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 5.4.20.1). The advice for *Nephrops* stocks is given by functional units in Sections 5.4.20.1–3.

Section	FU no.	Name	ICES Division	Statistical rectangles
5.4.20.1	11	North Minch	VIa	44–46 E3–E4
5.4.20.2	12	South Minch	VIa	41–43 E2–E4
5.4.20.3	13	Firth of Clyde + Sound of Jura	VIa	39–40 E4–E5

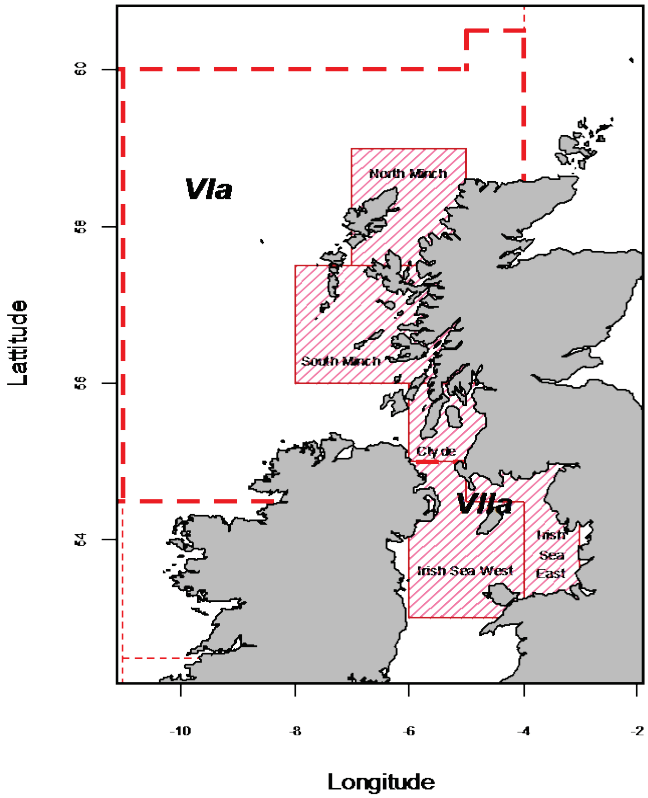

Figure 5.4.20.1 *Nephrops* functional units in Subarea VIa and Division VIIa (see Section 5.4.21).

Summary of the advice for 2014

A summary of the advice per functional unit can be found in Table 5.4.20.1.

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 tonnes. No information on discards is available for these rectangles.

Table 5.4.20.1 *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 (FU11)	South Minch (FU12)	Firth of Clyde (FU13)	Sound of Jura (FU13)	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	16.3
2008	3.2	7.2	3.765		0.8	15.0	19.9	15.2
2009	< 4.1	< 5.0	< 5.7		< 0.3	[3]	18.4	12.7
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	13.1
2012	< 3.2	< 5.5	< 4.2	< 0.9	[4]	[3]	14.1	14.3
2013	< 4.2	< 5.8	< 5.6	< 0.8	[4]	[3]	16.7	
2014	< 3.485	< 5.211	< 5.744	< 0.521	< 0.326	[3]		

Weights in thousand tonnes.
[1] Subarea VI and EC 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.

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.

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%.

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 burrows 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

Management 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 5.4.20.4).

Change in the fisheries

The *Nephrops* (TR2) fleet has been observed to have had high discard rates of haddock and whiting in recent years. The selectivity for this fleet needs to be improved. In 2009, under the west coast emergency measures a square-meshed panel of 120 mm was required in the *Nephrops* trawlers and the minimum mesh size is now 80 mm. This is likely to have had little effect on *Nephrops* selection. Twin-rig vessels tend to use a 200 mm square-meshed panel (with a 100 mm codend), and some of them are slightly bigger than that. This means that they do not catch bulk quantities and this leads to *Nephrops* of larger average size and better quality. Reported effort by all Scottish *Nephrops* trawlers has shown an increase in 2012, particularly during the first half of the year.

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* by 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 and the west coast emergency measures, *Nephrops* trawlers are required to use more selective gears. However, these gears are designed to release fish and do not significantly improve selectivity of *Nephrops*. Under the EU Cod Recovery Plan, trawl effort in Division VIa has declined significantly. So far this has mainly affected effort in the larger mesh gears (>100 mm), with effort in the *Nephrops* fisheries remaining relatively stable.

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, and is based on a 20% reduction (precautionary buffer) with respect to the average landings of the last three years (2010-2012), according to category 6.2 (ICES, 2012). 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. At the benchmark meetings (ICES, 2009, 2013a) it was proposed that the UWTV surveys provide 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 2014 are derived for a range of F_{MSY} and other options by applying the appropriate harvest ratios to the population numbers estimated from the most recent UWTV survey. This assumes that population numbers remain stable in the interim year. Landings are derived from the resultant total catch numbers after multiplying by the recent average of proportion retained and the mean weight in the landings.

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.

Stock monitoring continues, and enhanced work on observer trips on-board commercial vessels should furnish additional data which will be beneficial in further developing assessment approaches. Vessel monitoring data from satellite (VMS) are being successfully used to match survey and fishery areas for vessels >15 m.

The overall area of the ground is estimated by contoured sediment data. VMS data linked to landings (through interrogation of the Scottish FIN system) suggest that not all areas are covered in the current UWTV approach and as such, the absolute abundance estimate for this ground is likely to be an underestimate. In the North Minch, the survey area was extended in 2010 and refined in 2013 to include the VMS distribution of fishing effort.

In the provision of catch options based on the absolute survey estimates additional uncertainties related to mean weight in the landings, discard rates and discard survival also arise. A three-year average of discard rates (2010–2012) has been used in the calculation of catch options. The discard rates for some stocks in Division VIa have been quite variable.

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

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

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Sangster, G. I., Breen, M., Bova, D. J., Kynoch, R., O'Neill, F. G., Lowry. N., Moth-Poulsen, T., Hansen, U. J., Ulmestrand, M., Valentinsson, D., Hallback, H., Soldal, A. V., and Hoddevik, B. 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.

Table 5.4.20.2 ***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	-	-	7 422	-	7 428
1981	5	26	-	-	9 519	-	9 550
1982	1	1	-	1	9 000	-	9 003
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	9 941	-	10 364
2005	-	153	17	153	7 616	-	7 939
2006	-	133	1	255	13 419	-	13 808
2007	-	155	-	2 088	14 120	-	16 363
2008	-	56	1	419	14 795	-	15 271
2009	-	53	-	1 226	11 462	-	12 741
2010	-	45	1	1 962	10 250	-	12 258
2011	35	76	0	-	-	12 934	13 045
2012*		29				14 267	14296

*Preliminary.

Table 5.4.20.3 ***Nephrops*** **in Division VIa**. Landings (tonnes) by functional unit plus other rectangles (creel landings are included).

Year	FU11	FU12	FU13	Other	Total
1981	2861	3651	2968	39	9519
1982	2799	3552	2623	27	9001
1983	3196	3412	4077	34	10719
1984	4144	4300	3310	36	11790
1985	4061	4008	4285	104	12458
1986	3382	3484	4341	89	11296
1987	4083	3891	3007	257	11238
1988	4035	4473	3665	529	12702
1989	3205	4745	2812	212	10974
1990	2544	4430	2912	182	10068
1991	2792	4442	3038	255	10527
1992	3560	4237	2805	248	10849
1993	3192	4455	3342	344	11332
1994	3616	4415	2629	441	11101
1995	3656	4680	3989	460	12785
1996	2871	3995	4060	239	11165
1997	3046	4345	3618	243	11252
1998	2441	3730	4843	157	11171
1999	3257	4051	3752	438	11498
2000	3246	3952	3419	421	11038
2001	3259	3992	3182	420	10853
2002	3440	3305	3383	397	10525
2003	3268	3879	3171	433	10751
2004	3135	3868	3025	403	10431
2005	2984	3841	3423	254	10502
2006	4160	4554	4778	241	13733
2007	3968	5451	6495	420	16334
2008	3799	5347	5997	128	15271
2009	3497	4282	4777	185	12741
2010	2263	3725	5701	569	12258
2011	2696	3699	6431	219	13045
2012*	3388	3889	6584	435	14296

* Preliminary.

