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Using a size indicator based on survey data to evaluate the state of the Flemish Cap ecosystem

by

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Abstract

The proportion biomass of larger fish over the total from survey results was calculated using 30, 35 and 40 centimetres as reference length. Results indicate a continuous decline in the last 20 years (Figure 1), but their complete interpretation is still uncertain. The decline in the proportion of large fish appears as a consequence of good redfish recruitment (i.e., increase in the proportion of young fish) in the last four years.

Introduction

A way in which Ecosystem Approach to Fisheries Management (EAF) could be applied has been developed based on a set of criterion to be considered, each one containing an ecological objective, a state indicator, a pressure indicator, and a management plan. Each state indicator may measure some property of the ecosystem that is considered favourable for the ecosystem and which is modified by some pressure, as measured by the related pressure indicator. The relationship between possible state indicator and pressure indicators has been explored by the ICES Working Group on Ecosystem Effects of Fishing Activities (WGECO) (ICES, 2006).

Data and Methods

Gerjan *et al.* (2007) describe and make a proposal on how to calculate six indicators to support an EAF. The indicator named *Proportion of large fish* is defined as *Indicator for the proportion of large fish by weight in the assemblage, reflecting the size structure and life history composition of the fish community*. For data requirements it is stated that:

> *Species, length and abundance from fisheries-independent research survey(s) for relevant marine region. Accurate reporting of these indicators requires that all species that contribute to the indicator are consistently and reliably identified. Survey catches must be fully sorted (not sub-sampled) to ensure that all individuals of every species that contributes to the indicator are recorded.*

Further recommendation is:

> *Research survey should cover largest proportion of the marine region over the longest available time period. The indicator would be survey specific. The methods require that surveys are conducted annually in the same area with a standard gear.*

Results from the EU bottom-trawl survey on Flemish Cap, 1988-2007 (Vázquez and González-Troncoso, 2008), were used. Since 1988, the survey covered the shallowest 19 strata, those with less that 730 m depth, but the area coverage was extended in 2003 up to 1460 m depth. Data from the 19 shallowest strata were used in this study to allow the longest uniform survey series.

The following steps describe the method used to calculate the size indicators:

- The list of fish species appeared in the survey was revised, and those without a known length weight relationship were eliminated. The final set comprised 40 key species.

- For each survey and each key species:

1. Survey biomass (swept area estimates) and its length distribution were calculated.
2. Sum of products (SOP) were calculated for both, the whole distribution (SOP-total), and those fish larger than the reference length (SOP-large-fish).
3. Biomass of large fish was then calculated as a fraction of the survey biomass equal to the ratio SOP-large-fish / SOP-total.
4. Survey biomass and biomass of large fish of every species were added to calculate totals for the whole set of species.
5. The survey indicator was calculated as the quotient between Total biomass of large fish and Total survey biomass.

Three reference lengths were considered: 30, 35, and 40 cm.

Bootstrap with 2000 replicates was followed to calculate standard deviates. The random selection process was only applied to hauls on each stratum, but not to the length distribution of each selected haul because it is considered a minor component.

Results and Discussion

Results indicate a deep decline of the large fish survey indicator in the last four years: 2004-2007 (Figure 1), but the whole image is different depending of the reference length used. Using 40 cm as reference length, the indicators' series does not show any significant tendency in the period 1988-2003, but the tendency is significant with 30 cm. The intermediate 35 cm reference only indicates a weak significant tendency. Knowing the deep changes that occurred in Flemish Cap in that period, both in fishing effort and species' composition, results from the 30 cm reference length was judged preferable because it could better explain those changes.

Using 30 cm as reference length, Figure 2 shows the confidence intervals for the indicator (L30).

High inter-annual variability is a characteristic of the L30 indicator. To explore the dependence between the indicator and abundance of species, the contribution of each species to the indicator was calculated. Seven species accounted 90% of the indicator's value: cod, redfish, American plaice, Greenland halibut, witch flounder, Atlantic wolfish and spotted wolfish. Thorny skate has only a contribution around 10% in 2004-2005. The contribution of these species is compared with the indicator in Figure 3. Contribution of redfish was high in the whole period but very variable and showing no tendency. Contribution of cod was high and variable in the initial and last periods: 1988-1994 and 2006-2007. Contribution of Greenland halibut was also high and variable in the intermediate period: 1998-2002. These result indicate that when species with large mean size, such as cod, Greenland halibut and skates, are abundant they dominated the large size portion of the fish community.

