

## Symposium Proceedings

### **Diversity, species composition, and richness of marine fish fauna in Isabela Waters, Philippines**

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#### **Abstract**

The Philippines is globally important hotspot for biological diversity particularly in the Northern coast of the country due to the presence of Kuroshio Current that brings high nutrients and contributes to high diversity of marine fish fauna in the area. Survey of marine fish fauna was conducted from July 2014 to June 2015 in Isabela Waters covering the four coastal municipalities of Isabela, Philippines. Data were collected from the fisherfolk unloading their catch using different types of fishing gears and was analyzed using the biological indices of Species richness, Diversity index, and Pielou's evenness index. Species dominance was computed using the Simpson's dominance index formula. In terms of total catch landings, *Thunnus obesus* dominated the total catch (18.63%) followed by *Decapterus macarellus* (14.27%) and *Terapon theraps* (13.66%). The total catch landing was shared by 286 fisherfolk using 15 different types of fishing gears. A total of 23,980 fish samples belonging to 54 families, 109 genera, and 238 species were recorded. As to conservation status, four species are nearly threatened, one vulnerable and one endangered. Diversity index of the study area was 3.77 with species evenness of 0.7 and dominance index value of 0.94 indicating high fish diversity and even distribution of species in the fishing ground. The study revealed that Isabela waters harbors a diverse community of marine fish fauna.

Key words: diversity, species richness, composition, Isabela Waters

## **INTRODUCTION**

Isabela Waters is one of the marine fishing grounds of the Cagayan Valley Region, Philippines and located along the flow of the Kuroshio Current that has been known to contain the country's most diverse ecosystems enriched by nutrients leached from the land. The water is a home of diverse small and big oceanic species like marlins, dolphin fishes, and bill fishes. The lengthy range of seacoast is rich in untapped fisheries and marine resources. It has also extensive seagrass beds and coral reef that harbours a variety of pelagic and demersal species.

The province of Isabela is the biggest province of the Cagayan Valley, Region and the second largest province in the Philippines with four coastal municipalities namely: Palanan, Maconacon, Divilacan, and Dinapigue (Ayson and Encarnacion

2008). Fishing is the primary source of livelihood in the coastal area. There are 286 fishing boats operating throughout the year in the waters of Isabela using different types of fishing gears. With the increasing fishing pressure on the fish stocks, it is important to know the diversity of fish in the fishing ground, the abundance, and the status in order to develop management and conservation programs in the area. Information on biodiversity particularly on the natural resources which includes the marine fishes is important for the sustainability of the resource.

However, to date there is no available information on species composition and status, diversity, and abundance of marine species in the Isabela waters which is needed by policy makers and resource managers in making decisions for rational and sustainable fisheries management in the fishing ground.

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## MATERIALS AND METHODS

### Study area

The Province is politically bounded on the North by the Province of Cagayan, on the south by Nueva Vizcaya, and Aurora, on the West by the Cordillera Administrative Region and on the East by the Pacific Ocean (Fig. 1). It has a coastline of 208 kilometers inhabited by 3,693 fisherfolk from 45 coastal barangays (BFAR-R02 FishR 2017).

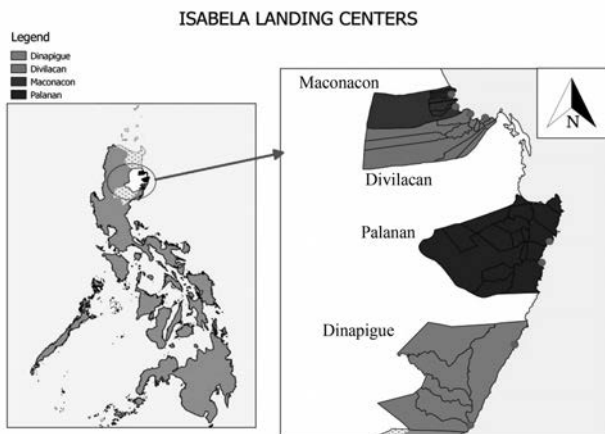


Fig.1. Map of Isabela showing the established landing centers.

### Data collection

Trained NSAP enumerators were tapped to collect information on landed catch from fishers unloading their catch. Data were collected at established landing centers in Palanan, Divilacan, Maconacon, and Dinapigue. Sampling was done every other two days regardless of Saturdays, Sundays, and Holidays starting July 2014 to June 2015. Information on species composition, species weight, total species count, and the fishing gear used were recorded.

