

ECOREGION Celtic Sea and West of Scotland
STOCK *Nephrops* in Subarea VII

Introduction

Nephrops are limited to a muddy habitat and the distribution of suitable sediment defines the species distribution. The stocks are assessed as seven separate functional units (FUs) as shown in Figure 5.3.21.1. There are also some smaller catches from areas outside these functional units as well as in all of FU 18 which are not formally assessed. The advice for *Nephrops* stocks is given by functional unit in Sections 5.3.21.1–7.

Section	FU no.	Name	ICES Divisions	Statistical rectangles
5.3.21.1	14	Irish Sea East	VIIa	35–38 E6; 38 E5
5.3.21.2	15	Irish Sea West	VIIa	36 E3; 35–37 E4–E5; 38 E4
5.3.21.3	16	Porcupine Bank	VIIb,c,j,k	31–35 D5–D6; 32–35 D7–D8
5.3.21.4	17	Aran Grounds	VIIb	34–35 D9–E0
5.3.21.5	19	Ireland SW and SE coasts	VIIa,g,j	31–33 D9–E0; 31 E1; 32 E1–E2; 33 E2–E3
5.3.21.6	20–21	Celtic Sea – Labadie	VIIg,h	28–29 E0, 28–30 E1; 28–31 E2; 29–30 E3
5.3.21.7	22	Celtic Sea – the Smalls	VIIg,f	31–32 E3; 31–32 E4

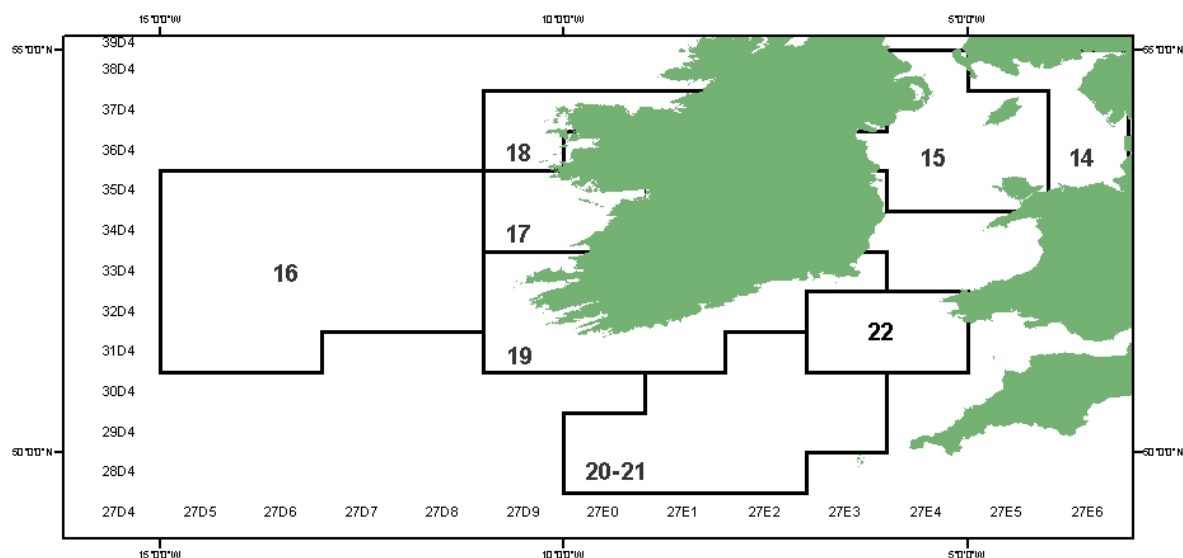


Figure 5.3.21.1 *Nephrops* functional units in Subarea VII (around Ireland).

Summary of the advice for 2015

A summary of the advice for all of Subarea VII can be found in Table 5.3.21.1.

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 FU 18 and 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 FU 18 and 'other rectangles' should be no more than 235 tonnes. No information on discards is available for the area corresponding to FU 18 and 'other rectangles'.

Table 5.3.21.1

Nephrops in Subarea VII. ICES advice, management, and landings by functional unit, plus other rectangles.

