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Estimated stock dynamics of North West Pacific Striped-Marlin by Using a Stock Production Model Incorporating Covariates (ASPIC)

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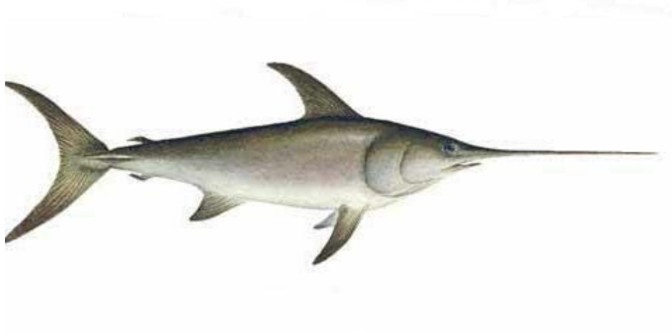

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Summary

The analysis of stock dynamics for striped marlin in North West Pacific Ocean by using A Stock Production Model Incorporating Covariates (ASPIC) was provided. Time series of 5 stock abundances and Catch (JP DW LL, JP CW LL, JP Drift net, TW LL and USA) was used for analysis. We found negative correlation between JP DW LL, JP CW LL and USA V.S. JP Drift net and TW LL. Thus, three scenarios which have different weighting factors were constructed. Under the equal weighted model, estimated total stock biomass decreased from 2.5 times of Bmsy to 0.8 times Bmsy, smoothly and estimated fishing intensity increased from 1.4 times of Fmsy to 2 times Fmsy, The result with down-weighting to JP DW LL, JP CW LL and USA LL becomes optimistic, and the result with down-weighting to JP Drift net and TW LL becomes pessimistic. In conclusion, there are two sets of time series whose annual trends are contradictory to each other. Thus, estimated biomass is changeable by setting of weighting factors for each time series. These time series of stock indices would reflects different aspects of the stock.

Introduction

For North Pacific Striped Marlin assessment, it was agreed to use Stock Synthesis as base model to estimate stock abundance. To evaluate the result, it is useful to compare with other results by using models which have different assumption (Anonymous 2011). A Stock Production Model Incorporating Covariates (ASPIC) can fit the surplus production model which is different assumption in Stock Synthesis. The results by ASPIC to evaluate Stock Synthesis's results are provided in this paper.

Material & Method

Catch and standardized CPUE data between 1952 and 2009 which were provided in ISC Billfish Working group workshop, 2011-02 were used for analyze (Anonymous 2011). Because ASPIC can treat only 10 series of catch and CPUE data as maximum number of series, we summarize data to 5 series, i.e. Japanese offshore longline, Japanese coastal longline, Japanese drift net, Taiwanese longline and U.S. longline (Table 1). The catches of other fisheries were allocated to those 5 fisheries which are supposed to have similar selectivity pattern (Table 2). To make the effects of the limitation of number of series and the differences in length distribution pattern between series on the results of ASPIC minimize, the single area stratification scenario were used and single time series of CPUE of Japanese offshore and distant-water longliners were used in the analysis.

All initial values of estimated parameters, i.e. starting relative biomass (B1/K), maximum sustainable yield (MSY), Maximum population biomass (K) and catchabilities for each fishery (q1-q5), which area generated by ASPIC are shown in Table 3.

Result & Discussion

There were several correlations between some stock indices (Figure. 1). Between JP dw LL and JP cw LL, JP dw and HI LL, there are positive correlations. Between JP dw LL and JP drift net, JP dw LL and TW LL, there are negative correlations. Estimated B / Bmsy and F / Fmsy are shown in Figures 2 - 4. In Figure2 and 5 and table 4, the results where all time series of fisheries set same weight (=1) to estimate are shown. The initial biomass is about 2.4 times larger than Bmsy and the initial F is about 1.8 times larger than than Fmsy. F increase slightly over the years and biomass decrease slightly, also. As a result, the biomass becomes about 90% of Bmsy in 2009.

In Figures 3, the results where for JP dw LL, JP cw LL and HI LL, lower weights (= 0.01) are set than JP drift net and TW (= 1) is shown. Then the trend of biomass becomes more moderate than first scenario. In Figure 4, the results where for JP dw LL, JP cw LL and HI LL, higher weights (=1) are set than JP drift net and TW (= 0.01) is shown. In this scenario, biomass decrease more rapidly than first scenario.

