Data Provision and evaluation of measures employed in Scotland under the management plan for cod stocks Article 13 provision during 2012

Results collated by Marine Scotland Science

Introduction

The Council Regulation (Council Reg. 1342/2008) applying in 2009 to the present, continued in 2012 with the provision for Member States to employ alternative measures under Article 13 so long as they delivered equivalent fishing mortality reductions to those specified in the management plan for cod stocks. In Scotland the Conservation Credits Scheme, an initiative involving industry, NGOs, scientists and government official, provides the framework for delivering a management process to achieve the targets.

The use of real time closures as a management measure to avoid catches of unwanted juvenile cod were introduced in Scotland in 2007. During 2008, provisions in the December Council Regulation enabled member states to trial schemes which reduced cod mortality without further effort reductions. The Real Time Closure (RTC) Scheme was expanded and extended to include all cod and a number of gear measures proposed.

STECF reviewed the progress of the scheme in November 2008 concluding that the RTCs offered promise but there were too few in 2008 (15) and that the scheme would need to be expanded considerably and the gear measures actually adopted by fishermen. In 2009 and 2010 the scheme was expanded considerably and reports of outcomes were submitted in 2010 and 2011. STECF reviewed these and highlighted evidence of reduction of cod catch through RTCs (although not as large as predicted) and the reductions in discards. However, it was noted that the use of selective gears had not been sufficiently extensive to be expected to contribute a great deal to reducing fishing mortality. In 2011, one of the overarching conclusions was that available evidence suggested that the effects of Article 13 measures had not been sufficient to justify the amount of effort 'bought back' by the UK. The general conclusion was, however, that although the targets of the cod plan had note been achieved (or by any other Member States) the types of measures in place had the potential to deliver the established targets and that they should be extended in the future.

This document summarises results arising from the Scottish Conservation Credits scheme in 2012. Scotland's fleet mainly operates in two regions covered by the cod plan namely North Sea and West of Scotland where the required fishing mortality reductions in 2012 were $0.45F_{2008}$ and 25% respectively.

Measures in 2012

In 2012, unlike previous years, Scotland did not make use of Article 13b (<5% cod catch provision). This decision was taken because of widespread high cod catches in previous years which generally met the 5% provision but only through relatively high catches (landings and discards) of other species. Scotland, however maintained its efforts to reduce cod mortality through the use of Article 13c.

Article 13c – Cod avoidance measures

The Fisheries Management and Conservation Group (FMAC) agreed that for 2012 the Conservation Credits Scheme would continue with measures intended to achieve the main objective of meeting the management plan for cod stocks targets. The starting point was a 25% cut in fishing mortality in 2009 followed by further cuts of 10% in 2010 and 2011. Within the plan, cuts in effort of the same magnitude were to be applied to the main cod catching fleets. The scheme operates with two components:

i) A compulsory part involving full observance by all vessels of RTCs. In line with the STECF recommendations these were scaled up during 2010 and 2011 and the target number for 2012 was maintained at the outturn number of the previous year.
ii) The second part of the scheme is voluntary, involving options to take various selective gears. An additional component is available for vessels taking CCTV cameras and required to report and land all cod catches – for these, effort restriction becomes unnecessary providing that all catch is known and catch limits are observed.

Outcomes in 2012

Real Time Closures (RTCs)

a) RTC implementation

Full details of how the positions for RTCs are determined and of how use is made of fishery dependent data are given in Holmes et al (2009) and Holmes et al (2011)
As a key element for delivering cod avoidance, an effective system for ensuring rapid identification and implementation of RTCs was essential. During 2008 the triggering of RTCs had relied on boardings of vessels by fisheries inspectors and estimates of the catch rate of cod. It was not possible in subsequent years to deploy resources sufficient to enable the large increases in RTC numbers to be identified by inspections alone. Instead a method was devised utilising landings data linked to VMS information to give estimates of LPUE (landings per 'ping'). The approach basically delivers an ongoing routine for identifying RTCs so that at least 12 are in

place at any one time (each lasts 21 days). A fully integrated management procedure was developed to allow identification, notification and monitoring. Figure 1 shows the overall distribution of RTCs in 2011 and 2012. In 2012 there were 173 mostly distributed in a broad arc around the north of Scotland and across the northern part of the North Sea. This represents a small reduction on the 2011 number (185). Note that each closure lasted 21 days and the basic size was 15nm x 15nm (following new analysis in July 2010). When appropriate, the shape of the RTC was adjusted to better match the perceived distribution of cod (for example to align better with the shelf edge or to align with underwater pipelines where fish aggregate). Note, in 2012 there were no west coast RTC – the scheme was stopped there owing to its limited impact and new approaches are being considered.

The general distribution of the RTCs corresponds very well with cod distribution shown in ICES IBTS surveys and also with the distribution of highest cod catch rates as shown in observer trips on board commercial vessels.

b) Analysis of landings

A simple measure of the contribution to cod avoidance is given by a comparison of the landings of vessels operating in the areas which subsequently become RTCs with the landings by the same vessels in the period immediately following the establishment of the RTC when they have moved away. Assuming that if they had continued fishing in the RTC they would have continued to catch similar quantities of fish (in the short term at least) then savings accrue if the vessel moves to areas where the catch rate is less. The greater the differential between the RTC catch rate and the new location the greater the saving. Table 1 shows the number of trips by Scottish vessels affected by an interaction with an RTC. Table 2 tabulates a few examples of fishing trips and the RTC (s) they encountered together with catches in the vicinity of the RTC and following their movement away from the RTC. Results in Table 3 show annual estimates of catch 'savings' arising from vessels that move away from areas designated as RTCs (2009-2012). Overall the North Sea landings saving amounted to around 916 tonnes. When raised to reflect the discard rate (ICES 2012 =23%) , the amount is just over 1189 tonnes.

It is important to note that the analysis so far takes no account of vessels which simply avoid RTC areas completely so that the 'real effect' of the presence of RTCs may be much greater than implied by the calculated quantities.

c) Analysis of fishermen's behaviour

Another approach used to analyse the effect of RTCs relies on spatial behaviour of fishermen and involves the consideration of movements of individual vessels in response to RTCs. The method is described in Needle and Caterino (2011) and relies on the establishment of a relative cod index of abundance across the North Sea informed by survey and observer data (Figure 2 shows an example of the smoothed distribution map). VMS data are then analysed from individual fishing trips to establish whether vessels move away from RTCs to areas of lower cod abundance or to areas characterised by generally high cod abundance (an examples of the track of a vessel is given in Figures 3. These are derived from VMS pings but show aggregated

data. Similar information is available from all trips by Scottish vessels. Results in Table 4 summarise the findings for 2012 . These show that significant movements away from RTCs to areas of low abundance could be identified in all quarters and for the year as a whole (for boats in RTC areas prior to closure). In 2012 there was evidence of movement towards RTC areas after re-opening. Instances of vessels in RTCs *during* closures were nearly always confined to foreign boats or pelagic vessels

Spawning closures

Earlier analysis of the effects of the few small spawning area closures suggested that, based on observed landings from these areas in previous years their closure contributed only a small amount to reduced cod catches. New analysis has not been erformed.

Gear Measures and FDF vessels

The Conservation Credits steering group encouraged development of cod avoidance measures involving selective gears of various types. This was achieved in conjunction with industry and several working meeting were held to identify a suite of gear options offering choices to whitefish (TR1) vessels and Nephrops (TR2) vessels. The development involved extensive trialling of novel and modified fishing gears the results of which are too detailed to report in full here but were made available in the 2011 report (STECF, 2011).