Fish species were identified using the books of White et al. (2013), Alava et al. (2014), Allen et al. (2003), Randall (2005), FAO species identification guide (1998), field guides on commercial marine fishes of the Philippines, and internet using the Fishbase website, World of Marine Species (WorMS), Encyclopedia of Life (EOL), and Catalogue of Life (COL).

### Data analysis

Species richness was determined by the number of species present in the area. Based on the total landed catch (in kg.) relative abundance for each species was computed using the formula:

$$\text{Relative Abundance} = \left( \frac{n_i}{N} \right) 100\%$$

where:  $n_i$  – is the number of individuals caught in the  $i$ th species, and  $N$  is the total number of species collected during the entire duration of the study.

Diversity index was computed using the formula of Shannon-Weinier diversity index ( $H'$ ) (Shannon and Weaver, 1949):

$$H' = - \sum_{i=1}^s p_i \ln p_i$$

where  $s$  is the number of species;  $p$  is the proportion of individuals found on the  $i$ th species and  $\ln$  is the natural logarithm. Evenness index ( $J'$ ) was computed following the Shannon's diversity index:

$$J' = H' / \ln S$$

where  $S$  is the total number of species. Species dominance was computed using the Simpson's index formula ( $\lambda$ ) (Simpson 1949):

$$\lambda = \sum_{i=1}^S \frac{n_i(n_i-1)}{N(N-1)}$$

where  $s$  is the number of species,  $n_i$  is the number of individuals in the  $i$ th species and  $N$  is the total number of individuals.

## RESULTS AND DISCUSSION

### Fishing gears used

There were 15 different types of fishing gears operating in Isabela waters (Fig.2). Majority of the fishing gears used are troll line (47.99%), followed by bottom set gillnet (15.5%),

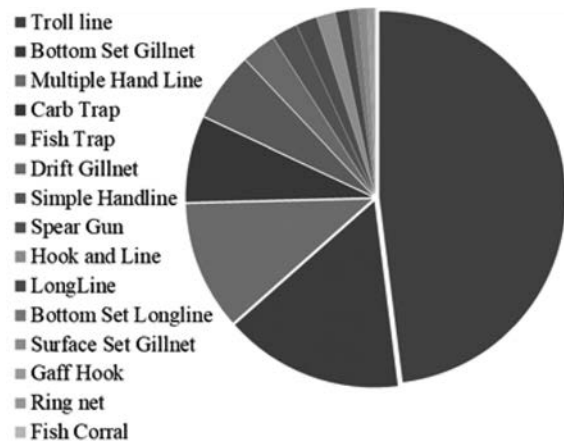


Fig. 2. Fishing gears operating in Isabela Waters, Philippines.

multiple handline (11.14%), crab trap (7.43%), and fish trap (5.94%). Drift gill net only has 2.97% contribution and spear gun, hook and line, and longline have gear contribution of 1.7%, 1.6%, and 1.2%, respectively. Bottom set longline, surface gill net, gaff hook, ring net, and fish corral only accounted less than 1%. Lines and nets are the most predominant gears used along the coastal municipalities of Isabela. Pots and traps are the top four (4) fishing gears being operated in the area which is in contrast to the findings of Baleta and Bolaños (2017) where fishing gears of this category are only few in Isabela Province.

Troll line locally known as “Hilada” or “Saliwsiw” is the major fishing gear used in the area. The length of mainline is 200 m with a length of branch line of 1 m - Ø - 0.45 m. The most common species caught by this gear are yellowfin tuna, big-eye tuna, skipjack tuna, other species of tuna, and dolphinfishes. The gear is operated by towing the baited hooks located on the astern portion of the boat. The speed on the boat during towing depends on the target species of the fishers. The fish is caught by snapping the baited hooks and eventually brought aboard as the line is hauled in.

Conversely, bottom set gill net locally known as “Palned/Sigay” or “Panting ilalim” is commonly used for demersal fishes. The depth ranges from 5 to 9 cm with a mesh size of 4 to 6 cm and a length of “banata” of 200 m to 1000 m. Common species caught by this gear are snappers, trevallies, emperor fish, and siganids. Sometimes, rays become by catch of this gear. It is being operated by simply setting the gear vertically in the water and kept stationary by the use of anchors and weights.

