INTER-AMERICAN TROPICAL TUNA COMMISSION

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POTENTIAL EFFECTS ON TUNA STOCKS OF ALTERNATIVE MANAGEMENT SCHEMES

At the request of a Member, the staff prepared analyses to estimate the effects of the following three scenarios.

1. The impact on the stocks of continuing the 62-day closure with the current capacity of the purse-seine fleet.
2. The impact on the bigeye tuna stock of an increase of 250 to 1,000 tons in the annual catches of bigeye by longline vessels greater than 24 meter .
3. The impact on the stocks if the purse-seine closure were extended to 72 days, but vessels could divide that period into two or more shorter periods.

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1. What would be the impacts on the stocks if the purse-seine closure continued at 62 days with the current capacity of the purse-seine fleet?

As of 14 July 2017, the capacity of the purse-seine fleet operating in the EPO was 265,027 cubic meters (m^3)[1], greater than both the 30 April 2017 level of 263,283 m^3 used as a basis for the staff's recommendation to the 8th meeting of the Scientific Advisory Committee (SAC) in May 2017 and the 2016 value of 261,555 m^3. It is 7.39% greater than the 2014-2016 average of 246,787 m^3.

The impacts on the stocks of continuing the 62-day closure with the current capacity of 265,027 m^3 were assessed by projecting the population through 2027, assuming average recruitment and increasing the purse-seine fishing mortality (*F*) by 7.39%. For yellowfin (Figure 1, upper panel), due to strong recent recruitments, the spawning biomass (*S*) is predicted to increase above the management target level (S_{MSY}) by mid-2018, then decrease to that level by the end of 2019, and level off at 94%S_{MSY}, assuming no further increase in fishing mortality. For bigeye (Figure 1, lower panel), since the current *F* is estimated to be moderately below the level corresponding to the maximum sustainable yield (F_{MSY}) (*F* multiplier = 1.15), even after adjusting for the increase in purse-seine fleet capacity, the population is predicted to remain above S_{MSY}, assuming average recruitment and no further increase in fishing mortality.

[1] The effect of the capacity increase has been evaluated at the overall fleet level, and the only adjustment for differences in fishing behavior among vessels was for vessels that make a single trip within a year under the special allowance in paragraph 12 of resolution C-02-03, which are counted as one-quarter of their capacity (Document CAP-18-03)

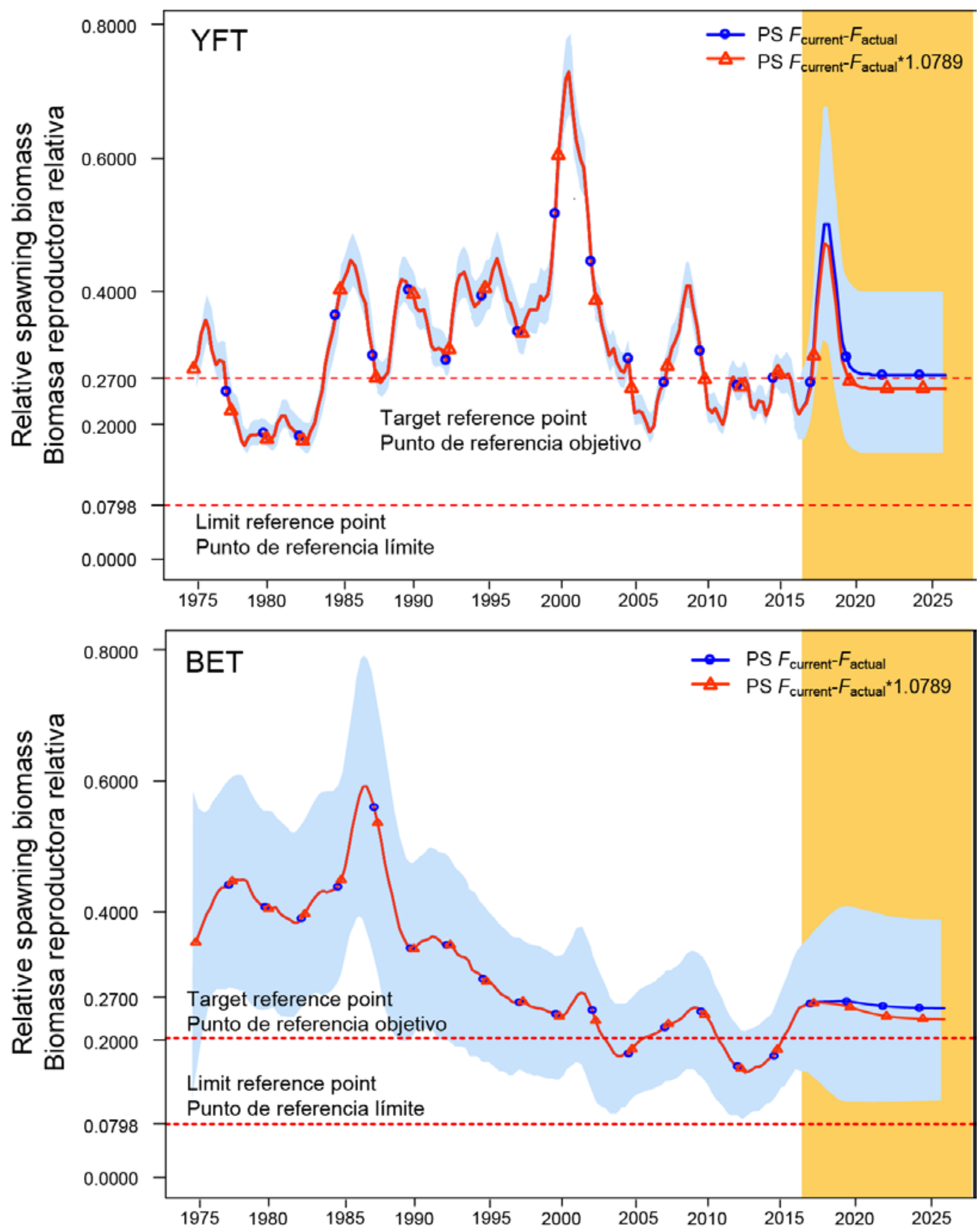

FIGURE 1. Estimated spawning biomass ratios (SBRs) of yellowfin (upper panel) and bigeye (lower panel) tuna in the EPO, including projections (orange shaded area) for 2017-2027 based on: 1) average *F* during 2014-2016 ($F_{current}$) from the base case assessment, and 2) the increase in *F* due to the increase in purse-seine capacity (PS $F_{current}$*1.0739). The dashed horizontal lines, at 0.27 (yellowfin)/0.21 (bigeye) and 0.0798, represent the target (S_{MSY}) and limit reference points, respectively. The solid lines represent the maximum likelihood estimates, and the blue shaded area represents the approximate 95% confidence intervals around those estimates

2. What would be the impact on the bigeye stock if the annual catch of bigeye by longline vessels greater than 24 meters increased by 250 to 1,000 tons?