In particular, trials were conducted to: i) improve selectivity in TR1 gears through larger meshes generally, square meshed panels SMPs and the introduction of very large meshed panels eg 300mm - 600 mm in the belly of nets ; ii) SMPs in TR2 Nephrops gears and iii) grids based on the 'Swedish Grid'. Trials were carried out by Marine Scotland Science gear technologists using chartered commercial vessels.
In 2012, new trials were conducted on TR2 'highly selective gears' (HSG) - reducing cod catches by at least 60%. The two gears, 'Flip-Flap' and 'FCAP' were evaluated by STECF in 2012 and became mandatory for use by the TR2 fleet. Examples of the selectivity results and including the HSG gears are shown in Figure 4. Based on the relative performance of the different gears in avoiding cod capture, 'a schedule' of effort buy-backs were developed for vessels opting to use one of the options. At this stage, establishing a true 'worth' for each of the gears is not possible.

The text table below provides a summary of the gears being used between 2009 and 2012 and the numbers of vessels involved. TR1 numbers using these gears are still low compared to the overall fleet size (approx 115 TR1 vessels). In 2012, the numbers increased slightly. Given the uptake of gears (about 25% of vessels), the aggregate effect of the few vessels involved would not contribute very much to the required reduction in F unless these were the highest cod catching boats. Nevertheless, the gears when fished correctly have been shown to reduce cod catch in trials (all else being equal) and so at the individual level may represent a contribution which requires to be assessed during routine operation. During 2012, all of the TR2 vessels were expected to operate with a HSG . Disappointingly, no vessels are so far using the grid option but the two gears commonly in use reduce cod catches by 60%. Uptake

of selective gears has been slower on the west coast although in 2012, all TR2 vessels were expected to operate with a larger, 200mm SMP. This only became fully operational in October. Many of the larger vessels operate in both sea areas and those from the North Sea frequently continue to use the selective gear when working on the west coast. Some of these vessels were monitored by observers in 2012

North Sea

2009	TR1		TR2	
	Orkney	4	smp	20
	130mm	9		
2010	TR1		TR2	
	Orkney	25	smp	15
	130mm	8		
2011	TR1		TR2	
	Orkney	15	smp	9
	130mm	8		
	200mm	2		
	600 belly panel	1		
2012	TR1		TR2	
	Orkney	13	HSG	133
	130mm	7		
	200mm	8		

A number of the vessels using the gear options or installing CCTV cameras and operating an FDF system have been sampled by observers and Table 5 provides details of trips on board TR1 vessels using either the 130mm cod end mesh, the Orkney trawl, the large meshed belly panel or operating in the FDF fishery. Some of these vessels were sampled by Marine Scotland Science observers and some by additional observers (funded by Marine Scotland) targeting vessels using these special measures. For completeness the table also includes sampled vessels not using special measures (the remainder of the fleet). The table essentially contains information on all the TR1 observer samples taken from 2008- 2012. From these trips it is possible to derive cod catch rates (kg/hour) and make two kinds of comparison: a) catch rates prior to the use of the gear with a period when the gear was in use and b) to compare the catch rate in 2012 between vessels using the options and the remainder of the fleet. These observations are limited compared to the overall number of trips and cannot be treated as controlled comparisons. For example, skippers of vessels decide on a day by day basis where the vessel will fish so it is not possible to design sampling which takes account of fishing area, time of year, fishing opportunities (eg the buying in of extra quota which could confound comparison of catch rates, even if the gear effectively reduced catch rates. Furthermore the analysis is confounded by i)

vessels sampled over a period of years during which they have taken different gear options and ii) by previously un-sampled vessels carrying an observer for the first time in 2012 . Early assessments of the results by STECF (in 2010) drew the initial conclusions that the 130mm codend reduced cod catch but that the Orkney trawl did not appear to do so. However, with more gear measures presented and a longer time period, the results for 2011 in Table 5 illustrate a more complicated picture and highlight some of the extreme variability observed. Different vessels adopting the same gears exhibit marked variability and in some cases very different catch rates are observed in the same vessel (when sampled more than once in a year). As discussed above, these differences most likely reflect different business choices, locations and timing of fishing etc.

For simplicity, time series considerations here refer only to the 'Totals' rows shown for each measure, recognising that temporal, spatial and vessel characteristics are ignored in the summary values. In the case of the 130mm mesh this shows a general reduction in catch rate when comparing the pre- gear measure data (2008) with later years. The rate has stabilised at around 64kg/hr. Results for the Orkney trawl are more variable with an initial increase in catch rate but then a progressive fall to 2012 with a catch rate similar to the 130mm mesh . This may reflect early difficulties with implementing a new gear which are now being overcome so that catch rates are falling. Alternatively, it is noticeable that the list of vessels involved have changed quite a bit and several of the vessels shifted to the FDF group during the course of 2010. Boats involved in the FDF scheme are generally acknowledged as being some of the main cod catching boats and the observed catch rate is relatively high compared to other groups, although this is also falling and in 2012 was at its lowest level. This group are required to land all cod catch.

Perhaps most interesting are the results for the vessels not adopting any of the measures. These start out in 2008 with a high catch rate which subsequently declined to the lowest value of any of the groups in 2012. The interpretation of this is difficult. It could reflect a group of vessels from which the most efficient at catching cod take up other gear options to reduce catch rate, leaving only the most inefficient. Another possibility is that these vessels are transferring quota to other group eg the FDF ones but then succeeding in avoiding cod so that their own catch rate declines. Examination of the areas of fishing by these boats suggests many still operate in the same general areas (stat rectangles) as the other groups but given the highly aggregating behaviour of cod, avoidance may still be possible.

Since the data presented in Table 5 for TR1 gears represents all observer sampling of this gear group in the period 2008-2012, it is informative to look at the overall catch rate achieved. The bottom row of Table 5 shows that this has fluctuated without much overall downeard trend and in 2012 was at its lowest level. This time series can be compared with the output of stock size from the 2013 ICES assessment which points to a slowly increasing stock. Figure 5 shows diverging plots of the two series of data standardised to the 2008 value. Whereas the stock (plotted as interpolated biomass at the middle of the year) shows an increasing trend, the CPUE of the TR1 Scottish vessels has declined slightly. If nothing had changed in the fishing activity by the TR1s then the catch rate would have been expected to rise with stock – this has not happened. Furthermore, there is evidence (below) that discard rate has dropped.

The North Sea TR2 data are shown in Table 6. These are more sparse and are also confounded by differences in the vessels sampled through time and the introduction of the Highly selective gears for only one year. Results suggest much lower catch rates than for TR1 as expected. In 2010 there was a rise in CPUE but otherwise the rate is fairly stable and was lower in 2011 and 2012 compared with 2008 before gear measured were introduced. Figure 6 shows the comparison between relative observed catch rates and the relative (to 2008) North Sea SSB. In 2011 and 2012, observed catch rates are well below those of the SSB.

Table 7 shows results for the West Coast. Here the use of selective gears has been over a shorter time scale. In the case of the TR1 group, a variety of gears have been employed by vessels moving around to the West Coast from the North Sea. Results are again very variable between different vessels. Most of the CPUE's are lower than those observed in the North Sea although a couple of the 130mm mesh observations show very high catch rates. In the TR2 category, catch rates are extremely low in those using 200mm mesh net. These vessels are mostly very small and operate close inshore in the Minches and Clyde where cod abundance is very low. Some higher catch rates are observed in larger visiting vessels using HSG (this gear is not a requirement on the West Coast). The higher rate probably reflects fishing activity on more offshore Nephrops grounds (eg close to Stanton Bank) where cod abundance is a little higher.

Discards

Although it is almost impossible to fully estimate the individual contributions of Conservation Credits measures in the reduction of unwanted cod catches, there are nevertheless key out-turn metrics that provide an indication of the net effect.

Observations of changes in discard rates provide a key indicator of the aggregate effect of the measures employed to encourage cod avoidance

Table 8 shows a time series of estimates of discard rates in the North Sea and west Coast for TR1 gear and TR2 gear respectively as supplied to ICES. Of special note is the rapid decline in discard rate observed in the North Sea TR1 gear in recent years. These show that North Sea TR1 discards have dropped to under 20% although TR2 figures remain higher. Overall the discard rate by Scottish trawlers is now about the same as the Overall cod discard rate estimated by ICES.Results for the west coast are much less encouraging with TR1 and TR2 discard rates close to 90% in 2012 although the quantities of cod taken by the TR2 gears are much lower.

