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Further consideration of issues related to setting rebuilding objectives for southern bluefin tuna in the context of management procedures

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Prepared for the CCSBT 5th Meeting of the Stock Assessment Group (SAG5) and the 9th Meeting of the Scientific Committee (SC9)
6-11 and 13-16 September 2004, Seogwipo KAL Hotel in Jeju, Korea

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Abstract

The development of a management procedure has been defined by the CCSBT as one of the highest priorities for the scientific committee (Anon. 2001). An essential component of the management procedure process is the explicit definition of management objectives and their translation into measurable and quantifiable performance indicators. Although management has the responsibility for setting its objectives, science has an important role in this process in advising on what is realistically achievable and the potential consequences/risks associated with different objectives. This paper follows on from one submitted to last year's SC meeting (document CCSBT-ESC/0309/30).

The paper refers to the lists of approaches, discussed in CCSBT-ESC/0309/30, that can be used to define rebuilding objectives, including:(1) empirical/historical considerations (e.g. the target of 1980 SSB), (2) spawning biomass depletion level (e.g. biomass = 0.4 of biomass at theoretical unfished equilibrium) (3) recruitment trends (e.g. assuming a stationary stock recruitment relationship, ensure that SSB is high enough to maintain mean recruitment above 0.8 of unfished recruitment) (4) stock productivity (e.g. MSY levels) and (5) relative to maximum possible rebuilding in a specified timeframe. These five approaches are discussed in the context of SBT and the currently defined operating model for testing candidate management procedures for SBT. Additional comments are made in the light of results from the updated operating model and most recent assessments, particularly with regard to the plausible range of stock rebuilding potential.

Introduction

This paper discusses approaches for and issues related to setting rebuilding objectives for SBT in the context of management procedures. It is, however important to note (as we did in CCSBT-ESC/0309/30) that scientists and managers have distinct and separate roles in the overall fishery management process and it is important to avoid inappropriate confounding of roles in the interface between the advice and the decision. Although science cannot provide objectives – this requires value judgements on what are preferable outcomes - science does nonetheless have an important role in this process in advising on what is realistically achievable and the potential consequences/risks associated with different objectives.

Substantial progress has been made in the development of operating models and candidate management procedures. It is, however, still the case that the technical work cannot be finalised without the development of quantifiable performance measures which reflect management's basic objectives. It becomes impossible to undertake meaningful evaluation of the performance of different candidate procedures, or to provide advice on the relative trade-off in objectives that might be obtained from different procedures, in the absence of such measures. For example, evaluation of candidate management procedures showed that identical performance with respect to one measure (e.g. rules tuned to the same tuning level in terms of B2022/B2002) can have quite different performance in terms of another measure (e.g. the probability of SSB falling below some proportion of current). One of the most critical objectives for which agreed performance measures are required is indeed the stock-status related targets that should be used in the management procedure evaluation process.

Background

One of the main reasons for setting rebuilding targets stems from the concern that, for depleted stocks, environmental variability will combine with the vulnerable state of the resource to cause an abrupt recruitment decline and a subsequent further decline in the parental biomass. It is however, difficult to meaningfully quantify the probability of a collapse for a particular stock at any particular spawning stock level because of at least three reasons:

1) recruitment dynamics are usually poorly understood, particularly at low stock sizes,
2) both environmental factors and spawning stock level can play a major role in recruitment and its variability,
3) productivity (e.g. steepness in the stock-recruit relationship) is usually poorly estimated.

The inability to quantify the risk of collapse and the fact that a stock has not collapsed at current catch levels can make it difficult to determine what is an appropriate rebuilding target for a depleted stock based on estimates or models of its dynamics. Nevertheless, the region of "low" spawning stock biomass levels is generally recognized as an area to be avoided in order to ensure the long term sustainability of the resource and the fisheries. It is also risky to rely on detecting stock and recruitment collapse before taking action. Detection of a collapse at the time it is actually occurring is difficult, because it generally takes several years of observations to reliably confirm the strength of recently recruited cohorts and it is a feature of stock assessments that the most recent estimates are generally the most uncertain.

The current rebuilding objective for the CCSBT is to rebuild the parental biomass to the 1980 levels by 2020. The background to the origin of this objective was discussed in detail in CCSBT-ESC/0309/30, and further commented on below.

