Mapping Marine Fisheries Catches of West Africa: 1950 to 2000

— Article —

Cartographie des prises halieutiques d'Afrique occidentale : 1950 à 2000

— Article —

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ABSTRACT

A NEW approach is presented which allows broad regional landing statistics from FAO and other sources to be examined as detailed catch maps using available knowledge of the distribution of commercial species and historical records of fishing access arrangements. Results are presented as time series compositions and as regional maps detailing changes since 1950 to 2000. These catches can be related to current exclusive economic zone boundaries and to the areas represented by ecological models (such as Ecospace), facilitating better use of landing statistics in economic, ecological and other analysis.

Key words

Mapping — Catch — Methods — West Africa — Modelling

RÉSUMÉ

UNE nouvelle approche est présentée qui permet d'examiner en détail les données de la F.A.O. ou d'autres, sous forme d'une cartographie des prises, elle-même fondée sur les connaissances existantes de la distribution des espèces exploitées, et une documentation de l'historique des accords de pêche. Les résultats sont présentés sous forme de séries temporelles et d'une cartographie régionale qui, ensemble, documentent les changements survenus entre 1950 et 2000. Les prises peuvent être exprimées au niveau des zones exclusives économiques et aux aires couvertes par des modèles spatiaux (Ecospace), permettant ainsi une meilleure analyse des prises dans des contextes économiques, écologiques, ou autres.

Mots clés

Cartographie — Prises — Méthodes — Afrique occidentale
Modélisation

INTRODUCTION

CATCH statistics are a vital element in the investigation of all aspects of fishing. For the countries of northwestern Africa there are a variety of data sources, but none publicly available offers the coverage provided by the landing statistics produced by the Food and Agriculture Organization (FAO) of the United Nations (FAO, 2002). Moreover, this part of the world is provided with a series of sub areas and divisions as established by the Fishery Committee for the Eastern Central Atlantic (Cecaf) in the early 1970s which greatly improved the spatial precision of the reported landings compared to the very large statistical areas usually used by FAO for reporting. Unfortunately though FAO's statistics are available from 1950, data by Cecaf divisions are available only since 1970.

Construction of ecosystem and other spatial models require catch data that are georeferenced to a much finer precision than that typically provided by data sources such as those from FAO. The aerial extent of these models is usually in the 100s to 1000s of km^2, whereas the statistical reporting areas can exceed 10 million km^2. With data represented by such large regions, it is not possible to prorate accurately the landings data simply by any ordinary aerial method, in order to estimate the catches assumed to come from the small areas being represented by most spatial models. Moreover, observer data could be used to georeference successfully the catches but only a very small fraction of them is available. An attempt to fill in these data gaps through modelling is now available.

It is possible to use information about the distribution of the reported taxa, as well as the fishing access of the reporting country (in the year for which the catch was reported) to limit and even prioritise fine regions of the potential catch area within the statistical areas being cited. We produced comprehensive databases which describe the global distribution of all commercial marine taxa, and also the areas of agreed and/or observed fishing access by functional taxon group for each fishing nation for every year since 1950. A computer program called SimMap (WATSON *et al*., 2001) was used in conjunction with these databases to convert large-scale records of landings, such as those from FAO, to grid-like maps of catches for each taxon, country and fishing year. Through this process, which relies on spatial cells measuring a half-degree of latitude and longitude as the basic unit, it was possible to make landing data useable in the spatial modelling process.

MATERIAL & METHODS

FOR each reported landing statistic, in addition to the weight of the landings, there is usually the same type of information available: the reporting year, the taxonomic identity of the product landed, the country reporting the catch and the statistical area from which the product was taken. Each of these pieces of information supplies clues as to the specific area of the sea from which the catches were taken.

The procedures used by the SimMap program can be viewed as the process of 'deciding', on the basis of the constraints provided by these data, specifically where the catches could not have come from, as opposed to the whole of the large statistical reporting area that serves as our starting point.