Catch tracking

Ongoing monitoring of Scottish landings takes place routinely in accordance with management of the Scottish quota – the landings total available to Scotland. In order to inform on progress towards cod recovery targets it is necessary to monitor and track Scottish *catch* (including discards). This is achieved by applying the relevant discard rates for the TR1 and TR2 gears to the relevant landings for these gears and to build up a cumulative picture. In this case the relevant population of vessels used are taken to be those belonging to Scottish producer organisations (POs). The objective is

to remain within the amounts of catch (ie landings + ICES estimate of international discard rate) implied by the ICES forecast and which is allocated to the Scottish POs.

Table 9 summarises the monthly uptake of North Sea catch by the two gear types including the appropriate amounts of discards to provide a cumulative catch. Combining gears gives the Scottish catch. It should be noted here that the quarterly estimates of discard rate used are subject to much greater uncertainty than those applying to the annual figures reported above. The observer sampling by MSS, part funded by DCF and used to furnish ICES with data, is statistically designed to give a robust annual estimate. In Table, TR1 quarterly values are somewhat low while TR2 are rather high.

Figure 7 illustrates the catch trajectory (solid black line + black hatching) against the target values required to meet the Scottish allocation of catch. Results suggest that in 2012 the total catch did stay within the bounds implied by available Scottish quota + an allowance for discards equivalent to the ICES estimate of international discard rate *and* stayed well within the prediction of what was required to meet the management plan for cod stocks. This achievement compares with a small overshoot in 2011.

Overall, results suggest that a marked improvement (reduction) in discard rate in the TR1 gears has contributed significantly to reducing catches in 2009 to 2012. This may partly be the result of the reducing catch rates reported above and partly through spatial avoidance encouraged by the presence of RTCs.

Analysis of Partial F

Calculation of partial F values provides a way of quantifying the contribution made by different countries or gear groups etc to the overall fishing mortality. In this case the overall F should be taken from the 2013 ICES assessment used in its June 2013 advice.

It is also important to note that, strictly speaking, these values can give misleading results if not all countries submit a full set of landings and discard data. Similarly, if the overall TAC is not taken because some countries do not take their full quota, then this can distort the apparent share contributed by each country. Both these issues affect calculations.

The STECF effort expert working group has recently met and makes calculations of partial F by fleet and by gear. These will be examined at the STECF summer plenary to see how the partial F rates generated by the Scottish fleet have changed and whether the proportion attributable to them is in line with the cod plan and expected catch

Conclusions

a) A synthesis is presented of observations during Conservation Credits regime in 2012
b) It is not possible to evaluate fully the effects of individual measures although exploratory analysis of RTC information suggests that these have led to reductions in North Sea cod catch through changes in behaviour and fishermen moving to lower cod abundance areas
c) The contribution to overall mortality reduction by TR1 vessels adopting selective gears in 2012 is likely to be reflective of the fact that only around 25% of the boats use these gears. Analysis of catch rate observed across a sample of all the TR1 fleet in the North Sea, however, suggests that overall catch rate has declined from the 2008 level despite the fact that the stock has been increasing in the period 2008-2012. This may be arising from a combination of gear and avoidance behaviours.
d) There has been a further reduction in North Sea cod discards in 2012 relative to 2008-2010 largely through reductions observed in the TR1 gears. TR2 discard rates remain disappointingly high and greater overall reductions could be achieved in this gear – it is hoped that the adoption of HSG technical solutions (reducing cod catches by at least 60%)will begin to have more effect in 2013 when a full 12 months operation will occur.
e) The reduction in Scottish discards translates to a reduction in the fishing mortality attributable to discards, and the partial Fs will be examined at the STECF summer plenary .
f) The positive direction of travel should be built on and the approach strengthened in order to further enhance cod avoidance. This happened in 2010 with the agreement by the Conservation Credits Steering Group to increase the size of individual RTCs by 4 times following analysis of cod tagging data which has provided information of cod movement. The more recent initiative of catch quotas and fully documented fisheries should further assist in enabling cod catches to be controlled in line with cod plan targets. It should also be noted that in 2012, the provision to allow buybacks of effort for vessels catching less than 5% cod was removed from the Scottish scheme following the observations of STECF in 2011 that this could lead to unacceptably high cod catch.
g) Results for the West Coast of Scotland are more disappointing. There is little evidence of reduction in cod being caught and discard rates remain high. The problem is mainly focussed on the TR1 gear (TR2 discard rates are also high, but overall catches are relatively small since cod are not presently distributed significantly in areas where TR2 gear operates). Recent requirements for vessels to take up cod avoidance gears (presently limited to 200mm mesh) will take a while to have a widespread effect . Additional spatial measures to encourage fishing for haddock in areas south of 59 degrees latitude in order to avoid cod have yet to be evaluated.

References

S. J. Holmes, N. Campbell, C. Aires, P. G. Fernandes, R. Catarino, N. Bailey & K. Barratt. 2009. Using VMS and Fishery Data in a Real Time Closure Scheme as a Contribution to Reducing Cod Mortality and Discards. **ICES CM 2009/M:13**

Holmes et al 2011. Using fishery dependent data to inform the development and operation of a co-management inititive to reduce cod mortality and cut discards**.** **ICES Journal Marine Science 68 (8) pp1679 -1688**

C. Needle and R. Caterino, 2011. Evaluating the effect of real-time closures on cod targeting. **ICES Journal Marine Science 68 (8) pp1647 -165**

Table 1 Number of vessels and trips affected by the presence of RTCs (shown annually and quarterly) during 2012

	all	q1	q2	q3	q4
Vessels in dataset	569	-	-	-	-
Vessels directly affected by RTCs	214	155	118	147	153
Trips directly affected by RTCs	1995	539	488	431	537

Table 2 Example of the 'landings difference' output for analysis of 5 example trips. 'diff' represents the change in landings occurring when a vessel moves away from an RTC. Negative values signify a reduction while positives suggest a move to a more cod rich area. The net effect is the result of analysing the 1995 trips (see table above)

trip	quarter	rtcs	cod1	cod2	diff
240081032	1	21	8185.9	12111.8	-3925.9
240081178	1	31	10112.3	1041.3	9071
240081444	1	49	10594.4	93.6	10500.8
240081752	2	63	10373.8	12174.4	-1800.6
240081942	2	71, 74, 75, 76	7775.2	8364.9	-589.7

Table 3 North Sea estimated cod landing reductions arising from RTCs. Note the equivalent catch reduction is bigger.

