INTER-AMERICAN TROPICAL TUNA COMMISSION

98TH MEETING (RESUMED)

(by videoconference)

18 – 22 October 2021

DOCUMENT IATTC-98-02c

IMPLEMENTATION OF A LONG-TERM SAMPLING PROGRAM FOR SHARK FISHERIES IN CENTRAL AMERICA

SUMMARY

Since 2014, the IATTC staff has carried out extensive collaborative research with OSPESCA and IATTC's Central American CPCs to develop a robust sampling methodology to improve data collection for shark fisheries[1] in Central American eastern Pacific Ocean (EPO) states. After almost 7 years (2015–2021), this work, funded by the FAO-GEF ABNJ project, IATTC capacity building fund, and the European Union, is scheduled for completion in December 2021. A summary of the project's final results will be presented at SAC-13 (May 2022), but there is a great need to maintain continuity of data collection to generate key fisheries data required by the IATTC staff and IATTC CPCs to assess and manage shark species in the EPO. As such, the IATTC scientific staff proposes to establish a long-term sampling program for shark fisheries in Central America.

A long-term sampling program for shark fisheries in Central America, based on the sampling design developed during the previous project, will cost US$ 785,900 per year. Although the program is planned to initially focus on the currently prioritized shark species in the staff's workplan (*i.e.*, silky and hammerhead sharks), it is envisaged that data collection will be expanded to include other species (*e.g.,* tuna, billfish, sharks, mobulids and dorado) to fulfill various mandates under the Antigua Convention (*e.g.,* ecological risk assessment, biometric studies). The data collected will be used to estimate the necessary inputs for stock assessments (*e.g.,* annual times series of total catches of shark species by country, estimates of the size and sex composition of this catch, and indices of relative abundance). The program will also generate data for biological and ecological studies, including tissue samples for genetic analysis in other IATTC projects such the proposed Close Kin Mark Recapture Study (Project H.7.e.), the mobulid genetic population structure study (Project M.2.c) and the development of fishery-dependent ecological sampling program for EPO tuna fisheries (Project O.1.a). This would generate an opportunity for development of collaborations with regional universities and/or research institutes for capacity building through student research projects, such as those funded under the IATTC capacity building Fund.

The initiation of a long-term sampling program for shark fisheries in Central America in early 2022 will allow retention of the 17 highly experienced technicians that have already been trained for this program and are currently deployed in the field. In addition, this timing will coincide with the initiation of a shark fishery data collection improvement in Mexico, Ecuador and Peru under a second phase of the ABNJ program, tentatively planned to begin in early 2022. Sustaining the Central American program would mean that there would be a shark monitoring program that would be spatially continuous along most of the EPO

[1] In the context of this proposal, a "shark fishery" is defined as any fishery in which sharks are caught, whether as target species or bycatch. It is recognized that these fisheries are multispecies and interact with various species/groups of large pelagic fishes (*e.g.* tuna, billfish, dorado, sharks). Although with a primary focus on sharks, it is envisaged that the proposed program will be expanded to include other species to fulfill various mandates under the Antigua Convention.

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BACKGROUND

Several projects have been carried out since 2014 to develop the sampling methodology necessary to obtain reliable data from artisanal[2] and commercial medium and advanced scale fisheries[3] that land sharks and rays throughout Central America. Such data are critical for assessing stock status of shark species in the EPO. The FAO-GEF Common Oceans program, and specifically the *Sustainable Management of Tuna Fisheries and Biodiversity Conservation in the Areas Beyond National Jurisdiction* (ABNJ) project, funded research aimed to improve data collection for shark catches in the EPO, specifically in Central America, where it is believed much of the EPO shark catch is landed. Phase 1 of this collaborative project between the IATTC and OSPESCA[4] spanned September 2014 to December 2018[5], during which time a long-term regional data collection program for sharks was developed. During Phase 1, the data available for these fisheries were identified and compiled, and recommendations formulated for improving data collection. Also, three workshops were held, on data collection, assessment methods for shark species, and designing a pilot sampling program. Based on the success of Phase 1, Phase 2 of the project was funded for the period January 2018[6] to December 2019 to further develop and test sampling designs in a pilot study that would serve as a framework for a regional program in Central America for the IATTC Members to consider. Phase 2 led to improvements in sampling designs for estimation of shark catches species composition for artisanal fisheries, as well as for size composition of catches in the medium and advanced scale longline fleets in Costa Rica (Lennert-Cody *et al*. *In prep*.). Again, owing to the success of the work, additional funding was provided by the European Union (EU) in 2020 to more fully evaluate logistical challenges, modify catch and effort sampling designs, as necessary, to address those challenges, and develop protocols for biological sampling. Despite significant challenges created by the COVID-19 pandemic—delayed initiation of field work and a reduction in survey days—data collection and analyses have continued and will cease in December 2021. A final technical report with these most recent data will not be available prior to SAC 13 (May 2022). However, after completing nearly 7 years (2015–2021) of collaborative research with OSPESCA and IATTC's Central American CPCs, the IATTC staff proposes to establish a long-term shark sampling program for fisheries in Central America. The establishment of such program in Central America will coincide with the initiation of a shark fishery data collection improvement in Mexico, Ecuador and Peru under a second phase of the ABNJ program, tentatively planned to begin in early 2022. Sustaining the Central American program would mean that there would be a shark monitoring program that would be spatially continuous along most of the EPO coastline, an outstanding initiative that exists nowhere else in the world.

