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FLOATING-OBJECT FISHERY INDICATORS: A 2022 REPORT

Jon Lopez, Marlon H. Román, Cleridy E. Lennert-Cody, Mark N. Maunder, Nick Vogel, Leanne M. Fuller

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SUMMARY

The importance of monitoring the FAD fishery as a whole has widely been claimed by scientists, managers and other stakeholders. Based on the recommendations and guidelines of the joint technical Working Group on FADs (Lopez, 2019), as well as the repeated requests by some member countries on the production of specific data and analyses (e.g. IATTC-93 INF-A), this document compiles a comprehensive series of spatial and temporal indicators for the floating-object fishery in the EPO with the aim to better monitor and assess its potential impacts in the short, medium and long term. The indicators have been grouped into 8 categories: catch and effort, activities on FADs, satellite buoy-based indices, capacity, technology, ecosystem impacts, socio-economic, and biology, ecology and behavior indicators. This document will also inform data collection and reporting needs on FADs and prioritize future actions for conservation and management of target, non-target species and the ecosystem.

1. INTRODUCTION

The tropical tuna purse-seine fishery in the Eastern Pacific Ocean (EPO) is one of the biggest in the world, with recent annual catches exceeding 600,000 tons (SAC-14-03). Also, recently, about 60% of the catches correspond to the floating object (OBJ) fishery, which includes man-made fish aggregating devices (FADs) and natural objects (logs). However, the vast majority of activities conducted by purse seiners (e.g. sets, deployments) since mid-90s are on FADs (SAC-14-03).

Despite being a very efficient fishing tool, the continual increase in the use of FADs by the purse seine fishery raises the possibility of several potential negative impacts on ecosystems and tuna populations. Examples include i) a reduction in yield per recruit of some tuna species, ii) increased bycatch and perturbation of pelagic ecosystem balance, iii) increased amount of marine debris and stranding events on sensitive habitats, and, iv) alteration of the normal movements of the species associated with FADs (Dagorn et al. 2012; Escalle et al. 2019). Because of the multi-dimensional potential impacts of the fishery, it must be holistically monitored through a series of comprehensive metrics and indicators that capture its evolution and dynamics at different spatial and temporal scales. Considering a wide variety of indicators can improve both the integral assessment of the impacts of the fishery and the utility and interpretation of the results, whereas single indicators can be misleading and lead to conservation measures that do not meet management objectives.

The importance of monitoring the FAD fishery as a whole has widely been claimed by scientists, managers and other stakeholders, who, during the 1rst joint t-RFMO Working Group (WG) on FADs meeting in Madrid in 2017, agreed to establish a small technical working group (TWG) to progress on key areas for future action. These aspects, largely technical or of scientific nature, range from the development of harmonized definitions to the coordination of regional and international research plans, but also include the development of fishery indicators, a task led by the IATTC staff within the TWG since 2018. An extensive list with more than 40 indicators grouped in 8 categories (Table 1), from catch and effort to ecosystem indicators (Lopez, 2019), was presented and discussed during the 2nd joint t-RFMO Working Group on FADs meeting in San Diego in 2019. The process resulted in 4 of the categories considered as “major” priority indicators: catch and effort, activities on FADs, satellite buoy-based indices, and capacity (Table 1). Indicators related to the technology onboard and ecosystem impacts were classified as “moderate” priority level. Socio-economic and biology, ecology and behavior indicators, although important, were considered as “minor” priority level by this first assessment, particularly due to the difficulties to regularly obtain reliable and significant amounts of data on these matters.

Based on the recommendations and guidelines of the TWG , as well as the repeated requests by some member countries on the production of specific data and analyses (e.g. IATTC-93 INF-A), this document compiles a comprehensive series of spatial and temporal indicators for the floating-object fishery in the EPO with the aim to better monitor and assess its potential impacts in the short, medium and long term. It will also inform data collection and reporting needs on FADs and prioritize future actions for conservation and management of target, non-target species and the ecosystem.

TABLE 1. A list of the indicator types considered by Lopez *et al.* 2019 and discussed and prioritized during the 2nd joint t-RFMO working group on FADs.
TABLA 1. Lista de los tipos de indicadores considerados por Lopez *et al*. 2019 que fueron discutidos y priorizados durante la segunda reunión del Grupo de Trabajo conjunto de las OROP atuneras sobre plantados.

Indicator Type	Priority level (1 Major, 2 Moderate, 3 Minor)
Catch and effort	1
Activity	1
Buoy/FAD use	1
Capacity	1
Technology	2
Ecosystem Impacts	2
Socio-Economic	3
Biology, Ecology and Behavior	3

2. MATERIALS AND METHODS

2.1. Data

Three main datasets were used in the study:

a. 2017-2022[1] AIDCP observer data for Class-6 vessels, which contain FAD-related information such as deployment, origin, and object characteristics, as well as on fishing activities on FADs. This dataset was used to estimate the indicators in the following categories: fleet behavior, activities, and technology.
b. Catch and effort data for all vessels (Classes 1-6), from observers and vessel logbooks. This dataset was exclusively used to estimate catch and effort indicators, including catch by set type, catch by species, and number of OBJ sets, among others.
c. Daily active buoy data for 165 vessels (Classes 1-6) reporting under Resolution C-17-02 and C-20-06 between 2018-2021 and Resolution C-21-04 in 2022. Daily vessel coverage and reporting rates vary by size class and month (e.g., min = 137, mean = 148, max = 158 for 2022), with not all vessels present in the active buoy dataset at any one time. See 2022 report of the Review Committee for further details on data reporting rates and categories. This dataset was used to estimate the indicators in the buoy-based indices category.

Indicators for categories biology, ecosystem impacts and capacity were not estimated in this study but extracted from the fishery status report (FSR) (SAC-14-03) and the Ecosystem Consideration report (SAC-14-11). The indicators included in this document refer mainly to FADs, unless the contrary is specified.

2.2. Methods

Because the degree to which each vessel fishes on OBJ is vessel-specific, all the indicators were, when possible, broken down into different OBJ-usage categories (see section 3.1. below for details) to better understand and detect the fishery evolution and dynamics.

All the indicators were estimated for 2022 and averaged for the previous five years (i.e. 2017-2021) to allow comparison between periods and detect potential anomalies; the exceptions are catch and effort

[1] Except for the long-term deployment and retrieval indicator, where 2005-2020 data were used

indicators, which are taken from the FSR and have longer time series, and the long-term deployment and retrieval trend, an indicator repeatedly requested by some Members. In addition, yearly indicators were also estimated, as well as trip (e.g. activities within the trip), quarterly (e.g. activities), monthly (e.g. buoy-densities) or daily (e.g. total active buoys) indicators, when appropriate and depending on data availability, quality and resolution. A 1°x1° cell resolution was used to estimate spatial indicators. Summary statistics, convex hull areas (i.e. density areas where 66% of the activites of the fleet segments occur), and boxplots, as well as frequency and density histograms were also produced to describe the general trends of many indicators, particularly those based on observer data to depict cluster-specific dynamics (see section 3.1 for clustering details).

When observer data were used to estimate indicators, data corresponding to Class 1-5 vessels and Class-6 vessels conducting less than 5 OBJ sets per year were not included based on the following reasons: i) few Class-6 vessels conduct less than 5 OBJ sets per year and their impact on the OBJ fishery is negligible compared to the rest of the FAD-oriented vessels, which are the focus of this document; ii) Class 1-5 vessel data are not collected systematically for the whole fleet, lack consistency (e.g. voluntary versus mandatory programs, yearly differences in coverage and quality, time series), and in the past, have typically corresponded to vessels that needed to carry an observer for specific reasons (e.g. certification purposes, closure fishing), and thus, the representativeness of these data remains unkown. The latter is of particular importance as the FAD form 09-2018[2] (a logbook designed to be used by skippers of small vessels; Res C-19-01) intends to collect the most significant FAD-oriented data for vessels not carrying observers (e.g. activities, bycatch of sensitive groups of species, FAD characteristics by Class 1-5 vessels). However, and despite recent improvements, the reporting ratio and the quality of the data currently being provided on the FAD form may be not representative for this component of the fleet, and thus, no valid assumptions can be made at this stage. Moreover, not all vessels are reporting buoy data under Resolution C-17-02 and C-20-06 in 2018-2021 or under Resolution C-21-04 in 2022 (see point c in section 2.1). Because of this, the indicators estimated using only Class-6 data (e.g. activities), or using data partially reported (e.g. buoy-based indices), might be understimates. Nonetheless, we believe that those indicators represent well Class-6 vessels patterns and depict properly overall trends for the whole fleet.
Specifics on the exceptions, rules and assumptions considered in the development of each indicator, if any, are specified for each indicator below.

3. INDICATORS

3.1. Fleet behavior

To identify fleet segments among Class-6 vessels based on their fishing strategies, a cluster analysis was conducted using operational characteristics related to OBJ fishing (number of vessels per year included in the analysis: min = 127, max = 156, mean = 146). Only Class-6 vessels making at least five OBJ sets per year during 2017-2022 were considered (for convenience, detailed results of the cluster are only shown for the analysis year, 2022). The methodology described in Lennert-Cody et al. (2018) was applied, where vessels were grouped into different fleet segments based on the following variables: (i) proportion of OBJ sets by object "origin" category (FADs deployed by the vessel on the current trip or a previous trip; FADs deployed by other vessels, either "given" by another vessel or encountered opportunistically, "taken"; unmonitored drifting objects – presumably natural objects such as logs); (ii) proportion of sets made by type (on tuna associated with dolphins, "DEL"; on unassociated schools of tuna, "NOA"; on OBJ); and (iii) proportion of OBJ sets made in the western EPO (west of 100°W).

The cluster analysis indicated several clear vessel groupings with different fishing behaviors (Figs 1-2). There are three main clusters in the dendrogram produced by the cluster analysis, labelled Clusters A-B-

[2] Download at https://www.iattc.org/Downloads.htm

C. Cluster A is comprised of vessels for which about 30% or more of their sets were DEL, with many making almost exclusively DEL sets. Most of the OBJ sets made by the vessels in Cluster A tended to be on FADs that were "taken" or were on unmonitored drifting objects, presumably logs. The majority of OBJ sets conducted by vessels in Cluster A were west of 100°W. The number of vessels in Cluster A ranged from 19 to 40 in the study period and the 2022 value was 31 (Figs 1-2). Cluster B is comprised of vessels that primarily made OBJ sets, with a few vessels also making UNA sets and almost no vessels making DEL sets. OBJ sets of the vessels in Cluster B tended to be west of 100°W and were primarily on FADs deployed by the vessels themselves or on FADs that were "given". The number of vessels in Cluster B ranged from 35 to 50 in the study period and the 2022 value was 45 (Figs 1-2). Cluster C is comprised of vessels that mostly made a lesser proportion of OBJ sets and a greater proportion of UNA sets, as compared to the vessels in Cluster B, with few vessels making DEL sets. Vessels in Cluster C tended to make more OBJ sets east of 100°W and a greater proportion of their OBJ sets were on FADs that were "taken" or were on unmonitored drifting objects, presumably logs. The number of vessels in Cluster C ranged from 57 to 79 in the study period and the 2022 value was 77 (Figs 1-2). The patterns for 2022 are similar to those found by Lopez et al. 2020 (FAD-05-INF-A), Lopez et al. 2021 (FAD-05-INF-C) and Lopez et al. 2022 (FAD-06-01) for 2018-2021 and by Lennert-Cody et al. (2018) for 2012-2015, suggesting that these fleet segment characterizations are not the result of an anomalous year. All three fleet segments seem to represent different OBJ-fishing strategies (e.g. Cluster B – nearly pure OBJ-oriented, fishing FADs monitored by themselves, so a clearer connection between active FADs and number of sets should be expected, for example). Therefore, the cluster analysis results were used to break down the indicators by cluster when possible, so that a better understanding of the relationship between the different metrics and the trends included in this document is possible.

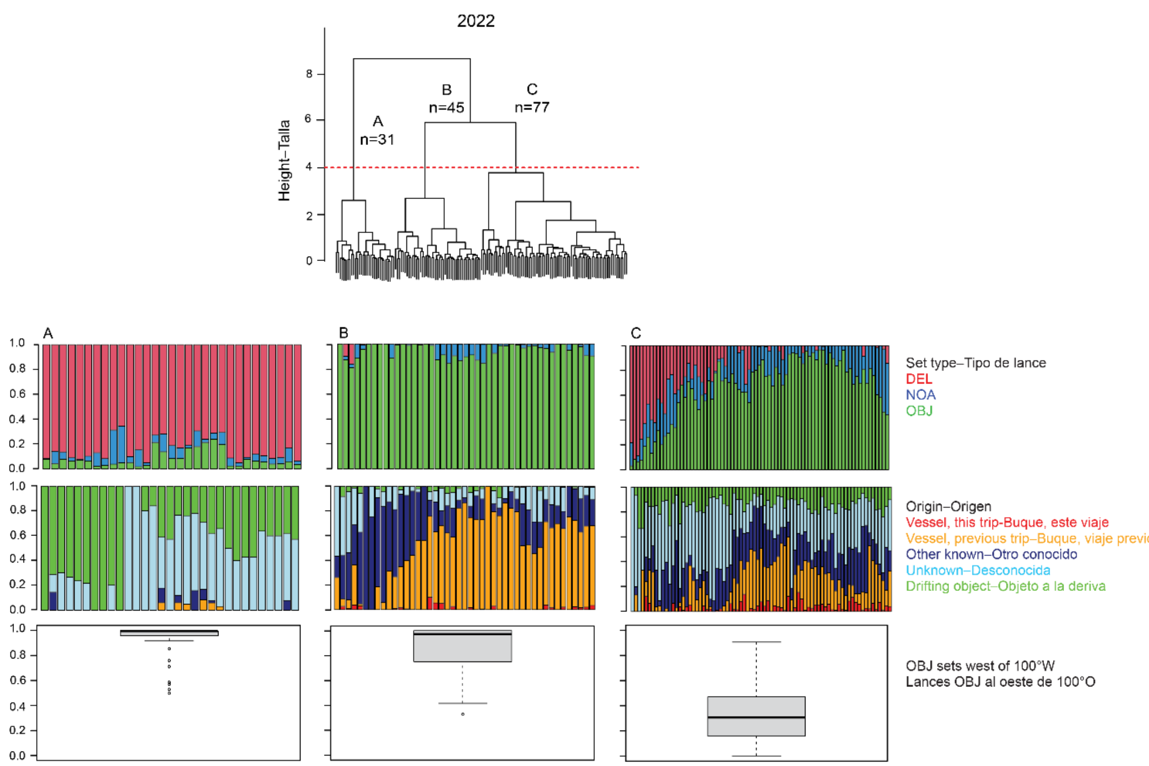

FIGURE 1. Fleet segments identified by the cluster analysis, 2022. Cluster A, B and C include 31, 45 and 77 vessels, respectively.

FIGURA 1. Segmentos de la flota identificados por el análisis de conglomerados, 2022. Los conglomerados A, B y C incluyen 31, 45 y 77 buques, respectivamente.

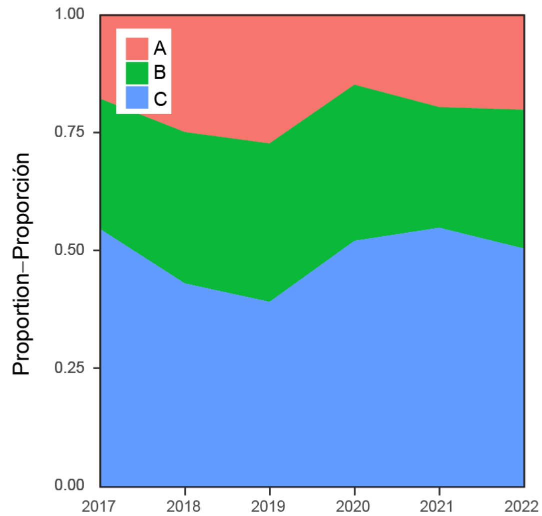

FIGURE 2. Evolution of the proportion of Clusters A, B, and C, 2017-2022.
FIGURA 2. Evolución de la proporción de los conglomerados A, B y C, 2017-2022.

3.2. Catch and effort

The purse-seine tropical tuna catch (section 3.2.1; catch by set type, Fig. 3; catch by species in mt and numbers, Fig. 4-5; spatial distribution of catches, Fig. 6) and effort (section 3.2.2; Number of set per set type, Fig. 7; OBJ sets by class, Fig. 8; Sets by OBJ type, Fig. 9; Cumulative number of OBJ sets, Fig. 10) indicators included in this section were taken/modified/updated from documents SAC 14-03, SAC 14-04 and IATTC-93 INF-A, whereas the catch per set indicators (section 3.2.3; Fig. 11) were estimated using Class-6 observer data only to depict cluster-specific differences based on different OBJ-fishing strategies.