For the most part we accept that the catches were likely taken from within the geographical confines of the statistical reporting area indicated by the landing record. But we need much more information to work with. We know the taxon or specific identity of the organism being described. Sometimes this is defined with precision but it can be described in vague terms such as 'miscellaneous fishes'. Nevertheless, knowing the specific or broader identity of an organism allows us to use information on its distribution to eliminate some of the potential catch area or at least decide that some of the potential catch area is a more likely origin. For all marine organisms at least, some information is available. FishBase (FROESE & PAULY, 2000), for example, provides information as to the depth and latitudinal ranges, and the habitat requirements of most fishes (commercial or otherwise). Similar information can be gathered for commercial non-fish species (*e.g*. www.cephbase.-org). Notably, it is usually possible to know whether a specific commercial organism has ever been reported from a particular FAO statistical reporting area. Our project has compiled such a comprehensive database, and this is used in the process of prorating catches reported as landing statistics to a system of rectangular spatial cells measuring 30 minutes of longitude by 30 minutes of latitude (nearly 260,000 are needed to cover the earth and 4,915 are required to represent the Eastern Central Atlantic).

The process of transforming statistical landings data into catch by spatial cells will be referred to as spatial allocation (fig. 1). Catch will only be allocated from cells where the organism has been found (otherwise the catch's taxonomic description or the organism's distribution are in error). This usually means that of the many spatial cells within an FAO statistical area, a certain fraction could not have been the origin of the catch being reported. Moreover, of the possible cells, some are more likely to have produced more of the catch based on their depth, latitude etc. As organisms are less abundant near the extremes of their ranges, some cells would be expected to allow greater landings than others.

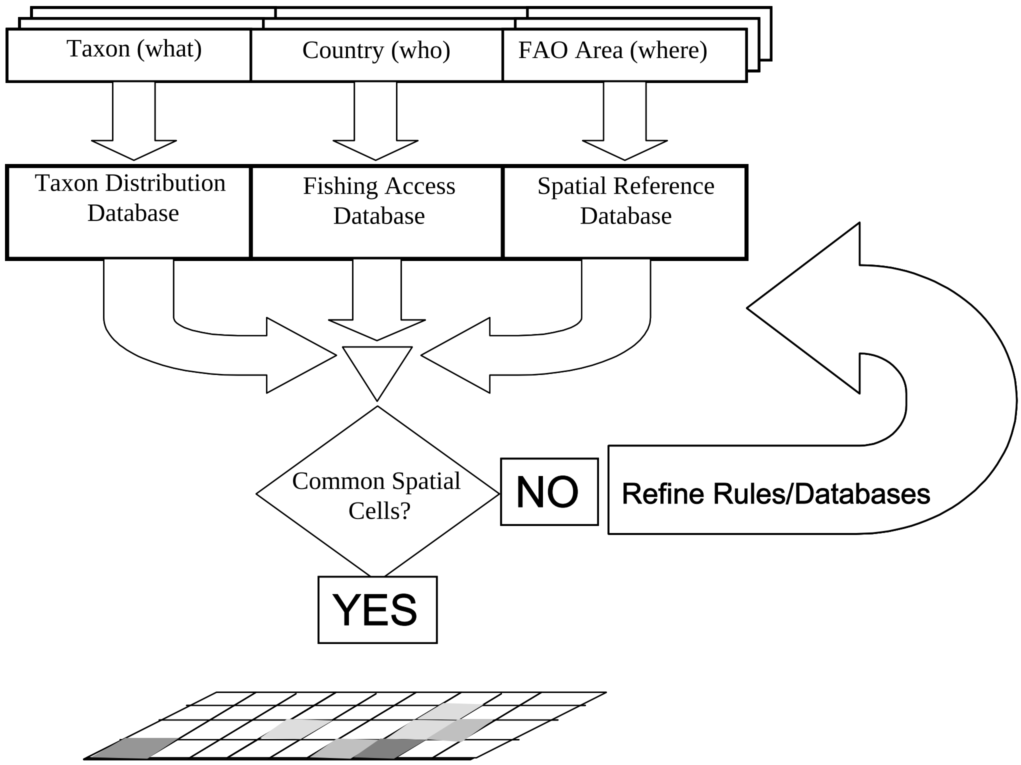

FIG. 1. — Allocation of fisheries landings statistics to spatial cells within SimMap program.
Attribution des prises halieutiques à des cellules spatiales par le logiciel SimMap.