Year	Estimate of direct RTC cod landing reduction (Tonnes) -
2009	380
2010	892
2011	883
2012	916 (equiv. 1189 catch)

Table 4 Means of trip RCII differences, for different quarters (rows) and categories of event (columns). Negative values signify movement away from RTCs .

all		before	during	after
All	-0.017 (p = 0)	-0.052 (p = 0)	-0.043 (p = 0)	0.037 (p = 0)
q1	-0.021 (p = 0.0001)	-0.063 (p = 0)	-0.06 (p = 0)	0.059 (p = 0)
q2	-0.024 (p = 0)	-0.05 (p = 0)	-0.044 (p = 0)	0.018 (p = 0.003)
q3	-0.014 (p = 0.0038)	-0.071 (p = 0)	-0.05 (p = 0)	0.05 (p = 0)
q4	-0.008 (p = 0.0164)	-0.024 (p = 0)	-0.024 (p = 0)	0.023 (p = 0.0004)

Table 5 Catch, effort and CPUE results from North Sea Scottish observer trips (2008-2012) on TR1 vessels using various measures

TR1

Cod catch, effort and CPUE on Observed vessels

	Vessel	2008			2009			2010			2011			2012		
	analysis numbe	CATCH (KG)	EFFORT (HRS)	CPUE	CATCH (KG)	EFFORT (HRS)	CPUE	CATCH (KG)	EFFORT (HRS)	CPUE	CATCH (KG)	EFFORT (HRS)	CPUE	CATCH (KG)	EFFORT (HRS)	CPUE
130mm	1							7716	94	82.09	1038	106	9.79			
	2	7028.1	62.92	111.70				2929.34	86.25	33.96						
	3				4387.2	65.67	66.81	23192.2	241.38	96.08						
	4	3897.25	75.58	51.56	8462.45	133.2	63.53	3324.55	46.25	71.88	11384	32	355.75	4245.8	64.9	65.42
	4										4145	75	55.27	113.1	26.4	4.28
	5				3904.35	157.3	24.82	8130.16	254.42	31.96						
	6										4103	98	41.87	8957.2	126.8	70.64
	7										8598	70	122.83	8900.6	56.0	158.94
														1034.8	62.1	16.67
	8										2464	108	22.81			
	71													1417.5	38.9	36.44
	Total	**10925.35**	**138.5**	**78.88**	**16754**	**356.17**	**47.04**	**45292.25**	**722.3**	**62.71**	**31732**	**489**	**64.89**	**24669.0**	**375.1**	**65.76**
											20348	**457**	**44.53**			
Orkney	9	9078.31	195.18	46.51	11306.16	154.75	73.06	21461.35	338.5	63.40						
	10	11640.1	123.98	93.89	680.12	110.75	6.14	10998	74.03	148.56						
	11							6466.23	122	53.00						
	12	93.97	18.22	5.16	3265.95	156.83	20.82	8152	108.83	74.91						
	13	0	116	0.00	6601.08	125.53	52.59	10368.43	75	138.25						
	14	3904.5	145	26.93	27964.5	280	99.87	22411.1	297.83	75.25						
	15							18128.9	77	235.44	1700	46	36.97			
	15										11432	148	77.24			
	15										721	50	14.43			
	16				554.65	129	4.30	6544.6	163.75	39.97	3070	107	28.69	2947.1	102.8	28.67
	16										3207	77	41.65			
	17							8910.31	121.17	73.54						
	18							6852.15	108.83	62.96						
	19							29253.15	162.65	179.85						
	20	7969	122.5	65.05	40193.79	172.17	233.45	18912.19	246.5	76.72						
	21							14010.87	155.67	90.00						
	22				234.56	14.25	16.46	2237.89	23.92	93.56						
	23							15626.68	152.83	102.25						
	24	14894.6	71.5	208.32				6450.9	48.42	133.23						
	25							15874.66	49	323.97						
	26							10981.44	48	228.78						
	27										3288	85	38.68	8578.7	96.6	88.81
	27										7444	79	94.23	8406.1	127.8	65.78
	28										8843	86	102.82			
	28										9997	83	120.44			
	29										15130	119	127.14	4857.6	110.5	43.96
	30										5298	84	63.08			
	31										13310	118	112.79	5983.3	123.4	48.49
	72													1245.8	60.5	20.59
	73													5769.2	153.6	37.56
	32													5622.5	22.8	247.14
	32													1159.1	18.5	62.66
	Total	**47580.48**	**792.38**	**60.05**	**90800.81**	**1143.28**	**79.42**	**233640.85**	**2373.93**	**98.42**	**83440**	**1082**	**77.12**	**44569.5**	**816.4333333**	**54.59**

Table 5 cont

	Vessel	2008			2009			2010			2011			2012		
	analysis numbe	CATCH (KG)	EFFORT (HRS)	CPUE	CATCH (KG)	EFFORT (HRS)	CPUE	CATCH (KG)	EFFORT (HRS)	CPUE	CATCH (KG)	EFFORT (HRS)	CPUE	CATCH (KG)	EFFORT (HRS)	CPUE
Belly panel	32										11332	41	276.39			
FDF	9							21461.35	338.5	63.40	5453	65		8380	108	77.59
	9										12812	135	94.90			
	9										6131	95	64.53			
	10							10998	74.03	148.56				95.4	37.9	2.52
	12							8152	108.83	74.91	7792	89	87.55	10798	119.3	90.51
														8752.5	86	101.77
	13							10368.43	75	138.25						
	14							22411.1	297.83	75.25	19878	105	189.32	5150.8	137.1	37.57
														4646.0	111.1	41.82
	18							6852.15	108.83	62.96	9455	142	66.58	5238.5	109	48.06
														9461.9	90	105.13
	21							14010.87	155.67	90.00						
	25							15874.66	49	323.97						
	33							1273	116	10.97						
	34							6536	95	68.80	14309	127	112.67	7910	68.75	115.05
	35										5419	130	41.69	5358	35.7	150.08
	35										943	51	18.49	11354.8	48.4	234.60
	36										297	30	9.91	4558.5	121.3	37.58
	37										4465	72	62.01	703.5	14.4	48.80
	37										255	8	31.87	6347.0	3.4	1857.66
	38										10899	77	141.54	4237.0	89.7	47.25
	38										5667	83	68.28	0.0	16.0	0.00
														5075.0	79.7	63.70
	39										6293	97	64.88			
	40										2802	85	32.97			
	41										11355	79	143.73			
	74													3.8	10.3	0.37
	74													12602.0	41.8	301.48
	75													3897.6	96.5	40.39
	76													4836.9	60.3	80.28
	76													3.2	9.4	0.33
	Total							**117937.56**	**1418.69**	**83.13**	**124226**	**1470**	**84.51**	**119410.3071**	**1493.966667**	**79.93**

Table 5 cont

	Vessel	2008			2009			2010			2011			2012		
	analysis numbe	CATCH (KG)	EFFORT (HRS)	CPUE	CATCH (KG)	EFFORT (HRS)	CPUE	CATCH (KG)	EFFORT (HRS)	CPUE	CATCH (KG)	EFFORT (HRS)	CPUE	CATCH (KG)	EFFORT (HRS)	CPUE
No Measures	32							11844	29	408.41						
	6							1580	83	19.04						
	37							13973	57	245.14						
	42							2810	207	13.57						
	43							1868	108	17.30	4447	103	43.17	4212.9	120.4	34.99
	43										5003	117	42.76			
	44							6825	32.5	210.00				1711.6	11.8	144.64
														4550.2	25.0	182.01
	45							33	39	0.85						
	46							9166	129	71.05						
	47							5699	120	47.49						
	48							10082	36	280.06						
	49							46	23	2.00	9455	82	115.31	1529.0	100.3	15.24
	49										2686	12	223.81	2212.0	45.0	49.12
	49										8198	69	118.81			
	50							3507	79	44.39						
	51							2861	72	39.74						
	52							1251	21	59.57				2159.5	103.8	20.80
														2513.1	86.8	28.94
	53										3066	56	54.76			
	54										5508	147	37.47			
	55										2821	16	176.31			
	56										1459	112	13.03			
	57										6411	119	53.87			
	58										2725	73	37.33	2989.7	113.3	26.39
	59										3599	82	43.89			
	77													203.4	12.8	15.89
	78													2436.5	13.2	184.58
	79													992.5	96.5	10.28
		2008 and 2009 from data collected in MSS observer scheme- no measure vessels														
	Total	**106313.17**	**971.12**	**109.4748023**	**43816.79**	**647.55**	**67.66549301**	**71545**	**1035.5**	**69.09**	**55377**	**988**	**56.05**	**25510.30167**	**729.0666667**	**34.99**
Overall total - all categories		**164819**	**1902**	**86.66**	**151371.6**	**2147**	**70.50**	**468415.66**	**5550.42**	**84.39**	**294774.7905**	**4029**	**73.16**	**214159.1129**	**3414.583333**	**62.72**

