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THE EFFECTS OF THE INDIVIDUAL VESSEL THRESHOLD PROGRAM ON TROPICAL TUNA CATCHES AND FLEET BEHAVIOR: A 2024 UPDATE

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SUMMARY

This document presents a 2024 update of the analysis conducted in SAC-15-INF-K evaluating the effects of the Individual Vessel Threshold (IVT) program on catches of bigeye tuna (BET) in the eastern Pacific Ocean (EPO). The update estimated a similar effect of the IVT in 2024 as it did in 2022 and 2023. Including the 2024 data, our model estimates that the IVT reduced annual highliner vessel BET catches on floating-object (OBJ) sets by on average 8,040 metric tons (t), equivalent to a 22% reduction relative to the expected purse-seine BET catch from 2022 through 2024 without the IVT (Figure 3). In an anonymous skipper survey conducted in 2024-2025, 60% said they had taken measures to reduce captures of BET. The most common action reported to reduce BET catches was to change fishing locations, followed by changes in FAD design or the configuration of the vessel's net, use of technology and improved communication.

1. INTRODUCTION

The conservation measures for tropical tunas in Resolution C-21-04 implemented an "Individual Vessel Threshold" (IVT) program for bigeye tuna (BET) catches. This IVT program went into effect in 2022. Under this IVT program, applicable purse-seine vessels receive increased closure days if they exceed certain annual BET catch values, with the amount of closure days increasing as a function of the amount by which

a vessel exceeds the threshold (Table 1). In support of the IVT, per Resolution C-21-04, the Enhanced Monitoring Program (EMP) was established in 2023 to fulfill the Commission's request to the IATTC scientific staff for the best scientific estimate (BSE) of BET catch per trip and per vessel. The EMP is focused on sampling a subset of trips of those IATTC Class-6 vessels that had historically high catches of BET. In response to requests made in SAC-14-16, SAC-15 INF-K evaluated evidence for the effects of the IVT program on catches of BET for 2022-2023. Using a range of methods, SAC-15-INF-K estimated that the IVT had likely resulted in a reduction of on average 8,500 MT in 2022 and 2023, equivalent to a 23% reduction from the predicted catch levels in the absence of the IVT.

This report updates the results of SAC-15 INF-K adding data from 2024, to check if the estimated effect of the IVT on BET catches remains consistent with the addition of this latest year of data. In addition, and following a SAC-15 recommendation on improved dialogue between the IATTC scientific staff and the fishing industry on topics of interest, including changes in the fishing strategy caused by management measures, the IATTC staff interacted with skippers in two main ways in 2024-2025: i) creating open-dialogue spaces during skippers workshops (both organized by the IATTC and externally), and ii) conducting an anonymous skippers' survey. These communication channels provided an opportunity for skippers to provide feedback on key topics of interest for the Commission. A total of 208 skippers participated in the survey so far. In this document, relevant results related to fishing strategy changes and capture of BET are included as well.

2. METHODS

This report holds all methods constant from SAC-15 INF-K, so readers should refer to that document for specific methods and expanded analyses. The core strategy for estimating the effect of the IVT centered on separating vessels into two different groups; a set of "highliners" that historically caught relatively large amounts of BET and as such are more likely to be directly impacted by the IVT program and a set of "non-highliners" that historically did not catch much bigeye and as such as likely to continue on with operations as normal regardless of the presence of the IVT. Many of the analyses in SAC-15 INF-K assumed that these "non-highliner" vessels could serve as an indicator of broad unobserved environmental, abundance, and/or market trends in the fishery that might affect catches regardless of the presence of the IVT.

SAC-15 INF-K presented a range of different analyses to provide evidence for the effects of the IVT. Collectively, the alternative methods presented in SAC-15 INF-K provided multiple lines of evidence in support of a reduction in BET catch among highliner vessels coinciding with the implementation of the IVT. Among those multiple lines of evidence, the synthetic control analysis provides the most direct measure of the effect of the IVT, providing an estimate of the reduction in BET catch caused by the IVT in the years following its implementation. As such, here we present only an update to the synthetic control analyses for BET.

