APPLICATION OF SURPLUS PRODUCTION MODELS TO THE INDIAN OCEAN BIGEYE (*Thunnus obesus*) TUNA FISHERY

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ABSTRACT

Surplus production models characterized by an increasing level of complexity were applied to the Indian Ocean bigeye tuna (Thunnus obesus) fishery to assess the current status of the stock and provide reference points to fishery managers. Data included catch rates standardised based on generalized linear models including several environmental and technical covariates to derive abundance indices for bigeye tuna on a 5- by 5 and 1- by 1 degree basis for 1960-2008 and 1980-2008, respectively. The results of the models were consistent in terms of diagnostic and suggested that the bigeye tuna stock would be close to a situation of MSY, with a biomass in 2008 comprised between 1.17-1.3 times the biomass at the maximum sustainable yield (MSY) and a fishing mortality in 2008 equal to 65-79% of the fishing mortality at MSY (F_{MSY}) for the base case runs. A sensitivity analysis performed to account for uncertainty in some input parameters and based on the 1980-2008 standardised CPUE time series showed that the results were quite robust to the parameter changes with F_{2008}/F_{MSY} and B_{2008}/B_{MSY} comprised between 0.7-0.84 and 1-1.28, respectively. The use of random walks on catchability showed a sharp shift upward in the abundance index time series in 1977-78 that could suggest a problem in the standardisation process linked to the implementation of deep longline in the late 1970s. Overall, the diagnostic and fisheries indicators derived from surplus production models were shown to be consistent with results derived in the course of the 2009 Working Party on Tropical Tunas from more complex models such as SS3 and ASPM.

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KEYWORDS: *fishing mortality, purse seining, bigeye, stock assessment, surplus production model, tuna fisheries*

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1. Introduction

Several models were performed to assess the status of the Indian bigeye (*Thunnus obesus*) stock during the WPTT of 2006 held in Victoria, Seychelles, namely CASAL (Hillary & Mosqueira 2006), SS2 (Shono et al. 2006), ASPM (Nishida & Shono 2006), and a Bayesian surplus production model (Hillary 2006). In addition, a run of the ASPIC software, implementing the Fox form of the surplus production model and based on the Japanese CPUE time series was carried out during the meeting. Overall, the Maximum Sustainable Yield (MSY) estimates were rather consistent among models with a range of MSY estimates comprised between 111,000 t and 137,000 t. By contrast, the SS2 and CASAL integrated models produced quite different estimates of absolute levels of virgin and current biomass, probably due to a different modelling interpretation in abundance index variations (Anonymous 2006). This eventually led the WPTT to adopt the ASPM results in the Bigeye Executive Summary and to conclude that the stock was exploited in 2004 around its maximum level, with a spawning stock biomass (SSB) just above the SSB at MSY and the fishing mortality (F) just below F at MSY (Anonymous 2006).

In the present analysis, three different surplus production models were applied to the Indian Ocean bigeye tuna fishery to assess the current status of the stock and provide reference points to fishery managers, namely PRODFIT (Fox 1975), ASPIC (Prager 1994, 2000, 2005), and PROCEAN (Maury 2000). Although biomass models are not able to account for changes in fishing pattern and do not explicitly represent the age-structured complexity of fish stocks (e.g. variations of natural mortality with age) and reproduction process, they are considered as robust tools to assess the dynamic response of fish populations to exploitation and eventually provide a scientific advice on the state of the stocks (Ludwig & Walters 1985, Hilborn & Walters 1992, Laloë 1995, Prager 2000). All these models are based on the generalized surplus production form (Pella & Tomlinson 1969), but they are characterized by different estimation methods and increasing levels of complexity, from an approximation of equilibrium conditions (PRODFIT), to non-equilibrium (i.e. dynamic) models.

Although the effort-averaging method implemented in PRODFIT has been criticized for long (e.g. Polacheck et al. 1993), it offers the advantage of being simple to run and most often giving biologically reasonable estimates of the main variables of interest, i.e. MSY and F_{MSY}. The population parameter estimates derived from this method can then provide benchmarks for applying dynamic models that are generally quite sensitive to initial guess values, especially for short time series. The ASPIC model is more powerful but more complex to run and it offers a wide range of flexible possibilities, for instance allowing for estimating some of the parameter uncertainties through bootstrap methods. The PROCEAN (PRoduction Catch / Effort ANalysis) model has been developed to expand classical biomass dynamic models such as ASPIC by including several statistical refinements that allow addressing issues related to temporal variation in catchability associated with changes in fishing power, technological improvements or fishing methodology (Maury 2000, 2001). PROCEAN offers a flexible modelling approach capable of handling these complex effects with the production modelling framework. Considering different types of surplus production models based on different estimation methods might eventually help to account for model uncertainty. The potential interest and biases associated with the application of surplus production models and more generally of stock assessment models to tuna fisheries have been discussed by Fonteneau et al. (1998).

