Specification of Standardised CPUE for the MP

Data to be used

The CPUE dataset to be used in the MP is based on the longline catch and effort data of Japanese, Australian (Real-Time Monitoring Program in the 1990s) and New Zealand (NZ) charter vessels at the shot-by shot resolution. Southern bluefin tuna (SBT) aged 4 years or older are used in the CPUE dataset. In the most recent year of the dataset, CPUE (number of SBT individuals per 1000 hooks) is calculated from Japanese data available at the time which are mainly from RTMP. From this dataset, a set of core vessels are selected which meet certain conditions. These conditions are: CCSBT statistical areas (Area) 4-9, Month 4-9, x (top rank of SBT catch in a year) = 52, and y (number of years in the top ranks) = 3.

The dataset each year is further adjusted by:

- Deleting records from operations south of 50^0S;
- Combining operations of Area 5 into Area 4 and that of Area 6 into Area 7; and
- Deleting operations with extremely high CPUE values (>120).

The shot-by-shot data are then aggregated into 5x5 degree cells by month before standardization. Aggregated data cells with little effort (<10,000 hooks) are deleted.

CPUE standardization

Unweighted CPUE

The aggregated CPUE dataset is standardized using the following Generalised Linear Model (GLM)[1]:

$$log(CPUE+const) = Intercept + Year + Month + Area + Lat5 + BET\_CPUE + YFT\_CPUE + (Month*Area) + (Year*Lat5) + (Year*Area) + Error \quad (1)$$

where

Area	is the CCSBT statistical area
Lat5	is the latitude in 5 degree
BET_CPUE	is the bigeye tuna CPUE
YFT_CPUE	is the yellowfin tuna CPUE
const	is the constant as 0.2 derived as 10% of the mean nominal CPUE in Nishida and Tsuji (1998)

Area weights

To obtain the area weighted CPUE indices described below, the area of SBT distribution was calculated based on a 1x1 degree square resolution. The area was calculated in the form of an area index such that an area size of 1x1 degree square along the equator was defined as 1, and the area size for other 1x1 degree squares of different latitudes was determined as the proportion of the square area along the equator. The area index for the Constant Square (CS)[2] was simply a union of fished 1x1 degree squares through all years (1969-present) and was calculated for each quarter, month, statistical area, and latitude (5 degree) combination. The

[1] Currently, there is no specification of the procedure to be followed for the GLMs here and below that have fixed interaction effects if in a future year one of the associated cells is empty of data.

[2] For explanation of Constant Square and Variable Square CPUE interpretations, see Anonymous (2001b).

area index for the Variable Square (VS) was the sum of fished 1x1 degree square areas and was calculated for each year, quarter, month, statistical area, and latitude combination. For VS, a square counts as fished only for the month in which fishing occurred. More details of the area index calculation are described in Nishida (1996).

Area weighted CPUE

With the estimated parameters obtained from the CPUE standardization above (1), the Constant Square (CS) and Variable Square (VS) CPUE abundance indices are computed by the following equations:

$$CS_{4+,y} = \sum_m \sum_a \sum_l (AI_{CS})_{(yy\text{-}present)}[\exp(Intercept + Year + Month + Area + Lat5 + BET\_CPUE + YFT\_CPUE + (Month*Area) + (Year*Lat5) + (Year*Area) + \sigma^2/2) - 0.2] \quad (2)$$

$$VS_{4+,y} = \sum_m \sum_a \sum_l (AI_{VS})_{ymal}[\exp(Intercept + Year + Month + Area + Lat5 + BET\_CPUE + YFT\_CPUE + (Month*Area) + (Year*Lat5) + (Year*Area) + \sigma^2/2) - 0.2] \quad (3)$$

where

$CS_{4+,y}$	is the CS abundance index for age 4+ and *y*-th year,
$VS_{4+,y}$	is the VS abundance index for age 4+ and *y*-th year,
$(AI_{CS})_{(yy\text{-}present)}$	is the area index of the CS model for the period *yy*-present (*yy*=1969 or 1986 depending on the period of standardization,
$(AI_{VS})_{ymal}$	is the area index of the VS model for *y*-th year, *m*-th month, *a*-th SBT statistical area, and *l*-th latitude,
σ	is the mean square error in the GLM analyses.