3.2.1. Catch

3.2.1.a Catch by set type

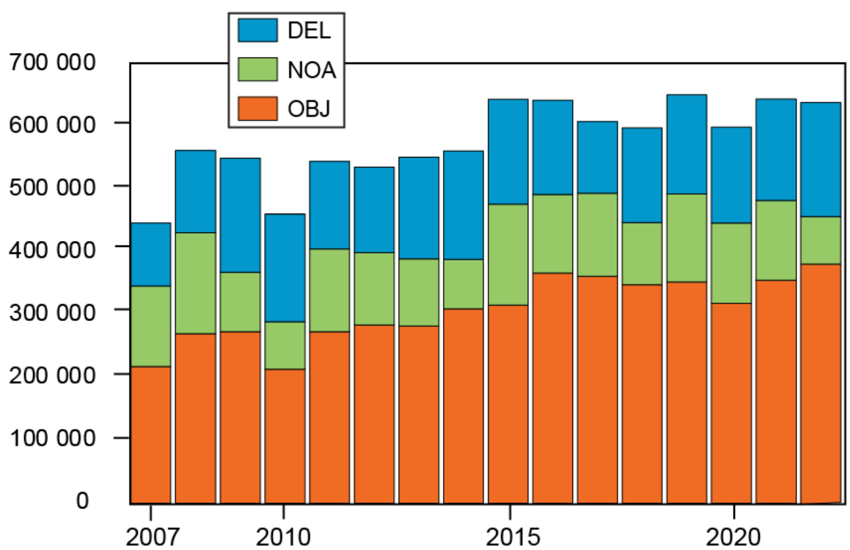

FIGURE 3. Evolution of purse-seine tropical tuna catches, by set type (OBJ: floating object; DEL: dolphin; NOA: unassociated), 2007-2022. Source: Document SAC-14-03, Table A-7.
FIGURA 3. Evolución de las capturas cerqueras de atunes tropicales, por tipo de lance (OBJ: objeto flotante; DEL: delfín; NOA: no asociado), 2007-2022. Fuente: Documento SAC-14-03, Tabla A-7.

3.2.1.b Catch by species (in weight)

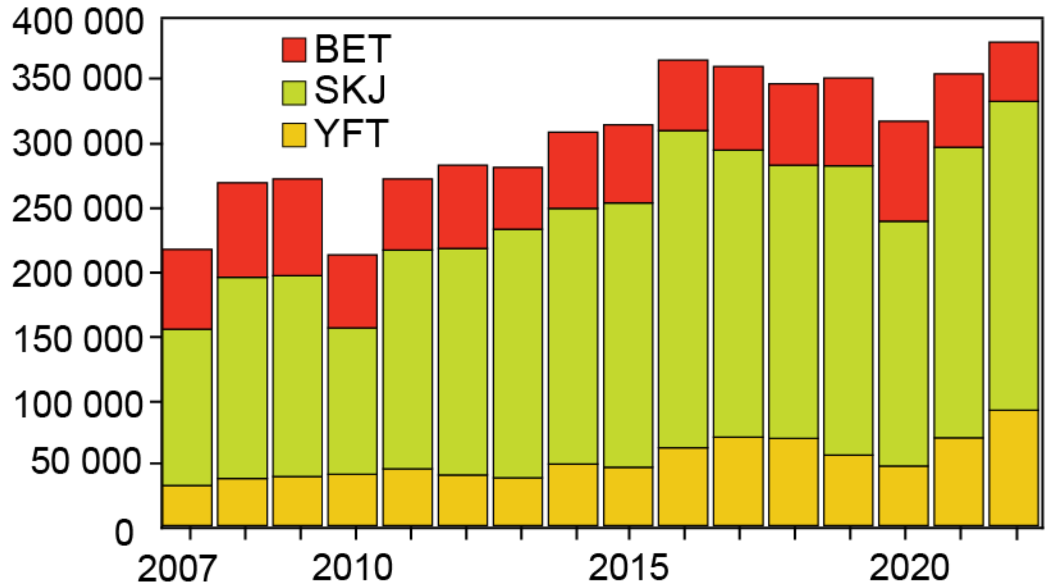

FIGURE 4. Evolution of purse-seine OBJ catches (mt), by species (BET: bigeye; SKJ: skipjack; YFT: yellowfin), 2007-2022. Source: Document SAC-14-03, Table A-7.
FIGURA 4. Evolución de las capturas OBJ de cerco (t), por especie (BET: patudo; SKJ: barrilete; YFT: aleta amarilla), 2007-2022. Fuente: Documento SAC-14-03, Tabla A-7.

3.2.1.c Catch by species (in numbers)

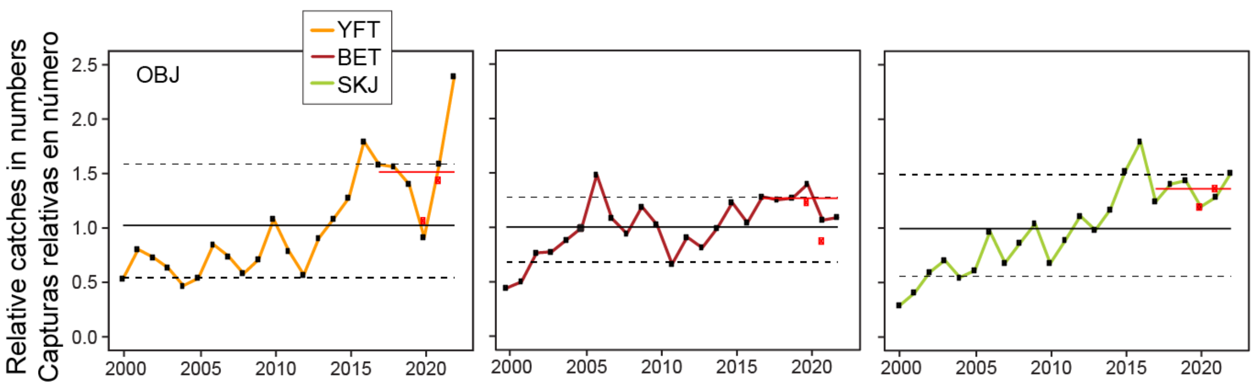

FIGURE 5. Indicators based on purse-seine catch in numbers, 2000-2022. Source: Document 4, Fig 2b
FIGURA 5. Indicadores basados en la captura de cerco, en número, 2000-2022. Fuente: Documento SAC-14-04, Fig. 2b

3.2.1.d Spatial distribution of OBJ catches

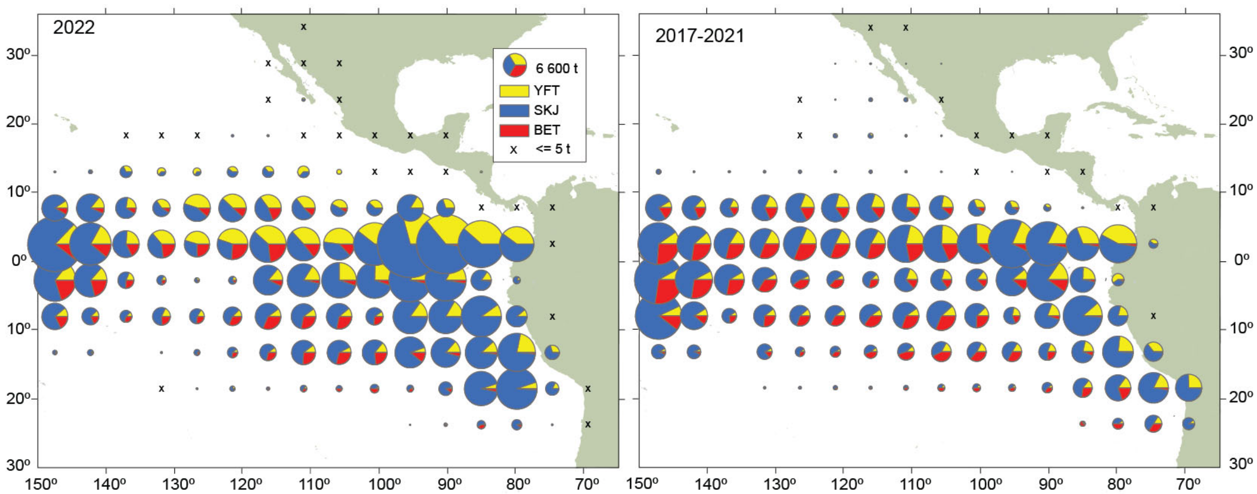

FIGURE 6. 5°x5° purse-seine catches on OBJ by species for 2022 (left panel) and the 2017-2021 averages (right panel).

FIGURA 6. Capturas OBJ de cerco 5°x5° por especie, en 2022 (panel izquierdo) y los promedios de 2017-2021 (panel derecho).

3.2.2. Effort

3.2.2.a Number of set per set type

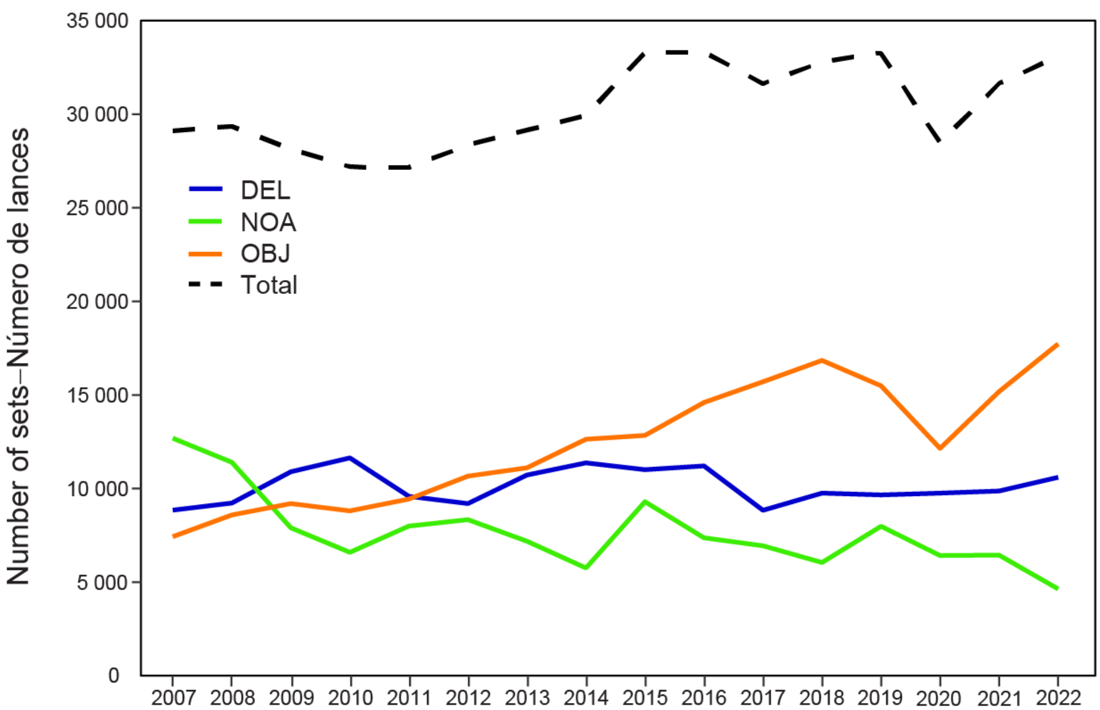

FIGURE 7. Evolution of the number of purse-seine sets, by set type (OBJ: floating object; DEL: dolphin; NOA: unassociated), 2007-2022. Source: Document SAC-14-03, Table A-7.

FIGURA 7. Evolución del número de lances cerqueros, por tipo de lance (OBJ: objeto flotante; DEL: delfín; NOA: no asociado), 2007-2022. Fuente: Documento SAC-14-03, Tabla A-7.

3.2.2.b OBJ sets by class

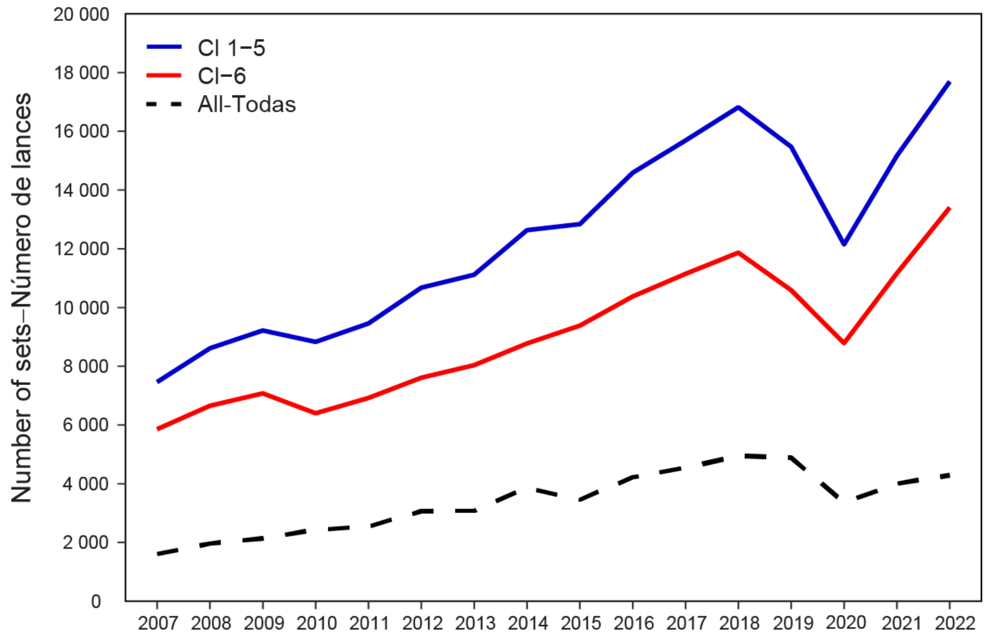

FIGURE 8. Evolution of the number of floating-object sets by Class 1-5 and Class 6 vessels, 2007-2022. Source: Document SAC-14-03, Table A-7.
FIGURA 8. Evolución del número de lances sobre objetos flotantes por buques de clases 1-5 y clase 6, 2007-2022. Fuente: Documento SAC-14-03, Tabla A-7.

3.2.2.c Sets by OBJ type

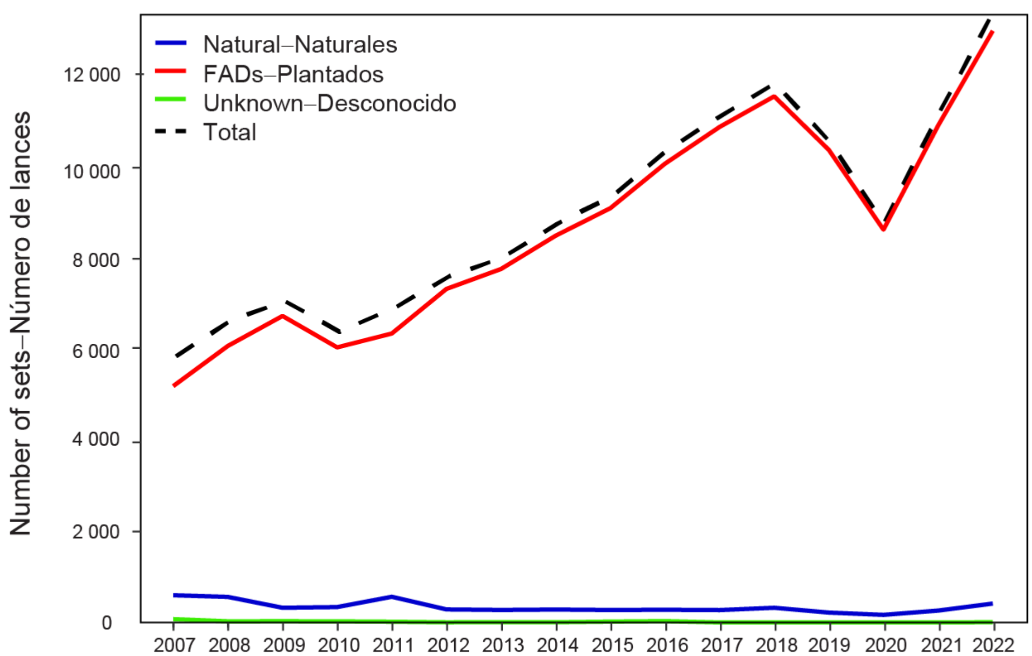

FIGURE 9. Evolution of the number of floating-object sets by Class-6 vessels, by type of floating object, 2007-2022. Source: Document SAC-14-03, Table A-8.
FIGURA 9. Evolución del número de lances sobre objetos flotantes por buques de clase 6, por tipo de objeto flotante, 2007-2022. Fuente: Document SAC-14-03, Table A-8.

