# Using all the information: examining the possibilities of aggregated size composition to support fisheries management

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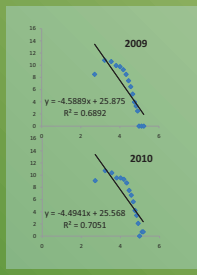
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## INTRODUCTION

Size structures of individual populations are basic data used for monospecific assessments needed for the management of marine resources. Within an ecosystem based approach, some indicators have been developed from size based data to measure the impact of fishing on ecosystems. Multispecific length structures have been proposed as useful tools to provide an interpretation of the evolution of fish assemblages. The size structure of aggregated catches at a given point could be then considered as a snapshot showing the interrelationships among interacting elements in a intensively exploited ecosystems as Bay of Biscay.

Current EU Data Collection Framework has adopted since 2009 a concurrent sampling strategy, implying that the length structures of all species caught are obtained during a sampling operation. Compared with the previous scheme, in which only the main target species were sampled, the shift to concurrent sampling involves a significant increase in data obtained.

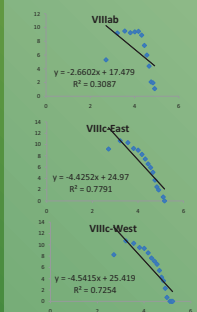
The aim of this study is to explore the possibilities of size based indicators using all landed species to detect ecosystem changes/response due to fishing impacts in highly multispecific fisheries.




Annual

Despite different changes in sampling, both years show the same slope. Size structure can be interpretated as a characteristic property of a fishery ecosystem as considered by Murawski & Idoine, 1992.

Indicator usefulness for fishing impacts could come from examining changes through a wider interval.




Areas

Differences in slopes between VIIIcEast and VIIIcWest were minor as compared to differences with VIIIab.

Fishing activities along the southern Bay of Biscay could be considered the same in front of those in VIIIab. The aggregate size differences reflect differing exploitation patterns in the different areas.

*Diversity table*

By line: Over the 66th percentile | Between 33rd and 66 th percentile | Under the 33rd percentile

