**INTER-AMERICAN TROPICAL TUNA COMMISSION**

**SCIENTIFIC ADVISORY COMMITTEE**

**11TH MEETING**

**La Jolla, California (USA)**
**11-15 May 2020[1]**

# DOCUMENT SAC-11-13

# PILOT STUDY FOR A SHARK FISHERY SAMPLING PROGRAM IN CENTRAL AMERICA

Ricardo Oliveros-Ramos, Cleridy E. Lennert-Cody, Salvador Siu, Sonia Salaverría, Mark. N. Maunder, Alexandre Aires-da-Silva, José Carvajal Rodríguez[2]

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## 1. INTRODUCTION

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 a project to improve data collection for shark fisheries in the eastern Pacific Ocean (EPO), particularly in Central America, where much of the shark catch is landed and where the need for better data collection is greatest.

This project carried out by the IATTC and OSPESCA[3] between September 2014 and December 2018[4],

[1] Postponed until a later date to be determined
[2] Instituto Nacional de Pesca y Acuicultura (INCOPESCA), Costa Rica
[3] Organización del Sector Pesquero y Acuícola del Istmo Centroamericano
[4] Initially, the contract was to expire on 23 September 2017; it was later extended through 2018

formed Phase 1 of the development of a long-term regional data-collection program for sharks. During Phase 1, the data available for these fisheries were identified and compiled, and recommendations were formulated for improving data collection. Also, three workshops were held, on data collection, assessment methods for shark species, and designing a pilot sampling program.

The objective of Phase 2, initiated in January 2018[5] and completed in December 2019, was to develop sampling designs and test them via a pilot study, thus creating a framework for a regional program for the IATTC Members to consider.

This document is the technical report of Phase 2; there are also three quarterly reports on this phase, in addition to a separate report on the capacity-building activities carried out under the project. The FAO-GEF funding covered the period from April 2018 through March 2019; subsequent work was funded by the IATTC's Capacity Building Fund. This report covers all aspects of Phase 2 of the project, regardless of their funding source.

The study is described in general terms in the text of this report; the details of both the methodology and the results are presented in Supplements 1-6, and the forms developed to collect the data are shown in Appendices A-C.

## 2. WORK PLAN

### 2.1. Background

At the workshop on designing the pilot study, held in September 2017, an external panel of experts in fisheries sampling provided advice and made recommendations, and a panel of scientific and technical experts from OSPESCA's Regional Working Group on Sharks and Highly Migratory Species (GTEAM) provided advice on the feasibility and practicality of relevant logistical aspects, as well as information on the current status of catch monitoring programs in the various countries. At the workshop, it was agreed that, for the purposes of the project, and as recommended at the meeting of the IATTC Scientific Advisory Committee in 2016 (SAC-07-06b (iii)), the fleet of vessels that unload catches of sharks in Central America should be categorized into two groups, based on their length overall (LOA): smaller artisanal vessels, called *pangas* (≤ 10 m LOA; code PNG), and larger longline vessels (>10 m LOA; code NPG).

A second important conclusion of the workshop was that more information on the various shark fisheries[6] is essential in order to design the sampling program. Specifically, all sites where shark catches are landed must be identified and, since the primary objective is to estimate the total catch, a measure of the level of fishing activity (*e.g.*, the number of vessels) must be determined for each site, and the magnitude of catches must be obtained from a subset of all sites. This is particularly important for countries (El Salvador, Guatemala and Nicaragua) in which the fishery is dominated by small artisanal vessels, which have received little research focus by the IATTC staff. Sampling these fleets is critical for monitoring population trends for species of high conservation concern, such as hammerhead sharks.

On the basis of these conclusions and recommendations, the initial work to be carried out during Phase 2 (Services 3-6) was grouped into **Task 1.** This task would focus first on gathering data to map potential shark landing sites on the Pacific coast of Central America; it would then focus on obtaining order-of-magnitude estimates of total catch for key species by the *panga* (PNG) fleet, which was the focus of this

[5] 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.

[6] A "shark fishery" is defined as any fishery in which sharks are caught, whether as target species or bycatch.

task because much less is known about its catches than those of the NPG fleet.

Another important conclusion of the workshop was that there is great diversity in unloading strategies for shark catches among companies, landing sites, and fleet components. The unloading strategies of individual companies and vessels may affect the accessibility of the catch to samplers, and thus are an important consideration in determining the sampling design needed to produce reliable estimates of the sex and size composition of the catch. Therefore, before sampling designs can be developed and tested, detailed data on unloading strategies must be collected and analyzed.

Given this situation, **Task 2** (Services 7-9) focused on the larger (NPG) vessels, and on developing and testing of different designs for a sampling program to collect reliable data on the sex and size composition of shark catches. Sampling technicians were to survey NPG vessels and their landing sites in Costa Rica and Panama, where most of the NPG fleet operates, to identify these strategies, and to collect detailed data for testing sampling designs. The results of this task are expected to be generally applicable to the vessels of both fleets throughout the region.

### 2.2. Implementation

To implement the two tasks, they were broken down into a series of sub-tasks, reflecting the services specified in the contract, as follows:

| **Task 1: Determine locations, catches, and effort of the *panga* (PNG) fleet** | | |
|---|---|---|
| **Sub-task** | **Service**[7] | **Activity** |
| 1.1 | 3 | Identify and map all sites where shark catches are potentially landed along each country's EPO coastline |
| 1.2 | 4 | Verify mapped landing sites *in situ*, and collect data on site characteristics and the level of fishing activity |
| 1.3 | 5 | Collect data at selected landing sites on vessel operations and catch composition |
| 1.4 | 6 | Compute order-of-magnitude estimates of shark catches landed at all sites, using information from 1.1-1.3 |
| 1.5[8] | - | Develop possible catch sampling designs and conduct simulations to evaluate performance |
| **Task 2: Testing sampling designs for composition data (NPG vessels)** | | |
| **Sub-task** | **Service** | **Activity** |
| 2.1 | 7 | *In-situ* surveys of vessels and landing sites to collect data on unloading practices |
| 2.2 | 8 | Based on results of 2.1, collect catch size and sex composition data with which to develop and test sampling designs |
| 2.3 | 9 | Develop sampling designs based on analysis of data collected in 2.1-2.2, and conduct simulations to evaluate performance |

#### 2.2.1. Task 1: Determine locations, catches, and effort of the *panga* (PNG) fleet

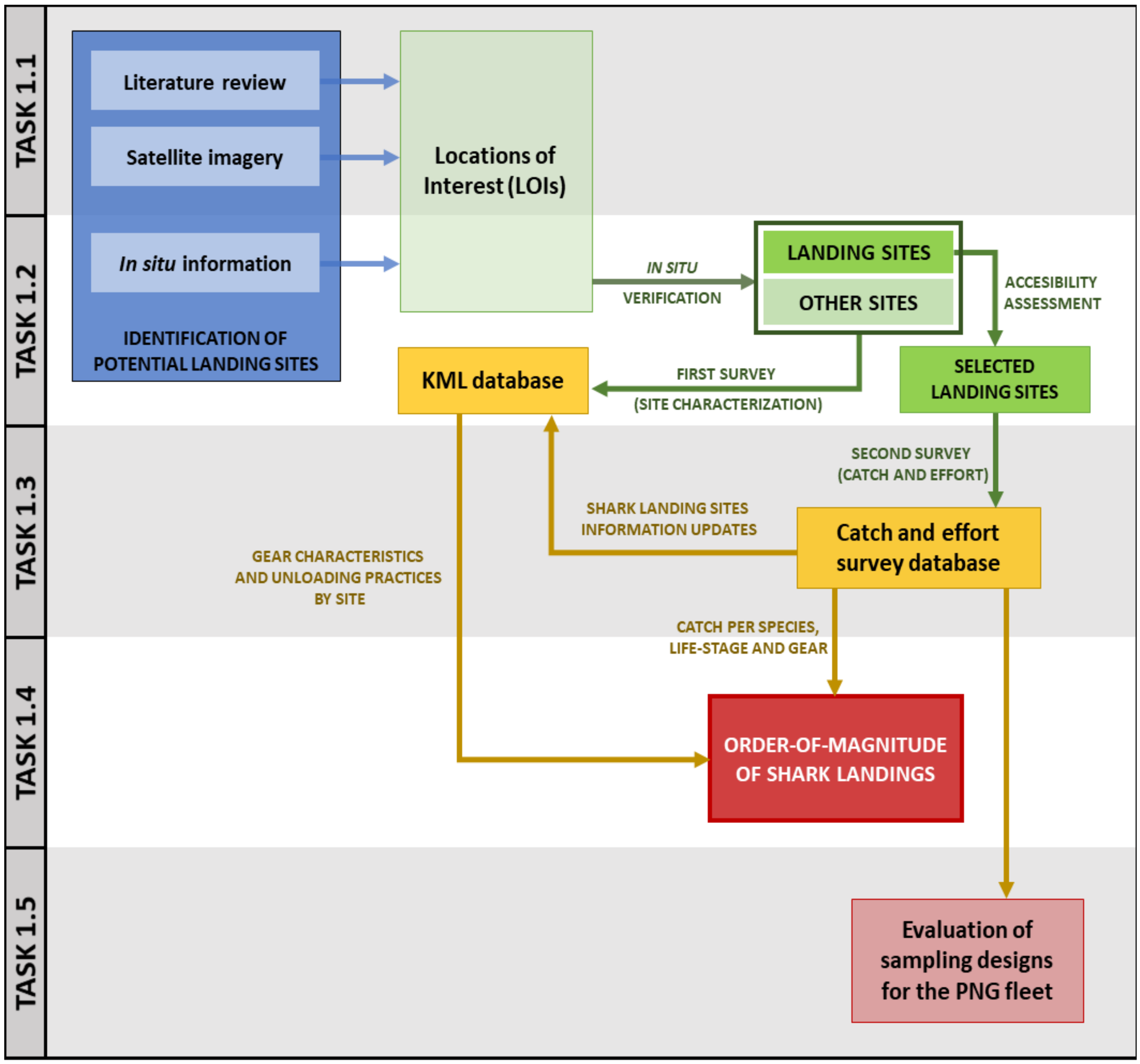
**Sub-task 1.1: Identify and map all sites where shark catches are potentially landed along each country's EPO coastline**

As a first step towards identifying fishing localities and catch landing sites, and eventually creating the first regional database for artisanal fisheries in Central America, various documentary sources of information

[7] Services 1 and 2 under the contract involved organizing a training workshop on shark landing procedures and writing the report of the workshop, respectively. These services, which are outside the scope of this report, were completed.

[8] This activity was not specified in the contract; it was added by the IATTC staff.

were reviewed (*e.g.* annual catch reports published by fisheries agencies and NGOs, surveys carried out by local fishing authorities, registers of companies and fishing cooperatives), and those locations with



Work flowchart of Task 1.

documented historical landings were classified as 'locations of interest' (LOIs).

Next, satellite imagery available on Google Earth was reviewed to identify additional potential landing sites. Locations with one or more *panga*-like vessels (assumed to be fishing vessels) visible in the satellite images, and/or with characteristics that would make them suitable as landing sites, were also classified as LOIs.

All LOIs were then assigned to one of three categories of potential landing sites (Figure 1):

a. **historical**, for locations where fishing activity had previously been documented;
b. **new**, for locations where no fishing activity had previously been documented, but *panga*-like vessels were observed in the satellite imagery; and

c. **prospective**, for locations that had the characteristics of a landing site, but where no fishing activity had previously been documented, and no *panga*-like vessels were observed in the satellite imagery.

A unique numerical code ("ID") was assigned to each LOI, for constructing a georeferenced database with six fields (site name, site ID, longitude, latitude, number of vessels, and category).


**FIGURE 1.** Locations of interest (LOIs), as shown in satellite imagery (Google Earth™). Top: historical sites in documented sources; centre: new sites identified from satellite imagery; bottom: prospective sites identified from satellite imagery.

Google Earth satellite imagery is updated periodically, so the images for the region were reviewed once again during 2018 to evaluate possible changes in location characteristics over time. This second review led to changes in the number of LOIs, in part due to differences in the number of vessels visible in the imagery (from a 23% decrease in El Salvador to a 66% increase in Costa Rica), and highlighted the need for *in situ* verification of the 1,332 LOIs that were identified and mapped at this stage.

**Sub-task 1.2: Verify mapped landing sites *in situ*, and collect data on site characteristics and the level of fishing activity**

Sampling technicians made an initial visit to every LOI to verify whether it was currently used for landing catches of any marine species, and should thus be classified as a landing site for the project. In addition to the 1,332 LOIs identified in sub-task 1.1, they visited 111 previously unknown locations that were not identified during sub-task 1.1 because they were hidden under mangroves or trees and were thus invisible in satellite images, but which the sampling technicians were informed of or otherwise found out about while visiting the LOIs.

During sub-task 1.1, a number of LOIs were identified only because vessels were visible in the satellite imagery, and a visit was necessary to ascertain whether the site should actually be classified as a landing site. In particular, many locations in Costa Rica, initially identified as potential landing sites because of the presence of *panga*-like vessels in the satellite imagery, were subsequently found to be associated with marine transport, sportfishing, and/or tourism, not with artisanal fishing. Also, in some cases, vessels visible in the satellite images were no longer in use.

All LOIs where unloading of fish was verified were classified as **landing sites** (Figure 2). If expedient for the purposes of the project, contiguous landing sites forming fishing communities were grouped into **fishing localities**, defined as communities or geographical regions whose population is primarily dedicated to marine fisheries, and contain one or more landing sites. A total of 1,443 LOIs were visited; eventually, 789 (54.7%), distributed among 243 fishing localities, were verified as active landing sites, and of these 676 reported landings of sharks, and were thus classified as 'shark sites', regardless of whether the catches were intentional or incidental (Table 1; Figures 2 and 3).

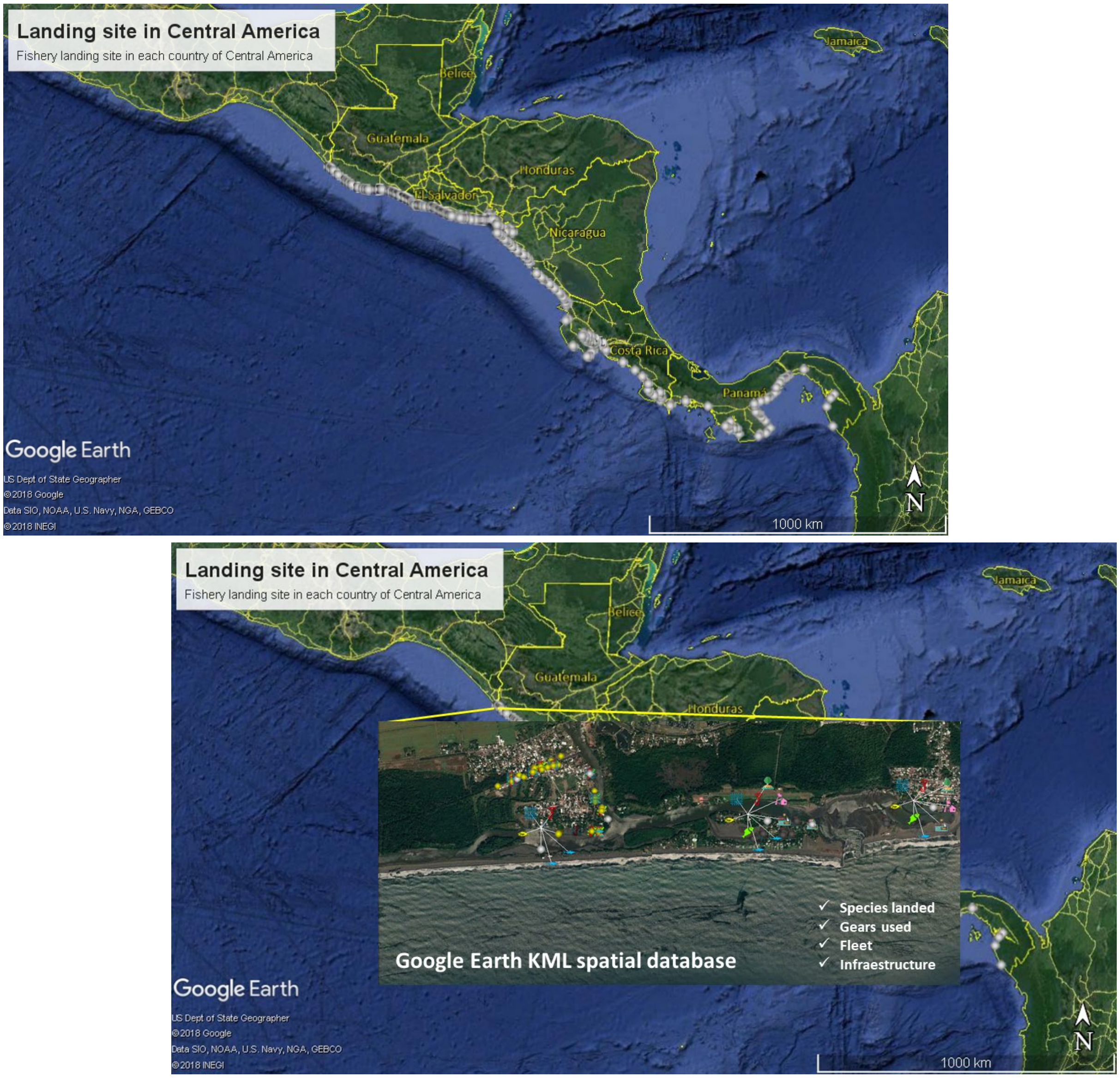



**FIGURE 2.** Maps generated from the data collected during sub-tasks 1.1 and 1.2: landing sites (top), and information recorded at specific sites (bottom).

**TABLE 1.** Locations of interest (LOIs), and landing sites and fishing localities with reported landings of any species, and of sharks ('shark sites'), identified during April 2018-November 2019.

| Country | LOIs | Landing sites | | | Fishing localities | | |
|---|---|---|---|---|---|---|---|
| | | Any species | Sharks | % | Any species | Sharks | % |
| Costa Rica | 612 | 173 | 145 | 84 | 58 | 43 | 74 |
| El Salvador | 318 | 240 | 206 | 86 | 79 | 60 | 76 |
| Guatemala | 241 | 169 | 167 | 99 | 32 | 31 | 97 |
| Nicaragua | 170 | 147 | 108 | 73 | 37 | 27 | 73 |
| Panama | 102 | 60 | 50 | 83 | 37 | 29 | 78 |
| **Total** | **1,443** | **789** | **676** | 86 | **243** | **190** | 78 |

A first survey was carried out at all landing sites, using the forms in Appendix A, including a group interview with fishers available at the site, to obtain information on the characteristics and levels of fishing activity (Table 2). Both the metadata about the sites (number of vessels observed, accessibility and safety considerations, *etc*.) and detailed information on species composition of the landings, gears used, vessel characteristics, and site infrastructure (Figure 2) were incorporated in a KML spatial database, which was used to plan the subsequent activities within the project, and is also useful for other fishery-related projects in Central America managed by OSPESCA and/or fisheries authorities.

