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13 Norway lobster (*Nephrops norvegicus*) in Division 6.a, Functional Unit 12 (West of Scotland, South Minch)

Type of assessment in 2022

The assessment and provision of advice through the use of the UWTV survey data and other commercial fishery data follow the process defined by the benchmark WG (WKNEPH, 2009; WKNEPH, 2013). Full details are provided in the stock annex.

ICES advice applicable to 2021

‘ICES advises that when the EU multiannual plan (MAP) for Western Waters and adjacent waters is applied, catches in 2021 that correspond to the F ranges in the MAP are between 4703 tonnes and 5916 tonnes, assuming recent discard rates. The entire range is considered precautionary when applying the ICES advice rule.

To ensure that the stock in Functional Unit 12 is exploited sustainably, management should be implemented at the functional unit level.’

ICES advice applicable to 2022

‘ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of the years 2018–2020, catches in 2022 should be no more than 3977 tonnes.

To ensure that the stock in Functional Unit (FU) 12 is exploited sustainably, management should be implemented at the FU level.

ICES notes the existence of a management plan, developed and adopted by one of the relevant management authorities for Subarea 6. ICES considers this plan to be precautionary when implemented at the FU level.’

13.1 General

Stock description

The South Minch (FU12) is located midway down the west coast of Scotland (see. Section 12 FU11 North Minch, Figure 12.1). The area is characterised by numerous islands of varying size, with sea lochs occurring along the mainland coast. These topographical features create a diverse habitat with complex hydrography and a patchy distribution of various soft sediments. Further details are provided in the stock annex.

Management applicable to 2021 and 2022

Management is at the ICES subarea level as described at the beginning of Section 12 FU11 North Minch.

Ecosystem aspects

Details of the ecosystem aspects for this functional unit are provided in the stock annex where available.

Fishery description

Information on developments in the fishery was provided by Marine Scotland compliance officers. In 2021 the fishery was described as remaining generally very poor. The COVID-19 affected the markets for product, with even small local markets ceasing operations due to closure of restaurants and other establishments for extended periods of time.

Two distinct fleets operate in the South Minch and the main ports are Oban and Mallaig. In Oban there are 56 local vessels (40 <10m vessels), while there was no information available from Mallaig for 2021. The local fleet in Oban changes quite frequently, e.g. some operators attempt to move to larger vessels but cannot find sufficient numbers to crew them.

Since 2009, vessels have been required to fit 120 mm square meshed panels, in accordance with the west coast emergency measures (Council Reg. (EU) 43/2009). Large SMPs (200 mm) are also widely used and were made mandatory for all TR2 vessels with power >112 kW fishing as part of the previous Scottish Conservation Credits scheme. Twin rig vessels tend to use a 200 mm square mesh panel with a 100 mm or larger mesh codend. These vessels do not catch bulk quantities and this leads to *Nephrops* of better average size and quality. A comment was noted in 2017 about the use of bungee cords to keep the meshes closed. This was investigated by Compliance officers but was deemed to be legal and was not reported as a problem in subsequent years.

There is very little fish bycatch landed due to the restrictions on cod, haddock and whiting (detailed in ICES, 2016a, ICES, 2016b and ICES, 2016c). Estimates of discard rates of haddock and whiting remain high (ICES, 2016d and ICES, 2017a). Haddock in areas 6a are now covered by the landings obligation in area.

Further general information on the fishery can be found in the stock annex.

13.2 Data available

InterCatch

Data for 2021 were uploaded to InterCatch prior to the 2022 WG meeting. Uploaded data were worked up in InterCatch to generate 2021 raised international length–frequency distributions. Allocation schemes for any unsampled fleets are described in the stock annex. Data exploration in InterCatch has previously shown that outputs of raised data were very close to those generated by the previous method applied internally with differences being <0.1%. As such, InterCatch length–frequency outputs have been used in the stock assessment since 2012.

The COVID-19 pandemic resulted in reduced sampling of commercial catches for FU12 in 2021, as was also the case in 2020. Discard sample data for FU12 was only available for quarter three of 2021, and so, InterCatch estimates of discard rates for quarters one, two, and four were based on samples collected in quarter three. Following download of data from InterCatch, alternate methods of 2021 discard estimation were also considered. It was agreed at WGCSE that estimates of discard rates and associated size distributions for 2021 would be based on an averaging of discard samples across all available quarters between 2017 and 2021. Minimum and maximum discard rates over the same period were also examined to gain an appreciation of the plausible range of discarding that might have occurred in 2021. Assessment estimates affected by changes

in discard rates are annotated hereafter to reflect this; i.e. " $x (y/z)$ ", where x is the estimate based on the average discard rate from samples available between 2017 and 2021, y is based on minimum discard rate, and z on maximum discard rate over the same period.

Commercial catch

Official catch statistics (landings) reported to ICES are shown in Table 12.1.1 (see. Section 12 FU11 North Minch). These relate to the whole of 6.a, of which the South Minch is a part. Landings for FU12 provided through national laboratories are presented in Table 13.2.1, broken down by country and by gear type. Landings from this fishery are predominantly reported from Scotland, with low levels reported from the rest of the UK and Ireland. Total reported Scottish landings in 2021 were 2577.3 tonnes (plus 77 tonnes from other UK vessels, and 42 tonnes from Ireland), consisting of 1939 tonnes (75%) landed by Scottish *Nephrops* trawlers and 619 tonnes (24%) landed by Scottish creel vessels. A small amount of below minimum size (BMS) landings was also reported (0.3 tonnes). The proportion of creel caught landings has generally increased somewhat over the past decade, from 19% in 2012 to 24% in 2021.

Effort data

In 2015, WGCSE agreed that effort should be reported in kW days as this is likely to be more informative about changes in the actual fleet effort. Effort shows an overall decreasing trend since 2003 but there are peaks in 2008 and 2012, which can be attributed to visiting North Sea trawlers (Figure 16.2.1). The decline in effort observed in recent years halted in 2021, with a slight observed increase in effort following the extensive interruptions the fishery experienced in 2020 due to the COVID-19 pandemic. Note that the effort time-series range (2000–2021) does not match the more extensive range available for landings due to a lack of confidence in the reliability of older effort data in the Marine Scotland Science database. The effort is also slightly inconsistent with the landings data because effort is provided for TR2 vessels only, while the '*Nephrops* trawl' landings also includes landings by large mesh trawlers targeting *Nephrops*.

Sampling levels

Length compositions of landings and discards are obtained during market sampling and on-board observer sampling respectively. These sampling levels are shown in Table 12.2.2 (see. Section 12 FU11 North Minch). Sampling effort in 2021 was lower than years preceding 2020, due to disruptions to both the fishing industry and government sampling programmes attributable to the COVID-19 pandemic. Length compositions for the creel fishery are available for landings only as the small numbers of discards from the fishery survive well. Therefore, these animals are not considered to be removed from the population, and 100% survival is assumed (ICES, 2013).

Length compositions

Figure 13.2.2 shows a series of annual length–frequency distributions from 2002 onwards which appear fairly stable across the time-series. Catch and landings length compositions, and mean size are shown for each sex. The mean size of males and females decreased slightly in 2021.

Sex ratio

The sex ratios observed in the South Minch in 2020 & 2021 showed some divergence from those observed in years with better sample coverage, although males still made the largest contribution

to the annual landings in most quarters. In the years prior to 2020, males were available to the fishery throughout the year while females were mainly caught in the summer when they emerge from their burrows after egg hatching has occurred. This seasonal change could be observed in the quarterly sex ratios, with males dominating the catch in quarters one and four, and a more even sex ratio observed in quarters two and three. However, in 2020, all quarterly sex ratios were majority male (Figure 13.2.3) due to the decreased number of samples which were available for the year. In 2021, the quarterly sex ratios were more similar to typical years, although quarter four had the highest male ratio of the series. This metric is used as an indicator, whereby increasing proportions of females in the catch might signal an effect of acute overfishing. In the case of recent years, however, the unusual sex ratios are known to be due to poor sampling, and not a cause for concern to management.

