Developing the Sardine Management Plan for Fisheries Management Area 7

Wilfredo L. Campos[1], Alexanra Bagarinao-Regalado[1], Antonino Mendoza[2], Plutomeo Nieves[2], Jesus T. Racuyal[3], Kim Nuñez[1], Roan Jay A. Lovendino[2], Joshua Karl B. Bista[2], Francisco L. Pasucal[3] and Regie B. Jabon[3]

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01. Introduction

Small pelagic fisheries make up over half of total marine capture fisheries production in the Philippines. Of this, sardines make up the bulk, comprising one out of every six kg of fish caught in Philippine seas. From 2016 -2020, annual total sardine production in the country averaged about 348,300 metric tons (mt), down from over 450,000 mt in 2009 (Philippine Statistics Authority Fisheries Statistics). The decrease over the past decade indicates reduced productivity of local stocks, making sound management plans urgent.

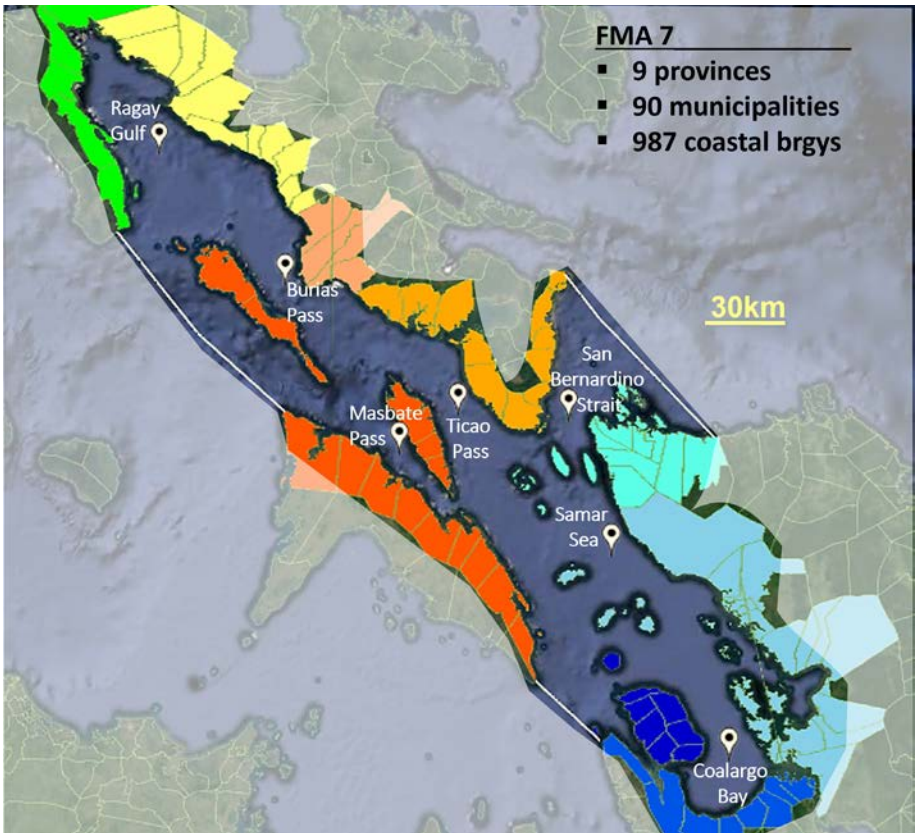


Figure 1. Map of Fisheries Management Area 7 (FMA 7).

Region	Province	Municipality	Coastal Barangays
Region IV A	Quezon	6	66
Region V	Camarines Sur	11	49
	Albay	4	23
	Sorsogon	11	147
	Masbate	15	181
Region VIII	Northern Samar	9	89
	Samar	18	237
	Leyte	8	100
	Biliran	8	95
Total		**90**	**987**

Fisheries Management Area (FMA) 7 includes waters extending from Ragay Gulf in the north to Ticao and Burias Passes/San Bernardino Strait, and Samar Sea in the south (Fig. 1), which make up one of the major sardine fishing grounds in the country where catches are dominated by the Bali sardine, *Sardinella lemuru*, similar to the sardine fishery off the Zamboanga Peninsula. Based on fisher registration records of 2014, fisher densities along the coasts range from 25-77 individuals per km of coastline (CNFIDP, 2022), which translates to "heavily" to "very heavily fished" waters (Tandog-Edralin, 1987). In addition, a compilation of assessments of sardine stocks from different fishing grounds in the country from 1965-2014, including Ragay Gulf, show that on average, fishing mortality rates exceeded sustainable levels by 28% (CNFIDP, 2022).

Overview of fishing operations in FMA 7

Marine capture fisheries in FMA 7 are dominated by small pelagic resources, with sardines as the principal target. Because of the narrowness of the Burias Pass, water flow entering San Bernardino Strait from the Pacific results in strong currents north and south of the strait. This is the reason why drift gill nets (DGN) are the principal gear type used to fish sardines from the Burias Pass to the mouth of Samar Sea. DGN operations vary in size and capacity, with most of the larger (referred to as small commercial vessels >3-20 GT in size) vessels based in Bulan, Sorsogon, where the main fishing port of the region is located. Catches landed north or south of this main port are accumulated first before transporting (by land or boat) to Bulan, Sorsogon, although some amounts are retained on-site for local processing.

Most municipal (<3 GT) vessels are, at best, loosely organized around buyers of their catches, who also commonly provide the funds needed for their day-to-day fishing operations. Fishers are hence compelled to "sell" their catches to these buyers to settle the advanced funds, subject to prices determined by the buyer. Such arrangements are time-honored and verbal, without need for formal documentation. Similar arrangements are also made with the small commercial operations. Details of this typical arrangement, together with results of the market and value chain study, are provided in the report of the parallel study by Bradecina et al. (2021). Under this typical scheme, fishers land as much as they can catch, with the buyer reducing the dockside prices as the supply (landings) fills up the demand. The drop in prices is most pronounced during peak months as fishers aim to maximize catches to compensate for reduced prices. Prices hit bottom when there is a supply glut, which leads to large amounts of spoiled and wasted catches. There is little, if any, coordination between buyers/middlemen and fishers, or even between fishers or fishing operators themselves.

Philippine laws prohibit medium to large commercial vessels (> 20 GT) from fishing in waters less than 15 km from the shore, known as municipal waters. In some cases, negotiations with local government units (LGUs), with certain conditions, may allow them to fish from 10.1 to 15 km from the shore. Use of active gear types, such as trawls and seines, is generally prohibited. Fine meshed nets (< 3 cm) are also prohibited, except for use on specific (target) resources. Enforcement is typically done at the municipal level, often with support from the provincial government, but is focused on compliance with laws and ordinances. There is no reporting of catches or effort unless special projects are implemented. These general conditions apply to FMA 7 as well.

Available fisheries data

Production statistics and assessment of stocks for management are tasked to different government agencies but there is little coordination between them. The Bureau of Agricultural Statistics (BAS) was previously mandated to record fisheries production statistics until the Philippine Statistics Authority (PSA) took over this mandate. The PSA reports production (landings) by province and administrative region for major commodities, but little else that is useful in assessing stocks. In 5 of the 9 provinces in FMA 7, production statistics do not distinguish between

catches from the Pacific Coast and internal waters, making them of limited use for management purposes. Since the late 1990s, the BFAR implemented the National Stock Assessment Program (NSAP), which was designed to collect biological information relevant to management and to comprehensively cover landings at the major landing sites in selected fishing grounds around the country, but not to extrapolate total landings for the fishing ground. Initially, fishing effort data were not routinely collected, but now they are included in the program. Hence the NSAP can only provide estimates of total monitored landings. While the fishing port authority in Bulan may have records of sardines "landed" (including those transported by land) in Bulan, it is uncertain what portion of the total catch from the FMA is included, since not all catches landed outside of Bulan are transported there.

In relation to fishers, there are only a handful of medium to large commercial vessels that illegally fish within FMA 7, and while they are supposedly required to submit catch and effort information from their logbooks to renew their licenses each year, no such information has been made available by BFAR. The rest of the fishers, including small commercial fishing operations, are not required to submit any information on their catches and effort. Hence, there are no estimates of total annual landings reported by fishing ground, unless other independent efforts or studies had been or are being conducted by other institutions.

Recent studies on sardines in FMA 7

Recent studies in the area provide information on the sardine fishery (Tajonera, 2016) as well as reproductive biology of the stock (Campos et al., 2017). However, both studies were done independently of each other, and neither covered a complete year, with study periods contiguous from September 2015 to December 2016. The combined results of these studies suggest extensive movement of the stock after peak spawning (November-December), resulting in limited availability of the stock in the fishing ground and indicate that a large (> 50%) portion of the catch is smaller than the size at first maturity, which is indicative of overfishing. In spite of these findings, there was not enough processed information to characterize seasonal productivity and its relation to the fishery, spawning and recruitment, nor to determine the distribution of fishing effort or to estimate annual sardine production, and how all these varies between years. Hence, this study aimed to address these gaps.

Objectives

The overall goal of the study was to provide inputs to the holistic management of sardine resources in FMA 7 in terms of fisheries biology and to strengthen local partner universities in terms of serving their advisory role in the FMA as members of the Science Advisory Group (SAG). The study was designed to complement existing efforts of the BFAR-NSAP in the FMA to fill in major gaps in information necessary for sound fisheries management. The specific objectives were to:

1) design and implement a fisheries catch and effort monitoring scheme to provide a systematic estimate of annual sardine production in FMA 7;
2) examine trends in fisheries catch and effort, as well as biological characteristics of the catch and to determine how these relate to the seasonal and geographical distribution of the stock and primary productivity;
3) document interannual variability in the fishery and how this relates to variability in the biology of the stocks; and
4) recommend and/or validate proposed Reference Points and Harvest Control Rules and Measures for the effective conservation and management of sardine stocks in FMA 7.

02. Materials and Methods

2.1 Standardization Workshop

A training workshop was held at the beginning of the study to set the procedures and standardize the methods for data and sample collection, laboratory processing of specimens, as well as initial data processing and summaries. The workshop was held at Bicol University Tabaco Campus, Tabaco City, Albay from January 28 – 31, 2020 (Figure 2). The list of participants in the workshop can be found in Table A.1 (Annex 1), while photo- documentation of the training is shown in Figure A.1 (*Annex 1*).

Figure 2. FMA 7 Sardines project team: front left to right Kim Nuñez, Alexanra Bagarinao-Regalado; Standing left to right Regie Jabon, Francisco Pasucal, Michael Borejon, Jasper Nieves, Antonino Mendoza, Plutomeo Nieves, Wilfredo Campos, Jose Mari Delos Santos, Jesus Racuyal and Nielmar Condat.

The program of activities is shown in Table 1 below. These included discussions of what is known about the sardines in the area and the reasons to study sardine fisheries biology and their value/market chain. The next portion introduced the protocols for fisheries catch and effort monitoring and recording, vessel tracking and exercises on recording and summarizing this information. The next session was on field sampling and laboratory processing of samples. These included sardine species identification, dissection, macro-staging of gonads, and specimen preservation, packing and transport. The last sessions covered how to build a profile of fisheries and how this information is summarized and used to arrive at a rough approximation of annual catch. The last day of the training consisted of actual fisheries profiling focus group discussions (FGDs) in Pio Duran, Albay and Donsol, Sorsogon. The latter provided adequate exposure for our partners to continue the profiling in the remaining municipalities targeted for profiling.

Table 1. Program of activities of the standardization workshop

Date	Activities	Resource Person
28 January 2020	**Introduction**	
	• Sardine biology & fisheries in FMA 7	Dr. Wilfredo L. Campos
	• Sardine value chain in FMA 7	Dr. Raul Bradecina
	Fisheries monitoring protocols	Alexanra Bagarinao-Regalado and Kim P. Nuñez
	• Catch and effort monitoring	
	• Vessel tracking monitoring	
29 January 2020	• Catch and effort monitoring exercise	
	Field collection and laboratory analysis of specimens	Alexanra Bagarinao-Regalado and Kim P. Nuñez
	• Sardine species identification	
	• Macro-staging of gonads	
	• Species identification, dissection & gonad staging exercise	
30 January 2020	**Fisheries profiling**	Alexanra Bagarinao-Regalado and Kim P. Nuñez
	• Overview of fisheries operations	
	• Constructing of fisheries profile	
	• Preparations for FGD activity	
31 January 2020	**Actual fisheries profiling (FGDs)**	All
	• Pio Duran, Albay (AM)	
	• Donsol, Sorsogon (PM)	

2.2 Fisheries Profiling

Fisheries profiles were constructed from information gathered through focus group discussions (FGDs) in representative municipalities in FMA 7 to address information gaps necessary for providing estimates of total annual sardine catch in the area. These gaps included estimates of catch rates, the fisher population (e.g., number of fishers and vessels by gear type), frequency of fishing (fishing days per year), locations of fishing operations and seasonality in catches.

A series of FGDs targeting fishers and barangay (village) leaders were conducted in representative municipalities in the FMA (Fig. 3) to gather the following information: (a) types of fishing gear and or vessels, (b) number of units of each gear type, (c) typical catch rates (kg/trip), (d) composition of catches, (e) seasonality in catch rates and effort, (f) number of fishers per operation and number of hours per trip, (g) number of fishing days each month and months per year, and (h) typical locations of fishing operations by gear type. This information was then

summarized in the form of a catch matrix, a table indicating seasonality in fishing operations, bar charts of annual catch and effort estimates by gear type, and maps showing typical locations of fishing operations.

Site Selection

There are 90 coastal municipalities bordering FMA 7. Of these, 22 had been targeted for fisheries profiling but only 14 were actually completed (Fig. 3). Target municipalities were initially selected after categorizing all 90 into (a) those with limited to no sardine-related fisheries (roughly` 10% of all fishers involved in sardine fisheries); (b) those with moderate (roughly 10-50% of total fishers); and (c) those with extensive (> 50% of all fishers involved in sardine fisheries) sardine-related fisheries based on best available information provided by the regional BFAR NSAP teams as well as Municipal Agriculture Office (MAO) staff in most municipalities. After categorizing all the municipalities, a map was then constructed, and the target municipalities were narrowed down to 22 based on the extent of sardine fisheries, geographical location within the FMA, and their relative accessibility.

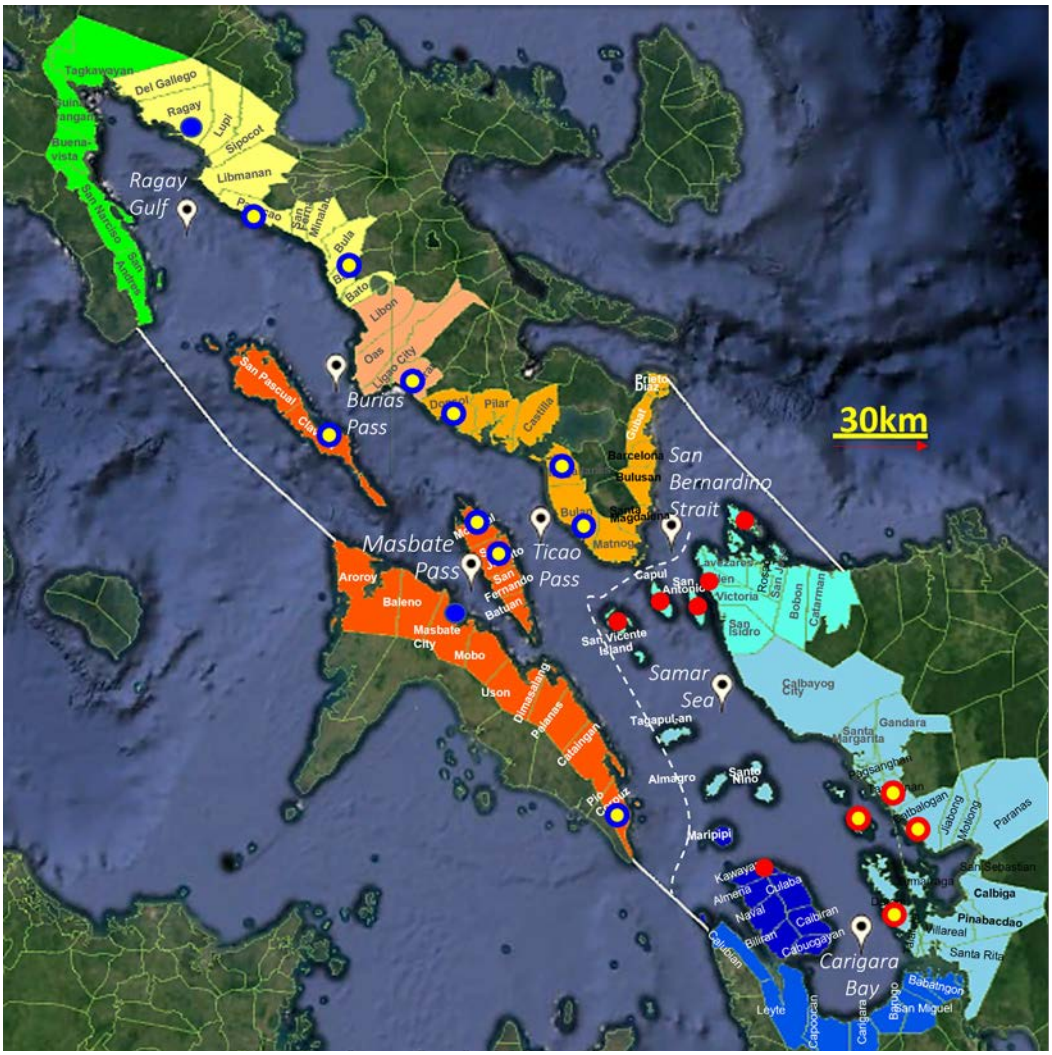


Figure 3. Map of FMA 7 showing the coastal municipalities belonging to the 9 bordering provinces (color-coded). Target municipalities for fisheries profiling are indicated by blue (north) and red (south) dots. Those with yellow or white inner portions are the actual sites where FGDs were conducted. The dashed line between the Ticao and Burias Passes and the Samar Sea delineates the northern & southern portions of FMA 7.

Focus Group Discussions (FGDs)

The FGDs were scheduled from February to early March 2020 but were interrupted due to travel restrictions related to the spreading of Asian Swine Fever and later COVID 19. As a result, only 14 municipalities were covered, 10 in the north and four in the south portions of the FMA (Fig. 3). The FGDs targeted 3-4 residents of each coastal barangay in each target municipality. The invitees included fishers and barangay leaders/officials familiar with the demographics of their barangay. Questions aimed at getting the information enumerated below (next page, Fig. 6) were fielded to members of each barangay, one at a time, for all participants to hear, and answers were listed on sheets of manila paper for all participants to see (Figs. 4 & 5). This provided opportunities for participants to comment and or disagree with answers from any of the barangays and served as a means of validating the information provided. A list of general questions typically asked during the profiling is shown in

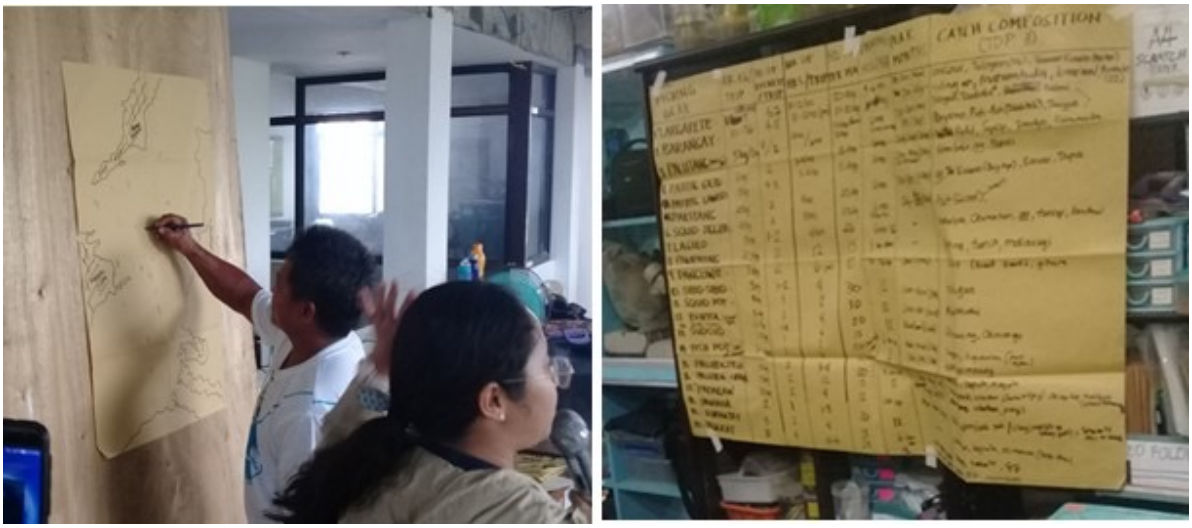


Figure 4. Fisher marking on the map the locations where they fish (left), while project staff continues to ask questions to the other participants as information is tabulated on manila paper (right) that constitutes the catch matrix.

Figure 5. Project staff conducting the FGDs in Donsol, Sorsogon (left) and Pio Duran (right) on 31 January 2020.

Two to three members of the project staff fielded questions to clusters of fisher groups simultaneously, and the information was recorded onto four different sheets of manila paper (Fig. 5) showing (1) list of gear types used and the number of units for each, (2) a catch table showing typical catch rates, number of fishing days each month by season, and rough catch composition by gear type, (3) a map showing where the different gear types are deployed or used (gear map), and (4) a gear calendar showing peak and lean seasons of fishing by gear type. The FGDs included all fishing gear used in the target municipalities. Only after collating and summarizing the data on catch composition were major gear types in the sardine fishery identified and confirmed. Examples of FGD information sheets are shown in Fig. 6. These data were summarized across all barangays to construct a *catch table or matrix* consisting of median values for parameters used in computing for annual catch across all gear types for each municipality (see *Table 2*).

The intention of the profiling activity was to represent typical or average conditions during the year, but such data usually cover wide ranges in values. Nevertheless, such information as number of gear units, number of fishers per trip, trip durations and fishing days each month are likely to be more reliable and meaningful than those on catch rates. As a result, the derived estimates of annual catch are subject to compounded uncertainties in parameter estimates and hence may be meaningful only in a relative sense. For the objectives of this research project, fisheries profiles were used primarily to identify the major gear types as well as the principal municipalities in the area that contribute most to the sardine fisheries in FMA 7. By focusing on these gear types and target sites, a much more intensive fisheries monitoring scheme was designed (*see section 2.3*) so that more reliable estimates of annual sardine production could be derived in a more systematic manner.

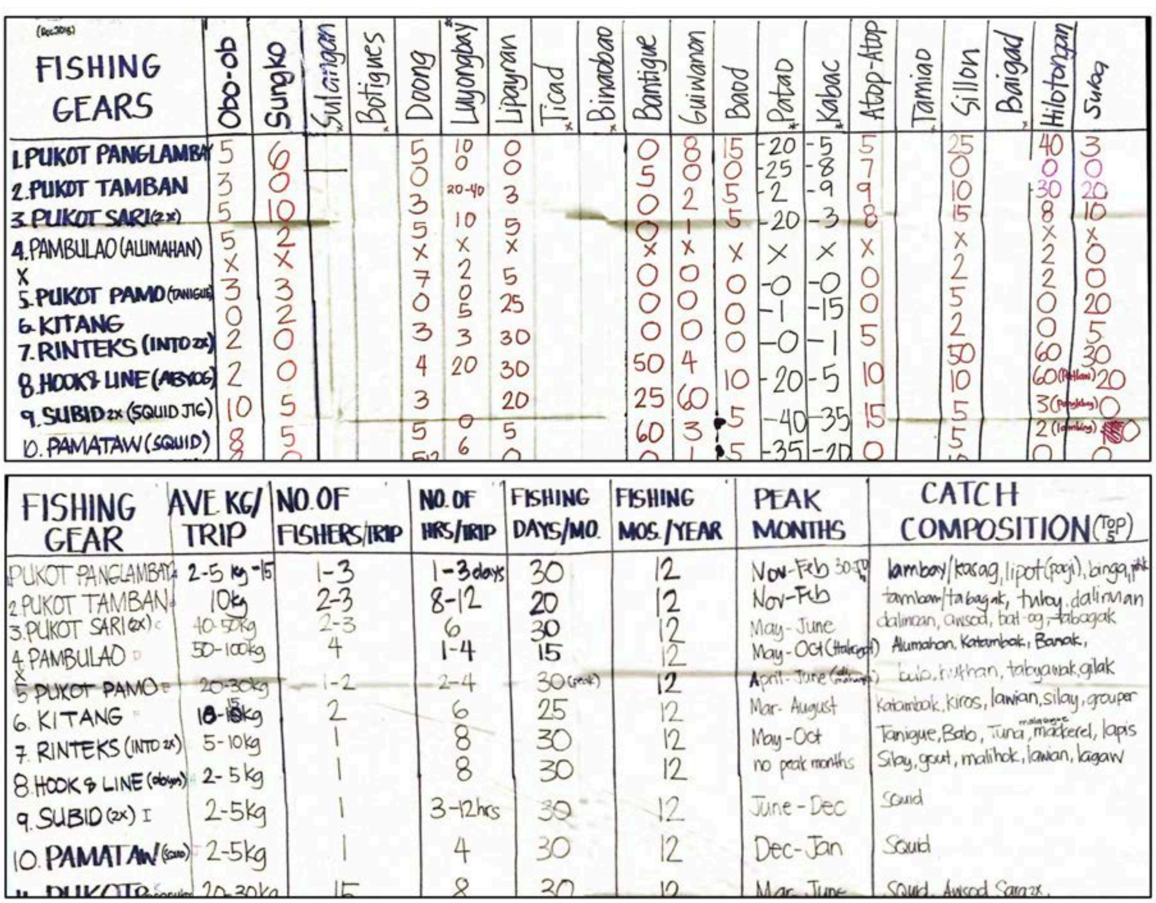


Figure 6. Sample output of fisheries profiling showing the number of gear units per barangay (top) and catch table output from the focused group discussion (bottom).

A secondary objective for the fisheries profiling activity was to provide the target municipalities with basic information that would be useful in managing their fisheries. This includes all the information summarized in the catch matrix, the gear calendar and the gear map. These will be explained in detail in the fisheries profiles section of the results.

Table 2. The quantities needed to estimate the annual catch of each gear and the total annual catch (mt).

	Parameters estimated	Type of summarized data
(A)	No. of units/vessels operating in the area	Count of all units
(B)	Median catch rate (kg/trip)	Median of reported catches
(C)	Median fishing days per month	Median of range of fishing days
(D)	Fishing months in a year	Count of all fishing months
(E)	Annual catch of each gear (mt)	(A x B x C x D)/ 1000
	Total annual catch (municipality)	Sum of all (E)

2.3 Catch and Effort Monitoring

From the 14 municipalities profiled early in the study, the largest sardine fishing village in seven of them were chosen for intensive (daily) fisheries catch and effort monitoring. These included sites in Balatan (Camarines Sur), Pio Duran (Albay), Monreal (Masbate) and Bulan (Sorsogon) (Fig. 7), whose combined landings made up about 64% of approximated landings of profiled municipalities in north FMA 7. In Samar Sea, the 3 chosen landing sites were located in Tarangnan, Daram (Samar) and Kawayan (Biliran) (Fig. 7). These three sites were identified as among those with the highest fisheries catches in the area and were the most accessible to monitoring and periodic supervision from project staff based in Catbalogan City.

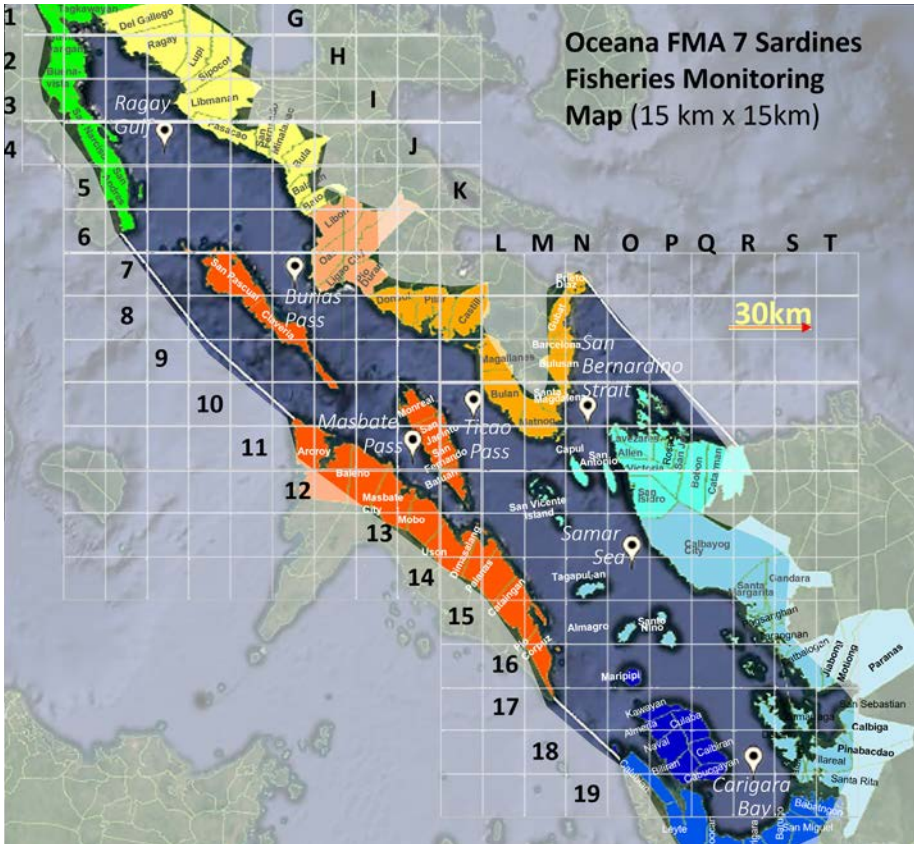


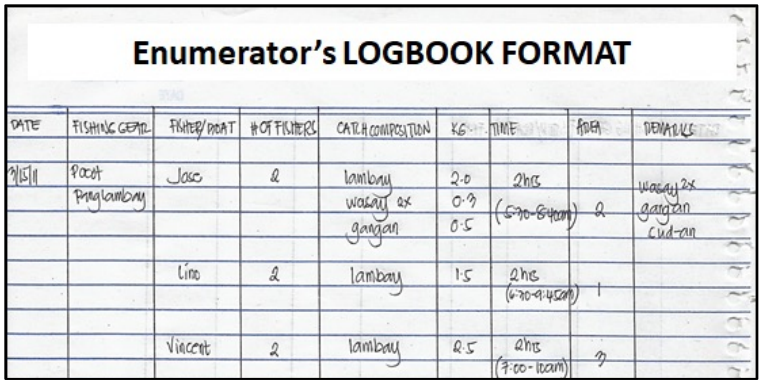
Figure 7. Map of FMA 7 showing the locations of fisheries monitoring sites (red dots) with a labelled grid of 15 x 15km squares used to indicate the locations of fishing operations.

Catches of targeted gear types (drift gill nets (DGN) (north), surface gill nets (SGN), ring nets (RN) and scoop nets (south)) were monitored daily at the selected monitoring sites (Fig. 7). Because of less obstructions to water flowing through San Bernardino Strait, the currents in the northern part of the FMA are stronger, leading to DGNs being the predominant gear type used. The profiling information also showed that about 90% of overall sardine landings in this area are from DGNs. Hence, only this gear type was monitored in the northern part of the FMA. In contrast, tidal currents are weaker in Samar Sea, so that a variety of gear types are commonly used to catch sardines in this area. These include encircling gill nets and ring nets, which, together with DGNs, were the gear types monitored in the southern part of the FMA.

At each site, a trained field assistant recorded the catch and effort of at least 10 tagged fishers/fisher groups (i.e., some gear types are operated by more than 1 fisher) known to use the target gear type(s) in the monitored site. Tagged fishers were consistently monitored during the entire study (February 2020 – April 2021) to document how the percentage of the gear fleet actually fishing each day (i.e., fishing frequency) varied within each month and between seasons. The term "gear fleet" is used here to refer to the total number of vessels operating the monitored gear type and was estimated during the fisheries profiling activity. The decision to monitor ten (10) tagged fishers or vessels was based on the likely distances between fishers' residences and the time needed for recording their catches each day, as well as the other regular tasks of the field assistant, which included twice weekly size measurements of fish in the catches and weekly purchases/on-site fixing of fish samples. While 10 fishers or vessels out of over 100 per municipality is a small sample, we believe that daily records would nevertheless provide accurate and reliable estimates of catch rates by gear type. Hence, using gear fleet size estimates from the fisheries profiles, and actual fishing frequencies and catch rates from daily monitoring at 7 of the largest sardine fishing villages in the FMA, reliable and reasonably accurate estimates of monthly and annual catch can be provided.

The daily recorded data are listed below, and an example of record book entries is shown in Fig. 8.

- Date of fishing trip
- Name of fisher/vessel
- Time of fishing (duration of actual fishing operation)
- Number of fishers in operation
- Specific location of fishing operation (with use of gridded map)
- Total catch (kg)
- Catch composition (by sardine species and categories/groups for other species)



Enumerator's LOGBOOK FORMAT

DATE	FISHING GEAR	FISHER/BOAT	# OF FISHERS	CATCH COMPOSITION	KG	TIME	AREA	REMARKS
3/15/11	Pocot Paglambay	Jose	2	lambay	2.0	2hrs (5:30-8:30am)	2	
				wasay 2x	0.9			wasay 2x
				gangan	0.5			gangan cut-an
		Lino	2	lambay	1.5	2hrs (6:30-9:45am)	1	
		Vincent	2	lambay	2.5	2hrs (7:00-10am)	2	

Figure 8. Part of a page of a field assistant's logbook showing records of data listed above for one day

Field assistants made use of gridded maps with coded rows and columns (Fig. 7) to identify grids (15 km x 15 km boxes) where fishing on each trip was done. While the grid sizes may seem large, they are more readily discernible by fishers in the field than smaller-sized grids and provide adequate coverage of the extent of movement of the fleet and/or stock within FMA 7. Daily catch and effort information were recorded on ordinary school notebooks to minimize cost and to impress on observers the simplicity of the task, especially to LGUs who ideally should adapt monitoring schemes on their own but are oftentimes discouraged by misconceptions of high cost. The seven monitored sites and the target gear types in each are shown in Table 3.

Table 3. List of fisheries monitoring sites in FMA 7, and the target gear types in each.

Site (LGU)	Province	Drift Gill Net	Other Drift Gill Net	Ring Net	Blast fishing w/ scoop net
Northern FMA 7					
Balatan	Camarines Sur	X	X		
Pio Duran	Albay	X	X		
Bulan	Sorsogon	X*			
Monreal/ San Jacinto	Ticao Island, Masbate	X			
Southern FMA 7					
Kawayan	Biliran	X			
Daram	Samar			X*	
Tarangnan	Samar				X

*Small commercial fishing vessel

2.3.1 Catch and effort data processing

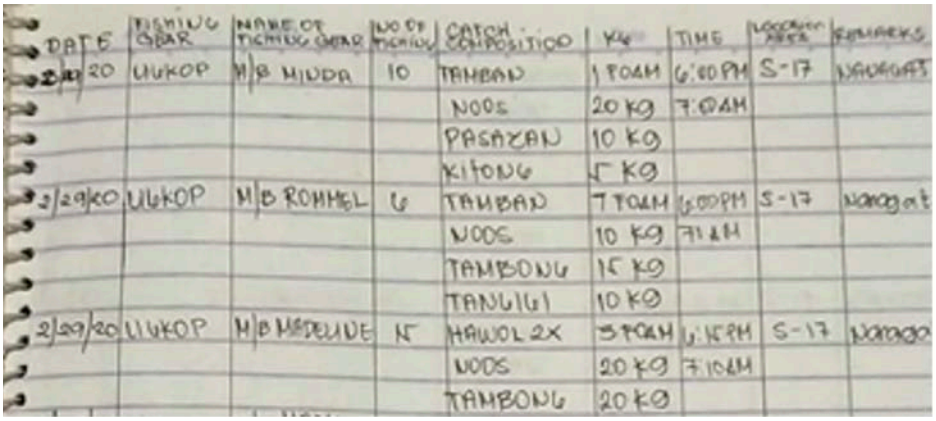


Figure 9. Example of a page from the field assistant's record book in Daram, Samar showing the data recorded daily.

A portion of a typical record book (Daram, Samar) is shown in Figure 9. The columns from left to right show the date, fishing gear, name of fishing (vessel), no. of (fishers), catch composition (in local name categories), catch in kg, time (start & end), fishing location/area (coded according to grids in Fig. 7), and remarks. In this record, the catch in kg is oftentimes listed as "foam" for Styrofoam boxes with a capacity of 50 kg of fish for species that are caught in bulk, like sardines (tamban). In other records, basins or tubs (banyera) are listed, which have a capacity of 35-40 kg depending on the type of catch. These data were "translated" to standard form and quantities during the encoding.

Table 4. Sample of processed encoded data sheet based on catch and effort monitoring records in Bulan, Sorsogon in February 2020.

		Catches in Kilograms									
Date	Record no.	*Rastrelliger*	*Priacanthus*	*Selar*	*Decapterus*	*Auxis*	*Sardinella*	**Total**	**No. of fishers**	**No. hrs**	**Area fished**
02-Feb-20	1	0	0	0	0	0	800	800	10	13.5	L10
02-Feb-20	2	0	0	0	0	0	1000	1000	8	16	L10
02-Feb-20	3	0	0	12	0	0	1040	1052	10	14	K10
02-Feb-20	4	0	0	11	0	0	730	741	7	14.5	L11
02-Feb-20	**5**	**0**	**0**	**0**	**0**	**0**	**950**	**950**	**10**	**16.5**	**L10**
02-Feb-20	6	0	0	0	0	0	1300	1300	10	17.5	L11
02-Feb-20	7	15	0	0	0	0	1540	1555	10	13.5	K10
02-Feb-20	8	0	0	0	0	0	700	700	10	12.5	L10
02-Feb-20	9	0	0	0	0	0	580	580	8	13.5	L11
02-Feb-20	10	13	0	0	0	0	920	933	9	10.5	L11
03-Feb-20	1	0	0	13	0	0	580	593	10	12.5	K10
03-Feb-20	2	0	0	10	0	0	860	870	8	13.5	L10
03-Feb-20	3	0	0	0	0	0	950	950	10	12	L11

An example of encoded data for Bulan, Sorsogon is shown in Table 4. The table shows a full entry for 02 Feb 2020, showing the information for each of the 10 tagged fishers (record number) in the site, and the first 3 records for the following day, 03 Feb 2020. Thus, for each day, the encoded sheet has 10 rows, 1 row for each tagged fisher, whether they fished that day or not. Those who did not fish on any of the days would show blanks or "x" for the last four columns, from "total" (catch) to "area fished". The remarks column is not shown in the table. All catch categories listed in the record books are assigned a column to show their catches (kg). The sum of all catch categories is the total catch (kg) for the trip, shown under the column "total." The number of hours is computed from the start and end time in the record books. From this worksheet, daily averages (from the 10 records) for catch by category, number of fishers/trip and number of hours per trip can be computed to produce a summary for each month. Table 5 is part of an example of the monthly summary for one of the sites.

