caught in

these western waters using growth marks on spines appeared unreliable and further work is required on use of age determination using vertebrae.

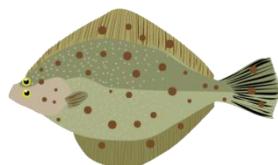
References

- Bubleby WJ, Kneebone J, Sulikowski JA, Tsang PCW (2011) Reassessment of spiny dogfish *Squalus acanthias* age and growth using vertebrae and dorsal-fin spines. *J Fish Biol* 80:1300-1319
- De Oliveira JAA, Ellis JR, Dobby H (2013) Incorporating density dependence in pup production in a stock assessment of NE Atlantic spurdog *Squalus acanthias*. *ICES Journal of Marine Science: Journal du Conseil* 70:1341-1353
- European Commission (2015) COUNCIL REGULATION (EU) 2015/104 of 19 January 2015 fixing for 2015 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union vessels, in certain non-Union waters, amending Regulation (EU) No 43/2014 and repealing Regulation (EU) No 779/2014. 163 pp.
- Holden MJ, Meadows PS (1962) The structure of the spine of the spur dogfish (*Squalus acanthias* L.) and its use for age determination. *J Mar Biol Assoc UK* 42:179-197
- ICES (2014) Report of the Working Group on Elasmobranch Fishes (WGEF), ICES CM 2014/ACOM:19, ICES, Copenhagen, 681 pp.
- Ketchen KS (1975) Age and growth of dogfish *Squalus acanthias* in British Columbia waters. *J Fish Res Bd Can* 32:43-59
- Mandelman JW, Farrington MA (2007) The estimated short-term discard mortality of a trawled elasmobranch, the spiny dogfish (*Squalus acanthias*). *Fish Res* 83:238-245
- McFarlane GA, King JR (2009) Re-evaluating the age determination of spiny dogfish using oxytetracycline and fish at liberty up to 20 years In: Gallucci VF, McFarlane GA, Bargmann GG (eds) *Biology and Management of Dogfish Sharks*. American Fisheries Society, Bethesda, MD, 153-160
- Milligan RJ, Neil DM, Albalat A (2013) Scottish Nephrops Survey Phase III: Evaluation of Measures for Reducing Bycatch and Discards in a Nephrops Fishery. , Project Report, University of Glasgow, Glasgow, 124 pp.
- Pawson MG, Ellis JR, Dobby H (2009) The evolution and management of spiny dogfish (Spurdog) fisheries in the Northeast Atlantic In: Gallucci VF, McFarlane GA, Bargmann GG (eds) *Biology and Management of Dogfish Sharks*. American Fisheries Society, Bethesda, MD, 373-390
- Rulifson RA (2007) Spiny Dogfish Mortality Induced by Gill-Net and Trawl Capture and Tag and Release. *North American Journal of Fisheries Management* 27:279-285

Sosiński J (1978) Characteristics of the North Sea spurdog (*Squalus acanthias* L.) stock. Acta Ichthyologica Et Piscatoria 8:9-22

Appendix I

Instructions issued to participating vessels



ISLANDER SHELLFISH

Fishing Industry Science Alliance – Spurdog/Spiny dogfish project



Spiny Dogfish

Aims The project will run over the next two winters (2013/14 and 2014/15) and aims to collect biological data on spurdog (*Squalus acanthias*) by-catch in the **Nephrops fisheries** operating in ICES VIa. Data will be used to inform negotiations regarding the need to discard rather than land this species.

The project will collect data from fishing vessels on:-

1. Where are spurdog being caught?
2. How much is being caught?
3. What are the sizes, sex and maturity of the spurdog being caught?