3.2.2.d Cumulative number of OBJ sets

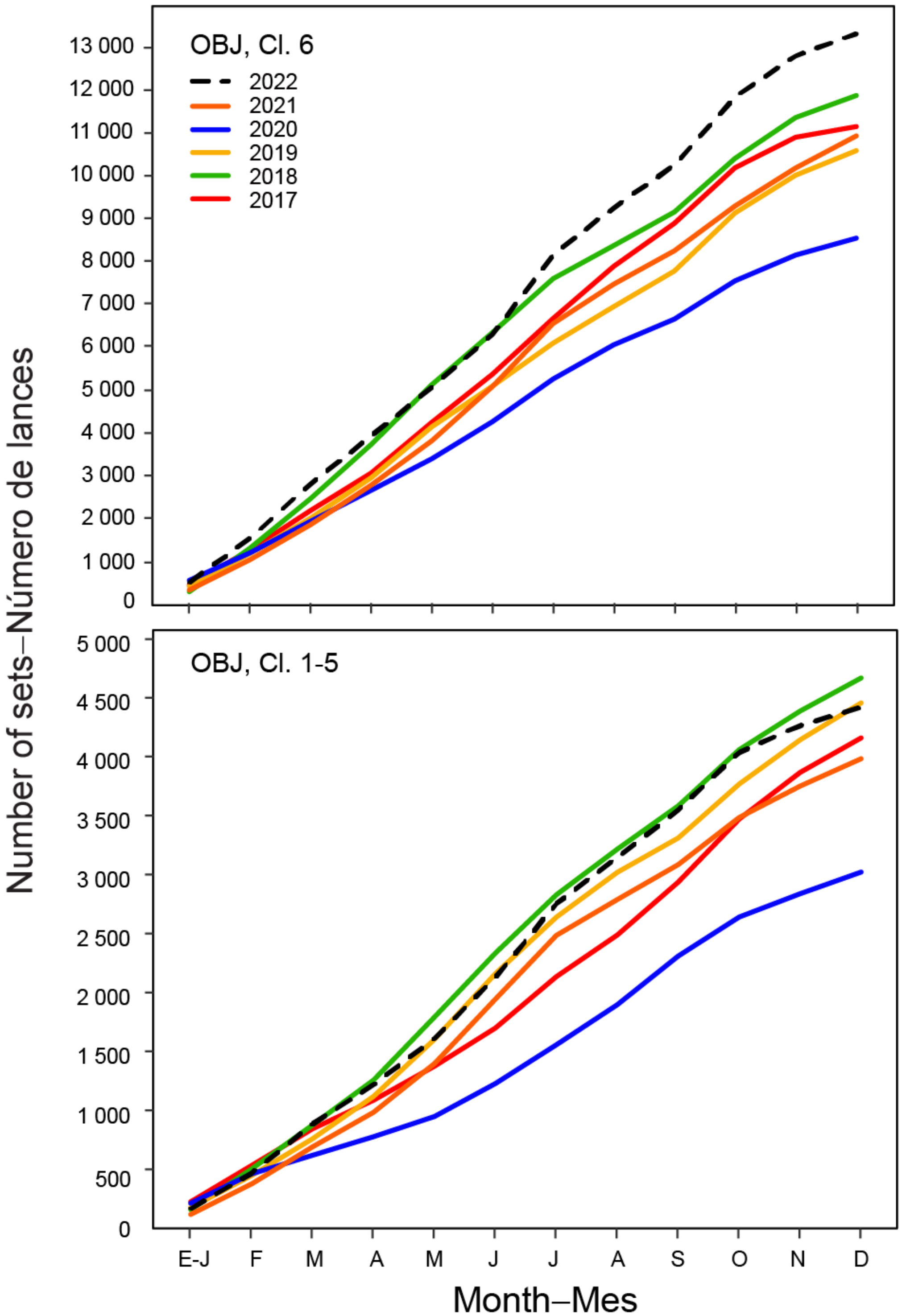

FIGURE 10. Cumulative number of floating-object (OBJ) sets, by month, 2017-2022: Class-6 vessels (top); Class 1-5 vessels (bottom). Updated from Document IATTC-93 INF-A.

FIGURA 10. Número acumulativo de lances sobre objetos flotantes (OBJ), por mes, 2017-2022: buques de clase 6 (arriba); buques de clases 1-5 (abajo). Actualizada del Documento IATTC-93 INF A.

3.2.3. Catch per set

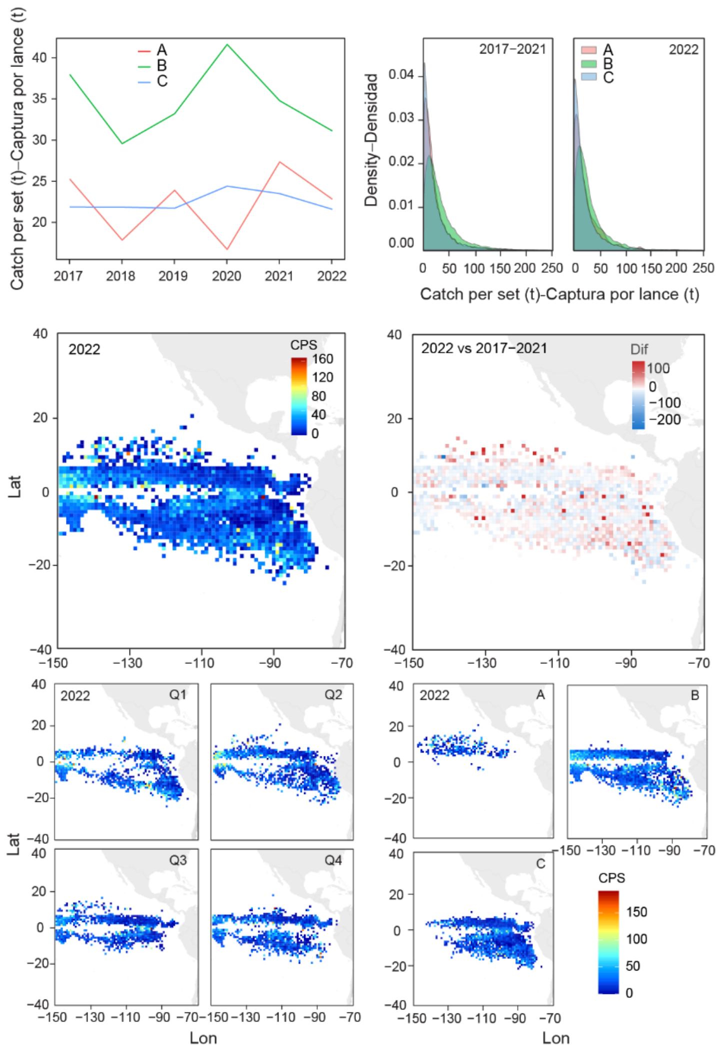

FIGURE 11. Top left: Evolution of catch per set, by cluster, 2017-2022 (see section 3.1 for details); Top right: Density plot of catch per set for 2017-2021 average and 2022, by cluster; Center left: average catch per set, by 1°-area, for 2022; Center right: differences of average catch per set, by 1°-area, 2022 vs 2017-2021; Bottom left: average catch per set, by 1°-area and quarter, for 2022; Bottom right: average catch per set, by 1°-area and cluster, for 2022**.**

FIGURA 11. Panel superior izquierdo: evolución de la captura por lance, por conglomerado,2017-2022 (ver sección 3.1 para más detalles); panel superior derecho: gráfica de densidad de la captura por lance del promedio de 2017-2021 y de 2022, por conglomerado. Panel central izquierdo: captura promedio por lance, por área de 1°, 2022; panel central derecho: diferencias de la captura promedio por lance, por área de 1°, 2022 vs. 2017-2021. Panel inferior izquierdo: captura promedio por lance, por área de 1° y trimestre, 2022; panel inferior derecho: captura promedio por lance, por área de 1° y conglomerado, 2022.

3.3. Activity

The indicators in this section were estimated for all activities, based on OBJ origin information and fishing activity records from observers, for the whole Class 6 fleet, by trip and vessel (section 3.3.1, Table 2), and by cluster (section 3.3.2, Table 4), as well as by cluster, vessel and trip for activities of special interest: sets, deployments and encounters (Tables 3, 5; section 3.3.3, Fig. 12). Because of their importance, sets, deployments and encounters were also analyzed in detail for the whole fleet, by cluster, spatially (section 3.3.4-3.3.8, Figs 13-17), and within the trip (section 3.3.9, Fig. 18). A long-term deployment and retrieval indicator was also prepared for the whole Class 6 fleet, a figure repeatedly requested by some Members (section 3.3.7, Fig. 16). For indicators on encounters (sections 3.3.8-3.3.9; Figs. 17-18), deployments and OBJ sets were disregarded, as results were otherwise completely driven by those activities and would hinder any interesting spatial and temporal patterns. In these cases, encounters reflect the evolution and the areas where FADs were visited but led to no OBJ sets or floating-object deployments/re-deployments. A spatial indicator of the differences between encounters and OBJ sets was also computed to highlight areas where presence of objects was associated with subsequent fishing, or the lack of it. Similarly, the evolution of the different locating methods of floating-objects was also estimated for encounters and sets, by cluster (section 3.3.11, Fig. 20), to inform different OBJ-oriented strategies.

3.3.1. General activity table

TABLE 2. Class 6 vessels activities on floating-objects, 2022 and 2017-2021 averages. Included, for information, the number of vessels (Ves) and trips in the analysis. “Dep”: deployment, “Unk”: unknown, “Oth”: other, “Enc”: encounter.
TABLA 2. Actividades de buques de clase 6 sobre objetos flotantes, 2022 y promedios de 2017-2021 Se incluye, con fines informativos, el número de buques y viajes en el análisis.

Year	Own Now	Own Prev	Dep	Given	Taken	Adrift	Unk	Oth	Enc	Sets	Ves	Trips
2017-2021	25	6485	23252	3829	6891	2776	6	5	45367	10258	142	653
2022	21	7139	27287	4332	8446	3280	4	0	54113	13004	153	702

TABLE 3. Class-6 vessel floating-object deployment, encounter and OBJ set average rates, by vessel and trip, for 2022 and 2017-2021.
TABLA 3. Tasas promedio de siembras, encuentros y lances OBJ de buques de clase 6, por buque y viaje, en 2022 y 2017-2021.

Year	Deployments		Encounters		Sets	
	Vessel	Trip	Vessel	Trip	Vessel	Trip
2017-2021	163.5	35.6	319.0	69.5	72.1	15.7
2022	178.3	38.9	353.7	77.1	85.0	18.5

3.3.2. Activity table by cluster

TABLE 4. Class 6 vessel activities on floating-objects, by cluster, for 2022 and 2017-2021 averages. Included, for information, is the number of vessels (Ves) and trips in the analysis. “Dep”: deployment, “Unk”: unknown, “Oth”: other, “Enc”: encounter.
TABLA 4. Actividades de buques de clase 6 sobre objetos flotantes, por conglomerado, 2022 y promedios de 2017-2021. Se incluye, con fines informativos, el número de buques y viajes en el análisis.

Year	Cluster	Own Now	Own Prev	Dep	Given	Taken	Adrift	Unk	Oth	Enc	Sets	Ves	Trips
2017-2021	A	3	85	181	131	732	264	4	1	1446	761	30	100
	B	8	4034	16472	1688	1775	404	1	2	25810	4396	43	191
	C	14	2366	6600	2010	4384	2108	1	2	18112	5101	69	362
2022	A	0	10	0	14	291	243	0	0	576	501	31	111
	B	7	4238	19627	1894	2285	440	0	0	30882	4976	45	194
	C	14	2891	7660	2424	5870	2597	4	0	22655	7527	77	397

TABLE 5. Class-6 vessel floating-object deployment, encounter and OBJ set average rates, by cluster, vessel and trip, for 2022 and 2017-2021.
TABLA 5. Tasas promedio de siembras, encuentros y lances OBJ de buques de clase 6, por conglomerado, buque y viaje, en 2022 y 2017-2021.

Year	Cluster	Deployments		Encounters		Sets	
		Vessel	Trip	Vessel	Trip	Vessel	Trip
2017-2021	A	6.0	1.8	47.9	14.5	25.2	7.6
	B	381.3	86.2	597.4	135.1	101.8	23.0
	C	95.9	18.2	263.3	50.0	74.1	14.1
2022	A	0.0	0.0	18.6	5.2	16.2	4.5
	B	436.2	101.2	686.3	159.2	110.6	25.6
	C	99.5	19.3	294.2	57.1	97.8	19.0

3.3.3. Evolution of activities by cluster

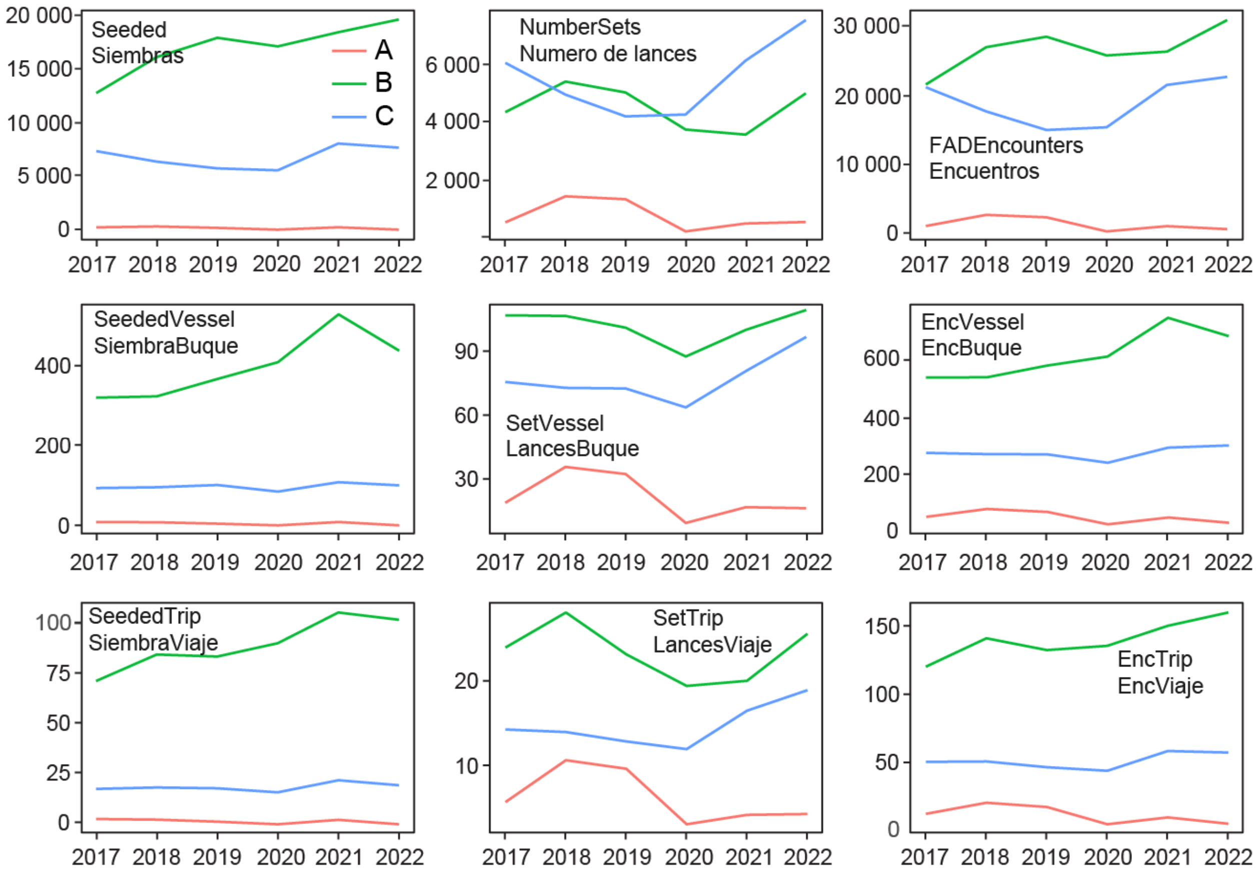

FIGURE 12. Top: Evolution of floating-object deployments, sets and encounters, by cluster, 2017-2022; Center: Evolution of floating-object deployments, sets and encounters, by cluster-vessel average, 2017-2022; Bottom: Evolution of floating-object deployments, sets and encounters, by cluster-trip average, 2017-2022.

FIGURA 12. Arriba: evolución de las siembras, lances y encuentros de objetos flotantes, por conglomerado, 2017-2022. Centro: evolución de las siembras, lances y encuentros de objetos flotantes, por promedio de conglomerado-buque, 2017-2022. Abajo: evolución de las siembras, lances y encuentros de objetos flotantes, por promedio de conglomerado-viaje, 2017-2022.