Table 5. Summary of mean catch and effort by day with overall mean values for the month (Feb 2020: 6-29 Feb only) at the bottom of the table.

	Catches in Kilograms									
Date	*Rastrelliger*	*Priacanthus*	*Selar*	*Decapterus*	*Auxis*	*Sardinella*	**Total Catch**	# vessels fishing	# fishers/ trip	# hrs fishing
06-Feb-20	8	0	3.6	0	0	547.5	557.6	8	8.8	12.6
07-Feb-20	0	0	0	0	0	497.8	497.8	9	8.8	11.0
08-Feb-20	1.3	0	5.7	0.43	0	257.7	265.1	7	8.1	8.9
09-Feb-20										
10-Feb-20										
11-Feb-20										
12-Feb-20	10	1	11	2.3	1.7	8.3	34.3	3	5.7	9.2
13-Feb-20	1.5	0	9.3	0	1	413.3	425.2	3	8.0	10.3
.	.	.	.	.	.	.	.	.	.	.
29-Feb-20	.	.	.	.	.	.	.	.	.	.
n	24	24	24	24	24	24	24	24	24	24
mean	2.9	0.2	4.9	0.3	0.3	705.2	713.6	7.67	8.8	11.7
sd	3.5	0.6	3.9	0.7	0.6	271.9	269.0	2.5	0.9	1.5
min	0	0	0	0	0	8.3	34.3	2	5.7	8.9
max	12.0	2.5	15.5	2.3	2.5	1,145.0	1,146.0	10	10.0	14.2

It shows the daily averages, and the number of vessels fishing each day from the counts of non-zero entries for those dates. For example, on 06 Feb 2020 only 8 of the 10 tagged vessels went out to fish, 9 the next day, and only 7 on 08 Feb 2020. For some dates, 9-11 Feb 2020 in the table, none of the tagged or target fishers went fishing because of bad weather (based on the remarks column of the record books). Hence, such days are not included in the number of fishing days for the month. A summary for the entire month is also shown at the bottom of Table 5.

Table 6. Summary of catch and effort estimates for Bulan in Sorsogon, Monreal & San Jacinto on Ticao Island in Masbate, Daram in Samar, and Kawayan in Biliran for February and March 2020. Note: DGN (drift gill net); RNet (ring net); SGN (surface gill net) and D/S (dip/scoop net). C – catch.

Summary estimates	Bulan	Ticao Is.	Pio Duran	Balatan	Daram	Kawayan	Tarangnan
Fishing gear monitored	DGN	DGN	DGN	DGN	RNet	SGN	D/S net
Month and year of data	Feb 20	Feb 20	Feb 20	Feb 20	Mar 20	Mar 20	Feb –May20
Mean total C (kg/trip)	713.8	241.4	97.3	275.2	276.7	35.6	52.1
Mean sardine C (kg/trip)	705.2	241.4	87.3	270.6	131.3	35.6	25.6
Mean sardine C as % of total	98.8	100.0	89.7	98.3	47.5	100.0	49.3
Mean C/fisher (kg/fisher/trip)	81.2	46.9	29.7	57.7	19.8	35.6	17.5
Mean C rate (kg/hr/trip)	60.8	18.1	9.3	22.8	22.7	11.9	9.9
Mean hrs fishing/day	11.7	13.4	10.5	12.0	12.2	3.0	5.2
Mean no. fishers/trip	8.8	5.1	3.3	4.8	14	1.0	3.0
Mean % fleet fishing/day	76.7	52.1	72.2	54.4	92.6	80.9	75.3
No fishing days in a month	24	29	23	18	23	11*	24

*out of 15 days monitoring only

A sample monthly summary for each of the 7 sites is shown in Table 6. These summarized data were used together with selected information from the fisheries profiles to provide estimates of the total catch for each month. For example, estimates of the number of units of various gear types from the fisheries profile of Pio Duran are shown in Table 7. There are 2 types of drift gill nets used in the area, numbering (99 + 100 =) 199 in all. Thus, for Feb 2020, the estimated catch in Pio Duran amounted to: 87.3 *kg/trip X 72.2% of 199 gear units fishing/day X 23 fishing days = 288.5 mt of sardines.*

The same procedure was done across all gear types and all months to estimate annual sardine production in each of the monitored sites.

Table 7. Estimates of the number of units of the different gear types operated from Pio Duran, Albay based on the fisheries profile of the municipality (Jan 2020).

Fishing Gears		
Local name	**English name**	**Gear/Units**
Pakitang	Multiple hook & line	43
Lagulo	Simple hook & line	72
Tangkab	Squid Jigger	133
Balakwit	Troll Line	32
Largarete	Drift gill net (Pamo)	99
Patitig	Bottom set gill net	65
Barangay	Drift gill net	100
Palutang	Surface gill net	26
Labay Labay	Bottom set gill net (Pamo w/o weights)	43
Basnig	Bag net	1

Table 7. (Continued)

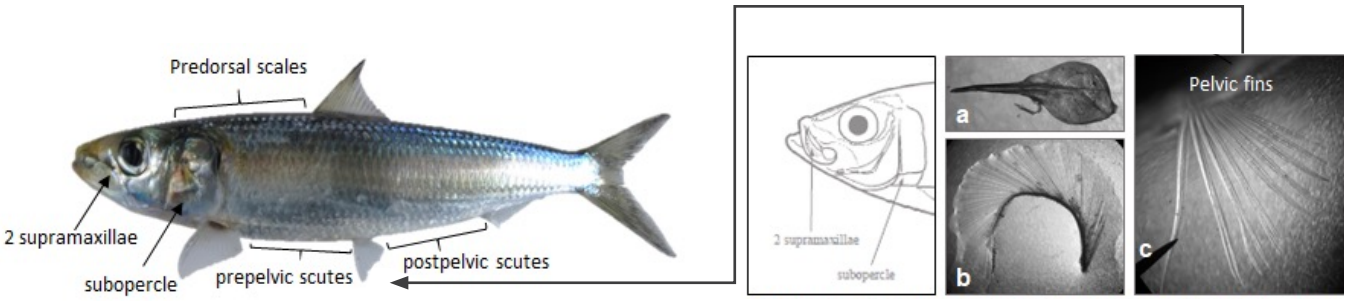
Fishing Gears		
Local name	**Bulan**	**Gear/Units**
Bugkat	Surface gill net	4
Sinsuro	Beach Seine/Boat Seine	38
Palakaya	Round Haul Seine	7
Pangulong	Purse Seine	1
Bubo sa Isda	Fish Trap	14
Bubo sa Kasag	Crab Trap/Pot	2
Pana	Spear	18

2.4 Biological Sampling

In addition to recording catch and effort data, the field assistant also measured at least 1 kg of catches of each major species (if available) from each target gear type twice weekly. Samples (about 1 kg) for each major species from each target gear type were also purchased once a week, fixed and stored in ethanol for pick up by research assistants once a month. These samples were then processed in the labs of partner universities. After identification, specimens were measured for standard length (SL) and total length (TL) to the nearest millimeter and weighed to the nearest 0.1 gram, then dissected to extract the otoliths, guts and gonads. Otoliths were cleaned of adhering tissue, rinsed, air-dried and then stored in small, coded paper packets placed in small envelopes labeled with catch sub-sample information for processing and analysis at a later time. Guts were fixed in 10% buffered seawater-formalin solution and stored in small plastic pouches inserted into a labeled plastic jar also for analysis at a later time. The processing of gonads is described in the section on reproductive capacity below.

By design, catch and effort were to be monitored in sites where vessels were based. This is to ensure that only tagged vessels are monitored and that they are accounted for every day. However, because many drift net operators based on islands in FMA 7 land their catches directly in mainland Bicol (i.e., Bulan, Sorsogon), biological sampling at the latter had to be coordinated with field assistants in the other sites (especially in Monreal, Ticao Island) so that catches from these island-based vessels could be sampled systematically. Occasionally, field assistants on island sites were able to persuade boat captains to set aside randomly selected samples of their catches so these could be collected and purchased when they return to their base.

While there are several species of sardines caught in the northern part of FMA 7, including smaller species (herring), the major species reported from previous studies were *Sardinella lemuru* and *Amblygaster sirm*. In Samar Sea, *S. pacifica* (erroneously referred to in the past as *S. fimbriata*) was also common. Since this study included all sardine species, it was necessary that field identifications were correct. To ensure this, a field guide was prepared and used during the training of research assistants held from 28-31 January 2020. Diagnostic characteristics of the major anatomical features used to differentiate the various species of sardines in the area (Fig. 10) were reviewed and compiled to create the field guide. It was agreed that samples of whole specimens would be brought back to the labs at Bicol University Tabaco Campus (BUTC) and Samar State University (SSU) for detailed examination and verification during at least the initial months of monitoring until such time that field assistants got the on-site identifications correctly.



(a) 2nd supramaxilla (b) lower gill rakers (c) pelvic fins with 1 unbranched and 8 branched fin rays

Figure 10. External anatomical features of sardines that are used to differentiate the several species occurring together in the study area.

2.5 Vessel Tracking Scheme

Two types of devices were used to elucidate the movement of the fleet, possibly in response to the movement of the stock in the study area. Solar-powered vessel tracking devices (Zunibal Vessel Tracer Solar iVMS) were installed on small commercial vessels (> 3 GT) since they would more likely show more extensive movement than smaller municipal vessels (Fig. 11).

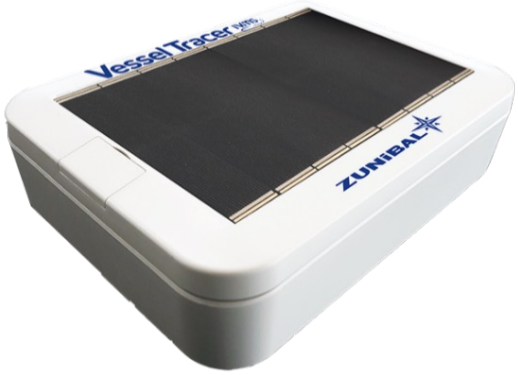


Figure 11. Solar-powered GPS Vessel Tracking device from Zunibal.

The second type of GPS devices used were battery-powered data loggers, which were provided to collaborators together with rechargeable 1.5v AA batteries and battery chargers (Fig. 12). These devices can only record and store information at chosen time intervals and needed to be downloaded regularly (monthly at least) for fishing tracks to be seen and analyzed. Research assistants and field assistants were instructed to ensure that collaborators recharged the batteries before each fishing trip and were trained to download the logged data into worksheet format.

Table 8. List of fisheries monitoring sites and the vessel tracking program details in FMA 7.

Site (LGU)	Province	Drift Gill Net	Ring Net	Dip/Scoop Net
Balatan	Camarines Sur	x		
Pio Duran	Albay	x		
Bulan	Sorsogon	X[1, 2]		
Monreal/San Jacinto	Ticao Island, Masbate	X[1, 2]		
Kawayan	Biliran	x[2]		
Daram	Samar		X[1, 2]	
Tarangnan	Samar			X

[1] Solar-powered GPS tracker, [2] Holux GPS data logger
"X" (upper case) – small commercial fishing vessel; "x" (lower case) – municipal fishing vessel

Table 9 below shows the type of information and their frequency of gathering in the seven monitoring sites in FMA 7.

Table 9. Field catch and effort data, frequency of recording, and number of sites being monitored in the northern (Bicol) and southern (Samar) portions of FMA 7 during the study.

		No. of sites	
Task	Recording Frequency	Bicol	Samar
Catch (amount & composition)	daily	4	3
Effort (no. boats, fishers, location)	daily	4	3
Size distribution of catches	2x /week	4	3
Collection of specimens for lab analysis	1x /week	4	3
Vessel tracking data	daily	4	2

2.6 Estimating Annual Catch

To derive annual catch, values of several parameters needed to be estimated first. These include determining gear fleet size, or the number of vessels operating each major gear type used to catch sardines. This was accomplished during the fisheries profiling activity in selected municipalities as discussed above. The major gear types that catch sardines in FMA 7 include drift gill nets, encircling, and surface gill nets. Ring nets and purse seines are operated by commercial vessels (> 3 GT) and while they are supposedly prohibited from fishing within FMA 7, enforcement has not been strict on the smaller (3.1 - 20 GT) vessels of this sector. Other minor gear types that also catch sardines are shown in Table 10.

The next set of parameters have to do with *fishing frequency*, which consists of (a) the mean proportion of the gear fleet that fishes daily, and (b) the number of fishing days each month for each gear fleet. These may differ within weeks and between months or seasons, depending on such factors as sea and wind conditions, vessel condition, and target resource abundance. Estimates for these two parameters were based on the daily monitoring of catch and effort of the major gear types (Table 3) in the 7 sites. For the minor gear types included in Table 10, fishing frequency was based solely on information provided by fishers during the fisheries profiling activities.

Table 10. The gear types that catch sardines were identified during the fisheries profiling activities in FMA 7 during the study.

Drift gill net 1	Scoop net
Purse seine	Encircling gill net w/ Fish Aggregating Device (FAD)
Modified lift net	DGN w/ scareline
Drift gill net 2	Surface gill net
Ring net	Multiple hook & line
Encircling gill net	Bag net
Boat seine	

Table 11. The percent contribution of sardines in catches of the different gear types used in FMA 7 during the study. Values with * are based on purchased samples of catches examined in the lab.

Gear Type	% of sardines
Bag net/modified lift net	80-100*
Drift gill net (DGN)	80-100*
Drift gill net 2 (larger mesh)	10-20*
DGN w/ light	75
DGN w/ scareline	20
Encircling gill net (EGN)	30
EGN w/ FADs	50
Surface Gill Net	10
Purse Seine	50
Ring Net	30-80*
Round Haul Seine	20
Scoop Net	20-50*
Multiple HL	10

Average *daily catch rates* (kg/trip) for the major gear types (Table 3) were also estimated through daily monitoring of catch and effort at the representative fishing communities in the 7 municipalities. For minor gear types, the median of catch rates provided by fishers during the fisheries profiling was used. Since catches of the different gear types also included species other than sardines, it was necessary to determine the proportion of sardines in their respective catches. The *% composition of sardines* in catches of the major gear types was determined from weekly sub-samples of catches which were examined and identified in the laboratory. The values are in ranges, which reflect natural variability between sites and months. For the minor gear types, the percent composition is based on the median of values compiled from the fisheries profiling. The overall percent composition of sardines in the catches across the different gear types is shown in Table 11.

Table 12. Quantities needed to estimate annual catch in municipalities involved in the sardine fisheries in FMA 7, and the data sources used in estimating these quantities in areas where either daily catch and effort were monitored or only fisheries profiling was done, or where only nominal information on sardine landings was available.

Parameters	Data Sources		
	Municipalities monitored (7)	**Municipalities profiled (14)**	**Other municipalities targeting sardines**
(A) No. units by gear type	Fisheries profiles	Fisheries profiles	
(B) Mean catch rate (kg/trip)	Daily monitoring	Data from monitored sites for major gear; fisheries profiles for minor gear types	
(C) % gear fleet fishing	Daily monitoring of targeted no. of operations	Same as above	
(D) Fishing days per month	Daily monitoring	Same as above	
(E) Fishing months in year (E)	Daily monitoring	Same as above	
Annual Catch (kgs)	**A x B x C x D x E**	**A x B x C x D x E**	Mean of annual catches of monitored & profiled municipalities categorized as high, moderate or low sardine production

Table 12 shows the quantities needed to estimate annual catch. For major gear types in non-monitored but profiled municipalities, mean parameter values from the intensively monitored sites were used. For minor gear types in monitored or profiled areas, median values from the fisheries profiles were used. These municipalities were then categorized into five levels (very high, high, moderate, low-moderate and low) based on the ranges of their estimated annual catches. The mean values of these ranges were then assigned to non-monitored unprofiled municipalities falling under each category.

2.7 Reproductive Capacity

Macroscopic gonad staging and gonado-somatic index

Specimens collected each week in 5 of the 7 monitored sites were examined for gonad development. These include Pio Duran, Monreal, Bulan in northern FMA 7 and Daram and Tarangnan in southern FMA 7. Gonad developmental stages were determined macroscopically following the criteria of Landry & McQuinn (1988) (Table 13).

Table 13. Macroscopic stages of the gonads of *S. lemuru* (Landry and McQuinn, 1988).

Stage	Females	Males
I Immature	Ovaries are very small, transparent and measuring up to 3 mm. No eggs are visible to naked eye.	Testes are very small, transparent and measuring up to 3 mm wide.
II Maturing	Ovaries are more swollen and opaque , occupying about 1/2 of the ventral cavity. Yellow/white eggs are visible in lamellae.	Testes are more swollen and opaque, occupying about half of the central cavity. It appears reddish grey or greyish.
III Mature	Ovaries are pale yellow, filling about 2/3 of the ventral cavity. Eggs are distinct and grainy and not transparent yet and some large transparent eggs are also present. Ovaries do not run under pressure.	Testes fill 2/3 of the ventral cavity. Milt appears whitish.
IV Spawning	Ovaries run when light pressure is applied, and eggs are now transparent.	Testes run when light pressure is applied.
V Spent	Ovaries are slack with residual eggs. Walls are striated vertically, and blood vessels are prominent.	Testes are baggy, bloodshot, firmer and larger than stage II. Walls are striated vertically, and blood vessels are prominent.

The gonado-somatic index (GSI) was computed as the ratio of gonad weight/total body weight expressed as a percentage:

$$GSI\ (\%) = (\text{Gonad weight}/\text{Total Body weight}) \times 100$$

Macroscopically determined maturity stages were plotted against standard length to determine at what size sexual maturity is attained. The GSI mean values were compared with the relative frequency of the stages of gonads to determine the spawning peak in terms of months.

Fecundity

The fecundity of specimens was estimated using the gravimetric method, which is based on the relationship between the weight of the ovary and the density of the oocytes that compose it (Murua et al. 2003). Batch fecundity was estimated by counting all the hydrated oocytes (swelling due to water entry, main feature of oocyte maturation), while total fecundity was estimated by counting both hydrated and yolky oocytes. Batch fecundity is the number of viable eggs usually released by a serial spawner in a pulse of spawning. Regression was used to determine the relationship between fish fecundity and size (standard length), fish fecundity and gonad weight, and fish fecundity and body weight.

Length at first maturity (L_{m50})

Length at first maturity (L_{m50}) in this study is the median length of all mature fish in the population, where the mature specimens have oogonia or spermatogonia in the gonads. This was determined by grouping the fish by sex into 0.5 cm size classes. Minimum size at maturity, on the other hand, is the smallest size of the fish having mature gonads. For each sex, a logistic curve was fitted to the cumulative percentage of mature specimens against the length classes and plotted using GeoGebra software. L_{m50} for each sex was computed using the following equation from El Habouz et al., (2011):

$$f(x) = \frac{1M}{1 + a \bullet e^{-bx}}$$

where, f(x) = percentage of mature specimens
M = maximum value of f(x)
x = length
a and b = parameters of the curve
e = natural logarithm base

2.8 Environmental Conditions

Monthly phytoplankton abundance proxied by chlorophyll a concentration (chl a) and sea surface temperature (SST) conditions within an area defined by the coordinates 11.2° to 13.5° N and 124.2° to 125° E were obtained from MODIS Aqua data set accessed in Goddard Earth Sciences Data and Information Services Center (GES DISC).

2.9 Growth, Mortality and Exploitation

Monthly length-frequency data were grouped into 0.5 cm SL size classes and then plotted against time to form sequential monthly length-frequency histograms. Length-frequency data from all monitored areas were pooled by species. We decided to combine by species since there was no significant difference in the population parameters obtained by area. The obtained monthly length-frequency data were used as input to estimate population parameters of *S. lemuru* and *S. pacifica* using routines included in the Fish Stock Assessment Tools (FISAT) II software (Gayanilo et al. 2005). Growth was characterized using the von Bertalanffy growth model. The program ELEFAN I was used to estimate growth parameters K (growth constant) and L_∞ (asymptotic length) of the von Bertalanffy growth model. The Length-converted catch curve routine was used to estimate total mortality (Z), natural mortality (M) and fishing mortality (F). To compare performance of different sardine stocks, the phi-prime (ø') growth performance index was computed as defined by the following equation:

$$ø' = \log10(K) + 2 \cdot \log10(L_\infty)$$

Where: K = growth constant (yr^{-1}); L_∞ = asymptotic length (mm)

2.10 Spawning Potential Ratio

The spawning potential ratio (SPR) is the fraction of the stock's spawning potential that is not caught by the fishery (and therefore allowed to spawn). SPR values were estimated based on the size distribution of the catches, size at first maturity (L_{m50}, L_{m95}), growth (K, L_{∞}) and natural mortality (M) parameter values for the target species using a web-based software accessible at http://barefootecologist.com.au/lbspr. The software also computes size at first capture (L_c) or the size at which 50% of all fish at that size are caught by the fisheries, which can be used as a reference in establishing size limits. Hence, when the resulting actual SPR was below the set target minimum limit of 20-30%, the input size distribution was adjusted by sliding from one to several size classes to the right (i.e., by increasing L_c) until the target SPR range was attained. This necessarily corresponded to a larger L_c value which we considered as the target "length at first capture" in succeeding years to attain sustainability.

03. Results and Discussion

3.1 Fisheries Profiles of Representative Municipalities in FMA 7

A fisheries profile is an initial characterization of a fishery in a locality with the main objective of gathering basic information that is needed to manage natural marine resources. This information includes fishing gear types, fishing effort, catch rate, location of the fishing operations, and catch composition. In areas where basic fisheries information is unavailable, fisheries profiling through focus group discussions may serve as the primary source of information. This activity is quick, inexpensive, and can be replicated easily by local government units. Moreover, this activity, through active discussions with and among the participants, allows some validation of the fisheries information.

Because the information provided by fishers during the profiling activities were based on past experiences, most of it were in ranges of values. For example, typical catch rates for drift gill net operations with 4-5 fishers may range from 250-650 kg/trip. In summarizing across barangays, the average of the medians of the ranges was used in the catch matrix (rounded off to the nearest whole or half number) and are referred to in the matrix as the "median kg/trip", with daily trips for most gear types. The same was done for all other information. The annual catch derived from such information is necessarily rough, but nevertheless useful as initial approximations. Among all the information provided, those on lean and peak months, fishing locations, and the major species in the catch are the most reliable. The number of gear units for most gear types is also similarly reliable because these are associated with fishers they personally know.

Table 14 shows the number of participants and the number of coastal barangays represented in each of the profiling activities conducted in FMA 7. For barangays with no representatives, the information was provided by participants from nearby barangays and/or by the staff of the municipal agriculturist office. In north FMA 7 (Bicol & Masbate), focus group discussions were conducted in 10 municipalities, six from mainland Bicol and four from Masbate. In south FMA 7, focus group discussions were conducted in three municipalities, namely, Tarangnan, Catbalogan, and Daram (including Sierra Island), all in the province of Samar.

Table 14. Schedule and summary of representation in the FGDs conducted during the study.

Province	Municipality	No. of Coastal Barangays	No. of Barangays Represented	No. of Participants	Date of Profiling
Camarines Sur	Pasacao	6	6	15	19 Feb 20
	Balatan	6	6	16	20 Feb 20
Albay	Pio Duran	9	9	10	31 Jan 20
Sorsogon	Donsol	14	14	50	31 Jan 20
	Magallanes	20	3	7	17 Feb 20
	Bulan	21	4	10	17 Feb 20
Masbate	Claveria	22	9	28	18 Feb 20
	Monreal	6	6	33	04 Mar 20
	San Jacinto	9	7	37	03 Mar 20
	Pio V. Corpuz	12	11	30	05 Mar 20
Samar	Tarangnan	29	29	76	14 Apr 21
	Catbalogan City	30	14	39	04 Mar 20
	Sierra Island, Catbalogan City	7	7	11	15 Feb 21
	Daram (mainland)	53	24	65	19 Feb 20

Pasacao, Camarines Sur

The catch matrix for Pasacao, Camarines Sur is shown in Table 15a. Seventeen (17) gear types comprised of various modifications of gill nets, seines, lines, and traps were identified. The estimated annual catch of all gear types is 4,497.5 mt, 70% of which is contributed by drift gillnets, ring nets, and encircling gillnets, which primarily catch sardines. The computed median daily catch per fisher, with 1 trip typically lasting 1 day, of the various gear types, ranged from 2.5 – 60.0 kg/fisher/trip, with an overall median value (weighted by catch) of 19.9 kg/fisher/trip across all gear types. The gear calendar shows that peak catches for the various gill nets occur during the northeast (NE) monsoon (November – March), while peak months for the others are towards the summer (April – May) (Table 15b).

Balatan, Camarines Sur

For Balatan, 17 gear types were identified (Table 16a), with 1.5–2 times more total fishing effort and catch than in Pasacao, Camarines Sur (Table 15a). The estimated annual catch is 10,654.5 mt, mostly contributed by seines and trawls, particularly the modified trawl and beach seine for *sirum-sirum* (mostly fry/early juveniles of mixed species) (81.4%). The reported median daily catch rate across the various gear types ranged from 0.8 – 166.7 kg/fisher/trip, with an overall weighted median value of 31.7 kg/fisher/trip across all gear types. Most of the gear types operate for 8 – 9 months only, with overall peak catches during the NE monsoon towards the summer (Table 16b). Unlike Pasacao, there is a larger fishing fleet in Balatan with the bulk of fishing effort contributed by seines and trawls, both targeting sardines and other small pelagics like round scads, bigeye scads, and other carangids and scombrids.

Pio Duran, Albay

Pio Duran, Albay listed 17 fishing gear types (Table 17a) with comparable fishing effort and catch to Balatan. The estimated annual catch is 8,334.2 mt, mostly contributed by gillnets (71.9%). The reported median daily catch rates across the various gear types ranged from 0.2 – 100.0 kg/fisher/trip, with an overall weighted median value of 20.2 kg/fisher/day across all gear types. Like in Pasacao, most of the gear types are seasonal, operating on average for 7 months with peak catches occurring during the NE monsoon (Table 17b). The bulk of the fishing effort is contributed by gillnets which target sardines and other small pelagics belonging to the family Carangidae and Scombridae.

Table 15a. Catch matrix for Pasacao, Camarines Sur based on profiling conducted on 19 February 2020.

Fishing Gear														
Local Name	English Name	Code	Gear units	Median kg/trip	No. of fishers/ trip	No. of hrs. trip	Fishing days/ month	Fishing mos./ year	Fishing trips/ year	%	Fishing days/ year	%	Estimated annual catch (MT)	%	days/ year
Gill Nets															
Largarete/ Kurantay	Drift gill net	DGN	15	400	8	8.0	18.0	10	2,700	3.9	21,600	9.5	1,080	24	180
Palakaya/ Taksay (Dayo)	Ring net	RN	13	500	13	18	18	10	2,340	3.3	30,420	13.4	1,170	26	180
Panglikos	Encircling gill net	EGN	6	800	15	11	20	10	1,200	1.7	18,000	8	960	21.3	200
Tikpaw	Scoop net	Scoop N	41	50	2	7	6	4	984	1.4	1,968	0.9	49.2	1.1	24
Pangking pang irarom	Bottom set gill net	BSGN	110	12	2	6	30	9	29,700	42.4	59,400	26.3	356.4	7.9	270
Pangking pang ibabaw	Surface gill net	SGN	57	25	4	7	15	5	4,275	6.1	17,100	7.6	106.9	2.4	75
Pangkeng Pangasag	Bottom set gill net (crabs)	BSGN*	6	5	1	4	25	10	1,500	2.1	1,500	0.7	7.5	0.2	250
Hook and Lines															
Kitang	Bottom set longline	BSLL	41	25	2	12	18	10	7,380	10.5	14,760	6.5	184.5	4.1	180
Og-og	Multiple hook & line	MHL	93	7	2	3	3	7	1,953	2.8	3,906	1.7	13.7	0.3	21
Saliwsiw	Troll line	TL	18	13	3	8	14	9	2,268	3.2	6,804	3	29.5	0.7	126
Banwit (Single big hook)	Handline (Big)	HL	12	15	2	6	15	9	1,620	2.3	3,240	1.4	24.3	0.5	135
Tangkab	Jigger	Jig	40	12	1	4	30	2	2,400	3.4	2,400	1.1	28.8	0.6	60
Seins/trawls															
Pangulong (Dayo)	Purse Seine	PS	1	900	15	12	18	10	180	0.3	2,700	1.2	162	3.6	180
Sinsara	Beach Seine	BS	22	60	6	13	22	10	4,840	6.9	29,040	12.8	290.4	6.5	220
Traps															
Bubo Pamusit	Squid Trap	Squid T	20	5	2	3.5	30	11	6,600	9.4	13,200	5.8	33	0.7	330
Bubo Pangkasag	Crab Pot	Crab P	1	14	2	12	16	6	96	0.1	192	0.1	1.3	0	96
								Total	**70,036**	**100**	**226,230**	**100**	**4,497.5**	**100**	**2,527**
								Weighted median kg/fisher/trip	**19.88**						
								Weighted median kg/trip	**64.22**						

Table 15b. Seasonality of fishing operations in Pasacao, Camarines Sur (February 19, 2020). Arrows indicate the fishing months and shaded areas indicate the peak months.

Fishing Gear		Month														
Local Name	English Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	F mos./ year	Peak mos.	Catch composition
Gill Nets																
Largarete/ Kurantay	Drift gill net														Jan-Apr	Lawlaw, Galunggong, Kuwaw
Palakaya/ Taksay (Dayo)	Ring net														Feb-Jun	Mbaka, Galunggong, Kabalyas, Turingan, Tiso, Dorado, assorted fishes
Panglikos	Encircling gill net														Feb-Jun	Galunggong, Nordeste, Dilis, Tunsoy, Turingan
Tikpaw	Scoop net														Nov-Dec	Silog, Sirum-sirum, Balao
Pangking pang irarom	Bottom set gill net														Nov-April	Matang baka, Kabalyas, Kuwao, Malimno, Galunggong, etc..
Pangking pang ibabaw	Surface gill net														Dec-Jan	Bangkulis, Rayado, Pundahan, Ngipunan, Tanguigi, Malasugi
Pangkeng Pangasag	Bottom set gill net (crabs)														Jan-Jun	Bisugo, Manuping, etc.
Hook and Lines																
Kitang	Bottom set longline														Mar-May	Lapu-lapu, Maya-maya, Bagoong, big Kuwao, Mirapina
Og-og	Multiple hook & line														Apr-Jul	Turingasn, Galunggong, Kuwao, Tunsoy, Kabalyas, Matangbaka
Saliwsiw	Troll line														Mar-May	Tuna
Banwit (Single big hook)	Handline (Big)														Mar-Jun	Tanigue, Rayado, Tuna, Pak-an, Pundahan
Tangkab	Jigger														No peak months	Pusit, Galunggong, Squid
Seins/trawls																
Pangulong (Dayo)	Purse Seine														Mar-Apr	Galunggong, Lawlaw, Sheborlet, Turingan, Matangbaka, assorted fishes
Sinsara	Beach Seine														Feb-Jul	Dilis, Sirum-sirum, Tunsoy, Pusit, Tuakang, etc..
Traps																
Bubo Pamusit	Squid Trap														Feb-May	Lokus, Pusit, Lapu-lapu
Bubo Pangkasag	Crab Pot														Sep-Dec	Kasag, Sira assorted

Table 16a. Catch matrix for Balatan, Camarines Sur (February 20, 2020).

Fishing Gear														
Local Name	English Name	Code	Gear units	Median kg/trip	No. of fishers/ trip	No. of hrs. trip	Fishing days/ month	Fishing mos./ year	Fishing trips/ year	%	Fishing days/ year	%	Estimated annual catch (MT)	%
Gill Nets														
Kurantay	Drift gill net	DGN	66	3.5	4.5	13	10	10	6,600	5.0	29,700	8.8	23.10	0.2
Pangke (Lubog)	Surface gill net	SGN	94	35	3.5	18	20	12	22,560	17.2	78,960	23.5	789.60	7.4
Pangke (Ibabaw)	Bottom set gill net	BSGN	3	8	3	5	14	12	504	0.4	1,512	0.4	4.03	0.0
Pangke (Pang kasag)	Crab gill net	CGN	9	2.5	2	13	10	5	450	0.3	900	0.3	1.13	0.0
Barangayan	Drift gill net	DGN (bgyn)	81	15	2.5	8	17.5	9	12,758	9.7	31,894	9.5	191.36	1.8
Bintol	Crab lift net	Crab LN	3	6	2	5	15	12	540	0.4	1,080	0.3	3.24	0.0
Hook and Lines														
Kitang	Bottom set longline	BSLL	132	30	2	8	12.5	9	14,850	11.3	29,700	8.8	445.50	4.2
Lagulo	Squid jigger	Sq Jig	125	14	1.5	5	25	9	28,125	21.5	42,188	12.5	393.75	3.7
Saliwsiw	Hook and line	H&L	65	10	1.5	4	20	10	13,000	9.9	19,500	5.8	130	1.2
Seins/trawls														
Palukso	Modified drift trawl	Mod D Trawl	38.5	750	4.5	4.5	17.5	9	6,064	4.6	27,287	8.1	4,547.81	42.7
Palakaya	Round haul seine	Round HS	8	600	15.5	5.5	1.5	9	1,080	0.8	16,740	5	648	6.1
Pangulong	Purse seine	Purse S	2	38	27.5	11	22	10	440	0.3	12,100	3.6	16.72	0.2
Sinsoro (Pamolinao	Beach seine	BS (Bolinao)	6	80	15	2.5	12.5	8	600	0.5	9,000	2.7	48	0.5
Tikpaw (Silag)	Beach seine	BS (Silag)	12	10	1.5	3	15	9	1,620	1.2	2,430	0.7	16.20	0.2
Tikpaw (Sirum-sirum)	Beach seine	BS (Sirum))	157	160	1.5	3	15	9	21,195	16.2	31,793	9.5	3,391.20	31.8
Traps														
Bubo sa Sira	Fish Trap	F trap	8	10	3.5	3.5	3	12	288	0.2	1008	0.3	2.88	0
Bubo sa Pusit	Squid Trap	Sq trap	11	5	1	3.5	4	9	396	0.3	396	0.1	1.98	0
								Total	**131,069.3**	**100**	**336,186.6**	**100**	**10,654.5**	**100**
								Weighted median kg/fisher/trip	**31.7**					
								Weighted median kg/trip	**81.3**					

Table 16b. Seasonality of fishing operations in Balatan, Camarines Sur (February 20, 2020). Arrows indicate the fishing months and shaded areas indicate the peak months.

Fishing Gear		Month														
Local Name	English Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	F mos./ year	Peak mos.	Catch composition
Gill Nets																
Kurantay	Drift gill net	←											→	9	Nov-Dec	Lawlaw, Galunggong, Kuwaw
Pangke (Lubog)	Surface gill net	→											←	12	May-Aug	Mbaka, Galunggong, Kabalyas, Turin-gan, Tiso, Dorado, assorted fishes
Pangke (Ibabaw)	Bottom set gill net	←						→						12	Jan-Jul	Galunggong, Nordeste, Dilis, Tunsoy, Turingan
Pangke (Pang kasag)	Crab gill net					←			→					9	Jul-Aug	Silog, Sirum-sirum, Balao
Barangayan	Drift gill net	→											←	9	Mar-May	Matang baka, Kabalyas, Kuwao, Malimno, Galunggong, etc..
Bintol	Crab lift net	←											→	12	Oct-Jun	Bangkulis, Rayado, Pundahan, Ngipunan, Tanguigi, Malasugi
Hook and Lines																
Kitang	Bottom set longline	→											←	9	May-Jun	Lapu-lapu, Maya-maya, Bagoong, big Kuwao, Mirapina
Lagulo	Squid jigger	→						→					←	9	May Jun	Turingasn, Galunggong, Kuwao, Tunsoy, Kabalyas, Matangbaka
Saliwsiw	Hook and line							→					←	10	Jun-Jul	Tuna
Seins/Trawls																
Palukso	Modified drift trawl				←								→	9	April-May	Lawlaw
Palakaya	Round haul seine	←									→			9	Oct-Dec	Turingan, Sibubong, Bolinao, Salaysalay, Galunggong, Kabalyos
Pangulong	Purse seine			→							←			10	Mar-Apr	Lawlaw, Galunggong, Turingan, Baraw, Matangbaka, Newlook, etc.
Sinsoro (Pamolinao	Beach seine					←							→	8	Nov-Dec	Bolinao
Tikpaw (Silag)	Beach seine	→										←		9	Dec-Mar	Silag na Bolinao
Tikpaw (Sirum-sirum)	Beach seine	→										←		9	Dec-Mar	Sirom sirom
Traps																
Bubo sa Sira	Fish Trap	←						→					→	12	Jun-Oct	Tagisi, Lapu-Lapu, Maya Maya
Bubo sa Pusit	Squid Trap	→										←		9	Nov-Dec	Kanoos

Table 17a. Catch matrix for Pio Duran, Albay (January 31, 2020).

Fishing Gear														
Local Name	English Name	Code	Gear units	Median kg/trip	No. of fishers/ trip	No. of hrs. trip	Fishing days/ month	Fishing mos./ year	Fishing trips/ year	%	Fishing days/ year	%	Estimated annual catch (MT)	%
Gill Nets														
Largarete	Drift gill net (Pamo)	DGN	99	375	6	12	25	6	14,850	12.4	89,100	21.6	5,568.75	66.8
Patitig	Bottom set gill net	BSGN	65	10	4.5	4.5	20	5	6,500	5.4	29,250	7.1	65	70.8
Barangay	Drift gill net	DGN*	100	10	4.5	12	25	9	22,500	18.8	101,250	24.6	225	2.7
Palutang	Surface gill net	SGN	26	20	3	12	15	8	3,120	2.6	9,360	2.3	62.4	0.7
Labay Labay	Bottom set gill net (Pamo w/o weight)	BSGN*	43	12.5	2	12	20	6	5,160	4.3	10,320	2.5	64.5	0.8
Basnig	Bagnet	Bag net	1	3.5	15	12	15	7	105	0.1	1,575	0.4	0.3675	0.0
Bugkat	Surface gill net	SGN*	4	25	4.5	4	13.5	5	270	0.2	1,215	0.3	6.75	0.1
Hook and Lines														
Pakitang	Mutliple hook & line	MHL	43	7.5	2	4	20	9	7,740	6.5	15,480	3.8	58.05	0.7
Lagulo	Simple hook & line	SHL	72	2.5	1.5	10	20	6	8,640	7.2	12,960	13.1	21.6	0.3
Tangkab	Squid jigger	Sq Jig	133	7.5	1.5	12	25	8	26,600	22.2	39,900	9.7	199.5	2.4
Balakwit	Troll line	Troll	32	20	2	6	15	6	2,880	2.4	5,760	1.4	57.6	0.7
Seins/trawls														
Sinsuro	Beach seine/ Boat seine	BS	38	10	4.5	2	30	10	11,400	9.5	51,300	12.4	1141	1.4
Palakaya	Round haul seine	RHS	7	50	12.5	12	27.5	6	1,155	1.0	14,437.5	3.5	57.75	0.7
Pangulong	Purse seine	PS	1	5,000	50	12	30	12	360	0.3	18,000	4.4	1,800	21.6
Traps														
Bubo sa Sira	Fish trap	Fish trap	14	5	2	2.5	30	9	3,780	3.2	7,560	1.8	18.9	0.2
Bubo sa Kasag	Crab trap	Crab trap	2	2	1	12	30	9	540	0.5	540	0.1	1.08	0
Miscellaneous														
Pana	Spear	Spear	18	3	1	3	20	12	4,320	3.6	4,320	1.0	12.96	0.2
								Total	**119,920**	**100**	**412,327**	**100**	**8,334.2**	**100**
								Weighted median kg/fisher/trip	**20.2**					
								Weighted median kg/trip	**69.5**					

Table 17b. Seasonality of fishing operations in Pio Duran, Albay (January 31, 2020). Arrows indicate the fishing months and shaded areas indicate the peak months.

