Australian Government
Bureau of Rural Sciences

Report on the potential of spawning ground surveys

K. Phillips, G. Begg

The Australian Government acting through the Bureau of Rural Sciences has exercised due care and skill in the preparation and compilation of the information and data set out in this publication. Notwithstanding, the Bureau of Rural Sciences, its employees and advisers disclaim all liability, including liability for negligence, for any loss, damage, injury, expense or cost incurred by any person as a result of accessing, using or relying upon any of the information or data set out in this publication to the maximum extent permitted by law.

Postal address:
Bureau of Rural Sciences
GPO Box 858
Canberra, ACT 2601

Abstract

In 2007, the Stock Assessment Group (SAG) recommended that the Extended Scientific Committee (ESC) develop a work plan for possible spawning or feeding ground surveys to address uncertainties in the current CPUE series. This report reviews uncertainty and biases associated with the Japanese longline CPUE series used to condition the operating model, discusses how fishery-independent indices of abundance (such as those obtained from spawning ground surveys) can reduce uncertainty in SBT stock trends, and revises the principles of a spawning ground survey previously agreed to by members of the CCSBT. Feeding ground surveys were not considered. The value of a spawning ground survey must be balanced against the cost involved and the usefulness of other potential indicators of stock trend.

Contents

Background

In 2007, the Stock Assessment Group (SAG) recommended that the Extended Scientific Committee (ESC) develop a work plan for possible spawning or feeding ground surveys to address uncertainties in the current CPUE series (CCSBT-ESC12 2007, paragraphs 89–90). This report discusses the potential of a spawning ground survey to provide a fishery-independent index of relative abundance as a data input for the SBT stock assessment and indicator of stock size for decision rules (i.e. management procedures) used to set TACs. Feeding ground surveys were not considered in this report.

Currently, stock assessment advice provided to the Commission is based on an operating model conditioned by seven sets of input data:

- Catch by the 9 fleets of CCSBT members and cooperating non-members
- Commercial Japanese longline catch-per-unit-effort (CPUE)
- Tagging data
- Age composition from Indonesia's longline fishery
- Age composition from Australia's surface fishery
- Size composition from other fleets
- Biological input data (eg. age-length, weight at age) (CCSBT-SAG8 2007).

Japanese longline CPUE data currently provides the only index of stock abundance for the operating model. It is the only available data source that covers most of the SBT distribution range and age-classes, and is the only index covering the entire history of the fishery (CCSBT13 2006). However, significant uncertainties constrain the use of fishery-dependent CPUE as abundance indices in general, and Japanese longline CPUE in particular (see below).

The objectives of this report were to:

- Briefly review the uncertainty and biases associated with the Japanese longline CPUE series
- Discuss how resultant uncertainty in stock trends could be reduced by a fishery-independent index of abundance developed from spawning ground surveys
- Revise the principles of a spawning ground survey previously agreed to by members of the CCSBT.

CPUE as indices of abundance

Fishery-dependent CPUE time series, such as that from the Japanese longline fishery, can produce confounded indices of abundance as a result of:

- Non-random concentration of fishing effort in time and space
- Non-retention practices
- Changes in location and contraction of fishing grounds
- Changes to management arrangements
- Changes in targeting practices, and
- Improvements to gear and technology over time ('effort creep').

Problems inherent in the use of fishery-dependent CPUE data as abundance indices are widely documented (e.g. Walters & Maguire 1996). On top of the generic factors that introduce bias into most CPUE series, the Japanese longline CPUE index is further compromised by large changes in the spatial coverage of the Japanese fleet over time (e.g. a shift away from the spawning ground to feeding grounds in the 1960s), the aggregation of available data (all catch and effort within a month and 5° latitude and longitude squares), and a lack of data on changes in catchability (Polacheck 2002).

In more recent years, two further sources of uncertainty have undermined confidence in the Japanese longline CPUE series as an index of abundance: (1) revelations of unreported catch being sold through Japanese markets during 1985–2005, together with an absence of information on the amount of fishing effort associated with this catch; and (2) major changes to the management of the Japanese longline fleet as of April 2006 (introduction of individual quotas and removal of restrictions on fishing area and season; see Itoh 2006). A lack of consistency between CPUE series before and after 2006, arising from these two sources of uncertainty, was noted to be potentially very difficult to resolve (CCSBT14 2007).