**TABLE 2.** Fisheries characteristics recorded during the first survey at landing sites.

| Characteristic | Data recorded |
|---|---|
| Vessels | Total number observed during the initial visit; number reported by fishers. |
| Effort | Number of active vessels, engine type and horsepower, LOA (m); average number, per vessel, of fishers, fishing days, rest days between fishing trips. |
| Fishing gear and equipment | **Longline:** number of sets, length of mainline, hooks (number, type, size), effective fishing days, bait type, vertical position of longline in the water column, use of steel leaders.<br>**Gillnet:** number of sets, length and depth of the net, vertical position of the net in the water column, mesh size. |
| Catch | Main species landed and type of catch processing; differences between seasons (dry, November-April); rainy, May-October). |

**TABLE 3.** Vessels in Central American PNG fisheries, by country and data source, November 2018

| | Data source | | | |
|---|---|---|---|---|
| | **Registry** | **Satellite** | **Sampling techs.** | **Fishers** |
| Costa Rica | 1,653 | 1,064 | 312 | 1,545 |
| El Salvador | 2,926 | 2,213 | 2,770 | 2,448 |
| Guatemala | 1,395 | 1,193 | 662 | 974 |
| Nicaragua | 1,913 | 804 | 1,239 | 1,128 |
| Panama[9] | 829 | 419 | 930 | 3,071 |
| **Total** | **8,716** | **5,693** | **5,913** | **9,166** |

[9] Panama registry value corresponds to April 2019.

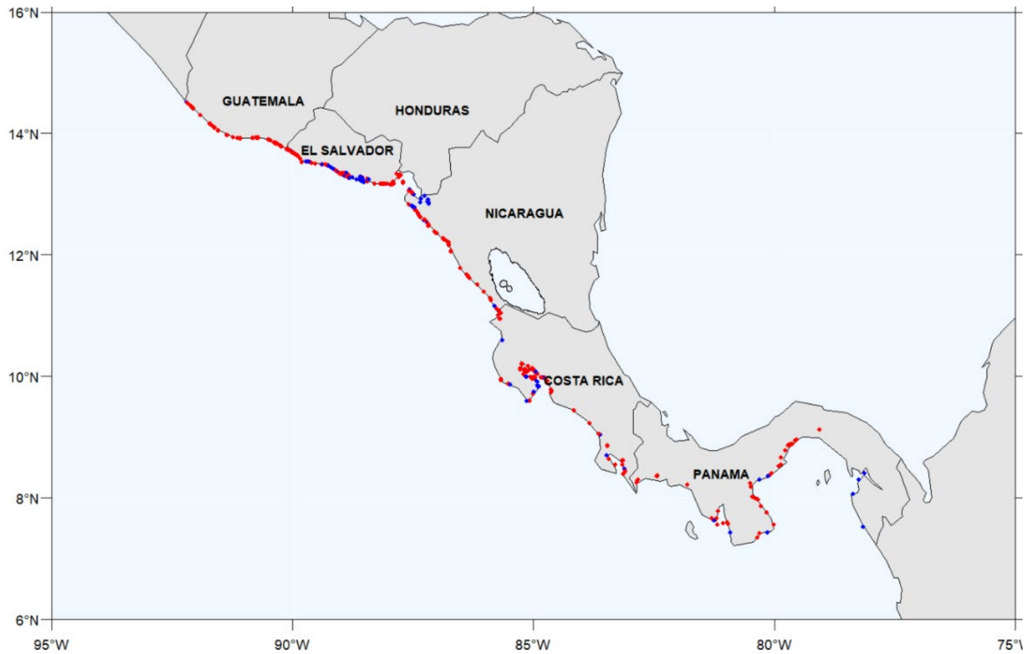



**FIGURE 3.** Landing sites (n=789) with reported shark landings ('shark sites', red, n=676) and without (blue, n=113).

Regarding fishing activity at these landing sites, the estimated number of PNG vessels in each country is shown in Table 3, from four sources: a) national vessel registries b) satellite imagery; c) visits by sampling technicians; and d) interviews with local fishers. There are significant variations among sources (Figure 4).

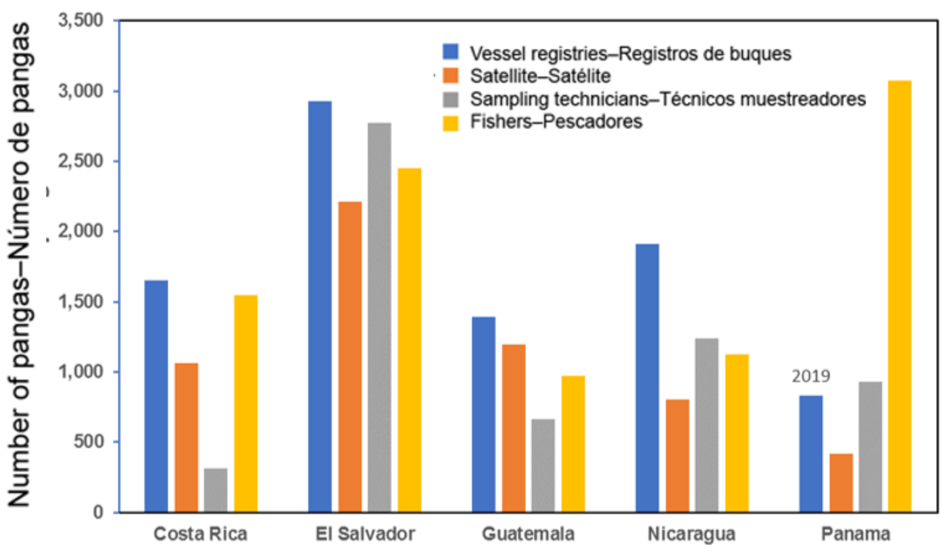



**FIGURE 4.** Vessels in Central American PNG fisheries, by country and data source, November 2018[9].

**Sub-task 1.3. Collect data at selected landing sites on vessel operations and catch composition**

To obtain data for order-of-magnitude estimates of effort and shark catch at the landing sites, a second survey was carried out at selected landing sites. The objective was to interview a crew member, usually the captain, of several vessels at each site, to obtain information on catch composition, by individual trip, and on variability in catch composition among trips, vessels, seasons, and sites (see forms, Appendix B). Catch and effort data were collected for 2018 only, for both dry (November-April) and rainy (May-October) seasons, since the fishers' recollection of prior years might not be reliable, and to avoid possible biases due to different years of experience among fishers.

About a third of the sites were not selected for this sub-task (Table 4), due in some cases to accessibility issues identified by sampling technicians during their initial visits. In other cases, sites were not selected because of safety concerns previously identified by the relevant national fisheries authorities.

**TABLE 4.** Landing sites and fishing localities included in the second survey.

| | Fishing localities | | Landing sites | |
|---|---|---|---|---|
| | **No.** | **% of total** | **No.** | **% of total** |
| Costa Rica | 53 | 91 | 107 | 62 |
| El Salvador | 48 | 61 | 180 | 75 |
| Guatemala | 24 | 75 | 86 | 51 |
| Nicaragua | 30 | 81 | 95 | 65 |
| Panama | 33 | 89 | 45 | 75 |
| **Total** | **188** | **77** | **513** | **65** |

The data collected show shark landings all along the Pacific coast of Central America, with landings all year round at some sites and only in certain months of the year, mainly April-July, at others (Figure 5a). It was also possible to identify seasonal differences in the unloadings by life stage (Figure 5b), with neonates showing the most marked seasonality. These results suggest that a sampling program for shark unloadings by the PNG fleet should be implemented year-round.

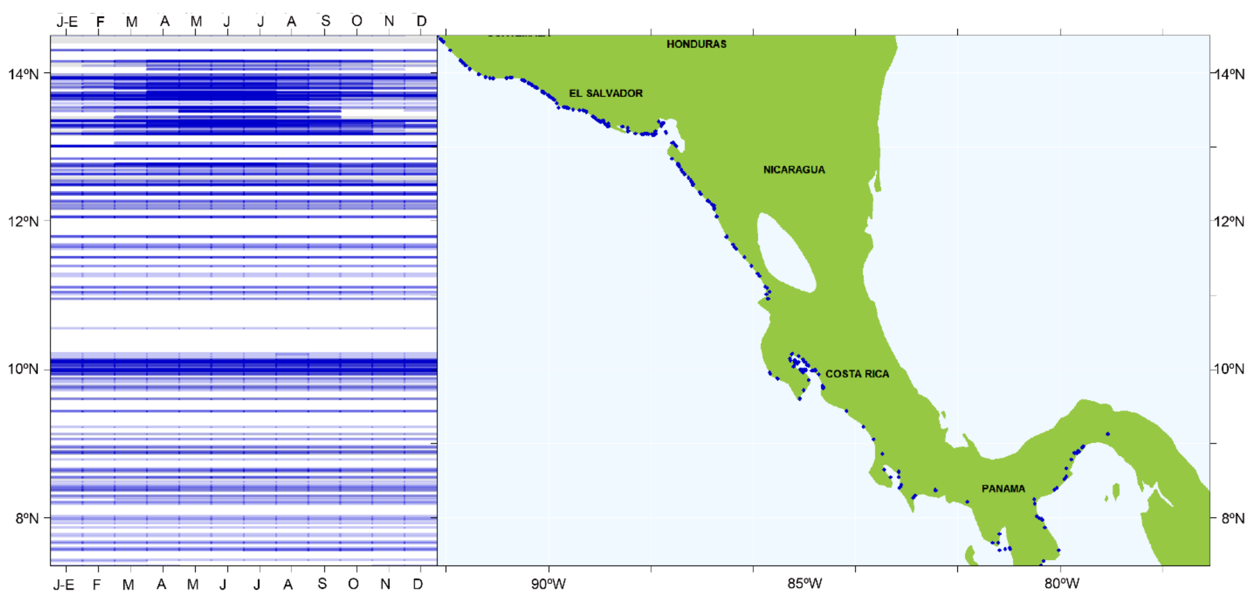



**FIGURE 5a.** Spatial and seasonal variation (seasonality) in Central American shark landings. The horizontal lines indicate reported shark landings at the sites on the map (blue dots) at the corresponding latitude; blue means they were reported monthly, grey that information on seasonality is lacking.

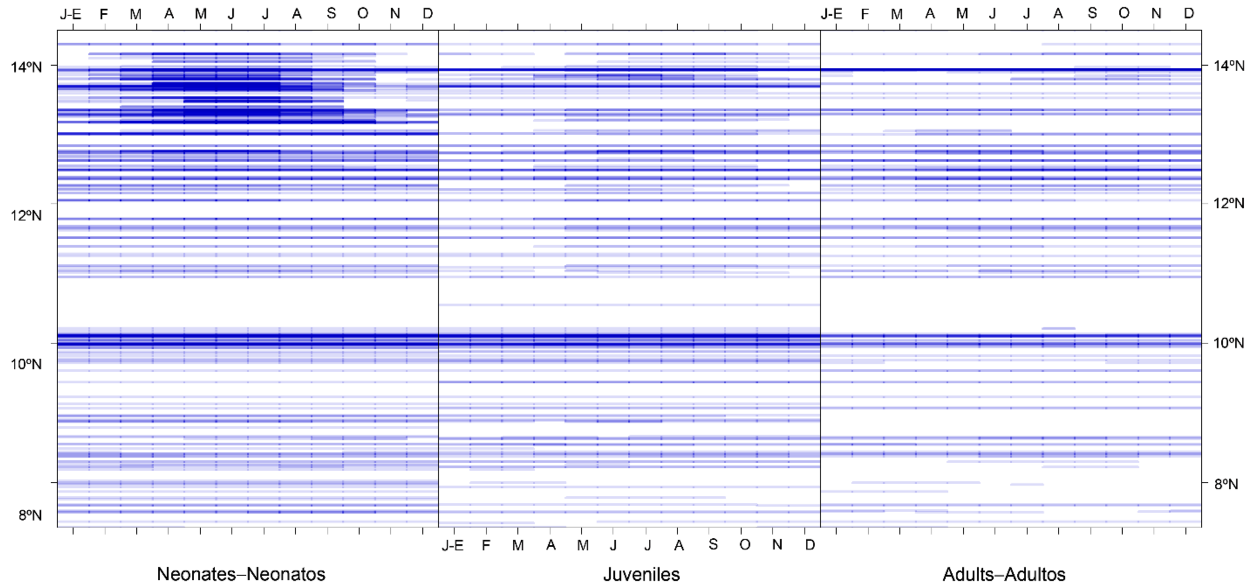



**FIGURE 5b.** Fishing seasonality, by life stage: neonates (left), juveniles (center) and adults (right). As in Figure 5a, the lines correspond to the latitudes of the landing sites.

Four fishing gears were reported in the PNG fishery for sharks. The most widely used were gillnets (65%), followed by longlines (18%) and handlines (17%); purse-seine nets, although reported, were rare (≈ 0.1%). These proportions are essentially constant throughout the year, varying only slightly by season (Table 5).

**TABLE 5.** Gears used in the PNG fishery, by season.

| % | Dry season | Rainy season | Overall |
|---|---|---|---|
| Gillnet | 66 | 63 | 65 |
| Longline | 17 | 19 | 18 |
| Handline | 17 | 18 | 17 |
| Purse seine | ≈ 0.1 | ≈ 0.1 | ≈ 0.1 |

**Sub-task 1.4: Compute order-of-magnitude estimates of shark catches landed at all sites, using information from 1.1-1.3**

Site-specific order-of-magnitude estimates of catch, by species and life stage, were computed using data collected as part of sub-tasks 1.2 and 1.3, including: catch per trip (minimum, typical, maximum), by season (dry, rainy); start, end, and peak months for shark catches; number of trips per week (minimum, typical, maximum); and, number of vessels. Data with which to compute site-specific estimates were available for 513 of the 676 shark sites (Table 1). The site-specific order-of-magnitude estimates from these sites were used to generate the annual order-of-magnitude estimates of regional shark catch by extrapolating to the 163 unsampled landing sites using information available for all sites, such as fishing gears, number of vessels, and association with a beach or mangrove[10]. Details of the catch estimation methodology are provided in Supplement 1. The seasonal variability of the estimates is shown in Supplement 2.

At some landing sites, sharks are landed "dressed" (less head and guts, Figure 8) or with other types of

[10] Believed to be an important predictor of the species composition of the landings; hammerheads are thought to be landed mainly in mangrove sites.

processing, so a correction factor was applied to raise the landed weight to total body weight. Raising factors were calculated for each family, based on estimates of the weight percentage of body parts from the literature (see Table S1.2). The biometric data to be collected during the shark-fishing season in Central America in the coming years will improve these factors, particularly since fishers have agreed to land some sharks without any processing, thus allowing species-specific conversion factors to be estimated.

The order-of-magnitude estimates of annual catches differ considerably among species and life stages (Tables 6a and 6b). Estimated landings of adults of the 25 species reported by shark sites were in the 10,000s of tons (Column F) for two species (SPL, *Sphyrna lewini*; FAL, *Carcharhinus falciformis*), and in the 1,000s to 10,000s of tons (Column E) for nine species or genera (TIG, *Galeocerdo cuvier;* PTH, *Alopias pelagicus;* GNC, *Ginglymostoma cirratum;* CNX, *Nasolamia velox*; CCL, *Carcharhinus limbatus*, CCE, *Carcharhinus leucas*; ALV, *Alopias vulpinus*; THR, *Alopias* spp.; SPN, *Sphyrna* spp.). Estimated landings of juveniles were in the 1,000s to 10,000s of tons (Column E) for six species or genera (SPL, *Sphyrna lewini;* GNC, *Ginglymostoma cirratum;* FAL, *Carcharhinus falciformis;* CNX, *Nasolamia velox;* CCL, *Carcharhinus limbatus*; THR, *Alopias* spp.), and those of neonates in the 10,000s of tons (Column F) for *Sphyrna lewini* (SPL), and in the 1,000s to 10,000s of tons (Column E) for other hammerheads (SPN) and whitenose (CNX) sharks. Lesser catches (Columns A-D) were estimated for all life stages of species such as *Carcharhinus albimarginatus* (ALS), *Alopias superciliosus* (BTH), *Alopias pelagicus* (PTH), *Rhizoprionodon longurio* (RHU), *Isurus oxyrinchus* (SMA), *Sphyrna mokarran* (SPK) and *Galeocerdo cuvier* (TIG).

More accurate and precise estimates of catches cannot be obtained without trip-level data, which the IATTC sampling program planned for 2020 is designed to collect. The order-of-magnitude estimates (Table 6) required a number of assumptions (Supplement 1) that could not be validated, and thus come with several caveats. In particular, the estimates of catch are based on the recollections of fishers in interviews, whose accuracy cannot be determined: some may overstate catches of which they are proud, or understate, or omit, catches of some species or life-stages (*e.g.* neonates) for fear this might lead to additional regulations, catch limits, or other restrictions. Gaining the trust of fishers was critical to improving the reliability of the information collected: for instance, after the first survey only 399 sites reported landings of sharks, but this has since risen to 676 of the 789 landing sites (Table 1, Figure 3).

In addition, to quantify variability in catch rates and effort, the minimum, typical, and maximum values reported by fishers were translated into statistical distributions for catch rates and effort quantities, but there are no data to evaluate how well these assumed distributions describe the true distributions of those quantities. Moreover, in addition to the 163 unsampled sites, 82 of the sampled sites had incomplete data. Extrapolations required because of missing or incomplete data to arrive at regional catch estimates may further affect the reliability of the results. Finally, it is assumed that fishers can accurately identify shark species from an identification key, but any extensive misidentification of species would compromise the species-level estimates presented in Table 6.

The principal results of sub-task 1.4 are as follows:

1. The catches of several species of sharks by the PNG fleet are probably high enough that they need to be considered in population dynamics models that seek to determine the status of these species.
2. Accurate estimates of catches are required for assessing their impact on the shark populations, and for any guidance on managing populations.
3. Improving the accuracy and precision of the catch estimates requires landing information collected by trained technicians in accordance with a sampling design.

**TABLE 6a.** FAO codes and species/genus names of sharks caught by the *panga* (PNG) fishery in Central America in 2018, by life stage, within each of six order-of-magnitude intervals of tonnage caught (A-F), based on information elicited from fishers. *: genus (species not identified).