Fishing Gear		Month														
Local Name	English Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	F mos./ year	Peak mos.	Catch composition
Gill Nets																
Largarete	Drift gill net (Pamo)	→	→	→								←	←	6	Nov-Dec	Clupeidae, Scombridge, Carangidae
Patitig	Bottom set gill net						←	←	←	←				5	Jul-Aug	Scombridge, Carangidae
Barangay	Drift gill net			→	→	→	→	→				←	←	9	Mar-May	Scombridge, Carangidae
Palutang	Surface gill net	→	→	→	→	→							→	8	Dec-Mar	Scombridge, Marlin
Labay Labay	Bottom set gill net (Pamo w/o weight)	←	←	←	←	←	→	→	→	→				6	Jan-Mar	Scombridge, Carangidae Menidae
Basnig	Bagnet			←	←	←	←	←	←	←	←	←	→	7	Mar-May	Clupeidae, Engraulidae, Carangidae, Squid
Bugkat	Surface gill net	→	→	→								←	←	5	Dec-Feb	Flying fish, Hemiramphid
Hook and Lines																
Pakitang	Mutliple hook & line	←	←	←	←	←	→	→	→	→	←	←	←	9	Nov-Mar	Priacanthidae, Nemipteridae, Carangiae
Lagulo	Simple hook & line			←	←	←	←	→	→	→	→	→	→	5.5	Mar-May	Carangidae, Scombridae
Tangkab	Squid jigger	←	←	←	←	←	←	←	←	←	←	←	←	8	Jun-Aug	Giant Squid (Sepio)
Balakwit	Troll line	←	←	←	←	←	→	→	→	→	→	→	→	6	Jan-Mar	Scombridae
Seins/Trawls																
Sinsuro	Beach seine/ Boat seine	←	←	←	←	←	←	→	→	→	←	←	←	10	Dec-May	Scombridae Cluepid, Engraulidae, Carangidae
Palakaya	Round haul seine	←	←	←	←	←	→	→	→	→	→	→	→	6	Mar-May	Carangidae, Menidae, Clupeidae, Scombridae
Pangulong	Purse seine	←	←	←	←	←	←	←	←	←	←	←	←	12	No peak	Leiognothidae, Engraulidae, Fry, Shrimp
Traps																
Bubo sa Sira	Fish trap	→	→	→	→	→	→	→	→	→	←	←	←	9	Dec-Feb	Lutjanidae, Serranidae, Nemipteridae
Bubo sa Kasag	Crab trap	→	→	→	→	→	→	→	→	→	←	←	←	9	No peak	Portunidae
Miscellaneous																
Pana	Spear	←	←	←	←	←	←	←	←	←	←	←	←	12	No peak	Siganidae, Serranidae, Scaridae

Donsol, Sorsogon

There were 23 fishing gear types identified in Donsol, Sorsogon (Table 18a). The estimated annual catch is 11,547 mt, contributed mostly by drift gillnets (69.3%). The reported median daily catch rate across the various gear types ranged from 0.33 – 90.9 kg/fisher/trip, with an overall weighted median value of 14.8 kg/fisher/trip. There were 2,140 gear units recorded in the area, with the majority of gear types (13/23) operating year-round with catches peaking during the northeast monsoon (Table 18b). This results in relatively higher fishing effort, which is 3–5 times more compared to the areas presented earlier, but not necessarily resulting in a higher catch in comparison to those in Balatan and Bulan. The bulk of the fishing effort is contributed by gill nets and various lines which catch a variety of resources such as small & large pelagics, reef-associated fish, crustaceans, and mollusks.

Magallanes, Sorsogon

For Magallanes, Sorsogon, only 3 of the 20 coastal barangays were able to participate in the focus group discussion. The team originally planned to return and conduct the FGD for the remaining barangays however because of Covid-19 travel restrictions they were not able to do so. This explains the relatively few fishing gear types (9) identified in the area (Table 19a). The estimated annual catch for the gears identified is 1,001.8 mt, contributed mostly by gill nets (72.4%) particularly drift gill nets (67.3%) which target sardines. The reported median daily catch rate across the various gear types ranged from 1.0 – 100.0 kg/fisher/trip, with an overall median value (weighted by catch) of 8.6 kg/fisher/trip. Most of the fishing gears are operated year-round and varied in terms of peak season (Table 19b). For gill nets and lines, catches peak during the northeast monsoon months, whereas traps targeting squid, crabs, and shrimp peak during southwest monsoon months (Jun-Aug).

Bulan, Sorsogon

There were 20 fishing gear types identified in Bulan, Sorsogon (Table 20a). The estimated annual catch is 30,106.1 mt, contributed mostly by drift gill nets (47.2%) and bottom set gill nets (47.8%). Drift gill nets target sardines whereas bottom set gill nets catch a mix of species. The reported median daily catch rate across the various gear types ranged from 1.0 – 357.1 kg/fisher/day, with an overall weighted median value of 55.4 kg/fisher/day. Half of the gear types (mostly traps and gill nets) operate year-round with no reported peak months, while the remaining half (including drift gill nets, but mostly seines, hook & lines) operates for about 4-9 months, with catches peaking during the northeast monsoon months towards the summer (Table 20b). The gear map showed extensive fishing operations of drift gill nets, reaching Burias Island in the northern portion of FMA 7 down to San Vicente/Capul islands in the south.

Table 18a. Catch matrix for Donsol, Sorsogon (January 31, 2020).

Fishing Gear														
Local Name	English Name	Code	Gear units	Median kg/trip	No. of fishers/ trip	No. of hrs. trip	Fishing days/ month	Fishing mos./ year	Fishing trips/ year	%	Fishing days/ year	%	Estimated annual catch (MT)	%
Gill Nets														
Barangay	Drift gill net	DGN	101	37.5	4.5	11	15	7.5	11,362.5	3.1	51,131.3	6.6	426.1	3.7
Bugkat	Surface gill net	SGN**	19	10	4	5	20	12	4,560	1.3	18,240	2.3	45.6	0.4
Kurantay	Drift gill net	DGN**	2	5	2	4	15	6	180	0	360	0	0.9	0
Largarete	Drift gill net (Pamo)	DGN*	160	500	5.5	11	20	5	16,000	4.4	88,000	11.3	8,000	69.3
Padaraw	Scoop Net	Scoop Net	62	30	2	4	12	4	2,976	0.8	5,952	0.8	89.3	0.8
Palubog (Crab)	Crab gill net	BSGN (C)	78	5	2	12	15	12	14,040	3.9	28,080	3.6	70.2	0.6
Palubog (Fish)	Bottom set gill net	BSGN (F)	47	10	2	3.5	20	5	4,700	1.3	9,400	1.2	47	0.4
Palutang (Nylon)	Surface gill net	SGN	35	2	2	6	15	6	3,150	0.9	6,300	0.8	6.3	0.1
Palutang (Pamo)	Surface gill net	SGN*	9	5	3	12	15	12	1,620	0.4	4,860	0.6	8.1	0.1
Patitig (Gilid)	Bottom set gill net NS	BSGN (NS)	143	2	2	3.5	31	12	53,196	14.7	106,392	13.7	106.4	0.9
Patitig (Lawod)	Bottom set gill net OS	BSGN (OS)	90	10	4.5	3.5	15	12	16,200	4.5	72,900	9.4	162	1.4
Sud Sud	Push Net	PN	56	1	1	2	10	12	6,720	1.9	6,720	0.9	6.7	0.1
Hook and Lines														
Lagulo	Mutliple hook & line	MHL*	269	5	1.5	4	26	6	41,964	11.6	62,946	8.1	209.8	1.8
Pakitang	Mutliple hook & line	MHL	146	20	2	4	25	12	43,800	12.1	87,600	11.3	876	7.6
Pampating	Mutliple hook & line (Shark)	MHL (S)	103	30	2	12	15	3	4,635	1.3	9,270	1.2	139.1	1.2
Pangliwit	Simple hook and line	SHL	322	3	2	6	10	7	22,540	6.2	45,080	5.8	67.6	0.6
Sibid Sibid	Troll line	TL	126	5	1.5	4	30	12	45,360	12.5	68,040	8.7	226.8	2.0
Squid Jigger	Squid jigger	Sq Jig	252	25	2	10	25	6	37,800	10.4	75,600	9.7	945	8.2
Traps														
Bintol (Crab)	Crab pot	Crab pot	19	3	1	4	20	12	4,560	1.3	4,560	0.6	13.7	0.1
Bintol (Hipon)	Shrimp pot	Shrimp pot	8	0.5	1.5	6	15	6	720	0.2	1,080	0.1	0.4	0
Fish Pot	Fish pot	Fish pot	16	4.5	1	6	15	12	2,880	0.8	2,880	0.4	13	0.1
Squid Pot	Squid pot	Squid pot	38	5	1	2	30	12	13,680	3.8	13,680	1.8	68.4	0.6
Miscellaneous														
Pamana	Spear fishing	Spear	39	2	1	2	20	12	9,360	2.6	9,360	1.2	18.7	0.2
								Total	362,003.5	100	778,431.3	100	11,547	100
								Weighted median kg/fisher/trip	14.8					
								Weighted median kg/trip	31.9					

Table 18b. Seasonality of fishing operations in Donsol, Sorsogon (January 31, 2020). Arrows indicate the fishing months and shaded areas indicate the peak months.

Fishing Gear		Month														
Local Name	English Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	F mos./ year	Peak mos.	Catch composition
Gill Nets																
Largarete	Drift gill net (Pamo)													4-6	Dec-Jan	LawLaw, Tulingan, Kuwao (Big eye)
Barangay	Drift gill net													3-12	Jan-May	Tulingan, Matambaka, Buraw, Nodeste (Galunggong)
Palutang (Pamo)	Surface gill net													12	Oct-Jan	Tulingan, Tambakol, Mackarel
Palutang (Nylon)	Surface gill net													6	Dec	Pampano, Puti-puti (Talakitok), Tanigue
Patitig (Gilid)	Bottom set gill net NS													12	July-Sept	Mullid, Sapsap, Tamodyos, Salmonite
Patitig (Lawod)	Bottom set gill net OS													12	Nov-May	Matambaka, Galunggong, Burao
Sud sud	Push net													12	Oct-Dec	Hipon, Alimasag
Palubog (Fish)	Bottom set gill net													5	Jul-Aug	Talakitok, Altan (Sweet lips), Salay salay, Malibno
Palubog (Crab)	Crab gill net													12	Aug-Sept	Alimasag, Alatan, Pagi
Padaraw	Scoop net													4	Mar-Apr	Dilis,Nylon/Dilis puti/ Silag, Sirum sirum
Kurantay	Drift gill net*													6	Jan	Tulingan, Hasa-hasa, Galunggong
Bugkat	Surface gill net													12	Aug-Sept	Bugiw, dual, balamban
Hook and Lines																
Pakitang	Mutliple hook & line													12	Oct-Dec	Galunggong, Kuwao (Big eye), Kanasi, Tapas
Squid Jigger	Squid Jigger													6	July-Aug	Pusit (Giant-12 kg)
Lagulo	Multiple hook and line													7	No peak months	Kabalyas, Alumahan, Galunggong, Tunsoy, Lawlaw
Pampating	Multiple hook and line (Shark)													3	No peak months	Pating, Tuna, Malasugi
Pangliwit	Simple hook and line													7	Jan	Liwit (bait liwit), Gitara
Sibid Sibid	Troll line													12	Jun-Nov	Tulingan
Traps																
Squid pot	Squid pot													12	Jul-Oct	Sepiotiuthis
Bintol (Crab)	Crab pot													12	Nov-Jan	Alimasag, Alimango
Bintol (Hipon)	Lift net													6	Mar-May	Sugpo, Ligsawan (Puti hipon)
Fish pot	Fish pot													12	No peak months	Bisugo, Lapu-lapu, Maya-maya
Miscellaneous																
Pamana	Spear fishing													12	No peak months	Samaran, Lapu-lapu, Alimusan (Hito itom)

Table 19a. Catch matrix for Magallanes, Sorsogon (February 17, 2020).

Fishing Gear														
Local Name	English Name	Code	Gear units	Median kg/trip	No. of fishers/ trip	No. of hrs. trip	Fishing days/ month	Fishing mos./ year	Fishing trips/ year	%	Fishing days/ year	%	Estimated annual catch (MT)	%
Gill Nets														
BSGN for fish	BSGN (Fish)	BSGN	12	5	2	12	20	12	2,880	4	5,760	4.9	14.4	1.4
Labsag	BSGN (Crabs)	BSGN*	4	5	2	12	20	12	960	1.3	1,920	1.6	4.8	0.5
Largarete	Drift gill net	DGN	11	500	5	10	17.5	7	1,347.5	1.9	6,738	5.8	673.8	67.3
Pangke	Surface gill net	SGN	45	3	2	3.5	20	12	10,800	15	21,600	18.5	32.4	3.2
Hook and Lines														
Banwit	Simple hook & line	SHL	133	1.5	1	3	21	12	33,516	46.4	33,516	28.8	50.3	5
Jigger	Lagulo for Lipatang	Jig	5	2	1	3	16	6	480	0.7	480	0.4	1	0.1
Lagulo	Jigger for squids	Jig*	131	10	2.5	12	14	7	12,838	17.8	32,095	27.5	128.4	12.8
Traps														
Bintol	Crab pot	CP	18	2	1	12	20	12	4,320	6	4,320	0.6	8.6	0.9
Bubo trap	Fish trap	FT	14	17.5	2	24	30	12	5,040	7	10,080	0.1	88.2	8.8
								Total	**72,181.5**	**100**	**116,508.5**	**100**	**1,001.8**	**100**
								Weighted median kg/fisher/trip	**8.60**					
								Weighted median kg/trip	**13.88**					

Table 19b. Seasonality of fishing operations in Magallanes, Sorsogon (February 17, 2020). Arrows indicate the fishing months and shaded areas indicate the peak months.

Fishing Gear		Month														
Local Name	English Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	F mos./ year	Peak mos.	Catch composition
Gill Nets																
BSGN for fish	BSGN (Fish)	←										■	→	12	Nov-Dec	Kasag Portunidae, Bungkang Charybdis, Gerrys, Kurusan
Labsag	BSGN (Crabs)	←											→	12	No peak months	Kasag, Bungkang, Sakalan, Krusan
Largarete	Drift gill net		■	■	■	→							←	7	Feb-May	Lawlaw, Galunggong, Kuwaw, Burao
Pangke	Surface gill net	←											→	12	No peak months	Osoos, Sapsap, Tabirus, Tabudyos/mullet
Hook and Lines																
Banwit	Simple hook & line	←											→	12	No peak months	Osoos, Latab, Kanasi, Ponong
Jigger	Lagulo for Lipatang	←	■	■	■	→								6	Feb-May	Lipatang (Anchovy)
Lagulo	Jigger for squids	←		■	■	■	→							7	Mar-May	Pusit
Traps																
Bintol	Crab pot	←						■	■	→				12	Jul-Aug	Kasag, Bungkang
Bubo trap	Fish trap	←						■	■	■	■	■	→	12	Jun-Oct	Kasag, Krusan, Bungkang

Table 20a. Catch matrix for Bulan, Sorsogon (February 17, 2020).

Fishing Gear															
Local Name	English Name	Code	Gear units	Median kg/trip	No. of fishers/ trip	No. of hrs. trip	Fishing days/ month	Fishing mos./ year	Fishing trips/ year	%	Fishing days/ year	%	Estimated annual catch (MT)	%	days/ year
Gill Nets															
Barangay Bugkat	Drift gill net	DGN*	89	37.5	4.5	11	15	7.5	2,160	1.8	4,320	0.8	64.8	3.7	240
Largarete	Drift gill net	DGN	40	10	4	5	20	12	47,376	39.3	355,320	65.3	14,212.8	47.21	168
Pangkasa Net	BSGN for crabs	BSGN	63	5	2	4	15	6	2,160	1.8	3,240	0.6	21.6	0.07	48
Pangke (Gillnet)	Gill net	GN	160	500	5.5	11	20	5	3,960	3.3	13,860	2.5	122.8	0.41	72
Patitig	Bottom set gill net	BSGN	62	30	2	4	12	4	4,800	4	84,000	15.4	14,400	47.83	240
Tambogan	Ring net	RN*	78	5	2	12	15	12	400	0.3	2,800	0.5	1,000	3.32	40
Tombolan	Drift gill net w/ scaring device	DGN*	47	10	2	3.5	20	5	1,800	1.5	2,700	0.5	10.8	0.04	120
Hook and Lines															
Banwit	Handline	HL*	89	5	1	4	30	7	18,690	15.5	18,690	3.4	93.5	0.31	210
Kitang	Bottom set long line	BSLL	40	5	1.5	48	30	12	14,400	11.9	21,600	4	72	0.24	360
Lugulo	Jigger	Jig	63	1	1	8	150	4	2,520	2.1	2,520	0.5	2.5	0.01	40
Traps															
Bubo (Pangkasag)	Crab trap	Crab pot	19	3	1	4	20	12	576	0.5	576	0.1	2.9	0.01	144
Bubo (Pangpusit)	Squid trap	Shrimp pot	8	0.5	1.5	6	15	6	3,600	3	5,400	1	36	0.12	360
Bubo (Pangsira)	Fish pot	Fish pot	16	4.5	1	6	15	12	10,800	9	21,600	4	54	0.18	360
Miscellaneous															
Compressor	Compressor	Comp	0	27.5	3	5	16	12	0	0	0	0	0	0	192
Pana	Spear	Spear	5	2.5	1	2	25	12	1,500	1.2	1,500	0.3	3.8	0.01	300
Rapala	Fishing lures	FL	80	1	1	8	10	4	3,200	2.7	3,200	0.6	3.2	0.01	40
Matyang		MT	63	2	1	8	10	4	2,520	2.1	2,250	0.5	5	0.02	40
Tiktik		TK	5	5	1	4	5	4	100	0.1	100	0	0.5	0	20
								Total	120,562	100	543,946	100	30,106	100	3,129
								Weighted median kg/fisher/trip	55.35						
								Weighted median kg/trip	249.71						

Table 20b. Seasonality of fishing operations in Bulan, Sorsogon (February 17, 2020). Arrows indicate the fishing months and shaded areas indicate the peak months.

Fishing Gear		Month														
Local Name	English Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	F mos./ year	Peak mos.	Catch composition
Gill Nets																
Barangayan Bugkat	Drift gill net	←						■					→	12	Jul	Dual, Batkan, Lliw, Bugiw
Kalansisi	Ring net				→	■				←				9	Apr-May	Turingan, Bolinao, Mamsa
Largarete	Drift gill net			→	■	■					←			8	Mar, Apr, May	Lawlaw
Pangkasa Net	BSGN for crabs	←				■						■	→	12	Nov & May	Kasag, Assorted fish
Pangke (Gillnet)	Gill net	←											→	12	No peak months	Bagaong, Osoos, Buraw, Latab, Saramolyete
Patitig	Bottom set gill net	←											→	12	No peak months	Assorted fish
Tambogan	Ring net				←			■	→					4	Jul	Alubaybay, Chevrolet
Tombolan	Drift gill net w/ scaring device	←											→	12	No peak months	Titso, Asoos, Lawihan, Lawlaw
Hook and Lines																
Banwit	Handline				←						→			7	No peak months	Putian, Talakitok, Mablad, Kanasi
Kitang	Bottom set long line	←											→	12	No peak months	Baraka, Pagi, Mablad, Mamsa, Kanasi
Lagulo	Jigger									←	■	■	→	4	Oct-Nov	Kanoos, Kulambotan
Seine/Trawl																
Sensoro	Beach seine/ Boat seine				→	■				←				9	Apr-May	Turingan, Bolinao
Traps																
Bubo (Pangkasag)	Crab trap	←											→	12	No peak months	Kasag
Bubo (Pangpusit)	Squid trap	←											→	12	No peak months	Pusit
Bubo (Pangsira)	Fish pot	←											→	12	No peak months	Baraka, Pusit, Bagoong
Miscellaneous																
Compressor	Compressor	←											→	12	No peak months	Talakitok
Pana	Spear	←											→	12	No peak months	Kasag, Alimango, Lapu-lapu, Kanasi
Rapala	Fishing lures									←	■	■	→	4	Oct-Nov	Tanguige, Tulingan, Mamsa
Matyang										←	■	■	→	4	Oct Nov	Kanoos, Kulambotan
Tiktik				←	■	■	→							4	Apr-Jun	Silag, Kabalyas, Matangbaka

Claveria, Masbate

In Claveria, Masbate, 16 fishing gear types were identified (Table 21a). The estimated annual catch is 3,029.2 mt, contributed mostly by fish corrals (19.3%) and gill nets, particularly drift gill nets or *largarete* (27.7%) and surface gill nets for flying fish (37.9%). The reported median daily catch rates across the various gear types ranged from 1.17 – 54.55 kg/fisher/trip, with an overall weighted median value of 18.2 kg/fisher/trip. Fishing effort is lower in Claveria compared to other areas which may be explained by the seasonal (4-8 mos.) operation of most fishing gears (13 out of 16). Catches peak during the northeast monsoon months (Table 21b) for gears targeting small and large pelagics, while catches peak during summer and southwest monsoon months for gears targeting reef-associated fish, crustaceans and mollusks. Year-round operations are shown by bottom set gill net, crab gill net and fish corral.

Monreal, Masbate

At least 10 fishing gear types were identified in Monreal, Masbate (Table 22a). Although few, the number of gear units of some of these gears were high, and all operate year-round (Table 22b). This results in a relatively high fishing effort comparable to Donsol, Sorsogon. The estimated annual catch, however, is only 5,728 mt and is comparatively low for the amount of fishing effort being put in. The bulk of the catch is contributed mostly by drift gill nets (66.5%) which target sardines. The median daily catch rates across the various gear types ranged from 0.62 – 42.31 kg/fisher/trip, with an overall median value (weighted by catch) of 8.88 kg/fisher/trip.

San Jacinto, Masbate

For San Jacinto, Masbate, there were at least seven fishing gear types identified (Table 23a). The estimated annual catch is 7,891.4 mt and is higher compared to other areas in Masbate even with relatively low fishing effort. The median daily catch rates of the various gear types ranged from 1.0 – 80.0 kg/fisher/trip, with an overall weighted value of 31.1 kg/fisher/trip. Multiple hook and line operated all year round and contributed the most to the annual catch (62.2%), which targets a variety of species such as bigeye scads, round scads, threadfin breams and sharks. This is followed by drift gill nets (18.3%) which target sardines, and bottom set gill nets (18.3%) which target cephalopods and other pelagics such as jacks & round scads (Table 23b).

Pio V. Corpuz, Masbate

For Pio V Corpuz, 16 fishing gear types were identified (Table 24a). The estimated annual catch is 2,547.1 mt, contributed mostly by bottom set gill nets (33.0%) and drift gill nets (19.9%). These gears target sardines, jacks, round scads and reef-associated fish. The median daily catch rate of the various gear types ranged from 1.9 – 83.3 kg/fisher/trip, with an overall weighted value of 8.93 kg/fisher/trip. The majority of the fishing gears (13 out 16) operate throughout the year, with overall peak catches occurring during the NE monsoon months (Table 24b). Similar to Monreal, the estimated annual catch is low for the amount of overall fishing effort being put in.

Table 21a. Catch matrix for Claveria, Masbate (February 18, 2020).

Fishing Gear														
Local Name	English Name	Code	Gear units	Median kg/trip	No. of fishers/ trip	No. of hrs. trip	Fishing days/ month	Fishing mos./ year	Fishing trips/ year	%	Fishing days/ year	%	Estimated annual catch (MT)	%
Hook and Line														
Kitang	Bottom set longline	BSLL	47	12.5	2	8	13	7	4,277	6.6	8,554	5.1	53.5	1.8
Squid Jigger (Giant)	Squid Jigger (w/light)	Sq Jig (G)	41	30	2	6	12	6	2,952	4.6	5,904	3.6	88.6	2.9
Squid Jigger (Small)	Squid Jigger	Sq Jig	65	7.5	1.5	8	15	10	9,750	15.1	14,625	8.8	73.1	2.4
Ondak	Multiple hook & line	MHL	15	20	1.5	3	15	5	1,125	1.7	1,125	0.7	22.5	0.7
Gill Nets														
Lagarete/ Kurantay	Drift gill net (Pamo)	DGN (pamo)	14	600	11	11	10	10	1,400	2.2	15,400	9.3	840	27.7
Barangayan	Drift gill net	DGN	19	15	11	11	11	4	836	1.3	9,196	5.5	12.5	0.4
Patitig	Bottom set gill net	BSGN	29	5	1.5	5	22	12	7,656	11.8	11,484	6.9	38.3	1.3
Bugkat Pangbalo	Surface gill net (needlefish)	SGN (nf)	6	12.5	8.5	9	10	6	360	0.6	3,060	1.8	4.5	0.1
Patitig (Iliw)	Surface gill net (flyingfish))	SGN (ff)	102	75	2.5	7	15	10	15,300	23.6	38,250	23	1,147	37.9
Lagarete (Dilis)	Drift gill net (anchovies)	DGN (anc)	5	20	2.5	2	15	6	450	0.7	1,125	0.7	9	0.3
Pangke sa Kasag	Crab gill net	Crab GN	16	15	2	12	30	12	5,760	8.9	11,520	6.9	86.4	2.9
Seine/Trawl														
Sunsuro	Round haul seine	Round HS	6	17.5	15	1.5	20	8	960	1.5	14,400	8.7	16.8	0.6
Pukot Pangkanoos	Beach seine	Beach S	16	15	5.5	8	14	8	1,792	2.8	9,856	5.9	26.9	0.9
Traps														
Bubo sa sira	Fish trap	F Trap	13	10	3	12	22	8	2,288	3.5	6,864	4.1	22.9	0.8
Bunoan/Baklad	Fish corral	F corral	37	60	1.5	3	22	12	9,768	15.1	14,652	8.8	586.1	19.3
Bunoan (Danggit)	Fish corral (Danggit)	F corral (sig)	1	6.5	1.5	3	22	5	110	0.2	165	0.1	0.7	0
								Total	64,784	100	166,180	100	3,029.2	100
								Weighted median kg/fisher/trip	18.23					
								Weighted median kg/trip	46.76					

Table 21b. Seasonality of fishing operations in Claveria, Masbate (February 18, 2020). Arrows indicate the fishing months and shaded areas indicate the peak months.

Fishing Gear		Month														
Local Name	English Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	F mos./ year	Peak mos.	Catch composition
Hook & Lines																
Kitang	Bottom set longline													7	Feb-Mar	Dual, Batkan, Lliw, Bugiw
Squid Jigger (Giant)	Squid jigger (w/light)													6	Mar-Apr	Giant squid
Squid Jigger (Small)	Squid jigger													10	Nov-Jan (Pob 1) May-Aug (Pob 2)	Pusit
Ondak	Multiple hook & line													5	Jul-Aug	Assorted fish
Gill Nets																
Largarete/ Kurantay	Drift gill net (Pamo)													10	Dec-Mar	Lawlaw-Buraw, Turingan, Galunggong, Matangbaka, Newlook
Barangayan	Drift gill net													4	no peak months	Lawlaw-Buraw, Turingan, Galunggong, Matangbaka, Newlooki
Patitig	Bottom set gill net													12	Sep-May	Buraw, Tiso, Salaysay, Barakuda, Sapsap, Lagaw, Nordeste
Pangke sa Kasag	Crab gill net													12	Jul-Aug	Kasag, Tamaral, Manuping, Pagi
Bugkat Pangbalo	Surface gill net (needlefish)													6	Jul-Aug	Balo, Hemiramhus species
Patitig (lliw)	Surface gill net (flying fish)													10	Jul-Aug	Liiw, Balo, Dual
Largarete (dilis)	Drif gill net (for anchovies)													6	no peak months	Dilis
Seine/Trawl																
Sinsuro	Round haul seine													8	Jul-Aug	Assorted fish
Pukot Pangkanoos	Beach seine													8	Mar-Jun	Kanoos/cuttle fish
Traps																
Bunoan (Danggit)	Fish Corral (Danggit)													5	no peak months	Danggit, Sapsap, Manoping, Titso, Kulambatan, Lapu-Lapu
Bubo sa sira	Fish trap													8	Feb-May	Assorted Fish
Bunoan/ Baklad	Fish Corral													12	Mar-Jul	Dilis, Tulisok

Table 22a. Catch matrix for Monreal, Masbate (March 4, 2020).

Fishing Gear														
Local Name	English Name	Code	Gear units	Median kg/trip	No. of fishers/ trip	No. of hrs. trip	Fishing days/ month	Fishing mos./ year	Fishing trips/ year	%	Fishing days/ year	%	Estimated annual catch (MT)	%
Hook and Line														
Pakitang	Bottom set longline	BSLL	275	5	1.5	4	30	12	99,000	28.27	148,500	23.01	495	8.64
Lagulo	Multiple hook & line	MHL	330	5	1	6	30	12	118,800	33.93	118,800	18.41	594	10.37
Gill Nets														
Lagarete	Drift gill net	DGN	77	275	6.5	8	15	12	13,860	3.96	90,090	13.6	3,811.5	66.54
Baby Palutang	Surface gill net	SGN (baby)	118	5	3	8	20	12	28,320	8.09	84,960	13.17	141.6	2.47
Anod	Drive-in gill net	DGN	26	7	3	8	20	12	6,240	1.78	18,720	2.90	43.68	0.76
Palutang (Dagko)	Surface gill net	SGN (big)	7	20	4	8	20	12	1,680	0.48	6,720	1.04	33.6	0.59
Kalinsisi	Ring net	Ring N	7	275	15	8	15	12	1,260	0.36	18,900	2.93	346.5	6.05
Patitig	Bottom set gill net	BSGN	5	3	1.5	4	30	12	70,560	20.15	105,840	16.40	211.68	3.70
Pamalu-Bola	Trammel net	Trammel N	12	6	3	6	30	12	4,320	1.23	12,960	2.01	25.92	0.45
Boleste		Bol	17	4	6.5	6	30	12	6,120	1.75	39,780	6.16	24.48	0.43
								Total	350,160	100	6,452.70	100	5,728	100
								Weighted median kg/fisher/trip	8.88					
								Weighted median kg/trip	16.36					

Table 22b. Seasonality of fishing operations in Monreal, Masbate (March 4, 2020). Arrows indicate the fishing months and shaded areas indicate the peak months.

Fishing Gear		Month														
Local Name	English Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	F mos./ year	Peak mos.	Catch composition
Hook & Lines																
Pakitang	Bottom set longline	←	—	—	—	—	—	—	—	—	—	—	→	12	no peak month	Matangbaka, Boraw, Nordeste, Tulingan, Isdang Bato, Dalagang Bukid
Lagulo	Multiple hook & line	←	—	—	—	—	—	—	—	—	—	—	→	12	No peak month	Galunggong, Turingan, Nordeste, Boraw
Gill Nets																
Largarete	Drift gill net	■	■	←	—	—	—	—	—	—	—	■	→	10	Nov-Apr	Lawlaw, Galunggong, Turingan
Baby Palutang	Surface gill net	■	←	—	—	—	—	—	—	—	—	—	→	4	Jan-Mar	Turingan, Boraw
Anod	Drive-in gill net	■	■	■	■	■	←	—	—	—	—	—	→	12	Jan-June	Turingan, Boraw-Boraw, Matangbaka, Nordeste, Galunggong, Malasugi, Bukawbukaw, Sirum-Sirum
Palutang (Dagko)	Surface gill net	■	■	←	—	—	—	—	—	—	—	■	→	12	Dec-Apr	Blue Marlin, Yellowfin Tuna, Bangkulis, Manta Ray, Lumod
Kalinsisi	Ring net	←	—	—	—	—	—	—	—	—	—	—	→	6	no peak months	Lawlaw, Pusit, Turingan, Kabalyas, Galunggong, Dilis, Newlook,
Patitig	Bottom set gill net	←	—	—	—	—	—	—	—	—	—	—	→	10	no peak months	Matangbaka, Boraw, Nordeste, Tulingan, Isdang Bato, Dalagang Bukid
Pamalu-Balo	Trammel net	←	—	—	—	—	—	—	—	—	—	—	→	6	no peak months	Balo, Iliw, Burok, Batokad, Budiw
Boleste	Surface set gill net	←	—	—	—	—	—	—	—	—	—	—	→	10	no peak months	Buraw, Matangbaka, Turingan

Table 23a. Catch matrix for San Jacinto, Masbate (March 3, 2020).

Fishing Gear														
Local Name	English Name	Code	Gear units	Median kg/trip	No. of fishers/ trip	No. of hrs. trip	Fishing days/ month	Fishing mos./ year	Fishing trips/ year	%	Fishing days/ year	%	Estimated annual catch (MT)	%
Hook and Line														
Pakitang	Mutiple hook & line	MHL	186	100	2	8	22	12	49,104	41.1	98,208	38.7	4,910.4	62.22
Gill Nets														
Lagarete	Drift gill net (lar)	DGN (lar)	32	600	7.5	24	15	5	2,400	2	18,000	7.1	1,440	18.25
Barangay	Drift gill net (bgy)	DGN (bgy)	23	240	6.5	24	7	2	322	0.3	2,093	0.8	77.28	0.98
Palutang	Surface gill net	SGN	96	2	2	12	20	5	9,600	8	19,200	7.6	16.2	0.24
Patitig	Bottom set gill net	BSGN	160	25	2	3	30	12	57,600	48.2	115,200	45.4	1,440	18.25
Boleste		Bol	2	40	2	4.5	5	2	20	0	40	0	0.8	0.01
Traps														
Bubo sa Pasayan	Shimp pot	Shrimp P	20	7.5	2	3	5	5	500	0.4	1,000	0.4	3.75	0.05
								Total	119,546	100	253,741	100	7,891.4	100
								Weighted median kg/fisher/trip	31.10					
								Weighted median kg/trip	66.01					

Table 23b. Seasonality of fishing operations in San Jacinto, Masbate (March 3, 2020). Arrows indicate the fishing months and shaded areas indicate the peak months.

Fishing Gear		Month														
Local Name	English Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	F mos./ year	Peak mos.	Catch composition
Hook & Lines																
Pakitang	Bottom set longline	←	—	—	—	—	—	—	—	—	—	—	→	12	no peak month	Bokaw-Bokaw, Pating, Galunggong, Kanasi, Pinyapinya
Gill Nets																
Largarete	Drift gill net	■	→	—	—	—	—	—	—	←	—	—	■	10	Dec-Jan	Lawlaw, Bangkulis, Parangan Pino, Kuwao, Turingan
Barangay	Drift gill net											←	■	2	Dec	Galunggong, Turingan, Matangbaka, Lawlaw
Palutang	Surface gill net	←	—	■	→								↔	5	Apr-May	Galunggong, Turingan, Matangbaka, Lawlaw, Salaysalay
Patitig	Bottom set gill net	←	—	—	—	—	—	—	—	—	—	—	→	12	no peak months	Matangbaka, Galunggong, Kulambot, Bangkang, Moblad, Lipstik
Boleste												←	■	2	Dec	Lipstik, Galunggong, Red Tail
Trap																
Bubo sa Pasayan	Shrimp pot	←	—	→								←	■	5	Nov-Dec	Pasayan, Kasag, Lakon, Lobster, Alimango

Table 24a. Catch matrix for Pio V Corpuz, Masbate (March 5, 2020).

Fishing Gear														
Local Name	English Name	Code	Gear units	Median kg/trip	No. of fishers/ trip	No. of hrs. trip	Fishing days/ month	Fishing mos./ year	Fishing trips/ year	%	Fishing days/ year	%	Estimated annual catch (MT)	%
Hook and Line														
Lagulo for Lokus	Squid Jigger	Squid Jig	86	13	1	3	14	12	14,448	9.6	14,448	5.1	187.8	7.4
Kitang	Multiple hook & line	MHL	148	4	1.5	3	20	12	35,520	23.6	53,280	18.7	142.1	5.6
Handline	Handline	HL	160	7.5	1	4	15	12	28,800	19.2	28,800	10.1	216	8.5
Gill Nets														
Panglokus-pamusit	Squid gill net	Squid GN	53	7.5	4	7	15	12	9,540	6.3	38,160	13.4	71.6	2.8
Gill net (Pangdako)	Surface gill net	SGN (Big)	2	12.5	4	7	15	12	360	0.2	1,440	0.5	4.5	0.2
Pamuraw (Gill net)	Surface gill net	SGN*	33	12	2	3	20	12	7,920	5.3	15,840	5.6	95	3.7
Pamo	Drift gill net (Pamo)	DGN (Pamo)	31	30	3	7	15	12	5,580	3.7	16,740	5.9	167.4	6.6
Sapyaw	Scoop net	Sc. Net	23	20	5	4	15	12	4,140	2.8	20,700	7.3	82.8	3.3
Patitig	Bottom set gill net	BSGN	7	1000	12	8	30	4	840	0.6	10,080	3.5	840	33
Drift gill net (Palubog)	Drift gill net	DGN	80	10	2	3	15	12	14,400	9.6	28,800	10.1	144	5.7
Kurantay	Drift gill net	DGN*	18	60	3	6	15	12	3,240	2.2	9,720	3.4	194.4	7.6
Kalansisi/ Kubukan	Ring net	RN	1	1000	12	8	30	4	120	0.1	1,440	0.5	120	4.7
Payao with net	Baited lift net	BLN	27	17.5	4	6	30	6	4,050	2.7	16,200	5.7	70.9	2.8
Traps														
Bobo sa isda	Fish trap/pot	Fish pot	12	2.5	1	24	15	12	2,160	1.4	2,160	0.8	5.4	0.2
Squid pot	Squid trap/pot	Squid trap	45	15	2	6	15	12	8,100	5.4	16,200	5.7	121.5	4.8
Miscellaneous														
Pana Manual	Spearfishing	Spear	62	7.5	1	2	15	12	11,160	7.4	11,160	3.9	83.7	3.3
								Total	**150,378**	**100**	**285,168**	**100**	**2,547.1**	**100**
								Weighted median kg/fisher/trip	**8.9**					
								Weighted median kg/trip	**16.9**					

Table 24b. Seasonality of fishing operations in Pio V Corpuz, Masbate (March 5, 2020). Arrows indicate the fishing months and shaded areas indicate the peak months.

