# Stock Annex: Norway lobster (*Nephrops norvegicus*) in Division 3.a, Functional units 3 and 4 (Skagerrak and Kattegat)

Stock specific documentation of standard assessment procedures used by ICES.

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|---|---|
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| **Working group:** | Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) |
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## A. General

### A.1. Stock definition

Throughout its distribution, Norway lobster (*Nephrops norvegicus)* is limited to muddy habitats, and requires sediment with a silt & clay content of between 10–100% 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. In Division 3.a, ICES traditionally distinguishes between FU 3 (Skagerrak) and FU 4 (Kattegat). However, no significant differences in biological features between *Nephrops* in the Kattegat and Skagerrak have been identified, and therefore the two FUs are assessed as a single unit. ICES provides biological management advice for 3.a as a single management unit.

### A.2. Fishery

Denmark and Sweden are the main countries exploiting *Nephrops* in 3.a. Norway has only a small fishery in the northern Skagerrak along the Norwegian coast. On average (10 years), Denmark accounts for 69%, Sweden for 29% and Norway for 2% of total landings. Since 1998 Germany reports minor landings from 3.a.

#### Recent changes in fishery regulations

Besides a TAC regulation, fishing in the Kattegat and Skagerrak is restricted by effort limitations. The system was introduced in 2004 as part of the first cod recovery plan (EC No. 423/2004). Effort was limited by allowed number of fishing days for individual fishing vessels. Details were given each year in an annex of the TAC regulation. The system was quite complicated since different types of fishing gear, mesh-size ranges and types of selection devices gave different numbers of allowed fishing days. The sorting grid used in the Swedish *Nephrops* fisheries was given unlimited days since it was shown that bycatches of cod were very small. In 2007, fishermen were allocated additional fishing days when using trawls with a square-meshed exit-window with a minimum mesh size of 120 mm.

Since 1st February 2008, the usage of the exit-window in trawls has been made mandatory in Denmark. In 2008, each fishing day during the period between

1 February and 30 April was further counted as 2.5 days. The objective was to further restrict the targeted Kattegat cod fisheries. In 2009, following the introduction of the new management plan (EC No. 1342/2008) for the North Sea (incl. Kattegat) cod, a new effort system was introduced. In this system, each Member State (MS) is allocated an amount of kW days for different gear groups. It is then the MSs responsibility to distribute the kW days among the fishing vessels. The amount of kW days for the gear groups catching cod has be subject to yearly cuts as long as the cod stock is below reference points in the management plan. MSs can apply for derogation from the kW days system if the catches by a certain part of the fleet can be shown (after evaluation by STECF) to consist of less than 1.5% cod (article 11(2)(b)). In 2009, Sweden obtained derogation from the kW days system for *Nephrops* trawlers using the Swedish grid. MSs can further avoid cuts (or a part of the cuts) if they introduce highly selective gear and cod avoidance plans (article 13). Denmark introduced such a cod avoidance plan in 2010. As a part of this plan, since 2011 it is mandatory in Danish fisheries to use a SELTRA trawl. In the Kattegat, it is mandatory during the first three quarters of the year to fish with either a 180 mm square mesh panel or a 270 mm diamond mesh panel. The reason for the exemption in the fourth quarter is due to the targeting of Sole (*Solea solea*) during this period. In the Skagerrak, it is mandatory throughout the entire year to fish with a SELTRA trawl with either a 140 mm square mesh panel or a 270 mm diamond mesh panel. In 2009, as a part of the attempts to rebuild the cod stock in the Kattegat, Denmark and Sweden introduced protected areas on historically important spawning grounds. The protected zone consists of three different areas in the Kattegat in which the fisheries are either completely forbidden or limited to certain selective gears (Swedish grid and Danish SELTRA trawl) during all or different periods of the year. The effect of the protected area was evaluated in 2012.In summary, the increase (in the range 45–112% as estimated by ICES) in the cod SSB estimated for 2012 compared to the values estimated for 2009 can partly be attributed to the measures related to the implementation of closed areas.

#### Denmark

The restrictions introduced in the fisheries, especially for cod, seem to have resulted in some significant changes in the Danish fisheries for *Nephrops* in recent years. Traditionally, *Nephrops* have mainly been caught by trawls using mesh sizes between 70–89 mm. In recent years, an increasing proportion of total landings of *Nephrops* have been caught by vessels using gears with mesh sizes >89 mm (which has previously been used in the fishery for cod, plaice and other demersal fish species). Since 2005 in the Skagerrak and Kattegat, it has not been allowed to use mesh sizes between 70–89 mm unless the codend and the extension piece is constructed of square meshed netting with a sorting grid (Council Regulation 27/2005). According to Council Regulation 51/2006, there are unlimited days when using this species selective trawl.

These recent changes in the fishing patterns may be seen in the light of the declines in the most important demersal fish stocks in the North Sea, Skagerrak and Kattegat. Economically, *Nephrops* is one of the most important human consumption species in the Danish and Swedish fisheries in 3.a.

A new national management system was introduced in Denmark from the 1st of January 2007, see Section 14. In this new, rather complex, fishing rights system (FKA, 'vessel quota share'), each fisher is allocated an annual share of the national quota, which he can dispose of in a much more flexible way than previously. He may now trade his share, exchange it or pool it with other fishers' share within the frames of the

other regulations, e.g. total effort (fishing days) and national quotas and/or closed seasons.

The sharp increase in lpue in 2007 observed for the Danish vessels in both 3.a and the North Sea, mainly in the Norwegian Deep, may to some extent be explained as a consequence of the ITQ regulation system.

- One would expect that the *Nephrops* share will gradually become concentrated among the more skilled *Nephrops* fishers.
- The fishers targeting *Nephrops* will optimise (minimise) their use of effort in catching their share of the FKA.

One consequence of this new system is a more efficient use of the effort by the skilled fishers, which again renders the use of logbook recorded effort data even more problematic when using the data for tuning assessment models or for instance lpue directly as indicators of stock fluctuations for *Nephrops* stocks.

#### Sweden

The specialised Swedish *Nephrops* trawlers (catching >3 t/yr) have decreased in number from 2008 to 2009 due to decommissioning incentives. However, in 2009 the proportion of vessels with annual landing >5 t have increased. (Figure A2-1). At present, the mean size of a *Nephrops* vessel is 14m (ranging from 8 to 35 m) and GRT of 41 tonnes (ranging from 3 to 308 tonnes).

Since 2004, new technical regulations were introduced for Swedish national waters in both FUs 3 and 4. As Sweden has bilateral agreements with Denmark and Norway to fish inside the 12 NM limit, the regulations cover only waters exclusively fished by Swedish vessels (inside 3 NM in Kattegat and 4 NM in Skagerrak). The new regulations imply that it is mandatory to use a 35 mm species selective grid together with an 8 m long 70 mm full square mesh codend and extension piece (often refered to as the Swedish grid) when trawling for *Nephrops* in Swedish national waters. The Swedish *Nephrops* landings from 3.a during the period 1989–2014 are shown in Figure A2-2. Twin trawls were introduced in 1990 and the grid and square mesh trawls were legislated in Swedish national waters during 2004 and have shown an increasing use since then.

A new coding of fishing gears in the Swedish logbooks has taken place since 2007 where the twin trawl code is phased out and the number of trawls of the new trawl codes should be registered. This means that since 2007 twin trawls are likely to have been included in other trawl categories that were earlier considered single trawls. During 2014, 76% of the Swedish *Nephrops* trawl landings in 3.a were caught using the Swedish grid. In the first quarter of 2008 a new effort regulation was introduced in the Kattegat, whereby each day at sea would be counted as 2.5 days if the Swedish grid was not used. This has further increased the incentives to use the sorting grid.

