EU request for advice on a sentinel fishery for Norway lobster (*Nephrops)* in Functional Unit 31, Division 8.c

Advice summary

ICES advises that in order to minimize the impact on the stock, catches should be zero since underwater television (UWTV) surveys to monitor *Nephrops* stock abundance are conducted without removing any animals.

ICES considers that fisheries-independent approaches such as the use of UWTV surveys, a methodology that is used for many other Norway lobster (*Nephrops*) functional units (FUs) in the ICES area, would be the best method to obtain an index of abundance while minimizing the impact on the stock as it does not require that animals are captured. Alternatively, a scientifically-designed trawl survey either conducted by a research institute or by industry, would likely provide the most representative CPUE series while minimizing catches.

However, if a UWTV or a scientific trawl survey cannot be conducted, a sentinel fishery of approximately seven days in July would be needed to collect CPUE data with reasonable precision whilst minimizing impact on the stock. It is estimated that this effort would imply catches of about 697 kg. ICES notes that a sentinel fishery would need to be conducted for several years (usually 5 years or more) to be useful and that further work will be needed to determine if this CPUE data could be used as an appropriate abundance index for assessing the status of the stock.

If a sentinel fishery is carried out, it should be within an observers' on-board programme in the month of July, conducted on commercial vessels experienced in the use of the commercial gear normally used in the *Nephrops* fishery in this FU. As well, it should include the collection of representative biological samples of *Nephrops*.

Request

Background:

In relation to the setting of fishing opportunities, ICES has advised that for 2017-2019 the 8c Nephrops fishery should have a zero TAC. For 2018 and 2019 the Commission has proposed a TAC exclusively for catches taken as part of a sentinel fishery to collect per unit effort (CPUE) data in functional unit 25 during five trips per months in August and September with vessels carrying observers on board. *In discussions with Spain, there has been a request tabled for a sentinel fishery for 8c FU 31 Nephrops in 2019 in the order of 2 t along the lines of last year's request for FU 25 (see above) for which ICES advised on 1.7 t. This could allow for the collection of necessary catch/landing data for FU 31.*

Request:

- *Assess a level of catches that would minimise impact on the stock but would be sufficient to allow collection of LPUE data for potential use as an abundance index*
- *Suggest any specific conditions that should apply to the fishery, and data collected, in order for it to be useful in an abundance index context – i.e. trips, timeframe, geographical area, etc.*

Elaboration on the advice

ICES notes that there are two FUs for *Nephrops* in Division 8.c (FUs 25 and 31; see Figure 1); the advice provided here is for FU 31 only.

ICES considers that fisheries-independent approaches such as the use of underwater television (UWTV) surveys, a methodology that is used for many other *Nephrops* FUs in the ICES area, would be the best method to obtain an index of abundance while minimizing the impact on the stock as it does not require animals to be captured. Catches from such a survey would therefore be zero. In addition, UWTV surveys provide absolute estimates of population abundance which can be used immediately to provide a quantitative basis for advice. Alternatively, a scientifically designed trawl survey would likely provide the most representative CPUE series. This would entail using a standardized fishing gear, consistent haul duration, consistent time of year and day (taking account of known emergence patterns), and the survey should be design-based (e.g. stratified random design). This would allow the CPUE index and its precision to be calculated and should lower the risk of the CPUE not tracking the changes in the abundance of the stock. On the other hand, non-random fishing which could occur in a sentinel fishery, can result in potential bias in the CPUE index because of hyperstability or hyperdepletion. Hyperstability in catch rates signifies that CPUE values can remain high even when stocks are rapidly depleted. This can happen if catch rates are derived from fishing activities that remain concentrated in areas or periods of relatively higher abundance. Hyperdepletion can occur if the fishery is conducted over areas of lower densities. In both cases, the CPUE is not representative of the abundance of the stock.