Fishing Gear		Month														
Local Name	English Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	F mos./ year	Peak mos.	Catch composition
Hook & Lines																
Lagulo for Lokus	Squid Jigger	◄	■	■	■	■	■	■	■	■	■	■	►	12	Jan-Mar	Rumpi, Galunggong, Talakitok
Kitang	Multiple hook & line	◄	■	■	■	■	■	■	■	■	■	■	►	12	Mar-Apr	Bisugo, Kilawan, Talakitok, Rumpi, Pagi, Pating
Handline	Simple hook & line	◄	■	■	■	■	■	■	■	■	■	■	►	12	Apr-May Sep-Nov	Reef fishes, Lapu-lapu, Maya-maya
Gill Nets																
Pangglokus-pamusit	Squid gill net	◄	■	■	■	■	■	■	■	■	■	■	►	12	Jul-Aug	Pusit
Gill net (Pangdako)	Surface gill net	◄	■	■	■	■	■	■	■	■	■	■	►	12	Jul-Oct	Iliw, Balo, Balila
Pamuraw (Gillnet)	Surface gill net	◄	■	■	■	■	■	■	■	■	■	■	►	12	Apr-May Nov-Jan	Alumahan
Pamo	Drift gill net	◄	■	■	■	■	■	■	■	■	■	■	►	12	Sep-Dec	Turingan, Tanguigi, Pagi, Malasugi
Sapyam	Scoop net	◄	■	■	■	■	■	■	■	■	■	■	►	12	Sep-May	Dilis
Patitig	Bottom set gill net	◄	■	■	■	■	■	■	■	■	■	■	►	4	Sep-Dec	Turingan, Talakitok, Buraw
Drift gill net (Palubog)	Drift gill net	◄	■	■	■	■	■	■	■	■	■	■	►	12	May-Jun	Galunggong, Alumahan, Salmonite
Kurantay	Drift gill net	◄	■	■	■	■	■	■	■	■	■	■	►	12	Nov-Dec	Tuloy
Kalansisi/ Kubkuban	Ring net	◄	■	■	■	■	■	■	■	■	■	■	►	4	Sep-Dec	Tulingan, Talakitok, Buraw
Payao with net	Baited lift net	◄	■	■	■	■	■	■	■	■	■	■	►	5	Aug	Lambiyaw, Marapati, Tamban
Traps																
Bobo sa isda	Fish trap	◄	■	■	■	■	■	■	■	■	■	■	►	12	Sep-Dec	Lapu-lapu, Labayan, Dalagang bukid, Uwak, Dusgo
Squid pot	Squid trap	◄	■	■	■	■	■	■	■	■	■	■	►	12	Jul	Lokus
Miscellaneous																
Pana Manomano	Spearfishing	◄	■	■	■	■	■	■	■	■	■	■	►	12	Apr-May	Crab, Bisugo, Lapu-lapu, Maya-Maya, Bonak, Small-medium octopus, Balat, Sea cucumber, Itang

Tarangnan, Samar

The catch matrix for Tarangnan is shown in Table 25a. There were 34 fishing gear types identified comprised of various modifications of gill nets, seines, hook & lines, and traps. The estimated annual catch of all gear types is 1,130.8 mt, 39.2% of which is contributed by gill nets, which target small and large pelagics, as well as crustaceans and reef-associated fish. The overall fishing effort of all gear types is very high, with the number of fishing trips/ year and fisher-days/year comparable to those in Donsol and Monreal, but the estimated annual catch is very low and is only equivalent to 15-30% of the catches of Donsol and Monreal. The median daily catch rate of the various gear types ranged from 0.25 – 12.5 kg/fisher/trip, with an overall weighted value of only 1.72 kg/fisher/trip. The majority of the gears (20 out of 34) are seasonal and peak catches occur during the northeast monsoon months. Most of the gears that operate year-round do not show peak months (Table 25b).

Catbalogan City, Samar

In Catbalogan City, Samar, 23 fishing gear types were identified (Table 26a). The estimated annual catch of all gear types is 2,420.2 mt, 48.9% of which is contributed by seines/trawls followed by dynamite fishing (18.0%), which catch primarily sardines. Like Tarangnan, the estimated annual catch is also relatively low if the overall fishing effort is considered. The median daily catch rate of the various gear types ranged from 1.0 – 87.5 kg/fisher/trip, with an overall weighted value of 6.81 kg/fisher/trip. Most gears operate year-round (14 out of 23) with peak catches during the northeast (NE) monsoon (Nov-Mar) or towards the summer (Apr-May) (Table 26b).

Sierra Island, Catbalogan City, Samar

In Sierra Island, Catbalogan City, at least nine fishing gear types were identified (Table 27a). Overall fishing effort is high and is contributed mostly by hook & lines (64.6-72.4%). The estimated annual catch of all gear types on the island is 894.8 mt, 75% of which is contributed by bottom set gill nets (29%), ring nets (15.4%) which target sardines, jacks, and mackerels, and bottom set longlines (30.6%), which target threadfin breams and barracudas. The median daily catch rates of the various gear types ranged from 0.33 – 8.33 kg/fisher/trip, with an overall weighted value of 1.7 kg/fisher/trip. All identified gears operate year-round and the catches peak during the northeast monsoon and summer months (Table 27b).

Daram, Samar

There were 18 fishing gear types identified in Daram, Samar (Table 28a). The estimated annual catch of all gear types is 4,294.5 mt, 63.8% of which is contributed by ring nets and encircling gill nets used with dynamite, which primarily target sardines and other small pelagics such as mackerels. The median daily catch rates of the various gear types ranged from 1.5 – 41.6 kg/fisher/trip, with an overall weighted value of 10.28 kg/fisher/trip. Similar to Catbalogan, almost all gear types operate year-round with peak catches during the northeast monsoon or towards the summer (Table 28b).

Table 25a. Catch matrix for Tarangnan, Samar (14 April 2021).

Fishing Gear														
Local Name	English Name	Code	Gear units	Median kg/trip	No. of fishers/ trip	No. of hrs. trip	Fishing days/ month	Fishing mos./ year	Fishing trips/ year	%	Fishing days/ year	%	Estimated annual catch (MT)	%
Hook and Line														
Kitang	Bottom set long line	BSL	186	2	1	7	30	7	39,060	11	39,060	5.9	78.12	6.91
Sanit	Squid Jigger	SG	230	2	1	7	15	4	13,800	3.9	13,800	2.1	27.6	2.44
Undak	Multiple handline	MHL	52	5	1	3	15	12	9,360	2.6	9,360	1.4	46.8	4.14
Pangawil (Pasayan)	Hook & line (shrimp)	HL (shrimp)	65	1	1	10	15	10	9,750	2.7	9,750	1.5	9.75	0.86
Pangawil	Simple handline	SHL	152	1	1	10	20	12	36,480	10.3	36,480	5.5	36.48	3.23
Pangawil panglaw	Simple handline for Nemipteridae	SHLN	20	1	1	10	30	12	7,200	2	7,200	1.1	7.2	0.64
Panlapu	Simple handline for Grouper	SHLG	20	0.5	1	4	30	7	4,200	1.2	4,200	0.6	2.1	0.19
Rambo noos	Hook and line	HL	5	1	1	4	15	12	900	0.3	900	0.1	0.9	0.08
Pangawil Pan-aso-os	Simple handline for Sillaginidae	SHLS	6	5	2	8	20	12	1,440	0.4	2,880	0.4	7.2	0.64
Gill Nets														
Panmasag	Crab gill net	CGN	220	1.5	2	8	30	12	79,200	22.3	158,400	24	118	10.51
Palubog	Bottom set gill net	BSGN	45	4	2	3	30	5	6,750	1.9	13,500	2	27	2.39
Panumbok	Encircling gill net	EGN	102	2	2	8	15	10	15,300	4.3	30,600	4.6	30.6	2.71
Pamasayan (Dragging) net	Sweeping gill net	SGN	86	1	2	5	30	10	25,800	7.3	51,600	7.8	25.8	2.28
Panumbok Baysa	Encircling gill net for Mojaras	EGNM	20	2	2	6	20	10	4,000	1.1	8,000	1.2	8	0.71
Push net	Push net	PN	15	1	1	3	15	6	1,350	0.4	1,350	0.2	1.35	0.12
Pamalanak net	Encircling gill net	EGN	8	1	2	8	15	10	1,200	0.3	2,400	0.4	1.2	0.11
Pocot panlambiyaw	Surface gill net for Trevally	SGNT	30	5	3	4	30	5	4,500	1.3	13,500	2.0	22.5	1.99
Pamoraw net	Surface gill net for Mackerels	SGNM	60	2	2	9	20	6	7,200	2	14,400	2.2	14.4	1.27
Pa-anod/ Pamasayan	Drift shrimp entangle net	DSEN	27	2	2	4	20	12	6,480	1.8	12,960	2.0	12.96	1.15
Ligkop	Ring net	RN	2	250	20	12	30	12	720	0.2	14,400	2.2	180	15.92
Warlog	Drift gill net	DGN	3	5	6	5	15	5	225	0.1	1,350	0.2	1.125	0.10

Fishing Gear														
Local Name	English Name	Code	Gear units	Median kg/trip	No. of fishers/ trip	No. of hrs. trip	Fishing days/ month	Fishing mos./ year	Fishing trips/ year	%	Fishing days/ year	%	Estimated annual catch (MT)	%
Seine/Trawls														
Pahulbot	Danish Seine	DS	21	2	3	6	30	12	7,560	2.1	22,680	3.4	15.12	1.34
Panhipon	Scoop seine for shrimp	SS	32	10	2	6	15	10	4,800	1.4	9,600	1.5	48	4.24
Trawl Panoos	DV Trawl	DVT	75	2	2	5	20	10	15,000	4.2	30,000	4.6	30	2.65
Trawl Pamasayan	Shrimp trawl	ST	87	3	2	11	20	5	8,700	2.4	17,400	2.6	26.1	2.31
Sarap noos	Scoop seine or squid	SSS	5	1	4	4	20	12	1,200	0.3	4,800	0.7	1.2	0.11
Sarap balo	Scoop seine for Garfish	SSG	5	2	2	6	30	12	1,800	0.5	3,600	0.5	3.6	0.32
Traps														
Pabhas net	Fish corral	FN	22	1	3	8	10	6	1,320	0.4	3,960	0.6	1.32	0.12
Bobo Panmasag	Crap pot	CP	10	2	2	8	30	4	1,200	0.3	2,400	0.4	2.4	0.21
Bobo isda	Fish pot	FP	12	2	2	5	30	3	1,080	0.3	2,160	0.3	2.16	0.19
Timeng	Crab pot	CP	80	5	2	12	30	12	28,800	8.1	57,600	8.7	144	12.73
Bobo noos	Squid pot	SP	25	1	1	5	15	7	2,625	0.7	2,625	0.4	2.625	0.23
Baklad	Set net (outoshi-ami)	SN	13	30	10	24	30	12	4,680	1.3	46,800	7.1	140.4	12.42
Bunu-an	Fish corral	FC	5	30	5	24	30	12	1,800	0.5	9,000	1.4	54	4.78
								Total	**355,480**	**100**	**658,715**	**100**	**1,130.8**	**100**
								Weighted median kg/fisher/trip	**1.72**					
								Weighted median kg/trip	**3.18**					

Table 25b. Seasonality of fishing operations in Tarangnan, Samar (14 April 2021).

Fishing Gear		Month														
Local Name	English Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	F mos./ year	Peak mos.	Catch composition
Hook & Lines																
Kitang	Bottom set longline													7	Jul-Dec	Lagaw, Baysa, Talho, Tinggog
Sanit	Squid jigger													4	Jan-Feb	Noos
Undak	Multiple handline													12	Jun-Aug	Tamban, Galunggong, Hasa-hasa
Pangawil (Pasayan)	Hook and line													10	Nov-Jan	Lokan
Pangwil	Simple handline													12	no peak months	Sagision, Aso-os
Pangwil panlagaw	Simple handline for Nimipteridae													12	no peak months	Lagaw, Sunog
Panlapu	Simple handline for Grouper													7	Nov-Feb	Lapu-lapu
Rambo noos	Hook and line													12	no peak months	Noos
Pangawil-Pan-aso-os	Simple handline for Sillaginidae													12	Aug-Oct	Aso-os, Lagaw
Gill Nets																
Panmasag	Crab gill net													12	Aug-Dec	Masag, Sunog
Palubog	Bottom set gill net													5	Dec-Jan	Boraw, Hasa-hasa, Talho
Panumbok	Encircling gill net													10	Nov-Jan	Baysa, Lawayan, Bago-bago
Pamasayan (Dragging) net	Sweeping gill net													10	Sep-Nov	Sap-sap. Pasayan
Panumbok Baysa	Encircling gill net for Mojaras													10	Nov-Jan	Baysa, Sap-sap
Push net	Push net													6	no peak months	Pasayan, Sap-sap, Tingog
Pamalanak net	Encircling gill net													10	Nov-Jan	Bolanok
Pocot panlambiyaw	Surface gill net for Trevally													5	Feb-May	Lambio
Pamoraw net	Surface gill net for Mackerels													6	Apr-Jun	Boraw, Sap-sap
Pa-anod/ Pamasayan	Drift shrimp entangle net													12	no peak months	Tangigi, Sap-sap, Puti
Ligkop	Ring net													12	no peak months	Hasa-hasa, Lambaio
Warlog	Drift gill net													5	Nov-Jan	Boraw

Fishing Gear		Month														
Local Name	English Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	F mos./ year	Peak mos.	Catch composition
Seines/Trawls																
Pahulbot	Danish seine	←											→	12	no peak months	Lapu-lapu, Labayan, Dalagang bukid, Uwak, Dusgo
Pahipon	Scoop seine for shrimp	←		■	■	■							→	10	Mar-Apr	Lokus
Trawl panoos	DV Trawl	■	■	→				←			■	■	■	10	Oct-Mar	
Trawl Pamasayan	Shrimp trawl								←		■	→		5	Oct	
Sarap noo	Scoop seine for Squid	←											→	12	no peak months	
Sarap balo	Scoop seine for Garfish	←											■	12	Dec	
Traps																
Pabhas net	Fish corral							←			■	■	→	6	Oct-Dec	Kikiro, Toros, Balanok
Bobo Panmasag	Crab pot						←	■	■					4	Jun-Aug	Masag
Bobo isda	Fish p;ot										←		■	3	Dec	Tinggag, Pating
Timeng	Crab pot	■	←								■	■	→	12	Oct-Jan	Masag
Bobo noos	Squid pot						←				■	■	→	7	Oct-Nov	Noos
Baklad	Set net (Outoshi-ami)	←											→	12	no peak month	Sap-sap, Boraw, Lambiao
Bunu-an	Fish corral	■	←									■	→	12	Nov-Jan	Noos, Sap-sap, Boraw, Hasa-hasa

Table 26a. Catch matrix for Catbalogan City, Samar (March 4, 2020).

Fishing Gear														
Local Name	English Name	Code	Gear units	Median kg/trip	No. of fishers/ trip	No. of hrs. trip	Fishing days/ month	Fishing mos./ year	Fishing trips/ year	%	Fishing days/ year	%	Estimated annual catch (MT)	%
Hook and Line														
Kawel	Simple hook and line	SHL	101	3	1	8	25	8	20,200	11.5	20,200	5.7	60.6	2.5
Undak	Mutliple hook and line	MHL	27	3	1	5	21	6	3,402	1.5	3,402	1	10.206	0.4
Sanit	Squid jigger	Sq Jig	28	4	2	10	15	10	4,200	2.4	8,400	2.4	16.8	0.7
Kitang	Bottom set longline	BSLL	22	4	1	4	26	12	6,864	3.9	6,864	1.9	27.456	1.1
Gill Nets														
Panumbok	Encricling gill net	EGN	59	6	2	9	26	7	10,738	6.1	21,476	6	64.428	2.7
Panmasag	Crab gill net	CGN	64	3	1	8	25	12	19,200	11	19,200	5.4	57.6	2.4
Trammel net	Trammel net	Trammel net	61	4	2	5	22	4	5,368	3.1	10,736	3	21.472	0.9
Pamalo gar fishing	Surface gill net for Garfish	SGN	4	20	3	13	17	12	816	0.5	2,448	0.7	16.32	0.7
Drift entangle net	Drift gill net	Drift GN	10	16	2	24	18	12	2,160	1.2	4,320	1.2	34.56	1.4
Paturay	Drive-in gill net	Drive-in GN	5	3	3	4	30	12	1,800	1	5,400	1.5	5.4	0.2
Pamasayan	Shrimp entangling net	Shrimp EN	15	4	2	6	24	12	4,320	2.5	8,640	2.4	17.28	0.7
Legkop	Ring net	Ring N	4	165	18	7	22	12	1,056	0.6	19,008	5.4	174.24	7.2
Palubog	Bottom set gill net	BSGN	32	7	2	3	30	12	11,520	6.6	23,040	6.5	80.64	3.3
Largarete	Drift gill net	DGN (Lar)	3	175	2	7	20	8	480	0.3	960	0.3	84	3.5
Seines/Trawls														
Pamasayan shrimp trawl	Trawl (shrimp)	Trawl	30	10	2	12	26	12	9,360	5.3	18,720	5.3	93.6	3.9
Pahulbot	Danish seine	Danish S	86	15	3	6	26	12	26,832	15.3	80,496	22.7	402.48	16.6
Buklad (Outoshi-ami)	Otoshi-ami	Oto	11	220	15	7	23	12	3,036	1.7	45,540	12.8	667.92	27.6
Palupad	Mid-water trawl	MWT	31	4	2	3	13	12	4,836	2.8	9,672	2.7	19.344	0.8
Traps														
Timing/Panggal	Crab pot	Crab P	35	3	1	8	21	12	8,820	5	8,820	2.5	26.46	1.1
Bobo Pangisda	Fish trap	Fish T	11	3	1	6	22	9	2,178	1.2	2,178	0.6	6,534	0.3
Bobo Pannoos	Squid trap	Squid T	6	3	1	8	30	6	1,080	0.6	1,080	0.3	3.24	0.1
Miscellenous														
Pamana	Spearfishing	Spear F	94	5	1	10	20	10	18,800	10.7	18,800	5.3	94	3.9
Dynamite (blastfishing)	Dynamite (blastfishing)	Dyn	22	5	2	3	30	12	7,920	4.5	15,840	4.5	435.6	18
								Total	174,986	100	355,240	100	2,420.2	100
								Weighted median kg/fisher/trip	6.81					
								Weighted median kg/trip	13.83					

Table 26b. Seasonality of fishing operations in Catbalogan, Samar (March 4, 2020).

Fishing Gear		Month														
Local Name	English Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	F mos./ year	Peak mos.	Catch composition
Hook & Lines																
Kawel	Simple hook and line	◄	►									◄	►	8	Jan-Feb	Sagisoon, Aso-os, Lagao
Undak	Mutliple hook and line			◄	►	►	►	►	►					6	May-Jun	Lagao, Sagisoon, Aso-os
Sanit	Squid jigger	◄	►	►	►									10	Mar-Apr	Noos
Kitang	Bottom set longline	◄	►	►	►	►							►	12	Mar-May	Sagisoon, Tingag, Aso-os
Gill Nets																
Panumbok	Encricling gill net						◄	►	►	►	►	►	►	7	Aug-Dec	Balanak, Mublad, Danggit, Masag
Panmasag	Crab gill net	◄	►	►	►	►	►	►					►	12	Jun-Aug	Masag
Trammel net	Trammel net			◄	►									4	no peak months	Pasayan puti
Pamalo gar fishing	Surface gill net for Garfish	◄	►	►	►	►	►	►	►	►	►	►	►	12	Nov-Dec	Balo
Drift entangle net	Drift gill net	◄	►	►	►	►	►	►	►	►	►	►	►	12	no peak months	Agumaa, Buraw, Balo
Paturay	Drive-in gill net	◄	►	►	►	►	►	►	►	►	►	►	►	12	Feb-Dec	Hasa-hasa, Agumaa, Buraw
Pamasayan	Shrimp entangling net	◄	►	►	►	►	►	►	►	►	►	►	►	12	Feb-Jun	Pasayan puti, Suahe
Legkop	Ring net	◄	►	►	►	►	►	►	►	►	►	►	►	12	Aug-Dec	Tamban, Hasa-hasa
Palubog	Bottom set gill net	◄	►	►	►	►	►	►	►	►	►	►	►	12	Apr-Jun	Sagison, Hilos, Sap-sap, Baysa
Largarete	Drift gill net	◄	►	►	►							◄	►	8	Feb-Apr	Tamban, Hawal-hawal, Hilos
Seines/Trawls																
Pamasayan shrimp trawl	Trawl (shrimp)	◄	►	►	►	►	►	►	►	►	►	►	►	12	Sep-Mar	Borok, Suahe, Bangkigan
Pahulbot	Danish seine	◄	►	►	►	►	►	►	►	►	►	►	►	12	Mar-Dec	Sap-sap, Noos, Baga-baga, Lawayan
Buklad (Outoshi-ami)	Otoshi-ami	◄	►	►	►	►	►	►	►	►	►	►	►	12	Jun-Aug	Agumaa, Hasa-hasa, Lambiao, Tanguige
Palupad	Mid-water trawl	◄	►	►	►	►	►	►	►	►	►	►	►	12	Oct-Nov	Noos, Lawayan
Traps																
Timing/Panggal	Crab pot	◄	►	►	►	►	►	►	►	►	►	►	►	12	Dec-Jan	Masag
Bobo Pangisda	Fish trap				◄	►	►	►	►	►	►	►	►	9	Jun-Nov	Tinggag, Sunog, Moong
Bobo Pannoos	Squid trap						◄	►	►	►	►			6	Jul-Aug	Noos
Miscellaneous																
Pamana	Spearfishing	◄	►				◄	►	►	►	►	►	►	10	no peak monrths	Lapu-lapu, Masag, Maya-maya
Dynamite (blastfishing)	Dynamite (blastfishing)	◄	►	►	►	►	►	►	►	►	►	►	►	12	Jan-Oct	Bolinao, Tamban, Hasa-hasa, Tanguigue

Table 27a. Catch matrix for Sierra Island, Catbalogan City, Samar (February 15, 2021)

Fishing Gear														
Local Name	English Name	Code	Gear units	Median kg/trip	No. of fishers/ trip	No. of hrs. trip	Fishing days/ month	Fishing mos./ year	Fishing trips/ year	%	Fishing days/ year	%	Estimated annual catch (MT)	%
Gill Net														
Panmasag	Crab entangling net	Crab EN	21	2	2	6	30	12	7,560	2.7	15,120	2.9	15.12	1.7
Palubog	Bottom set gill net	BSGN	180	4	2	2	30	12	64,800	23.3	129,600	24.7	259.2	29
Panumbok	Encircling gill net	EGN	3	2	6	1	30	12	1,080	0.4	6,480	1.2	2.16	0.2
Baranggayan	Drift gill net	DGN	3	50	6	4	30	12	1,080	0.4	6,480	1.2	54	6.0
Tambugan	Surface gill net	SGN	2	40	12	2	30	12	720	0.3	8,640	1.6	28.8	3.2
Pangulong	Ringnet with light	RN w/ light	9	85	12	2	15	12	1620	0.6	19,440	3.7	137.7	15.4
Hook and Line														
Kitang	Bottom set longline	BSLL	380	2	2	3	30	12	136,800	49.1	273,600	52.2	273.6	30.6
Kawil	Simple hook and line	SHL	30	1.5	1	12	30	12	10,800	3.9	10,800	2.1	16.2	1.8
Sanit	Squid Jigger	Sq Jig	300	2	1	12	15	12	54,000	19.4	54,000	10.3	108	12.1
								Total	278,460	100	524,160	100	894.8	100
								Weighted median kg/fisher/trip	1.71					
								Weighted median kg/trip	3.21					

Table 27b. Seasonality of fishing operations in Sierra Island, Catbalogan City, Samar (February 15, 2021).

Fishing Gear		Month														
Local Name	English Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	F mos./ year	Peak mos.	Catch composition
Hook and Line																
Panmasag	Crab entangling net								■					12	Aug	Masag
Palubog	Bottom set gill net	■											■	12	Dec-Jan	Agumaa, Boraw, Alho, Matambaka
Panumbok	Encircling gill net				■	■	■							12	Apr-Jun	Boraw, Baysa, Tambang, Dalagang bukid
Baranggayan	Drift gill net	■											■	12	Dec-Jan	Boraw, Tangigue, Panit
Tambugan	Surface gill net	■	■											12	Jan-Feb	Panit, Turingan, Boraw
Pangulong	Ringnet with light				■	■								12	Apr-May	Panit, Tangigue, Tamban, Mamsa, Sap-sap, Hasa-hasa
Seines/Trawls																
Kitang	Bottom set longline													12	no peak months	Lagaw, Sagision, Sunog, Alho, Aguma-a
Kawil	Simple hook and line													12	no peak months	Tinag, Mamsa
Sanit	Squid Jigger	■											■	12	Dec-Jan	Noos

Table 28a. Catch matrix for Daram, Samar (February 19, 2020).

Fishing Gear														
Local Name	English Name	Code	Gear units	Median kg/trip	No. of fishers/ trip	No. of hrs. trip	Fishing days/ month	Fishing mos./ year	Fishing trips/ year	%	Fishing days/ year	%	Estimated annual catch (MT)	%
Hook and Line														
Sanit	Squid Jigger	Sq Jig	53	5	1	6	24	7	8,904	6.1	8,904	2.1	44.5	1.0
Kawil	Simple hook and line	SHL	87	4	1	5	20	10	17,400	11.9	17,400	4.2	69.6	1.6
Undak	Multiple hook and line	MHL	41	4	2	4	26	12	12,792	8.7	25,584	6.1	51.2	1.2
Kitang	Bottom set longline	BSLL	4	5	1	5	20	12	960	0.7	960	0.2	4.8	0.1
Gill Nets														
Palubog	Bottom set gill net	BSGN	74	6	2	3	26	12	23,088	15.8	46,176	11.1	138.5	3.2
Ligkop	Ring net	Ring N	35	105	11	11	28	12	11,760	8	129,360	31	1,234.8	2.8.8
Palutaw	Surface gill net	SGN (garfish)	13	73	2	6	25	9	2,925	2	5,850	1.4	213.5	5
Pamalo	Surface gill net for Garfish	SGN	23	7	2	4	27	12	7,452	5.1	14,904	3.6	52.2	1.2
Panamasag	Crab gill net	CGN	31	3	2	10	26	10	8,060	5.5	16,120	3.9	24.2	0.6
Pa arak	Encircling gill net w/ dynamite	EGN w/ dynamite	12	560	15	12	28	8	2,688	1.8	40,320	9.6	1,505.3	35.1
Treenet	Trammel net	Trammel N	12	5	2	5	26	12	3,744	2.6	7,488	1.8	18.7	0.4
Seines/Trawls														
Pamasayan	Trawl (shrimp)	Trawl (shr)	15	6	2	9	30	12	5,400	3.7	10,800	5.3	32.4	0.8
Pahulbot	Danish seine	Danish S	25	5	3	4	25	12	7,500	5.1	22,500	22.7	37.5	0.9
Panno-os	Bottom trawl	Bottom T	9	7	2	5	27	12	2,916	2	5,832	12.8	20.4	0.5
Otter trawl	Otter trawl	Otter T	6	375	9	12	27	12	1,944	1.3	17,496	2.7	729	17
Traps														
Teming, Pangal	Crab pot	Crab P	65	4	2	7	25	12	19,500	13.3	39,000	2.5	78	1.8
Bentol	Crab lift net	Crab LN	19	4	1	6	26	12	5,928	4.1	5,928	0.6	23.7	0.6
Miscellenous														
Pamana	Spearfishing	Spear F	18	5	1	4	20	9	3,240	2.2	3,240	5.3	16.2	0.4
								Total	146,201	100	417,862	100	4,294	100
								Weighted median kg/fisher/trip	10.28					
								Weighted median kg/trip	29.37					

Table 28b. Seasonality of fishing operations in Daram, Samar (February 19, 2020).

Fishing Gear		Month														
Local Name	English Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	F mos./ year	Peak mos.	Catch composition
Hook & Lines																
Kitang	Bottom set longline	◄			■	■	■	■	■	■	■	■	►	12	Apr-Aug	Lagao, Talho, Tiaw
Undak	Multiple hook and line	◄			■	■	■	■	■	■	■	■	►	12	May-Jul	Tamban, Hasa-hasa, Hilo-hilos
Kawil	Simple hook and line		◄		■	■	■	■	■	■	■	■	►	10	Apr-Jun	Lagao, Aso-os
Sanit	Squid Jigger		◄		■	■	■	■	■	■	■	■	►	7	May-Jul	Noos
Seines/Trawls																
Pahulbot	Danish seine	◄			■	■	■	■	■	■	■	■	►	12	Oct-Dec	Noos, Lawayan
Pa arak	Encircling gill net w/dynamite	■	■	■	■	■	■	■	■	■	■	■	■	8	Feb-Jul	Hawal-hawal
Panno-os	Bottom trawl	◄			■	■	■	■	■	■	■	■	►	12	Sep-Nov	Noos, Lawayan, Tiaw
Otter trawl	Otter trawl	■	■	■	■	■	■	■	■	■	■	■	■	12	Dec-Feb	Lawayan, Buraw, Bago-bago
Pamasayan	Trawl (shrimp)	◄			■	■	■	■	■	■	■	■	►	12	Aug-Sep	Bulik, Bangkigan, Moong, Suahe
Gill Net																
Palubog	Bottom set gill net	◄			■	■	■	■	■	■	■	■	►	12	Jun-Aug	Buraw, Agoma-a, Bago-bago, Sagisoon
Panamasag	Crab gill net	◄	■	■	■	■	■	■	■	■	►			10	Feb-Apr	Masag, Bagulan, Sunog
Palutaw	Surface gill net	◄			■	■	■	■	■	■	►			9	no peak months	Panit, Malasugi, Lari
Pamalo	Surface gill net for Garfish	■	◄		■	■	■	■	■	■	■	■	►	12	Dec-Jan	Balo
Ligkop	Ring net	■	■	■	■	■	■	■	■	■	■	■	►	12	Dec-Mar	Agoma-a, Hasa-hasa
Treenet	Trammel net	◄			■	■	■	■	■	■	■	■	►	12	no peak months	Puti, Sap-sap
Traps																
Teming, Pangal	Crab pot	■	■	■	■	■	■	■	■	■	■	■	►	12	Jan-May	Masag, Bagulan
Bentol	Crab lift net	◄			■	■	■	■	■	■	■	■	►	12	Sep-Oct	Masag, Bagulan
Miscellaneous																
Pamana	Spearfishing	◄			■	■	■	■	►					9	May-Jun	Tingag, Sunog, Kitong

3.2 Estimated Annual Catch

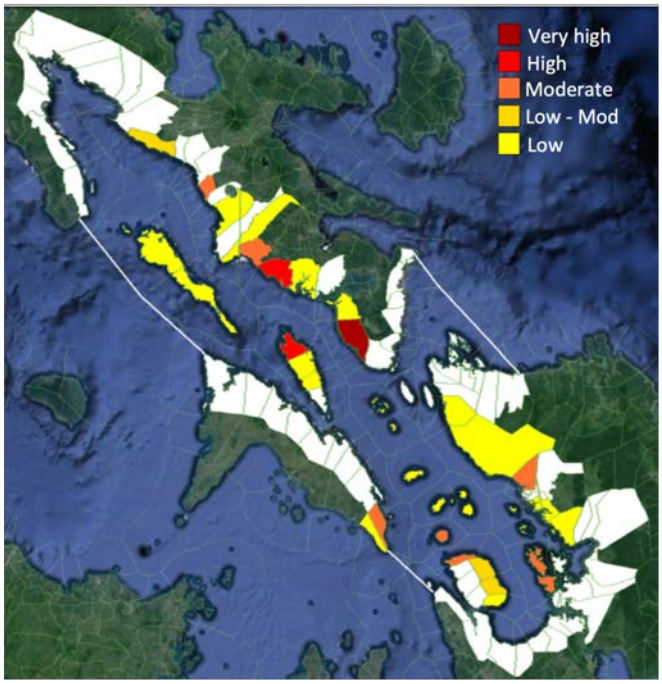


Figure 13. Identified municipalities in FMA 7 with local sardine landings. Color-coded areas correspond to municipalities with very high (brown), high (red), moderate (red-orange), Low-moderate (orange), low (yellow) and no (white) annual sardine landings.

Of the 90 municipalities bordering FMA 7, 32 were identified as having local sardine landings, 16 in the northern (Camarines Sur, Albay, Sorsogon, and Masbate) and 16 in the southern (Northern Samar, Samar, and Biliran) portions (Fig. 13). Based on the actual annual catch estimates in monitored and profiled sites, five production levels were defined, from low to very high (Fig. 13), under which each non-monitored and unprofiled municipality was categorized. The production categories were based on an end-of-project feedback consultation (by phone) with the regional BFAR-NSAP teams, Municipal Agriculture Office (MAO) staff of the different municipalities, as well as observations of project staff during the study. The values assigned to each category were the means of actual estimates for municipalities that were either monitored or profiled. Table 29 shows the range of actual sardine production estimates in the latter and the mean values by category. The parameter values used to compute annual sardine production in each of the 32 municipalities is shown in Annex 3.

Table 29. Range of actual annual sardine production estimates (mt) in monitored and profiled sites, and their mean values used as estimates for the other municipalities in FMA 7.

Category	n	min	max	mean
Very High	1		45,021.4	
High	2	2,009.9	2,055.0	2,032.5
Moderate	5	413.4	837.6	606.4
Low-moderate	2	223.2	250.9	237.1
Low	8	70.7	176.0	120.6

The estimated (for monitored & profiled municipalities) and approximated total annual sardine catch by municipality is presented in Table 30. The overall annual sardine production in FMA 7 in 2020 is estimated to be 56,450.5 mt. The fleet based in Bulan, Sorsogon contributed 79.8% of this annual catch and was thus categorized in the "very high" level. Of the remaining seventeen (17) monitored or profiled sites, two (2) municipalities, also in the northern half, were categorized as high (Monreal & Donsol; 2010-2055 mt/yr), five (5) as "moderate" (Balatan, Pio Duran & Pio V. Corpuz in the north and Daram & Kawayan in the south; 413.4 – 837.6 mt/yr), two (2) as "low-moderate" (Pasacao in the north and San Vicente in the South; 223.2 – 250.9 mt/yr) and the remaining eight (8) as "low" (Magallanes, Claveria & San Jacinto in the north and Tarangnan, Catbalogan City, Rama, Calbayog & San Isidro in the south; 71 – 176.0 mt/yr) (Table 30).

Table 30. Estimated and approximated annual sardine catches in the 16 municipalities in FMA 7 with sardine fisheries.

North FMA 7			South FMA 7		
Municipality	**Annual Production Category**	**Estimated Annual Sardine Prod (mt)**	**Municipality**	**Annual Production Category**	**Estimated Annual Sardine Prod (mt)**
Monitored					
Bulan	Very High	45,021.4	Daram	Moderate	681.4
Balatan	Moderate	608.5	Kawayan	Moderate	490.9
Pio Duran	Moderate	837.6	Tarangnan	Low	100.3
Monreal	High	2,055.0			
Profiled (FGD)					
Donsol	High	2,009.9	San Vicente*	Low-mod	223.2
Magallanes	Low	163.6	Catbalogan City*	Low	176.0
Pio V Corpuz	Moderate	413.4	Rama/ Catbalogan*	Low	108.1
Pasacao	Low-mod	250.9	Calbayog*	Low	120.1
Claveria	Low	70.7	San Isidro*	Low	111.6
San Jacinto	Low	114.6			
Approximated from estimated annual catches					
San Fernando	Low	120.6	Sta Margarita	Moderate	606.4
Libon	Low	120.6	Marapipi	Moderate	606.4
Ligao	Low	120.6	Caibiran	Low-mod	237.1
Pilar	Low	120.6	Culaba	Low-mod	237.1
San Pascual	Low	120.6	Sto Nino	Low	120.6
Esperanza	Low	120.6	Almagro	Low	120.6
			Tagapul-an	Low	120.6
			Cabucgayan	Low	120.6
Sub-total		**52,269.6**			**4,181.0**
Total					**56,450.5**

*Estimates for these municipalities were based on limited interviews with MAO staff and fishing vessel operators in the final months of the study

3.3 Catch Composition

Based on weekly samples collected during the entire study, only *Sardinella lemuru* was recorded from the monitored catches. In 2016, the composition of catches of clupeiforms in the same area also consisted mostly of *S. lemuru* (98.3% of total catch), with the rest made up of other sardine species such as *Amblygaster sirm* (1.1%), *Herklotsichthys quadrimaculatus* (0.13%), *Spratelloides gracilis* & S. *delicatulus* (0.19%) and the anchovies *Encrasicholina heteroloba* & *E. punctifer* (0.23%) (Fig. 14). These other species were not recorded from the catches in the current study (2020) perhaps because of the focus on drift gill nets. Olano et al. (2009) report that the white sardine, *Escualosa thoracata*, is locally abundant inside Sorsogon Bay, a shallow enclosed embayment bordering Ticao Pass (Fig. 1). This area was not covered in the present study. Similarly, Guarin et al. (1996) recorded *S. pacifica* (previously referred to as *S. fimbriata*) as one of the more common resources, together with *S. lemuru* (previously referred to as *S. longiceps*), in inner (west part) Ragay Gulf. During the fisheries profiling at Pasacao, Camarines Sur at the mouth of Ragay Gulf, stakeholders indicated that sardine catches were seasonal at best, so subsequent monitoring efforts were concentrated south of Ragay Gulf. In more recent years, the NSAP in Region 5 included *Sardinella gibbosa* as one of the common sardine resources in north FMA 7, although the specific contribution to the total catch was not provided. Interestingly, the distinction between adults of *S. pacifica* and *S. gibbosa* (e.g., deeper body) may not be recognizable in juvenile or young adult fish. Similarly, the gold stripe characteristic of *S. gibbosa* may fade soon after catching. A more accurate basis for distinguishing these 2 look-alike species is the count of post-pelvic fin scutes which do not overlap in juveniles or adults (i.e., 11-12 in *S. pacifica*, 13-14 in *S. gibbosa*) (FAO, 1998). Correct identification of species with substantial contributions to the sardine stocks is important because biological parameters used as harvest reference points may differ between species. It is nevertheless clear that sardine catches in northern FMA 7 are overwhelmingly dominated by the Bali sardine, *S. lemuru*.