The landings from the Swedish creel fishery show an increasing trend in recent years, comprising between 26–36% of the Swedish Skagerrak landings. The trends in effort and lpue (g/creel) are shown in Figure A2-3 and show an increasing trend in effort until 2008 and a slight decrease in 2009, while lpue fluctuates without trend. The Swedish creel fishery is restricted to a maximum of 800 creels for a single fisher and maximum 1400 creels for two or more fishers.

#### Norway

In Skagerrak, *Nephrops* is fished all year round. There is no Norwegian fishery in the Kattegat. The largest part of the catches is taken with *Nephrops* and shrimp trawls (as bycatch). In 2001, a creel fishery started developing with landings constituting 9–23% of the total annual landings (2001–2014).

The structure of the Norwegian fleet fishing for *Nephrops* in FU 3 has remained fairly constant since 2007, with vessels <15 m dominating the fleet. According to the logbooks in 2014 most fishing trips last from 1 to 4 days, undertaking 1–2 hauls per day, each with an average duration of approximately 7 hrs.

Mandatory electronic logbooks (for vessels ≥12 m) were introduced in 2011. These data have helped to define the most important areas for the Norwegian trawl fishery for *Nephrops,* where the northeastern part of Skagerrak is defined as the most improtant.

The recreational creel fishery for *Nephrops* along the Norwegian coast has increased in recent years.

#### Regulations

Fishing with mesh sizes down to 70 mm is legal, but requires square meshes in the codend. New Norway-EU agreements on technical measures for Skagerrak were implemented in 2013 and also require a species selective grid with 35 mm bar spacing for such gear. The bycatch of other species should not exceed 70% of the total weight. The minimum landing size (MLS) is 40 mm CL (130 mm total length), however, *Nephrops* landings can contain up to 10% animals (in weight) below MLS. Trawling with more than two trawls is illegal south of 62°N, but this does not apply to the trawl fishery for *Nephrops* in Skagerrak. In Skagerrak it is allowed to trawl within the 4 nm limit from the baseline, but not during night.

### A.3. Ecosystem aspects

*Nephrops* live in burrows in suitable muddy sediments and is characterised by being omnivorous and emerge out of the burrows to feed. It can, however, also sustain itself as a suspension feeder (in the burrows) (Loo *et al*., 1993). This ability may contribute to maintaining a high production of this species in 3.a, due to increased organic production.

Severe depletion in oxygen content in the water can force the animals out of their burrows, thus temporarily increasing the trawl catchability of this species during such environmental changes (Bagge *et al*., 1979). A specially severe case was observed in late 1988 in the southern part of 3.a (Kattegat) in late summer, where initially unusually high catch rates of *Nephrops* were observed. Eventually the increasing amount of dead specimens in the catches lead to the conclusion of severe oxygen deficiency (Bagge *et al*., 1990).

No information is available on the extent to which larval mixing occurs between *Nephrops* stocks, but the similarity in stock indicator trends between FUs 3 and 4 for both Denmark and Sweden indicates that recruitment has been similar in both areas. These observations suggest they may be related to environmental influences.

## B. Data

### B.1. Commercial catch

Two types of sampling occurs for this stock: Catch and discard sampling at sea (on-board sampling) and to a small extent (in Danish ports) some sampling of landings. The sampling provides information on size distributions and sex ratios. Due to the large minimum landing size of 40 m CL in 3.a the proportion of undersized individuals in the catch is normally high. Effective catch sampling provides good estimates of the proportion of undersized and discarded individuals.

### B.2. Biological

A natural mortality rate of 0.3 was assumed for all age classes and years for males and immature females, with a value of 0.2 for mature females based on Morizur, 1982. The lower value for mature females is based on the assumption of reduced burrow emergence while ovigerous, and hence an assumed reduction in mortality.

Data on size-at-maturity for males and females were presented at the ICES Workshop on *Nephrops* Stocks in January 2006 (ICES, WKNEPH 2006). The size-at-maturity for females was calculated to be 28.5 mm CL (L50). A sigmoid maturity function is used with L25 = 24.7 mm, L75 = 32.4 mm. Growth parameters have been estimated from tagging experiments (Ulmestrand and Eggert, 2001). Discard survival is assumed to be 25% (Wileman *et al*., 1999).

#### Summary

Growth:

Males; $L_\infty$ = 73 mm, k = 0.14

Mature Females; $L_\infty$ = 65 mm, k = 0.10

Size-at-maturity L25=24.7 mm, L50=28.5 mm.

Weight–length parameters:

Males a = 0.00045, b = 3.113

Females: a= 0.00108, b = 2.847

Discards

Discard survival rate: 25%

Discard proportion: around 50% (by weight)

### B.3. Surveys

Abundance indices (densities) are available from the following research vessel surveys:

A Danish underwater TV survey started in 2007. In 2007 and 2008 the survey could be considered as being in a trial phase, where the technical routines were steadily improving. Preliminary estimates of stock abundance for Kattegat based on the 2007 and 2008 data have been made. The coverage of the Danish UWTV survey in 2009 was extended, but there was no coverage of Skagerrak. In 2009 a similar Swedish UWTV survey started, but due to technical problems no data were collected. Preliminary estimates of total abundance based on the Danish survey data in 2007 and 2008 indicate low harvest rates (HRs). Since 2011, both Denmark and Sweden are expected to

provide UWTV survey data. A number of factors are suspected to contribute with bias to the indices from the TV surveys: Edge effect, detection rate, species identification, occupancy. These uncertaincies are decribed in details in the reports of WKNEPHTV (2007), and WKNEPHBID (2009). However, apart from the problem of biased indices there is also the problem of raising from index, e.g. number/sqm to total stock. In Division 3.a the dististribution of *Nephrops* is limited to soft-bottom areas, but as densities vary within this type of bottom, stratification of the sampling localities are necessary in order to provide uncertainty estimates of the idices. The survey design has been based on the maps of the seabed for the Kattegat provided by GEUS (Danish geological Institute) and for 3.a combined Danish and Swedish VMS data for the recent years (2010; Figure B3-1). Recommendations from WGNEPS 2013 for 3.a were:

- Revision of subarea boundary definitions based on update of VMS and other information (sediment map, logbook for non VMS trawlers and creel fishery);
- Consider extension of survey coverage towards the western Skagerrak and Swedish coastal waters (two potentially new subareas);
- Revision of subarea station allocations based on their contribution to the overall relative standard error;
- Build up a set of reference footage for 3.a (FUs 3 & 4).

A number of factors are suspected to contribute bias to the surveys. In order to use the survey abundance estimate as an absolute it is necessary to correct for these potential biases. The used bias estimates are as follows.

| Area | Edge effect | Detection rate | Species identification | Occupancy | Cumulative bias |
|---|---|---|---|---|---|
| FU 3 and 4 | 1.3 | 0.75 | 1.05 | 1 | 1.1 |

## B.4. Commercial lpue as stock indicators

### Skagerrak (FU 3)

#### *Landings*

FU 3 is primarily exploited by Denmark, Sweden and Norway. Denmark and Sweden dominate this fishery, with 65% and 31% by weight of the landings in 2014, respectively. Landings by the Swedish creel fishery represented 13–18% of the total Swedish *Nephrops* landings from the Skagerrak in the period 1991 to 2002. Since 2002 creel catches have been steadily increasing and in 2014 accounted for 34% of Swedish landings (Table B4-1). In the early 1980s, total *Nephrops* landings from the Skagerrak increased from around 1000 t to just over 2670 t. Since then they have been fluctuating around a mean of 2500 t (Figure B4-1).

Effort data for the Swedish fleet are available from logbooks for 1978–2014 (Figure B4-1 and Table B4-2). During the period 1998 to 2005, twin trawlers shifted to targeting both fish and *Nephrops*, which resulted in a decreasing trend in lpue during this period (Table B4-2). Since 2005, lpue for twin trawls has increased. The lpue for single trawls has shown and increasing trend throughout the entire time-series. The long-term trend

in lpues is similar in the Swedish and Danish fisheries (Figure B4-1). Total Swedish trawl effort shows a decreasing trend since 1992 and has been fluctuating without trend since 2003. From 2007 onwards, total Swedish trawl effort has been estimated from lpues from the single trawl with a grid (targeting only *Nephrops*).