Table 5.4.20.4 ***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

* Preliminary.

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

Advice for 2014

ICES advises on the basis of the MSY approach that landings in 2014 should be no more than 3485 tonnes. If total discard rates do not change from the average of the last three years (2010–2012), this implies total catches of no more than 3702 tonnes. Note that this figure includes discards expected to survive the discarding process – assumed to be 25% of the total number discarded for this stock.

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

Stock status

F (Fishing Mortality)	2010	2011	2012
MSY (F_{MSY})	✓	✓	✗ Above target
Precautionary approach (F_{pa},F_{lim})	?	?	? Not defined

SSB (Spawning-Stock Biomass)	2011	2012	2013
MSY ($B_{trigger}$)	✓	✓	✓ Above trigger
Precautionary approach (B_{pa},B_{lim})	?	?	? Not defined

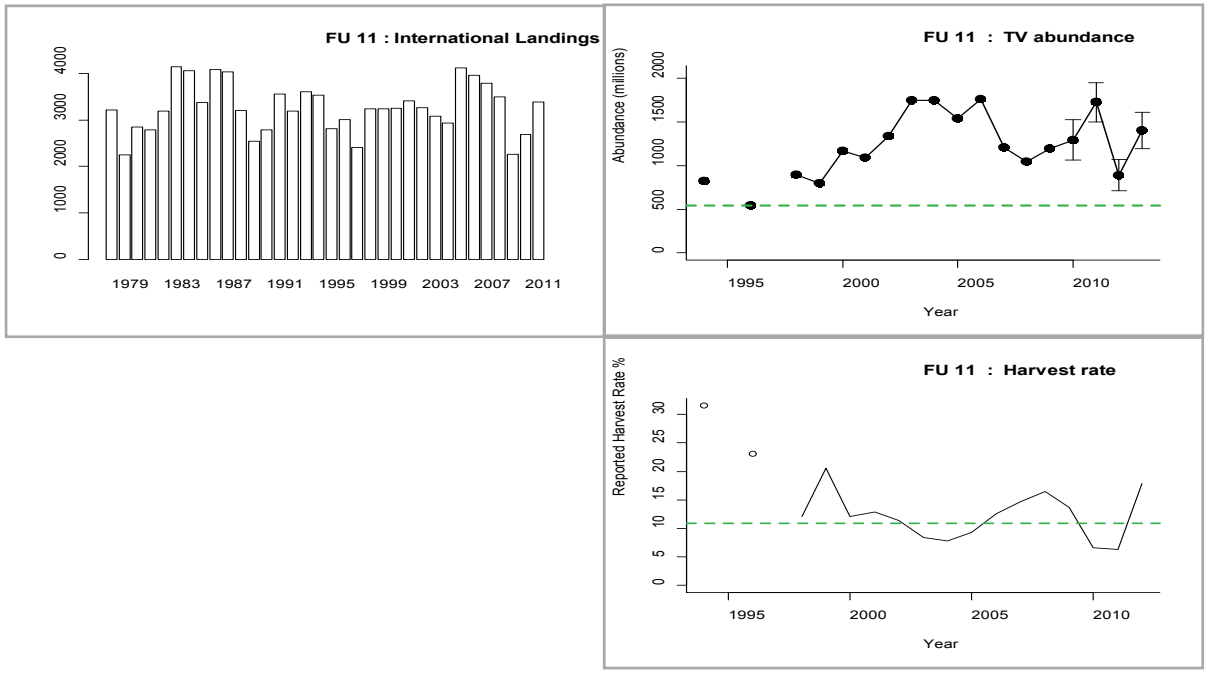

Figure 5.4.20.1.1 *Nephrops* in North Minch (FU 11). Landings (tonnes), UWTV survey abundance (millions; SSB proxy; 95% confident intervals), and harvest rate (fishing mortality proxy). Harvest rates before 2006 may be unreliable due to underreporting of landings. Green dashed lines represent MSY $B_{trigger}$ and F_{MSY} harvest ratio proxy.

The stock has been above MSY $B_{trigger}$ for more than 15 years. The results from the UWTV survey indicate that the abundance has decreased in 2012 and recovered in 2013 to an abundance similar to those observed in 2010–2011. The historical harvest ratios (removals/UWTV abundance) have fluctuated around the F_{MSY} proxy. The harvest ratio in 2012 increased to 17.9% and is above 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 5.4.20). The North Minch stock consistently exhibits medium densities compared to other stocks.

The fisheries

The fishery has been fairly stable over the time-series. Landings have increased in the last two years and the drop observed in 2010 seems to be mainly related to market conditions. Reported effort by all Scottish *Nephrops* trawlers has shown an increase in 2012 particularly during the first semester. 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 (2012) = 3592 t, where 3388 t are landings (84% trawl, 16% creel) and 204 t discards.

Effects of the fisheries on the ecosystem

There is a bycatch of other species, particularly haddock and whiting, in *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

Assessment type	Underwater TV survey linked to yield-per-recruit analysis from length data.
Stock data category	1
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	Discards from Scottish trawls were included in the assessment.
Indicators	Size structure of catches, mean size, lpue.
Other information	Latest benchmark (based on the UWTV survey) was performed in 2013 (WKNEPH; ICES, 2013a).
Working group report	WGCSE (ICES, 2013b).

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	Equivalent to $F_{35\%SpR}$ combined sex. F_{MSY} proxy based on length-based yield-per-recruit analysis.
Precautionary approach	Not defined.		

(unchanged since: 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 burrows 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 2014

Basis: $F_{2013} = F_{2012} = 17.9\%$; Bias-corrected survey index (2013) = 1403 million; Mean weight in landings (1999–2012) = 25.33 g; Dead discard rate (by number) = 10.0%; Mean weight in discards (1999–2012) = 10.64 g; Survey bias = 1.33; Discard survival rate = 25%.

Basis	Total catches*	Landings	Dead discards**	Surviving discards**	Harvest rate
	L+DD+SD	L	DD	SD	for L+DD
F_{MSY} proxy	3702	3485	163	54	10.9%
F_{2013}	6081	5725	267	89	17.9%
$F_{0.1}$	2615	2462	115	38	7.7%
F_{max}	4486	4223	197	66	13.2%

Weights in tonnes.
* Total catches are the landings, plus dead and surviving discards.
** The total discard rate is assumed to be 12.9% of the catches (in number, average of the last three years, 2010–2012); discard survival is assumed to be 25%.

MSY approach

Following the ICES MSY approach implies the harvest ratio for the North Minch functional unit should be reduced to less than 10.9%, resulting in landings of no more than 3485 tonnes in 2014. If discard rates do not change from the average of the last three years (2010–2012, assuming 25% discard survival), this implies total catches of no more than 3702 tonnes.

Additional considerations

The advice takes into account the 2013 UWTV survey results.

Recent work using VMS has refined the estimate of the area. Results from a recent study on mapping the spatial extent of *Nephrops* habitat in the North Minch sea lochs indicate that the muddy habitat in the lochs is only a very small proportion of the total *Nephrops* grounds in this FU.

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 5.4.20.1.2), but the mean weight in landings has increased markedly in 2010 and decreased again in the last two years. To dampen this variability, the time-series average (1999–2012) 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 that some areas outside the "sediment area" traditionally used to conduct the UWTV survey could be suitable ground for *Nephrops* 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

The method to derive landings for the catch options is sensitive to the input of discard rate, survival of discards, and mean weight in landings. A recent fluctuation in the mean weights in landings for this functional unit introduces uncertainties in the catch forecasts.

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 (2013b) 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 with previous assessment and advice

The advice for 2014 was delayed until autumn to take account of the most up-to-date survey information.

The basis for the advice this year is the same as last year, the MSY approach.

Sources

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 Celtic Seas Ecoregion (WGCSE), 8–17 May 2013, Copenhagen, Denmark. ICES CM 2013/ACOM:12.