OBJECTIVES OF THE SAMPLING PROGRAM

The two primary objectives of a proposed long-term shark sampling program for Central American

[2] In Central America, vessels that catch sharks, as target species or incidentally, can be broadly divided by size into two categories: smaller 'artisanal' vessels, generally called pangas, which are typically less than 10 meters length overall (LOA), with outboard motors and fiberglass hulls; and larger vessels, which are generally included in an 'industrial' category, although the number of categories, their names and cutoff points, vary among countries, as do the criteria for allocating vessels to categories (Table 1 in Metadata Report).

[3] Fisheries where the fleet is composed of smaller artisanal vessels, called 'pangas', that are less than or equal to 10 m length overall (LOA) and/or medium and advanced scale longline vessels (>10m LOA).

[4] Organización del Sector Pesquero y Acuícola del Istmo Centroamericano

[5] Initially, the contract was to expire on 23 September 2017; it was later extended through 2018.

[6] FAO funding for Phase 2 was not available until April 2018. To ensure continuity of the project, and particularly to retain the sampling technicians recruited in December 2017, implementation during the first quarter of 2018 was financed by the IATTC capacity-building fund. Also, after FAO funding for the project ceased in April 2019, the IATTC funded its continuation.

fisheries[7] are to:

1. Implement a robust and cost-effective sampling program in Central America for collection of data pertaining to sharks and the artisanal fisheries in which they are caught for use in scientific research and management of sharks in the EPO.

2. Expand data collection efforts within the shark sampling program to include other species for which mandates exist under the Antigua Convention, such as associated or dependent species that interact with tuna fisheries in the EPO.

LESSONS LEARNED FROM THE PILOT STUDY

Practical experiences accumulated from the previous work so far have provided invaluable information for refining sampling methodology, mitigating logistical challenges and minimizing costs, which is summarized below:

1) **Only a subset of all possible landing sites can be routinely monitored:** Phase 1 of the pilot study identified hundreds of potential landing sites for fishing vessels along the Pacific coastline of Central America. Sampling all sites is cost prohibitive and so a subset of landing sites must be selected for sampling according to their perceived contribution to the total fleet catch of the species of interest. Sites were prioritized based on the two groups of species that have been identified as priority groups in the staff's workplan to improve data collection and assessments for sharks: the silky shark and hammerhead sharks (**Tables 1-2**). Importantly, however, the proposed long-term sampling program allows expansion to include catches of other shark species, as specific needs arise. The final list of sampling sites in each country was determined by ranking each site according to its contribution of silky shark and hammerhead sharks to the total fleet catch as: 1) primary sites, contributing to 80% of landings; 2) secondary sites, contributing to the subsequent 10% of the landings, such that the sum of landings from primary and secondary sites is 90% of the estimated total landings; and, 3) tertiary sites, contributing the last 10% of the landings, such that the sum of landings from primary, secondary and tertiary sites is 100% of the estimated total landings (**Table 3**).

   Due to the spatial and temporal variation in effort, catch composition, and shark catches in these artisanal fisheries (see below), periodic evaluations of all sites with shark landings, using fisher interviews and imagery from Google Earth (pangas can be counted in Google Earth imagery), allows confirmation of site importance for total shark catch. Only sites that are accessible (*e.g.,* having main road access, where fishers permit catch sampling, etc.) will be routinely monitored by the long-term sampling program. However, estimates of total fleet catch of sharks will be made for each country by assuming catch data from sampled sites is representative of unsampled sites. Sampling technicians will record the complete catch composition of landings, including tunas, billfishes, sharks and dorado, and thus catch estimates can be made for these species at sampled sites. It will be possible to estimate total catch for non-shark species, although they may be less reliable than for shark species if non-shark catch is unloaded at sites outside of the survey frame. However, the precision of catch estimates for non-shark species may be improved through changes in the sampling design should IATTC prioritized species change in future.