The timeframe for rebuilding was set to 2010 prior to 1994, but it was changed in that year to 2020. Since 1994, the CCSBT has either maintained its annual TAC at a constant level. During this time, global SBT catches have increased. While from the perspective of 1994 and the stock assessments at that time, the 2020 rebuilding timeframe was realistic. Ten years later, given the late age of maturity for SBT that is now recognized, and the current set of operating models being used in the MP process, it is not clear whether this provides a useful measure against which to measure performance. The reference set is currently being revised and an update of the situation awaits further work.

Approaches for Defining Rebuilding Targets

As noted in CCSBT-ESC/0309/30, there are a number of approaches that could be used to define rebuilding targets, and they differ in terms of the units or currency used to express them. Among the most direct and commonly ones considered in fisheries are:

1) Empirical/historical
2) Spawning biomass depletion
3) Recruitment trends
4) Stock productivity – MSY related
5) Rebuilding relative to maximum

Each of these approaches are only summarised briefly below since details can be found in CCSBT-ESC/0309/30. A discussion of potential use in the SBT context, and comments on whether the situation has changed in the light of the most recent work to update the operating model, follow. Note that because the historic data have changed, the comments pertain to the update in the sense of a different dataset for the whole period rather than just an update in terms of the addition of three more years of data.

Although the discussion below is mostly aimed at reference points in the general sense, it is important to note the distinction between, what has been called, target reference points (defining a target to aim for) and limit reference points (defining a limit or threshold which should not be exceeded). In many fisheries management schemes both types of reference points are used together.

Empirical/Historical Approach

In this approach the historic trends in biomass, recruitment, and any other indicators of stock and/or fishery status, are used to identify a period with reasonably stable and satisfactory recruitment. This is used to guide the choice of a reference target for spawning biomass. The basis for selecting a level/(time in the past) is based on direct observations, and as such there is no theoretical underpinning for the selection of a reference level.

The basis of selecting a target might include an economically attractive CPUE, or no apparent recruitment overfishing. The original Scientific Committee recommendation about the 1980 level appears to contain a large element of this empirical approach.

As was the case in 2003, it is currently less clear that the period prior to and around 1980 represents a period with reasonably stable and satisfactory recruitment. The wide range of assessment runs presented in CCSBT-ESC/0409/23 do, however, suggest that recruitment in the 1970's was generally higher than in the post-1980's period. In most cases, the estimated trends suggest both a generally continuous and steady decline in SSB and recruitment since at least 1970. As such, these estimated trends provide little empirical basis for selecting a reference level. However, as indicated above, the perception that the 1980 level provided a reasonable rebuilding target was not based simply on the assessment of stock trends from analytical assessments, but also on changes in about 10 other indicators which together suggest both overfishing and an overfished stock – many of them are associated with the period after 1980. In particular, those related to spatial contraction combined with the apparent large reduction in older fish, and the rapid change (increase) in the late 1970's in the growth rates of SBT (Polacheck et al 2002)[1] suggest that the stock sizes in the post 1980 level had been reduced to such low levels that the basic population and habitat dynamics of the stock were being disrupted. In this context, the 1980 spawning biomass might continue to be considered as a reasonable empirical rebuilding target, particularly if the past is to provide the guide for setting objectives in the future. There is, of course, no certainty that rebuilding the stock to the 1980 levels would reverse all of the above indicators (e.g. that the history is reversible).

Spawning Biomass Depletion Level

This approach aims to set a depletion level (spawning biomass relative to unexploited spawning biomass) which would keep the stock above the threshold where recruitment is likely to decline notably. There is no rigorous theoretical underpinning for the choice of a depletion level, but the choice should recognise the importance to mangement objectives of robustness and the need to unduly avoid "risk". Setting a depletion level can help ensure that there is a buffer away from the region where recruitment and stock collapses are more likely

On the basis of studies on a wide range of stocks, levels of 25-50% of their unfished level (e.g. B_0) might be worth considering (i.e. stock levels below which the stock should not be allowed to reach and if it does go below that level, a recognition that rebuilding needs to occur).

One advantage of using depletion levels as a rebuilding target is that there can often be a relatively high degree of concordance among different estimates of depletion across a range of assessment models and alternative hypotheses for the major dimensions of uncertainty. This has frequently been the case within the SBT stock assessments. Results from assessments done with the operating model (CCSBT-ESC/0409/23) show that this is still mostly the case, though there are some factors to which it SSB ratios can be sensitive (e.g. age range over which catchability is assumed to operate).