2. Materials and methods

2.1 Data

2.1.1 Data sources

Yearly total catches at the scale of the whole Indian Ocean were provided by the IOTC secretariat (http://www.iotc.org) and available for the period 1950-2008 for the 6 fisheries harvesting bigeye tuna: artisanal (ART), baitboats (BB), European purse seiners fishing on free schools (PSFS) and log-schools (PSLS), Taiwanese longliners, and Japanese longliners (LLJPN) (Figure 1).

2.1.2 CPUE and effort standardisation

Nominal catch divided by the number of hooks between float (NHF) were standardised based on generalized linear models including several environmental and technical covariates to derive abundance indices for bigeye tuna on a 5- by 5 and 1- by 1 degree basis for 1960-2008 and 1980-2008, respectively (Okamoto et al. 2009, Okamoto et al. 2009). The 2 series show a decreasing trend in time from a relative index of about 1.4 in the early 1980s to 0.6 in the late 1980s (Figure 2). For the application of the PROCEAN model, the standardised effort of Japanese effort was computed as the ratio between Japanese longliners catch and the standardised CPUE indices.

Catches by other gears not documented in terms of fishing effort are included in the model as fixed values and not predicted.

2.2 Stock assessment models

2.2.1 PRODFIT

The PRODFIT model is based on the computation of a weighted average fishing effort to approximate the equilibrium conditions (Gulland 1961, Fox 1975). A least square estimator is constructed to predict yearly catch rates based on observed catch rates and variability indices of all the parameters are computed by the delta method (Fox unpublished). The method allows the PRODFIT model to estimate the uncertainty in the estimated MSY and fishing effort producing this MSY. The PRODFIT model was run using an exponential growth model (Fox 1975), as it is has been concluded with good reasons that the Schaefer model should not be used for tuna stocks (Maunder 2003). This model assumes a high steepness in the stock recruitment relationship, allowing sustained high catches, even at fishing effort over F_{MSY}. The model was alternatively fitted to the 2 series of Japanese longline CPUE. Two hypotheses upon the number of significant year classes exploited k were used for sensitivity analysis: (i) $k = 5$ in the early period of the fishery, i.e. 1960-1985, followed by a value of k set equal to 8 after 1986; (ii) $k = 12$. The model was also ran based on the hypothesis that the CPUE of the initial period 1960-1976 was underestimating the real biomass of the stock by a factor of 40% (Figure 3).

2.2.2 ASPIC

ASPIC is a computer program allowing estimating the parameters of a non-equilibrium surplus production model from one or more series of catch and effort data (Prager 1994, Prager 2000). Initially based on the logistic model (Schaefer 1954), the most recent version of the program allows for selecting between logistic and generalized production models (Prager 2005). The fitting procedure includes estimation conditional on observed catch (effort), assuming lognormal observation error in fishing effort rate (catch), i.e. it relies on an observation-error estimator. The parameters are then estimated by minimizing the least squares between predicted and observed efforts, equivalent to maximum likelihood estimation under the assumptions used. Uncertainty around parameter estimates is computed through bootstrap method accounting for bias (Prager 2000).

2.2.3 PROCEAN

The PROCEAN model is a biomass dynamics model based on the generalized surplus production model of Pella and Tomlinson (1969) that allows for separating the different fishing fleets targeting the stock (Maury 2001, 2002). In PROCEAN, a semi-implicit numerical scheme is used to integrate the ordinary differential equation of Pella and Tomlinson (1969) and the catches are predicted (Fournier 1996). Definitions of estimated parameters and observed variables as well as process and observation equations are given in Tables 1-2, respectively. Observed annual fleet-specific catches were assumed to be lognormally distributed about their model-predicted counterparts with some standard deviation σ (Table 4, S1). Variability in stock carrying capacity and in the catchability of individual fleets can be considered to be process error and modelled as lognormal random walk process to represent small permanent changes through time (e.g. Fournier et al. 1998) (Table 4, S2-S3).

In the present analysis, no temporal variability was considered for the stock carrying capacity and fluctuations of the stock surface were assumed to have only effects on fleet catchability. In addition, a process error can be used to model large transient deviations in the effort-fishing mortality relationship. To reduce the influence of outliers that can bias estimates of model parameters, a two-component mixture distribution composed of a normal and a fat-tailed t-distribution is used for the fleet catchabilities (Fournier et al. 1998, Chen and Fournier 1999, Chen et al. 2000, 2003) (Table 4, S4). The fat-tail distribution is a desirable alternative to the normal distribution as it allows higher probabilities of events occurring in the tails of the distribution and is parameterized by the proportion of data (p) subject to atypical errors in the fat-tailed likelihood and the size of the tail (e) (Table 5, L4). To allow a separation between observation errors and process stochasticity, the ratio between the variance of the random walk process assumed to operate for temporal changes in catchability and the variance of observation errors was fixed to 0.4.