Given the biases associated with the Japanese longline CPUE series, especially the uncertainty regarding actual catch and effort levels during 1985–2005, now is a prudent time to again consider the option of developing a fishery-independent index of abundance from spawning ground surveys, noting that it will take several years to develop a time series that could be used as an indicator of stock trends.

Fishery-independent index of abundance

The development of reliable, non-CPUE based indices of abundance, such as a fishery-independent index of relative abundance on the spawning ground, would greatly reduce uncertainty in the conditioned operating model and future projections of stock size. Ideally, indices of abundance should be proportional to stock size and reflect stock trends (Hilborn & Walters 1992). Although surveys of abundance would ideally be conducted over the entire range of SBT, this is clearly not feasible given the spatial distribution of the species. Annual stratified surveys that representatively sample SBT from the spawning ground offer an alternative. In addition to providing a spatial location that is persistent over time (cf. surveys of feeding grounds), a spawning ground survey could also address other areas of uncertainty in the stock assessment, including:

- An estimate of spawning stock biomass
- Age composition of the spawning stock
- Age at maturity
- Relative potential spawning productivity of SBT with age
- Longevity
- Sex ratio and residence time on the spawning ground, and
- Physical variables (e.g. temperature) that influence spawning (EFGWG2 1999).

Principles for the design of a spawning ground survey

The basic principles of a structured spawning ground survey were agreed to by participants of a technical subgroup of the Experimental Fishing Program Working Group in 1999 (EFWG2 1999) and are revised here as a general guide for potential development of a survey. The spawning ground survey would be designed to produce scientifically valid results with adequate statistical power to reduce uncertainty in the stock assessment, and be implemented by commercial longline vessels. In 1999, Indonesian longline vessels were considered to be the most appropriate because of: lowest costs per vessels compared with fleets of other CCSBT members; proximity of the spawning ground to Indonesia (and associated lower operating costs); access to the Indonesian Exclusive Economic Zone; and the ability to standardise fishing gear among the fleets of one member rather than among fleets of multiple members (EFPWG2 1999). As of 2008, spawning ground surveys would provide Indonesia with an opportunity to participate in a CCSBT research program as a relatively new member of the Commission.

The technical subgroup agreed that a spawning ground survey should:

- Be spatially and temporally comprehensive, i.e. cover the entire spawning ground (10–20°S, 105–120°E) and over the entire spawning season (September to March)
- Comprise standardised and representative sampling in terms of gear, soak time, depth, time of day, habitat strata (i.e. fishery-independent sampling)
- Incorporate accurate logbooks and onboard observers (EFPWG2 1999).

Structured spawning ground surveys are designed to sample a discrete stock of fish during their spawning period, when they are assumed to be reproductively isolated, in order to provide key information about the reproductive status of a stock. Importantly, structured surveys using standardised and representative sampling methods (i.e. fishing gears and protocols) provide a means for collecting fishery-independent catch and effort data, as well as biological data (length, weight, age, maturity) from individually sampled fish, thereby removing the need for potentially biased fishery-dependent catch and effort data. The surveys can be conducted by chartering commercial fishing vessels rather than research vessels, resulting in significant cost savings, with costs further offset by the sale of commercially valued species. Surveys can also be timed to coincide with the peak spawning period rather than being conducted throughout the entire spawning season, providing a snapshot of information on the status of the stock while further reducing costs imposed by more temporally extensive surveys.

Prior to the potential design and implementation of a spawning ground survey, extensive consultation would need to occur between members and fishers. The work should build upon the previous considerations of the EFPWG2 (1999) and be a collaborative initiative. Clearly defined objectives and data collection protocols would need to be articulated, as too appropriate monitoring and review procedures. Fiscal and human resources would be required for the design and operation of the survey, including vessel charter and observer costs, as well as for data collection, storage, analysis and interpretation. The survey should be designed to collect data that will provide improved estimates of key inputs to the assessment in a statistically robust manner, and reduce reliance on fishery-dependent CPUE indices so that direct and reliable measures of relative changes in parental biomass and abundance can be obtained.