Danish effort figures for the Skagerrak (Table B4-3 and Figure B4-1) were estimated from logbook data. For the whole period, it is assumed that effort is exerted mainly by vessels using twin trawls. The overall trend in effort for the Danish fleet is similar to that in the Swedish fishery. After having been at a relatively low level in 1994–1998, effort increased again in the next four years, followed by a decrease to a relatively low level in 2007 to 2014. Also the trend in lpue is similar to that in the Swedish single trawl fishery, however with a much more marked increase in the Danish lpue for 2007 and 2008. This high lpue level is likely to be a consequence of the national (Danish) management system introduced in 2007.

It has not been possible to explicitly incorporate 'technological creeping' in a further evaluation of the Danish effort data. However, since 2000 the Danish logbook data have been analysed in various ways to elucidate the effect of factors likely to influence the effort/lpue, e.g. vessel size (Figure B4-2).

#### Kattegat (FU 4)

##### *Landings*

Both Denmark and Sweden have *Nephrops* directed fisheries in the FU 4 (Kattegat). In 2014, Denmark accounted for about 71% of total landings in FU4, while Sweden took 29% (Table B4-4). Minor landings have been taken by Germany (<1%).

After a decline in the observed landings in 1994, total *Nephrops* landings from the Kattegat increased again until 1998 and have fluctuated around 1500 t. However, since 2006 the landings have increased and were in 2010 the highest on record over the 50 year period (Figure B4-3). Since 2012, landings have declined from 1900 t to around 1300 t.

Swedish total effort, converted to single trawl effort, has been relatively stable over the period 1978–1990. Effort increased from 1990 to 1993, followed by a decrease to 1996. During the last 20 years effort has remained relatively stable, except for 2007 and 2008 where effort increased. (Figures B4-3 and Table B4-5). Figures for total Danish effort are based on logbook records since 1987. Danish effort increased from 1995 to 2001, decreased from 2002 to 2007 and has been fluctuating without trend since (Figure B4-3 and Table B4-6).

Since 2000 the Danish logbook data have been standardised to account for changes in fishing power due to changes in the physical characters of the *Nephrops* fleet. The data have been analysed in various ways to elucidate the effect of factors likely to influence the effort/lpue, e.g. vessel size (Figure B4-4).

#### ICES Division 3.a (FUs 3 & 4)

The *Nephrops* stock in Division 3.a was assessed with an UWTV survey for the fourth year (all six subareas) and the time-series of UWTV estimates is still insufficient to draw conclusions regarding stock trajectory (Figure B4-5).

The 2014 Harvest Ratio was estimated to be relatively low (3.0% from UWTV survey) implying the stock appears to be exploited sustainably.

The analysis of commercial lpue and effort data indicate that lpue shows an increasing trend while effort shows a decreasing trend and the WG concludes that current levels of exploitation appear to be sustainable.

The assessment of the state of the *Nephrops* stocks in the Skagerrak and Kattegat area has for many years been based on fluctuations of total combined lpue by Denmark and Sweden. The patterns in fluctuations of discards in the fisheries as estimated from the catch samples for the same period are considered as indictors of fluctuations in recruitment.

The densities found in the UWTV surveys, 2011–2014 are of similar magnitudes as densities found in other *Nephrops* grounds covered by UWTVs, where stocks are stable. There have been no signs of overexploitation of *Nephrops* in 3.a.

## C. Historical stock development

1 ) Survey indices are worked up annually resulting in the TV index.

2 ) Adjust index for bias (see Section B3). The combined effect of these biases is to be applied to the new survey index.

3 ) Generate mean weight in catch. Check the time-series of mean landing weights for evidence of a trend in the most recent period. If there is no firm evidence of a recent trend in mean weight use the average of the three most recent years. If, however, there is strong evidence of a recent trend then apply most recent value (don't attempt to extrapolate the trend further in the future).

## D. Short-term projection

1 ) The catch option table will include the harvest ratios associated with fishing at $F_{0.1}$ and $F_{MAX}$. These values have been estimated by the Benchmark Workshop (see Section 9.2) and are to be revisited by subsequent benchmark groups. The values are FU specific and have been put in the Stock Annexes.

2 ) Create catch option table on the basis of a range of harvest ratios ranging from 0 to the maximum observed ratio or the ratio equating to $F_{MAX}$, whichever is the larger. Insert the harvest ratios from step 4 and also the current harvest ratio.

3 ) Multiply the survey index by the harvest ratios to give the number of total removals.

4 ) Create a landings number by applying a discard factor. This conversion factor has been estimated by the Benchmark Workshop and is to be revisited at subsequent benchmark groups. The value is FU specific and has been put in the Stock Annex.

5 ) Produce landings biomass by applying mean weight.

The suggested catch option table format is as follows.

| Basis | Harvest rate % | Total catches (t) | Landings (t) | Dead discards (t) | Surviving discards (t) |
|---|---|---|---|---|---|
| | 5.0 | 6513 | 3366 | 2360 | 787 |
| $F_{0.1}$ | 5.6 | 7294 | 3770 | 2643 | 881 |
| F2013 (UWTV) | 5.8 | 7555 | 3904 | 2738 | 913 |
| $F_{MAX}$ | 7.9 | 10290 | 5318 | 3729 | 1243 |
| | 9.0 | 11723 | 6059 | 4248 | 1416 |
| $F_{35\%SpR}$ | 10.5 | 13677 | 7068 | 4956 | 1652 |
| | 12.0 | 15630 | 8078 | 5664 | 1888 |

## E. Medium-term projections

## F. Long-term projections

## G. Biological reference points

Under the new ICES MSY framework, exploitation rates which are 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 $F_{MSY}$ are $F_{0.1}$, $F_{35\%SpR}$ and $F_{MAX}$. Owing to the strong difference in relative exploitation rates between the sexes, values for each of the candidates are determined for males, females and the two sexes combined. These calculations assume that the TV survey has a knife-edge selectivity at 17 mm. The appropriate $F_{MSY}$ candidate has been determined for each Functional Unit independently according to the perception of stock resilience, factors affecting recruitment, population density and the nature of the fishery (relative exploitation of the sexes and historical Harvest Rate vs stock status).

At the 2010 WG, preliminary estimates of these reference points were provided, based on per-recruit analysis which made use of catch-at-length frequency data which had been made available to the Benchmark WG in 2009. These are presented below.

| | | Fbar(30-50 mm) | | | HR (%) | SPR (%) | | |
|---|---|---|---|---|---|---|---|---|
| | | Fmult | M | F | | M | F | T |
| $F_{0.1}$ | M | 0,16 | 0,07 | 0,03 | 4,9 | 51,0 | 67,7 | 59,7 |
| | F | 0,28 | 0,12 | 0,05 | 7,6 | 36,1 | 53,7 | 45,3 |
| | T | 0,19 | 0,08 | 0,04 | 5,6 | 46,3 | 63,6 | 55,4 |
| $F_{max}$ | M | 0,24 | 0,11 | 0,04 | 6,8 | 40,1 | 57,7 | 49,3 |
| | F | 0,40 | 0,18 | 0,07 | 10,0 | 27,6 | 44,2 | 36,3 |
| | T | 0,29 | 0,13 | 0,05 | 7,9 | 35,2 | 52,8 | 44,4 |
| $F_{35\%SpR}$ | M | 0,30 | 0,13 | 0,06 | 8,1 | 34,3 | 51,9 | 43,5 |
| | F | 0,58 | 0,26 | 0,11 | 12,9 | 20,3 | 34,7 | 27,8 |
| | T | 0,43 | 0,19 | 0,08 | 10,5 | 26,0 | 42,3 | 34,6 |