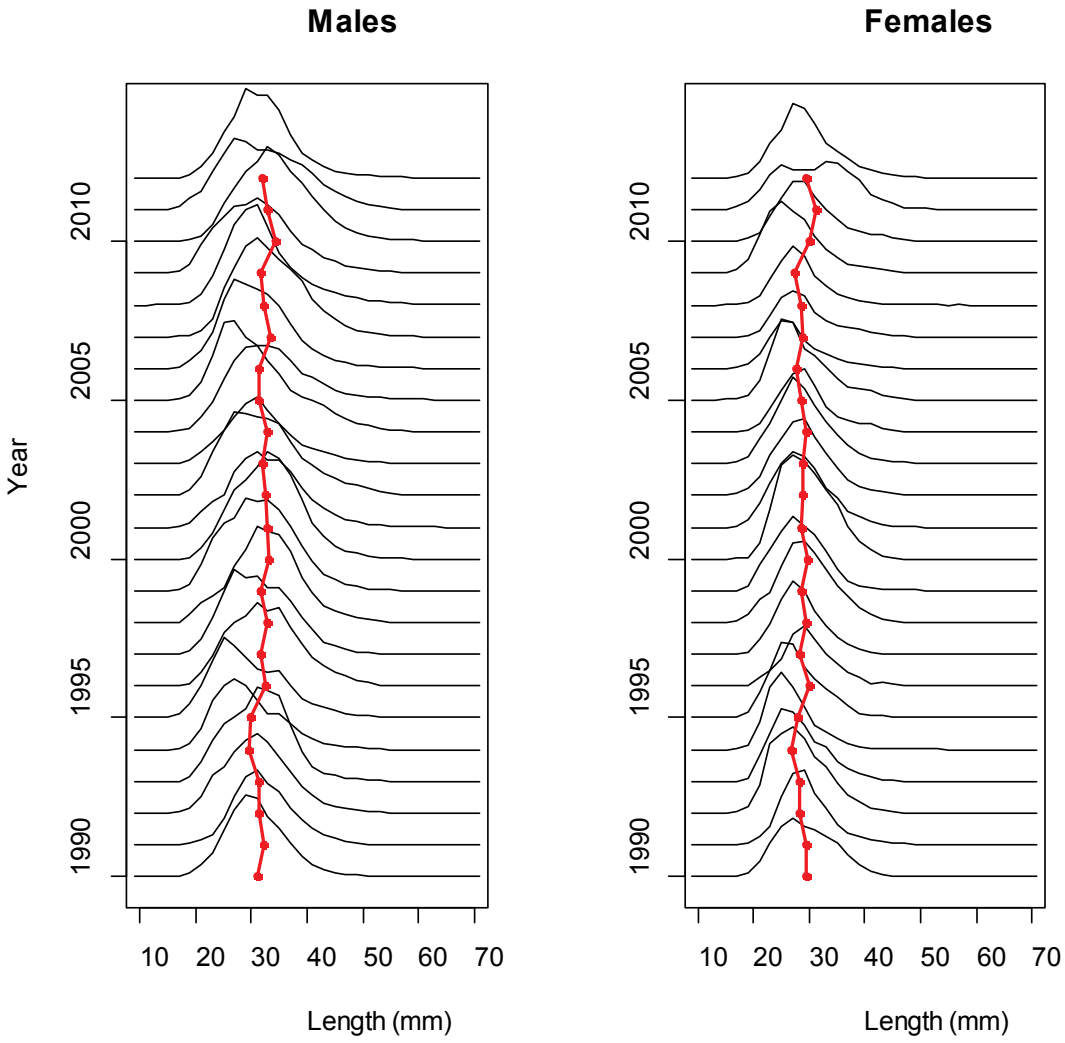

Figure 5.4.20.1.2 *Nephrops* in North Minch (FU 11). Annual length composition (black lines) of catch of males (left) and females (right) from 1990 (bottom) to 2012 (top). Mean sizes of catch (red line) are also shown.

Table 5.4.20.1.1 ***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		3.0	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	2.3	0.1
2011	MSY transition scheme	< 3.1	2.7	0.2
2012	MSY approach	< 3.2	3.4	0.2
2013	MSY approach	< 4.2		
2014	MSY approach	< 3.5		

Weights in thousand tonnes.
[1)] Assumed survival rate of 25%.

Table 5.4.20.1.2 ***Nephrops*** **in North Minch (FU 11).** Landings (tonnes) reported to ICES (ICES estimates).

Year	UK Scotland				Other UK & Ireland	Total
	Nephrops trawl	Other trawl	Creel	Subtotal		
1981	2320	170	371	2861	0	2861
1982	2323	105	371	2799	0	2799
1983	2784	95	317	3196	0	3196
1984	3449	161	534	4144	0	4144
1985	3236	117	708	4061	0	4061
1986	2642	203	537	3382	0	3382
1987	3458	143	482	4083	0	4083
1988	3449	149	437	4035	0	4035
1989	2603	112	490	3205	0	3205
1990	1941	134	469	2544	0	2544
1991	2228	125	439	2792	0	2792
1992	2978	150	432	3560	0	3560
1993	2699	85	408	3192	0	3192
1994	2916	246	454	3616	0	3616
1995	2940	184	532	3656	0	3656
1996	2355	147	369	2871	0	2871
1997	2553	102	391	3046	0	3046
1998	2023	67	351	2441	0	2441
1999	2791	56	410	3257	0	3257
2000	2695	28	523	3246	0	3246
2001	2651	41	567	3259	0	3259
2002	2775	79	586	3440	0	3440
2003	2607	44	617	3268	0	3268
2004	2400	25	710	3135	0	3135
2005	2267	18	699	2984	0	2984
2006	3446	17	697	4160	0	4160
2007	3362	16	590	3968	0	3968
2008	3230	12	557	3799	0	3799
2009	2858	26	613	3497	0	3497
2010	1717	6	540	2263	0	2263
2011	2110	16	570	2696	0	2696
2012*	2844	6	536	3386	2	3388

*Provisional.

Table 5.4.20.1.3 ***Nephrops*** **in North Minch (FU 11).** Time-series of UWTV survey results (after correction for bias), with 95% confidence intervals.

Year	Number of valid stations	Mean density	Abundance (Sediment)	95% confidence interval (sediment)	Abundance (VMS)	95% confidence interval (VMS)
		burrows/m²	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	1075	101	1762	-
2007	36	0.55	736	91	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

Table 5.4.20.1.4 ***Nephrops* in North Minch (FU 11).** Adjusted TV survey abundance, landings, total discard rate (proportion by number), dead discard rate (by number), and estimated harvest rate.

Year	Landings in number (millions)	Discards in number (millions)	Removals in number (millions)**	Adjusted survey VMS (millions)	Harvest ratio VMS*	Landings (tonnes)	Discard (tonnes)	Discard rate	Dead discard rate***	Mean weight in landings (g)
1999	145	28	164	794	20.6	3257	275	16.4	12.8	22.7
2000	133	10	141	1166	12.1	3246	98	6.9	5.2	24.19
2001	130	17	141	1092	12.9	3259	161	11.7	9.1	25.33
2002	132	28	153	1337	11.4	3440	276	17.6	13.8	25.93
2003	127	30	148	1751	8.4	3268	303	19.2	15.2	26.03
2004	123	18	136	1751	7.8	3135	203	13.0	10.1	25.16
2005	108	51	144	1540	9.3	2984	514	32.0	26.1	27.65
2006	171	74	223	1762	12.6	4160	762	30.3	24.6	24.52
2007	170	12	177	1206	14.7	3968	216	6.5	5.0	23.61
2008	162	19	173	1047	16.5	3799	198	10.5	8.1	23.81
2009	145	37	164	1195	13.7	3497	344	20.3	16.0	25.34
2010	77	11	85	1293	6.6	2263	121	12.4	9.6	29.33
2011	96	16	108	1726	6.3	2696	154	14.2	11.0	27.56
2012	145	20	159	891	17.9	3388	204	12.0	9.3	23.43
2013				1403						
Average									10.0	25.33

***** Harvest rates previous to 2006 are unreliable.

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

*** Dead discards: average of 2010–2012; Mean weight in landings: average of 1999–2012.

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

Advice for 2014

ICES advises on the basis of the MSY approach that landings in 2014 should be no more than 5211 tonnes. If total discard rates do not change from the average of the last three years (2010–2012), this implies total catches of no more than 5394 tonnes. Note that this figure includes discards expected to survive the discarding process – assumed to be 25% of the total number discarded for this stock.

