WGIDEEPS REPORT 2017

ICES STEERING GROUP ON INTEGRATED ECOSYSTEM OBSERVATION AND MONITORING

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Interim Report of the Working Group on International Deep Pelagic Surveys

25-27 April 2017

ICES Headquarters, Denmark

ICES International Council for the Exploration of the Sea
CIEM Conseil International pour l'Exploration de la Mer

International Council for the Exploration of the Sea
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Contents

Executive summary

The Working Group on International Deep Pelagic Surveys (WGIDEEPS) met on 25–27 April 2017 in Copenhagen, Denmark. The group worked and succeeded in transferring data from the WGIDEEPS surveys into the ICES-DATRAS database. WGIDEEPS recommends that ICES Data Centre provides support and guidance so that, in the coming years, WGIDEEPS survey data can be 1) uploaded into the ICES Acoustic and Trawl database and 2) automatically transferred from this database into DATRAS.

The group developed a new method for the estimation of abundance and biomass in the Irminger Sea. The method will be tested on existing datasets and the results compared with those from earlier calculations at the next WGIDEEPS meeting scheduled in January 2018.

The provision of data products from WGIDEEPS to advisory expert groups was discussed and it is recommended that advisory expert groups make formal data requests to the group (submit a ToR to WGIDEEPS) to ensure that specific data products can be prepared and provided to advisory groups on time.

WGIDEEPS recognized the importance of the Russian Federation to the working group and recommends that the participation of scientists, the harmonization of data format and the conduction of surveys in the WGIDEEPS areas by the Russian federation be secured.

1 Administrative details

Working Group name

Working Group on International Deep Pelagic Ecosystem Surveys (WGIDEEPS)

Year of Appointment within the current cycle

2016

Reporting year within the current cycle (1, 2 or 3)

1

Chair(s)

Kristjan Kristinsson, Iceland

Benjamin Planque, Norway

Meeting venue

Copenhagen, Denmark

Meeting dates

25–27 April 2017

2 Terms of Reference a) – g)

- ToR a: Finalize transfer of trawl survey data from international deep pelagic ecosystem surveys coordinated by the group to ICES DATRAS databases September/2017);
- ToR b: Evaluate calculation of biomass and abundance indices derived from the trawl method in the Irminger Sea;
- ToR c: Set up a formal procedure for the use and transfer of Norwegian survey data to AFWG and WGINOR expert groups;
- ToR d: Plan the international deep pelagic ecosystem survey with special emphasis on redfish to be carried out in the Irminger Sea and adjacent waters in June/July 2018 (January 2018 meeting);
- ToR e: Prepare the report on the outcome of the 2018 Irminger Sea survey (August 2018 meeting);
- ToR f: Plan the international deep pelagic ecosystem survey with special emphasis on redfish to be carried out in the Norwegian Sea and adjacent waters in August 2019 and write SISP (January 2019 meeting);
- ToR g: Prepare the report on the outcome of the 2019 Norwegian Sea survey (September 2019 meeting).

3 Summary of Work plan

	Meeting dates	Venue	Reporting details	ToRs
Year 2017	25–27 April	ICES HQ, Denmark	Interim report by 29 May to SSGIEOM	a, b, c
Year 2018	23–25 January	ICES HQ, Denmark	Interim report by 1 March to SSGIEOM	d
Year 2018	XX-XX August	Town, Country	Interim report by 1 September to SSGIEOM	e
Year 2019	XX-XX January	Town, Country	Interim report by 1 March to SSGIEOM	f
Year 2019	XX-XX September	Town, Country	Interim report by 10 September to SSGIEOM	g
Year 2019	By correspondence		Final report by 15 September to SSGIEOM	a, b, c, d, e, f, g