2.2.3 Estimation procedure

Computations were performed using AD Model Builder (Fournier 1996), a flexible, stable and efficient tool adapted for estimating non-linear model parameters (Maunder 2000, 2004), based on automatic differentiation (Griewank and Corliss 1991). Parameters were estimated based on the method of the maximum of posterior distribution (Bard 1974) by minimizing the total objective function, which includes the negative log-likelihood components (Table 5) and the prior probability contributions. Posterior distributions of the model parameters can also be estimated using a Markov Chain Monte Carlo (MCMC) simulation approach starting from the parameters at the mode of the posterior distribution. In this case, the Hastings–Metropolis algorithm implemented in AD Model Builder is used. Confidence statements about parameters were here inferred from the estimates of the Hessian matrix at the mode of the posterior distribution (Fournier 1996).

3. Results

3.1 PRODFIT

The *MSY* was estimated in a range between 127 and 132,000 t, with an uncertainty of about 5%, the 2008 fishing effort being always slightly lower than F_{MSY}. Hence, the stock was estimated to be just below the *MSY* situation in 2008.

3.2 ASPIC

The ASPIC model did not converge for the 1960-2008 CPUE time series. The model fitted well the data for the 1980-2008 time series based on 1° squares data (Fig. 4). The MSY was estimated to be 116,000 t with the fishing mortality in 2008 lower than $\mathrm{F_{MSY}}$ and the biomass larger than $\mathrm{B_{MSY}}$ (Table 6).

3.3 PROCEAN

The base case run model fit the individual fleet catches well, without any trend in the residuals, but showing outliers in 1977 and 1978 due to the sudden major increase in the standardised Japanese CPUE (Fig. 4). In the base case run, the MSY was estimated to be 127,000 t, with the biomass in 2008 above B_{MSY} and fishing mortality below F_{MSY} (Table 6). The sensitivity analysis run with respect to the initial biomass in 1960 increased the MSY to 132,000 t but did not affect the current status of the stock (Table 6). Including process error on catchability also poorly affected the results, but allowed tracking the changes in catchability through time by showing a major change in 1977 (Fig. 7).

4. Discussion

The results obtained were consistent among the 3 surplus production models used, and also quite similar to the results previously obtained for this stock derived from various other models (Anonymous 2006). They indicate that the stock in 2008 would be close to the MSY, with fishing mortality just below $\mathrm{F_{MSY}}$ and biomass above $\mathrm{B_{MSY}}$.

4.1. Assumptions, limits, and caveats

These results should be considered with caution, as the relationship between the longline CPUEs and bigeye adult stock biomass is far to be demonstrated. Despite the standardisation process of the fishing effort (Okamoto et al. 2009, Okamoto et al. 2009), some issues such as changes in targeting, technological improvements, and high mobility of fishing vessels might blur the CPUE-Biomass relationship (e.g. Fonteneau et al. 1998). Such issues are however classic problems in tuna fisheries and common to all stock assessment approaches, whatever their complexity.

Surplus production models are not able to account for changes in fishing selectivity and therefore implicitly include changes in yield per recruit. In particular, the declining average weight of bigeye (Fig. 9), mainly due to the increasing catches of small fishes taken by purse seiners under FADs, reflects strong changes in the fishing pattern that have occurred in the bigeye fishery since the mid-1980s. In this context, the analysis of yield per recruit should indicate a decline in stock productivity since the mid-1980s, but this decline remains difficult to estimate because of the still major uncertainties in the bigeye parameters (growth, natural and fishing mortality of juvenile bigeye). The present analysis of the catch and CPUE relationship would tend to show that this decline of yield per recruit is not fully visible in the longline CPUE trends: there is a steady decline of longline CPUEs, but it would appear that this decline can easily be explained by the increased efforts and increased catches. The expected decline of yield per recruit should be evaluated from the results of analytical models such as age specific production models (Nishida et al. 2009).

4.2. Why still using surplus production models in 2009?

The PRODFIT production model allows for estimating the equilibrium productivity of fished stocks based upon the Gulland's approximation estimating a vector of fishing efforts, the stock biomass of a given year being conditioned by the fishing efforts exerted during previous years, in function of the duration of the exploited life of the population (*k* parameter). The advantage of this basic assessment model is its simplicity and its efficiency to provide realistic results. It only requires 2 vectors of yearly catches and CPUEs estimated to be representative of the stock biomass, and an assumption of the number of year classes *k* significantly fished. Furthermore the model is fully flexible and allows for a wide range of production curves, from generalized (Pella & Tomlinson 1969) to logistic (Schaefer 1954), exponential (Fox 1970), and even hyperbolic; the MSY being caught at infinite fishing effort in this latter case. Such approximation has often been criticized (Polacheck & Hilborn 1987, Hilborn & Walters 1992, Polacheck et al. 1993), but it should be kept in mind that this so-called "equilibrium model" does not assume that the observed fisheries are at equilibrium. The PRODFIT model has been widely used in data-poor situations (e.g. no length-frequency data) and its performances well demonstrated during many years for various fisheries and also on complex simulated datasets (Fonteneau et al. 1998), even for highly unstable stocks and fisheries showing "one-way trip" trends, i.e. showing a continuous increase of catch and efforts. In such situations, the PRODFIT model tends to provide most often realistic results, at least when the series cover a sufficient time period, and when the number of year classes fished (*k* parameter) is well known.