3.3.4. OBJ sets

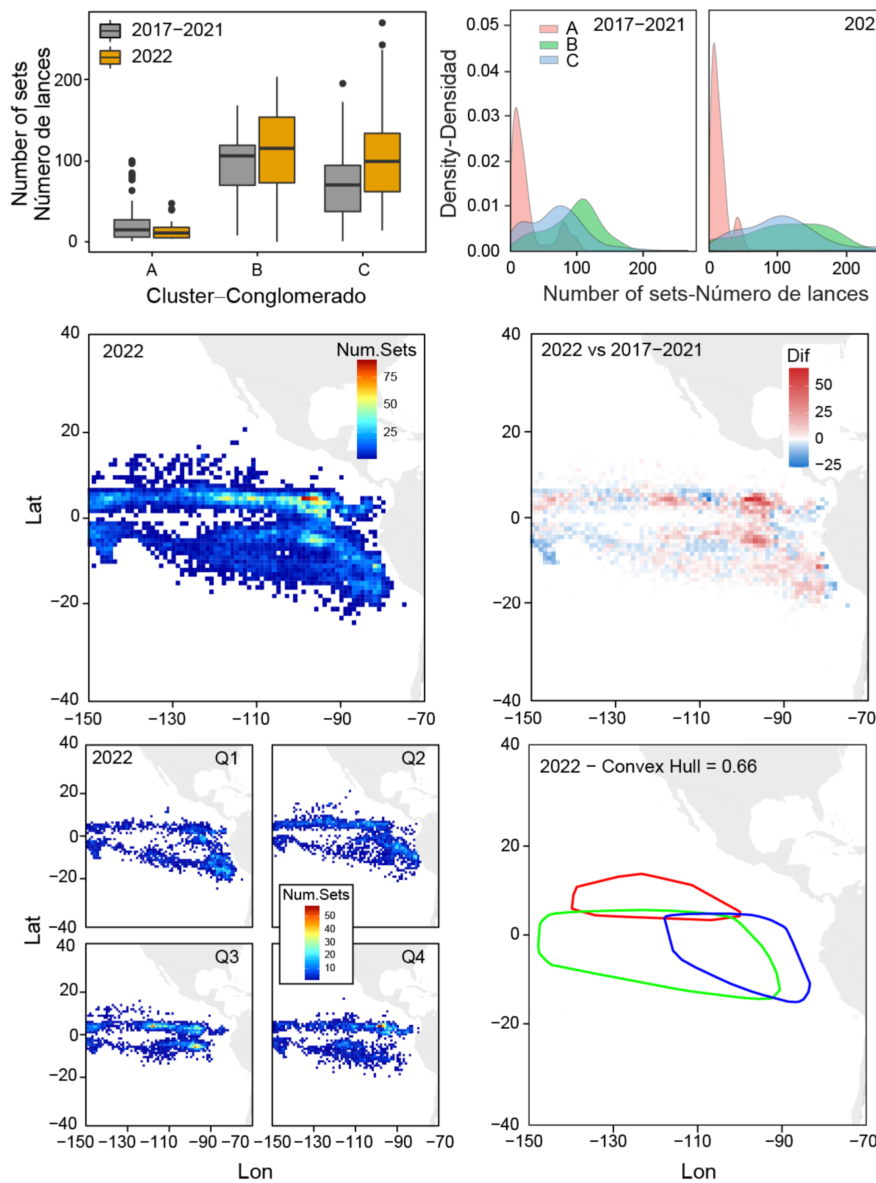

FIGURE 13. Top left: Boxplots of the number of OBJ sets per vessel, by cluster, 2017-2021 average and 2022; Top right: Density plot of OBJ sets per vessel for 2017-2021 average and 2022, by cluster; Center left: number of OBJ sets, by 1°-area, for 2022; Center right: differences of OBJ sets, by 1°-area, 2022 vs 2017-2021 average; Bottom left: number of OBJ sets, by 1°-area and quarter, for 2022; Bottom right: convex hull estimates of 66% of OBJ sets, by cluster (Red = A, Green = B, Blue = C), for 2022.

FIGURA 13. Panel superior izquierdo: diagramas de caja del número de lances OBJ por buque, por conglomerado, promedio de 2017-2021 y 2022; panel superior derecho: gráfica de densidad de lances OBJ por buque para el promedio de 2017-2021 y 2022, por conglomerado. Panel central izquierdo: número de lances OBJ, por área de 1°, para 2022; panel central derecho: diferencias de lances OBJ, por área de 1°, 2022 vs promedio de 2017-2021 . Panel inferior izquierdo: número de lances OBJ, por área de 1° y trimestre, para 2022; panel inferior derecho: estimaciones de la envolvente convexa del 66% de los lances OBJ, por conglomerado (rojo = A, verde = B, azul = C), para 2022.

3.3.5. Set time

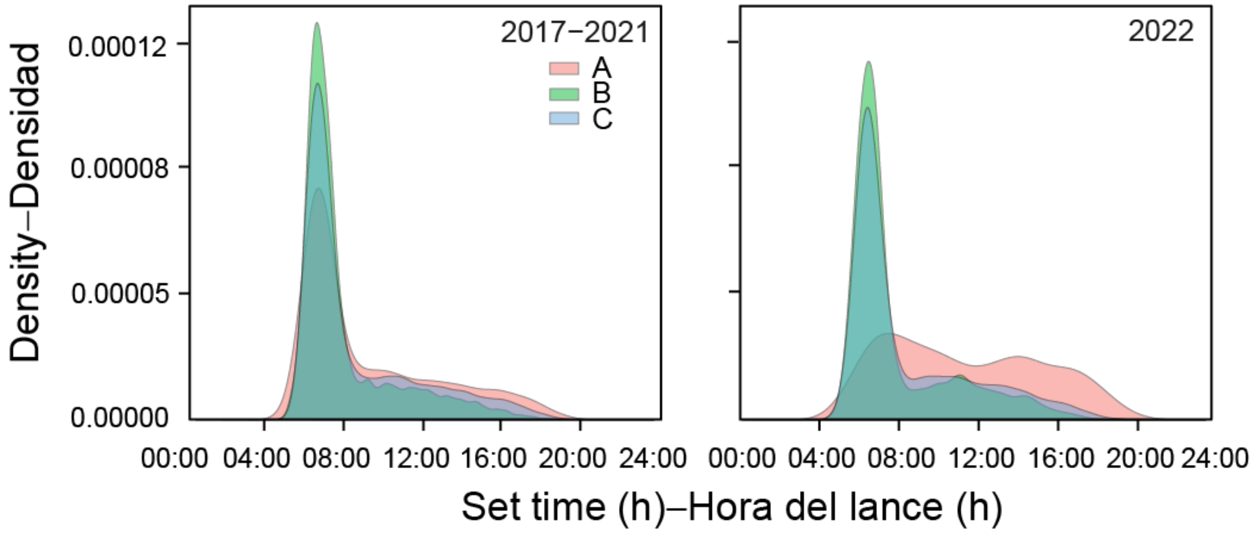

FIGURE 14. Density plot of OBJ set time, by cluster, 2017-2021 average and 2022.
FIGURA 14. Gráfica de densidad de la hora de los lances OBJ, por conglomerado, promedio de 2017-2021 y 2022.

3.3.6. Deployments

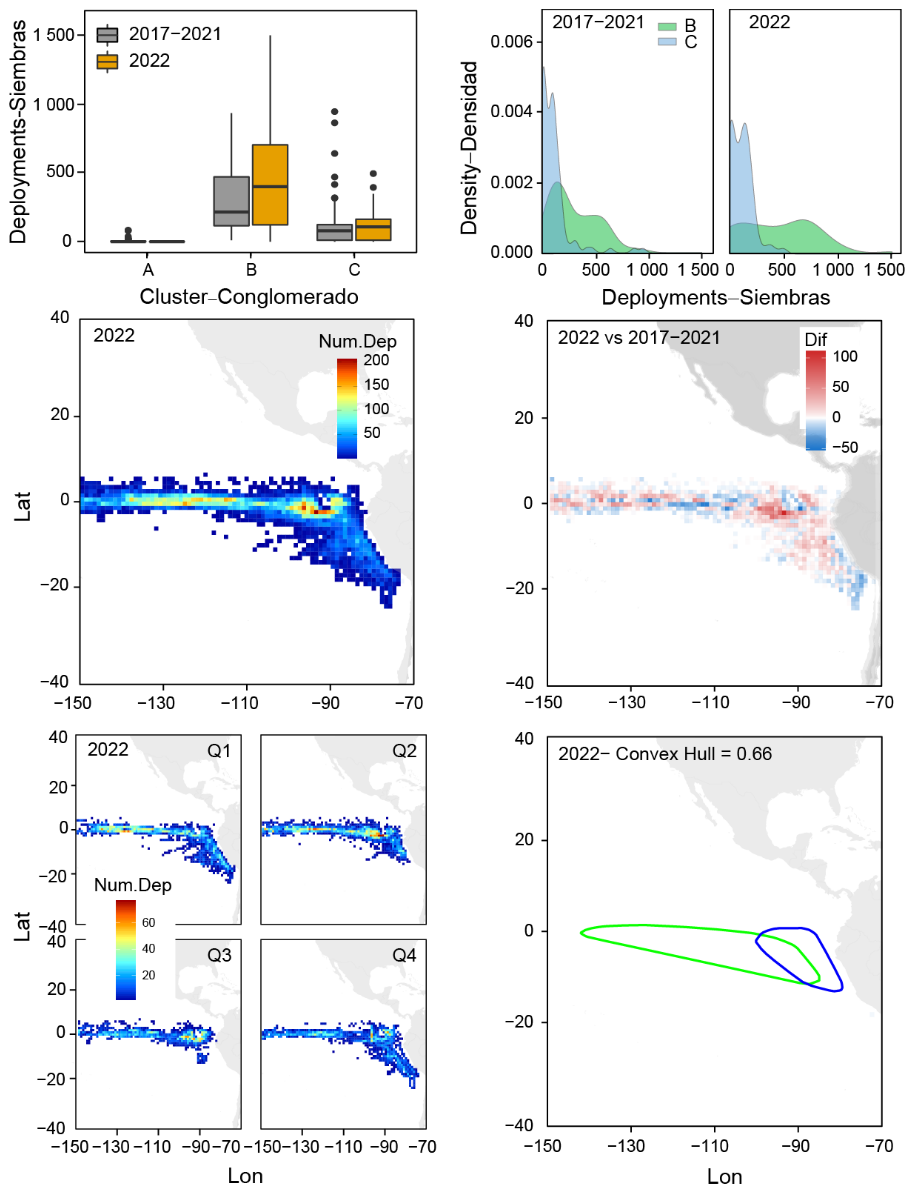

FIGURE 15. Top left: Boxplots of the number of deployments per vessel, by cluster, 2017-2021 average and 2022; Top right: Density plot of deployments per vessel for 2017-2021 average and 2022, by cluster; Center left: number of deployments, by 1°-area, for 2022; Center right: differences of deployments, by 1°-area, 2022 vs 2017-2021 average; Bottom left: number of deployments, by 1°-area and quarter, for 2022; Bottom right: convex hull estimates of 66% of deployments, by cluster (Green = B, Blue = C), for 2022.

FIGURA 15. Panel superior izquierdo: diagramas de caja del número de siembras por buque, por conglomerado, promedio de 2017-2021 y 2022; panel superior derecho: gráfica de densidad de siembras por buque para el promedio de 2017-2021 y 2022, por conglomerado. Panel central izquierdo: número de siembras, por área de 1°, para 2022; panel central derecho: diferencias de siembras, por área de 1°, 2022 vs promedio de 2017-2021. Panel inferior izquierdo: número de siembras, por área de 1° y trimestre, para 2022; panel inferior derecho: estimaciones de la envolvente convexa del 66% de las siembras, por conglomerado (rojo = A, verde = B, azul = C), para 2022.

3.3.7. Long-term deployment and retrieval trend

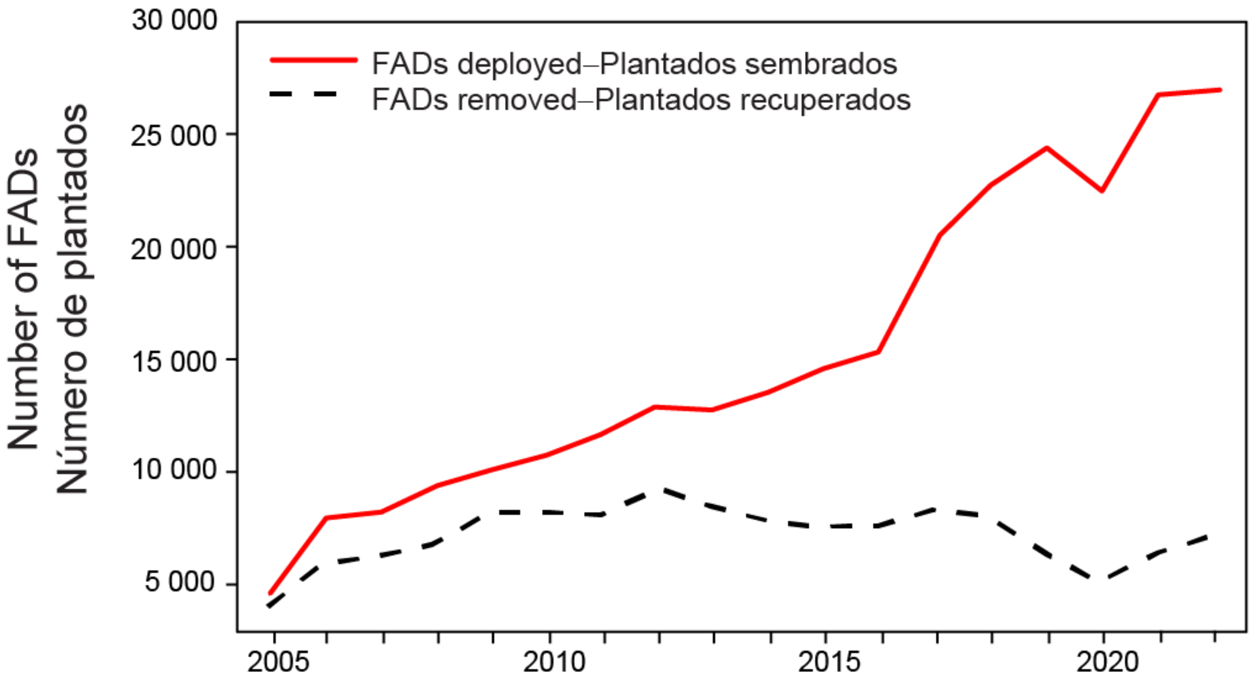

FIGURE 16. FAD deployments and retrievals by Class-6 vessels, 2005-2022. Adapted from document IATTC-93-INF-A.

FIGURA 16. Siembras y recuperaciones de plantados por buques de clase 6, 2005-2022. Adaptado del documento IATTC-93-INF-A.

3.3.8. Encounters

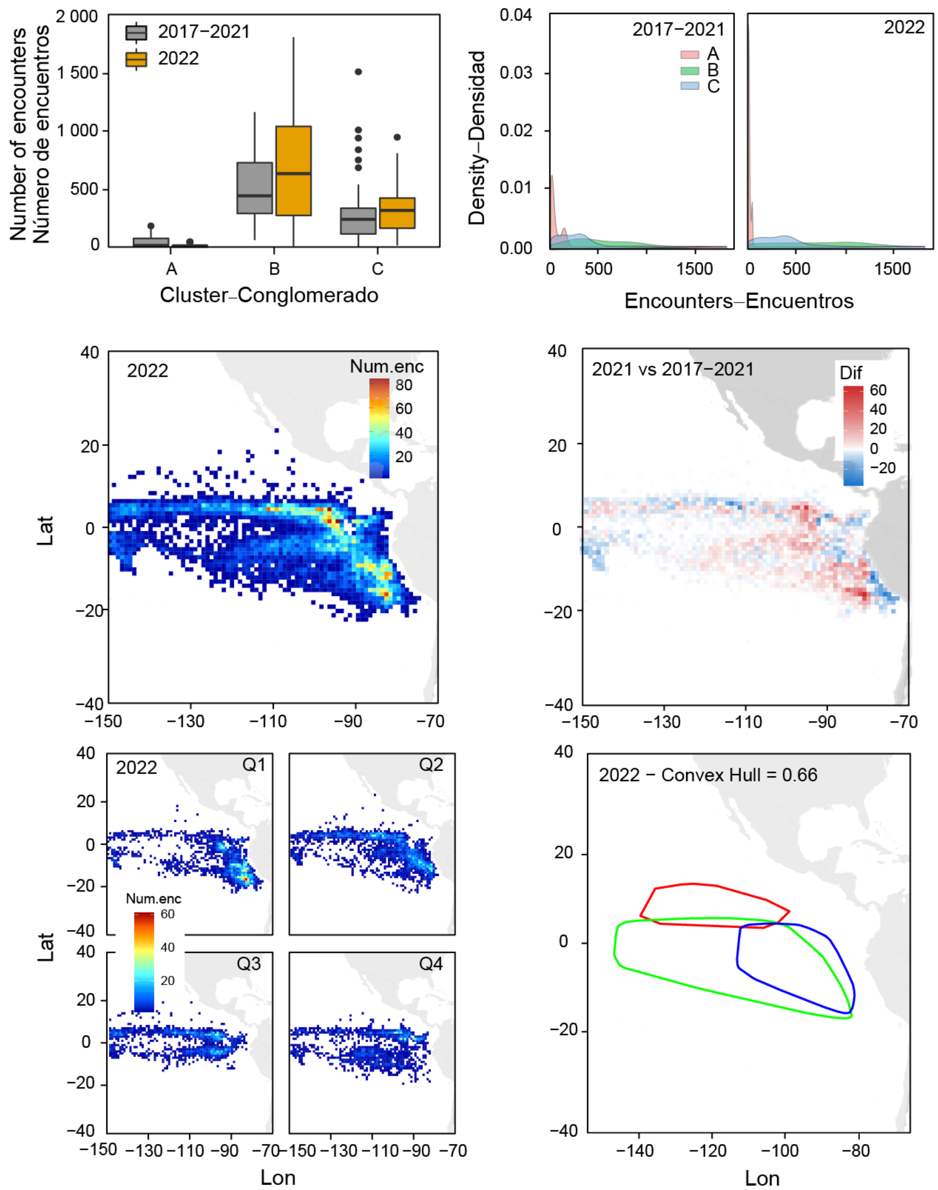

FIGURE 17. Top left: Boxplots of the number of OBJ encounters per vessel, by cluster, 2017-2021 average and 2022; Top right: Density plot of OBJ encounters per vessel for 2017-2021 average and 2022, by cluster; Center left: OBJ encounters, by 1°-area, for 2022; Center right: differences of OBJ encounters, by 1°-area, 2022 vs 2017-2021 average; Bottom left: OBJ encounters, by 1°-area and quarter, for 2022; Bottom right: convex hull estimates of 66% of OBJ encounters, by cluster (Red = A, Green = B, Blue = C), for 2022.