To provide a statistically robust index of abundance over space and time, the survey must sample SBT in any area in proportion to their abundance in that area. Previous research provided evidence that SBT aggregate by size and depth on the spawning ground (Davis & Farley 2001), and that in this region SBT exhibit a preference for certain habitats e.g. waters less than 150 m depth and as warm as 28°C (Gunn et al. 2006). Because SBT are more likely to aggregate in particular areas (e.g. depth, temperature strata) within the spawning ground, a survey would preferably be stratified so that catch and effort can be standardised to represent the proportional abundance of SBT over the entire spawning ground based on a habitat model.

If a spawning ground survey were to proceed, it should be implemented as soon as possible because it will take several years before a time series of trends in abundance became available. However, many statistical design issues must first be resolved, particularly regarding development of a habitat model and appropriate stratification for the survey. Vertically-resolved, temperature-based habitat models have been developed for SBT off the east coast of Australia using data obtained from pop-up satellite archival tags (Hobday & Hartmann 2006), and such research could provide a starting point for the definition of habitat strata within the spawning ground.

Once a statistical design had been agreed to, the greatest constraint to a spawning ground survey would be cost. Although some costs could be offset through the sale of SBT sampled during the survey, the value of post-spawners is relatively low and revenue could not fully compensate for vessel charter (noting rising fuel prices) and employment of independent observers. Preliminary research into habitat strata, e.g. via attachment of pop-up tags on SBT on the spawning ground, would add to the initial costs of the spawning ground survey. Considerable resources would need to be contributed by CCSBT members if a spawning ground survey were to be implemented.

The value of an abundance index and supplementary biological information obtainable from a spawning ground survey must be balanced against the cost involved and the usefulness of other potential indicators of stock trend.

References

Bravington M, Grewe P (2007) A method for estimating the absolute spawning stock size of SBT using close-kin genetics. CCSBT-ESC/0709/18. CCSBT-SAG/ESC, Hobart

CCSBT13 (2006) Report of the thirteenth annual meeting of the Commission. CCSBT, Miyazaki

CCSBT14 (2007) Report of the fourteenth annual meeting of the Commission. CCSBT, Canberra

CCSBT-ESC12 (2007) Report of the twelfth annual meeting of the Scientific Committee. CCSBT-SAG/ESC, Hobart

CCSBT-SAG8 (2007) Report of the eight annual meeting of the Stock Assessment Group. CCSBT-SAG/ESC, Hobart

Davis TLO, Farley JH (2001) Size distribution of southern bluefin tuna by depth on their spawning ground—*Thunnus maccoyii*—statistical data included. Fishery Bulletin Apr 2001; http://findarticles.com/p/articles/mi_m0FDG/is_2_99/ai_75434053

EFPWG1 (1999a) Attachment D: objectives and principles for the design and implementation of an experimental fishing program. CCSBT, Tokyo, 1–3 February 1999

EFPWG1 (1999b) Attachment L: discussion paper on the design and implementation of an experimental fishing program for southern bluefin tuna. CCSBT, Tokyo, 1–3 February 1999

EFPWG1 (1999c) Attachment M: an overview of a proposal for an experimental fishing program for SBT: a spatially comprehensive tagging experiment. CCSBT, Tokyo, 1–3 February 1999

EFPWG2 (1999) Further elaboration of a SBT spawning ground survey: target unvertainties, elements of experimental design, feasibility considerations and possible alternatives. CCSBT, Tokyo, 25 February–3 March 1999

Gunn JS, Evans K, Patterson TA, Carter TI (2006) Examining the movement and residency of adult SBT in the Tasman Sea and on their spawning grounds south of Indonesia using pop-up archival tags. Final report to the Department of Agriculture, Fisheries and Forestry. CSIRO, Hobart

Hilborn R, Walters CJ (1992) Quantitative fisheries stock assessment. Chapman and Hall, New York

Hobday AJ, Hartmann K (2006) Near real-time spatial management based on habitat predictions for a longline bycatch species. Fisheries Management and Ecology 13:365–380

Itoh T (2006) Possible effect on longline operation resulted from the 2006 changes in Japanese SBT fishery regulation. CCSBT-ESC/0609/44. CCSBT-SAG/ESC, Tokyo

Polacheck T (2002) Experimental catches and the precautionary approach: the southern bluefin tuna dispute. Marine Policy 26:283–294

Walters C, Maguire JJ (1996) Lessons for stock assessment from the northern cod collapse. Rev Fish Biol Fish 6:125-137