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UPDATED STOCK STATUS INDICATORS FOR SILKY SHARKS IN THE EASTERN PACIFIC OCEAN (1994-2016), WITH OCEANOGRAPHIC CONSIDERATIONS

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CONTENTS

1. SUMMARY

Indices of relative abundance for the silky shark in the eastern Pacific Ocean (EPO), developed from purse-seine catch-per-set, were updated with data from 2016. The index for all silky sharks north of the equator (north EPO) shows a large decrease in 2016 relative to 2015. In contrast, the index for all silky sharks south of the equator (south EPO) remains at about the 2014-2015 level. Some recent strong increasing trends in the indicators for silky sharks have been identified in previous reports, but they are not biologically plausible. To help further the understanding of potential processes driving the recent trends in the north EPO indices, silky shark indices by sub-region within the north EPO, and by shark size category, were compared to an index of variability in oceanographic conditions, and to a preliminary silky shark index for the Western and Central Pacific Ocean (WCPO) associated-set purse-seine fishery. Based on the preliminary results of these comparisons, it is hypothesized that the recent changes in the silky shark indices for the north EPO, particularly for small silky sharks, may be influenced by changing oceanographic conditions (*e.g.*, El Niño and La Niña events), and thus the north EPO indices are potentially biased. Further analysis will be necessary to evaluate the magnitude of this bias quantitatively and, if the indices for large silky sharks are found to be less susceptible to bias caused by changing oceanographic conditions, they may be used exclusively as stock status indicators in the future. The IATTC staff reiterates its previous recommendation (SAC-07-06b(i), SAC-07-06b(iii)) that improving shark fishery data collection in the EPO is critical. This will facilitate the development of other stock status indicators and/or conventional stock assessments to better inform the management of the silky shark and other co-occuring shark species. Spatio-temporal models that

combine data from multiple gear types to improve spatial coverage should also be explored in the future, to facilitate modeling efforts once data from other sources become available.

2. BACKGROUND

An attempt by the IATTC staff in 2013 to assess the status of the silky shark (*Carcharhinus falciformis*) in the EPO, using conventional stock assessment models, was severely hindered by major uncertainties in the fishery data, primarily total annual catch in the early years for all fisheries that caught silky sharks in the EPO (SAC-05 INF-F). Although the stock assessment attempt produced a substantial amount of new information about the silky shark in the EPO (*e.g.*, absolute and relative magnitude of the catch by different fisheries, and their selectivities), the absolute scale of population trends and the derived management quantities were compromised. Since a conventional stock assessment was not possible, in 2014 the staff proposed a suite of possible stock status indicators (SSIs) that could be considered for managing the silky shark in the EPO (SAC-05-11a), including standardized catch-per-set (CPS) indices from the purse-seine fishery. This document updates the purse-seine CPS indices with data for 2016, hypothesizes possible drivers underlying observed trends, and discusses future research directions with respect to purse-seine indicators for the silky shark.

3. DATA AND METHODS

Data collected by IATTC observers aboard Class-6[1] purse-seine vessels were used to generate CPS-based indices of relative abundance for the silky shark. Observers record bycatches of silky sharks, which occur predominantly in floating-object (OBJ) sets (SAC-07-07b), by size category: small (< 90 cm total length (TL), medium (90-150 cm TL), and large (>150 cm TL)). Annual summaries of spatial data on bycatches (in numbers) of silky sharks in floating-object sets, by size category and for all sizes combined, are shown in Figure 1.

CPS trends for floating-object sets (CPS-OBJ) were estimated using generalized additive models (GAMs). A zero-inflated negative binomial (ZINB) GAM was used to model the bycatch data from OBJ sets because of the presence of many sets with zero bycatch, and also sets with large bycatches. Predictors used in this model were: year (factor); smooth terms for latitude, longitude, time of set, and day of the year (to capture seasonal patterns); and linear terms for depth of the purse-seine net, depth of the floating object, sea-surface temperature, natural logarithm of non-silky bycatch, natural logarithm of tuna catch, and two proxies for local floating-object density. Trends were computed by shark size category and for all sizes combined, using the method of partial dependence, which produces a data-weighted index. Approximate 95% pointwise confidence intervals were computed for the trends for all shark sizes combined by resampling from the multivariate normal distribution of the estimated GAM coefficients, assuming known smoothing and scale parameters. As in previous years, trends were computed for the EPO north and south of the equator, and for four smaller areas within the north EPO:

Area	Latitude	Longitude	No. of OBJ sets
1	North of 8°N	Coast-150°W	2,007
2	0°-8°N	120°W-150°W	6,353
3	0°-8°N	95°W-120°W	17,953
4	0°-8°N	Coast-95°W	7,444

It has been suggested that recent trends in the north EPO silky shark indices integrate immigration and/or recruitment processes with a linkage to the WCPO (SAC-07-06b(i)). To investigate this hypothesis, two exploratory analyses were conducted to develop a better understanding of processes potentially affecting the indices.

[1] Carrying capacity > 363 t

First, through a collaboration with the Western and Central Pacific Fisheries Commission (WCPFC) that was initiated to support a forthcoming ABNJ Tuna Project-funded Pacific-wide assessment for the silky shark[2], it was possible to compute a preliminary standardized trend for the silky shark from observer data collected in associated sets in the purse-seine fishery from 2004-2015 in the WPO between 145°E-180°E and 10°S-5°N. This area was selected because it was fished consistently across the 12-year time period. The trend was estimated using the same ZINB GAM methods used for the EPO, with the following predictors: year (factor), smooth terms for latitude, longitude, time of set and month (month was specified as a cyclic cubic spline), linear terms for the natural logarithm of tuna catch and the natural logarithm of a proxy for local object density, and vessel flag and association type as factors. This preliminary trend was compared to the north EPO CPS-OBJ trends for both small and medium silky sharks, following on a preliminary comparison of the size composition of the sampled catch in the WCPO with that of EPO OBJ sets during 2005-2015 (see Results).

Second, it has been noted previously that silky trends differed spatially within the north EPO (SAC-07-06b(i)). Therefore, a second analysis compared the north EPO silky shark trends, by area, and the WCPO trend, with an indicator of variability in oceanographic conditions, the Indo-Pacific Tripole (TPI) (Henley *et al*. 2015). The TPI is a measure of variability in sea-surface temperature anomalies that captures low and high-frequency links between ocean basins, which influence tropical Pacific oceanographic conditions (Lian *et al*. 2014 and references therein). The TPI shows similarities to the better-known Multivariate El Niño-Southern Oscillation (ENSO) Index (MEI) (Figure 2) (Wolter and Timlin 1993; 1998; 2011;), which is based on sea-level pressure, surface winds, sea-surface temperature, surface air temperature, and cloud cover.

4. RESULTS

4.1. Updated trends in the EPO

For the north EPO, the CPS-OBJ index shows an initial sharp decline during 1994-1998, followed by a period of relative stability at a low level (1999-2009), then a sharp increase from 2009 to 2010, a sharp decrease from 2010 through 2012, a sharp increase from 2012 through 2015 and another sharp decrease in 2016 (Figure 3). As noted in previous documents (*e.g*., SAC-07-06b(i)), the CPS-OBJ trend in the north EPO shows general agreement with standardized presence/absence indices for all silky sharks in the north EPO (obtained using logistic GAMs) for dolphin sets and unassociated sets (Figure 4).

In the north EPO, the trends for the three size categories of silky sharks (Figure 5a) are generally similar to the trend for all silky sharks. However, year-to-year changes in the index for small sharks have not always been the same as those of the indices for medium and large sharks (Figure 5b). This might be expected if the small shark category is a proxy for recruitment (ages 0+ and 1+ years) and the trends in the larger sizes are more reflective of changes in overall stock abundance. Since about 2009, however, the year-to-year changes in the small shark index more closely follow the trends for medium and large sharks (Figure 5b). This suggests that the mechanisms acting on the different size classes may be more complex.

Trends computed by sub-area within the northern EPO suggest that the recent changes in the north EPO index for all silky sharks are most consistent with the trends for the more offshore equatorial regions (Areas 2-3, Figure 6). Updated indices show contrasting trends by sub-area for the most recent year. There was only a small decrease in 2016 in the indices in the far northern area (Area 1, Figure 6) and an increase in 2016 in the indices in the coastal area (Area 4, Figure 6). However, in the more offshore equatorial areas

[2] Led by Dr. Shelley Clarke, Technical Coordinator-Sharks and Bycatch, Western and Central Pacific Fisheries Commission

(Areas 2-3, Figure 6) there was a decrease for all size categories in 2016, with the most pronounced decreases for the indices of small- and medium-sized sharks. Because the EPO indices are data-weighted, the trends are influenced by areas with more sets in the analysis data set. Of the four northern sub-regions, Areas 2 and 3 represent 19% and 53%, respectively, of the sets in the analysis data set for the north EPO (see Data and Methods above).