Year	Predicted landings corresponding to ICES advice								Agreed TAC	ICES landings
	Irish Sea East (FU 14)	Irish Sea West (FU 15)	Porcupine Bank (FU 16)	Aran Grounds (FU 17)	Ireland SW and SE coasts (FU 19)	Celtic Sea – Labadie (FUs 20–21)	Celtic Sea – the Smalls (FU 22)	FU 18 and other rectangles ¹⁾		
Division	VIIa		VIIb,c,j,k			VIIg,h	VIIg,f		VII	VII
1992	8.9			3.8		~3.8			20.0	15.8
1993	9.4			~4.0		3.8			20.0	16.6
1994	9.4			~4.0		3.8			20.0	17.2
1995	9.4			~4.0		3.8			20.0	18.5
1996	9.4			4.0		3.8			23.0	16.6
1997	9.4			4.0		3.8			23.0	18.9
1998	9.4			4.0		3.8			23.0	18.3
1999	9.4			4.0		3.8			23.0	18.7
2000	9.4			4.0		3.8			21.0	16.4
2001	9.4			4.0		3.8			18.9	16.1
2002	9.55			4.44		3.8			17.79	16.1
2003	9.55			4.44		3.8			17.79	15.7
2004	9.55			3.3		4.6			17.45	15.3
2005	9.55			3.3		4.6			19.544	16.0
2006	9.55			3.3		4.6			21.498	16.2
2007	²⁾	²⁾	³⁾	³⁾	³⁾	²⁾			25.153	19.0
2008	²⁾	²⁾	³⁾	³⁾	³⁾	< 5.3			25.153	20.5
2009	< 1.0	< 8.5	< 1.0	< 0.9	< 0.8	< 5.3		< 0.2	24.650	17.9
2010	< 1.0	< 5.5	0	< 0.5	< 0.8	< 5.3		< 0.2	22.432	17.2
2011	< 0.68	< 9.5	0	< 0.9	⁴⁾	⁴⁾		< 0.2	21.759	16.2
2012	< 0.96	< 9.8	⁵⁾	< 1.1	⁶⁾	⁶⁾	< 2.3	⁵⁾	21.759	18.4
2013	< 0.88	< 9.3	< 1.8	< 0.59	< 0.82	< 2.5	< 3.1	< 0.2	23.065	16.2
2014	< 0.951	< 8.244	< 1.848	< 0.591	< 0.521	< 2.5	< 2.674	< 0.235	20.989	
2015	< 0.662	< 8.223	< 1.850	< 0.524	< 0.715	< 2.5 ⁷⁾	< 3.409	< 0.235 ⁷⁾		

Weights in thousand tonnes.

¹⁾ Prior to 2009, landings corresponding to advice for other rectangles and FU 18 were included with adjacent FUs.²⁾ No increase in effort.³⁾ Constrain effort to recent levels.⁴⁾ ICES provided advice based on MSY and precautionary scenarios.⁵⁾ No increase in catches.⁶⁾ Reduce catches.⁷⁾ ICES advises same landings as advised last year for FUs 20–21 (2500 t) and for FU 18 and ‘other rectangles’ (235 t).

Biology

Nephrops is limited to a muddy habitat, requiring 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. This makes some stocks, particularly those with lower average density, vulnerable to localized depletion. Catch rates and composition vary daily and seasonally between different areas and sexes due to different emergence patterns and underlying population densities. After the onset of maturity the male *Nephrops* grows faster and attains a larger size than the female. Density limits growth, and *Nephrops* have a smaller average size on grounds with high *Nephrops* density (>0.7 individuals m^{-2}) than on grounds with low density. Whilst females are carrying their eggs their emergence rate from burrows is much reduced. 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, particularly during the larval phase, are critical to recruitment success in *Nephrops*. Some stocks in Division VII, such as the FU 15 stock, have well known and understood larval retention mechanisms (i.e. the Western Irish Sea Gyre). Other stocks, such as the Porcupine Bank stock, have less well

understood larval retention mechanisms. This results in very different population structure, productivity, and vulnerability to fishing. Increasing water temperature leading to shorter larval development times is thought to improve recruitment in areas such as the Irish Sea. Increased storminess related to the North Atlantic Oscillation (NAO) has also been linked to reduced recruitment and low catch rates several years later on the Porcupine Bank.