4 List of Outcomes and Achievements of the WG in this delivery period

- The data collected by Norway during the WGIDEEPS survey in the Norwegian Sea in 2016 has been successfully uploaded onto the DATRAS database during the meeting (ToR a).
- The data collected by Norway during the WGIDEEPS survey in the Norwegian Sea in 2009 and 2013 has been successfully uploaded onto the DATRAS database after the meeting (ToR a).
- The data collected by Iceland during the WGIDEEPS survey in the Irminger Sea in 2009 has been successfully prepared into the DATRAS format but has been successflully uploaded in the database (ToR a).
- A new method for the estimation of abundance and biomass of redfish in the deeper layers in the Irminger Sea has been discussed and is proposed for future use (ToR b, Annex 3).
- The transfer of data into DATRAS will allow for future efficient and transparent access to WGIDEEPS data by relevant assessment working groups (AFWG, NWWG, WGINOR, ToR c).

5 Progress report on ToRs and workplan

Progress by ToR

ToRs a, b, and c were discussed and addressed during the meeting. Specific recommendations associated with these ToRs are provided.

Changes/ Edits/ Additions to ToR

There are no changes to the current list of ToRs

Cooperation with other WG

Collaboration and coordination between WGIDEEPS and assessment EG's (AFWG, NWWG, WGINOR) need to be reinforced and specific recommendations are made in this direction. Collaboration and coordination between WGIDEEPS and observation EG's (WGFAST, WGFTFB) need to be reinforced and the workshop on monitoring technologies for the mesopelagic zone (WKMESO) scheduled in November 2017 will progress in this direction.

Cooperation with Advisory structures

WGIDEEPS does not generate advice but contributes by providing data to advisory EG's.

Science Highlights

WGIDEEPS does not have direct scientific output but contributes to scientific research by providing data which have been used in a number of publications in recent years:

Bethke, E., Götze, E., and Planque, B. 2010. Estimation of the catchability of redfish and blue whiting for survey trawls in the Norwegian Sea. Journal of Applied Ichthyology, 26 (Suppl. 1): 47-53.

Klapper, R., Bernreuther, M., Wischnewski, J., Klimpel, S. (2017). Long-term stability of Sphyrion lumpi abundance in beaked redfish *Sebastes mentella* of the Irminger Sea and its use as biological marker. Parasitology Research 116(5), 1561–1572.

Nuñez-Riboni, I., Kristinsson, K., Bernreuther, M., van Aken, H., Stransky, C., Cisewski, B., Rolskiy, A. (2013). Impact of interannual changes of large scale circulation and hydrography on the spatial distribution of beaked redfish (*Sebastes mentella*) in the Irminger Sea. Deep-Sea Research (Part 1) 82, 80-94.

Planque, B., Kristinsson, K., Astakhov, A., Bernreuther, M., Bethke, E., Drevetnyak, K., Nedreaas, K., et al. 2013. Monitoring beaked redfish (*Sebastes mentella*) in the North Atlantic, current challenges and future prospects. Aquatic Living Resources, 26: 293-306.

Siegelman-Charbit, L., and Planque, B. 2016. Abundant mesopelagic fauna at oceanic high latitudes. Marine Ecology Progress Series, 546: 277-282.

6 Revisions to the work plan and justification

No revision of the work plan.

7 Next meetings

The next WGIDEEPS will take place on 23–25 January 2018 at ICES HQ, Copenhagen, Denmark.

Annex 1: **List of participants**

Name	Address	E-mail
Matthias Bernreuther	Thünen Institute of Sea Fisheries, Palmaille 9, 22767 Hamburg, Germany	bernreuther@thuenen.de
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Benjamin Planque	Institute of Marine Research Postboks 6404 9294 Tromsø Norway	benjamin.planque@imr.no

