Update of the ADAPT VPA and projection in 2004

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ADAPT VPA   2004

Abstract

Stock assessment with the ADAPT VPA and future projection of southern bluefin tuna were conducted with the updated information.　The purpose of this paper is to compare the updated assessment with the previous assessment conducted in 2001.　The results show that the stock status and projection largely depend on the plus group options and abundance indices.　Under the same assumptions, however, the 2004 results are similar to the results obtained in 2001.　It suggests that there has been no large change in stock status since the 2001 assessment.

ADAPT VPA

2001

2004   2001   2001

1. Introduction

In 2001 the SC recommended that it was not necessary to conduct a full assessment every year, and noted that current trends in the status of the SBT stock were not expected to change suddenly (Anonymous 2001, 2002).　Since then, only the review of fisheries indicators has been conducted to determine the need for a full stock assessment.

This paper presents the results of stock assessment and projection based on the ADAPT VPA with the most updated information, and compares the updated results with the 2001 assessment.

2. Materials and Methods

2.1 Data and input parameters for the VPA

The data used in this analysis are basically based on the exchanged data sets (data from 2001 to 2003) or the same data used in the 2001 assessment (data from 1969 to 2000). The input parameters are the same as those in the 2001 assessment.   The basic data is as follows;

    Catch at age: 1969-2003, all fisheries combine, yearly base (Table 1)
    Abundance indices: 1969-2003, based on the Japanese longline CPUE (Table 2)
    Tag recovery: 1991-1997 release

Some of the data sets were not exchanged or not appropriate for the ADAPA VPA this year and several data sets used in the 2001 assessment were modified after 2001 (Anonymous 2004a).   Catch at age data for Japanese longline was provided by Takahashi, and Indonesian catch at age data and tag recovery data were provided by Australia.   Two abundance indices (W05: proxy of B-ratio CPUE and W08: proxy of geostatistical CPUE) were presented in Tsuji et al. 2004a and 2004b.   Catch at age data for Korea, Taiwan, and others was calculated from the length frequency data preparing for the Operating Model.   The data sources used in the analysis are summarized in the Appendix.

2.2 Assessment Methods

2.2.1 Basic structure of the VPA

The VPA model structure is the same as the VPA used in the 2001 assessments.   The detail of the model structure is documented in Tsuji and Takeuchi (1998), Polacheck et al. (1997), and Polacheck et al. (2001).   The key parameters estimated are Fs in year 2003 and Fs for age 11.

2.2.2 Specification of VPA runs

All VPA runs were conducted from 1969 using V6 M-vector.   For the plus group options, C1 to C6 options in priority set in 1997 SC (Anonymous 1997) were used (Table 3).   We use two interim abundance indices (W05 and W08).   We also conducted the VPA with data until 2000 for the comparative purpose (results are not presented here).   In total,

we examined 24 VPA runs.

2.3 Projection

2.3 Projection

The procedures used in the projection are the same as those used in 2001 as described Hiramatsu and Tsuji (2001).   The projections are conducted under the following three constant catch scenarios (a unit of weight is MT, scenario 1) is a reference case);

	Surface	Longline	Indonesia	Total
1) Present TAC	5265	8865	800	14930
2) TAC in OM	5147	8310	1473	14930
3) 2001 projection	5759	8283	2241	16283

2.4 Statistics

For the comparison outputs (reference points), we present following references;

Assessment

$N_{0,1980}$, $N_{0,1999}$, $B_{5-7,1980}$, $B_{5-7,1990}$, $B_{5-7,2004}$, $B_{8-11,1980}$, $B_{8-11,1990}$, $B_{8-11,2004}$, $B_{12+,1980}$, $B_{12+,1990}$, $B_{12+,2004,}$ SSB_{2004}/SSB_{1980}, SSB_{2004}/SSB_{1988}, SSB_{2004}/SSB_{1990}, SSB_{2004}/SSB_{2002},

Slope of five most recent N_0

Projection

Probability of SSB2020>SSB1980, $N_{0,2005}$, $N_{0,2010}$, $N_{0,2020}$, $B_{5-7,2005}$, $B_{5-7,2010}$, $B_{5-7,2020}$

$B_{8-11,2005}$, $B_{8-11,2010}$, $B_{8-11,2020}$, $B_{12+,2005}$, $B_{12+,2010}$, $B_{12+,2020}$

where B_{5-7} is biomass of ages 5 to 7.   We assume that age at maturity is 8 and hence SSB is biomass at ages 8 and above.

3. Results and Discussion

The runs for C3 and C6 plus group options are not converged and hence we exclude them and present only the results of C1, C2, C4, and C5 options.   The trajectory of SSB and recruitment for C1, C2, C4, C5 options are shown in Figures 1 and 2.   For the comparative purpose, the 2001 results are also shown in Figures 3 and 4.   The probability of recovery (SSB2020>SSB1980) are presented in Table 4.   Summary of VPA and projection results are shown in Table 5.

3.1 Results of the 2004 assessment and projection

Figure 1 indicates that after decline in the 1980s, SSB has been stable since early 1990s. The absolute values and degree of decline depend on the plus group options and abundance indices.   The results of projection and the probability of recovery also depend on the plus group options and abundance indices.

The estimates of the recruitment are robust to the different assumptions as shown in Figure 2.   All results show decreasing trend until early 1990s, and increase late 1990s. However, the 1999 recruitment estimates are historically low level.   It should be noted that the 1999 estimates largely depend on the abundance index at age 4 in year 2003.

3.2 Comparison of 2004 results with 2001 results

Overall, the 2004 assessment results (Figures 1 and 2) are similar to the 2001 results (Figures 3 and 4).   The major differences are trends in SSB in the 1970s and the result of C5W05 option.   The 2004 assessment indicates stable SSB trend in the 1970s.   The difference in trend in the 1970s seems to be caused by the difference in catch at age data. The difference between CAA used in the 2004 assessments and CAA in 2001 is shown in Table 6.   The Table indicates several thousand fish decrease over age 8 and several or tens of thousand fish increase ages 5 to 7 from 1976 to 1985.   The other difference is SSB of C5 options.   The 2004 assessment shows considerable lower estimates than the 2001 estimates.   This instability of C5 option is also seen in the 2001 assessment (Hiramatsu and Tsuji 2001).

The 2004 projections (Figure 1) are also similar to the 2001 projections (Figure 3).   It should be noted that the assumed future catches in Fig.1 and Fig 3 are 14930mt and 16283mt, respectively.   The probability of recovery using the same TAC is shown in Table 4.

3.3 Comparison of the ADAPT VPA with OM

The model structure and input data of the ADAPT VPA differ from those of OM in several respects.   The major differences are as follows:

    the basic data is catch at age data
    tuned by age separate abundance indices
    No assumption for stock recruitment relationship
    Calculation is conducted from 1969
    No assumption for separability
    age at maturity is assumed to be 8

In spite of these differences, there are some similarities in trend and/or absolute values of SSB and recruitment estimates.   In particular, SSB for C4 options is similar to those for PANEL_tag.mcmc results (Anonymous 2004b) in both trend and absolute values.