During 2014-2016 the average annual longline catch of bigeye was 42,159 t. This is predicted to increase to 49,921 t during 2017-2019, assuming no increase in effort. If the increase in fishing mortality resulting from the increased purse-seine fleet capacity is taken into account, it will increase to 49,229 t.

An increase of 1,000 t in catch is equivalent to an increase of about 2.4% in longline *F*. The effect on the spawning biomass over the 10-year projection period would be indistinguishable from the scenario of increased purse-seine *F* alone (Figure 3). Increases of less than 1,000 t would produce lower impacts. All those results have wide confidence intervals (Figure 2).

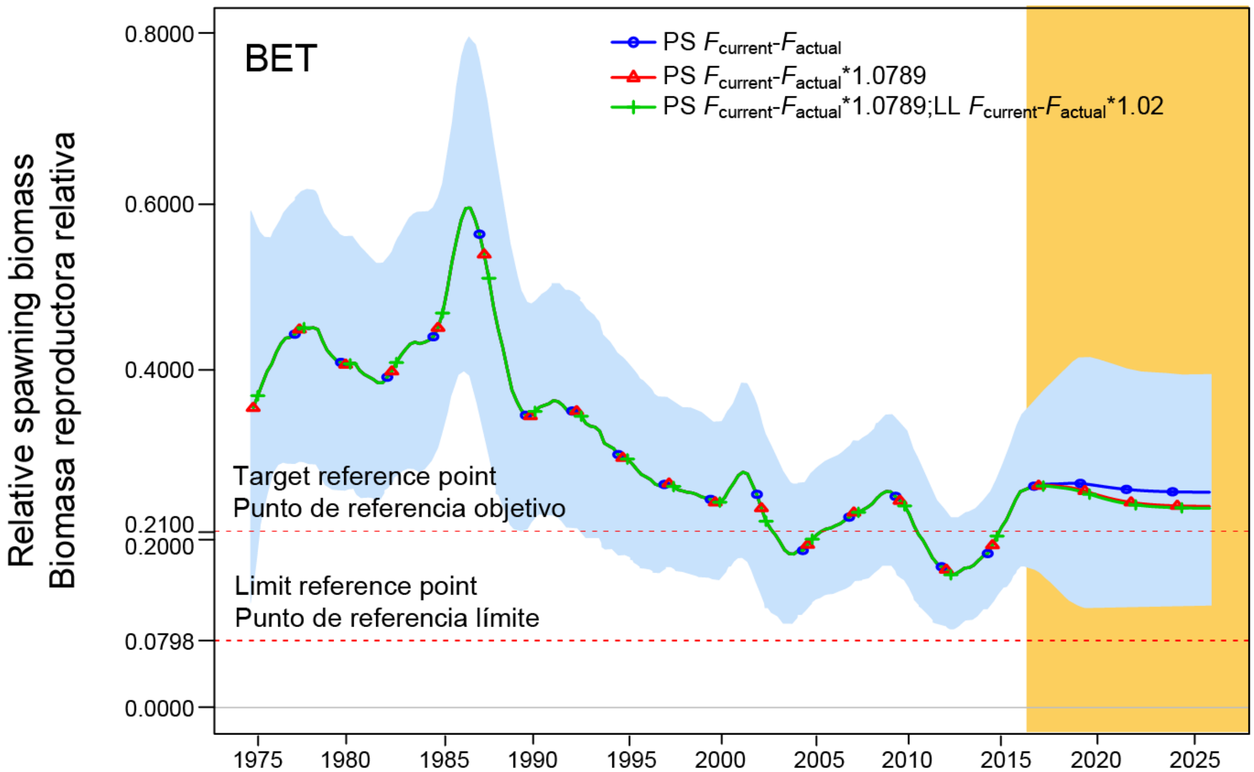

FIGURE 2. Estimated spawning biomass ratios (SBRs) of bigeye tuna in the EPO, including projections (orange shaded area) for 2017-2027 based on: 1) average *F* during 2014-2016 ($F_{current}$) from the base case assessment; 2) the increase in *F* due to the increase in purse-seine capacity (PS $F_{current}$*1.0739); and 3) the increase in *F* for both purse-seine and longline (LL $F_{current}$*1.02) fleets. The dashed horizontal lines, at 0.21 and 0.0798, represent the target (S_{MSY}) and limit reference points, respectively. The solid lines represent the maximum likelihood estimates, and the blue shaded area represents the approximate 95% confidence intervals around those estimates

3. What would be the impact on the stocks if the purse-seine closure were extended to 72 days, but vessels could divide that period into two or more shorter periods?

The current closure periods of 62 consecutive days are from 29 July to 28 September and from 18 November to 18 January. This analysis is based on the assumption that vessels would cease to fish during either two 36-day periods or three 24-day periods (Table 1).

TABLE 1. Closure periods used in the analysis.

	36 days		24 days
1	20 December–25 January	1	20 December–12 January
2	20 March–25 April	2	1 February–24 February
3	1 July–5 August	3	2 April–25 April

4	30 October–4 December	4	8 June–1 July
		5	15 August–7 September
		6	30 October–22 November

The effectiveness of the closures, and the effect on catches, would depend on many factors, including the seasonal variability of effort and catch rates in different regions of the EPO. Also, because of the seasonal closures implemented since 2004, the information available to evaluate such scenarios is biased. Therefore, without more extensive analysis, only the general relative effects of closures at different times of the year can be presented.