Mean weights

The mean weight in the landings (Figures 15.2.4 and 15.2.5; see. Section 12 FU11 North Minch, Table 15.2.3) have fluctuated around a relatively high level since 2011. Seasonal variability (and occasional outliers) in mean weights are seen in the individual sample estimates. There appears to be a small increase in the mean weight of the males for the trawl caught *Nephrops* and also for both males and females caught by creels (Figure 15.2.5). The annual estimate of mean weight in the landings has an effect on the catch forecast. Over the time-series, there is a general increasing trend in mean weights in the landings, however, there was a substantial decrease in mean weight in 2021 following the highest recorded mean weight in 2020.

Discarding

Discarding of undersized and unwanted *Nephrops* occurs in this fishery. Discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 1990. Discarding rates in this FU have varied considerably over the years, ranging from 3% to over 25%. In 2021, the discarding rate was 5.6% (2.1%/28.6%) based on mean discard rates observed between 2017 and 2021. This represents a decrease on 2020 (7.8%). The low levels of discarding in recent years may be explained by poor fishing and a gradually decreasing fleet (Table 13.2.2).

Studies (Charuau *et al.*, 1982; Sangster *et al.*, 1997; Wileman *et al.*, 1999) suggest that some *Nephrops* survive the discarding process, thus, an estimate of 25% survival is assumed for this FU in order to calculate removals (landings + dead discards) from the population. The discard survival rate for creel caught *Nephrops* has been shown to be high (ICES, 2013) and a value of 100% is assumed. The discard rate (adjusted to account for survival) which will be used in the forecast was estimated by taking a three-year average (2019–2021), amounting to 6.8% (3.7%/10.7%).

Abundance indices from UWTV surveys

An underwater TV survey of the stock is conducted annually according to standards set out by the Manual for the *Nephrops* Underwater TV Surveys (Dobby *et al.*, 2021). Surveys use a stratified random approach, and have been carried out for this stock since 1995. TV surveys are targeted at known areas of mud, sandy mud and muddy sand in which *Nephrops* construct burrows. The numbers of valid stations used in the final analysis in each year are shown in Table 16.2.3. On average, 36 stations have been considered valid each year, and raised to a stock area of 5072 km² (derived from BGS sediment data). The 2022 UWTV survey of FU 12 was carried out in two stages, during June/July and August/September of 2022. The first part was the regularly scheduled annual survey, while the second was an ad hoc survey to collect data in areas which

were missed during the annual survey for logistic reasons. The first part of the survey collected random stations mostly located in the inshore areas to the east and south of the FU, and some in the central area. The second part of the survey collected stations in the northwest, some of which were randomly assigned and some which were moved from the southwest to maximise sample collection during the time which was at the survey team's disposal. A total of 41 valid TV stations were completed in 2022 and used in the survey analysis (Table 13.2.3; 24 stations in the first part of the survey and 17 in the second part), with one station excluded from the second part of the survey due to an excessively rocky seabed.

TV survey abundance estimates from 1995–2022 are shown in Table 13.2.3 and Figure 13.2.4. Since 2007, the stock has undergone cycles wherein abundance oscillates between high and low values over five to six year periods (Figure 13.2.4), with changes of up to 1199 million individuals between the lowest and highest points of a cycle (between 2012 and 2016). The 2022 abundance represents a 32% increase in relation to 2021.

Table 13.2.4 shows a more detailed summary of the results from the three most recent TV surveys conducted in FU12. The table includes estimates of abundance and variability in each of the strata adopted in the stratified random approach. Mean burrow density decreased in 2022, in comparison to the 2021 survey, in all strata apart from Sandy Mud. Densities are generally lower in the western parts of the area towards the Outer Hebrides and higher in the inshore areas to the south west of Skye (Figure 13.2.5). The CV for the 2022 TV survey (Table 13.2.4) is lower than the 20% precision level agreed by WGNeps (2019; 12.6%).

The use of the UWTV surveys for *Nephrops* in the provision of advice was extensively reviewed by WKNEPH (ICES, 2009; ICES, 2013), WGNeps (ICES, 2018a), WKNEPH (ICES, 2018b) and (Leocádio *et al.*, 2018). A number of potential biases were highlighted including those due to edge effects, species burrow misidentification and burrow occupancy. The cumulative relative to absolute conversion factor estimated for FU12 was 1.32 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 32%.

13.3 Assessment

Comparison with previous assessments

The assessment follows the same procedure as last year and is based on a combination of examining trends in fishery indicators and underwater TV abundance estimates. The process was defined by the benchmark WG and is described in the stock annex.

State of the stock

The underwater TV survey is presented as the best available information on the South Minch (FU12) *Nephrops* stock. The details of the 2022 survey are shown in Table 16.2.4, and compared with the 2020 and 2021 outcomes. At present, it is not possible to extract any length or age structure information from the survey and therefore it only provides information on abundance over the area of the survey.

TV survey estimated stock abundance in 2022 was 1677 million individuals, above the MSY B_{trigger} value of 1016 million, or the rounded value of 1020 million used for the provision of advice.

The calculated harvest rate in 2021 (dead removals/TV abundance = 7.5%; 7.2%/9.2%) was below the F_{MSY} proxy for this stock (the value associated with high long-term yield and low risk depletion) of 11.7%.

13.4 Catch scenarios table

Landings predictions and catch options at various harvest rates (based on principles established at WKNEPH (ICES, 2009)), are made on the basis of the 2022 UWTV survey conducted in June. These were presented at WGCSE NEPH in September 2022 for the provision of advice.

Catch scenarios table inputs and historical estimates of mean weight in landings and harvest rates are presented in Table 16.2.2 and summarised below. The calculation of catch scenarios for the South Minch follows the procedure outlined in the stock annex.

Given the variability in mean weights it was considered more appropriate to use a full time-series average, from 1999 (first year with creel and trawl length distributions combined) until 2021.

The table below shows the agreed inputs to the catch scenario table.

| Input | Data | 2022 assessment |
|---------------------------------------|--------------------------------|-----------------|
| Survey abundance (millions) | UWTV 2022 | 1677 |
| Mean weight in projected landings (g) | 1999–2021 | 27.43 |
| Mean weight in projected discards (g) | 1999–2021 | 10.18 |
| Projected discard rate | 2019–2021 | 6.8%* |
| Discard survival rate | Proportion by number (assumed) | 25%** |

* Based on mean discard rate (2017–2021) allocated to 2021; estimates of 10.7% and 3.7% were derived based on the maximum and minimum observed discard rates, respectively, for the same period

** Discard survival in the creel fishery is assumed to be 100%, as outlined in the stock annex.

13.5 Reference points

New reference points were derived for this stock at WKMSYRef4 (ICES, 2016e). These are updated on the basis of an average of estimated F_{MSY} proxy harvest rates over a period of years which corresponds more closely to the methodology for finfish. In cases where there is a clear trend in the values, a five-year average was chosen. Similarly, the five-year average of the F at 95% of the YPR obtained at the F_{MSY} proxy reference point was proposed as the F_{MSY} lower bound and the five-year average of the F above F_{MAX} that leads to YPR of 95% of the maximum as the upper bound. Using an average value also has the advantage of reducing the effect of any unusually high or low estimates of the F_{MSY} proxy, which occasionally appear. For this stock, the F_{MSY} proxy has been revised from 12.3% to 11.7%.

