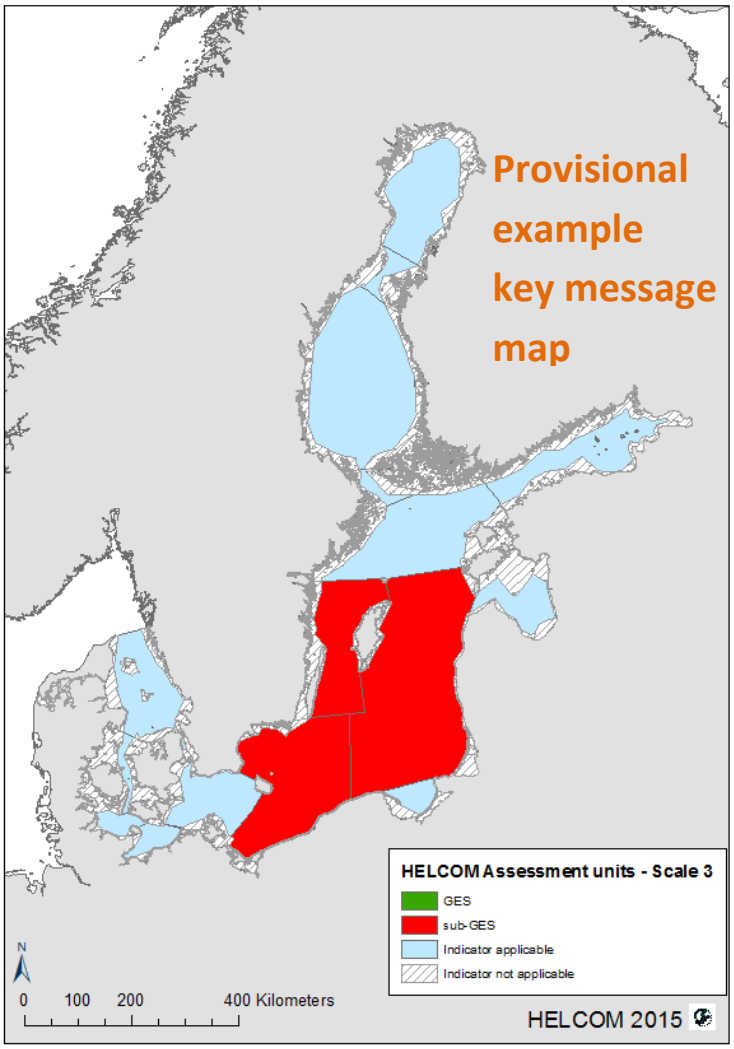
Proportion of large fish in the community (LFI -demersal and pelagic)

Key message



No actual status evaluation has been made for the indicator at this time as the GES-boundary is still under discussion among experts. The status map is provisional and presented based on provisional evaluations of both the demersal and the pelagic fish communities. The indicator reflects the status of the environment based on the size structure of the offshore fish communities, the higher the proportion of large fish, the better the status is perceived to be.

In the demersal community, the proportion of large fish has recently begun to increase, however this is probably due to the higher proportion of cod in the community while the size structure in the population of other species has not improved significantly. Initial evaluations indicate that the demersal community does not yet reflect a good environmental status.

In the pelagic community the proportion of large fish is not at a level that would reflect good environmental status in the Baltic Proper. During a few years (1995-2007) no changes in the community structure was detected and the community is considered to then have reflected a good status, however after this time a continuously decreasing trend without any sign of reversal has been detected.

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

Relevance of the core indicator

The Large Fish Indicator (LFI) evaluate the proportion in weight of large fish (above a chosen length threshold) in the fish community. Fish communities with relatively high amount of large fish, e.g. fish predators, have higher functional diversity than fish community dominated by small species (or small fish). Therefore, LFI describes certain aspects of the health of a food-web.

Since large predatory fish are usually also the most economically valuable fish and therefore the most targeted components of the fish assemblage, the indicator is expected to responds to fishing pressure. In the Baltic proper there is however also a large fishery for small pelagic species (sprat and herring).

Policy relevance of the core indicator

	Primary importance	**Secondary importance**
BSAP Segment and Objective	• Viable populations of species (biodiversity)	
MSFD Descriptors and Criteria	4.2. Proportion of selected species at the top of food-webs.	
Other relevant legislation: Common Fisheries Policy, Habitats Directive		

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Cite this indicator

HELCOM [2015]. [Indicator name] HELCOM core indicator report. Online.

Indicator concept

Good Environmental Status

The indicator development work shows a high potential for applying the LFI to evaluate good environmental status (GES) based on the Baltic Sea off-shore fish communities. However, it is also noted that suitable monitoring data to test the indicator is only available from western and central parts of the Baltic Sea, and that due to environmental gradients such as salinity the fish communities in the northern Baltic Sea are different and the same GES-boundaries and concepts may not be applicable in those regions. More specifically, cod which is dominating the large fish component in the southern Baltic Sea is only periodically present in the northern parts. The GES concept for the LFI in the Baltic Sea must recognize the regional differences, and GES-boundaries may need to be specifically set for different regions.

The LFI and target values originally developed for the North Sea cannot be directly applied in the Baltic Sea due to a number of factors. In the Baltic Sea, the diversity of marine fish species is lower than in other marine areas (Ojaveer and Kalejs, 2005). Additionally, the mean length of marine fish species utilized commercially is smaller in the Baltic compared to the same species in the North Sea. Therefore the LFI defined for the North Sea by Greenstreet et al. (2011.) has been modified by Oesterwind et al. (in prep.), Casini et al. (in prep.) as well as by Psuty et al. (2012a, 2012b) to suit the Baltic Sea conditions and attempt to identify relevant threshold sizes for GES-boundary evaluation.

The demersal and pelagic communitites are treated separately in the indicator assessment protocol and have been given separate GES-boundaries. This is a practical approach due to the fact that the monitoring data differs between the communities. The two communities are however in actual fact very closely linked by the same fish species, and even individual fish, occurring in both communities. To ensure a relevant status evaluation of an area in the Baltic Sea, both the demersal and the pelagic community should reach the defined GES-boundaries for an area to be considered as having achieved GES.