Synthetic controls (Abadie et al., 2010; Abadie, 2021) adaptively weight the contributions of individual vessels in the non-highliner group to best approximate the pre-IVT trends in the highliner group (with steps in place to prevent over-fitting to the estimated trends of the individual vessels in the non-highliner group, the "synthetic control units"). This approach provides a custom synthetic "control" unit for every highliner vessel in the analysis, which we can then compare to the actual values of interest post-IVT to estimate the effect of the policy in question. We used an implementation of synthetic controls here called the "generalized synthetic control" (GSC, Xu, 2017), implemented with the gsynth package in R (R Core Team, 2024). We utilized the "matrix completion" estimation method, as described in Athey et al. (2021), as it performed better in cross-validation testing.

2.1. Catch Data

The main data used for this analysis are observer data from the Daily Activity Records (DAR) form, for 2009-2024. We performed some filtering of these data for this analysis. We only included purse-seine vessels with capacity greater than 363 metric ton (t) fish-carrying capacity (IATTC Class-6 vessels), and OBJ sets made east of 150°W. Prior to running the analyses, the data were further limited to vessels with a similar overall fishing behavior. Part of the goal of this study is to compare trends in vessels that are broadly similar in their overall fishing behavior but that had very different histories of BET catch. To identify general types of fishing behavior, we ran a cluster analysis using the methods described in Lennert-Cody et al. (2018) and FAD-07-01, assigning each vessel to one cluster over the time period of 2010 to 2020.

The final filtered database used in this analysis has 157,185 sets by 106 vessels. Taking 2024 as a benchmark, this filtered database accounts for 28,155 t of BET, out of the total of 40,050 t reported in the DAR in 2024 (70%).

2.2. Skipper Survey Data

An anonymous survey was administered to fishing industry participants on the skipper workshop organized by the IATTC staff in January 2024. Additionally, the survey was shared with several fishing organizations for further participation. The skipper survey was voluntary and anonymous and was designed following the guidelines established for the collection of local (i.e., fishers) ecological knowledge (Johannes et al., 2000; Lopez et al., 2014; Moreno et al., 2007).

As of April 2025, 208 skippers participated in the survey. The survey asked a wide range of questions of interest for the Commission and the SAC (see SAC-15 recommendations), from biodegradable FADs to fishing strategy changes and Best Handling and Release Practices (BHRP) of vulnerable taxa, but in this document, we focus on the questions relevant to the IVT evaluation. Specifically, we assessed what proportion of respondents said that they had reduced BET catches since 2022, and what measures they said they had taken to achieve these reductions. Responses for specific actions taken were grouped into categories manually by the IATTC staff.

3. RESULTS

2024 continued the trend of BET catch per set declining faster post-IVT among the highliner groups compared to the non-highliner group, though to a lower extent than 2022 and 2023 (Figure 1). If regional differences in abundance alone was the cause of these differences in CPUE trends, we would expect highliner and non-highliner vessels fishing the same area (e.g. the western EPO) to have similar CPUE of BET on OBJ sets. Instead, non-highliners fishing in both the east and west showed the same general downward trend, whereas highliners in the east and west had largely the same stable CPUE followed by a sharp decline coinciding with the IVT years (Figure 2). This result lends support to the hypothesis that the differences in CPUE trends between the highliner and non-highliner groups are driven more by fine-scale differences in fishing practices than large-scale fishing processes and decisions.

The synthetic control approach estimated that the IVT reduced annual highliner BET catches on OBJ sets by on average 8,040 t, equivalent to a 22% reduction relative to the expected purse-seine BET catch from 2022 through 2024 without the IVT (Figure 3). The synthetic control was able to match the pre-IVT trends (see Xu, 2017 for details on how the synthetic control method avoids overfitting). As an additional measure to check of the performance of the model, we ran a placebo trial where we artificially assigned 2015 as the year the IVT was implemented (meaning that the model thinks the IVT was in effect from 2015-2024), and then evaluated the performance of the model under these placebo settings (Figure 4). As in SAC-15 INF-K, the estimated IVT effects in the true IVT years in the data (2022-2024) were consistent

between the true model and the placebo model. Estimated IVT effects in the placebo years (2015-2021, the years the model was told the IVT was in effect when in reality it was not) were generally near zero, with the exception of 2018. Broadly, the placebo test supports the persistent reduction in BET catch attributable to the IVT estimated by the synthetic control model.

