APPENDIX/ANNEXE 1: List of participants, CECAF Working Group on the assessment of demersal resources, Saly, Senegal, 14–23 September 2004/Liste des participants au Groupe de travail du COPACE sur l'évaluation des ressources démersales, Saly, Sénégal, 14-23 septembre 2004

Prénom	Nom	Organisation	Adresse	Pays	Tél.	Fax	E-mail
Pedro	Barros	FAO	Faculdade de Ciencias do Mar e do Ambiente Campus de Gambelas FARO	Portugal	+351 91 9418723	+351 289 81 96 60	PedroConteBarros@sapo.pt
Eduardo	Balguerias Guerra	IEO	Centro Oceanográfico de Canarias	Espagne	+34 922 549439	+34 922 549554	ebg@ca.ieo.es
Mariama	Barry	CRODT	B.P. 2241, Dakar	Sénégal			
Said	Benchoucha	INRH	INRH, 2 rue Tiznit, Casablanca	Maroc	+212 2 2200249	+212 22266967	benchoucha@inrh.org.ma / said8731@hotmail.com / bench2468@yahoo.fr
Ana Maria	Caramelo	FAO	Viale Terme di Caracalla, 00100 Rome	Italie	+39 06 57055863	+39 06 570523020	ana.caramelo@fao.org
Ad	Corten	RIVO-DLO	Haringkade 1, 1976 CP Ymuiden	Pays-Bas	+31 255564646 +31 255564644		adcorten@yahoo.co.uk
Famara	Darboe	Fisheries Dep.	6, Marina Parade, Banjul, The Gambia	Gambie	+220 202355/ 223346	+220 224154	gamfish@gamtel.gm
Mika Samba	Diop	IMROP	Nouadhibou, BP 22, Mauritanie	Mauritanie	+222 5745124	+222 5745379	mika_dfr@yahoo.fr/ dvis@toptechnology.mr
Lourdes	Fernández Peralta	IEO	Puerto Pesquero s/n 29640 Fuengirola (Málaga)	Espagne	+34 952471907	+34952463808	lourdes.fernandez@ma.ieo.es
Eva	García	IEO	Puerto Pesquero. Muelle de Levante s/n.11006 Cádiz	Espagne	+34956261333	+34956263556	eva.garcia@cd.ieo.es
Cheikh Abdellahi	Inejih	IMROP	BP 22 Nouadhibou, IMROP	Mauritanie	+ 222 5749104	+222 5745081	inejih_ca@imrop.mr/ inejih_ca@hotmail.com
Asberr N.	Mendy	Fisheries Dep.	6, Marina Parade, Banjul, The Gambia	Gambie	+220 202355/ 223346	+220 224154	anmendy@yahoo.com/ gamfish@gamtel.gm
Amina	Najd	INRH	INRH, 2 rue Tiznit, Casablanca	Maroc	+212 022297329	+212 48930156	mha_idrissi2002@yahoo.com
Beyah	Ould Meissa	IMROP	B.P:22 Nouadhibou, IMROP	Mauritanie	+222 6363722	+222 5745081	beyahem@yahoo.fr

APPENDIX/ANNEXE 1 (cont./suite)

Prénom	Nom	Organisation	Adresse	Pays	Tél.	Fax	E-mail
Ana	Ramos Martos	IEO	Centro Oceanográfico de Málaga	Espagne	+34 95 2471907	+34 95 2463808	ana.ramos@ma.ieo.es
Pedro	Pascual Alayon	IEO	Centro Oceanográfico de Canarias	Espagne	+34 922 549439	+34 922 549554	
Birane	Samb	CRODT	Km 10 Rte de Rufisque Dakar	Sénégal	+221 8348041	+221 8342792	bsambe@yahoo.fr
Ibrahima	Sow	CRODT	Km 10 Rte de Rufisque Dakar	Sénégal	+221 8348041	+221 8342792	isow@crodt.isra.sn
Ignacio	Sobrino Yraola	IEO	Apdo 2609	Espagne	+34 956261333	+34 956263556	ignacio.sobrino@cd.ieo.es
Merete	Tandstad	FAO	Viale Terme di Caracalla, 00100 Rome	Italie	+390657052019	+390657052019	merete.tandstad@fao.org
Djiga	Thiao	CRODT	Km 10 Rte de Rufisque Dakar	Sénégal	+221 8348041	+221 8342792	dthiao@crodt.isra.sn

MFRD= Marine Fisheries Research Station.
IEO=Instituto Español de Oceanografía.

APPENDIX/ANNEXE 2

SURPLUS PRODUCTION MODELLING/ MODÈLE DE PRODUCTION EXCÉDENTAIRE

by Pedro Barros

The stocks in the area were assessed using a non-equilibrium production model based on the Schaefer (logistic) population growth model.