Demersal off-shore community

[1]Taken into account the situation of demersal fish community in the Baltic Sea, the GES-boundary is defined as a certain percentage of large fish >30cm in the community, excluding cod (see Oesterwind et al. 2013 below), and a certain percentage of large fish >58cm in the community, including cod (see below). The percentage defining GES has not yet been proposed by the experts.

Species evaluated against the >30cm length threshold include e.g. flatfish. In order to reflect the length distribution in the whole demersal fish community and describe and evaluate the status from a biodiversity and food-web perspective, not only commercial species like cod and flatfish should be considered. However, due to the gear and mesh size used in the surveys supplying data to the indicator many species belonging to the demersal community are not caught. This has to be kept in mind when evaluating biodiversity using this indicator.

[1] *There is no consensus on the Large Fish Indicator in the group. The LFI TMAs (DE, Thünen Institute) do not agree with the proposal to take cod as „indicator species" for the demersal as well as the pelagic fish community; in this form, in the opinion of TI, cod should be discussed under D3 and not in the context of D1 and D4.*

If the >30cm length threshold would be taken as the only threshold for the whole fish community, there would be a danger of falsely evaluating the status as having achieved GES. This danger is mainly due to the fact that also >30cm long cod would be categorized as 'large fish' although they are still sexually immature at this length, maturity is normally reached at a length of 38cm however the fish are not considered 'large' at this size. One of the underlying assumptions of a community reflecting a good status when the proportion of large fish is high, is that large individuals generally are more effective spawners. Thus, a community dominated by sexually immature cod is not considered to reflect a good status. It is therefore proposed that the threshold value for considering cod individuals as 'large' to be set at the mean catch length of 58cm (which is 75% of the L_{opt} length) (see Froese and Sampang 2013, WKLIFE IV draft report 2014)

L-optimum (L_{opt}) is a reference point (first suggested by Sidney Holt in 1958) and is defined as the length where cohort biomass and egg production are maximal when no exploitation takes place (for details see Froese and Sampang 2013). L_{opt} is the length with maximum biomass per length class (Froese 2004). Catch is maximized for a given fishing mortality (F) at L_{opt}, and consequently the theoretical maximum catch could be obtained with infinite F (Holt 1958). Thus, the least impact on the size and age structure of the stock occurs, when a given catch is taken only at this length. In reality, it is not possible to catch fish only at one length. However, Froese et al. (2008) pointed out that catching fishes only at and beyond the size when they reflect L_{opt} results in a similarly low impact on the size and age structure as fishing at L_{opt} since biomass per length class declines only at lengths above L_{opt} .

L_{opt} can be calculated from:

$$L_{opt} = L_{inf} * 3 /(3 + M/K)$$

$\mathbf{L_{inf}}$ is a parameter of the "von Bertalanffy growth function" (VBGF), describing the asymptotic length that individuals of a population would approach if they were to live forever. **K** is a parameter of the VBGF, describing how fast asymptotic length or weight is approached. **M** is the natural rate of mortality, i.e., the fraction of fish dying from causes such as predation, environmental hazards, diseases or old age

According to the WKLIFE Report 2014, the length where growth rate is maximum (L_{opt}), was considered a better reference point as it represents the point where cohort biomass and egg production are maximal in an unexploited status and where and where catch is maximal for a given F, or F is minimal for a given catch (i.e. the optimum harvest length) (Cope & Punt, 2009; ICES, 2012c). If L_{mean} is close to L_{opt}, then either the stock is very lightly exploited or the fishery is operating with a target length that is sustainable and close to MSY.

Based on DATRAS - SMALK for growth and ICES working group for natural rate of mortality (M)(see Froese and Sampang p.31ff) L_{opt} has been defined as:

L_{opt} = 82 cm for cod in ICES rectangle 2224 Western Baltic Sea
L_{opt} = 71.6 cm for cod in ICES rectangle 2532 Eastern Baltic Sea
mean L_{opt} = 77 cm

The average length of commercial caught cod should be as close as possible to L_{opt}, e.g. the target for 2020 could be 75% L_{opt} resulting in an average catch length of 58 cm, which can be calculated from official landing data (Froese and Sampang 2013). Currently the proportion of cod >58cm in the BITS survey data is very low.

Pelagic off-shore community

The pelagic community is considered to reflect a good environmental status (GES) when the LFI values for the evaluated period are above the 5th percentile of the median distribution during a baseline period. The current environmental status should be evaluated as a comparison with this GES-baseline. The environmental status is evaluation based on the deviation of the median value of the indicator during the assessment period in relation to the variation of the indicator value during the baseline period.

The pelagic catches from BIAS are dominated (in average 99.9 %, both in abundance and biomass) by four species, sprat, herring, cod and sticklebacks, and therefore only these species were used in the LFI estimations. The GES-boundary is structured around a threshold value for pelagic LFI where large fish are defined as being of ≥38 cm length. This threshold value is used because it corresponds to the cod mimimum landing size in force between 2003-2014 and therefore can be linked to cod fishing mortality. Moreover, cod maturity is normally reached at a length around 38cm. In the BIAS pelagic trawl haul catches, only cod can have a length ≥38 cm. Testing 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.

Since the species of the pelagic off-shore fish community are highly mobile and likely prone to density-dependent habitat occupation (i.e. at high population size the stocks expand, and at low population size it contracts, behaviour especially known for cod, Casini et al. 2012), a single GES-boundary for the peagic community of the whole Baltic Proper is needed as well as a single evaluation of the community for the whole area. If the indicator is applied in other areas of the Baltic Sea (outside the Baltic Proper), separate GES-boundaries and evaluations may be needed.

For the baseline period to be relevant and comparable to the assessment period, it must be carefully selected to reflect time periods with stable environmental conditions, as stated within the MSFD (EC 2010). The baseline period should cover at least 10 years to extend over more than two times the generation time of the typical species representing the indicator (in our case cod, whose 50% of the population become reproductive at 3-years of age), to cater for natural variation in the indicator value due to for example strong and weak year classes. During the last 100 years, the Eastern Baltic cod population has never been as high as in the late 1970s-early 1980s as a consequence of several simultaneous biotic and abiotic circumstances favourable for cod. Therefore, the late 1970s-early 1980s corresponds to a situation that can be hardly re-established in the future and thus the baseline should not be taken during this period. Moreover, a substantial turnover in the ecosystem abiotic conditions in the Baltic Sea has been apparent in the early 1990s, leading to shifts in the baseline state (Möllmann et al 2009). Therefore, it is not advisable to compare the current status to a status before the early 1990s, however it should be noted that the baseline should be selected for a period where cod has not yet been affected by fishing.