3.1. Skippers Survey

Survey responses were voluntary and anonymous, and thus, individual highliner captains that responded to survey questions cannot be identified. However, examining total participation in the 2024 January IATTC skipper workshop as a proxy, 38% of the captains that worked on a highliner vessel included in our IVT analyses between 2022 and 2024 likely participated in the workshop.

One of the relevant questions in the survey was "In the last 2-3 years, since 2022, has your vessel taken measures to reduce captures of BET"? 81% of participants responded to this question. Among those that responded, 60% said that *yes*, they had taken measures to reduce captures of BET. The most common action to reduce BET catches self-reported by survey respondents was to change fishing locations (23%), followed by changes in FAD design (10%), avoidance of FADs with BET (7%), changes in the configuration of vessel's net (5%), use of technology or improved communication (3%) (Figure 5).

Some respondents said they avoided BET by avoiding FADs they believed had high levels of BET. Another question on the survey asked "Before setting, is it possible to identify FADs with high concentrations of BET or juvenile tunas?". 83% of survey participants responded to this question. Among those that responded, there was an almost even split, with 53% saying such pre-set detection of BET or juvenile tuna was possible (by, for example, using satellite-linked echo-sounder buoys -14%, the vessel's technology like sonar or echo-sounders – 14%, or improved communication with other fishers - 24%), while 47% said it was not possible. Additionally, fishers were asked whether the new multifrequency satellite-linked echo-sounder buoys can help identify FADs with high concentrations of BET or juvenile tuna. This question was answered by around 80% of participants. While 25% of participants responded "no, almost never", around 75% responded "sometimes" (52%) or "yes, almost always" (20%).

Communication between fishers seems an important component that regulates fishing dynamics in the EPO. As such, fishers were asked which were the main communication methods used by them. 95% of participants responded to this question. Since communication methods can vary and multiple can be used, fishers were asked to select all the relevant options. WhatsApp was selected 92% of the times, email 35% of the times, radio 27% of the times and social media 5% of the times. When asked about what kind of information they share in such communications (93% of participation), successful fish location was selected 89% of the times, followed by catch and size composition (53%), other vessel's locations (45%), satellite buoy information (e.g., biomass, trajectories - 30%), presence of juvenile tuna (23%) and presence of BET specifically (18%).

4. DISCUSSION

Our results suggest that the IVT program had a similar (though smaller) effect on BET catches in 2024 as it did in 2022 and 2023, conditional on all the same assumptions and caveats listed in SAC-15 INF-K. The survey responses provide some support for mechanisms behind this estimated effect, with a majority (60%) of survey responded acknowledging that they had taken steps to reduce BET captures since 2022, with the most common mechanism for this reduction being changes in fishing locations (~23%) and changes in FAD design (10%) and avoidance of FADs with BET (7%). While Figure 2 indicates that highliner and non-highliner vessels had different trends in catch per set within the same very broad geographic region (east versus west), the frequency of changes in fishing locations as a strategy to reduce BET self-reported by survey respondents suggests that fishers may be able to exploit spatial differences in BET catch rates at finer scales than the regions shown in Figure 2.

5. REFERENCES

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6. TABLES

TABLE 1. IVT program threshold levels as defined by C-21-04. BET threshold for 2022 refers to the average catch from 2017:2019. For 2023:2024 BET threshold is calculated as the catch from the prior year.

TABLA 1. Umbrales del programa de UIB según lo definido por la res. C-21-04. El umbral de BET para 2022 se refiere a la captura promedio de 2017-2019. Para 2023-2024, el umbral de BET se calcula como la captura del año anterior

Annual BET Threshold	Additional Closure Days	Years Applied
>1,200 MT	8	2022
>1,200 MT	10	2023:2024
>1,500 MT	13	2023:2024
>1,800 MT	16	2023:2024
>2,100	19	2023:2024
>2,400	22	2023:2024