Effects of the fisheries on the ecosystem

Trawling for *Nephrops* results in bycatch and discards of other commercial species, including cod, haddock, whiting, hake, monkfish, and megrim. Given that 80 mm is the predominant mesh size used in *Nephrops* fisheries the resulting discard rates of small *Nephrops* and fish can be high.

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. Despite the high intensity of fishing (some areas are impacted >7 times year⁻¹) 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 likely to generate high long-term yield (and low probability of stock overfishing) have been explored 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} are determined. Three candidates for F_{MSY} proxies are $F_{0.1}$, $F_{35\%SpR}$, and F_{max} . There may be strong differences in relative exploitation rates between the sexes for many stocks. To account for this, values for each of the candidates have been determined for males and females separately, and for the two sexes combined. The appropriate F_{MSY} candidate has been selected for each functional unit independently according to the perception of stock resilience, factors affecting recruitment, population density, knowledge of biological parameters, and the nature of the fishery (relative exploitation of the sexes and historical harvest rate versus stock status).

A decision-making framework based on the table below was used in the selection of preliminary stock-specific F_{MSY} proxies. These may be modified following further data exploration and analysis. 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%. In such a case a more conservative sex-specific F_{MSY} proxy should be chosen over the combined proxy.

		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}
Historical fishery	Stable spatially and temporally	$F_{35\%SpR}$	$F_{35\%SpR}$	F_{max}
	Sporadic	$F_{0.1}$	$F_{0.1}$	$F_{35\%SpR}$
	Developing	$F_{0.1}$	$F_{35\%SpR}$	$F_{35\%SpR}$

Preliminary MSY $B_{trigger}$ reference points were proposed at the lowest abundance observed in the UWTV burrow abundance, unless the stock has shown signs of stress at higher abundance (in which case a higher value is used). However, the time-series of surveys in Subarea VII are too short for that. For FU 15, where a longer series of survey trawl cpue was available; this was used to estimate a preliminary MSY $B_{trigger}$.

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 VII (both in terms of TACs and effort) does not provide adequate safeguards ensuring that local effort is sufficiently limited to avoid depletion of resources in separate functional units. The current situation allows for catches to be taken anywhere (other than in FU 16) in the TAC area and this could imply inappropriate harvest rates in some FUs. The “of which” clause applied on the Porcupine Bank since 2011, without other management measures, has increased the risk of highgrading and area misreporting in that area (See Section 5.3.21.3).

Management considerations

Landings from the northwest coast of Ireland (FU 18) have previously been treated as a separate functional unit although landings have been negligible in recent years and there is no major *Nephrops* fishery in that area. There are also *Nephrops* catches in other rectangles outside functional units in Subarea VII. There is no information available on the trends in the stock or exploitation status for FU 18 and the rectangles outside the FUs (‘other rectangles’) for which ICES provides advice.

Landings in Subarea VII in recent years have been well below the TAC due to low uptake by France and Spain, whereas the UK and Irish landings are close to the quota.

Regulations and their effects

Landings by some fleets prior to 2007 are thought to have been underreported. The implementation of the ‘buyers and sellers’ legislation in the UK in 2006 and ‘sales notes’ in Ireland in 2007, coupled with the increased TAC in 2007, is thought to have improved the reliability of reported landings data. The transition has been accompanied by a large change in reported landings and a significant recent increase in landings per unit effort (lpue) for some countries that cannot completely be attributed to changes in the stock.

Data and methods

The assessments and advice for the main *Nephrops* stocks in Subarea VII 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). The advice in all cases makes use of the most recent surveys in the summer of 2014. Additional indicators of changes in stocks are derived from trends in length compositions and sex ratio in the catches, fishery lpue, and trawl survey catch rates (for FUs 15 and 16).