The closure scenarios were evaluated with data from 2012-2016. The current 62-day closures extend from 29 July (day 210 of the year) to 28 September (day 271) or from 18 November (day 322) to 18 January (day 18). The closure period a vessel selects depends on many factors, including the set type it mainly makes (floating-object (OBJ), unassociated (NOA), or dolphin-associated (DEL)). Most vessels focus on either floating-object sets or dolphin-associated sets, but also make unassociated sets. The data on the average number of sets, by set type and day of the year, made by individual vessels do not indicate any strong preference by either type of vessel for one or the other closure period (Figure 3). Also, vessels tend to reduce fishing activities at the start and end of the year.

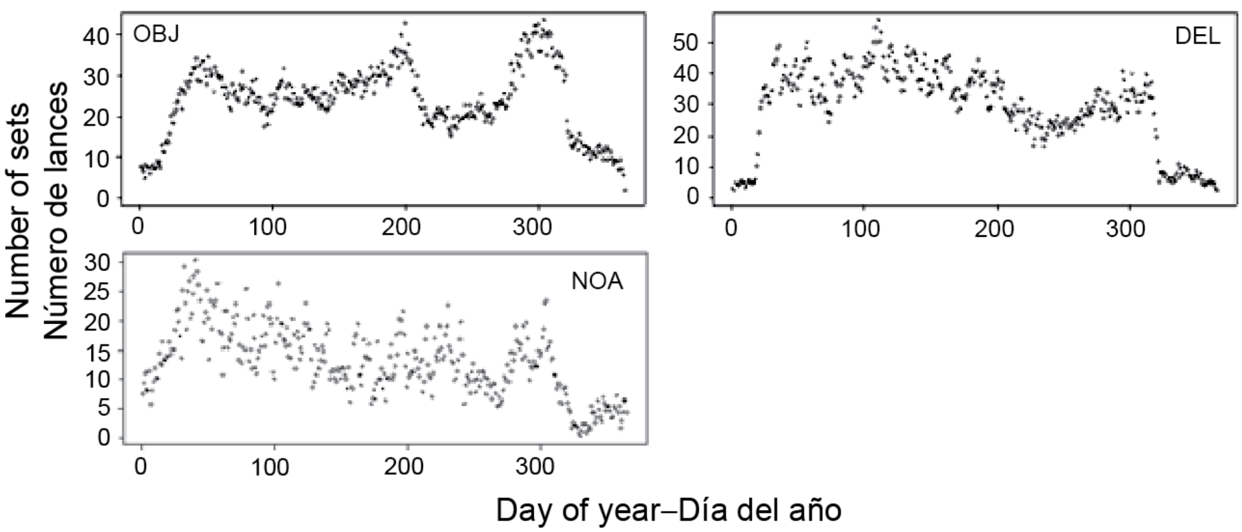

FIGURE 3. Average number of sets, by day of the year and set type, by purse-seine vessels ≥363 t carrying capacity (IATTC Class 6).

Comparison of catch rates (catch-per-unit-of-effort; CPUE) among seasons is the most appropriate way to determine the influence of different timing of the closures. This works best if the CPUE is proportional to abundance, and therefore requires an adequate measure of effort. Unfortunately, effort in purse-seine fisheries is difficult to define. Compounding this issue is that individual vessels make more than one type of set, and allocating effort to each set type is complicated. Therefore, CPUE is calculated in two ways: by simply computing average catch per set for each set type, or by first dividing the vessels into categories based on the proportion of sets of each type that they make, and then calculating the average catch per day fished (CPDF) by vessel category.

Bigeye tuna are caught mainly in the floating-object fishery, so changes in the timing of the closure related to the other purse-seine fisheries will have little impact on the bigeye stock (Figure 4). The catch per set (CPS) of bigeye in the floating-object fishery is lower around days 20-60 and higher around days 100-150. Yellowfin CPS in the floating-object fishery is generally fairly constant throughout the year, but is lower around days 20-60 (Figure 5), while in the dolphin-associated fishery it increases at the beginning of the year, declines slightly during the year, and increases again at the end of the year (Figure 5). In the unassociated fishery it is cyclic, with low catches at the start and end of the year and around day 150 (Figure 5). The CPS of skipjack in the floating-object fishery is lower between about days 100 and 200 (Figure 6). Catches of skipjack in the dolphin-associated fishery are low, and the CPS is highly variable; it is also variable in the unassociated fishery, with lower values around days 160-250 (Figure 6).