For this core indicator, the selected baseline period is 1995-2007 which is constituted by a nearly constant values of LFI in all the assessment units (see Results). This period is constituted by low cod biomass, but relatively high cod mean length (and mean lengh-at-age) in all the assessment units (ICES WGBFAS). Moreover, this period is characterized by a low biomass of small pelagic fish as herring and stickelbacks, while sprat biomass was relatively high.

The pelagic off-shore LFI is based on trawl catches form the currently ICES-coordinated BIAS (Baltic International Acoustic Survey). As data is currently not compiled jointly by all Contracting Parties, the analysis for GES-boundary has been done based on Swedish BIAS data.

Anthropogenic pressures linked to the indicator

	Strong connection	Secondary connection
General	Fishing targeting fish of large size	
MSFD Annex III, Table 2	Biological disturbace: - selective extraction of species, including incidental non-target catch (e.g. by commercial and recreational fishing)	

Fishing activities affect the status of the fish community, and the LFI is a strong indicator with significant responses to fishing mortality. Since fishing is highly selective, and extracts from the sea the largest species (and largest individuals of each species), the indicator is expected to respond to fishing pressure. However through sustainable fishing practices the pressure on the community can be minimized by targeting a broader range of sizes and species.

Assessment protocol

Demersal community

Catch numbers per length per haul of eight demersal species are to be converted into weight-at-length. The sum of biomass of individuals is then to be calculated, grouped in two size classes: larger than 30 cm, and larger than 58 cm. For every year, these sums are to be divided each by the sum of total biomass of the eight species caught in the BITS, resulting in an LFI value for each legth threshold defined in the GES-boundary concept.

A cross-correlations analysis between the different LFI time-series and fishing mortality of species in the community can in addition be made, using e.g. a bootstrap hypothesis testing for the cross correlation estimations (Oesterwind et al. in prep).

Pelagic community

HELCOM areas 31, 33 and 34 (ICES subdivisions 25, 26&28, and 27).

LFI is estimated for each trawl haul as a proportion in kilos of the catch/hour of fish ≥38 cm. The weight-at-length used to estimate LFI are taken to be constant to avoid the influence of changes in fish body condition in the LFI time-series.

A baseline approach is chosen to evaluate the environmental status of the off-shore pelagic community. The fish datasets must meet certain criteria for an evaluation of GES using the baseline-approach:

1) The baseline data set should cover a minimum number of years, which should be two times the generation time of the species most influential to the indicator evaluation in order to account for the influence of strong year classes. For the off-shore pelagic community the cod is the species with the longest turnover rate, fully maturing at age 4. A baseline period between 1995-2007 has been chosen as representing GES, since the period was constituted by low cod biomass although a relatively large proportion of big cods (≥38 cm) in the cod stock and a relatively high mean length were recorded (ICES 2014). Moreover, this period was characterized by a low biomass of small pelagic fish as herring and stickelbacks, while sprat biomass was relatively high.
2) The baseline data set must not display a linear trend within itself (n>10, p>0.05), as the baseline for evaluation should optimally reflect the community structure at stable conditions and not a development towards a change in the environmental status. For the off-shore pelagic community the period 1995-2007 shows a constant LFI.
3) Before evaluating GES, it must be decided whether or not the baseline period reflects a period of GES. This could be done either by using data dating back earlier then the start of the baseline period, using additional information, or by expert judgment. If there is data e.g. preceding the baseline period of much higher values than the ones in the baseline period, the baseline might represent sub-GES (in case of an indicator where higher values is indicative of a good environmental status) or GES (in case of an indicator where higher values are indicative of an undesirable status). For the off-shore pelagic ommunity, the baseline period (1995-2007) was judged to reflect GES. The assessment period covered the years 2011-2013 to cater for natural variability.

During the last 100 years, the Eastern Baltic cod population has never been as high as in the late 1970s-early 1980s as a consequence of several simultaneous biotic and abiotic circumstanceshaveing been favourable for cod. Therefore, the late 1970s-early 1980s corresponds to a situation that can hardly be re-established in the future and thus the baseline should not be defined for this period. Moreover, a substantial turnover in the ecosystem abiotic conditions in the Baltic Sea has been apparent in the early 1990s, leading to shifts in the baseline status (Möllmann et al 2009). Therefore, it is not advisable to compare the current status to a status before the early 1990s. The baseline period was taken between 1995-2007, which is constituted by nearly constant values of LFI in all the assessment units (see Results).

The GES-boundaries have been defined as the value of the indicator at the 5^{th} percentile of the median distribution of the baseline data set. The median distribution is computed by re-sampling (with replacement) from the baseline data set. In each repetition, the number of samples equals the number of years in the baseline data set. In order to improve precision, a smoothing parameter may be added in each repetition. The smoothing parameter is computed as the normal standard deviation of the re-sampled data set divided by the number of years re-sampled.

To evaluate the environmental status during the assessment period the median value of the indicators during the assessment period is compared with the specific GES-boundary. In situations where the baseline dataset represents GES, as is the case in this indicator, the median of the years to be assessed should be above the 5^{th} percentile of the median distribution of the baseline data set in order to reflect GES.

Relevance of the indicator

Policy Relevance

The indicator (LFI) addresses the MSFD criteria "Proportion of selected species at the top of food webs" in the Descriptor 4 (Food Webs). Healthy ecosystems are characterised by high proportion of large individuals. The EU's Marine Strategy Framework Directive (MSFD) requests Member States to develop marine strategies for the marine areas under their jurisdiction. However, the off-shore pelagic community is constituted by highly motile fish species showing large and natural changes in spatial distributions. Therefore, LFI for this community cannot be assessed for too small areas such as national boundaries or economic zones, but must be assessed across national jurisdictions. Off-shore fish communities (both demersal and pelagic) comprise also other important segments of international policies such as the Common Fisheries Policy (CFP) and the Baltic Sea Action Plan BSAP.