2) **Sampling design needs to be flexible:** The sampling protocol must allow sampling locations to vary through time to accommodate for changes in site importance (*e.g.,* a primary site becomes a secondary site) or IATTC priorities. Data collected over the last 3–4 years has illustrated some level of stability in the level of effort at shark landings sites, but also the ability to shift landing activity among sites (**Figure 1**). A reasonable relationship between the numbers of pangas reported per site based on fisher interviews conducted during the pilot study and technician counts in 2019 was established. For the subset of sites sampled intensively in 2020–2021, a reasonable correlation

[7] Shark fisheries are defined as fisheries catching sharks, whether as target species in multispecies fisheries (e.g. longline fisheries that target tunas, billfishes and sharks) or as incidental catch.

existed between technician counts for the two time periods. However, effects of the pandemic are evident, with the number of pangas changing considerably at a few sites. Although 2020–2021 catch rate data are still being analyzed, preliminary results indicate that sites with catch of the silky shark and hammerhead sharks were principally those identified as primary and secondary sites from the fisher interviews in 2019, and those sites with no catch were principally those sites identified as tertiary sites using the 2019 data. However, some effects of the pandemic are evident (**Table 4**), further illustrating the dynamic nature of these artisanal fisheries.

3) **Stratification by sampling area is a practical necessity:** The most cost-effective means of sampling the main shark landing sites is to group landing sites into a small number of areas, and stratify the sampling by these areas to reduce travel costs. Technician accommodations can then be rented within each area, close to primary and secondary landing sites—those sites sampled most frequently (see below)—thus reducing the cost of sampling (technicians travel shorter distances between their residence and landing sites).

4) **Sampling design must consider temporal variability:** Temporal variability in vessel numbers at a landing sites exists at multiple scales and must be considered in the sampling design to be able to obtain reliable annual catch estimates. For example, at some sites, the number of pangas can vary significantly from month to month (**Figure 2**), while at other sites panga numbers change by day of the week (**Figure 3**). The extent to which these scales of variability are present at each site is currently being evaluated for the 2020–2021 data.

5) **Tissue sampling for genetic analysis:** There is an increased need in fisheries for genetic material to not only undertake traditional genetic analyses to identify stocks, such as the current IATTC collaboration with University of California at Santa Cruz for manta rays (Project M.2.c), but also to use cutting-edge Close Kin Mark Recapture methods (Project H.7.e.) described by the staff at SAC-12 to estimate abundance for stock assessment. During the 2020-2021 project it was determined that both catch and effort data, and tissue samples, can be collected by technicians when sampling at landing sites. The tissue sample data are best collected once all catch and effort sampling at the site has concluded. More than 150 tissue samples have been collected in Guatemala and Nicaragua and staff are now able to ship samples of CITES-protected species with relevant permits. Even in cases where sampling is not possible or practical at landing sites, tissue can be purchased at local markets near landing sites. Therefore, collection of tissue samples for genetics analysis should be part of the operational and time budgets for technician duties.

6) **Opportunistic biological and ecological sampling:** Collection of data and samples for biological and ecological purposes is also important for ecological risk assessment and stock assessment, developing length-weight relationships, and diet analyses for ecosystem studies. As part of the 2020–2021 project, collection of biological data in Guatemala, El Salvador, and Nicaragua was periodically conducted to develop methodology for collection of maturity data and data for length-weight conversions for shark and ray species. Collection of these types of data could be expanded to other species groups. This would generate an opportunity to develop collaborations with regional universities and/or research institutes to generate capacity building through student research projects, such as those funded under the IATTC capacity building Fund (*e.g.,* the Jimmy Martinez Scholarship). The Central American program would also allow for ample sampling opportunities for the staff's proposed fishery-dependent ecological sampling program for EPO tuna fisheries (Project O.1.a).

LONG-TERM SAMPLING PROGRAM

Sampling methodology

Based on the results of data analyses, and field experience obtained over the last 4 years, a sampling protocol for a cost-effective long-term shark catch sampling program is:

1) A minimum of 80% of accessible primary and secondary shark landing sites will be monitored in each country.

2) Sampling within each area likely will be stratified by type of site (primary, secondary, tertiary), with different sampling frequencies for the different site types. The sampling protocol will give priority to primary sites, but must also be flexible. Specifically, the nominal sampling frequencies will be: 3 times per week at primary sites, for two weeks out of every month; 3 times per week at secondary sites, for one week out of every month; and, 4 times per year, for several days at a time, at tertiary sites. Modifications to these nominal sampling frequencies may be made for any areas that include sites with significant within-week periodicity in fishing activity. The order of visits to sites within each month will be established using a systematic sampling protocol, from a random starting point, to ensure that the program generates statistically appropriate data for estimation of total catch composition. Stratified estimators of catch composition will be used, consistent with the sampling protocol. Once analysis of the 2020-2021 data has been completed, details of the sampling protocol and estimators to be used will be finalized.

3) Accessible sites will be grouped into areas, and the technician stationed at each area will be responsible for monitoring six sites: three primary, two secondary and one tertiary site.

4) All technicians of each country will be rotated among sampling areas within a year.