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

Stock status

F (Fishing Mortality)	2010	2011	**2012**	
MSY (F_{MSY})	✓	✓	✗	Above target
Precautionary approach (F_{pa},F_{lim})	?	?	?	Not defined

SSB (Spawning-Stock Biomass)	2011	2012	**2013**	
MSY ($B_{trigger}$)	✓	✗	✓	Above trigger
Precautionary approach (B_{pa},B_{lim})	?	?	?	Not defined

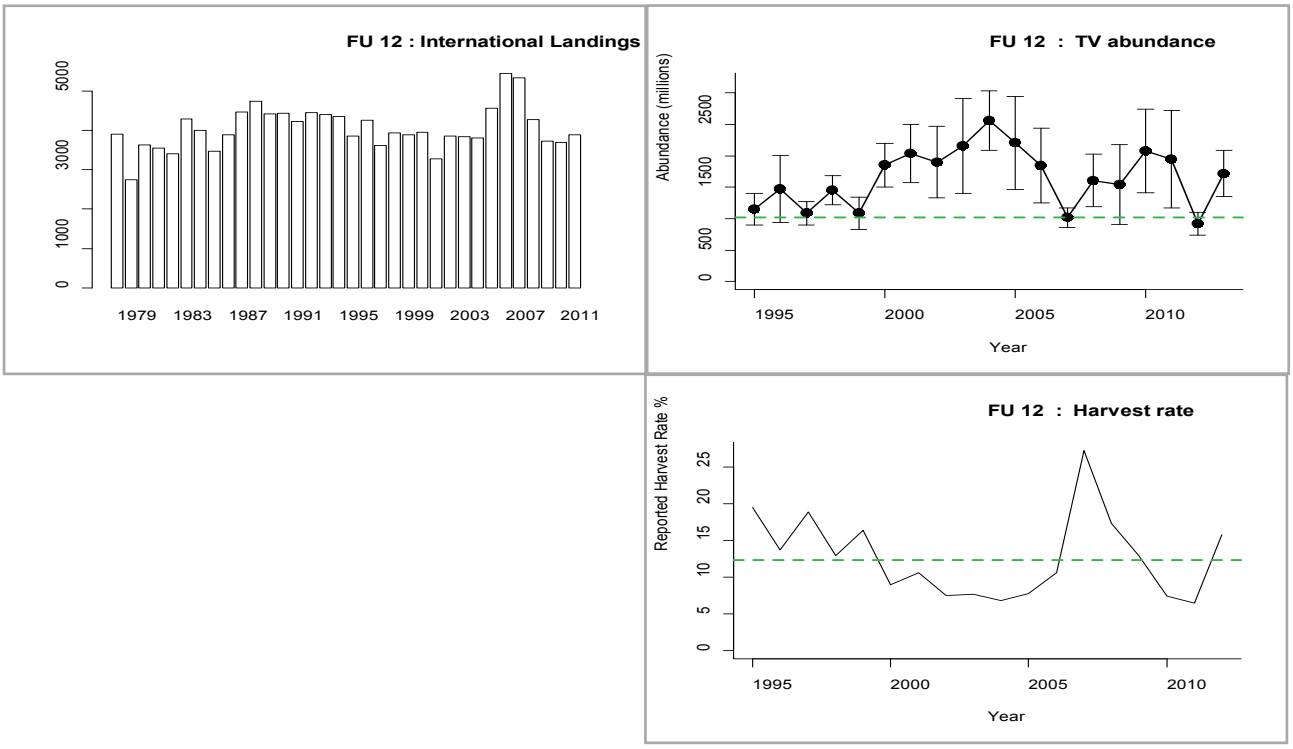

Figure 5.4.20.2.1 *Nephrops* in South Minch (FU 12). Long-term trends in landings (tonnes), UWTV survey (millions; SSB proxy; confidence intervals 95%), and harvest rate (fishing mortality proxy). Harvest rates before 2006 may be unreliable due to underreporting of landings. Green dashed lines represent MSY $B_{trigger}$ and F_{MSY} harvest ratios.

The stock fell below MSY $B_{trigger}$ in 2012 but increased in 2013 and is now above MSY $B_{trigger}$. The results from the TV survey indicate that the abundance has decreased in 2012 and recovered in 2013 to levels similar to those observed in 2011. The harvest ratio (removals/UWTV abundance) has increased to 15.8% in 2012 and is now above 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 5.4.20). The South Minch stock consistently 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 an increase in 2012, particularly during the first semester. Inshore trawlers are mainly small, but in the offshore areas of this FU larger boats operate. 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 (2012) = 4034 t, where 3889 t are landings (81% trawl and 19% creel) and 145 t discards from the trawl fleet. Discards from the creel fishery are considered to be very low.

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

Assessment type	Underwater TV survey linked to yield-per-recruit analysis from length data.
Stock data category	1
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	Discards from Scottish trawls were included in the assessment.
Indicators	Size structure of catches, mean size, lpue.
Other information	Latest benchmark (based on the UWTV survey) was performed in 2009 (ICES, 2009).
Working group report	WGCSE (ICES, 2013).

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.	Equivalent to $F_{35\%SPR}$ combined sex. F_{MSY} proxy based on length-based yield-per-recruit analysis.
Precautionary approach	Not defined.		

(unchanged since: 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 burrows 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 2014

Basis: $F_{2013} = F_{2012} = 15.8\%$; Bias-corrected survey index (2013) = 1718 million; Mean weight in landings (1999–2012) = 26.45 g; Dead discard rate (by number) = 6.8%; Mean weight in discards (1999–2012) = 9.53 g; Survey bias = 1.32; Discards survival rate = 25%.

Basis	Total catches*	Landings	Dead discards**	Surviving discards**	Harvest rate
	L+DD+SD	L	DD	SD	for L+DD
F_{MSY} proxy	5394	5211	137	46	12.3%
F_{2013}	6927	6692	176	59	15.8%
$F_{0.1}$	3813	3684	97	32	8.7%
F_{max}	7058	6819	179	60	16.1%

Weights in tonnes.
* Total catches are the landings plus dead and surviving discards.
** Total discard rate is assumed to be 8.9% of the catches (in number, average of the last three years, 2010–2012), discard survival is assumed to be 25%.

MSY approach

Following the ICES MSY approach implies that the harvest ratio for the South Minch functional unit is reduced to less than 12.3%, resulting in landings of no more than 5211 tonnes in 2014. If discard rates do not change from the average of the last three years (2010–2012, assuming a 25% discard survival), this implies total catches of no more than 5394 tonnes.

Additional considerations

The advice takes into account the 2013 UWTV survey results.

Work comparing the area based on available VMS and sediment data on which the UWTV survey is based showed no major differences between the two; the original area of ground was therefore retained for the UWTV survey. However, the survey should still be considered as a minimum estimate since areas of suitable sediment in the sea lochs are not included.

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 5.4.20.2.2), suggesting low recruitment in the last four years. The mean weight in landings has increased markedly in recent years and the time-series average (1999–2012) 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 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.

Uncertainties in the assessment and forecast

Abundance bias estimates for FU 12 are largely based on expert opinion. The precision of these bias corrections cannot yet be quantified.

Mean weights in the landings were relatively high in the last three years compared to the long-term average.

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 with previous assessment and advice

The advice for 2014 was delayed until autumn to take account of the most up-to-date survey information.

The basis for this year's advice 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. 2013. Report of the Working Group on the Celtic Seas Ecoregion (WGCSE), 8–17 May 2013, Copenhagen, Denmark. ICES CM 2013/ACOM: 12.