The role of pelagic and demersal off-shore fish communities in the ecosystem

The proportion of large fish in a community follows the structure of the fish community and particularly the proportion of large predatory fish, which are significant balancing features in a food web but at the same time heavily targeted by the commercial fisheries. Commercial fisheries often target the large, high-value fish species and individuals in the off-shore community. Fishing has a direct effect on the structure of fish communities, because it can lead to an increase in the relative abundance of small fish (Jennings et al., 1999) and reduces the mean body size within a tageted population (Beverton and Holt, 1957). Based on this concept, the LFI maps the fishing pressure (Greenstreet et al., 2011). Several studies to understand and improve the LFI for different marine areas and surveys techniques are being prepared at the moment (Oesterwind et al., in prep.; Psuty et al., 2012a; Psuty et al., 2012b; Casini et al., in prep).

LFI evalautes the size-composition in the fish community. Fish communities with relatively high number of large fish have higher functional diversity than fish community dominated by small fish. LFI could also reflect changes in the recruitment success of different species (for example depending on hydrological conditions as salinity and temperature, favouring different species). Natural processes influence the LFI to some extent, however large shifts in the proportion is deemed to be the effect of anthropogenic fishing pressure.

Due to a number of factors, including the influence of brackish water, the diversity of marine fish species in the Baltic Sea is lower than in other marine areas (Ojaveer and Kalejs, 2005). Additionally, the mean length of marine commercial fish species is smaller in the Baltic compared to the same species in the North Sea. Therefore Oesterwind et al. (in prep.) as well as Psuty et al. (2012a, 2012b) modified for the demersal community the LFI which was defined for the North Sea by Greenstreet et al. 2011. The off-shore pelagic fish community, on the other hand, is dominated by fewer species than the demersal community, and the cod is the only top predator. Therefore, for the off-shore pelagic community a threshold length of 38 cm was used (mirroring large cods), since it corresponds to the cod minimum landing size and therefore closely linked to fishing pressure on cod (Casini et al., in prep).

Results and confidence

Demersal off-shore community

Only provisional results are available for the off-shore demersal community and no results have yet been calculated for the proportion of cod ≥58cm in accordance with the GES-buondary.

Indicative results from the time period 2000-2011 in the southern Baltic Proper show that cod dominates the demersal off-shore community (Figure 1).

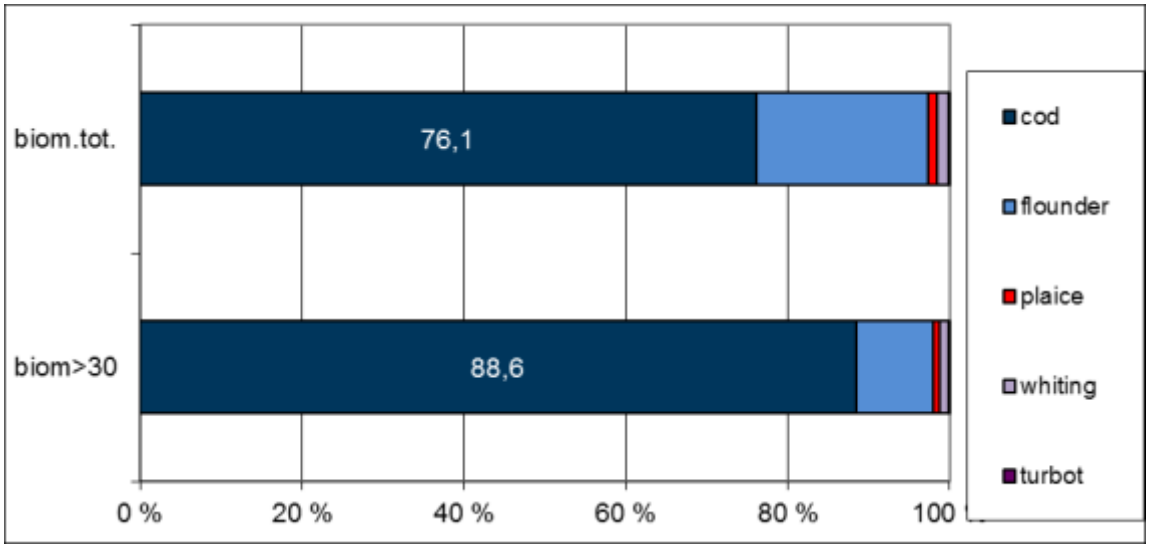

Figure 1. The total biomass and the biomass of fish >30cm in Polish waters (ICES SD 25 and 26) during the period 2000-2011. Note; the GES-concept proposes exclusion of cod from the ≥30 cm size class and this figure needs to be re-calculated.

The temporal development of the fish community in the southern Baltic Proper shows an increase in the share of large fish individuals (Figure 3). The majority of cod is, however, still small compared to the situation when the population had not been affected by humans when the mean length of the Baltic cod was estimated to be 56 cm and 10 % of the fish exceeded 75 cm (Limburg et al. 2008). The increasing trend seems to depend on the decreased fishing mortality of cod but there may be an increase of fish size also for the community if cod is removed from the calculation (Figure 3).