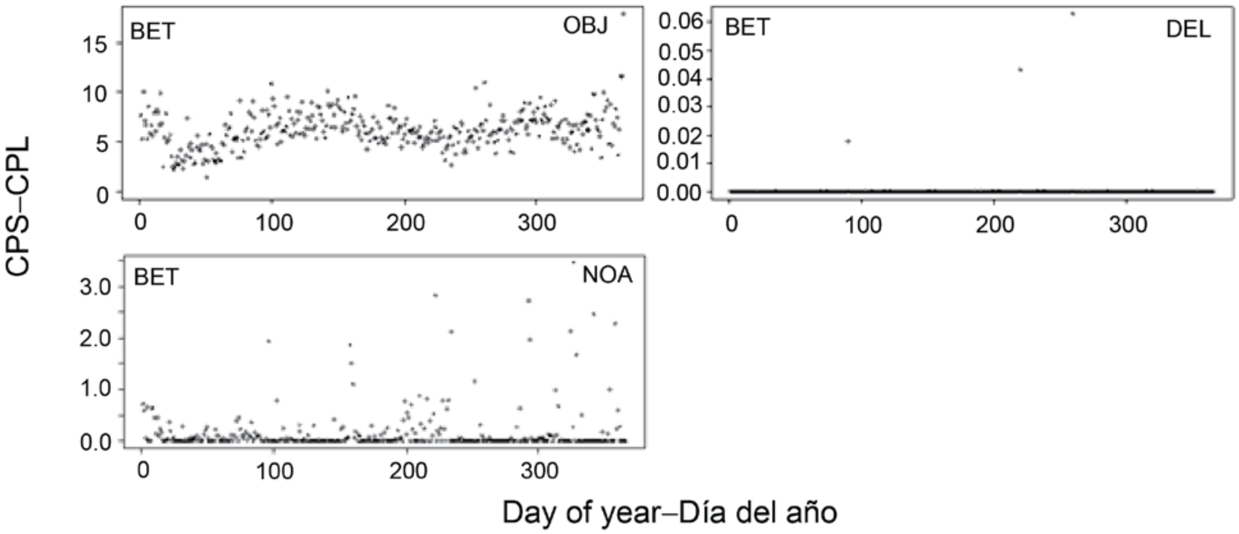

FIGURE 4. Average catch per set of bigeye, by set type and day of the year

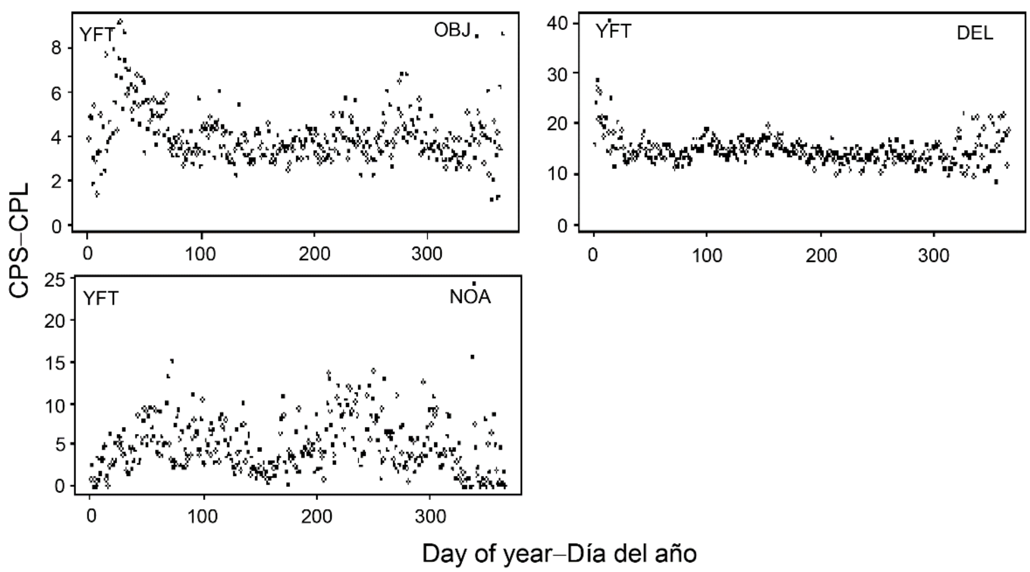

FIGURE 5. Average catch per set of yellowfin, by set type and day of the year

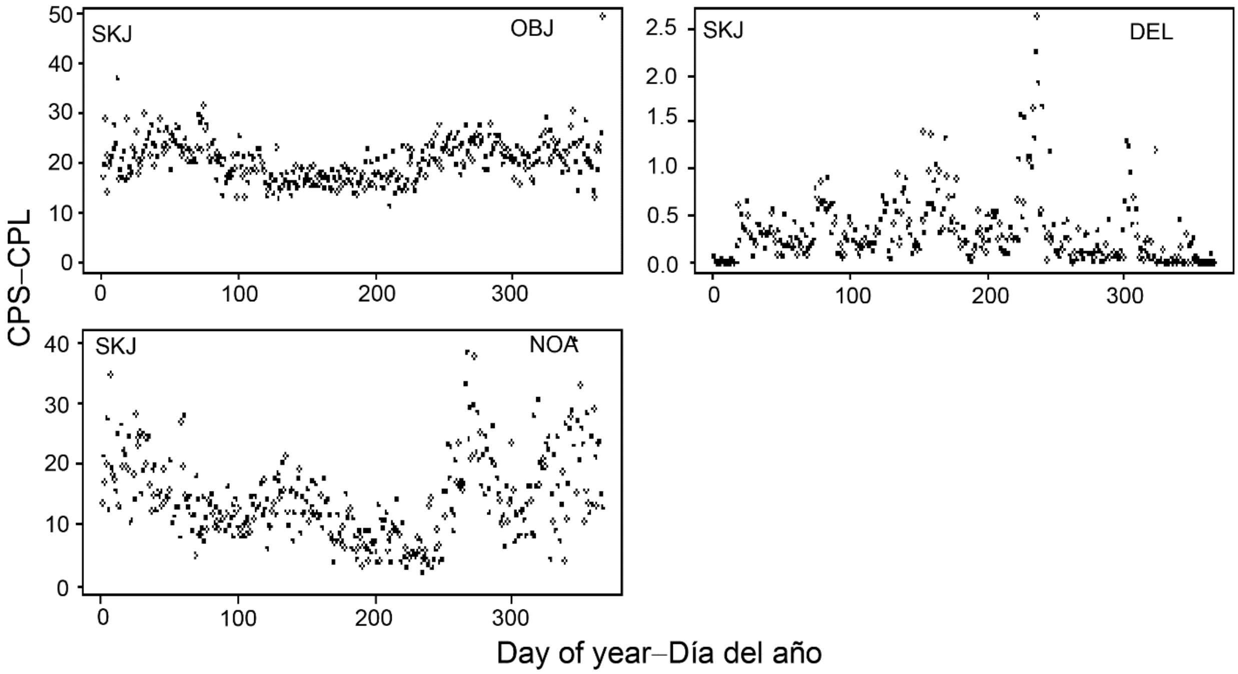

FIGURE 6. Average catch per set of skipjack, by set type and day of the year.

To evaluate seasonal patterns in the CPDF, vessels are classified as follows:

Category	Definition
DEL50+	Vessels that make more than 50% of their sets on dolphins
OBJ50+	Vessels that make more than 50% of their sets on floating objects
DEL10-50	Vessels that make between 10 and 50% of their sets on dolphins, but 50% or less of their sets on floating objects
OTR	Vessels that make less than 10% of their sets on dolphins, and 50% or less of their sets on floating objects

The CPDF of yellowfin for DEL50+ vessels is similar to the CPS of yellowfin in the dolphin-associated fishery, but with a larger decline as the season progresses (Figure 7). The CPDF by species for OBJ50+ vessels (Figure 8) is similar to the CPS for the floating-object fishery. it is variable for vessels of the other two categories (Figures 9 and 10).