While the results of such simple models should be examined with great care and in a precautionary context, they are always interesting to consider, in comparison with the results obtained by more realistic and more flexible production models such as ASPIC, PROCEAN, CLIMPROD[3] (Fréon 1991), surplus production models with an inaccessible quantity of biomass dependent on fishing area or environmental conditions (Laloë 1988, 1989), and other-age structured model (Virtual population analysis and ASPM) or complex statistical models (SS3, Multifan-CL) that have been shown to provide sometimes biologically unrealistic results (e.g. Fonteneau & Ariz 2008). In the present analysis, the status of the bigeye stock derived from the pseudo-equilibrium approach implement in PRODFIT was fully consistent with ASPIC and PROCEAN biomass dynamic models.

4.2. Tracking changes in catchability

The big "jump" upward of the Japanese standardised CPUEs observed in 1977-78 might be due to some factors not included in the present GLM procedure, such as increasing bigeye targeting and deeper longline. Indeed a rapid 30% increase in bigeye stock biomass from one year to another seems inconsistent with the lifespan of bigeye, the adult biomass being comprised of several cohorts. As a consequence, the early fishing effort estimated during the 1960-1974 period are probably overestimated, as this early bigeye biomass was probably underestimated by the present 1960-1974 CPUEs. However, the alternate hypothesis ran by PRODFIT that the original fishing efforts were estimated by a factor of 40% (a rate based on the CPUE shift in 1977) does not significantly affect the estimated MSY and F_{MSY}, simply because these early fishing efforts were low and occurring during a now remote period.

Furthermore, the present analysis does not take into account a potential increase of the fishing efficiency of Japanese longliners, when there is no doubt that this fishing efficiency has been permanently and significantly increasing during the 1952-2008 period (Ward 2007). Any reasonable estimates of the increase of fishing efficiency would tend to lead to a worse decline of the CPUE trend (WCPFC 2009), and then to a more pessimistic stock status diagnosis.

It has also been noted that longline CPUEs are widely conditioned by the levels of local total fishing effort exerted in the strata by the international longline fleet; in other word, when there is a single longliner in a fishing stratum fishing a given biomass of tunas, its CPUE is statistically higher than the CPUEs obtained on the same fishing ground by 20 longliners (Fonteneau & Richard 2004). This important factor of the total local effort exerted in the fished strata is currently not taken into account in the present Japanese longline CPUE standardisation. This may have introduced a bias in the estimated biomass trend, now underestimating the tuna real biomass, knowing that there was a permanent increase of total effort exerted in the Indian Ocean during the last 55 years and also a major decline in Japanese relative fishing effort.

5. Conclusion

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[3] CLIMPROD is a peculiar case of surplus production model incorporating environmental covariates that are related to stock carrying capacity and/or fisheries catchability.

The converging results obtained by various production models may be indicative of the present stock status of the bigeye stock in the Indian Ocean. Here, the diagnostic and fisheries indicators derived from simple surplus production models were shown to be consistent with results derived in the course of the 2009 Working Party on Tropical Tunas from more complex models, namely ASPM (Nishida et al. 2009) and SS3 (Shono et al. 2009).

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Table 1. Parameters and variables used in PROCEAN. NS = not shown

Notation	Definition	Origin	Value	Equation
B	Biomass (t)	Calculated	Table 6	D1,D3
R	Intrinsic growth rate (y^{-1})	Estimated	Table 6	D1
K	Stock carrying capacity (t)	Estimated	Table 6	D1
m	Shape parameter	Estimated	Table 6	D1
Y	Catch for effort non documented fleets (t)	Fixed	NS	D1
q	Catchability	Estimated	NS	D2
E	Fishing effort	Fixed	NS	D2
C	Catch (t)	Calculated	Fig. 5	D1,D3
F	Fishing mortality	Calculated	Fig. 6	D2-D3

Table 2. Deterministic process and observation equations in the PROCEAN model. *i* and *t* index fleet and year, respectively. Notations are given in Table 1

Process equation	
$B_{t+1} = \dfrac{\left(B_t\left(1+r\right)-Y_t\right)}{\left(1+r\left(\dfrac{B_t}{K}\right)^{\left(m-1\right)}+\sum_{i=1}^{n-1} C_{i,t}\right)}$	D1
State moment	
$F_{i,t} = q_{i,t} E_{i,t}$	D2
Observation equation	
$C_{i,t} = F_{i,t} B_t$	D3

Table 3. Parameters and variables used in the stochastic equations and likelihood components.