For the south EPO, the CPS-OBJ indicator for all sharks shows a sharp decline during 1994-2004, followed by a period of stability at much lower levels until 2013, and then a small increase in 2014, with little change through 2016 (Figure 3). In general, the trend for medium sharks is similar to the trend for all sharks, although it does not show as great an increase from 2013 to 2014 as the trend for all sharks. This greater increase in the trend for all silky sharks may be the result of an increased presence of small sharks along the western boundary of the southern EPO in recent years (Figure 1a), and will be investigated further in the future. The trend for large sharks, however, differs from the trend for all sharks in recent years in that it continued to decrease slightly in 2016 (Figure 5b). Trends by sub-area, and for other set types, were not computed for the southern area because of the low levels of silky shark bycatch (Figure 1). In particular, very few small silky sharks are generally caught in the southern area (Figure 1a), which may be due to a lack of recruitment, or possibly a lower selectivity for small sharks by the southern fishery.

4.2. Trends in the WCPO

The size-composition data for silky sharks caught in associated sets in the WCPO between 145°E and180°E from 10°S to 5°N are skewed towards smaller-sized individuals, as are samples from OBJ sets in the north EPO (Figure 7). The modes of the distributions of fork length (FL) from the WCPO, by 5° area, ranged from 67cm to 110cm, with the median at 83 cm, about 10 cm above the upper limit of the EPO 'small' category of 72 cm FL (90 cm TL). For 90% of sharks sampled in the WCPO, fork length was below the upper limit of the EPO 'medium' category of 122cm FL (150cm TL). The range of sampled fork lengths in the WCPO data thus largely overlaps with the 'small' and 'medium' categories of the EPO data, and so the WCPO trend was compared to the trends for both small and medium sharks for OBJ sets for the north EPO, by sub-area, (Areas 1-4 of Figure 6).

The level of agreement between the WCPO and north EPO trends depends on which region within the north EPO is chosen for comparison. In the equatorial region (Areas 2-4, Figure 6), the WCPO trend shows the greatest agreement with the EPO trend for small and medium sharks in the offshore areas (Areas 2-3) and the least agreement with the small shark trend in the coastal area (Area 4) (Figure 8). There is even less agreement between the WCPO trend (Figure 8) and the small shark trend in the region north of 8°N (Area 1 of Figure 6). Thus, the level of agreement between the WCPO trend and the north EPO small and medium trends appears to decrease closer to the coast, as well as north of the equatorial area. To some extent this might be expected, given the difference in oceanographic conditions between the coastal and offshore equatorial areas of the EPO (*e.g.*, Martinez *et al*. 2015). Although the WCPO trend is relatively short (12 years), and comparisons of short time series can be problematic because apparent correlations are more likely to be spurious, the peak in the WCPO trend in 2011 appears to lag one year behind the peak in the EPO trend in 2010 (Figure 8, Areas 2-3). Since the 2009-2010 period included an El Niño event, it may be that this one-year lag is related to the evolution of El Niño conditions across the Pacific.

4.3. Comparison of trends with the TPI

Environmentally-driven population growth (via increased recruitment), movement, and availability to fishing gear are processes that might lead to similar trends in the indices for the WCPO and EPO (Figure 8), and among purse-seine set types within the EPO (Figure 4). However, the increases in the OBJ indices for all sharks in consecutive years, especially in the north EPO, are generally too large to attribute to population growth alone. Specifically, in several years there is no overlap of the upper confidence limit on the estimated finite rate of population increase for a virgin population and the lower confidence limit on the proportional change in the OBJ index from one year to the next (Figure 9).

Although a formal time series analysis will be undertaken in future (see below), the coherence between the OBJ trends for small sharks in the north EPO, the WCPO silky shark trend, and the TPI (Figure 10) suggests that the EPO trend may be biased by changes in oceanographic conditions that influence catchability and/or movement. For the north EPO, the level of agreement of the small shark index and the TPI differs between coastal and offshore areas: in the offshore equatorial area (Area 2) there is considerable agreement between the longer-period fluctuations of the TPI and the small shark index. It is noteworthy that, for both of the strongest El Niño events between 1995 and -2016 (1997-1998 and 2015-2016), the small shark index in Area 2 increased about one year prior to the peak in the TPI. In the coastal equatorial area (Area 4), however, there appears to be less overall agreement between the small shark index and the TPI, and there is about a 1-year lag between the peak in the TPI in 1997-1998 and the peak in the small shark index in about 1998-1999. For the large shark indices, there appears to be less agreement with the TPI, even in the offshore equatorial area (Area 2 of Figure 10). This would be expected if large silky sharks are less sensitive to habitat fluctuations caused by oscillations in the oceanographic environment and/or the abundance of an adult population is inherently less influenced by recent, oceanographically-driven recruitment events.

5. FUTURE WORK

Given the apparent oceanographic influence on the EPO silky shark indices, especially for small sharks in the equatorial north EPO, it is essential that data from other sources be collected to develop additional indicators. Although further analysis may show that the indices for large silky sharks might be better stock status indicators than indices based on all silky sharks, purse-seine fishery indices alone are not sufficient to determine stock status for a species that may be impacted by different oceanographic factors and fisheries in different regions within the EPO. Obtaining reliable catch data for all fisheries catching silky sharks in the EPO, indices of relative abundance for other fisheries (especially longline fisheries, which take the majority of the catch), and composition data, by length/age and sex, is vital. In addition, given the apparent similarities between the WCPO index and the EPO index for small sharks in the western north EPO, Pacific-wide collaborative stock assessment work between WCPFC and IATTC should be pursued to better understand the population dynamics and stock status at the biological stock level, rather than within the confines of RFMO boundaries.

To evaluate the relationship between silky shark indices and environmental forcing quantitatively, future work will focus on using multiple applications of linear autoregressive models to obtain filtered oceanographic indicators (Di Lorenzo and Ohman 2013) on time scales biologically relevant for the silky shark life stages of interest. This filtering process removes variability in an environmental index on scales that are too short to be biologically meaningful for the species and life stages under consideration, while enhancing environmental variability at lower frequencies. The correlation of the filtered environmental indicators with silky shark indices can be computed to quantify the level of agreement between the indices and environmental forcing on specific time scales. Furthermore, changes in the degree of correlation with different amounts of filtering of the environmental indices can be investigated. Indices of oceanographic forcing that will be considered in the analysis include the TPI, the MEI, the North Pacific Gyre Oscillation index, and the Pacific Decadal Oscillation.

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We thank the WCPFC for purse-seine data on silky shark bycatch from the WCPO, Nickolas Vogel for database assistance with the EPO data, and Shane Griffiths for helpful discussions and comments on this document.

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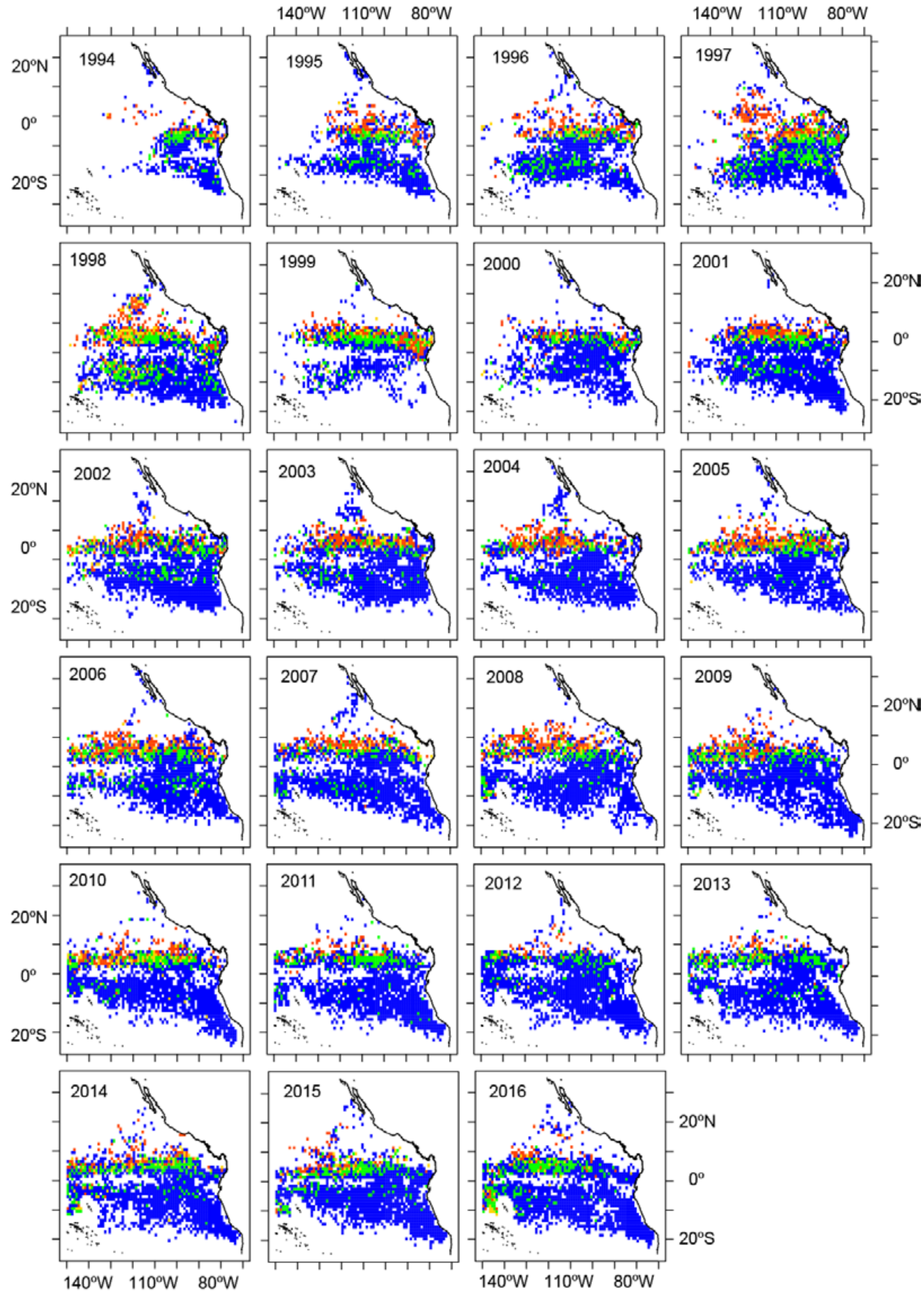

FIGURE 1a. Average bycatch per set in floating-object sets, in numbers, of small (< 90 cm total length) silky sharks, 1994-2016. Blue: 0 sharks per set, green: ≤ 1 shark per set; yellow: 1-2 sharks per set; red: > 2 sharks per set.