7. FIGURES

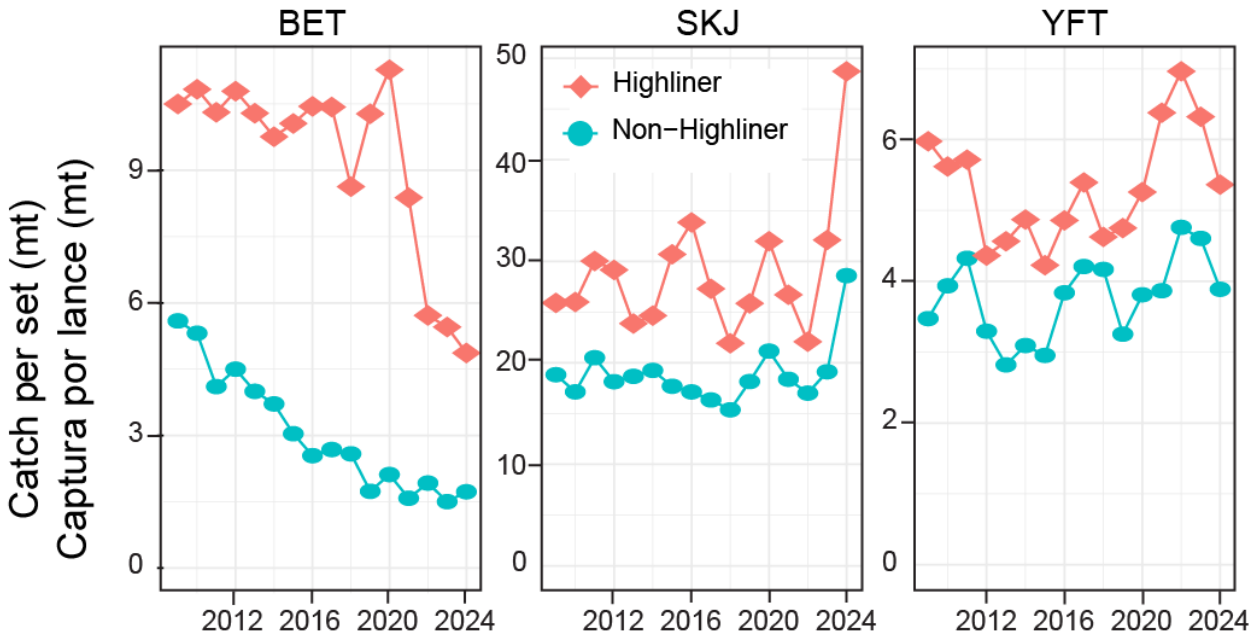

FIGURE 1. Class-6 purse-seine vessel catch (t) per set per year (x-axis) per species (panels). Color and symbol shape indicates BET highliner status**.**

FIGURA 1. Captura de buques de cerco de clase 6 (t) por lance por año (eje 'x') por especie (paneles). El color y la forma del símbolo indican el estado de *highliner*.

