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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 longline catches are not to exceed 2001 levels. We investigate the effectiveness of this management measure, first by examining the changes in purse-seine fishing effort and 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 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 21% reduction in days fished, with a 46% reduction in the third quarter. However, the third-quarter effort was only 23% less, and the total effort was 12% greater, in 2005 than in 2003.

Effort in the unassociated fisheries was reduced by 18% in the fourth quarter of 2004, but this was more than offset by increased effort in the second and third quarters, resulting in 2% more days fished for the year (Tables 3 and 4). In 2005, the number of days fished in the fourth quarter 4 was 36% higher than in 2003, and the year's total was 7% higher than in 2003.

Effort in the dolphin-associated fisheries dropped 24% in the fourth quarter of 2004, but increases in the first through third quarters resulted in a 15% increase in days fished in 2004 (Tables 3 and 4). Dolphin-associated effort in the second quarter was again higher in 2005 than in 2003, but in all other quarters was lower. Effort in the fourth quarter was 15% below 2003, and the year's total was 11% lower.

3. LONGLINE CATCH

The longline catch of bigeye tuna has decreased substantially since 2001 (Table 5); in 2004 it was only 60% of that in 2001. Data for 2005 are not complete yet.

4. SIMULATION OF EFFECTS OF MEASURES

4.1. Methods

To assess the utility of these management actions, we projected the population forward through 2010, 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. 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.

Bigeye tuna: For each year in the future (2006-2010), 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), purse-seine effort in the **third** quarter was increased by 86%, and the effort in the southern longline fishery was increased by 39% in all quarters.

Yellowfin tuna: For each year in the future (2006-2010), 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 2005 with the management restrictions is about 23% higher than if no restrictions had been implemented (Tables 6 and 7). The spawning biomass has recently increased, due to recent spikes in recruitment, and will continue increasing through 2007 before declining again. It is still below the level required to support AMSY, except for the third quarter of 2007 (Figure 1) and will, under average conditions, remain below that level. It will decline even further if no restrictions were implemented.

If no restrictions were implemented, the catch of bigeye tuna in 2004 and 2005 would have been 13% and 7% higher for purse seine and 31% and 18% higher for longline. However, it is predicted that by 2007, the catches based on the lower effort due to the restrictions would be higher than under the unrestricted effort (Tables 6 and 7).

The spawning biomass of yellowfin tuna at the end of 2005 with the management restrictions is about 17% higher than if no restrictions had been implemented (Tables 8 and 9).

If no restrictions had been implemented the catch of yellowfin tuna in 2004 and 2005 would have been 9% and 3% higher for purse seine and 30% and 17% higher for longline, respectively. However, it is predicted that by 2008, the purse-seine catches with restricted effort would be higher than without the restrictions (Tables 8 and 9). Catches in the longline fishery are predicted to remain lower 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 compared to 2003. The average for 2004 and 2005 was slightly higher than 2003. The effect of the Resolution was reduced by nine large purse-seine vessels that continued to fish during the closure, contributing a little to the greater effort in 2004. The effort on unassociated schools was greater during the two years of the closure. 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; that occurred particularly during 2004. 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 compared to 2003. The average of the two years was about 5% less than that in 2003, compared to about 12% anticipated in the simulation. 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, and 213,000 m³ in 2003, 2004, and 2005, 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	1061	362	1128	309	2861
	2	1094	542	962	772	3370
	3	622	2339	1361	1303	5624
	4	1104	2675	808	675	5261
Total		3880	5918	4260	3059	17117
2004	1	1463	408	1124	270	3265
	2	1397	279	377	730	2783
	3	596	1053	421	979	3050
	4	854	2423	427	657	4360
Total		4310	4164	2348	2636	13458
2005	1	1143	778	1376	517	3814
	2	1142	1458	1693	1264	5556
	3	495	1415	1319	1082	4311
	4	1048	2381	1224	900	5553
Total		3828	6032	5611	3763	19234

TABLE 2. Relative change in effort from 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	1.38	1.13	1.00	0.87	1.14
	2	1.28	0.51	0.39	0.95	0.83
	3	0.96	0.45	0.31	0.75	0.54
	4	0.77	0.91	0.53	0.97	0.83
Total		1.11	0.70	0.55	0.86	0.79
2005	1	1.08	2.15	1.22	1.67	1.33
	2	1.04	2.69	1.76	1.64	1.65
	3	0.80	0.60	0.97	0.83	0.77
	4	0.95	0.89	1.51	1.33	1.06
Total		0.99	1.02	1.32	1.23	1.12