- Carcharhiniformes (ground sharks), includes Carcharhinidae (requiem sharks), Sphyrnidae (hammerhead sharks), Triakidae (houndsharks).
- Lamniformes (mackerel sharks), includes Alopiidae (thresher sharks), Lamnidae (shortfin mako shark).
- Orectolobiformes (carpet sharks), includes Ginglymostomatidae (nurse sharks).

| A | B | C | D | E | F |
|---|---|---|---|---|---|
| kg x 100 | t | t x 10 | t x 100 | t x 1,000 | t x 10,000 |
| **NEONATES** | | | | | |
| CTD Sharptooth smooth-hound | THR Thresher sharks* | TRB Whitetip reef shark | SDV Smooth-hounds* | SPN Hammerhead sharks* | **SPL Scalloped hammerhead** |
| | RSK Requiem sharks* | OCS Oceanic whitetip shark | RHU Pacific sharpnose shark | CNX Whitenose shark | |
| | GNC Nurse shark | CCR Smalltail shark | MUU Sicklefin smooth-hound | | |
| | DUS Dusky shark | | **FAL Silky shark** | | |
| | BSH Blue shark | | CCL Blacktip shark | | |
| | | | CCE Bull shark | | |
| | | | ALV Common thresher shark | | |
| **JUVENILES** | | | | | |
| | | THR Thresher sharks* | TRB Whitetip reef shark | **SPL Scalloped hammerhead** | |
| | | SMA Short fin mako shark | TIG Tiger shark | GNC Nurse shark | |
| | | OCS Oceanic whitetip shark | SPN Hammerhead sharks* | **FAL Silky shark** | |
| | | | SDV Smooth-hounds* | CNX Whitenose shark | |
| | | | RSK Requiem sharks* | CCL Blacktip shark | |
| | | | RHU Pacific sharpnose shark | ALV Common thresher shark | |
| | | | PTH Pelagic thresher shark | | |
| | | | MUU Sicklefin smooth-hound | | |
| | | | CTD Sharptooth smooth-hound | | |
| | | | CCE Bull shark | | |
| | | | BSH Blue shark | | |
| | | | ALS Silvertip shark | | |
| **ADULTS** | | | | | |
| | | SPK Great hammerhead | TRB Whitetip reef shark | TIG Tiger shark | **SPL Scalloped hammerhead** |
| | | RSK Requiem sharks* | SMA Short fin mako shark | THR Thresher sharks* | **FAL Silky shark** |
| | | MUU Sicklefin smooth-hound | SDV Smooth-hounds* | SPN Hammerhead sharks* | |
| | | | RHU Pacific sharpnose shark | PTH Pelagic thresher shark | |
| | | | CTD Sharptooth smooth-hound | GNC Nurse shark | |
| | | | BTH Bigeye thresher shark | CNX Whitenose shark | |
| | | | BSH Blue shark | CCL Blacktip shark | |
| | | | | CCE Bull shark | |
| | | | | ALV Common thresher shark | |

**TABLE 6b.** Descending order-of-magnitude estimates of catches of sharks by the *panga* (PNG) fishery in Central America, by species/genus and life stage, 2018, based on information elicited from fishers. *: genus (species not identified). See Table 6a for explanation of 'Life stage' columns.

| FAO Code | Common name | Scientific name | Family | Life stage | | | |
|---|---|---|---|---|---|---|---|
| | | | | N | J | A | All |
| SPL | Scalloped hammerhead | *Sphyrna lewini* | Sphyrnidae | F | E | F | F |
| FAL | Silky shark | *Carcharhinus falciformis* | Carcharhinidae | D | E | F | F |
| CCL | Blacktip shark | *Carcharhinus limbatus* | Carcharhinidae | D | E | E | F |
| ALV | Common thresher shark | *Alopias vulpinus* | Alopiidae | D | E | E | F |
| CNX | Whitenose shark | *Nasolamia velox* | Carcharhinidae | E | E | E | E |
| CCE | Bull shark | *Carcharhinus leucas* | Carcharhinidae | D | D | E | E |
| SPN | Hammerhead sharks* | *Sphyrna* spp. | Sphyrnidae | E | D | E | E |
| GNC | Nurse shark | *Ginglymostoma cirratum* | Ginglymostomatidae | B | E | E | E |
| TIG | Tiger shark | *Galeocerdo cuvier* | Carcharhinidae | | D | E | E |
| MUU | Sicklefin smooth-hound | *Mustelus lunulatus* | Triakidae | D | D | C | E |
| THR | Thresher sharks* | *Alopias* spp. | Alopiidae | B | C | E | E |
| PTH | Pelagic thresher shark | *Alopias pelagicus* | Alopiidae | | D | E | E |
| BSH | Blue shark | *Prionace glauca* | Carcharhinidae | B | D | D | E |
| SDV | Smooth-hounds* | *Mustelus* spp. | Triakidae | D | D | D | E |
| CTD | Sharptooth smooth-hound | *Mustelus dorsalis* | Triakidae | A | D | D | E |
| TRB | Whitetip reef shark | *Triaenodon obesus* | Carcharhinidae | C | D | D | D |
| RHU | Pacific sharpnose shark | *Rhizoprionodon longurio* | Carcharhinidae | D | D | D | D |
| RSK | Requiem sharks* | *Carcharhinus* spp. | Carcharhinidae | B | D | C | D |
| BTH | Bigeye thresher shark | *Alopias superciliosus* | Alopiidae | | | D | D |
| SMA | Shortfin mako shark | *Isurus oxyrinchus* | Lamnidae | | C | D | D |
| ALS | Silvertip shark | *Carcharhinus albimarginatus* | Carcharhinidae | | D | | D |
| OCS | Oceanic whitetip shark | *Carcharhinus longimanus* | Carcharhinidae | C | C | | C |
| SPK | Great hammerhead | *Sphyrna mokarran* | Sphyrnidae | | | C | C |
| CCR | Smalltail shark | *Carcharhinus porosus* | Carcharhinidae | C | | | C |
| DUS | Dusky shark | *Carcharhinus obscurus* | Carcharhinidae | B | | | B |

**Sub-task 1.5: Develop possible catch-sampling designs and conduct simulations to evaluate performance**

The data collected to estimate the order-of-magnitude of shark landings in sub-task 1.4 can be used to evaluate which sampling designs will produce the best estimates of the total catch in the region. One of the key considerations of any sampling design for monitoring the landings of the PNG fleet is the spatial distribution of the sampling effort among fishing localities, as the high cost of hiring and deploying sampling technicians means that only a small number will be available. Computer algorithms for testing various sampling designs are currently under development (see Supplement 3). Variability in the spatial distribution of fishing effort is considered by using a weighting scheme to select fishing localities for sampling, and the main variables considered for parameterizing the probability of choosing a fishing locality for sampling are its relative total shark landings and the variability of those landings for each fishing locality. Once fully developed and tested, these methods can be used to evaluate different sampling designs for use in 2020 and beyond.

For practical reasons, larger areas with shark landings were divided into smaller landing sites. While this is useful for sampling purposes, it generated some confusion during data collection because the definition of a 'landing site' was not always clear to fishers. This issue will be reviewed during 2020 to determine whether the classification of landing sites needs to be revised to facilitate data collection.

#### 2.2.2. Task 2: Testing sampling designs for composition data (NPG vessels)

**Sub-task 2.1: *In-situ* surveys of vessels and landing sites to collect data on unloading practices**

As noted in Section 2.1 and described in detail in SAC-07-06b (iii), a first step in the project was to categorize the fleet of vessels that unload catches of sharks in Central America into two groups, based on their length overall (LOA): artisanal vessels (*pangas*; ≤10 m LOA, code PNG), and larger longline vessels (>10 m LOA; code NPG). **Task 1** focused on the former; **Task 2** focused on the NPG vessels, and on developing and testing designs for sampling the sex and size composition of shark catches.

Unloading strategies for shark catches vary considerably among companies, landing sites, and fleet components. They also affect the sampling technicians' access to the landings, and are thus an important factor in designing a sampling protocol that will produce reliable estimates of sex and size composition. Therefore, detailed data on unloading strategies must be collected and analyzed, to define the operational variables to be considered in the development of sampling designs. The first step was to collect data on how catches are processed and unloaded by individual NPG vessels, and how those practices vary by landing site.

The survey was conducted by the sampling technicians and staff of the national fisheries authorities of Costa Rica (INCOPESCA) and Panama (ARAP), where most of the NPG fleet operates, at as many landing sites of NPG vessels in those countries as possible with the time and resources available. A survey form (Appendix C) was completed for each vessel and for each landing site where that vessel unloaded; thus, if a vessel unloaded at three different sites, four forms were required, one for the vessel and one for each landing site. The following data were recorded on the forms:

i. **General:** fishing locality and landing site; name, registration number, and length of vessel;
ii. **Storage and processing:** how the catch is processed and stored aboard the vessel;
iii. **Unloading methods:** how the catch is unloaded, in groups or individually, by species, size and/or quality;
iv. **Accessibility for sampling:** catch handling and residence time of the catch on the dock.

A total of 181 NPG vessels were surveyed, 119 in Costa Rica and 62 in Panama, at 25 landing sites distributed among 11 fishing localities (Table 7). Landings in Costa Rica are concentrated in Puntarenas, the main fishing port in the country, where ten landing sites were identified. In Panama, landing locations are more widely distributed geographically, with a greater number of fishing localities but about the same number of landing sites.

| TABLE 7. NPG vessels surveyed, by fishing locality. | | | |
|---|---|---|---|
| | **Fishing locality** | **Landing sites** | **Vessels** |
| Costa Rica (119 vessels) | Puntarenas | 10 | 112 |
| | Chacarita | 1 | 3 |
| | Boca Vieja | 1 | 4 |
| Panama (62 vessels)) | Puerto Pedregal | 5 | 36 |
| | Puerto Remedios | 1 | 1 |
| | Puerto Mutis | 1 | 1 |
| | Puerto Panamá | 1 | 8 |
| | Puerto Juan Díaz | 1 | 1 |
| | Puerto Vacamonte | 1 | 11 |
| | Puerto Mensabé | 1 | 3 |
| | Puerto Coquira | 2 | 1 |
| **Total** | **11** | **25** | **181** |

The analysis of the survey data focused on the following questions that needed to be addressed in order to develop sampling designs:

1. **Unloading methods:** Can catch unloading be assumed to be random with respect to species/size/quality?
2. **Preservation and processing procedures:** Are multiple protocols for measuring/weighing catches necessary due to differences in preservation and processing procedures among vessels and/or landing sites?
3. **Access to landings for sampling:** How accessible is the catch for sampling at various points during the unloading process?

**Results of the surveys**

**Unloading methods.** Different methods are used to unload catches of sharks from NPG vessels in Costa Rica and Panama: in Costa Rica they are almost always unloaded one-by-one, while in Panama they are usually unloaded in groups (Figures 6 and 7).

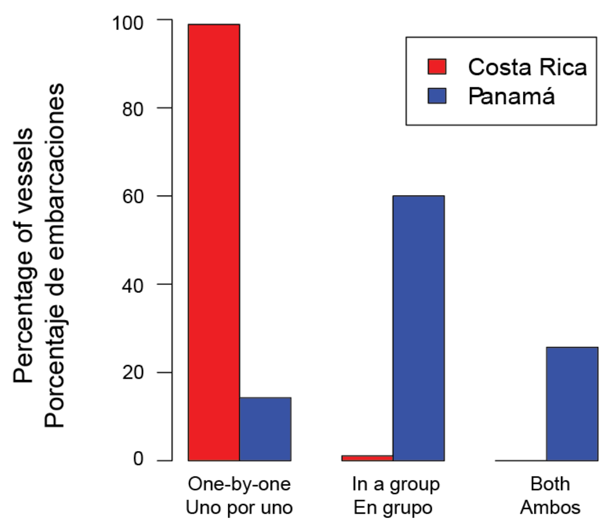



**FIGURE 6.** Unloading methods for sharks by NPG vessels in Costa Rica and Panama.

**FIGURE 7.** ‘Group’ (left) and ‘one-by-one’ (right) unloading of sharks.

A more detailed analysis of the unloadings in Costa Rica revealed that unloading is rarely random (Figure 8). Most unloading practices took species into consideration and/or the catch in a well was unloaded continuously in reverse order to its loading (referred to as unloading “by well”). However, 64% of the vessels that unloaded by well had loaded the catch into wells non-randomly, and often catch storage methods appear to separate species. Similar results (not shown) were obtained in Panama, although their catches are generally unloaded in groups (Figure 6).

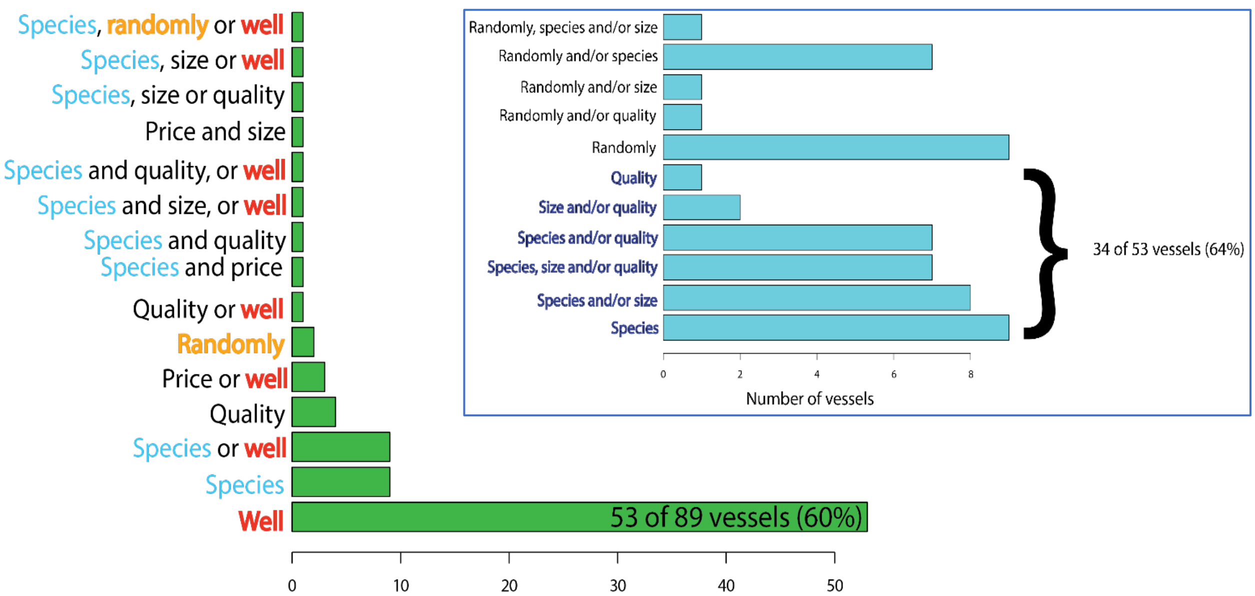



**FIGURE 8.** Frequency of unloading (main figure) and loading (inset) methods used by NPG vessels in Costa Rica.

**Preservation and processing procedures.** In Costa Rica, most of the sampled vessels chill their shark catches on ice and a few freeze them, whereas in Panama catches are as likely to be frozen as chilled (Table 8). Typically, sharks are stored in a vessel’s wells “dressed” (head cut off, guts removed, fins partially cut off[11]), making it impossible to obtain standard length measurements (*e.g.*, total length) or total weight at the time of unloading.

[11] National and regional regulations related to “finning” of sharks in Central America are described in Document SAC-07-06(ii).

| **TABLE 8.** Preservation methods used by NPG vessels for shark catches in Costa Rica and Panama | | | |
|---|---|---|---|
| | **Preservation method** | **Vessels** | |
| | | **Number** | **%** |
| Costa Rica (88 vessels) | Frozen | 13 | 17 |
| | Fresh/chilled | 75 | 83 |
| Panama (62 vessels)) | Frozen | 31 | 50 |
| | Fresh/chilled | 31 | 50 |

**Access to landings.** The data collected indicate that, in general, more time is available to measure individual sharks if the catch is unloaded in groups rather than one-by-one (Table 9). However, in practice, the time available will depend on how many sharks are in the group: the larger the group that is weighed, the more time available to measure individuals. According to informal interviews with fishers, the best time to measure sharks is before they are weighed, regardless of condition (fresh/chilled or frozen), but this can still impede unloading operations.

| **TABLE 9.** Median time, in minutes, available for measuring sharks in Costa Rica and Panama, by unloading method (*: data not available). | | | | |
|---|---|---|---|---|
| | **Preservation method** | | **Unloading method** | |
| | | | **One-by-one** | **Group** |
| Costa Rica | Fresh/chilled | Before weighing | 4 | 10 |
| | | After weighing | - | - |
| | Frozen | Before weighing | 1 | 10 |
| | | After weighing | * | - |
| Panama | Fresh/chilled | Before weighing | 2 | 4 |
| | | After weighing | 1 | 4 |
| | Frozen | Before weighing | 4 | * |
| | | After weighing | 2 | * |

In both countries, most shark catches are weighed in groups after unloading (Table 10). Of the 63 Costa Rican vessels that reported weighing sharks in groups, 60 sorted the groups by species, while 21 of the 31 Panamanian vessels that weigh sharks in groups sorted them by size class (length and weight).

| **TABLE 10.** Weighing methods used for shark catches by NPG vessels in Costa Rica and Panama. | | | |
|---|---|---|---|
| | **Weighing method** | **Vessels** | |
| | | **Number** | **%** |
| Costa Rica (82 vessels) | One-by-one | 13 | 16 |
| | In groups | 63 | 77 |
| | Both | 6 | 7 |
| Panama (34 vessels) | One-by-one | - | - |
| | In groups | 31 | 91 |
| | Both | 3 | 9 |

The conclusions drawn from the data collected by the survey (Figures 6 and 8, Tables 8-10) are:

1. **Unloading methods:** Most vessels do not load or unload shark catches randomly with respect to species, size, or quality; therefore, sampling designs for species and size composition cannot assume random loading or unloading of the catch. Also, unloading practices differ by country, so the sampling protocol will need to be adjusted for each country.

2. **Preservation and processing procedures:** Shark catches are processed both when loaded aboard the vessel and when unloaded at a landing site. Therefore, individual length and weight measurements collected must be robust to any processing of the catch aboard the vessel, and additional data will be needed to convert these measurements to typical measurements used for estimating size composition.
3. **Access to landings:** Sampling for species and size composition impacts fisher activities and catch unloading, and the need to minimize these impacts limits access to the fish. Sampling designs should take this limitation into account.

**Sub-task 2.2: Based on results of 2.1, collect catch size and sex composition data with which to develop and test sampling designs**

Since the results of sub-task 2.1 indicated that the sampling design cannot assume randomness in loading or unloading catches, specialized sampling protocols had to be developed and tested (see Supplement 5). Because access to catches for sampling in group unloadings, used mainly in Panama, was problematic, the collection of data for testing sampling designs was limited to Costa Rica, where one-by-one unloading is dominant (Figure 6). However, it proved impractical to measure the fish, so they were instead assigned to the three commercial weight categories (small, medium, large (<25 kg, 25-32 kg, and >32 kg for sharks; Table S5.1)).

The results of sub-task 2.1 also indicated that detailed data from vessel unloadings would be necessary to parameterize any statistical model of the variability in the unloading process. To this end, 'super-sampling' was conducted during the shark season of one-by-one unloadings from 90 trips, with and without shark catch, 69 by 'medium-scale' vessels and 21 by 'advanced' vessels[12] (Supplement 5). The objective of the super-sampling procedure was to obtain detailed data on species, weight, and sex (if possible) for every fish as it was unloaded, to arrive at a complete unloading history of the catch from each of the 90 trips.

**Sub-task 2.3: Develop sampling designs based on analysis of data collected in 2.1-2.2, and conduct simulations to evaluate performance**

Various sampling designs were applied to the super-sample data collected in sub-task 2.2, and the results analyzed to determine which design produced the most accurate reflection of the true composition of the landings. Because it was not always possible to collect sex information, sampling designs have to date been tested for size composition only. Evaluating the various designs involved three steps:

1. Develop a simulator (Supplements 4-5) to generate 'data' for complete unloadings under scenarios that approximate the fishery. This was necessary because super-sampling is a time-consuming process that can only be used for a limited number of unloadings.
2. Use each candidate sampling design to sample the simulated data and estimate the size composition of the catch.
3. Rank the candidate sampling designs by the accuracy of their estimate of the size composition of the catch from the 'data' generated in step (1). Specifically, the proportion of 'good' samples (those for which it was statistically unlikely that the estimated size composition of the sample was different from the 'true' size composition that generated the 'data') produced by a sampling design was used to measure the performance of that design.

[12] Costa Rica classifies its NPG vessels as either 'medium scale' (autonomy <25 days, <40 nautical miles from coast) or 'advanced' (autonomy >25 days, >40 nautical miles from coast). This classification is used for convenience in this study, since the super-sampling to date has involved Costa Rican vessels only.

**Elements to consider in the design**

Several lessons learned in the data collection to date influenced the candidate sampling designs considered. For example, the survey results and practical experience during the super-sampling showed that unloading speed varies mainly with the size of the fish, with smaller fish being unloaded faster, and the preservation method, with frozen fish unloaded faster than fresh fish because they are not washed as they are unloaded. Thus, measuring every fish may not be possible in practice, and some fish will have to be skipped. Scenarios tested with the simulator included skipping *m* fish, where *m* = 0, 1, 2, 3, …, 10.[13]

Another consideration for sampling designs is whether to sample entire unloadings, or only part of them. Whether partial sampling of unloadings is viable depends on the variability in catch composition within *versus* among unloadings, which may vary seasonally. This has been evaluated with the current data for the shark-fishing season.