In conclusion, there are two sets of time series which are contradictory to each other. Thus, estimated biomass is changeable by setting of weighting factors for each time series. Thus, estimated biomass is changeable by setting of weighting factors for each time series. These time series of stock indices would reflects different aspects of the stock, but the present study successfully produced results to attain compromise of these contradicting time series and this result seems more realistic than the ones obtained using one of two contradicting time series of inputs in a relative sense. The production model used in this study does not account for the historical size information, and length based stock analysis model such as the Stock Synthesis would have more complicating problems if size information is not so informative under the situation that the some input CPUE series are contradicting each other.

References

Anonymous, Report of the Billfish Working Group Workshop 2011/02.

Table 1 CPUE series which are used for analysis

year	JP dw LL	JP cw LL	JP drift	TW LL	HI LL
1952	0.030				
1953	0.014				
1954	0.024				
1955	0.037				
1956	0.033				
1957	0.026				
1958	0.044				
1959	0.061				
1960	0.034				
1961	0.031				
1962	0.044				
1963	0.034				
1964	0.062				
1965	0.063				
1966	0.047				
1967	0.041			0.085	
1968	0.033			0.074	
1969	0.045			0.086	
1970	0.053			0.066	
1971	0.046			0.083	
1972	0.033			0.102	
1973	0.030			0.105	
1974	0.023			0.060	
1975	0.019			0.066	
1976	0.016			0.122	
1977	0.009		0.286	0.105	
1978	0.010		0.188	0.128	
1979	0.020		0.146	0.143	
1980	0.023		0.149	0.121	
1981	0.015		0.132	0.128	
1982	0.013		0.071	0.200	
1983	0.011		0.069	0.066	
1984	0.016		0.099	0.061	
1985	0.021		0.096		
1986	0.029		0.099		
1987	0.019		0.109	0.030	
1988	0.023		0.138		
1989	0.022		0.132	0.076	
1990	0.013		0.162	0.063	
1991	0.013		0.173	0.113	
1992	0.018		0.159	0.064	
1993	0.030		0.206	0.127	
1994	0.023	0.027			
1995	0.022	0.041		0.121	
1996	0.018	0.024		0.095	0.739
1997	0.017	0.033		0.079	0.636
1998	0.029	0.042		0.088	0.644
1999	0.022	0.019		0.091	0.488
2000	0.013	0.019		0.090	0.255
2001	0.013	0.022		0.073	0.761
2002	0.010	0.021		0.119	0.327
2003	0.009	0.020		0.117	0.932
2004	0.010	0.023		0.157	0.443
2005	0.006	0.017		0.152	0.409
2006	0.005	0.014		0.111	0.588
2007	0.004	0.019		0.101	0.142
2008	0.005	0.015		0.092	0.345
2009	0.004	0.015		0.081	0.170