Table 6 Catch, effort and CPUE results from North Sea Scottish observer trips (2008-2012) on TR2 vessels using various measures

TR2
Cod catch, effort and CPUE on Observed vessels

	vessel	2008			2009			2010			2011			2012		
	analysis number	CATCH (KG)	EFFORT (HRS)	CPUE	CATCH (KG)	EFFORT (HRS)	CPUE	CATCH (KG)	EFFORT (HRS)	CPUE	CATCH (KG)	EFFORT (HRS)	CPUE	CATCH (KG)	EFFORT (HRS)	CPUE
SMP	60	3218.7	441.9	7.28	1363.1	141.75	9.62	2677.1	146.75	18.24						
	61				543.1	67.58	8.04	2015.79	134.93	14.94						
	62							4400.97	170.75	25.77						
	63							1958.88	81.75	23.96						
	64							4179.39	169.12	24.71						
	65				2051.8	272.17	7.54	466.01	117.5	3.97						
	66				550.61	126.28	4.36	581.86	136.67	4.26						
	67										614	116	5.29			
	68							947	60.15	15.74	612	156	3.93			
	69										350	103	3.40			
	70										52	42	1.24			
	80													0.25	7.50	0.03
	81													4.22	22.83	0.18
	82														15.17	0.00
	83													13.13	6.08	2.16
	84													18.75	7.17	2.62
	85													833.76	30.00	27.79
	Total	**3218.7**	**441.9**	**7.28**	**4508.61**	**607.78**	**7.42**	**17227**	**1017.62**	**16.93**	**1628**	**417**	**3.90**	**870**	**88.75**	**9.80**

Highly	86													254.14	102.40	2.48
Selective Gear	87													1347.94	86.93	15.51
(HSG)	88													446.76	98.75	4.52
	89													1.41	13.13	0.11
	90													376.22	154.83	2.43
	91													192.21	98.42	1.95
	92													246.38	92.50	2.66
	66													368.34	167.50	2.20
	93													2045.60	135.30	15.12
	94													109.45	73.28	1.49
	95													0.56	10.33	0.05
	96													151.24	137.00	1.10
	Total													**5540.26**	**1170.38**	**4.73**
	Overall	**3218.7**	**441.9**	**7.28**	**4508.61**	**607.78**	**7.42**	**17227**	**1017.62**	**16.93**	**1628.348932**	**417**	**3.90**	**6410.378341**	**1259.133333**	**5.09**

Table 7

TR1
Cod catch, effort and CPUE on Observed vessels

	Vessel	2012		
	analysis numb	CATCH (KG)	EFFORT (HRS)	CPUE
130	18	357.0	70.7	5.05
	18		128.4	0.00
	18	851.9	12.5	68.06
	19	4138.2	71.5	57.88
	19	10911.1	78.0	139.89
	18	6261.0	60.7	103.20
	18	2861.0	82.3	34.75
	18	649.3	35.3	18.38
Orkney	20	1516.5	66.7	22.75
	21	3621.3	58.3	62.17
FDF	22	6.9	4.0	1.72
	22	919.5	31.3	29.35
	23	1162.1	19.9	58.35
	24	2096.5	63.5	33.01
None	25	1978.2	43.9	45.05
	25	945.0	44.0	21.48
	25	676.4	18.7	36.24

TR2
Cod catch, effort and CPUE on Observed vessels

	Vessel	2012		
	analysis numb	CATCH (KG)	EFFORT (HRS)	CPUE
HSG	1	283.6	93.5	3.03
	1	995.9	65.0	15.32
	2	73.9	126.3	0.59
	3	205.7	86.0	2.39
	4	8.5	15.3	0.56
		1567.6	386.0	4.06
200mm	5	2.4	25.5	0.10
	6	3.7	27.8	0.13
	7	0.5	11.5	0.04
	8	14.3	22.1	0.65
	9	16.8	22.0	0.76
	10	18.3	39.4	0.46
	11	0.1	32.1	0.00
	12	0.7	31.5	0.02
	13	0.0	70.0	0.00
	14	4.3	62.8	0.07
	14	2.7	64.8	0.04
	15	3.7	25.0	0.15
	16	0.9	22.3	0.04
	10	3.7	21.9	0.17
	17	10.5	32.0	0.33
	9	0.0	11.7	0.00
		82.6	522.3	0.16

Table 8 Scottish cod landings and discards estimated from MSS Scottish observer trips 2003-2012 on TR1 and TR2 vessels in the North Sea and West of Scotland (as supplied to ICES.

North Sea
TR1

Year	landings	cod discards	% dis (of catch)
2003	6558	628	9.00%
2004	5617	691	11.00%
2005	5699	755	12.00%
2006	5926	1057	15.00%
2007	5819	4412	43.00%
2008	6344	10905	63.00%
2009	8677	5945	41.00%
2010	11362	3861	25.00%
2011	10228	2529	19.80%
2012	10590	2463	18.87%

North Sea
TR2

Year	landings	cod discards	% dis (of catch)
2003	944	635	40.00%
2004	766	336	30.00%
2005	779	506	39.00%
2006	651	675	51.00%
2007	606	2147	78.00%
2008	515	1040	67.00%
2009	334	927	74.00%
2010	436	1014	69.90%
2011	222	885	79.90%
2012	163	948	85.00%

West Coast
TR1

Year	landings	cod discards	% dis (of catch)
2003	720	5	1.00%
2004	337	7	2.00%
2005	298	3	1.00%
2006	274	263	49.00%
2007	226	566	71.00%
2008	203	576	74.00%
2009	97	609	86.00%
2010	108	507	82.40%
2011	102	1439	93.40%
2012	127	1070	89.00%

West Coast
TR2

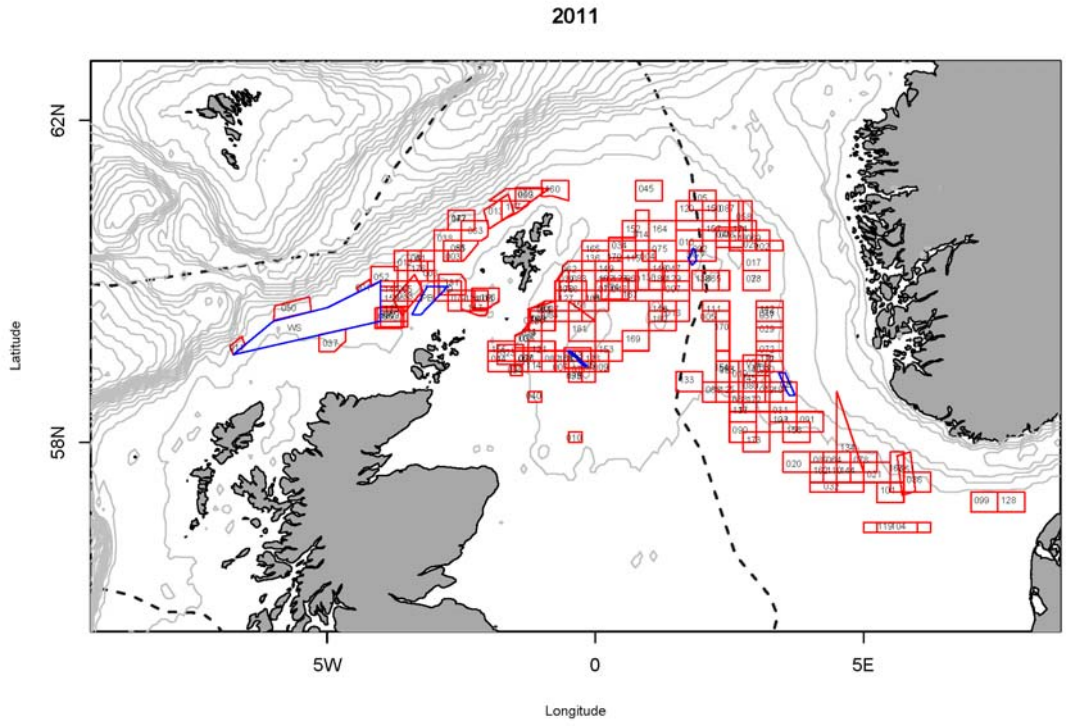
Year	landings	cod discards	% dis (of catch)
2003	146	16	10.00%
2004	52	32	38.00%
2005	25	27	52.00%
2006	19	59	76.00%
2007	30	125	81.00%
2008	25	7	22.00%
2009	7	47	87.00%
2010	5	131	96.90%
2011	8	133	94.30%
2012	8	130	93.89%

Table 9 North Sea monthly uptake of cumulative catch (Scottish PO vessels) and discard proportion building towards the annual total for TR1 above and TR2 below.

