ECOREGION Celtic Sea and West of Scotland
STOCK *Nephrops* in Division VIa

Introduction

Nephrops are limited to a muddy habitat. This means that the distribution of suitable sediment defines the species distribution and the stocks are therefore assessed as three separate functional units (FUs) (Figure 5.3.20.1). The advice for *Nephrops* stocks is given by functional units in Sections 5.3.20.1–3.

Section	FU no.	Name	ICES Division	Statistical rectangles
5.3.20.1	11	North Minch	VIa	44–46 E3–E4
5.3.20.2	12	South Minch	VIa	41–43 E2–E4
5.3.20.3	13	Firth of Clyde + Sound of Jura	VIa	39–40 E4–E5

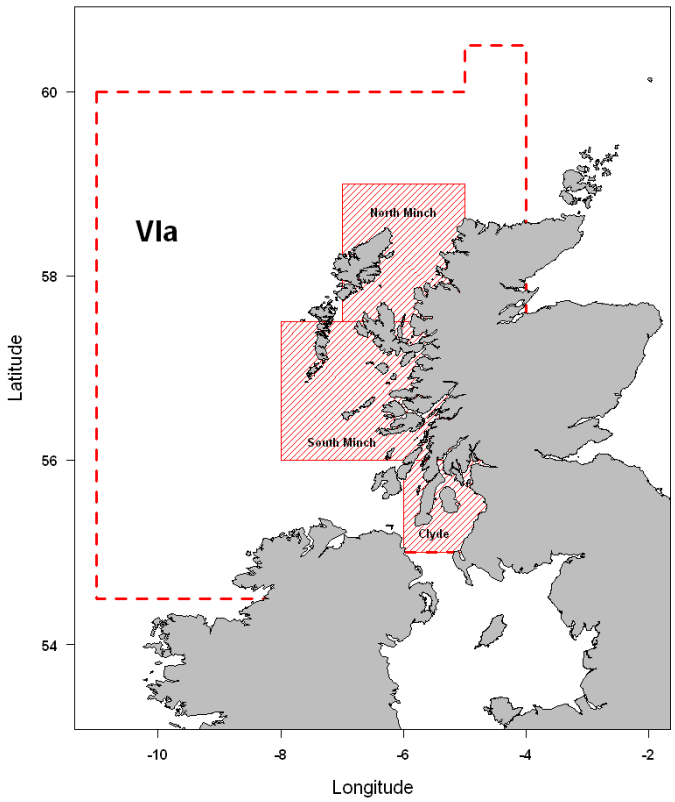

Figure 5.3.20.1 *Nephrops* functional units in Division VIa.

Summary of the advice for 2015

A summary of the advice per functional unit can be found in Table 5.3.20.1.

To protect the *Nephrops* stocks in this management area, management should be implemented at the functional unit level.

There is no information available on the trends in the stock or exploitation status for the rectangles outside the FUs ('other rectangles') for which ICES provides advice. Based on the ICES approach to data-limited stocks, ICES advises that landings from the 'other rectangles' should be no more than 326 t. No information on discards is available for these rectangles.

Table 5.3.20.1 *Nephrops* in Division VIa. Summary of ICES advice by functional unit (FU) plus other rectangles.

Year	Predicted landings corresponding to ICES advice						Agreed TAC [1)]	ICES landings
	North Minch (FU 11)	South Minch (FU 12)	Firth of Clyde (FU 13)	Sound of Jura (FU 13)	Other rectangles	Total advice		
1992						~11.4	12.0	10.8
1993						~11.3	12.0	11.3
1994						11.3	12.6	11.1
1995						11.3	12.6	12.8
1996						11.3	12.6	11.2
1997						11.3	12.6	11.2
1998						11.3	12.6	11.2
1999						11.3	12.6	11.5
2000						11.3	12.6	11.0
2001						11.3	11.34	10.9
2002						11.3	11.34	10.5
2003						11.3	11.34	10.8
2004						11.3	11.3	10.4
2005						11.3	12.7	10.5
2006						-[2)]	17.7	13.7
2007	3.2	7.2	3.765		0.8	15.0	19.9	16.1
2008	3.2	7.2	3.765		0.8	15.0	19.9	14.8
2009	< 4.1	< 5.0	< 5.7		< 0.3	[3)]	18.4	12.4
2010	< 1.0	< 4.1	< 3.9		< 0.25	[3)]	16.1	12.2
2011	< 3.1	< 4.0	< 4.1	< 0.5	< 0.25	[3)]	13.7	12.5
2012	< 3.2	< 5.5	< 4.2	< 0.9	[4)]	[3)]	14.1	13.8
2013	< 4.2	< 5.8	< 5.6	< 0.8	[4)]	[3)]	16.7	12.2
2014	< 3.485	< 5.211	< 5.744	< 0.521	< 0.326	[3)]	15.3	
2015	< 3.092	< 6.382	< 3.776	< 0.614	< 0.326 [5)]	[3)]		

Weights in thousand tonnes.
[1)] Subarea VI and EU waters of Division Vb.
[2)] Effort should not be increased.
[3)] ICES advises that stocks should be managed by functional unit.
[4)] ICES advises that the catches in the other rectangles should not increase.
[5)] ICES advises the same landings as advised last year for the 'other rectangles' (326 t).

Biology

Nephrops is limited to a muddy habitat and requires sediment with a silt and clay content of between 10% and 100% to excavate its burrows. This means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* only undertake very small-scale movements (a few 100 m), but larval transfer may occur between separate mud patches in some areas. Catches typically consist of a smaller proportion of females than males, due to the lower burrow emergence (resulting in lower catchability) of females during the egg bearing. It is likely that maximum stock size and fishery potential is constrained by the available space since the species competes for space and there are upper limits on density. Males are limited in their geographical range for finding mates, hence low densities of males can have a significant impact upon stock spawning potential.

Environmental influence on the stock

Temperature and hydrographic factors are critical to recruitment success in *Nephrops*, particularly during the larval phase. Different environmental factors such as sediment type and hydrography result in very different population structure, productivity, and vulnerability to fishing.

Effects of the fisheries on the ecosystem

There is a bycatch of other species in the *Nephrops* fisheries in Division VIa. This bycatch reflects the species associated with muddy sediments. Estimates of discards of whiting and haddock are high in Division VIa. Bycatches of cod are low and the Scottish Conservation Credits Scheme is in place to minimize cod catches. The use of creels for *Nephrops* fishing has increased in inshore areas in the Division VIa FUs. Discards and bycatch in the creel fisheries are considered to be low. The high mud content and soft nature of *Nephrops* grounds means that trawling readily marks the

seabed, with trawl marks remaining visible for some time. Burrowing fauna can be seen re-emerging from freshly trawled grounds, implying that there is some resilience to trawling.

MSY approach for stocks with underwater TV surveys

Most functional units are monitored by underwater TV (UWTV) surveys, in which burrows are counted by means of video analysis. For these FUs, MSY reference points for fishing mortality have been evaluated. No precautionary reference points have been defined for *Nephrops*.

Under the ICES MSY approach, exploitation rates which are likely to generate high long-term yield (and low probability of overfishing) have been evaluated and proposed for each functional unit. Owing to the way *Nephrops* are assessed, it is not possible to estimate F_{MSY} directly and hence proxies for F_{MSY} have been determined. Three stock-specific candidates for F_{MSY} proxies ($F_{0.1}$, $F_{35\%SPR}$, and F_{max}) were derived from a length-based per-recruit analysis (these may be modified following further data exploration and analysis). An appropriate F_{MSY} candidate was then selected for each individual functional unit, taking into account the following factors: observed burrow density, historical harvest rates, historical stability in stock size, knowledge of biological parameters (including factors affecting recruitment), and the nature of the fishery. The table below illustrates the framework against which stocks were evaluated and appropriate F_{MSY} proxies chosen. In general, $F_{35\%SPR}$ was used unless there were stock-specific justifications for either higher or lower harvest ratios.

		Burrow density (average individuals m^{-2})		
		Low < 0.3	Medium 0.3–0.8	High > 0.8
Observed harvest rate or landings compared to stock status (historical performance)	> F_{max}	$F_{35\%SPR}$	F_{max}	F_{max}
	F_{max}–$F_{0.1}$	$F_{0.1}$	$F_{35\%SPR}$	F_{max}
	< $F_{0.1}$	$F_{0.1}$	$F_{0.1}$	$F_{35\%SPR}$
	Unknown	$F_{0.1}$	$F_{35\%SPR}$	$F_{35\%SPR}$
Stock size estimates	Variable	$F_{0.1}$	$F_{0.1}$	$F_{35\%SPR}$
	Stable	$F_{0.1}$	$F_{35\%SPR}$	F_{max}
Knowledge of biological parameters	Poor	$F_{0.1}$	$F_{0.1}$	$F_{35\%SPR}$
	Good	$F_{35\%SPR}$	$F_{35\%SPR}$	F_{max}
Fishery history	Stable spatially and temporally	$F_{35\%SPR}$	$F_{35\%SPR}$	F_{max}
	Sporadic	$F_{0.1}$	$F_{0.1}$	$F_{35\%SPR}$
	Developing	$F_{0.1}$	$F_{35\%SPR}$	$F_{35\%SPR}$

There may be great differences in the relative exploitation rates between the sexes for many stocks. To account for this, values for each of the candidates have been determined individually for males, females, and the two sexes combined. The combined sex F_{MSY} proxy should be considered appropriate, provided that the resulting percentage of virgin spawner-per-recruit for males or females does not fall below 20%. If this happens a more conservative sex-specific F_{MSY} proxy should be chosen instead of the combined proxy.

Where possible, a preliminary MSY $B_{trigger}$ was proposed based on the lowest observed UWTV burrow abundance, unless the stock has shown signs of stress at higher abundance (in which case a higher value is used).

Additional considerations

Advice considerations

The overriding management consideration for these stocks is that management should be at the functional unit rather than the ICES subarea/division level. Management at the functional unit level should provide the controls to ensure that catch opportunities and effort are compatible and in line with the scale of the resources in each of the stocks defined by the functional units. Current management of *Nephrops* in Subarea VI (both in terms of TACs and effort) does not provide adequate safeguards to ensure that local effort is sufficiently limited to avoid depletion of resources in functional units. In the current situation vessels are free to move between grounds, allowing effort to develop on some grounds in a largely uncontrolled way; this has historically resulted in inappropriate harvest rates from some parts.

There are also *Nephrops* catches in "other rectangles" in Division VIa, e.g. from offshore areas adjacent to Stanton Bank where Irish fishers frequently operate from the shelf edge.

There are no functional units in ICES Division VIb, but occasional small *Nephrops* landings occur (Table 5.3.20.4).

Regulations and their effects

The minimum landing size for *Nephrops* is 20 mm carapace length (CL), and usually very few of the landed animals are under this size. The average discard rate of *Nephrops* in number over the last five years is below 20%. In 2009 the minimum mesh size was increased from 70 mm to 80 mm which is expected to have reduced slightly the small *Nephrops* in the catch.

Under the Scottish Conservation Credits Scheme (SCCS) and the west coast emergency measures, *Nephrops* trawlers are required to use more selective gears. 200 mm square mesh panels have been widely used since 2012 as these panels are required for all TR2 vessels with power > 112 kW fishing under the SCCS. However, these gears are designed to release fish and do not significantly improve selectivity of *Nephrops*.

Reported effort by all Scottish *Nephrops* trawlers (in terms of days absent) has shown a decrease in 2013 (Figure 5.3.20.2) which may, in part, be due to a limit on the effort allocated to visiting North Sea-based TR2 vessels (allocated only 85% of their average annual effort in 2009–2011).

Data and methods

The assessments and advice for *Nephrops* stocks in all the FUs of Division VIa are primarily based on abundance estimates from underwater TV (UWTV) surveys together with fishery landings data and estimates of quantities of discards (from which dead discards are calculated). Additional indicators of changes in stocks are derived from trends in length compositions and sex ratio in the catches, and fishery lpue.

The advice for 'other rectangles' follows the ICES approach to data-limited stocks. In 2013 it was based on a 20% reduction (precautionary buffer) compared to the average landings of the last three years (2010–2012), in accordance with data category 6.2 (ICES, 2012). The advice given this year for 2015 is the same as the landings advice for 2014 (326 t). No information on discards is available for 'other rectangles'.