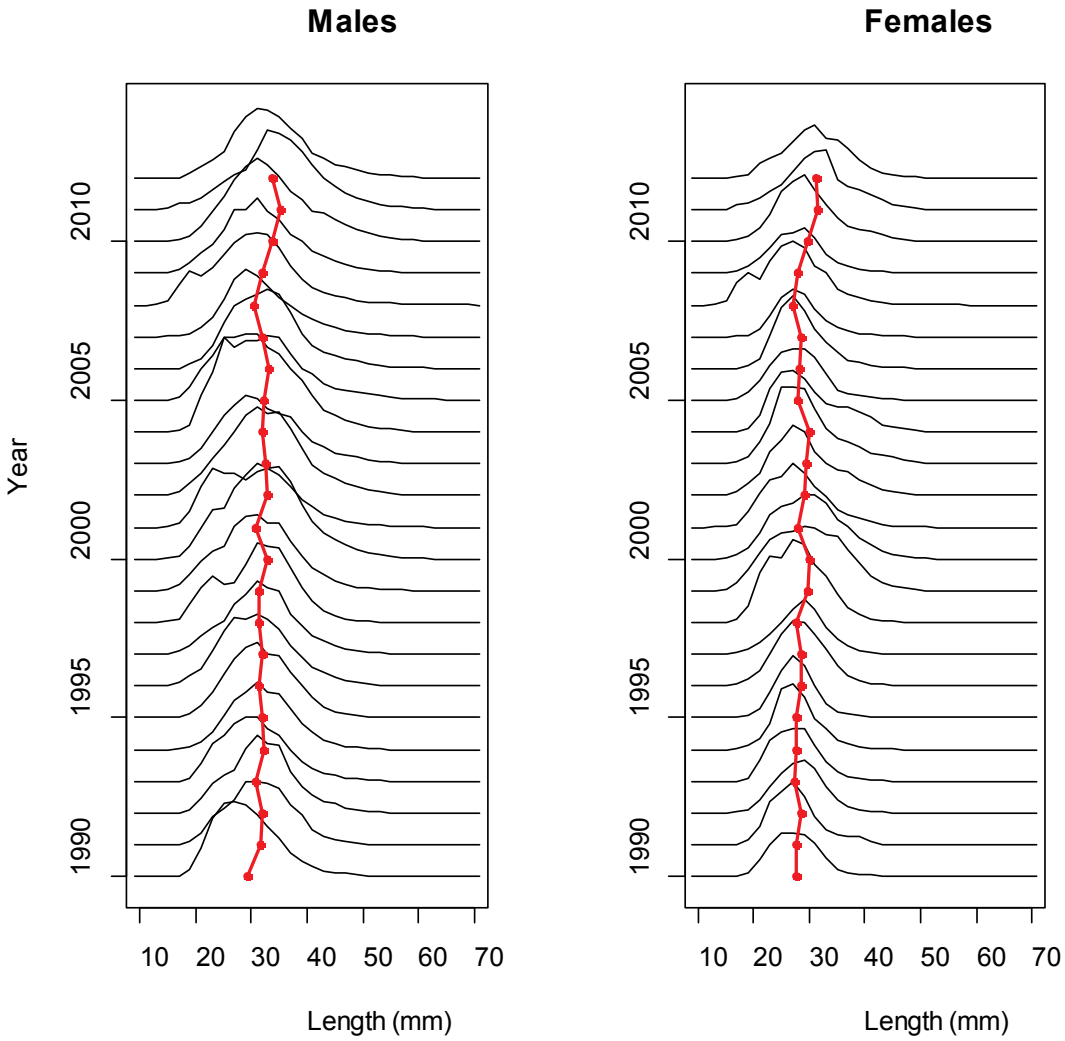

Figure 5.4.20.2.2 *Nephrops* in South Minch (FU 12). Annual length composition (black lines) of catch of males (left) and females (right) from 1990 (bottom) to 2012 (top). Mean sizes of catch (red line) are also shown.

Table 5.4.20.2.1 ***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] (FU12)
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	5.3	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	3.7	0.1
2011	MSY transition scheme	< 4.0	3.7	0.1
2012	MSY approach	< 5.5	3.9	0.1
2013	MSY approach	< 5.8		
2014	MSY approach	< 5.2		

Weights in thousand tonnes.
[1)] Assumed survival rate of 25 %.

Table 5.4.20.2.2 ***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	Sub-total			
1981	2965	254	432	3651	0	0	3651
1982	2925	207	420	3552	0	0	3552
1983	2595	361	456	3412	0	0	3412
1984	3228	478	594	4300	0	0	4300
1985	3096	424	488	4008	0	0	4008
1986	2694	288	502	3484	0	0	3484
1987	2927	418	546	3891	0	0	3891
1988	3544	364	555	4463	10	0	4473
1989	3846	338	561	4745	0	0	4745
1990	3732	262	436	4430	0	0	4430
1991	3597	341	503	4441	1	0	4442
1992	3479	208	549	4236	1	0	4237
1993	3608	193	649	4450	5	0	4455
1994	3743	265	404	4412	3	0	4415
1995	3442	716	508	4666	14	0	4680
1996	3107	419	468	3994	1	0	3995
1997	3519	331	492	4342	3	1	4345
1998	2851	340	538	3729	0	0	3730
1999	3165	359	513	4037	0	14	4051
2000	2939	312	699	3950	0	2	3952
2001	2823	393	767	3983	0	9	3992
2002	2234	315	742	3291	0	14	3305
2003	2812	203	858	3873	0	6	3879
2004	2865	104	880	3849	0	19	3868
2005	2810	46	953	3809	1	31	3841
2006	3569	19	922	4510	9	35	4554
2007	4436	8	958	5402	19	30	5451
2008	4432	5	895	5332	2	13	5347
2009	3347	20	900	4267	4	11	4282
2010	2801	13	889	3703	16	6	3725
2011	2878	6	783	3667	23	9	3699
2012*	3102	20	742	3864	19	6	3889

* Provisional.

Table 5.4.20.2.3 ***Nephrops* in South Minch (FU 12).** Time-series of UWTV survey results (after correction for bias), with 95% confidence intervals.

Year	Number of Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1995	33	0.30	1152	251
1996	21	0.38	1473	530
1997	36	0.28	1086	185
1998	38	0.38	1452	232
1999	37	0.28	1086	260
2000	41	0.48	1854	348
2001	47	0.53	2037	459
2002	31	0.49	1899	567
2003	25	0.56	2157	756
2004	38	0.67	2558	473
2005	33	0.57	2208	740
2006	36	0.48	1845	598
2007	39	0.26	1016	155
2008	33	0.42	1608	415
2009	25	0.40	1542	634
2010	34	0.54	2076	665
2011	36	0.51	1945	779
2012	38	0.24	919	185
2013	38	0.44	1718	365

Table 5.4.20.2.4 ***Nephrops* in South Minch (FU 12).** Adjusted TV survey abundance, landings, total discard rate (proportion by number), dead discard rate (by number), and estimated harvest rate.

Year	Landings in number (millions)	Discards in number (millions)	Removals in number (millions)**	Adjusted Survey (millions)	Harvest Ratio*	Landings (tonnes)	Discard (tonnes)	Discard rate	Dead discard rate	Mean weight in landings (g)
1999	154	28	178	1086	16.4	4051	196	15.4	12.0	25.14
2000	140	32	168	1854	9.0	3952	275	18.7	14.7	27.3
2001	160	62	215	2037	10.6	3992	562	27.9	22.5	23.79
2002	119	25	142	1899	7.5	3305	239	17.6	13.8	26.83
2003	139	38	167	2157	7.7	3879	380	21.3	16.9	27.86
2004	138	43	173	2558	6.8	3868	443	23.8	19.0	27.37
2005	135	49	173	2208	7.8	3841	447	26.5	21.2	28.11
2006	174	29	196	1845	10.6	4554	320	14.3	11.1	26.24
2007	227	65	277	1016	27.2	5451	896	22.4	17.8	23.95
2008	224	74	279	1608	17.3	5347	605	24.7	19.8	23.84
2009	179	25	199	1542	12.9	4282	215	12.5	9.6	23.79
2010	142	12	153	2076	7.4	3725	127	7.7	5.9	25.79
2011	118	11	126	1945	6.5	3699	92	8.2	6.3	31.10
2012	133	16	145	919	15.8	3889	145	10.8	8.3	29.17
2013				1718						
Average***									6.8%	26.45

* Harvest rates previous to 2006 are unreliable.