Annex 2: **Recommendations**

Recommendation	Adressed to
1. Advisory groups which use data from WGIDEEPS should make formal data requests to the group (submit a ToR to WGIDEEPS) to ensure that specific data products can be prepared and provided to advisory groups on time.	AFWG, NWWG, WGINOR, ICES Secretariat
2. ICES Data Centre to provide support and guidance so that WGIDEEPS survey data can be 1) uploaded into the ICES Acoustic and Trawl database and 2) automatically transferred from this database into DATRAS.	ICES Data Centre
3. Encourage and support participation of Russian scientists to WGIDEEPS and preparation of survey data in DATRAS format, even if not uploaded onto the DATRAS database.	Council/Delegates, SSGIEOM
4. Secure participation of Russian vessel to WGIDEEPS survey in the Irminger Sea in 2018 and to WGIDEEPS survey in the Norwegian Sea in 2019.	Council/Delegates, SSGIEOM

Annex 3: **Proposed method for the calculation of biomass and abundance indices derived from the trawl method in the Irminger Sea**

The method currently used to calculate biomass indices within and deeper than DSL from the trawl data is based on a combination of standardized survey catches and the hydroacoustic data. A proportional relationship is assumed between trawl catch and acoustic values (s_A) during trawling in the shallower layer (0–350 m) where redfish can be acoustically identified. This relationship is used to predict acoustic values (s_A) for trawl catch in the deeper layer. That is, trawl catch indices are transformed into acoustic values (s_A) and then biomass is estimated in similar manner as biomass estimates based on acoustic measurements (Kristinsson, 2015).

It was recognized by the group that the current approach used to estimate biomass in deeper layers, that is to translate trawl catch indices into acoustic energy (s_A), should be replaced by a more direct approach to biomass and abundance estimation, using swept volume estimates. The group recommends testing the following approach:

1) Convert s_A from acoustic registrations of individual trawls into estimated biomass per trawl haul. This can be done as follows:

Identify the appropriate s_A [m²/NM²] value within the horizontal and vertical extensions of the trawl haul. For each haul, calculate the acoustic based biomass, B_{ac}, as follows:

$$B_{ac} = \frac{s_A}{\bar{\sigma}} \cdot \bar{W} \cdot A_{tr}$$

with

$$\bar{\sigma} = 4\pi \cdot 10^{-k/10} \cdot \bar{L^2} \quad \text{(mean acoustic cross section for individual redfish)}$$

$$\bar{L^2} = \frac{1}{n}\sum_{j=1}^{n} L_j^2 \quad \text{(mean square length of redfish in cm}^2\text{)}$$

$$\bar{W} = \frac{1}{n}\sum_{j=1}^{n} W_j \quad \text{(mean redfish individual weight)}$$

$$A = D \cdot H \quad \text{(horizontal area covered by trawl)}$$

where

L_j = length of redfish j in cm, $j = 1, 2, ..., n$

W_j = weight of redfish j

n = number of redfish

D = trawled distance (in NM)

H = horizontal trawl opening (in NM)

k = parameter in TS equation $\text{TS} = 20 \cdot \log L - k$

2) Compare the calculated acoustic estimates, $B_{ac,j}$, with the corresponding trawl catches, $B_{tr,j}$, and estimate the trawl-acoustic conversion factor, q:

$$\hat{q} = \frac{\sum_{j=1}^{n} B_{tr,j}}{\sum_{j=1}^{n} B_{ac,j}}$$

where n is the number of trawl hauls.

This can be performed for distinct strata, years, vessels, etc. Alternatively, q could be estimated using linear mixed effect models to derive stratum-, year-, or vessel- effects from the whole dataset.