The assessment procedure involves the following steps:

- Total population numbers are estimated from the UWTV surveys, including adjustments for a range of biases associated with the method. This bias adjustment is based on expert opinion for each stock. At the benchmark meetings (ICES, 2009, 2013a) it was proposed that the UWTV surveys provide absolute abundance estimates for *Nephrops* of 17 mm carapace length and over.
- Historical harvest ratios are calculated as the ratio of total dead catch numbers (landings and dead discards) to population numbers from the UWTV survey in each year.
- Recent fishery length compositions (landings and dead discards) are analysed using a length-based assessment model to estimate population numbers and fishing mortality at length for *Nephrops* of 17 mm carapace length and over. This method assumes that the length compositions are representative of a population at equilibrium. The analysis is done separately for males and females using stock-specific growth and maturity parameters.
- Yield-per-recruit and spawning biomass-per-recruit curves are derived for male and female *Nephrops*, based on fishery selectivity parameters from the length-based assessment model. The harvest ratios associated with potential F_{MSY} proxies (e.g. $F_{0.1}$, F_{max}, $F_{35\%SPR}$) are computed for males and females individually, and for both sexes combined. These are conditional on a fishery selectivity pattern that includes fishing mortality due to landings and dead discards of *Nephrops* in the years covered by the assessment model.

Catch options tables for 2015 are derived for a range of options, including F_{MSY}, by applying the appropriate harvest ratios to the population numbers estimated from 2014 UWTV surveys. This assumes that population numbers remain stable in the interim year. Landings and discards are derived from the resultant total catch numbers after multiplying by the recent average of proportion retained and the mean weight in the landings and discards.

Uncertainties in assessment and forecast

The calculations of MSY proxies are all based on yield-per-recruit analyses from a length-based age-structured population model. These analyses utilize average length–frequency data taken over a three-year period and therefore assume that the stock is in equilibrium. However, it is unlikely that the *Nephrops* stocks to which the approach has been applied are actually in equilibrium due to variable recruitment. MSY proxy estimates may vary in time due to changes in selection pattern. In addition, important assumptions are made on growth, natural mortality, and discard rates in the derivation of reference points. Improved knowledge of growth rates are needed for development of analytical assessment models and improvement of MSY reference points

In the provision of catch options based on the survey estimates additional uncertainties related to mean weight in the landings, discard rates, and discard survival also arise. The variability in mean weight and discarding is a key uncertainty in the derivation of catch options. The procedure outlined in the benchmarks (ICES, 2009, 2013a) is to use a multi-annual average to dampen variability.

The survival rate of discarded trawl-caught *Nephrops* is highly variable and depends on many factors, including tow duration, catch composition, air temperature, and post-capture handling. A value of 25% is used for *Nephrops* in Division VIa, based on studies conducted off the Scottish coast (Sangster *et al.*, 1997; Wileman *et al.*, 1999) that show values in the range of 20–40%. Discard survival of creel-caught *Nephrops* is much higher than that of trawl-caught *Nephrops*. Studies conducted in northern European waters (Chapman, 1981; Harris and Ulmestrand, 2004) suggest that with good post-capture handling and discarding over appropriate habitat, the discard mortality of creel-caught *Nephrops* could be almost zero. On this basis, a 100% creel discard survival rate is used for *Nephrops* in Division VIa.

There were concerns over the accuracy of historical landings and effort data prior to 2006 when the "buyers and sellers" legislation was introduced and the reliability began to improve. Harvest ratios since 2006 are also considered more reliable due to more accurate landings data reported under the new legislation. The incorporation of creel length compositions since the 2010 assessment has also improved estimates of harvest ratios.

Sources

Chapman, C. J. 1981. Discarding and tailing *Nephrops* at sea. Scottish Fisheries Bulletin, 46: 10–13.

Harris, R. R., and Ulmestrand, M. 2004. Discarding Norway lobster (*Nephrops norvegicus L.*) through low salinity layers – mortality and damage seen in simulation experiments. ICES Journal of Marine Science, 61: 127–139.

ICES. 2009. Report of the Benchmark Workshop on *Nephrops* (WKNEPH), 2–6 March 2009, Aberdeen, UK. ICES CM 2009/ACOM:33.

ICES. 2012. ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM:68. 42 pp.

ICES. 2013a. Report of the Benchmark Workshop on *Nephrops* (WKNEPH), 25 February–1 March 2013, Lysekil, Sweden. ICES CM 2013/ACOM:45.

ICES. 2013b. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 8–17 May 2013, Copenhagen, Denmark. ICES CM 2013/ACOM:12.

ICES. 2014a. Advice basis. *In* Report of the ICES Advisory Committee, 2014. ICES Advice 2014, Book 1, Section 1.2.

ICES. 2014b. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 13–22 May 2014, Copenhagen, Denmark. ICES CM 2014/ACOM:12.

Sangster, G. I., Breen, M., Bova, D. J., Kynoch, R., O'Neill, F. G., Lowry. N., *et al*. 1997. *Nephrops* survival after escape and discard from commercial fishing gear. Presented at ICES FTFB Working Group, Hamburg, Germany 14–17 April, 1997. ICES CM 1997/B:2.

Wileman, D. A., Sangster, G. I., Breen, M., Ulmestrand, M., Soldal, A. V., and Harris, R. R. 1999. Roundfish and *Nephrops* survival after escape from commercial fishing gear. Final report to European Commission, Brussels, FAIR-CT95-0753.

Figure 5.3.20.2 ***Nephrops* in Division VIa**. Effort trends (days absent) for all *Nephrops* trawl (TR2) by functional unit.

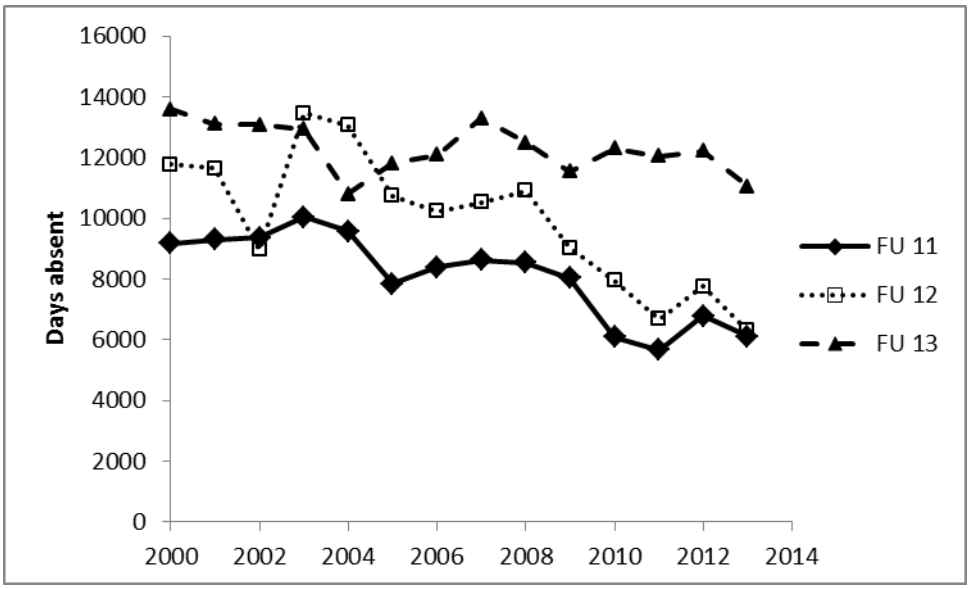

Table 5.3.20.2 ***Nephrops*** **in Division VIa**. Landings (tonnes) by country as officially reported to ICES.

	France	Ireland	Spain	UK-(Engl+Wales+N.Irl)	UK-Scotland	UK	TOTAL
1980	5	1	-	-	7422	-	7428
1981	5	26	-	-	9519	-	9550
1982	1	1	-	1	9000	-	9003
1983	1	1	-	11	10 706	-	10 719
1984	3	6	-	12	11 778	-	11 799
1985	1	1	28	9	12 449	-	12 488
1986	8	20	5	13	11 283	-	11 329
1987	6	128	11	15	11 203	-	11 363
1988	1	11	7	62	12 649	-	12 730
1989	-	9	2	25	10 949	-	10 985
1990	-	10	4	35	10 042	-	10 091
1991	-	1	-	37	10 458	-	10 496
1992	-	10	-	56	10 783	-	10 849
1993	-	7	-	191	11 178	-	11 376
1994	3	6	-	290	11 047	-	11 346
1995	4	9	3	346	12 527	-	12 889
1996	-	8	1	176	10 929	-	11 114
1997	-	5	15	133	11 104	-	11 257
1998	-	25	18	202	10 949	-	11 194
1999	-	136	40	256	11 078	-	11 510
2000	1	130	69	137	10 667	-	11 004
2001	9	115	30	139	10 568	-	10 861
2002	-	117	18	152	10 225	-	10 512
2003	-	145	12	81	10 450	-	10 688
2004	-	150	6	267	9941	-	10 364
2005	-	153	17	153	7616	-	7939
2006	-	133	1	255	13 419	-	13 808
2007	-	155	-	2088	14 120	-	16 363
2008	-	56	1	419	14 795	-	15 271
2009	-	53	-	1226	11 462	-	12 741
2010	-	45	1	1962	10 250	-	12 258
2011	-	38	-	2517	10 419	-	12 974
2012	-	28	-	2502	11 807	-	14 337
2013		24		495	12 247	-	12 766

Table 5.3.20.3 ***Nephrops* in Division VIa**. Landings (tonnes) by functional unit plus other rectangles (creel landings are included).

Year	FU 11	FU 12	FU 13	Other	Total
1981	2861	3652	2277	39	8829
1982	2799	3552	1983	27	8361
1983	3197	3413	3395	34	10 039
1984	4143	4300	2600	36	11 079
1985	4060	4008	3561	104	11 733
1986	3381	3484	3228	89	10 182
1987	4084	3892	2408	257	10 641
1988	4035	4473	3509	529	12 546
1989	3205	4745	2595	212	10 757
1990	2546	4430	2592	182	9750
1991	2793	4442	2654	255	10 144
1992	3559	4237	2383	248	10 427
1993	3193	4458	2766	344	10 761
1994	3614	4414	2095	441	10 564
1995	3655	4682	3693	460	12 490
1996	2872	3995	3671	239	10 777
1997	3046	4344	3135	243	10 768
1998	2441	3730	4373	157	10 701
1999	3257	4052	3423	438	11 170
2000	3247	3953	3229	421	10 850
2001	3259	3991	2979	420	10 649
2002	3440	3305	3350	397	10 492
2003	3269	3879	3154	433	10 735
2004	3082	3869	2965	403	10 319
2005	2949	3848	3388	254	10 439
2006	4166	4633	4769	241	13 809
2007	3978	5471	6580	420	16 449
2008	3799	5356	5845	128	15 128
2009	3496	4285	4688	185	12 654
2010	2413	3846	5782	569	12 610
2011	2697	3702	6363	219	12 981
2012	3542	3989	6634	435	14 600
2013*	3395	3783	5258	234	12 670

* Preliminary.

Table 5.3.20.4 ***Nephrops*** **in Division VIb**. Landings (tonnes) by country as officially reported to ICES.

	France	Germany	Ireland	Spain	UK-(Engl+Wales+N.Irl)	UK- Scotland	TOTAL
1980	-	-	-	-	-	-	0
1981	-	-	-	-	-	-	0
1982	-	-	-	-	-	-	0
1983	-	-	-	-	-	-	0
1984	-	-	-	-	-	-	0
1985	-	-	-	-	-	-	0
1986	-	-	-	8	-	-	8
1987	-	-	-	18	11	-	29
1988	-	-	-	27	4	-	31
1989	-	-	-	14	-	-	14
1990	-	-	-	10	1	-	11
1991	-	-	-	30	-	-	30
1992	-	-	-	2	4	1	7
1993	-	-	-	2	6	9	17
1994	-	-	-	5	16	5	26
1995	1	-	-	2	26	1	30
1996	-	6	-	5	65	5	81
1997	-	-	1	3	88	23	115
1998	-	-	1	6	46	7	60
1999	-	-	-	5	2	5	12
2000	2	-	8	3	4	4	21
2001	1	-	1	14	2	7	25
2002	1	-	-	7	3	7	18
2003	-	-	1	5	6	18	30
2004	-	-	-	2	7	13	22
2005	3	-	1	1	5	7	17
2006	-	-	-	-	1	3	4
2007	-	-	-	2	3	-	5
2008	-	-	-	-	-	-	0
2009	-	-	-	-	-	-	0
2010	-	-	-	-	-	-	0
2011	-	-	-	-	-	-	0
2012	-	-	-	-	-	-	0
2013*	-	-	-	-	-	-	0

* Preliminary.