For *Nephrops* stocks, $MSY B_{trigger}$ has been defined as the lowest stock size from which the abundance has increased and is calculated as 1016 million individuals (in 2010). This value was rounded to 1020 million, in the advice from WKMSYRef4 on $MSY B_{trigger}$. Full details are contained in the stock annex.

These should remain under review by WGCSE and may be revised should improved data become available.

Table 13.2.2 and Figure 13.5.1 show the harvest rates for FU12. The harvest rate has fluctuated over the time-series and has been below the F_{MSY} proxy since 2013. The increase in 2016, compared to the 2013–2015 harvest rates, was due to relatively increased landings compared to abundance. The harvest rate more than halved in 2018 compared to 2017, and has continued to decrease through 2020 to a new historical low, increasing again in 2021 (7.5%; 7.2%/9.2%).

It is likely that prior to 2006, the harvest rates are underestimates due to under-reported landings.

13.6 Management strategies

Scotland has established a network of regional Inshore Fisheries Groups (rIFGs), non-statutory bodies that aim to improve the management of Scotland's inshore fisheries out to six nautical miles, and to give commercial inshore fishermen a strong voice in wider marine management developments. The rIFGs will contribute to regional policies and initiatives relating to management and conservation of inshore fisheries, including impacts on the marine environment and the maintenance of sustainable fishing communities and measures designed to better conserve and sustainably exploit stocks of shellfish and sea fish (including salmon) in their local waters. Although no IFG proposals specific to the management of *Nephrops* fisheries have yet been adopted, some of the IFG management plans for the Scottish West Coast include spatial management of *Nephrops* fisheries and the introduction of creel limits.

On the 8th of February 2016, phase 1 of the fisheries management measures for inshore MPAs in Scottish waters came into force (SG, 2016). These measures relate to both Nature Conservation MPAs (NCMPAs; Marine (Scotland) Act and the UK Marine and Coastal Access Act) and Special Areas of Conservation (SACs; EC Habitats Directives – Council Directive 92/43/EEC) both of which have the aim of conserving biological diversity in Scottish waters and contribute to Scotland's MPA network (SG, 2017a). Although not specific to the management of the *Nephrops* fishery, they will influence spatial patterns of fishing for *Nephrops* where controls on the two main gear types, demersal trawls and creels, are implemented on *Nephrops* habitat. There are seven protected areas within the South Minch functional unit with fisheries management measures. MPAs on the main areas of *Nephrops* habitat include the Loch Sunart to the Sound of Jura NCMPA where demersal trawling is banned in some areas, i.e. zoned, and seasonal closures implemented in others, Loch Sunart NCMPA/SAC, where demersal trawling is banned and creeling is zoned, the East of Mingulay SAC, demersal trawling banned and creeling zoned, and the Trenish Isles SAC, demersal trawling banned. Another area is the Loch Duich, Long and Alsh NCMPA/SAC, covering some patches of muddy sediment, where demersal trawling is banned or temporally closed in other areas that extend beyond the MPA onto muddy sediment. Other areas include the Loch Creran SAC/NCMPA, demersal trawling banned and creeling zoned, and the Firth of Lorn SAC, which has the same management as the Loch Sunart to the Sound of Jura NCMPA. For the Firth of Lorn and Loch Creran, management was in place prior to 2016 (SG, 2016). An additional NCMPA, at Loch Carron, was designated using emergence powers in 2017 (SG, 2017b). The areas of the SACs and NCMPAs relative to the estimated *Nephrops* habitat within the South Minch functional unit are displayed in Figure 13.6.1.

13.7 Quality of assessment and forecast

The length and sex composition of the landings data is considered to be generally adequately sampled, sampling levels have remained relatively consistent over the past two years (see Section 16.2), with the exception of quarter 2 of 2020 where sampling efforts were disrupted by the COVID-19 pandemic. Discard sampling has been conducted for Scottish *Nephrops* trawlers in this fishery since 1990, and is considered to represent the trawl fishery adequately. The reduced sampling effort in 2021 meant that discard sample data were only available for Quarter three, and it was agreed at WGCSE that estimates of discard rates and size distributions for 2021 would be adequately approximated for the purpose of forecasting by averaging of discard samples across all available Quarters between 2017 and 2021. The landings length compositions from 1999 onwards are derived from both creel and trawl samples. The creel fishery, which accounts for an increasing proportion of the landings in recent years (~24-29% in the past three years) and

increasingly operates over similar areas to trawling, exhibits a length composition composed of larger animals.

There are concerns over the accuracy of historical landings and effort data prior to 2006 when Buyers and Sellers legislation was introduced and the reliability began to improve. Because of this, the final assessment adopted is independent of official statistics. Harvest rates since 2006 are also considered more reliable due to more accurate landings data reported under new legislation. Incorporation of creel length compositions has also improved estimates of harvest rates.

Underwater TV surveys have been conducted for this stock every year since 1995. The number of valid stations in the survey has remained relatively stable throughout the time period. The survey 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, resulting in large confidence intervals and a greater uncertainty on the abundance estimates than in other FUs. This makes it difficult to determine which population changes are significant. Although the CV's have been smaller in recent years.

There is a need to explore options to implement further stratification for the South Minch survey area. In the provision of catch options based on the absolute survey estimates, additional uncertainties related to mean weight in the landings and the discard rates also arise. A three-year average (i.e. 2019–2021 for the 2022 assessment) of discard rates (adjusted to account for some survival of discarded animals) has been used in the calculation of catch options.

The cumulative relative to absolute conversion factor estimates for FU12 are largely based on expert opinion. The precision of these bias corrections cannot yet be characterised. The landings derived in the forecast (catch options table) are sensitive to the input dead discard rate and mean weights in landings, and this introduces uncertainties in the catch forecasts. Precision estimates are needed for these forecast inputs.

The overall area of the ground is estimated from the available BGS contoured sediment data and at present is considered to be a minimum estimate. Work is underway to improve the area estimation. VMS data linked to landings (from queries of the Scottish FIN database) suggest no major differences between areas fished and the mud sediment maps. Two other factors however, are likely to increase the estimate of ground area available for *Nephrops* and *Nephrops* directed fishing. Firstly, the inclusion of vessels smaller than 15 m would likely increase the fished area in some of the inshore locations and secondly, it is known that most of the sea lochs have areas of mud substrate and are typically fished by creel boats. In recent years, limited TV surveys have taken place in some of the sea lochs and attempts are being made to utilise these data to improve estimates of mud area and *Nephrops* abundance in the South Minch.

13.8 Recommendation for next benchmark

This stock was last benchmarked in 2009. WGCSE will keep the stock under close review and recommend future benchmark as required.

At WGCSE 2022 it was agreed that a benchmark/interbenchmark should be carried out on FU12 *Nephrops*, addressing the potential for provision of abundance estimates with reduced uncertainty using alternate estimation methods (REF WGCSE 2022 report).

13.9 Management considerations

ICES and STECF have repeatedly advised that management should be at a smaller scale than the ICES division level. Management at the functional unit level could provide controls to ensure effort and catch were in line with resources available.

Creel fishing takes place in this area but overall effort in terms of creel numbers is not known and measures to control numbers are not in place. There is a need to ensure that the combined effort from all forms of fishing is taken into account when managing this stock.

There is a bycatch of other species in the area of the South Minch and estimated discards of whiting and haddock by the TR2 fleet are high in area 6.a generally. It is important that efforts continue to ensure that unwanted bycatch is kept to a minimum in this fishery.