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

*** Dead discard: average of 2010–2012; Mean weight in landings: average of 1999–2012.

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Advice for 2014

ICES advises on the basis of the MSY approach that landings in 2014 should be no more than 6265 tonnes (5744 tonnes for Firth of Clyde and 521 tonnes for Sound of Jura). If total discard rates do not change from the average of the last three years (2010–2012), this implies total catches of no more than 6959 tonnes (6382 tonnes for Firth of Clyde and 577 tonnes for Sound of Jura). Note that this figure includes discards expected to survive the discarding process – assumed to be 25% of the total number discarded for this functional unit.

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 maybe required to ensure that the landings taken in each subarea are in line with the advice.

Stock status

Firth of Clyde

F (Fishing Mortality)	2010	2011	2012	
MSY (F_{MSY})	✗	✗	✗	Above target
Precautionary approach (F_{pa},F_{lim})	?	?	?	Not defined

SSB (Spawning-Stock Biomass)	2011	2012	2013	
MSY ($B_{trigger}$)	✓	✓	✓	Above trigger
Precautionary approach (B_{pa},B_{lim})	?	?	?	Not defined

Sound of Jura

F (Fishing Mortality)	2010	2011	2012	
MSY (F_{MSY})	✓	✓	✓	Below target
Precautionary approach (F_{pa},F_{lim})	?	?	?	Not defined

SSB (Spawning-Stock Biomass)	2011 -2013	
MSY ($B_{trigger}$)	?	Not defined
Precautionary approach (B_{pa},B_{lim})	?	Not defined
Qualitative evaluation	↘	Decreasing

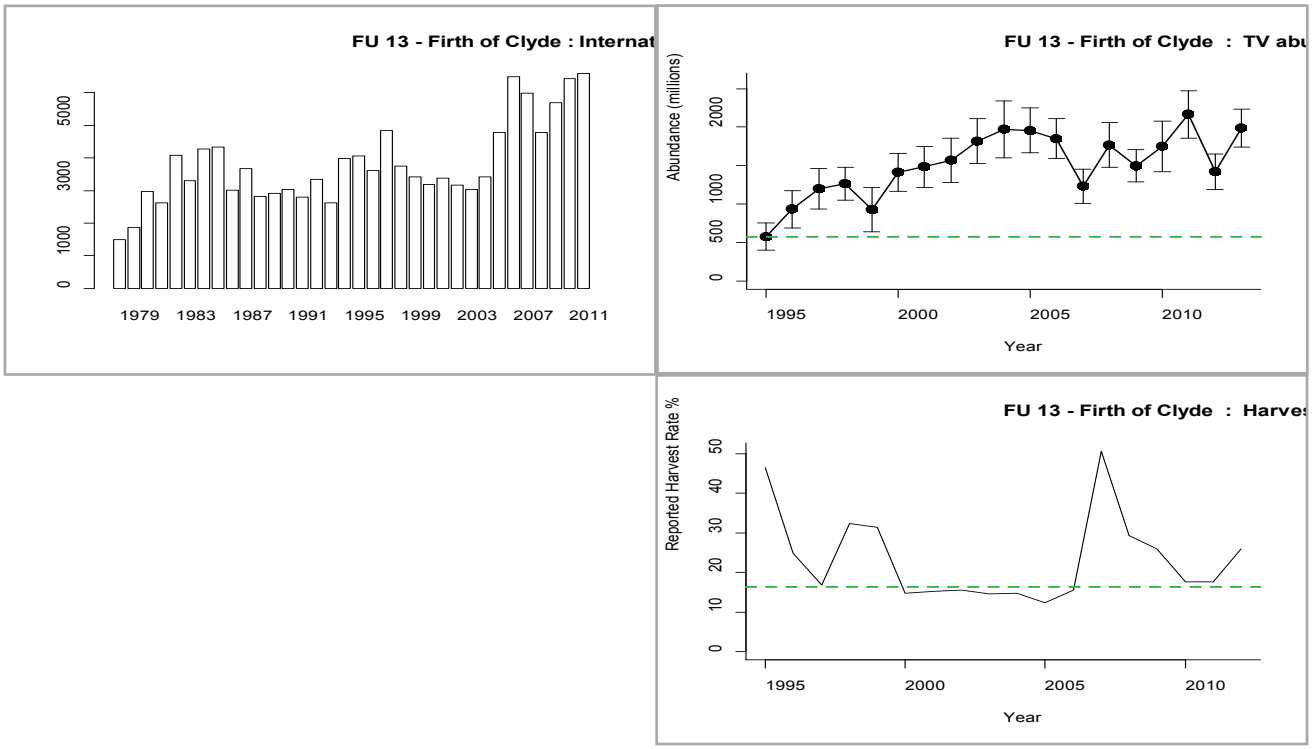

Figure 5.4.20.3.1 *Nephrops* in the **Firth of Clyde** (FU 13). Long-term trends in landings (tonnes), UWTV survey (in millions; SSB proxy), and harvest rate (fishing mortality proxy). Harvest rates before 2006 may be unreliable due to underreporting of landings. Green dashed lines represent MSY $B_{trigger}$ and F_{MSY} harvest ratios.

UWTV abundance remains above the MSY $B_{trigger}$. Harvest rates (removals/UWTV abundance) for *Nephrops* in the Firth of Clyde have increased in 2012 to 26.0% and remain above the proposed F_{MSY} proxy.