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**Table B4-1. *Nephrops* in Skagerrak (FU 3): Landings (tonnes) by country, 1991–2014.**

| Year | Denmark | Norway | | | Sweden | | | Germany | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | Trawl | Creel | Subtotal | Trawl | Creel | Subtotal | | |
| 1991 | 1639 | 185 | 0 | 185 | 949 | 151 | 1100 | 0 | 2924 |
| 1992 | 1151 | 104 | 0 | 104 | 524 | 114 | 638 | 0 | 1893 |
| 1993 | 1485 | 101 | 2 | 103 | 577 | 123 | 700 | 0 | 2288 |
| 1994 | 1298 | 62 | 0 | 62 | 531 | 90 | 621 | 0 | 1981 |
| 1995 | 1569 | 90 | 0 | 90 | 659 | 111 | 770 | 0 | 2429 |
| 1996 | 1772 | 102 | 0 | 102 | 708 | 113 | 821 | 0 | 2695 |
| 1997 | 1687 | 117 | 0 | 117 | 690 | 118 | 808 | 0 | 2612 |
| 1998 | 2055 | 184 | 0 | 184 | 864 | 145 | 1009 | 0 | 3248 |
| 1999 | 2070 | 214 | 0 | 214 | 793 | 117 | 910 | 0 | 3194 |
| 2000 | 1877 | 181 | 0 | 181 | 689 | 147 | 836 | 0 | 2894 |
| 2001 | 1416 | 125 | 13 | 138 | 594 | 134 | 728 | 0 | 2282 |
| 2002 | 2053 | 99 | 17 | 116 | 658 | 150 | 808 | 0 | 2977 |
| 2003 | 1421 | 90 | 9 | 99 | 471 | 135 | 606 | 0 | 2126 |
| 2004 | 1595 | 85 | 10 | 95 | 449 | 173 | 622 | 0 | 2312 |
| 2005 | 1727 | 71 | 12 | 83 | 538 | 198 | 736 | 0 | 2546 |
| 2006 | 1516 | 80 | 11 | 91 | 583 | 201 | 784 | 0 | 2391 |
| 2007 | 1664 | 127 | 18 | 145 | 709 | 253 | 962 | 0 | 2771 |
| 2008 | 1745 | 124 | 34 | 158 | 675 | 273 | 948 | 0 | 2851 |
| 2009 | 2012 | 101 | 27 | 128 | 605 | 260 | 864 | 0 | 3004 |
| 2010 | 1981 | 105 | 20 | 125 | 563 | 266 | 829 | 4 | 2938 |
| 2011 | 1801 | 74 | 12 | 87 | 432 | 188 | 621 | 2 | 2510 |
| 2012 | 1516 | 80 | 24 | 104 | 592 | 324 | 916 | 0 | 2536 |
| 2013 | 1309 | 57 | 16 | 73 | 484 | 279 | 763 | 0 | 2146 |
| 2014 | 1868 | 68 | 20 | 88 | 900 | 305 | 1205 | 0 | 3161 |

**Table B4-2. *Nephrops* Skagerrak (FU 3): Catches and landings (tonnes), effort ('000 hours trawling), cpue and lpue (kg/hour trawling) of Swedish *Nephrops* trawlers, 1991–2014. (*Include only *Nephrops* trawls with grid and square mesh codend).**

| | | SINGLE TRAWL | | | |
|---|---|---|---|---|---|
| Year | Catches | Landings | Effort | Cpue | Lpue |
| 1991 | 676 | 401 | 71.4 | 9.5 | 5.6 |
| 1992 | 360 | 231 | 73.7 | 4.9 | 3.1 |
| 1993 | 614 | 279 | 72.6 | 8.4 | 3.8 |
| 1994 | 441 | 246 | 60.1 | 7.3 | 4.1 |
| 1995 | 501 | 336 | 60.8 | 7.8 | 5.2 |
| 1996 | 754 | 488 | 51.1 | 14.8 | 9.6 |
| 1997 | 643 | 437 | 44.4 | 14.4 | 9.8 |
| 1998 | 794 | 557 | 49.7 | 16.0 | 11.2 |
| 1999 | 605 | 386 | 34.5 | 17.5 | 9.3 |
| 2000 | 486 | 329 | 32.7 | 14.9 | 10.9 |
| 2001 | 446 | 236 | 26.2 | 17.0 | 10.4 |
| 2002 | 503 | 301 | 29.4 | 17.1 | 8.8 |
| 2003 | 310 | 254 | 21.5 | 13.9 | 11.4 |
| 2004* | 474 | 257 | 20.1 | 23.6 | 13.4 |
| 2005* | 760 | 339 | 29.7 | 25.6 | 12.7 |
| 2006* | 839 | 401 | 37.5 | 22.4 | 12.2 |
| 2007* | 894 | 314 | 24.1 | 37.0 | 13.0 |
| 2008* | 605 | 264 | 20.0 | 30.3 | 13.2 |
| 2009* | 482 | 285 | 19.6 | 24.5 | 14.5 |
| 2010* | 476 | 286 | 20.7 | 23.0 | 13.8 |
| 2011* | 334 | 198 | 16.8 | 19.9 | 11.8 |
| 2012* | 542 | 238 | 16.0 | 33.8 | 14.9 |
| 2013* | 251 | 137 | 11.3 | 22.2 | 12.1 |
| 2014* | 240 | 157 | 11,0 | 21,7 | 14,2 |

| Twin trawl | | | | | |
|---|---|---|---|---|---|
| Year | Catches | Landings | Effort | Cpue | Lpue |
| 1991 | 740 | 439 | 39.5 | 18.7 | 11.1 |
| 1992 | 370 | 238 | 34.1 | 10.9 | 7.0 |
| 1993 | 568 | 258 | 35.9 | 15.8 | 7.2 |
| 1994 | 444 | 248 | 34.1 | 13.1 | 7.3 |
| 1995 | 403 | 270 | 32.9 | 12.2 | 8.2 |
| 1996 | 187 | 121 | 13.0 | 14.4 | 9.3 |
| 1997 | 219 | 149 | 17.5 | 12.5 | 8.5 |
| 1998 | 254 | 178 | 16.7 | 15.2 | 10.6 |
| 1999 | 382 | 244 | 27.6 | 13.8 | 8.8 |
| 2000 | 349 | 237 | 31.3 | 11.1 | 10.1 |
| 2001 | 470 | 249 | 33.7 | 14.0 | 7.4 |
| 2002 | 392 | 244 | 33.3 | 11.8 | 7.1 |
| 2003 | 168 | 138 | 22.5 | 7.5 | 6.1 |
| 2004 | 217 | 118 | 21.7 | 10.0 | 5.4 |
| 2005 | 263 | 117 | 22.1 | 11.9 | 5.3 |
| 2006 | 253 | 121 | 19.6 | 12.9 | 6.2 |
| 2007* | 248 | 87 | 5.4 | 45.6 | 16.0 |
| 2008* | 139 | 61 | 3.4 | 41.3 | 18.0 |
| 2009* | 211 | 125 | 7.1 | 29.5 | 17.5 |
| 2010* | 165 | 99 | 5.9 | 27.8 | 16.7 |
| 2011* | 202 | 120 | 7.7 | 26.3 | 15.6 |
| 2012* | 544 | 239 | 12.9 | 42.2 | 18.6 |
| 2013* | 423 | 231 | 13.8 | 30.7 | 16.8 |
| 2014* | 484 | 316 | 16,0 | 30,3 | 19,8 |

