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EVALUATION OF THE EFFECT OF RESOLUTION C-04-09

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1. INTRODUCTION

[Resolution C-04-09](#) on the conservation of tuna in the eastern Pacific Ocean called for restrictions on purse-seine effort and longline catches for 2004 to 2006: a 6-week closure during the third OR fourth quarter of the year for purse-seine fisheries, and for limits on the longline catches of each country equal to their 2001 longline catches or, in the case of Japan, 34,076 metric tons (t). Resolution C-06-02 extended the measures into 2007. We investigate the effectiveness of this management measure, first by examining the changes in purse-seine fishing effort (measured by days fishing) and the longline catches of bigeye, and then with a simulation of the effect of assumed purse-seine effort and longline catch in the absence of the Resolution.

2. PURSE-SEINE EFFORT

In this section the effort by purse-seine vessels, in number of days fished, is compared with the effort by purse-seine vessels in 2003. Previous analyses had suggested that the conservation measures in that year had little effect on the purse-seine fishery.

In 2004 there was a reduction of effort in the floating-object fisheries, particularly in the third quarter (Tables 1 and 2). Overall, there was a 22% reduction in days fished, with a 46% reduction in the third quarter. However, for 2005 and 2006, respectively, the third-quarter effort was only 27% and 9% less, and the total effort was 7% and 21% greater than in 2003 .

Effort in the fisheries for unassociated fish was reduced by 15% in the fourth quarter of 2004, but this was more than offset by increased effort in the second and third quarters, resulting in 7% more days fished for the year (Tables 3 and 4). In 2005 and 2006, respectively, the number of days fished in the fourth quarter was 38% greater and 48% less than in 2003. The year's total was 17% greater for 2005 and about the same in 2006 as 2003.

Effort in the dolphin-associated fisheries dropped 25% in the fourth quarter of 2004, but increases in the first through third quarters resulted in an overall 14% increase in days fished in 2004 (Tables 3 and 4). Dolphin-associated effort in the second quarter was again greater in 2005 than in 2003, but in all other quarters was lower, resulting in 5% less effort than in 2003. Effort in 2006, compared to that in 2003, was lower in all but the first quarter, and the total effort was 11% lower.

3. LONGLINE CATCH

Data for longline catch is provided to the IATTC staff on a monthly basis. The data from most recent years are not complete, but, due to the monthly reporting, the majority of the catch is accounted for. The longline catch of bigeye tuna has decreased substantially since 2001 (Table 5); in 2006 it was only 44% of that in 2001 and 52% of the combined catch cap for Chinese Taipei, the Peoples Republic of China, Korea, and Japan.

4. SIMULATION OF EFFECTS OF MEASURES

4.1. Methods

To assess the utility of these management actions, we projected the population forward through 2011, assuming that the conservation measures were not implemented, as described below. We started the projections in 2004, to include the first year of the management measure. To approximate the choices of fishing nations, it was assumed that the 6-week closure occurred in the third and fourth quarters for bigeye tuna and yellowfin tuna, respectively, and that the effect of the closure was to reduce fishing effort by xx% in that quarter. For the longline fisheries for which catch was restricted in 2004, the ratio of catch in 2003 to catch in 2004 was used to increase the effort to represent no restrictions. It was also assumed that the limitations on bigeye catches resulted in the same reduction of fishing effort for yellowfin as for bigeye.

Bigeye tuna: For each year in the future (2007-2011), quarterly effort was set equal to the effort in 2006 for purse seine and 2004 for longline, both adjusted to remove the effect of the conservation measures. The current implementation of the Stock Synthesis II assessment of bigeye tuna does not allow for quarter-specific future effort, so the effect of the resolution is spread over all quarters. For 2004-2006, purse-seine catch in the **third** quarter was increased by 86%, and the catch in the southern longline fishery was increased by 39% in all quarters. For 2007 to 2011, purse-seine effort was increased by 13% for all quarters and the effort in the southern longline fishery was increased by 39% in all quarters.