| Factor | Indicat. | 10-19 | 20-29 | 30-39 | 40-49 | 50-59 | 60-69 | 70-79 | 80-89 | 90-99 | 100-109 | 110-119 | 120-129 | 130-139 | 140-149 | 150-159 | 160-169 | 170-179 | slope |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2009 | S | 23 | 48 | 52 | 53 | 54 | 48 | 23 | 19 | 11 | 9 | 5 | 4 | 4 | 1 | | 1 | | -0.0134 |
| | H' | 1.9703 | 2.5564 | 2.5045 | 1.4195 | 0.7574 | 0.8739 | 0.9754 | 1.0447 | 0.8555 | 0.9802 | 1.4189 | 0.8257 | 1.1457 | | | | | |
| 2010 | S | 17 | 46 | 53 | 53 | 54 | 47 | 15 | 11 | 8 | 6 | 3 | 3 | 1 | | | 2 | 1 | -0.0107 |
| | H' | 1.7273 | 2.5099 | 2.6183 | 1.7265 | 0.9781 | 0.8343 | 0.9462 | 1.0189 | 0.7694 | 0.9702 | 0.8486 | 0.9278 | 0.9003 | | | 0.6931 | | |
| VIIIab | S | 5 | 14 | 24 | 28 | 29 | 19 | 10 | 8 | 5 | 4 | 2 | 1 | | | | | | -0.004 |
| | H' | 1.2356 | 1.8833 | 2.103 | 1.3196 | 0.6603 | 0.54 | 0.5641 | 0.8325 | 1.0974 | 1.1702 | 1.0735 | 0.6829 | | | | | | |
| VIIIc-East | S | 16 | 42 | 49 | 39 | 29 | 18 | 13 | 11 | 8 | 4 | 3 | 2 | 2 | | | 2 | 1 | -0.0123 |
| | H' | 1.9867 | 2.3179 | 2.4367 | 1.8037 | 0.8504 | 1.1258 | 1.0416 | 0.822 | 0.3548 | 0.3587 | 0.5758 | 0.6931 | 0.6829 | | | 0.6931 | | |
| VIIIc-West | S | 20 | 44 | 50 | 53 | 54 | 48 | 19 | 13 | 9 | 4 | 4 | 3 | 2 | | | 1 | 1 | -0.0122 |
| | H' | 1.8408 | 2.427 | 2.1299 | 1.4877 | 0.9448 | 1.1612 | 1.2583 | 1.0487 | 0.8453 | 0.9024 | 0.955 | 0.6244 | 0.6829 | 0.6931 | | | | |
| AUTUMN | S | 16 | 41 | 48 | 44 | 27 | 22 | 11 | 8 | 4 | 3 | 3 | 2 | | | | 2 | 1 | -0.0036 |
| | H' | 2.0339 | 2.4902 | 2.4479 | 1.6453 | 0.9837 | 0.8586 | 0.9791 | 1.1963 | 0.8035 | 0.5222 | 0.8559 | 0.7299 | 1.0397 | | | 0.6931 | | |
| WINTER | S | 11 | 32 | 35 | 34 | 17 | 12 | 9 | 5 | 3 | 2 | 1 | 1 | | | | | | -0.0033 |
| | H' | 1.6862 | 2.4294 | 1.9751 | 1.4932 | 0.6203 | 0.8625 | 0.9071 | 0.9815 | 0.9327 | 0.501 | 0.5004 | | 1.0397 | | | | | |
| SPRING | S | 15 | 45 | 51 | 49 | 28 | 22 | 18 | 14 | 10 | 4 | 2 | 2 | 1 | | | 1 | | -0.0036 |
| | H' | 1.9868 | 2.5998 | 2.3955 | 1.3945 | 0.7989 | 0.964 | 1.0734 | 1.2958 | 1.0258 | 1.0703 | 0.8344 | 0.6581 | 0.5623 | | | | | |
| SUMMER | S | 17 | 46 | 44 | 42 | 24 | 17 | 16 | 13 | 12 | 7 | 6 | 4 | 3 | 1 | | | | -0.0021 |
| | H' | 1.9478 | 2.4529 | 2.5123 | 1.6394 | 0.8857 | 0.7202 | 0.8642 | 1.1141 | 1.1338 | 1.1265 | 1.2491 | 1.0965 | 0.9557 | | | | | |
| GNS | S | 9 | 39 | 36 | 33 | 20 | 15 | 14 | 10 | 7 | 5 | 1 | 2 | | | | 2 | | -0.0109 |
| | H' | 1.6052 | 2.0451 | 1.8408 | 1.1947 | 0.4811 | 0.6245 | 0.7373 | 0.9488 | 0.7106 | 0.3083 | 0.452 | 0 | 0.3768 | | | 0.6931 | | |
| LLS | S | 1 | 10 | 18 | 18 | 14 | 7 | 6 | 6 | 5 | 2 | 2 | 1 | | | | | | -0.0205 |
| | H' | 0 | 1.6288 | 1.1711 | 0.859 | 0.0853 | 0.0378 | 0.0999 | 0.5465 | 1.4854 | 1.7423 | 0.687 | 0.6365 | | | | | | |
| OTB | S | 20 | 43 | 51 | 52 | 39 | 34 | 20 | 18 | 10 | 9 | 5 | 4 | 3 | 2 | | 1 | 1 | -0.0243 |
| | H' | 2.0762 | 2.3592 | 2.5451 | 1.7063 | 1.0524 | 1.1032 | 1.4668 | 1.2701 | 1.0051 | 1.3796 | 1.2958 | 0.9257 | 0.6837 | 0.6931 | | | | |
| PS | S | 14 | 42 | 51 | 51 | 37 | 31 | 19 | 16 | 10 | 8 | 5 | 4 | 3 | 2 | | 1 | 1 | -0.0276 |
| | H' | 1.0668 | 0.8505 | 1.3927 | 1.226 | 0 | | | | | | | | | | | | | |
| PTB | S | 4 | 16 | 16 | 11 | 8 | 6 | 4 | 4 | 3 | 2 | 2 | 1 | 1 | | | | | -0.0679 |
| | H' | 0.9407 | 1.1226 | 1.7181 | 0.6415 | 0.2653 | 0.3741 | 0.5575 | 0.9238 | 0.6877 | 0.6365 | 0.6365 | | | | | | | |

S) total number number of species. (H') Shannon–Wiener, H'=SUM(Pi *log2(Pi)), where Pi is the proportion of each species in each group

The overall shape of the diversity spectrum will be determined both by the number of species present in each size group as well as by their relative abundance (Gislason & Rice, 1998). Diversity spectra change as a result of changes in the fishery pattern or changes in the system due to fishing impacts. Slope is expected to decrease with a increase of the fishing impacts.