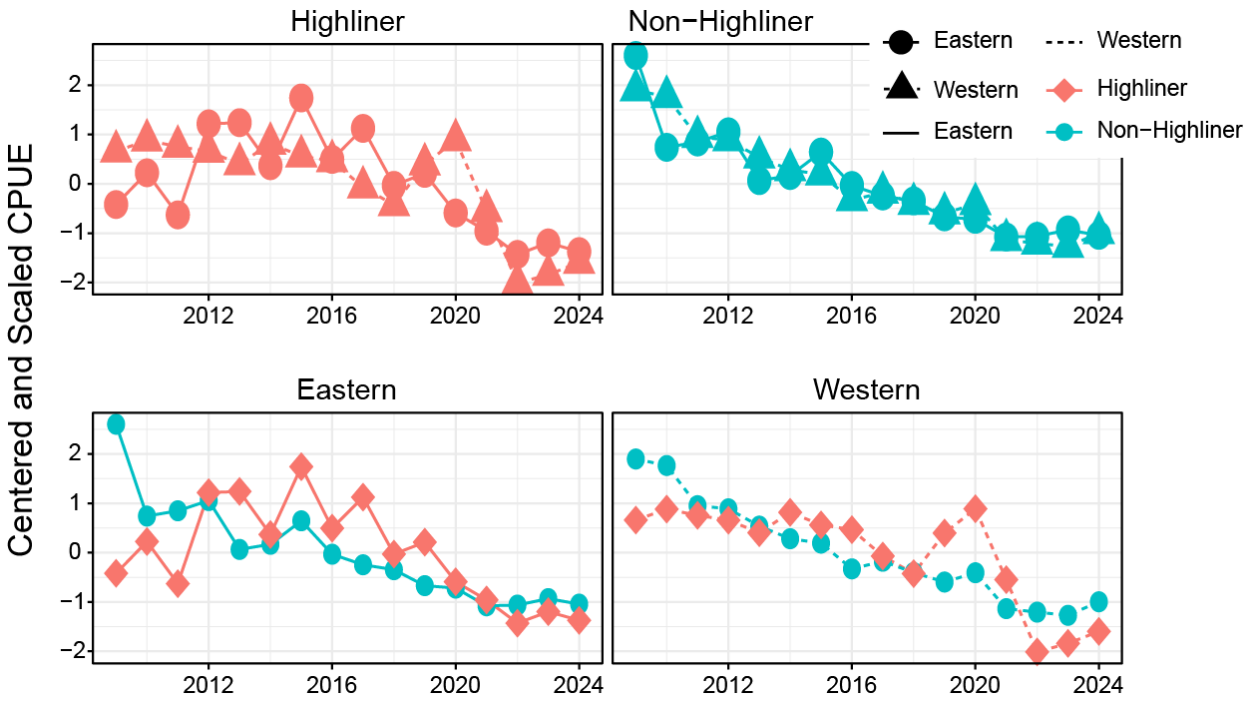

FIGURE 2. Centered and scaled OBJ catch per set. Top row compares catch per set in the Eastern and Western portions of the fishing grounds with panels for Highliner status. The bottom row shows the same data, but now comparing catch per set between Highliner groups with panels for Eastern and Western regions. Western defined as fishing west of 115W, East as east of 115W.

FIGURA 2. Captura por lance OBJ, centrada y escalada. La fila superior compara la captura por lance en el este y el oeste de los caladeros con paneles que indican el estado de *highliner*. La fila inferior muestra los mismos datos, pero ahora compara la captura por lance entre los grupos *highliner* con paneles que indican las regiones este y oeste. El oeste se define como la pesca al oeste de 115°O, y el este, al este de 115°O.