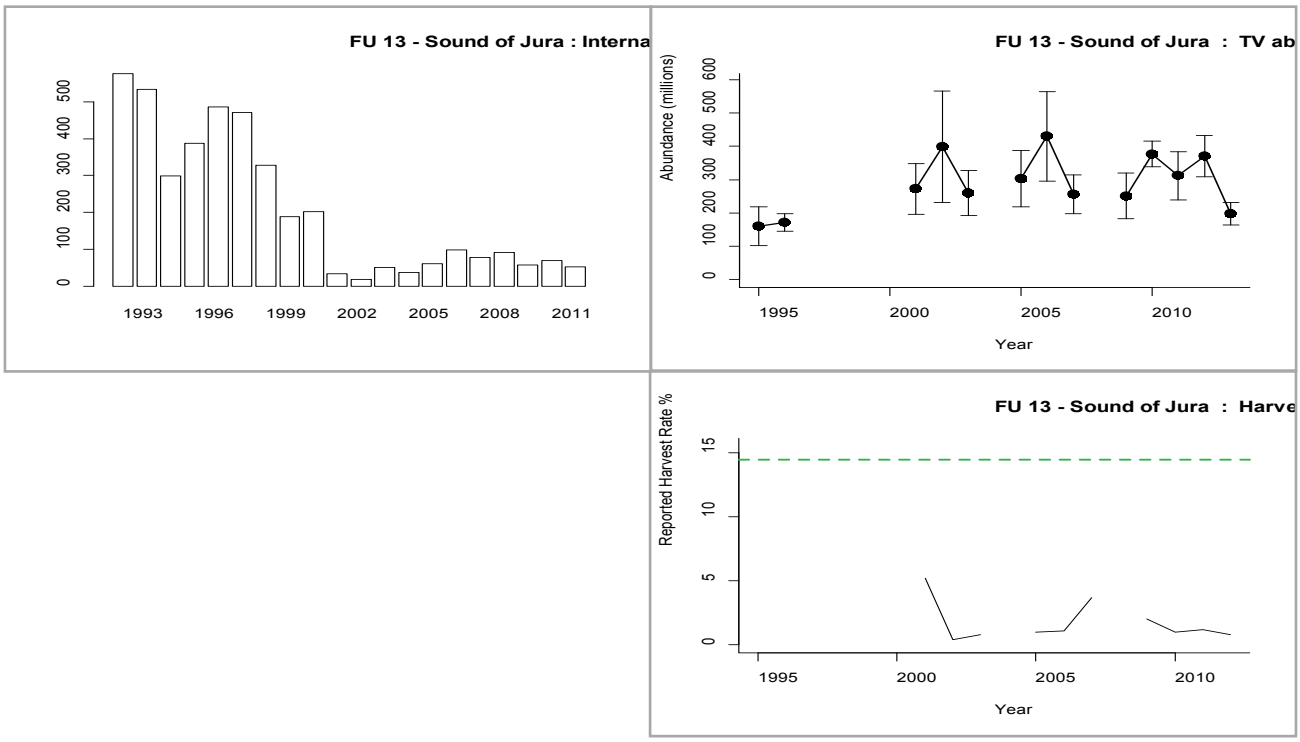

Figure 5.4.20.3.2 *Nephrops* in the **Sound of Jura** (FU 13). Long-term trends in landings (tonnes), UWTV survey (millions; SSB proxy), and harvest rate (fishing mortality proxy). Harvest rates before 2006 may be unreliable due to underreporting of landings. Green dashed line represents F_{MSY} harvest 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 remains higher than observed at the start of the series, but the series is 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 5.4.20). *Nephrops* in the Firth of Clyde and the Sound of Jura occur at a very high density (average around 0.8 burrows 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 (2012) in Firth of Clyde + Sound of Jura = 7630 t, where 6584 t are landings (97% trawl and 3% creel) and 1046 t discards from the trawl fleet. Discards from the creel fishery are considered to be very low.

Effects of the fisheries on the ecosystem

The *Nephrops* trawl fisheries 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 and 2012 no commercial catch-at-length samples were collected from Sound of Jura and data from 2008–2010 were 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

Assessment type	Underwater TV survey linked to yield-per-recruit analysis from length data.
Stock data category	1
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	Discards from Scottish trawls were included in the assessment.
Indicators	Size structure of catches, mean size, lpue.
Other information	Latest benchmark (based on the UWTV survey) was performed in 2009 (ICES, 2009).
Working group report	WGCSE (ICES, 2013).

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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.	Equivalent to F_{max} combined sex. F_{MSY} proxy based on length-based yield-per-recruit analysis.
Precautionary approach	Not defined.		

(unchanged since 2011)

Reference points – Sound of Jura

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

(unchanged since 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 burrows m^{-2} for the entire series and around 1.0 burrows 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 on the UWTV survey is generally high (over 0.8 burrows m^{-2} for the entire series and around 1.0 burrows 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 2014

Firth of Clyde

Basis: $F_{2013} = F_{2012} = 26.0\%$; Bias-corrected survey index (2013) = 1990 million; Mean weight in landings (2010–2012) = 20.78 g; Dead discard rate (by number) = 15.3%; Mean weight in discards (2010–2012) = 9.58 g; Survey bias = 1.19; Discards survival rate = 25%.

Basis	Total catches*	Landings	Dead discards**	Surviving discards**	Harvest rate
	L+DD+SD	L	DD	SD	for L+DD
F_{MSY} proxy	6382	5744	478	159	16.4%
F_{2013}	10118	9106	759	253	26.0%
$F_{0.1}$	3775	3398	283	94	9.7%
$F_{35\%SPR}$	5642	5079	422	141	14.5%

Weights in tonnes.
* Total catches are the landings plus dead and surviving discards.
** Total discard rate is assumed to be 19.5% of the catches (in number, average of the last three years, 2010–2012); discard survival is assumed to be 25%.

Sound of Jura

Basis: $F_{2013} = F_{2012} = 0.8\%$; Bias-corrected survey index (2013) = 198 million; Mean weight in landings (2008–2010) = 21.44 g; Dead discard rate (by number) = 15.3%; Mean weight in discards (2010–2012) = 9.58 g; Survey bias = 1.19; Discards survival rate = 25%.

Basis	Total catches*	Landings	Dead discards**	Surviving discards**	Harvest rate
	L+DD+SD	L	DD	SD	for L+DD
F_{MSY} proxy	577	521	42	14	14.5%
F_{2013}	31	28	2	1	0.8%
$F_{0.1}$	385	347	28	9	9.7%
F_{max}	653	590	48	16	16.4%

Weights in tonnes.
* Total catches are the landings plus dead and surviving discards.
** Total discard rate is assumed to be 19.5% (from Firth of Clyde estimates); discard survival is assumed to be 25%.

MSY approach

Following the ICES MSY approach implies the harvest ratio for the Firth of Clyde subarea should be reduced to less than 16.4%, resulting in landings of no more than 5744 tonnes in 2014. If discard rates do not change from the average of the last three years (2010–2012, assuming 25% discard survival), this implies total catches of no more than 6382 tonnes.

Following the ICES MSY approach implies the harvest ratio for the Sound of Jura subarea should be reduced to be less than 14.5%, resulting in landings of no more than 521 tonnes in 2014. If discard rates do not change from the average of the last three years (2010–2012, assuming 25% discard survival), this implies total catches of no more than 577 tonnes.

Additional considerations

The advice takes into account the 2013 UWTV survey results.

An increasing number of creel boats operate in the Clyde. Creeling activity often takes place during the weekend when the trawlers are not allowed to fish. One third of the creelers operate throughout the year, the rest prosecute a summer fishery.

Regulations and their effects

The minimum landing size for *Nephrops* in the Division VIa is 20 mm carapace length. Discarding of both undersize 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 and 2012 no samples were collected from 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 with previous assessment and advice

The advice for 2014 was delayed until autumn to take account of the most up-to-date survey information.

The basis for the assessment method is consistent with last year. The advice is based on the MSY approach, as last year.