Table 2 Catch series which are used for analysis. Unit is MT

	JP dw LL	JP cw LL	JP drift	TW LL	HI LL
combined fishery		JP other LL, net, trap	JP other,squid drift, bait	all TW, KOR, WCPFC	
year					
1952	2901.1	926.4	1359.9	0.0	187.2
1953	2137.6	182.0	819.3	0.0	177.7
1954	3053.5	135.0	1005.0	0.0	98.3
1955	3075.1	170.5	895.9	0.0	115.3
1956	3726.7	193.2	1862.4	0.0	106.7
1957	3160.0	216.8	2360.9	0.0	117.7
1958	4101.4	418.3	2776.2	0.0	167.9
1959	4129.1	289.4	3059.8	0.0	142.5
1960	3746.9	274.7	1767.8	0.0	106.2
1961	3817.9	369.7	1597.6	0.0	109.2
1962	4289.1	379.7	1650.8	0.0	133.8
1963	3747.5	202.5	1787.3	0.0	161.1
1964	6290.9	139.3	2247.6	0.0	241.5
1965	4493.6	127.0	2687.0	0.0	185.1
1966	2961.4	344.0	1340.0	0.0	159.3
1967	4503.4	246.0	1435.0	591.0	191.5
1968	4358.5	320.0	953.0	541.0	241.9
1969	3026.1	715.0	2559.0	765.0	158.9
1970	6181.0	930.0	976.0	694.8	163.6
1971	4080.6	1014.0	1964.0	596.0	81.5
1972	2157.7	1058.0	1160.0	527.5	69.4
1973	3075.1	902.0	3815.0	723.0	52.4
1974	2569.3	466.0	3797.0	810.4	74.4
1975	1676.8	430.0	7114.0	909.8	93.2
1976	1610.2	329.0	4095.0	535.0	109.4
1977	1411.9	375.0	4867.0	781.2	46.7
1978	1830.6	492.0	5917.0	717.5	73.3
1979	3034.0	454.2	2991.0	605.9	98.8
1980	3014.3	692.1	3923.0	448.4	131.7
1981	1996.3	364.1	4315.0	645.8	157.2
1982	1621.8	347.0	2943.0	603.0	185.9
1983	1397.3	489.0	2535.0	828.3	216.6
1984	2237.2	539.0	2908.0	1330.7	247.4
1985	3096.3	818.0	3013.0	745.3	274.0
1986	3994.7	1071.0	4024.0	388.9	303.7
1987	2602.9	1295.0	2299.0	670.7	276.7
1988	4374.0	822.0	2816.0	755.0	482.6
1989	2849.3	1141.0	2154.0	448.6	586.8
1990	1716.9	1194.0	2424.0	445.0	483.7
1991	2344.5	1257.0	1779.0	636.6	549.9
1992	2567.6	1329.0	1435.0	482.8	545.4
1993	3103.3	1753.0	1507.0	427.9	532.5
1994	2377.3	1360.0	1751.0	405.4	363.3
1995	2440.4	1909.0	1187.0	259.8	738.2
1996	1518.7	1880.0	815.0	307.4	515.1
1997	1198.0	1437.0	942.0	498.4	468.0
1998	1312.7	2012.0	1361.0	1009.9	499.0
1999	1402.6	1582.9	1282.0	680.5	451.1
2000	902.1	1157.9	1318.0	889.1	233.1
2001	778.2	1387.9	1263.0	510.0	415.4
2002	585.1	881.1	1474.0	624.6	232.0
2003	841.7	886.5	1225.0	578.3	759.3
2004	561.3	1025.9	1407.0	557.6	460.0
2005	461.3	696.5	1284.0	453.6	733.0
2006	479.2	570.3	1254.0	598.9	704.5
2007	291.0	886.3	1028.0	630.2	348.3
2008	359.3	645.3	1373.0	804.4	476.7
2009	127.0	643.5	894.0	524.7	352.1

Table 3 Initial values for estimated parameters

	initial value	lower boundary	upper boundary
B1/K	0.5	–	–
MSY	6404.37	640.437	128087
K	64043.7	6404.37	1280870
q1: JP dw LL	1.8949E-06	–	–
q2: JP cw LL	3.9216E-06	–	–
q3: JP drift	8.3556E-06	–	–
q4: TW LL	2.6805E-05	–	–
q5: HI LL	1.7444E-04	–	–

Table 4 estimated parameters

	estimated value
B1/K	0.8399
MSY	1345
K	560600
q1: JP dw LL	6.963E-08
q2: JP cw LL	1.146E-07
q3: JP drift	4.910E-07
q4: TW LL	3.658E-07
q5: HI LL	2.288E-06
Bmsy/K	0.35
γ	-27.73
n	0.91