FIGURA 17. Panel superior izquierdo: diagramas de caja del número de encuentros OBJ por buque, por conglomerado, promedio de 2017-2021 y 2022; panel superior derecho: gráfica de densidad de encuentros OBJ por buque para el promedio de 2017-2021 y 2022, por conglomerado. Panel central izquierdo: encuentros OBJ, por área de 1°, para 2022; panel central derecho: diferencias de encuentros OBJ, por área de 1°, 2022 vs promedio de 2017-2021. Panel inferior izquierdo: encuentros OBJ, por área de 1° y trimestre, para 2022; panel inferior derecho: estimaciones de la envolvente convexa del 66% de los encuentros OBJ, por conglomerado (rojo = A, verde = B, azul = C), para 2017-2021.

3.3.9. Encounters versus sets

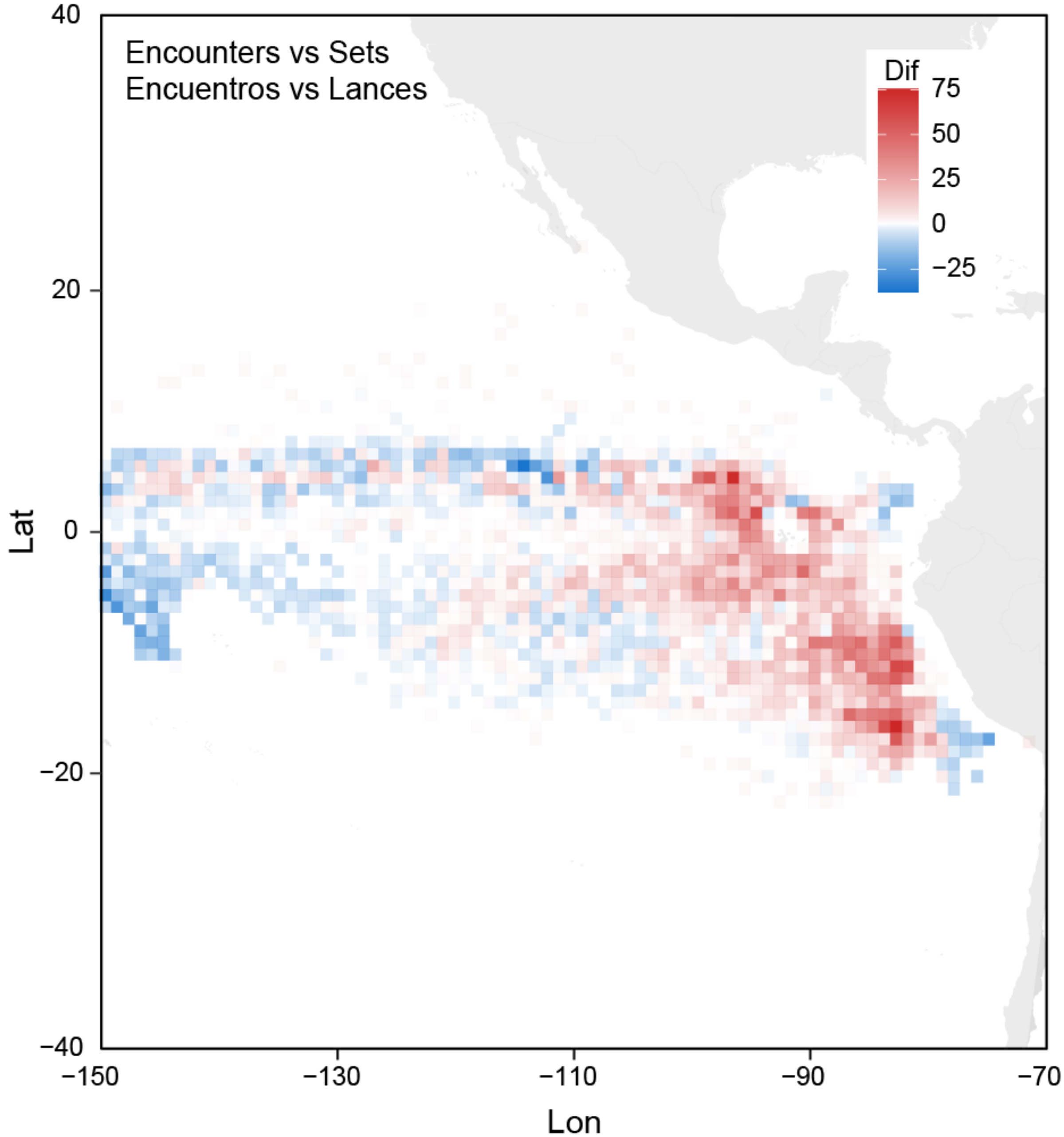

FIGURE 18. Differences between the number of OBJ encounters and the number of OBJ sets, by 1°-area, 2022. Red areas denote hotspots of floating objects visits with no fishing activity associated. Blue cells, instead, denote areas where visits led to fishing sets.

FIGURA 18. Diferencias entre el número de encuentros OBJ y el número de lances OBJ, por área de 1°, 2022. Las áreas rojas indican sitios clave de visitas de objetos flotantes sin actividad de pesca asociada. Las celdas azules, en cambio, indican áreas donde las visitas resultaron en lances de pesca.

3.3.10. Activity dynamics within the trip

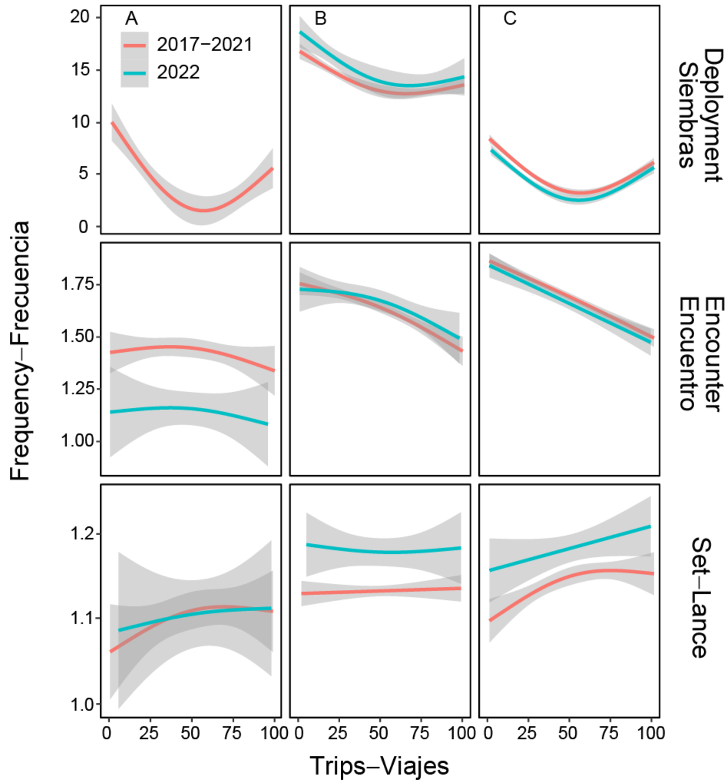

FIGURE 19. Evolution of floating-object deployment, encounter and set activities (number of each activity) within the trip, 2017-2021 averages and 2022. Only trips with a duration of 25-90 days were considered, quantiles 5 and 95, respectively. Trips were divided into 100 equal parts for standardization purposes.
FIGURA 19. Evolución de las actividades de siembras, encuentros y lances de objetos flotantes (número de cada actividad) en el viaje, promedio de 2017-2021 y 2022. Solo se consideraron viajes con una duración de 25 a 90 días, cuantiles 5 y 95, respectivamente. Los viajes se dividieron en 100 partes iguales con fines de estandarización.

3.3.11. Evolution of location method

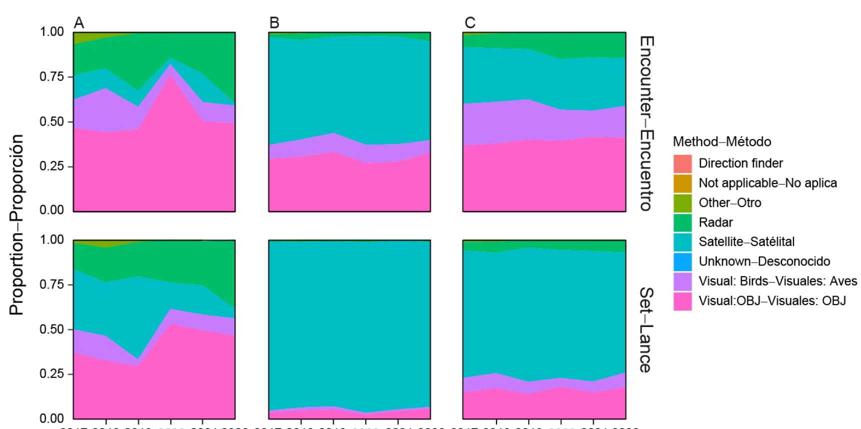

FIGURE 20. Evolution of locating methods for OBJ encounters and sets, by cluster, 2017-2021.
FIGURA 20. Evolución de los métodos de localización para encuentros y lances OBJ, por conglomerado, 2017-2021.

3.4. Buoy-based indices

The indicators in this section have been estimated using buoy data for 158 Class 1-6 vessels reporting in 2022 (43 and 115 vessels for Class 1-5 and Class 6, respectively). Because the limits on the number of active FADs per vessel (i.e. active buoys) are class-specific, as established by Resolution C-21-04[3], the indicators in this category have been estimated for each class-limit, when appropriate (sections 3.4.1-3.4.2, Table 6, Fig. 21). In addition, the indicators in this category have been mainly estimated for 2022 and for 2018-2022 to help inform interpretations on the short, medium and long-term evolution of the fishery.

Most of the vessels that deploy FADs comply with the requirement of Resolution C-21-04 to report daily FAD data, and some do so only intermittently. Observer data indicate that reporting rates for Class 6 vessels deploying and fishing on their own FADs are high (>90%). Reporting rates for Class 1-5 vessels cannot be estimated, as that fleet segment does not routinely and systematically carry observers, as noted above. The staff considers that extrapolating from these data to estimate the total number of FADs is not advisable yet, since the fishing strategies used by vessels vary by capacity, company, flag, season, or a combination of these and other factors, and the assumptions that would have to be made may lead to misleading results and interpretation. Since 2022, the staff has access to raw buoy data reported under Resolution C-21-04 and analyzing it will help better understand this relationship in the near future. Thus, active FADs do not represent total FADs at sea, because (a) buoys can be deactivated remotely but the FAD remains at sea, and (b) not all vessels report, so these are probably underestimates.

3.4.1. Daily active buoys per vessel

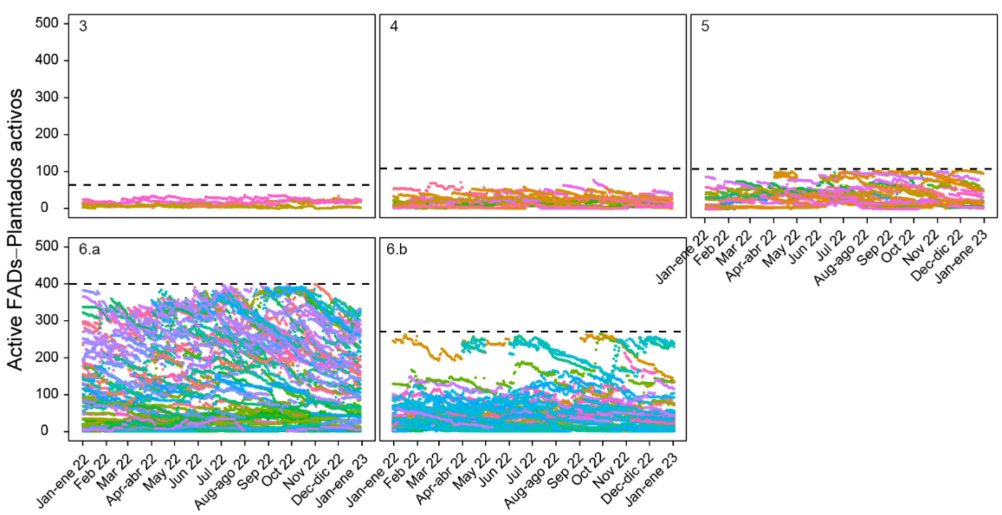

FIGURE 21. Evolution of daily active FADs per vessel and class, 2022. Each color represents a vessel (158 total). Points are used to show data reporting gaps per vessel. The following class and class-limits are considered: Class 6 ≥ 1,200 m^3 = 400 (6.a in the figure); Class 6 < 1,200 m^3 = 270 (6.b in the figure); Class 4-5 = 110, Class 1-3 = 66.

FIGURA 21. Evolución de plantados activos diarios por buque y clase, 2022. Cada color representa un buque (158 en total). Se usan puntos para mostrar las deficiencias en la notificación de datos por buque. Se consideran las siguientes clases y límites de clase: clase 6 ≥ 1,200 m^3 = 400 (6.a en la figura); clase 6 < 1,200 m^3 = 270 (6.b en la figura); clases 4-5 = 110; clases 1-3 = 66.

3.4.2. Annual and monthly statistics

[3] Class 6 (⩾ 1,200 m^3) = 450; Class 6 (< 1,200 m^3) = 300; Class 4-5 = 120, Class 1-3 = 70

TABLE 6. Monthly and annual minimum, mean, maximum, and standard deviations of active FADs (i.e. buoys), by class-limit, 2022. The analysis includes 50 Class-6 <1200 m^3, 65 Class-6 ≥ 1200 m^3, 38 Class-4-5, and 5 Class-1-3 vessels.

TABLA 6. Mínimo, promedio, máximo y desviación estándar mensuales y anuales de plantados activos (es decir, boyas), por límite de clase, 2022. El análisis incluye 50 buques de clase 6 <1200 m^3, 65 de clase 6 ≥ 1200 m^3, 38 de clases 4-5, y 5 de clases 1-3.

	Class 1-3				Class 4-5				Class 6 < 1200				Class 6 >1200			
Month	Min	Mean	Max	SD	Min	Mean	Max	SD	Min	Mean	Max	SD	Min	Mean	Max	SD
Jan	3	14.7	28	5.9	1	21.1	88	19	1	45.2	262	45.4	1	123.4	382	103.6
Feb	6	13.2	29	5.5	1	26.4	76	18.3	1	51.4	258	41.1	1	111.9	359	107.3
Mar	6	16.1	35	8.8	1	27.6	75	17.9	2	49.8	224	39.6	1	122	342	106.7
Apr	5	17.5	37	9.1	1	33.7	102	24.5	1	60	257	60	1	149	383	120.7
May	5	15.7	34	7.5	1	28.7	92	18.3	1	49.6	251	41.5	1	141.1	390	121.6
Jun	6	16	34	8.2	1	35.6	100	24	1	63.3	259	56.8	1	167.3	380	133.1
Jul	6	16.4	33	8.1	1	35.1	103	26.2	1	64.3	254	56.3	1	168.9	396	127.2
Aug	3	16.4	39	9.1	1	35	104	28.5	1	64.7	220	51.8	1	164.1	400	118.7
Sep	2	18.7	39	11.1	1	35.2	105	29.3	1	72.2	264	57.1	1	158.3	399	119.6
Oct	4	19.8	32	7.6	1	34.2	103	26.9	1	67.9	261	61.6	1	158.8	392	125.8
Nov	2	18.3	30	7.9	1	30.2	107	26.1	1	62.3	256	62.7	1	151.3	399	115.8
Dec	5	19.6	36	7.1	1	30.2	107	25	1	62.9	256	64.6	1	149	356	108.5
Annual	2	16.9	39	8.0	1	31.1	107	23.7	1	59.5	264	53.2	1	147.1	400	117.4