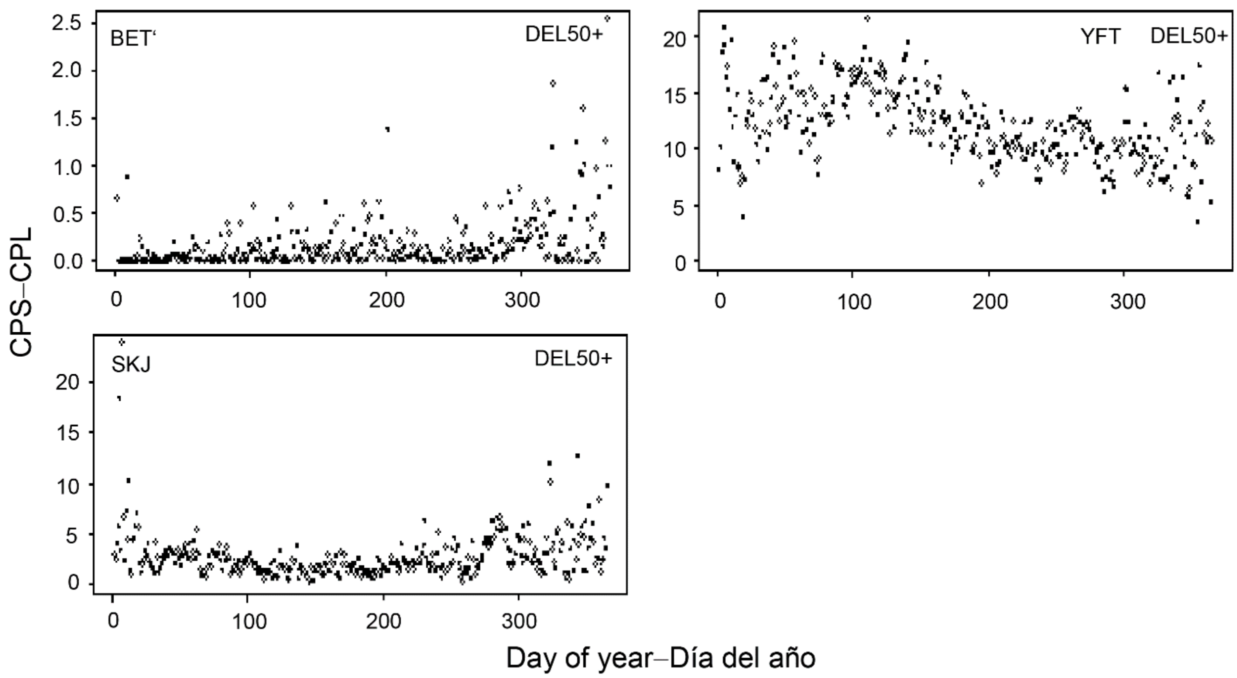

FIGURE 7. Average CPDF, by species, for DEL50+ vessels.

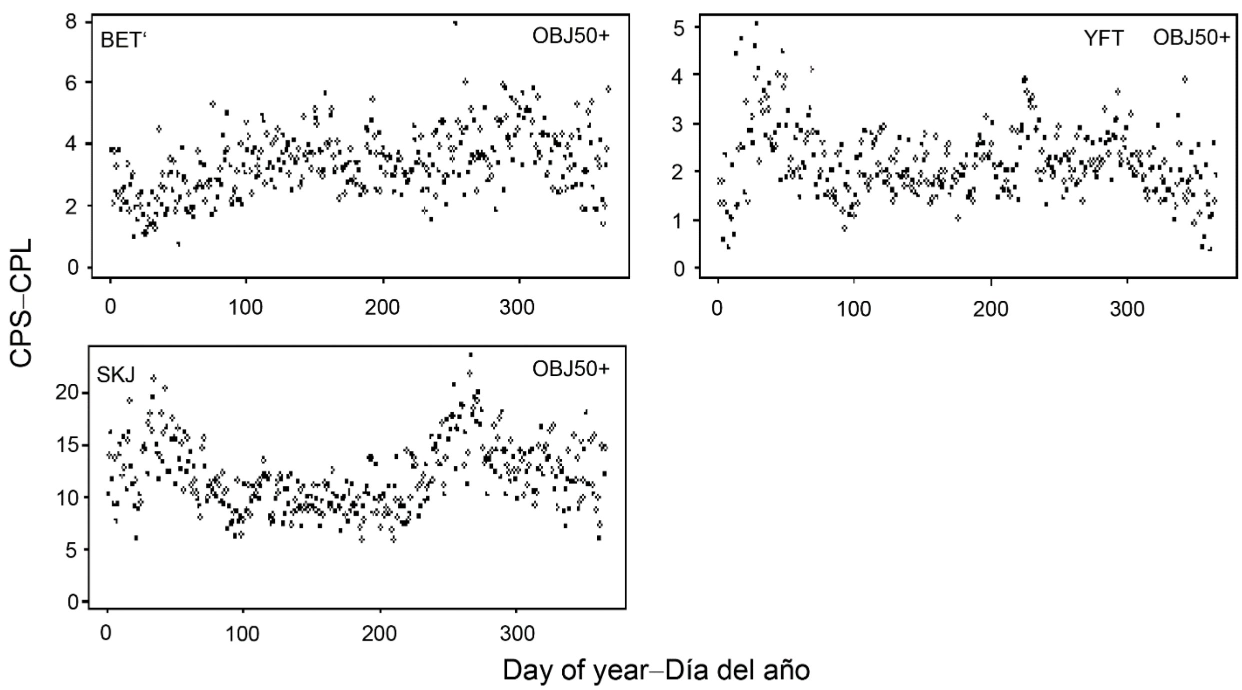

FIGURE 8. Average CPDF, by species, for OBJ50+ vessels.