FIGURA 1a. Captura incidental media por lance en lances sobre objetos flotantes, en número, de tiburones sedosos pequeños (< 90 cm de talla total), 1994-2016. Azul: 0 tiburones por lance, verde: ≤ 1 tiburones por lance; amarillo: 1-2 tiburones por lance; rojo: > 2 tiburones por lance.

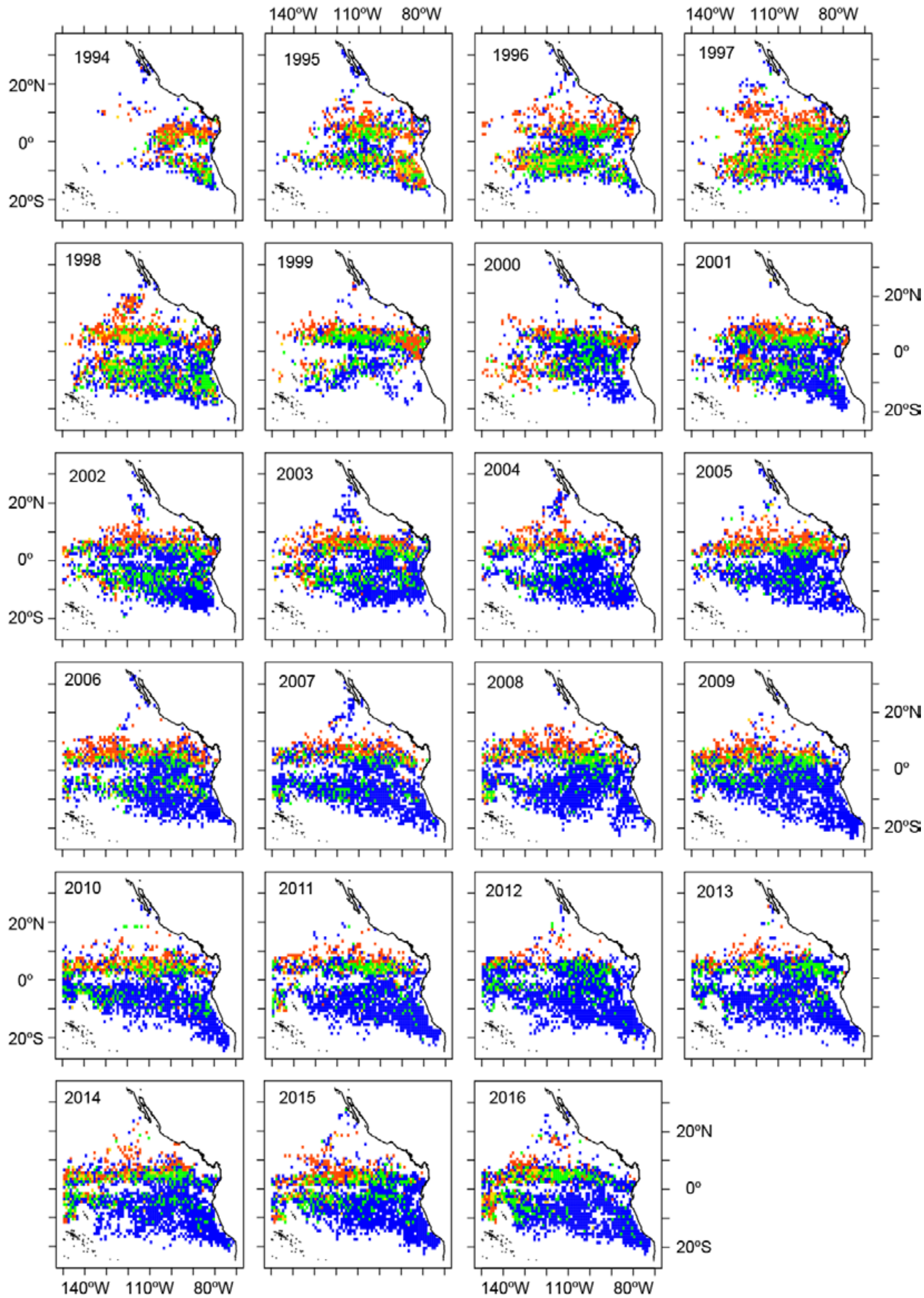

FIGURE 1b. Average bycatch per set in floating-object sets, in numbers, of medium (90-150 cm total length) silky sharks, 1994-2016. Blue: 0 sharks per set, green: ≤ 1 shark per set; yellow: 1-2 sharks per set; red: > 2 sharks per set.

FIGURA 1b. Captura incidental media por lance en lances sobre objetos flotantes, en número, de tiburones sedosos medianos (90-150 cm de talla total), 1994-2016. Azul: 0 tiburones por lance, verde: ≤ 1 tiburones por lance; amarillo: 1-2 tiburones por lance; rojo: > 2 tiburones por lance.

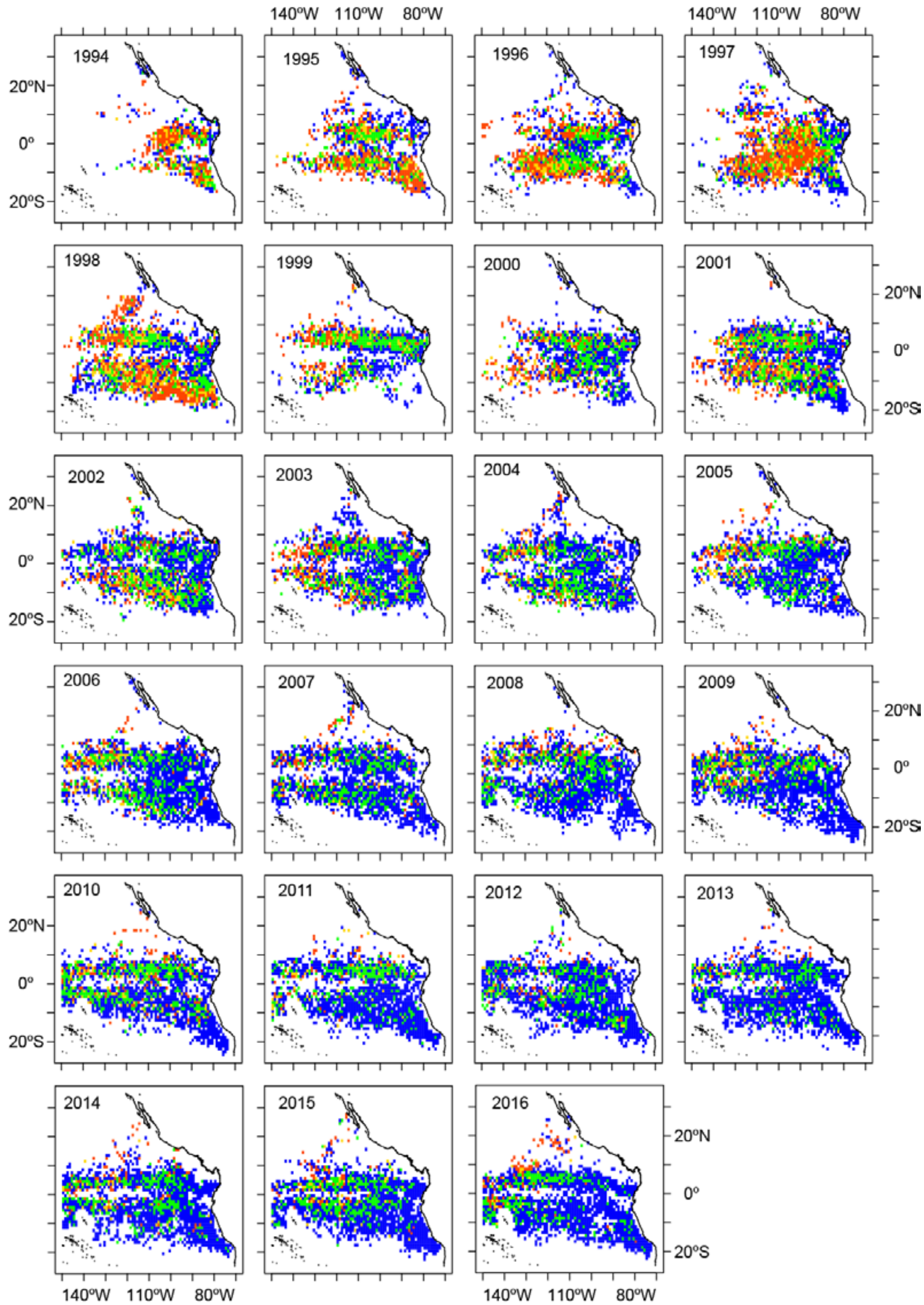

FIGURE 1c. Average bycatch per set in floating-object sets, in numbers, of large (> 150 cm total length) silky sharks, 1994-2016. Blue: 0 sharks per set, green: ≤ 1 shark per set; yellow: 1-2 sharks per set; red: > 2 sharks per set.