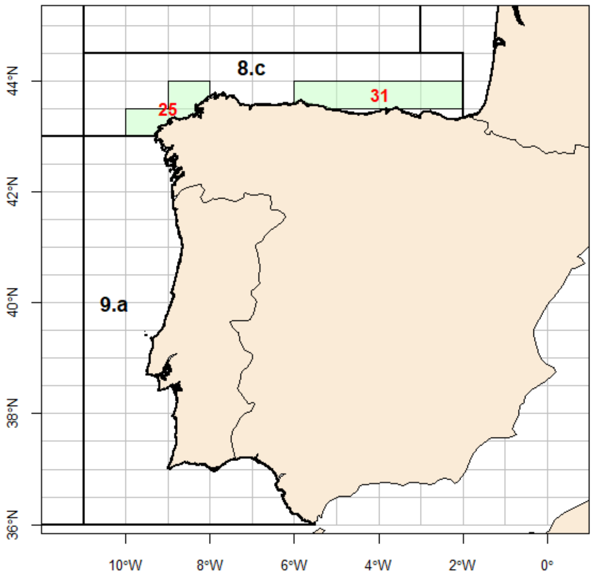

Figure 1 *Nephrops* functional units in Division 8.c. FU 31 covers statistical rectangles 16E4–E7.

If a sentinel fishery is to be conducted, it would only provide a relative index of abundance and it would need to be conducted for several years (usually 5 years or more) before it could be used in the advice process. ICES estimates approximately seven fishing days in July would allow a reasonable precision (a coefficient of variation [CV] of 30% with 90% probability) for a sentinel fishery CPUE index (Table 1; Figure 2). The estimate of the implied catch is about 697 kg. The estimate includes an arbitrary 15% buffer to account for potential catches in case catch rates in 2019 are higher than in 2014–2016 as was done in estimating catches for a sentinel fishery for FU25 in 2018 (ICES, 2018a). While the data collected should allow the calculation of a CPUE series, further work will be required to determine if this CPUE series is appropriate for use as an unbiased index of abundance. Such an evaluation normally requires a minimum of three to five years of data collection.

This sentinel fishery should be carried out within an observers' on-board programme, with seven fishing days in July, using commercial vessels captained by fishers with experience in the *Nephrops* fishery and using the usual commercial gears. Several areas in the FU seem to be adequate for the sentinel fishery (Figure 3). Vessels that participate in the sentinel fishery must have similar power and tonnage (within and between years) and should use similar gears. The specifications of the gear to be used as well as the sampling area must be clearly documented. To reduce potential bias and to lower the risk of the CPUE not tracking the changes in the stock abundance, the fishing hauls should be randomly distributed over the sampling area and not concentrated at a single location.

In addition to these general conditions, data on catch rates should be collected on a haul basis and should include the following variables: the shooting and hauling positions, the time of day (start and end), duration of the haul, depth, vessel id, vessel specifications, gear specifications, catch of *Nephrops* in kg, as well as length frequency and sex ratio. Catch information on the numbers and length frequencies of other species caught during the individual hauls should also be recorded, as the presence of other species may have a potential effect on catch rates. The collection of all of these data would allow for standardization of catch rates and calculation of CPUE at a finer level than by trip. While not considered essential, it would be desirable to standardize the haul duration. It is recommended that the sentinel fishery be under the supervision of a research institute to ensure data quality and integrity. A representative sample (all length distribution and males and females) of *Nephrops* must be kept for biological sampling in a research institute.

Basis of the advice

Background

Nephrops landings from ICES Division 8.c have been constantly decreasing since 1989 (González Herraiz *et al.*, 2012; ICES, 2017), resulting in an ICES advice of zero tonnes since 2002 (ICES, 2016) in both of the FUs 25 and 31 in Division 8.c (Figure 1). A total allowable catch (TAC) of zero tonnes for Division 8.c was established for 2017 (EU, 2017) and 2018 (EU, 2018). For 2019, a precautionary TAC of 2 tonnes was set (EU, 2019) for *Nephrops* in Division 8.c to allow for a sentinel data collection fishery in FU 25.

The current request is similar to the request addressed in 2018 for FU 25 (ICES, 2018a). In FU 25, the request was linked to the continuation of a CPUE index started in 2015 and the analysis was based on data from that fishery. A similar approach has been used in this evaluation to provide advice for a sentinel fishery in FU 31.