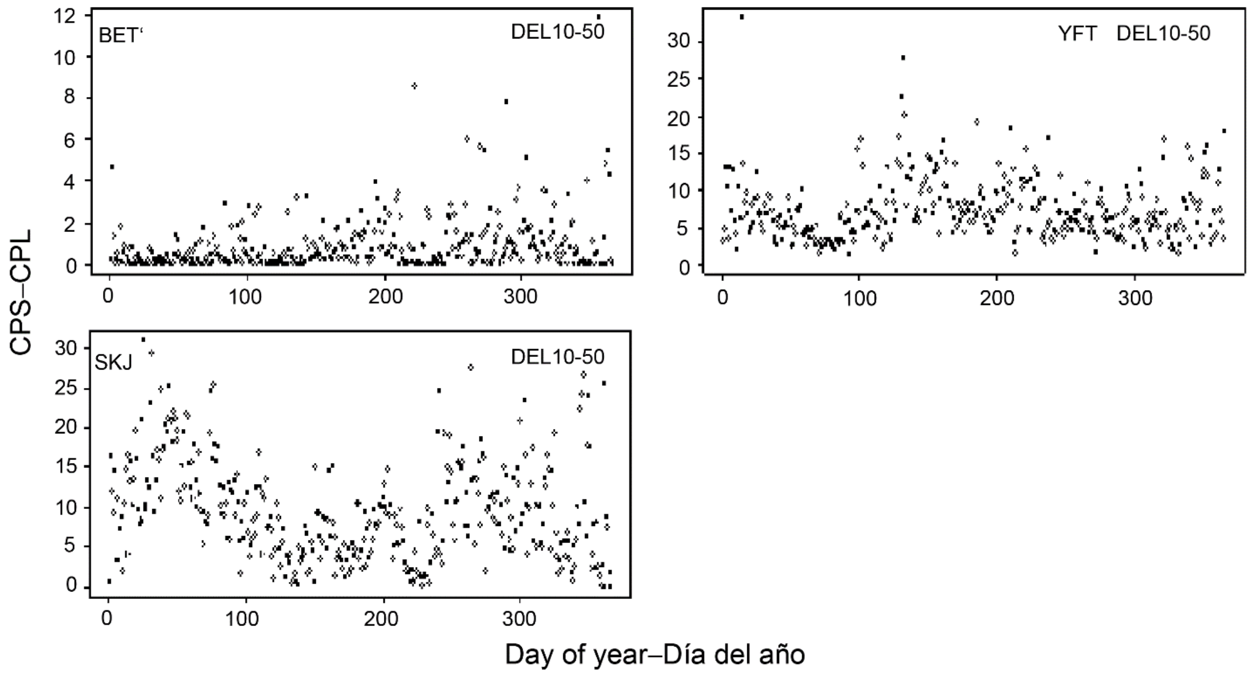

FIGURE 9. Average CPDF, by species, for DEL10-50 vessels.

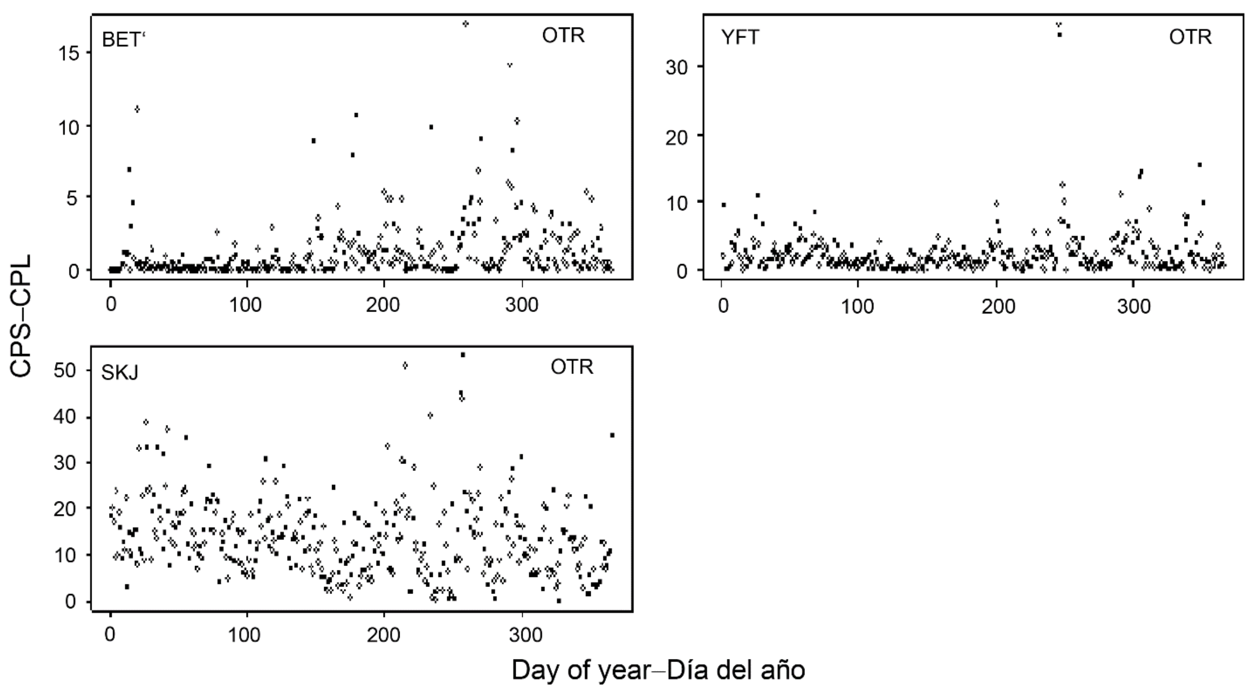

FIGURE 10. Average CPDF, by species, for OTR vessels.