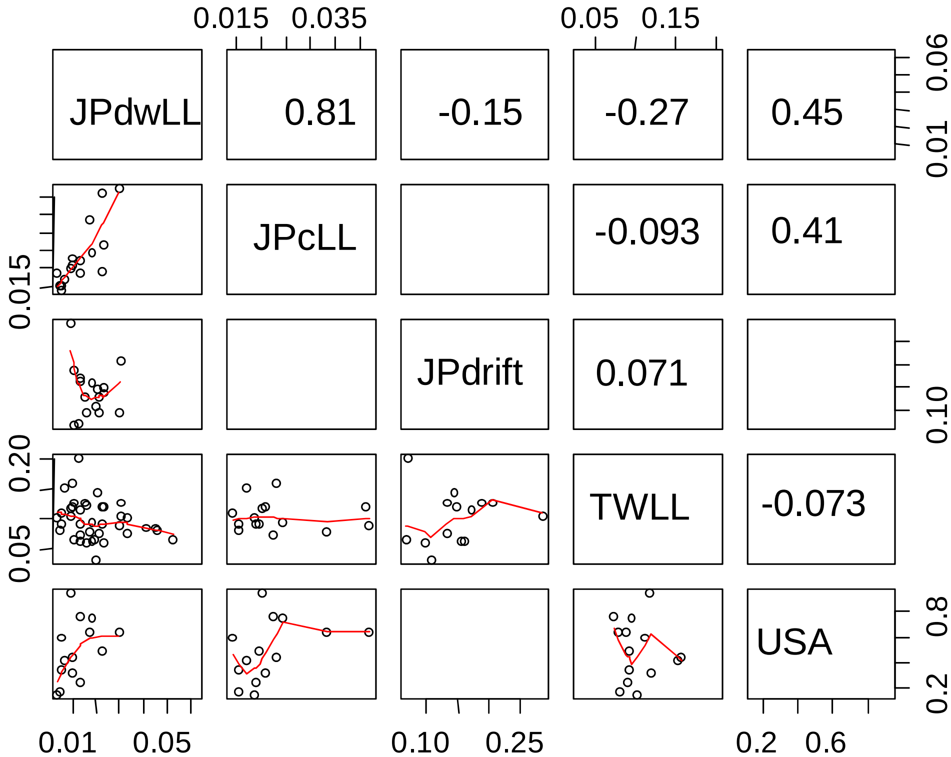


Figure. 1 Correlation between each stock indices.

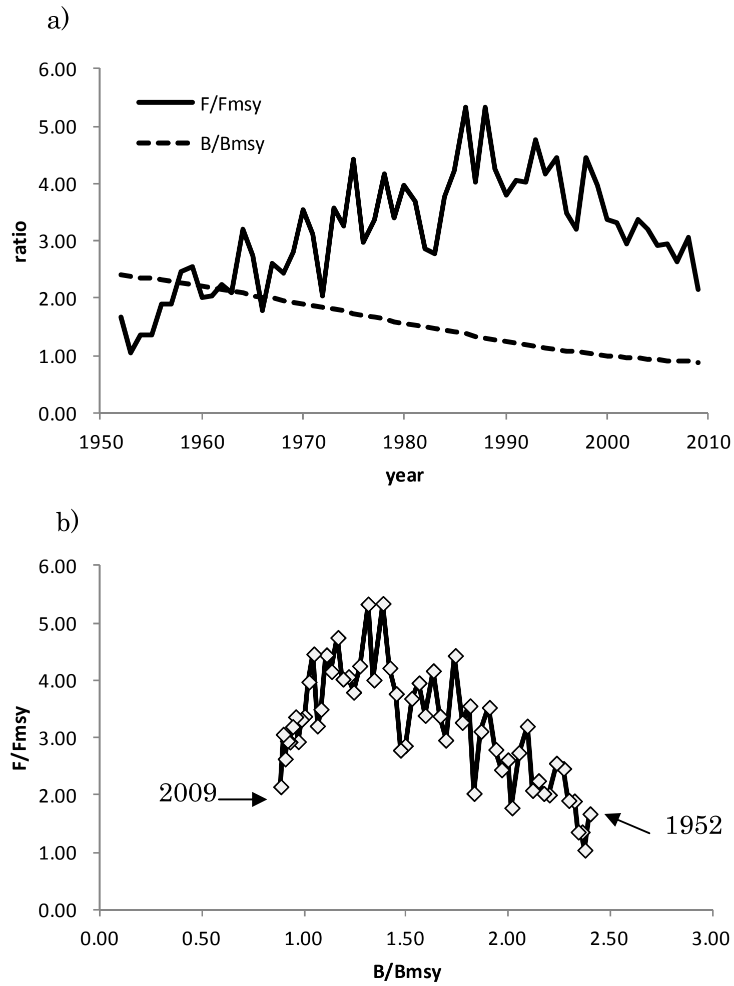
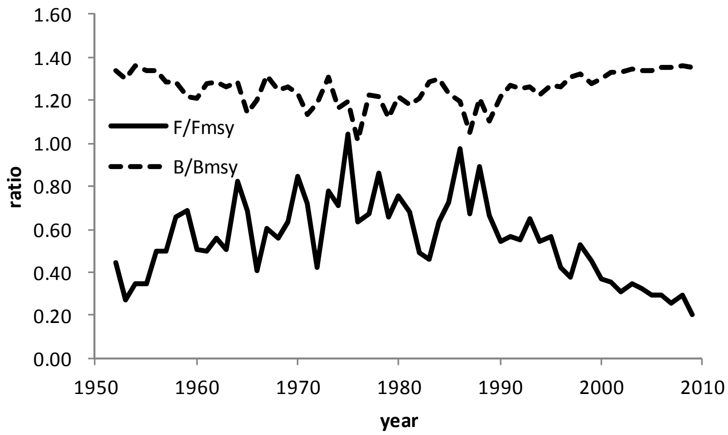