3.4.3. Daily total active buoys

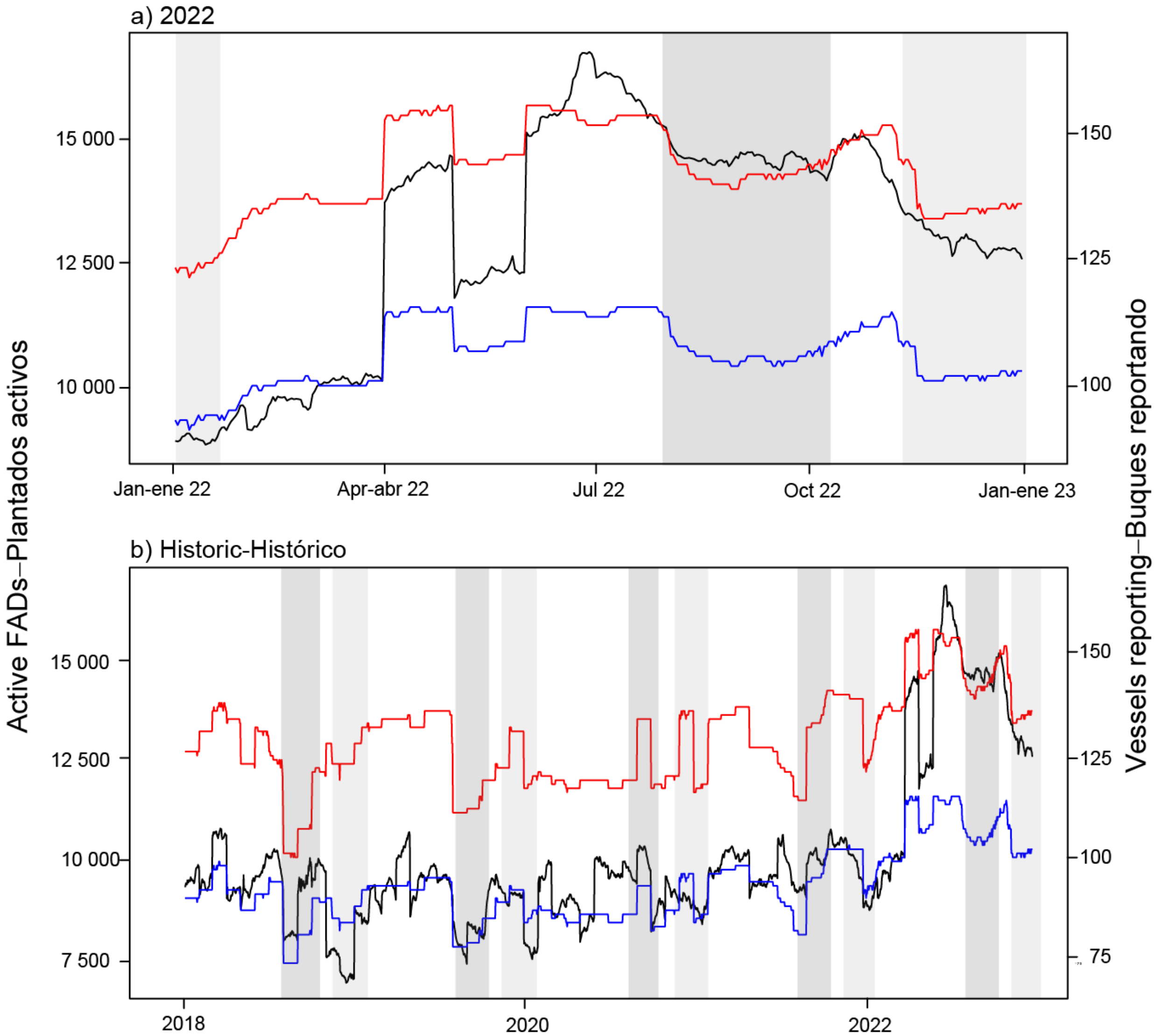

FIGURE 22. Number of active FADs (black line) reported by the purse-seine fleet in 2022 (a, top panel) and historically, 2018-2022 (b, bottom panel), and number of vessels reporting daily (red: total; blue: Class-6 vessels). Includes 115 Class-6 vessels, 21 Class-5, 17 Class-4, and 5 Class-2-3 in 2022. The number of total vessels reporting daily ranged from 122 to 158 (median = 143, average = 143). The number of total daily active buoys reported in 2022 ranged from 8800 to 16791 (median = 14052, mean = 13114), and historically from 7013 to 10813 (median = 9468, mean = 9350).

FIGURA 22. Número de plantados activos (línea negra) reportados por la flota cerquera en 2022 (a, panel superior) e históricamente, 2018-2022 (b, panel inferior), y número de buques que reportan diariamente (rojo: total; azul: buques de clase 6). Incluye 115 buques de clase 6, 21 de clase 5, 17 de clase 4, y 5 de clase 2-3 en 2022. El número de buques totales que reportan diariamente osciló entre 122 y 158 (mediana = 143, promedio = 143). El número de boyas activas diarias totales reportadas en 2022 osciló entre 8800 y 16791 (mediana = 14052, promedio = 13114), e históricamente entre 7013 y 10813 (mediana = 9468, promedio = 9350).

3.4.4. Monthly buoy densities

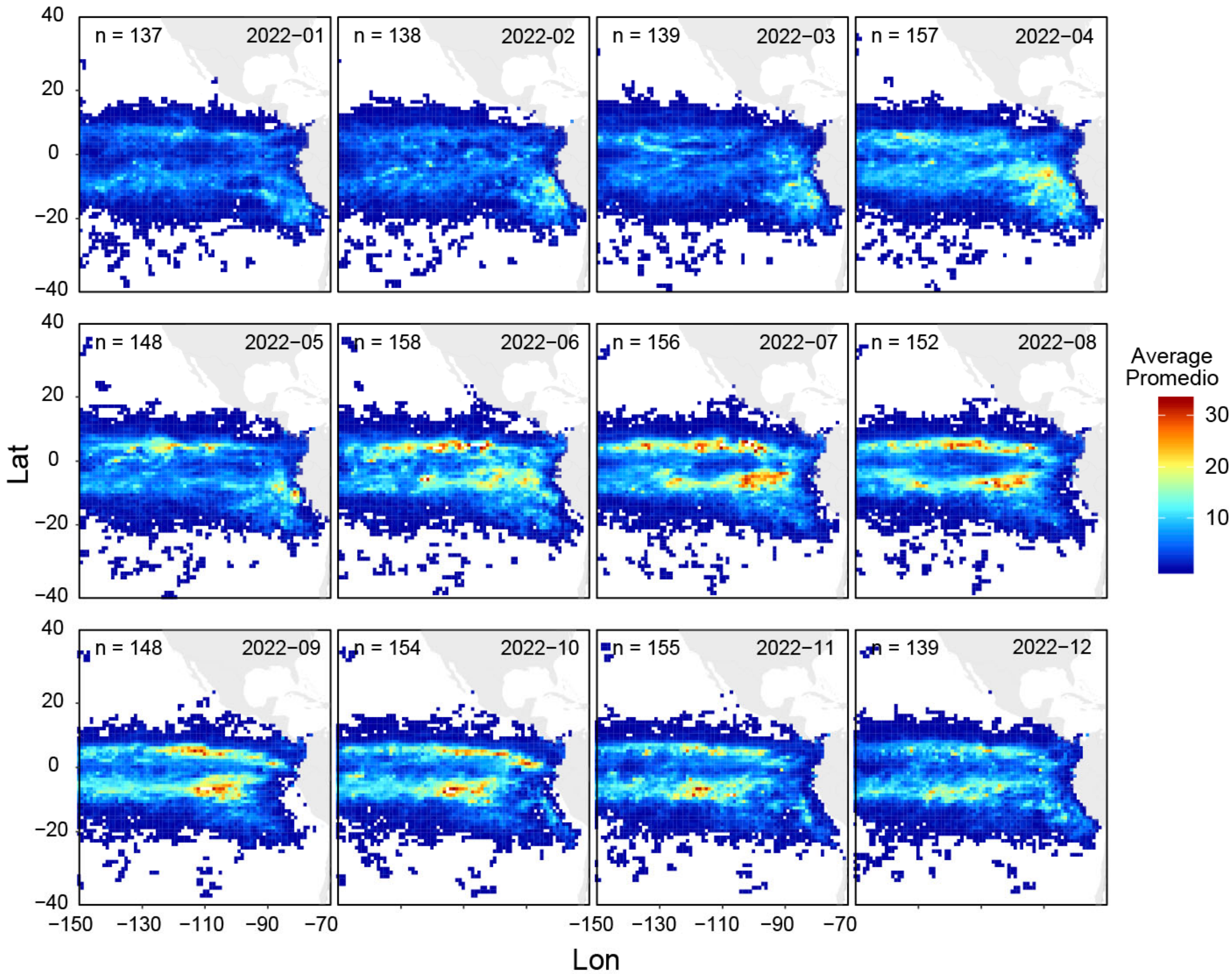

FIGURE 23. Average number of active FADs, by 1°-area, reported by between 137 and 158 vessels (mean = 148), by month, during the January-December 2022 period.

FIGURA 23. Número promedio de plantados activos, por área de 1°, reportado por entre 137 y 158 buques (promedio = 148), por mes, durante el periodo de enero-diciembre de 2022.

TABLE 7. Total number of active FADs in the EPO, reported by between 137 and 158 vessels (mean = 148), by month, and average, 2022. Number of active FADs ranged from 8550 to 15519 (average = 12541). Values correspond to those shown in Figure 23 above. Although very similar, these numbers do not match exactly the values provided in Figure 22 as the methods to estimate these figures vary.
TABLA 7. Número total de plantados activos en el OPO, reportado por entre 137 y 158 buques (promedio = 148), por mes y promedio, 2022. El número de plantados activos osciló entre 8550 y 15519 (promedio = 12541). Los valores corresponden a los que se muestran en la Figura 23 anterior. Aunque muy similares, estos números no coinciden exactamente con los valores provistos en la Figura 22, ya que los métodos para estimar estas figuras varían.

Month	Sum of average active FADs	Number of vessels
Jan	8550	137
Feb	9029	138
Mar	9646	139
Apr	13725	157
May	11694	148
Jun	15343	158
Jul	15519	156
Aug	14219	152
Sep	14032	148
Oct	13923	154
Nov	12715	155
Dec	12095	139
Average	12541	148

3.4.5. Annual buoy densities

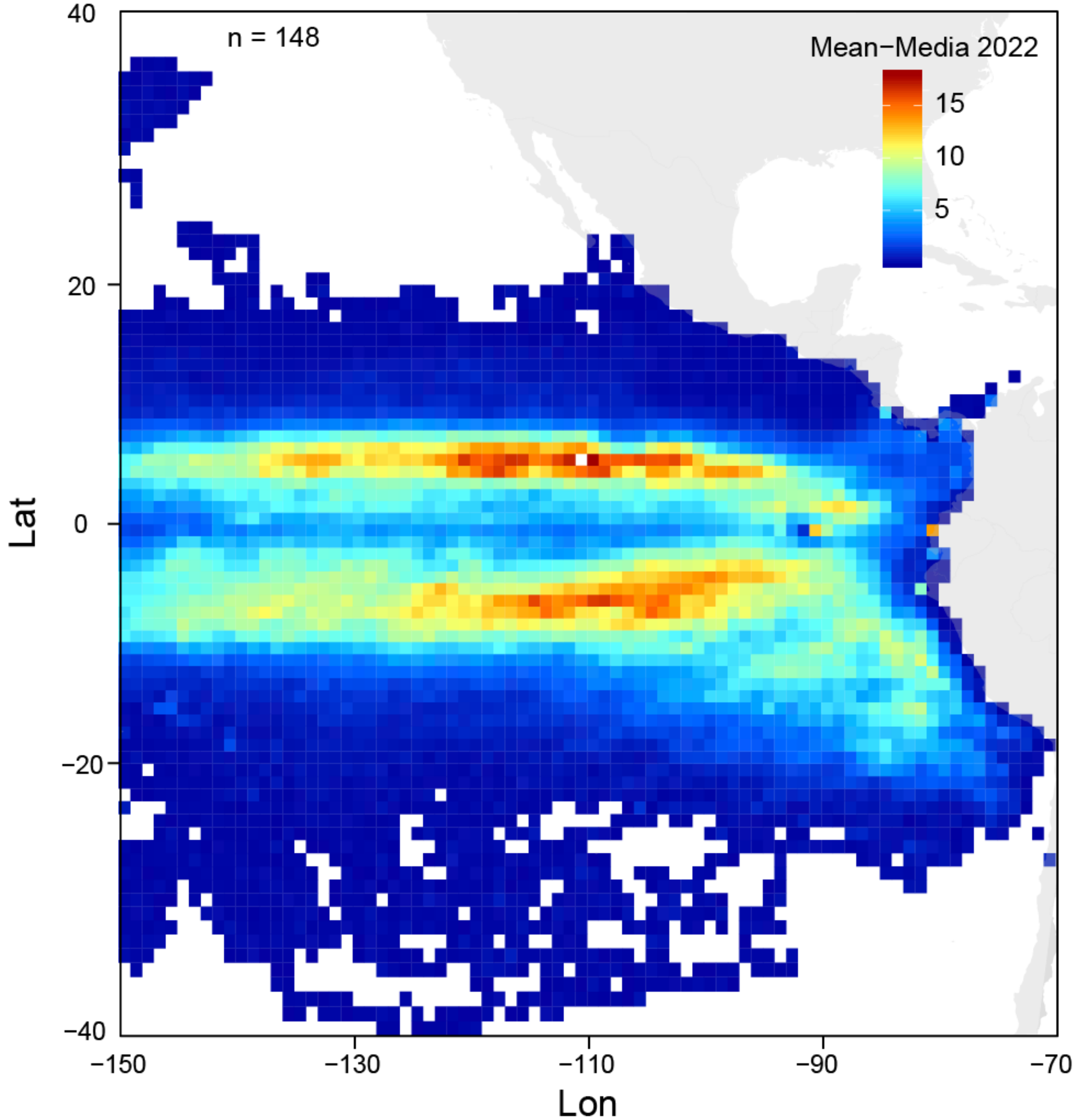

FIGURE 24. Average number of active FADs, by 1°-area, reported by between 137 and 158 vessels (mean = 148) during the January-December 2022 period.

FIGURA 24. Número promedio de plantados activos, por área de 1°, reportado por entre 137 y 158 buques (promedio = 148) durante el periodo de enero-diciembre de 2022.

3.5. Capacity indicators

The IATTC uses well volume, in cubic meters (m^3), to measure the carrying capacity of purse-seine vessels. When reliable well volume data are not available for a purse-seine vessel, it is calculated by applying a conversion factor to its capacity in tons. In 2022, the estimated carrying capacity is 253,071 m^3 for a total of 239 purse seine vessels (Figure 25).

The cumulative capacity at sea during 2022 is compared to those of the previous five years in Figure 26.

The monthly values of the averages of the total well volumes at sea (VAS), in thousands of cubic meters, are estimated at weekly intervals by the IATTC staff. The average monthly VAS values for 2012-2021 and 2022 were slightly lower 144,000 m^3 (59% of total capacity) and about 150,000 m^3 (59% of total capacity), respectively.

The figures and indicators in this category were taken from section 6.1 of SAC-14-03 (Tables A-10, A-11a, A-11b and A-12; Figs. 2-3).

3.5.1. Carrying capacity

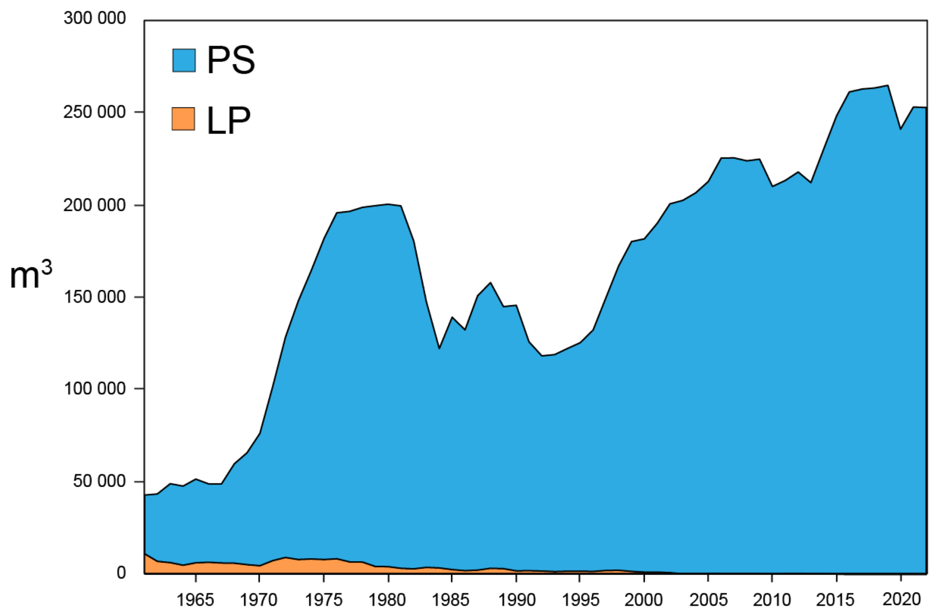

FIGURE 25. Carrying capacity, in cubic meters of well volume, of the purse-seine and pole and line fleets in the EPO, 1961-2022. Source: SAC-14-03 (Fig. 2).
FIGURA 25. Capacidad de acarreo, en metros cúbicos de volumen de bodega, de las flotas de cerco y de caña en el OPO, 1961-2022. Fuente: SAC-14-03 (Fig. 2).

3.5.2. Cumulative capacity

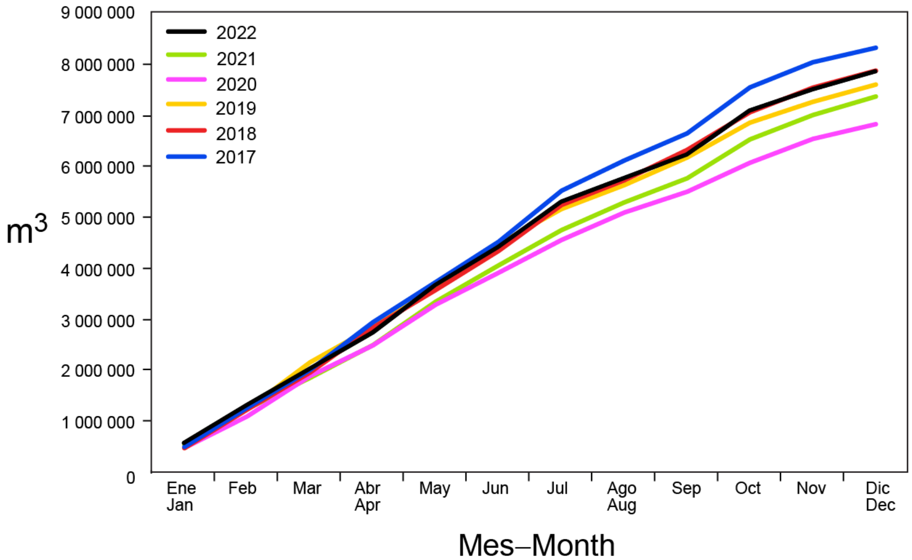

FIGURE 26. Cumulative capacity of the purse seine and pole and line fleet at sea, by month, 2017-2022. Source: SAC-14-03 (Fig. 3).
FIGURA 26. Capacidad acumulativa de la flota cerquera y cañera en el mar, por mes, 2017-2022. Fuente: SAC-14-03 (Fig. 3).