ECOREGION Celtic Sea and West of Scotland
STOCK *Nephrops* in North Minch (FU 11)

Advice for 2015

ICES advises, on the basis of the MSY approach and considering that no discards ban is in place in 2015, that landings should be no more than 3092 t. Assuming that discard rates do not change from the average of the last three years (2011–2013) the resulting catch would be no more than 3312 t.

In order to ensure the stock in this FU is exploited sustainably, management should be implemented at the functional unit level.

Stock status

Fishing pressure	2011	2012	2013	
MSY (F_{MSY})	✓	✗	✓	Below target
Precautionary approach (F_{pa}, F_{lim})	?	?	?	Not defined

Stock size	2012	2013	2014	
MSY ($B_{trigger}$)	✓	✓	✓	Above trigger
Precautionary approach (B_{pa}, B_{lim})	?	?	?	Not defined

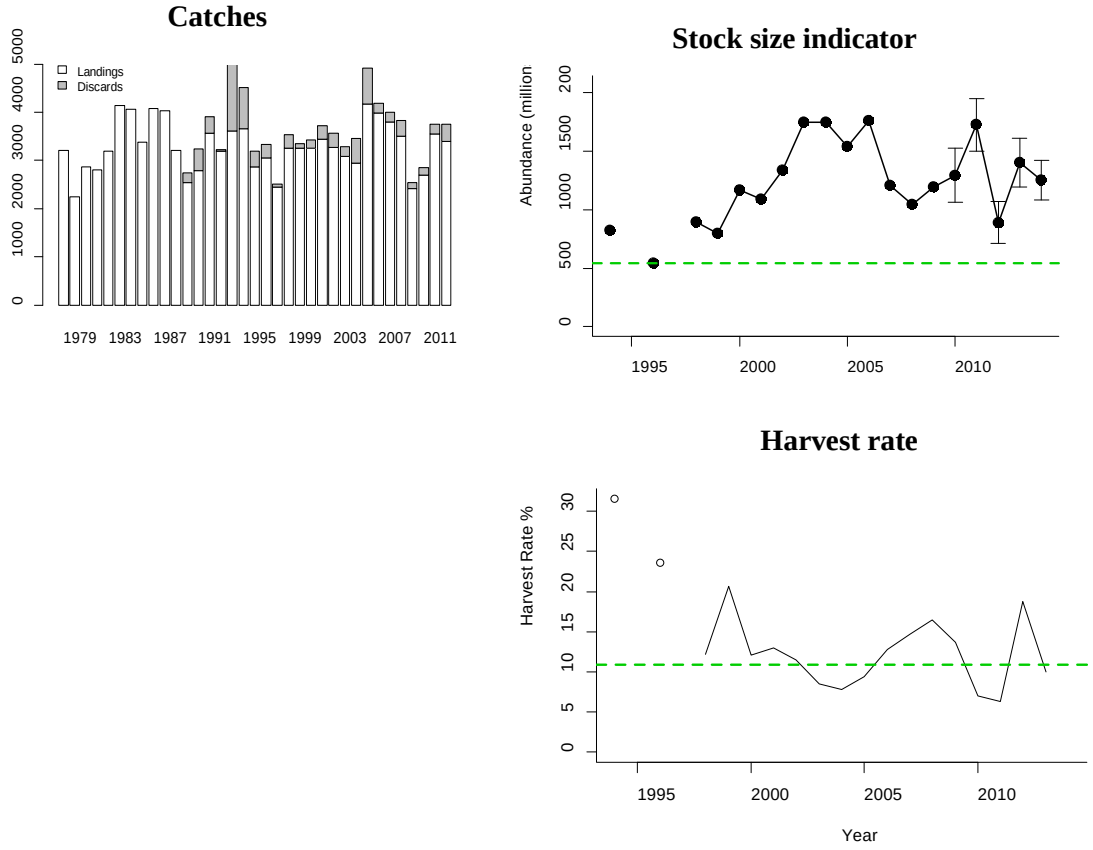

Figure 5.3.20.1.1 *Nephrops* in North Minch (FU 11). Catches (tonnes), UWTV survey abundance (millions; SSB proxy; 95% confident intervals), and harvest rate (fishing mortality proxy). Harvest rates before 2006 may be unreliable due to underreporting of landings. Green dashed lines represent MSY $B_{trigger}$ and F_{MSY} harvest ratio proxy.

The stock has been above MSY $B_{trigger}$ for more than 15 years. In 2014 estimated abundance has seen a small 11% decrease in comparison to 2013. The historical harvest ratios (removals/UWTV abundance) have fluctuated around the F_{MSY} proxy. The harvest ratio in 2013 decreased to 10.0% and is below the F_{MSY} proxy.

Management plans

No specific management objectives are known to ICES.

Biology

The general biology of *Nephrops* is discussed in the overview (Section 5.3.20). The North Minch stock consistently exhibits medium densities compared to other stocks.

The fisheries

The fishery has been fairly stable over the time-series. Reported effort by all Scottish *Nephrops* trawlers has shown a decrease in 2013 (Figure 5.3.20.2), especially in the first and last quarters due to particularly bad weather. It is an all-year-round fishery and creel fishing takes place mainly in the sea loch areas, but has recently extended also to further offshore. Overall effort in terms of creel numbers is not known and there are no limits on the number of creels.

Catch distribution	Total catch (2013) = 3759 t, where 3395 t were estimated landings (83% trawl, 17% creel) and 364 t discards from the trawl fleet.

Effects of the fisheries on the ecosystem

There is a bycatch of other species, particularly haddock and whiting, in the *Nephrops* fisheries in the North Minch.

Quality considerations

Harvest ratios since 2006 are considered reliable due to more accurate landings data reported under the new legislation. The survey area was extended in 2010 and refined at the latest benchmark in 2013 and now corresponds to the VMS distribution of fishing effort. From 1999, the incorporation of creel length compositions of catches has also improved estimates of harvest ratios.

Scientific basis

Stock data category	1 (ICES, 2014a).
Assessment type	Underwater TV survey combined with yield-per-recruit analysis from length data.
Input data	One survey index (UWTV-FU11); commercial catches (international landings, length frequencies from Scottish catch sampling); fixed maturity parameters from survey data; fixed natural mortalities. Discard survival rate.
Discards and bycatch	Included in the assessment since 1990, data series from the majority of the main fleets covering all landings.
Indicators	Size structure of classes, mean size, lpue, and sex ratio.
Other information	The latest benchmark (based on the UWTV survey) was performed in 2013 (ICES, 2013).
Working group	Working Group for the Celtic Seas Ecoregion (WGCSE).

ECOREGION Celtic Sea and West of Scotland
STOCK *Nephrops* in North Minch (FU 11)

Reference points

	Type	*Value*	*Technical basis*
MSY approach	MSY $B_{trigger}$	541 million individuals	Bias-adjusted lowest observed UWTV survey estimate of abundance.
	F_{MSY}	10.9% harvest rate	F_{MSY} proxy equivalent to $F_{35\%SpR}$ combined sex. F_{MSY} proxy based on length-based yield-per-recruit analysis.
Precautionary approach	Not defined.		

(Last changed in: 2013)

Harvest ratio reference points (2013):

	Male	Female	**Combined**
F_{max}	11.1	23.0	13.2
$F_{0.1}$	6.9	12.8	7.7
$F_{35\%SpR}$	8.2	19.6	**10.9**

For this FU, the absolute density observed in the UWTV survey is medium (~0.59 individuals m^{-2}). Historical harvest ratios in this FU have been around those equivalent to fishing at $F_{35\%SpR}$ and landings have been relatively stable in the past thirty years. $F_{35\%SpR}$ (combined between sexes) is expected to deliver high long-term yield with a low probability of recruitment overfishing and is therefore chosen as a proxy for F_{MSY}. New size-at-maturity parameters were available at the 2013 benchmark, leading to revisions in the harvest rate reference points.

Outlook for 2015

Basis: Absolute survey abundance index 2015 = 1251 million (2014 index); Mean individual weight in landings (1999–2013) = 25.49 g; Mean individual weight in discards (1999–2013) = 10.95 g; Dead discard rate (in number) = 11%.

Basis	Total catches*	Landings	Dead discards**	Surviving discards**	Harvest rate
	L+DD+SD	L	DD	SD	for L+DD
F_{MSY} proxy	3312	3092	165	55	10.9%
F_{2014}	3038	2837	151	50	10%
$F_{0.1}$	2339	2184	116	39	7.7%
F_{max}	4010	3745	199	66	13.2%

Weights in tonnes.
* Total catches are the landings, plus dead and surviving discards.
** The total discard rate is assumed to be 14.2% of the catches (in number, average of the last three years, 2011–2013); discard survival is assumed to be 25% (see Section 5.3.20).

MSY approach

Following the ICES MSY approach implies a harvest ratio for the North Minch functional unit of F_{MSY} = 10.9%. Considering that no discard ban is in place in 2015, this results in landings of no more than 3092 t. Assuming that discard rates do not change from the average of the last three years (2011–2013) the resulting catch would be no more than 3312 t.

Additional considerations

General considerations for *Nephrops* in Division VIa can be found at the beginning of Section 5.3.20.

Advice considerations

In order to ensure the stock in this FU is exploited sustainably, management should be implemented at the functional unit level (see Section 5.3.20).

Regulations and their effects

The minimum landing size for *Nephrops* in Division VIa is 20 mm carapace length. Discarding of both undersize and poor quality *Nephrops* sometimes takes place in this FU. Discard rates have been variable but generally lower than 20%. The mean sizes in the length compositions of larger individuals (>35 mm CL) are relatively stable (Figure 5.3.20.1.2), but the mean weight in landings has fluctuated markedly over the last five years, although 2013 is a particularly high year. To dampen this variability, the time-series average (1999–2013) was used as input for the mean weight in landings for the catch forecasts.

Data and methods

The long-term average (rather than a three-year average) was considered to be more appropriate as input for the mean weight in landings, due to the interannual variation.

Underwater TV (UWTV) surveys have been conducted for this stock since 1994, with annual surveys available since 1998.

Anecdotal evidence from the fishing industry identified some areas outside the "sediment area" traditionally used to conduct the UWTV survey as possible suitable ground for *Nephrops*. This was confirmed by VMS data linked to landings and as such, it was considered likely that the absolute abundance estimate was an underestimate. To account for this, the VMS area in the North Minch was used to generate the sampling stations since 2010. A correction ratio calculated as 1.64 (VMS area/sediment area) was applied to back-calculate the abundance estimates in previous years.

Uncertainties in the assessment and forecast

As the VMS areas are calculated only for vessels of 15 m and over, the inclusion of vessels smaller than 15 m would likely increase the fished area in some of the inshore locations. A number of UWTV surveys have taken place in the major North Minch sea lochs in an attempt to improve estimates of the ground area and *Nephrops* abundance. Work presented to the ICES working group (ICES, 2014b) showed that the total area of the sea lochs is 105 km^2, which is considerably smaller than the offshore VMS area estimated at 2908 km^2. Therefore, it is unlikely that the exclusion of these inshore areas from the survey have an impact on the mean densities and overall abundance of *Nephrops* in the North Minch.

Comparison of the basis of previous assessment and advice

The basis for the assessment has not changed from last year and the basis for the advice this year is the same as last year: the MSY approach.

Sources

ICES. 2013. Report of the Benchmark Workshop on *Nephrops* (WKNEPH), 25 February–1 March 2013, Lysekil, Sweden. ICES CM 2013/ACOM:45.

ICES. 2014a. Advice basis. *In* Report of the ICES Advisory Committee, 2014. ICES Advice 2014, Book 1, Section 1.2.

ICES. 2014b. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 13–22 May 2014, Copenhagen, Denmark. ICES CM 2014/ACOM:12.