Multiple handline locally known as “Ug-ug” or “Bira-bira” has multiple hooks with an equal distance to a mainline with a length of 300 m, 0160 mm to 0180 mm line size and 0.35m - Ø - 0.20 m branchline length. Live fish or artificial bait made of silk is being used to attract fish. Operators simply tug the line in a vertical motion. The gear is being operated during dawn or dusk where there is a slight portion of sunlight that lights the surface but mostly the operation are being done at night with the use of lights. Majority of the catch is composed of oceanic and neritic tuna (i.e. *Thunnus albacares*, *Auxis* spp.), and other small pelagics and demersal species.

Moreover, crab trap and fish trap locally called “Bubu” is a very traditional fishing gear in the area. It is made of a very simple apical non-returning valve that serves as entrance for the fish. It is often baited with dead fish or artificial bait that is placed on the middle section of the gear to ensure that the bait is not consumed. Gear is deployed overnight or a day until such time there is a catch. The operators collect the catch and again deploy the gear in the area and wait again the next day for possible catch. Most common species caught by crab trap is mud crab while fish trap caught a variety of large pelagics,

demersal, invertebrates and small pelagic species. Dolphinfishes, rays, and barracudas were also noted.

Ring net and fish corral known as “Sirot/Saprot” and “Tarik”, respectively have the least number of gear. However, ring net contributed to the bulk of landed catch for small and large pelagic species in all landing areas.

### Catch composition

The total catch was based on the total landed catch per species from the fisherfolk on the established landing area and the total counts of the species were based on the available length measurements taken from the landed catch as subsample. The percentage abundance of fishes in the landing area was determined based on the total kilograms of a particular species landed with the corresponding species identification.

Figure 3 shows that demersal species dominated the catch (21.9%) in Isabela waters followed by large pelagic species (13.68%), small pelagics (22.53%), oceanic tunas (29.35%), pelagics (7.66%), neritic tuna (3.86%), invertebrates (0.93%), rays (0.047%), and sharks (0.036%).

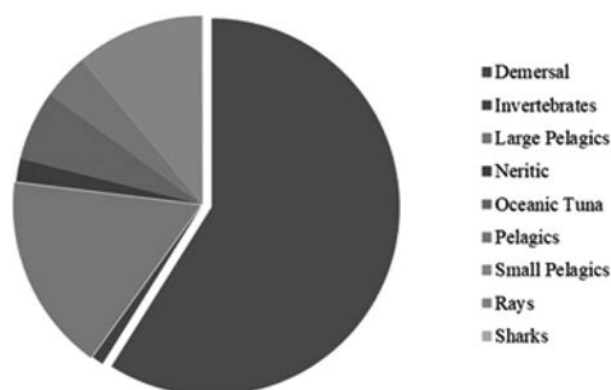


Fig. 3. Catch composition and abundance in Isabela Waters, Philippines.

Categorically, there were 28 families of demersal species belonging to Family Scianidae, Teraponidae, Scaridae, Lutjanidae, Acanthuridae, Lethrinidae, Nemipteridae, Serranidae, Mullidae, Siganiidae, Haemulidae, Priacanthidae, Labridae, Chaetodontidae, Gerridae, Leiognathidae, Polynemidae, Kyphosidae, Mugillidae, Synodontidae, Ephippidae, Psettodidae, Holocentridae, Centropomidae, Sparidae, Drepanidae, Silliganidae, and Monacanthidae. Large pelagic species belong to four families to include Family Scombridae, Coryphaenidae, Istiophoridae, and Xiphiidae. Small pelagics has seven families belonging to Family Clupeidae, Carangidae, Exocoetidae, Scombridae, Caesionidae, Engraulidae, and Chirocentridae (Table 1).

Diversity, species composition, and richness of marine fish fauna in Isabela Waters, Philippines