Recruitment Trends

An approach for setting rebuilding targets can be based on the spawning stock level that produced some percentage of the initial or unfished recruitment. Recruitment trends are often one of the more robust components estimated by stock assessment models (over periods for which reasonable age and/or size data for the catch exists). The approach is, however, made more difficult when there is high recruitment variability relative to any trend, particularly

[1] Information for estimating this change in growth was not available to the 1988 Scientific Committee.

when combined with autocorrelations and potential non-stationarity. This means that recruitment trends can be difficult by themselves to use as a basis for setting rebuilding objectives.

In the SBT case, estimates of recent relative recruitment trends (up to the mid 1990s) are relatively consistent over a wide range of uncertainties. Estimates also tended to exhibit small amounts of inter-annual variability particularly between about 1975-1995. More recently, however, estimated recruitments have showed greater inter-annual variability (e.g. 1996-2000, though recognising greater uncertainty in the most recent year's estimates) . Trends are, however, difficult to interpret. For example, recruitment appears to have been relatively stable between 1985 and 1995, during which time the SSB is estimated to have declined from around 75% of the 1980 level to 25% of the 1980 level. The new dataset (used for this year's assessment) tends to estimate relatively high recruitment in 1996 and 1998 (not that different from the 1980 level, in fact) while SSB is estimated to have been at its lowest level. In contrast, early indications are that recruitment in 2000 and 2001 may have been the lowest ever, with SSB at about the same level.

Stock productivity (e.g. MSY levels)

Historically, fishery management has frequently defined its stock-status related objective in terms of the biomass that would provide maximum sustainable yield.
Historically MSY has been used as target reference point, but it is now considered to be a limit reference point[2]. It is dependent upon a specified functional form for the productivity function and based on equilibrium considerations.

Many papers have been written about the merits of and problems with MSY as a reference point (e.g. Mace 2001). Criticisms of MSY can be divided into three categories (Punt and Smith, 2001): (i) estimation problems, (ii) the appropriateness of MSY as a management goal; and (iii) the ability to effectively implement harvest strategies based on MSY. In the context of a management procedure, the third concern is maybe less relevant. General concerns exist about the utility of using estimates of MSY as a management objective[3], at least in terms of a target reference point for management. Among these concerns are (1) stock productivity and MSY levels have proved elusive to estimate accurately, (2) recruitment variability and associated auto-correlation combined with lags in their detection and management response can result in stock declines stock well below MSY and (3) stocks managed under MSY objectives have frequently ended up in depleted, if not collapsed, state[4].

In the case of SBT, steepness plays a crucial role in the estimation of MSY. The problems with fitting the stock-recruit information to a Beverton-Holt relationship remain in the current dataset. It is, for example, still the case that systematic temporal deviations apparent in many assessment runs, can be interpreted as the result of large auto-correlations in recruitment. When such "auto-correlations" are estimated to have long time lags, the performance of the stock in the more recent years (perhaps the whole period where extensive data exist) can be seen as providing little useful indication of what one might expect in the future. On the other hand, the ratio of Bmsy/B0 appears not to be sensitive to the wide range of factors considered

[2] The Precautionary Guidelines of UN Fish Stocks Agreement suggest that MSY should be treated as at most a limited reference point (United Nations 1995)
[3] "The role of stock assessment is not to make best guesses as MSY, but rather to help design a fishery management system that can respond to the types of variability we see in nature" Hilborn and Walters 1992.
[4] This latter does not necessarily mean that the MSY objective was the cause.

in the assessment runs (CCSBT-ESC/0409/23), except of course for steepness to which it is very sensitive.

Rebuilding relative to the maximum rebuilding possible given a specified timeframe

In a rebuilding situation where there is substantial uncertainty about the productivity of a stock, it may be very difficult to specify meaningful absolute rebuilding targets to be achieved within a specified timeframe. An alternative may be to specify a rebuilding objective in terms of some percentage of the maximum possible rebuilding (i.e. under zero catches) given a time window. This takes into account that a primary objective of management may be to ensure that its actions have a high probability of achieving some rebuilding over shorter term time horizons (i.e. that one is "heading in the right direction"). It is not, however, sufficient in the long term and also requires an objective that determines when sufficient rebuilding has been achieved.

The relevance of a management objective which seeks to ensure a high probability of achieving some rebuilding over shorter term time horizons (i.e. that one is "heading in the right direction") may be particularly true for long lived and late maturing species (such as SBT) where the expected timeframes to achieve substantial rebuilding may be long. Within the CCSBT context, concerns has been express that the rebuilding object has only been focused on a goal up to 26 years in the future, without any intermediate measures about the stock's performance in the interim.