**Table B4-3. *Nephrops* Skagerrak (FU 3): Logbook recorded effort (kW days, Days at sea, and fishing days) and lpue (kg/day) for bottom trawlers catching *Nephrops* with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1991–2014.**

| Year | kW days | Days at sea | Fishing days | Lpue |
|---|---|---|---|---|
| 1991 | 6 272 817 | 23 695 | 21 854 | 75 |
| 1992 | 4 797 327 | 18 565 | 16 891 | 68 |
| 1993 | 4 151 784 | 15 274 | 13 615 | 109 |
| 1994 | 3 532 464 | 13 253 | 11 667 | 111 |
| 1995 | 3 453 419 | 13 344 | 11 964 | 131 |
| 1996 | 3 699 633 | 13 871 | 12 740 | 139 |
| 1997 | 3 512 641 | 13 455 | 12 328 | 137 |
| 1998 | 3 641 085 | 13 073 | 11 917 | 172 |
| 1999 | 4 312 598 | 14 816 | 13 445 | 154 |
| 2000 | 4 574 172 | 15 530 | 14 040 | 134 |
| 2001 | 4 074 471 | 13 565 | 11 925 | 119 |
| 2002 | 4 798 320 | 16 791 | 14 489 | 142 |
| 2003 | 3 609 840 | 11 884 | 10 717 | 133 |
| 2004 | 4 008 783 | 13 401 | 11 993 | 133 |
| 2005 | 3 762 911 | 12 571 | 11 183 | 154 |
| 2006 | 3 298 814 | 10 829 | 9732 | 156 |
| 2007 | 2 424 173 | 8026 | 7295 | 228 |
| 2008 | 2 332 056 | 8016 | 7300 | 239 |
| 2009 | 2 549 895 | 8814 | 8058 | 250 |
| 2010 | 2 668 904 | 9027 | 8338 | 238 |
| 2011 | 2 666 680 | 9767 | 8912 | 202 |
| 2012 | 2 181 133 | 8321 | 7547 | 201 |
| 2013 | 1 737 339 | 6769 | 6372 | 205 |
| 2014 | 2 093 183 | 8054 | 7656 | 244 |

**Table B4-4. *Nephrops* Kattegat (FU 4): Landings (tonnes) by country, 1991–2014.**

| | | Sweden | | | | |
|---|---|---|---|---|---|---|
| Year | Denmark | Trawl | Creel | Subtotal | Germany | Total |
| 1991 | 1185 | 119 | 0 | 119 | 0 | 1304 |
| 1992 | 901 | 111 | 0 | 111 | 0 | 1012 |
| 1993 | 765 | 159 | 0 | 159 | 0 | 924 |
| 1994 | 751 | 142 | 0 | 142 | 0 | 893 |
| 1995 | 850 | 148 | 0 | 148 | 0 | 998 |
| 1996 | 1072 | 213 | 0 | 213 | 0 | 1285 |
| 1997 | 1272 | 319 | 3 | 322 | 0 | 1594 |
| 1998 | 1486 | 306 | 4 | 310 | 12 | 1808 |
| 1999 | 1416 | 329 | 4 | 333 | 6 | 1755 |
| 2000 | 1448 | 357 | 4 | 361 | 7 | 1816 |
| 2001 | 1464 | 304 | 6 | 309 | 1 | 1774 |
| 2002 | 1240 | 219 | 5 | 224 | 7 | 1471 |
| 2003 | 1336 | 287 | 5 | 292 | 13 | 1641 |
| 2004 | 1360 | 270 | 11 | 281 | 12 | 1653 |
| 2005 | 1175 | 303 | 8 | 311 | 2 | 1488 |
| 2006 | 916 | 347 | 11 | 358 | 6 | 1280 |
| 2007 | 1223 | 491 | 15 | 505 | 13 | 1741 |
| 2008 | 1429 | 561 | 16 | 577 | 19 | 2025 |
| 2009 | 1360 | 450 | 16 | 467 | 15 | 1842 |
| 2010 | 1740 | 403 | 17 | 420 | 25 | 2185 |
| 2011 | 1136 | 308 | 16 | 324 | 15 | 1475 |
| 2012 | 1454 | 406 | 33 | 439 | 0 | 1893 |
| 2013 | 1241 | 341 | 27 | 368 | 3 | 1612 |
| 2014 | 917 | 335 | 34 | 369 | 7 | 1294 |

**Table B4-5. - Kattegat (FU 4): Catches and landings (tonnes), effort ('000 hours trawling), cpue and lpue (kg/hour trawling) of Swedish *Nephrops* trawlers, 1991–2014 (*Include only *Nephrops* trawls with grid and square mesh codend).**

| SINGLE TRAWL | | | | | |
|---|---|---|---|---|---|
| Year | Catches | Landings | Effort | cpue | lpue |
| 1991 | 66 | 39 | 10.3 | 6.4 | 3.7 |
| 1992 | 44 | 28 | 11.6 | 3.8 | 2.4 |
| 1993 | 128 | 58 | 14.9 | 8.6 | 3.9 |
| 1994 | 95 | 53 | 16.2 | 5.7 | 3.2 |
| 1995 | 79 | 53 | 9.6 | 7.8 | 5.5 |
| 1996 | 207 | 134 | 13.7 | 15.1 | 9.8 |
| 1997 | 269 | 183 | 18.0 | 15.0 | 10.2 |
| 1998 | 181 | 127 | 13.1 | 13.8 | 9.7 |
| 1999 | 146 | 93 | 8.1 | 17.9 | 11.4 |
| 2000 | 114 | 77 | 8.5 | 13.4 | 9.1 |
| 2001 | 117 | 62 | 7.6 | 15.4 | 8.2 |
| 2002 | 42 | 25 | 3.7 | 11.2 | 6.7 |
| 2003 | 49 | 40 | 4.6 | 10.7 | 8.7 |
| 2004 | 70 | 44 | 4.3 | 16.2 | 10.1 |
| 2005 | 147 | 100 | 12.3 | 11.9 | 8.1 |
| 2006 | 234 | 154 | 15.1 | 15.5 | 10.2 |
| 2007* | 107 | 51 | 4.1 | 25.7 | 12.3 |
| 2008* | 121 | 57 | 4.4 | 27.6 | 13.0 |
| 2009* | 157 | 81 | 5.1 | 30.9 | 16.1 |
| 2010* | 181 | 102 | 7.6 | 23.8 | 13.4 |
| 2011* | 75 | 45 | 3.8 | 20.0 | 12.0 |
| 2012* | 80 | 45 | 3.4 | 23.5 | 13.3 |
| 2013* | 44 | 26 | 2.3 | 19.5 | 11.6 |
| 2014* | 35 | 25 | 2,2 | 15,8 | 11,6 |

| Twin trawl | | | | | |
|---|---|---|---|---|---|
| Year | Catches | Landings | Effort | cpue | lpue |
| 1991 | 93 | 55 | 8.8 | 10.6 | 6.2 |
| 1992 | 101 | 65 | 14.2 | 7.1 | 4.6 |
| 1993 | 187 | 85 | 17.8 | 10.6 | 4.8 |
| 1994 | 138 | 77 | 14.2 | 9.7 | 5.4 |
| 1995 | 125 | 84 | 11.0 | 12.2 | 7.7 |
| 1996 | 97 | 63 | 7.5 | 13.0 | 8.4 |
| 1997 | 183 | 124 | 12.7 | 14.3 | 9.7 |
| 1998 | 215 | 151 | 15.0 | 14.4 | 10.1 |
| 1999 | 306 | 195 | 20.1 | 15.2 | 9.7 |
| 2000 | 330 | 224 | 24.5 | 13.5 | 9.1 |
| 2001 | 353 | 187 | 25.1 | 14.1 | 7.4 |
| 2002 | 256 | 153 | 23.2 | 11.0 | 6.6 |
| 2003 | 222 | 181 | 24.8 | 8.9 | 7.3 |
| 2004 | 253 | 158 | 16.5 | 15.4 | 9.6 |
| 2005 | 198 | 135 | 15.3 | 12.9 | 8.8 |
| 2006 | 183 | 121 | 12.7 | 14.4 | 9.5 |
| 2007* | 112 | 54 | 3.6 | 30.9 | 14.8 |
| 2008* | 164 | 78 | 4.8 | 34.1 | 16.1 |
| 2009* | 309 | 161 | 11.0 | 28.2 | 14.6 |
| 2010* | 297 | 167 | 9.2 | 32.2 | 18.1 |
| 2011* | 266 | 159 | 9.7 | 27.3 | 16.3 |
| 2012* | 406 | 231 | 12.4 | 32.8 | 18.6 |
| 2013* | 354 | 210 | 15.0 | 23.7 | 14.0 |
| 2014* | 282 | 206 | 14,4 | 19,6 | 14,4 |