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In conclusion, the results of the ADAVP VPA suggest that there has been no large change in stock status since the 2001 assessment. The potential concern is the low recruitment in 1999.

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References

Anonymous. 1997. Report of the third CCSBT scientific committee meeting.

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

Anonymous. 2002. Report of the Third Stock Assessment Group Meeting. 3-7 September 2002, Canberra, Australia.

Anonymous 2004a. Record of discussion leading to a change in decision on data to be used in the 2004 assessment. CCSBT-ESC/0409/41.

Anonymous. 2004b. Report from panel meeting held at NOAA Alaska Fisheries Laboratory, Seattle, 20-23 July 2004. CCSBT-ESC/0409/42.

Hiramatsu, K. and S.Tsuji. 2001. Stock assessment and future projection of southern bluefin tuna based on the ADAPT VPA. CCSBT-SC/0108/31.

Polacheck,T., A.Betlehem and A.Preece. 1997. Documentation of the virtual population analysis methods and model inputs used for estimating of current and historical stock sizes of southern bluefin tuna population for the third CCSBT scientific committee meeting. 1997. CCSBT-SC/97/24.

Polacheck,T., A.Preece and D.Ricard. 2001. Assessment of the status of the Southern Bluefin Tuna stock using virtual population analyses-2001. 2001. CCSBT-SC/0108/20.

Tsuji, S. and Y.Takeuchi. 1998. Stock assessment and future projection of southern bluefin tuna – 1998 (revised). CCSBT-SC/9807/27.

Tsuji, S., N.Takahashi, M.Nagasaka, and T.Itoh. 2004a. Preparation of Japanese catch/effort and size data and CPUE series for 2004 stock assessment and mechanical updata of Operating Model. CCSBT-ESC/0409/31.

Tsuji, S., T.Itoh and N.Takahashi. 2004b. Summary of fisheries indicators in 2004. CCSBT-ESC/0409/34.

Table 1 Catch at age data used in the ADAPT VPA

Year	0	1	2	3	4	5	6	7	8	9	10
1969	16332.8	811286.9	265341.2	116422.9	60870.9	73778.0	78636.1	81036.8	102030.3	115520.3	92315.4
1970	18202.3	742527.3	151997.5	77007.9	91488.8	67286.4	56622.4	62114.6	73588.0	83697.1	74417.5
1971	664.6	495445.4	301954.6	110074.8	81517.7	71996.9	65199.2	65590.4	83683.7	82753.7	63208.9
1972	11430.0	288195.6	451066.0	315867.9	147122.3	122540.7	96974.7	80767.8	85084.6	80220.7	55753.5
1973	3455.4	116116.6	136213.4	431652.1	144225.9	100407.9	74291.7	66161.4	60982.6	54041.9	43485.3
1974	89557.8	495653.7	339471.0	204955.3	196943.1	124724.5	77682.5	68004.2	69670.5	66857.6	49191.5
1975	158677.0	572728.5	321732.4	96368.9	47647.6	48156.3	46091.3	52820.3	60438.1	58832.0	43386.9
1976	142469.5	398894.9	334601.4	165230.6	45394.5	43103.5	64262.3	95725.7	92948.9	83596.3	65811.4
1977	88081.4	566084.7	466273.0	263185.9	73979.6	34501.2	42437.1	85266.8	101287.9	71597.2	40311.2
1978	74571.7	662861.4	310554.7	211960.7	133981.3	72109.5	49360.9	62736.5	62857.3	44504.3	26442.8
1979	253919.0	693250.2	294560.3	136115.3	81572.6	106458.6	59339.3	48477.8	50761.3	52047.0	33482.3
1980	110938.9	906490.6	507473.8	115620.7	85467.7	54774.8	65286.1	65479.1	74532.8	76776.1	57009.7
1981	143760.3	627705.3	385092.0	275768.4	113336.4	96165.6	46591.4	54192.0	53127.9	49333.1	38685.7
1982	196769.8	1097890.8	880948.0	136563.7	89852.4	55017.5	37269.2	38355.7	42198.2	35648.5	27122.1
1983	83568.3	1255234.8	520354.6	148151.9	80211.2	84172.7	70284.6	76017.5	51929.9	35440.4	25534.4
1984	26291.2	791755.6	492477.6	101566.8	83652.5	56098.0	39960.7	42283.4	43690.0	38680.0	29144.9
1985	13087.9	406737.3	312884.4	156893.5	85395.9	60119.0	39707.4	46195.0	42598.8	34640.2	25593.9
1986	1691.5	239213.7	495078.1	221903.8	63574.3	29555.8	17503.4	19474.4	23685.6	25531.9	21395.6
1987	4149.9	222722.8	234848.1	323838.7	67117.1	22424.6	17144.4	18266.4	20128.6	20986.5	17883.0
1988	35835.8	329011.6	568686.7	146207.8	54418.7	16090.1	10185.0	12785.1	15782.2	16658.2	15317.1
1989	917.8	62131.6	334081.7	149734.7	42138.9	26957.9	18195.4	12451.3	11859.5	11010.5	12157.3
1990	369.7	36186.6	153572.2	193806.9	38128.8	16452.8	14792.2	10656.4	7415.6	8074.9	8350.0
1991	998.2	49685.2	85392.2	167568.0	53236.8	23079.4	12903.1	9667.7	7644.7	5263.2	5938.6
1992	23.7	7754.4	43697.7	134079.2	78151.8	34080.1	17095.6	8761.9	6259.8	4655.0	4310.9
1993	2.4	688.6	47906.9	119253.4	64391.7	48354.1	30892.6	16867.8	10180.6	5153.4	4583.9
1994	0.0	3455.7	25575.9	117920.7	71318.2	31433.1	24742.9	15984.3	9767.3	5957.6	4302.7
1995	2.5	1646.0	49964.0	120290.1	57802.5	38583.8	27370.8	20880.7	14714.6	7881.1	5166.0
1996	50.2	11148.5	63435.7	152143.6	73785.2	39880.4	26347.0	20631.0	16508.7	10618.7	7096.3
1997	0.0	3430.9	46419.2	165902.9	69464.5	42831.4	26916.2	21217.9	16719.4	10604.3	7275.0
1998	12.0	784.1	75299.2	196353.7	80288.3	28780.5	29790.2	31503.3	24610.5	15712.6	10638.2
1999	1.0	521.8	68553.8	312708.9	59658.6	33860.4	18592.4	21158.5	21097.5	15665.9	11618.6
2000	2.0	4982.9	63478.0	189801.9	80539.8	24270.1	21381.8	15808.7	17407.0	14595.5	10104.5
2001	48.0	13031.1	80521.0	226582.5	52603.4	33119.7	19204.6	14311.9	14240.8	14631.7	12270.2
2002	5.0	4164.4	20912.0	221298.7	52160.8	28812.8	24205.9	19774.9	14218.7	12404.4	10659.5
2003	0.0	17533.2	65430.9	176244.8	67149.9	32707.1	22378.1	18383.1	13583.6	9605.4	7446.7