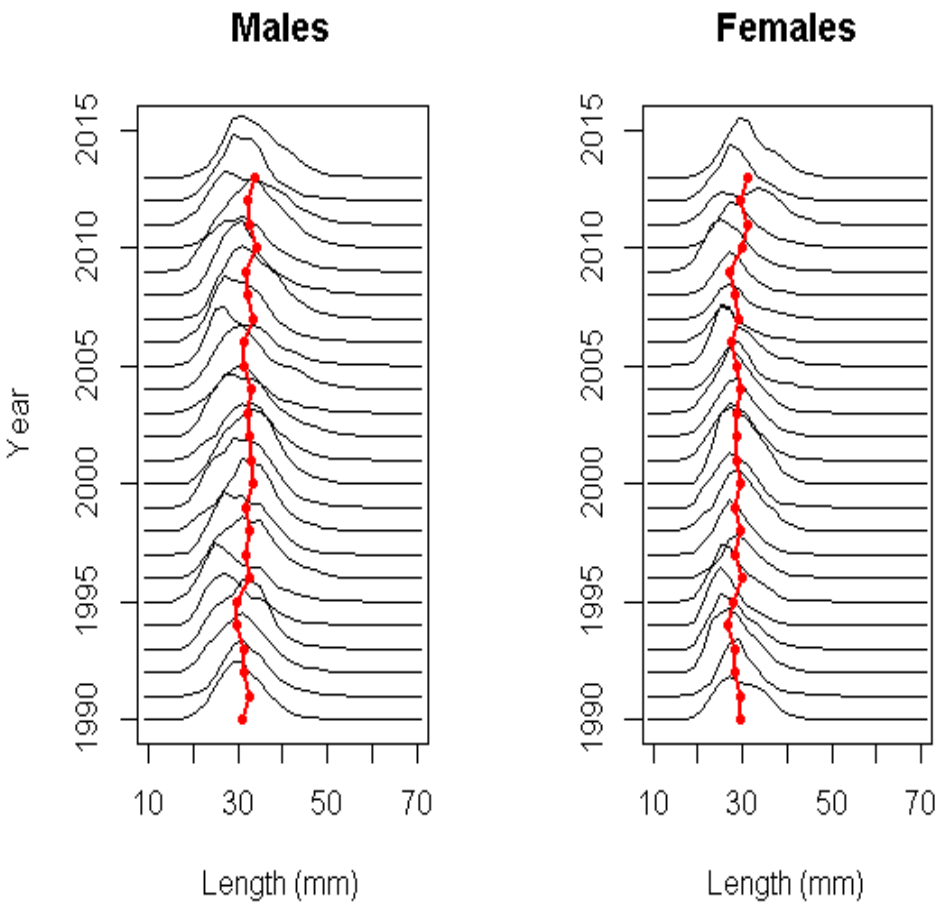

Figure 5.3.20.1.2 *Nephrops* in North Minch (FU 11). Annual length composition (black lines) of catch of males (left) and females (right) from 1990 (bottom) to 2013 (top). Mean sizes of catch (red line) are also shown.

Table 5.3.20.1.1 ***Nephrops*** **in North Minch (FU 11).** ICES advice, management, landings, and discards.

Year	ICES advice	Predicted landings corresp. to advice North Minch (FU 11)	ICES landings (FU 11)	Total discards [1)] (FU 11)
1989			3.2	
1990			2.5	
1991			2.8	
1992	maintain current effort		3.6	
1993	maintain current effort		3.2	
1994	maintain current effort		3.6	
1995	maintain current effort		3.7	
1996	maintain current effort		2.9	
1997	as for 1996		3.0	
1998	maintain current effort		2.4	
1999	as for 1998		3.3	0.3
2000	maintain current effort		3.2	0.1
2001	as for 2000		3.3	0.2
2002	maintain current effort		3.4	0.3
2003	as for 2002		3.3	0.3
2004	maintain current effort		3.1	0.2
2005	as for 2004		2.9.	0.5
2006	No increase in effort		4.2	0.8
2007	No increase effort and harvest rate of 15%	3.2	4.0	0.2
2008	As for 2007	3.2	3.8	0.2
2009	No increase effort and recent average catch	< 4.1	3.5	0.3
2010	Harvest rate no greater than that equivalent to fishing at $F_{0.1}$	< 1.0	2.4	0.1
2011	MSY transition scheme	< 3.1	2.7	0.2
2012	MSY approach	< 3.2	3.5	0.2
2013	MSY approach	< 4.2	3.4	0.4
2014	MSY approach	< 3.5		
2015	MSY approach	< 3.1		

Weights in thousand tonnes.
[1)] Of which 25% are assumed to survive.

Table 5.3.20.1.2 ***Nephrops* in North Minch (FU 11).** Landings (tonnes) reported to ICES (ICES estimates).

	UK Scotland				Other UK & Ireland	Total
	***Nephrops* trawl**	**Other trawl**	**Creel**	**Subtotal****		
1981	2320	171	370	2861	0	2861
1982	2323	105	371	2799	0	2799
1983	2784	96	317	3197	0	3197
1984	3449	160	534	4143	0	4143
1985	3235	117	708	4060	0	4060
1986	2641	203	537	3381	0	3381
1987	3459	143	482	4084	0	4084
1988	3450	148	437	4035	0	4035
1989	2603	112	490	3205	0	3205
1990	1941	134	471	2546	0	2546
1991	2229	126	438	2793	0	2793
1992	2978	149	432	3559	0	3559
1993	2699	86	408	3193	0	3193
1994	2916	246	453	3614	0	3614
1995	2940	183	532	3655	0	3655
1996	2354	148	370	2872	0	2872
1997	2553	102	391	3046	0	3046
1998	2023	68	350	2441	0	2441
1999	2792	56	409	3257	0	3257
2000	2695	28	524	3247	0	3247
2001	2649	42	568	3259	0	3259
2002	2775	79	586	3440	0	3440
2003	2606	45	618	3269	0	3269
2004	2391	30	661	3082	0	3082
2005	2270	23	656	2949	0	2949
2006	3446	23	697	4166	0	4166
2007	3361	26	591	3978	0	3978
2008	3229	13	557	3799	0	3799
2009	2849	34	613	3496	0	3496
2010	1783	9	621	2413	0	2413
2011	2109	17	571	2697	0	2697
2012	2963	12	565	3540	2	3542
2013	2817	4	572	3393	2	3395

Table 5.3.20.1.3 ***Nephrops*, North Minch (FU 11).** Results of the UWTV surveys (absolute abundance estimates).

Year	Number of valid stations	Mean density	Abundance (sediment)	95% confidence interval (sediment)	Abundance (VMS)	95% confidence interval (VMS)
		individuals m^{-2}	millions	millions	millions	millions
1994	41	0.38	500	74	820	-
1995				No survey		
1996	38	0.25	330	47	541	-
1997				No survey		
1998	38	0.41	547	77	898	-
1999	36	0.36	484	89	794	-
2000	39	0.53	711	82	1166	-
2001	56	0.50	666	81	1092	-
2002	37	0.61	815	91	1337	-
2003	41	0.80	1068	129	1751	-
2004	38	0.80	1068	107	1751	-
2005	41	0.70	939	100	1540	-
2006	30	0.81	1074	101	1762	-
2007	36	0.55	735	92	1206	-
2008	41	0.48	638	95	1047	-
2009	26	0.55	729	138	1195	-
2010	37	0.59	-	-	1293	231
2011	41	0.79	-	-	1726	226
2012	41	0.41	-	-	891	181
2013	41	0.64	-	-	1403	206
2014	44	0.43			1251	171

Table 5.3.20.1.4 ***Nephrops*** **in North Minch (FU 11).** Adjusted TV survey abundance, landings, total discard rate (proportion in number), dead discard rate (in number), and estimated harvest rate.

Year	Landings in number (millions)	Discards in number (millions)	Removals in number (millions) **	Absolute survey abundance (millions)	Harvest ratio VMS* (%)	Landings (tonnes)	Discard (tonnes)	Discard rate in number (%)	Dead discard rate (%)	Mean weight in landings (g)	Mean weight in discards (g)
1999	144	28	165	794	20.7	3 257	273	16.4	12.8	22.7	9.69
2000	134	10	142	1 166	12.1	3 247	100	6.9	5.2	24.19	10.08
2001	129	17	141	1 092	13.0	3 259	160	11.7	9.1	25.33	9.32
2002	133	28	154	1 337	11.5	3 440	277	17.6	13.8	25.93	9.78
2003	126	30	148	1 751	8.5	3 269	299	19.2	15.2	26.03	10
2004	122	18	136	1 751	7.8	3 082	202	13.0	10.1	25.16	11.02
2005	107	50	144	1 540	9.4	2 949	507	32.0	26.1	27.65	10.09
2006	170	74	225	1 762	12.8	4 166	757	30.3	24.6	24.52	10.27
2007	168	12	177	1 206	14.7	3 978	214	6.5	5.0	23.61	18.1
2008	159	19	173	1 047	16.5	3 799	194	10.5	8.1	23.9	10.36
2009	138	35	164	1 195	13.7	3 496	327	20.3	16.0	25.42	9.34
2010	82	12	91	1 293	7.0	2 413	128	12.4	9.6	29.39	10.98
2011	96	16	108	1 726	6.3	2 697	154	14.2	11.0	27.56	9.66
2012	152	21	167	891	18.8	3 542	213	12.0	9.3	23.43	10.33
2013	122	24	140	1 403	10	3 395	364	16.4	12.8	27.52	15.18
2014				1 251							
Average***									11.0	25.49	10.95

* Harvest rates prior to 2006 are unreliable.

** Removals numbers take the dead discard rate into account.

*** Dead discards: average of 2011–2013; Mean weight in landings and discards: average of 1999–2013.

ECOREGION Celtic Sea and West of Scotland
STOCK *Nephrops* in South Minch (FU 12)

Advice for 2015

ICES advises, on the basis of the MSY approach and considering that no discard ban is in place in 2015, that landings should be no more than 6382 t. Assuming that discard rates do not change from the average of the last three years (2011–2013) the resulting catch would be no more than 6567 t.

In order to ensure the stock in this FU is exploited sustainably, management should be implemented at the functional unit level.

Stock status

Fishing pressure	2011	2012	2013	
MSY (F_{MSY})	✓	✗	✓	Below target
Precautionary approach (F_{pa}, F_{lim})	?	?	?	Not defined

Stock size	2012	2013	2014	
MSY ($B_{trigger}$)	✗	✓	✓	Above trigger
Precautionary approach (B_{pa}, B_{lim})	?	?	?	Not defined

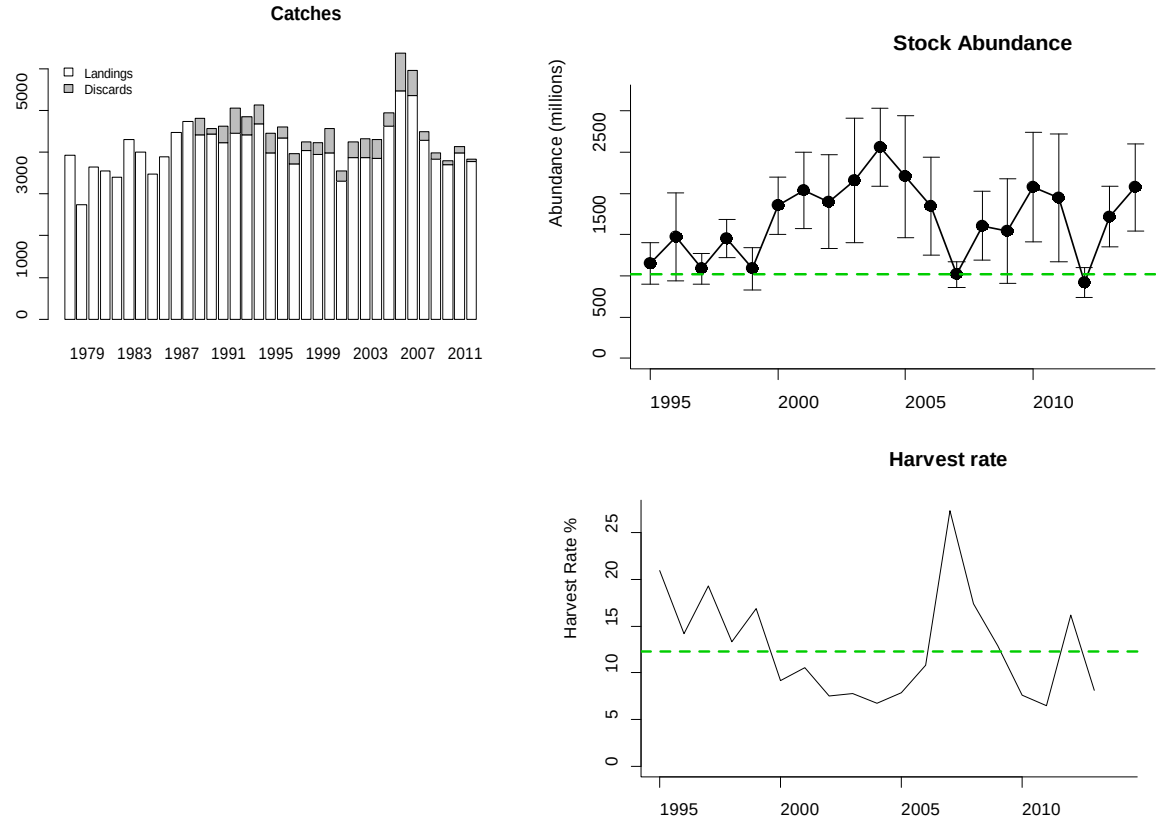

Figure 5.3.20.2.1 *Nephrops* in South Minch (FU 12). Catch (tonnes), UWTV survey (millions; SSB proxy; confidence intervals 95%), and harvest rate (fishing mortality proxy). Harvest rates before 2006 may be unreliable due to underreporting of landings. Green dashed lines represent MSY $B_{trigger}$ and F_{MSY} harvest ratios.