FIGURA 1c. Captura incidental media por lance en lances sobre objetos flotantes, en número, de tiburones sedosos grandes (> 150 cm de talla total), 1994-2016. Azul: 0 tiburones por lance, verde: ≤ 1 tiburones por lance; amarillo: 1-2 tiburones por lance; rojo: > 2 tiburones por lance.

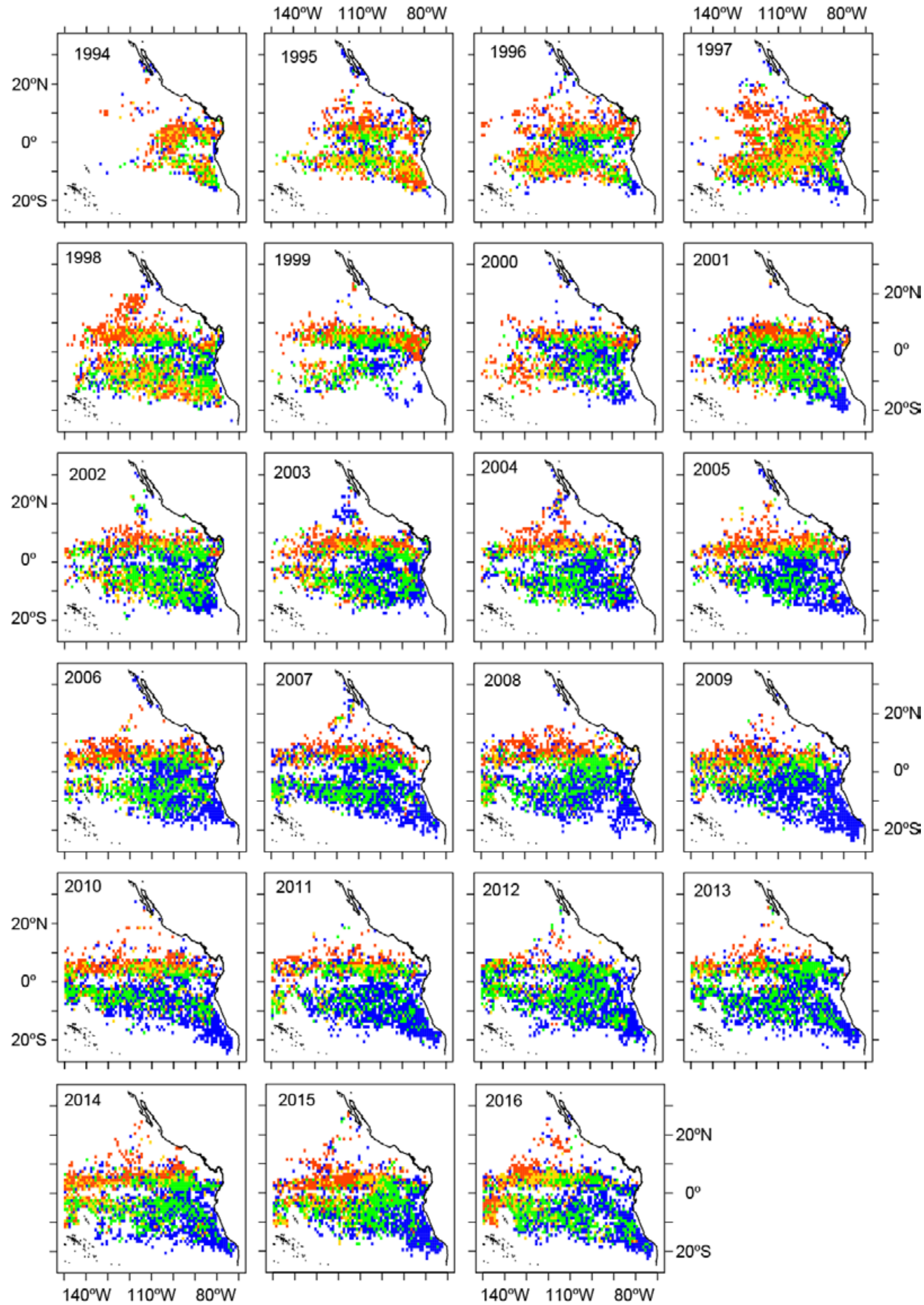

FIGURE 1d. Average bycatch per set in floating-object sets, in numbers, of all silky sharks, 1994-2016. Blue: 0 sharks per set, green: ≤2 shark per set; yellow: 2-5 sharks per set; red: >5 sharks per set.

FIGURA 1d. Captura incidental media por lance en lances sobre objetos flotantes, en número, de todos tiburones sedosos, 1994-2016. Azul: 0 tiburones por lance, verde: ≤ 2 tiburones por lance; amarillo: 2-5 tiburones por lance; rojo: > 5 tiburones por lance.

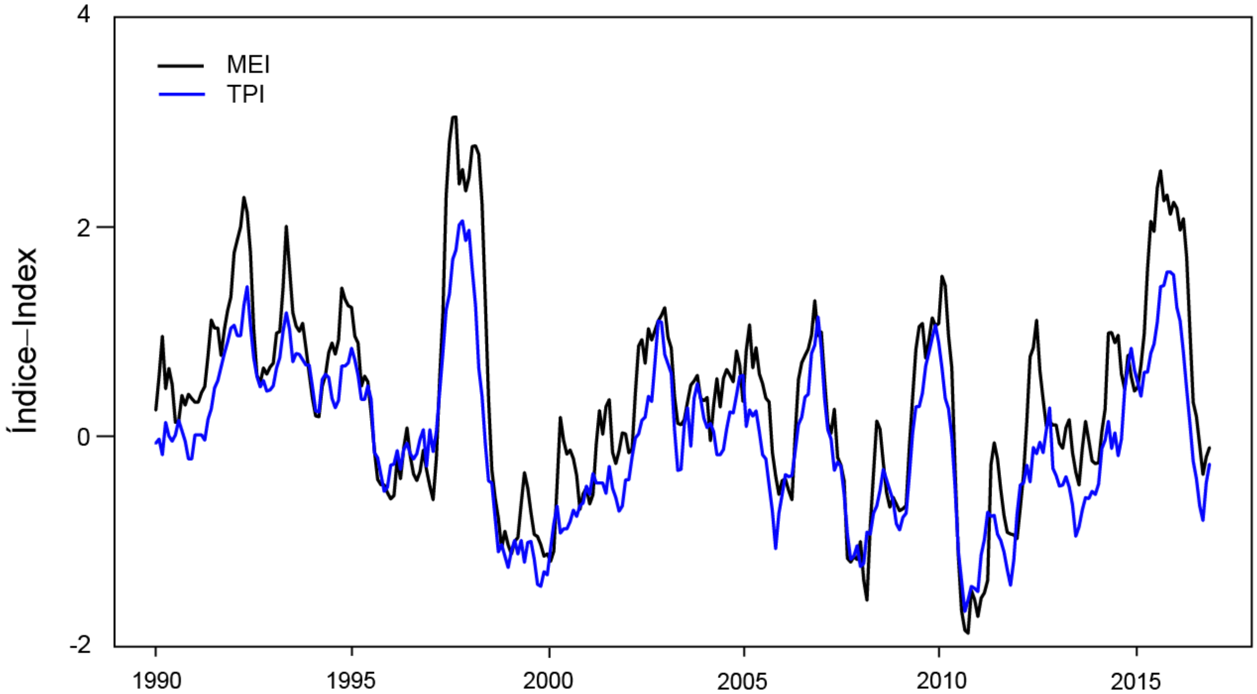

FIGURE 2. Multivariate ENSO Index (MEI; https://www.esrl.noaa.gov/psd/enso/mei/index.html) and Indo-Pacific Tripole Index (TPI; https://www.esrl.noaa.gov/psd/data/timeseries/IPOTPI/), 1990-2016.
FIGURA 2. Índice ENOS multivariable (MEI; https://www.esrl.noaa.gov/psd/enso/mei/index.html) e índice tripolar indopacífico (TPI; https://www.esrl.noaa.gov/psd/data/timeseries/IPOTPI/), 1990-2016.