Year	11	12	13	14	15	16	17	18	19	20	Total
1969	66753.6	43288.8	27783.8	17906.3	10631.0	6355.1	3704.1	2652.8	1654.8	4866.4	1999168.3
1970	51825.3	36509.6	25820.0	17758.5	11062.8	7741.4	4463.5	3188.0	2090.2	5844.0	1665253.2
1971	42464.2	28296.8	18157.4	11767.5	6565.2	4787.1	3044.7	2099.9	1499.6	4051.6	1544823.9
1972	32363.2	19046.3	11459.8	6829.8	4224.1	2176.4	1763.6	863.5	465.3	1626.9	1815842.9
1973	28400.7	18843.3	12270.1	7404.3	4057.2	2897.5	2327.9	1111.9	864.2	2211.3	1311422.6
1974	34073.8	18256.1	12560.7	8022.2	4511.5	3325.7	2135.2	1217.9	884.1	1825.6	1869524.5
1975	26709.6	14499.8	10720.4	6395.2	2908.2	1953.6	1206.9	478.8	338.6	1350.3	1573440.7
1976	41026.5	23009.3	13541.7	9267.0	5569.7	2797.7	1561.9	774.3	416.9	1021.4	1631025.4
1977	23783.9	10621.4	8459.2	5421.6	2417.0	1582.2	1558.7	676.8	314.1	718.2	1888559.1
1978	13671.1	8007.3	5341.6	3007.1	1692.7	821.8	936.1	551.6	320.9	711.1	1747002.1
1979	34495.3	15854.9	11831.3	12062.2	5249.0	3434.4	4252.4	1121.0	1763.5	5646.6	1905694.4
1980	36709.8	19718.4	10865.2	7118.3	4345.0	3249.4	1945.9	1156.6	764.2	2833.3	2208556.4
1981	27780.2	18671.9	13919.7	7299.4	4516.0	2925.4	1771.1	1123.9	677.4	2027.6	1964470.7
1982	21408.5	16394.7	11285.0	7061.7	4458.7	3285.8	2151.1	1155.7	837.9	2481.4	2708156.4
1983	19468.6	14502.4	10744.0	6138.0	3980.8	3240.9	2499.9	1572.9	1042.9	3705.4	2496620.6
1984	21202.8	15193.3	10744.0	7701.5	5448.9	4145.7	3124.5	1845.3	1320.7	4638.2	1820965.5
1985	19023.7	13536.9	9377.9	6656.9	4590.1	3795.5	2969.9	1855.3	1387.0	4383.0	1291429.7
1986	18095.1	13357.4	10011.1	6640.3	5186.9	4163.4	3077.5	2258.2	1699.3	6782.5	1229879.5
1987	14859.3	11256.7	9147.3	6430.9	4867.5	3817.0	2818.0	2015.5	1757.6	8264.8	1034744.6
1988	10984.6	8879.4	6945.6	4836.8	2946.5	3037.1	2758.6	1465.3	1756.4	8324.4	1272913.6
1989	10939.1	9179.3	7678.2	6209.6	3991.9	3281.7	3179.7	1810.1	1640.5	11926.0	741472.5
1990	7465.3	6049.6	4942.7	3771.4	2800.9	2260.5	2018.7	1363.4	1184.3	8028.1	527690.9
1991	4786.3	5421.8	5351.9	4694.5	3245.1	3027.2	2931.4	2121.4	1854.5	13525.7	468337.0
1992	3760.9	4116.5	4243.9	3808.1	3279.5	3060.1	2882.4	2292.4	1898.2	19443.2	387655.3
1993	3531.9	3380.5	3555.8	3505.0	3000.0	2521.0	2276.1	1936.9	1618.9	17256.4	390858.1
1994	2767.8	3044.1	3257.3	2623.5	2475.3	2323.7	2062.8	1494.1	1231.6	13176.3	344914.9
1995	3684.4	2890.9	3011.1	2870.0	2282.3	1970.9	1524.4	1502.2	1036.7	10054.2	375129.4
1996	5242.9	4038.6	4116.9	3736.5	2968.9	2507.3	1833.7	1910.3	1325.2	15462.8	464788.6
1997	4736.3	3646.5	3418.7	2749.4	2405.6	1976.4	1548.4	1674.5	1258.3	15792.3	449988.0
1998	6567.9	4527.0	3619.4	2683.2	1984.1	1815.6	1352.1	1293.4	1097.3	12518.5	531231.1
1999	7295.2	5215.8	4263.6	3314.1	3005.1	2335.9	1939.3	1800.6	1366.6	17731.6	611707.7
2000	6743.8	4599.7	3538.3	2397.0	1790.3	1398.2	1083.0	1213.5	737.1	8055.7	473928.8
2001	8709.1	5758.5	4709.2	3224.3	2122.5	1611.3	1317.2	1309.9	1016.8	9149.5	519493.3
2002	7842.4	6070.5	4708.3	2978.3	2058.1	1773.5	1265.8	1038.2	720.3	5493.8	442966.3
2003	5874.9	4409.0	3177.4	2277.3	1497.2	1099.2	852.9	664.3	531.9	3503.5	454350.3

Table 2 Abundance indices used in the ADAPT VPA (upper W05, lower W08)

	age 4	age 5	ages 6-7	ages 8-11	ages 12+	ages 8+
1969	1.10288	1.60038	2.00404	3.01582	2.68030	2.89950
1970	2.07613	1.87983	1.71976	2.63303	2.98466	2.69561
1971	2.05772	2.07742	1.92154	2.13809	2.10236	2.13573
1972	2.30953	2.39551	2.14118	1.95857	1.62926	1.85266
1973	2.07094	1.97206	1.85369	1.60811	1.37863	1.54214
1974	2.54142	2.08691	1.79778	1.75082	1.05405	1.56459
1975	1.02310	1.46484	1.42503	1.63181	1.00630	1.45266
1976	1.26632	1.39174	2.43227	2.00915	1.11505	1.75608
1977	1.22877	0.94390	1.61125	1.96174	0.79731	1.64645
1978	1.46763	1.14159	1.48650	1.14846	0.51002	0.98008
1979	1.18387	1.46167	0.88554	1.12169	1.13755	1.10862
1980	1.10848	1.06371	1.31160	1.24631	0.80872	1.13047
1981	0.88034	1.19565	1.13058	1.24642	1.17131	1.22916
1982	0.69952	0.85383	0.98713	0.99510	0.91521	0.96519
1983	1.01636	1.24606	1.15987	0.71794	0.87240	0.75883
1984	0.74051	0.81807	1.00267	1.04564	0.96408	1.03181
1985	0.63142	0.72470	0.86187	0.86349	0.86946	0.86450
1986	0.33723	0.35467	0.43990	0.61838	0.87122	0.68901
1987	0.40219	0.39420	0.42880	0.62923	0.98968	0.72382
1988	0.44731	0.29515	0.33166	0.51903	0.84701	0.60566
1989	0.48440	0.45116	0.34358	0.40533	0.86111	0.52648
1990	0.56342	0.43921	0.37333	0.39021	0.77945	0.49802
1991	0.72335	0.49847	0.32906	0.30770	1.08628	0.52340
1992	1.11553	0.69729	0.35269	0.24035	0.87916	0.42400
1993	1.01113	0.94265	0.61864	0.31610	0.78323	0.44883
1994	0.94055	0.69561	0.59538	0.34496	0.75155	0.46187
1995		0.87309	0.74343	0.39229	0.54314	0.44784
1996		0.63039	0.48656	0.34471	0.52228	0.40062
1997	0.43401	0.63320	0.54681	0.35303	0.50755	0.40148
1998	0.51255	0.47708	0.63107	0.45821	0.54149	0.49622
1999	0.49728	0.49796	0.46238	0.45761	0.55198	0.49846
2000	0.52908	0.47859	0.41588	0.49291	0.52686	0.50655
2001	0.61417	0.75690	0.52597	0.52313	0.63768	0.56100
2002	0.68602	0.91319	0.91520	0.64233	0.73853	0.66365
2003	0.29685	0.65331	0.72738	0.47229	0.58509	0.50904