3.6. Technology

Fishing efficiency is known to be related to the gear and onboard technology used by vessels. Because of that, in this first approximation, a series of indicators showing the evolution of FAD designs (e.g. FAD depth), net size (i.e. depth), as well as their spatial distribution have been analyzed. Only information related to deployments and fishing sets was used to estimate FAD depth (Fig. 27) and net size (Fig. 28) indicators, respectively. Besides, the proportion of trips using specific technologies, by cluster (Fig 29), was analyzed to inform the evolution of OBJ-oriented fishing strategies in the study period.

3.6.1. FAD depth

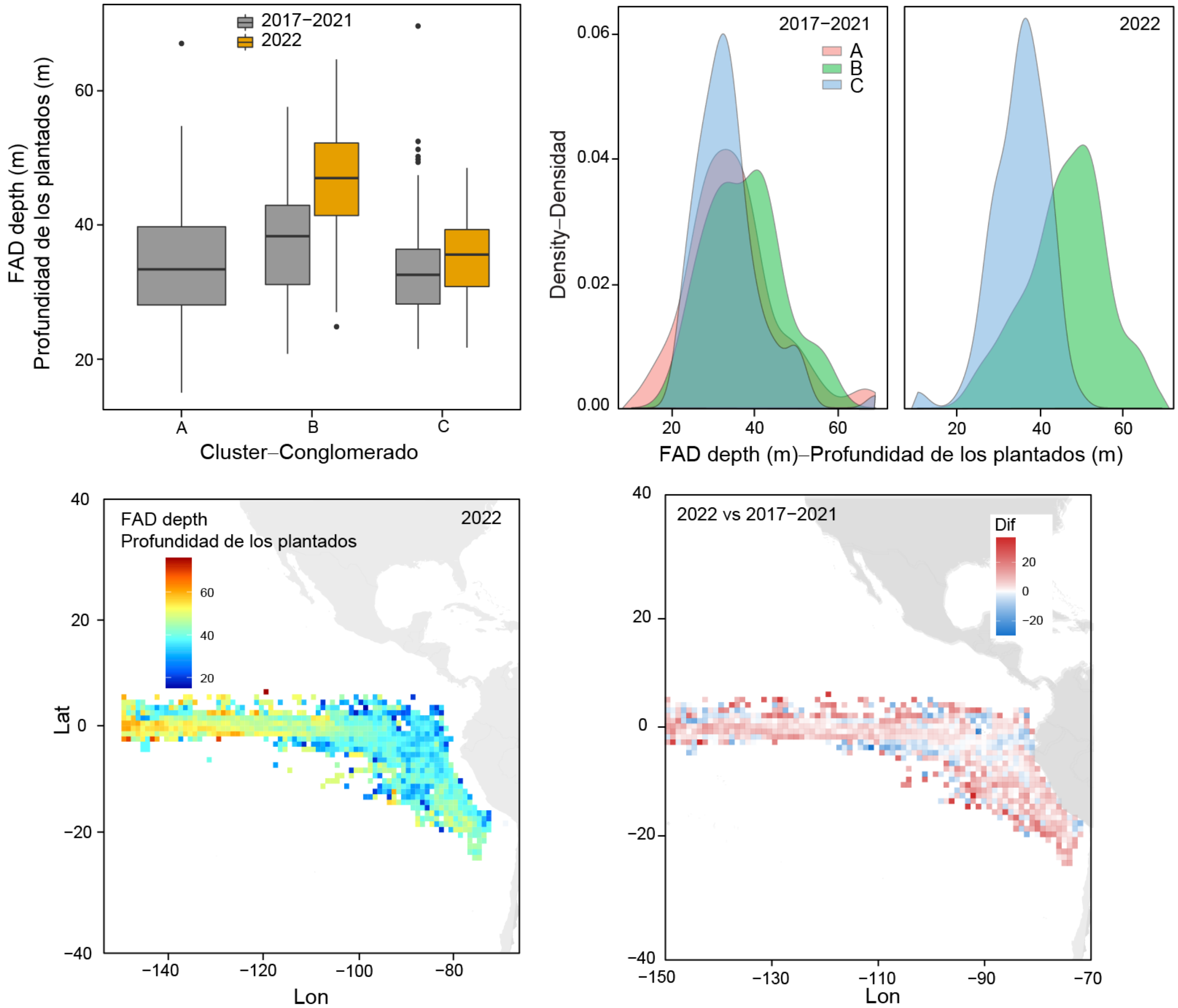

FIGURE 27. Top left: Boxplots of FAD depth for deployments, by cluster, 2017-2021 average and 2022; Top right: Density plot of FAD depth for deployments, 2017-2021 average and 2022, by cluster; Bottom left: average FAD depth, by 1°-area, for 2022; Bottom right: differences of FAD depth, by 1°-area, 2022 vs 2017-2021 average. All indicators are in meters. A clear tendency of deploying deeper FADs is observed in 2017-2021, compared to the average of the previous five years (2017-2021).

FIGURA 27. Panel superior izquierdo: diagramas de caja de la profundidad de los plantados para las siembras, por conglomerado, promedio de 2017-2021 y 2022; panel superior derecho: gráfica de densidad de la profundidad de los plantados para las siembras, promedio de 2017-2021 y 2021, por conglomerado. Panel inferior izquierdo: profundidad promedio de los plantados, por área de 1°, en 2022; panel inferior derecho: diferencias de la profundidad de los plantados, por área de 1°, 2022 vs promedio de 2017-2021. Todos los indicadores están en metros. Se observa una clara tendencia a la siembra de plantados más profundos en 2022, en comparación con el promedio de los cinco años anteriores (2017-2021).

3.6.2. Net size

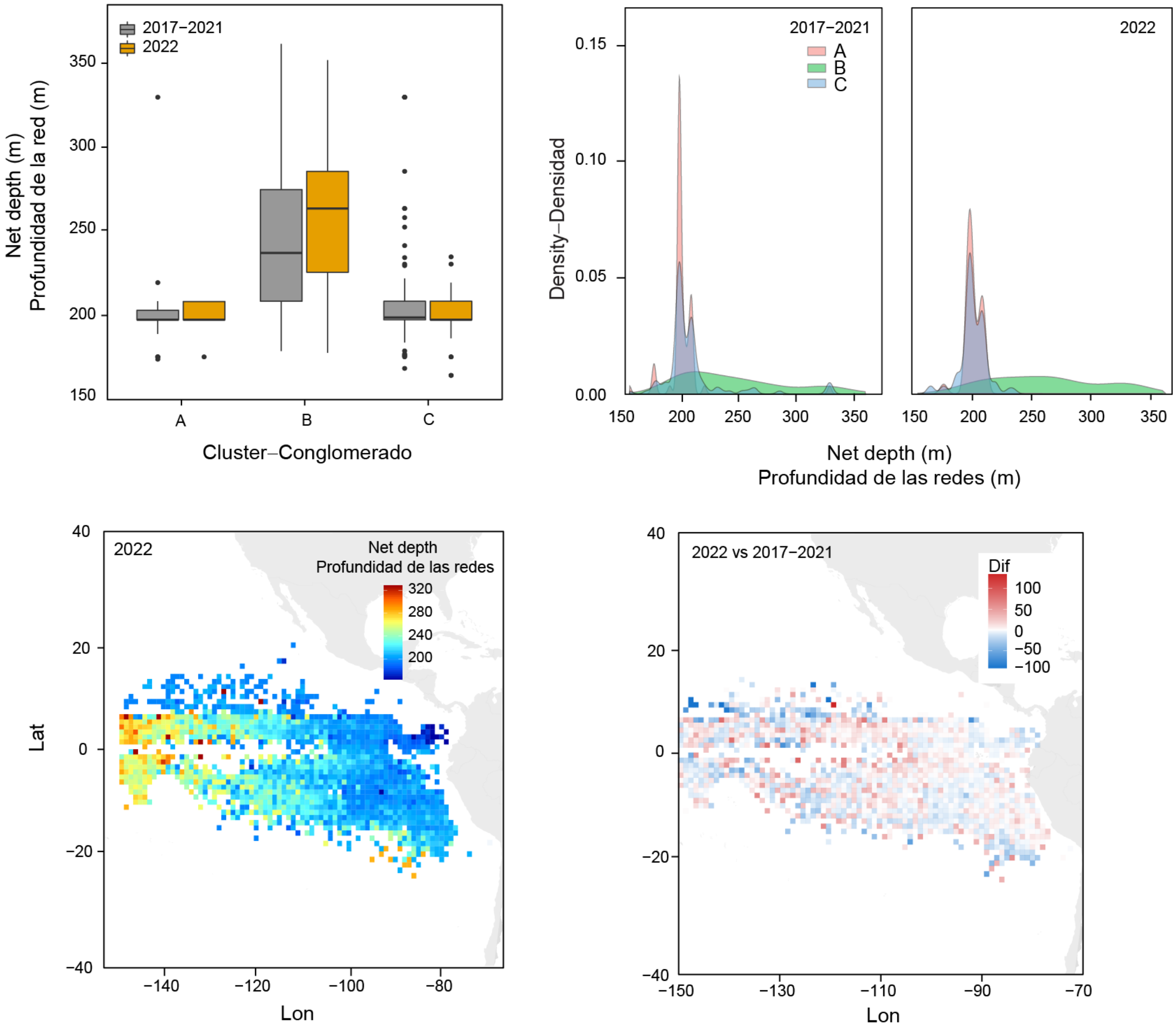

FIGURE 28. Top left: Boxplots of the net depth used in OBJ fishing sets, by cluster, 2017-2021 average and 2022; Top right: Density plot of the net depth used in OBJ fishing sets, 2017-2021 average and 2022, by cluster; Bottom left: average net depth used in OBJ fishing sets, by 1°-area, for 2022; Bottom right: differences of the net depth used in OBJ fishing sets, by 1°-area, 2022 vs 2017-2021 average. All indicators are in meters. A clear tendency of fishing with deeper nets is observed for higher longitudes, as well as in the southern area, in 2022.

FIGURA 28. Panel superior izquierdo: Diagramas de caja de la profundidad de las redes usadas en los lances OBJ, por conglomerado, promedio de 2017-2021 y 2022; panel superior derecho: gráfica de densidad de la profundidad de las redes usadas en los lances OBJ, promedio de 2017-2021 y 2022, por conglomerado. Panel inferior izquierdo: profundidad promedio de las redes usadas en los lances OBJ, por área de 1°, en 2022; panel inferior derecho: diferencias de la profundidad de las redes usadas en los lances OBJ, por área de 1°, 2022 vs promedio de 2017-2021. Todos los indicadores están en metros. Se observa una clara tendencia a la pesca con redes más profundas para longitudes mayores, así como al sur de la región, en 2022.

3.6.3. Onboard equipment

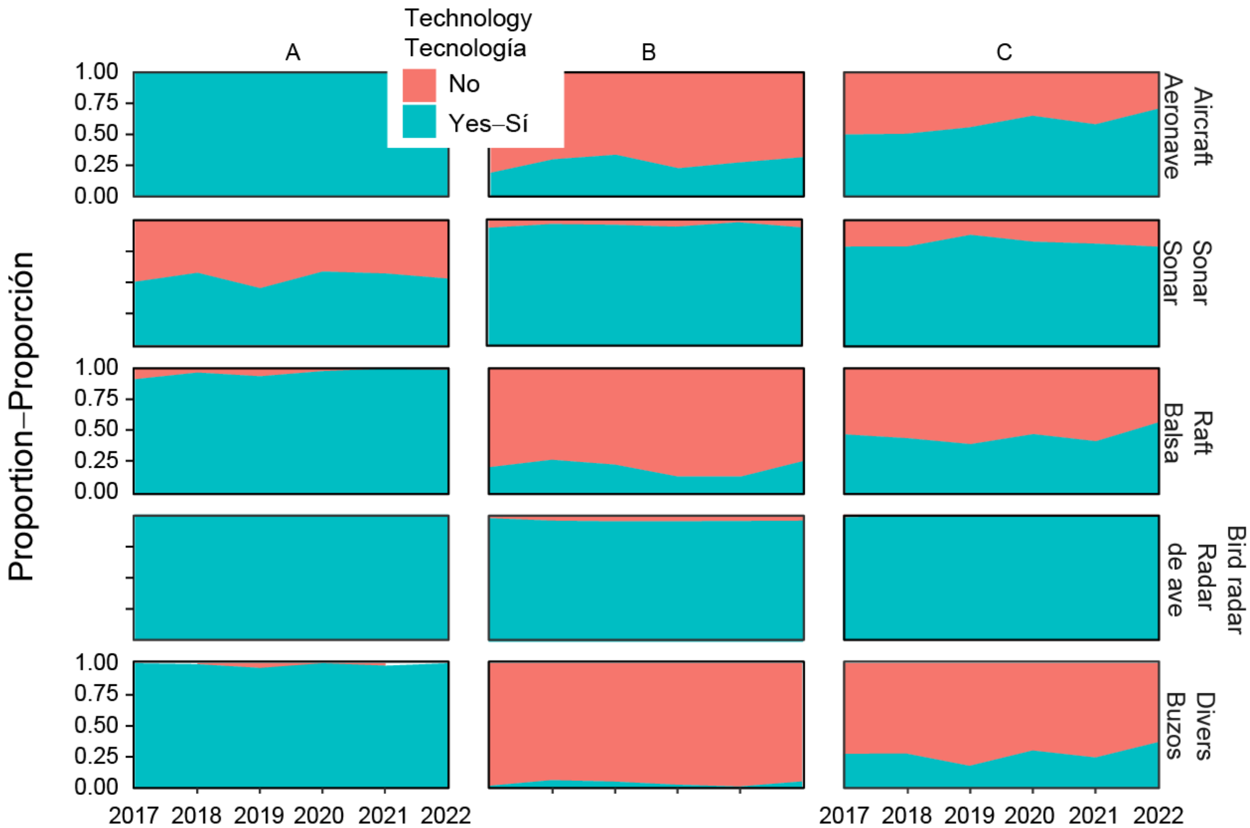

FIGURE 29. Evolution of the proportion of trips using different technologies, by cluster, including the use of aircrafts, sonars, rafts, bird radar and divers, for 2017-2021. Although some of these technologies have traditionally been used for dolphin fishing (e.g. raft, divers, aircrafts), they have been included in the analysis, as are an important component of the technology used by some clusters (see section 3.1 for details on clustering).

FIGURA 29. Evolución de la proporción de viajes en los que se usan diferentes tecnologías, por conglomerado, incluyendo el uso de aeronaves, sonares, balsas, radares de aves, y buzos, para 2017-2021. Aunque algunas de estas tecnologías se emplean tradicionalmente en la pesca sobre delfines (por ejemplo, balsas, buzos, aeronaves), se incluyeron en el análisis ya que son un componente importante de la tecnología empleada por algunos conglomerados (ver la sección 3.1 para más detalles sobre los conglomerados).

3.7. Ecosystem impacts

The Ecosystem Considerations document (SAC-14-11) is an extensive review of many different aspects of the tuna fisheries in the EPO. Of particular importance are the estimates of bycatch ratios for the different components of the purse-seine fishery, including the OBJ fishery. Appendix 1 shows 2017-2022 bycatch estimates of the OBJ fishery for many sensitive taxa ranging from turtles to elasmobranchs.

3.8. Biology indicators

Length-frequency samples are necessary to obtain age-structured estimates of the populations for various purposes, primarily for the integrated modeling that the staff uses to assess the status of the stocks. Length-frequency samples are obtained from the catches of purse-seine vessels in the EPO by IATTC personnel at ports of landing in Ecuador, Mexico, Panama, and Venezuela. The methods for sampling the catches of tunas are described in the appendix of Suter (2010). The methods for sampling the catches of tunas are described in the appendix of Suter (2010).

Historical long-term time series of size-composition data for yellowfin and bigeye are available in the Stock Assessment Reports, and the average length stock status indicators are available for the three tropical tuna species in SAC-14-04. In this document, data on the size composition of OBJ catches during 2017-2022 are presented (Fig. 30). The indicators in this section were extracted from SAC-14-03, section 5.