Sources

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

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

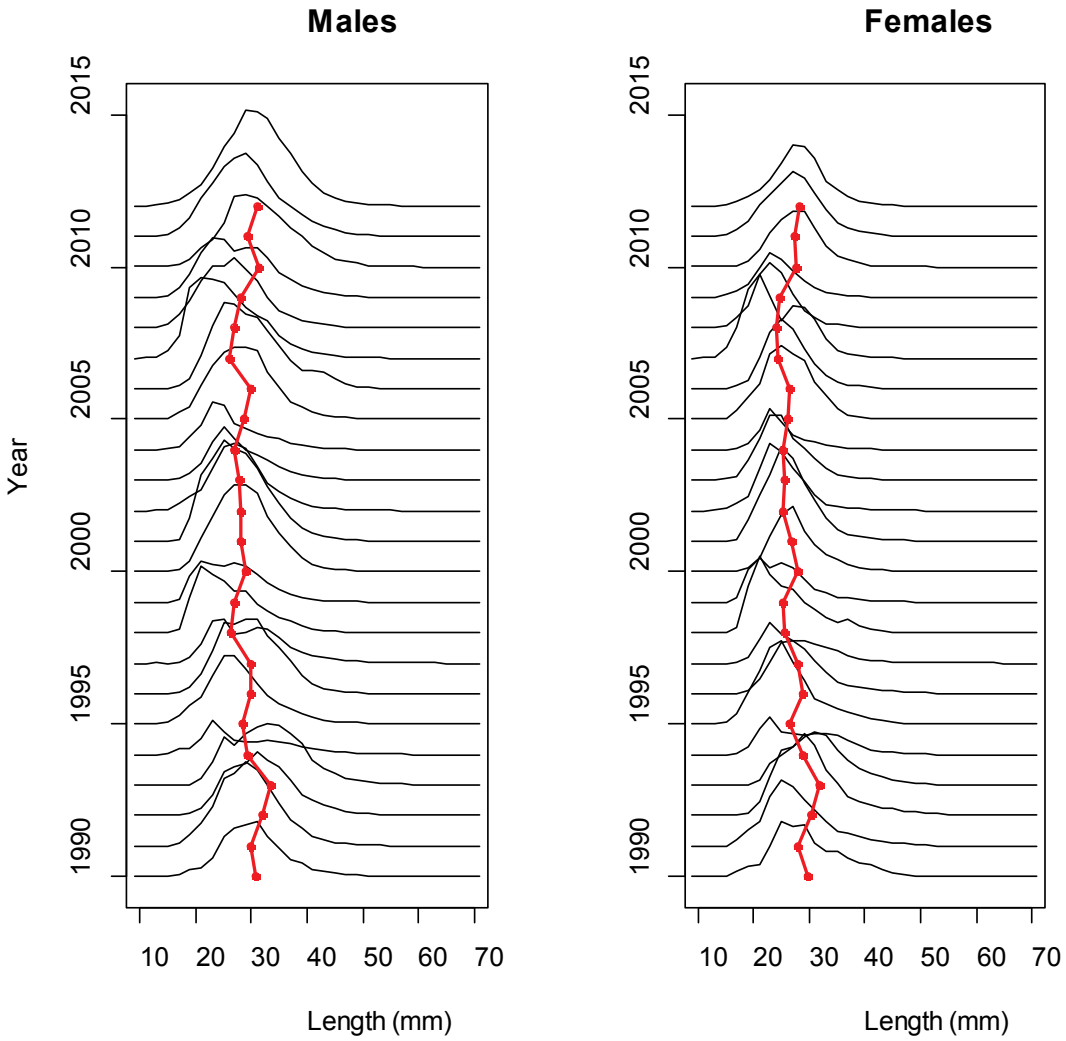

Figure 5.4.20.3.3 *Nephrops* in Clyde (FU 13). Annual length composition (black lines) of catch of males (left) and females (right) from 1990 (bottom) to 2012 (top). Mean sizes of catch (red line) are also shown.

Table 5.4.20.3.1 ***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] (FU13)
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		
2014	MSY approach both in Firth of Clyde and Sound of Jura	< 5.7	< 0.5		

Weights in thousand tonnes.
[1)] Assumed survival rate of 25%. Only includes estimates from Firth of Clyde.

Table 5.4.20.3.2 ***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	Sub-total		
1981	2498	404	66	2968	0	2968
1982	2373	171	79	2623	0	2623
1983	3890	120	53	4063	14	4077
1984	3069	154	77	3300	10	3310
1985	3921	293	64	4278	7	4285
1986	4074	175	79	4328	13	4341
1987	2859	80	65	3004	3	3007
1988	3507	108	43	3658	7	3665
1989	2577	184	35	2796	16	2812
1990	2732	122	24	2878	34	2912
1991	2845	145	25	3015	23	3038
1992	2532	246	10	2788	17	2805
1993	3199	110	5	3314	28	3342
1994	2503	49	28	2580	49	2629
1995	3767	132	26	3925	64	3989
1996	3880	111	27	4018	42	4060
1997	3486	44	25	3555	63	3618
1998	4539	81	40	4660	183	4843
1999	3475	29	38	3542	210	3752
2000	3143	63	76	3282	137	3419
2001	2889	67	94	3050	132	3182
2002	3074	53	105	3232	151	3383
2003	2954	20	117	3091	80	3171
2004	2659	18	90	2767	258	3025
2005	3166	14	95	3275	148	3423
2006	4446	0	0	4534	244	4778
2007	6129	0	0	6129	366	6495
2008	5382	2	197	5581	416	5997
2009	4305	0	189	4494	283	4777
2010	5050	0	186	5236	465	5701
2011	5672	0	219	5891	540	6431
2012*	5523	4	194	5721	863	6584

*Provisional.
** Total also includes Rep. of Ireland.

Table 5.4.20.3.3 ***Nephrops*** **in the Firth of Clyde (FU 13).** Time-series of UWTV survey results (after correction for bias), with 95% confidence intervals.

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1995	29	0.33	579	176
1996	38	0.54	935	242
1997	31	0.68	1198	262
1998	38	0.72	1262	213
1999	39	0.53	930	289
2000	40	0.81	1411	246
2001	39	0.85	1486	268
2002	36	0.90	1571	288
2003	37	1.04	1817	292
2004	32	1.13	1970	367
2005	44	1.12	1959	287
2006	43	1.05	1851	257
2007	40	0.71	1233	218
2008	38	1.01	1769	291
2009	39	0.86	1499	210
2010	37	1.00	1750	327
2011	40	1.24	2165	305
2012	37	0.81	1421	227
2013	34	1.14	1990	246

Table 5.4.20.3.4 ***Nephrops* in the Sound of Jura (FU 13).** Time-series of UWTV survey index estimates (after correction for bias), with 95% confidence intervals.

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1995	7	0.50	160	58
1996	10	0.53	171	26
1997				
1998			no surveys	
1999				
2000				
2001	13	0.85	272	76
2002	9	1.24	398	167
2003	12	0.81	260	68
2004			no survey	
2005	11	0.94	303	84
2006	10	1.34	430	134
2007	10	0.80	255	58
2008			no survey	
2009	12	0.78	251	68
2010	12	1.17	376	38
2011	12	0.97	312	73
2012	12	1.16	371	61
2013	9	0.62	198	35

Table 5.4.20.2.5 ***Nephrops*** **in the Firth of Clyde (FU 13).** Adjusted TV survey abundance, landings, total discard rate (proportion by number), dead discard rate (by number), and estimated harvest rate.

Year	Landings in number (millions)	Discards in number (millions)	Removals in number (millions)**	Adjusted survey (millions)	Harvest ratio*	Landings (tonnes)	Discard (tonnes)	Discard rate	Dead discard rate	Mean weight in landings (g)
1999	189	79	267	930	28.7	3424	481	29.6	24.0	16.88
2000	154	43	197	1411	14.0	3230	418	21.8	17.3	19.82
2001	141	71	211	1486	14.2	2980	584	33.5	27.4	19.45
2002	193	47	243	1571	15.4	3349	379	19.4	15.3	16.3
2003	161	130	264	1817	14.5	3153	1209	44.7	37.8	19.16
2004	143	152	284	1970	14.4	2975	1298	51.5	44.4	18.81
2005	179	66	240	1959	12.3	3387	580	26.9	21.6	17.97
2006	234	52	286	1851	15.4	4717	487	18.3	14.3	19.28
2007	323	357	614	1233	49.8	6397	2372	52.5	45.3	19.05
2008	332	192	513	1769	29.0	5919	1329	36.6	30.2	16.42
2009	236	152	382	1499	25.5	4686	1248	39.1	32.5	18.09
2010	236	48	306	1750	17.5	5643	460	16.8	13.1	21.16
2011	326	73	380	2165	17.6	6362	556	18.2	14.3	19.34
2012	300	92	369	1421	26.0	6532	1046	23.4	18.6	21.83
2013				1990						
Average 2010–2012									15.33	20.78

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

Table 5.4.20.2.6 ***Nephrops*** **in the Sound of Jura (FU 13).** Adjusted TV survey abundance, landings, total discard rate (proportion by number), dead discard rate (by number), and estimated harvest rate.

Year	Removals in number (millions)	Adjusted survey (millions)	Harvest ratio	Landings (tonnes)	Discard rate*	Dead discard rate*	Mean weight in landings (g)
2005	2.9	303	1.0	36	26.9	21.6	15.47
2006	4.7	430	1.1	61	18.3	14.3	15.05
2007	9.4	255	3.7	98	52.5	45.3	19.02
2008	5.1	NA	NA	78	36.6	30.2	21.60
2009	5.0	251	2.0	91	39.1	32.5	25.58
2010	3.9	376	1.0	58	16.8	13.1	17.13
2011	3.6**	312	1.2	69	18.2	14.3	na
2012	2.3**	371	0.8	52	23.4	18.6	na
2013		198					
Average 2010-2012						15.33	21.44**

* Discard rates assumed to be the same as in the Firth of Clyde.
** Average mean weight in landings and removals numbers were calculated from years 2008–2010 as there were no samples in 2011 and 2012.