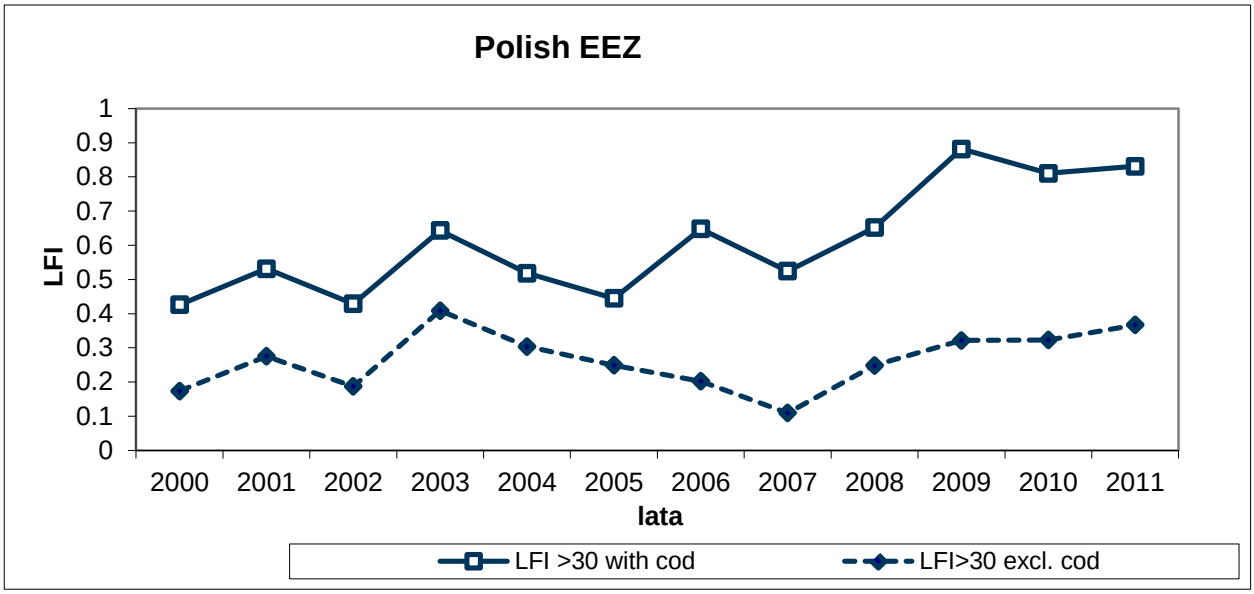

Figure 2. Proportion of large fish (LFI) by biomass in the Polish EEZ during 2000-2011. LFI was calculated separately for the whole community and the community without cod. Data from 476 polish stations and 261 Danish stations.

The cod fishery influences the demersal fish assemblage and consequently the $LFI_{>30\ cm}$ excluding cod also responds indirectly to the fishing mortality (F) of cod. In the Belt Sea region (ICES SD 22, 24) the current management plan for cod fisheries and the reduction of by-catches within the cod fishery in the period 2001-2012, the fishing mortality is decreasing while the $LFI_{>30\ cm}$,including and excluding cod, is increasing however not significantly (Figure 2) (Oesterwind et al., in prep).

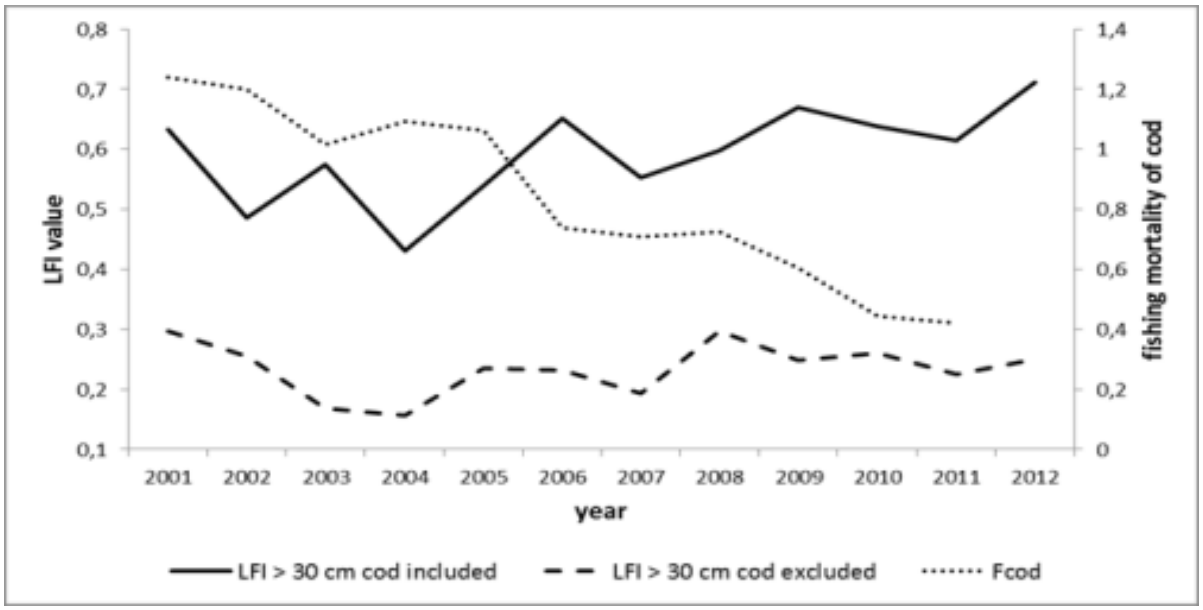

Figure 3. Temporal development of LFI > 30 cm with (bold solid line) and without cod (bold broken line) in the Belt Sea region (ICES SD 22-24). Cod fishing mortality (Fcod, dotted line) is shown for comparison.
Note; the LFI incuding cod needs to be recalculated using the ≥58cm threshold defined in the GES-boundary concept.

Pelagic off-shore community

Evaluations for the pelagic community in the indicator has so far only been made using Swedish data. Sweden has preformed standarized acoustic surveys since the late 1970s and has covered 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. Specifically, in the early years Sweden covered basically the whole Baltic Proper, while in the last 15-20 years the Baltic Sea has been divided between the countries and thus Sweden has covered more or less half of the Baltic Proper, basically the Swedish EEZ, but still sampling in all the HELCOM assessment units Arkona Basin (31), Gdansk Basin (33), Eastern Gotland Basin (34), Gulf of Riga (36) and Åland Sea (39) (full spatial coverage in areas 34). Hence, even if the use of only Swedish data is certainly a limitation, the spatial coverage might be considered sufficient to produce LFI time-series representative of the HELCOM assessment units.

For the Bothnian Sea a shorter Swedish time series exists (2007-2012) from the BIAS survey. The time seris are however still considered to be too short to evaluate the environmental status based on either trends or the baseline-approach.