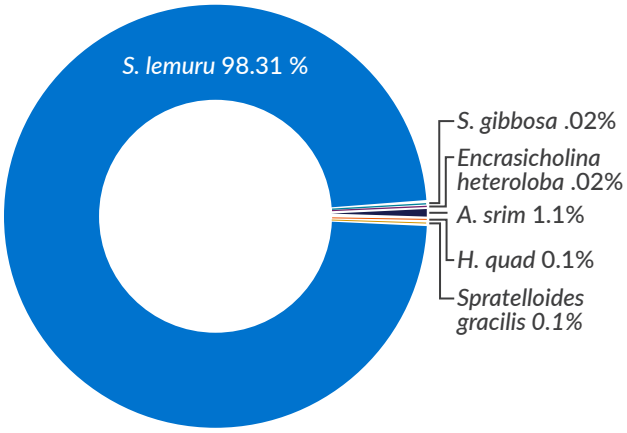


Figure 14. Composition of catches of clupeiforms in Ticao Pass, north FMA 7 in 2016 (Campos et al., 2017).

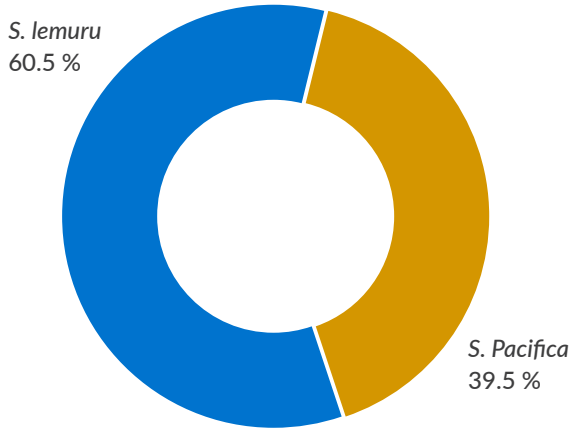


Figure 15. Composition of catches of clupeids in south FMA 7 in 2020.

The species composition in north FMA 7 is substantially different from the composition of sardine catches in the southern portion where *S. pacifica* made up 39.5% of the catches (Fig. 15) during the study. For the entire FMA, drift gill nets contributed 96.1% of the total catch during the study, determined largely by the catches in the northern portion (Fig. 16). Again, a different picture is shown in the southern portion, with DGNs and ring nets contributing similar amounts (41.4 and 37.8%, respectively) to the total catch, with substantial contributions from the use of dynamite with encircling gill nets (12.6%) and scoop nets (7.3%).

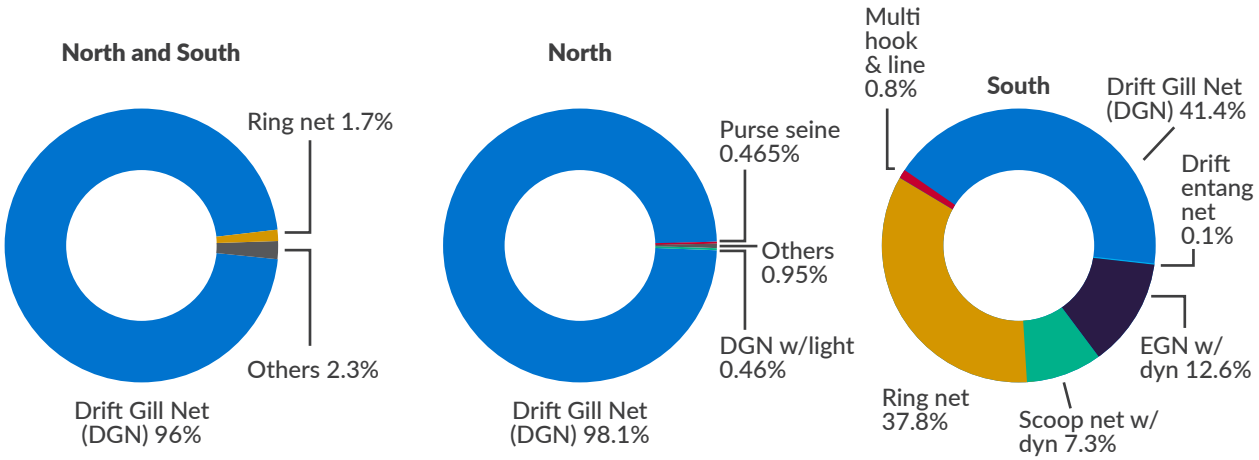


Figure 16. Contribution of fishing gears to sardine catches for the entire FMA 7.

3.4 Catch and Effort

Catch and effort statistics are summarized by month for each of the 7 sites monitored during the study and shown in Table 31. Due to delays in the release of funds, monitoring activities began in February/March 2020, following the completion of profiling in most of the target municipalities. There were some interruptions due to the pandemic because some landing sites were closed down for brief periods. For most sites, however, monitoring was completed in December 2020, but was cut short in Balatan (until September 2020) because of travel restrictions. For some sites (Bulan, Daram & Tarangnan), monitoring continued until April 2021 to ensure coverage of at least 12 months.

Figures 17 and 18 show the seasonality in catch rates (total and sardines only) and fishing effort (percent of fishing fleet operating and number of fishing days each month) in each of the sites. For north FMA 7, catch rates for sardines (represented by orange bars) were lowest during the SW monsoon months (Jun/Jul to Oct) in all sites, except in Bulan, Sorsogon where catch rates remained moderate to high during this period. Overall, catch rates increased in November/ December in all sites, and remained consistently high from March to April in both years. Fishing effort was also generally low in Pio Duran and Monreal, Ticao Island during the SW monsoon months although fishers in Balatan and Pio Duran shift to using deeper drift gill nets with larger meshes (*barangayan*) targeting small mackerel and other small pelagic fish during these months, as indicated by the blue bars and the absence of orange bars in Figure 17.

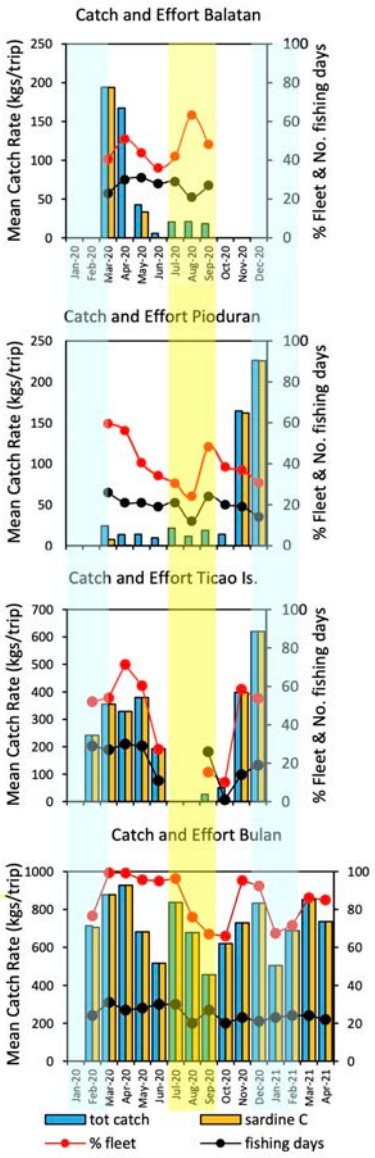


Figure 17. Seasonality in catch rates (total and sardines only) and fishing effort (% of fishing fleet operating & no. of fishing days each month) in northern FMA 7 monitoring sites. Blue and yellow areas indicate NE and SW monsoon months, respectively.

Table 31. Summary of catch and effort statistics of target gear types in the 7 monitoring sites in FMA 7 during the study.

	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21
Balatan (DGN)															
Mean Tot Catch (kg/trip)			194.0	167.3	42.6	5.9	20.5	21.0	18.2						
Mean Sardine Catch (kg/trip)			193.9	0	33.5	0	0	0	0						
Mean % fleet fishing per day			40.4	51.0	43.9	36.1	42.1	63.3	48.1						
No. fishing days in the month			23/31	30/30	31/31	28/30	29/31	21/31	27/30						
Pio Duran (DGN)															
Mean Tot Catch (kg/trip)		24.2	13.6	13.9	9.51	21.5	11.4	18.7	14.0	164.4	226.3				
Mean Sardine Catch (kg/trip)		7.4	0.5	0	0	0.05	0	0	0	162.1	225.9				
Mean % fleet fishing per day		59.6	56.2	40.5	34.2	30.5	42.1	63.3	48.1	36.8	30.7				
No. fishing days in the month		26/31	21/30	21/31	19/30	21/31	29/31	21/31	27/30	19/30	14/31				
Monreal (DGN)															
Mean Tot Catch (kg/trip)	241.4	355.0	328.8	379.9	102.2		17.0	22.6	28.6	397.8	619.7				
Mean Sardine Catch (kg/trip)	241.4	355.0	328.8	379.9	98.5		0	1.4	3.2	397.8	619.7				
Mean % fleet fishing per day	52.1	54.0	71.3	60.3	35.6		17.8	18.2	16.8	58.6	53.7				
No. fishing days in the month	29/29	27/31	30/30	29/31	16/30		23/31	28/30	19/31	14/30	19/31				
Bulan (DGN)															
Mean Tot Catch (kg/trip)	713.8	878.5	928.5	682.0	515.9	837.5	678.1	456.4	619.9	729.2	833.6	505.1	688.6	851.6	735.7
Mean Sardine Catch (kg/trip)	705.2	878.3	9285	682.0	515.9	837.5	678.1	456.4	619.9	729.2	833.6	505.1	688.6	851.6	735.7
Mean % fleet fishing per day	76.7	99.4	99.3	95.7	95.0	96.3	76.0	67.0	66.0	95.2	92.4	67.4	71.7	86.3	85.0
No. fishing days in the month	24/29	31/31	27/30	28/31	30/30	30/31	20/31	27/30	20/31	23/30	21/31	21/31	24/28	24/31	22/30
Kawayan (DGN)															
Mean Tot Catch (kg/trip)		35.6			17.9	38.4	9.4	8.2	9.1	19.3	34.8				
Mean Sardine Catch (kg/trip)		35.6			17.9	38.4	9.4	8.3	9.1	19.3	34.8				
Mean % fleet fishing per day		80.9			56.9	63.3	42.9	72.0	55.7	61.7	96.7				
No. fishing days in the month		11/31			26/30	30/31	7/31	5/30	7/31	12/30	6/31				
Daram (Ring Net)															
Mean Tot Catch (kg/trip)		276.7	274.8	247.5	270.6	229.6	217.4	199.4	233.1	95.5	157.6	151.2	87.4	110.5	172.8
Mean Sardine Catch (kg/trip)		131.3	113.8	101.2	106.6	8.0	23.4	37.7	58.2	7.3	17.5	6.0	12.1	5.6	0.3
Mean % fleet fishing per day		92.6	78.4	77.4	58.2	90.0	67.4	78.9	75.1	34.3	50.6	67.5	39.0	63.6	45.5
No. fishing days in the month		23/31	25/30	23/31	22/30	22/31	29/31	25/30	23/31	22/30	21/31	19/31	24/28	22/31	19/30
Tarangnan (Dyn w/ Scoop Net)															
Mean Tot Catch (kg/trip)	69.7	46.0	38.2	47.3	38.7	39.7	22.6	26.2	20.1	21.7	21.8	19.8	18.5	17.3	13.7
Mean Sardine Catch (kg/trip)	46.1	19.5	13.7	17.5	5.9	1.2	1.1	2.0	1.7	0.8	2.9	0.7	3.6	0	0
Mean % fleet fishing per day	95.8	73.8	5.3	65.7	84.3	86.1	76.8	73.3	69.4	65.2	64.6	63.3	60.5	55.3	54.7
No. fishing days in the month	26/29	26/31	14/30	30/31	30/30	31/31	28/31	30/30	31/31	23/30	28/31	30/31	21/28	19/31	17/30

The reduction or absence of sardine catches during the SW monsoon is due to dispersal of the stock southwards during this time of the year. This is explained in the next section. The continuing moderate to high sardine catch rates together with high fishing effort in Bulan during this period is the result of its fleet of larger vessels that are capable of fishing further south towards San Vicente and Tagapul-an Islands (Fig. 1) during this time of the year.

In the southern part of FMA 7 (Fig. 18), sardine catch rates were high from at least the tail end of the NE monsoon (February/March) towards the Summer after which catches decreased to lower levels, particularly in Daram and Tarangnan, which are both located well within Samar Sea (Fig. 1). Catch rates in Kawayan were high in March and July, and also increased in November to December of 2020. Fishing effort decreased somewhat from August to October before increasing again towards the end of the year. Sardine catches in this area consisted entirely of *S. lemuru*, similar to catches in the San Bernardino Strait Area and north FMA 7. However, catches in Daram, located well within Samar Sea but on an island off the mainland coast (Fig. 1), consisted of a mix of *S. lemuru* and *S. pacifica*, locally called "tamban yapad", with the Bali sardine progressively decreasing in proportion up to July and the latter species dominating local catches thereafter (Note: *Sardinella pacifica* is the correct name to use for what has been traditionally referred to as *S. fimbriata* in different fishing grounds in the country (Hata & Motomura, 2019)). Sardine catches in this area from September onwards were almost exclusively of *S. pacifica*. In Tarangnan, located in the innermost coastal waters of Samar Sea (Fig. 1), sardine catches were comprised of only *S. pacifica*. Fishing effort in Daram and Tarangnan showed a somewhat continuous decrease throughout the study period, with fleet operations in February/March at 80-90% decreasing to 50-60% fleet operations a year later (Mar/Apr 2021). Due to the lack of historical data on sardine catches in Samar Sea, our interpretation of this decreasing trend is more of a reflection of year-to-year differences in sardine abundance rather than a true decline in sardine production in the area from the previous year. Demersal resources in Samar Sea have been documented as overfished as early as the 1980s (Silvestre et al., 1986) and it is likely that the status of small pelagic resources followed the same trend not long after. Hence, the observed decrease in catch rates from 2020-21 is likely just a blip in the long-term historical trend. Further support for much reduced fisheries productivity in Samar Sea is provided by the information provided by fishers during the fisheries profiling activities, which showed that the weighted median catch per fisher per trip was on average 40% lower than areas in the north with the lowest values for this parameter (Magallanes, Monreal, and Pio V. Corpuz) (Tables 14-28).

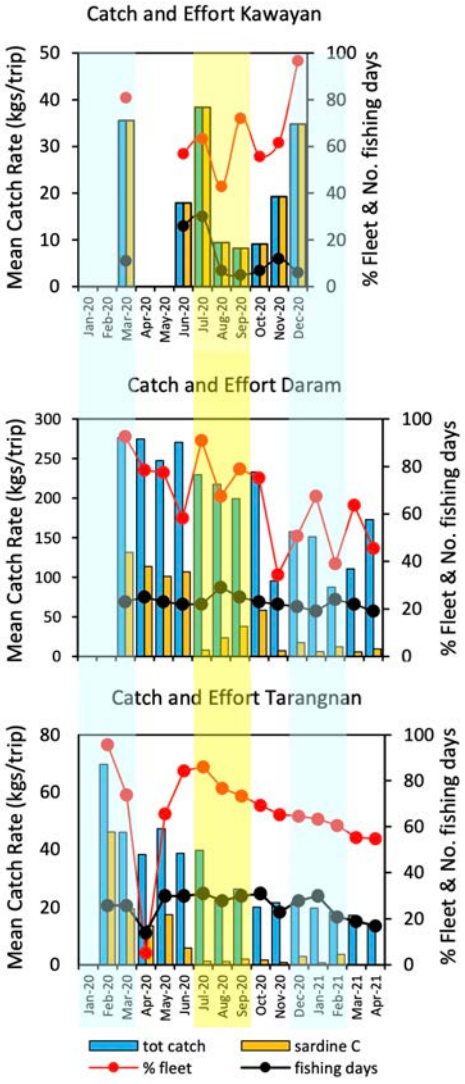


Figure 18. Seasonality in catch rates (total and sardines only) and fishing effort (% of fishing fleet operating & no. of fishing days each month) in southern FMA 7 monitoring sites.

3.5 Fleet Movement

Previous work done in the vicinity of Ticao Pass showed that fishing operations from Bulan, Sorsogon moved southwards to the vicinity of the San Bernardino group of Islands in June or July, at the onset of the SW monsoon (Tajonera et al., 2016; Campos et al., 2017). Since both efforts covered the same year (September 2015 – June 2016 and July to December 2016, respectively), the current study aimed to confirm if this shift in operations occurred each year, and if this was due to dispersal or simple local depletion of the stock.

This section characterizes the spatial distribution of catch and effort of the fishery, specifically the locations of fishing operations from positional data. The principal objective for this aspect of the study was to document the distribution of fishing effort for sardines in the area and to analyze if such can provide insights into the movement of the stock. GPS trackers were installed in vessels of several fishing operators who agreed to collaborate with the project. Figure 19 shows the installation of solar-powered VMS trackers in some of the monitored fishing gears.

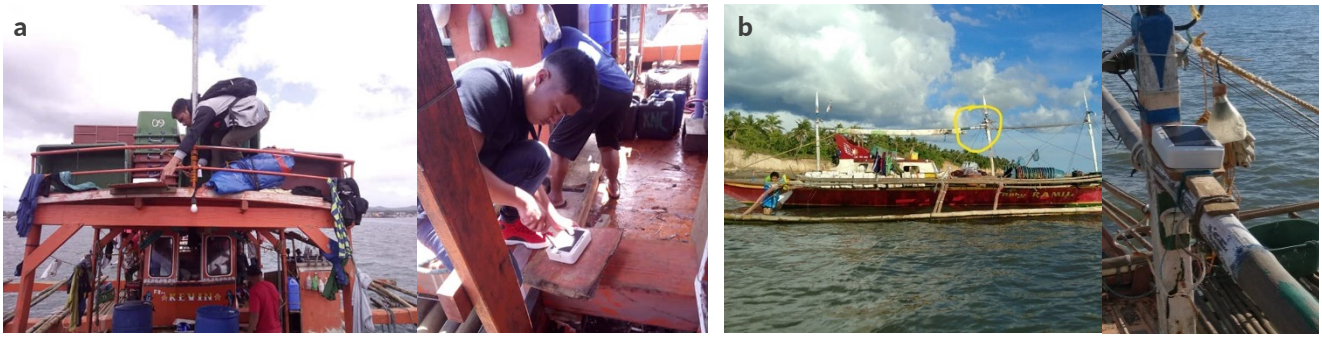


Figure 19. Installation of solar-powered VMS trackers in (a) ring net operating out of Daram, Samar and (b) drift gill net operating out of Bulan, Sorsogon.

Initially, GPS trackers/loggers were deployed in all seven monitoring sites, but because of difficulties in supervising their use, maintaining the units, and downloading the data in the different sites during the lockdown, it was decided that in north FMA 7 tracking would focus only in Bulan, Sorsogon since the larger vessels in this site were the most likely ones to show extensive movement. From an initial two units deployed in March 2020, a total of 6 units were in use with small commercial drift gill net vessels (9-10 fishers per vessel) from November 2020 until April 2021. In south FMA 7, Kawayan, Biliran became inaccessible in March 2020, so tracking was focused on Daram from March 2020 to April 2021, with two units deployed in small commercial ring net vessels (12-17 fishers per vessel). Track data for scoop net (with dynamite) operations (2-6 fishers per vessel) in Tarangnan were only available for October and November 2020, before the unit broke down and could not be replaced. The deployment sites and the extent of fishing operations in the different sites in FMA 7 are shown in Figure 20. The color-coded polygons indicate areas of operations for different months. Vessels based in Bulan are larger and have the capacity to fish further from their base, reaching up to 90 km north into Burias Pass and at least 60 km south to the San Bernardino Island group area. In south FMA 7, both monitoring sites are located in the inner portion of the Samar Sea where operations were confined to areas very close to the coast and within a few kilometers from vessel bases (Fig. 20, right) all year round.

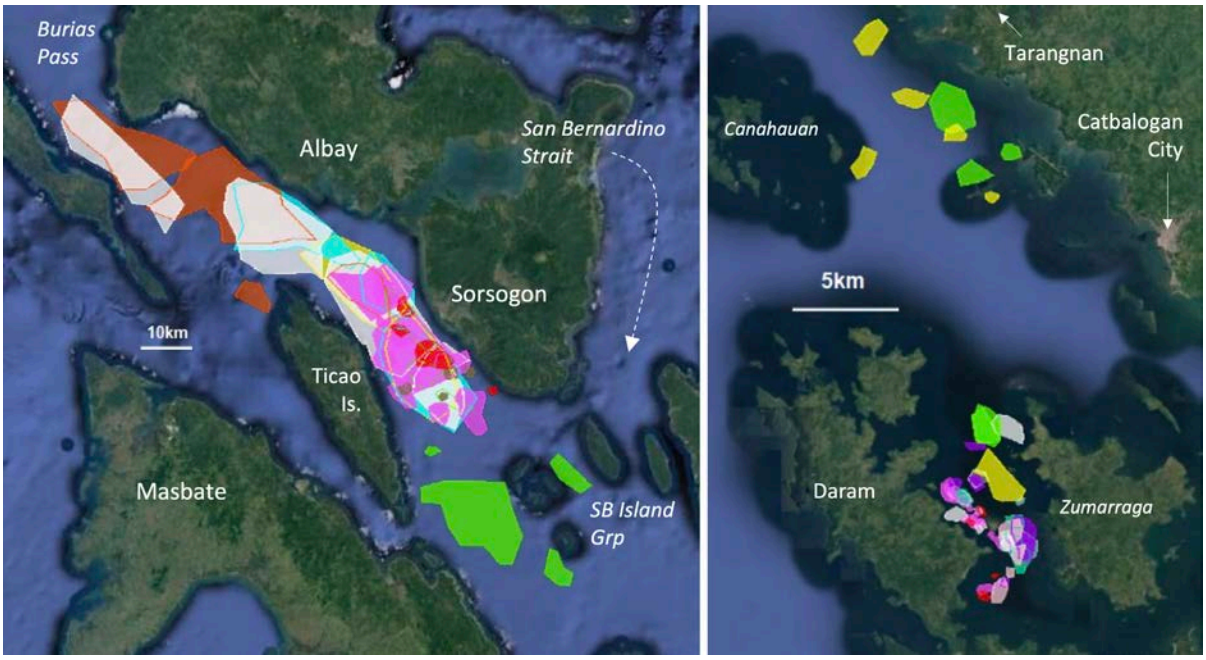


Figure 20. Geographic extent of fishing operations from Bulan (left) and from sites in south (right) FMA 7. The colored polygons refer to locations of operations in different months.

Figure 21 (a-j) shows the detailed monthly movement of the fleet targeting sardines based in Bulan. From March to May 2020, fishing operations were concentrated in the area between mainland Sorsogon and Ticao Island (i.e., Ticao Pass). The patchy appearance of fishing locations during these months, as well as the absence of tracking data from June to September 2020 reflect restrictions on fishing and traveling in the months following the lockdown in March. In October, operations had already extended further south to the vicinity of Tagapul-an and the San Bernardino Island group (Fig. 21d). Fleet operations then moved back to Ticao Pass in November and December (Fig. 21 e-f), when catch rates attained the highest levels (Fig. 17). These are also the months of peak spawning, which will be discussed in a later section. Beginning in December, there was a gradual movement northward, extending into Burias Pass in January, then back to the Ticao Pass in late February, where drift gill net vessels continued to operate until April (Fig. 21 g-j), and perhaps up to May as in the previous year (Fig. 21c).

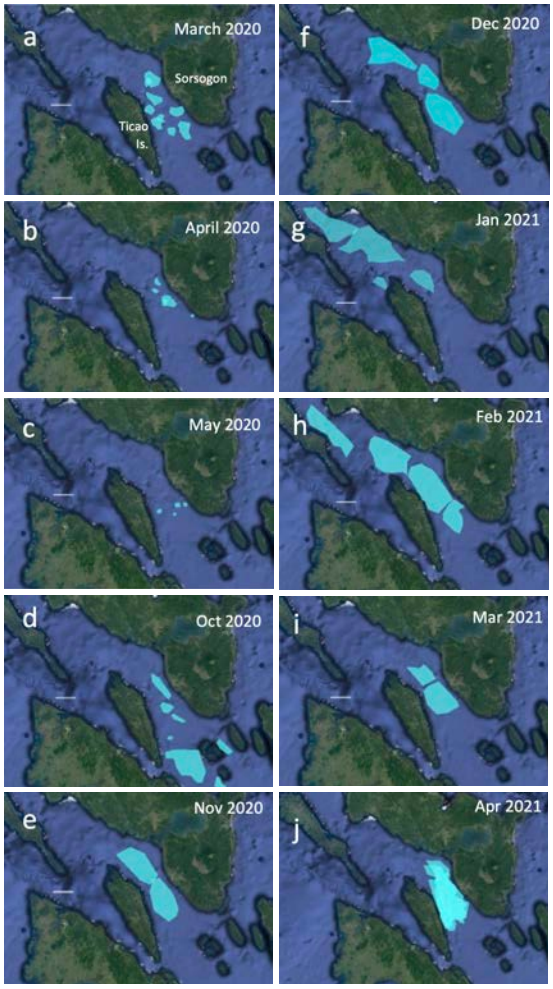


Figure 21. Monthly movement of the fishing fleets targeting sardines based in Bulan.

This pattern of movement of the fleet is even clearer when locations of fishing operations monitored daily in Bulan using the gridded map are plotted by month (Figs. 22a – n). Fleet operations from Bulan were largely concentrated very close to the coast from March 2020 until June 2020 (Fig 22a-d). The fleet began moving south towards the San Bernardino Island group in July and remained there until October (Fig. 22 e-h). Fishing effort in all north FMA 7 sites was lowest during these months (Fig. 17), with only 60-70% of the fleet operating from Bulan. This may be due to the increased cost of fishing farther away than usual when catch rates were also lower (Fig. 17). Fishing operations then moved back northwards in November 2020 with most of them distributed within Ticao Pass. The fleet gradually moved operations further north into Burias Pass in December and January 2021, with a reduction of fishing effort until February (Fig. 22 i-l), and then back again to Ticao Pass towards April 2021 (Fig. 22 m-n). These vessels seemed to follow the movement of *S. lemuru* year-round. Such movement and distribution are discussed in relation to spawning seasonality, maturity, size distribution of catches, seasonality in catch and effort, and the dynamics of productivity in Ticao Pass/San Bernardino Strait area in the next sections.

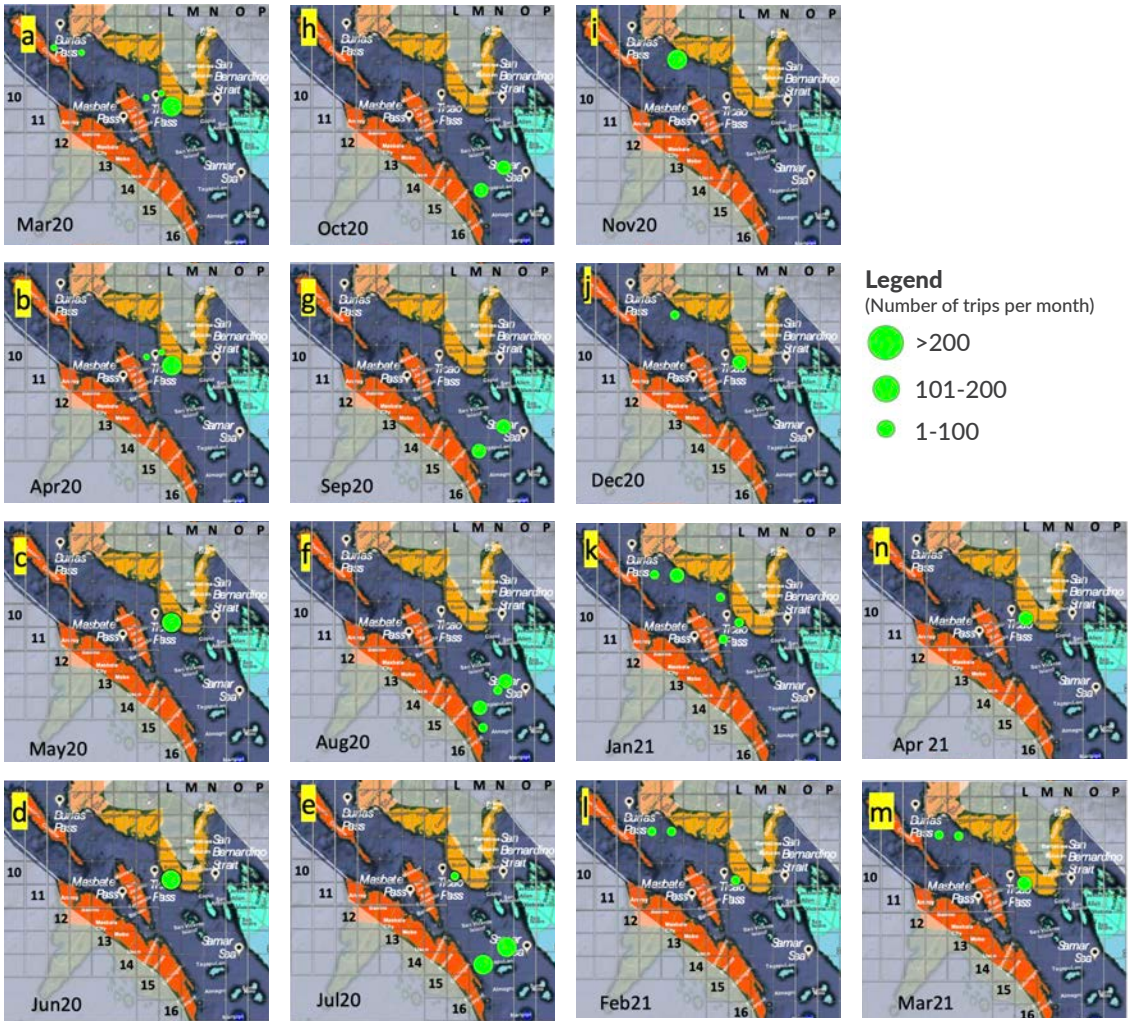


Figure 22. Monthly location of fishing operations based on the gridded maps used in monitoring catch and effort in Bulan, Sorsogon.

In addition to insights on stock movement patterns, the results of this study also showed that tracking of fishing vessels (small-scale or commercial) need not be expensive, risky. It also illustrates the feasibility of designing a monitoring system to efficiently generate information on fishing grounds, fishing intensity, and monitoring of compliance with regulations.

3.6 Spawning, Productivity and Dispersal

Spawning seasonality

S. lemuru peaked in November and December in the northern portion of FMA 7 as indicated by the high proportions of mature females and males during these months in all three sites, as well as by the seasonality in GSI values (Fig. 23). Because sampling was variably interrupted in the different monitoring sites, there are gaps in the months covered in most sites. Patterns are nevertheless recognizable. There appears to be some spawning in July and August, although samples were available for only one of the sites (Monreal), where 62-83% of males and females were mature during these months. In the following month, September, the proportion of mature fish in this area (Ticao Pass) dropped to much lower values (Bulan: 0-8.5% for both sexes; and Monreal: 0%). GSI was also substantially low further north in Pio Duran (27-54%) during this month. Since sample sizes were also comparable and consistent between sexes and between sites during the study period, the observed secondary spawning peak in July/August followed by a trough in September is not due to under-sampling. It is thus likely that in north FMA 7 some spawning during the SW monsoon months (July & August) takes place outside of the main spawning area of Ticao Pass.

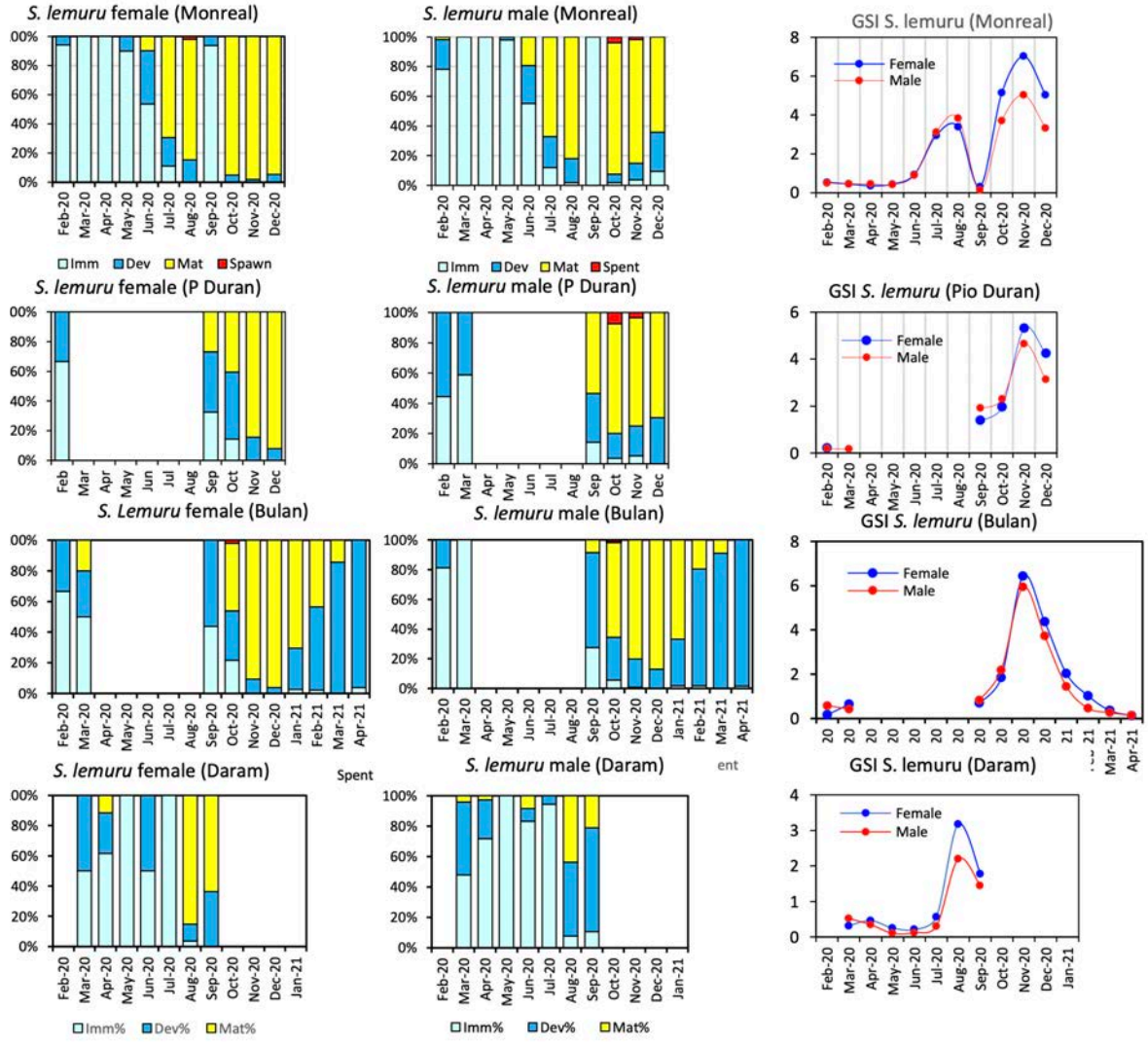


Figure 23. Gonad development stage distribution and GSI by month of female and male *S. lemuru* from Bulan, Monreal and Pio Duran in north FMA 7 and Daram in south FMA 7.

Only *S. lemuru* were recorded in the samples from the north. In south FMA 7, *S. lemuru* was also the sole sardine species recorded in Kawayan, at the mouth of Samar Sea. However, both *S. lemuru* and *S. pacifica* were recorded in Daram (Figs. 23 & 24), in the inner central part of the basin, while only *S. pacifica* was recorded in Tarangnan (Fig. 24), where catches were consistently taken from the innermost part along the coast of mainland Samar (Fig. 20). It thus seems that *S. pacifica* occurs in the innermost and shallowest portions of this basin, followed by

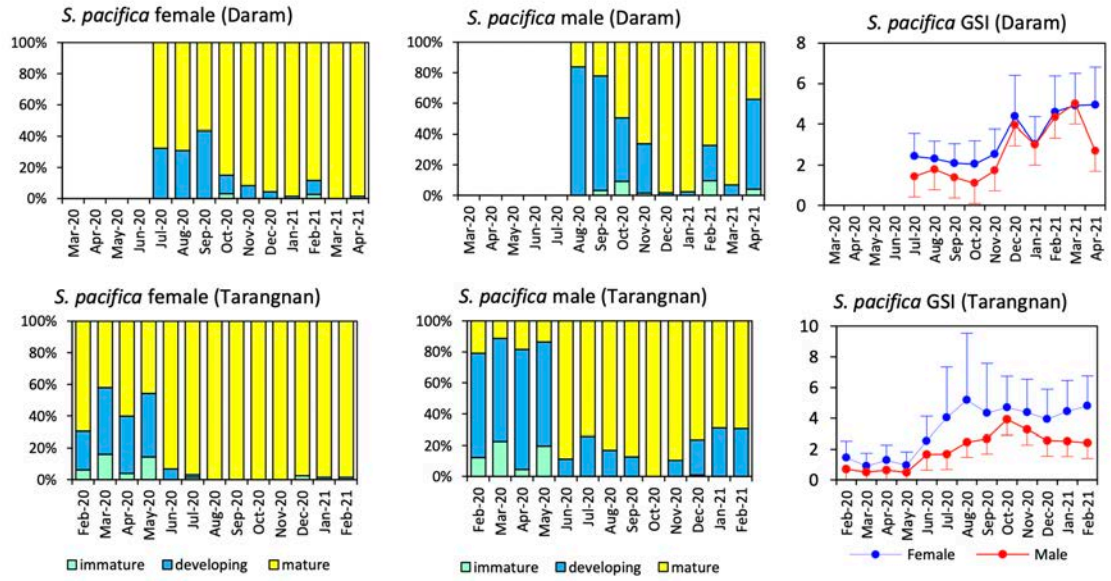


Figure 24. Gonad development stage distribution and GSI by month of female and male *S. pacifica* from Daram and Tarangnan in inner Samar Sea. Note: error bars are 1 sd from the mean.