**Table 1.** Species composition and conservation status of marine fish species landed in Isabela Waters, Philippines.

Category	Family	Scientific Name	English Name	Local Name	Catch (Kg.)	% Abundance	Species Count (n)	Conservation status
Demersal	Acanthuridae	<i>Acanthurus dussumieri</i>	Eyestripe surgeonfish	Mungit	21.7	0.019	15	LC
		<i>Acanthurus guttatus</i>	White spotted surgeonfish	Mungit	45.0	0.039	20	LC
		<i>Acanthurus lineatus</i>	Lined surgeonfish	Mungit	70.1	0.060	4	LC
		<i>Acanthurus mata</i>	Elongate surgeonfish	Mungit	2.7	0.002	6	LC
		<i>Acanthurus nigricauda</i>	Blackstreak surgeonfish	Mungit	11.7	0.010	7	LC
		<i>Ctenochaetus strigosus</i>	Gold string bristle tooth	Mungit	729.6	0.629	2	LC
		<i>Naso hexacanthus</i>	Sleek unicornfish	Sarunguan	18.4	0.016	3	LC
	Centropomidae	<i>Lates calcalifer</i>	Barramundi	Tul-wan/Kaka	10.0	0.009	7	NE
		<i>Parachaetodon ocellatus</i>	Sixspine butterflyfish	Bayang-bayang	35.3	0.030	4	LC
	Chaetodontidae	<i>Parachaetodon sp.</i>	Butterflyfishes	Bayang-bayang	5.2	0.004	7	NE
	Drepaneidae	<i>Drepane punctata</i>	Sickle fish	Bayang-bayang	7.5	0.006	3	NE
	Ephippidae	<i>Platax orbicularis</i>	Orbicular batfish	Alibangbang/Bayang-bayang	11.4	0.010	7	NE
		<i>Platax teira</i>	Longfin batfish	Alibangbang/Bayang-bayang	11.1	0.010	4	NE
	Gerridae	<i>Gerres erythrorus</i>	Deep-bodied mojarra	Salesi	2.8	0.002	7	LC
		<i>Gerres filamentosus</i>	Whipfin mojarra	Salesi	24.5	0.021	13	LC
		<i>Gerres meluani</i>	Striped silver biddy	Salesi	7.3	0.006	7	NE
	Haemulidae	<i>Plectorhinchus chaetodontoides</i>	Harlequin sweetlips	Bibiran	13.5	0.012	3	NE
		<i>Plectorhinchus diagrammus</i>	Striped sweetlips	Bibiran	0.4	0.000	3	NE
		<i>Plectorhinchus gibbosus</i>	Brown sweetlips	Bibiran	3.6	0.003	8	LC
		<i>Plectorhinchus lineatus</i>	Yellowbanded sweetlips	Bibiran	17.4	0.015	2	NE
		<i>Plectorhinchus pictus</i>	Trout sweetlips	Bibiran	53.6	0.046	1	NE
	Holocentridae	<i>Pomadasys argenteus</i>	Silver javelin	Agut	0.7	0.001	2	LC
		<i>Myripristis adusta</i>	Shadowfin soldierfish	Ter-ter/Siga-siga	9.0	0.008	7	LC
<i>Myripristis hexagona</i>		Doubletooth soldierfish	Ter-ter/Siga-siga	2.1	0.002	9	LC	
Demersal	Kyphosidae	<i>Sargocentron rubrum</i>	Redcoat	Bagsang	2.6	0.002	15	LC
		<i>Kyphosus bigibbus</i>	Brown chub	Umipos	11.8	0.010	2	LC
	Labridae	<i>Kyphosus cinerascens</i>	Blue sea chub	Umipos	23.9	0.021	9	LC
		<i>Chlorurus bowersi</i>	Bower's parrotfish	Mulmul	1.0	0.001	1	NT
		<i>Chlorurus japanensis</i>	Palecheek parrotfish	Mulmul	2.2	0.002	17	LC
		<i>Chlorurus sordidus</i>	Daisy parrotfish	Mulmul	12.0	0.010	12	LC
		<i>Choerodon robustus</i>	Robust tuskfish	Mulmul	3.5	0.003	7	LC
		<i>Coris auricularis</i>	Western king wrasse	Mulmul	2.8	0.002	3	LC
		<i>Coris ballieui</i>	Light colored wrasse	Mulmul	2.6	0.002	2	LC
		<i>Coris flavovittata</i>	Yellostripe coris	Mulmul	1.5	0.001	1	LC
	Leiognathidae	<i>Cheilinus undulatus</i>	Humphhead wrasse	Mulmul	30.0	0.026	2	EN
		<i>Gazza achlamys</i>	Smalltoothed ponyfish	Sap-sap	3.4	0.003	2	LC
		<i>Gazza minuta</i>	Toothed ponyfish	Sap-sap	5.6	0.005	2	LC
		<i>Leiognathus bindus</i>	Orangefin ponyfish	Sap-sap	4.6	0.004	15	NE
		<i>Leiognathus daura</i>	Goldstripe ponyfish	Sap-sap	5.7	0.005	2	NE
		<i>Leiognathus equulus</i>	Common ponyfish	Sap-sap	5.1	0.004	4	LC
	Lethrinidae	<i>Leiognathus fasciatus</i>	Threadfin ponyfish	Sap-sap	7.6	0.007	2	LC
		<i>Leiognathus smithursti</i>	Longfinned ponyfish	Sap-sap	4.3	0.004	1	NE
		<i>Lethrinus amboinensis</i>	Ambon emperor	Dugso	20.8	0.018	4	LC
		<i>Lethrinus atkinsoni</i>	Pacific yellowtail emperor	Dugso	15.0	0.013	5	LC
		<i>Lethrinus erythropterus</i>	Tail saddle emperor	Dugso	3.8	0.003	10	NE
		<i>Lethrinus harak</i>	Thumbprint emperor	Dugso	45.9	0.040	6	LC
		<i>Lethrinus lentjan</i>	Pinkear emperor	Dugso	84.6	0.073	36	LC
<i>Lethrinus microdon</i>		Smalltooth emperor	Dugso	31.1	0.027	70	LC	
<i>Lethrinus miniatus</i>		Trumpet emperor	Dugso	226.2	0.195	25	LC	
<i>Lethrinus nebulosus</i>		Spangled emperor	Dugso	62.0	0.053	68	LC	
<i>Lethrinus olivaceus</i>		Longface emperor	Dugso	6.0	0.005	42	LC	
Lutjanidae		<i>Lethrinus semicinctus</i>	Black spot emperor	Dugso	1.0	0.001	2	LC
	<i>Lethrinus sp.</i>	Emperor fish	Dugso	2.7	0.002	5	NE	
	<i>Lethrinus variegatus</i>	Slender emperor	Dugso	63.2	0.054	7	LC	
	<i>Monotaxis grandoculis</i>	Humpnose big-eye bream	Bisugo	3.0	0.003	1	NE	
	<i>Aphareus rutilans</i>	Rusty jobfish	Maya-maya	9.6	0.008	2	LC	
		<i>Etelis oculatus</i>	Blur-eyed snapper	Maya-maya	178.1	0.153	4	DD