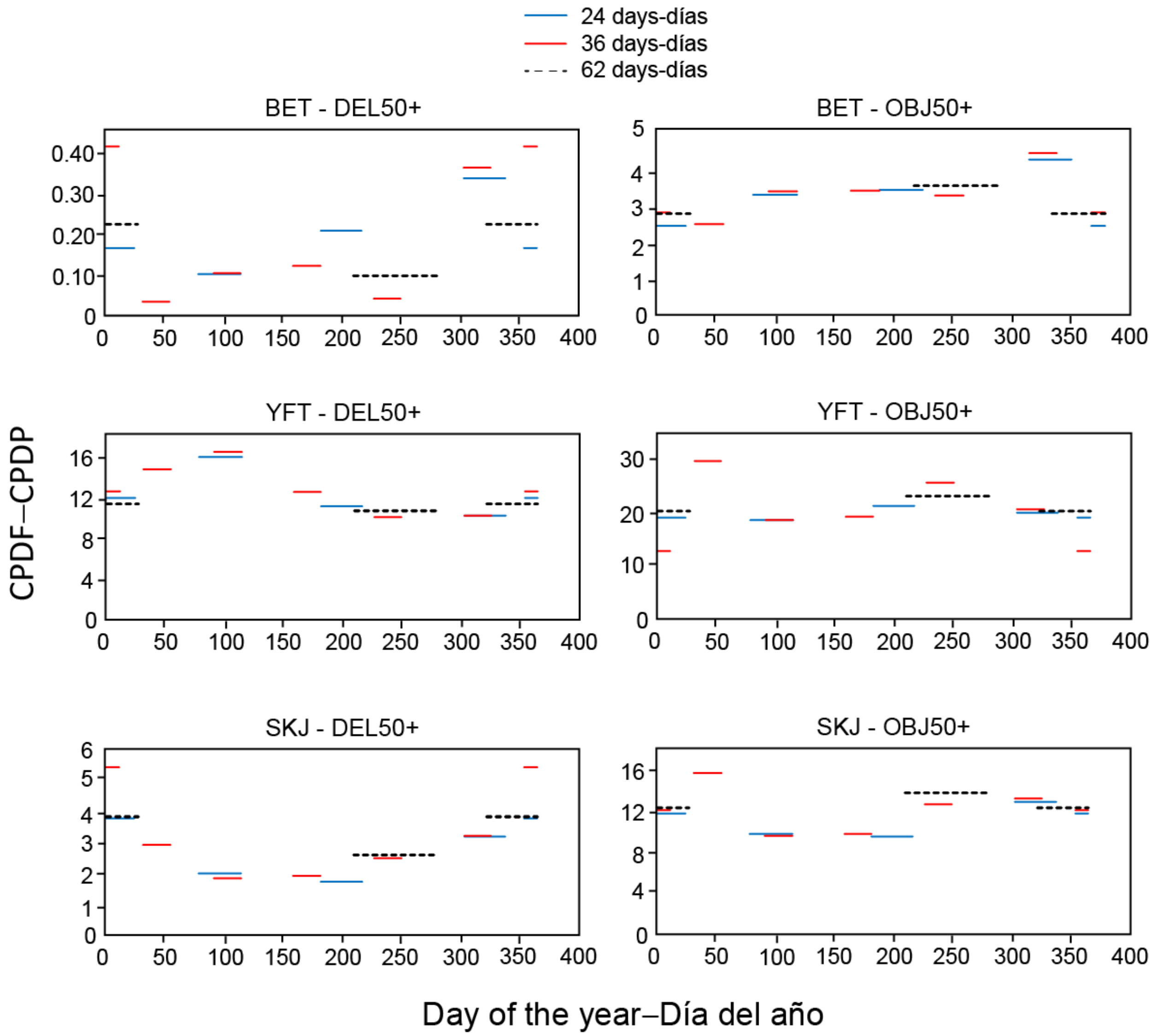

FIGURE 11. Average CPDF, by species and vessel category, for the different closure periods, using data from 2012-2016.