The model uses four basic parameters: Virgin Biomass ***K***, population intrinsic growth rate ***r***, initial depletion ***D*** (starting biomass relative to K) and catchability ***q***. All other parameter estimates are derived from these four.

Given the best parameter estimates, the model calculates the MSY, B_{MSY} and F_{MSY} reference points. It also calculates the reference points B_{Ratio}, $\frac{B_{Cur}}{B_{MSY}}$ (the ratio between the estimated biomass for the last year in the data series and B_{MSY}), and F_{Ratio}, $\frac{F_{Cur}}{F_{SYCur}}$ (the ratio between the effort actually exerted on the stock in the last year of the data series and the effort that would have produced the sustainable yield in the same year).

The absolute values of F_{MSY}, B_{MSY} and even K must not be considered, since the model provides more accurate estimate for F_{ratio} and B_{ratio}.

Trends of these ratios and whether or not they are above/below 100% provide useful information for management purposes.

B_{Ratio}, $\frac{B_{Cur}}{B_{MSY}}$ indicates the current status of the stock biomass in the last year of the data series B_{Cur}, relative to the biomass that would produce MSY, B_{MSY}. Values smaller than 100% indicate a stock abundance below B_{MSY}, while values larger than 100% indicate a stock abundance larger than B_{MSY}.

F_{Ratio}, $\frac{F_{Cur}}{F_{SYCur}}$ measures the fishing effort in the last year of data available, as a proportion of the fishing effort that would have been necessary to extract the sustainable catch at the Biomass levels estimated for the same year. The value of this ratio is the same as the Yield ratio Y_{Ratio}, the current yield as a proportion of the sustainable yield at the current stock biomass level, $\frac{Y_{Cur}}{SY_{Cur}}$. Values below 100% indicate that the catch currently being extracted is lower than the natural production of the stock, and so stock biomass can be expected to increase, while values above 100% suggest that the catch exceeds the production from the stock and so this will decrease next year.

Incorporation of environmental variability

Pelagic stocks are known to be significantly affected by environmental variability. Years with exceptionally favourable environmental conditions will see an above-average set of growth conditions of the stock, while years with exceptionally poor environmental conditions will be associated with large decreases in stock biomass or at least in stock growth rate. The evolution of the stock biomass in these periods cannot be explained solely by the dynamic of the catches or the average stock growth conditions. The model with constant parameters cannot describe the evolution of the pelagic stocks under these circumstances. Therefore, a modification of the model to include environmental variability was made during the Working Group meeting.

An environmental quality index was introduced for each point in the data series, and the ***r*** and ***K*** parameters of each year were considered to depend on the corresponding value of the index.

The stock growth parameters in each year I, $\boldsymbol{K_i}$ and $\boldsymbol{r_i}$, were defined as

$$K_i = K \times \left(1 + \alpha |E_i|^{\mathrm{sgn}(E_i)}\right)$$

$$r_i = r \times \left(1 + \alpha |E_i|^{\mathrm{sgn}(E_i)}\right)$$

where $\boldsymbol{K}$ and $\boldsymbol{r}$ are the overall base level of the carrying capacity, and of the intrinsic growth rate of the stock, respectively, $\boldsymbol{E_i}$ is the value of the environmental quality index for this stock in year $\boldsymbol{i}$, and α is a constant defining the intensity of the environmental effect on the population growth parameters.

Implementation

The model and its fitting were implemented in an MS Excel spreadsheet, modified from the spreadsheets distributed by FAO under the BioDyn package. The minimisation algorithm used was the Newton-Raphson algorithm implemented in the Solver add-in in MS Excel. Given that the different parameters have different orders of magnitude, automatic scaling of the parameters was chosen.

The basic data used for each stock was total yearly catch estimates, and a series of abundance indices. The fitting of the model was based on fitting the series of observed abundance indices, assuming an observation error model. The objective function minimised was the sum of the squared residuals between the logarithms of the observed and predicted indices.

Given the limitations in the data, it was decided not to combine different abundance indices series in any single assessment. Accordingly, a single abundance index series was used in each model run, using the abundance indices series considered by the researchers involved as having the best probability of actually reflecting the changes in underlying stock abundance.

When more than one candidate abundance index series was available, a separate run of the model was done for each of them. Care was taken to ensure that the start (seed) values of the parameters were the same for all abundance indeces series considered.

The four parameters of the model, $\boldsymbol{r}$, $\boldsymbol{K}$, $\boldsymbol{q}$ and $\boldsymbol{D}$, are strongly correlated, a well-known problem in non-linear model estimation. For example, given the same data series, a larger intrinsic stock growth rate estimate is necessarily linked with a smaller carrying capacity and/or a larger catchability.