Yellowfin tuna: For each year in the future (2007-2011), quarterly effort was set equal to the effort in 2005 for purse seine and 2004 for longline, both adjusted to remove the effect of the conservation measures. For all years (2004-2010), the purse-seine effort in the fourth quarter was increased by 86%, and the effort in the southern longline fishery was increased by 39% in all quarters.

4.2. Results

The spawning biomass of bigeye tuna at the end of 2006 with the management restrictions is about 56% greater than it would have been if no restrictions had been implemented (Table 6). The spawning biomass has recently increased, due to recent spikes in recruitment, and will continue increasing through 2008 before declining again. It is still below the level required to support the average maximum sustainable yield (AMSY), except during 2008 (Figure 1) and will, under average conditions, remain below that level. It will decline even further if no restrictions are implemented.

If no restrictions were implemented, the catch of bigeye tuna in 2004 to 2006 would have been 13% greater for purse seine and 39% greater for longline. (This is a consequence of the method used to implement the affect of the restriction in the model.) However, it is predicted that by 2007, the catches based on the lesser effort due to the restrictions would be greater than under the unrestricted effort (Table 6).

The spawning biomass of yellowfin tuna at the end of 2006 with the management restrictions is about 14% greater than it would be if no restrictions had been implemented (Table 7).

If no restrictions had been implemented, the catch of yellowfin tuna in 2004 and 2005 would have been 9% and 3% greater for purse seine and 32% and 21% greater for longline, respectively. It is predicted that the purse-seine catch in 2006 would be less if the restriction had not been in place. It is predicted that by 2008, the purse-seine catches with restricted effort would be greater than without the restrictions (Tables 8 and 9). Catches in the longline fishery are predicted to remain less with the restricted effort than would have been the case without the restrictions.

5. DISCUSSION

Most yellowfin tuna are taken in sets on schools associated with dolphins. Fishing effort of this type, measured by days fished, increased in 2004 and decreased in 2005 and 2006, relative to 2003. The effect of the Resolution was reduced by the fact that nine large purse-seine vessels that continued to fish during

the closure in 2004, contributing to the greater effort. The effort on unassociated schools was greater during the two years of the closure and about the same for 2006. All of the effort on schools associated with dolphins is directed at yellowfin. However, some of the effort on unassociated schools during the second and third quarters of the year is directed at bluefin tuna. Notwithstanding these factors, the simulation probably overestimates the effect of the management measures on yellowfin tuna.

In the floating-object fishery there was a reduction of fishing effort in 2004 and an increase in 2005 and 2006, relative to 2003. For longlining, the actual reduction of catches of bigeye tuna in 2004 compared to 2003 was used as the basis for the simulation. This was a greater reduction than that required by the Resolution.

The capacity of the purse-seine fleet, in cubic meters of well volume, was 203,000, 206,000, 213,000, and 225,000 m³ in 2003, 2004, 2005, and 2006, respectively. This growth in capacity, together with other adaptations to the closures, is constraining the effect of the management measures.

TABLE 1. Effort, in days fished, for the floating object fisheries defined in the bigeye tuna assessment.

Year	Quarter	Fishery 2	Fishery 3	Fishery 4	Fishery 5	Total
2003	1	1086	386	1203	336	3010
	2	1108	580	1024	828	3540
	3	628	2401	1465	1389	5884
	4	1123	2746	878	722	5470
Total		3944	6114	4571	3275	17904
2004	1	1513	436	1152	286	3387
	2	1417	303	406	784	2910
	3	605	1089	445	1035	3173
	4	870	2453	441	698	4462
Total		4405	4280	2444	2804	13933
2005	1	1113	768	1310	479	3670
	2	1121	1418	1743	1183	5466
	3	477	1446	1339	1057	4319
	4	1090	2372	1327	893	5683
Total		3801	6005	5719	3612	19137
2006	1	1226	857	1778	344	4205
	2	1554	1496	1356	1240	5646
	3	898	2489	593	1377	5357
	4	1075	3229	1216	855	6376
Total		4754	8072	4943	3815	21585