**Table B4-6. *Nephrops* Kattegat (FU 4): Logbook recorded effort (kW days, Days at sea, and fishing days) and lpue (kg/day) for bottom trawlers catching *Nephrops* with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1991–2014.**

| Year | kW days | Days at sea | Fishing days | lpue |
|---|---|---|---|---|
| 1991 | 4 074 212 | 22 534 | 16 924 | 70 |
| 1992 | 3 587 105 | 19 829 | 14 449 | 62 |
| 1993 | 2 744 914 | 15 120 | 10 683 | 72 |
| 1994 | 2 408 095 | 13 723 | 11 086 | 68 |
| 1995 | 2 282 190 | 12 860 | 10 245 | 83 |
| 1996 | 2 654 978 | 14 676 | 11 831 | 91 |
| 1997 | 2 785 958 | 14 338 | 11 571 | 110 |
| 1998 | 2 918 412 | 15 153 | 12 383 | 120 |
| 1999 | 3 359 469 | 16 623 | 13 601 | 104 |
| 2000 | 3 632 346 | 18 281 | 14 661 | 99 |
| 2001 | 3 803 086 | 18 689 | 15 294 | 96 |
| 2002 | 3 236 501 | 16 497 | 13 333 | 93 |
| 2003 | 3 141 247 | 15 267 | 12 582 | 106 |
| 2004 | 2 933 114 | 14 237 | 11 325 | 120 |
| 2005 | 2 452 042 | 11 811 | 9335 | 126 |
| 2006 | 2 147 461 | 10 431 | 8467 | 108 |
| 2007 | 2 022 910 | 9883 | 7897 | 155 |
| 2008 | 2 147 785 | 10 537 | 8469 | 169 |
| 2009 | 2 219 200 | 11 120 | 8726 | 156 |
| 2010 | 2 438 736 | 12 055 | 9707 | 179 |
| 2011 | 2 009 220 | 10 284 | 8099 | 140 |
| 2012 | 2 287 683 | 11 777 | 9826 | 148 |
| 2013 | 2 218 508 | 11 653 | 9261 | 134 |
| 2014 | 1 904 440 | 10 373 | 7873 | 116 |