The stock fell below MSY $B_{trigger}$ in 2012 but has increased since and is now above MSY $B_{trigger}$. The harvest ratio (removals/UWTV abundance) has decreased and is now below F_{MSY} proxy.

Management plans

No specific management objectives are known to ICES.

Biology

The general biology of *Nephrops* is discussed in the overview (Section 5.3.20). The South Minch stock exhibits medium densities (compared to other stocks).

The fisheries

Trawling is the predominant fishing method and fishing takes place all year round. Landings have been fairly stable in the last four years but length sampling information suggests a series of low recruitments in recent years. Reported effort by all Scottish *Nephrops* trawlers has shown a decrease in 2013, particularly during the winter months. Inshore trawlers are mainly small, but larger boats operate in the offshore areas of this FU. Creel fishing takes place mainly in inshore areas (including the sea lochs), but has extended further offshore in recent years. Overall effort in terms of creel numbers is not known and there are no limits on the number of creels.

Catch distribution	Total catch (2013) = 3833 t, where 3783 t were estimated landings (80.5% trawl and 19.5% creel) and 50 t discards from the trawl fleet.

Effects of the fisheries on the ecosystem

There is a bycatch of other species, particularly haddock and whiting, in the *Nephrops* fisheries in the South Minch.

Quality considerations

Harvest ratios since 2006 are considered reliable due to more accurate landings data reported under the new legislation. From 1999, the incorporation of creel length compositions of catches has also improved estimates of harvest ratios.

Scientific basis

Stock data category	1 (ICES, 2014a).
Assessment type	Underwater TV survey combined with yield-per-recruit analysis from length data.
Input data	One survey index (UWTV-FU12); commercial catches (international landings, length frequencies from Scottish catch sampling); fixed maturity parameters (from survey data) and natural mortality. Discard survival rate.
Discards and bycatch	Included in the assessment since 1990; data series from the majority of the main fleets cover almost all landings.
Indicators	Size structure of classes, mean size, lpue, and sex ratio.
Other information	The latest benchmark (based on the UWTV survey) was performed in 2009 (ICES, 2009).
Working group	Working Group for the Celtic Seas Ecoregion (WGCSE).

ECOREGION Celtic Sea and West of Scotland
STOCK *Nephrops* in South Minch (FU 12)

Reference points

	Type	*Value*	*Technical basis*
MSY approach	MSY $B_{trigger}$	1016 million individuals.	Bias-adjusted lowest observed UWTV survey estimate of abundance.
	F_{MSY}	12.3% harvest rate.	F_{MSY} proxy equivalent to $F_{35\%SPR}$ combined sex. F_{MSY} proxy based on length-based yield-per-recruit analysis.
Precautionary approach	Not defined.		

(Last changed in: 2011)

Harvest ratio reference points (2011):

	Male	Female	**Combined**
F_{max}	13.3	26.8	16.1
$F_{0.1}$	7.8	13.8	8.7
$F_{35\%SpR}$	9.6	18.3	**12.3**

For this FU, the absolute density observed in the UWTV survey is medium (~ 0.44 individuals m^{-2}). The fishery in this area has been in existence since the 1960s. Historical harvest ratios in this FU have been variable, but generally around $F_{35\%SPR}$. $F_{35\%SPR}$ (combined between sexes) is expected to deliver high long-term yield with a low probability of recruitment overfishing and is therefore chosen as a proxy for F_{MSY}.

Outlook for 2015

Basis: Absolute survey abundance index 2015 = 2073 million (2014 index); Mean individual weight in landings (1999–2013) = 26.53 g; Mean individual weight in discards (1999–2013) = 9.65 g; Dead discard rate (in number) = 5.7%.

Basis	Total catches*	Landings	Dead discards**	Surviving discards**	Harvest rate
	L+DD+SD	L	DD	SD	for L+DD
F_{MSY} proxy	6567	6382	139	46	12.3%
F_{2013}	4326	4203	92	31	8.1%
$F_{0.1}$	4646	4514	99	33	8.7%
F_{max}	8597	8353	183	61	16.1%

Weights in tonnes.
* Total catches are the landings plus dead and surviving discards.
** Total discard rate is assumed to be 7.4% of the catches (in number, average of the last three years, 2011–2013). Discard survival is assumed to be 25% (see Section 5.3.20).

MSY approach

Following the ICES MSY approach implies a harvest ratio for the South Minch functional unit at F_{MSY} = 12.3%. Considering that no discard ban is in place in 2015, this results in landings of no more than 6382 t. Assuming that discard rates do not change from the average of the last three years (2011–2013) the resulting catch would be no more than 6567 t.

Additional considerations

General considerations for *Nephrops* in Division VIa can be found at the beginning of Section 5.3.20.

Advice considerations

In order to ensure the stock in this FU is exploited sustainably, management should be implemented at the functional unit level (see Section 5.3.20).

The advice takes the 2014 UWTV survey results into account.

The minimum landing size for *Nephrops* in Division VIa is 20 mm carapace length. Discarding of both undersize and poor quality *Nephrops* sometimes takes place in this FU. Discard rates have been variable but generally lower than 20%. The mean sizes in the length compositions of smaller individuals (< 35 mm CL) has increased consistently (Figure 5.3.20.2.2), suggesting low recruitment in recent years. The mean weight in landings increased markedly in 2011, with some decrease over the last two years. The time-series average (1999–2013) was used as input for the mean weight in landings for the catch forecasts.

Data and methods

Underwater TV surveys have been conducted for this stock every year since 1995. The coverage is good and precision is adequate. Biological sampling for this stock is sufficient.

The long-term average (rather than a three-year average) was considered to be more appropriate as input for the mean weight in landings and discards, due to the interannual variation.

Uncertainties in the assessment and forecast

The overall area of the ground is estimated from the available British Geological Survey contoured sediment data and at present this is considered to be a minimum estimate. It is known that most of the sea lochs have areas of mud substrate and are typically fished by creel boats, but not by the trawl fleet. Limited TV surveys have taken place in some of the sea lochs and attempts are being made to utilize these data to improve estimates of mud area and *Nephrops* abundance in the South Minch.

The UWTV-FU12 is targeted at known areas of mud, sandy mud, and muddy sand within the South Minch. The variance of density estimates in the South Minch is relatively high, particularly in the sandy mud strata (e.g. 77% of total variance in 2011). This results in large confidence intervals and a greater uncertainty on the abundance estimates. There is a need to explore options to implement further stratification of the South Minch survey area.

Comparison of the basis of previous assessment and advice

The basis for the assessment has not changed from last year and the basis for the advice this year is the same as last year: the MSY approach.

Sources

ICES. 2009. Report of the Benchmark Workshop on *Nephrops* (WKNEPH), 2–6 March 2009, Aberdeen, UK. ICES CM 2009/ACOM:33.

ICES. 2014a. Advice basis. *In* Report of the ICES Advisory Committee, 2014. ICES Advice 2014, Book 1, Section 1.2.

ICES. 2014b. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 13–22 May 2014, Copenhagen, Denmark. ICES CM 2014/ACOM:12.

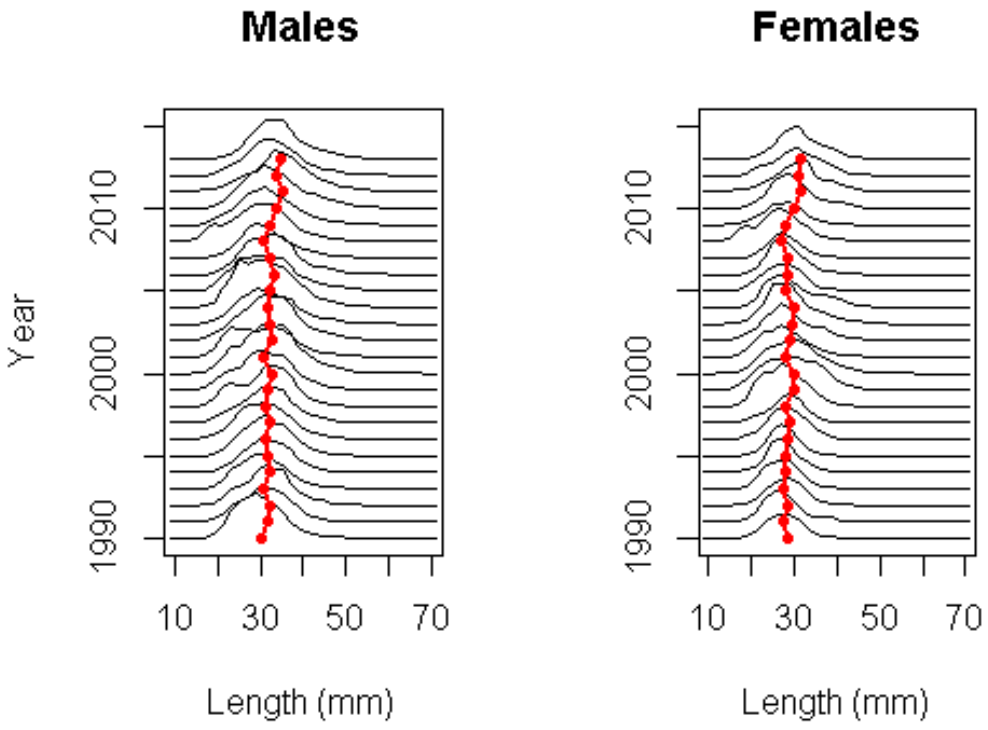

Figure 5.3.20.2.2 *Nephrops* in South Minch (FU 12). Annual length composition (black lines) of catch of males (left) and females (right) from 1990 (bottom) to 2013 (top). Mean sizes of catch (red line) are also shown.

Table 5.3.20.2.1 ***Nephrops*, South Minch (FU 12).** ICES advice, management, landings, and discards.