Resources and budget

A total of 33 sampling technicians will be required by the program. The number of technicians per country depends on the number of accessible sites in each country (**Table 5**). Of the 33 sampling technicians, 28 will focus exclusively on collection of catch and effort data. One additional technician per country will be required to compile and process the completed catch and effort data collection forms, assist with data editing, conduct the catch and effort interviews, and collect tissue samples for genetic analyses, biological and ecological studies. The annual cost of the program is US$ 785,900 with specific costs, by country, presented in **Table 6**.

Project outputs and opportunities

The long-term sampling program is expected to generate fisheries data needed to further assess and manage shark species that interact with tuna fisheries in the EPO. In particular, data collected by the program will be used to estimate the necessary inputs for stock assessments, including annual time series of estimated total catches of shark species by country, estimates of the size and sex composition of this catch, and trip-level samples of catch and effort data which can be used to develop methods for estimating indices of relative abundance in multispecies, multi-gear fisheries. The program will also generate data for biological and ecological studies, including tissue samples for genetic analysis, which will provide information for other IATTC projects such as the proposed Close Kin Mark Recapture Study (Project H.7.e.), the mobulid population structure study (M.2.c), and the development of a fishery-dependent ecological sampling program for EPO tuna fisheries (Project O.1.a).

Tied to the establishment of a long-term sampling program for shark fisheries in Central America, the port of Puntarenas, Costa Rica, is proposed by the staff as an ideal strategic location to open a new IATTC field office.

The initiation of a long-term sampling program for shark fisheries in Central America will coincide with the expansion of the work done in this region to other EPO coastal nations. In particular, under a second phase of the ABNJ program, tentatively planned to initiate in early 2022, the IATTC has received support for a new project to improve data collection for shark fisheries in Mexico, Ecuador and Peru. Therefore, sustaining the Central American program in parallel with the work to be initiated in other IATTC Member countries could potentially lead to a shark fishery sampling platform covering most of the EPO coastline.

Challenges anticipated

The success of the long-term sampling program will depend on both adequate funding to carry out the necessary sampling and cooperation of local fisheries authorities and fishers. Even with adequate funding, sampling cannot be conducted without the permission of fishers. It is therefore incumbent on CPCs in the region to assist the IATTC with implementation of this program and with the development and maintenance of cooperation of local fisheries authorities and fishers.

Another associated challenge as sampling for biological and ecological studies continues is the obtention of CITES permits for tissue shipment. However, the IATTC staff experience with this process so far has been very positive.

REFERENCES

Lennert-Cody, C.E., Mccracken, M., Siu, S., Oliveros-Ramos, R., Maunder, M.N., Aires-da-Silva, A., Carvajal Rodríguez, J.M., Opsomer, J., Barros, P. *In prep*. Single-cluster systematic sampling designs for shark catch size composition in a Central American longline fishery. For submission to Fisheries Research in November 2021.

TABLE 1. Number of shark landing sites, both accessible and non-accessible combined, by country, in Central America. Main landing sites are defined as those with landings of silky and/or hammerhead sharks.

TABLA 1. Número de sitios de descarga de tiburones, tanto accesibles como no accesibles, por país, en Centroamérica. Los sitios de descarga principales se definen como aquellos con descarga de tiburón sedoso y/o tiburones martillo.

Country	Shark landing sites	Main shark landing sites
Costa Rica	145	37
El Salvador	206	171
Guatemala	167	98
Nicaragua	108	95
Panama	50	43
Total	**676**	**444**

TABLE 2. Classification of landing sites, accessible and non-accessible combined, according to the order of importance of the two species groups that are currently considered priority species groups.

TABLA 2. Clasificación de sitios de descarga, tanto accesibles como no accesibles, según el orden de importancia de los dos grupos de especies actualmente considerados grupos de especies prioritarios

Country	Main shark landing sites								All sites
	Silky shark				Hammerhead sharks				
	Primary	Secondary	Tertiary	Total	Primary	Secondary	Tertiary	Total	
Costa Rica	1		1	**2**	4	4	29	**37**	**39**
El Salvador	5	1	4	**10**	36	33	100	**169**	**179**
Guatemala	15	6	12	**33**	13	4	65	**82**	**115**
Nicaragua	6	4	23	**33**	13	15	67	**95**	**128**
Panama	1	0	0	**1**	13	6	24	**43**	**44**
Total	**28**	**11**	**40**	**79**	**79**	**62**	**285**	**426**	**505**

TABLE 3. Percentage of catch represented by the sites that are currently planned for sampling in 2022 (Table 5), by country, for each of the main shark species. The low percentage of catch for the sites in Guatemala is due to the fact that many of the primary sites in Guatemala are no longer accessible. Should the status of these primary sites change in 2022, they will be sampled giving better representation of sites monitored by the program.

TABLA 3. Porcentaje de la captura que representan los sitios que actualmente se prevé muestrear en 2022 (Tabla 5), por país y por cada una de las principales especies de tiburón. El bajo porcentaje de la captura en los sitios de Guatemala se debe a que muchos de los sitios primarios en Guatemala ya no son accesibles. Si la situación de esos sitios primarios cambia en 2022, se procederá a muestrearlos, con lo que se obtendrá una mejor representación de los sitios monitoreados por el programa.

