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Composite distribution of jack mackerel catches and surveyed acoustic biomass off the Chilean coast from 24°S to 52° S

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Introduction

In terms of the SPRFMO Interim Measures for Pelagic Fisheries, the SPRFMO Scientific Working Group (SWG) is required to "*give advice to the Meeting of Participants on the status of the pelagic stocks*", particularly jack mackerel, in 2009. Such advice will be a key focus of the November 2009 meeting of the SWG Jack Mackerel Sub-Group (JMSG). Provision of such advice will require that the SWG indicate to which stock or stocks that advice pertains. This will require SWG participants to reach some conclusions on likely boundaries of the stock/s to which specific fishery indicators are considered to apply.

The Chilean Jack Mackerel Stock Structure and Assessment Workshop (CHJMWS, Santiago, Chile, 30 June - 4 July 2008) (SPRFMO 2008) developed four alternate hypotheses regarding jack mackerel stock structure but reached no agreement on the relative likelihoods of each hypothesis. To provide information which may be used to further evaluate the likelihood of alternate stock structure hypotheses, the CHJMWS recommended that:

> *"Consideration should be given by Data & Information Working Group and the participants in the negotiations to establish a SPRFMO to amend the definition of public domain data in the SPRFMO Data Standards to provide for release of data aggregated at the level of 1°x1° square, month and gear."*

and requested that, as soon as fine-scale data are made available, the SPRFMO Interim Secretariat should prepare summaries of actual data, and not just meta-data, summarising catch, effort and CPUE by 1°x1° square, month and gear, as well as catch-at-age and catch-at-length data, for use at future SWG meetings. A request for release of jack mackerel data at this resolution for use by the JMSG of the SPRFMO Scientific Working Group was approved by participants in the 6th international SPRFMO negotiation meeting.

The intention of requesting the provision to the JMSG of jack mackerel data at this resolution was to provide for these data to be used in scientific analyses and discussions related to jack mackerel stock structure delineation, and for use in stock assessments. With regard to use of such data for stock delineation, the CHJMS emphasized that:

> *"Caution must be exercised in drawing inferences regarding stock structure only from commercial effort or catch distribution data. ... Fishery-independent and properly designed surveys provide better information on fish, egg or larval distribution patterns, and greater reliance should be placed on such surveys, than on commercial catch and effort data."*

but went on to note that

> *" In the absence of survey data commercial data can be used."*

While some participants have conducted fishery independent surveys in some portions of the overall jack mackerel distribution area, and wider area surveys have been recommended in the *Jack Mackerel Research Programme* proposal, such surveys have not yet been conducted over a wide enough area to serve as the primary basis for investigating stock structure. In the absence of such wide-area surveys, the CHJMS recognized that analysis of spatial distribution maps of commercial catch data at 1°x 1° square resolution could provide useful insights regarding possible boundaries of hypothesized stocks. In particular, maps of seasonal changes in spatial distribution may be useful in describing stock movement patterns which could indicate the potential spatial extent of particular stocks.

Participants in the jack mackerel fisheries have only recently (2009) provided 1° block or finer resolution data to the SPRFMO Secretariat, and the Secretariat has not yet had an opportunity to produce the 1°x 1° square by month summaries requested by the CHJMWS. However, a number of participants have already tabled scientific papers or national reports at recent SPRFMO SWG meetings which contain maps of data at this resolution. As a first step towards using such information to explore the likely spatial extent of specific jack mackerel stocks, the purpose of this paper is to graphically combine these available maps into a composite overlay of available information on recent spatial distribution of jack mackerel catches and surveyed acoustic biomass off the Chilean coast.

Information Sources and Methods

Maps of spatial distribution of jack mackerel catches off the Chilean coast, or of results of acoustic biomass surveys, have been provided in a number of papers submitted to the CHJMWS and subsequent SWG JMSG meetings, and in national reports tabled for the November 2009 SWG meetings. Of these, the most comprehensive maps of recent catch or acoustic biomass distribution, produced at 1° square or finer resolution, are those of total combined Chinese jack mackerel catch per 1° square over the years 2000 - 2007 provided by Zhang *et al*. (2008), European Community jack mackerel catch per tow in 2007 and 2008 provided by Corten (2009) and maps of surveyed acoustic biomass within and beyond the Chilean EEZ provided by Córdova *et al*. (2009).