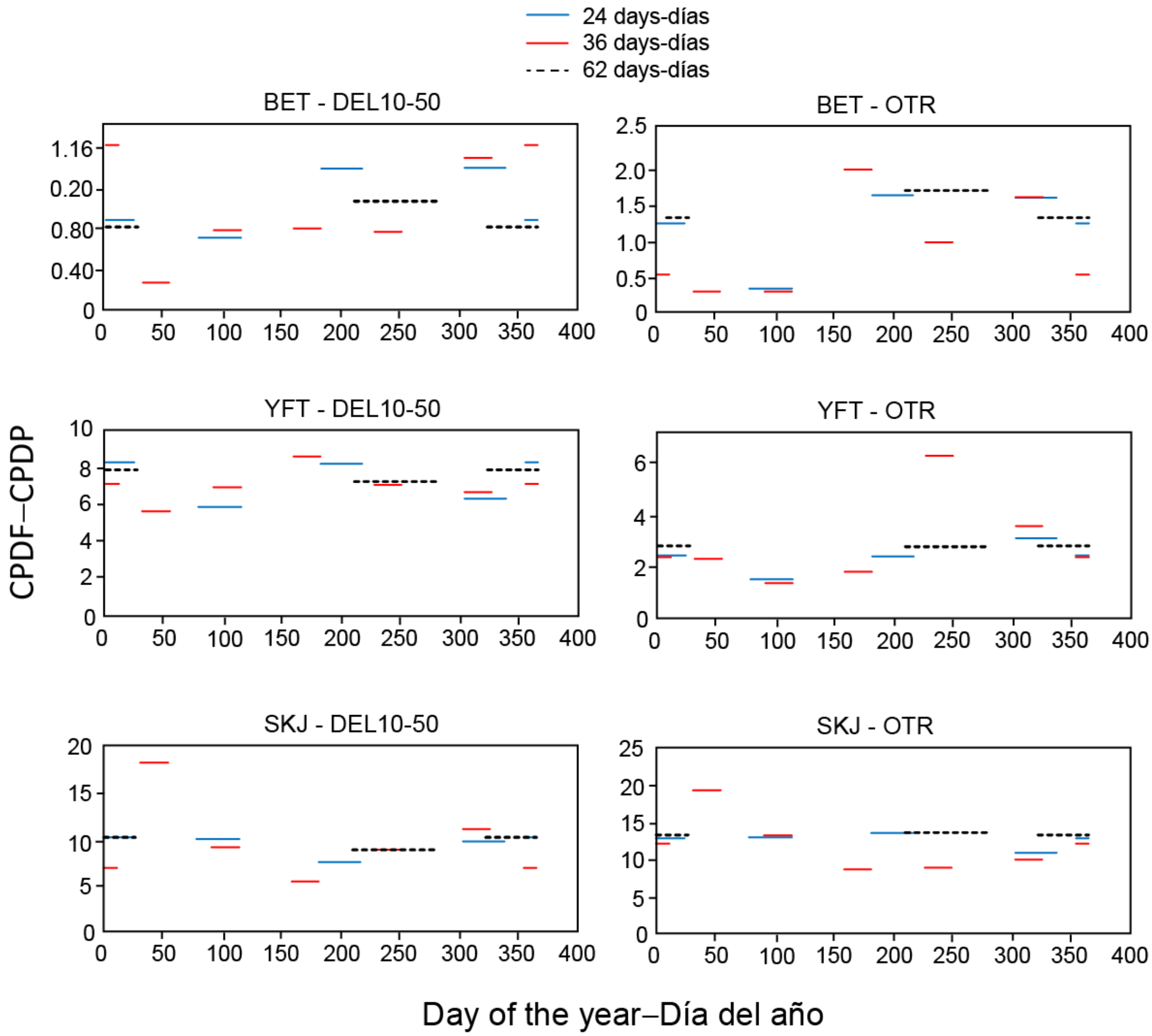

FIGURE 11 (cont.). Average CPDF, by species and vessel category, for the different closure periods, using data from 2012-2016.

TABLE 2. Average CPDF, by species and vessel category, for the different closure periods, using data from 2012-2016. See Table 1 for details of the closure periods.

Closure		**Vessel category**											
		DEL50+			**OBJ 50+**			**DEL10-50**			**OTR**		
		BET	YFT	SKJ	BET	YFT	SKJ	BET	YFT	SKJ	BET	YFT	SKJ
24 days	1	0.17	11.80	3.74	2.48	1.92	11.70	0.87	8.28	10.12	1.19	2.38	12.93
	2	0.10	15.76	1.97	3.33	1.87	9.71	0.70	5.83	9.94	0.30	1.45	13.06
	3	0.21	11.00	1.70	3.45	2.13	9.46	1.36	8.17	7.45	1.58	2.34	13.60
	4	0.34	10.14	3.16	4.28	2.01	12.89	1.37	6.28	9.72	1.54	3.03	10.95
36 days	5	0.42	12.46	5.38	2.83	1.29	12.06	1.59	7.10	6.85	0.49	2.29	12.09
	6	0.03	14.51	2.88	2.53	2.99	15.66	0.26	5.60	18.24	0.26	2.23	19.37
	7	0.11	16.23	1.80	3.41	1.87	9.54	0.77	6.92	9.12	0.26	1.31	13.25

	8	0.12	12.40	1.89	3.43	1.94	9.67	0.79	8.58	5.38	1.92	1.75	8.71
	9	0.04	9.99	2.46	3.29	2.59	12.58	0.75	7.04	8.85	0.94	6.20	8.84
	10	0.37	10.07	3.18	4.47	2.07	13.19	1.47	6.65	11.04	1.55	3.49	10.02
62 days	11	0.10	10.60	2.55	3.56	2.33	13.72	1.05	7.21	8.85	1.64	2.71	13.71
	12	0.23	11.27	3.81	2.82	2.04	12.30	0.80	7.84	10.16	1.27	2.73	13.40

TABLE 3. Average CPDF as a proportion of the average in the current closures, by species and vessel category, different closure periods using data from 2012-2016. See Table 1 for details the closure periods.

Closure		Vessel category											
		DEL50+			OBJ 50+			DEL10-50			OTR		
		BET	YFT	SKJ	BET	YFT	SKJ	BET	YFT	SKJ	BET	YFT	SKJ
24 days	1	1.03	1.08	1.18	0.78	0.88	0.90	0.94	1.10	1.06	0.82	0.87	0.95
	2	0.64	1.44	0.62	1.04	0.86	0.75	0.75	0.77	1.05	0.21	0.53	0.96
	3	1.29	1.01	0.54	1.08	0.98	0.73	1.47	1.08	0.78	1.09	0.86	1.00
	4	2.08	0.93	0.99	1.34	0.92	0.99	1.48	0.83	1.02	1.06	1.11	0.81
36 days	5	2.56	1.14	1.69	0.89	0.59	0.93	1.72	0.94	0.72	0.34	0.84	0.89
	6	0.21	1.33	0.91	0.79	1.37	1.20	0.28	0.74	1.92	0.18	0.82	1.43
	7	0.65	1.48	0.57	1.07	0.86	0.73	0.83	0.92	0.96	0.18	0.48	0.98
	8	0.76	1.13	0.59	1.08	0.89	0.74	0.85	1.14	0.57	1.33	0.64	0.64
	9	0.26	0.91	0.77	1.03	1.18	0.97	0.81	0.94	0.93	0.65	2.28	0.65
	10	2.24	0.92	1.00	1.40	0.95	1.01	1.59	0.88	1.16	1.07	1.28	0.74
62 days	11	0.61	0.97	0.80	1.12	1.06	1.05	1.13	0.96	0.93	1.13	1.00	1.01
	12	1.39	1.03	1.20	0.88	0.94	0.95	0.87	1.04	1.07	0.87	1.00	0.99

As noted above, there appears to be no strong preference among DEL50+ or OBJ50+ vessels to select exclusively one or the other of the current closure periods. However, vessels tend to reduce fishing activities at the start and end of the year. The catch rates of the three tropical tuna species differ somewhat seasonally, and therefore the effectiveness of the closures for each species will depend to some degree on their timing. Some of these trends are probably consistent among years, while others could change over time. In general, catch rates of bigeye in the floating-object fishery are lower at the start of the year, while those of yellowfin in the dolphin-associated fishery decline throughout the year.

In addition to catch rates, there are several other factors that need to be taken into consideration when determining the effectiveness of various closures. For example, closures during a period when vessel tend not to fish anyway, like around the end of the year, will have little effect. Multiple short closures will mean that vessel maintenance and repair that would normally reduce fishing time can be done within the closure period. In addition, if the closures are shorter it may be practical to leave FADs in the water to continue attracting fish.