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	1074	2751	1006	1719	507	3826	3232
	2	1226	2733	969	1313	571	3959	2852
	3	1342	1305	1177	1673	422	2646	3272
	4	1110	1648	952	1559	440	2758	2952
Total		4752	8436	4104	6264	1940	13188	12308
2004	1	897	2671	563	2022	1209	3567	3794
	2	1347	3363	1041	1896	1360	4710	4298
	3	1636	1271	1330	1897	636	2906	3863
	4	688	1572	832	920	479	2260	2232
Total		4567	8877	3767	6736	3684	13443	14186
2005	1	1327	2894	658	1407	506	4221	2571
	2	1235	2342	1227	1821	446	3576	3495
	3	1799	737	743	1548	128	2536	2419
	4	706	3042	882	1518	118	3748	2517
Total		5066	9015	3510	6295	1197	14081	11002

TABLE 4. Relative change in effort from 2003 for the yellowfin fisheries.

Year	Quarter	Fishery 5	Fishery 6	Fishery 7	Fishery 8	Fishery 9	Unassociated	Dolphin
2004	1	0.83	0.97	0.56	1.18	2.38	0.93	1.17
	2	1.10	1.23	1.08	1.44	2.38	1.19	1.51
	3	1.22	0.97	1.13	1.13	1.51	1.10	1.18
	4	0.62	0.95	0.87	0.59	1.09	0.82	0.76
Total		0.96	1.05	0.92	1.08	1.90	1.02	1.15
2005	1	1.24	1.05	0.65	0.82	1.00	1.10	0.80
	2	1.01	0.86	1.27	1.39	0.78	0.90	1.23
	3	1.34	0.56	0.63	0.93	0.30	0.96	0.74
	4	0.64	1.85	0.93	0.97	0.27	1.36	0.85
Total		1.07	1.07	0.86	1.00	0.62	1.07	0.89

TABLE 5. Annual longline catches of bigeye tuna and relative change from 2001 and from the previous year. Catch in 2005 is not complete, and data for some countries are extrapolated.

Year	Catch in thousands of fish	Difference from 2001	Difference from previous year
2001	1577		
2002	1644	1.04	1.04
2003	1398	0.89	0.85
2004	945	0.60	0.68
2005	713	0.45	0.75

TABLE 6. Bigeye spawning biomass and catch (t) compared between the current effort levels, which are restricted by Resolution C-04-09, and effort levels adjusted to represent no restrictions.

Year	End of year spawning biomass		Base case catch		No restrictions catch	
	Base case	No restrictions	Purse seine	Longline	Purse seine	Longline
2004	360378	315925	68074	43534	76686	56960
2005	474916	384199	71370	34213	76654	40408
2006	515982	382390	95863	60049	95875	65507
2007	521575	361783	85470	60149	82402	61314
2008	457185	300359	66136	54371	63535	52093
2009	383554	246227	57862	46317	55871	42621
2010	340907	218966	57179	40837	55463	37256

TABLE 7. 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.

Year	End of year spawning biomass	Purse-seine catch	Longline catch
2004	0.88	1.13	1.31
2005	0.81	1.07	1.18
2006	0.74	1.00	1.09
2007	0.69	0.96	1.02
2008	0.66	0.96	0.96
2009	0.64	0.97	0.92
2010	0.64	0.97	0.91

TABLE 8. Yellowfin spawning biomass and catch (t) compared between the current effort levels, which are restricted by Resolution C-04-09, and effort levels adjusted to represent no restrictions.

Year	End of year spawning biomass		Base case catch		No restrictions catch	
	Base case	No restrictions	Purse seine	Longline	Purse seine	Longline
2004	5283	4789	271742	34989	295523	45658
2005	5305	4543	269761	32562	278404	38101
2006	5525	4689	268794	32259	272707	35804
2007	6712	5633	293050	30485	294543	33180
2008	4999	4145	301003	44171	289785	48007
2009	4949	4120	248184	31926	244211	33941
2010	4939	4114	246747	31296	243409	33512

TABLE 9. 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	1.30
2005	0.86	1.03	1.17
2006	0.85	1.01	1.11
2007	0.84	1.01	1.09
2008	0.83	0.96	1.09
2009	0.83	0.98	1.06
2010	0.83	0.99	1.07