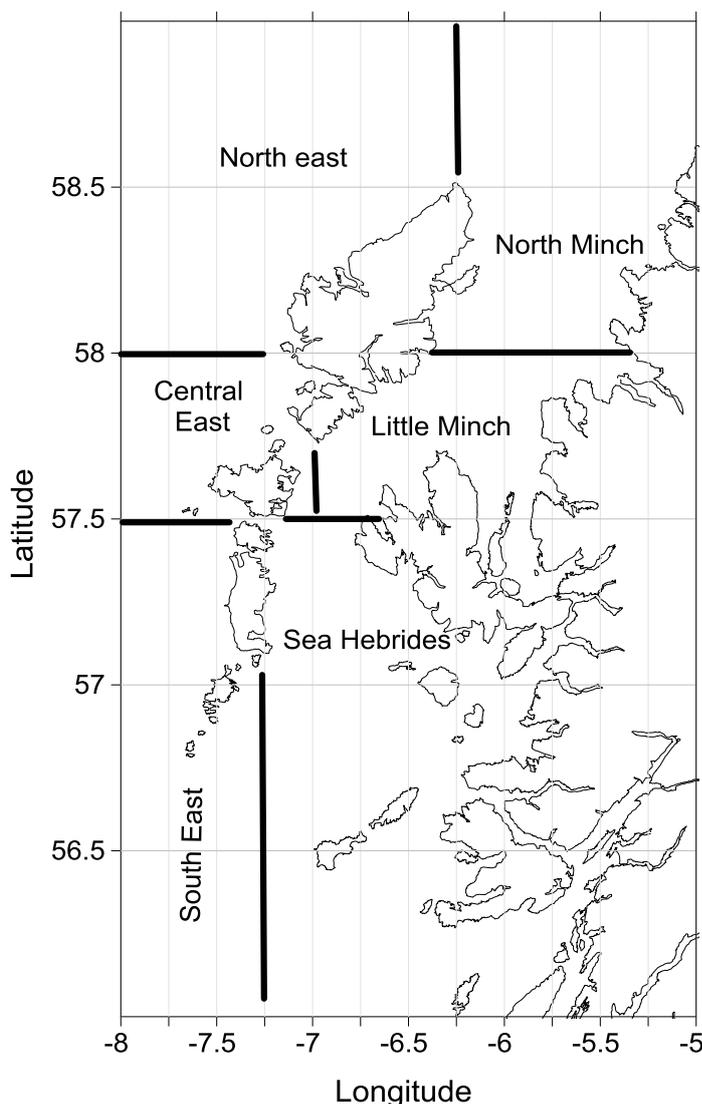
As well as recording the **weight** of spurdog discarded by location and date we are asking skippers to return samples via Barratlantic and Islander Shellfish. These samples will be measured by biologists from the Scottish Association for Marine Science to address aim 3 above.

To be scientifically useful it is **essential** that the sampled fish can be matched up with where and when they were caught so careful record keeping is required. Special logsheets and labels will be supplied to skippers who agree to participate.

A small payment (£250) will be made for each weekly set of samples which are returned from a fishing trip **with a fully filled in logsheet**. The payment is strictly to offset the additional work required on board the fishing vessels and is designed not to encourage targeting of the spurdog. If samples are collected on a total of more than 40 individual weeks of fishing each winter further payments will not be possible because of the available budget for the project.

Methodology – Please read carefully and if anything is unclear contact Clive Fox (01631 559000, clive.fox@sams.ac.uk for clarification).

- 1) Recording logsheets are supplied and need to be filled in for **each haul even if no spurdog** are encountered.
- 2) If no spurdog are caught on a tow record the tow information and enter “0” in the Spurdog caught column.
- 3) If spurdog are caught on a tow fill in the tow details and retain a sample of the spurdog as described below.
- 4) If only a few spurdog are being caught, fish from several tows from a fishing area (see map below) can be combined with the aim of retaining 50 randomly selected fish from each area fished per week. A week being defined as starting on Monday and finishing on Sunday.
- 5) Place the spurdog in a fish box and label clearly with vessel name and the date and chill or freeze the fish.
- 6) If a lot of spurdog are caught, it is only necessary to retain up to 50 fish but ensure that fish are picked out at random. **Do not** pick fish from just the first or last few boxes discarded and **do not choose** fish on basis of size, just take the



top few fish from several of the boxes and retain them.

7) The sample of up to 50 spurdog **must be labelled** and the box of fish **along with** that week’s log-sheet/s returned to Islander Shellfish or Barratlantic where the biological data will be recorded once sufficient samples have accumulated.

Only these vessels have derogations to retain spurdog

Astra III. SY 153
 Brighter Morn. CY 77
 Cheerful. Cy 254
 Heather Isle, SY47
 Joanna, CY701
 Nordic Way. CY 340
 Sheigra, SY7



© Crown copyright 2015

OGL

This publication is licensed under the terms of the Open Government Licence v3.0 except where otherwise stated. To view this licence, visit nationalarchives.gov.uk/doc/open-government-licence/version/3 or write to the Information Policy Team, The National Archives, Kew, London TW9 4DU, or email: psi@nationalarchives.gsi.gov.uk.

Where we have identified any third party copyright information you will need to obtain permission from the copyright holders concerned.

This publication is available at www.scotland.gov.uk

Any enquiries regarding this publication should be sent to us at
The Scottish Government
St Andrew's House
Edinburgh
EH1 3DG

ISBN: 978-1-78544-396-1 (web only)

Published by The Scottish Government, May 2015

Produced for The Scottish Government by APS Group Scotland, 21 Tennant Street, Edinburgh EH6 5NA
PPDAS50808 (05/15)

W W W . G O V . S C O T