	age 4	age 5	ages 6-7	ages 8-11	ages 12+	ages 8+
1969	1.03417	1.49433	1.86624	2.81851	2.47577	2.70118
1970	1.91588	1.73340	1.58722	2.46857	2.78088	2.52289
1971	1.96536	1.98517	1.82807	2.00443	1.96000	1.99861
1972	2.23870	2.32555	2.08618	1.94545	1.62157	1.83965
1973	1.94372	1.87553	1.77308	1.56025	1.31495	1.48779
1974	2.38457	1.97554	1.72756	1.73831	1.05200	1.55354
1975	0.97362	1.41615	1.41525	1.61770	0.98548	1.43497
1976	1.23704	1.35848	2.37586	1.97813	1.08283	1.72179
1977	1.23437	0.95753	1.62151	1.94543	0.77813	1.62729
1978	1.60215	1.24033	1.51894	1.18019	0.52633	1.00360
1979	1.08075	1.34548	0.82812	1.03774	1.03131	1.01878
1980	1.20109	1.05442	1.25433	1.19558	0.78061	1.08419
1981	0.93007	1.21547	1.12850	1.26948	1.16883	1.24538
1982	0.65245	0.84381	1.00236	1.04654	0.92088	0.99999
1983	0.99683	1.18856	1.15141	0.72284	0.85753	0.75905
1984	0.71819	0.78270	0.96981	1.02734	0.93059	1.00903
1985	0.59439	0.68703	0.84149	0.86130	0.82139	0.84998
1986	0.30857	0.33125	0.42335	0.60455	0.81567	0.66463
1987	0.38427	0.37876	0.41569	0.62181	0.95276	0.71008
1988	0.44626	0.29083	0.32688	0.52058	0.83869	0.60710
1989	0.46370	0.42839	0.32259	0.39214	0.83621	0.51098
1990	0.58799	0.45646	0.37976	0.39771	0.80791	0.51084
1991	0.73391	0.50446	0.33600	0.31661	1.13598	0.54359
1992	1.15810	0.72268	0.37261	0.25674	0.93813	0.45342
1993	1.11496	1.01144	0.65941	0.35007	0.85360	0.49394
1994	1.15101	0.84493	0.71242	0.41422	0.90253	0.55374
1995		1.00440	0.84482	0.44818	0.60784	0.50856
1996		0.66877	0.52458	0.38408	0.55749	0.43918
1997	0.47871	0.70335	0.60794	0.40588	0.58164	0.46159
1998	0.55725	0.50709	0.67840	0.49746	0.59638	0.54178
1999	0.53044	0.52634	0.48926	0.50057	0.60059	0.54422
2000	0.58575	0.53802	0.47304	0.57850	0.62909	0.59725
2001	0.65869	0.81626	0.57776	0.58402	0.71069	0.62576
2002	0.79150	1.03317	1.03587	0.74626	0.85551	0.77027
2003	0.34553	0.75392	0.84371	0.56285	0.69023	0.60536

Table 3 Specification of the plus group options

	C1	C2	C3	C4	C5	C6
Plus group age	12+	8+	12+	12+	12+	12+
Plus group CPUE	On	On	On	Off	On	Off
Fcont or	On	Off		Off	Off	
	Est	Est	Est	1	1	1

Table 4 Probability of SSB2020>SSB1980 with different TAC scenarios

	C1W05	C1W08	C2W05	C2W08	C4W05	C4W08	C5W05	C5W08
1) 2004-TAC	0.81	1.00	0.00	0.00	0.00	0.04	0.99	1.00
2) OM-TAC	0.79	1.00	0.00	0.00	0.00	0.04	0.99	1.00
3) 2001 proj.	0.31	1.00	0.00	0.00	0.00	0.01	0.77	1.00
2001 results*	0.64	1.00	0.00	0.00	0.00	0.29	0.00	1.00

*based on Hiramatsu and Tsuji (2001)

Table 5 Summary of VPA and projection results

	C1	C1	C2	C2	C4	C4	C5	C5
	W05	W08	W05	W08	W05	W08	W05	W08
$N_{0,1980}$	5659819	5669540	6087718	5841304	5621174	5594636	5641303	5652417
$N_{0,1999}$	1836609	1989331	2091698	2141471	1844400	1985331	1814119	1961557
$B_{5-7,1980}$	65400	65768	74166	64468	61178	60627	60833	61244
$B_{5-7,1990}$	18465	19015	24783	21534	18913	19279	18659	19022
$B_{5-7,2004}$	27025	32132	36527	37054	27406	32043	26104	31013
$B_{8-11,1980}$	59701	59538	114570	90650	60862	58839	54163	54236
$B_{8-11,1990}$	18570	18832	32052	25242	17678	16999	18188	18454
$B_{8-11,2004}$	25701	29996	44200	42436	26839	30326	24294	28442
$B_{12+,1980}$	27636	26307	430665	235747	105049	86283	17924	17803
$B_{12+,1990}$	28534	28601	227219	129443	49412	40480	16363	17153
$B_{12+,2004}$	21085	26295	131855	94748	28331	30848	16094	20732
SSB_{2004}/SSB_{1980}	0.536	0.656	0.323	0.420	0.333	0.422	0.560	0.683
SSB_{2004}/SSB_{1988}	0.752	0.903	0.525	0.684	0.603	0.774	0.877	1.042
SSB_{2004}/SSB_{1990}	0.914	1.093	0.607	0.797	0.745	0.967	1.088	1.285
SSB_{2004}/SSB_{2002}	1.105	1.133	0.976	1.019	1.072	1.109	1.124	1.155
Slope of $N_{0,1995-1999}$	-176638	-166808	-286304	-254515	-185518	-169282	-169480	-160767
$Pr(SSB_{2020}>SSB_{1980})$	0.81	1.00	0.00	0.00	0.00	0.04	0.99	1.00
$N_{0,2005}$	3138769	3914582	2344073	2868371	2431797	3079739	3278606	4066059
$N_{0,2010}$	3438471	4931898	2113157	2736222	2214752	3215006	3814635	5413529
$N_{0,2020}$	6671144	9201371	1051970	2514568	1621689	4465924	8411702	8967857
$B_{5-7,2005}$	28349	34797	33598	36203	25215	31145	28241	34361
$B_{5-7,2010}$	38678	53089	27986	36924	26579	38826	41106	55584
$B_{5-7,2020}$	71553	128429	12541	33599	19554	55372	90863	149702
$B_{8-11,2005}$	28798	34124	48617	46842	29564	34111	27463	32577
$B_{8-11,2010}$	28498	39353	30706	36689	20473	29997	29516	39994
$B_{8-11,2020}$	21032	102053	15001	36294	16877	48819	69521	118371
$B_{12+,2005}$	21073	26872	126806	92575	28176	31273	15876	21126
$B_{12+,2010}$	26392	37853	117178	95651	30294	39244	21065	31769
$B_{12+,2020}$	49521	93496	55035	81228	19920	55416	52433	96871