In order to reduce this difficulty, the initial depletion $\boldsymbol{D}$ was fixed from knowledge of the fishery in the years preceding the start of the data series. When there were doubts about this ratio, the model was run several times with different values of the ratio, and the results compared.

The other three parameters, $\boldsymbol{r}$, $\boldsymbol{K}$ and $\boldsymbol{q}$, were estimated using the non-linear minimisation algorithm.

Initial (seed) values and constraints

The minimisation algorithm is in general very sensitive to the starting (seed) values for the parameters. The following procedure was adopted:

1. A start value, B_1, was estimated for the average stock biomass during the period analysed, from external knowledge about the fish stock;

2. The initial value for $\boldsymbol{q}$, q1, was calculated dividing the average value of the abundance index during the period, $\overline{U}$, by B_1, $q_1 = \dfrac{\overline{U}}{B_1}$;

3. The initial value for $\boldsymbol{K}$, K_1, was estimated taking the average value of the abundance indices for the two first years, dividing it by q_1 to obtain a first estimate of the initial Biomass B_1, and dividing it by the value established for initial depletion $\boldsymbol{D}$

$$K_1 = \frac{1}{D} \times \frac{1}{q_1} \times \frac{U_1 + U_2}{2}$$

4. The initial value for ***r*** was taken to be 0.5 for slow-growing long-lived species like horse mackerel, and 1.0 for faster-growing, short-lived species like e.g. sardine or chubb mackerel.

In the estimation, ***K*** and ***q*** were constrained to be between half and twice the initial values,

$$\frac{q_1}{2} \le q \le 2 \times q_1 \, , \; \frac{K_1}{2} \le K \le 2 \times K_1$$

r was only required to be positive.

Abundance indices used

Theoretically, any abundance index that is supposed to be correlated with stock abundance can be used to fit the model. In the case of the stocks evaluated during this Working Group, two sets of abundance indices were used, commercial CPUE series and series of acoustic abundance estimates from the December surveys carried out by R\V DR. FRIDTJOF NANSEN, the longest series of fisheries-independent abundance indices available. The commercial CPUE series were allocated to the year they were collected in, while the acoustic estimates, collected in December, were allocated to the following year.

Other forms of using the abundance indices, e.g. considering the average abundance of two consecutive December surveys as index of abundance for the year between the surveys, should be explored, and possibly used in future assessments.

The first meeting of the FAO/CECAF Working Group on the Assessment of Demersal Resources – Subgroup North, was organized in Saly, Senegal, from 14 to 23 September 2004. The overall objective of the Group is to contribute to the improvement of the management of demersal resources in northwest Africa through assessment of the state of stocks and fisheries to ensure the best sustainable use of the resources for the benefit of coastal countries. The study zone for the Working Group is the CECAF zone of the Central-East Atlantic Ocean between Cap Spartel and the south of Senegal. For reasons of heterogeneity, the species and stocks of the demersal Working Group were divided into four groups: hake, demersal fish, shrimps and cephalopods. For each of these groups information is provided on the fisheries: sampling schemes and sampling intensity, biological characteristics, stock identity, trends (catch, effort, biological data and abundance indices), assessment, management recommendations and future research. Approximately 22 different stocks–units were analysed and the results discussed. The Working Group decided that the majority of the demersal stocks were fully exploited and that, for some of them, the fishing effort should be heavily reduced.

La première réunion du Groupe de travail FAO/COPACE sur l'évaluation des ressources démersales – Sous-groupe Nord, a été organisée à Saly, Sénégal, du 14 au 23 septembre 2004. L'objectif général du Groupe est de contribuer à l'amélioration de l'aménagement des ressources démersales en Afrique du Nord-Ouest par l'évaluation de l'état des stocks et des pêcheries afin d'assurer la meilleure utilisation durable de ces ressources pour le bénéfice des pays côtiers. La zone d'étude pour le Groupe de travail est la zone COPACE de l'océan Atlantique centre-est, entre le Cap Spartel et le sud du Sénégal. En raison de l'hétérogénéité des espèces et des stocks, le Groupe de travail sur les démersaux a été divisé en quatre groupes: merlus, démersaux, crevettes et céphalopodes. Pour chacun de ces groupes, des informations sont données sur les pêcheries: système et intensité d'échantillonnage, caractéristiques biologiques, identité du stock, tendances (capture, effort, données biologiques et indices d'abondance), évaluation, recommandations d'aménagement et de recherche future. Quelque 22 stocks-unités différents ont été analysés et les résultats discutés. Le Groupe de travail a conclu que la plus grande partie des stocks démersaux était pleinement exploitée et que pour certains d'entre eux l'effort de pêche devrait être fortement réduit.

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