Notation	Definition	Equation
T	Total number of years of observations	L1
n	Number of fishing fleets	L1,L3-L4
C^*	Observed catch	L1
C	Predicted catch	L1
σ	Standard deviation of the observation error	L1
γ	Standard deviation of the carrying capacity process error	L2
t_i	Initial year of observation for the fleet i	L3
T_i	Final year of observation for the fleet i	L3
δ_i	Standard deviation of the catchability process error for the fleet i	L3
F	Fishing mortality	L4
p	Proportion of data subject to atypical errors	L4
e	Parameter of the fat-tailed probability distribution	L4
ε	Standard deviation of the fishing mortality process error	L4

Table 4. Definitions to extend the deterministic model in Table 2 to a stochastic model. The generic notation Θ represents the set of parameters to estimate. ~: distributed as; N: normal distribution; t-Dist: t-distribution function

Model	Notation
$\log\left(C_{i,t}\right) \sim N\left(\log\left(C_{i,t}\right)\left(\theta\right), \sigma_i^2\right)$	S1
$\log\left(K_t\right) \sim N\left(\log\left(K_{t-1}\right), \gamma^2\right)$	S2
$\log\left(q_{i,t}\right) \sim N\left(\log\left(q_{i,t-1}\right), \delta_i^2\right)$	S3
$\log\left(F_{i,t}\right) \sim \left(1-p\right)\left(N\left(\log\left(q_{i,t}E_{i,t}\right), \varepsilon_i^2\right)\right) + p\left(t - Dist\left(\log\left(q_{i,t}E_{i,t}\right), \varepsilon_i^2\right)\right)$	S4

Table 5. Likelihood components of the PROCEAN model.

$$L\left(\left(\{C_{i,t}\}\right)\theta\right) = \prod_{i=1}^{n-1}\prod_{t=1}^{T}\frac{1}{C_{i,t}\sigma\sqrt{2\pi}}\exp\left(\frac{-\left(\log\left(C_{i,t}\right)-\log\left(C_{i,t}(\theta)\right)\right)^2}{2\sigma^2}\right) \tag{L1}$$

$$L\left(\left(\{K_{t}\}\right)\theta\right) = \prod_{t=1}^{T-1}\frac{1}{\gamma\sqrt{2\pi}}\exp\left(\frac{-\left(\log\left(K_{t+1}\right)-\log\left(K_{t}\right)\right)^2}{2\gamma^2}\right) \tag{L2}$$

$$L\left(\left(\{q_{i,t}\}\right)\theta\right) = \prod_{i=1}^{n-1}\prod_{t=t_i}^{T_i-1}\frac{1}{\delta_i\sqrt{2\pi}}\exp\left(\frac{-\left(\log\left(q_{i,t+1}\right)-\log\left(q_{i,t}\right)\right)^2}{2\delta_i^2}\right) \tag{L3}$$

$$L\left(\left(\{F_{i,t}\}\right)\theta\right) = \prod_{i=1}^{n-1}\prod_{t=t_i}^{T_i-1}\frac{(1-p)}{\varepsilon_i\sqrt{2\pi}}\exp\left(\frac{-\left(\log\left(F_{i,t}\right)-\log\left(q_{i,t}E_{i,t}\right)\right)^2}{2\varepsilon_i^2}\right)+\frac{2p}{e\varepsilon_i\sqrt{\pi}}\left(1+\frac{\left(\log\left(F_{i,t}\right)-\log\left(q_{i,t}E_{i,t}\right)\right)^4}{\left(e\varepsilon_i\right)^4}\right)^{-1} \tag{L4}$$

Table 6. Parameter estimates and related fisheries indicators, i.e. *MSY* and F_{2008}/F_{MSY}, and B_{2008}/B_{MSY} estimates

	m	r	B_0/K	K ('000 t)	MSY ('000 t)	F_{2008}/F_{MSY}	B_{2008}/B_{MSY}
Base case runs							
PRODFIT	1.00	-	0.94	500	132	0.65	1.30
PROCEAN	1.28	1.71	0.9	811	127	0.67	1.24
ASPIC – 1980-2008	1.00	-	-	-	116	0.79	1.17
Sensitivity runs							
PRODFIT – k = 12	1.00	-	-	468	123	0.70	1.28
PRODFIT – 1980-2008	1.00	-	-	565	128	0.79	1.10
PRODFIT Corrected Initial Effort	1.00	-	-	470	124		1.11
PROCEAN – B0	1.41	1.9	0.95	546	132	0.64	1.24
PROCEAN – Process error	1.31	0.72	0.9	1676	121	0.67	1.33
PROCEAN – 1980-2008	2.4	0.64	0.9	620	125	0.84	1

Figure captions

Fig. 1. Catch (t) of the Indian Ocean bigeye tuna fisheries during 1950-2008

Fig. 2. Standardised CPUE time series derived from Japanese longliners

Fig. 3. (a) Corrected CPUEs and (b) Corrected efforts used in PRODFIT as an alternative working hypothesis (see text for details)