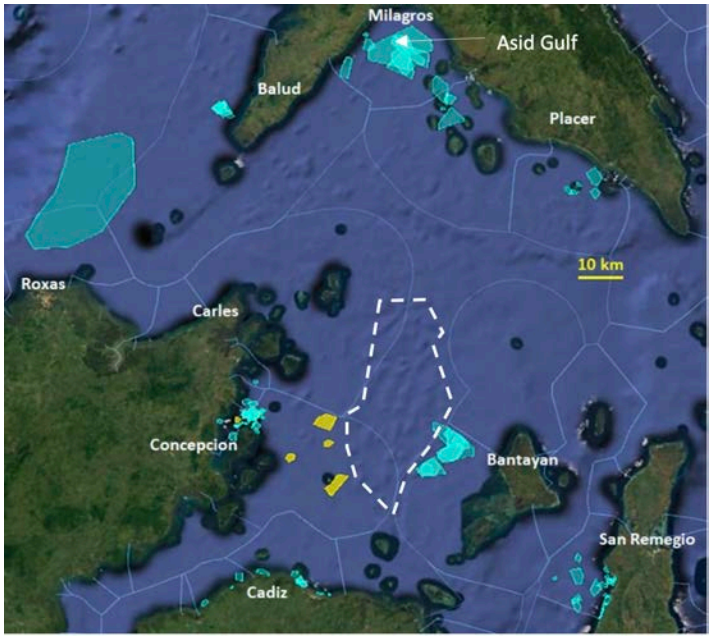


Figure 25. Locations of sardine fishing operations of monitored vessels in the Visayan in 2018. Polygons represent the areas where operations were recorded each month. The dotted white polygon marks a rocky outcrop area.

S. lemuru, which dominates in deeper more open waters such as Ticao Pass, San Bernardino Strait and mouth of Samar Sea. A similar pattern in the spatial distribution of sardine species has been reportedly in the Visayan Sea (Campos et al., 2019). The goldstripe sardine, *S. gibbosa*, dominates catches in the SW portion of the basin (mean: 77.8%; range: 40.9-100%) from Bantayan Island west to Northeast Panay (Fig. 25). In this relatively shallow open area, *S. lemuru* made up only 12.6% of the overall catches, with the rest consisting of three other sardine species (*Herklosichthys dispilonotus*, *Dussumieria elopsoides* & *S. pacifica*). On the other hand, *S. pacifica* made up almost half the catches (mean 46.7%; range: 24-78%) in the shallow inner parts of Asid Gulf in northern Visayan Sea (Campos et al., 2019 & 2021). Interestingly, *S. pacifica* also made up over 30% (range: 11-58%) of catches off Cadiz City also in the SW part of the Visayan Sea, where fishing operations targeting sardines were limited very close to the shore year-round (Campos et al., 2019).

In the inner Samar Sea (Daram), immature *S. lemuru* were present in sardine catches from March (likely earlier even) up to August-September, when the proportion of mature individuals increased (Fig. 23), particularly in females. Hence, similar to what was observed north of Ticao Pass, there appears to be some spawning during the SW monsoon months (August-September) in Daram, in the inner Samar Sea. The disappearance of *S. lemuru* from local catches after September may be related to the movement of maturing fish northwards, as will be discussed later. In contrast, *S. pacifica* was recorded in Daram year-round but was not recorded in the biological samples until July 2020 (Fig. 24). A possible explanation for this is their low relative abundance (mean 21.8%) during these months, based on on-site size measurements done twice weekly.

The seasonality in gonad development in Daram showed recognizable differences from the trend observed in Tarangnan, even if these areas are just over 30 km apart (Fig. 1). While *S. pacifica* in both areas showed moderate to high proportions of mature fish and GSI values almost the entire study period, particularly in females (Fig. 24), there were significantly less mature fish in Daram (mean: female = 69.6%; male = 23.6%) during the SW monsoon months (July to October) than in Tarangnan (mean: female = 99.2%; male = 86.2%) (t-tests: female p=0.015; male p=0.002). Thus, peak spawning in *S. pacifica* took place from December to March in Daram but was spread throughout most of the year (July to February) closer to the mainland coast in Tarangnan. Interestingly, the size distributions of fish in the two sites also showed differences. From February to June 2020 (FMA 20 & MJJ), the modal size of fish in Daram was up to 1.0 cm longer (Fig. 26), but for most of the SW monsoon (ASO), fish in Daram were smaller with higher proportions of immature individuals (34% < Lm_{50}) than in Tarangnan (8% < Lm_{50}). A similar situation was observed from November 2020 to January 2021.

While the progression of modal sizes was more recognizable in Daram, an increase in the relative abundance of smaller fish was observed only in Tarangnan, especially from February to April 2020. It is uncertain if the observed differences in spawning patterns and size distributions between these two sites are related. We believe that the size selectivity of catches from ring nets in Daram and blast fishing in Tarangnan may not provide a picture that is comprehensive enough to articulate any size- or age-related movement within the inner Samar Sea.

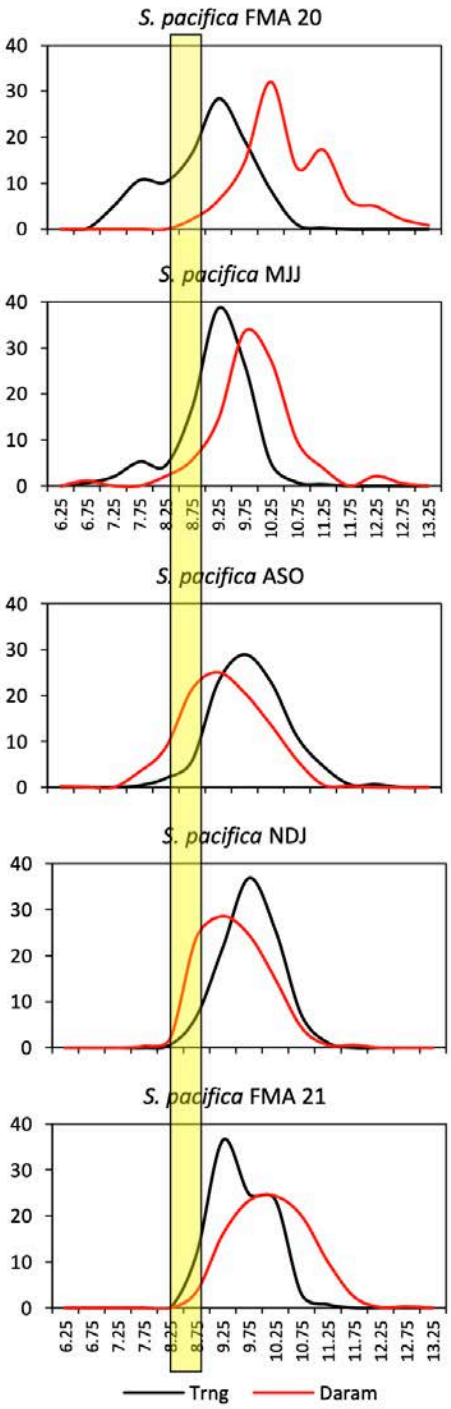


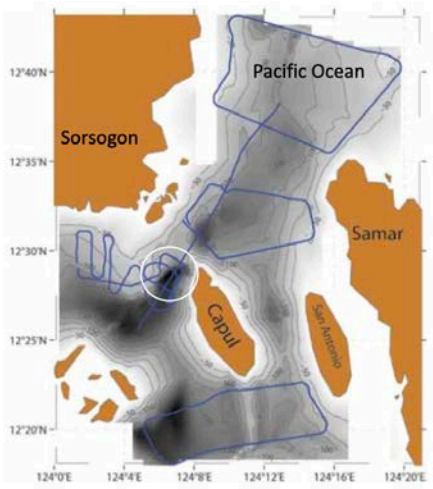
Figure 25. Size distributions of S. pacifica in Daram (red) and Tarangnan (black) by quarter. The yellow rectangle indicates the range of Lm_{50} for females (8.4 cm SL) and males (8.9 cm SL).

Primary Productivity in San Bernardino Strait

The observed seasonality in gonad development of *S. lemuru* is closely related to the seasonal cycle of primary productivity in Ticao Pass. The months when peak spawning of *S. lemuru* occurs, November and December, correspond closely to elevated chlorophyll a (chl a) concentration in the area (1.6-3.6 mg/m^3, Fig. 27, DJF 2020), particularly along the coast of mainland Bicol (white to red area). In addition,

lower sea surface temperatures (SST) extending from San Bernardino Strait into Burias Pass (light orange area) during the same period are indicative of upwelled nutrient-rich subsurface water.

The mechanism for upwelling in this area is explained in Jones et al. (2011). A sill rising from the bottom to about 80 m from the surface just west off the north tip of Capul Island (Fig. 28, top) causes subsurface water flowing eastwards from Ticao Pass through San Bernardino Strait to be deflected upwards towards the surface (Fig. 28, bottom). During flood tides, incoming water moving westwards through the Strait entrains this upwelled water and transports it northwest to Ticao Pass and further north. High phytoplankton abundance and the resulting dense zooplankton concentrations support high sardine abundance. The seasonality in this increase is most pronounced in Ticao Pass, where overall zooplankton densities may be up to 2.3 times higher in November than in the previous Summer (Campos et al. 2004).



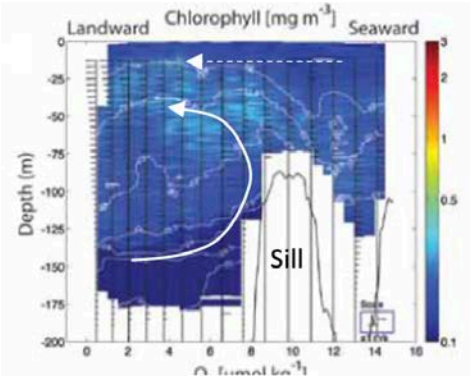


Figure 28. The mechanism for upwelling in San Bernardino Strait area. Images from Jones et al (2011).

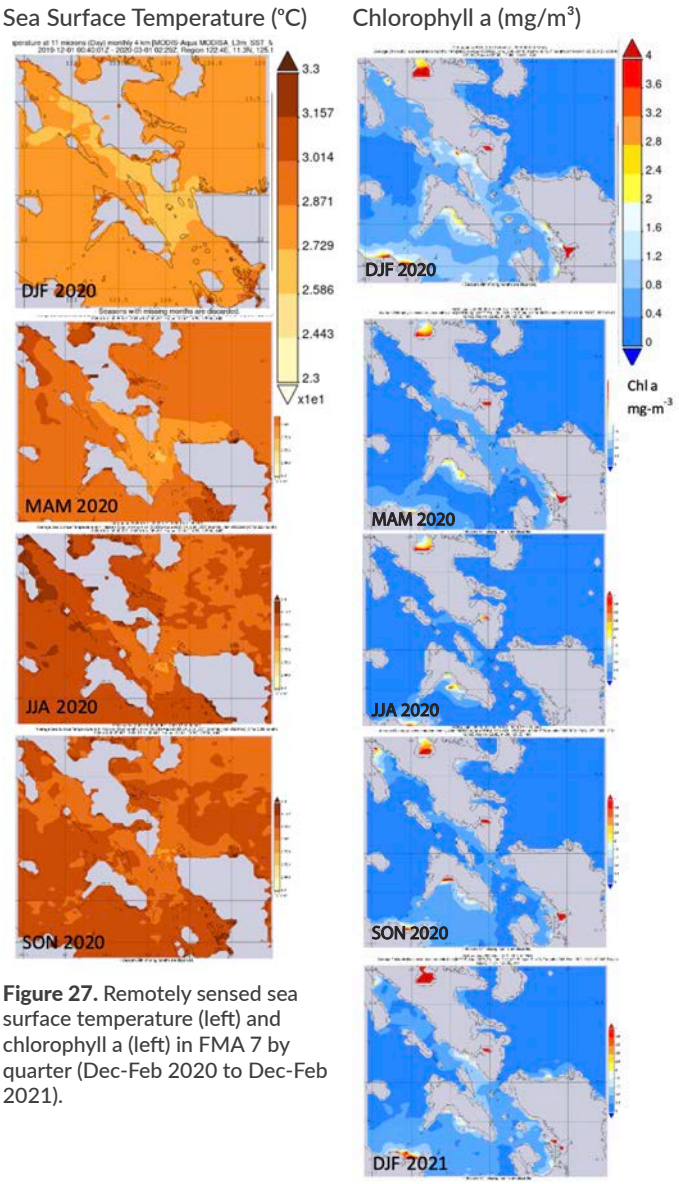


Figure 27. Remotely sensed sea surface temperature (left) and chlorophyll a (left) in FMA 7 by quarter (Dec-Feb 2020 to Dec-Feb 2021).

While sardines are known to be zooplanktivorous, *S. lemuru* in particular, also feeds substantially on phytoplankton (Metillo et al., 2019). Horizontal differences in SST persist somewhat until the following quarter (MAM; Fig. 27) but at higher temperature values, retreating southwards towards Ticao Pass and extending outside of San Bernardino Strait. Similarly, surface chl a concentrations are only slightly elevated (0.8-1.2 mg/m^3) between Ticao Pass and Burias Pass during the Summer (March to May). Both SST and surface chl a are dissipated for most of the SW monsoon (June to November), although chl a concentrations appear to begin increasing again at the onset of the NE monsoon in 2021 (November to February 2021).

Figure 29. Sub areas in FMA 7 used to assess the seasonal cycle of productivity.

An examination of trends in SST and surface chl a concentrations in different portions/subareas (Fig. 29) of the study area from 2015-2021 indicate that the seasonal cycle of productivity is consistent between years but with differing ranges (Figs. 30 & 31). While chl a concentrations reached highest levels between December and February each year, the mean values in peak seasons covering shorter periods (< 2 months; 2017 & 19) were somewhat higher than those when peak seasons covered 3-4 months (2015, 18 & 21). Spatial variability within sub-areas as well as differences between sub-areas were highest during peak season. Overall, chl a concentrations were lowest year-round in sub-areas north of Ticao Pass, and highest in Ticao Pass and San Bernardino Strait (Fig. 30). In Samar Sea, a slight increase was discernible in July-August in 2015, 16, 18 & 19. In terms of surface temperature, lowest

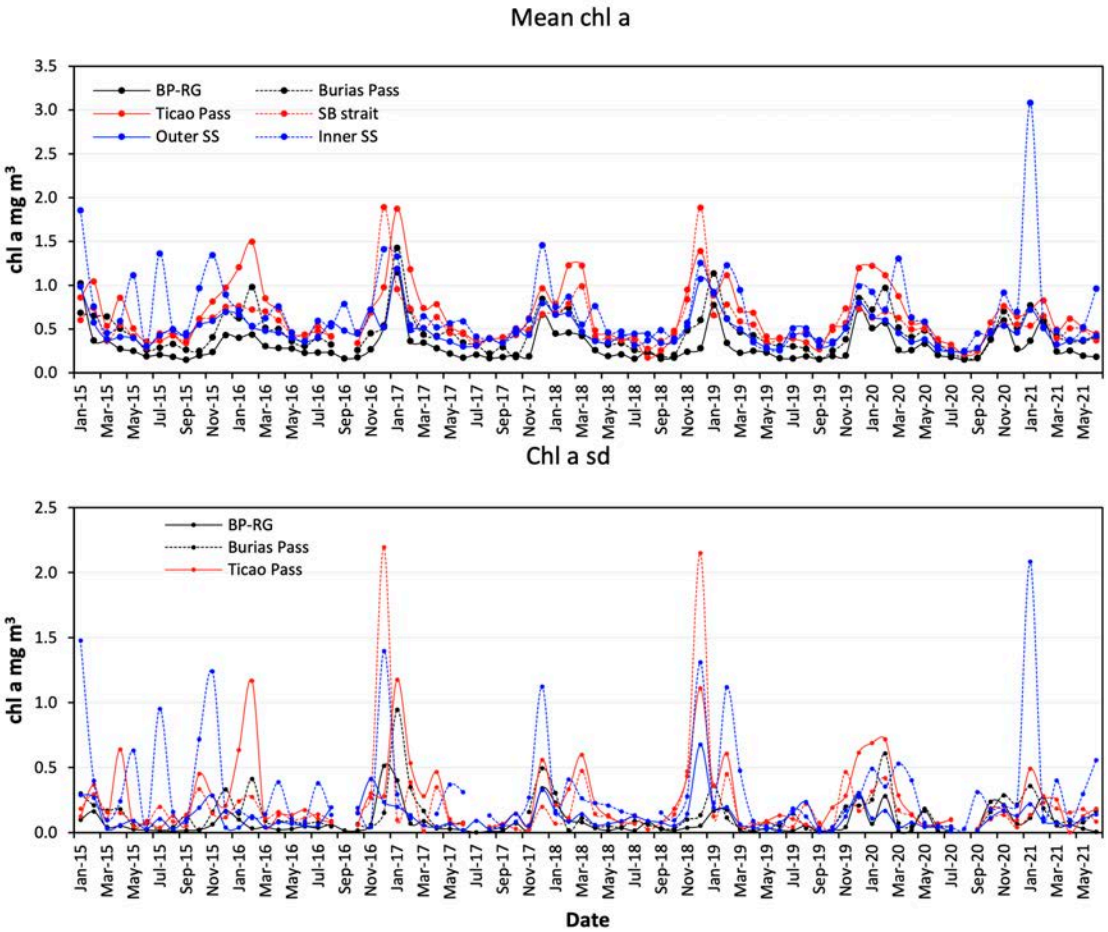


Figure 30. Trends in surface chlorophyll (mg/m^{-3}) in different subareas of FMA 7 from 2015-2021.

values were reached during the NE monsoon months, with the lowest monthly means during apparently shorter NE monsoon periods (2016, 17 19 & 29) being around 2°C cooler than in years with longer NE monsoon periods (4 months; 2018 & 21). Overall, surface temperature was lowest in Ticao Pass & San Bernardino throughout the year, suggesting that upwelling of subsurface water in these sub-areas takes place year-round, but at varying intensities. This is attributed to the bottom topography associated with the San Bernardino Island group. Highest mean surface temperatures were highest year-round within the relatively shallow embayment of Samar Sea (Fig. 31)

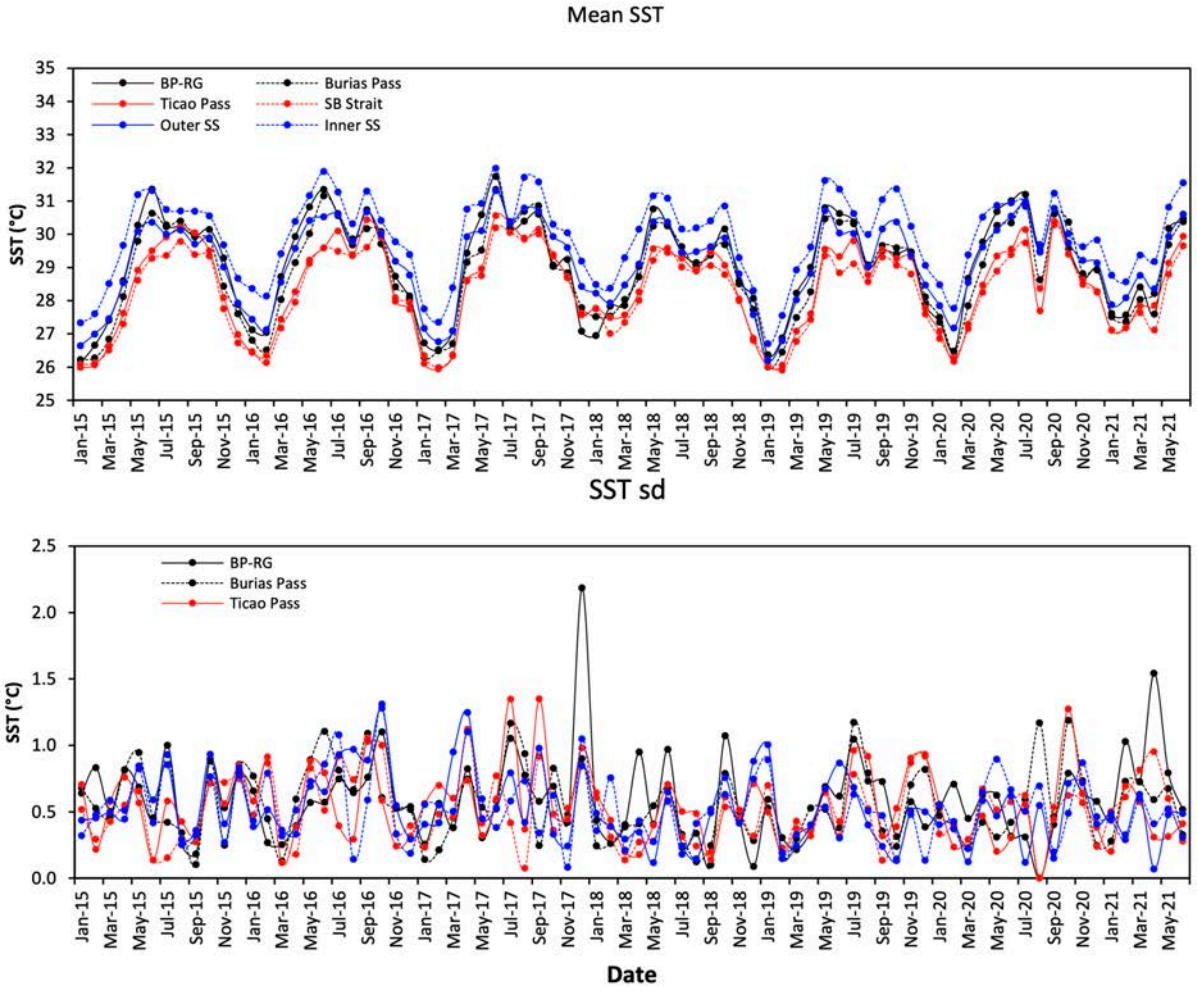


Figure 31. Trends in sea surface temperature (°C) in different subareas of FMA 7 from 2015-2021.

Spawning aggregation and stock dispersal

High drift gill net catch rates from Balatan to Bulan (Fig. 17), together with the concentration of fishing operations in Ticao Pass (Fig. 20) strongly suggest aggregation of fish in this area in November and December to time of spawning (Fig. 21 e-f, Fig. 22 a-d) with increased primary productivity and prey/food abundance. Fishing operations from Bulan gradually move northwards as plankton-rich waters extend towards Burias Pass (Fig. 27). As the NE monsoon winds and current flow gradually wane after February, sardines disperse, as indicated by the decreased catch rates (Fig. 17) during the Summer months (April to June) and the return of fishing operations to Ticao Pass (Fig. 22 a-d) at first, and then further south to the San Bernardino Island group in July, where fishing from the Bulan fleet is concentrated until October (Fig. 22 e-h). Operations move back to Ticao Pass again in November as primary productivity increases.

The extent of dispersal after peak spawning months is not known for north FMA 7, but this likely extends into Sibuyan Sea as well as in Ragay Gulf, where seasonal and annual variability in the availability of sardines was reported during the profiling activity in Pasacao, located at the mouth of Ragay Gulf. The BFAR Regional Office 4A also reports local abundances of *S. lemuru* in Tayabas Bay, Quezon, which lies about 100 km to the west of Ragay Gulf, but it is not known to what extent this stock interacts with the stock in the study area.

For south FMA 7, dispersal of *S. lemuru* extends into the inner portion of Samar Sea (Daram), particularly juveniles of those spawned during the peak spawning months. A comparison of the size distributions of catches in Samar Sea (Kawayan & Daram) and Bulan (Fig. 32) clearly shows the preponderance of young fish in the former area throughout the year. On average, 96.8% (range: 95-99%) of all fish caught from Balatan to Bulan (north FMA 7) were larger than 13.25 cm SL, the mid-point of the size range of all *S. lemuru* recorded during the study. In contrast, an average of 69.1% (range: 59-96%) of all *S. lemuru* recorded in the catches in Samar Sea were smaller than this size. There appears to be 2-3 batches (cohorts) during the year in Samar Sea, although gonad maturity showed only two discernible episodes: the peak spawning months of November and December, and a secondary episode in July-August in Ticao Pass (Monreal) and August-September in inner Samar Sea (Daram) (Fig. 23).

In contrast, catches in the vicinity of Bulan and the other sites in north FMA 7 were consistently comprised of larger fish (> 13 cm SL) (Fig. 33). The movement of Bulan fleet operations to the San Bernardino Island Group in July (Fig. 22 e-h) is likely in pursuit of southward dispersing adults that had spawned the previous season. This is consistent with the lack of any change in the size distribution of catches of the Bulan fleet (Fig.33) and the absence of sardine catches in north FMA 7 from June to September (Fig. 17). The consistent differences in sizes of fish between the north and south portions of FMA 7 suggest that the dispersal of both adult and juvenile sardine offspring is towards the south, but also likely into Camotes Sea and the deeper eastern half of the Visayan Sea. While juvenile dispersal extends into Samar Sea, the absence of adults in catches in the inner part of this basin suggests that older fish move into deeper layers of the water column perhaps in all basins south of the San Bernardino

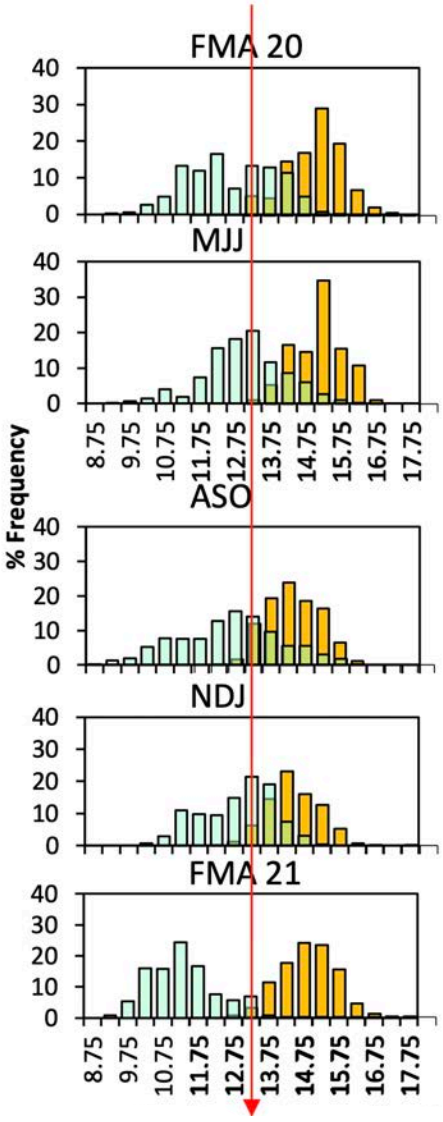


Figure 32. Comparison of size distributions of catches of *S. lemuru* in Samar Sea and Bulan by quarter. Red line denotes the mid-point of the overall size range of catches.

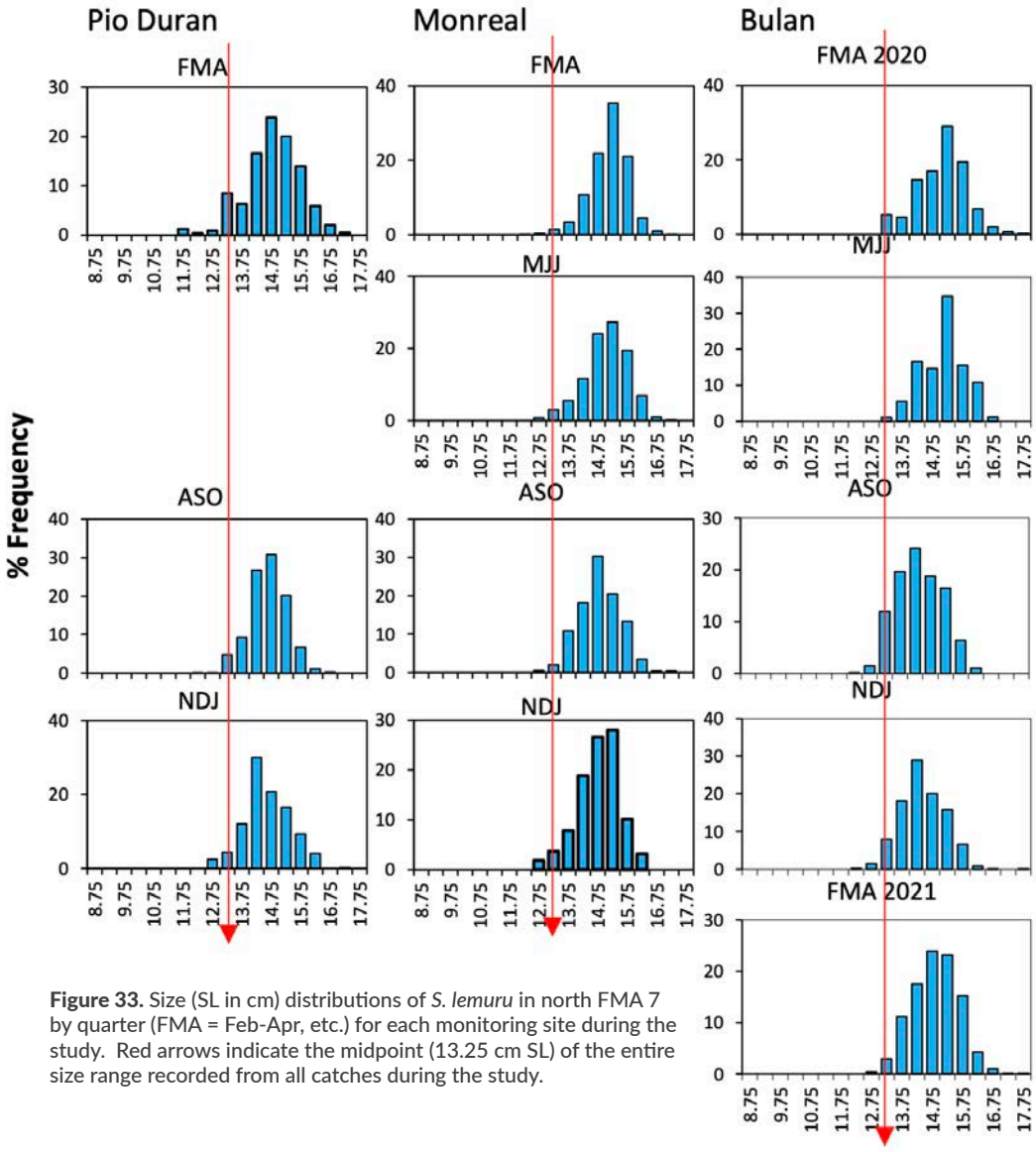


Figure 33. Size (SL in cm) distributions of *S. lemuru* in north FMA 7 by quarter (FMA = Feb-Apr, etc.) for each monitoring site during the study. Red arrows indicate the midpoint (13.25 cm SL) of the entire size range recorded from all catches during the study.

3.7 Growth, Mortality and Exploitation

This section presents estimates of sardine stock population parameters and complements the work of NSAP of BFAR but is based on sampling of catches covering the entire FMA. It also includes a compilation of previously estimated population parameters on growth, mortality, reproduction, spawning/recruitment and exploitation of different stocks of the sardine species examined in this study.

Compiled population parameters

Table 32 shows a compilation of population parameters on *S. lemuru* and *S. pacifica* stocks based on information from published studies and non-published technical reports dating back to the 1980s. Much of this information was lifted from the FSP/FRMP REA reports (PhilFIS, 1992-99), as well as from various sources in FishBase (Froese

Table 32. Population parameters of the clupeid species based on various reports of studies done in different basins from the 1950s to the present. (a & b are parameters of the L-W relationship; K to φ ' are standard population parameters; L_{m50} is the length at 1st maturity; L_m (min) is the smallest size of mature fish; L_{min} is the smallest size recorded; L_{max} is the largest size recorded; L_c is the length at 1st capture; Recruitment peaks refers to number of pulses per year).

Species	a	b	K	L_∞	M	F	Z	E	φ '	L_{m50}	L_{min}	L_c	L_{max}	Recruitment peaks
Sardinella fimbriata*			1.6	16.0	2.99		5.39	0.44						2
*S. fimbriata**			0.9	22.3	1.78		2.5						20.69	
*S. fimbriata**				21.6									21.88	
*S. fimbriata**			1.2	24.8	2.12		5.3							
*S. fimbriata**			1.03	19.4		4.17		0.61	2.6			11.12	19.5	2
*S. fimbriata**										13.0				
*S. fimbriata**			1.05	18.30	2.12	3.11	5.23	0.59	2.55	11.72		10.69	17.5	2
*S. fimbriata**			0.7	18.0	1.63		3.38	0.52				10.4		
*S. fimbriata**			1.15	22	2.12		6.56	0.68				14.7		2
*S. fimbriata**														1
Sardinella lemuru														
S. lemuru														
S. lemuru														
S. lemuru			0.65	21.21	1.48	2.13	3.61	0.59	2.47			13.03	21.3	
S. lemuru														
S. lemuru														
S. lemuru										13.8 SL				
Sardinella longiceps*			0.768		1.7	1.508	3.208	0.456			10.05		20.65	1
*S. longiceps**			1.042	23.706		6.87		0.69	2.61	16.10		15.36	22.76	2
*S. longiceps**			0.9	16.52	2.14		3.57	0.4						2
*S. longiceps**			1.1	23	2.02		7.26	0.72				16.8		1
*S. longiceps**			1.1	21	2.1		7.37	0.72				13.5		2
*S. longiceps**			1	15.8	2.1		5.52	0.62				11.3		2
*S. longiceps**				30.4									27.14	
*S. longiceps**			1.0	19.4	2.01		2.54							
*S. longiceps**			0.85	22.3	1.76		6.28	0.72				16		2
*S. longiceps**			0.8	21.1	1.72		2.24	0.23				13.5		2
*S. longiceps**			1.5	22.33	2.53	2.52	5.05	0.5					22.5	

* valid name is *Sardinella pacifica*
** valid name is *Sardinella lemuru*

Species	Major spawning (months in #)	Period of study	Area or Basin	Remarks
Sardinella fimbriata*		94 95	Ragay Gulf	Guarin et al. 1996
*S. fimbriata**		84-86	Guimaras Strait	Lavapie-Gonzales et al. 1987
*S. fimbriata**		86-88	Visayan Sea	Lavapie-Gonzales et al. 1987
*S. fimbriata**		1987	Tayabas Bay	Lavapie-Gonzales et al. 1987
*S. fimbriata**	7 - 9	00-02	Visayan Sea	Guanco et al. 2009
*S. fimbriata**		2000		Froese & Pauly, 2000
*S. fimbriata**	1 – 6	09-10	Visayan Sea	Mesa & Guanco, 2011
*S. fimbriata**		1959	Manila Bay	Ingles & Pauly, 1984
*S. fimbriata**		1965	Palawan	Ingles & Pauly, 1984
*S. fimbriata**	10 - 1	13-15	N Mindanao	De Guzman, 2016
Sardinella lemuru	10 - 1		Lagonoy Gulf	
S. lemuru	10 - 1	11-14	Sulu Sea	De Guzman, 2016
S. lemuru	1	2012	Verde Island Passage	Campos et al. 2013
S. lemuru	10-1	2014	S Zamboanga	BFAR-NSAP9
S. lemuru	11-2	2015-16	Ticao Pass	Tajonera/ECOFISH
S. lemuru	3; 6-9	2015-16	San Bernardino	Tajonera/ECOFISH
S. lemuru	10-1; 6-9	2013-14	N/S Zamboanga	Almaquer, 2016
Sardinella longiceps*	4 - 6	98-02	So Visayan Sea	Belga et al.2002
*S. longiceps**	3 - 5	98-02	W/C Visayan Sea	Guanco et al. 2009
*S. longiceps**		94 95	Ragay Gulf	Guarin et al. 1996
*S. longiceps**		1965	Palawan	Ingles & Pauly, 1984
*S. longiceps**		78-79	Manila Bay	Ingles & Pauly, 1984
*S. longiceps**		81	Ragay Gulf	Corpuz et al. 1985
*S. longiceps**		83-87	Visayan sea	Lavapie-Gonzales et al. 1987
*S. longiceps**		1987	S Sulu Sea	Lavapie-Gonzales et al. 1987
*S. longiceps**		1977	Bali Strait	Dwiponggo et al. 1986
*S. longiceps**		1981	Bali Strait	Dwiponggo et al. 1986
*S. longiceps**		98-01	Sulu Sea	Mamalangkap et al. 2003

* valid name is *Sardinella pacifica*
** valid name is *Sardinella lemuru*

& Pauly, 2016). The compilations of Ingles & Pauly (1984), Corpuz et al. (1985) and Lavapie-Gonzales et al. (1997) were major sources of information as well. An obvious limitation of these sources is that most of them need to be updated, especially for those parameters that are directly influenced by fishing intensity (as well as duration of overfishing), such as mortality and exploitation rates. For stocks that were shown to be already overfished at the time of assessment, their status likely remains unchanged unless sound management interventions had been effectively implemented in the fishing ground.

Growth of *S. lemuru*

The monthly size distributions of *S. lemuru* caught by the fishery during the monitoring period (February 2020 – April 2021) are shown in Figure 34. A total of 8,420 *S. lemuru* individuals were measured within the 15-month period. The smallest individual caught measured 9.2 cm SL, while 18.0 cm SL was the largest. The smaller individuals were mostly caught in Samar Sea (Kawayan & Daram). Figure 35 compares the overall size distribution of *S. lemuru* catches in drift gill nets, the principal gear type used in north FMA 7, and ring nets which are a major gear type in the south. While there is considerable overlap in the size ranges (12.5-16.5 cm SL), catches from both ring nets (Daram) and drift gill nets (Kawayan) in Samar Sea are smaller than those in the north.

Based on the combined size data for the entire FMA, the derived von Bertalanffy growth curve for *S. lemuru* in this study (Fig. 36) yielded the following growth parameter estimates: asymptotic length ($L\infty$) = 21.2 cm SL (= 23.2 cm TL) and growth constant (K)= 1.23 yr^{-1}. There are several sets of growth parameter estimates for *S. lemuru* from various fishing grounds, including the Visayan Sea (Belga et al., 2002), Palawan and Manila Bay (Ingles & Pauly, 1984), South Zamboanga (BFAR-NSAP 9) and Ragay Gulf (Guarin et al., 1996). The respective growth curves, together with the present study's, are shown in Figure 36. The growth curves from

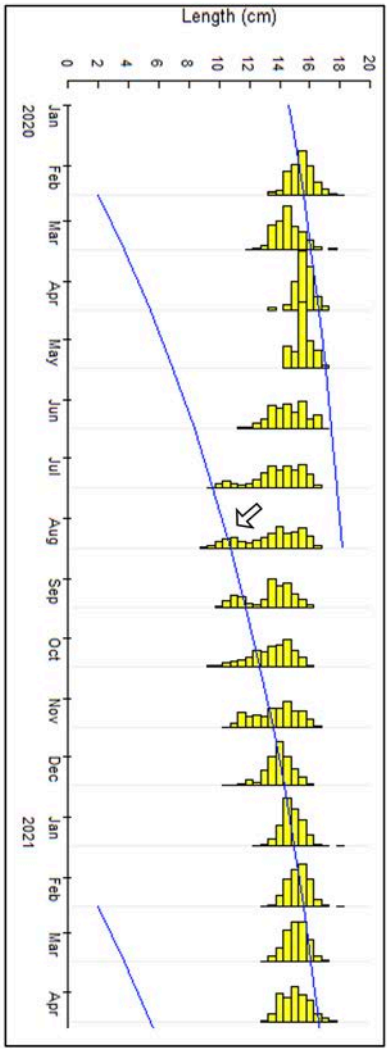


Figure 34. The monthly size distributions of S. lemuru caught by the fishery during the monitoring period and the fitted von Bertalanffy growth curve.