**Results of the simulations**

Results from the simulations (Supplement 6, Figures S6.1, S6.3) provide guidance on both minimum sample sizes and sampling frequency. In order to ensure high-quality samples, the number of sharks measured must be greater than 27 for medium-scale vessels, and 29 for advanced vessels. For medium-scale vessels, skipping 2 or 3 fish when measuring (*i.e.* measuring every 3rd or 4th fish) is expected to ensure a high proportion of good samples. If it is not possible to measure every 4th fish, the sampling should be aborted, because the simulations did not produce the same level of good samples if four or more fish were skipped. Similarly, for advanced vessels, skipping 3 or 4 fish is expected to yield a high proportion of good samples, but the sampling should be aborted if it is not possible to measure every 5th fish. The simulation results also showed that there is no advantage to measuring every fish; in fact, larger samples sizes are required when measuring every fish, which is consistent with the non-random structure of the unloading, where contiguous fish are likely to be similar to each other.

The simulations also showed that sampling must start before 20% of the catch is unloaded for medium-scale vessels, or 50% for advanced vessels. Additionally, for medium-scale vessels, all the remaining unloading needs to be sampled, while for advanced vessels, at least half the unloading needs to be sampled.

The results of the sampling design experiments are summarized in Table 11 as practical recommendations for the sampling program. Detailed results of the experiments are presented in Figures S6.2 and S6.4.

**TABLE 11.** Recommended designs for sampling size composition of sharks in one-by-one unloadings.

| **Vessel category:** | **Medium-scale** | **Advanced** |
|---|---|---|
| Start of sampling | Before 20% of total unloading | Before 50% of total unloading |
| Fraction of unloading sampled | All the remaining unloading | > 50% of the unloading |
| Fish to skip* | 2 or 3 | 3 or 4 |
| Minimum shark sample size | 27 | 29 |

***** Choice dictated by practicality, depending on unloading rate.

[13] Skipping fish may introduce error into the estimates of size composition if a sampler loses count of the number of fish skipped, but the impact of this error can be evaluated for the various sampling designs by using data from the simulator. Such errors in *m*-skipping are considered as "jumps" in the counting, and are positive if more fish are skipped than required and negative if less. Additionally, if the sampler corrects the error during the unloading, the impact of catching up (or not) with the skipping schedule can be evaluated.

**ACKNOWLEDGEMENTS**

This project would had not have been possible without the invaluable efforts of the sampling technicians (Costa Rica: Alejandra Zúñiga, Isaac Cruz; El Salvador: Erick Maravilla; Guatemala: Julio Cordón; Nicaragua: Yesenia Rodríguez; Panama: Anabel Barria, Tatnay Cedeño) and the active cooperation of the fishers in Central America, who shared their knowledge and provided support for all our sampling work. We particularly thank the Costa Rican longline sector for its support and patience during the constant interruptions to the unloading process during our sampling experiments. We also extend our gratitude to the national fisheries authorities of the countries involved, particularly the technical personnel, and to the ABNJ project management team at FAO (Alejandro Anganuzzi, Shelley Clarke, Janne Fogelgren, Kathrin Hett and Nicolás Gutiérrez) for their constant support. We appreciate the trust placed in all the IATTC staff members involved in this project. At IATTC headquarters, we thank Christine Patnode and Nick Webb for their graphical and editorial contributions to the many reports, and Paulina Llano for the translation. The continuous guidance and support for the project by Guillermo Compeán at IATTC is greatly appreciated. The IATTC has provided financial support for the project, with co-finance as well as capacity-building funds.

**Supplement 1.** Algorithm used to compute estimates of shark catches

The annual estimated catch at a landing site was obtained by summing weekly estimates of catch over the year. The weekly estimates were computed as the product of estimates of catch per week per vessel and the estimated number of active vessels. A Monte Carlo simulation was used to obtain estimates of catch per week per vessel for every week of the year. For each species, life stage, and week of the year, the Monte Carlo simulation involved implementing the following steps:

**Step 1. Simulate the number of trips per week per vessel:** Draw a random number ($n_{trips}$) of trips per week per vessel from an appropriate distribution (*e.g.*, a PERT, g=2; Figure S1.1), for the corresponding season (dry or rainy) and environmental conditions (good or bad). The same distribution is used for every week within a season.

**Step 2. Simulate $n_{trips}$ catches:** Take $n_{trips}$ random draws from an appropriate distribution of catch per trip (*e.g.*, PERT, g=4; Figure S1.1.), for the species, life stage, and week of the year. The distribution differs by week, as explained below.

**Step 3. Estimate catch per week per vessel:** Sum the $n_{trips}$ simulated catch-per-trip values (from Step 2) to obtain an estimate of catch per week per vessel for the current week.

The weekly distribution of catch per trip (Step 2 of the Monte Carlo simulation) were assumed to follow a PERT distribution (*e.g.* Figure S1.1). The catch-related information necessary to define the PERT catch-per-trip distribution for a given week is the minimum, typical, and maximum catch for the week. These three quantities are estimated from the seasonal information provided by fishers, as follows:

a. For the weekly estimates of the minimum and maximum catch per trip, the values provided by fishers for dry and rainy seasons were smoothed over the weeks of the year using cubic splines, assuming continuous and smooth change.

b. The weekly estimate of the typical catch-per-trip was assumed to follow a generalized PERT distribution from the start month to the end month of the season, with the mode at the peak month.

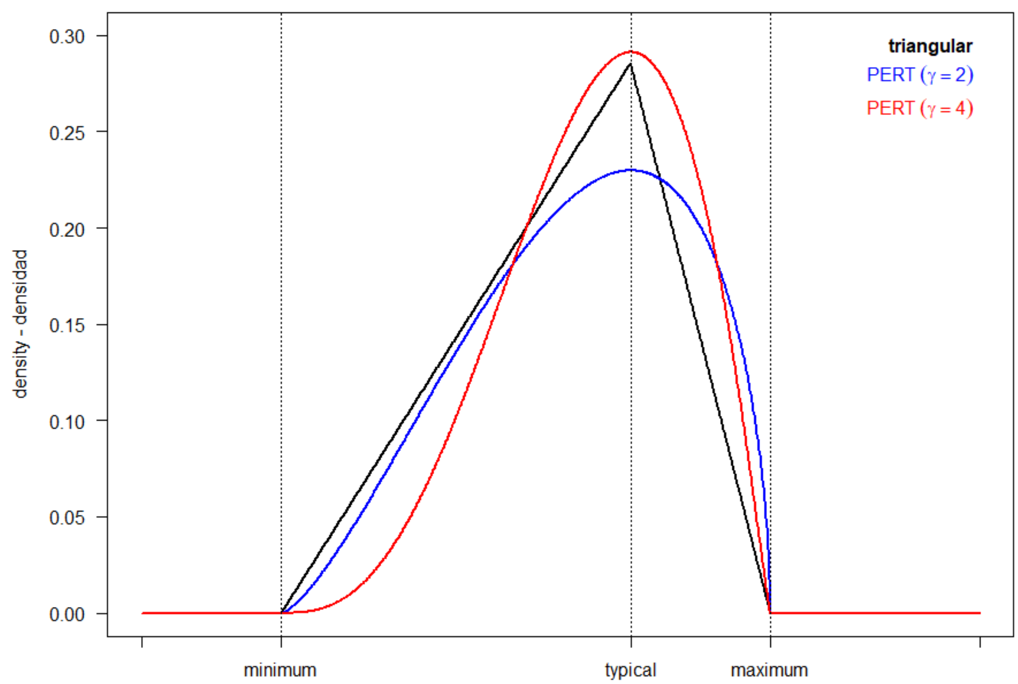



**FIGURE S1.1.** Examples of the distributions (triangular and PERT) used in the Monte Carlo simulations, for the same “three-point” estimates. See text for details.

The results of Steps (a)-(b) are three-point estimates of catch per trip (minimum, typical, and maximum) for each of the 52 weeks of the year. These were used to parameterize the weekly PERT distributions of Step (2) in the Monte Carlo simulation above.

The weekly landings at a site were estimated by multiplying the weekly catch per vessel by the number of vessels at that site, as reported by the fishers. The effective number of vessels used in this calculation was estimated from the proportion of vessels using a particular gear, assuming that adult sharks are targeted by vessels using only longlines, and that neonates and juveniles are targeted by vessels using only gillnets. In future studies, these assumptions should be tested with data collected by technicians from a port-sampling program.

To simulate a range of plausible yearly catches, a distribution of estimates of total yearly catch for each landing site was obtained by running the Monte Carlo simulation procedure 1,000 times per landing site. The mean, lower 5%, and upper 95% of values from those distributions were computed as a summary of the central tendency and range of the simulated catch estimates per landing site.

To take into account the landings from sites that were not sampled, a logistic regression model was fitted to predict the catch at those sites, by family and life-stage, using fishing gear, number of vessels, and whether the site is associated with a beach or mangrove as predictors. The total landings were raised to the number of vessels at the unsampled sites predicted using results of the logistic regression model. The estimated raising factors, by family and life-stage, are shown in Table S1.1.

**TABLE S1.1** Raising factor, by family and life-stage, to correct for unsampled landing sites

| Family | Neonates | Juveniles | Adults |
|---|---|---|---|
| Alopiidae (thresher sharks) | 1.000 | 1.252 | 1.373 |
| Carcharhinidae (requiem sharks) | 1.217 | 1.234 | 1.227 |
| Ginglymostomatidae (nurse sharks) | 1.228 | 2.186 | 1.243 |
| Lamnidae (mackerel sharks) | - | 1.000 | 3.255 |
| Sphyrnidae (hammerhead sharks) | 1.210 | 1.121 | 1.107 |
| Triakidae (hound sharks) | 1.282 | 1.227 | 1.312 |

To take into account processing of sharks before landing, a correction factor was used to raise the landed weight at each site to total weight. The estimated raising factors, by family and processing type, are shown in Table S1.2.

**TABLE S1.2** Raising factors, by family and life-stage, to correct for pre-landing processing of sharks, by cut type (1: trunk only; 2: dressed; 3: tail removed; 4: dressed and finned; 5: gutted). Calculated from Gordievskaya (1973).

| | Cut type | | | | |
|---|---|---|---|---|---|
| **Family** | **1** | **2** | **3*** | **4** | **5** |
| Alopiidae (thresher sharks) | - | - | - | - | - |
| Carcharhinidae (requiem sharks)** | 1.63 | 1.44 | - | 1.55 | 1.10 |
| Ginglymostomatidae (nurse sharks) | - | - | - | - | - |
| Lamnidae (mackerel sharks) | - | - | - | - | - |
| Sphyrnidae (hammerhead sharks) | 1.61 | 1.47 | - | 1.59 | 1.16 |
| Triakidae (hound sharks) | 1.64 | 1.54 | - | 1.65 | 1.15 |

*No data available, so no correction applied. **Also used for sharks with no family-specific raising factors

**Supplement 2.** Seasonality of the order-of-magnitude estimates of catch, by species/family and life-stage**.**

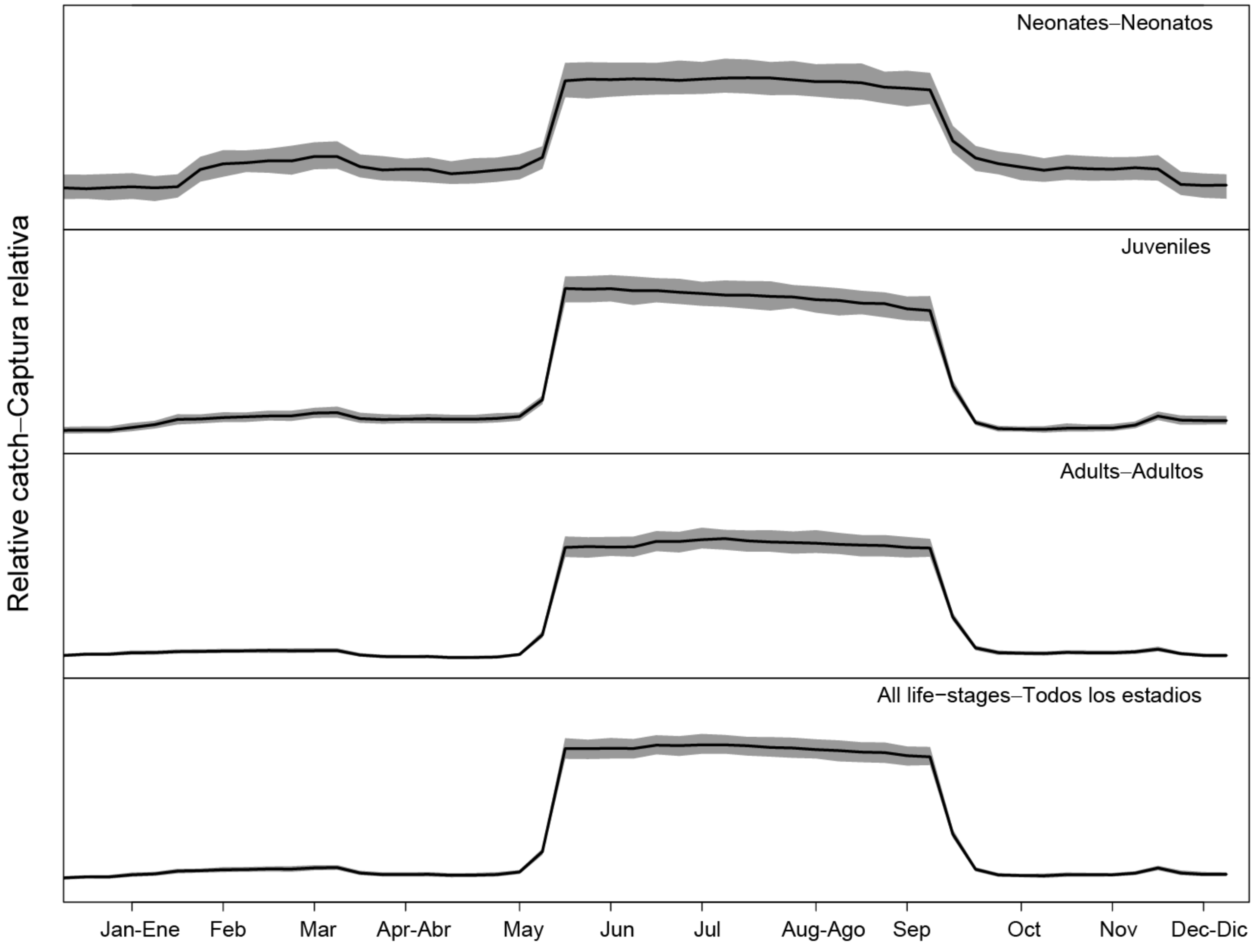



**FIGURE S2.1.** Seasonality of the landings of silky sharks, by life stage (neonate, juvenile, adult) and total. The solid lines represent the mean of the relative simulated values, and the grey bands the range from the lower 5% to the upper 95%.

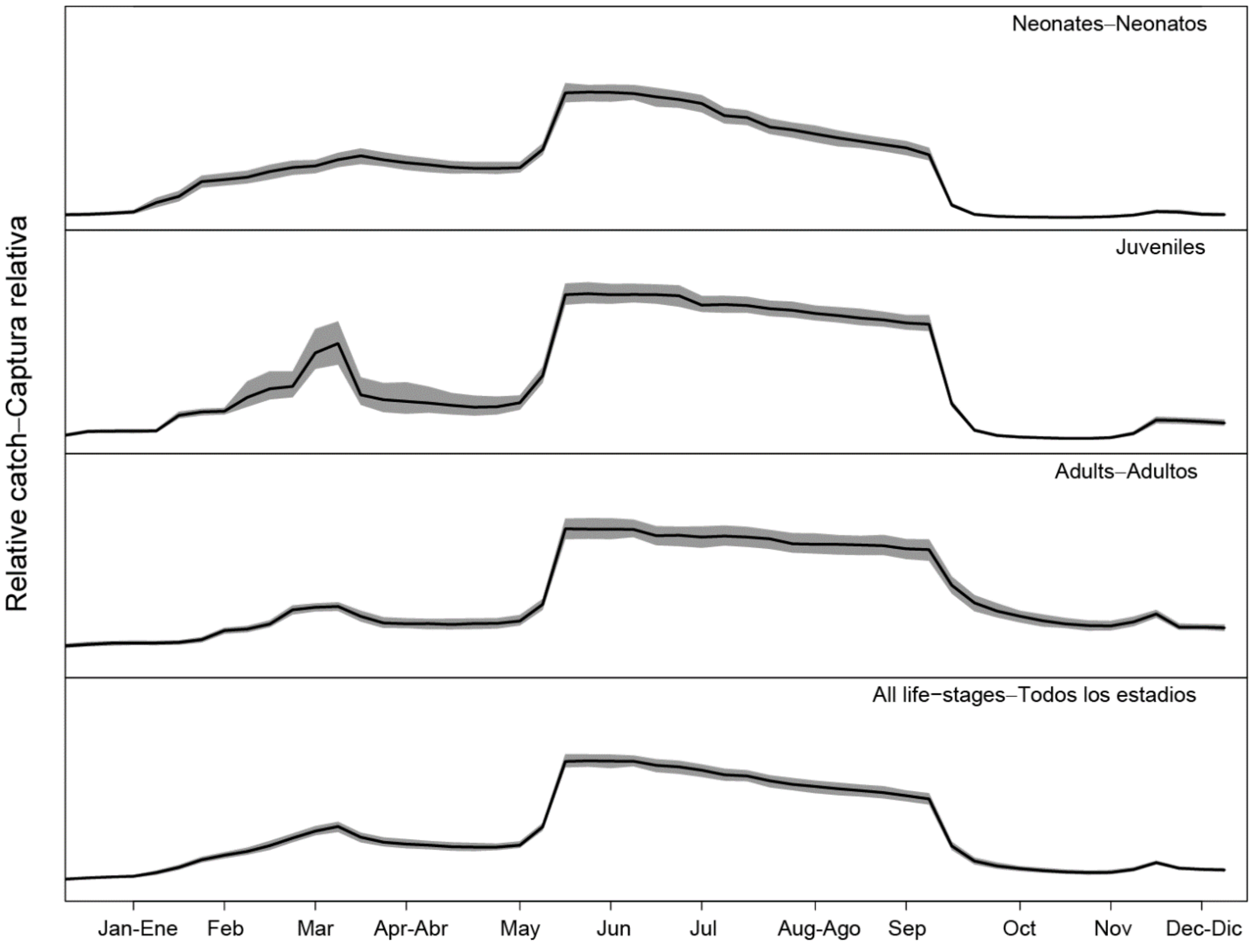



**FIGURE S2.2.** Seasonality of landings of hammerhead sharks (mainly *Sphyrna lewini*), by life stage (neonate, juvenile, adult) and total. The solid lines represent the mean of the relative simulated values, and the grey bands the range from the lower 5% to the upper 95%.