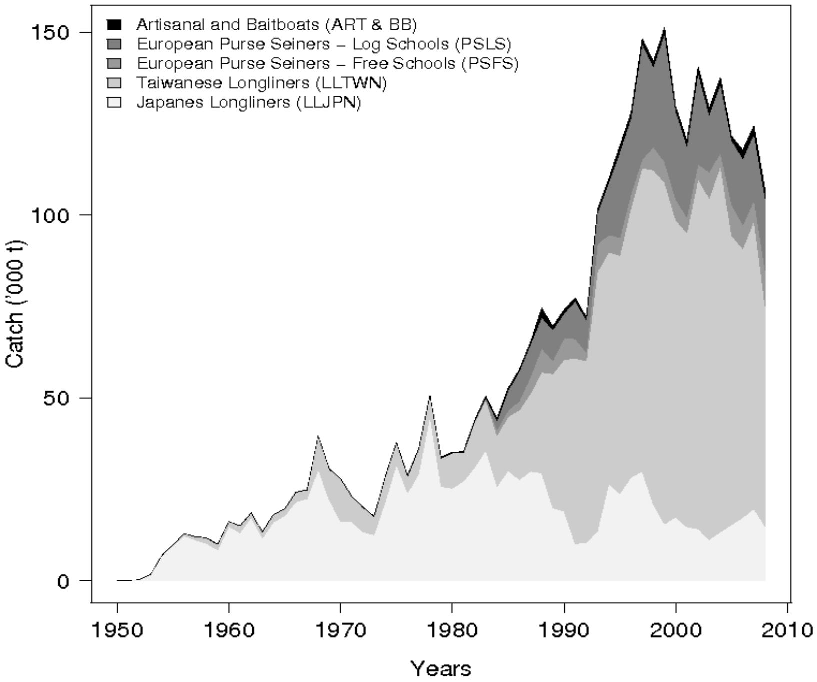
Fig. 4. CPUE observed (crosses) and predicted (solid line) in the base case runs for (a) ASPIC and (b) PROCEAN

Fig. 5. Total catch observed (circles) and equilibrium production curve (thick solid line) estimated in the base case run for PROCEAN

Fig. 6. Kobe diagrams representing the evolution of the annual fishing mortality relative to the fishing mortality at MSY (F/F_{MSY}) as a function of the annual biomass relative to the biomass at MSY (B/B_{MSY}) in the base case runs for (a) ASPIC and (b) PROCEAN

Fig. 7. Estimated trend in relative catchability modelled as a lognormal random walk process for the Japanese longline fishing fleet estimated by PROCEAN

Fig. 8. Average weight of bigeye tuna caught by the Indian Ocean fisheries computed as the ratio of catch and fish numbers from the IOTC CAS database



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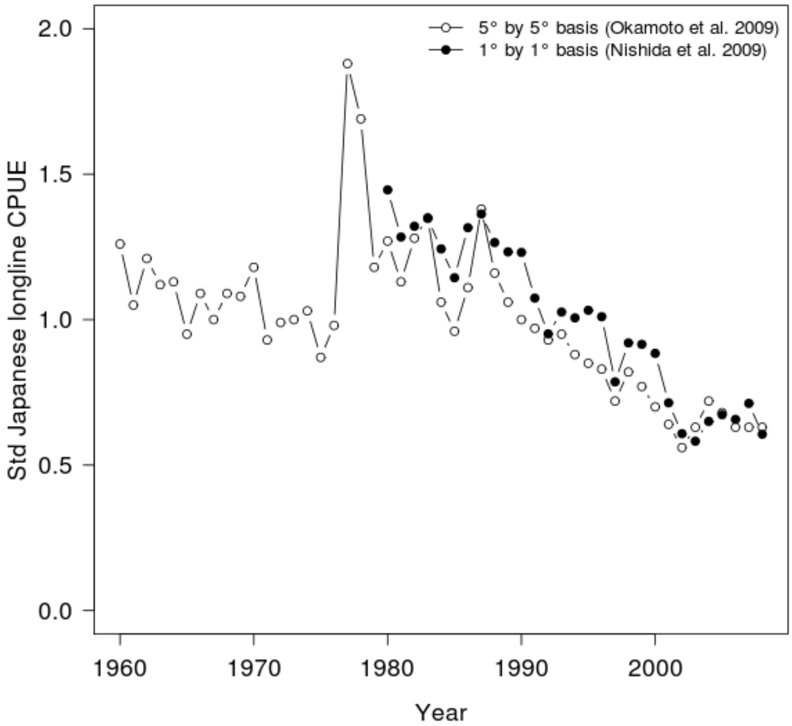

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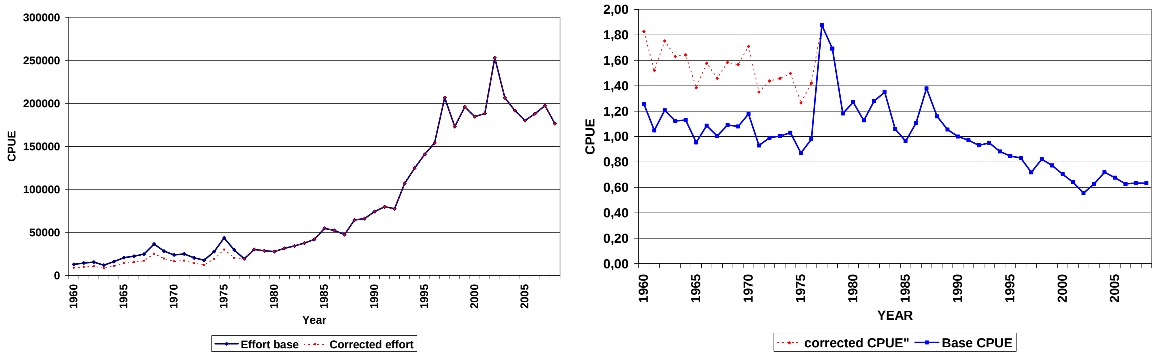