Only landings data are available for FU 18 and ‘other rectangles’ and the advice given this year for 2015 is the same landings advice given for 2014 (235 tonnes). This followed ICES approach to data-limited stocks, and is based on a 20% reduction (precautionary buffer) compared to the average landings of 2010–2012, according to category 6.2 (ICES, 2012). No information on discards is available for FU 18 and ‘other rectangles’. Landings from ‘other rectangles’ are estimated because no Spanish landings have been reported to ICES in 2011 and 2012 for this area. Prior to 2011 the Spanish landings represented around one third of the total landings from ‘other rectangles’.

For FUs 14, 15, 16, 17, 19, 20–21, and 22, the following procedure is adopted for providing assessment and advice based on UWTV survey estimates:

- 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, 2013) 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} , $F_{35\%SPR}$) for males, females, and for both sexes combined are computed. 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 F_{MSY} proxy and other options by applying the appropriate harvest ratios to the population numbers estimate from the most recent UWTV survey. In the case of FUs 20–21 it has not yet been possible to estimate an F_{MSY} proxy so the harvest rate associated with the previous advice is used. The UWTV approach assumes that population numbers remain stable in the interim year. Landings, dead discards, and surviving discards are derived from the resultant total catch numbers after multiplying by the recent average value for proportion retained and mean weight in the landings and discards.

Uncertainties in assessment and forecast

Preparing for the benchmark of UWTV assessments (ICES, 2009) ICES expert groups have worked to reduce uncertainty and increase precision in the interpretation of survey data. Despite these improvements, there remains a requirement for expert knowledge in the production of correction factors applied to UWTV abundance estimates.

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, 2013) is to use a multi-annual average to dampen variability. Improved quality of fishery data and knowledge of growth rates are needed for development of analytical assessment models and improvement of MSY reference points. The calculations of harvest ratio and reference points $F_{0.1}$ and F_{max} are all based on yield-per-recruit analyses. In addition, important assumptions are made on growth, natural mortality, and discard rates in the derivation of reference points.

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. There are no recent estimates for the fisheries in Subarea VII, but estimates from studies conducted in other areas range from 20–40% in Scottish waters (Wileman *et al.*, 1999) to 45–65% in the Bay of Biscay (Méhault *et al.*, 2011). Across most of Subarea VII discard survival is expected to be relatively low due to lengthy tow durations, volume of catches, prolonged sorting on deck, and relatively high density of *Nephrops* on the seabed. Taking this into account, a discard survival value of 10% is used in FUs 15 and 17. In the FUs 19, 20–21, and 22 a discard survival rate of 25% is used based on a study by Morizur *et al.* (1982). In FU 14 discarding is known to occur over non-*Nephrops* habitats and in these cases 0% survival is assumed.