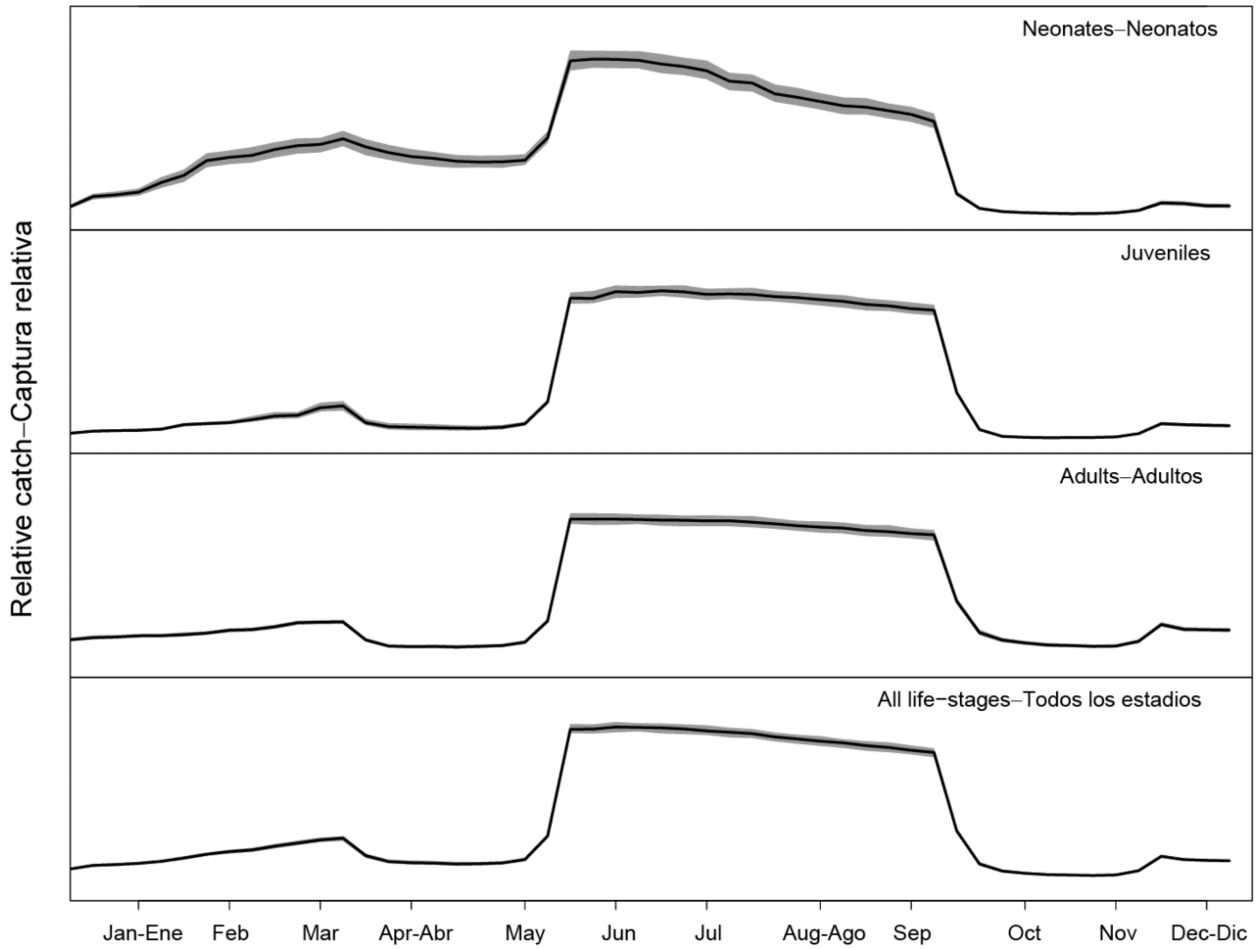



**FIGURE S2.3.** Seasonality of landings, all shark species, by life stage (neonate, juvenile, adult) and total. The solid lines represent the mean of the relative simulated values, and the grey bands the range from the lower 5% to the upper 95%.

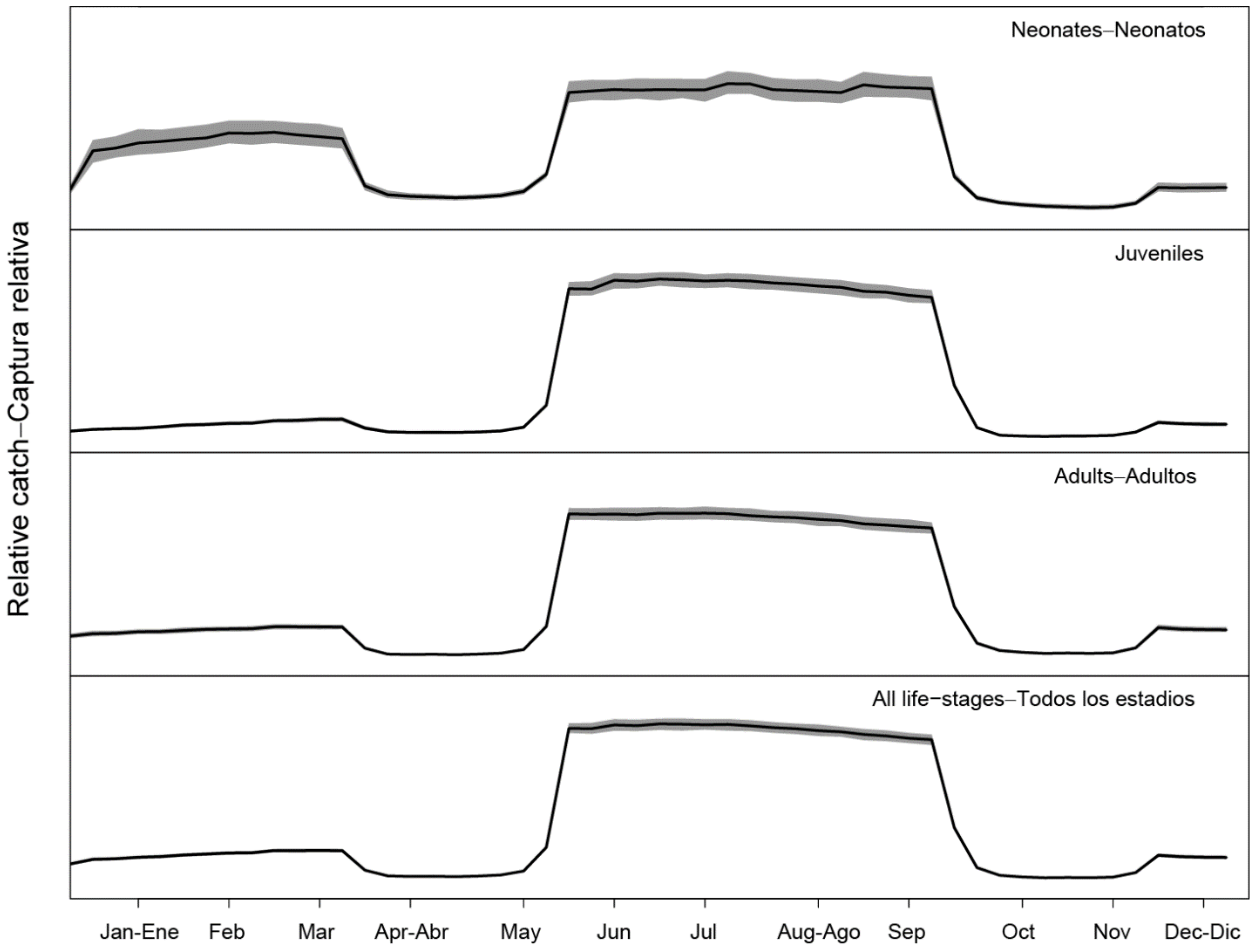



**FIGURE S2.4.** Seasonality of landings, all sharks except hammerheads, by life stage (neonate, juvenile, adult) and total. The solid lines represent the mean of the relative simulated values, and the grey bands the range from the lower 5% to the upper 95%.

**Supplement 3.** Procedure for evaluating sampling designs for landing sites of the PNG fleet

Using the weekly catch-per-trip parameters from Supplement 1, a Monte Carlo simulation was used to simulate landings from each landing site. For each week of the year, the Monte Carlo simulation involves implementing the following steps:

**Step 1. Simulate the number of trips per week per vessel:** Draw a random number ($n_{trips}$) of trips per week per vessel from an appropriate distribution (*e.g.*, a PERT, g=2), for the corresponding season (dry or rainy) and environmental conditions (good or bad).
**Step 2. Simulate $n_{trips}$ catches:** Take $n_{trips}$ random draws from an appropriate distribution of catch per trip (*e.g.*, PERT, g=4; Figure 7), for every species, life stage and week of the year.
**Step 3. Repeat steps 1 and 2 for every vessel:** Repeat steps 1 and 2 for the number of vessels reported for the site.

This simulation produces a set of catch-per-trip values for every vessel for one week. Iterating the process for every week of a year produces a complete simulated record of the catches landed in all the region during one year. After that, given *N* sampling technicians working *d* days per month and *D* fishing localities, we selected randomly and with replacement *Nd* fishing localities, where the probability of choosing fishing locality $D_i$ is $P(D_i) = p\frac{1}{D} + (1-p)C_i$, where $C_i$ is the relative catch by fishing locality (among all fishing localities; Figure S3.1) and *p* a constant. When *p*=1, the localities are chosen uniformly, and when *p*=0 the localities are chosen following a multinomial distribution relative to the catch. For a preliminary approach, we fixed N=15 and used *p* and *d* as parameters of the sampling designs. In the future, variability in $C_i$ also will be considered in the equation for $P(D_i)$.

For every candidate sampling design (*i.e*., a specific combination of *p* and *d*), we estimate the total catch of the region using the methods described in Supplement 1, but using the information from each random sampling instead of the fisher interviews conducted during sub-task 1.3. For every species, the squared error between the estimates from the sampling and the simulated 'real' value of the total catch are calculated as a measure of performance to select the best sampling design.

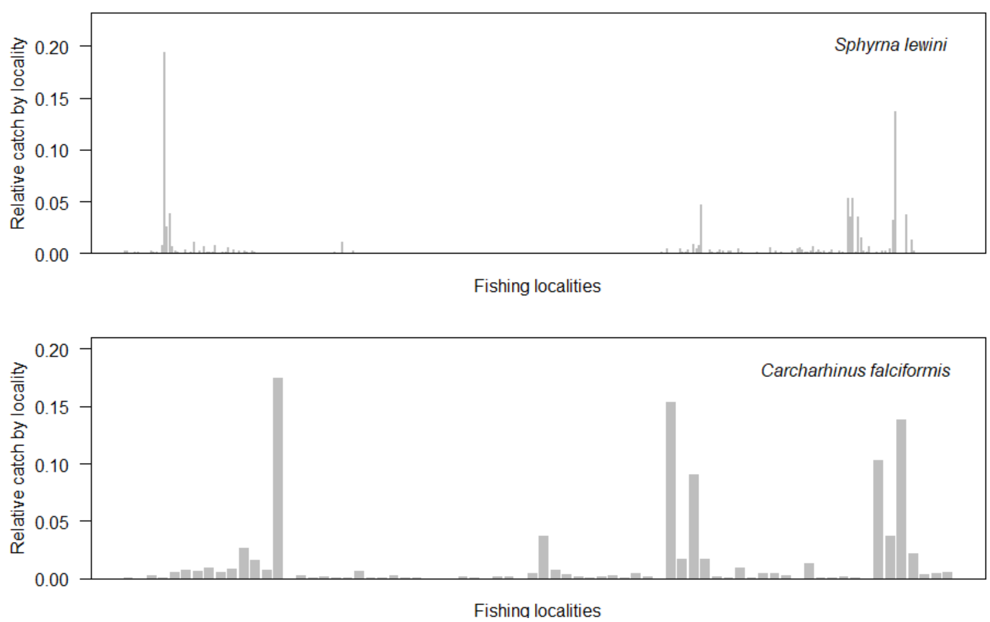



**FIGURE S3.1.** Relative catch, by fishing locality, used to parameterize the sampling designs for total catch of sharks in Central America. Only localities with non-zero landings of scalloped hammerhead (*Sphyrna lewini*, top) and silky (*Carcharhinus falciformis*, bottom) sharks are shown.

**Supplement 4.** Simulator of the one-by-one unloading process

**Data**

"Super-sampling" refers to the collection of a very large sample from a population, as close as possible to the whole population, with the aim of creating a data set that can be used in analysis to generate sub-samples that would normally be considered representative of the population. In the context of the unloading of catch from a vessel, during unloading, the position of each fish in the unloading sequence is recorded, along with other qualitative information (*e.g*., species, size, weight, sex, quality). Every fish in the super-sample is described as a vector of categorical values $X = (X_1, X_2, \ldots, X_k)$, where $k$ is the number of data categories collected. The unloading is described as a sequence of such vectors.

**Unloading groups**

A group of fish of predominantly the same type (species, quality, size, *etc*.) within each individual unloading is defined as an "unloading block". For practical reasons, unloading blocks can include a small amount of fish with different characteristics. To estimate the unloading blocks in each super-sample, the *n*-running proportion for each type of fish in the unloading is calculated, and the dominant (>50%) type identified for each group of *n* consecutive fishes. An unloading block is then computed as the union of contiguous groups with the same dominant type. Small blocks (less than *n* fish unloaded) separating two blocks of the same dominant type are absorbed to generate uninterrupted unloading blocks. Since the length of an unloading block is expected to change as a function of the total length of the unloading (*i.e.* the longer the unloading, the longer the unloading blocks), the value *n* to compute the running proportions should be taken as a small fraction (*e.g.* 3%) of the total number of fish unloaded (*N*).

**Algorithm**

The approach to simulate the unloading is carried out using the following three steps (see also the example below):

1. Determine the unloading group of the fish as a function of the total number of fish unloaded (*N*) and unloading group of the previously unloaded fish;
2. Determine species of the fish as a function of the unloading group determined in (1) and the species of the previously unloaded fish[14];
3. Determine the weight category of the fish as a function of the species determined in (2) and the weight category of the previously unloaded fish.

The algorithm can be generalised as described below, with some cases requiring fixing components to the appropriate values (*e.g*. step 3 does not depend on the unloading group).

**Model for unloading data**

Given a sequence $\{X(n)\}_{n=1}^{N}$ describing the unloading of $N$ fishes, the probability of $X(n) = (X_1(n), \ldots, X_k(n))$ taking the value $x = (x_1, x_2, \ldots, x_k)$ is described by the following equations:

$$P(X_1(n) = x_1) = f_1(x_1; X_1(n-1), N) \quad (1)$$

$$P\big(X_j(n) = x_j\big) = f_j(x_j; X_j(n-1), X_{j-1}(n), \ldots, X_2(n), X_1(n)); \text{ for } j=2, \ldots, k \quad (2)$$

From equations 1 and 2, we can deduce that each component of *X* satisfies the Markov property, and thus can be modelled as a Markov chain. In particular, equation 1 shows that the first component of *X* also depends on the length of the unloading process *N*. Also, equation 2 introduces a hierarchy between the components of *X*, making each component dependent on the current state of the previous components.

[14] The first fish in an unloading group is taken from an initial distribution for that unloading group

**Parameter estimation**

We can rewrite equation 1 as $P(X_1(n) = b \mid X_1(n-1) = a) = f_1(a; b, N) = g_{a,b}(N)$, so the probability of transition from state *a* to *b* is function of *N* only. So, for any pair (*a*,*b*) of categories for the first component $X_1$, the matrix $G(N) = [g_{a,b}(N)]$ is the transition matrix for $X_1$, and depends on the length of the unloading (*N*) only, measured in number of fishes. "Persistence" is defined as the expected proportion $p_i$ of fish of class *i* on a given unloading of duration *N*, and a "jump" as a transition (*i*,*j*) where *i*≠*j*. *G*(*N*) is parameterized as:

$$G(N) = P(N) + [1 - P(N)]\, J,$$

where *N* is the number of fishes, *P* is the "persistence matrix" modelling the length of the unloading of a particular unloading block, and *J* is the "jump matrix" for the transition between contiguous blocks of the same type of fish. *P* is a diagonal matrix with components $P_{ii} = 1 - \frac{1}{p_i N}$, with $p_i$ being the persistence of state *i*, assuming each contiguous block occurs at most once per unloading. This first component is designed to model the unloading blocks observed during an unloading which are the leading category structuring the unloading process. Using this, the unloading blocks can be parameterized with the observed persistence $p_i$ and the transition matrix for the jumps between unloading blocks *J*. The former makes it possible to improve the parametrization by including information on the proportion of individuals landed in each block from other sources of data like landing records, even if detailed information on the order of the unloading is not included.

Similarly, equation 1 can be rewritten as

$$P\big(X_j(n) = b \mid X_j(n-1) = a\big) = f_j\big(a; b, X_{j-1}, \dots, X_1\big) = s_{a,b}^{(j)}(X_1, \dots, X_{j-1}),$$

and $S_j\big(X_1, \dots, X_{j-1}\big) = \left[s_{a,b}^{(j)}(X_1, \dots, X_{j-1})\right]$ defined as the transition matrix for the component $X_j$. Since $S_j$ takes categorical values as input, the parameters can be estimated for any given valid combination of $(X_1, \dots, X_{j-1})$ using the maximum likelihood estimator based on transition counts.

**Example**

Let $X = (X_1, X_2, X_3)$ be a vector describing a fish, where $X_1$ is the unloading group it was landed in, $X_2$ is the species, and $X_3$ is the weight class of the fish. $X_1$ can take one of four values (dorado, billfishes, tunas, sharks); $X_2$ any of the 16 species recorded in the commercial landings; and $X_3$ one of three weight classes (small, medium, large). For simplicity, the distribution of weight classes can be assumed to be independent of the unloading group and $X_3 \sim S_3(X_2)$. Following this, a total of 21 transition matrices are estimated: one 4x4 matrix for the unloading blocks (G), four 16x16 matrices for the species distribution within the unloading blocks $S_2(X_1)$, and sixteen 3x3 matrices for the weight class distribution for each species landed $S_3(X_2)$. This model estimates a maximum of 1,184 parameters (1x4x4 + 4x16x16 + 16x3x3), of which many will be zero, since some transitions are never observed (*e.g.* some species never occur in an unloading block, some weight classes are never observed for some species).

**Supplement 5.** Super-sampling methods

**One-by-one super-sampling protocol**

Super-sampling of one-by-one unloading was conducted in two phases. The first phase focused on shark catch, and its purpose was to compare the order of unloading of the catch at the two possible sampling points (the deck of the vessel and the dock), determine whether it was possible to measure all sharks in the unloading, and evaluate the variability in the size composition of the shark catch. The purpose of the second phase was to expand the super-sampling to all taxa in the catch, guided by lessons learned in the first phase.

The super-sampling protocol for one-by-one unloading in the first phase involved the following three steps (Figure S5.1):

- **Step 1.** Record when each individual shark was unloaded from the vessel's wells (each shark was tagged with a unique identifier at the time it was unloaded from the well onto the deck);
- **Step 2.** Record when each individual shark was landed on the dock from the deck;
- **Step 3.** Measure the inter-dorsal length (LID) of each shark, keeping track of the tag number.

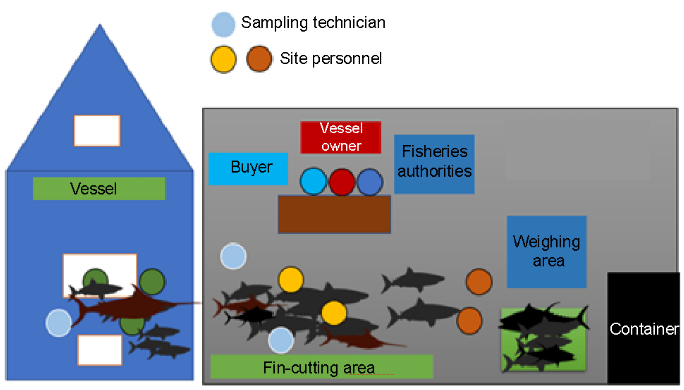



**FIGURE S5.1.** Schematic of super-sampling for 'one-by-one' unloading.

Little difference was found in the unloading order at the deck of the vessel compared to the dock. Additionally, during these experiments, it became clear that measuring every shark was a time-consuming process and delayed the unloading of the catch, causing the fishers to incur additional costs.

Following the lessons learned in the first phase, the sampling protocol was adapted for the second phase to minimize its impact on unloading operations, yet still generate information sufficient for developing of a simulator. Instead of measuring individual fish, the weight category of each fish was classified into a commercial weight category (small, medium, large; Table S5.1). Also, for safety reasons, the sampling technicians could not always be on the deck of the vessel to record the unloading order at that point (Step 1 of the first-phase protocol). Because little difference was observed between the order of unloading to the deck and landing on the dock in the first phase, the sampling protocol was therefore modified to record on the dock the unloading order (and weight category) of every fish landed.