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Table 13.2.1. *Nephrops*, South Minch (FU12), ICES estimates of landings of *Nephrops*, 1981–2021.

| UK SCOTLAND | | | | | | OTHER UK | IRELAND | TOTAL |
|-------------|----------------|-------|-------|--------------------|-----------|----------|---------|-------|
| YEAR | NEPHROPS TRAWL | OTHER | CREEL | BELOW MINIMUM SIZE | SUB TOTAL | | | |
| 1981 | 2966 | 254 | 432 | 0 | 3652 | 0 | 0 | 3652 |
| 1982 | 2925 | 206 | 421 | 0 | 3552 | 0 | 0 | 3552 |
| 1983 | 2595 | 362 | 456 | 0 | 3413 | 0 | 0 | 3413 |
| 1984 | 3229 | 477 | 594 | 0 | 4300 | 0 | 0 | 4300 |
| 1985 | 3096 | 424 | 488 | 0 | 4008 | 0 | 0 | 4008 |
| 1986 | 2694 | 288 | 502 | 0 | 3484 | 0 | 0 | 3484 |
| 1987 | 2928 | 418 | 546 | 0 | 3892 | 0 | 0 | 3892 |
| 1988 | 3544 | 364 | 555 | 0 | 4463 | 10 | 0 | 4473 |
| 1989 | 3846 | 338 | 561 | 0 | 4745 | 0 | 0 | 4745 |
| 1990 | 3732 | 263 | 435 | 0 | 4430 | 0 | 0 | 4430 |
| 1991 | 3596 | 342 | 503 | 0 | 4441 | 1 | 0 | 4442 |
| 1992 | 3478 | 209 | 549 | 0 | 4236 | 1 | 0 | 4237 |
| 1993 | 3609 | 194 | 650 | 0 | 4453 | 5 | 0 | 4458 |
| 1994 | 3742 | 264 | 405 | 0 | 4411 | 3 | 0 | 4414 |
| 1995 | 3443 | 717 | 508 | 0 | 4668 | 14 | 0 | 4682 |
| 1996 | 3108 | 417 | 469 | 0 | 3994 | 1 | 0 | 3995 |
| 1997 | 3518 | 329 | 493 | 0 | 4340 | 3 | 1 | 4344 |
| 1998 | 2851 | 340 | 538 | 0 | 3729 | 0 | 1 | 3730 |
| 1999 | 3165 | 359 | 514 | 0 | 4038 | 0 | 14 | 4052 |
| 2000 | 2940 | 311 | 700 | 0 | 3951 | 0 | 2 | 3953 |
| 2001 | 2823 | 391 | 768 | 0 | 3982 | 0 | 9 | 3991 |
| 2002 | 2234 | 314 | 743 | 0 | 3291 | 0 | 14 | 3305 |
| 2003 | 2812 | 203 | 858 | 0 | 3873 | 0 | 6 | 3879 |
| 2004 | 2864 | 105 | 879 | 0 | 3848 | 0 | 21 | 3869 |
| 2005 | 2812 | 46 | 955 | 0 | 3813 | 1 | 34 | 3848 |
| 2006 | 3570 | 97 | 922 | 0 | 4589 | 9 | 35 | 4633 |
| 2007 | 4437 | 21 | 959 | 0 | 5417 | 19 | 35 | 5471 |

| UK SCOTLAND | | | | | | OTHER UK | IRELAND | TOTAL |
|-------------|----------------|-------|-------|--------------------|-----------|----------|---------|--------|
| YEAR | NEPHROPS TRAWL | OTHER | CREEL | BELOW MINIMUM SIZE | SUB TOTAL | | | |
| 2008 | 4433 | 12 | 896 | 0 | 5341 | 2 | 13 | 5356 |
| 2009 | 3346 | 24 | 900 | 0 | 4270 | 4 | 11 | 4285 |
| 2010 | 2836 | 19 | 969 | 0 | 3824 | 16 | 6 | 3846 |
| 2011 | 2876 | 11 | 783 | 0 | 3670 | 23 | 9 | 3702 |
| 2012 | 3159 | 32 | 773 | 0 | 3964 | 19 | 6 | 3989 |
| 2013 | 2490 | 543 | 729 | 0 | 3762 | 13 | 1 | 3776 |
| 2014 | 2490 | 3 | 637 | 0 | 3130 | 32 | 17 | 3179 |
| 2015 | 2662 | 18 | 665 | 0 | 3345 | 22 | 33 | 3400 |
| 2016 | 3450 | 22 | 838 | 0 | 4310 | 33 | 59 | 4402 |
| 2017 | 2833 | 60 | 775 | 0 | 3668 | 23 | 66 | 3757 |
| 2018 | 1693 | 86 | 682 | 0 | 2461 | 45 | 34 | 2540 |
| 2019 | 1493 | 39 | 621 | 0 | 2153 | 29 | 38 | 2220 |
| 2020 | 1320 | 25 | 554 | 0 | 1899 | 8 | 69 | 1976 |
| 2021 | 1939 | 19 | 619 | 0.3 | 2577.3 | 77 | 42 | 2696.3 |

Table 13.2.2. *Nephrops*, South Minch (FU12): Adjusted TV survey abundance, landings, discard rate proportion by number) and estimated harvest rate.

| YEAR | LAND- INGS NUM- BER (MIL- LIONS) | DIS- CARDS NUM- BER (MIL- LIONS) | REMOV- ALS NUMBER (MIL- LIONS)** | AD- JUSTED SUR- VEY (MIL- LIONS) | HAR- VEST RATE* | LAND- INGS (TONNES) | DISCARDS (TONNES) | DIS- CARD RATE (%) | DEAD DIS- CARD RATE (%) | MEAN WEIGHT IN LAND- INGS (g) | MEAN WEIGHT IN DISCARDS (g) |
|------------|---|---|--|---|-----------------------|---------------------------|----------------------|-----------------------------|-------------------------------------|---|-----------------------------------|
| 1999 | 161 | 29 | 183 | 1086 | 16.9 | 4052 | 206 | 15.4 | 12 | 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 | 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 | 31.1 | 8.78 |
| 2012 | 133 | 16 | 145 | 919 | 15.8 | 3989 | 145 | 10.8 | 8.3 | 29.17 | 9.05 |
| 2013 | 136 | 4 | 140 | 1718 | 8.1 | 3776 | 50 | 3.1 | 2.4 | 27.48 | 11.31 |
| 2014 | 105 | 19 | 120 | 2073 | 5.8 | 3179 | 233 | 15.6 | 12.1 | 29.91 | 12.04 |
| 2015 | 120 | 10 | 128 | 1998 | 6.4 | 3400 | 121 | 7.7 | 5.9 | 28.15 | 12.04 |
| 2016 | 177 | 31 | 201 | 2118 | 9.5 | 4402 | 365 | 14.9 | 11.6 | 24.76 | 11.74 |
| 2017 | 131 | 13 | 140 | 1384 | 10.1 | 3757 | 108 | 9.4 | 7 | 27.76 | 8.29 |
| 2018 | 91 | 4 | 94 | 1946 | 4.8 | 2540 | 54 | 4.5 | 3.4 | 27.27 | 12.74 |
| 2019 | 79 | 4 | 83 | 2362 | 3.5 | 2220 | 46 | 4.9 | 3.7 | 28.54 | 11.22 |
| 2020 | 54 | 5 | 57 | 1927 | 3 | 1976 | 46 | 7.8 | 6 | 36.58 | 9.91 |
| 2021 | 90 | 7 | 95 | 1272 | 7.5 | 2696.3 | 84 | 7.6 | 5.8 | 29.96 | 11.35 |
| 2022 | - | - | - | 1677 | - | - | - | - | - | - | - |
| Average*** | | | | | | | | | 5.2 | 27.43 | 10.18 |

* Harvest rates previous to 2006 are unreliable.