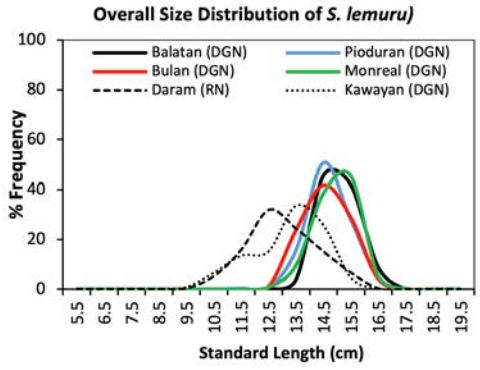


Figure 35. Overall size distribution of *S. lemuru* in catches of drift gill nets and ring nets operating in north and south FMA 7.

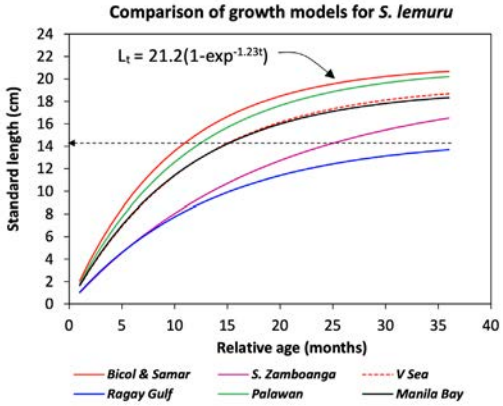


Figure 36. Von Bertalanffy growth curves (color-coded) for different stocks of *S. lemuru* in the Philippines. The red curve refers to the current study. All growth curves were adjusted to reflect SL. The horizontal dashed arrow refers to the L_{m50} of females.

Ragay Gulf and South Zamboanga show much slower growth than curves for the other fishing grounds and are considered as outliers. The current estimates for FMA 7 are in close agreement with most, suggesting that the parameter estimates are not unrealistic. *S. lemuru* is a fast-growing species as indicated by its high K value. The phi-prime index (ø') calculated for the estimated growth parameters is 2.74. This is comparable with the growth performances of the same species studied in different fishing grounds in the country (2.47-2.61; Table 32). Based on this growth model, the estimated L_{m50} for females (14.3 cm SL; discussed in a later section) would correspond to a relative age of about 11 months. Using the models showing slower growth (Ragay Gulf & South Zamboanga), *S. lemuru* at the same size would be at least 25 months of age, which is unrealistically "old" and closer to the lifespan for tropical sardines.

Mortality and Exploitation of *S. lemuru*

The length converted catch curve (Fig. 37) showed a total mortality (Z) estimate of 14.6 yr^{-1}. The natural mortality (M) estimate using the estimated growth parameters K = 1.23 yr^{-1} and L_{∞} = 21.2 cm SL and a mean water temperature of 28°C, is 2.25 yr^{-1}, which is within the range of values shown in Table 32 (1.5-2.5). However, the very high total mortality rate results in a very high estimate of mortality due to fishing (F = 12.3), which is from 1.8-8.6 times more than estimates for other stocks (Table 32), and a very high exploitation rate (E = 0.85). The estimated F is 5.5 times the natural mortality estimate (M), whereas the optimum value should be no more than M. Based on Fig. 37, high mortality ensues when individuals reach the size of approximately 15.5 cm SL and an age of 13.7 months. While this high rate of exploitation is consistent with large proportions of fish smaller than L_{m50} in the catches (Fig. 38), we believe that large part of the very high total mortality estimate reflects the dispersal or movement of fish out of the main fishing area (emigration) covered by the fleet (primarily Bulan-based) in north FMA 7, resulting to an inflated fishing mortality estimate. This makes the use of fishing mortality and/or exploitation rate estimates unreliable as harvest control reference points for this stock of *S. lemuru*.

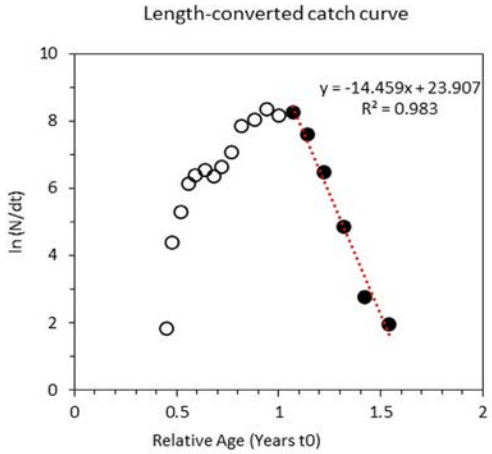


Figure 37. Length-converted catch curve for *S. lemuru* showing the relative abundance of length-based age groups. Only data points depicted by filled markers were used in estimating total mortality Z.

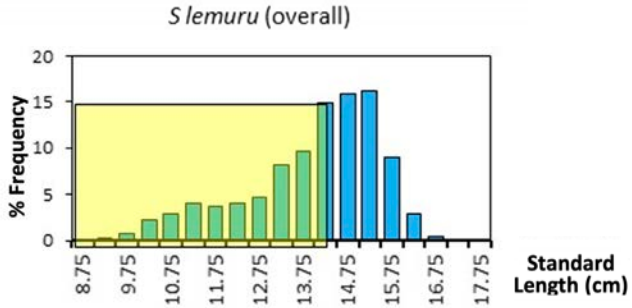


Figure 38. The proportion of the catch of *S. lemuru* which are smaller than L_{m50}. The size distribution is from combined data from all sites in north and south FMA 7 monitored during the study.

Growth of *S. pacifica*

The monthly size distribution of *S. pacifica* is shown in Figure 39. A total of 3,544 individuals were measured within the 11-month period. The smallest individual caught measured 5.8 cm SL, while the largest was 14.2 cm SL. Figure 40 compares the overall size distribution of *S. pacifica* catches between ring nets and scoop nets (with

blast fishing). The sizes of ring net catches ranged from 6.5 to 14.2 cm SL and were larger compared to scoop net catches (5.8 to 11.6 cm SL) by 1-3 cm SL. The von Bertalanffy growth parameters estimated for *S. pacifica* were L_∞ = 14.0 cm SL (~16.6 cm TL) and K = 1.1 yr-1. The estimates are in the lower range of L_∞ values reported for other stocks (16-24.8 cm TL) but are well within the range of reported K values (0.7-1.6) (Table 32). The von Bertalanffy growth curve is shown superimposed on the monthly size distributions of fish in the catches (Fig. 39).

The phi-prime index (ø') calculated for the estimated growth parameters is 2.71. This is comparable with the growth performances of the same species studied in different fishing grounds in the Philippines (2.55-2.6; Table 32).

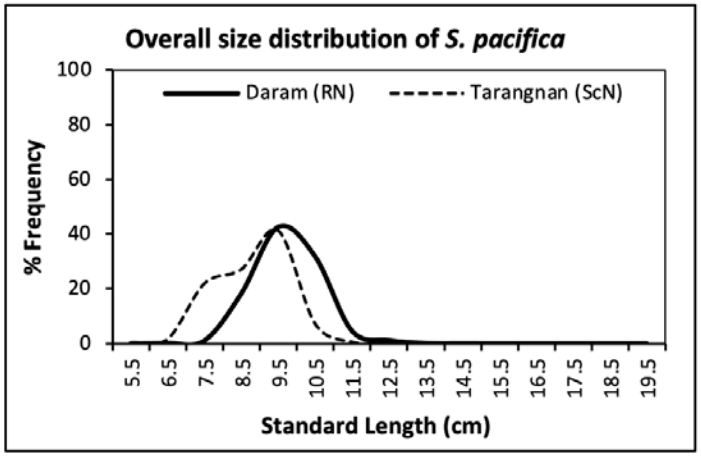


Figure 40. The monthly size distributions of *S. pacifica* caught by the fishery during the study period and the fitted von Bertalanffy growth curve.

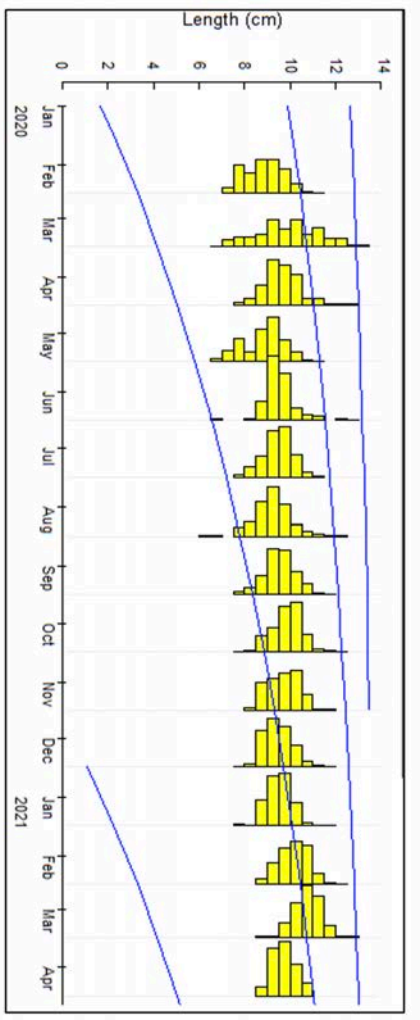


Figure 39. The monthly size distributions of *S. pacifica* caught by the fishery during the study period and the fitted von Bertalanffy growth curve.

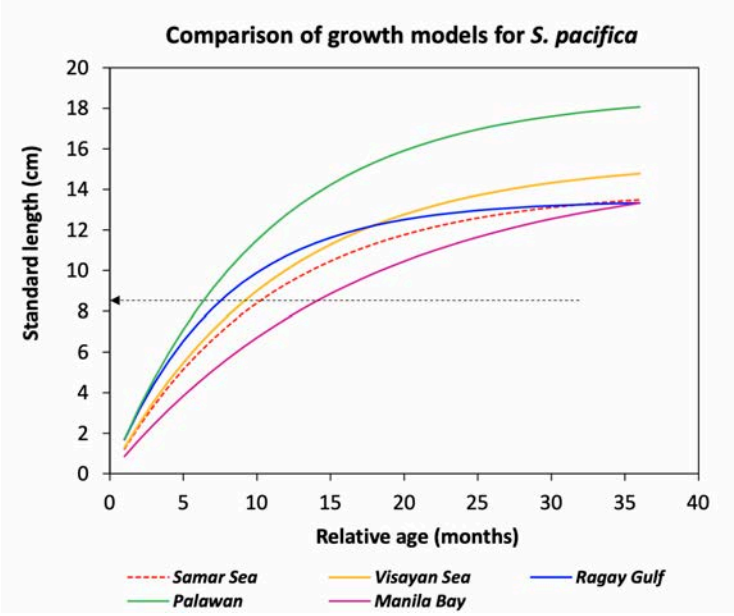


Figure 41. Von Bertalanffy growth curves for different stocks *S. pacifica* in the Philippines. All growth curves were adjusted to reflect SL. The horizontal dashed black line denotes the L_{m50} (8.4) for females.

A comparison of von Bertalanffy growth models for *S. pacifica* stocks in the Philippines is shown in Figure 41. Like S. lemuru, Palawan stocks of *S. pacifica* exhibited faster growth based on the parameters L_∞ = 22 cm TL and K = 1.15. However, stocks from the Visayan Sea (L_∞ = 18.3 cm TL; K = 1.05), Ragay Gulf (L_∞ = 16.0 cm TL; K = 1.60) and the study area showed comparable growth. Slowest growth was observed in Manila Bay (L_∞ = 18.0 cm TL; K = 0.7). Using the estimated growth parameters of the current study, females would be about 10 months old at the size at first maturity (L_{m50}). However, based on the fastest (Palawan) and slowest (Manila Bay) growth curves, they would be from 6 to 14 months old at this size.

Mortality and Exploitation of *S. pacifica*

The length-converted catch curve is shown in Figure 42. High mortality is shown when individuals reach the size of approximately 11.5 cm SL or the equivalent age of 13.0 months. Total mortality (Z) was estimated to be 5.78, which is comparable to those of other stocks of the same species (range: 2.5-6.6; Table 32). Natural mortality (M) at 28°C, given the growth parameters shown above, was estimated at 2.35, which is also well within the range of values (M = 1.6-3.0) reported for other stocks. Fishing mortality (F) was thus 3.43. The resulting exploitation rate (E) was 0.59, which is much less than the estimate for *S. lemuru* above, but nevertheless still over the target range of 0.3-0.5. Like the Bali sardine, *S. pacifica* is also under high fishing pressure.

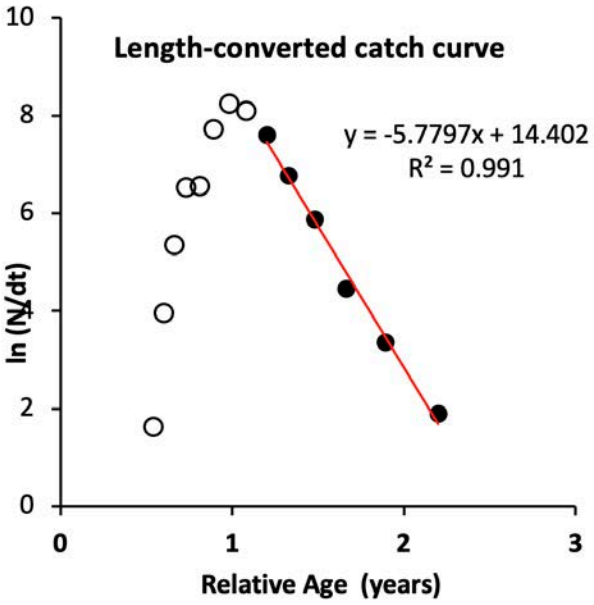


Figure 42. Length-converted catch curve for *S. pacifica* in Samar Sea from Feb-Dec 2020.

Emigration and Total Mortality

For both species, the growth estimates are well within the range of reported values for various stocks around the country, and for this reason are not under- or over-estimates. Our larger concern is the derived mortality estimates used to compute for exploitation rates, which are among the standard harvest control references used not only in the national management plan for sardines but for other stocks in the country as well. For both species, very few large individuals were seen in the catches, and this is the reason for the steep decline in abundance with age (= very high Z). While this may be expected with heavily fished stocks and is also consistent with the preponderance of juveniles in the catches, the possible movement of larger fish to deeper water, either horizontally or vertically, cannot be discounted.

For *S. lemuru*, overall our GPS tracking study suggests extensive dispersal of the stock within and outside of FMA 7 after the peak spawning months (November-December). Hence emigration from the main spawning area in Ticao Pass is substantial. In Samar Sea, the dispersal of juveniles into the area around March and their subsequent emigration in September-October are part of the ontogenetic changes in distribution of the stock. We believe that the high total mortality estimates reflect the dispersal or movement of fish out of areas where fishing vessels usually operate, resulting in inflated fishing mortality and exploitation rate estimates. Extremely high mortality and exploitation rates for sardines have not been reported in any fishing ground in the country (Table 32 and Campos et al., 2017). Perhaps the hydrographic and topographic features of the Ticao Pass-San Bernardino Strait area make FMA 7 unique in terms of spawning and dispersal of stocks. Hence, alternatives to using exploitation rates as harvest control references are necessary.

3.8 Reproductive Capacity

Size at first maturity

The proportions of fish in the various gonad development stages by size class of *S. lemuru* are shown for each site in Fig. 43. In Pio Duran, which lies north of Ticao Pass, over half of fish in the smallest size classes in the samples (12.75 cm SL) were already mature in both sexes. In females, this proportion decreased to about 50% in fish 14-15 cm SL and then increased again with size. In males, the proportion of mature fish peaked at around 14 cm SL and then decreased continuously in larger sizes. While sample sizes at both ends of the ranges in both sexes were small, the overall trends continue over 3-4 size classes with larger sample sizes. A similar trend can be seen in female *S. lemuru* off Monreal, where sampling was continuous over the entire study period.

In inner Samar Sea (Daram), while smaller *S. lemuru* made up a substantial portion of the catches, 50% maturity levels were attained at smaller sizes (11.75 cm SL) than in areas to the north. This may be an artifact of small sample sizes and less coverage in time since *S. lemuru* in Daram was no longer observed in the catches after September 2020. While the differences in the sizes of fish caught between the north and south portions of FMA 7 (Fig. 35) may be partly due to differences in the mesh sizes used by the respective fleets (north ≥ 3cm; south ≤ 3cm), it is likely that the amounts (volumes) typically caught in drift gill nets and ring nets will override any theoretical size selection effect on the size distribution of their catches. Instead, we believe the observed difference is due to the southward dispersal of juveniles beginning in March.

Except for the data from fish landed in Bulan, the data for Monreal and Pio Duran in north FMA 7, and for Daram in south FMA 7 are from fish caught closer to the monitored landing sites, well within 15 km. On the other hand, fish landed in Bulan are from a more extensive area reaching up to 80 km north and south (Fig. 20). Hence, given the extensive movement of the stock, characterizing size and development stage distributions from essentially spatially limited fishing operations will be difficult to do. As a result, the observed patterns of development stage with size in the other three sites are ambiguous in terms of the expected increase in proportions of mature and spent individuals with increase in size for either females or males (Fig. 43).

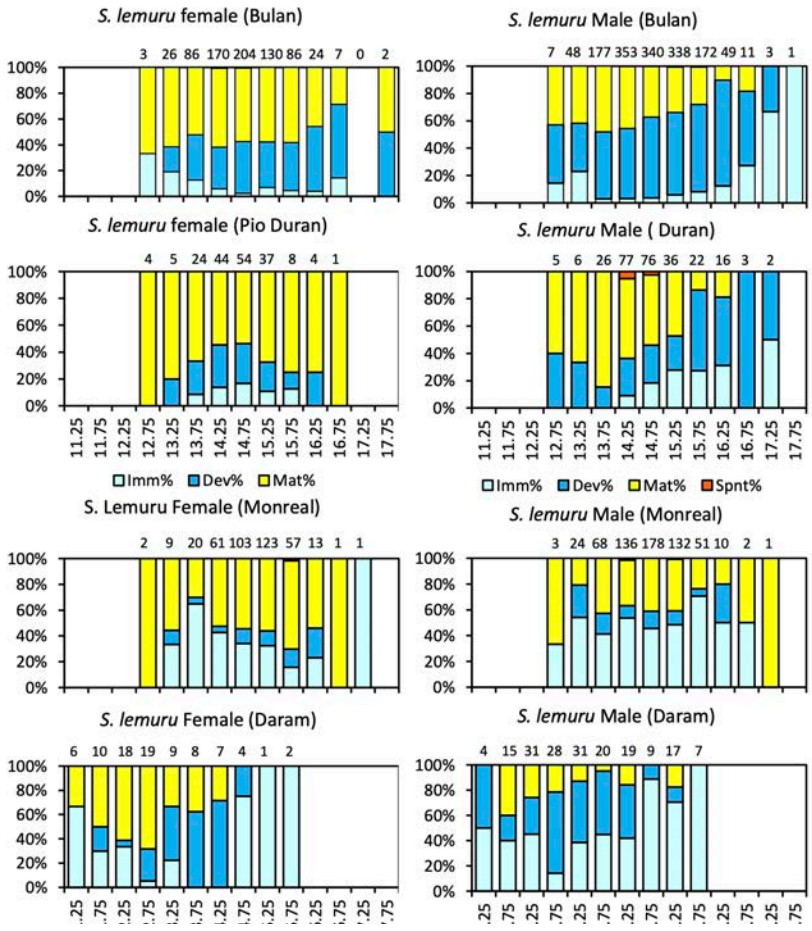


Figure 43. Maturity stages by size class of both male and female *S. lemuru* in FMA 7. The numbers above the bars are sample sizes for each size class.

In comparison, the patterns for Bulan showed moderate (50-65% in females; 40-50% in males) maturity levels over most size classes, with a decrease in larger fish. This apparent lack of pattern, specifically the absence of size classes with high (>80%) maturity levels, may be a consequence of fleet operations following the dispersal of the stock. The observed drop in stock abundance during the SW monsoon months in Balatan, Pio Duran and Monreal (Fig. 17), when more individuals in the catches also showed immature gonads, served to amplify the very high proportions of mature fish in November and December (Fig. 23), when stock abundance was also very high (Fig. 17), when combining data over the entire study period. Hence peaks in proportions of mature fish at specific size classes were observed. On the other hand, since the fleet from Bulan continues to catch fish in all months as they follow the dispersing stock, they continually catch mature fish, although at low to moderate levels, for most of the year. This dampens any potential patterns in maturity levels with size when data are combined across months. For this reason, only the data for Pio Duran and Monreal were used to represent the distribution of gonad maturity stages by sizes of catches in north FMA 7, the main fishing area for sardines (Fig. 44). The pattern is more coherent in females, where the proportion of mature individuals in each size class increases continuously from 13.75 to 16.75 cm SL. The limited number of specimens in the smallest and largest size classes may be the reason for incoherence with the general pattern. There is even less coherence in the distribution of maturity stages of males across the size classes. This is interesting because the female to male ratios for most of the year were overwhelmingly low in all samples from the different sites but started approaching a 1:1 ratio in October and remained high through the peak spawning months (Fig. 45). Bathymetric segregation of spawning stages has been reported for the Atlantic sardine, *Sardina pilchardus* (Ganias & Nunes, 2011) and the Japanese sardine, *Sardinops melanostictus* (Inagake & Hirano, 1983), where spawning females are located closer to the thermocline in deeper water layers than those in pre-spawning stages. Whether *S. lemuru* displays such behavior is not known, but it offers a possible explanation for the incoherence observed in maturity stage distributions.

In the vicinity of Ticao Pass, the typical depth of the

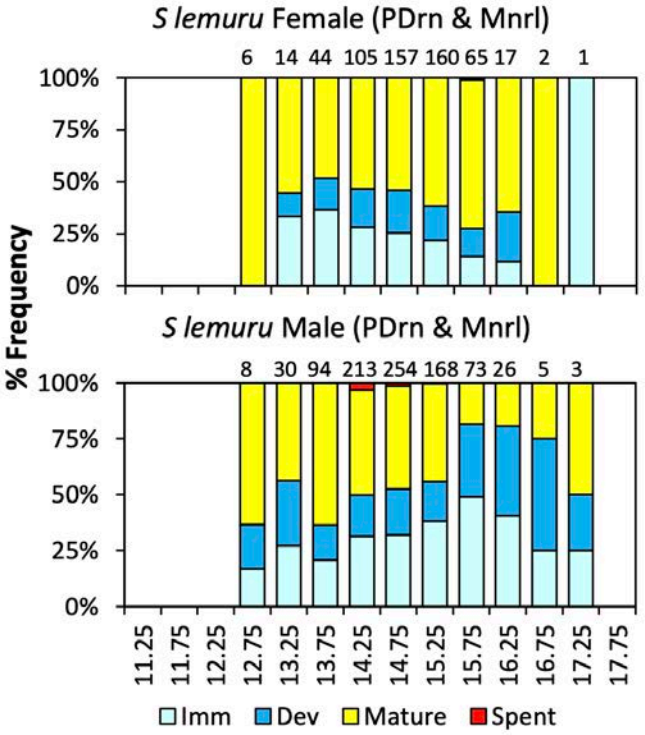


Figure 44. Maturity stages by size class of both male and female *S. lemuru* in Pio Duran and Monreal.

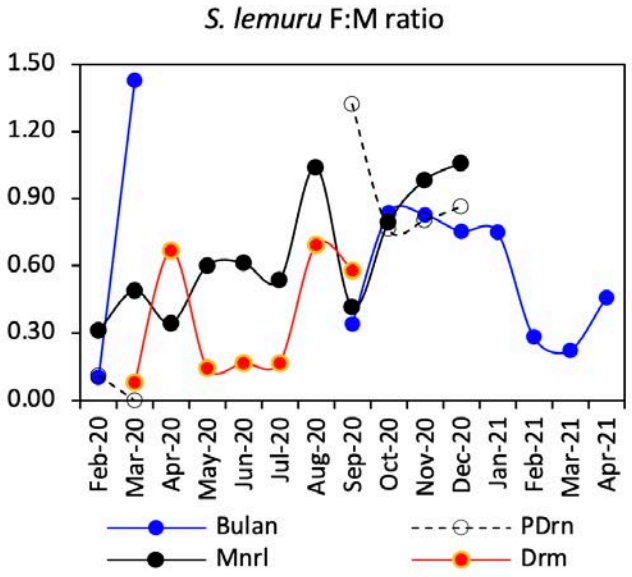


Figure 45. *S. lemuru* female: male ratio.

thermocline is between 100-150 m (Campos et al., 2004), but this is likely forced towards the surface during the NE monsoon when upwelling is strongest. Even so, these depths are well below the reach of typical drift gill net operations in the area for most of the year, which may lead to underrepresenting the true proportions of spawners in the stock, particularly among the larger fish. At the onset of the NE monsoon when peak spawning takes place, enhanced upwelling in the area of Ticao Pass leads to the shoaling of the thermocline and the concentration of spawners of both sexes closer to the surface.

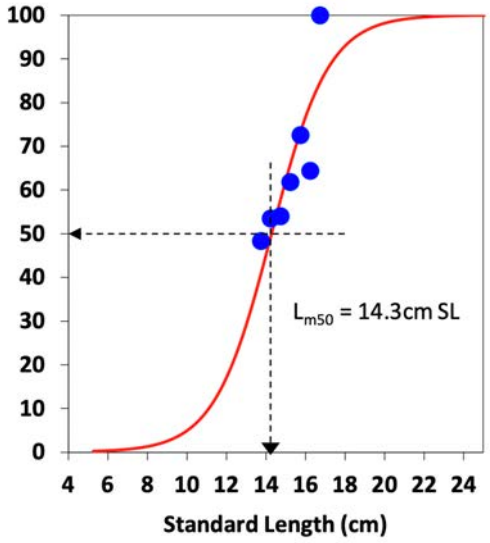


Figure 46. Estimated size at first maturity (L_{m50}) for female *S. lemuru*.

Using the combined data from Pio Duran and Monreal, the estimated size at first maturity (L_{m50}) for females is 14.3 cm SL (Fig. 46). This is the size at which 50% of fish are mature. The current estimate is lower than the estimated value for Ticao Pass in 2016 (L_{m50} = 15.0 cm SL; Campos et al., 2017), but does not necessarily mean a significant decrease. This will be discussed in a later section. The proportion of the catch of *S. lemuru* which are smaller than the L_{m50} (14.3c m SL) was about 48% (Fig. 38).

Maturity by size in female and male *S. pacifica* in Tarangnan and Daram is shown in Fig. 47. The size range in males is a bit smaller in both sites, although the progression of maturity followed a more coherent pattern in this species. The combined distributions show that size at first maturity is attained at a smaller size in females than in males.

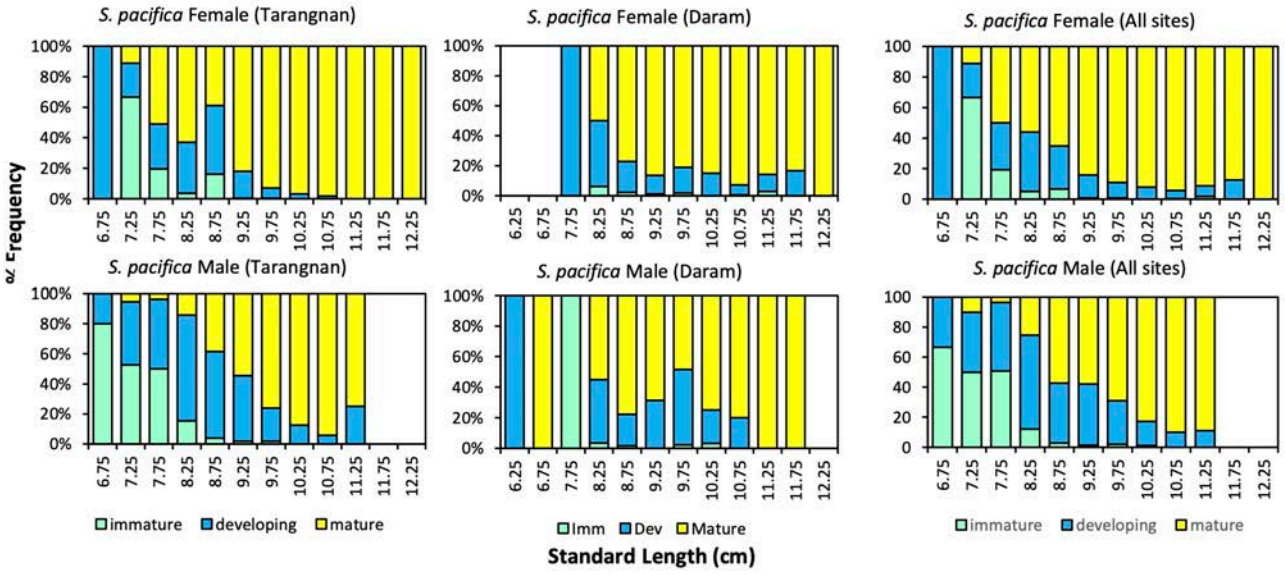


Figure 47. Maturity stages by size class of both male and female *S. pacifica* in Tarangnan and Daram.

The size at first maturity (L_{m50}) was estimated at 8.4 cm SL in females and 8.9 cm SL in males (Fig. 48a). The estimated value for females is comparable to the L_{m50} reported for the same species (misnamed as *S. fimbriata*) in the Visayan Sea from 2009-10 (L_{m50} = 8.1cm SL) (Mesa & Guanco, 2011). The original value in the latter study was in terms of total length (TL). To facilitate the comparison, conversion to SL was done by using the SL-TL relationship TL = 1.0978SL + 1.0564 (r2 = 0.8437, n = 3784; size range: 6.8-12.5 cm SL) derived from data of Tarangnan and Daram. The proportion of all *S. pacifica* in the catches smaller than the L_{m50} is only about 11.4% (Fig. 48b)

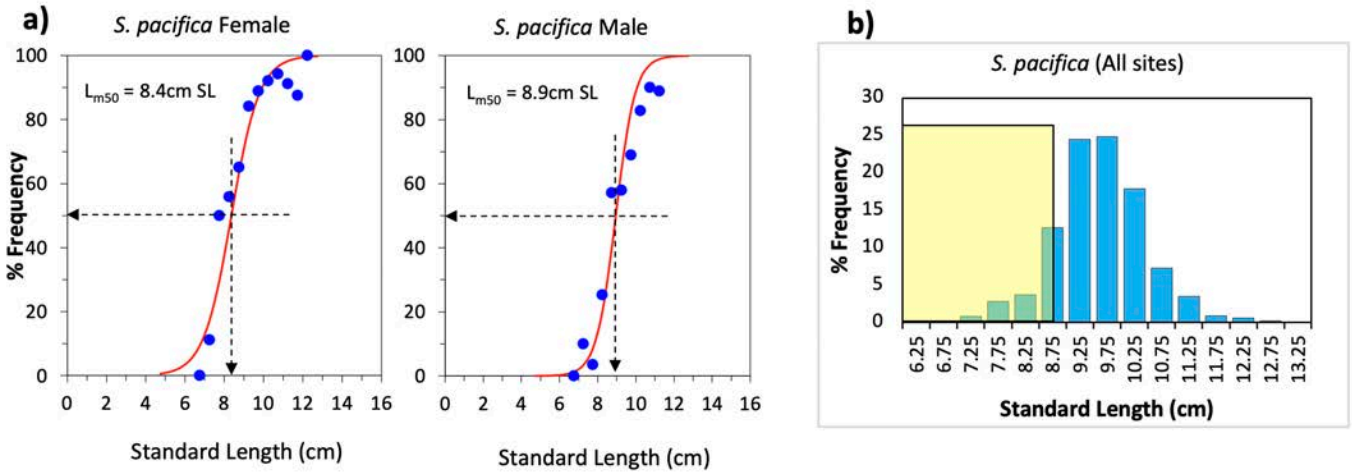


Figure 48. (a) Estimated size at first maturity (L_{m50}) for male and female *S. pacifica* and (b) the proportion of the catch of *S. pacifica* which are smaller than L_{m50}.

Fecundity and Size

This section presents the results related to the reproductive capacity of the Bali sardine, *S. lemuru* in FMA 7. While the original proposal intended to determine both fecundity and egg (oocyte) size distributions, the approved study could only accommodate limited coverage of fecundity. In this report, results from a previous study conducted in Bulan, Sorsogon in 2016 (Campos et al., 2017) are compared with those from the present study to gain insights on year-to-year variability in fecundity of the local sardine stock.

Table 33. Summary of information from specimens of *S. lemuru* collected in 2016 and 2020.

	2016	2020
No. specimens examined	50	33
Size range (cm SL)	13.4 – 17.2	12. 7– 16.3
Body Weight range (g)	38 – 69.3	22.0 – 49.5
GSI range (%)	0.8 – 12.7	3.3 – 12.7
Min fecundity estimate	2,555	6,706
Max fecundity estimate	56,606	34,622

To facilitate the comparison of fecundity between years, only specimens collected from the fishing fleet in Bulan during the peak spawning months of November and December in both 2016 and 2020 were examined. The data are summarized in Table 33 and presented in Fig. 49. Overall, the number of eggs produced by the smallest mature fish (13 cm SL) is doubled in fish at the size of first maturity (L_{m50} = 14.3 cm SL). Hence the proportion of catches with sizes below L_{m50} is critical to the stock's capacity to produce. North of Ticao Pass (Pio Duran), 41.2% of sardine catches were smaller than L_{m50}. In Ticao Pass these proportions were somewhat lower, 24.5% (Monreal) and 38.8% (Bulan) (Fig. 50).

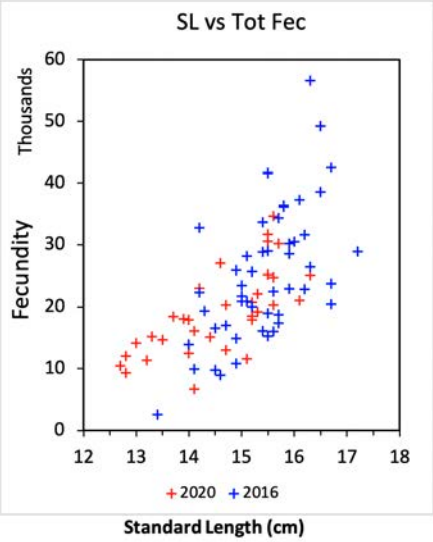


Figure 49. Total fecundity (no. eggs/ind) vs standard length (SL in cm) of *S. lemuru* caught off Bulan, Sorsogon in Nov-Dec 2016 & 2020.

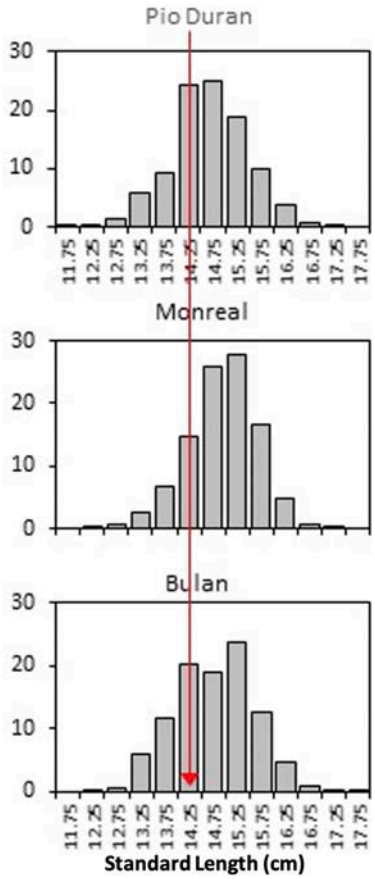


Figure 50. Size distribution of *S. lemuru* in catches in northern FMA 7.

There was substantial overlap in the size-fecundity trends for both years (Fig. 49), although specimen sizes in 2016 were about 1.0 cm larger than those in 2020 (Fig. 51). The modal size of mature females in 2020 was 14 -15 cm SL. The corresponding fecundity for these sizes ranged from about 8 – 25,000 eggs/ind. The modal size in 2016 was from 15 -16 cm SL, with corresponding fecundities ranging from 10 – 30,000 or from 20 - 25% more.

Further examination of the length-weight distributions for each year clearly showed that for the same lengths, fish in 2016 were heavier than those in 2020. This is clear for both females and males (Fig. 52). For both sexes for example, a 15 cm (SL) long fish weighed between 25 and 40 g in 2020 but would have weighed between 40 and 50 g in 2016, or from 25-60% more. This suggests that overall fecundity of the stock during peak spawning months (October to December) was higher in 2016 than in 2020. If we re-examine Fig. 49, outside of fish longer than about 16 cm SL, which represents < 15% of mature fish in 2016 and < 5% in 2020, the range of fecundities were comparable between the two years (Fig. 53) and there was little year-to-year variation in the fecundity-gonad weight relationship (Fig. 54). A plot of body weight (g) vs fecundity (Fig. 53) shows that smaller fish in 2020 (20 – 40 g) had the same range of fecundities than larger fish (40 – 60 g) in 2016. In addition, the trends of increase in fecundity with gonad weight (g) (Fig. 54) shows little, if any, difference between 2016 and

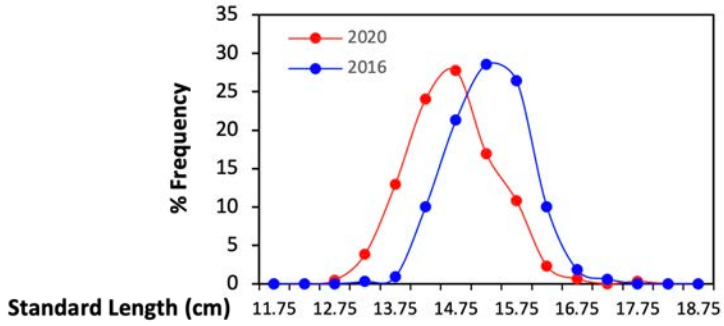


Figure 51. Size distribution of mature female *S. lemuru* caught by fleet in Bulan, Sorsogon in Nov-Dec 2016 and 2020.