Sources

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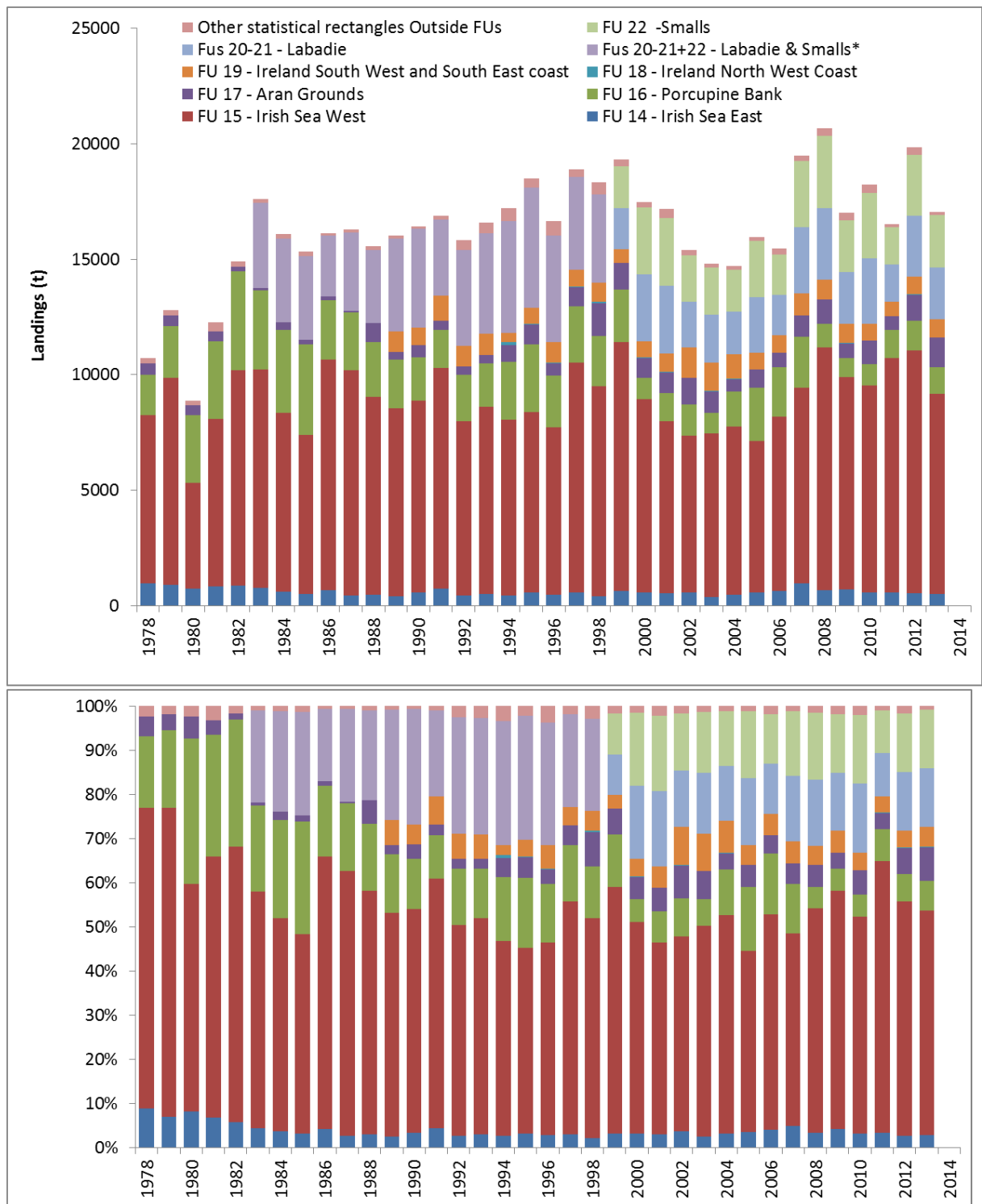


Figure 5.3.21.2

Nephrops in Subarea VII. Top: Total landings (in tonnes). Bottom: percentage of the total landings by functional unit (FU) and from rectangles outside the FUs. Landings from FUs 20–21 and FU 22 are combined prior to 1999.

Table 5.3.21.2 *Nephrops* in Subarea VII. ICES estimates of landings (tonnes) from all individual functional units within TAC Subarea VII.