**TABLE S5.1.** Weight categories, in kg, used in the super-sampling

| Taxon | Small | Medium | Large |
|---|---|---|---|
| Sharks | <25 | 25-32 | >32 |
| Dorado | <3 | 3-6 | >6 |
| Billfishes | <25 | 25-45 | >45 |
| Tunas | <20 | 20-30 | >30 |

Between April and July 2019, during the shark-fishing season in Central America, super-sample data for 90 NPG unloadings were collected using the new protocol. A sample of six of these super-samples is shown in Figure S5.2. Consistent with the results of the survey, these data illustrate that taxa are predominantly unloaded in blocks, although the order of the blocks differs among unloadings. The length of the taxon blocks, and the extent to which they repeat during the unloading, differ by sample (*e.g.*, the first super-sample of Figure S5.2). For sharks, there is perhaps an indication of sorting by size within species (*e.g.*, second super-sample of Figure S5.2).

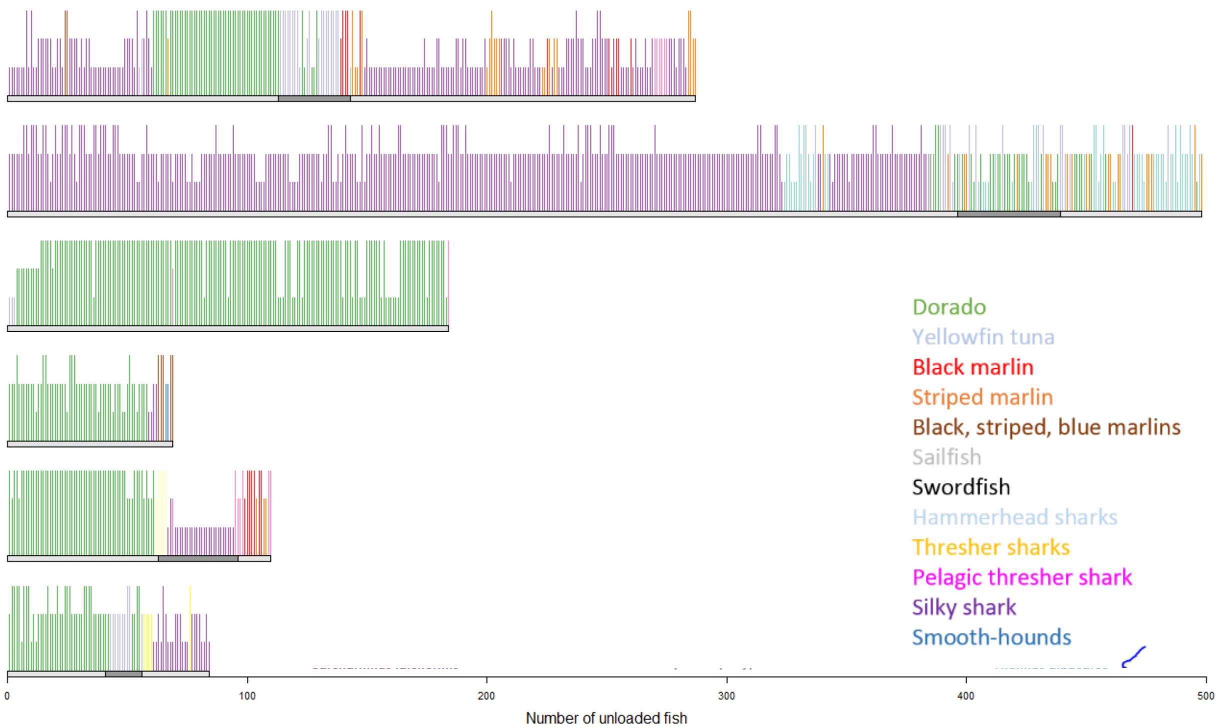



**FIGURE S5.2.** Species and size composition of six selected super-samples collected with the phase 2 protocol. Fish are shown according to the order in which they were unloaded from the vessel. Color indicates species, and the height of the bar indicates the weight class (see Table S5.1). The gray and black horizontal bar below each super-sample indicates the "unloading blocks" identified (see text).

To provide a quantitative summary of the observations noted above, an analysis was conducted to define "unloading blocks" for each super-sample; *i.e.*, groups of fish within each individual unloading that were predominantly of the same taxon. An unloading block was defined as the continuous unloading of a taxon, but in other applications, blocks could be based on other criteria (*e.g.*, quality or size of the product). Unloading blocks were allowed to contain small amounts of other taxa, for practical reasons. To estimate the unloading blocks in each super-sample, the proportion of each taxon in a running fraction of the unloading (3%) was calculated, and the dominant taxon (more than 50%) identified for each fraction. An unloading block was then defined as the sum of contiguous fractions with the same dominant taxon. Small blocks (less than 3% of total fish unloaded) dividing two blocks of the same dominant taxon were ignored, to generate uninterrupted unloading blocks of the same taxon. The dominant unloading blocks (by proportion of fish in the block) identified for each super-sample available are shown in Table S5.2. At the taxon level, the order of unloading blocks appears to be non-random.

| **TABLE S5.2.** Summary of super-samples (number of trips and number of fishes) collected, by vessel category and dominant unloading block | | | | |
|---|---|---|---|---|
| **Dominant unloading block** | **Medium-scale** | | **Advanced** | |
| | **Trips** | **Fishes** | **Trips** | **Fishes** |
| Billfishes | 22 | 2,872 | 10 | 2,371 |
| Dorado | 10 | 1,650 | 1 | 238 |
| Sharks | 29 | 7,319 | 10 | 7,344 |
| Tunas | 8 | 562 | 0 | 0 |

**Group super-sampling**

To conduct super-sampling of grouped unloadings, which occur mainly in Panama, it was necessary to revise the sampling protocol previously described. The main difficulties encountered with respect to the super-sampling of grouped unloadings were the safety of the sampling technicians (due to the quantity of catch being unloaded) and access to the catch for measuring. In the grouped unloadings, fish were grouped as they were removed from the vessel wells and unloaded as a group onto a platform on the dock that was next to a cargo container or truck, into which the catch was then immediately loaded (Figure 7). It was determined that it was unsafe for samplers to be on the deck of the vessel or near the unloading platform. A three-step sampling protocol (Figure S5.3) was therefore tested, in which photographs were taken of the unloading process, from which the lengths of the unloaded sharks could be estimated:

**Step 1.** Place reference marks on the unloading platform;
**Step 2.** Photograph fish on the platform, using remotely-activated wireless cameras;
**Step 3.** From the photographs, using specialized computer software and the numerical methods of Chang *et al.* 2009, identify species and estimate trunk length of unloaded fish.

Although the camera system performed well, it was clear from the imagery that species identification would be impossible because of the processing of the catch prior to unloading, the size of the groups unloaded, and the position of individuals in the cargo container/truck. Therefore, it was determined that the funds and time to develop methods for species identification of grouped unloadings was beyond the resources available, so this part of the project was suspended.

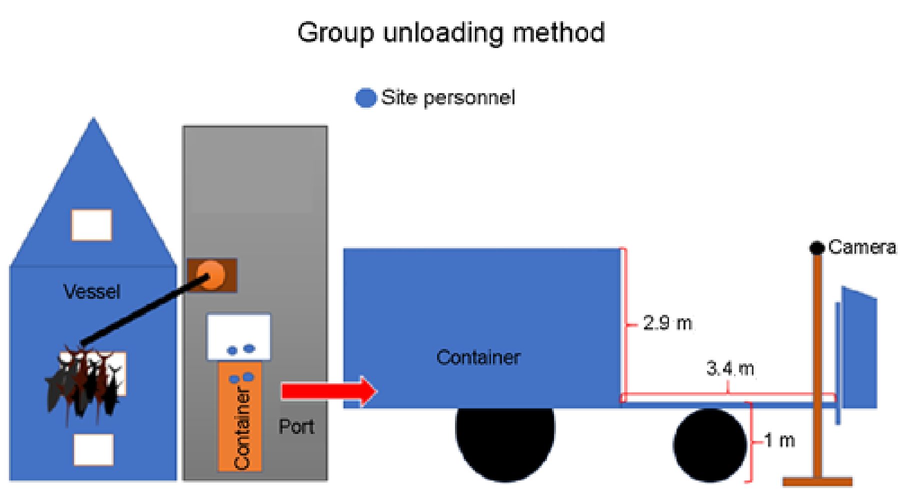



**FIGURE S5.3.** Schematic of super-sampling for 'group' unloading.

**Supplement 6.** Evaluation of sampling designs for length composition of the NPG catches.

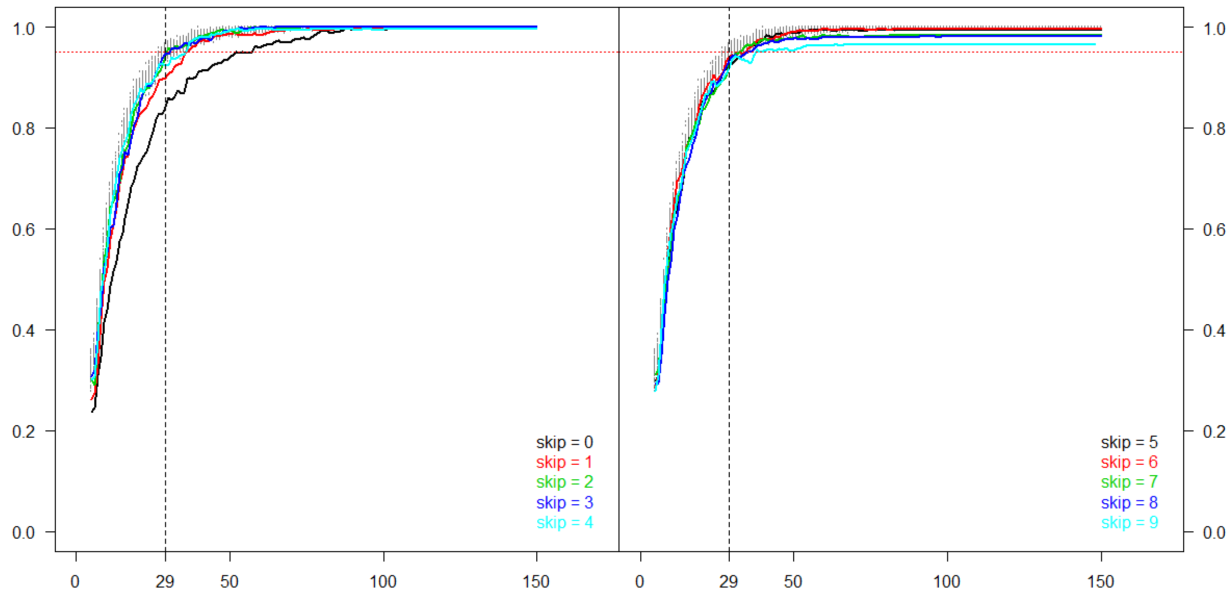



**FIGURE S6.1.** Proportion of 'good' samples for 'advanced' vessels. For every skipping pattern, the fraction sampled expressed as sample size is shown.

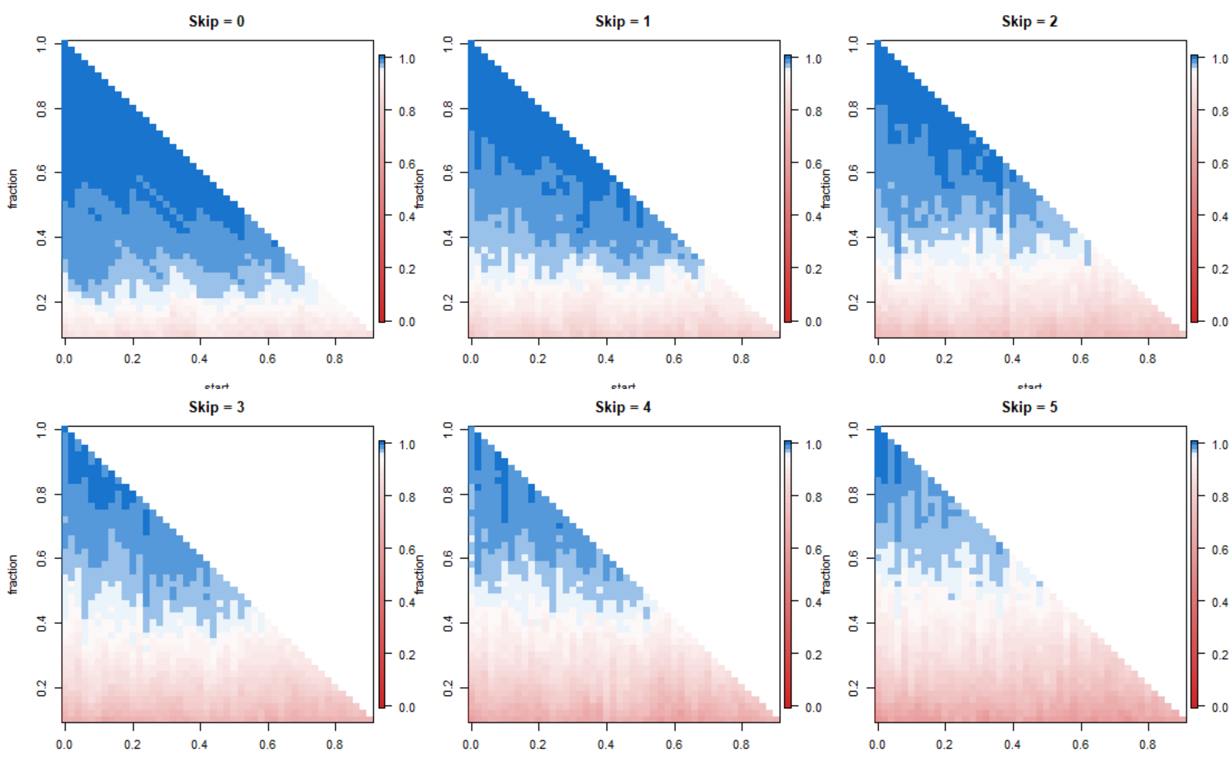



**FIGURE S6.2.** Proportion of 'good' samples for 'advanced' vessels, as a function of the start of sampling and the fraction sampled. The blue area shows the designs with a proportion greater than 95%, and the red area shows the designs with a proportion lower than 95% (see color scale for exact values).

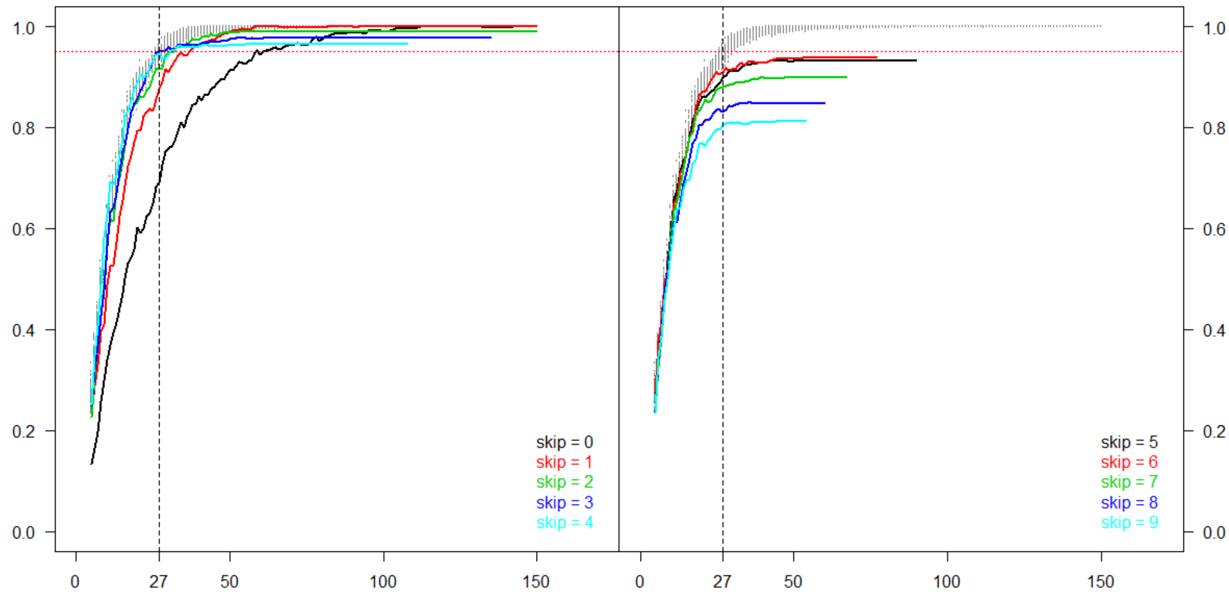



**FIGURE S6.3.** Proportion of 'good samples' for 'medium-scale' vessels. For every skipping pattern, the fraction sampled expressed as sample size is shown.

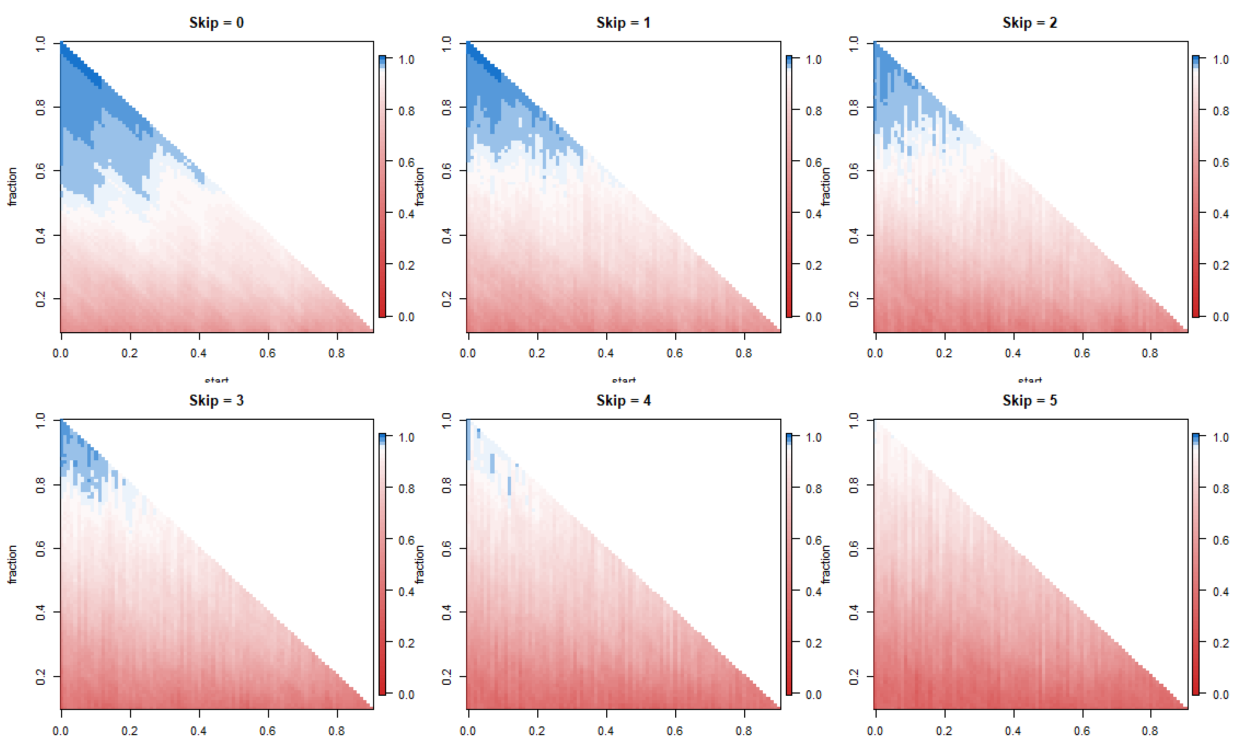



**FIGURE S6.4.** Proportion of 'good' samples for 'medium-scale' vessels, as a function of the start of sampling and the fraction sampled. The blue area shows the designs with a proportion greater than 95%, and the red area shows the designs with a proportion lower than 95% (see color scale for exact values).