The time-series of LFI are based on data from Swedish acoustic survey from 1979 onwards. The LFI time-series are shown in the figures below, for the single HELCOM assessment units (31, 33 and 34) and for the whole Baltic Proper (assessment units 31, 33 and 34 together). In the assessment units 31, LFI dropped from the 1979 to the early 1990s, whereas higher values were observed between 1995-2007. Since 1998 LFI has strongly declined (Figure 4). In the assessment units 33, on the other hand, LFI declined steadily along the whole time-series (Figure 5), while in the assessment area 34 LFI has decreased up to 1990, stabilized until 2010 and finally dropped between 2010 and 2013 (Figure 6).

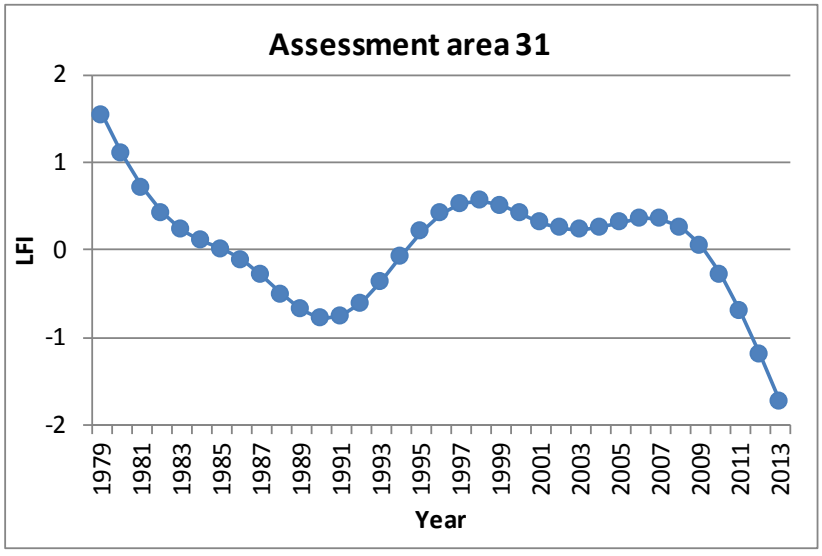

Figure 4. Standardized LFI for the off-shore pelagic community in the HELCOM assessment unit Arkona Basin (31).

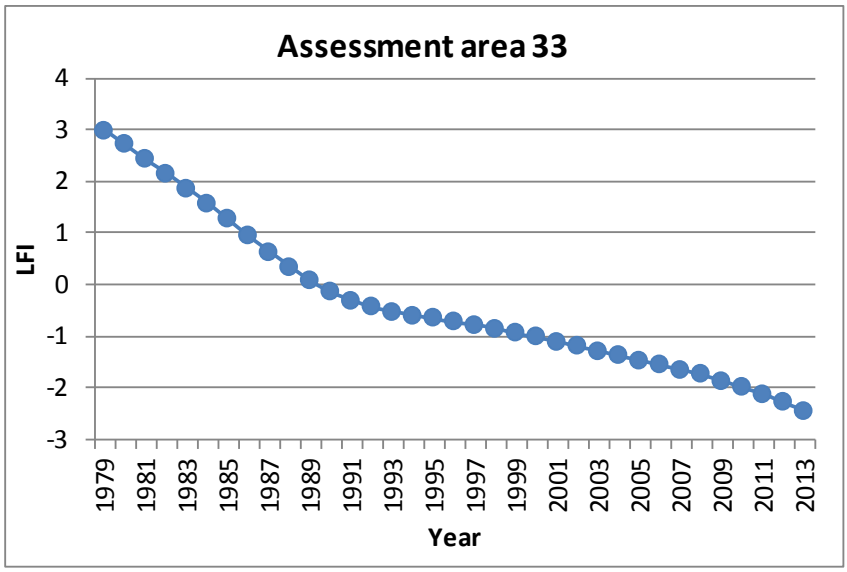

Figure 5. Standardized LFI for the off-shore pelagic community in the HELCOM assessment unit Gdansk Basin (33).

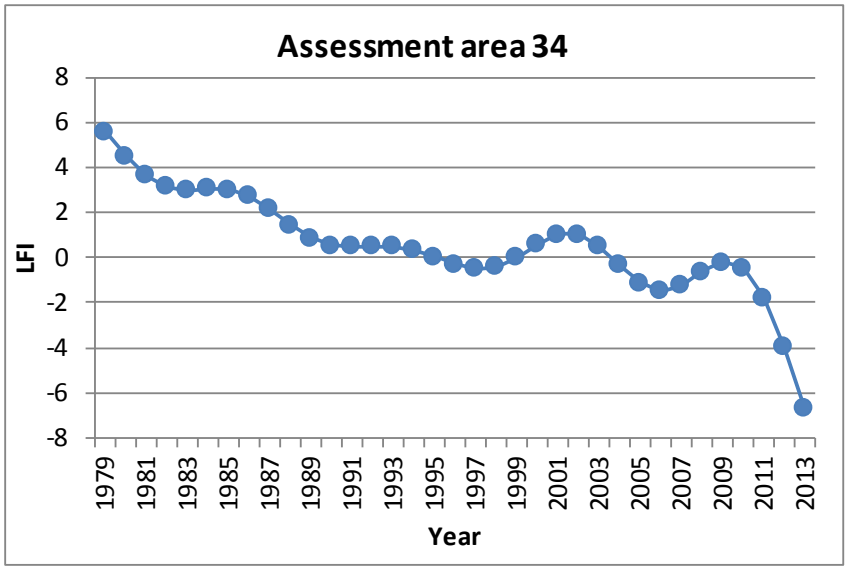

Figure 6. Standardized LFI for the off-shore pelagic community in the HELCOM assessment unit Eastern Gotland Basin (34).

Considering the whole Baltic Proper, LFI showed a trend similar to the one shown by the assessment area 31 (Figure 7). It must be kept in mind that since the LFI is estimated by a GAM modelling approach, smoothing the annual observations, potential year-to-year high frequency variabilities are not detectable.

The evaluation of the environmental status was done only for the whole Baltic proper. The fish species representative of the pelagic off-shore community are highly motile responding to external pressures (e.g. fishing) over a large geographical range. For example some species, e.g. cod, can show density-dependent habitat utilization, meaning that an external pressure (e.g. fishing) in one HELCOM assessment area can affect LFI not only in that area but also in the others. And conversely, an external pressure (e.g. fishing) in one area could appear not to produce changes in LFI just because this area could be filled up by cod coming from an adjacent area. Moreover, in the case of the Baltic Sea, separate fishing mortality estimates do not exist by assessment area.