Figure. 2 Time series of estimated F / Fmsy and B / Bmasy a) and scatter plot of these two. b) with same weight for 5 CPUE and catch time series.

a)



b)

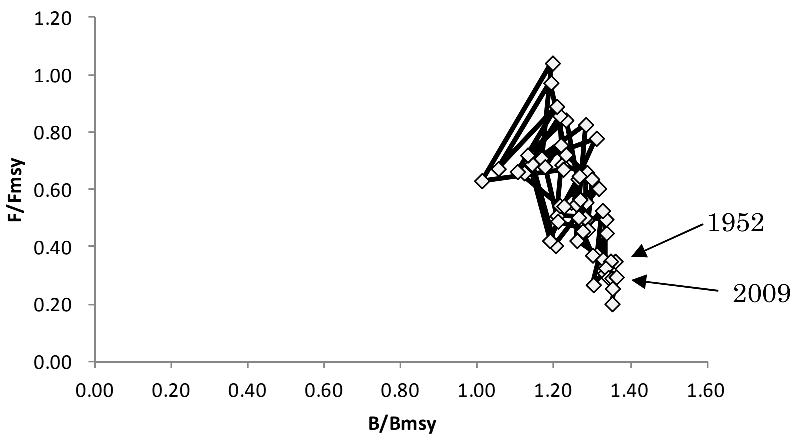


Figure. 3 Time series of estimated F / Fmsy and B / Bmasy a) and scatter plot of these two. b) set higher weight (1) for JP drift net and TW CPUE and catch time series than other three ones (0.01).