COD	Overall	TR1			
year	month	TR1 lnds	TR1 discard rate	TR1 discards	TR1 catch
2012	jan	678.05	0.154	123.23	801.28
2012	feb	563.56	0.154	102.42	665.98
2012	mar	704.14	0.154	127.97	832.11
2012	apr	1028.34	0.047	50.54	1078.88
2012	may	939.23	0.047	46.16	985.39
2012	jun	727.20	0.047	35.74	762.94
2012	jul	763.35	0.113	97.27	860.62
2012	aug	820.65	0.113	104.57	925.22
2012	sep	769.15	0.113	98.01	867.16
2012	oct	719.43	0.420	520.27	1239.69
2012	nov	668.97	0.420	483.78	1152.74
2012	dec	590.92	0.420	427.34	1018.26

TR2			
TR2 lnds	TR2 discard rate	TR2 discards	TR2 catch
31.5147	0.834174472	158.532637	190.05
16.1398	0.834174472	81.1902084	97.33
9.8312	0.834174472	49.4552087	59.29
3.1965	0.834174472	16.0797842	19.28
1.4393	0.834174472	7.24030452	8.68
7.0701	0.834174472	35.5656757	42.64
5.5981	0.745348966	16.3853175	21.98
11.4327	0.745348966	33.462857	44.90
22.5847	0.745348966	66.1041211	88.69
27.1642	0.177749624	5.87220934	33.04
14.8159	0.177749624	3.20282086	18.02
5.5483	0.177749624	1.19940138	6.75

Figure 1 Distribution of RTCs (red polygons) and seasonal closures (blue) in 2011and 2012. Note the existing permanent large west coast closure is also shown



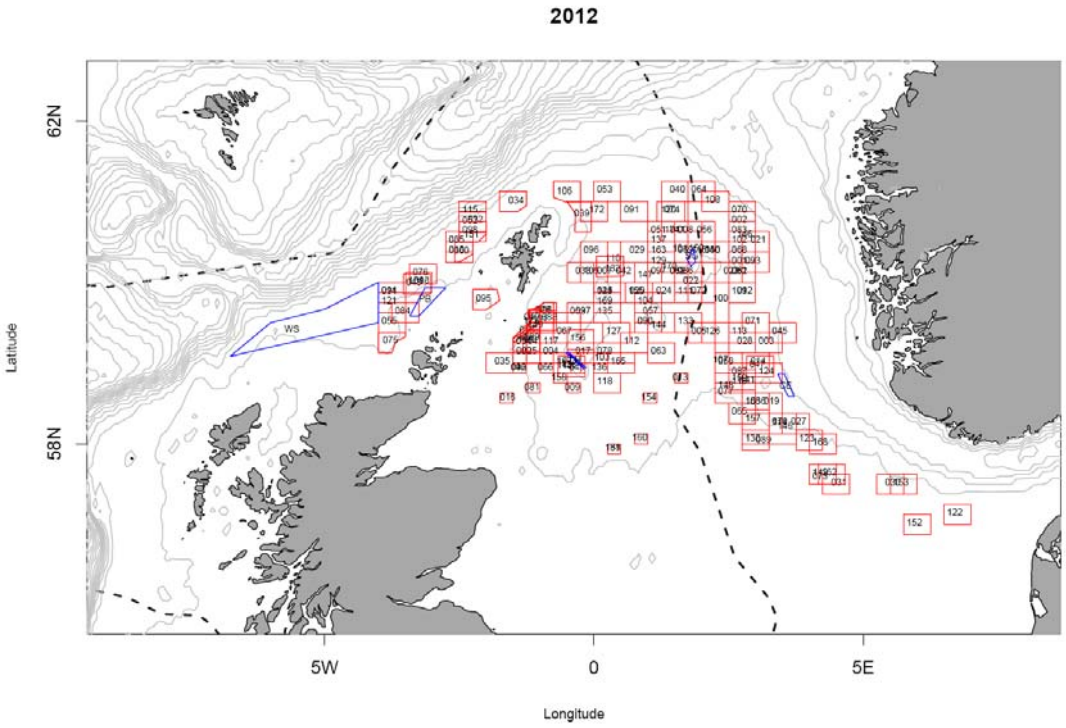


Figure 2 Example of relative abundance index for cod shown for February 2012 (index available for each month through the year.

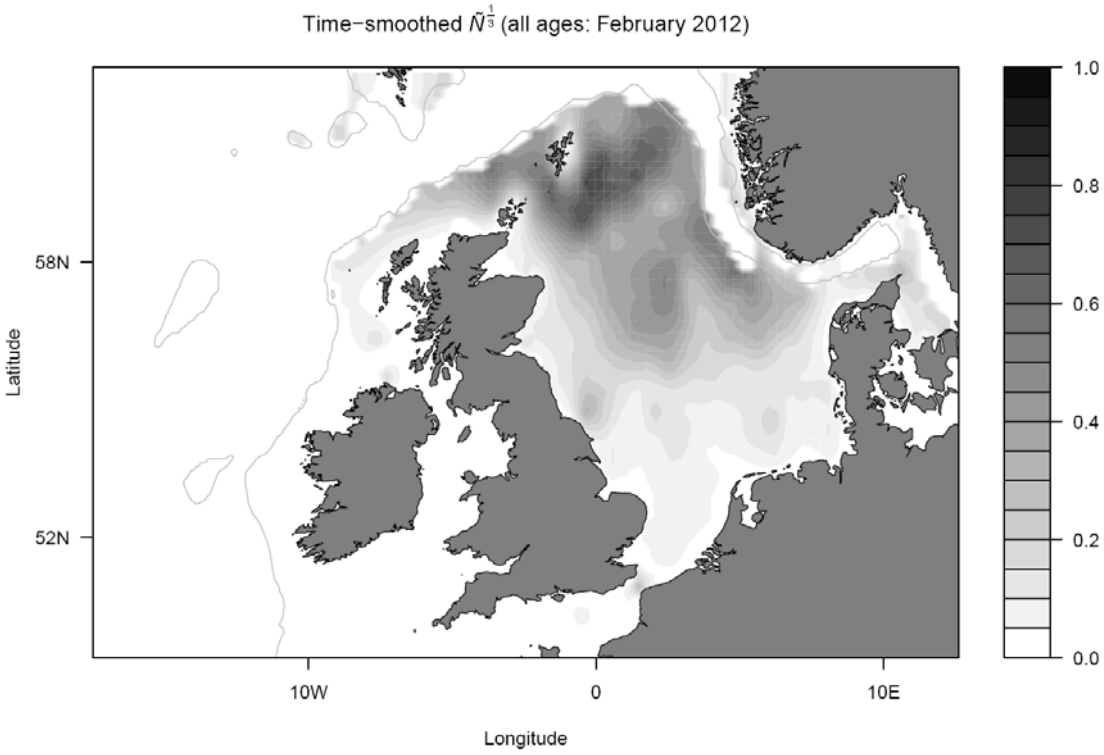


Figure 3 Example of individual track of vessel X during 7th fishing trip of 2012. Open red squares show RTCs). Spawning areas are shown in blue.