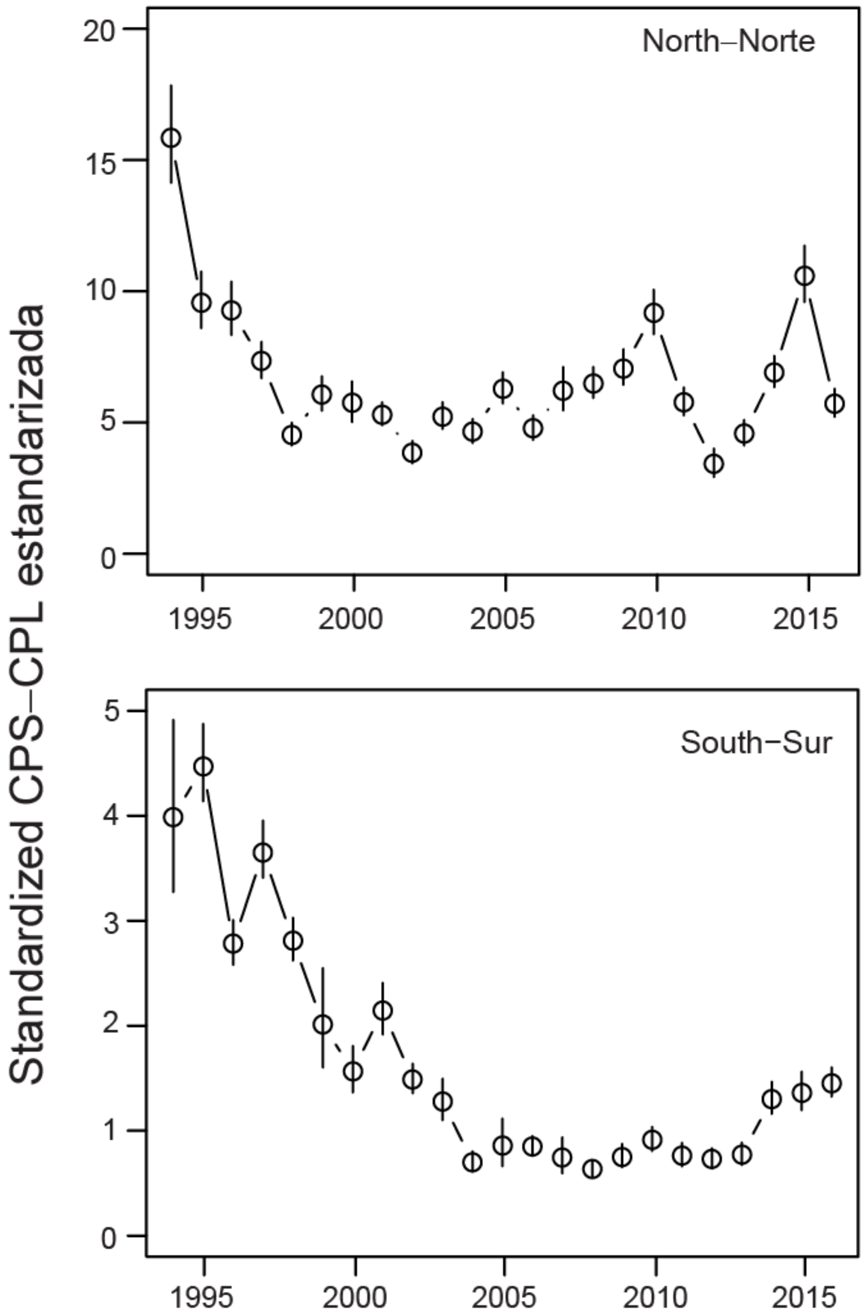

FIGURE 3. Standardized catch-per-set (CPS, in number of sharks per set) of silky sharks (all size classes combined) in floating-object sets in the north (top) and south (bottom) EPO.

FIGURA 3. Captura por lance (CPL, en número de tiburones por lance) estandarizada de todos los tiburones en lances sobre objetos flotantes en el OPO norte (arriba) y sur (abajo).

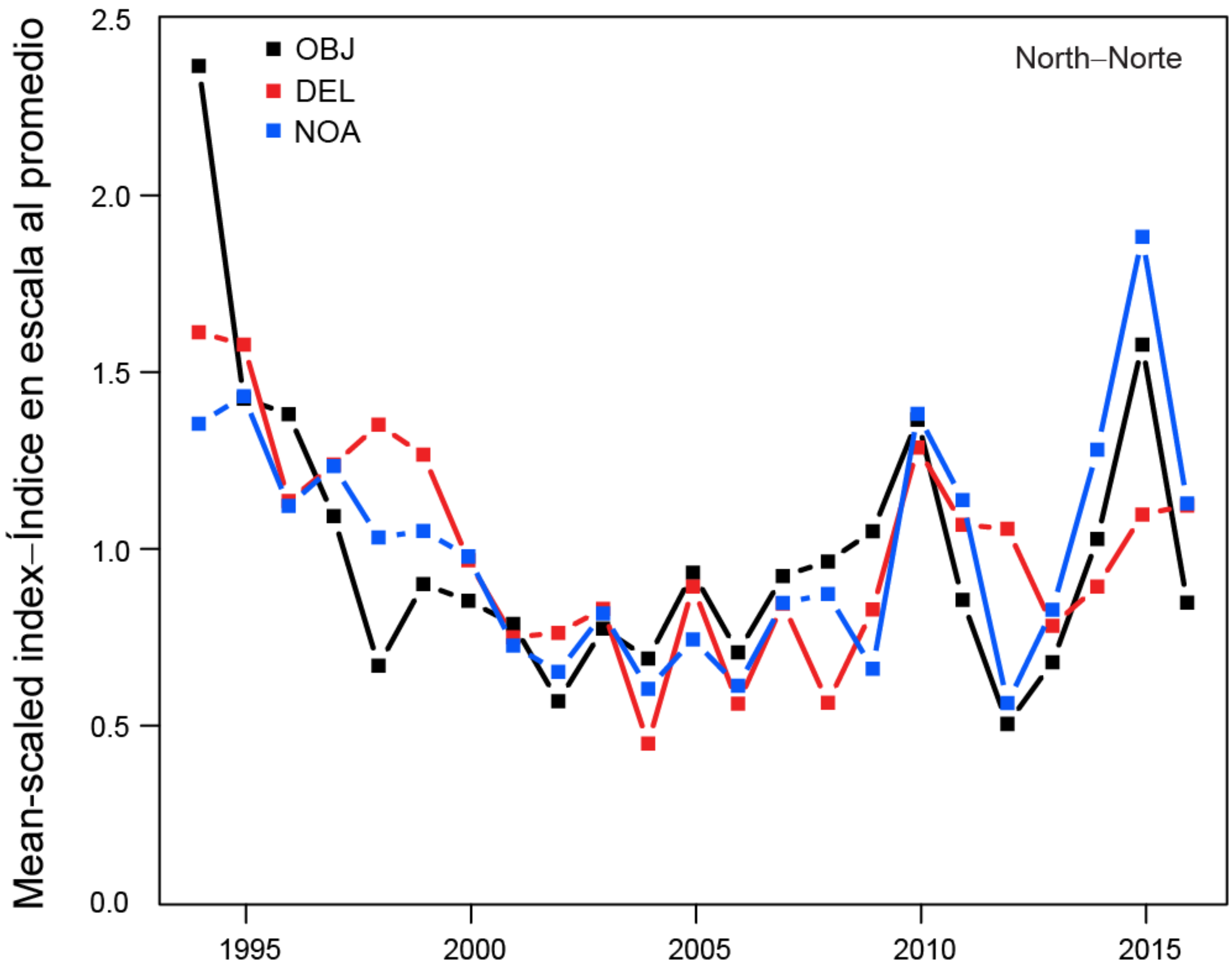

FIGURE 4. Mean-scaled indices for the silky shark in the north EPO for different purse-seine set types (floating-object (OBJ), dolphin (DEL), unassociated (NOA)).
FIGURA 4. Índices en escala al promedio para el tiburón sedoso en el OPO norte en distintos tipos de lance cerquero (objeto flotante (OBJ), delfín (DEL), no asociado (NOA)).