Of those cells that remain as a possible origin for the catch, some will not be in areas where the reporting country was allowed to, or was known to fish that year (at least for that organism). Our comprehensive database of fishing access includes records of fishing agreements which builds on the

Farisis database assembled by FAO (1999), as well as information from many published accounts. It takes note of the year when the exclusive economic zones (EEZ) were declared, but more importantly, we have estimates of when they were put into effect. This is an important factor when deciding on the origin of catch as most of the world's marine landing are taken in coastal waters which now lies within the boundaries of the EEZs of coastal states. Many countries allow other nations to fish under agreements but some reserve these rights for their own nation's fishing fleets. Most agreements place restrictions on access, often limiting catches to a group of species, or to a type of fishing method. Illegal access is known to have occurred in some coastal areas in some years. All of this information is important when deciding on the origin of commercial catch.

Combining the distribution of marine taxa with information on the fishing access by a country restricts the potential origin of catches in any one year to a subset of spatial cells defined for the world's oceans. If there is no overlap between the area for which the catch was reported, the range of the taxa's distribution, and the area of fishing access then either the reported landing record, the databases or the rules applied are in error. Though the development of this process we have made significant improvements to our databases such that now approximately 99.5 per cent of landings (by weight) can be allocated to spatial cells. Records have been discovered that appear in error and these have been referred back for review to the organisations that manage the landing records.

Allocation of the FAOs landings records produces an extensive database consisting with approximately 200,000 files describing the catch (tonnes per square kilometre) for each of the global spatial cells, for each reported taxa-country combination, for each of the 51 reporting years (1950 to 2000 inclusive). Each of these can be viewed as a map describing the global catch. Catch in tonnes per square kilometre rather than catches are mapped as the area of spatial cells changes with latitude. Linking this data with other information such as the trophic level of taxa, or their ex-vessel price, or even whether they are the food of marine mammals (KASCHNER *et al*., 2001) allows considerable additional analysis to be performed. For example we used FAO prices for groups of marine organisms ($US) to produce maps of the landed value of catches in the year the catches were taken.

RESULTS

AFTER FAO landings records have been allocated to a global system of spatial cells it is possible to produce maps showing the catch rate of any taxonomic group and any country for any year after 1950. Included here are examples that show maps for all taxa and by all countries combined for the years of 1950, 1970 and 2000 (fig. 2-a, -b, -c, Plate IV). As expected, the pattern of catch rates shows an expansion offshore over the last half century. In addition, there are concentrations of catch rates inshore near the northern Mauritanian border and near the northern border of Guinea.

Using prices published for commercial taxa it was also possible to produce maps of catch value for any taxonomic group, country or year. For comparison with maps of catch rates we produced similar ones for catch value for all taxa and countries combined for 1950, 1970 and 2000 (fig. 2-d, -e, -f, Plate IV) were included. Again, coastal areas show the largest catch value rates, though it is clear that some of the valuable catch occurs just outside the boundaries of current EEZs. As with the catch rates, there is a general level of background catch in the offshore areas which increases by year and is comprised mostly of tunas and other large pelagics.

By aggregating the catch of all taxa within the EEZs of the countries of West Africa for each year since 1950, it was possible to create graphics showing changes in catch through time (fig. 3).

Scaling each graph separately allows the patterns of catches to be compared.

The catch series from many countries EEZ shows rapid fluctuations that are not likely to have resulted from biological changes but rather from changes in the arrangements for the access of foreign vessels. Changes in access arrangements in one country can affect its neighbours as foreign fleets struggle to access coastal resources.