% of Catch								
Country	**Primary Landing Sites**		**Secondary Landing Sites**		**Tertiary Landing Sites**		**Total**	
	Silky shark	**Hammerhead sharks**	**Silky shark**	**Hammerhead sharks**	**Silky shark**	**Hammerhead sharks**	**Silky shark**	**Hammerhead sharks**
Costa Rica	70.1			5.4	3.7	5.9	**73.8**	**11.3**
El Salvador	86	71.6		8.2	3.4	2.3	**89.4**	**82.1**
Guatemala	10.4	21.8	1.6	2.6	4.9	6.2	**16.9**	**30.6**
Nicaragua	80.6	64	8.2	27.4	8	4.8	**96.8**	**96.2**
Panama		78.1		9.5		8.1		**95.7**

TABLE 4. Percentage of sites with and without shark catch in the sampled landings, grouped according to whether the sites were (Site Group A) or were not (Site Group B) primary and secondary sites. Shown in parentheses are the number of sites. There was no silky shark catch landed in the samples from Panama and no samples from Panama without catch of hammerhead sharks. Assuming that primary and secondary sites identified in the analysis of the fisher interview data continue to be of importance for catch landings of a species group, the expectation would be that most sites where catch of the species was present in the samples (Capture per trip > 0) would be primary and secondary sites, and similarly, most sites where catch of the species was not present in the samples (Capture per trip = 0) would be tertiary sites. In the case of hammerhead catch in Guatemala, for example, this expectation was not met, perhaps as a result of changes brought on by the pandemic.

TABLA 4. Porcentaje de sitios con y sin captura de tiburón en las descargas muestreadas, agrupados según se trate de sitios primarios y secundarios (grupo de sitios A) o no (grupo de sitios B). Se muestra entre paréntesis el número de sitios. No hubo descarga de captura de tiburón sedoso en las muestras de Panamá y no hubo muestras de Panamá sin captura de tiburones martillo. Suponiendo que los sitios primarios y secundarios identificados en el análisis de los datos de las entrevistas con pescadores sigan siendo importantes para las descargas de capturas de un grupo de especies, lo esperable sería que la mayoría de los sitios donde había captura de las especies en las muestras (captura por viaje > 0) fueran sitios primarios y secundarios y, asimismo, que la mayoría de los sitios donde no había captura de las especies en las muestras (captura por viaje = 0) fueran sitios terciarios. En el caso de la captura de tiburones martillo en Guatemala, por ejemplo, no se cumplió esta expectativa, quizá por cambios derivados de la pandemia.

	Capture per trip > 0		**Capture per trip = 0**	
	Site Group A	**Site Group B**	**Site Group A**	**Site Group B**
Costa Rica (9)				
Silky	0% (0)	100% (2)	28.6% (2)	71.4% (5)
Hammerheads	60% (3)	40% (2)	25% (1)	75% (3)
Guatemala (14)				
Silky	87.5% (7)	12.5% (1)	33% (2)	67% (4)
Hammerheads	22% (2)	77.8% (7)	20% (1)	80% (4)
Nicaragua (20)				
Silky	100% (9)	0% (0)	0% (0)	100% (11)
Hammerheads	93.8% (15)	6.2% (1)	75% (3)	25% (1)
Panama (12)				
Silky	-----	-----	-----	-----
Hammerheads	91.7% (11)	8.3% (1)	-----	-----
El Salvador (16)				
Silky	71.4% (5)	28.6% (2)	0% (0)	100% (9)
Hammerheads	83.3% (10)	16.7% (2)	75% (3)	25% (1)

TABLE 5. Number of sampling technician necessary for the long-term sampling program and the anticipated percentage of coverage of primary (1°) and secondary (2°) landing sites. The numbers of landing sites shown in this table are the numbers of sites where silky and hammerhead sharks are landed that are presently considered feasible to sample. The percent coverage of primary and secondary sites is computed assuming each technician will be able to monitor a total of 6 sites.

TABLA 5. Número de técnicos muestreadores necesarios para el programa de muestreo a largo plazo y el porcentaje previsto de cobertura de sitios de descarga primarios (1º) y secundarios (2º). Los números de sitios de descarga que se muestran en esta tabla corresponden al número de sitios donde se descargan tiburones sedosos y martillo y cuyo muestreo se considera factible actualmente. El cálculo del porcentaje de cobertura de sitios primarios y secundarios parte del supuesto de que cada técnico podrá monitorear un total de 6 sitios.

Country	Number of sampling technicians	Total number of accessible main landing sites	Number of 1° and 2° accessible landing sites	% Coverage of 1° and 2° landing sites
Costa Rica	3	24	18	100%
El Salvador	5	75	32	94%
Guatemala	5	57	32	94%
Nicaragua	8	98	58	83%
Panama	4	41	29	83%
Total	25	295	169	91%

TABLE 6. Annual cost of the long-term shark sampling program, including conducting an annual fisher interview at all landing sites with sharks, and tissue sample collection and storage for future genetic analysis for species identification and for close kin analysis. All costs are in U.S. dollars.