TABLE 2. Change in effort relative to that in 2003 for the floating-object fisheries defined in the bigeye tuna assessment

. Year	Quarter	Fishery 2	Fishery 3	Fishery 4	Fishery 5	Total
2004	1	1.39	1.13	0.96	0.85	1.13
	2	1.28	0.52	0.40	0.95	0.82
	3	0.96	0.45	0.30	0.75	0.54
	4	0.77	0.89	0.50	0.97	0.82
Total		1.12	0.70	0.53	0.86	0.78
2005	1	1.03	1.99	1.09	1.43	1.22
	2	1.01	2.44	1.70	1.43	1.54
	3	0.76	0.60	0.91	0.76	0.73
	4	0.97	0.86	1.51	1.24	1.04
Total		0.96	0.98	1.25	1.10	1.07
2006	1	1.13	2.22	1.48	1.02	1.40
	2	1.40	2.58	1.32	1.50	1.59
	3	1.43	1.04	0.40	0.99	0.91
	4	0.96	1.18	1.38	1.18	1.17
Total		1.21	1.32	1.08	1.17	1.21

TABLE 3. Effort, in days fished, for the yellowfin fisheries.

Year	Quarter	Fishery 5	Fishery 6	Fishery 7	Fishery 8	Fishery 9	Unassociated	Dolphin
2003	1	1093	2679	981	1685	469	3772	3135
	2	1241	2637	916	1267	532	3878	2715
	3	1359	1231	1101	1598	375	2589	3075
	4	1125	1568	908	1499	387	2694	2793
Total		4818	8115	3905	6049	1764	12933	11718
2004	1	944	2726	539	1933	1118	3670	3591
	2	1416	3453	974	1796	1258	4868	4028
	3	1681	1317	1262	1816	583	2998	3662
	4	699	1584	790	883	419	2283	2092
Total		4740	9080	3566	6428	3378	13819	13372
2005	1	1338	3206	654	1377	507	4544	2538
	2	1402	2606	1220	1859	465	4008	3544
	3	2009	855	743	1601	131	2864	2476
	4	702	3004	843	1457	226	3706	2526
Total		5451	9670	3460	6293	1330	15122	11083
2006	1	1121	3906	334	2772	588	5026	3694
	2	1145	2775	681	1546	322	3920	2549
	3	1564	1013	837	1355	173	2578	2364
	4	466	926	539	1152	153	1392	1844
Total		4295	8620	2391	6825	1235	12916	10451

TABLE 4. Change in effort relative to that in 2003 for the yellowfin fisheries.

Year	Quarter	Fishery 5	Fishery 6	Fishery 7	Fishery 8	Fishery 9	Unassociated	Dolphin
2004	1	0.86	1.02	0.55	1.15	2.38	0.97	1.15
	2	1.14	1.31	1.06	1.42	2.36	1.26	1.48
	3	1.24	1.07	1.15	1.14	1.55	1.16	1.19
	4	0.62	1.01	0.87	0.59	1.08	0.85	0.75
Total		0.98	1.12	0.91	1.06	1.92	1.07	1.14
2005	1	1.22	1.20	0.67	0.82	1.08	1.20	0.81
	2	1.13	0.99	1.33	1.47	0.87	1.03	1.31
	3	1.48	0.69	0.68	1.00	0.35	1.11	0.81
	4	0.62	1.92	0.93	0.97	0.59	1.38	0.90
Total		1.13	1.19	0.89	1.04	0.75	1.17	0.95
2006	1	1.03	1.46	0.34	1.64	1.25	1.33	1.18
	2	0.92	1.05	0.74	1.22	0.60	1.01	0.94
	3	1.15	0.82	0.76	0.85	0.46	1.00	0.77
	4	0.41	0.59	0.59	0.77	0.40	0.52	0.66
Total		0.89	1.06	0.61	1.13	0.70	1.00	0.89

TABLE 5. Annual longline catches in metric tons (t) of bigeye tuna for China, Japan, Korea, and Chinese Taipei, total catch, and change relative to 2001.