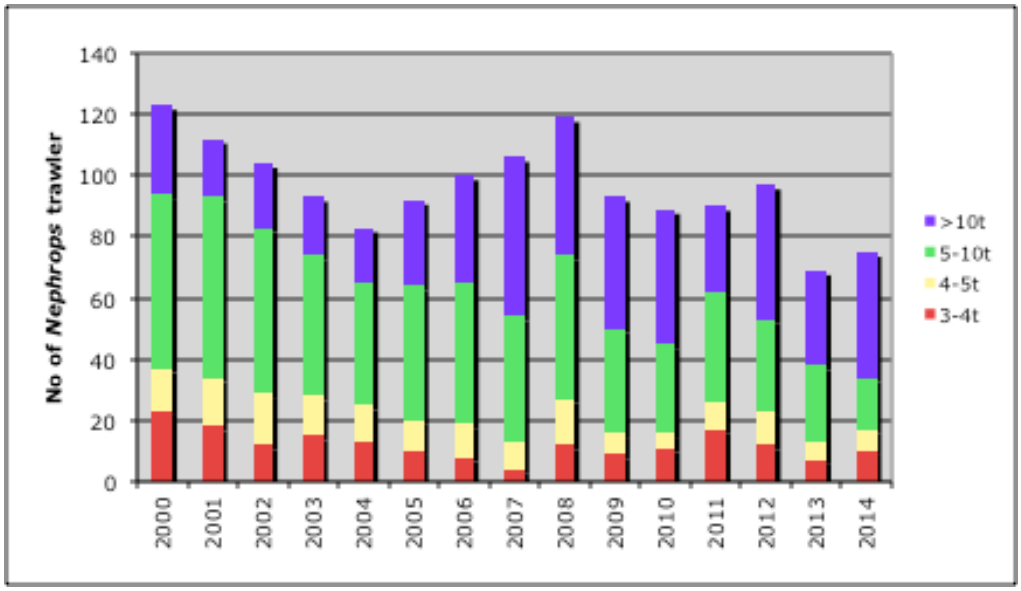


**Figure A2-1. Number of Swedish *Nephrops* trawler with respect to yearly landings during 2000–2014.**

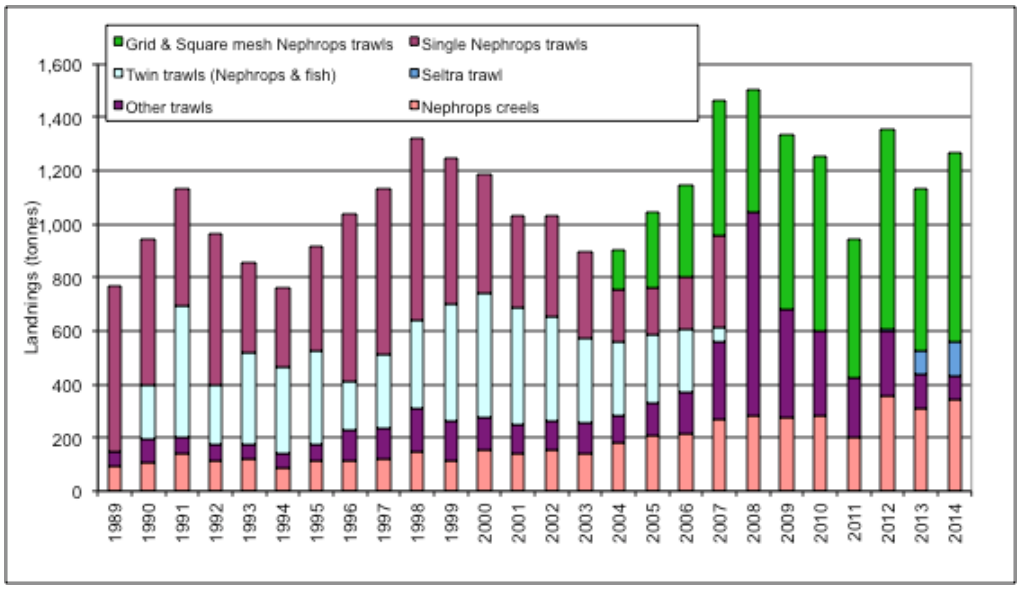


**Figure A2-2. Landings in the different Swedish fisheries by gear 1989–2014.**

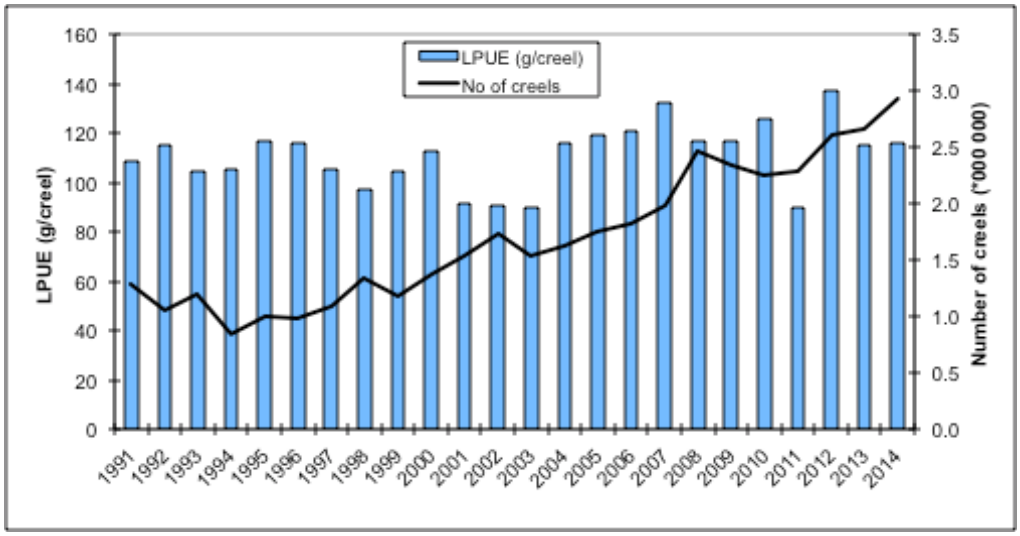


**Figure A2-3. Trends in effort and lpue (g/creel) within the Swedish creel fishery 1991–2014.**

**Figure A2-4.**

**Figure A2-5.**

**Figure A2-6.**

**Figure A2-7.**

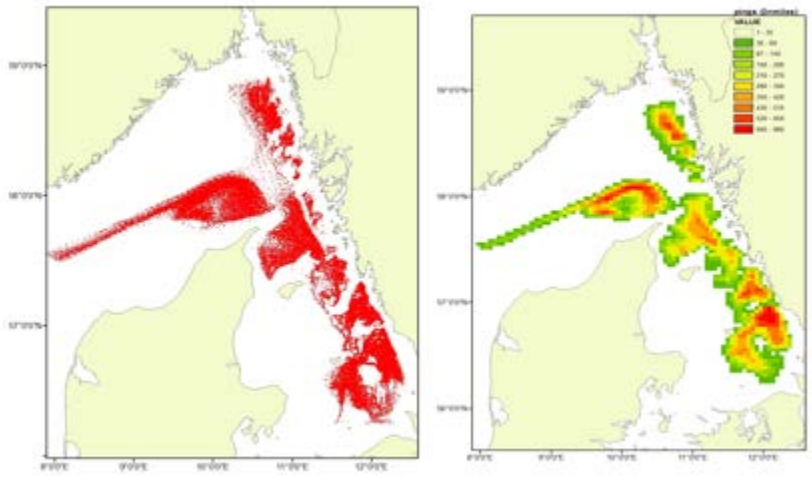

**Figure B3-1. The spatial distribution of the Danish and Swedish *Nephrops* fishery in 2010. Left map shows VMS pings and the right map shows density of VMS pings.**