TABLA 6. Costo anual del programa de muestreo de tiburones a largo plazo, que incluye la realización de una entrevista anual con pescadores en todos los sitios con descarga de tiburón y la recolección y almacenamiento de muestras de tejido para su posterior análisis genético para la identificación de especies y el análisis por parientes cercanos. Todos los costos se indican en dólares estadounidenses.

Sampling Program									
Country	**Staff**	**Quantity**	**Fee*12 months**	**Insurance (annual)**	**Transport and per diem * 12 months**	**Equipment**	**Transaction fee (annual)**	**Training**	**Total**
Panama	Data editor	3	$40,800.00	$3,000.00					$43,800.00
Costa Rica	Sampling technician	4	$60,000.00	$4,000.00	$28,800.00	$1,000.00			$93,800.00
El Salvador	Sampling technician	6	$80,400.00	$6,000.00	$43,200.00	$1,000.00			$130,600.00
Guatemala	Sampling technician	6	$80,400.00	$6,000.00	$43,200.00	$1,000.00			$130,600.00
Nicaragua	Sampling technician	9	$116,400.00	$9,000.00	$64,800.00	$1,000.00			$191,200.00
Panama	Sampling technician	5	$76,800.00	$5,000.00	$36,000.00	$1,000.00			$118,800.00
Transaction fee									$9,600.00
Training									$30,000.00
Total		33	$454,800.00	$33,000.00	$216,000.00	$5,000.00			$748,400.00
Catch and effort Interview activity						$2,500.00			$2,500.00
Tissue sample collection for genetic analysis in local market						$12,500.00			$12,500.00
Tissue sample collection for Close kin analysis						$17,500.00			$17,500.00
Stomach collection for diet analysis						$5,000.00			$5,000.00
Grand Total									$785,900.00

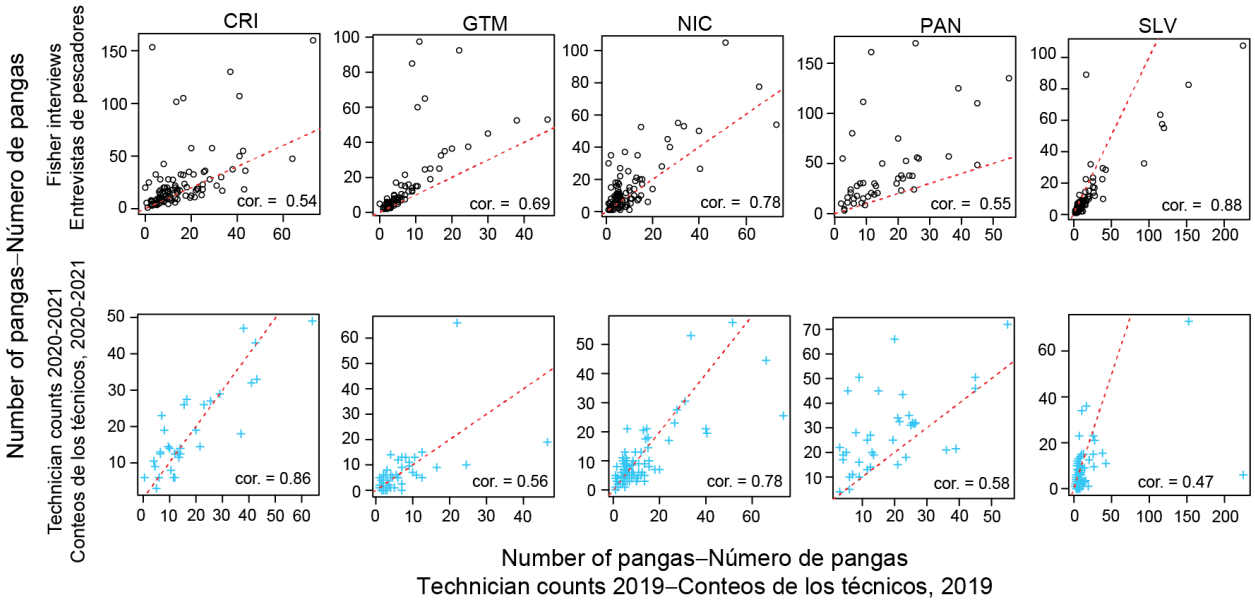

FIGURE 1. Average of the minimum and maximum number of pangas from: fisher interviews in 2019, technician counts during 2019, and technician counts during August 2020 – July 2021. Each point within a panel is a different site. The red dashed lines are the 1-to-1 lines. The technician counts during August 2020- July 2021 represent a subset of the sites shown for 2019. CRI: Costa Rica; GTM: Guatemala; NIC: Nicaragua; PAN: Panama; SLV: El Salvador.