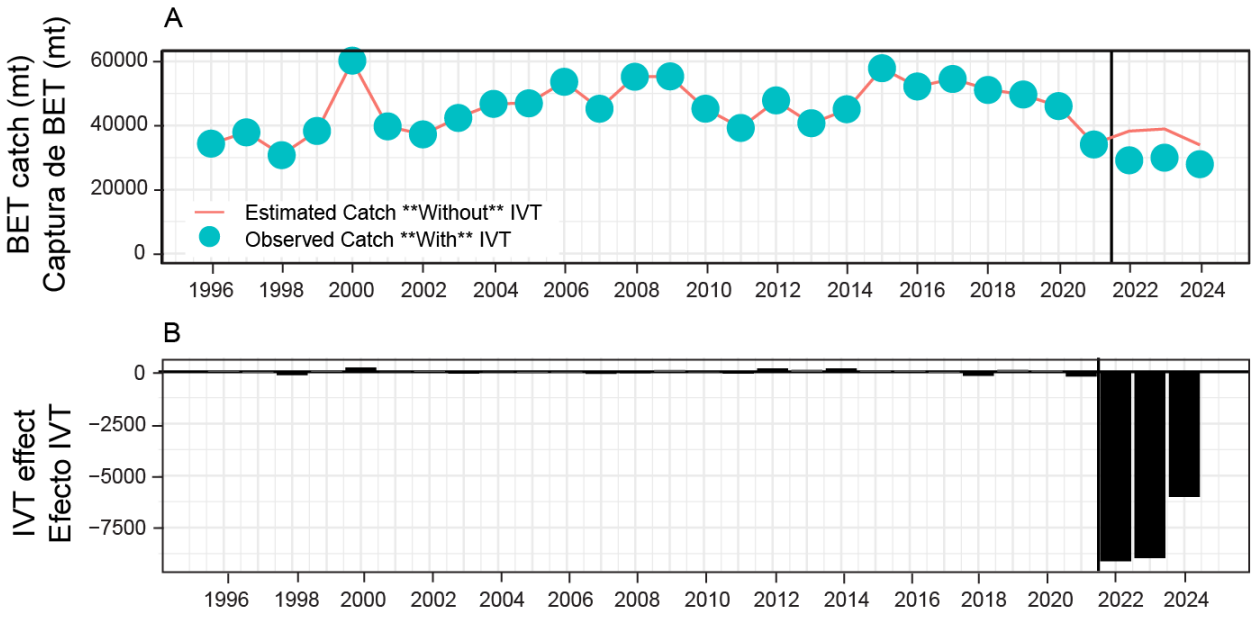

FIGURE 3. Impacts of IVT on BET catches estimated by synthetic control approach. A) Total observed with IVT and estimated without IVT class 6 purse-seine BET catches over time. B) Estimated difference in class 6 purse-seine BET catches over time. Vertical dashed lines show IVT year.

FIGURA 3. Impactos del programa de UIB en las capturas de BET estimados mediante un método de control sintético. A) Capturas de BET totales observadas con UIB y estimadas sin UIB para buques de cerco de clase 6 a lo largo del tiempo. B) Diferencia estimada en las capturas de BET de buques de cerco de clase 6 a lo largo del tiempo. Las líneas verticales indican el año del programa de UIB.

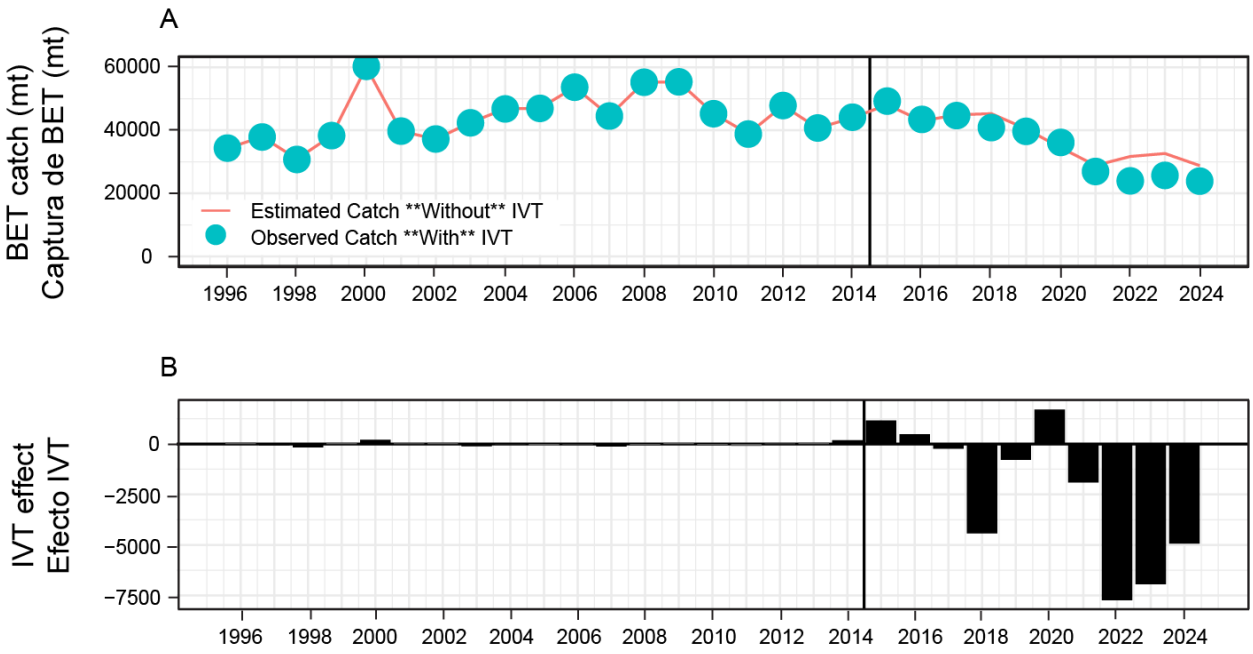

FIGURE 4. Placebo diagnostics of BET synthetic control. A) Total observed with IVT and estimated without IVT class 6 purse-seine BET catches over time. B) Estimated difference in class 6 purse-seine BET catches over time. Vertical dashed lines show placebo IVT year.