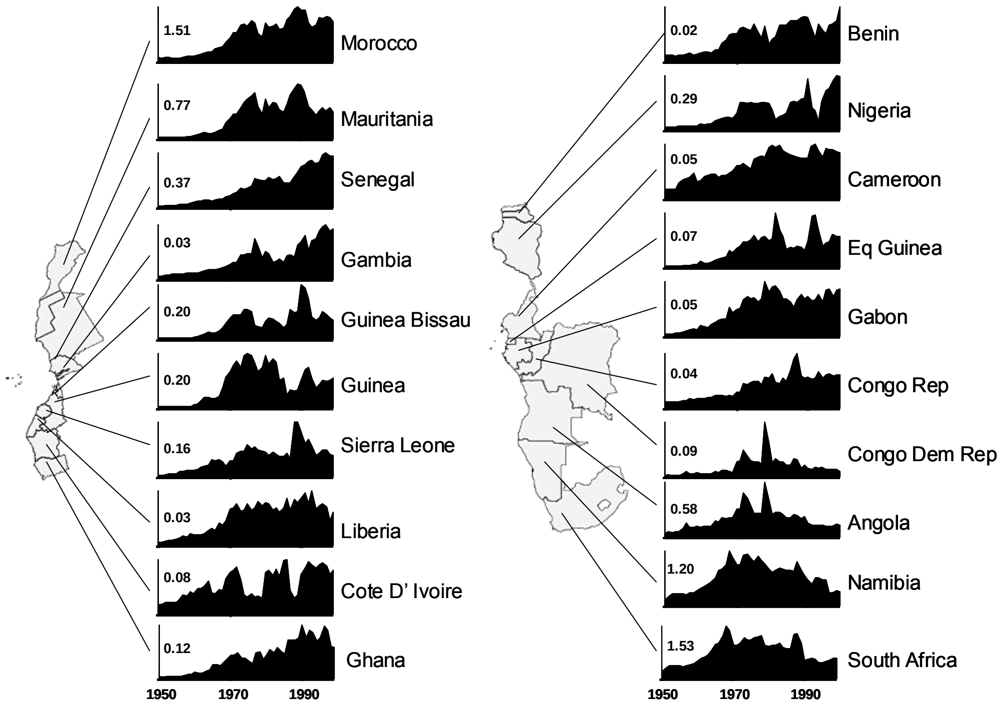

FIG. 3. — Historical catches in million t from 1950 to 2000 for the countries of West Africa, based on catches allocated to their current EEZ areas. Country series scaled individually to maximum year (prepared by A. KITCHINGMAN).

Prises historiques en million de tonnes de 1950 à 2000 pour les pays d'Afrique occidentale, distribuées dans les Z.E.E. Les échelles sont calibrées sur la valeur maximale pour chaque pays (exécution : A. KITCHINGMAN).

DISCUSSION

THE maps presented show preliminary findings based on our catch allocation process. The results were based on FAO data but did not use subarea data available since 1970. This, and detailed comparison with local datasets for verification purposes will be pursued. It is possible that additional information, especially with regard to historical fishing access, will be discovered which will be able to improve the allocation process. We are also aware that the boundaries we have used to represent the EEZs of some countries are not completely accurate, and in some cases are under review. This will change the results of the allocation process and the subsequent results.

The process described here has supported efforts to extend individual spatial models using Ecospace (WALTERS *et al.*, 1999) of the North Atlantic to an analysis of biomass changes in the entire ocean basin revealing dangerous declines in biomass of higher trophic level species (CHRISTENSEN *et al*., 2002). Catch maps such as presented here support work investigating changes to fisheries on a global scale including changes in the trophic levels of landings indicating generalised degradation (PAULY *et al*. 1998; 2002). Analysis of catches which were mapped using the methods described here have revealed, contrary to widely published statistics, that global total of marine landings has been declining for many years, masked by systematic over-reporting (WATSON, 2001; WATSON & PAULY, 2001). This work, and updates to the work presented here, may be found at www.seaaroundus.org

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