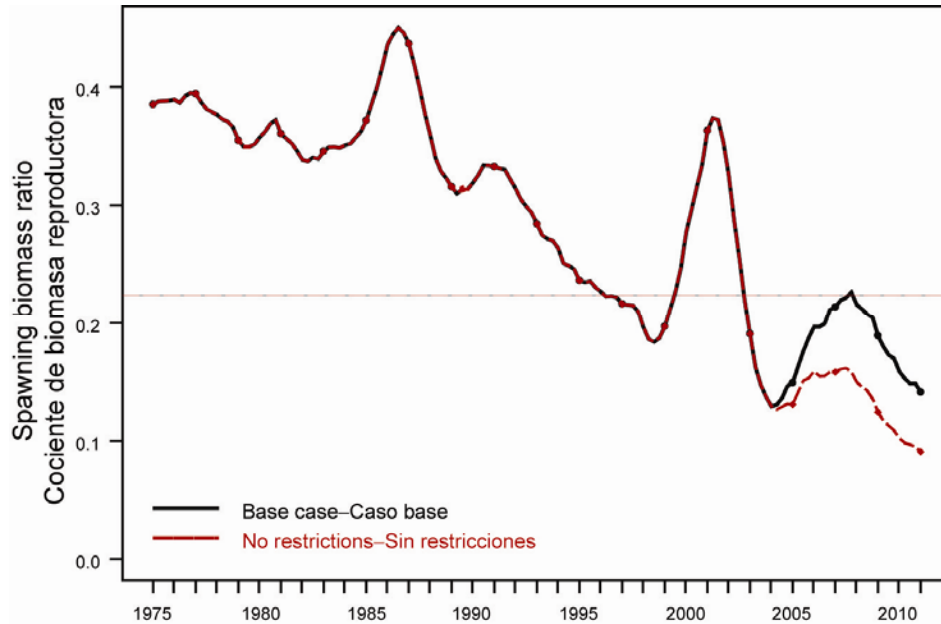


FIGURE 1. Maximum likelihood estimates of the projected spawning biomass ratios (SBRs) of bigeye tuna, with effort for 2004 and average catchability for 2002 and 2003 (“Base case”) and with purse-seine effort in the third quarter increased by 86% and effort increased in all quarters by 39% for the southern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

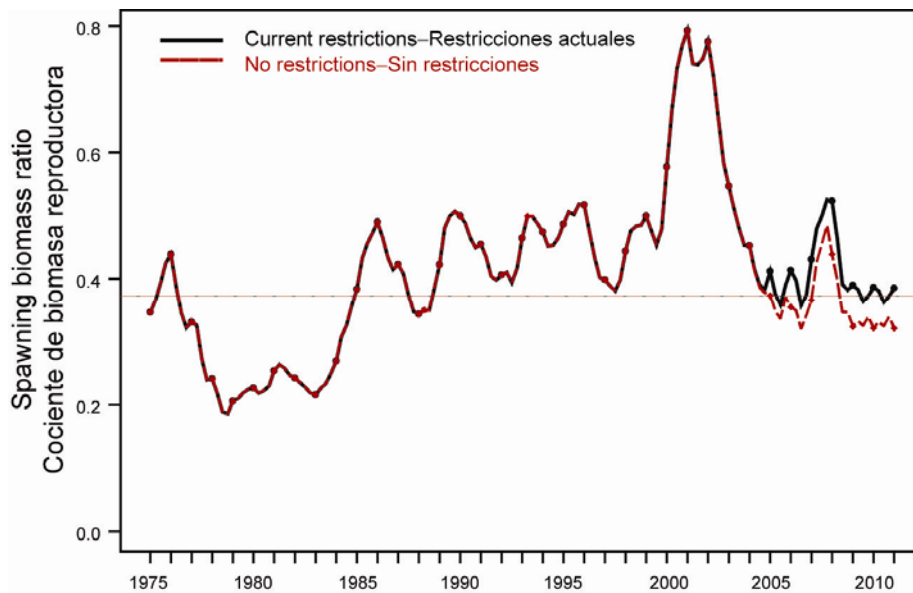


FIGURE 2. Maximum likelihood estimates of the projected spawning biomass ratios (SBRs) of yellowfin tuna, with effort for 2005 and average catchability for 2003 and 2004 (“Base case”) and with purse-seine effort in the fourth quarter from 2004 increased by 86% and effort from 2004 increased in all quarters 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).