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

*** Dead discard average: 2019–2021; Mean weight in landings and discards average: 1999–2021.

Table 13.2.3. *Nephrops*, South Minch (FU12): Results of the 1995–2022 TV surveys (adjusted for bias).

| YEAR | NUMBER OF VALID STATIONS | MEAN DENSITY (BURROWS/m ²) | ABUNDANCE (MILLIONS) | 95% CONFIDENCE INTERVAL (MILLIONS) |
|------|--------------------------|--|----------------------|------------------------------------|
| 1995 | 33 | 0.227 | 1152 | 251 |
| 1996 | 21 | 0.288 | 1473 | 530 |
| 1997 | 36 | 0.212 | 1086 | 185 |
| 1998 | 38 | 0.288 | 1452 | 232 |
| 1999 | 37 | 0.212 | 1086 | 260 |
| 2000 | 41 | 0.364 | 1854 | 348 |
| 2001 | 47 | 0.402 | 2037 | 459 |
| 2002 | 31 | 0.371 | 1899 | 567 |
| 2003 | 25 | 0.424 | 2157 | 756 |
| 2004 | 38 | 0.508 | 2558 | 473 |
| 2005 | 33 | 0.432 | 2208 | 740 |
| 2006 | 36 | 0.364 | 1845 | 598 |
| 2007 | 39 | 0.197 | 1016 | 155 |
| 2008 | 33 | 0.318 | 1608 | 415 |
| 2009 | 25 | 0.303 | 1542 | 634 |
| 2010 | 34 | 0.409 | 2076 | 665 |
| 2011 | 36 | 0.383 | 1945 | 778 |
| 2012 | 38 | 0.182 | 919 | 185 |
| 2013 | 38 | 0.339 | 1718 | 365 |
| 2014 | 36 | 0.409 | 2073 | 530 |
| 2015 | 35 | 0.394 | 1998 | 514 |
| 2016 | 37 | 0.417 | 2118 | 440 |
| 2017 | 41 | 0.273 | 1384 | 282 |
| 2018 | 39 | 0.383 | 1946 | 371 |
| 2019 | 40 | 0.466 | 2362 | 578 |
| 2020 | 40 | 0.38 | 1927 | 517 |
| 2021 | 41 | 0.251 | 1272 | 339 |
| 2022 | 41 | 0.33 | 1677 | 471 |

Table 13.2.4. *Nephrops* South Minch (FU12). Results by stratum of the 2020–2022 TV surveys. Note that stratification was based on a series of sediment strata (M – Mud, SM – Sandy mud, MS – Muddy sand).

| STRATUM | AREA (km ²) | NUMBER OF STA- TIONS | MEAN BURROW DENSITY (no./m ²) | OBSERVED VARIANCE | ABUN- DANCE (MIL- LIONS) | STRATUM VARIANCE | PROPOR- TION OF TOTAL VARIANCE | SURVEY PRECISION LEVEL (CV) |
|------------------|----------------------------|----------------------------|--|----------------------|-----------------------------------|---------------------|---|-----------------------------------|
| 2020 TV Suvey | | | | | | | | |
| M | 303 | 2 | 0.193 | 0.008 | 58.6 | 381 | 0.006 | |
| SM | 2741 | 20 | 0.474 | 0.148 | 1299.7 | 55679 | 0.834 | |
| MS | 2028 | 18 | 0.281 | 0.047 | 569.2 | 10685 | 0.16 | |
| Total | 5071 | 40 | | | 1927.4 | 66745 | | 0.131 |
| 2021 TV Suvey | | | | | | | | |
| M | 303 | 3 | 0.402 | 0.084 | 121.7 | 2564 | 0.089 | |
| SM | 2741 | 17 | 0.261 | 0.046 | 716.9 | 20574 | 0.716 | |
| MS | 2028 | 21 | 0.214 | 0.029 | 433 | 5580 | 0.194 | |
| Total | 5071 | 41 | | | 1271.6 | 28719 | 0.999 | 0.126 |
| 2022 TV Suvey | | | | | | | | |
| M | 303 | 4 | 0.317 | 0.057 | 95.8 | 1324 | 0.024 | |
| SM | 2741 | 16 | 0.448 | 0.105 | 1228.9 | 49419 | 0.89 | |
| MS | 2028 | 21 | 0.173 | 0.024 | 351.8 | 4766 | 0.086 | |
| Total | 5071 | 41 | | | 1676.5 | 55508 | 1 | 0.129 |

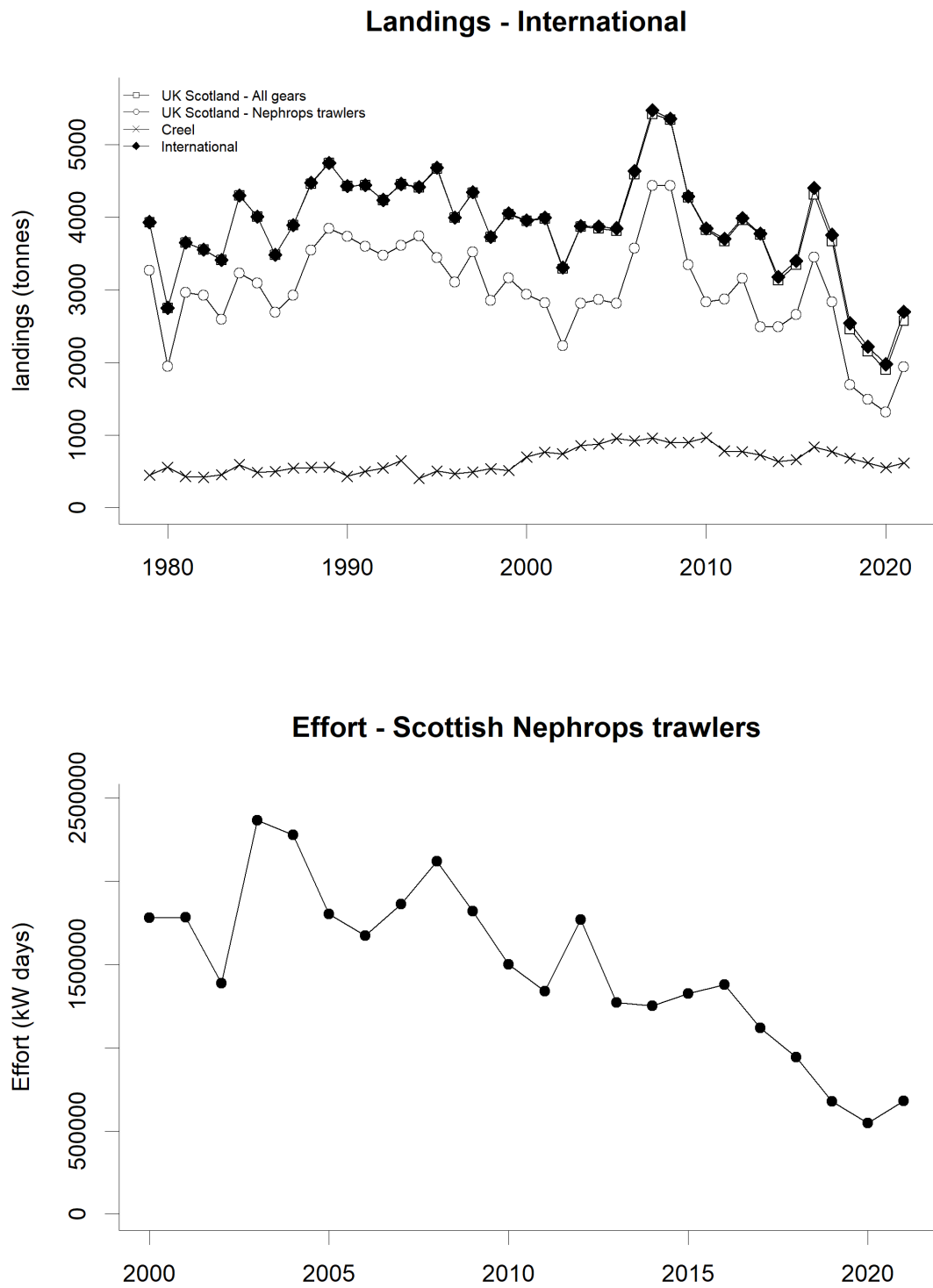


Figure 13.2.1. *Nephrops*, South Minch (FU12). Long-term landings and effort.