3.8.1. Size composition of tuna catches

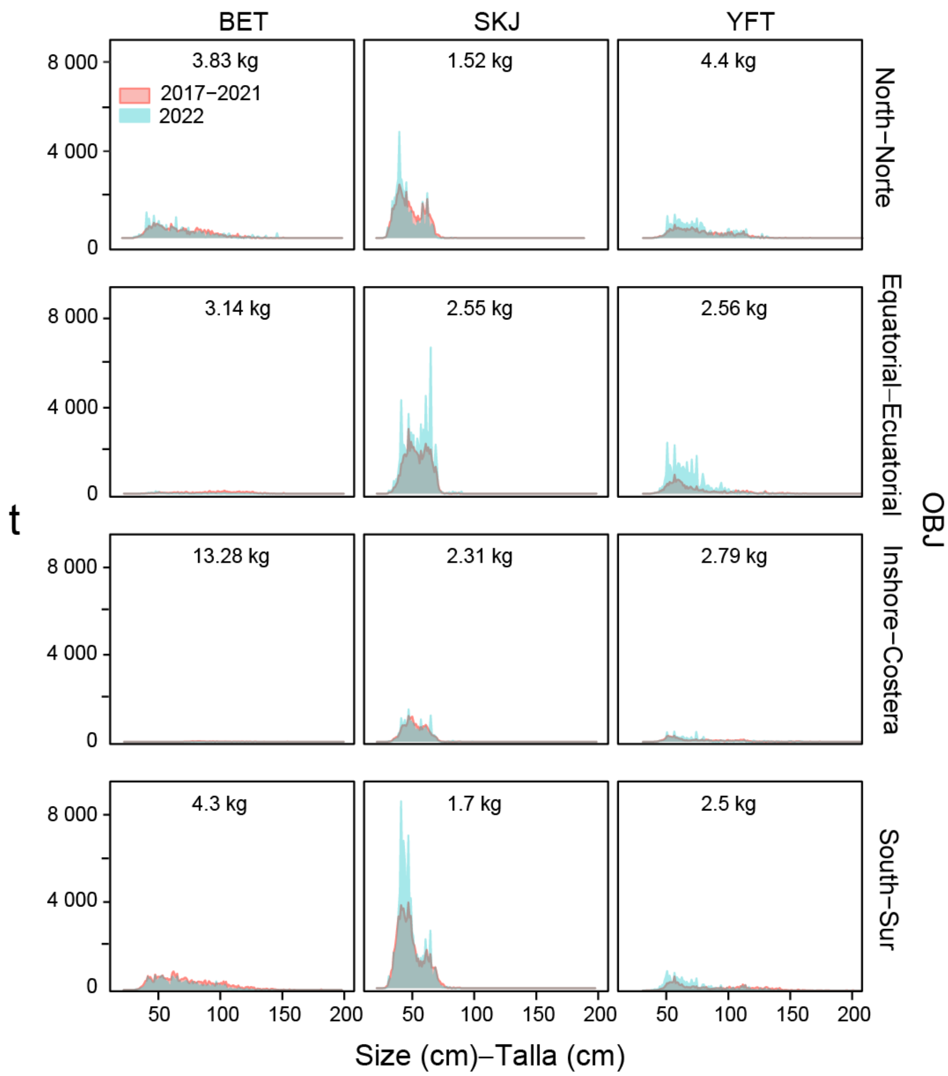

FIGURE 30. Estimated size compositions of bigeye, skipjack and yellowfin caught in the EPO, 2022 and 2017-2021 averages for each purse seine fishery defined by the IATTC staff for analyses of tropical tunas in the EPO (see Figure A-5 of SAC-14-03 for details on the designated areas). The value at the top of each panel is the average weight of the fish in the samples for 2022. Source: SAC-14-03.
FIGURA 30. Composiciones por talla estimadas del patudo, barrilete y aleta amarilla capturados en el OPO, 2022 y promedio de 2017-2021 , para cada pesquería cerquera definida por el personal de la CIAT para los análisis de los atunes tropicales en el OPO (ver detalles sobre las áreas designadas en Figura A-5 de SAC-14-03). El valor en la parte superior de cada panel es el peso promedio de los peces en las muestras para 2022. Fuente: SAC-14-03.

4. FUTURE PROSPECTS

Although this document presents the first holistic assessment for the OBJ fishery in the EPO through a set of ~50 indicators, there is still room for improvement. Some of the categories, particularly the socio-economic, the ecosystem impacts, or the biology-ecology and behavior are underrepresented due to the difficulties to systematically obtain large amounts of reliable data. Future versions of this document will attempt to increase the number of indicators to comply with the TWG recommendations . Indeed, the staff is currently involved in projects that could produce additional indicators. Euch as the buoy-derived abundance index (i.e. a pilot project in collaboration between the IATTC staff, AZTI, OPAGAC and Cape fisheries) (e.g. FAD-06-03), tuantifyingithe impact of stranding events in sensitive areas by lost or abandoned FADs (Project M.5.b), and analyzing class 1-5 vessels observer data that is voluntarily collected in TUNACONS vessels.

The data collected using different methodologies and used to produce the indicators in this document have proven to be useful for monitoring the OBJ fishery and its evolution. However, there are still many key aspects that remain unknown. For instance, catch per set analyses are merely descriptive and have not been standardized. The staff has emphasized the need of collecting additional data, including historical high-resolution buoy data, to connect databases and advance scientific analysis and management advice. This information become available to the staff in 2022 (see Resolution C-21-04 for details on raw buoy data reporting). However, the production of fisheries independent echo-sounder buoy indices relies on the availability of long-term data. We hope that initiatives like this will be well received by the scientific community and stakeholders in general, and will help promote, historical data exchange between institutions for a better assessment of fishery impacts and sustainability.

In addition, the staff plans to increase interaction with the fishing community, an endless source of first-hand information about the stock, the environment, and the fishery in general. Over the years, skippers' workshops have been conducted with the participation of the staff members for various reasons. The staff sees these forums as an excellent opportunity to build capacity and increase staff's knowledge of changes in the fleet behavior and strategy, the species, or the dynamics of the environment in a more tangible and immediate way. Starting in 2020, the workshops have been accompanied by a series of brief questionnaires on the most urgent matters, as well as basic questions about the fishery. The results of these consultations will be included in future versions of this document.

5. RECOMMENDATIONS

Please refer to the staff recommendations document (SAC-14-14) for the FAD fishery, including recommnedaions for data collection and any other relevant matters.

REFERENCES

Dagorn, L., K. N. Holland, V. Restrepo and G. Moreno (2012). "Is it good or bad to fish with FADs? What are the real impacts of the use of drifting FADs on pelagic marine ecosystems?" Fish and Fisheries: n/a-n/a.

Escalle, L., J. Scutt Phillips, M. Brownjohn, S. Brouwer, A. Sen Gupta, E. Van Sebille, J. Hampton and G. Pilling (2019). "Environmental versus operational drivers of drifting FAD beaching in the Western and Central Pacific Ocean." Scientific Reports 9(1): 14005.

Lennert-Cody, C. E., G. Moreno, V. Restrepo, M. H. Román and M. N. Maunder (2018). "Recent purse-seine FAD fishing strategies in the eastern Pacific Ocean: what is the appropriate number of FADs at sea?" ICES Journal of Marine Science: 75(75): 1748-1757.

Lopez, J. (2019). "FAD fishery indicators." 2nd joint t-RFMO WG on FADs, 8-10 May 2019, San Diego, USA.

Lopez, J., C. Lennert-Cody, M. Maunder and A. Aires-da-Silva (2019). "Adjusting current FAD limits to meet 2019 staff recommendations for tropical tuna management in the eastern Pacific Ocean." Document FAD-04-01 Ad-Hoc Permanent Working Group on FADs, Bilbao 2019.

Suter, J. M. (2010). "An evaluation of the area stratification used for sampling tunas in the eastern Pacific Ocean and implications for estimating total annual catches." La Jolla, CA, Inter-American Tropical Tuna Commision, 114pp. (Special Report, 18).

APPENDIX 1. OBJ bycatch rates, 2017-2021.

Source: from SAC-14-11, Tables J-2a; J-4a, J-5a, J-6a, J-7.

TABLE 8. Purse-seine interactions and mortalities of sea turtles (numbers of individuals) associated with floating objects as reported by onboard observers for size-class 6 vessels with a carrying capacity >363 t (2017-2022). Data for 2022 are considered preliminary. Adapted from SAC-14-11, table J-2a.
TABLA 8. Interacciones y mortalidades cerqueras reportadas por observadores a bordo, en número de tortugas, para buques de clase 6 con una capacidad de acarreo >363 t (2017-2022). Los datos de 2022 se consideran preliminares. Adaptada de SAC-14-11, tabla J-2a.

Year	***Lepidochelys olivacea,*** **olive Ridley**		***Chelonia agassizii, Chelonia mydas,*** **eastern Pacific green**		***Caretta caretta,*** **loggerhead**		***Eretmochelys imbricata,*** **hawksbill**		***Dermochelys coriacea,*** **leatherback**		**Unidentified turtles**	
	Interaction	*Mortality*	*Int.*	*Mort.*	*Int.*	*Mort.*	*Int.*	*Mor.*	*Int.*	*Mort.*	*Int.*	*Mort.*
2017	285	2	39	0	31	0	7	0	2	0	243	0
2018	150	2	50	2	17	0	7	0	3	0	160	0
2019	170	1	72	0	14	0	5	0	0	0	193	0
2020	91	0	29	0	17	0	5	0	2	0	108	1
2021	191	1	32	0	13	0	4	0	1	0	102	0
2022	133	0	40	0	19	0	10	0	2	0	92	0
Average	170	1	44	0	19	0	6	0	2	0	150	0

TABLE 9. Estimated purse-seine OBJ catches in metric tons (t) of sharks for size-class 6 vessels with a carrying capacity >363 t (2017-2022). Data for 2021 and 2022 are considered preliminary. "Other sharks" include whale shark (*Rhincodon typus*) and unidentified sharks (Euselachii). Adapted fromSAC-14-11, table J-4a.

TABLA 9. Capturas OBJ cerqueras estimadas de tiburones, en toneladas (t), para buques de clase 6 con una capacidad de acarreo >363 t (2017-2022). Los datos de 2021 y 2022 se consideran preliminares. "Otros tiburones" incluyen el tiburón ballena (*Rhincodon typus*) y tiburones (Euselachii) no identificados. Adaptada deSAC-14-11, tabla J-4a.

	Carcharhinidae				Sphyrnidae			
Year	***Carcharhinus falciformis*** **silky shark**	***Carcharhinus longimanus*** **oceanic whitetip**	***Prionace glauca*** **blue shark**	**Other Carcharhinidae** **requiem sharks**	***Sphyrna zygaena*** **smooth hammerhead**	***Sphyrna lewini*** **scalloped hammerhead**	***Sphyrna mokarran*** **great hammerhead**	***Sphyrna* spp.** **hammerheads nei**
2017	665	4	<1	54	11	8	<1	6
2018	397	3	<1	28	11	7	<1	6
2019	392	5	<1	26	17	11	1	5
2020	345	4	<1	87	7	13	<1	5
2021	542	12	<1	30	13	31	2	7
2022	615	11	1	30	11	47	<1	9
Average	**493**	**7**	**<1**	**42**	**12**	**20**	**<1**	**6**

Continued

	Alopiidae				Lamnidae		Triakidae		
Year	***Alopias pelagicus*** **pelagic thresher**	***Alopias superciliosus*** **bigeye thresher**	***Alopias vulpinus*** **thresher shark**	***Alopias* spp.** **thresher shark, nei**	***Isurus* spp.** **mako sharks**	**Lamnidae spp.** **mackerel sharks, porbeagles nei**	**Triakidae spp.** **houndsharks nei**	**Other sharks**	**All sharks**
2017	<1	<1	-	<1	<1	-	-	16	766
2018	<1	<1	<1	<1	2	-	-	5	460
2019	1	<1	-	<1	<1	-	-	6	465
2020	<1	<1	-	<1	2	-	-	3	467
2021	<1	<1	<1	<1	2	-	-	6	646
2022	<1	<1	<1	<1	1	-	-	2	731
Average	**<1**	**<1**	**<1**	**<1**	**1**	**-**	**-**	**6**	**589**

TABLE 10. Estimated purse-seine OBJ catches in numbers of individual rays for size-class 6 vessels with a carrying capacity >363 t (2017-2022). Data for 2022 are considered preliminary. ". Adapted fromSAC-14-11, table J-5a.

TABLA 10. Capturas OBJ cerqueras estimadas de rayas, en número de individuos, para buques de clase 6 con una capacidad de acarreo >363 t (2017-2022). Los datos de 2022 se consideran preliminares. Adaptada de SAC-14-11, tabla J-5a.

Year	***Mobula thurstoni*** smoothtail manta	***Mobula mobular*** spinetail manta	***Mobula munkiana*** munk's devil ray	***Mobula tarapacana*** chilean devil ray	***Mobula birostris*** giant manta	**Mobulidae spp.** mobulid rays, nei	***Pteroplatytrygon violacea*** pelagic stingray	**Dasyatidae spp.** stingrays, nei	**Oth rays**	**All rays**
2017	11	45	8	10	8	141	258	31	-	512
2018	6	37	22	8	11	102	247	62	-	495
2019	7	35	9	24	2	87	255	40	-	460
2020	9	19	1	5	7	62	260	17	-	380
2021	8	34	10	11	1	85	388	46	-	584
2022	4	42	12	22	3	128	421	34	-	667
Average	**7**	**35**	**10**	**13**	**5**	**101**	**305**	**39**	-	**516**

TABLE 11. Estimated purse-seine OBJ catches in metric tons (t) of large fishes for size-class 6 vessels with a carrying capacity >363 t (2017-2022). Data for 2022 are considered preliminary. "Other large fishes" include unidentified mackerels (Scombridae), and large fishes nei (not elsewhere identified). Adapted fromSAC-14-11, table J-6a.

TABLA 11. Capturas OBJ cerqueras estimadas de peces grandes, en toneladas (t), para buques de clase 6 con una capacidad de acarreo >363 t (2017-2022). Los datos de 2022 se consideran preliminares. "Otros peces grandes" incluyen caballas (Scombridae) no identificadas, y peces grandes nep (no identificados en otra parte). Adaptada deSAC-14-11, tabla J-6a.

Year	Coryphaenidae spp. dorado	*Acanthocybium solandri* *wahoo*	*Elagatis bipinnulata* *rainbow runner*	*Seriola spp.* *amberjacks, nei*	*Caranx* spp. jacks, crevalles, nei	*Seriola, Caranx spp.* *amberjacks, jacks, crevalles, nei*	*Molidae spp.* *molas, nei*
2017	1,557	335	18	12	4	4	8
2018	1,483	230	20	62	9	2	5
2019	1,208	201	21	12	5	3	2
2020	783	130	23	9	3	<1	1
2021	2,183	132	28	81	3	2	<1
2022	2,320	164	35	25	6	4	2
Average	**1,589**	**199**	**24**	**33**	**5**	**3**	**3**

Continued

Year	*Lobotes surinamensis,* *tripletail*	*Sphyraenidae spp.,* *barracudas*	*Lampris spp.,* *opahs*	Gempylidae *spp.,* *snake mackerels, nei*	Bramidae *spp.,* *pomfrets, nei*	Other large fishes	Unidentified fishes	All fishes
2017	5	<1	-	-	-	<1	1	1,946
2018	3	<1	-	-	-	<1	-	1,816
2019	2	<1	-	-	-	<1	<1	1455
2020	2	<1	-	-	-	<1	<1	953
2021	1	1	-	-	-	<1	<1	2,432
2022	4	<1	-	-	<1	<1	<1	2,560
Average	**3**	**<1**	**-**	**-**	**<1**	**<1**	**<1**	**1,860**

TABLE 12. Estimated purse-seine OBJ catches in metric tons (t) of small forage fishes for size-class 6 vessels with a carrying capacity >363 t (2017-2022). Data for 2021 and 2022 are considered preliminary. “Epipelagic forage fishes” include various mackerels and scad (*Decapterus* spp., *Trachurus* spp., *Selar crumenophthalmus*). “Other small fishes” include various Tetraodontiformes, driftfishes (Nomeidae), Pacific chub mackerel (*Scomber japonicus*), Pacific tripletail (*Lobotes pacificus*), remoras (Echeneidae), longfin batfish (*Platax teira*), and small fishes not elsewhere identified (nei). Adapted fromSAC-14-11, Table J-7.

TABLA 12. Capturas OBJ cerqueras estimadas de peces forrajeros pequeños, en toneladas (t), para buques de clase 6 con una capacidad de acarreo >363 t (2017-2022). Los datos de 2021 y 2022 se consideran preliminares. “Peces epipelágicos de forraje” incluyen varias caballas y jureles (*Decapterus* spp., *Trachurus* spp., *Selar crumenophthalmus*). “Otros peces pequeños” incluyen varios Tetraodontiformes, derivantes (Nomeidae), estornino del Pacífico (*Scomber japonicus*), dormilona del Pacífico (*Lobotes pacificus*), remoras (Echeneidae), pez murciélago teira (*Platax teira*), y peces pequeños (nep) no identificados en otra parte. Adaptada deSAC-14-11, tabla J-7.

Year	***Auxis* spp., bullet and frigate tunas**	**Balistidae, Monacanthidae spp., triggerfishes and filefishes**	**Kyphosidae sea chubs**	**Epipelagic forage fishes**	**Small Carangidae spp. carangids, nei**	**Other small fishes**
2017	131	83	8	3	<1	<1
2018	276	54	10	5	<1	<1
2019	182	57	7	5	<1	<1
2020	435	47	2	4	<1	<1
2021	423	50	6	15	<1	<1
2022	682	453	21	15	<1	1
Average	**355**	**139**	**9**	**8**	**<1**	**<1**