FIGURA 1. Promedio del número mínimo y máximo de pangas de las entrevistas con pescadores en 2019, los conteos de técnicos en 2019 y los conteos de técnicos entre agosto de 2020 y julio de 2021. Cada punto de cada panel corresponde a un sitio distinto. Las líneas de trazos rojas representan la correspondencia uno a uno. Los conteos de técnicos de agosto de 2020 a julio de 2021 representan un subconjunto de los sitios mostrados para 2019. CRI: Costa Rica; GTM: Guatemala; NIC: Nicaragua; PAN: Panamá; SLV: El Salvador.

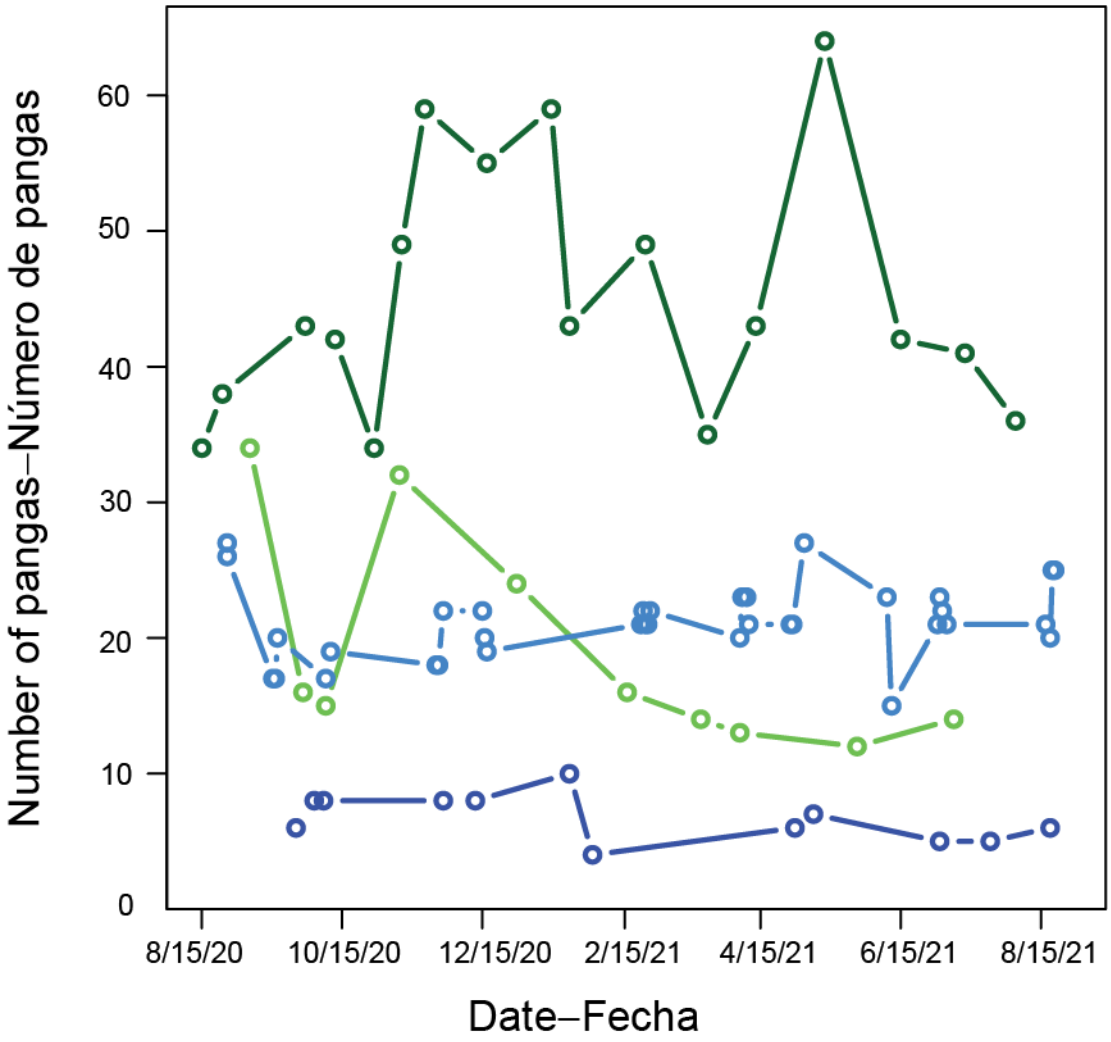

FIGURE 2. Examples of time series of technician counts of pangas at four different sites during August 2020 – July 2021. The blue lines show examples of counts that are fairly consistent through time and the green lines show examples of sites with greater variability among weeks and months.