Redfish dominates the portion fish less than 30 cm in length. The proportion of redfish biomass in this group is higher that 80% (Figure 4), excepts in 1993, when cod was very abundant. The low L30 value in the last four years is a consequence of the increased abundance of redfish, for which fish length less than 15 cm were very abundant in those years, but four years was not time enough for them to growth greater than 30 cm.

In conclusion, L30 appears to be not linked to fishing effort, which has a sharp decline in 1994, when fisheries for cod and American plaice collapsed, and remains low since then. The occurrence of redfish is the most influential phenomenon.

References

Gerjan, P., I. Lutchman, and S. Jennings. 2007. Report of the ad hoc meeting of independent experts on indicators and associated data requirements to measure the impacts of fisheries on the marine ecosystem. *EU Commission report*, 32 pp.

ICES. 2006. Report of the Working Group on Ecosystem Effects of Fishing Activities (WGECO), 5 12 April 2006 , ICES Headquarters, Copenhagen. ACE:05. 174 pp.

Vázquez, A. and D. González-Troncoso. 2008. Results from Bottom Trawl Survey on Flemish Cap of June-July 2007. *NAFO SCR* 08/34.

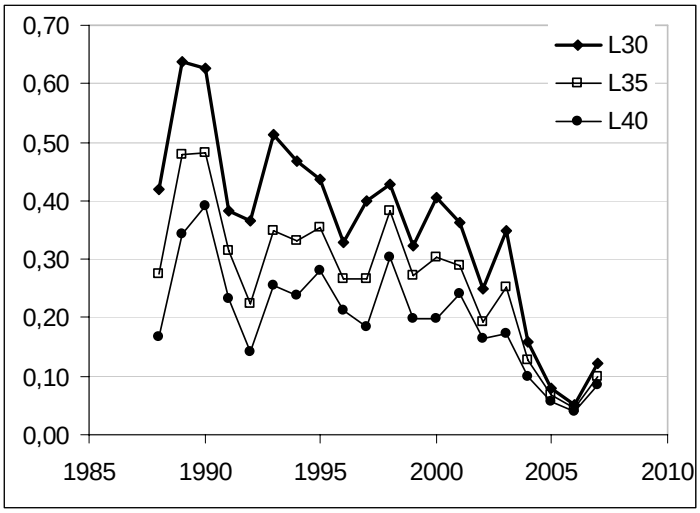

Figure 1. Proportion of survey biomass for fish grater than 30, 35 and 40 cm: Indicators L30, L35 and L40 respectively.

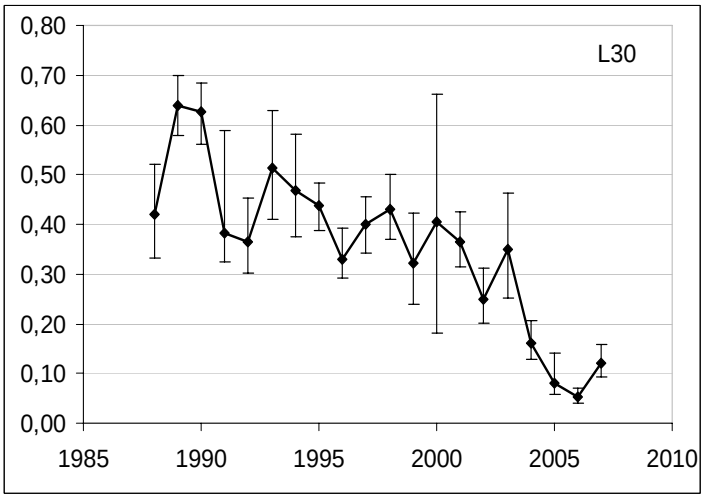

Figure 2. Indicator L30: proportion of survey biomass for fish grater than 30 cm, and it 95% confidence interval.

