

The Large Fish Indicator in North Sea waters: Does it respond to the recent decline in fishing?

Antonios Stamoulis (1,2), Hans Polet (1), Els Torreele (1) and Adriaan D. Rijnsdorp (3,2)

(1) The Institute for Agricultural and Fisheries Research (ILVO), Animal Sciences – Fisheries, Ankerstraat 1, 8400 Ostend, Belgium. (2) Aquaculture and Fisheries group, Wageningen University, Wageningen, The Netherlands. (3) Wageningen IMARES, Institute for Marine Resources and Ecological Studies, IJmuiden, The Netherlands. Presenter contact details: antonios.stamoulis@gmail.com, Phone +3259569834

Summary

The Large Fish Indicator (LFI) describes changes in the proportion of large fish at community level and gives an indication about its state. In the North Sea (>40cm total length), although proposed as an indicator of Good Environmental Status, the LFI may vary between different regions. Using data from the International Bottom Trawl Survey (IBTS) and Beam Trawl Survey (BTS), we investigated the LFI response to recent changes in fishing mortality rates. To examine changes in LFI trends, we calculated the indicator for different areas of the North Sea. The indicator responded to changes in fishing mortality but mainly based on BTS data. Moreover, when calculated with IBTS data, the indicator was highly influenced by single species contribution such as cod, underpinning that the LFI might be more sensitive to other pressures than fishing. A suite of indicators covering different data, dimensions and processes would elucidate trends and rapid changes of the LFI. The BTS survey can provide a reliable sound basis of information for calculating the LFI in the southern North Sea waters.

Introduction

Almost all fisheries are size-selective by nature. Size-dependent harvesting reduces the abundance of larger fish and those that have the potential to grow large. Size of fish, however, is a primary factor in ecological processes (Shin *et al.*, 2005). The Large Fish Indicator (LFI) describes changes in the proportion (by weight) of the fish community that is larger than a specified length threshold (40cm in the North Sea) (Greenstreet *et al.*, 2010). Fishing pressure in the North Sea is applied mainly by two bottom-trawling fishing gears: a) the beam trawl that targets primarily flatfish and is more common in the southern North Sea, and b) the otter trawl that is more common in the northern North Sea and targets mainly roundfish. It is known that fishing mortality in the North Sea has been declining. We calculated LFI trends in different areas of the North Sea and examined whether the indicator reflects changes in fishing mortality.

Materials and Methods

We analysed data from the ICES International Bottom Trawl Survey (NS-IBTS) and Beam Trawl Survey (BTS) collected during the first (Q1) and third (Q3) quarter of the year respectively. As an area of study, we defined spatial subsets of the North Sea (Greater NS, Northern NS, Southern NS), based on the design of each survey, with IBTS extending to the greater North Sea area and BTS focusing on the southern part. We used ICES statistical rectangles for reporting; statistical rectangles sampled less

than 50% of all years were excluded to reduce spatial bias. The north-south division of the North Sea was defined as described by Fraser *et al.* (2008). We calculated the LFI following the protocol proposed by Greenstreet *et al.* (2010), including only species defined as demersal according to Engelhard *et al.* (2010). North Sea's fishing mortality rates, available from ICES stock assessments, delivered demersal roundfish (RoundfishFcom) and flatfish (FlatfishFcom) community's averaged mortality rates. We investigated the statistical correlations between two groups, RoundfishFcom and IBTS-LFI, and FlatfishFcom along with BTS-LFI. Moreover, we applied time-lags of >10 years to examine the long-term relationship between LFI and fishing pressure.

Results and Discussion

IBTS-LFI 40cm trends for the greater North Sea were found being comparable to those reported in the literature (Greenstreet *et al.*, 2010). The 40cm BTS-LFI trends were strongly inversely correlated to changes in the fishing mortality applied on flatfish species. However, correlation for BTS-LFI in the northern NS was not statistically significant. BTS-LFI trends for most regions in study showed a time-lagged response to changes of fishing mortality between 1 to 5 years.

The IBTS-LFI series were not correlated to fishing mortality except the one calculated in the Southern Part of the North Sea (SPNS) (Figure 1A), which was correlated positively, implying that an increase in fishing mortality would be followed by an increase in the LFI. A possible explanation for this paradox is the high biomass contribution of a single species, cod, the abundance of which has been declining during recent times, as it is known that its centre of distribution to be shifting towards northern North Sea waters. When excluding cod, the aforementioned correlation was not significant.

Therefore, LFI trends calculated with BTS data did reflect the recent decline of fishing effort, especially in the southern waters (Figure 1B), whereas the IBTS-based ones did not. The BTS-LFIs were substantially lower than the IBTS-LFIs for the same regions (data not shown). This confirms the facts that SPNS is hosting smaller fish than the northern, as well as the increased catchability of the BTS towards smaller individuals.

A suite of indicators covering different data, dimensions and processes would elucidate trends and rapid changes of the LFI. The BTS survey can provide a reliable sound basis of information for calculating the LFI in the southern North Sea waters.

References

- Engelhard, G. H. G., Ellis, J. J. R., Payne, M. R., ter Hofstede, R., and Pinnegar, J. K. 2010. Ecotypes as a concept for exploring responses to climate change in fish assemblages. *ICES Journal of Marine Science*, 68: 580–591.
- Fraser, H. M., Greenstreet, S. P. R., Fryer, R. J., and Piet, G. J. 2008. Mapping spatial variation in demersal fish species diversity and composition in the North Sea: accounting for species- and size-related catchability in survey trawls. *ICES Journal of Marine Science*, 65 : 531–538.
- Greenstreet, S. P. R., Rogers, S. I., Rice, J. C., Piet, G. J., Guirey, E. J., Fraser, H. M., and Fryer, R. J. 2010. Development of the EcoQO for the North Sea fish community. *ICES Journal of Marine Science*, 68: 1–11.
- Shin, Y., Rochet, M., Jennings, S., Field, J., and Gislason, H. 2005. Using size-based indicators to evaluate the ecosystem effects of fishing. *ICES Journal of Marine Science*, 62: 384–396.

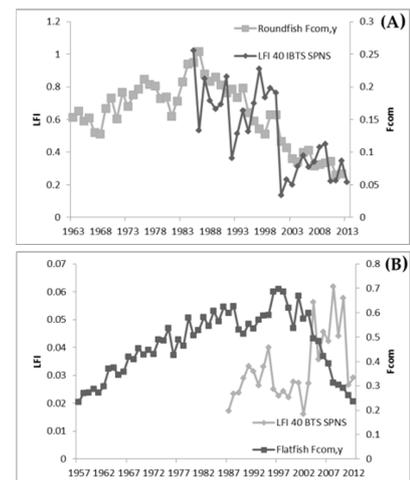


Figure 1: LFI-Fcom charts for (A) LFI IBTS SPNS and roundfish Fcom, (B) LFI BTS SPNS and flatfish Fcom. In both cases LFI is calculated for 40cm.