



Document title	Proportion of large fish in the community (LFI) – core indicator GES approach
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Background

HELCOM HOD 41-2013 (paragraph 2.45 of the outcome) agreed that the indicator ‘Proportion of large fish in the community’ (LFI) is a HELCOM core indicator. HOD 48-2015 noted that no GES boundary has yet been proposed for the offshore assessment units in which the indicator is applicable (paragraph 3.63 and Annex 4 of the outcome).

HOD 48-2015 agreed on a Lead Country approach to further develop the core indicators (paragraph 3.64 of the outcome). The Lead Country for the indicator is Sweden, with Co-Lead countries Germany and Finland.

Operationalizing the indicator has focused on developing an approach to evaluate GES. The aim is to develop the indicator as a food-web indicator evaluating the strong known links in the pelagic fish community between cod, herring, and sticklebacks, and at a later stage further the linkages of cod to demersal species such as flounder. The indicator is considered to react to anthropogenic fishing pressure and maybe also hypoxia in central parts of the Baltic Sea affecting the cod population. Issues that have delayed the operationalization of the indicator mainly relate to data availability and developing a relevant GES evaluation approach.

The [Workshop on HELCOM fish indicators](#) discussed the development of the indicator and in particular the data availability and GES boundary concept (point 22-37 of the outcome). The long-term aim for the indicator data-flow is to utilize catch data from both the Baltic International Trawl Survey (BITS) covering the demersal habitat and the Baltic International Trawl Survey (BIAS) covering the pelagic habitat. BITS catch data is available from the ICES DATRAS database whereas BIAS catch data is held nationally with an ongoing process at ICES of building a database during 2017. The workshop noted that an extensive effort to standardize the BITS data is required before it can be used in the core indicator, and that this is not feasible within the HOLAS II schedule. For the purposes of indicator development and delivery of a first indicator evaluation to HOLAS II, the workshop agreed that Swedish standardized catch data from BIAS can be used as they cover the relevant assessment units Bornholm basin, Eastern- and Western Gotland Basin. The workshop concluded that in the further development of the LFI indicator it would be relevant to explore the option of including data on cod from both the demersal and the pelagic trawl surveys, noting the drawback that the time-series of the indicator would be shorter since the demersal data in DATRAS start in 1991 compared to 1979 in the pelagic data. Cod is considered the key species of the indicator, and Swedish analyses of the trends in cod population size show similar trends in both demersal and pelagic trawl survey data except during the very last years, where a divergence has been identified. Considering the data-availability and the aim of the indicator to be used as a food-web indicator, the workshop agreed that a recent baseline approach linked to a trend based assessment could be relevant. The conclusions and aim to submit the indicator for endorsement and inclusion in HOLAS II were noted by [FISH 4-2016](#) (paragraph 2.6 of the outcome).

Based on the guidance provided by the HELCOM fish indicator workshop and the FISH 4-2016 meeting, the Lead- and Co-Lead Countries have finalized a proposal on a trend based GES evaluation approach for the indicator. The approach to assess GES is detailed in the document.

This document presents a trend based GES boundary approach for the core indicator 'Proportion of large fish in the community' (LFI).

The [CORESET II project version](#) of the full core indicator report is made available as reference material at the STATE & CONSERVATION 5-2016 meeting site. The indicator report has not been updated to reflect the GES boundary approach described in this document.

Action requested

The Meeting is invited to:

- endorse the trend based GES boundary approach,
- endorse updating the core indicator evaluation and report based on the proposed approach.

Proportion of large fish in the community (LFI) – core indicator GES approach

Monitoring and data analyses

Time-series of LFI in the pelagic habitat were constructed using catch data from the BIAS (Baltic International Acoustic Survey, coordinated by ICES), and from historical acoustic surveys, covering the autumn period. Data were collected by Sweden (covering the whole study period, 1979-2015), Germany (historic data), Latvia and Poland (BIAS recent data). The data covers a large part of the Baltic Sea, from the Bornholm Basin to the Bothnian Sea, even if with different degree of spatial coverage in different years. HELCOM assessment units Arkona Basin (31), Gdansk Basin & East of Gotland (33), West of Gotland (34), Gulf of Riga (36) and Åland Sea (39) are well covered. In the early years, Sweden and Germany covered basically the whole Baltic Proper, while in the last 15-20 years the sampling has been divided between the countries surrounding the Baltic Sea during the BIAS. Hence, the temporal and spatial coverage is considered very good to produce LFI time-series representative of the HELCOM assessment units.

Four species were included in LFI estimation, representing 99% of the catches in terms of both abundance and biomass: sprat, herring, sticklebacks and cod. Cod was included because in the Baltic it often dwells in the pelagic habitat in search of pelagic fish prey and because of the often hypoxic deep-water conditions that cod avoid.

LFI for each trawl haul was estimated as the proportion in weight of the fish ≥ 38 cm. This threshold value is used because it corresponds to the cod minimum landing size in force between 2003-2014 and therefore can be linked to cod fishing mortality. In the BIAS pelagic trawl haul catches, only cod can have a length ≥ 38 cm. Sensitivity analyses showed that the use of ≥ 35 cm as threshold (cod minimum landing size before 2003) shows the same time trends as when ≥ 38 cm is used. As the indicator is heavily dependent on the presence of cod, it is only evaluated in the assessment units where cod is normally present, i.e. the HELCOM assessment units 31, 33 and 34 corresponding to the ICES Subdivisions 25, 26&28 and 27, respectively. Time-series of LFI were produced jointly for the HELCOM assessment areas 31, 33 and 34.