Year	ICES advice	Predicted landings corresp. to advice for South Minch (FU 12)	ICES landings (FU 12)	Total discards [1)] (FU 12)
1989			4.7	
1990			4.4	
1991			4.4	
1992	maintain current effort		4.2	
1993	maintain current effort		4.5	
1994	maintain current effort		4.4	
1995	maintain current effort		4.7	
1996	maintain current effort		4.0	
1997	as for 1996		4.3	
1998	maintain current effort		3.7	
1999	as for 1998		4.1	0.2
2000	maintain current effort		4.0	0.3
2001	as for 2000		4.0	0.6
2002	maintain current effort		3.3	0.2
2003	as for 2002		3.9	0.4
2004	maintain current effort		3.9	0.4
2005	as for 2004		3.8	0.4
2006	No increase in effort		4.6	0.3
2007	No increase in effort and harvest rate of 15%	7.2	5.5	0.9
2008	as for 2007	7.2	5.4	0.6
2009	No increase effort and recent average catch	< 5.0	4.3	0.2
2010	Harvest rate no greater than that equivalent to fishing at $F_{0.1}$	< 4.1	3.8	0.1
2011	MSY transition scheme	< 4.0	3.7	0.1
2012	MSY approach	< 5.5	4.0	0.1
2013	MSY approach	< 5.8	3.8	0.1
2014	MSY approach	< 5.2		
2015	MSY approach	< 6.4		

Weights in thousand tonnes.
[1)] 25% of discards are assumed to survive.

Table 5.3.20.2.2 ***Nephrops* in South Minch (FU 12).** Landings (tonnes) reported to ICES (ICES estimates).

YEAR	UK SCOTLAND				OTHER UK	IRELAND	TOTAL
	Nephrops trawl	Other trawl	Creel	Subtotal			
1981	2966	254	432	3652	0	0	3652
1982	2925	206	421	3552	0	0	3552
1983	2595	362	456	3413	0	0	3413
1984	3229	477	594	4300	0	0	4300
1985	3096	424	488	4008	0	0	4008
1986	2694	288	502	3484	0	0	3484
1987	2928	418	546	3892	0	0	3892
1988	3544	364	555	4463	10	0	4473
1989	3846	338	561	4745	0	0	4745
1990	3732	263	435	4430	0	0	4430
1991	3596	342	503	4441	1	0	4442
1992	3478	209	549	4236	1	0	4237
1993	3609	194	650	4453	5	0	4458
1994	3742	264	405	4411	3	0	4414
1995	3443	717	508	4668	14	0	4682
1996	3108	417	469	3994	1	0	3995
1997	3518	329	493	4340	3	1	4344
1998	2851	340	538	3729	0	1	3730
1999	3165	359	514	4038	0	14	4052
2000	2940	311	700	3951	0	2	3953
2001	2823	391	768	3982	0	9	3991
2002	2234	314	743	3291	0	14	3305
2003	2812	203	858	3873	0	6	3879
2004	2864	105	879	3848	0	21	3869
2005	2812	46	955	3813	1	34	3848
2006	3570	97	922	4589	9	35	4633
2007	4437	21	959	5417	19	35	5471
2008	4433	12	896	5341	2	13	5356
2009	3346	24	900	4270	4	11	4285
2010	2836	19	969	3824	16	6	3846
2011	2876	11	783	3670	23	9	3702
2012	3159	32	773	3964	19	6	3989
2013	3032	12	725	3769	13	1	3783

Table 5.3.20.2.3 ***Nephrops*, South Minch (FU 12).** Results of the UWTV surveys (absolute abundance estimates).

Year	Stations	Mean density	Abundance	95% confidence interval
		individuals m^{-2}	millions	millions
1995	33	0.23	1152	251
1996	21	0.29	1473	530
1997	36	0.21	1086	185
1998	38	0.29	1452	232
1999	37	0.21	1086	260
2000	41	0.36	1854	348
2001	47	0.40	2037	459
2002	31	0.37	1899	567
2003	25	0.42	2157	756
2004	38	0.51	2558	473
2005	33	0.43	2208	740
2006	36	0.36	1845	598
2007	39	0.20	1016	155
2008	33	0.32	1608	415
2009	25	0.30	1542	634
2010	34	0.41	2076	665
2011	36	0.38	1945	778
2012	38	0.18	919	185
2013	38	0.34	1718	365
2014	36	0.41	2073	530

Table 5.3.20.2.4 ***Nephrops* in South Minch (FU 12).** Absolute abundance (UWTV survey), landings, total discard rate (proportion in number), dead discard rate (in number), and estimated harvest rate.

Year	Landings in number (millions)	Discards in number (millions)	Removals in number (millions)**	Absolute survey abundance (millions)	Harvest ratio* (%)	Landings (tonnes)	Discard (tonnes)	Discard rate in number (%)	Dead discard rate in number (%)	Mean weight in landings (g)	Mean weight in discards (g)
1999	161	29	183	1086	16.9	4052	206	15.4	12.0	25.14	7
2000	145	33	170	1854	9.2	3953	284	18.7	14.7	27.3	8.5
2001	168	65	216	2037	10.6	3991	591	27.9	22.5	23.79	9.11
2002	123	26	143	1899	7.5	3305	247	17.6	13.8	26.83	9.37
2003	139	38	168	2157	7.8	3879	381	21.3	16.9	27.86	10.1
2004	141	44	175	2558	6.8	3869	454	23.8	19.0	27.37	10.26
2005	137	49	174	2208	7.9	3848	452	26.5	21.2	28.11	9.17
2006	177	30	199	1845	10.8	4633	324	14.3	11.1	26.24	10.97
2007	228	66	278	1016	27.3	5471	903	22.4	17.8	23.95	13.73
2008	224	74	279	1608	17.4	5356	605	24.7	19.8	23.91	8.23
2009	179	26	199	1542	12.9	4285	216	12.5	9.6	23.87	8.44
2010	149	12	158	2076	7.6	3846	133	7.7	5.9	25.86	10.76
2011	118	11	126	1945	6.5	3702	92	8.2	6.3	31.10	8.78
2012	136	16	149	919	16.2	3989	149	10.8	8.3	29.17	9.05
2013	136	4	140	1718	8.1	3783	50	3.1	2.4	27.48	11.31
2014				2073							
Average***									5.7	26.53	9.65

* Harvest rates prior to 2006 are unreliable.

** Removals numbers take the dead discard rate into account.

*** Dead discards: average of 2011–2013; Mean weight in landings and discards: average of 1999–2013.

ECOREGION Celtic Sea and West of Scotland
STOCK *Nephrops* in the Firth of Clyde + Sound of Jura (FU 13)

Advice for 2015

ICES advises, on the basis of the MSY approach and considering that no discard ban is in place in 2015, that landings should be no more than 4390 tonnes (3776 t for the Firth of Clyde and 614 t for the Sound of Jura). Assuming that discard rates do not change from the average of the last three years (2011–2013) the resulting total catch would be no more than 4861 t (4184 t for the Firth of Clyde and 677 t for the Sound of Jura).

In order to ensure the stock is exploited sustainably, management of *Nephrops* should be implemented at the functional unit level. In this FU the two subareas imply that additional controls may be required to ensure that the landings taken in each subarea are in line with the advice.

Stock status

Firth of Clyde

Fishing pressure	2011	2012	2013	
MSY (F_{MSY})	✗	✗	✓	Below target
Precautionary approach (F_{pa}, F_{lim})	?	?	?	Not defined

Stock size	2012	2013	2014	
MSY ($B_{trigger}$)	✓	✓	✓	Above trigger
Precautionary approach (B_{pa}, B_{lim})	?	?	?	Not defined

Sound of Jura

Fishing pressure	2011	2012	2013	
MSY (F_{MSY})	✓	✓	✓	Below target
Precautionary approach (F_{pa}, F_{lim})	?	?	?	Not defined

Stock size	2012–2014	
MSY ($B_{trigger}$)	?	Not defined
Precautionary approach (B_{pa}, B_{lim})	?	Not defined
Qualitative evaluation	↘	Decreasing

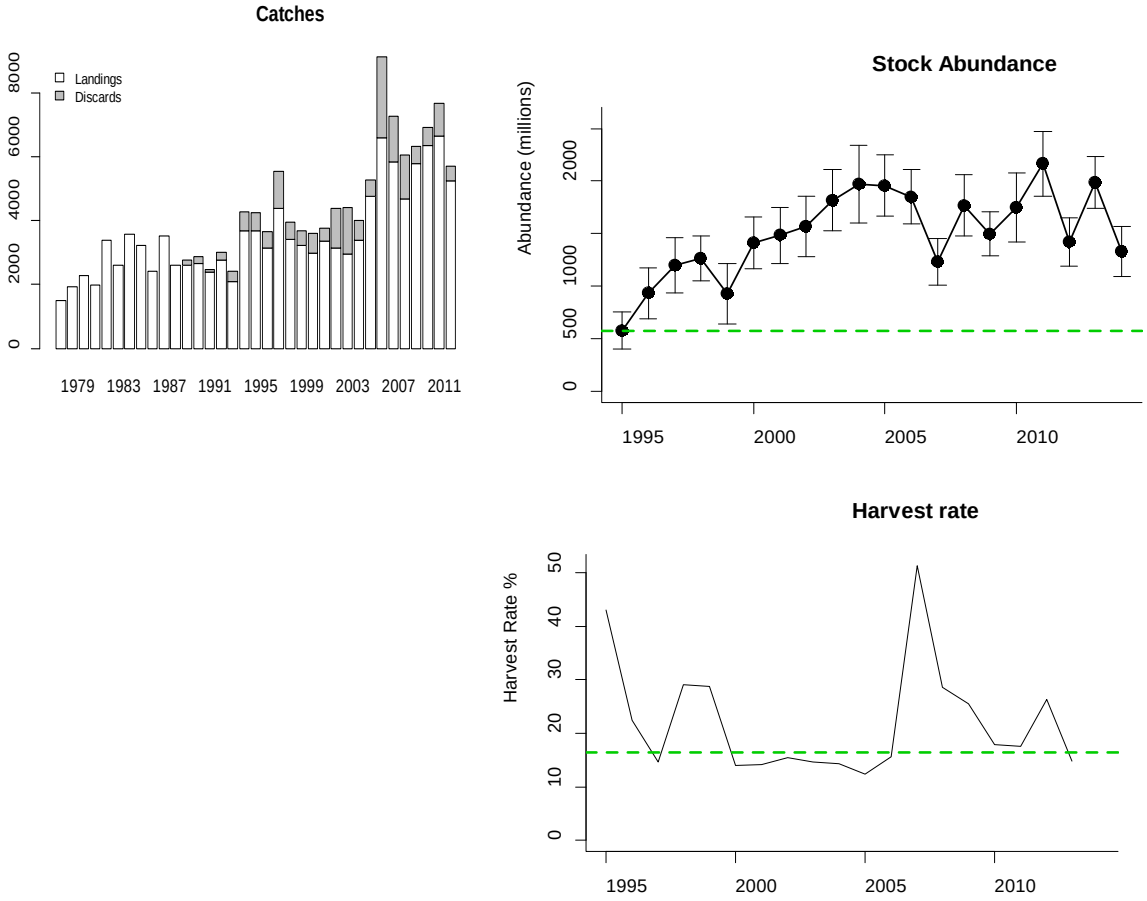

Figure 5.3.20.3.1 *Nephrops* in the **Firth of Clyde** (FU 13). Long-term trends in catch (tonnes), UWTV survey (in millions; SSB proxy), and harvest rate (fishing mortality proxy). Harvest rates before 2006 may be unreliable due to underreporting of landings. Green dashed lines represent MSY $B_{trigger}$ and F_{MSY} harvest ratios.

UWTV abundance remains above the MSY $B_{trigger}$. The harvest rate (removals/UWTV abundance) for *Nephrops* in the Firth of Clyde decreased in 2013 and is now below the proposed F_{MSY} proxy.