The maps of Chinese 2000 - 2007 and European Community 2007 - 2008 catch distributions were imported into CorelDraw® and re-drawn as accurately as possible, within the constraints of the resolution in the published documents, paying particular attention to graphically accurate positioning of the catch indicators in relation to grid lines of latitude and longitude. Sizes of the resulting re-drawn symbols were used to re-generate approximate catch data with associated position information, for importation and display in ArcView® GIS mapping software.

Maps of surveyed acoustic biomass were similarly imported into CorelDraw® and maps for 2003, 2004, 2006 and 2007 (chosen to represent the maximum spatial extent of surveyed biomass since extension of the Chilean survey to offshore areas from 2003 onwards, see Córdova *et al*. 2009), were then graphically overlaid, ensuring correct registration of the grid lines of latitude and longitude on each map. Transparency of each acoustic map was adjusted to make all maps visible and generate a combined acoustic biomass map showing the combined overall extent of the four contributing years. This combined acoustic biomass map was then imported into ArcView® and geo-referenced to the correct position.

The relative transparency of the three resulting jack mackerel spatial distribution layers was then adjusted within ArcView® to prevent symbols in different layers from obscuring one another, and to make the details of each layer visible.

Results

The resulting composite overlay map of recent jack mackerel catches and surveyed acoustic biomass off the Chilean coast (Figure 1) is undoubtedly not as accurate as it would be if it had been generated from the real data underlying each of the contributory maps, particularly with regard to the sizes of the catch symbols and the graphical approximation of 'acoustic density' of the combined acoustic distribution maps. However, at the scale shown, the positional accuracy of each of the contributory maps to this composite overlay is no less accurate than the positions of the original catch or biomass symbols. At the scale of the map shown here, the results are certainly accurate enough to depict the spatial distribution of the underlying data sets.

The overlaid acoustic and catch maps show an unbroken, contiguous distribution of jack mackerel from the Chilean coast, across the EEZ and out to at least 85°W, the seaward limit of the acoustic surveys shown. Chinese and EC catch data indicate that this contiguous distribution of catches (over the time periods of the data shown) then continues out to about 100°W, although the north-south range of catches depicted narrows westwards, being increasingly confined to the latitude range 32°S to 38°S. The combination of Chinese and EC catch data suggests that catches then tail off westwards out to 112°W. While the EC data for 2007 suggests a gap in catch distribution around 100°W, the Chinese data straddle this longitude, declining further westwards.

When the requested 1° x 1° or tow-by-tow data are made available, further geospatial analyses are recommended to investigate seasonal changes in spatial distribution of catches. Such analyses would likely be useful in identifying and mapping movements of jack mackerel accumulations which would help define the stock distribution boundaries within which these movements occur. Such analyses should ideally be associated with analysis of relationship between catches and sea surface temperatures, to ascertain whether SST patterns may explain observed catch distributions and seasonal changes in catch concentrations or discontinuities in catch.

Overall, about 95% of the reported Chinese catch over 2000 - 2007 and about 90% of the EC catch over 2007 - 2008 was made in the area east of 100°W, over an area which essentially shows contiguous distribution of jack mackerel catches over this period. For the purpose of providing advice to the participants in the SPRFMO negotiations on the status of jack mackerel in 2009, and in the absence of wide-area survey-based information on stock structure, it seems evident that jack mackerel catches over the current spatial extent of the fishery off the Chilean coast should be considered to have been taken from one single management unit. For the purposes of providing stock status advice in 2009, it is justifiable to assume that jack mackerel over the extent of the current fishery off the Chilean coast constitute a single 'stock' for management purposes. Given indications of ongoing decline in jack mackerel in this area in past assessments and current total catch trends, assumption of a single stock would also be the appropriate precautionary response to uncertainty in stock structure.

Conversely, it is evident from the mapped data shown, and from a number of other spatial analyses presented at the CHJMWS, that there is, at least currently, a substantial discontinuity between catches made off Chile south of about 30°S, and those made within the Peruvian EEZ. Following the rationale presented above, for the purposes of providing stock status advice in 2009, it appears justifiable to assume that the jack mackerel caught in the area currently fished within the Peruvian EEZ constitute a separate management unit.