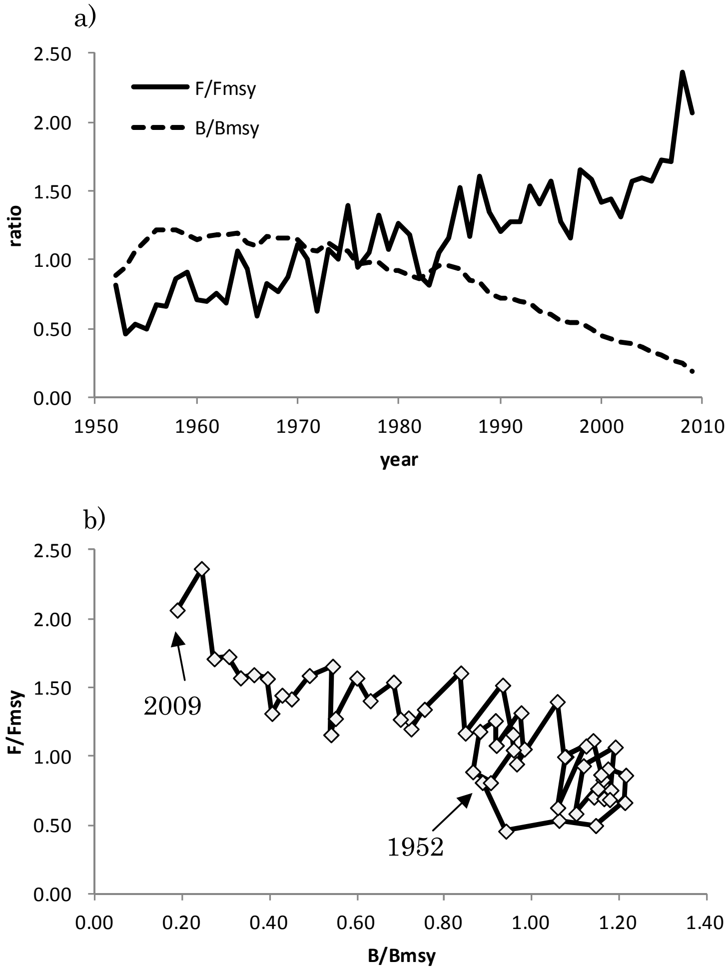


Figure. 4 Time series of estimated F / Fmsy and B / Bmasy a) and scatter plot of these two. b) set higher weight (1) for JP dw LL, JP cw LL and HI LL CPUE and catch time series than other two ones (0.01).

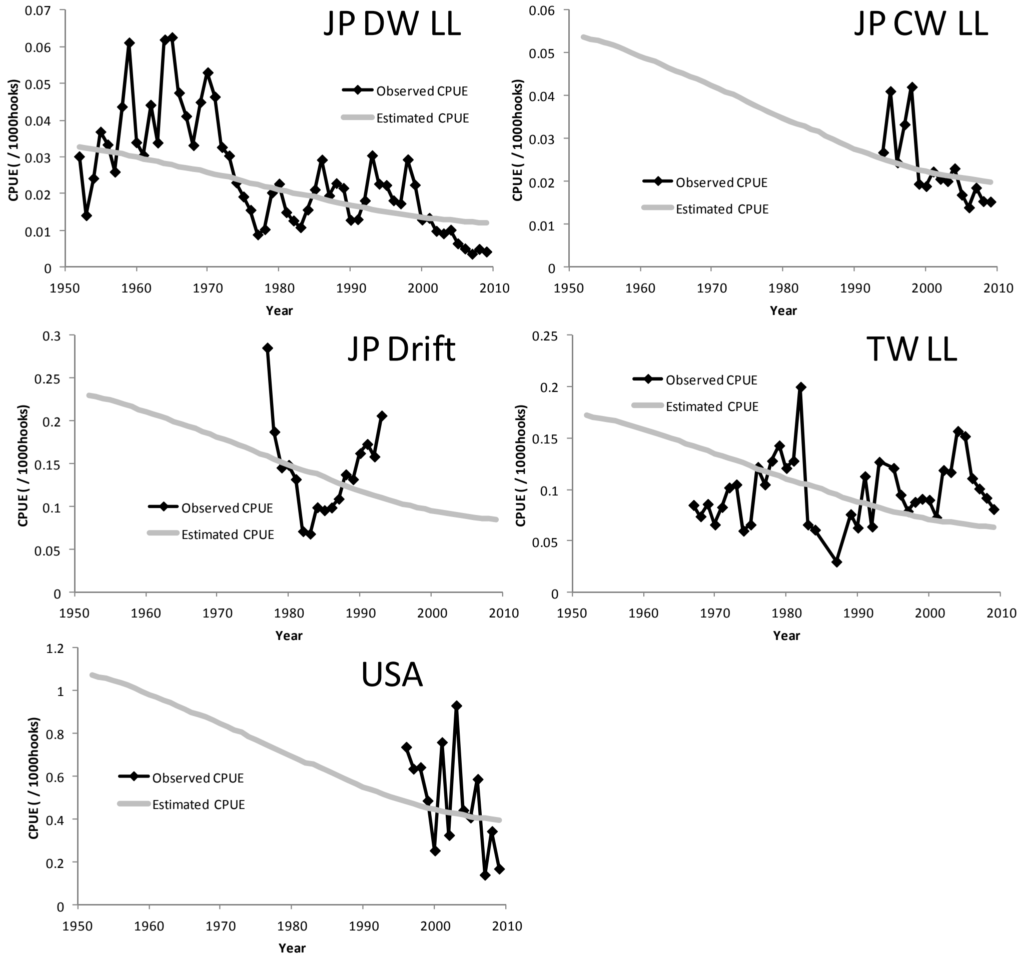


Figure. 5 Input and Estimated CPUE for each fleets.