FIGURA 4. Diagnóstico placebo del control sintético. A) Capturas de BET totales observadas con UIB y estimadas sin UIB para buques de cerco de clase 6 a lo largo del tiempo. B) Diferencia estimada en las capturas de BET de buques de cerco de clase 6 a lo largo del tiempo. Las líneas verticales indican el año placebo de UIB.

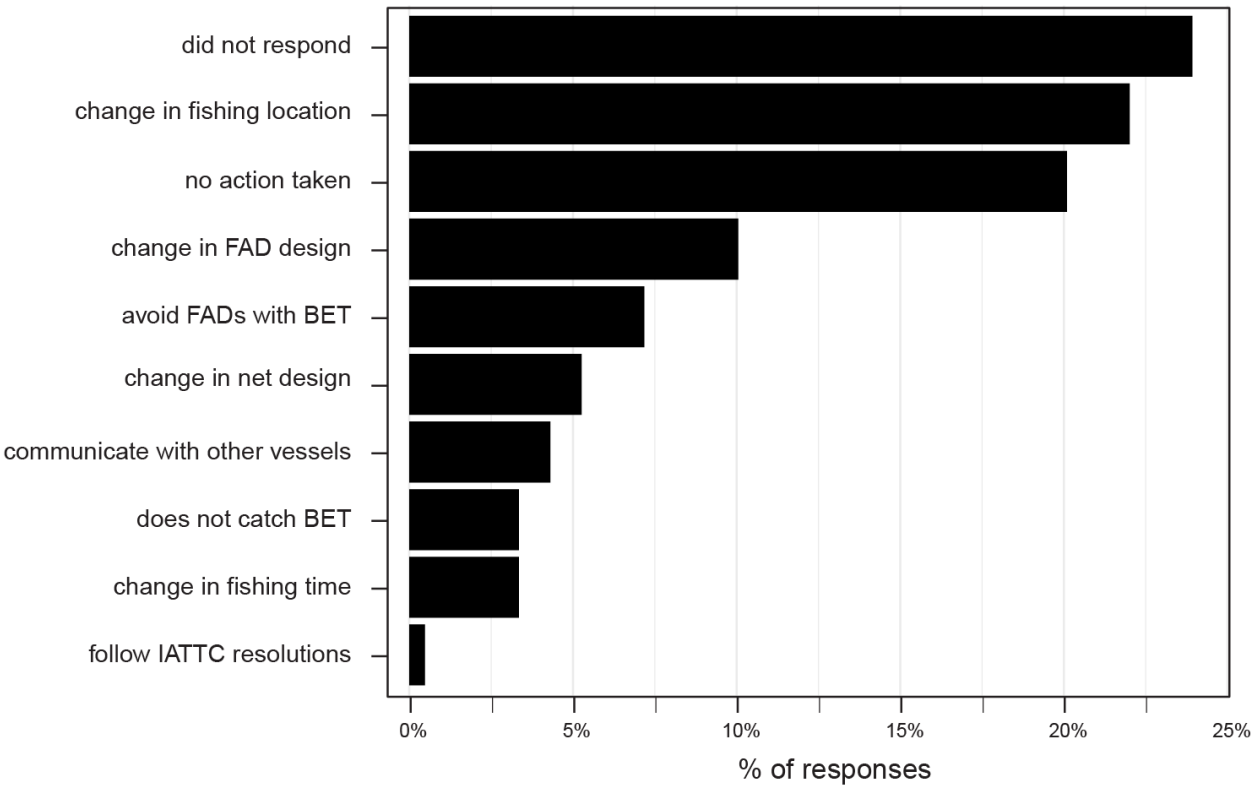

FIGURE 5. Proportion of survey responses grouped by categories of responses to question regarding actions taken to reduce BET catch since 2022. Individual responses assigned to response groups manually.
FIGURA 5. Proporción de respuestas de la encuesta, agrupadas por categorías de respuestas a la pregunta sobre las medidas adoptadas para reducir la captura de BET desde 2022. Las respuestas individuales se asignaron manualmente a los grupos de respuestas.