Table 6 Difference between 2004 CAA and 2001 CAA (2004 minus 2001)

Year	0	1	2	3	4	5	6	7	8	9	10
1969	1	219	-1441	-715	4834	3332	14192	4852	12856	1067	-7105
1970	-8	-62	-1974	-6810	-1617	10947	13225	8212	12614	305	69
1971	-8	-545	-2650	3001	-3548	4845	23697	13459	27805	10778	-7837
1972	0	-140	-3228	-17536	-5643	4884	36687	6605	26749	17771	-6094
1973	0	-103	-13773	-5063	-15180	-8427	-1976	-975	7959	7956	9352
1974	0	-105	-544	213	-2930	4735	-1391	-2663	-5694	-1102	2149
1975	23	-836	-7471	-8877	-2819	528	2809	2457	2477	4466	2424
1976	1	-605	-7766	-4696	-2937	10434	6529	4683	-1149	-1999	-1242
1977	45	403	-1085	1163	22	5471	12323	5964	-13031	-7453	-1763
1978	-0	0	2955	4956	-3809	7032	7951	15159	-105	-9569	-6790
1979	4	1766	-7239	-9499	-4163	14388	3545	5069	-2934	-468	-3661
1980	-126	836	896	-6481	-5230	17326	10436	12343	21090	10633	-10001
1981	-33	318	4604	1125	-1421	22427	1173	3447	2722	-1330	-8613
1982	0	13	442	1677	2044	20406	1975	7814	4077	-3528	-3825
1983	0	-63	706	-4453	-10590	24019	727	18577	3840	-2236	-2886
1984	0	-57	169	2436	7145	21083	4815	11078	-747	-4309	-8539
1985	1	91	-305	-1450	1952	13080	4133	18578	6763	-3197	-9105
1986	0	18	-643	-480	541	6614	1351	3587	5219	2966	-2148
1987	0	-22	-440	-2418	-110	6334	1976	6444	5768	4188	-2037
1988	1	-13	-309	-848	-544	4109	161	4228	4463	3829	182
1989	-8	-195	-167	-92	863	5369	-2943	-149	2710	2731	1661
1990	0	-384	-1502	-2587	1193	4641	331	-1260	308	2133	2136
1991	-11	-33	-983	-604	819	896	-165	-481	8	413	713
1992	-0	-71	-1555	-1434	-463	855	-1440	-310	-11	26	99
1993	0	7	7	-492	551	449	-235	97	554	-166	277
1994	0	20	191	93	921	1385	1345	866	770	161	-17
1995	-1	-1	815	2046	1688	908	1069	543	791	494	133
1996	-24	29	43	458	-92	648	116	-451	-221	-139	-129
1997	0	12	-40	-176	-698	146	416	593	-333	380	-201
1998	12	83	-342	-695	620	-127	19	372	-150	472	-175
1999	1	138	-920	-613	-540	338	336	137	-220	352	-201
2000	2	17	318	-799	284	767	512	1035	190	326	-336