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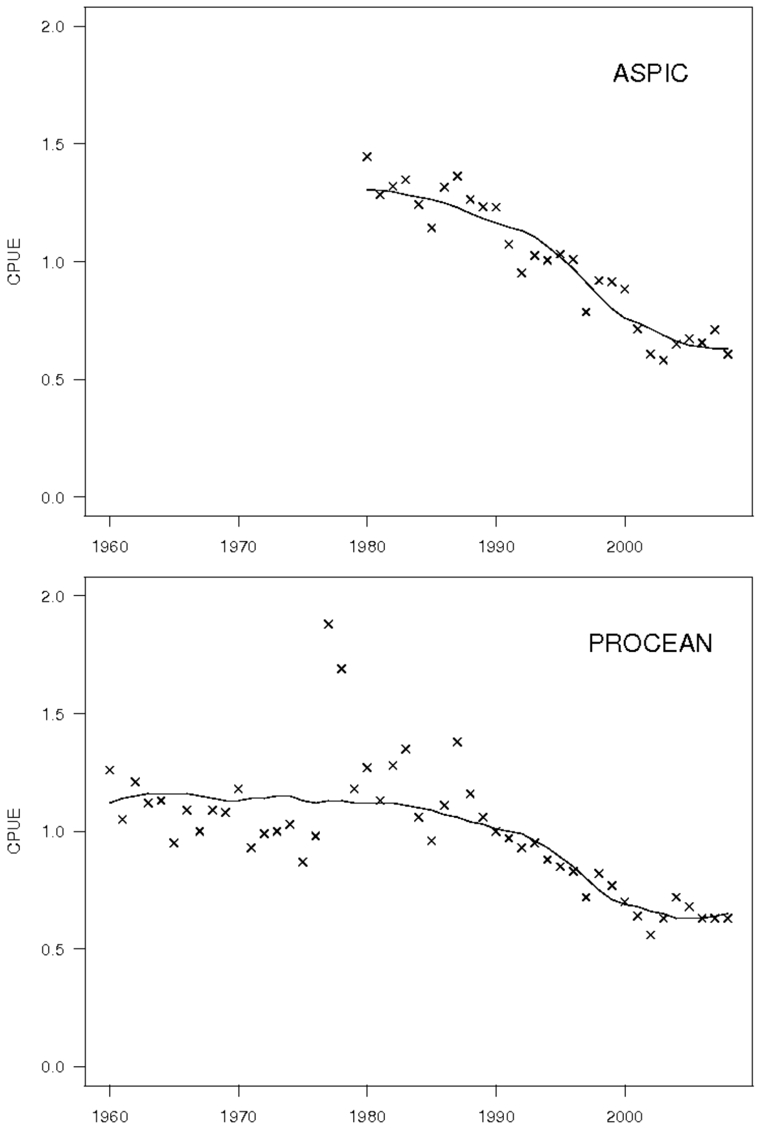

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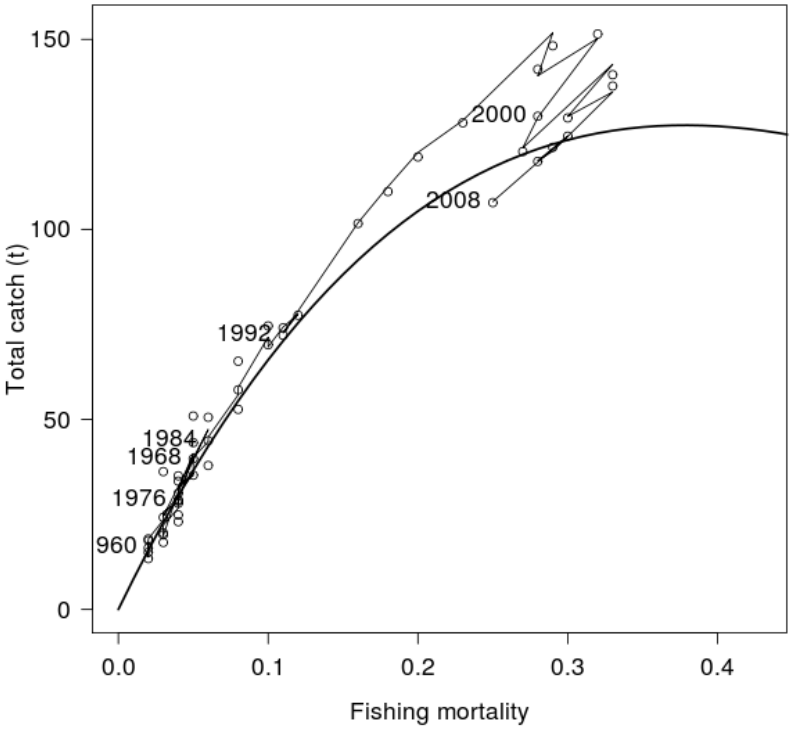