The importance of also having a longer term objective that determines when sufficient rebuilding has been achieved should be emphasised. In other words, setting a direction to head into does not alleviate the need to know when one has arrived. Nevertheless, having a stock status objective in such a relativistic framework may allow for realistic trade-offs between catches and rebuilding that do not require foregoing large amounts of catch if the more productive plausible scenarios turn out to be correct or sacrificing any chance of rebuilding if the lower productive scenarios turn out to be correct, assuming that procedures can be developed that produce such performance.

In the light of the review of the reference set, the details of such an approach cannot usefully be commented on at this stage.

Finally, it should be emphasized that, as was the case for paper CCSBT-ESC/0309/30, this paper was prepared to stimulate discussion on and is not advocating a particular solution to the question of how best to define rebuilding targets for SBT in the context evaluating the performance of management procedures.

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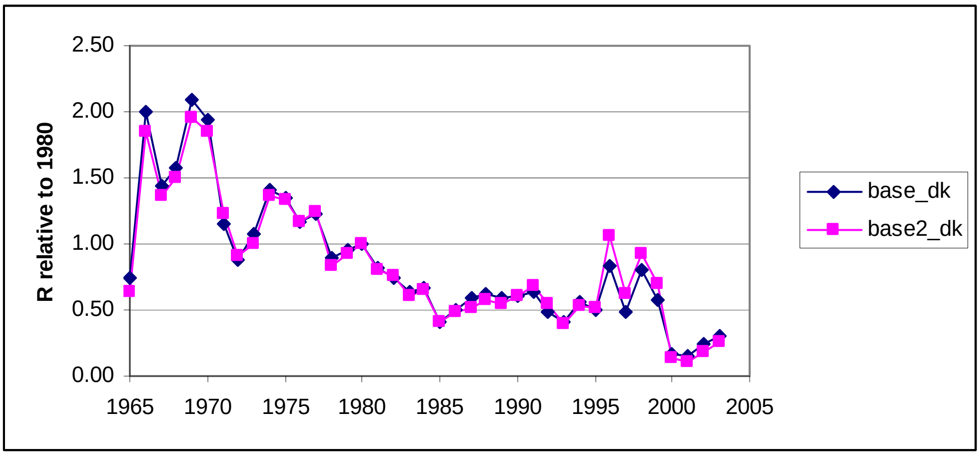

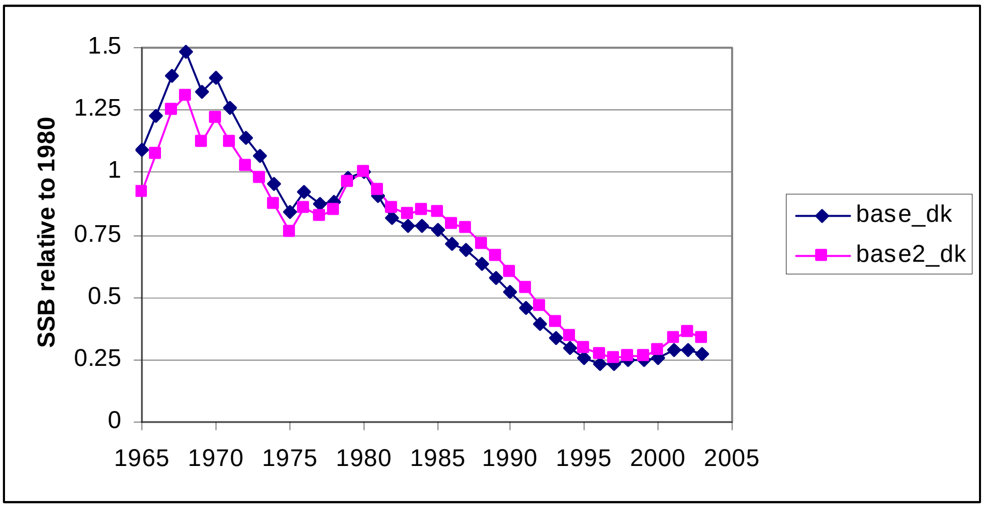

Figure 1 Recruitment and SSB relative to 1980 for two example runs of the OM with updated data (see CCSBT-ESC/0409/23 for detail)