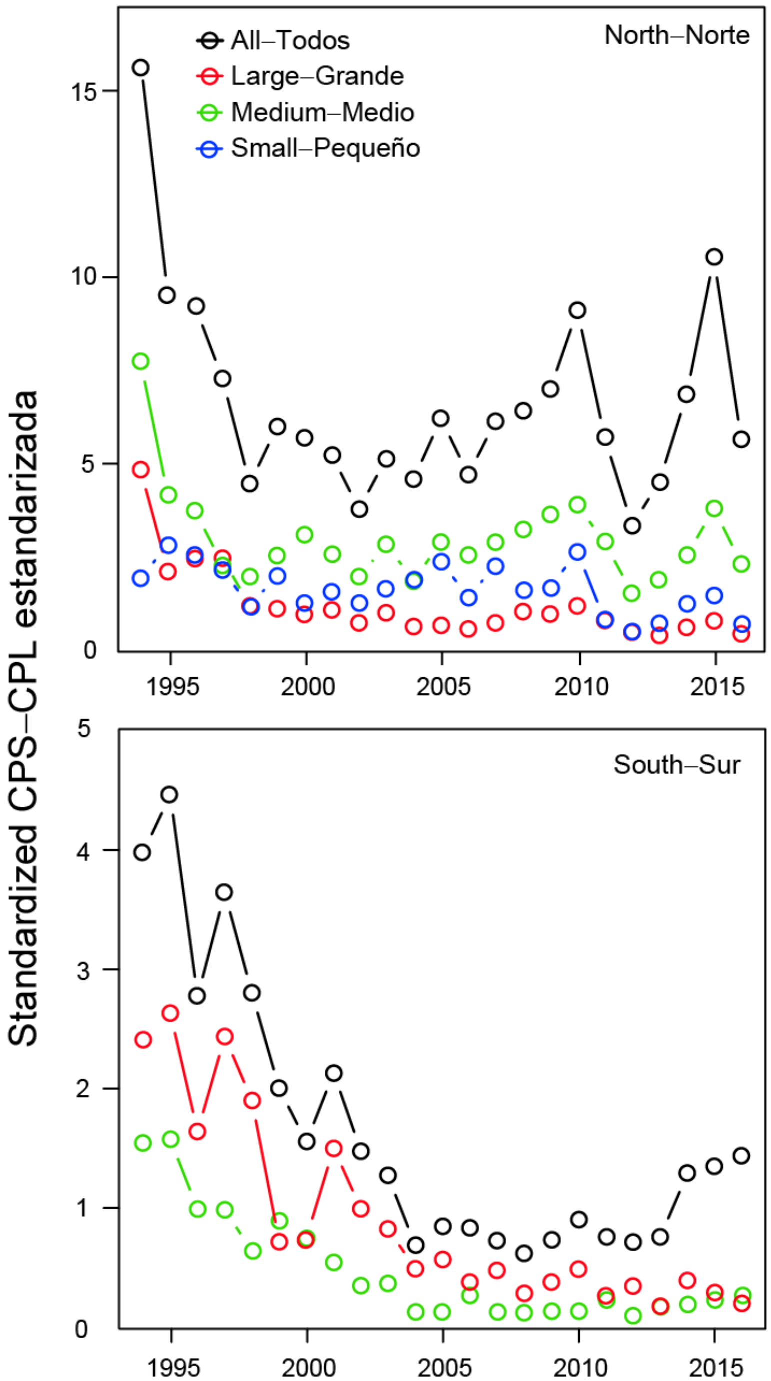

FIGURE 5a. Standardized catch-per-set (CPS; in numbers of sharks per set) in sets on floating objects of silky sharks of three size classes (small, medium, large) and all sizes combined in the north (top) and south (bottom) EPO. No index was computed for small silky sharks in the south EPO due to model instability caused by the low levels of bycatch in recent years; see Figure 1a.

FIGURA 5a. Captura por lance (CPL, en número de tiburones por lance) estandarizada en lances sobre objetos flotantes de tiburones sedosos de tres clases de talla (pequeño, mediano, grande) y todas las tallas combinadas, en el OPO norte (arriba) y sur (abajo). No se calculó un índice para los tiburones sedosos pequeños en el OPO sur debido a la inestabilidad del modelo causada por los bajos niveles de captura incidental en los años recientes (Figura 1a).

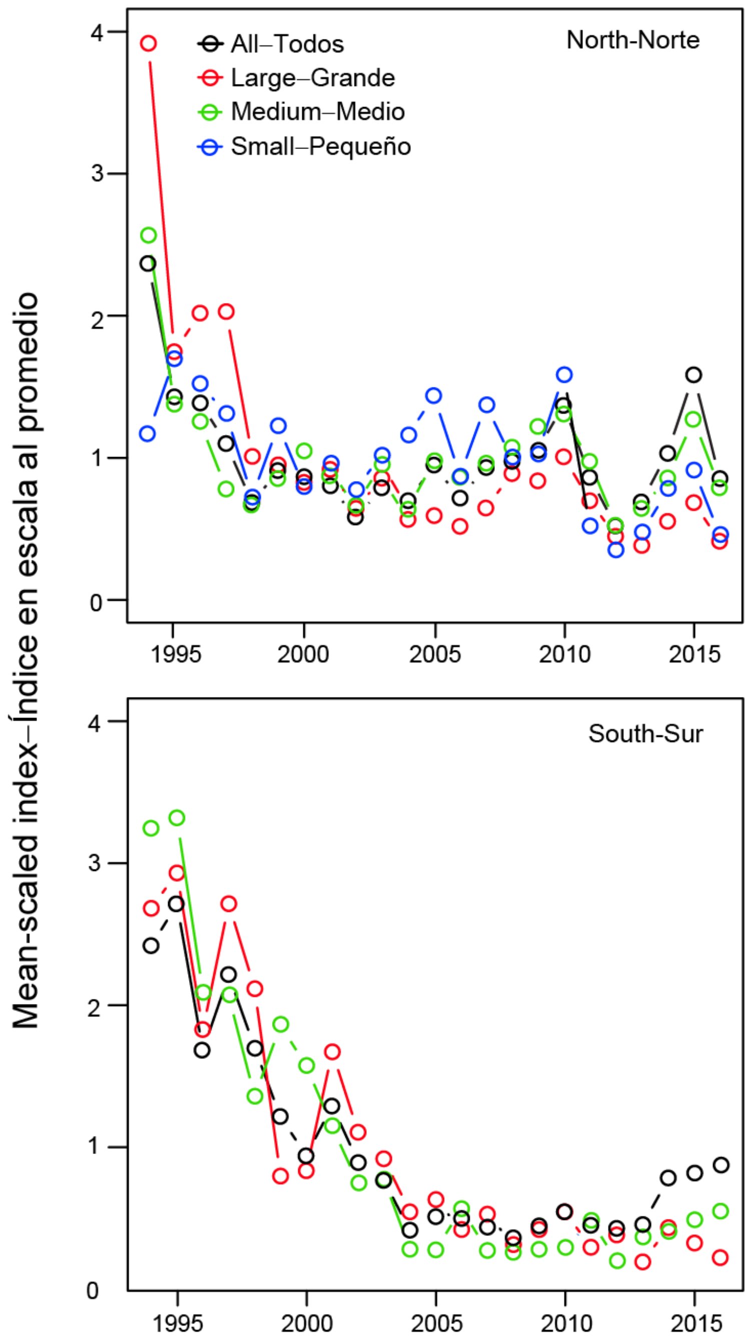

FIGURE 5b. Mean-scaled standardized catch-per-set in floating-object sets (from Figure 3a) for silky sharks of three size classes (small, medium, large) and all sizes combined for the north (top) and south (bottom) EPO. No index was computed for small silky sharks in the south EPO due to model instability caused by the low levels of bycatch in recent years (Figure 1a).

FIGURA 5b. Captura por lance estandarizada en escala as promedio en lances sobre objetos flotantes (de la Figura 3a) de tiburones sedosos de tres clases de talla (pequeño, mediano, grande) y de todas tallas combinadas, en el OPO norte (arriba) y sur (abajo). No se calculó un índice para los tiburones sedosos pequeños en el OPO sur debido a la inestabilidad del modelo causada por los bajos niveles de captura incidental en los años recientes (Figura 1a).