		<i>Lutjanus argentimaculatus</i>	Mangrove red snapper	Maya-maya	35.7	0.031	52	LC	
		<i>Lutjanus bohar</i>	Two spot red snapper	Maya-maya	14.0	0.012	4	LC	
		<i>Lutjanus decussatus</i>	Crossbanded snapper	Tagpian	146.0	0.126	31	LC	
Demersal	Lutjanidae	<i>Lutjanus erythropterus</i>	Crimson snapper	Maya-maya	108.5	0.093	56	NE	
		<i>Lutjanus fulviflammus</i>	Dory snapper	Maya-maya	0.8	0.001	39	LC	
		<i>Lutjanus fulvus</i>	Blacktail snapper	Maya-maya	101.3	0.087	3	LC	
		<i>Lutjanus gibbus</i>	Humpback red snapper	Maya-maya	67.6	0.058	43	LC	
		<i>Lutjanus johnii</i>	John's snapper	Maya-maya	5.1	0.004	10	LC	
		<i>Lutjanus kasmira</i>	Common bluestripe snapper	Maya-maya	63.4	0.055	21	LC	
		<i>Lutjanus lemniscatus</i>	Yellowstreaked snapper	Maya-maya	16.6	0.014	2	NE	
		<i>Lutjanus lunulatus</i>	Lunartail snapper	Maya-maya	57.9	0.050	26	LC	
		<i>Lutjanus lutjanus</i>	Bigeye snapper	Maya-maya	146.5	0.126	25	LC	
		<i>Lutjanus malabaricus</i>	Malabar bloody snapper	Maya-maya	2.1	0.002	79	NE	
		<i>Lutjanus monostigma</i>	One spot snapper	Maya-maya	8.7	0.007	7	LC	
		<i>Lutjanus quinquelineatus</i>	Five-lined snapper	Maya-maya	268.1	0.231	7	LC	
		<i>Lutjanus rivulatus</i>	Blubberlip snapper	Maya-maya	35.2	0.030	135	LC	
		<i>Lutjanus russellii</i>	Russell's snapper	Maya-maya	25.7	0.022	29	LC	
		<i>Lutjanus sebae</i>	Red emperor snapper	Maya-maya	18.8	0.016	14	LC	
		<i>Lutjanus sp.</i>	Snapper	Maya-maya	6.0	0.005	10	NE	
		<i>Lutjanus timorensis</i>	Timor snapper	Maya-maya	14.4	0.012	23	NE	
		<i>Lutjanus vitta</i>	Brownstripe red snapper	Maya-maya	190.0	0.164	5	LC	
		Monacanthidae	<i>Aluterus monocerus</i>	Unicorn leather jacket	Sarunguan	1.9	0.002	1	LC
		Mugilidae	<i>Crenimugil crenilabis</i>	Fringelip mullet	Gassak	8.5	0.007	10	LC
	<i>Lica macrolepis</i>		Largescale mullet	Gassak	2.0	0.002	23	LC	
	<i>Mugil cephalus</i>		Flathead mullet	Gassak	17.1	0.015	75	LC	
	Mullidae	<i>Mulloidichthys vanicolensis</i>	Yellowfin goatfish	Balaki	5.6	0.005	11	LC	
		<i>Parupeneus barberinus</i>	Dash-and-dot goatfish	Kudong	8.0	0.007	13	LC	
		<i>Parupeneus cyclostomus</i>	Gold-saddle goatfish	Kudong	11.9	0.010	10	LC	
		<i>Parupeneus indicus</i>	Indian goatfish	Kudong	3.7	0.003	16	LC	
		<i>Parupeneus multifasciatus</i>	Banded goatfish	Kudong	5.1	0.004	2	LC	
		<i>Parupeneus pleurostigma</i>	Sidespot goatfish	Kudong	66.0	0.057	6	LC	
		<i>Upeneus mollucensis</i>	Goldband goatfish	Balaki	1.6	0.001	2	NE	
		<i>Upeneus sulphureus</i>	Sulphur goatfish	Balaki	171.8	0.148	30	LC	
		<i>Upeneus vittatus</i>	Yellowstripe goatfish	Kudong	140.1	0.121	63	LC	