FIGURA 2. Ejemplos de series de tiempo de conteos de pangas por parte de técnicos en cuatro sitios distintos entre agosto de 2020 y julio de 2021. Las líneas azules muestran ejemplos de conteos que son bastante constantes a través del tiempo y las líneas verdes muestran ejemplos de sitios con mayor variabilidad entre semanas y meses.

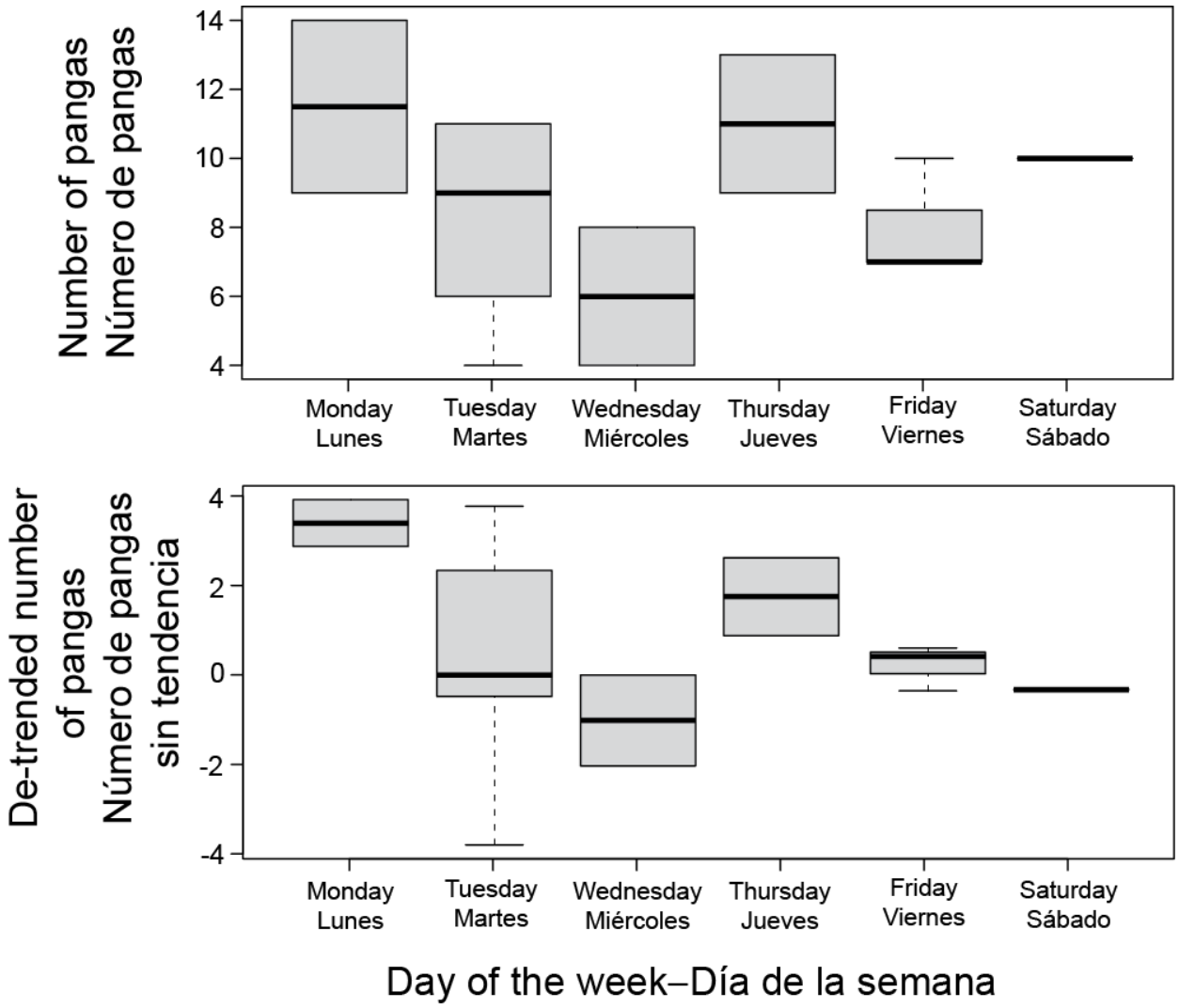

FIGURE 3. Box-and-whisker plots of technician counts of numbers of pangas, by day of the week, at one primary unloading site in El Salvador during August 2020 – July 2021. The top panel shows the raw counts. The bottom panel shows the detrended counts; the long-term trend in counts across the study period was removed to more clearly illustrate the differences in numbers of pangas by day of the week at this particular site.

FIGURA 3. Gráficas de caja y bigote de los conteos del número de pangas por parte de técnicos, por día de la semana, en un sitio de descarga primario en El Salvador entre agosto de 2020 y julio de 2021. El panel superior muestra los conteos brutos. El panel inferior muestra los conteos sin tendencia; se eliminó la tendencia a largo plazo de los conteos durante el periodo de estudio para ilustrar más claramente las diferencias en el número de pangas por día de la semana en este sitio en particular.