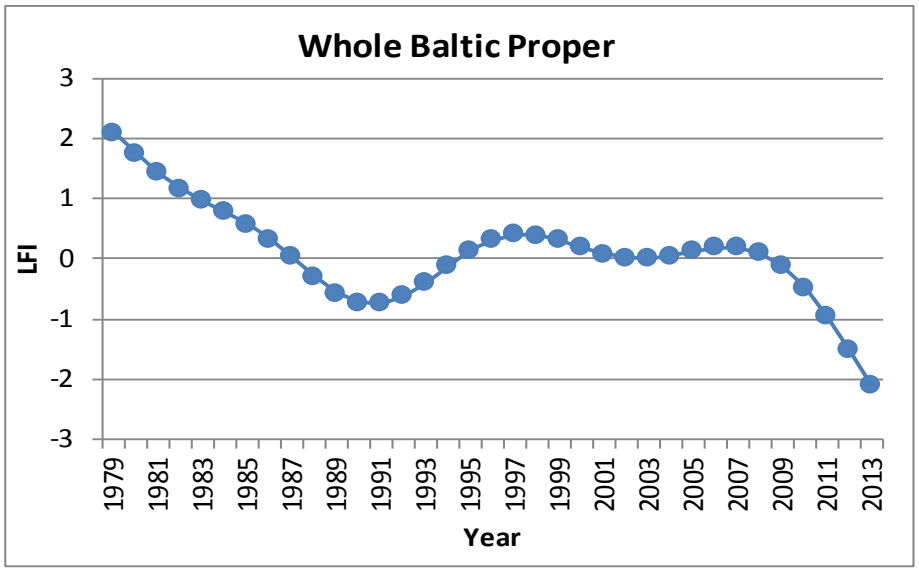

Figure 7. Standardized LFI for the off-shore pelagic community in the whole Baltic Proper (HELCOM assessment units 31, 33 and 34 together). The evaluation of the environmental status is done using this time-series.

The evaluation of the whole Baltic Proper showed that currently the environmental status is in sub-GES, i.e. with a LFI in 2012-2013 statistically lower than the GES baseline 1995-2007. The LFI trend is moreover still decreasing (Figure 8), clarifying the sub-GES evaluation.

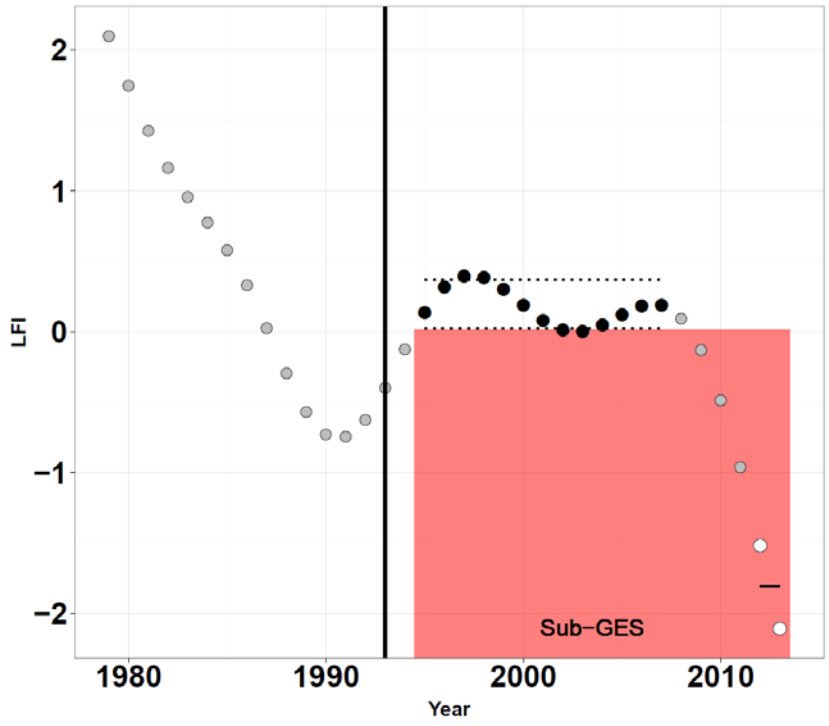

Figure 8. Evaluation of the environmental status for the off-shore pelagic community of the whole Baltic Proper (HELCOM assessment units 31, 33 and 34 together). The vertical thick line shows the time of the abiotic regime shift in the Baltic Sea (Möllmann et al. 2009), separating two different abiotic conditions. The analysis of the status evaluation was therefore performed using the period 1994-2013, comparing the current status (2012-2013, white dots) with GES-baseline (1995-2007, black dots). The horizontal dotted lines show the 5% an 95% percentile of the median distribution of the baseline dataset.

Confidence of the indicator status evaluation

Off-shore demersal community

No confidence estimate available yet.

Off-shore pelagic community

The confidence of the status indicator evaluation is judged to be **moderate**, because the spatial coverage in the different HELCOM assessment units is not complete due to the use of only Swedish data. Specifically, in the early years Sweden covered basically the whole Baltic Proper, while in the last 15-20 years the Baltic Sea has been divided between the countries and thus Sweden has covered more or less half of the Baltic Proper, basically the Swedish EEZ, but still sampling in all the HELCOM assessment units 31, 33, 34 (full spatial coverage in areas 34) used in this evaluation. Hence, even if the use of only Swedish data is certainly a limitation, the spatial coverage is considered sufficient to produce LFI time-series representative of the Baltic Proper. However, the use of all data form all the countries performing the BIAS survey would improve the quality and confidence of the indicator status to high. Especially needed are the data from the southern parts of the HELCOM assessment units 31 and 33, and the eastern part of the assessment unit 33.

Monitoring requirements

Monitoring methodology

General information about the HELCOM common monitoring activities for off-shore fish communities are presented in the HELCOM Monitoring Manual:

http://helcom.fi/action-areas/monitoring-and-assessment/monitoring-manual/fish-fisheries-and-shellfish/offshore-fish

Common guidelines are to be included in the HELCOM Monitoring Manual during 2015-2016. The monitoring methodologies in BITS and BIAS are described in detail in ICES (2012) and ICES (2010) and could form the basis for an agreed common HELCOM guideline.