Methods

In order to respond to the request, an analysis was performed for FU 31 similar to the one performed to produce the advice for FU 25 (ICES, 2018a). In the case of FU 31, as for FU 25, no previous sentinel fishery was conducted; however, data from logbooks were available to be used for the analysis. Discarding of *Nephrops* in this fishery is considered negligible (ICES, 2018b); therefore, CPUE in FU 31 is equivalent to the landings per unit effort (LPUE) reported in logbooks.

In FU 31*, Nephrops* are mainly caught in a mixed fishery and the duration of a trip in this FU is generally two fishing days: one directed towards *Nephrops* and the other targeting fish species according to logbook information. Fishing days directed towards *Nephrops* were considered to be those where *Nephrops* catches accounted for more than 10% of the total retained catch in weight. To estimate the levels of effort and corresponding catches implied by a sentinel fishery that allows for collection of a CPUE, the logbook data where *Nephrops* catches accounted for more than 10% of the total catch during fishing trips in 2014–2016 were analysed (Table 2). In the period 2014–2016, four fishing days were directed to *Nephrops* in the statistical rectangles of FU 31 in June, fifteen in July, and eleven in August. *Nephrops*-directed CPUEs were highest during the period from June to August (Figure 4)* when *Nephrops* males and females are out of their burrows. This is similar to the relative monthly CPUE distributions found in other FUs (Fariña, 1996; González Herraiz, 2011).

The analysis was a resampling simulation with replacement of the CPUEs for these *Nephrops*-directed fishing days performed by month (Tables 1 and 2; Figure 2). The objective of the resampling analysis was to identify the number of fishing days that would result in a CPUE with a 90% probability of a CV ≤ 30%. To avoid number values with three or four decimals for presentation purposes, the CPUEs (kg kWh^{-1}) were multiplied by 1000. To estimate the implied catch of a theoretical sentinel fishery, the 2014–2016 mean monthly CPUEs were considered a proxy of the expected CPUE for 2019. These catch rates were multiplied by the identified number of fishing days from the resampling simulation, by the vessels' average power, and by the average number of hours per fishing day. The resulting estimate was inflated by adding an arbitrary buffer of 15% to account for potential CPUE increases as it is not possible to accurately predict the scale of CPUE changes that might occur in the future. Finally, this result was divided by 1000 to return to the original scale. The steps can be summarized as follows:

1) A = CPUE (kg kWh^{-1}) × 1000 × Number of days from simulation × Average vessel power × Average number of hours per fishing day
2) B = A + 0.15 × A
3) Estimate of implied catch = B × 10^{-3}

* Version 2: Reference to non-existent Table 3 removed.

Results

The resampling simulation indicated that either seven fishing days in July or ten in August would be the minimum level of sampling required to achieve a CPUE with a 90% probability of a CV ≤ 30% (Table 1; Figure 2). Consequently, it was considered that a sentinel fishery sufficient to allow for collection of CPUE data for potential use as an abundance index while minimizing the impact on the stock would approximate to seven fishing days conducted in July. Following the method described above, the estimate of the implied catches of the programme was obtained by first multiplying the July 2014–2015[*] mean CPUE (25.6 kg kWh^{-1} [no data was available for July in 2016[†]; original catch rate value multiplied by 1000]; Table 3) by the identified number of fishing days from the resampling simulation for July (seven), then by the vessels' average power in July (261.7 kW), and finally by the average number of hours per fishing day in July (12.9) – step 1. This result was inflated by 15% (step 2), and the resulting value was divided by 1000 to return to the original scale – step 3. The calculation was conducted with full precision and resulted in an estimate of implied catches at about 697 kg.

Additional information

Table 1 Results from resampling simulations. Coefficient of variation (CV) depending on the number of fishing days. 2014–2016 CPUE (kg × 1000 kWh^{-1}) in fishing days directed at *Nephrops* (catch of *Nephrops* ≥ 10% of total catch) in July and August in FU 31, Cantabrian Sea (source: logbooks).