References

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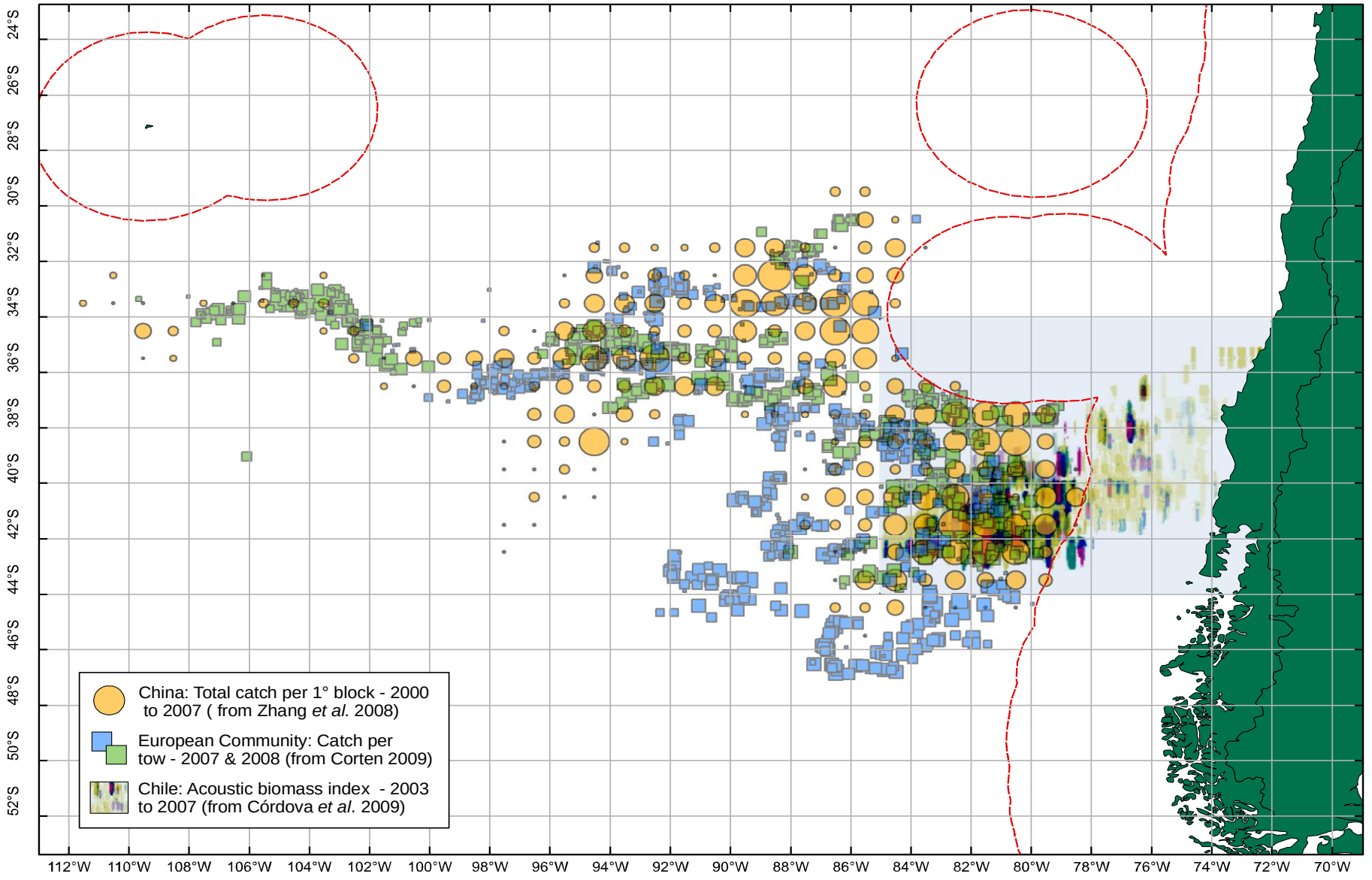

Figure 1. Composite graphical overlay of available information on jack mackerel catch and surveyed acoustic biomass distribution between 24°S and 52° S off the Chilean coast for China's catch per 1° block over 2000 - 2007 (from Zhang *et al*. 2008), European Community catch per tow in 2007 and 2008 (from Corten 2009) and surveyed acoustic biomass out to 85°W over 2003 - 2007 (from Córdova *et al*. 2009).