Year	FU 14 – Irish Sea East	FU 15 – Irish Sea West	FU 16 – Porcupine Bank	FU 17 – Aran Grounds	FU 18 – Ireland North West Coast	FU 19 – Ireland South West and South East coast	FUs 20– 21 & 22 – Labadie & Smalls*	FUs 20– 21 – Labadie	FU 22 – Smalls	Other statistical rectangles outside FUs	Total landings in ICES Subarea VII	TAC for Subarea VII
1978	961	7296	1744	481						249	10731	
1979	900	8948	2269	452						237	12806	
1980	730	4578	2925	442						205	8880	
1981	829	7249	3381	414						382	12255	
1982	869	9315	4289	210						234	14917	
1983	763	9448	3426	131			3667			174	17609	
1984	602	7760	3571	324			3653			187	16097	
1985	498	6901	3919	207			3599			194	15318	
1986	671	9978	2591	147			2638			113	16138	
1987	449	9753	2499	62			3409			107	16279	24700
1988	462	8586	2375	828			3165			140	15556	24700
1989	401	8128	2115	344		899	4005			134	16026	26000
1990	563	8300	1895	519		754	4290			102	16423	26000
1991	747	9554	1640	410		1077	3295			169	16891	26000
1992	427	7541	2015	372		888	4165			409	15816	20000
1993	515	8102	1857	372	10	905	4358			455	16573	20000
1994	447	7606	2512	729	126	390	4843			570	17223	20000
1995	584	7796	2936	866	26	695	5198			397	18498	23000
1996	475	7247	2230	528	46	888	4602			623	16639	23000
1997	566	9971	2409	841	15	756	3991			340	18888	23000
1998	388	9128	2155	1410	78	827	3819			514	18320	23000
1999	624	10786	2290	1140	16	579		1152	1788	322	18697	23000
2000	567	8370	910	880	9	696		1778	2907	243	16361	21000
2001	532	7441	1222	913	2	815		1833	2935	368	16062	18900
2002	577	6793	1327	1154	14	1318		2674	1990	243	16090	17790
2003	376	7065	908	933	16	1239		2953	2050	186	15726	17790
2004	472	7270	1526	525	22	1074		2443	1827	161	15320	17450
2005	570	6554	2315	778	15	711		2469	2425	180	16017	19544
2006	628	7561	2120	637	14	741		2523	1752	270	16246	21498
2007	959	8491	2186	913	3	957		2419	2881	206	19015	25153
2008	681	10508	1000	1057	1	866		2980	3114	322	20529	25153
2009	708	9198	825	625	10	833		3145	2245	316	17905	24650
2010	583	8963	917	1000	7	722		1793	2840	359	17184	22432
2011	561	10162	1205	600	13	608		1237	1617	149	16152	21759
2012	530	10529	1260	1135	35	770		1189	2633	325	18406	21759
2013	495	8672	1142	1295	10	781		1387	2255	181	16218	23065
2014												20989
Average	603	8376	2109	658	23	832	3919	2132	2351	270	16216	

*Landings from FUs 20–21 and FU 22 are combined prior to 1999.

Table 5.3.21.3*Nephrops* in Subarea VII. ICES estimates of landings (tonnes) by country for FU 18.

Year	Ireland	UK	Total
1993	9	1	10
1994	124	2	126
1995	24	2	26
1996	46	1	46
1997	13	2	15
1998	77	1	78
1999	15	0	16
2000	9	0	9
2001	2	0	2
2002	14	0	14
2003	16	0	16
2004	22	0	22
2005	15	0	15
2006	14	0	14
2007	3	0	3
2008	1	0	1
2009	10	0	10
2010	7		7
2011	13	0	13
2012	28		28
2013*	10		10

*Preliminary estimates.

Table 5.3.21.4 *Nephrops* in Subarea VII. ICES estimates of landings (tonnes) by country for other rectangles outside functional units, but within ICES Subarea VII.

Year	France	Ireland	Spain	UK	UK E&W	UK NI	UK SCO	Belgium	Total
1976				0					0
1977				1					1
1978			249	0					249
1979			237	0					237
1980			205	0					205
1981			382	0					382
1982			228	6					234
1983			168	6					174
1984			186	1					187
1985			151	43					194
1986			80	33					113
1987			58	49					107
1988			62	78					140
1989			88	46					134
1990			87	15					102
1991			131	38					169
1992			317	92					409
1993		62	323	70					455
1994		220	260	90					570
1995		100	188	109					397
1996		96	404	123					623
1997		112	81	147					340
1998		145	166	203					514
1999	51	136	88	47					322
2000	41	65	107	31					243
2001	26	104	217	21					368
2002	17	119	87	19					243
2003	0	152	34						186
2004	0	88	61	12					161
2005	0	125	50	5					180
2006	0	140	26	9	16	78			270
2007	0	89	23	3	33	57			206
2008	0	76	24	4	49	170			322
2009	0	29	209		29	49			316
2010	0	120	155		22	53	9		359
2011		92	39*				17		149
2012	1	194	92**		7	30		1	325
2013***	38	53	35		4	8	3	0	181

* Estimates based on the average percentage in 2010 and 2012.

** From STECF database.

*** Preliminary estimates.