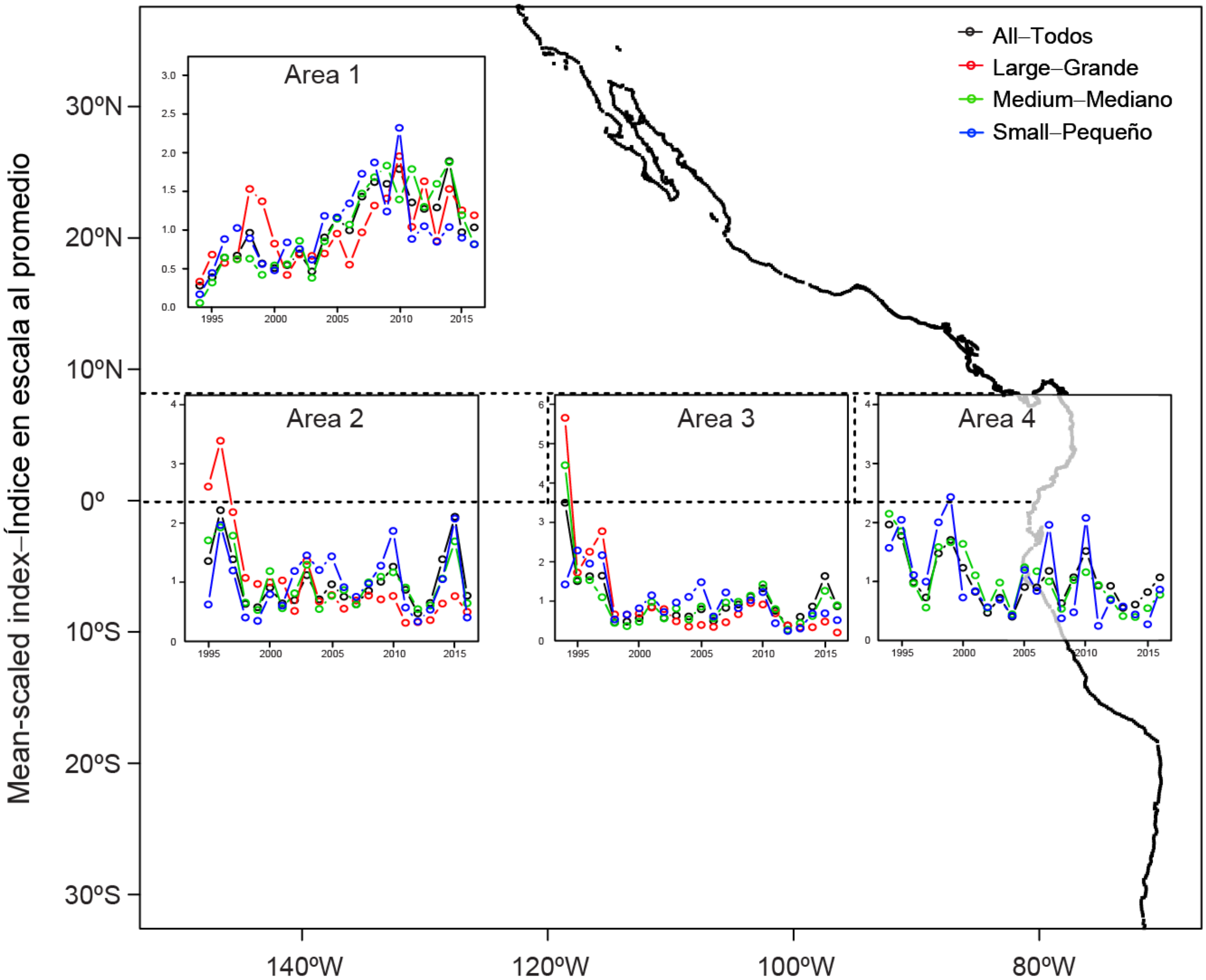

FIGURE 6. Mean-scaled standardized CPS for silky sharks in the north EPO, by sub-area. The black horizontal dashed lines show the locations of the four sub-areas: Area 1 (north of 8°N); Area 2 (0°-8°N and 120°-150°W); Area 3 (0°-8°N and 95°-130°W), and Area 4 (0°-8°N, from the coast to 95°W). No trend was computed for large sharks in Area 4 because of model instability identified in previous analyses.

FIGURA 6. Captura por lance estandarizada en escala al promedio de tiburones sedosos en el OPO norte, por subárea. Las líneas de trazos negras horizontales indican la posición de las cuatro subáreas: Área 1 (al norte de 8°N); Área 2 (0°-8°N y 120°-150°O); Área 3 (0°-8°N 95°-130°O), y Área 4 (0°-8°N, desde la costa hasta 95°O). No se calculó una tendencia para los tiburones grandes en el Área 4 debido a inestabilidad en el modelo identificado en análisis previos.

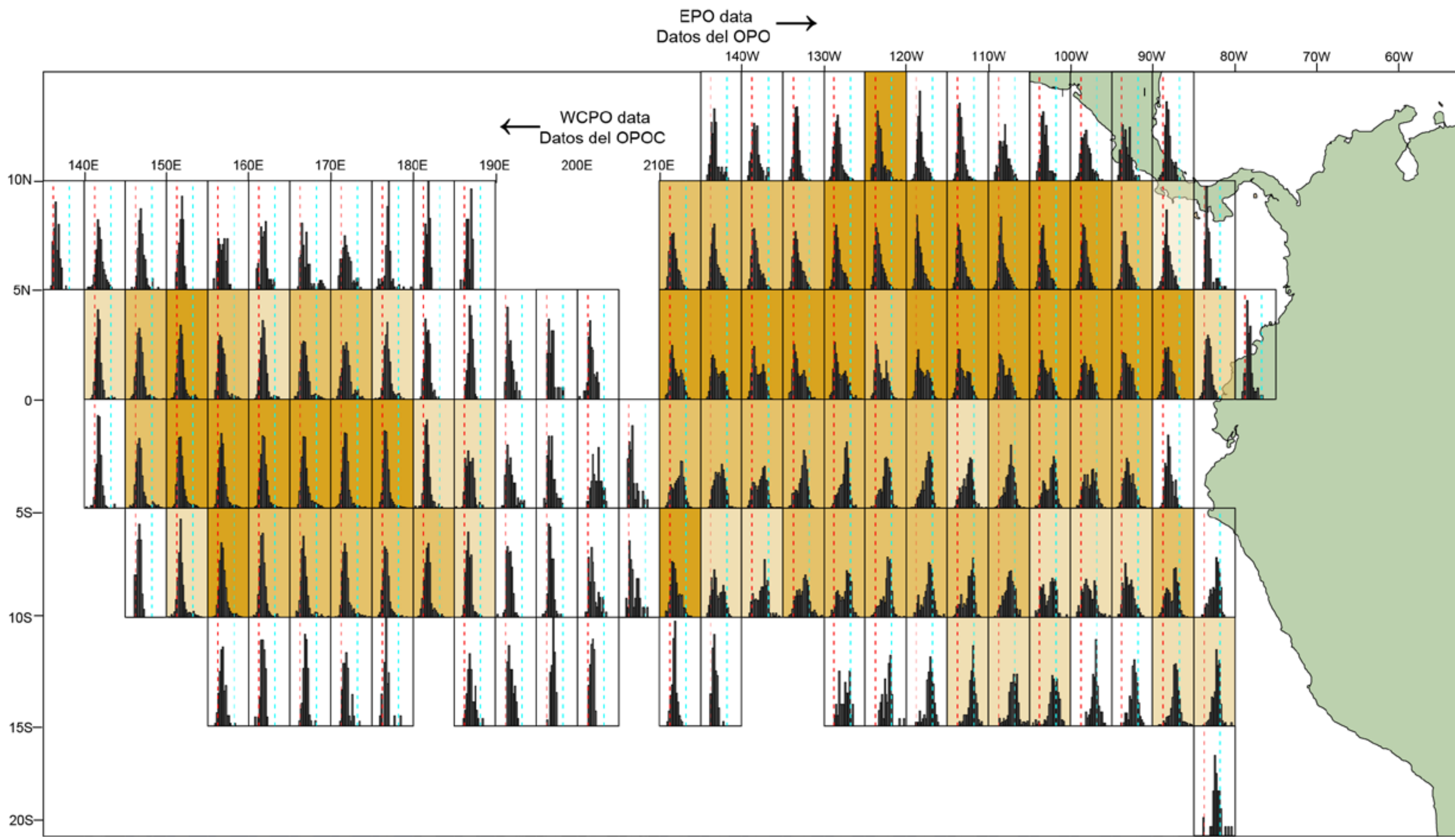

FIGURE 7. Length-frequency histograms (fork length, in cm; FL) for silky sharks sampled from purse-seine sets on floating-objects in the EPO and from associated sets in the WCPO, 2005-2015. The red and blue dashed lines are provided for visual reference and are located at 55cm FL and 165cm FL, respectively. Shading of the histogram panels indicates number of sets in which sharks were measured (white: ≤ 75 sets; light gold: 76-150 sets; gold: 151-300 sets; dark gold: > 300 sets).

FIGURA 7. Histogramas de la frecuencia de talla (talla furcal, en cm; TF) de tiburones sedosos muestreados en lances cerqueros sobre objetos flotantes en el OPO y en lances asociados en el OPOC, 2005-2015. Las líneas de trazos roja y azul representan TF de 55 cm y 165 cm, respectivamente. El color de las casillas indica el número de lances con tiburones medidos (blanco: < 75 lances; amarillo claro: 76-150 lances; amarillo: 151-300 lances; amarillo oscuro: > 300 lances).

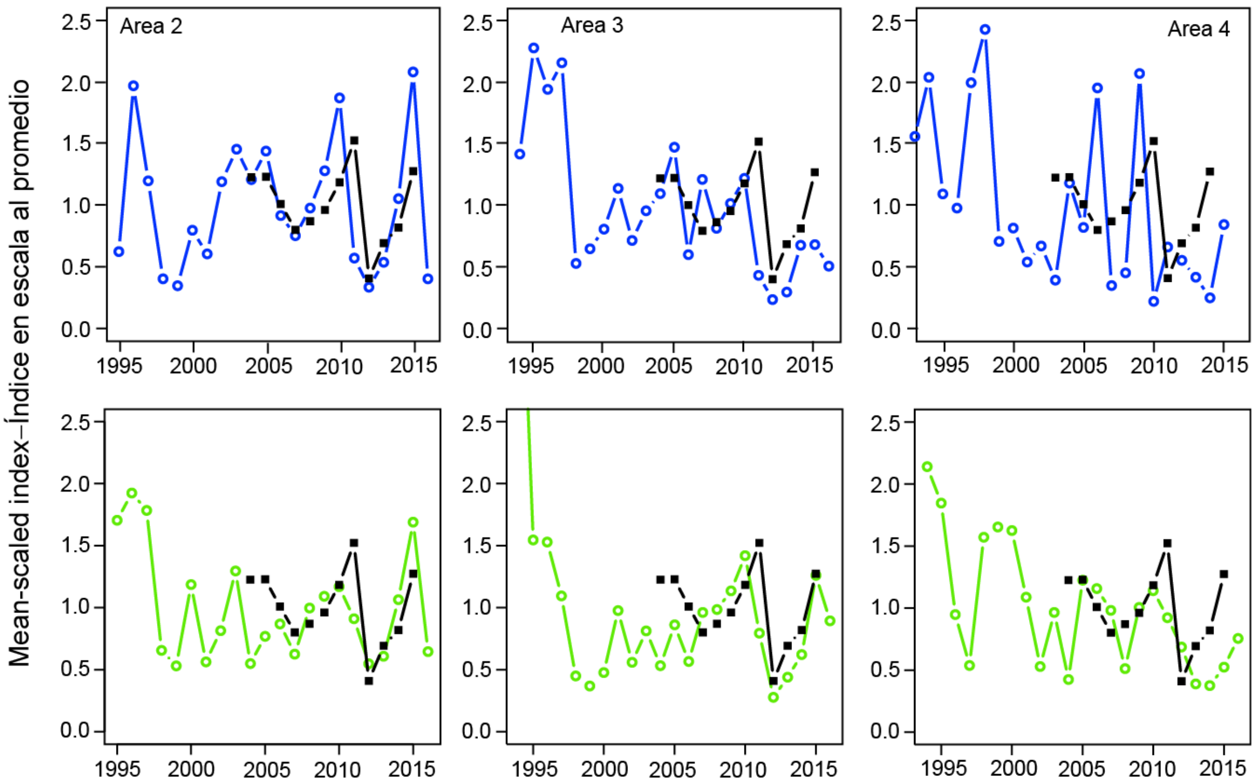

FIGURE 8. Mean-scaled standardized catch-per-set for small (blue) and medium (green) silky sharks in subareas 2-4 in the north EPO (Figure 6) and the preliminary index for the WCPO (black) (145°E-180°E, 10°S-5°N).