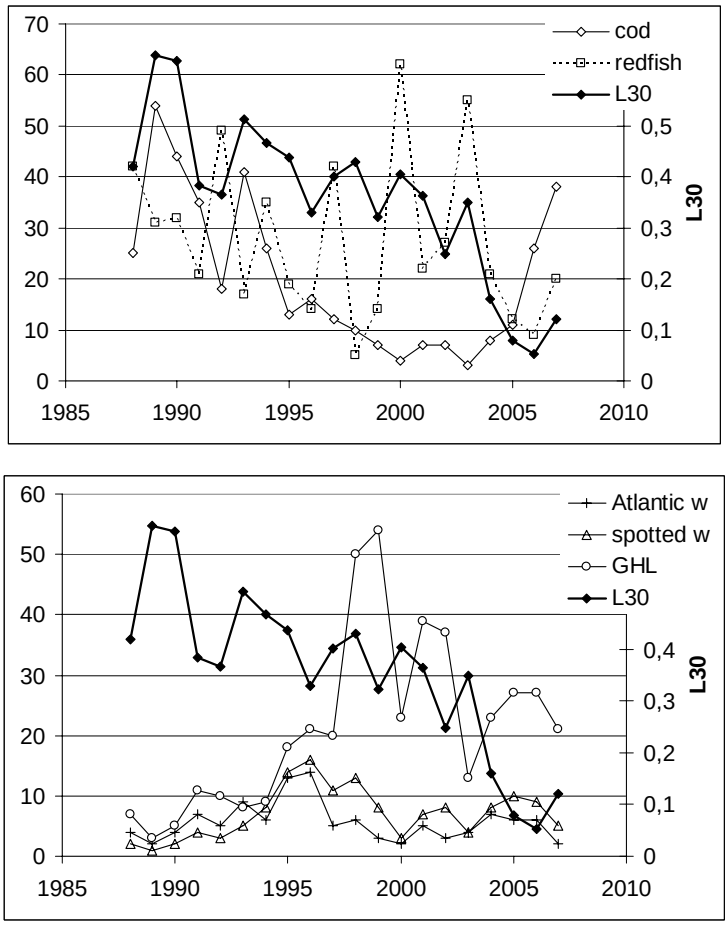

Figure 3. Evolution of the L30 indicator and contribution (%) of several species to its value.

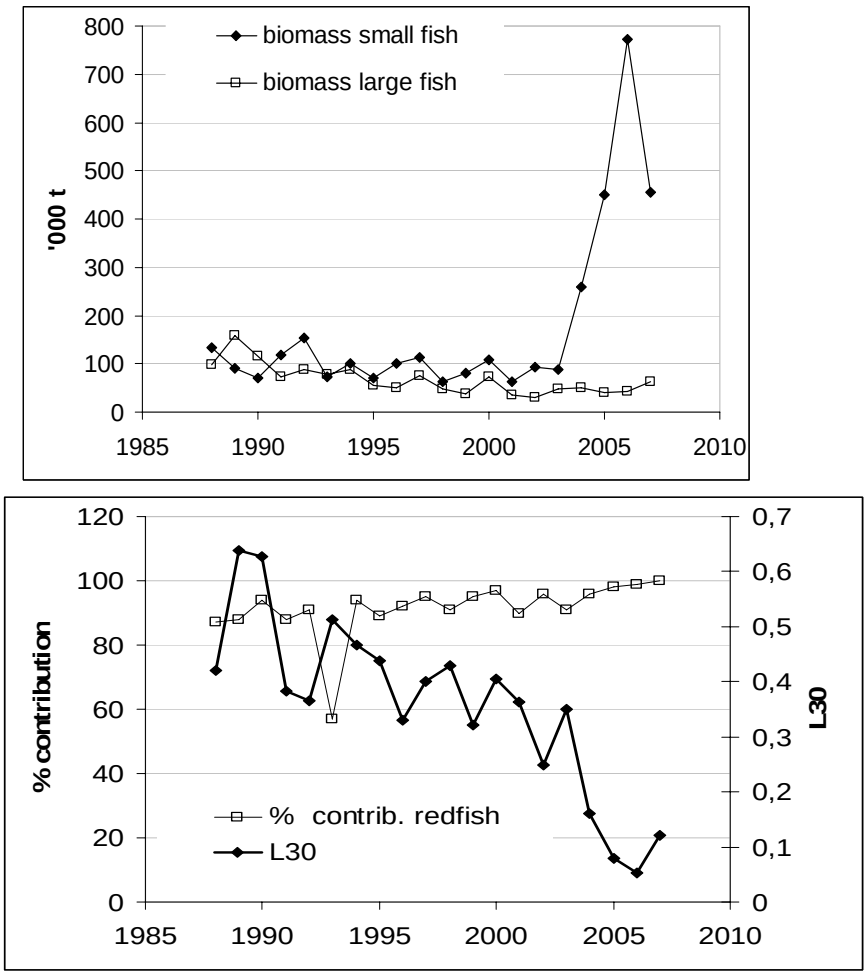

Figure 4. Evolution of the L30 indicator in relation to biomass of small and large fish (top panel) and the contribution of redfish to the biomass of small fish (bottom panel).