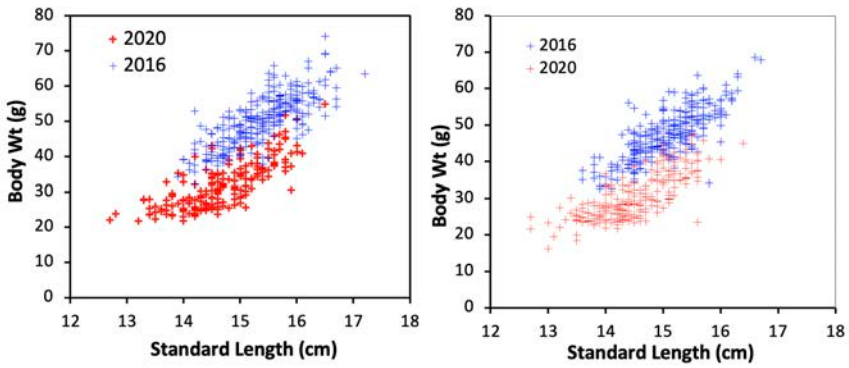


Figure 52. Standard length (SL in cm) and body weight (g) relationship of mature female (left) and male (right) *S. lemuru* caught off Bulan in Nov-Dec 2016 and 2020.

2020. Hence, if there was little difference in fecundity between the 2 years, gonad weights of smaller fish in 2020 should be comparable with those of the larger fish in 2016. This is what Fig. 55 shows. Gonad weights for smaller fish, below about 45 g (~ 16.4 cm SL), in 2020 showed the same range as those for larger fish (45-55 g) in 2016.

These combined results indicate that the size differences between stocks during peak spawning months in 2016 and 2020 are real differences and not artifacts of sampling periods covered by the different studies. These may result from year-to-year differences in food conditions, either in absolute (i.e., inter-annual differences in plankton productivity) or relative terms (i.e., differences in abundance and concentrations of sardine early stages), or both. What is noteworthy is that catch rates of drift gill nets in Bulan were up to two times higher in 2016 than in 2020 for the period August to December (Fig. 56). This indicates higher stock abundance, and possibly prey availability in 2016.

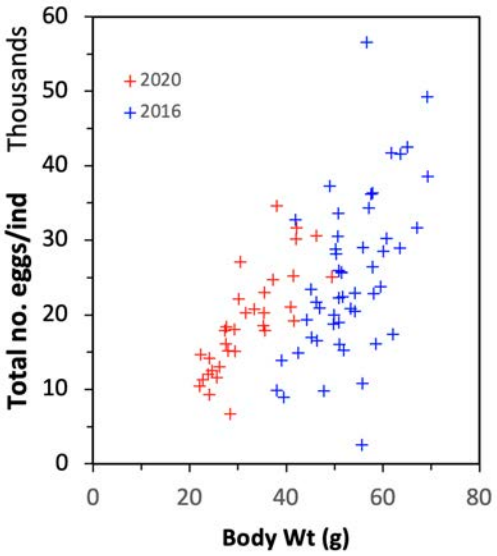


Figure 53. Plot of body weight (g) vs fecundity in *S. lemuru* specimens from 2016 & 2020.

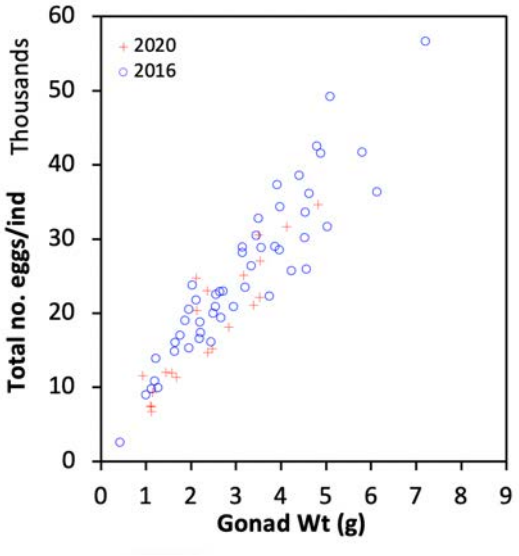


Figure 54. Plot of total fecundity vs gonad weight (g) in *S. lemuru* from 2016 & 2020.

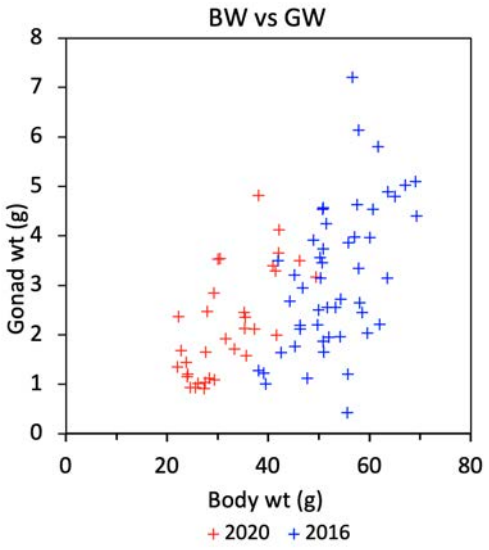


Figure 55. Plot of Gonad weight (g) vs Body weight (g) in mature female *S. lemuru* from 2016 & 2020.

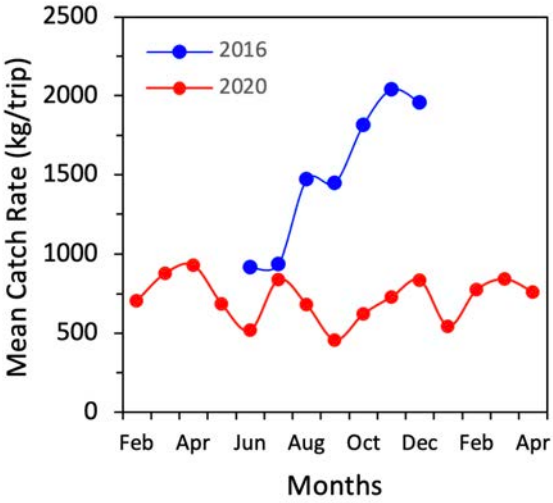


Figure 56. Catch rates of drift gill nets in Bulan from 2016 and 2020.

However, in spite of these differences, the investment in overall gonad development of individual fish in the stock seemed to change little. A possible argument would be that under reduced food conditions (2020), fish allocate relatively more energy to gonad development, resulting in less somatic growth, hence smaller fish. Such a strategy might be consistent when stock abundance is so depleted that maximizing reproductive capacity is the only means of enhancing possibilities of recruitment success.

Such year-to-year differences suggest that differences in nutrition, whether driven by temporal dynamics or geographical differences in primary productivity, do lead to considerable fluctuations in growth and reproductive capacity of the stock, although it is not certain what effect this will have on subsequent recruitment. This variability in fecundity is consistent with the hypothesis of high within-cohort variability in growth resulting from differing conditions of food availability of areas where early juveniles are dispersed from Ticao Pass.

Spawning Potential Ratios

The Spawning Potential Ratio refers to the proportion of mature fish that are not caught by the fishery and thus remain in the stock to spawn and produce offspring that make up the recruits of the following year. A minimum proportion is thus necessary for the stock to sustain adequate recruitment to the fishery year after year. The target value of 40% is considered a precautionary measure (Hordyk et al., 2015), while a range of 30-40% may be acceptable for heavily exploited stocks, such as the sardines in FMA 7.

An SPR analysis done in 2016 showed that at the length at first capture (L_c = 14.2 cm SL) estimated at the time, roughly only 12-16% of spawning potential remained in the stock, and that a 1.0 cm increase in L_c (= 15.2 cm SL) was necessary to increase the SPR to a more sustainable range of 25-30% (Table 34). SPR analysis using data from 2020 showed that at the actual L_c (= 14.8 cm SL), the SPR was about 23%. If the sizes of fish in the overall catch are allowed to grow to make the L_c = 15.5 cm SL, an SPR of 30% (range: 20 – 40%) is attained (Table 34). These results indicate that *S. lemuru* in FMA 7 is overfished. The results of the SPR analyses from 2016 and 2020 are consistent and show that the amount of small (< L_{m50} = 14.3 cm SL) Bali sardine in the catches need to be reduced to ensure there will be adequate spawners retained in the stock year after year. A size at first capture (L_c) larger than 15.2 cm SL would serve as a better harvest reference point than the estimated mortality or exploitation rate estimates, as earlier explained.

For *S. pacifica* in Samar Sea, the SPR analysis showed that with the current size distribution of the catches (L_c = 9.25 cm SL), from 27-46% (mean = 37%) of mature fish are retained in the stock (Table 35). This indicates that the local stock of *S. pacifica* is fully exploited and presents a somewhat uncommon opportunity to introduce management interventions to prevent overexploitation.

Table 34. Estimated values of L_c and the corresponding range of SPR values for *S. lemuru* in FMA 7 in 2016 & 2020. The input values for 2020 are: L_∞ = 21.2cm SL; K = 1.23 yr^{-1}; M = 2.25 yr^{-1}; L_{m50} = 14.3; L_{m95} = 18.55. These values are explained in detail in the section on population parameters.

Year	L_c (cm SL)	SPR (%)	SPR range
2016	14.2	14	(12 - 16)
	15.2	27.5	(25 - 30)
	15.7	35.5	(33 - 38)
2020	14.8	23	(14 - 33)
	15.5	30	(20 - 40)

Table 35. Estimated values of L_c and the corresponding range of SPR values for *S. pacifica* in south FMA 7 (Samar Sea) in 2020. The input values for 2020 are: L_∞ = 14.0 cm SL; K = 1.1 yr^{-1}; M = 2.35 yr^{-1}; L_{m50} = 8.4; L_{m95} = 10.5. These values are explained in the section on population parameters.

Year	L_c (cm SL)	SPR (%)	SPR range
2020	9.25	37	27 - 46
	9.75	46	36 - 57
	10.3	56	46 - 67

Of the overall size distribution of catches in Daram & Tarangnan in Samar Sea, only about 11.4% are smaller than the L_{m50} (= 8.4 cm SL) (Fig. 57). This relatively small proportion is consistent with the near-target value of the SPR but is inconsistent with the high fishing mortality and exploitation rate estimates which are indicative of overfishing. The major gear used in catching sardines south FMA 7 include drift gill/entangling nets, which are used in at the mouth of Samar Sea and north towards San Bernardino Strait where currents are strong, ring nets within Samar Sea and blast fishing in the shallow inner portions. The mesh sizes used are smaller than their counterparts in north FMA 7. Hence, catches of the Bali sardine are dominated by juveniles, similar to *S. pacifica* even if this species is a naturally smaller fish. *S. pacifica* may move to somewhat deeper water as they mature, away from the shallow inner portions of the embayment where fishing operations switch from sardines to anchovies when abundances of the former start to decline. The underrepresentation of mature fish in the catches leads to a bloating of non-natural mortality rate estimates, resulting to extremely high exploitation rates. For this reason, we believe the information related to the reproductive biology, such as the proportion of juveniles in the catches as well as the SPR, which are based on the size at first maturity (L_{m50}), are more reliable and meaningful indicators of the status of the stock of *S. pacifica*.

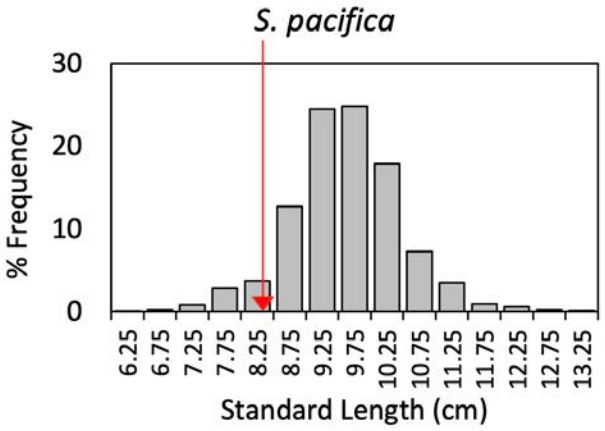


Figure 57. Size distribution of *S. pacifica* in southern FMA 7. The red line refers to L_{m50}.

04. Synopsis

There are 90 coastal municipalities that border FMA 7. The annual production of sardines in these fishing grounds in 2020 was estimated at 56,450 mt. More than a third of the coastal municipalities (32) contributed at least 70 mt of sardines in 2020. Half of these are located in the northern part of FMA 7 (Camarines Sur, Albay, Sorsogon & Masbate), while the other half are in the southern part (Northern Samar, Samar and Biliran). Fisheries profiling activities were conducted in 14 municipalities. These activities revealed the use of 13 gear types in the area, with sardines comprising between 10 and 100% of their typical catches. Of these, drift gill nets were the principal gear type employed, contributing 96.1% of the total annual sardine catch, primarily from Burias Pass to Ticao Pass in the north, and from the San Bernardino Island Group to the mouth of Samar Sea in the south. Nearly 80% of the total catch was landed by the fleet of drift gill net vessels based in Bulan, Sorsogon alone. Only the Bali sardine, *S. lemuru*, was recorded in sardine catches in the northern part of FMA 7, while *S. lemuru* and *S. pacifica* made up 60.5% and 39.5% of catches in Samar Sea. Bali sardines were more abundant in deeper water, from Burias Pass to the San Bernardino Island Group and further south to the mouth of Samar Sea but decreased in abundance in shallower water closer to shore, as in the inner Samar Sea, where *S. pacifica* dominated catches. A similar depth-related distribution pattern has been observed for the same sardine species in the Visayan Sea.

Peak spawning in Bali sardine *S. lemuru* took place in Ticao Pass from November and December 2020, timed with the increase in upwelling-driven primary productivity in the area at the onset of the NE monsoon. Monthly changes in catch and effort, size distributions of catches, and GPS tracking of fishing operations in the monitored sites were used to characterize dispersal of fish in subsequent months. Adults dispersed northwards into at least Burias Pass in January, and then back to Ticao Pass in March 2021 where the fleet continued operating until June. Adults then dispersed further south to the San Bernardino Island Group (and perhaps into other basins as well) from July to September, where the fleet of larger vessels based in Bulan shifted their operations. During this same period, catch rates (kg/trip) of smaller vessels in Ticao Pass and further north dropped, consistent with the stock's movement out of this area. Mature fish started appearing in Ticao Pass again in October/November to begin the spawning cycle anew. Juvenile sardines, on the other hand appeared to disperse southwards into Samar Sea (and perhaps into other basins) as early as March/April, when they start appearing in catches at the mouth of Samar Sea. *S. pacifica*, on the other hand, was only recorded in the shallower inner parts of Samar Sea, with hardly any dispersal traceable from the catch monitoring. For both species, the lack of larger fish in the catches suggests that fish move to deeper parts of the water column and/or basin as they become older.

A comparison of characteristics of the catches in 2020 with those from 2016 allowed examination of potential year-to-year differences. While there were larger (20-25% longer and from 25-60% heavier) individuals of *S. lemuru* in the catches in 2016, there was little difference in overall gonad weights and fecundity for fish within the same size range (< 16 cm SL) in the two years. Catch rates of drift gill nets were twice those in 2016, indicating higher stock abundance likely in response to higher prey availability. These differences suggest that under reduced food conditions (2020), fish allocate relatively more energy to gonad development, resulting in less somatic growth and smaller fish. Such a strategy would be advantageous when stock abundance is so depleted that maximizing reproductive capacity is the only means of enhancing possibilities of recruitment success.

The derived growth curves for the two species are comparable to those of stocks in different fishing grounds from previous studies. However, the estimated total mortality rate for *S. lemuru*, in particular, was very high (Z = 14.6 yr^{-1}), translating to an exceptionally high exploitation rate (E = 0.85). Such high rates are likely due to the extensive dispersal of the stock outside of the basins as well as movement to deeper water of older (larger) fish, making them inaccessible to current fishing operations. Such pronounced underrepresentation of larger fish in the sampled catches results to overestimates of total, and hence fishing, mortality rates. For this reason, the use of fishing mortality and exploitation rates as harvest control references in FMA 7 may be misleading. In contrast, this problem was not as pronounced for *S. pacifica*, whose exploitation rate was estimated to be 0.59, which is well within the range of values estimated for various sardine stocks in previous studies. Since this species tends to inhabit shallow inshore waters, it is likely to show less pronounced age-related horizontal or vertical movement.

The use of size at first maturity, the proportion of juveniles in the catches and spawning potential ratios are more meaningful alternatives as harvest control references. The results show that *S. lemuru* in FMA 7 is overexploited, with 48% of the catches smaller than the estimated L_{m50} (14.3 – 14.9 cm SL) for both sexes, similar to the results of the 2016 study. To attain SPR levels that are sustainable for the stock (30-40%), a 1 cm increase in the modal size of catches (L_c) is necessary. To achieve this, there must be a reduction in the proportion of the stock that is caught, thereby allowing some of the fish to grow to larger sizes. *S. pacifica* in the Samar Sea appears to be in a less severe situation, with only 11% of the catches smaller than the estimated L_{m50} (8.4-8.9 cm SL). The stock is nevertheless heavily fished and an increase in the sizes of caught fish is still necessary to maintain the viability of the local stock.

The stock dynamics of Bali sardine *S. lemuru* in FMA 7 is determined by the drivers of enhanced primary productivity during the NE monsoon, the geographically confined waters where this takes place (Ticao Pass), and its close hydrographical links with neighboring basins. These factors underlie the observed dispersal pattern throughout the year, limiting access to the stock. Movement to deeper water and to adjacent basins pose further limits to fishing access. Unlike more open sardine fishing grounds, such as the Visayan Sea and the northern Zamboanga Peninsula, a large portion of juveniles in FMA 7 is likely dispersed into other deeper fishing grounds where they are more spread out and thus less vulnerable en masse to fishing. In spite of these apparent opportunities for refuge, the biological traits manifested by the stock (e.g., reproductive capacity) indicate that it is nevertheless overexploited.

05. Recommendations

Local stocks of *S. lemuru* (Bali sardinella) and *S. pacifica* are overfished and interventions should be put in place now, even if harvest control reference points and their limits are still being estimated, validated and/or discussed. The following are recommendations for such interventions:

Focus on drift gill net fishery in Bulan, Sorsogon

The study showed that 96.1% of sardine catches in the entire FMA 7 is from drift gill nets, and that 79.8% of all sardine catches are from the sardine fishing fleet based in Bulan, Sorsogon. Focusing catch and effort regulations (see below) and other management interventions in this area will already cover most of the fishery.

This holds true for other aspects of the fishery, including handling of catches, ex-vessel value, transport, and postharvest. While the latter were covered comprehensively by the parallel study of Bradecina et al. (2021), the major on-site observations associated with drops in ex-vessel prices and large amounts of spoilage should be mentioned here. These include:

- apparent unregulated control on access to and sale of ice
- unorganized selling and buying of catches
- absence of arrangements between fishers/vessel operators and buyers/transporters of catches

The pandemic hit the country just as the first activities of the study were being conducted. While the lockdowns and accompanying travel restrictions had a strong impact on the selling and transport of catches, the observed deficiencies, particularly in the fishing port in Bulan, have long been existing but were exacerbated during this period. For example, during the lockdown, fewer buyers/middlemen were allowed inside the port area, quickly saturating the maximum amounts they could handle and driving down the selling price of catches. In addition, there were complaints of undue preference on the sale of ice which led to increased spoilage of catches, particularly those of the many small vessels landing small volumes of catches.

The inherent problem is the fixed buyer-seller relationship of municipal fishers mentioned earlier, which places the ex-vessel price of landed catches under the control of buyers. Fishers need to be organized, for example into cooperatives, so that they can negotiate as a group with similarly organized buyers and transporters. This is not a new idea, but while fishers' cooperatives do exist in some fishing grounds, they are not widespread in most. If fishers were organized, livelihood loans may be more accessible, freeing them from the obligation of paying for funds advanced to them with their catches and allowing them to sell to others offering fairer prices or at least to coordinate/negotiate with one another in terms of short-term supply-demand changes to avoid gluts (and spoilage) and plunges in prices. For example, an idea suggested during a stakeholder consultation held in early 2021 was to put up an information bulletin board or similar platform indicating the amount of catches each buyer can handle at current ex-vessel prices.

No estimates of the amounts of spoilage of catches were determined by this study, but 15-20%, particularly during peak months, is oftentimes used. Peak catch rates and fishing effort in Bulan occur from November to December, February to April, and June to July (Fig. 17), which represent over half of the year. Even if a spoilage rate of 10% is used for these months, any measure to reduce this amount would essentially contribute to a relative "increase"

in fisheries production that is consumable, rather than an increase in the catches. A close examination of daily landings and corresponding buying prices in the Bulan fishing port can shed light on the above concerns. To our knowledge, the port authority does not document such information and no studies have been done on this subject. Facts and data are critical to convincing not only policy makers but the principal actors themselves, and learnings from such studies will be instrumental in addressing similar or even the same issues in other FMAs as well.

Reduce fishing effort

This can be done by reductions in the frequency of fishing without necessarily removing vessels from the fleet, by regulating the number of trips each day or over a month. This is possible if fishing operators and or vessel owners were organized so that they can collectively work towards an acceptable scheme that will be consistent with sustainability. Such schemes are being implemented voluntarily in MPA areas of some municipalities in the country. While these are small-scale initiatives, upscaling is possible provided the scheme is acceptable to stakeholders. For the fleet in Bulan, fishing frequency was highest from March to July 2020 (Fig. 17) with about 97% of the fleet fishing daily (mean = 29.1 days) each month during this period. If each of the 274 vessels fished for only 6/7 days each week, this would correspond to a 14% reduction in fishing effort during this period, equivalent to a 5.8% overall reduction of effort for the year. With an average catch rate of 768.6 kg/trip during this period, the amount of sardines left in the stock by this reduction would amount to 4,200 mt, assuming catch rates for the remainder of the fleet do not change. This represents a 10% reduction in the amount extracted from the stock.

Another measure is to impose limits on the lengths of drift nets and their mesh sizes. This will require setting up a registration system of vessels and gear, as well as conducting periodic inspections. The BFAR has an existing system for this (BoatR and FishR) which is implemented together with LGUs, but it needs additional measures to ensure wider coverage. For example, the registration systems do not include information on gear types or sizes and is still voluntary in most if not all areas. So even if fishers are typically required to pay annual fees to the LGU to operate, not all gear types are included and most LGUs do not have the means to validate and monitor. Such gaps need to be addressed to improve the registration systems and a stronger role for the LGUs is necessary to effectively regulate fishing effort.

Reduce the amount extracted from the stock

These include more direct regulations on landed catches, such as quotas, which may apply per season or for the entire year, and “bag limits” pertaining to different sized vessels taking into account capacity of buyers to absorb catches, transport capacity from the port, access and supply of ice, cold storage facilities and other related concerns as discussed above.

Limits to fishing effort and caps on landings eventually lead to a reduction in the amount of sardines extracted from the stock and allow more fish to grow to maturity and ensure adequate recruitment. Such measures should eventually affect an increase in the size distribution of the catches and a corresponding increase in its spawning potential. Since both *S. lemuru* and *S. pacifica* are overfished, reductions in effort or in catches will eventually lead to an increase in catch rates because of more fish growing to larger sizes. Over time, this compensatory growth in the stock may balance out in the long term the initial reduction in income due to reduced fishing.

Aside from operational challenges to such measures, the actual reference point (limit or quota) is by itself a challenge. In Bulan, about 45,000 mt of sardines were landed by the fleet in 2020. In 2016, catch rates from August to December (effectively half a year) were up to twice the catch rates in 2020 for the same period. Hence, assuming that sardine landings for this period were 50% higher in 2016 and similar to those in 2020 for the

remaining months, the total sardine landings from the Bulan fleet would have been around 70,522 mt in 2016. Without any other historical data on annual catches, we do not know if either value represents lower or upper limits, and with the dynamics of productivity and hydrography in Ticao Pass, projecting annual catches from year to year is not yet possible. However, we do know that annual catches may exceed 45,000 mt so that setting a limit (cap) lower than this will very likely reduce the proportion of the stock that is caught, regardless of stock abundance levels. So, setting the cap at a level that is 10% lower than current annual catches will translate to an overall cap of 40,500 mt. With such a target and the make-up of the Bulan fleet, the social and economic costs of such a measure can be determined and its acceptability assessed.

Generate reliable estimates of total catch

Catch quotas and "bag limits" require reliable estimates of total catch, an actual value that will be the basis for setting limits to the amounts of fish landed. Such estimates need to be determined in a systematic manner and should be subject to validation. Unfortunately, total catch estimates are not available from BFAR-NSAP, and those from the PSA have yet to be examined closely to resolve questions with representativeness in the different FMAs. The monitoring scheme of the present study was designed to determine the proportion of the fleet fishing daily and the number of days fishing each month, as well as daily catch rates and how these varied within the year. Together with estimates of fleet size from the FGDs, the study provided an estimate of the total catch, showed how this was derived, and discussed its limitations. We recommend that the NSAP adopts a similar approach to determining fishing effort.

Do not rely on mortality and exploitation rates as HCRs

The size distribution and gonad development stage distributions of both species strongly indicate that older fish are underrepresented in the catches. While overfishing eventually leads to the loss (thru fishing) of older (larger) fish from the stock, the exceptionally high estimate of total mortality rate strongly suggests that older adults move to deeper water and/or outside to neighboring basins, and as a result are no longer caught by the major gear types employed in FMA 7. This leads to overestimates of non-natural sources of mortality, and by practice, uncommonly high exploitation ratios. Unfortunately, the study could not quantify the loss of older fish (emigration) and its contribution to total mortality (Z) separately from fishing mortality (F). For this reason, using such overestimates as baselines for reference points carries little meaning.

Account for natural high variability in stocks

The distribution of the principal sardine species in FMA 7, *S. lemuru*, is determined largely by the enhanced primary productivity at Ticao Pass (particularly the east half) at the onset of the NE Monsoon, from November to December. Since these are also the peak spawning months, any year-to-year differences in the intensity, duration, and geographical extent of upwelled waters will result in variations in larval survival and eventual recruitment between years, as well as the ensuing distribution of juveniles and adults between the north and south portions of the FMA.

In addition, the dynamics of productivity in Ticao Pass result in added year-to-year variability in stock structure. Hence, we can always expect considerable year-to-year differences in estimates of population parameters (e.g., growth and mortality rates) and even in catch rates (kg/trip) in FMA 7, and it is only when we have a sufficiently long time series of such estimates, wherein patterns can eventually be gleaned, that these can serve as meaningful harvest control references. At present, using the size and maturity stage distributions in the catches, the size at first maturity (L_{m50}) and SPR derived from them, as well as the proportion of juveniles in the catches are more meaningful options as harvest control references.

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07. Annex 1
Standardization Workshop

Table A.1 List of participants in the standardization training workshop

Name	Affiliation
Neilmar J. Condat	Partido State University
Regie B. Jabon	Samar State University
Francisco L. Pasucal	Samar State University
Mark Jason Bertiz	Samar State University
Jose Mari Delos Santos	Sorsogon State University/BUTC
Andrew C. Tolentino	Partido State University
Prof. Jesus T. Racuyal	Samar State University
Prof. Antonino P. Mendoza	Bicol University-Tabaco Campus
Dr. Plutomeo M. Nieves	Bicol University-Tabaco Campus
Diovanie De Jesus	Oceana
John Christopher C. Nolial	Oceana
Dr. Renan Bobiles	Bicol University-Tabaco Campus
Ronnel Dioneda Jr.	Partido State University
Jasper Nieves	Partido State University
Dr. Raul Bradecina	Partido State University
Dr. Wilfredo L. Campos	OceanBio Lab, UPV-CAS
Alexanra A. Bagarinao-Regalado	OceanBio Lab, UPV-CAS
Kim P. Nuñez	OceanBio Lab, UPV-CAS

Figure A.1 Photo documentation of the training workshop on standardization of methods

Project overview presented by Dr. Wilfredo L. Campos (left) and Dr Raul G. Bradecina (right).

Ms. Alex Bagarinao-Regalado giving lectures on monitoring catch and effort (top left), data encoding & processing (top right) and use of GPS data loggers for vessel tracking (bottom).

Exercise on specimen identification, dissection, gonad staging and specimen preservation.

Participants preparing for fisheries profiling activity (top left), Dr. Wilfredo L. Campos leading the fisheries profiling in Pio Duran, Albay (top right) and Dr. Plutomeo Nieves discussing with profiling participants in Donsol, Sorsogon (bottom).

Annex 2
List of typical questions asked during fisheries profiling

- What are the fishing gear types used in your barangay?
  - each barangay should be asked one after the other.
- Can someone illustrate and describe the nature of operation of each gear type?
- How many units of each gear type do you have in your barangay?
- How many fishers are involved per operation in each gear type?
- How long (no. of hours) is the fishing operation of each gear type?
- What is the average catch (in kg) of each fishing gear type per operation?
  - the value should be a consensus and is usually a range of values (e.g. minimum catch = 0kg; maximum catch = >50kgs). Average catch during peak season should be noted also.
- What is the common catch of each fishing gear type? What species dominates the catch?
  - this may slightly differ by barangay
- How many days in a month is each gear type operated?
  - the value should be a consensus and is usually in a range of values. Note also if fishing is influenced by moon phase
- How many months in a year is each gear type operated?
  - the value should be a consensus; when fishing is not year-round, fishing months should be identified for construction of the fishing gear calendar
- What months of the year are catches from these fishing gear types the highest (peak season)
  - the value should be a consensus. Note also if fishing is influenced by monsoon winds.
- Can you show on the map where each gear type is typically used?
  - Fishers using each gear type mark typical fishing locations using different symbols and colors
- Are there fish species that were caught in the 70's or 80's that are no longer caught at the present?
- What are the major problems concerning the fisheries in your area?
- What possible solutions can you suggest to answer these problems?

Annex 3

The parameter values used to compute annual sardine production in north FMA 7

Figure A.2 The parameter values used to compute annual sardine production in north FMA 7. Values in blue are actual estimates for municipalities where daily monitoring was done, and mean values for gear types used in profiled municipalities; black values are from the FGDs; and red values are approximated based on annual production categories.

	Monitored Municipalities				Profiled (FGD) Municipalities						Municipalities with Approximated Annual Catch					
Parameter values for Annual Sardine Production	Bulan	Balatan	Pio Duran	Monreal	Donsol	Magallanes	Pio V. Corpuz	Pasacao	Claveria	San Jacinto	San Fernando	Libon	Ligao	Pilar	San Pascual	Esperanza
No. of gear units																
Drift gill net	282	66	99	77	160	11	18	15	14	32						
Modified jigger (Tikitik)	5															
DGN w/ scaring device	15															
Bag net			1													
Round haul seine		8	7													
Purse seine		2	1					1								
Drift gill net 2 (Barangay)		81	100						19	23						
Modified drift net (Palukso)		39														
Boat seine (Sinsuro)		6						22								
Scoop net					62			41								
Encircling gill net w/ FAD							27									
Encircling gill net								6								
Surface gill net										96						
Multiple hook & line								93								
% of fleet fishing daily																
Drift gill net	0.82	0.23	0.28	0.45	0.45	0.45	0.45	0.26	0.26	0.26						
Ring net	0.24			0.24												
Modified jigger (Tikitik)	0.24															
DGN w/ scaring device	0.24															
Bag net			0.24													
Round haul seine		0.24	0.24													
Purse seine		0.24	0.24					0.24								
Drift gill net 2 (Barangay)		0.13	0.36					0.24	0.24	0.24						
Modified drift net (Palukso)		0.21														
Boat seine (Sinsuro)		0.24						0.24								

	Monitored Municipalities				Profiled (FGD) Municipalities						Municipalities with Approximated Annual Catch					
Parameter values for Annual Sardine Production	Bulan	Balatan	Pio Duran	Monreal	Donsol	Magallanes	Pio V. Corpuz	Pasacao	Claveria	San Jacinto	San Fernando	Libon	Ligao	Pilar	San Pascual	Esperanza
Scoop net					0.24			0.24								
Encircling gill net w/ FAD							0.24									
Encircling gill net								0.24								
Surface gill net										0.24						
Multiple hook & line								0.24								
No. of fishing days in year																
Drift gill net	288	59.5	48.3	206.7	100	119	180	180	100	75						
Ring net	40			180												
Modified jigger (Tikitik)	20															
DGN w/ scaring device	120															
Bag net			105													
Round haul seine		135	165													
Purse seine		220	360					180								
Drift gill net 2 (Barangay)		97.7	219.6						44	14						
Modified drift net (Palukso)		112.5														
Boat seine (Sinsuro)		100						220								
Scoop net					48			24								
Encircling gill net w/ FAD							150									
Encircling gill net								200								
Surface gill net										100						
Multiple hook & line								21								
Mean daily sardine catch (kg)																
Drift gill net	677.4	120.1	177.3	279.5	279.5	279.5	279.5	182.5	182.5	182.5						
Ring net	750			220												
Modified jigger (Tikitik)	0.5															
DGN w/ scaring device	1.2															
Bag net			2.8													
Round haul seine		120	10													
Purse seine		1900	5000					900								
Drift gill net 2 (Barangay)		32.1	21.07						26.6	26.6						
Modified drift net (Palukso)		255.3														
Boat seine (Sinsuro)		16						12								
Scoop net					15			10								
Encircling gill net w/ FAD							8.75									
Encircling gill net								240								
Surface gill net										0.2						
Multiple hook & line								0.7								

	Monitored Municipalities				Profiled (FGD) Municipalities						Municipalities with Approximated Annual Catch					
Parameter values for Annual Sardine Production	Bulan	Balatan	Pio Duran	Monreal	Donsol	Magallanes	Pio V. Corpuz	Pasacao	Claveria	San Jacinto	San Fernando	Libon	Ligao	Pilar	San Pascual	Esperanza
Estimated annual catch (mt)																
Drift gill net	44,948.8	109.4	237.5	1,988.4	1,999.2	163.6	404.8	126.1	65.4	112.1						
Ring net	72.1			66.6												
Modified jigger (Tikitik)	0.012															
DGN w/ scaring device	0.5															
Bag net			0.1													
Round haul seine		31.1	2.8													
Purse seine		200.9	432.6					38.9								
Drift gill net 2 (Barangay)		31.8	164.6						5.3	2.1						
Modified drift net (Palukso)		233.0														
Boat seine (Sinsuro)		2.3						14.0								
Scoop net					10.7			2.4								
Encircling gill net w/ FAD							8.5									
Encircling gill net								69.2								
Surface gill net										0.5						
Multiple hook & line								0.3								
Estimated Total Annual Sardine Catch (mt)	45,021.4	608.5	837.6	2,055.0	2,009.9	163.6	413.4	250.9	70.7	114.6	120.6	120.6	120.6	120.6	120.6	120.6
Assigned Annual Productivity Category	V High	mod	mod	High	High	low	mod	low mod	low	low	low	low	low	low	low	low

Figure A.3 The parameter values used to compute annual sardine production in south FMA 7. Values in blue are actual estimates for municipalities where daily monitoring was done, and mean values for gear types used in profiled municipalities and where key interviews were conducted; black values are from the FGDs or key interviews; and red values are approximated based on annual production categories.

	Monitored Municipalities			Profiled Municipalities with Key Interviews					Municipalities with Approximated Annual Catch							
Parameter values for Annual Sardine Production	Daram	Tarangnan	Kawayan	Catbalogan City	San Isidro	San Vicente	Rama/ Catbalogan	Calbayog	Sto. Nino	Almagro	Tagapul -an	Sta. Margarita	Caibiran	Culaba	Marapipi	Cabucgayan
No. of gear units																
Multiple hook & line	41	52														
Encircling gill net w/ dynamite	12															
Ring net	35			4			9	10								
Drift entangling net				10												
Drift gill net (largarete)			220	3	50	100										
Ring net w/ light				9												
Scoop net w/ blastfishing		40		22												
Mean daily sardine catch (kg)																
Multiple hook & line	1.15	1.15														
Encircling gill net w/ dynamite	105															

	Monitored Municipalities			Profiled Municipalities with Key Interviews					Municipalities with Approximated Annual Catch							
Parameter values for Annual Sardine Production	Daram	Tarangnan	Kawayan	Catbalogan City	San Isidro	San Vicente	Rama/ Catbalogan	Calbayog	Sto. Nino	Almagro	Tagapul -an	Sta. Margarita	Caibiran	Culaba	Marapipi	Cabucgayan
Ring net	60.5			108.8			60.5	60.5								
Drift entangling net				1.6												
Drift gill net (largarete)			21.6	21.6	21.6	21.6										
Ring net w/ light				25.5												
Scoop net w/ blastfishing		10.2		10.2												
% sardines in catch																
Multiple hook & line																
Encircling gill net w/ dynamite	105															
Ring net																
Drift entangling net																
Drift gill net (largarete)																
Ring net w/ light																
Scoop net w/ blastfishing																
% fleet fishing																
Multiple hook & line	60	60														
Encircling gill net w/ dynamite	60															
Ring net	70.4			70.4			70.4	70.4								
Drift entangling net				60												
Drift gill net (largarete)			66.3	66.3	66.3	66.3										
Ring net w/ light				60												
Scoop net w/ blastfishing		69.1		69.1												
No. fishing days in year																
Multiple hook & line	246	246														
Encircling gill net w/ dynamite	336															
Ring net	282			282			282	282								
Drift entangling net				216												
Drift gill net (largarete)			156	160	156	156										
Ring net w/ light				180												
Scoop net w/ blastfishing		324		360												
Estimated annual catch																
Multiple hook & line	7.0	8.8														
Encircling gill net w/ dynamite	254															
Ring net	420.4			86.3			108.1	120.1								

	Monitored Municipalities			Profiled Municipalities with Key Interviews					Municipalities with Approximated Annual Catch							
Parameter values for Annual Sardine Production	Daram	Tarangnan	Kawayan	Catbalogan City	San Isidro	San Vicente	Rama/ Catbalogan	Calbayog	Sto. Nino	Almagro	Tagapul -an	Sta. Margarita	Caibiran	Culaba	Marapipi	Cabucgayan
Drift entangling net				2.1												
Drift gill net (largarete)			490.9	6.9	111.6	223.2										
Ring net w/ light				24.8												
Scoop net w/ blastfishing		91.5		55.9												
Est. Total Annual Sardine Catch (mt)	681.4	100.3	490.9	176.0	111.6	223.2	108.1	120.1	120.6	120.6	120.6	606.4	237.1	237.1	606.4	120.6
Assigned Annual prod category	mod	low	mod	low	low	low-mod	low	low	low	low	low	mod	low-mod	low-mod	mod	low

OCEANA Protecting the World's Oceans

Oceana is the largest international advocacy organization dedicated solely to ocean conservation. Oceana is rebuilding abundant and biodiverse oceans by winning science-based policies in countries that control over one-quarter of the world's wild fish catch. With more than 225 victories that stop overfishing, habitat destruction, pollution, and the killing of threatened species like turtles and sharks, Oceana's campaigns are delivering results. A restored ocean means that 1 billion people can enjoy a healthy seafood meal, every day, forever. Together, we can save the oceans and help feed the world. Visit oceana.org to learn more.

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