The w0.5 and w0.8 (B-ratio and geostat proxies) CPUE abundance indices are then calculated using the following equation (Anonymous 2001a):

$$I_{y,a} = wCS_{y,a} + (1-w)VS_{y,a} \quad \text{where } w = 0.5 \text{ or } 0.8 \quad (4)$$

The final CPUE input series is the arithmetic average of the w0.5 and w0.8 series.

Data calibration

The estimated CPUE value in the most recent year, which is mainly derived from RTMP data, is corrected using the average of the “Logbook based CPUE / RTMP based CPUE” ratio for the most recent three years of logbook data.

The area weighted CPUE series between 1986 and the most recent year are then calibrated to the historical CPUE series between 1969 and 2008 using the following GLM (equation 5), described in Nishida and Tsuji (1998) for 5x5 degree cells by month data for all vessels (i.e. both core and other vessels) in Areas 4-9 and Months 4-9:

$$\log(CPUE+const) = Intercept + Year + Quarter + Month + Area + Lat5 + (Quarter*Area) + (Year*Quarter) + (Year*Area) + Error$$

(5)

where

const is 10% of the mean nominal CPUE.

CPUE series for monitoring

Two additional CPUE series will be used for monitoring purposes of the status of the stock and MP implementation. These include:

(1) Same procedure as specified above, but at the shot-by-shot level rather than the aggregated 5x5 level.
(2) Same procedure as specified above, but using the simpler GLM given by:

*log(CPUE+0.2) = Intercept + Year + Month + Area + Lat5 + (Month*Area) + Error*

(6)

Historical CPUE Series used as input to the Management Procedure

The CPUE series used in the MP is the average of the base CPUE series (w0.5 and w0.8) and is adjusted in the years 1989 -2005 for the case 1 LL over-catch. The overcatch correction is based on the same assumptions used in the base-case operating model used for MP testing, namely: (i) that 25% of the unreported catch was attributed to the LL1 reported effort and (ii) that the LL overcatch was distributed amongst LL1 subfleets, areas and months in proportion to the nominal catch, except for the Australian joint venture and New Zealand charter fleets (called Option A in Attachment 4 of OMMP 2009 meeting report). In 2009, the extent of LL1 overcatch corresponding to the Case 1 market estimates provided by Lou and Hidaka for 1985-2005 (with unreported catch in 2005 set equal to unreported catch in 2004) were re-estimated using a new equation for the lag from catch to market (documented in Attachment 4 of the OMMP2009 meeting report).

The resulting catch and CPUE multipliers are provided in Table 2. The CPUE multipliers are not exactly 0.25 because a small proportion of the CPUE catch (from the Australian joint venture and New Zealand charter fleets) is not affected by the overcatch. The historical CPUE series to be used as input of the MP is calculated using the following equation:

CPUE = (w0.5 + w0.8)/2 * (1+(Catch_multiplier-1)*CPUE_multiplier)

Table 2. Year, CPUE multipliers and Catch multipliers for the Case 1 LL CPUE adjustment.

	CPUE multiplier	Catch multiplier
Year	S=0.25-A	Case 1
1983	0.25	1
1984	0.25	1
1985	0.25	1
1986	0.25	1
1987	0.25	1
1988	0.25	1

1989	0.244	1.28
1990	0.249	1.8
1991	0.25	1.53
1992	0.275	1.24
1993	0.273	1.62
1994	0.266	2.66
1995	0.247	2.14
1996	0.25	2.2
1997	0.246	2.6
1998	0.247	1.82
1999	0.248	1.77
2000	0.247	2.13
2001	0.248	2.16
2002	0.249	2.13
2003	0.249	1.92
2004	0.248	1.75
2005	0.249	1.69
2006	0	1

Reference

Anonymous. 2001a. Report of the Fifth Meeting of the Commission for the Conservation of Southern Bluefin Tuna, Scientific Committee. 19-14 March 2001, Tokyo, Japan.

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