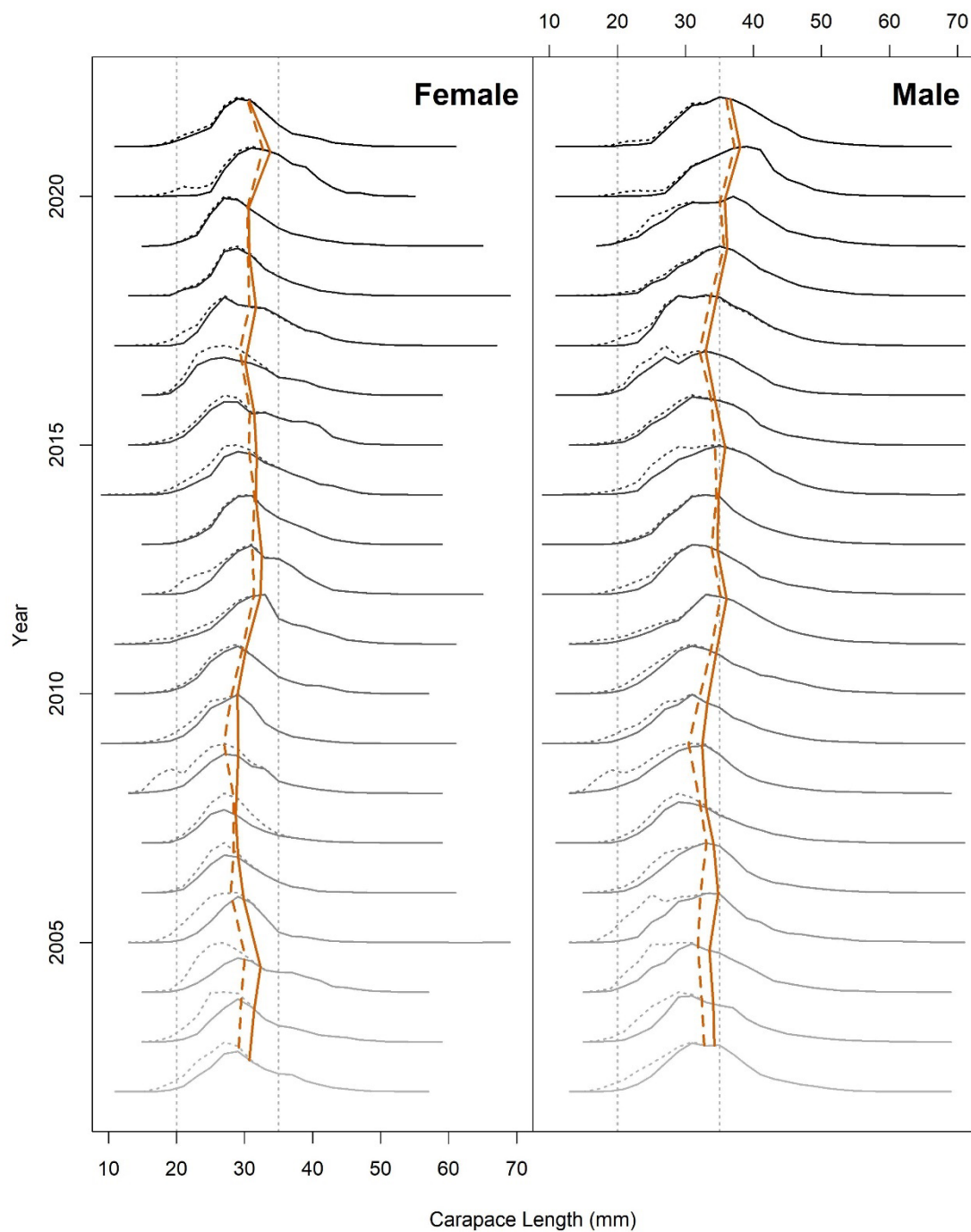


Figure 13.2.2. *Nephrops*. South Minch (FU12). Catch length–frequency distribution and mean size in catches (dotted) and landings (solid) for *Nephrops* in the North Minch, 2002–2021. Vertical dotted lines are minimum conservation reference size (20 mm) and 35 mm.

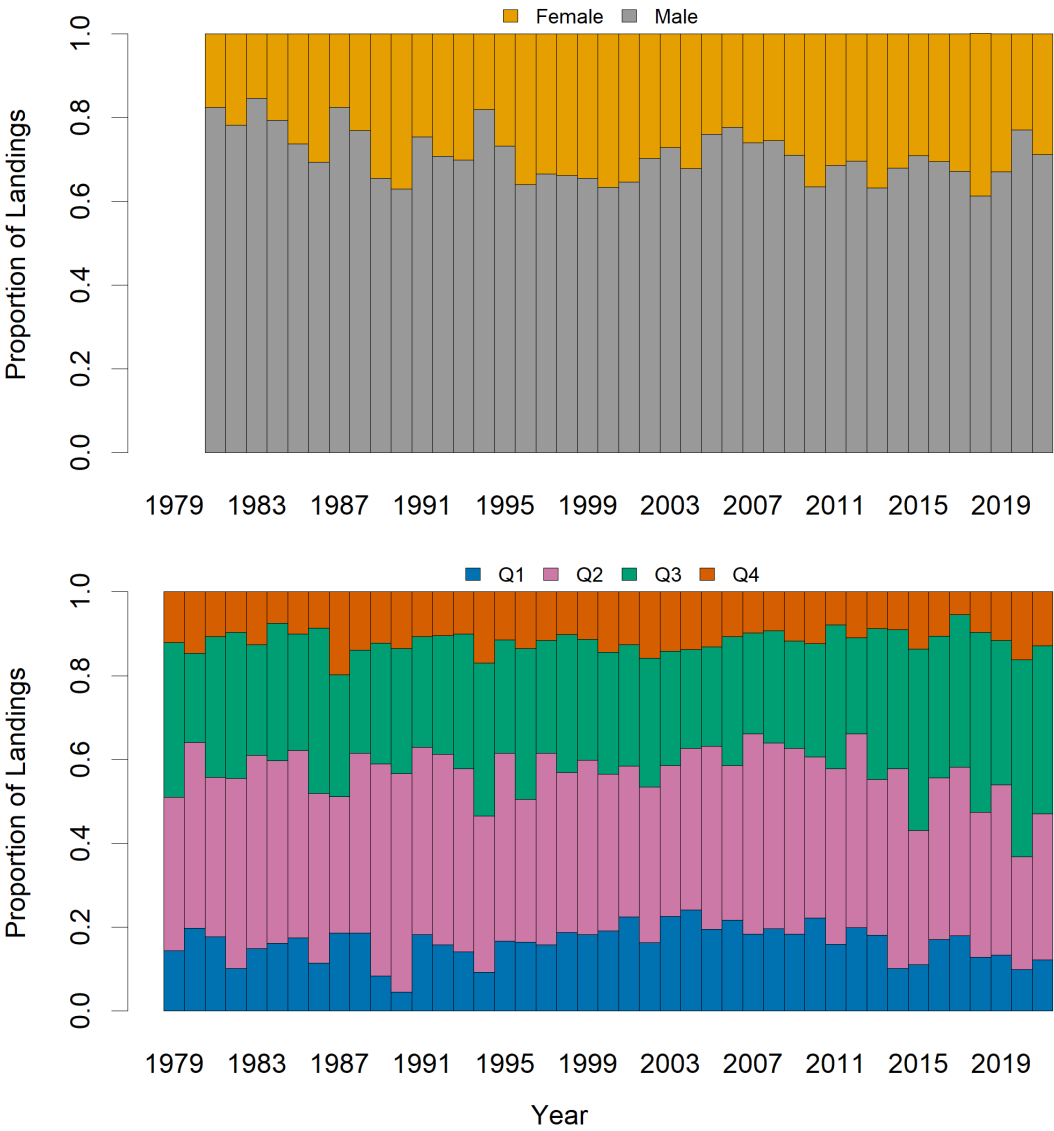


Figure 13.2.3. (a) *Nephrops*, South Minch (FU12). Proportion of landings by sex and quarter from Scottish trawlers.