| Year	11	12	13	14	15	16	17	18	19	20	Total
1969	-5564	-9155	-6830	-3777	-2183	-796	-913	-627	-363	-1883	1
1970	-8060	-9157	-7403	-4493	-2524	-696	-881	-1029	-426	-232	0
1971	-15334	-13017	-10037	-8157	-7141	-3915	-3028	-2592	-1036	-4739	0
1972	-15768	-10354	-5004	-5511	-6442	-3359	-2704	-1617	-692	-8607	0
1973	6256	4769	3606	1573	1793	602	887	417	261	64	0
1974	2767	-144	1523	1394	73	387	456	363	365	148	0
1975	2434	-83	1096	527	29	265	265	43	45	200	0
1976	-1939	1016	-24	1546	-536	-271	-224	10	-2	-828	-1
1977	-1071	-1470	322	-231	-65	298	439	65	-119	-226	-0
1978	-7026	-4603	-2093	-1313	-1060	-373	-383	26	-33	-923	-0
1979	2142	-1774	1956	1614	-1242	-1602	1605	-296	1035	-243	0
1980	-16621	-12308	-8116	-5719	-3148	-1722	-1526	-798	-443	-1320	0
1981	-7793	-8043	-1475	-2037	57	-989	-711	-964	-677	-1786	0
1982	-6198	-7202	-6735	-3921	-2500	-1368	-386	-675	-515	-1593	0
1983	-7164	-4528	-4343	-3887	-2925	-1007	-1794	-1352	-7	-635	-0
1984	-8284	-7131	-5804	-3920	-3256	-1197	-751	-733	-550	-1449	-1
1985	-7932	-6673	-5239	-3858	-2796	-992	-492	-636	-259	-1662	-0
1986	-3436	-3163	-3156	-3183	-2147	-1168	-456	-201	-217	100	-0
1987	-2130	-3944	-2378	-3464	-1429	-1660	-1076	-1198	-343	-2062	-1
1988	-2863	-2588	-2099	-2793	-1689	-1293	66	-173	46	-1884	-10
1989	-562	-1402	-651	-1856	-1166	-1232	-270	-226	-102	-2350	-36