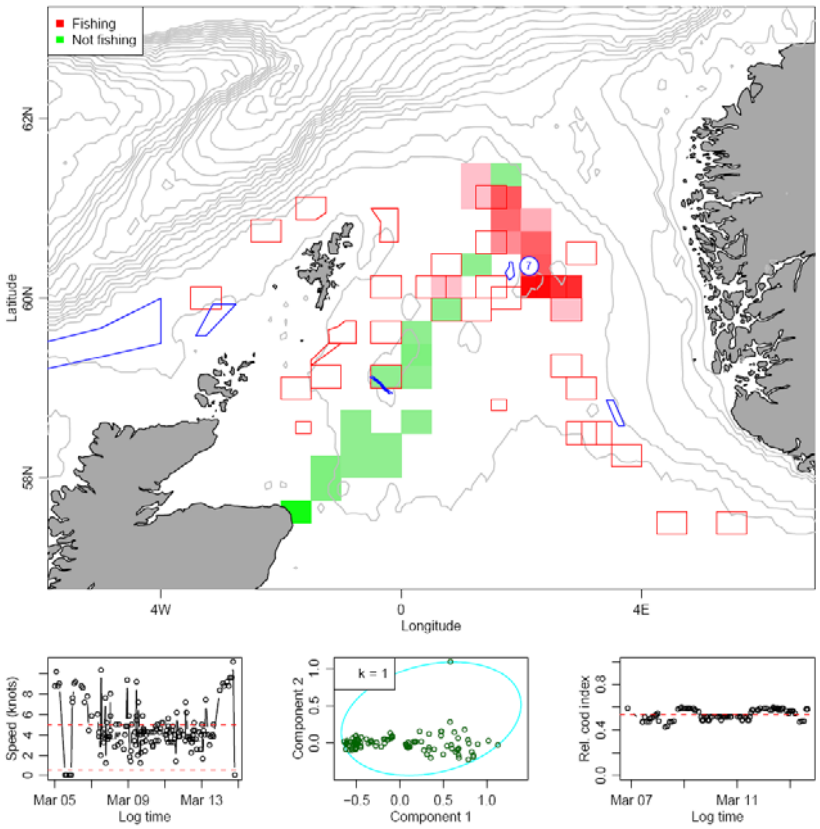
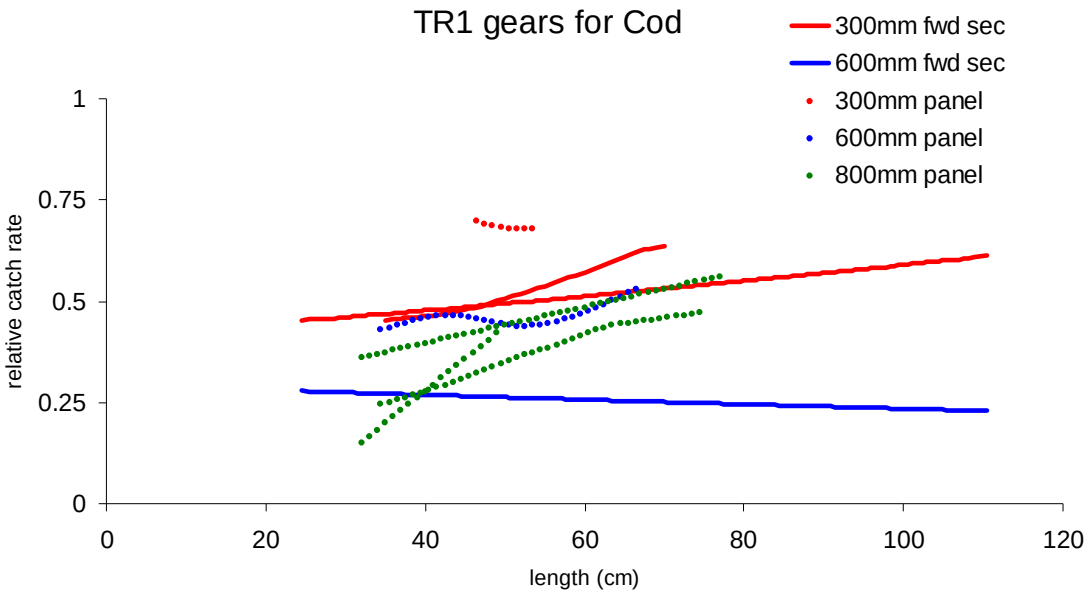
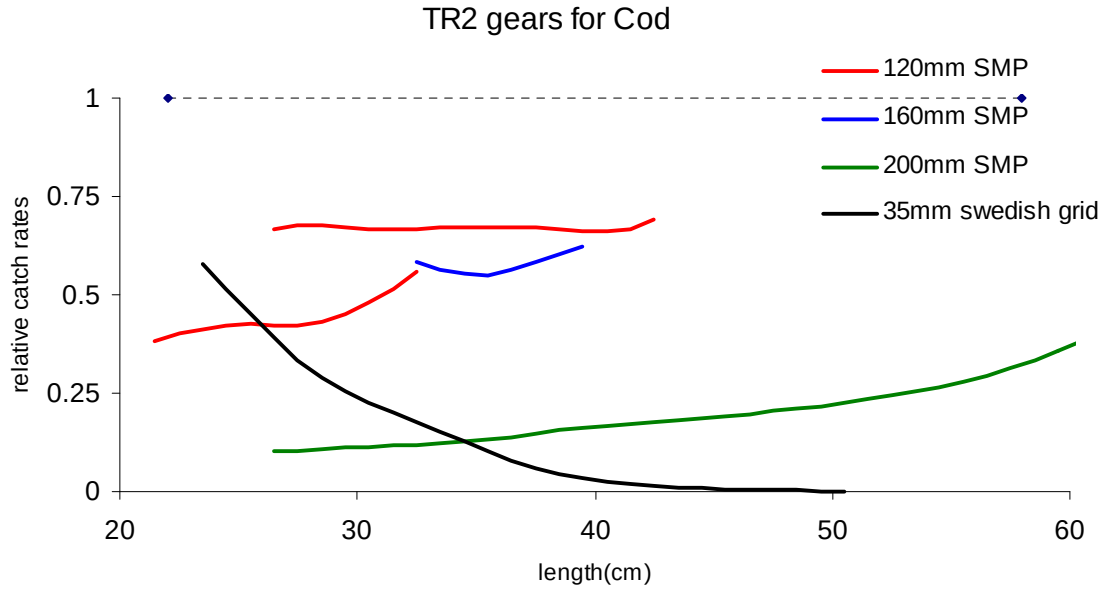
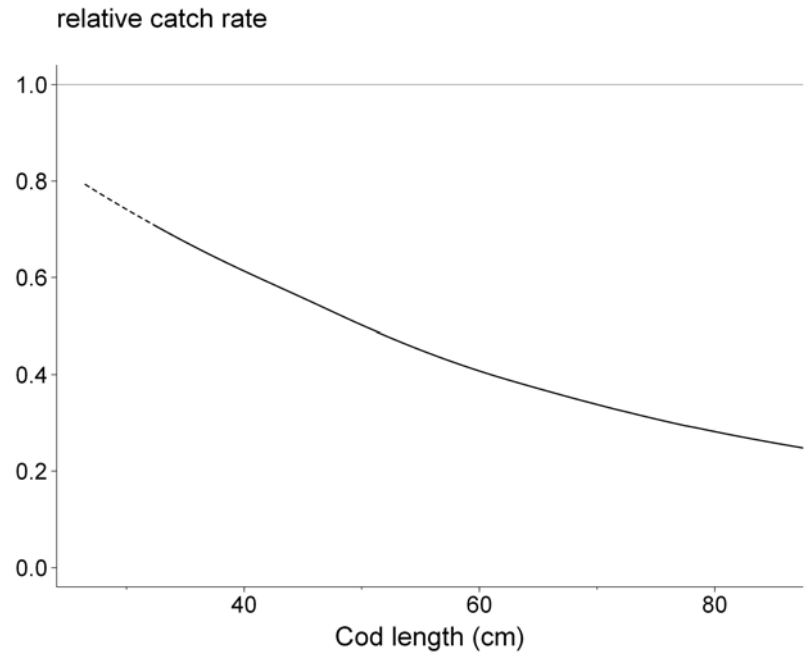


Figure 4 Selectivity results (first figure) for various configurations of large mesh (placed in the forward section of the net or as large panels in the belly of the net) all designed to reduce cod catch. Values of 1 would signify no difference from a small meshed control. Across a range of lengths cod catch rate is reduced significantly; (secon figure) comparing various square meshed panel types and the Swedish grid. The large meshed 200mm SMP shows particularly good reductions at small sizes of fish but only the grid reduces catches of larger fish effectively. Third and fourth figures show results for the new Highly Selective TR2 gears, 'Flip-Flap' and 'FCAP' repectively.