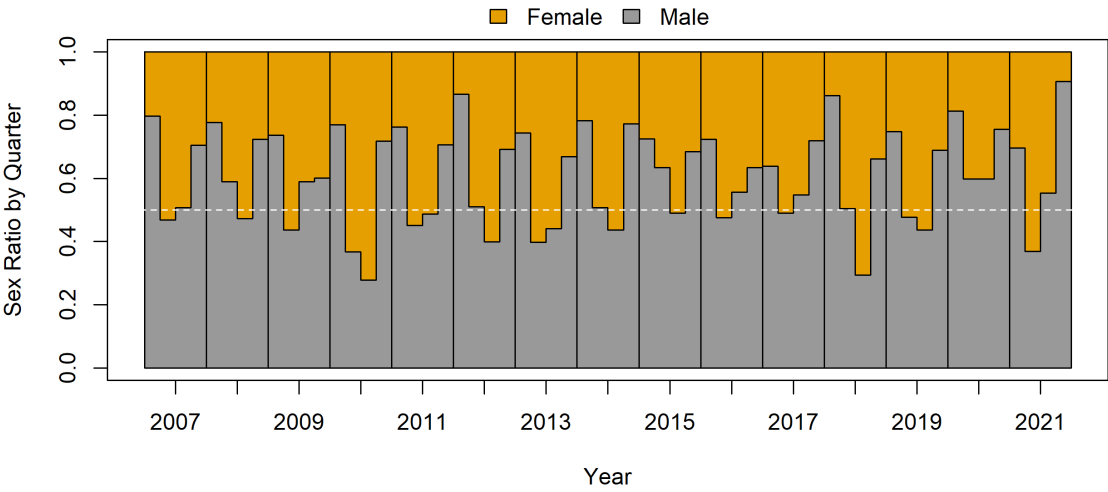


Figure 13.2.3 (b) *Nephrops*, South Minch (FU12), Proportion of males by quarter (2007–2021).

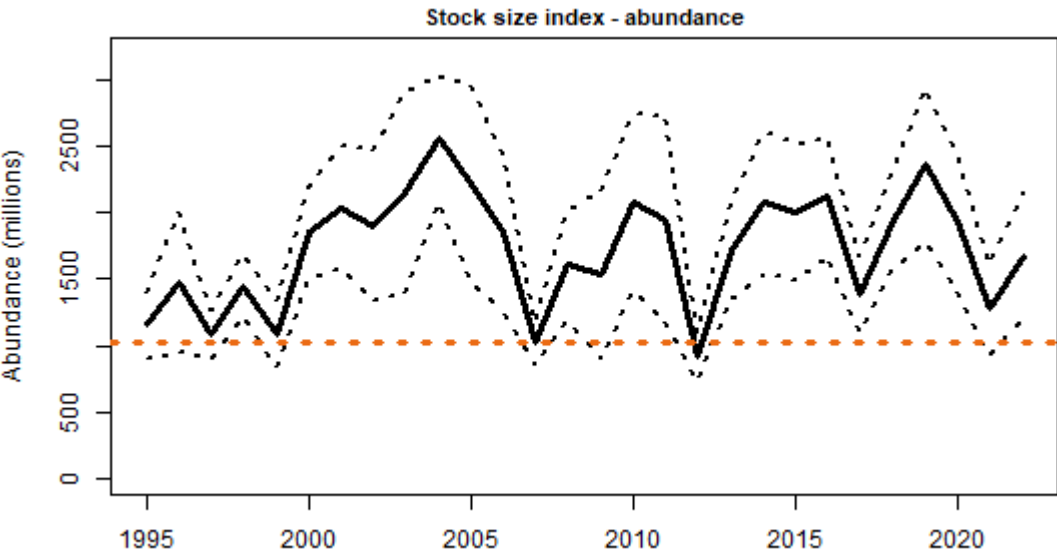


Figure 16.2.4. *Nephrops*, South Minch (FU12), Time-series of TV survey abundance estimate (adjusted for bias, solid black line), with 95% confidence intervals (dashed black lines), 1995–2022. The dashed red line is the rounded $B_{trigger}$ value of 1020 million individuals.