	China	Japan	Korea	Chinese Taipei	Total catch	Relative to 2001
2001	2639	38048	12576	9285	68726	1.00
2002	7614	34193	10358	17253	74405	1.08
2003	10066	24796	10272	12016	59666	0.87
2004	2645	21132	10729	7384	43354	0.63
2005	2104	21137	11580	6901	43893	0.64
2006	709	13618	8694	6878	30019	0.44
Catch limit	2639	34076	12576	7953		

TABLE 6. Bigeye spawning biomass and catch adjusted to represent no restrictions as a ratio of those quantities estimated under current effort levels, which are restricted by Resolution C-04-09.

	End-of-year spawning biomass	Purse-seine catch	Longline catch
2004	0.86	1.13	1.39
2005	0.76	1.13	1.39
2006	0.64	1.13	1.39
2007	0.60	0.90	0.89
2008	0.61	0.93	0.89
2009	0.62	0.97	0.89
2010	0.63	0.99	0.90
2011	0.62	0.99	0.92

TABLE 7. Yellowfin spawning biomass and catch adjusted to represent no restrictions as a ratio of those quantities estimated under current effort levels, which are restricted by Resolution C-04-09.

Year	End of year spawning biomass	Purse-seine catch	Longline catch
2004	0.91	1.09	1.32
2005	0.83	1.03	1.21
2006	0.88	0.95	1.10
2007	0.89	1.04	1.15
2008	0.87	0.99	1.18
2009	0.86	0.97	1.16
2010	0.87	0.98	1.16
2011	0.87	0.98	1.16

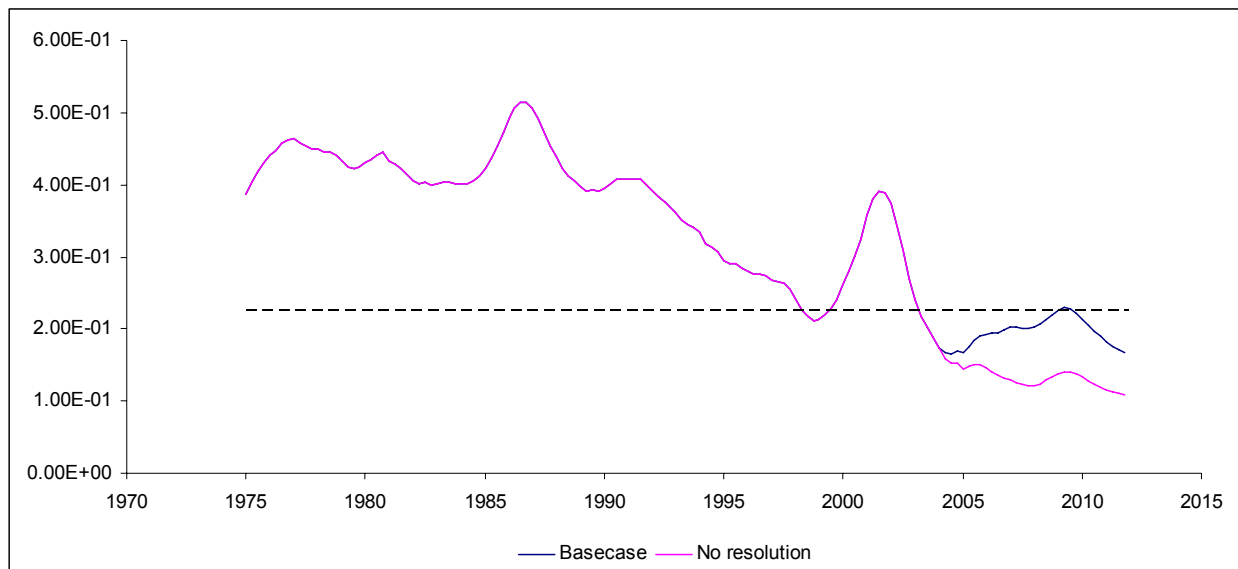


FIGURE 1. Maximum likelihood estimates of the projected spawning biomass ratios (SBRs) of bigeye tuna, with effort for 2004 and average catchability for 2002 and 2003 (“Base case”) and with purse-seine effort in the third quarter increased by 86% and effort increased in all quarters by 39% for the southern longline fishery to approximate the effect of no restrictions (“No resolution”). The horizontal line indicates the SBR_{AMSY} (0.21).