FIGURA 8. Captura por lance estandarizada en escala al promedia poro de tiburones sedosos pequeños (azul) y medianos (verde) en las subáreas 2-4 del OPO norte (Figura 6) y el índice preliminar del OPOC (negro) (145°E-180°E, 10°S-5°N).

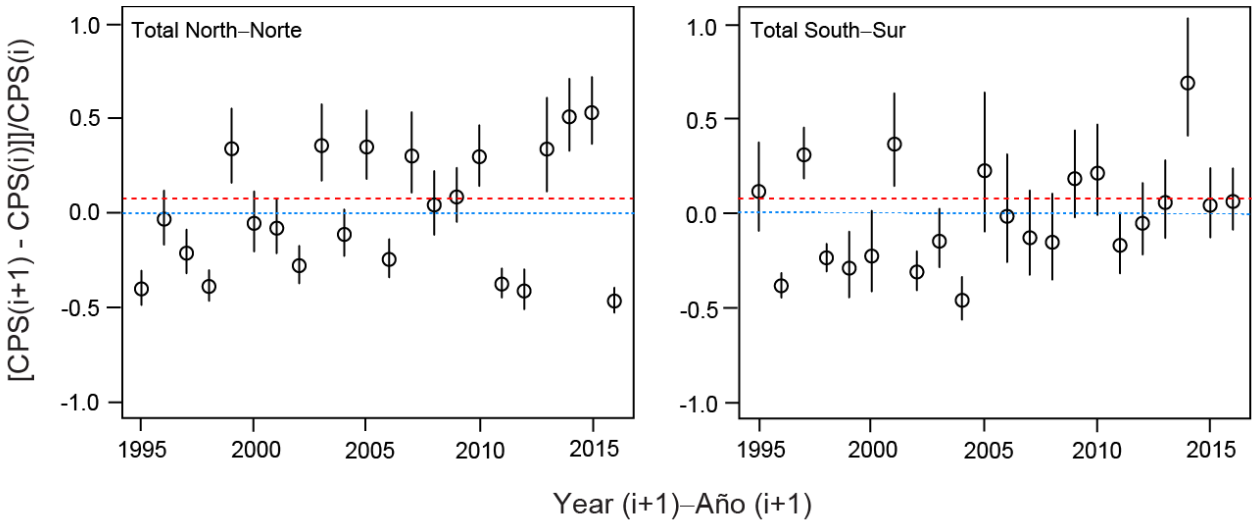

FIGURE 9. Proportional change in the indices for all silky sharks (Figure 2). The proportional change was computed as the difference in CPS from year *i*+1 to year *i*, divided by the CPS in year *i*. The blue dashed line denotes no change. The red dashed line is at the value 0.0745, which is the upper 95% confidence limit on the finite population growth rate for a virgin population, estimated by Román *et al*. (in prep.).

FIGURA 9. Cambio proporcional en los índices de todo tiburón sedoso (Figura 2). Se calculó el cambio proporcional como la diferencia en CPL del año *i* +1 al año *i*, dividido por la CPL en el año *i*. La línea de trazos azul indica ningún cambio. La línea de trazos roja señala el valor de 0.0745, el límite de confianza de 95% superior de la tasa de crecimiento de población finita para una población virgen, estimada por Román *et al*. (en prep.).

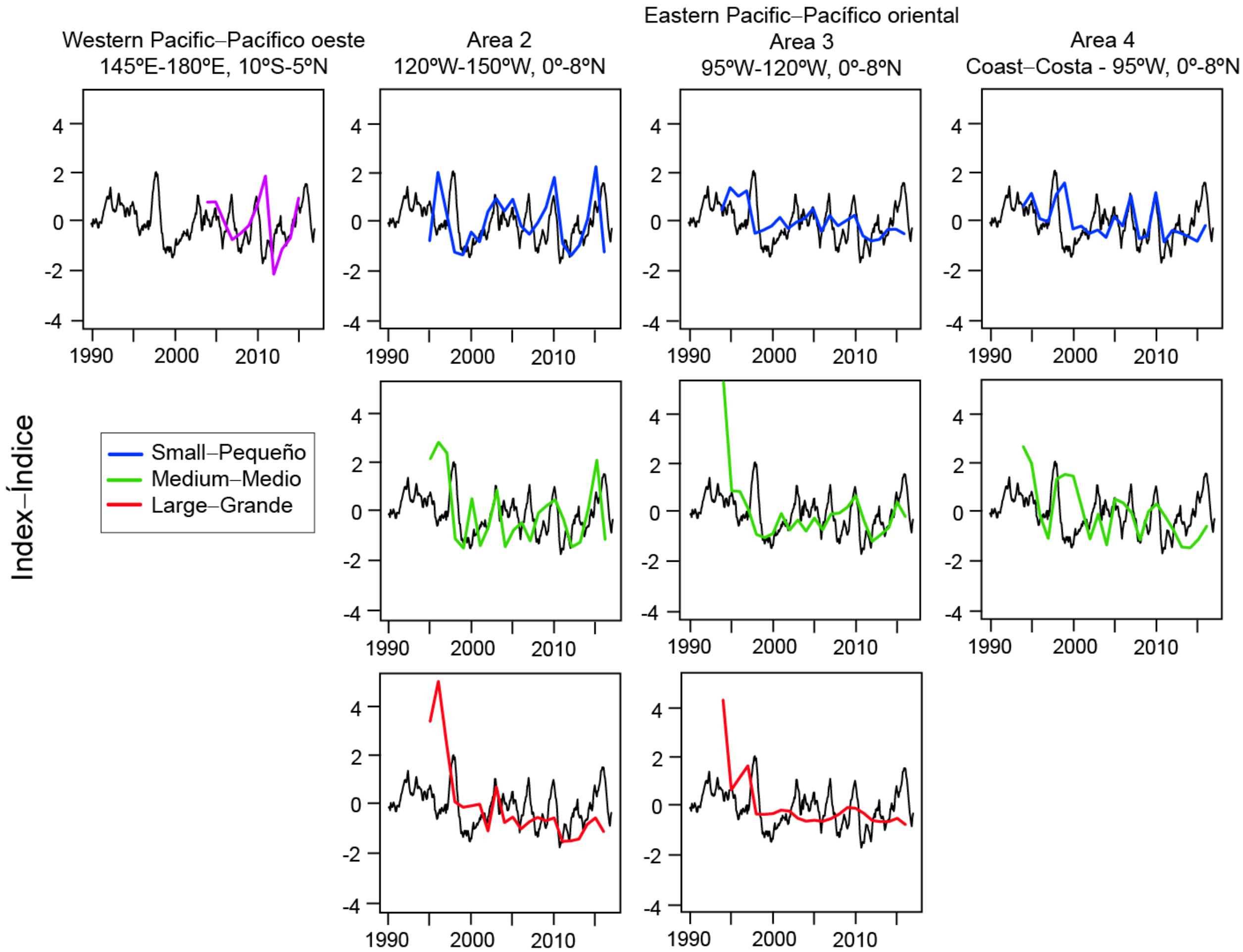

FIGURE 10. Silky shark indices by size for Areas 2-4 of the north EPO (Figure 6) and the WCPO (Figure 8) *versus* the TPI (Figure 2). The black lines correspond to the TPI, the blue, green, and red lines to the EPO indices for small, medium, and large sharks, respectively. And the gray line to the WCPO index. For comparison to the TPI, the shark indices are shown as anomalies (*i.e.*, index – mean(index)).

FIGURA 10. Índices de tiburón sedoso por talla en las áreas 2-4 del OPO norte (Figura 6) y el OPOC (Figura 8) graficados contra el TPI (Figure 2). Las líneas negras corresponden al TPI, las líneas azules, verdes, y rojas a los índices de tiburón sedoso pequeño, mediano, y grande, respectivamente, en el OPO, y la línea gris al índice del OPOC. Para compararlos con el TPI, se ilustran los índices de tiburón sedoso como anomalías (o sea, índice - promedio(índice))