Off-shore pelagic community

The BIAS (Baltic International Acoustic Survey) 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 a-priori fixed sampling scheme accounting for trawling depth, bottom depth etc. Therefore, the catch data (CPUE, catch-per-unit-effort, Kg/hour) 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:

$$CPUE \sim s(Year) + s(lat, long) + s(Ttime) + s(Tdepth, Odepth) + \varepsilon$$

where *Year* is the Year-effect and *(Lat, Long)* fits the overall spatial distribution. *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. In fact, in other areas cod has been shown to perform diel vertical migrations in the water column, generally concentrating close to the bottom at day-time and more dispersed in pelagic waters at night-time. *Tdepth* is the mean trawling depth (i.e. the mean depth of the gear headrope) 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). Cod in the Baltic has been shown however to avoid oxygen concentrations below 1 ml l^{-1} (Schaber *et al.*, 2012), and therefore we used *Odepth* (depth at which oxygen was 1 ml l^{-1} at the trawl haul location) as interactive effect with *Tdepth*. In the case the whole water column was well oxygenated (i.e. no *Odepth* was present), *Odepth* was set equal to bottom depth. *s* are the smoothing functions and ε the error term. A thin-plane regression spline was used to model the interaction between year and geographic coordinates. 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 (Wood, 2006). Different GAM analyses were done separately for the HELCOM assessment units 31, 33 and 34, moreover one GAM was done for the whole Baltic Proper covering the assessment units 31, 33 and 34 together. Based on the fitted models, we showed cod CPUE time-series in each assessment area, by extracting the Year-effect from the model, after having accounted for the effect of the other covariates. 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.

Description of optimal monitoring,

In order for the indicator to provide a high confidence evaluation of the environmental status based on the LFI indicator, monitoring would regularly need to be carried out covering the whole area of the HELCOM sub-basins.

Off-shore pelagic community

For the off-shore pelagic community, the data needed to estimate LFI and evaluates the environmental status basically exist, but are held in the national laboratories performing the BIAS, either in digitalized or paper formats. No international database exists impeding smooth regional evaluations. An international database with raw data on trawl catch (catches by species and length-classes) should be developed to render the update of the LFI and of the assessment easy.

Current monitoring

Demersal community

ICES sub-divisions 22 (Kattegat) to 28 (SE Baltic Proper).

Pelagic community

From ICES SD 25 (Bornholm Basin) to SD 32 (Gulf of Finland), excluding SD 31 (Bothnian Bay).

The HELCOM Contracting Parties performing the BIAS are Sweden, Germany, Poland, Russia, Lithuania, Latvia, Estonia and Finland, covering nearly the whole Baltic Sea.

The evaluation of LFI for off-shore pelagic community is currently based on standardized catch data from Swedish acoustic survey from 1979 onwards. There is no easy availability of data from other countries, since no international database exists. The stations used in the current assessment of the status of the indicator are shown in Fig. 14 below. Sweden covers entirely ICES Subdivision 27, the northern part of Subdivision 25, the western parts of Subdivision 26 and 28 and the southern part of Subdivision 29. Subdivision 30 is nowadays (since 2012) covered by Finland. Therefore, to have a full spatial coverage, the data from other countries should be collated. However, since Sweden covers a large part of the Baltic Proper the use of Swedish data can be considered as representative for the HELCOM assessment units analysed. The data needed to estimate LFI (standardized catches by species and length-classes) from some countries are in some circumstances digitalized, in other cases in paper format.

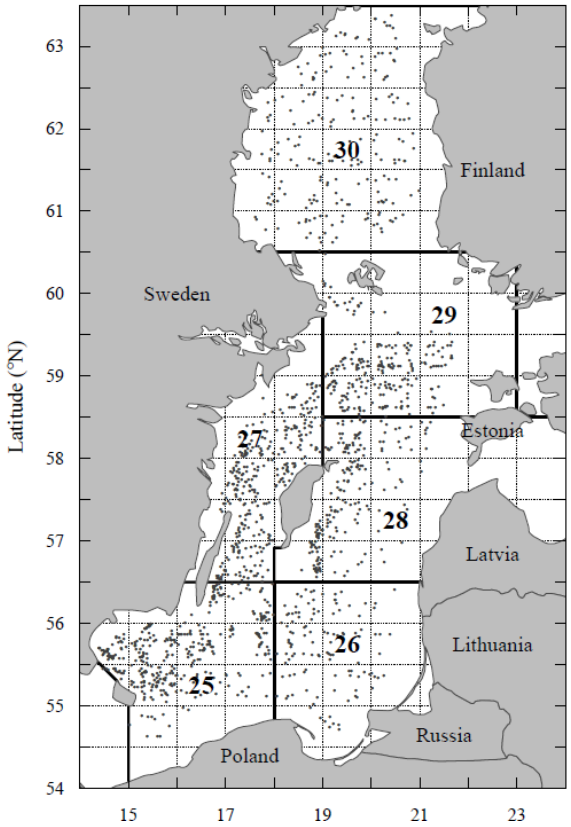

Figure 9. Trawl hauls swept by Sweden during the national acouctic survey from 1979 to 2013. The evaluation of the environmental status was done for the whole area encompassing ICES SDs 25, 26, 27 and 28.

Description of data and up-dating

Metadata

Baltic International Trawl Survey (BITS). See http://datras.ices.dk/Home/Descriptions.aspx

Baltic hydroacoustic survey (BIAS). See http://www.ices.dk/community/groups/Pages/WGBIFS.aspx

The pelagic off-shore LFI is based on trawl catches form the currently ICES-coordinated BIAS (Baltic International Acoustic Survey). There is currently no complete international database for this survey, and therefore the information has to be directly collated from the single countries. Moreover, this indicator relies on the existence of length-frequency information for all the trawl haul and fish species caught. Unfortunately, not all the countries performing the BIAS collect this information for all species (but only for the target species sprat and herring), or even if they do that, the information is sometimes not digitalized and therefore unavailable for direct analyses.

Publications and archive

(Archive)

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Additional relevant publications