**Appendix A.** Forms for landing site characterization.

## Formulario de conteo de Buques y caracterización de la Flota Panga que capturan directa o indirectamente especies de grandes pelágicos.

### Propósito

Recopilar datos que ayudarán a conocer la dimensión del esfuerzo pesquero en la que se encuentran las especies de grandes pelágicos por parte de la flota "Panga" de Centro América.

### El uso de esta forma

Esta forma debe completarse para las Buques identificados como pangas que realizan su faena de pesca frente a las costas del Océano Pacifico Oriental, independientemente al arte de pesca que utilizan.

Se debe completar un formulario por localidad pesquera en cada punto de acceso (por ejemplo, un muelle) donde ese grupo de Buques descarga su captura. Además de registrar las coordenadas geográficas (latitud/longitud) en formato grados decimales. Toda la información deberá mantener un orden cronológico.

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**Parte I: Datos Generales**

| Nombre del Muestreador | Fecha Inicio(dd/mm/aa) | Fecha Final(dd/mm/aa) |
|---|---|---|
| | | |
| **País** | **Departamento/Provincia** | **Localidad pesquera** |
| | | |

**Coordenadas de la Localidad pesquera[1]: Latitud: ____________________ Longitud____________________**

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**Parte II: Buques**

Tabla 1: Ingrese la información que se solicita a continuación

| Código localidad pesquera | Código Puntos descarga | Códigos Segmentos descarga | Número total buques (a2)[2] | | Número total buques (a1)[3] | | Número total buques Observados | | Número total de buques según pescadores | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PANGAS | NO PANGAS | PANGAS | NO PANGAS | PANGAS | NO PANGAS | PANGAS | NO PANGAS |
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[1] Ingresar el dato en grados decimales (DD), de la siguiente forma Latitud: 11.582332°; Longitud: -88.332332°

[2] Número de buques contabilizados usando la herramienta de Google Earth

[3] Número de buques según Autoridad de Pesca

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**Parte III: Esfuerzo** **País ID:________________ Departamento/ProvincialD:________________ Localidad ID:_________________**

**Tabla 3:** Datos de captura en las pesquerías directas e indirectas a especies de grandes pelágicos. Por favor describa la captura dirigida a tiburones y rayas (SKH), ATUNES, PICUDOS y DORADO durante los meses de captura. Utilice el código de la localidad pesquera proporcionados por la CIAT. Si es necesario utilice las hojas que sean necesarias para completar la información.

**2-** Datos sobre la Captura

| Código | Código | Meses donde se captura ATUN | | Promedio de captura de ATUN (kg) | | | | Meses donde se captura DORADO | | Promedio de captura de DORADO (kg) | | | | Meses donde se captura PICUDOS | | Promedio de captura de PICUDOS (kg) | | | | Meses donde se captura SKH | | Promedio de captura de SKH (kg) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Puntos descarga | Segmento descarga | Inicio | Final | LL[7] | GN | LHP | PS | Inicio | Final | LL | GN | LHP | PS | Inicio | Final | LL | GN | LHP | PS | Inicio | Final | LL | GN | LHP | PS |
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[7] Tipo de Arte de Pesca: Utilice los siguientes códigos GN: Red agallera; LL: Palangre; PS: Red de Cerco; LHP: línea de mano

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**Parte III: Esfuerzo** **PaísID:__________________ Departamento/ProvincialD:__________________ LocalidadID:___________________**

**Tabla 2**: Datos de esfuerzo de pesca de la flota de PANGAS. Por favor describa los diferentes tipos de buques por tipo de artes de pesca para la captura dirigida a especies de grandes pelágicos. Utilice el código de la localidad pesquera proporcionados por la CIAT. Si es necesario utilice las hojas que sean necesarias para completar la información.

**1-** Datos sobre Embarcación

| **Código Puntos descarga** | **Código Segmento descarga** | **Tipo de motor y caballaje[4]** | | **Rango Eslora (m)** | | **Buques activos** | | | | **Promedio Días de Pesca[5]** | | | | **Días de Descanso entre viajes[6]** | | | | **Número de pescadores por embarcación** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **min** | **max** | **min** | **max** | **LL** | **GN** | **LHP** | **PS** | **LL** | **GN** | **LHP** | **PS** | **LL** | **GN** | **LHP** | **PS** | **LL** | **GN** | **LHP** | **PS** |
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[4] Ingresara los principales motores utilizados en la faena de pesca de la siguiente forma: F: fuera de borda; I: interno; HP: caballos de fuerza
[5] Promedio de día de pesca semanal
[6] Días de descanso entre viaje semanal

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**Parte IV: Arte de Pesca** **País ID: _______________ Departamento/ProvincialD: _______________ LocalidadID: _______________**

**Tabla 4**: La información a colectar serán los datos mínimos y máximos sobre las dimensiones del arte de pesca, creando rangos promedio de la localidad a la que se está realizando la caracterización. Utilice el código de la localidad pesquera proporcionados por la CIAT. Datos sobre característica del arte de pesca: **Palangre**

| Código Puntos descarga | Código Segmento descarga | Promedio Numero de lances | Promedio Largo línea madre | Anzuelos | | | | | | Días efectivos de pesca | Carnada [%] | | | | | | | | | Principal Ubicación del arte de pesca (%) | | | Reinal inferior de acero (%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Cantidad | Tipo | | Tamaño | Anillo | | | Viva [ ] | | | Fresca [ ] | | | Congelada [ ] | | | | | | | |
| | | | | | J | C | | Si | No | | Sp 1 | Sp 2 | Sp 3 | Sp 1 | Sp 2 | Sp 3 | Sp 1 | Sp 2 | Sp 3 | Sup | Media | Fondo | Si | No |
| | | | | | | | | | | | | | | | | | | | | | | | | |
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| Especies Carnada[8] | Viva | Fresca | Congelada |
|---|---|---|---|
| Sp1 | | | |
| Sp2 | | | |
| Sp3 | | | |

[8] Códigos de Carnada
Calamar 178; Sardina:255; Tiburón:280; Atún:107; Peces en general:170; Raya: 269; Otro: 0

**Parte IV: Arte de Pesca** **País ID: _______________ Departamento/ProvinciaID: _______________ LocalidadID: _______________**

**Tabla 5**: La información a colectar serán los datos mínimos y máximos sobre las dimensiones del arte de pesca, creando rangos promedio de la localidad a la que se está realizando la caracterización. Utilice el código de la localidad pesquera proporcionados por la CIAT. Datos sobre característica del arte de pesca: **Línea de mano**

| Código Puntos descarga | Código Segmento descarga | Material de la línea | Promedio Largo línea principal [ ] | Anzuelos | | | | | | Principal Ubicación del arte de pesca (%) | | | Reinal inferior de acero (%) | | Carnada | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Cantidad | tipo | | Tamaño | Anillo | | | | | | | Viva [ ] | | | Fresca [ ] | | | Congelada [ ] | | |
| | | | | | J | C | | Si | No | Sup | Media | Fondo | Si | No | Sp 1 | Sp 2 | Sp 3 | Sp 1 | Sp 2 | Sp 3 | Sp 1 | Sp 2 | Sp 3 |
| | | | | | | | | | | | | | | | | | | | | | | | |
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| Especies Carnada[9] | Viva | Fresca | Congelada |
|---|---|---|---|
| Sp1 | | | |
| Sp2 | | | |
| Sp3 | | | |

[9] Códigos de Carnada: Calamar 178; Sardina:255; Tiburón:280; Atún:107; Peces en general:170; Raya: 269; Otro: 0

**Parte IV: Arte de Pesca** **País ID:** _______________ **Departamento/ProvincialD:** _______________ **LocalidadID:** _______________

**Tabla 6:** La información a colectar serán los datos mínimos y máximos sobre las dimensiones del arte de pesca, creando rangos promedio de la localidad a la que se está realizando la caracterización. Utilice el código de la localidad pesquera proporcionados por la CIAT. Datos sobre característica del arte de pesca: **Red Agallera/ Red de Cerco**

| Código Puntos descarga | Código Segmento descarga | Arte de pesca usado | | Promedio Numero de lances | Promedio Largo línea Principal | Alto del arte de pesca | Luz de malla [ ] | | | Principal Ubicación del arte de pesca (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | GN | PS | | | | Superior | Medio | Inferior | Superior | Media | Fondo |
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**Parte V: Pesca y descarga**

**País ID: ______ Departamento/ProvincialD: _____ LocalidadID: _______**

Tabla 7: De acuerdo con el orden ingresado del Centro de Acopio/muelle de la Tabla 1 en la Parte II de Buques, ingrese las tres principales especies capturadas y el correspondiente arte de pesca utilizado para su captura, así como también la información de cómo se descargan.

| Código Puntos de descarga | Código Segmentos descarga | Época seca | | Época lluvia | | Como se descarga el producto | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Principal especie capturada[10] | Tipo de arte de pesca[11] | Principal especie capturada | Tipo de arte de pesca | Entero | Procesado | | | |
| | | | | | | | Sin cabeza | Sin Vísceras | Corte parcial aletas | Sin aletas |
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[10] Usar el Código FAO que se encuentra en el Manual de Campo

[11] Tipo de Arte de Pesca: Utilice los siguientes códigos GN: Red agallera; LL: Palangre; PS: Red de Cerco; LHP: línea de mano

## Esfuerzo y captura de grandes pelágicos para la flota de "Pangas" de Centroamérica.

**Propósito:** Obtener información sobre la captura y esfuerzo de la flota de "pangas" dirigida hacia tiburones y otras especies durante las temporadas de pesca 2018.

**Parte I: Datos Generales**

| Nombre/código del muestreador | Fecha de inicio (dd/mm/aa) | Fecha Final (dd/mm/aa) |
|---|---|---|
| | | |

Localidad pesqueraID: ____________ Sitio de DescargaID: ______________
Número de busques observados: Pangas: _________ No-pangas __________

**Control:** **General: _________** **Capturas: __________**

**Parte II: Información sobre el pescador**

Años de experiencia: ____________ Edad:_______ Teléfono/Contacto[1]:
Posición en la embarcación: [ ] Tripulante [ ] Capitán Embarcación: ___________________
Trabajos previos a ser pescador: [ ] Operario de muelle [ ] Filetero [ ] Agricultura [ ] Ganadería [ ] Otros
Es residente del punto de descarga [ ] Sí [ ] No, de dónde proviene:__________________________
Ha realizado actividades relacionadas a la pesca en otra localidad: [ ] No [ ] Sí, dónde:_________________________

**Parte III: Información sobre la flota y personal**

1. ¿Cuántos buques DESCARGAN en esta área? (NA: si no sabe)

| **Número total buques** | Actualmente | Hace un año | Hace 5 años | Hace 10 años |
|---|---|---|---|---|
| Pangas | | | | |
| No-pangas | | | | |

| **Información Personal** | **Mínimo** | **Máximo** | **Típico** |
|---|---|---|---|
| ¿Cuántos tripulantes suele tener una embarcación? | | | |
| ¿Cuántos operarios de muelle trabajan aquí? | | | |
| ¿Cuántos fileteros trabajan aquí? | | | |
| ¿Cuántos compradores trabajan aquí? | | | |

| | **Temporada seca 2018** | **Temporada húmeda 2018** |
|---|---|---|
| **¿Con cuántos compradores distintos trabajó usted?** | | |

**Parte IV: Captura y Esfuerzo de especies de grandes pelágicos**

Durante las dos temporadas, qué define las malas condiciones para la pesca:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **TEMPORADA SECA** | Viento | | Marea | | Tormenta | | Otros | |
| **TEMPORADA HÚMEDA** | Viento | | Marea | | Tormenta | | Otros | |

2. ¿Cuántos viajes realiza a la semana durante buenas condiciones y malas condiciones? Y ¿Cuánto tiempo (horas) dura la faena de pesca?

| **Ambiente** | **TEMPORADA SECA** | | | | | | **TEMPORADA HÚMEDA** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Número de viajes por semana** | | | **Duración de los viajes [horas]** | | | **Número de viajes por semana** | | | **Duración de los viajes [horas]** | | |
| | **MIN** | **MAX** | **Típico** | **MIN** | **MAX** | **Típico** | **MIN** | **MAX** | **Típico** | **MIN** | **MAX** | **Típico** |
| **Buenas condiciones** | | | | | | | | | | | | |
| **Malas condiciones** | | | | | | | | | | | | |

[1] Registrará el número y nombre del encuestado hasta el final del desarrollo de la encuesta y si solo si el pescador ha sido colaborador en las respuestas.

**Appendix B.** Form for catch and effort surveys

## Esfuerzo y captura de grandes pelágicos para la flota de "Pangas" de Centroamérica.

**Propósito:** Obtener información sobre la captura y esfuerzo de la flota de "pangas" dirigida hacia tiburones y otras especies durante las temporadas de pesca 2018.

**Parte I: Datos Generales**

| Nombre/código del muestreador | Fecha de inicio (dd/mm/aa) | Fecha Final (dd/mm/aa) |
|---|---|---|
| | | |

Localidad pesqueraID: _____________ Sitio de DescargaID: _______________
Número de busques observados: Pangas: __________ No-pangas ___________

**Control:** **General:** __________ **Capturas:** ___________

**Parte II: Información sobre el pescador**

Años de experiencia: _____________ Edad:________ Teléfono/Contacto[1]:
Posición en la embarcación: [ ] Tripulante [ ] Capitán Embarcación: ____________________
Trabajos previos a ser pescador: [ ] Operario de muelle [ ] Filetero [ ] Agricultura [ ] Ganadería [ ] Otros
Es residente del punto de descarga [ ] Sí [ ] No, de dónde proviene:____________________________
Ha realizado actividades relacionadas a la pesca en otra localidad: [ ] No [ ] Sí, dónde:__________________________

**Parte III: Información sobre la flota y personal**

1. ¿Cuántos buques DESCARGAN en esta área? (NA: si no sabe)

| Número total buques | Actualmente | Hace un año | Hace 5 años | Hace 10 años |
|---|---|---|---|---|
| Pangas | | | | |
| No-pangas | | | | |

| Información Personal | Mínimo | Máximo | Típico |
|---|---|---|---|
| ¿Cuántos tripulantes suele tener una embarcación? | | | |
| ¿Cuántos operarios de muelle trabajan aquí? | | | |
| ¿Cuántos fileteros trabajan aquí? | | | |
| ¿Cuántos compradores trabajan aquí? | | | |

| | Temporada seca 2018 | Temporada húmeda 2018 |
|---|---|---|
| **¿Con cuántos compradores distintos trabajó usted?** | | |

**Parte IV: Captura y Esfuerzo de especies de grandes pelágicos**

Durante las dos temporadas, qué define las malas condiciones para la pesca:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **TEMPORADA SECA** | Viento | | Marea | | Tormenta | | Otros | |
| **TEMPORADA HÚMEDA** | Viento | | Marea | | Tormenta | | Otros | |

2. ¿Cuántos viajes realiza a la semana durante buenas condiciones y malas condiciones? Y ¿Cuánto tiempo (horas) dura la faena de pesca?

| Ambiente | TEMPORADA SECA | | | | | | TEMPORADA HÚMEDA | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Número de viajes por semana | | | Duración de los viajes [horas] | | | Número de viajes por semana | | | Duración de los viajes [horas] | | |
| | MIN | MAX | Típico | MIN | MAX | Típico | MIN | MAX | Típico | MIN | MAX | Típico |
| **Buenas condiciones** | | | | | | | | | | | | |
| **Malas condiciones** | | | | | | | | | | | | |

[1] Registrará el número y nombre del encuestado hasta el final del desarrollo de la encuesta y si solo si el pescador ha sido colaborador en las respuestas.

De las siguientes especies o grupo de especies no-tiburón, responda las preguntas que se encuentran en cada columna:

| ESPECIE | ¿Captura la especie? | ¿Qué mes [inicia] y [finaliza] la pesca de [especie] durante EL AÑO? | | | NOMBRE COMUN COMO SE CONOCE EN EL SITIO DE DESCARGA | Tipo de corte de la descarga |
|---|---|---|---|---|---|---|
| | | inicio | final | mayor captura | | |
| **PEQUEÑOS PELÁGICOS** | | | | | | |
| **PECES DEMERSALES** | | | | | | |
| **INVERTEBRADOS** | | | | | | |
| **ATUNES (TUN)** | | | | | | |
| SKJ – Barrilete | | | | | | |
| YFT - Aleta Amarilla | | | | | | |
| BET – Patudo | | | | | | |
| BKJ - Barrilete negro | | | | | | |
| **PICUDOS (PINI)** | | | | | | |
| SWO - Pez espada | | | | | | |
| SFA - Pez Vela | | | | | | |
| MLS - Marlín rayado | | | | | | |
| BUM - Marlín azul | | | | | | |
| **DORADO (DOL) -** Dorado | | | | | | |
| **RAYAS (RANI)** | | | | | | |
| **RMB -** Manta gigante | | | | | | |
| **RMJ -** Manta diablo/Móbula | | | | | | |
| **MNT -** Manta no identificada | | | | | | |
| Especie 1 | | | | | | |
| Especie 2 | | | | | | |
| Especie 3 | | | | | | |
| **RANI** | | | | | | |

Control: General: __________ Capturas: ____________

7. ¿Cuántos kilogramos (máximo, mínimo y típico) por viaje registro de las siguientes especies tiburón durante los meses de TEMPORADA SECA 2018? Colecte información de los estadios de madurez de los tiburones que fueron capturados en la TEMPORADA SECA 2018:

| ESPECIE | | ¿Objetivo (1) o incidental (2)? | ¿Cuántos kilogramos [ ] / libras [ ] capturaron de [especie] según arte de pesca por viaje durante LA TEMPORADA SECA 2018? | | | | | | | | | | | | ¿Cuál es la distancia de la costa en la que captura esa especie durante la TEMPORADA SECA 2018? Mn [ ] Km[ ] | | | ¿Cuál es la profundidad donde lanza el arte de pesca para la especie durante la TEMPORADA SECA 2018? Bz [ ] m[ ] | | ¿Cómo fue la temporada? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Minimo | | | | Máximo | | | | Típico | | | | Distancia de la costa | | | Profundidad | | |
| | | | LL | GN | LHP | PS | LL | GN | LHP | PS | LL | GN | LHP | PS | Minimo | Máximo | Típico | Minimo | Máximo | |
| | Neonatos | | | | | | | | | | | | | | | | | | | |
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| | Juveniles | | | | | | | | | | | | | | | | | | | |
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| | Adultos | | | | | | | | | | | | | | | | | | | |
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Control: General: _________ Capturas: ___________

5. ¿Cuántos kilogramos (máximo, mínimo y típico) por viaje registro de las siguientes especies no-tiburón durante los meses de TEMPORADA SECA 2018?