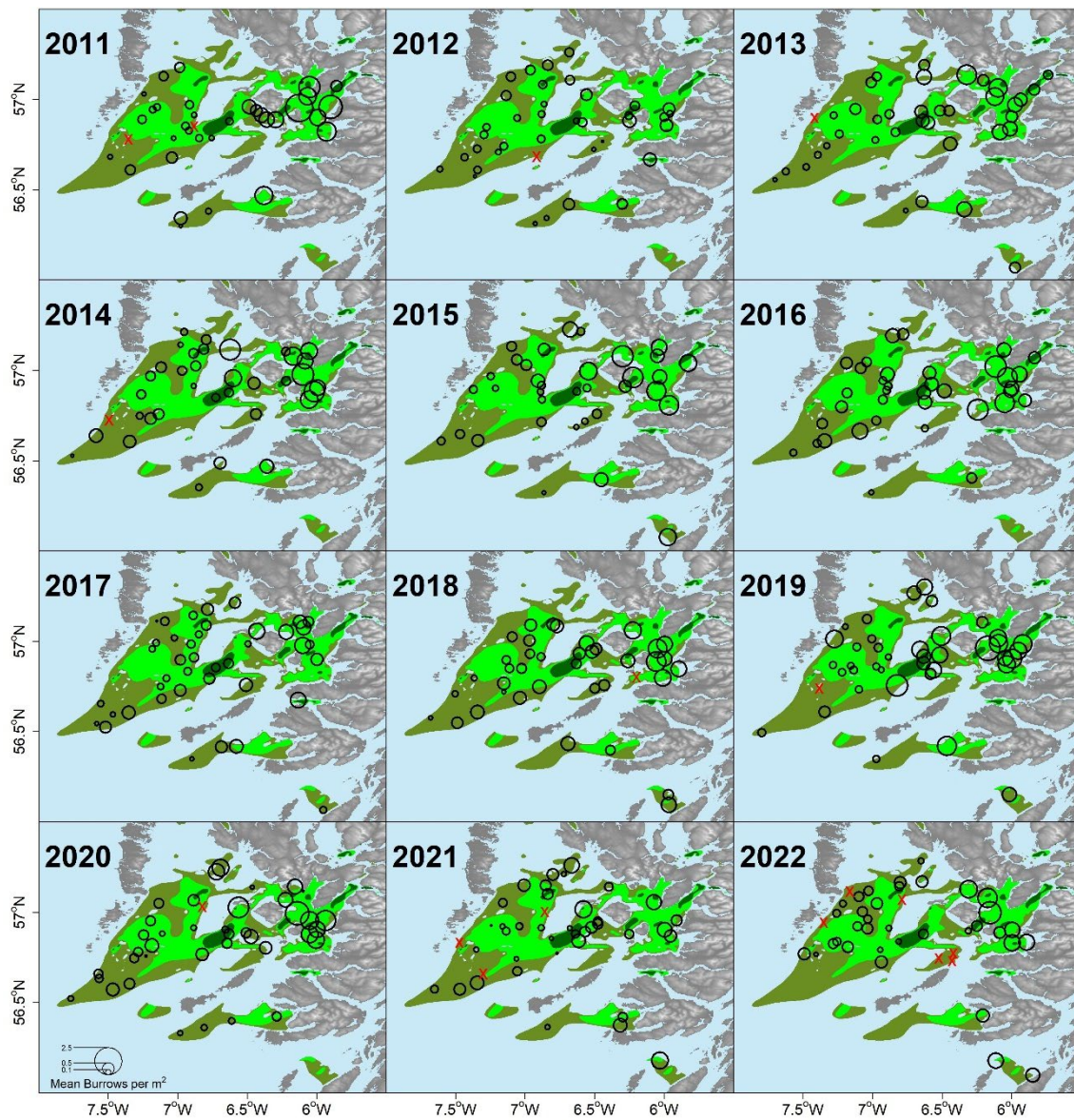


Figure 16.2.5. *Nephrops*, South Minch (FU12), TV survey station distribution and relative density (burrows/m²), 2011–2022. Shaded green and brown areas represent areas of suitable sediment for *Nephrops*. Bubbles in this figure are all scaled the same. Red crosses represent zero observations.

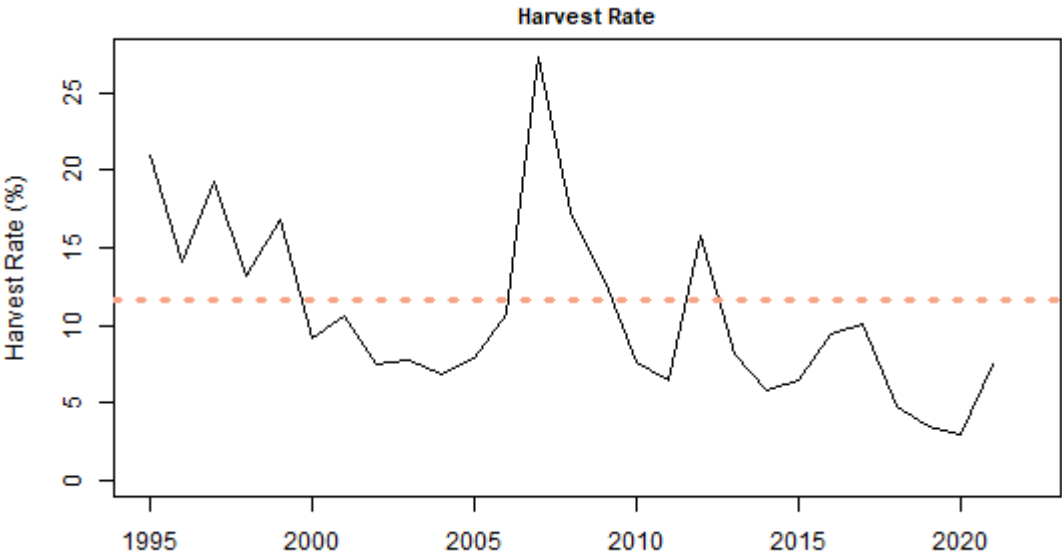


Figure 16.5.1. *Nephrops*, South Minch (FU12), harvest rate, 1995–2021. The dashed and solid lines are the F_{MSY} proxy harvest rate (11.7%) and the time-series of estimated harvest rates, respectively. Harvest rates prior to 2006 are considered unreliable.

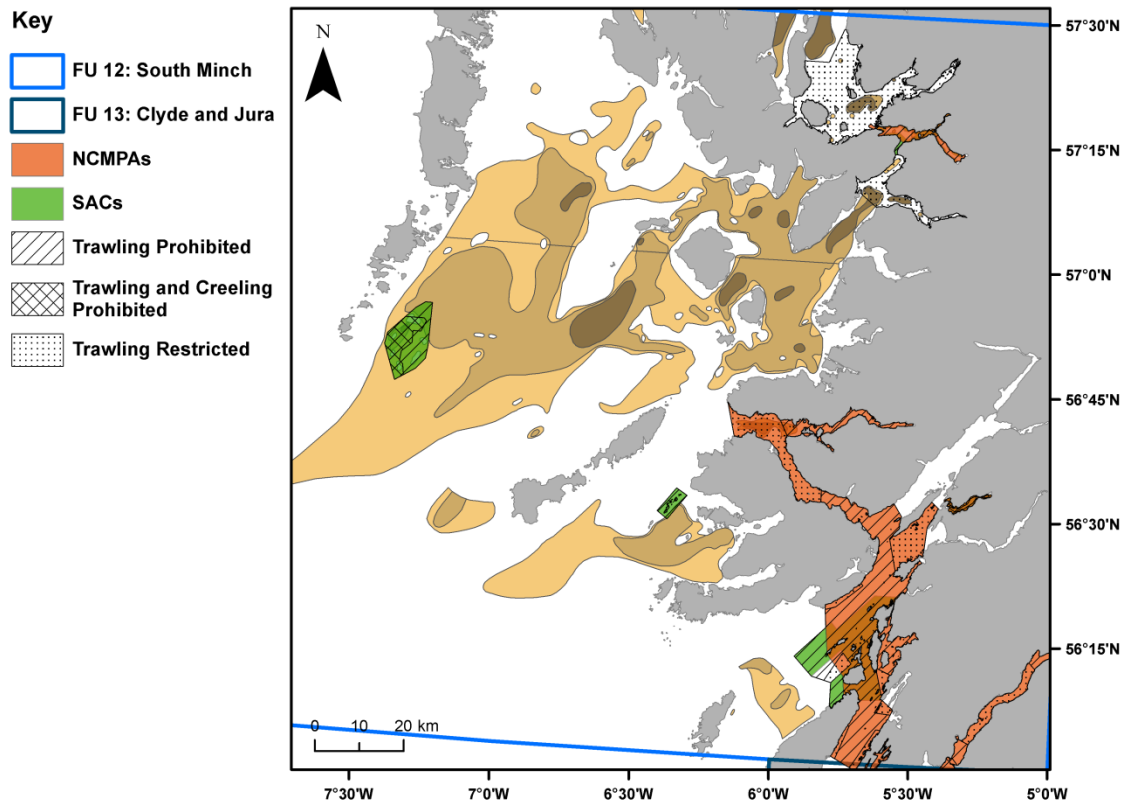


Figure 16.6.1. The area of *Nephrops* habitat (Mud, Muddy Sand and Sandy Mud) within the South Minch (FU12) relative to the areas of the Nature Conservation MPAs (NCMPAs) and Special Area of Conservations (SACs) with fisheries management measures. Areas where demersal trawling is prohibited, restricted (i.e. vessel size restrictions or seasonal closures) and where creeling is prohibited are displayed. For more detailed information see SG (2016). Geographic Coordinate System: OSGB 1936, Datum: OSGB 1936, Projected Coordinate System: British National Grid. Coastline by Wessel and Smith (2016), MPA sites subsetting from NCMPA (SNH, 2015) and SAC (SNH, 2016) layers, management areas from SG (2017c) and functional units generated from merged ICES rectangles (ICES, 2017b). Map and modified layers created using ArcGIS (ESRI, 2014).