1990	55	-512	-456	-1223	-836	-638	-146	-202	-66	-1184	-202
1991	176	86	698	-933	-307	-528	503	109	363	-720	19
1992	-105	58	219	-571	-146	-364	213	-81	75	-1411	-6419
1993	-154	75	235	-394	-246	-152	243	-189	-44	785	1206
1994	-243	64	140	-230	-151	-298	341	-28	97	841	6269
1995	411	26	219	-20	262	-235	181	208	117	-23	9631
1996	111	5	25	68	215	-168	29	203	137	-38	827
1997	464	-182	-172	85	162	-146	-170	106	-177	-87	-16
1998	608	-161	-71	147	127	-51	-102	161	-94	118	772
1999	540	-187	-56	170	300	-61	25	132	-43	339	-35
2000	657	-129	-107	415	130	135	42	200	-54	703	4311
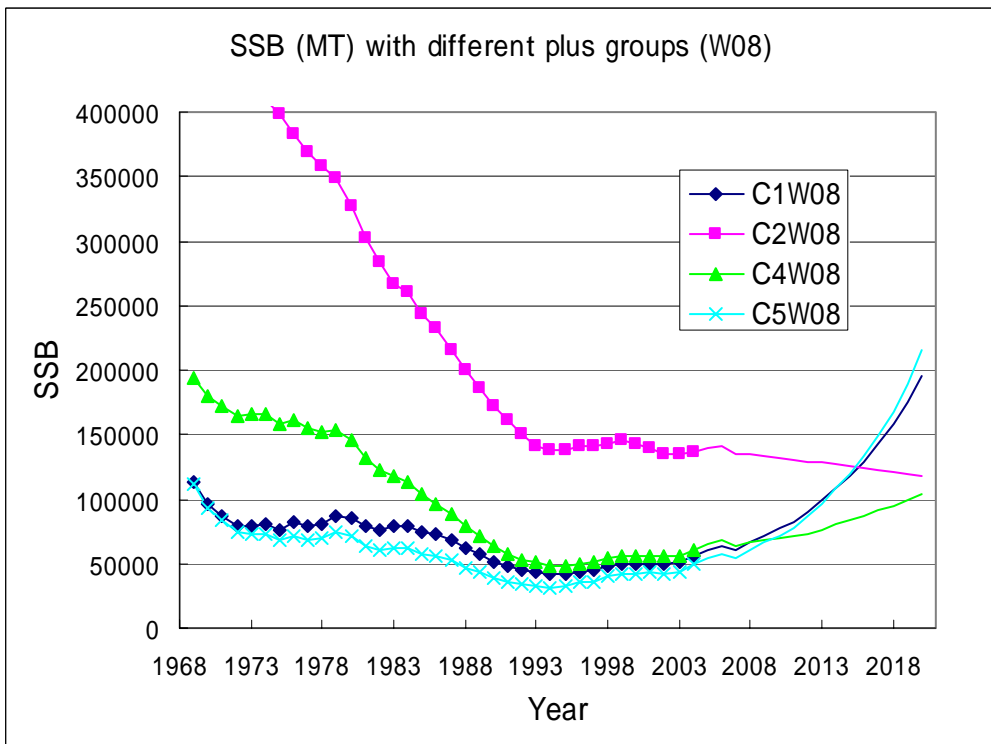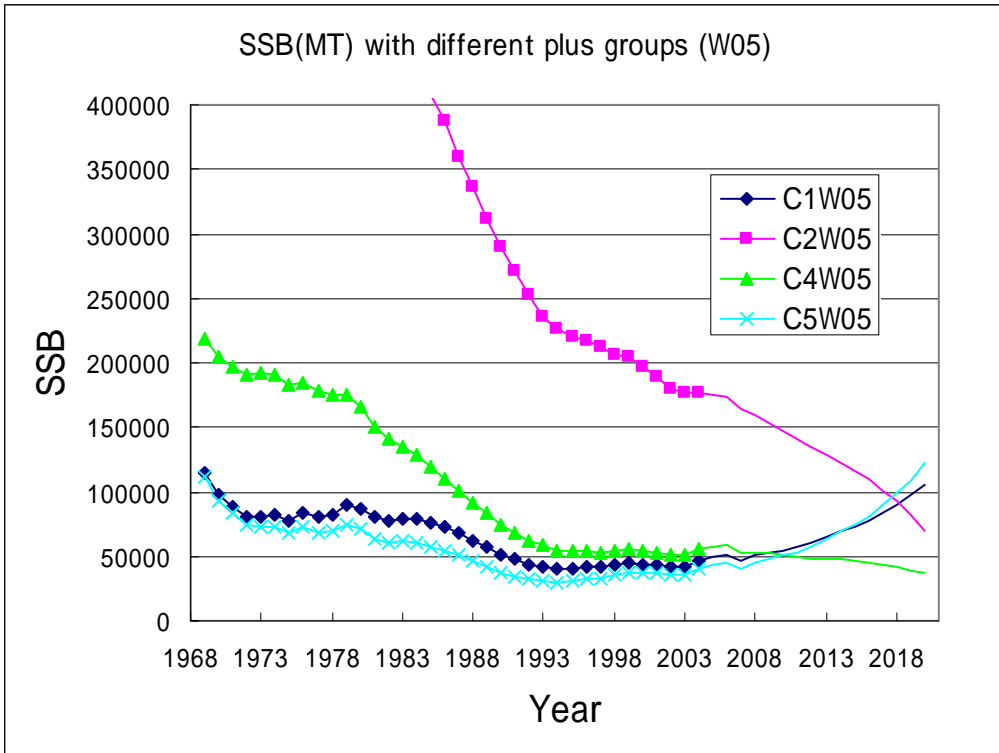
Figure 1 Trajectories of SSB for different options. With marker: VPA results, without marker: projection, W05: proxy of B-ratio, W08: proxy of geostatistical model.
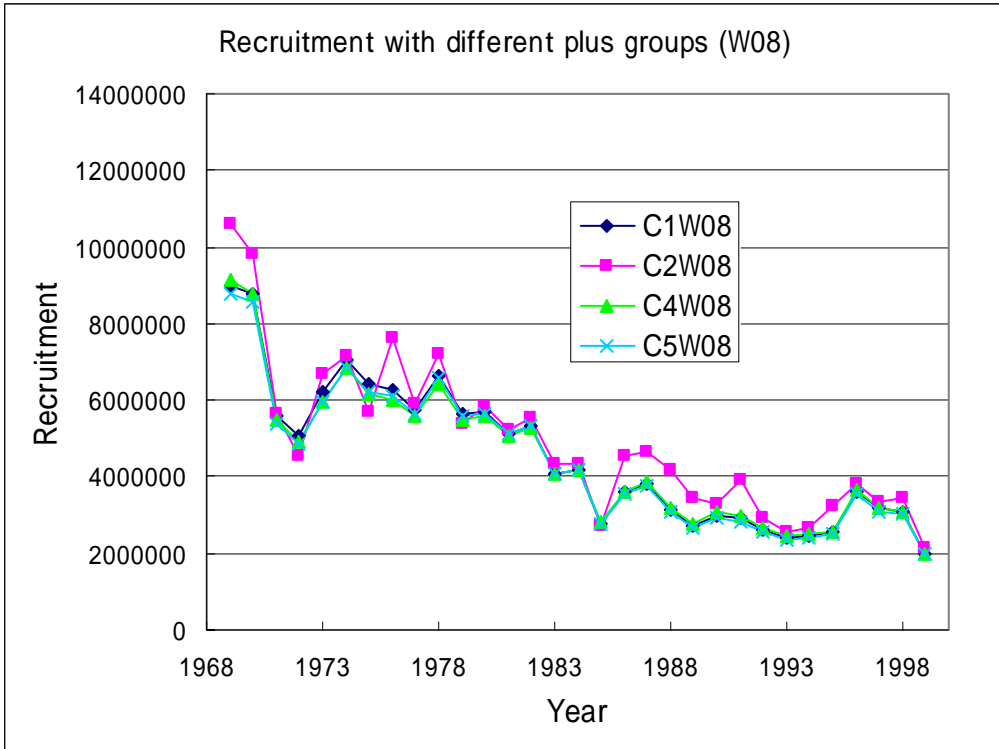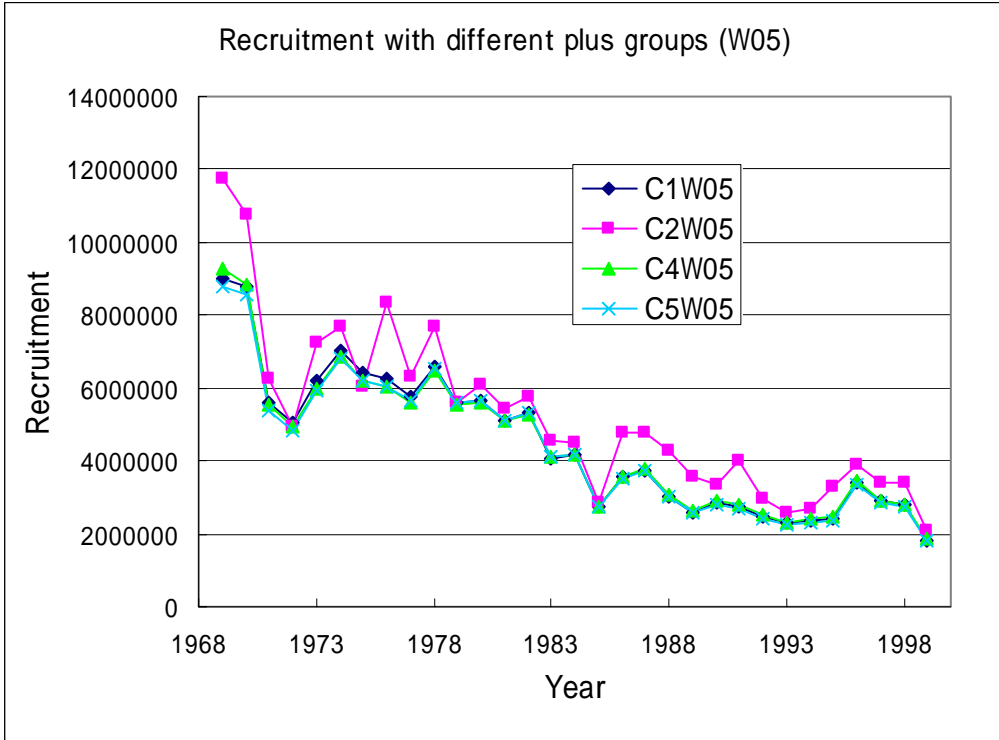
Figure 2 Recruitment estimates for different options. W05: proxy of B-ratio, W08: proxy of geostatistical model.
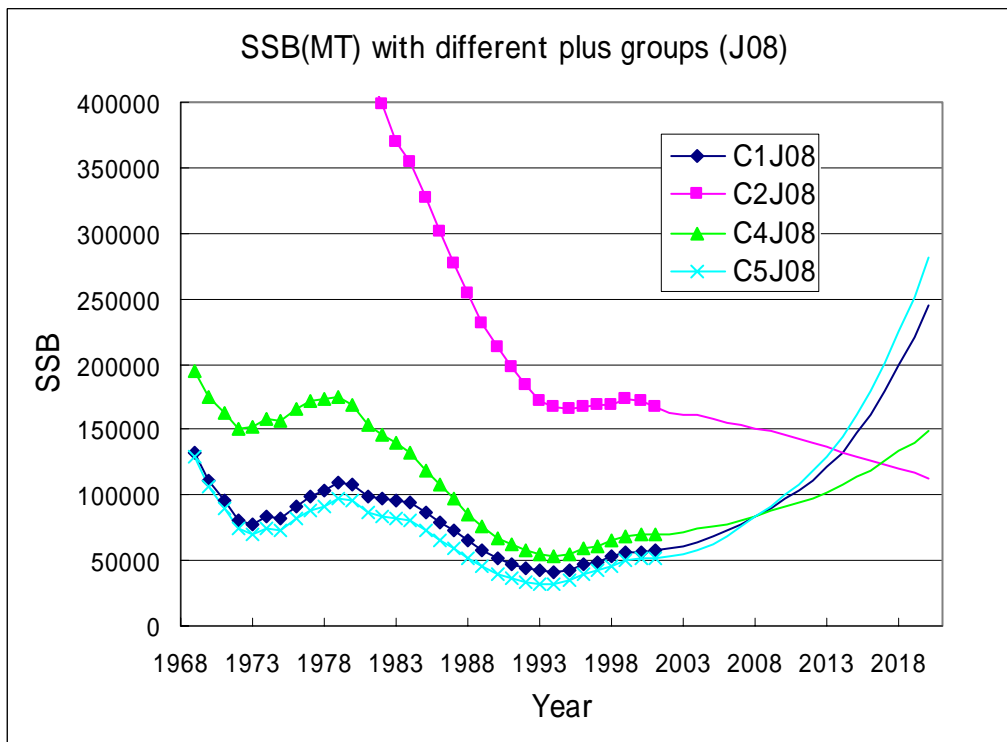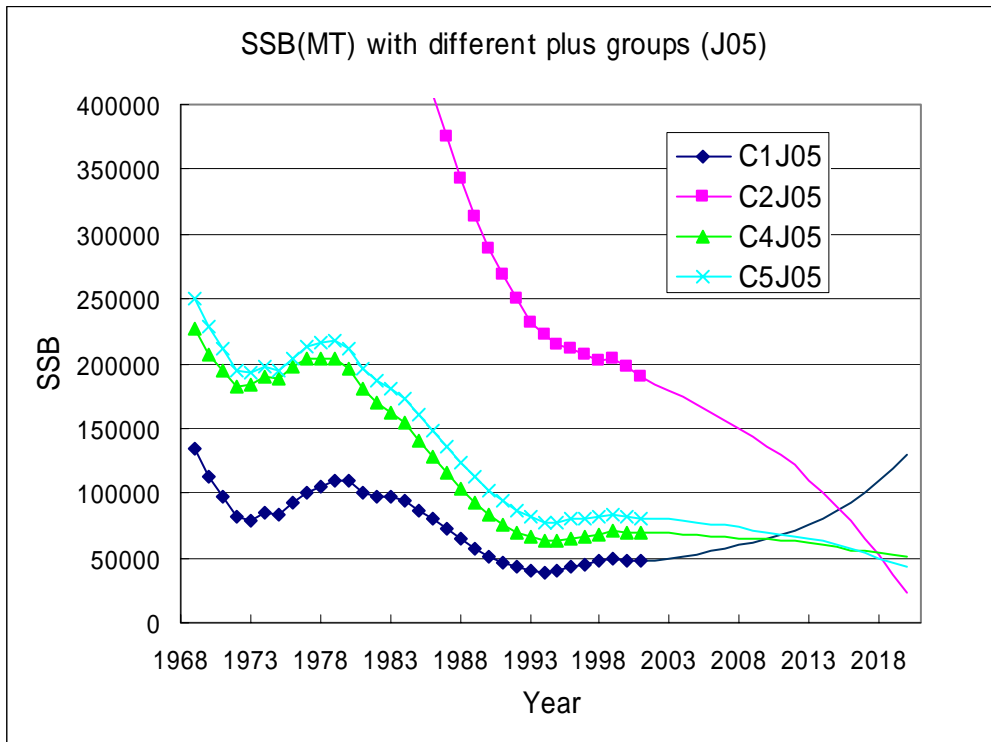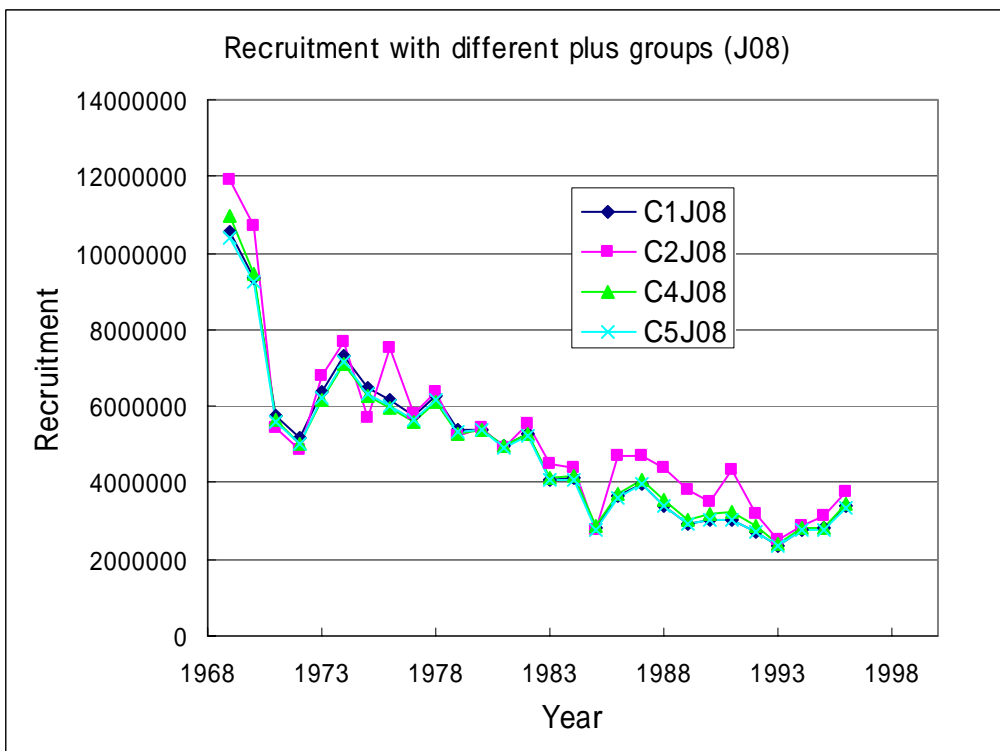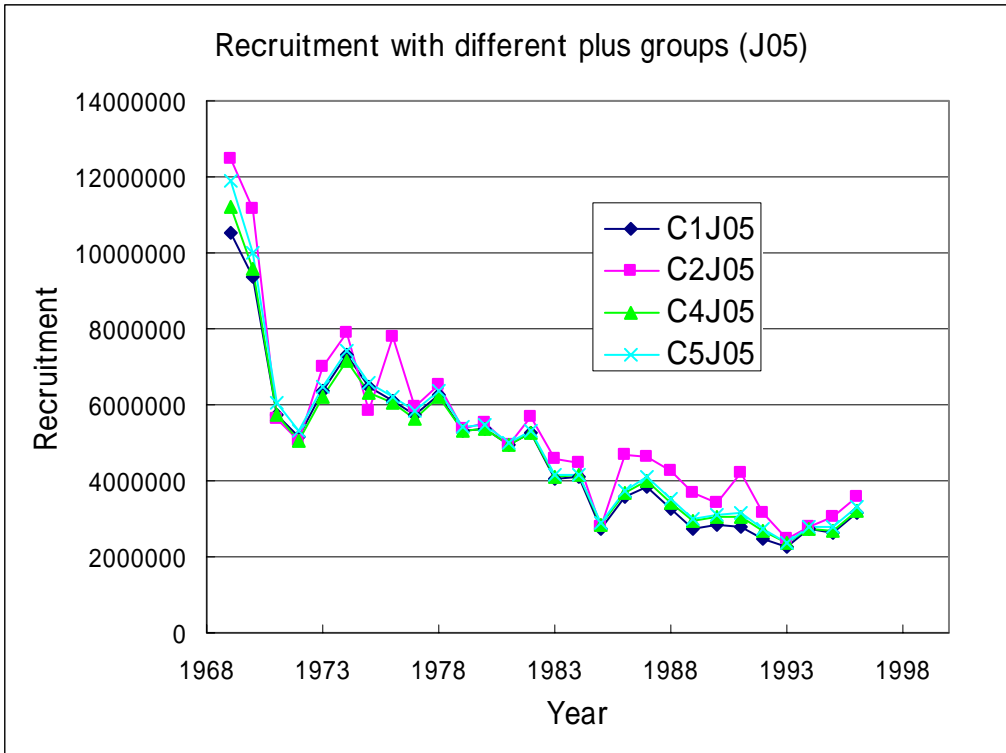
Figure 3 Trajectories of SSB for different options in the 2001 assessment. With marker: VPA results, without marker: projection, J05: proxy of B-ratio, J08: proxy of geostatistical model.