The BIAS sampling frequency and spatial resolution are based on 2 pelagic trawl haul for each ICES statistical rectangle every year.

The trawl hauls during the BIAS are taken corresponding to high fish concentrations as detected by the acoustic device (2 trawl hauls for each ICES statistical rectangle), without a-priori fixed sampling scheme accounting for trawling depth, bottom depth etc. Therefore, the LFI estimates (based on CPUE, catch-per-unit-effort, for each species) have to be standardized for other effects that can mask the annual signal. For standardization, Generalized Additive Models (GAMs) were used, using the following formulation:

$$\text{LFI} \sim s(\text{Year}, \text{lat}, \text{long}) + s(\text{Ttime}) + s(\text{Tdepth}) + \varepsilon$$

where *Year* is the Year-effect and (*Lat*, *Long*) fits the overall spatial distribution. *Year* is in interaction with (*Lat*, *Long*) because of the potential temporal changes in spatial distribution of the LFIs. *Ttime* is the trawling starting time, and was included in the model because of the potential difference in cod catchability in the pelagic waters depending on the fishing time. *Tdepth* is the mean trawling depth and was included in the model because of the potentially different catchability of cod at different depth (e.g. due to the demersal nature of the cod, we expected higher catches in deeper waters). A cyclic cubic regression spline was used to smooth the *Ttime* predictor because it forces the estimated effect to have the same value (and up to second derivative) at its start and end points. Based on the fitted models, we predicted cod LFI on a regular grid in

the Baltic seascape for each year. Thereafter these predictions were averaged for the study area. In this way, we obtained time-series of LFI in the pelagic water to be used to evaluate the environmental status of the pelagic off-shore fish community.

Assessment approach and Good Environmental Status

The assessment was performed jointly for the HELCOM assessment areas 31, 33 and 34. An assessment for smaller areas is possible, but discouraged, because of the migratory nature of the species involved and the potential occurrence of density-dependent processes. If the assessment is performed in other areas of the Baltic Sea (outside the Baltic Proper), different approaches to estimate LFI and GES-evaluations are needed.

Due to lack of sufficient process knowledge (e.g. set limits for good ecosystem functioning in a food-web context), it is not possible to set a GES boundary for the LFI of the Baltic Sea pelagic habitat. Therefore, a trend-based approach has been used for evaluating whether a Good Environmental Status (GES) is currently achieved. In the trend based approach, GES is defined based on the direction of the trend of the indicator compared to the desired direction of the indicator over time.

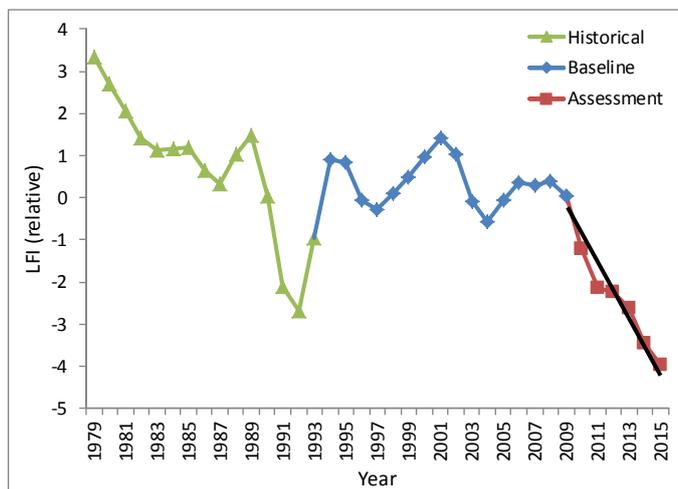


Figure 1. Temporal trends in LFI for the Central Baltic Sea (HELCOM assessment areas 31, 33 and 34). Green: historical period, before the regime shift; blue: baseline period; red: assessment period. The black line shows the linear trend of LFI during the assessment period from the latest values in the baseline period.

The approach to evaluate the food-web status was the following:

- 1) the historical period was not considered. This because during the last 100 years, the Eastern Baltic cod population has never been as high as in the late 1970s-early 1980s, as a result of several simultaneous biotic and hydrological circumstances particularly favourable for cod. Therefore, the historical period corresponds to a situation that can be hardly re-established in the future and that therefore cannot be taken as a target for management.
- 2) a baseline between 1994-2009 was taken during a time interval in which LFI has been fluctuating without trends. This baseline period is not to be considered as representing GES nor sub-GES.
- 3) the status of the assessment period was evaluated as linear trend from the baseline period, i.e. as a temporal linear regression from 2009.

The trend was strongly negative ($R^2 = 0.95$), with an intercept statistically different from zero. Since the linear trend was strongly negative, it does not matter whether the baseline represents GES or sub-GES. In both cases the assessment period would have been evaluated as being in sub-GES (strongly decreasing trend from a GES status or from an already sub-GES status).

The approach evidenced that, based on LFI, the current status of the pelagic offshore food-web in HELCOM assessment areas 31, 33 and 34 (taken together) is **sub-GES**.

Key message

GES-boundary is still under discussion among experts, and therefore the proposal is to assess GES using a trend-based approach. The indicator reflects the status of the environment based on the size structure of the fish community in the offshore pelagic habitat, the higher the proportion of large fish, the better the status is perceived to be.

In the pelagic community the proportion of large fish is not at a level that would reflect good environmental status in the Central Baltic Sea. During a few years (1990-2009) no trends in the community structure was detected, however after this time a continuously decreasing trend without any sign of reversal has been detected. During 2014-2015, LFI has been at the lowest level ever observed in the BIAS survey (since 1979).

The level of confidence of the assessment is medium to high at this stage of the indicator development.