Flip –Flap trawl



FCAP

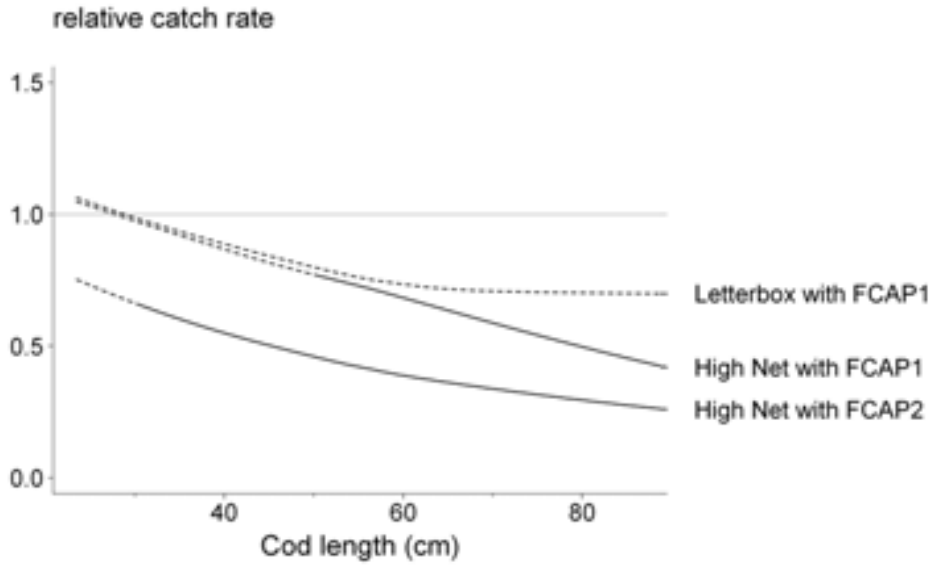


Figure 5 Time series of cod SSB (ICES 2013) at mid-point of year and Scottish TR1 cod CPUE (2008-2012) relative to 2008 values

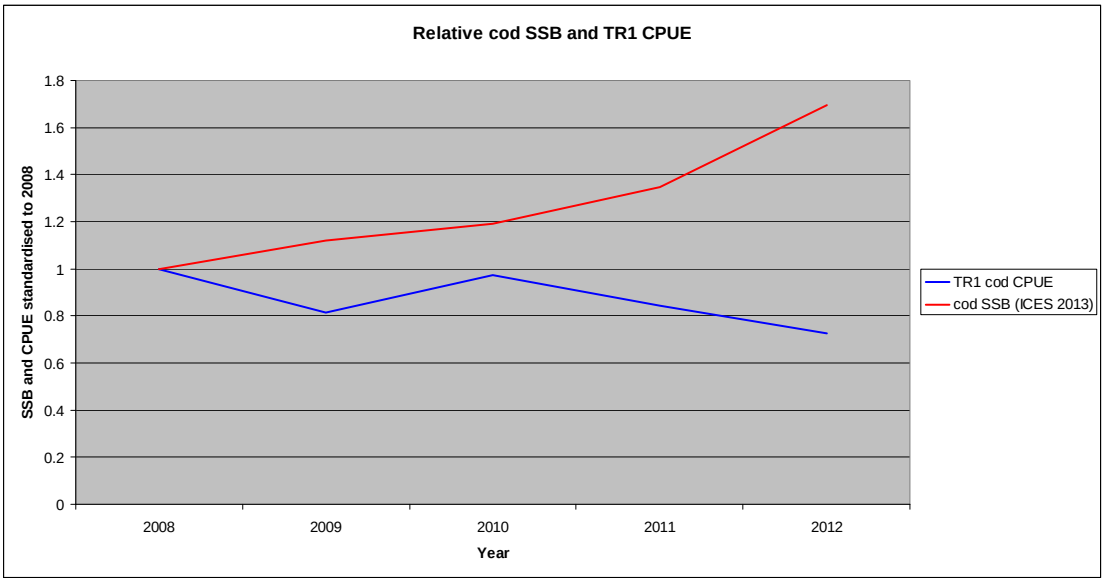


Figure 6 Time series of cod SSB (ICES 2013) at mid-point of year and Scottish TR2 cod CPUE (2008-2012) relative to 2008 values

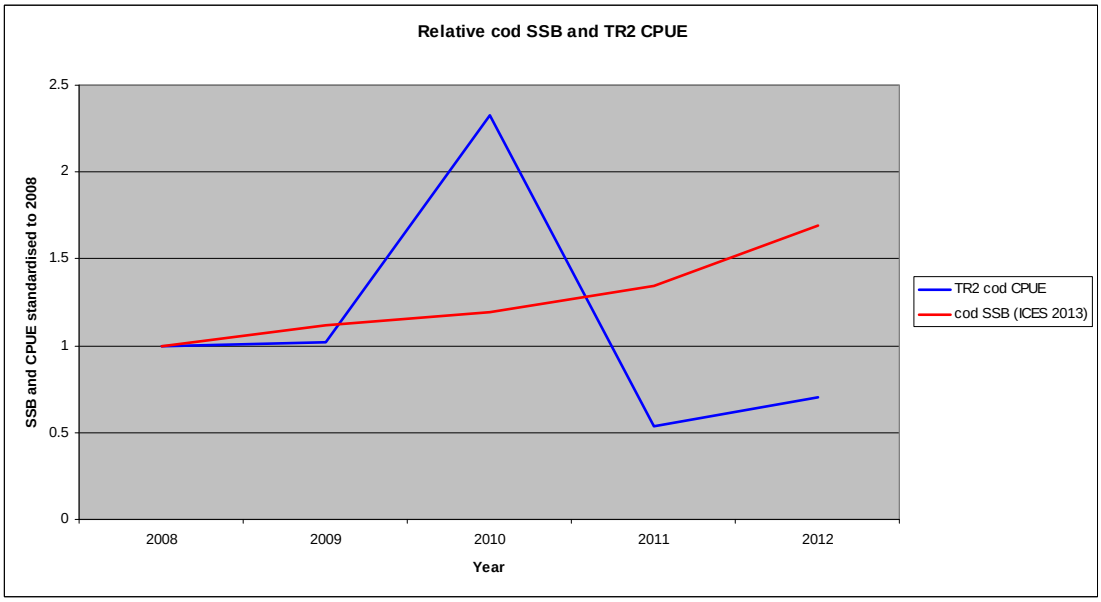


Figure 7 **Cod catch trajectory in 2011 2012**. Horizontal shaded bands represent Scottish landings quota – mid-grey - (based on producer organisation total), additional amount representing ICES prediction of international discard rate – dark grey- and overall 'Scottish catch' predicted by ICES forecast of cod recovery plan target –dark grey-. Solid black line represents landings uptake by Scotland , pale grey additional amount implied by international discard rate and hatched area the observed discards (as per Table 9)