		CV (%)		
Month	Number of fishing days directed at *Nephrops*	P95	P90	P50
July	2	64.95	57.03	26.85
July	3	51.28	44.15	26.45
July	4	41.68	37.81	24.08
July	5	38.38	33.33	22.62
July	6	33.56	30.91	20.64
July	7	30.81	28.21	19.43
July	8	28.82	25.81	18.53
July	9	26.75	24.19	18.26
July	10	25.53	23.48	17.02
August	2	75.79	69.76	34.80
August	3	62.29	56.55	35.35
August	4	53.60	47.93	32.69
August	5	47.56	44.01	30.57
August	6	42.16	38.34	27.95
August	7	39.37	35.30	26.04
August	8	36.33	33.13	24.60
August	9	33.94	31.37	23.47
August	10	31.86	29.61	22.44

[*] Version 2: Year corrected
[†] Version 2: Explanation inserted

Table 2 2014–2016 CPUE (kg × 1000 kWh^{-1} for each fishing day directed at *Nephrops* (catch of *Nephrops* ≥ 10% of total catch) in July and August in FU 31, Cantabrian Sea (source: logbooks). CPUE data were multiplied by 1000 to avoid number values with three or four decimals.

Year	Month	CPUE (kg × 1000 kWh^{-1})	Monthly average	SD	CV (%) (without resample)
2014	July	10.9	25.6	12.0	47%
2014	July	13.3			
2014	July	15.3			
2014	July	15.9			
2014	July	17.3			
2014	July	17.9			
2014	July	21.2			
2014	July	28.3			
2014	July	39.6			
2014	July	51.6			
2015	July	21.2			
2015	July	26.5			
2015	July	26.5			
2015	July	35.8			
2015	July	42.8			
2014	August	28.3	15.5	10.5	68%
2015	August	17.0			
2015	August	23.9			
2015	August	33.1			
2016	August	5.6			
2016	August	6.3			
2016	August	7.0			
2016	August	8.1			
2016	August	10.0			