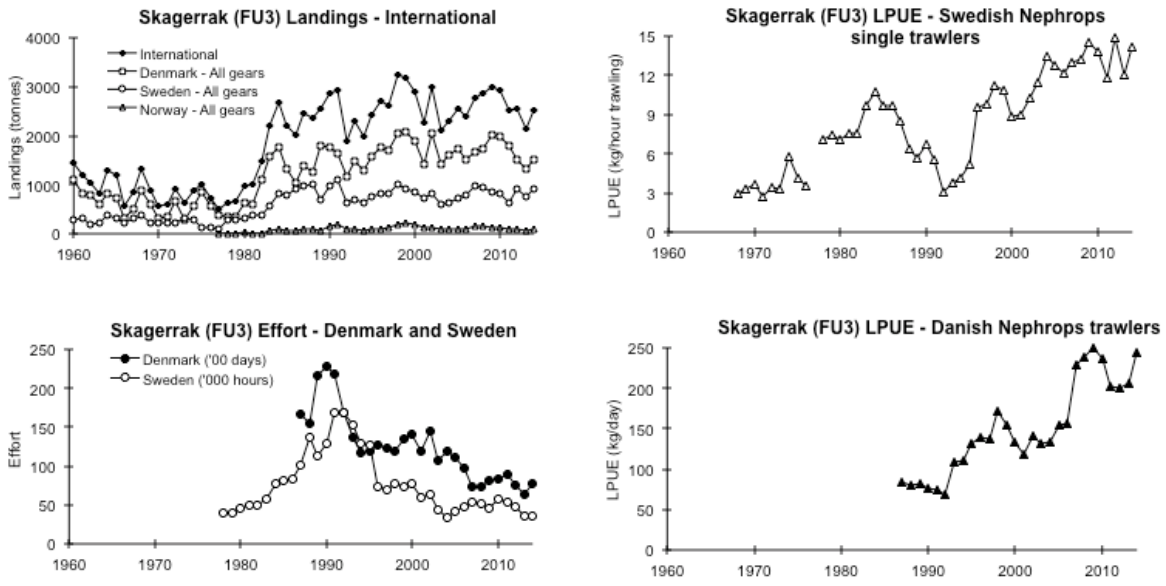


**Figure B4-1. *Nephrops* Skagerrak (FU 3): Long-term trends in landings, effort, lpues, and mean sizes of Nephrops.**

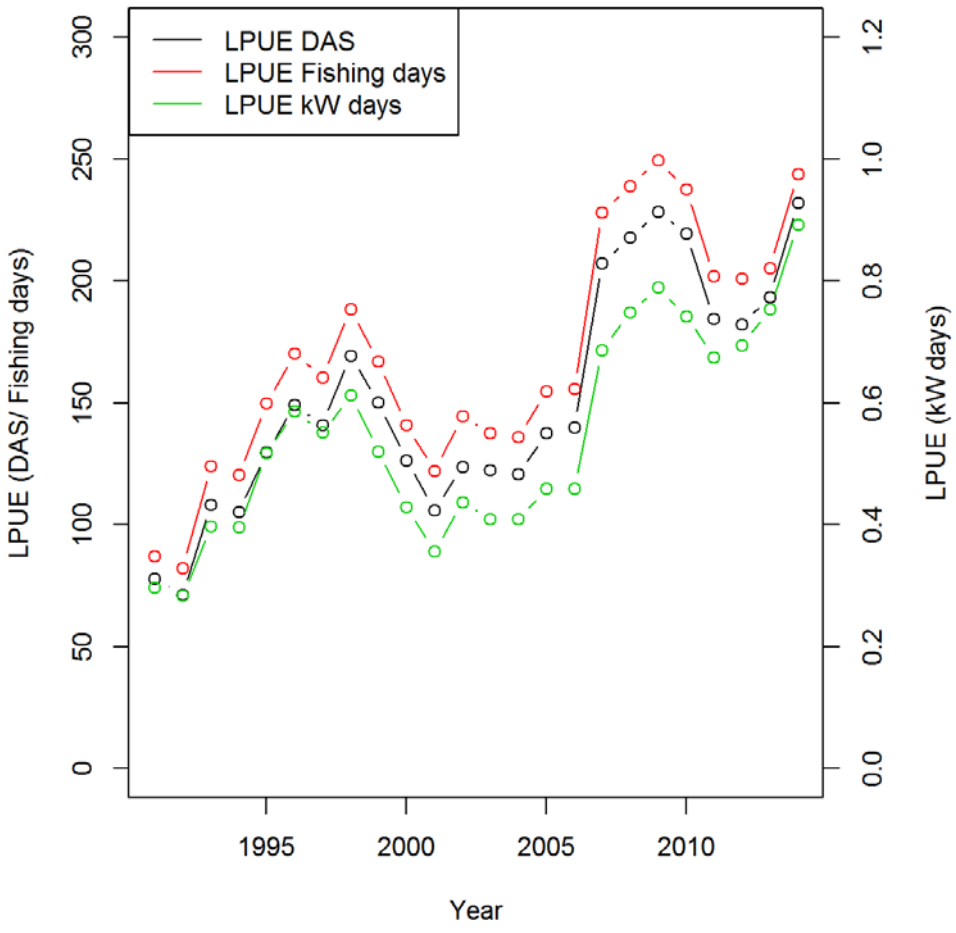


**Figure B4-2.** ***Nephrops*** **in FU 3. Danish lpue trends.**

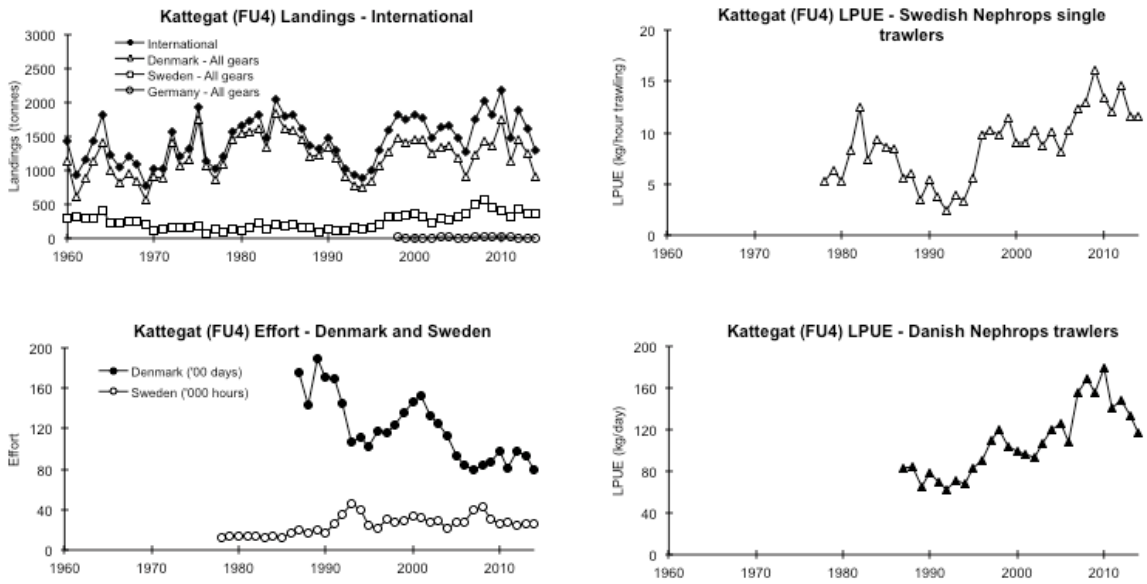


**Figure B4-3.** ***Nephrops*** **Kattegat (FU 4): Long-term trends in landings, effort, lpues, and mean sizes of** ***Nephrops*****.**

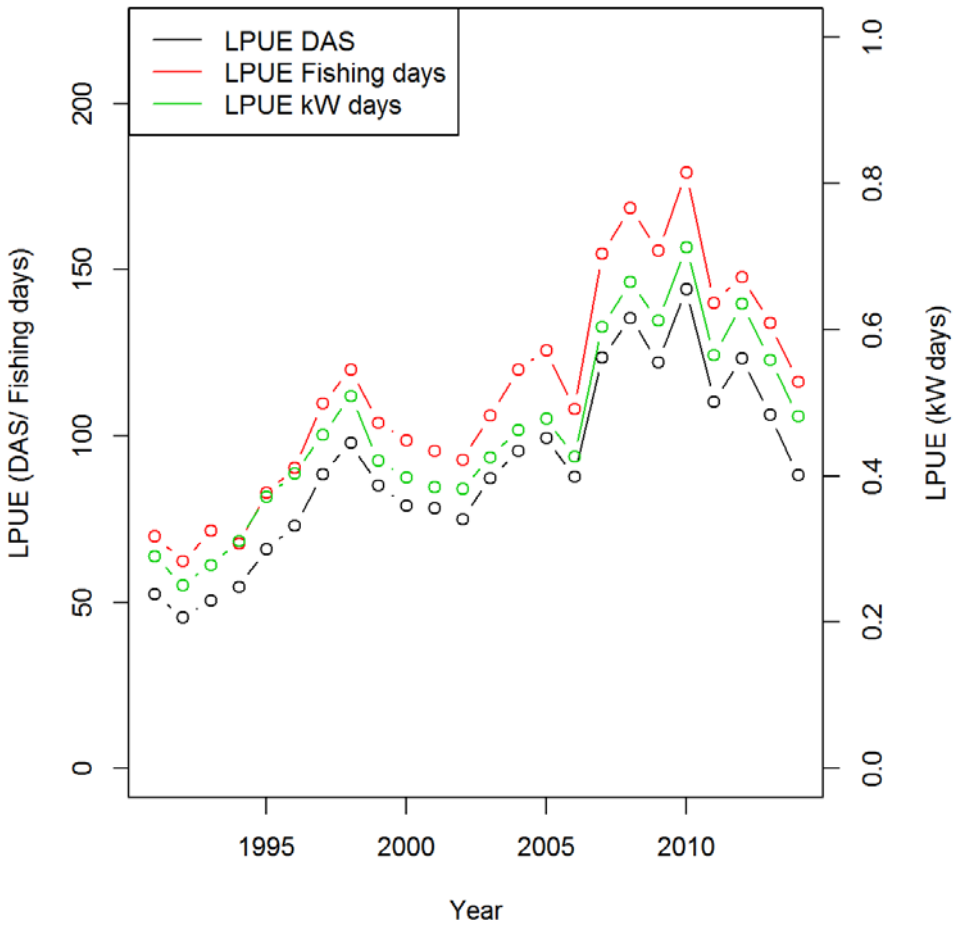


**Figure B4-4.** ***Nephrops*** **in FU 4. Danish lpue trends.**

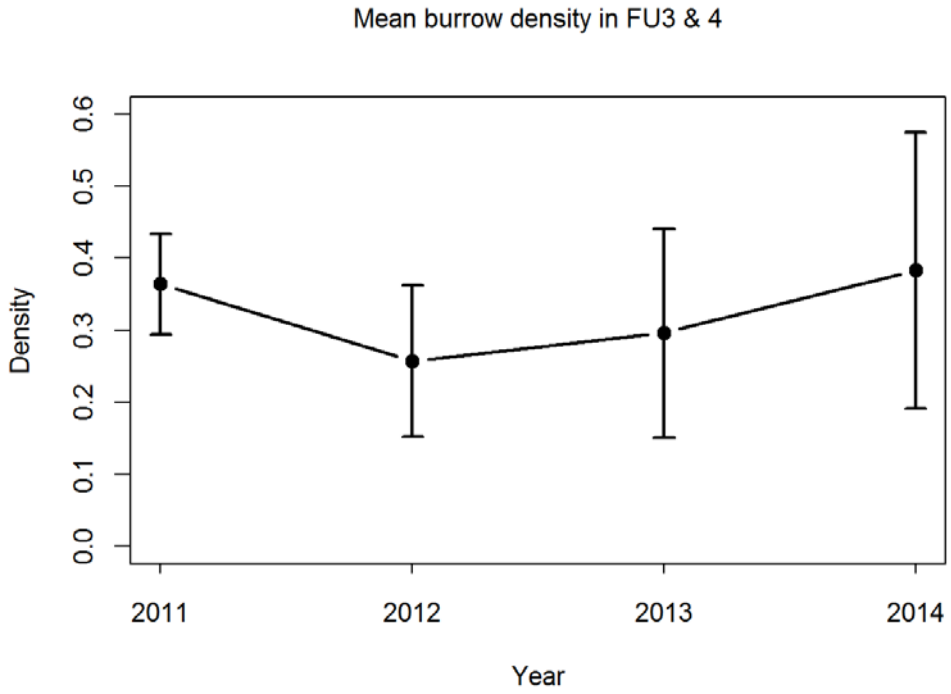


**Figure B4-5. Mean burrow density in 3.a by year. Error bars indicate the 95% confidence intervals.**