	Nemipteridae	<i>Nemipterus bathybius</i>	Yellowbelly threadfin bream	Bisugo	251.3	0.217	5	NE	
		<i>Nemipterus furcosus</i>	Fork-tailed threadfin bream	Bisugo	76.8	0.066	47	LC	
		<i>Nemipterus hexodon</i>	Ornate threadfin bream	Bisugo	11.9	0.010	35	LC	
		<i>Nemipterus nematophorus</i>	Doublewhip threadfin bream	Bisugo	85.6	0.074	4	NE	
	Nemipteridae	<i>Nemipterus nemurus</i>	Redspine threadfin bream	Bisugo	7.6	0.007	38	LC	
		<i>Nemipterus sp.</i>	Threadfin breams	Bisugo	3.1	0.003	12	NE	
		<i>Nemipterus zysron</i>	Slender threadfin bream	Bisugo	95.0	0.082	5	LC	
	Polynemidae	<i>Eleutheronema tetradactylum</i>	Blue threadfin bream	Bisugo	39.7	0.034	41	NE	
	Priacanthidae	<i>Heteropriacanthus cruentatus</i>	Glasseye snapper	Bulan-bulan	76.0	0.065	5	LC	
		<i>Priacanthus hamrur</i>	Moontail bullseye	Bulan-bulan	1.0	0.001	13	LC	
		<i>Priacanthus tayenus</i>	Purple-spotted bigeye	Bulan-bulan	1.4	0.001	3	LC	
	Psettodidae	<i>Psettoides erumei</i>	Spiny turbot	Dadali	14.8	0.013	3	NE	
	Scaridae	<i>Scarus festivus</i>	Festive parrotfish	Mulmul	0.8	0.001	1	LC	
		<i>Scarus hypselopterus</i>	Yellow-tail parrotfish	Mulmul	1.0	0.001	1	NT	
		<i>Scarus microrhinos</i>	Steephead parrotfish	Mulmul	145.0	0.125	3	LC	
		<i>Scarus rivulatus</i>	Rivulated parrotfish	Mulmul	2697.5	2.324	22	LC	
	Scianidae	<i>Pemnehia anea</i>	Donkey croaker	Tutu	1480.9	1.276	9	NE	
		<i>Otolithes ruber</i>	Tigertooth croaker	Tuwel	0.8	0.001	2	NE	
	Serranidae	<i>Cephalopholis argus</i>	Peacock grouper	Lapu-lapu	0.2	0.000	1	LC	
		<i>Cephalopholis boenak</i>	Brown-banded seabass	Kakak	3.3	0.003	3	LC	
		<i>Cephalopholis cyanostigma</i>	Blue spotted hind	Lapu-lapu	3.6	0.003	2	LC	
		<i>Cephalopholis miniata</i>	Coral Hind	Lapu-lapu	25.0	0.022	1	LC	
		<i>Epinephelus areolatus</i>	Areolate grouper	Lapu-lapu	5.8	0.005	3	LC	
		<i>Epinephelus bleekeri</i>	Duskytail grouper	Lapu-lapu	17.6	0.015	4	NT	
		<i>Epinephelus coioides</i>	Orange spotted grouper	Lapu-lapu	37.9	0.033	17	NT	
		<i>Epinephelus fasciatus</i>	Blacktip grouper	Lapu-lapu	2.1	0.002	13	LC	
		<i>Epinephelus faveatus</i>	Barred-chest grouper	Lapu-lapu	49.3	0.042	2	DD	
		<i>Epinephelus fuscoguttatus</i>	Brown-marbled grouper	Lapu-lapu	4.3	0.004	9	NT	
		<i>Epinephelus maculatus</i>	Highfin grouper	Lapu-lapu	9.3	0.008	2	LC	
		<i>Epinephelus malabaricus</i>	Malabar grouper	Lapu-lapu	7.3	0.006	5	NT	
		<i>Epinephelus morrhua</i>	Comet grouper	Lapu-lapu	3.3	0.003	1	LC	
		<i>Epinephelus ongus</i>	White-streaked grouper	Lapu-lapu	13.5	0.012	1	LC	