3) For the deeper layer with only trawl estimates, calculate the trawl based biomass density of redfish (e.g. tonne/NM^3), ρ_j, for each trawl haul:

$$\rho_j = \sum_{j=1}^{n} \frac{B_j}{V_j}$$

with

$$V_j = D_j \cdot H_j \cdot \Delta Z_j$$

where D_j is trawled distance, H_j is horizontal opening and ΔZ_j is vertical opening in NM-units (1m = 1/1852 NM), and B_j is the total redfish biomass in the trawl catch. The total trawl based biomass in a stratum, s, is then estimated as

$$\hat{B}_{tr,s} = \left(\frac{1}{n_s} \sum_{j=1}^{n_s} \rho_j \right) \cdot \frac{V_s}{q_s}, \quad s = 1, 2, \ldots, m$$

with

$$V_s = A_s \cdot \Delta Z_s$$

where A_s [NM^2] is the area and ΔZ_s [NM] is the vertical extension of stratum s and m is the total number of distinct strata. Assuming independent density estimates and stationary conditions within the stratum, the variance of $\hat{B}_{tr,s}$ can be estimated as follows:

$$\hat{\sigma}_s^2 = \hat{\mathrm{var}}\left(\rho_j\right) \cdot \frac{V_s^2}{n_j \cdot \hat{q}_s^2}$$

The total biomass, B, and its variance, V_B, are estimated by accumulating over the m strata:

$$\hat{B} = \sum_{s=1}^{m} \hat{B}_{tr,s}$$

$$\hat{V}_{\hat{B}} = \hat{\mathrm{var}}\left(\hat{B}\right) = \sum_{s=1}^{m} \hat{\sigma}_s^2$$

with estimated cv

$$\hat{cv} = \frac{\sqrt{\hat{V}_{\hat{B}}}}{\hat{B}}$$

The utility of the above approach is critically dependent on the appropriateness of the approach to estimate the trawl-acoustic conversion factor q. This factor can be defined as the expected ratio between the number of fish caught by the trawl and the number of fish acoustically observed in the same volume at the time of acoustic registration. This is in general different from the trawl catchability defined as the expected ratio of trawl catch to the number of fish that would have been present in the covered volume at the same time as trawling, if the fish was not disturbed by any trawling activity. The trawl-acoustic conversion factor as well as the trawl catchability may depend on several factors such as fish length, fish age, light and vibrations induced by the vessel or fishing gear.

In the present case, the echosounder is mounted on the hull, and fish are typically detected by acoustics about 1 km ahead of the trawl and in the order of 10 min before the trawl covers the same volume as the acoustics which gives enough time between registration and trawling for the fish density to change. This will easily cause a trawl-acoustic conversion factor to be different from one, even in the case when the trawl catchability equals one. In addition, it is difficult to be sure that the trawl-acoustic conversion factor (as well as the trawl catchability) is not substantially different below and above the mesopelagic layer.

Ideally the estimated trawl-acoustic conversation factors should not vary too much between trawl hauls. A way to examine this is to bootstrap trawl hauls many times, with the number of bootstrap draws equal to the number of trawl hauls in each simulation. For each simulation a new value of q is estimated, and if the cv of these simulated values is considerably lower than one, this is a good sign of strong proportionality between acoustic and trawl based estimates. If one assumes the acoustic estimate to be close to real fish density in the ocean, and that the fish density is close to stationary on a time-scale equal to the time-lag of the trawl compared to the acoustics, the trawl-acoustic conversion coefficient q will be a reasonable proxy for trawl catchability. In this case a value considerably larger than one will indicate a strong herding effect, while a value close to zero will indicate a strong escaping behaviour. Both outcomes may indicate that the trawl is too small to provide reliable abundance and biomass estimates.

The method needs to be tested on existing datasets and the results compared with those from earlier calculations.

References:

Bethke, E., Götze, E., and Planque, B. 2010. Estimation of the catchability of redfish and blue whiting for survey trawls in the Norwegian Sea. Journal of Applied Ichthyology, 26 (Suppl. 1): 47-53.

Kristinsson, K. 2015. Methodology of biomass estimatiion of deep pelagic beaked redfish (*Sebastes mentella*) from the international redfish survey in the Irminger Sea and adjacent waters. ICES WGIDEEPS 2015 - Working Document No 1. 17 pp.

Ricker, W. E. 1973. Linear regression in fishery research. Journal of the Fisheries Research Board of Canada, 30: 409-434.