Figure 4 Recruitment estimates for different options in the 2001 assessment. W05: proxy of B-ratio, W08: proxy of geostatistical model.

Appendix: The source of data used in the ADAPT VPA

<u>Catch at age</u>

Japan (1969-2003): provided by Takahashi. Based on the same data as used for standardizing CPUE, except for joint venture with Australia and New Zealand (Tsuji et al. 2004a).

Indonesia (1976-2003): provided by Preece

New Zealand (2000-2003): exchanged data "ccsbt_raised_length&age.xls"

Australia (2001-2003): calculated from exchanged data "CAA_AUSDOM_2000_2001.xls", "CAA_AUS_PS_byYare.xls", and "CAA_AUS_LL5x5xmonth.xls"

Taiwan, Korea and others (2001-2003): calculated from exchanged data for OM "MP_LengthAgeFrequencyData_5July_2004.xls". From catch at length data for Taiwan LL1, Korea, Misc-2, and Taiwan LL2, we calculated catch at age using length-age relation at 1 July.

Others (1969-2000): same as the 2001 assessment

Japanese longline Areas 3-9 (1969-2003): provided by Takahashi

<u>Abundance indices</u>

W05 (w=0.5, proxy of B-ratio, 1969-2003): provided by Takahashi

W08 (w=0.8, proxy of geostatistical model, 1969-2003): provided by Takahashi

<u>Tagging</u>

Provided by Australia, similar to the 2001 assessment data

<u>Weight at age</u>

Same as the 2001 assessment

<u>Natural mortality</u>

Same as the 2001 assessment

(V6; 0.4, 0.35, 0.3, 0.25, 0.233, 0.217, 0.2, 0.175, 0.15, 0.125, 0.1, 0.1, 0.1)