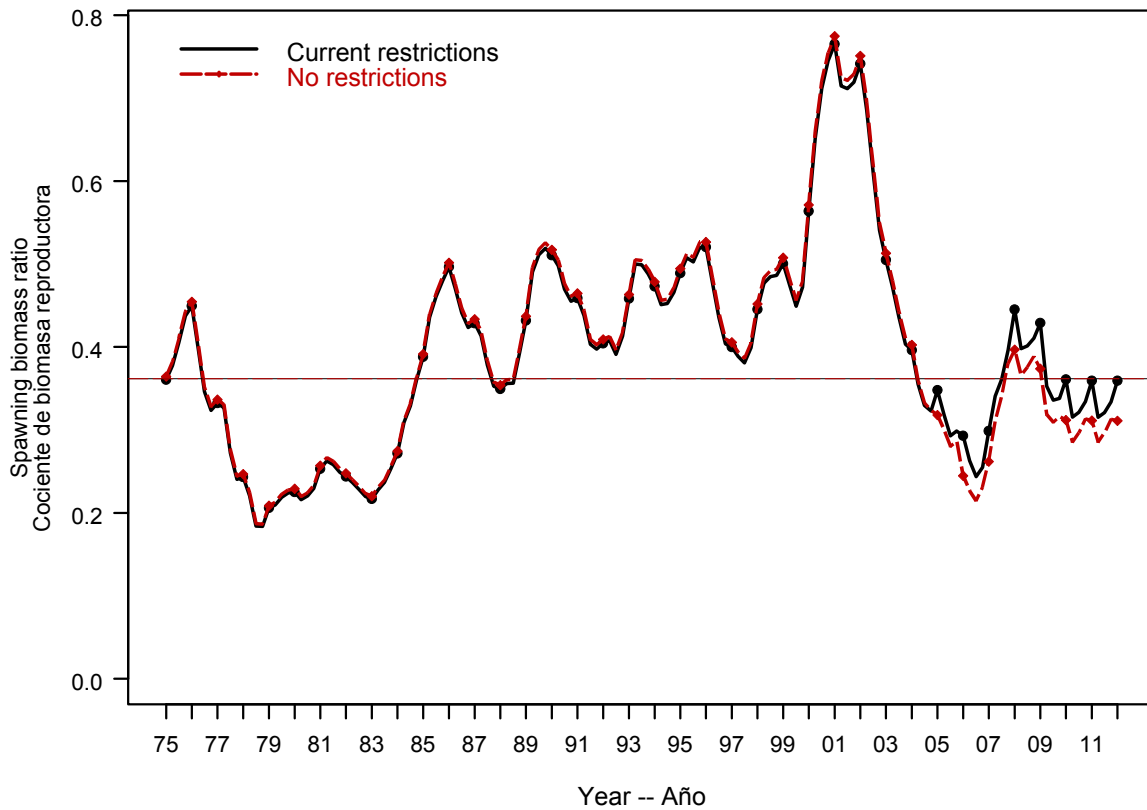


FIGURE 2. Maximum likelihood estimates of the projected spawning biomass ratios (SBRs) of yellowfin tuna, with effort for 2005 and average catchability for 2003 and 2004 (“Current restrictions”) and with purse-seine effort in the fourth quarter from 2004 increased by 86% and effort from 2004 increased in all quarters by 39% for the southern longline fishery to approximate the effect of no restrictions (“No restrictions”). The horizontal line indicates the SBR_{AMSY} (0.37).