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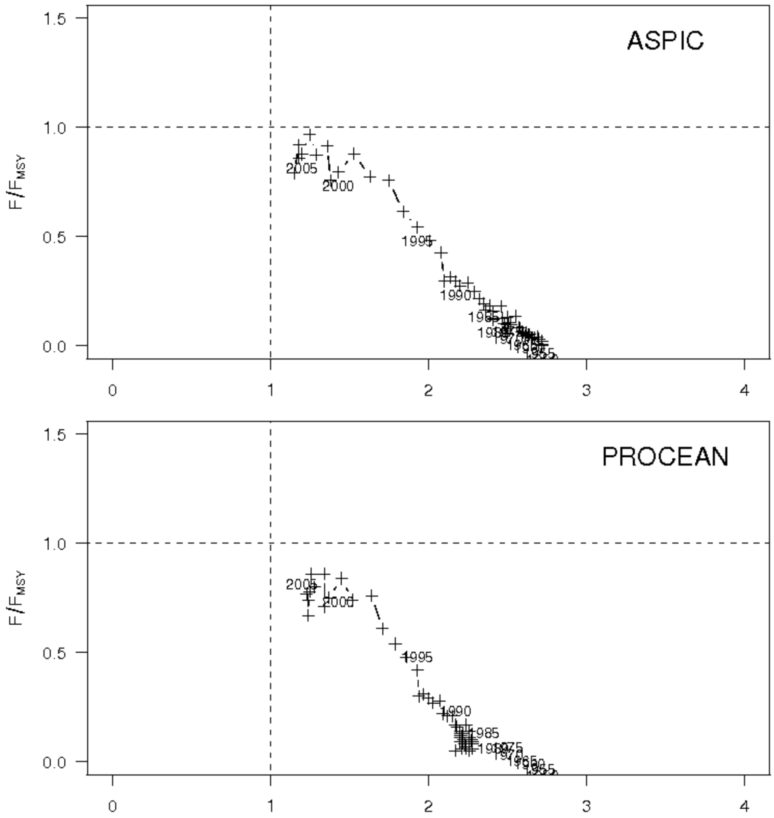

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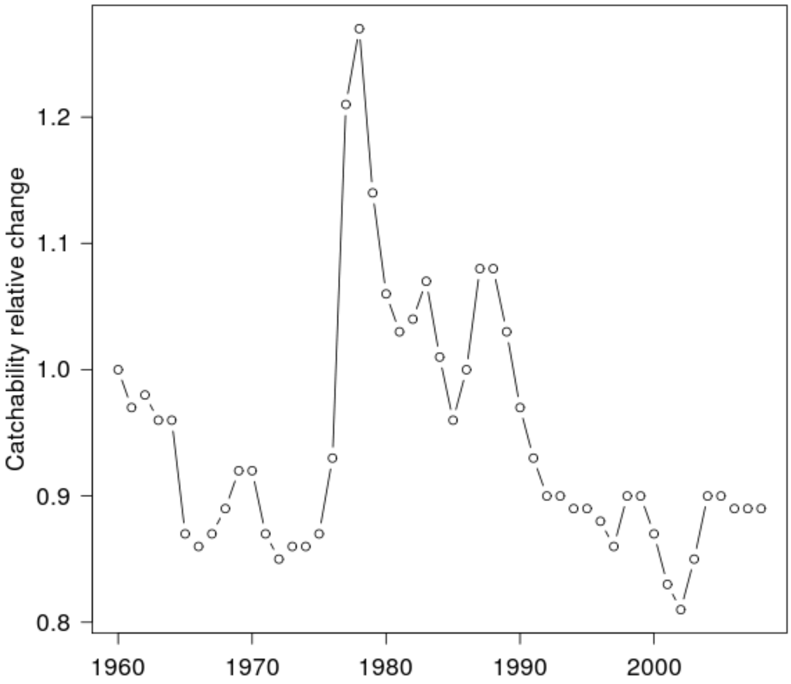

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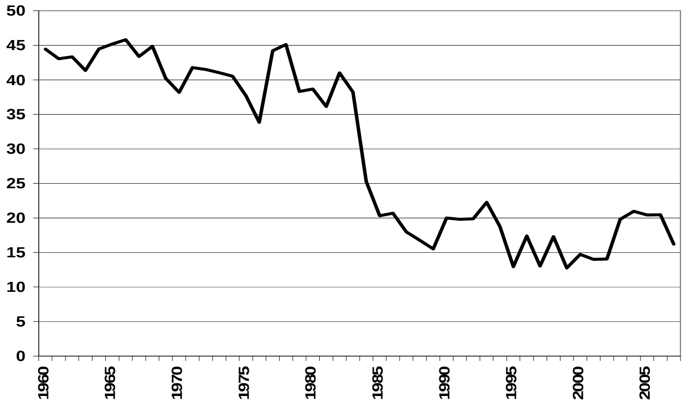

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