**Main references**

Bianchi, G., H. Gislason, K. Graham, L. Hill, X. Jin, K. Koranteng, S. Manickchand-Heileman, I. Paya, K. Sainsbury, F. Sa´nchez & K. Zwanenburg, 2000. Impact of fishing on size composition and diversity of demersal fish communities. ICES Journal of Marine Science 57: 558–571.

Gislason, H. & J. Rice, 1998. Modelling the response of size and diversity spectra of fish assemblages to changes in exploitation. ICES Journal of Marine Science 55:362–370.

Hall, S. J., J. S. Collie, D. E. Duplisea, S. Jennings, M. Bravington & J. Link, 2006. A length-based multispecies model for evaluating community responses to fishing. Canadian Journal of Fisheries and Aquatic Sciences 63: 1344–1359.

## MATERIAL AND METHODS

Sampling framework: Multi-species length structures obtained in market sampling during 2009-2010 through the IEO sampling programme were analyzed. 287161 individuals of a total of 114 species (or taxonomic groups) corresponding to teleosts and elasmobranchs were used.

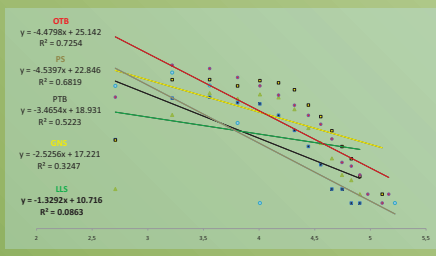
Fishing activities covered by the IEO sampling programme were grouped into 5 major sets according to their gear: bottom otter trawl (OTB), bottom pair trawl (PTB), purse seine (PS), longlines (LLS) and gillnets (GNS). Artisanal, fishing pots, live baits and trolling were excluded.

Division VIIIc (southern Bay of Biscay) and Divisions VIIIab (eastern Bay of Biscay) were used. For spatial comparison data from VIIIc were separated in two components (East and West, Cape Estaca de Bares 7º41'W) to explore the influence of Atlantic conditions.

Indicators: Size-based indicators used were slope of size spectra, slope of diversity spectra and number of species. Size spectra (Bianchi *et al*., 2000) were constructed by plotting the natural logarithm of the total number of individuals caught by 10-cm length class (y-axis) against the natural logarithm of the middle of each length class (x-axis). The slope of the size spectra is expected to decrease when increases fishing mortality (Hall *et al*., 2006), so it can be considered a good measure of fishing impacts (Gislason & Rice, 1998).

Diversity spectra (Gislason & Rice, 1998) were constructed by plotting the Shannon–Wiener index (calculated for each 10-cm length class) against the mid-length of each length group. Diversity spectra are not showed but slope and values are represented in the "Diversity table" through a traffic light system.

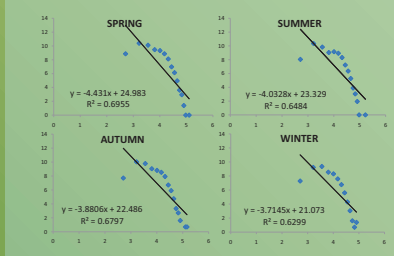
Both size and diversity spectra were computed by different aggregation levels: year, area, gear and season.




Gears

Each slope is determined by their different target species and their selectivity.

Despite their differences in catch composition, OTB and PS slopes have the nearest values.




Seasons

Slope of size spectra didn't show strong differences related to seasons. Nevertheless, a smaller increase of the bigger sizes could be appointed through the year, from spring to winter.

This could be related to the role of some characteristic small pelagic fisheries whose catches are concentrated in spring.

## CONCLUSIONS

Concurrent sampling provides large amounts of quality data from the commercial fisheries, which can be used for building indicators such as size-spectra, until now mainly used for experimental surveys.

As concurrent sampling covers different gears and all the year, it provides wider and complementary information from surveys -usually focussed in a concrete period of the year-.

It is known that an increase in fishing mortality leads to steepening of the slope, but an increase in the number of small fish can also have the same effect, which could reflect fisheries behaviour, as in this case, or some biological events, such as recruitment.

Comparisons presented shows that both slopes -size and diversity- fluctuate for the Bay of Biscay in the same ranges depending on the data aggregation level (years, areas, gears, seasons). Concurrent sampling seems to provide a characteristic value for the fish assemblage size compositions in each aggregation level –more clear for years and areas- showing the stability of the indicator.

The short data series covered by concurrent sampling prevents for further conclusions, but provides a first approach of the potential uses of this kind of data in future ecosystem assessments. Indicator validation could be obtained through a cross-comparison with combined fishing mortalities in the area.




*Length frequency multi-species distribution*

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