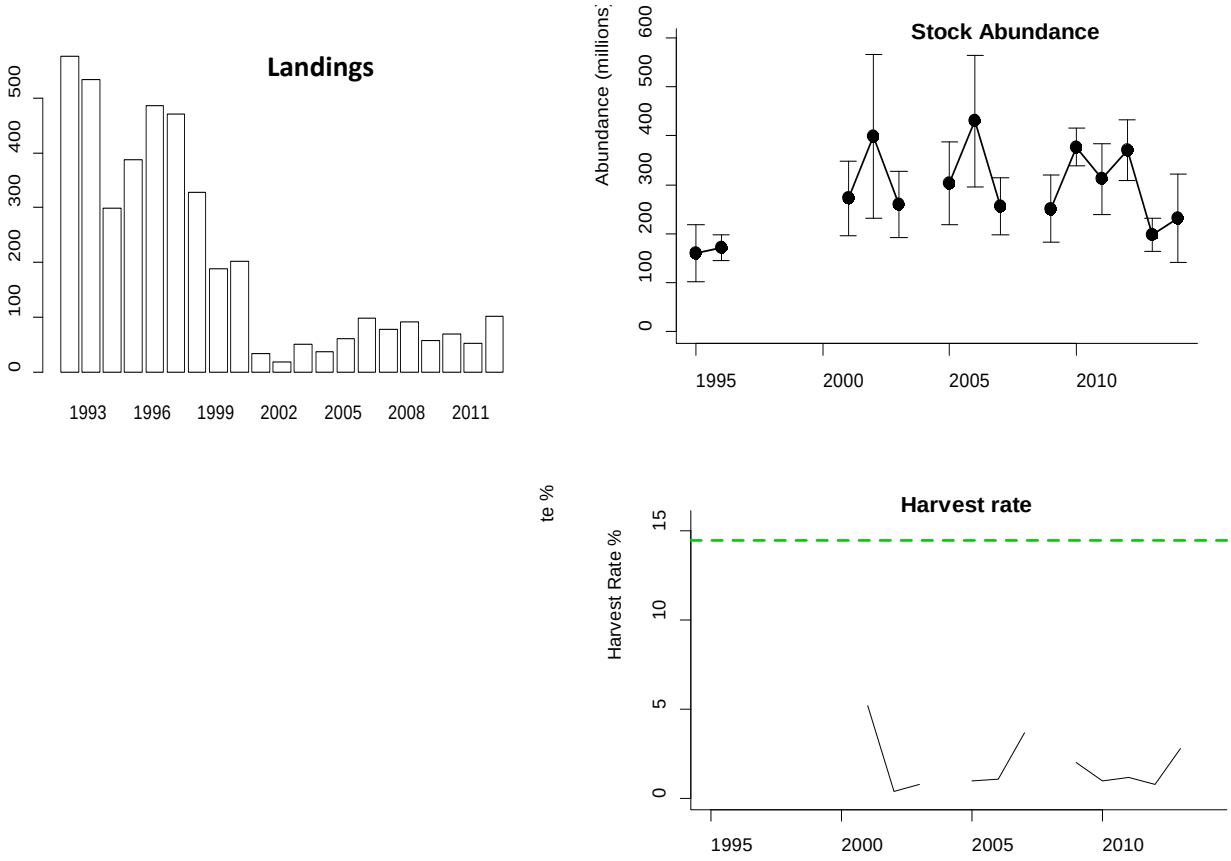

Figure 5.3.20.3.2 *Nephrops* in the **Sound of Jura** (FU 13). Long-term trends in catch (tonnes), UWTV survey (millions; SSB proxy), and harvest rate (fishing mortality proxy). Harvest rates before 2006 may be unreliable due to underreporting of landings. Green dashed line represents F_{MSY} harvest ratios.

Harvest rates (removals/UWTV abundance) for *Nephrops* in the Sound of Jura have been well below the proposed F_{MSY} proxy in recent years. UWTV abundance in 2013 was at the lowest observed level since 2000, with 2014 showing only a slight increase. The UWTV abundance series remains too short and patchy to propose a MSY $B_{trigger}$.

Management plans

No specific management objectives are known to ICES.

Biology

The general biology of *Nephrops* is discussed in the overview (Section 5.3.20). *Nephrops* in the Firth of Clyde and the Sound of Jura occur at a very high density (average around 0.8 individuals m^{-2}) and have a smaller average size and size-at-maturity than most other stocks. The high observed density implies intense competition for space and food on the seabed. This is thought to make the stock resilient to high fishing pressure. The habitat in Firth of Clyde is a relatively continuous patch of muddy sediment apart from the sea lochs, while the Sound of Jura consists of a single patch of muddy sediment.

The fisheries

Trawling is the predominant fishing method and fishing takes place all year round. The fishery has been fairly stable over the recent time-series. An increasing number of creel boats operate in the Clyde due to temporal and area bans on trawling. *Nephrops* discard rates from trawl fleets in this functional unit are higher than in other FUs in Division VIa.

Catch distribution	Total catch (2013) in Firth of Clyde + Sound of Jura = 5700 t, where 5258 t were estimated landings (97% trawl and 3% creel) and 442 t discards from the trawl fleet.

Effects of the fisheries on the ecosystem

The *Nephrops* trawl fishery in this functional unit has a bycatch of other species, including cod, haddock, and whiting. Bycatches of cod in the Clyde are generally low, but are higher than in other Division VIa FUs. This is an important area for cod spawning.

Quality considerations

Harvest ratios *since* 2006 are considered reliable due to more accurate landings data reported under the new legislation. In 2011–2013 no commercial catch-at-length samples were collected from the Sound of Jura; data from 2008–2010 were therefore used to calculate the mean weight in landings. The discard rates and mean weight of discards assumed for the Sound of Jura advice are estimates from the Firth of Clyde.

Scientific basis

Stock data category	1 (ICES, 2014a).
Assessment type	Underwater TV survey combined with yield-per-recruit analysis from length data.
Input data	One survey index (UWTV-FU13); commercial catches (international landings, length frequencies from Scottish catch sampling); fixed maturity parameters (from survey data); fixed natural mortalities. Discard survival rate.
Discards and bycatch	Included in the assessment since 1990; data series from the majority of the main fleets cover almost all landings.
Indicators	Size structure of classes, mean size, lpue, and sex ratio.
Other information	The latest benchmark (based on the UWTV survey) was performed in 2009 (ICES, 2009).
Working group	Working Group for the Celtic Seas Ecoregion (WGCSE).

ECOREGION Celtic Sea and West of Scotland
STOCK *Nephrops* in the Firth of Clyde + Sound of Jura (FU 13)

Reference points – Firth of Clyde

	Type	*Value*	*Technical basis*
MSY approach	MSY $B_{trigger}$	579 millions.	Lowest observed abundance estimate.
	F_{MSY}	16.4% harvest rate.	F_{MSY} proxy equivalent to F_{max} combined sex, based on length-based yield-per-recruit analysis.
Precautionary approach	Not defined.		

(Last changed in: 2011)

Reference points – Sound of Jura

	Type	*Value*	*Technical basis*
MSY approach	MSY $B_{trigger}$	Not defined.	
	F_{MSY}	14.5% harvest rate.	F_{MSY} proxy equivalent to $F_{35\%SPR}$ combined sex.
Precautionary approach	Not defined		

(Last changed in: 2011)

Harvest ratio reference points (2011):

	Male	Female	Combined
F_{max}	13.6	34.0	**16.4**
$F_{0.1}$	8.7	21.1	9.7
$F_{35\%SpR}$	10.7	25.7	**14.5**

For the Firth of Clyde subarea of this FU, the absolute density observed in the UWTV survey is generally high (over 0.8 individuals m^{-2} for the entire series and around 1.0 individuals m^{-2} in the last five years), suggesting that the stock has relatively high productivity. The fishery in this area has been in existence since the 1960s and the population and biological parameters have been studied numerous times. Historical harvest ratios in this FU have been generally high, at or above F_{max}. F_{max} is considered an appropriate F_{MSY} proxy and is expected to deliver high long-term yield with a low probability of recruitment overfishing.

For the Sound of Jura subarea of this FU, the absolute density observed in the UWTV survey is generally high (over 0.8 individuals m^{-2} for the entire series and around 1.0 individuals m^{-2} in the last five years), suggesting that the stock has relatively high productivity. The fishery in this area has been sporadic over its history and effort and landings have been low in the last decade. The population and biological parameters have been studied numerous times, but the time-series of UWTV data is more fragmented and sampling is at a relatively low level. A more cautious $F_{35\%SPR}$ is considered an appropriate F_{MSY} proxy for this stock.

Outlook for 2015

Firth of Clyde

Basis: Absolute survey abundance index 2015 = 1328 million (2014 index); Mean individual weight in landings (2011–2013) = 20.63 g; Mean individual weight in discards (2011–2013) = 8.81 g; Dead discard rate (in number) = 16%.

Basis	Total catches*	Landings	Dead discards**	Surviving discards**	Harvest rate
	L+DD+SD	L	DD	SD	for L+DD
F_{MSY} proxy	4184	3776	306	102	16.4%
F_{2013}	3776	3407	277	92	14.8%
$F_{0.1}$	2474	2233	181	60	9.7%
$F_{35\%SPR}$	3699	3338	271	90	14.5%

Weights in tonnes.

* Total catches are the landings plus dead and surviving discards.

** Total discard rate is assumed to be 20.2% of the catches (in number, average of the last three years, 2011–2013); discard survival is assumed to be 25%.

Sound of Jura

Basis: Absolute survey abundance index 2015 = 231 million (2014 index); Mean individual weight in landings (2008–2010) = 21.81 g; Mean individual weight in discards (taken from Clyde 2011–2013) = 8.81 g; Dead discard rate (in number) = 16%.

Basis	Total catches*	Landings	Dead discards**	Surviving discards**	Harvest rate
	L+DD+SD	L	DD	SD	for L+DD
F_{MSY} proxy	677	614	47	16	14.5%
F_{2013}	131	119	9	3	2.8%
$F_{0.1}$	454	411	32	11	9.7%
F_{max}	765	694	53	18	16.4%

Weights in tonnes.

* Total catches are the landings plus dead and surviving discards.

** Total discard rate is assumed to be 20.2% (from Firth of Clyde estimates); discard survival is assumed to be 25%.

MSY approach

Following the ICES MSY approach implies a harvest ratio of F_{MSY} = 16.4% for the Firth of Clyde subarea of Functional Unit 13. Considering that no discard ban is in place in 2015, this results in landings of no more than 3776 t. Assuming that discard rates do not change from the average of the last three years (2011–2013) the resulting catch would be no more than 4184 t.

Since MSY $B_{trigger}$ has not been identified for this stock, the ICES MSY approach has been applied without consideration of SSB in relation to MSY $B_{trigger}$. Following the ICES MSY approach implies a harvest ratio of F_{MSY} = 14.5% for the Sound of Jura subarea of Functional Unit 13. Considering that no discard ban is in place in 2015, this results in landings of no more than 614 t. Assuming that discard rates do not change from the average of the last three years (2011–2013) the resulting catch would be no more than 677 t.

Additional considerations

General considerations for *Nephrops* in Division VIa can be found at the beginning of Section 5.3.20.

Advice considerations

In order to ensure the stock in this FU is exploited sustainably, management should be implemented at the functional unit level (see Section 5.3.20).

The advice takes into account the 2014 UWTV survey results.

Regulations and their effects

The minimum landing size for *Nephrops* in Division VIa is 20 mm carapace length. Discarding of both undersized and poor quality individuals takes place in Clyde.

Data and methods

Underwater TV surveys have been conducted for the Firth of Clyde subarea every year since 1995. Confidence intervals around the abundance estimates are stable throughout the series and relatively low compared with other FUs in Division VIa. Underwater TV surveys for the Sound of Jura subarea have been more fragmented and sampling is at a relatively low level; confidence intervals are larger.

Uncertainties in assessment and forecast

In 2011–2013 no samples were collected from the Sound of Jura due to lack of sampling opportunities related to low fishing effort. Yield-per-recruit analysis is not yet available for the Sound of Jura subarea, therefore F proxies from the Firth of Clyde have been used.

The overall area of the ground is estimated from the available British Geological Survey contoured sediment data and at present may be a minimum estimate, although the possible underestimation is less severe than in the North Minch. Examination of VMS data shows a close correspondence with the area estimated by sediment. In the Clyde, the underestimated sea loch areas are relatively small, when compared with other FUs of Division VIa.

Comparison of the basis of previous assessment and advice

The basis for the assessment has not changed from last year and the basis for the advice this year is the same as last year: the MSY approach.

Sources

ICES. 2009. Report of the Benchmark Workshop on Nephrops (WKNEPH), 2–6 March 2009, Aberdeen, UK. ICES CM 2009/ACOM:33.

ICES. 2014a. Advice basis. *In* Report of the ICES Advisory Committee, 2014. ICES Advice 2014, Book 1, Section 1.2.

ICES. 2014b. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 13–22 May 2014, Copenhagen, Denmark. ICES CM 2014/ACOM:12.