| | ¿Objetivo (1) o incidental (2)? | ¿Cuántos kilogramos [ ] / libras [ ] capturaron de [especie] según arte de pesca por viaje durante la TEMPORADA SECA 2018? | | | | | | | | | | | | ¿Cuál es la distancia de la costa en la que captura esa especie durante la temporada SECA 2018? Mn [ ] Km[ ] | | | ¿Cuál es la profundidad donde lanza el arte de pesca para la especie durante la temporada SECA 2018? Bz[ ] m[ ] | | ¿Cómo fue la temporada? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mínimo | | | | Máximo | | | | Típico | | | | | | | | | |
| **ESPECIE** | | **LL** | **GN** | **LHP** | **PS** | **LL** | **GN** | **LHP** | **PS** | **LL** | **GN** | **LHP** | **PS** | **Mínimo** | **Máximo** | **Típico** | **Mínimo** | **Máximo** | |
| Atún TUN | | | | | | | | | | | | | | | | | | | |
| SKJ | | | | | | | | | | | | | | | | | | | |
| YFT | | | | | | | | | | | | | | | | | | | |
| BET | | | | | | | | | | | | | | | | | | | |
| BKJ | | | | | | | | | | | | | | | | | | | |
| Picudos PINI | | | | | | | | | | | | | | | | | | | |
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| SFA | | | | | | | | | | | | | | | | | | | |
| MLS | | | | | | | | | | | | | | | | | | | |
| BUM | | | | | | | | | | | | | | | | | | | |
| Dorado | | | | | | | | | | | | | | | | | | | |
| DOL | | | | | | | | | | | | | | | | | | | |
| Rayas | | | | | | | | | | | | | | | | | | | |
| **RMB** | | | | | | | | | | | | | | | | | | | |
| **RMJ** | | | | | | | | | | | | | | | | | | | |
| **MNT** | | | | | | | | | | | | | | | | | | | |
| **Especie 1** | | | | | | | | | | | | | | | | | | | |
| **Especie 2** | | | | | | | | | | | | | | | | | | | |
| **Especie 3** | | | | | | | | | | | | | | | | | | | |
| **RANI** | | | | | | | | | | | | | | | | | | | |

**Control:** **General:** __________ **Capturas:** ____________

8. ¿Cuántos kilogramos (máximo, mínimo y típico) por viaje registro de las siguientes especies tiburón durante los meses de la TEMPORADA HÚMEDA 2018? Colecte información de los estadios de madurez de los tiburones que fueron capturados en la TEMPORADA HÚMEDA 2018:

| ESPECIE | | ¿Objetivo (1) o incidental (2)? | ¿Cuántos kilogramos [ ] / libras [ ] capturaron de [especie] según arte de pesca por viaje durante LA TEMPORADA HÚMEDA 2018? | | | | | | | | | | | | ¿Cuál es la distancia de la costa en la que captura esa especie durante la TEMPORADA HÚMEDA 2018? Mn [ ] Km[ ] | | | ¿Cuál es la profundidad donde lanza el arte de pesca para la especie durante la TEMPORADA HÚMEDA 2018? Bz [ ] m[ ] | | ¿Cómo fue la temporada? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Minimo | | | | Máximo | | | | Típico | | | | Distancia de la costa | | | Profundidad | | |
| | | | LL | GN | LHP | PS | LL | GN | LHP | PS | LL | GN | LHP | PS | Minimo | Máximo | Típico | Minimo | Máximo | |
| | Neonatos | | | | | | | | | | | | | | | | | | | |
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| | Adultos | | | | | | | | | | | | | | | | | | | |
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Control: General: __________ Capturas: ___________

6. ¿Cuántos kilogramos (máximo, mínimo y típico) por viaje registro de las siguientes especies no-tiburón durante los meses de TEMPORADA HÚMEDA 2018?

| ESPECIE | ¿Objetivo (1) o incidental (2)? | ¿Cuántos kilogramos [ ] / libras [ ] capturaron de [especie] según arte de pesca por viaje durante la TEMPORADA HÚMEDA 2018? | | | | | | | | | | | | ¿Cuál es la distancia de la costa en la que captura esa especie durante la temporada HÚMEDA 2018? Mn [ ] Km[ ] | | | ¿Cuál es la profundidad donde lanza el arte de pesca para la especie durante la temporada HÚMEDA 2018? Bz[ ] m[ ] | | ¿Cómo fue la temporada? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mínimo | | | | Máximo | | | | Típico | | | | | | | | | |
| | | LL | GN | LHP | PS | LL | GN | LHP | PS | LL | GN | LHP | PS | Minimo | Máximo | Típico | Minimo | Máximo | |
| Atún TUN | | | | | | | | | | | | | | | | | | | |
| SKJ | | | | | | | | | | | | | | | | | | | |
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| BKJ | | | | | | | | | | | | | | | | | | | |
| Picudos PINI | | | | | | | | | | | | | | | | | | | |
| SWO | | | | | | | | | | | | | | | | | | | |
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| BUM | | | | | | | | | | | | | | | | | | | |
| Dorado | | | | | | | | | | | | | | | | | | | |
| DOL | | | | | | | | | | | | | | | | | | | |
| Rayas | | | | | | | | | | | | | | | | | | | |
| **RMB** | | | | | | | | | | | | | | | | | | | |
| **RMJ** | | | | | | | | | | | | | | | | | | | |
| **MNT** | | | | | | | | | | | | | | | | | | | |
| **Especie 1** | | | | | | | | | | | | | | | | | | | |
| **Especie 2** | | | | | | | | | | | | | | | | | | | |
| **Especie 3** | | | | | | | | | | | | | | | | | | | |
| **RANI** | | | | | | | | | | | | | | | | | | | |

**Control:** **General: __________** **Capturas: ____________**

De las siguientes especies o grupo de especies tiburón, responda las preguntas que se encuentran en cada columna:

| ESPECIE | | | ¿Captura la especie? | ¿Qué mes [inicia] y [finaliza] la pesca de [especie] durante EL AÑO? | | | NOMBRE COMUN COMO SE CONOCE EN EL SITIO DE DESCARGA | Tipo de corte de la descarga |
|---|---|---|---|---|---|---|---|---|
| **¿Qué especies de TIBURONES captura?** | | | Si /No | **inicio** | **final** | **mayor captura** | | |
| | **FAL** | **Neonatos** | | | | | | |
| | **SPL** | | | | | | | |
| | **SPZ** | | | | | | | |
| | **SPN** | | | | | | | |
| | **CNX** | | | | | | | |
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| | **FAL** | **Juveniles** | | | | | | |
| | **SPL** | | | | | | | |
| | **SPZ** | | | | | | | |
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| | **CNX** | | | | | | | |
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| | **FAL** | **Adultos** | | | | | | |
| | **SPL** | | | | | | | |
| | **SPZ** | | | | | | | |
| | **SPN** | | | | | | | |
| | **PTH** | | | | | | | |
| | **ALV** | | | | | | | |
| | **BTH** | | | | | | | |
| | **THR** | | | | | | | |
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| | **FAL** | **Hembras grávidas** | | | | | | |
| | **SPL** | | | | | | | |
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Control: General: __________ Capturas: ____________

**Appendix C.** Forms for surveying unloading and processing practices of NPG vessels.

# Cuestionario sobre los detalles de la almacenamiento y procesamiento de capturas de embarcaciones palangreras industriales

**Propósito**: recopilar datos que ayudarán a planificar ensayos de muestreo de composición por tamaño.

**El uso de esta forma**

Esta forma debe completarse para los buques palangreros de mediana y avanzada escala.

Se debe completar un formulario por separado para cada buque en cada punto de acceso (por ejemplo, un muelle) donde ese buque descarga su captura. Por ejemplo, si un barco en particular descarga su captura en tres puntos de acceso diferentes, entonces se necesitarían completar tres formularios para ese barco, uno para cada punto de acceso donde el buque descarga.

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**Parte I: Datos Generales**

**Nombre del colector de datos: ________________________Fecha (dd/mm/aa): ____/____/____**

**Comunidad pesquera: ____________________Centro de Acopio o muelle __________________________**

**Nombre del buque: ___________________________ Matricula: _____________ Eslora (metros): _________**

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**Parte II: Almacenamiento y Procesamiento**

1) ¿Cómo se guardan las especies en las bodegas durante el viaje de pesca? Con una “X” marque todo lo que aplique.

| **Categoría** | Marque “X” |
|---|---|
| Aleatoriamente en las bodegas conforme van siendo capturados | |
| Clasificadas por especies | |
| Según la talla (tamaño) | |
| De acuerdo con la calidad del producto (Primera, Segunda, para exportación, entre otras) | |
| Precio del producto en el mercado | |
| Otro (explique) | |

Otro:____________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

2) De la siguiente lista de principales especies de grandes pelágicos reportadas para Centroamérica, marque con una "X" aquella especie que al momento de estibarlo a bodega se realiza algún corte especial, si la especies no aparece buscarla en la lista completa de especies de grandes pelágicos que aparece en el manual.

**Tiburones:**

| CodigoFAO | Especie | Tipo de corte de limpieza del producto previo a estibarlo a bodega: | | | | Sin ningún corte |
|---|---|---|---|---|---|---|
| | | Sin cabeza | corte parcial de aletas | sin vísceras | sin panza | |
| FAL | Tiburón gris/ sedoso/ blanco / silky | | | | | |
| CNX | Tiburón punta zapato/ whitenose | | | | | |
| BSH | Tiburón azul/ blue shark | | | | | |
| THR | Tiburón Zorro pelágico, threasher | | | | | |
| MAK | Tiburón mako, nep | | | | | |
| SPN | Tiburón cornuda/ charruda negra | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

**Picudos y dorados:**

| CodigoFAO | Especie | Tipo de corte de limpieza del producto previo a estibarlo a bodega: | | | | Sin ningún corte |
|---|---|---|---|---|---|---|
| | | Sin cabeza | corte de aletas | sin vísceras | sin panza | |
| MRNI | Marlín no identificado | | | | | |
| SWO | Pez espada | | | | | |
| SSP | Marlín Blanco/trompa corta | | | | | |
| MLS | Marlín rayado/rosado | | | | | |
| SFA | Pez vela | | | | | |
| BUM | Marlín azul/aguja azul | | | | | |
| DOL | Dorado | | | | | |
| | | | | | | |
| | | | | | | |

Atunes:

| CodigoFAO | Especie | Tipo de corte de limpieza del producto previo a estibarlo a bodega: | | | | Sin ningún corte |
|---|---|---|---|---|---|---|
| | | **Sin cabeza** | **corte de aletas** | **sin vísceras** | **sin panza** | |
| SKJ | Barrilete /Skipjack | | | | | |
| ALB | Atún blanco/Albacora | | | | | |
| YFT | Aleta amarilla/Yellowfin | | | | | |
| BET | Patudo, ojo grande/Bigeye | | | | | |
| TUN | Atún no identificado | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

3) Cómo se encuentra el producto antes de la descarga y a la hora de pesarlo en este punto de acceso (por ejemplo, Entero/ cortado [sin cabeza, sin aletas, sin vísceras])? Con una "X" marque todo lo que aplique.

| | **Antes de la descarga** | | | | | **Durante la pesada** | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Categoría** | Tiburón | Picudos | Dorados | Atunes | | Tiburón | Picudos | Dorados | Atunes |
| Entero | | | | | | | | | |
| Sin cabeza | | | | | | | | | |
| Sin aletas | | | | | | | | | |
| Sin Vísceras | | | | | | | | | |
| Sin cola | | | | | | | | | |
| Otro (explique) | | | | | | | | | |

Otro:________________________________________________

**Parte III: La Descarga**

1) ¿En qué estado se descargan el producto en el muelle/puerto de desembarque? Con una "X" marque todo lo que aplique.

| Especie/condición | Congelado | Fresco | Salmuera | Otro (explique) |
|---|---|---|---|---|
| Tiburones | | | | |
| Picudos | | | | |
| Dorados | | | | |
| Atunes | | | | |

Otro:________________________________________________

2) Existen diferentes clasificaciones de la descarga de tiburones de acuerdo con la Talla/Peso y Calidad del producto: Si: ______; No: _______, si su respuesta es afirmativa por favor llenar el cuadro de la pregunta 3 con la principal especie descargada, si su respuesta es negativa dejar vacío el espacio del nombre científico de la especie.

3) Para clasificar la descarga, que rango de tallas/peso utilizaría y a que calidad del producto corresponden los siguientes términos:

a) Tiburones: ( nombre científico )

| Categoría | Rango | Unidad longitud[1] | Rango | Unidad peso[2] | Calidad (1°/2°/3°)[3] |
|---|---|---|---|---|---|
| Pequeño | | | | | |
| Mediano | | | | | |
| Grande | | | | | |

b) Picudos

| Categoría | Rango | Unidad longitud | Rango | Unidad peso | Calidad (1°/2°/3°) |
|---|---|---|---|---|---|
| Pequeño | | | | | |
| Mediano | | | | | |
| Grande | | | | | |

c) Dorados

| Categoría | Rango | Unidad longitud | Rango | Unidad peso | Calidad (1°/2°/3°) |
|---|---|---|---|---|---|
| Pequeño | | | | | |
| Mediano | | | | | |
| Grande | | | | | |

d) Atunes

| Categoría | Rango | Unidad longitud | Rango | Unidad peso | Calidad (1°/2°/3°) |
|---|---|---|---|---|---|
| Pequeño | | | | | |
| Mediano | | | | | |
| Grande | | | | | |

[1] En centímetros (cm) o en metros (m)
[2] En Libras (lb) o en Kilogramos (kg)
[3] 1°: Primera Calidad; 2°: Segunda Calidad; 3°: Tercera Calidad

4) ¿Cómo se descargan el producto de este barco al muelle? Con una "X" marque todo lo que aplique.

a) Tiburones

| Categoría | Uno a la vez | En grupo |
|---|---|---|
| Por especie | | |
| Por precio | | |
| Por Tamaño (Peso/Longitud) | | |
| Por calidad del producto | | |
| Por especie y precio | | |
| Por especie y tamaño (Peso/Longitud) | | |
| Por especie y calidad de producto | | |
| Por precio y tamaño (Peso/Longitud) | | |
| Por precio y calidad de producto | | |
| Por tamaño (Peso/Longitud) y calidad de producto | | |
| Aleatoriamente sin importar la bodega | | |
| Según la forma de acomodo en las bodegas | | |
| Otro (explique) | | |

Otro:______________________________________________________________________________

b) Picudos

| Categoría | Uno a la vez | En grupo |
|---|---|---|
| Por especie | | |
| Por precio | | |
| Por Tamaño (Peso/Longitud) | | |
| Por calidad del producto | | |
| Por especie y precio | | |
| Por especie y tamaño (Peso/Longitud) | | |
| Por especie y calidad de producto | | |
| Por precio y tamaño (Peso/Longitud) | | |
| Por precio y calidad de producto | | |
| Por tamaño (Peso/Longitud) y calidad de producto | | |
| Aleatoriamente sin importar la bodega | | |
| Según la forma de acomodo en las bodegas | | |
| Otro (explique) | | |

Otro:______________________________________________________________________________

c) Dorados

| Categoría | Uno a la vez | En grupo |
|---|---|---|
| Por especie | | |
| Por precio | | |
| Por Tamaño (Peso/Longitud) | | |
| Por calidad del producto | | |
| Por especie y precio | | |
| Por especie y tamaño (Peso/Longitud) | | |
| Por especie y calidad de producto | | |
| Por precio y tamaño (Peso/Longitud) | | |
| Por precio y calidad de producto | | |
| Por tamaño (Peso/Longitud) y calidad de producto | | |
| Aleatoriamente sin importar la bodega | | |
| Según la forma de acomodo en las bodegas | | |
| Otro (explique) | | |

Otro:______________________________________________________________________________

_________________________________________________________________________________

_________________________________________________________________________________

d) Atunes

| Categoría | Uno a la vez | En grupo |
|---|---|---|
| Por especie | | |
| Por precio | | |
| Por Tamaño (Peso/Longitud) | | |
| Por calidad del producto | | |
| Por especie y precio | | |
| Por especie y tamaño (Peso/Longitud) | | |
| Por especie y calidad de producto | | |
| Por precio y tamaño (Peso/Longitud) | | |
| Por precio y calidad de producto | | |
| Por tamaño (Peso/Longitud) y calidad de producto | | |
| Aleatoriamente sin importar la bodega | | |
| Según la forma de acomodo en las bodegas | | |
| Otro (explique) | | |

Otro:______________________________________________________________________________

_________________________________________________________________________________

_________________________________________________________________________________

5) Una vez descargado el producto ¿Cómo van pesando los individuos? Con una "X" marque todo lo que aplique.

a) Tiburones

| **Categorías** | Marca "X" todo lo que aplique | | | | |
|---|---|---|---|---|---|
| | | | | | |
| **Uno a la vez** | | | | | |
| | | | | | |
| **En grupo** | **Especie** | **Peso** | **Longitud** | **Calidad del producto** | **Precio** |
| **Especie** | | | | | |
| **Peso** | | | | | |
| **Longitud** | | | | | |
| **Calidad del producto** | | | | | |
| **Precio** | | | | | |

b) Picudos

| **Categorías** | Marca "X" todo lo que aplique | | | | |
|---|---|---|---|---|---|
| | | | | | |
| **Uno a la vez** | | | | | |
| | | | | | |
| **En grupo** | **Especie** | **Peso** | **Longitud** | **Calidad del producto** | **Precio** |
| **Especie** | | | | | |
| **Peso** | | | | | |
| **Longitud** | | | | | |
| **Calidad del producto** | | | | | |
| **Precio** | | | | | |

c) Dorado

| **Categorías** | Marca "X" todo lo que aplique | | | | |
|---|---|---|---|---|---|
| | | | | | |
| **Uno a la vez** | | | | | |
| | | | | | |
| **En grupo** | **Especie** | **Peso** | **Longitud** | **Calidad del producto** | **Precio** |
| **Especie** | | | | | |
| **Peso** | | | | | |
| **Longitud** | | | | | |
| **Calidad del producto** | | | | | |
| **Precio** | | | | | |

d) Atunes

| **Categorías** | Marca "X" todo lo que aplique | | | | |
|---|---|---|---|---|---|
| | | | | | |
| **Uno a la vez** | | | | | |
| | | | | | |
| **En grupo** | **Especie** | **Peso** | **Longitud** | **Calidad del producto** | **Precio** |
| **Especie** | | | | | |
| **Peso** | | | | | |
| **Longitud** | | | | | |
| **Calidad del producto** | | | | | |
| **Precio** | | | | | |

6) Una vez que se descargan el producto de las bodegas, ya sea individualmente o en grupos, ¿cuánto tiempo (minutos) permanecen en el área del muelle donde podrían ser accesibles para ser medidos y pesados? ¿O, es mejor medir y pesar después de pesar el producto?

**a) Tiburones**

| Categoría | Antes de pesar el producto congelado (minutos) | Antes de pesar el producto Fresco/ enhielado (minutos) | Después de pesar el producto congelado (minutos) | Después de pesar el producto Fresco/enhielado (minutos) |
|---|---|---|---|---|
| Individualmente | | | | |
| Grupos | | | | |

**b) Picudos**

| Categoría | Antes de pesar el producto congelado (minutos) | Antes de pesar el producto Fresco/ enhielado (minutos) | Después de pesar el producto congelado (minutos) | Después de pesar el producto Fresco/enhielado (minutos) |
|---|---|---|---|---|
| Individualmentebb | | | | |
| Grupos | | | | |

**c) Dorados**

| Categoría | Antes de pesar el producto congelado (minutos) | Antes de pesar el producto Fresco/ enhielado (minutos) | Después de pesar el producto congelado (minutos) | Después de pesar el producto Fresco/enhielado (minutos) |
|---|---|---|---|---|
| Individualmente | | | | |
| Grupos | | | | |

**d) Atunes**

| Categoría | Antes de pesar el producto congelado (minutos) | Antes de pesar el producto Fresco/ enhielado (minutos) | Después de pesar el producto congelado (minutos) | Después de pesar el producto Fresco/enhielado (minutos) |
|---|---|---|---|---|
| Individualmente | | | | |
| Grupos | | | | |