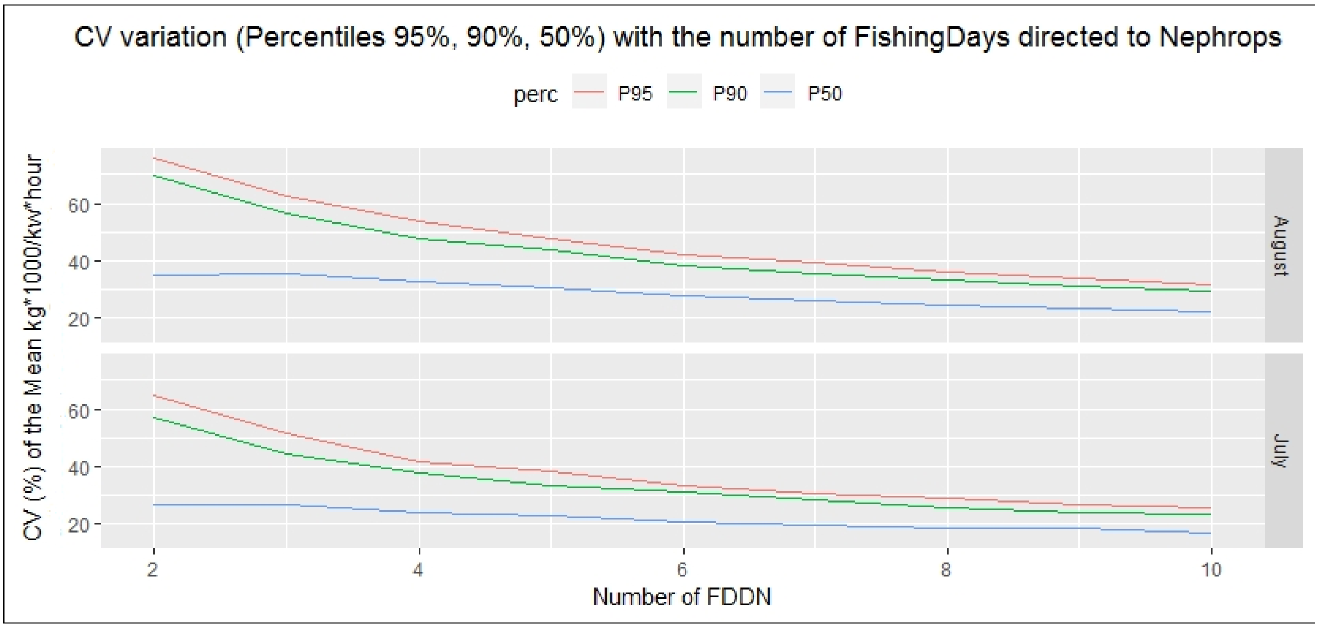

Figure 2 Results from resampling simulations. Relationship between the coefficient of variation of the mean CPUE (kg × 1000 kWh^{-1}) and the number of sampled fishing days directed to *Nephrops* (FDDN) per month with percentiles (95%, 90%, and 50%). Results from the resampling simulations with replacement for the months of July and August for fishing days directed at *Nephrops* based on the 2014-2016 commercial trips data (source: logbooks).

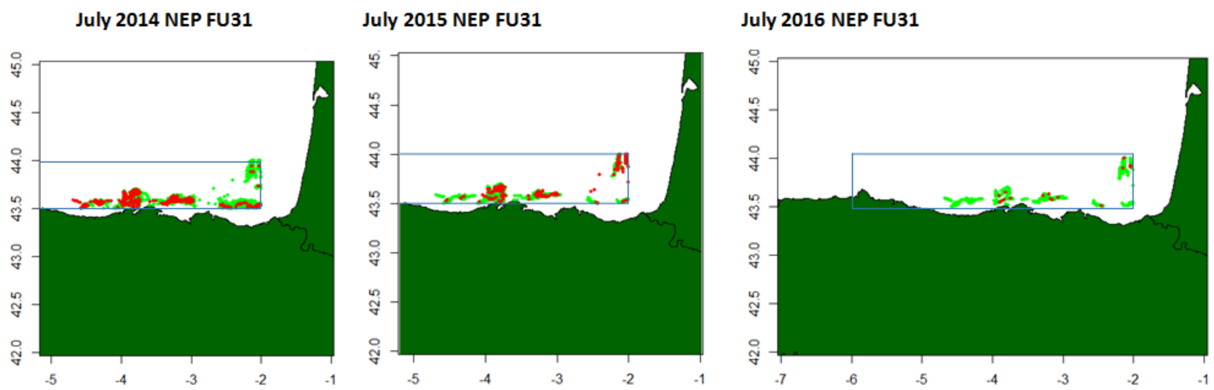

Figure 3* 2014–2016 FU 31 *Nephrops* partial effort distribution in the month of July. Red points are fishing days directed at *Nephrops* (catch of *Nephrops* ≥ 10% of total catch) and green points represent the remaining fishing days (catch of *Nephrops* < 10% of total catch). In blue the limits of the FU 31. Many points are missing because they could not be paired with logbooks.

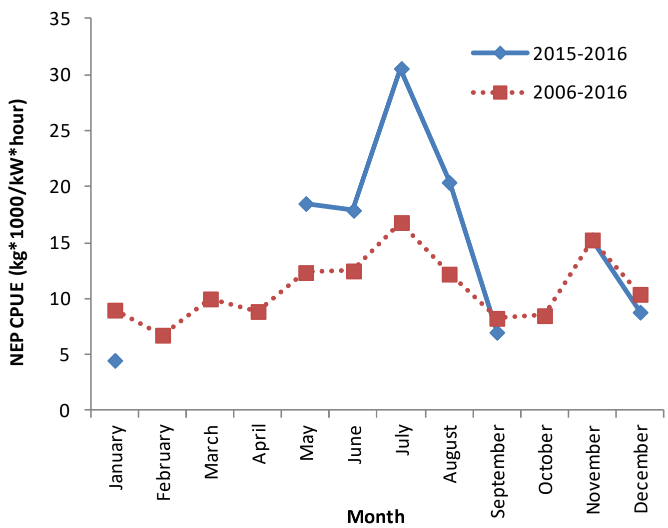

Figure 4 Monthly FU 31 *Nephrops* CPUE in kg × 1000 kWh^{-1}. 2006–2016 and 2015–2016 (source: logbooks). CPUE data were multiplied by 1000 to avoid number values with three or four decimals.

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* Version 2: Figure 3 updated.

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