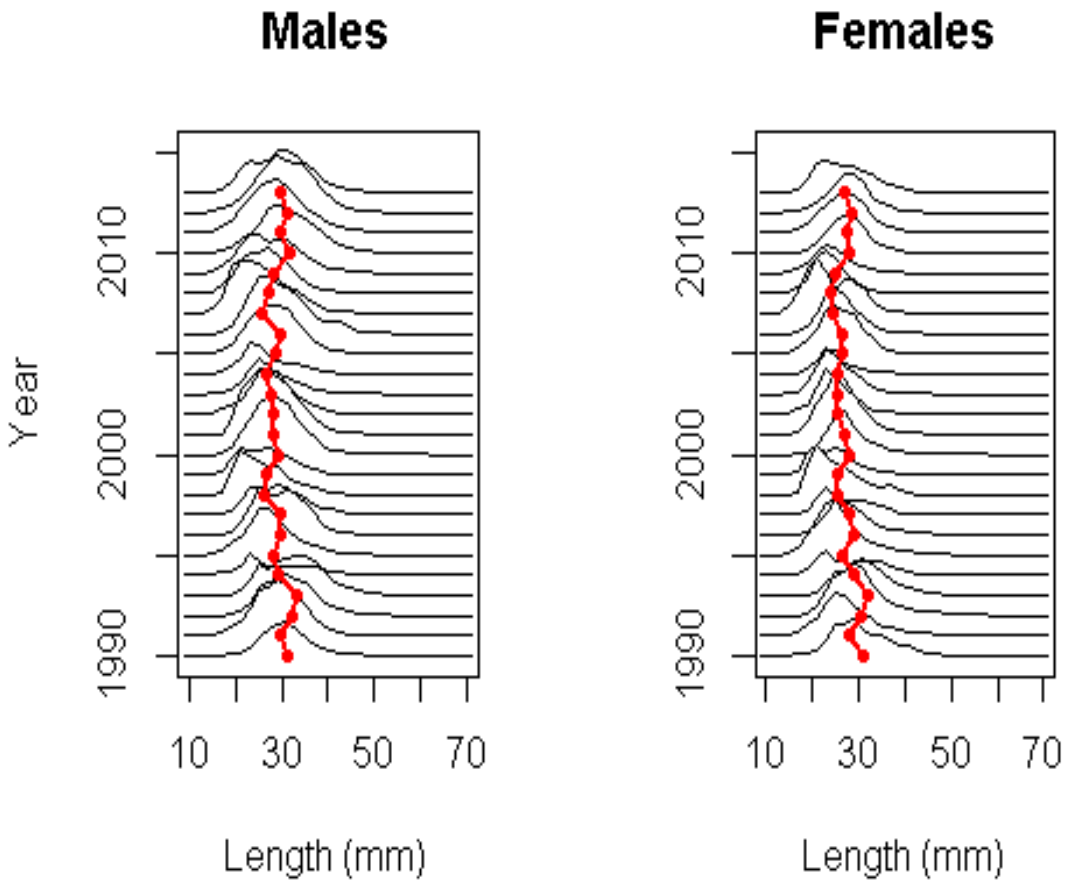

Figure 5.3.20.3.3 *Nephrops* in Clyde (FU 13). Annual length composition (black lines) of catch of males (left) and females (right) from 1990 (bottom) to 2013 (top). Mean sizes of catch (red line) are also shown.

Table 5.3.20.3.1 ***Nephrops*** **in the Firth of Clyde + Sound of Jura (FU 13).** ICES advice, management, landings, and discards.

Year	ICES advice	Predicted landings corresp. to advice for Firth of Clyde (FU 13)	Predicted landings corresp. to advice for Sound of Jura (FU 13)	ICES landings (FU 13)	Total discards [1)] (FU 13)
1989				2.8	
1990				2.9	
1991				3.0	
1992	maintain current effort			2.8	
1993	maintain current effort			3.3	
1994	maintain current effort			2.6	
1995	maintain current effort			4.0	
1996	maintain current effort			4.0	
1997	as for 1996			3.6	
1998	maintain current effort			4.8	
1999	as for 1998			3.8	0.5
2000	maintain current effort			3.4	0.4
2001	as for 2000			3.2	0.6
2002	maintain current effort			3.4	0.4
2003	as for 2002			3.2	1.2
2004	maintain current effort			3.0	1.3
2005	as for 2004			3.4	0.6
2006	No increase in effort			4.8	0.5
2007	No increase in effort and harvest rate no more than 15%	3.765		6.5	2.4
2008	as for 2007(no new advice)	3.765		5.9	1.3
2009	No increase effort and recent average catch	< 5.7		4.7	1.2
2010	Harvest rate no greater than that equivalent to fishing at F_{max}	< 3.9		5.7	0.5
2011	MSY transition scheme in Firth of Clyde and MSY framework in Sound of Jura	< 4.1	< 0.5	6.4	0.6
2012	MSY transition scheme in Firth of Clyde and MSY framework in Sound of Jura	< 4.2	< 0.9	6.6	1.0
2013	MSY approach both in Firth of Clyde and Sound of Jura	< 5.6	< 0.8	5.3	0.4
2014	MSY approach both in Firth of Clyde and Sound of Jura	< 5.7	< 0.5		
2015	MSY approach both in Firth of Clyde and Sound of Jura	< 3.8	< 0.6		

Weights in thousand tonnes.
[1)] 25% of the discards are assumed to survive. Only includes estimates from Firth of Clyde.

Table 5.3.20.3.2 ***Nephrops* in the Firth of Clyde + Sound of Jura (FU 13).** ICES estimates of landings (tonnes).

YEAR	UK SCOTLAND				OTHER UK	TOTAL*
	***Nephrops* trawl**	**Other trawl**	**Creel**	**Subtotal**		
1981	1862	404	11	2277	0	2277
1982	1798	169	16	1983	0	1983
1983	3257	121	3	3381	14	3395
1984	2434	153	3	2590	10	2600
1985	3257	293	4	3554	7	3561
1986	3035	176	4	3215	13	3228
1987	2311	80	14	2405	3	2408
1988	3386	107	9	3502	7	3509
1989	2393	183	3	2579	16	2595
1990	2435	121	2	2558	34	2592
1991	2490	139	2	2631	23	2654
1992	2125	239	2	2366	17	2383
1993	2632	105	1	2738	28	2766
1994	1999	45	2	2046	49	2095
1995	3501	124	3	3629	64	3693
1996	3529	95	5	3629	42	3671
1997	3020	44	8	3072	63	3135
1998	4107	71	12	4190	183	4373
1999	3175	27	11	3213	210	3423
2000	2979	62	51	3092	137	3229
2001	2710	65	72	2847	132	2979
2002	3034	52	104	3199	151	3350
2003	2937	20	117	3074	80	3154
2004	2611	8	88	2707	258	2965
2005	3141	5	94	3240	148	3388
2006	4345	1	178	4524	244	4769
2007	5995	4	215	6214	366	6580
2008	5257	3	169	5429	416	5845
2009	4238	1	166	4405	283	4688
2010	5126	5	186	5317	465	5782
2011	5614	9	200	5823	540	6363
2012	5587	2	182	5771	863	6634
2013	4580	4	163	4747	511	5258

* Total also includes Rep. of Ireland.

Table 5.3.20.3.3 ***Nephrops*** **in the Firth of Clyde (FU 13).** Results of the UWTV surveys (absolute abundance estimates).

Year	Stations	Mean density	Absolute abundance	95% confidence interval
		individuals m^{-2}	millions	millions
1995	29	0.28	579	176
1996	38	0.45	935	242
1997	31	0.57	1198	262
1998	38	0.61	1262	213
1999	39	0.45	930	289
2000	40	0.68	1411	246
2001	39	0.71	1486	268
2002	36	0.76	1571	288
2003	37	0.87	1817	292
2004	32	0.95	1970	367
2005	44	0.94	1959	287
2006	43	0.88	1851	257
2007	40	0.60	1233	218
2008	38	0.85	1769	291
2009	39	0.72	1499	210
2010	37	0.84	1750	327
2011	40	1.04	2165	305
2012	37	0.68	1421	227
2013	34	0.96	1990	246
2014	35	0.64	1328	237

Table 5.3.20.3.4 ***Nephrops*** **in the Sound of Jura (FU 13):** Results of the UWTV surveys (absolute abundance estimates).

Year	Stations	Mean density	Abundance	95% confidence interval
		individuals m^{-2}	millions	millions
1995	7	0.42	160	58
1996	10	0.45	171	26
1997				
1998			no surveys	
1999				
2000				
2001	13	0.71	272	76
2002	9	1.04	398	167
2003	12	0.68	260	68
2004			no survey	
2005	11	0.79	303	84
2006	10	1.13	430	134
2007	10	0.67	255	58
2008			no survey	
2009	12	0.66	251	68
2010	12	0.98	376	38
2011	12	0.82	312	73
2012	12	0.98	371	61
2013	9	0.52	198	35
2014	9	0.606	231	90

Table 5.3.20.3.5 ***Nephrops* in the Firth of Clyde (FU 13).** Absolute abundance (UWTV survey), landings, total discard rate (proportion in number), dead discard rate (in number), and estimated harvest rate.

Year	Landings in number (millions)	Discards in number (millions)	Removals in number (millions)**	Absolute survey abundance (millions)	Harvest ratio* (%)	Landings (tonnes)	Discard (tonnes)	Discard rate in number (%)	Dead discard rate in number (%)	Mean weight in landings (g)	Mean weight in discards (g)
1999	203	85	267	930	28.7	3423	516	29.6	24.0	16.88	6.05
2000	163	46	197	1411	14.0	3229	444	21.8	17.3	19.82	9.75
2001	153	77	211	1486	14.2	2979	634	33.5	27.4	19.45	8.23
2002	206	50	243	1571	15.4	3350	402	19.4	15.3	16.3	8.12
2003	165	133	264	1817	14.6	3154	1239	44.7	37.8	19.16	9.31
2004	158	168	283	1970	14.4	2965	1431	51.5	44.4	18.81	8.54
2005	189	69	240	1959	12.3	3388	610	26.9	21.6	17.97	8.81
2006	247	55	289	1851	15.6	4769	514	18.3	14.3	19.28	9.31
2007	345	382	632	1233	51.3	6580	2535	52.5	45.3	19.05	6.64
2008	354	204	506	1769	28.6	5845	1414	36.6	30.2	16.53	6.94
2009	258	166	382	1499	25.5	4688	1364	39.1	32.5	18.19	8.23
2010	272	55	313	1750	17.9	5782	531	16.8	13.1	21.26	9.68
2011	326	73	380	2165	17.6	6363	556	18.2	14.3	19.34	7.65
2012	305	93	375	1421	26.4	6634	1062	23.4	18.6	21.83	11.42
2013	251	59	295	1990	14.8	5258	434	19	15	20.72	7.37
2014				1328							
Average 2011–2013									15.97	20.63	8.81

* Harvest rates prior to 2006 are unreliable.
** Removals numbers take the dead discard rate into account.

Table 5.3.20.3.6 ***Nephrops* in the Sound of Jura (FU 13).** Absolute abundance (UWTV survey), landings, total discard rate (proportion by number), dead discard rate (by number), and estimated harvest rate.

Year	Removals in number (millions)**	Absolute survey abundance (millions)	Harvest ratio (%)	Landings (tonnes)	Discard rate in number* (%)	Dead discard rate in number* (%)	Mean weight in landings (g)	Mean weight in discards (g)*
2005	2.9	303	1.0	36	26.9	21.6	15.47	8.81
2006	4.7	430	1.1	61	18.3	14.3	15.05	9.31
2007	9.4	255	3.7	98	52.5	45.3	19.02	6.64
2008	5.1	NA	NA	78	36.6	30.2	21.60	6.94
2009	5.0	251	2.0	91	39.1	32.5	26.71	8.23
2010	3.9	376	1.0	58	16.8	13.1	17.13	9.68
2011	3.7*	312	1.2	69	18.2	14.3	21.86***	7.65
2012	2.9*	371	0.8	52	23.4	18.6	21.86***	11.42
2013	5.5*	198	2.8	102	19	15	21.86***	7.37
2014		231						
Average 2011–2013						15.33	21.81***	8.81

* Discard rates and mean weights assumed to be the same as in the Firth of Clyde.
** Removals numbers take the dead discard rate into account.
*** Average mean weight in landings and removals numbers were calculated from years 2008–2010 as there were no samples in 2011–2013.