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		<i>Hyporthodus quermus</i>	Hawaiian grouper	Lapu-lapu	9.9	0.009	1	NT	
		<i>Epinephelus quoyanus</i>	Longfin grouper	Lapu-lapu	8.9	0.008	1	LC	
		<i>Epinephelus summana</i>	Summan grouper	Lapu-lapu	128.7	0.111	56	DD	
		<i>Epinephelus tauvina</i>	Greasy grouper	Lapu-lapu	37.7	0.032	22	DD	
		<i>Plectropomus leopardus</i>	Leopard coral grouper	Lapu-lapu	49.0	0.042	20	NT	
Demersal	Serranidae	<i>Variola albimarginata</i>	White-edged lyre tail	Lapu-lapu	19.8	0.017	12	LC	
		<i>Siganus argenteus</i>	Forktail rabbitfish	Magerabu	23.8	0.021	64	LC	
		<i>Siganus canaliculatus</i>	White-spotted spinefoot	Magerabu	13.9	0.012	38	LC	
		<i>Siganus fuscescens</i>	Mottled spinefoot	Magerabu	118.5	0.102	22	LC	
		<i>Siganus guttatus</i>	Golden rabbitfish	Magerabu	20.3	0.017	102	LC	
		<i>Siganus javus</i>	Java rabbitfish	Magerabu	13.2	0.011	27	LC	
		<i>Siganus punctatus</i>	Gold-spotted rabbitfish	Magerabu	47.1	0.041	17	LC	
		<i>Siganus spinus</i>	Scribbled rabbitfish	Magerabu	58.8	0.051	9	LC	
		<i>Siganus vermiculatus</i>	Vermiculated spinefoot	Magerabu	4.8	0.004	6	LC	
		Sillaganidae	<i>Sillago maculata</i>	Trumpeter whiting	Uso-os/Al-alibut	0.5	0.000	5	NE
	<i>Sillago sihama</i>		Silver sillago	Uso-os/Al-alibut	2.0	0.002	24	LC	
	Sparidae	<i>Acanthopagrus australis</i>	Yellowfin bream	Bisugo	13.6	0.012	4	LC	
	Synodontidae	<i>Saurida gracilis</i>	Gracile lizardfish	Buttar	15.4	0.013	13	LC	
		<i>Saurida nebulosa</i>	Clouded lizardfish	Buttar	3.6	0.003	21	LC	
Teraponidae	<i>Terapon jarbua</i>	Tiger perch	Tuwel	11.8	0.010	6	LC		
	<i>Terapon theraps</i>	Largescaled terapon	Tuwel	15851.8	13.659	8	LC		
Large Pelagics	Scombridae	<i>Acanthocybium solandri</i>	Wahoo	Tanggigi	820.0	0.707	51	LC	
	Coryphaenidae	<i>Coryphaena equiselis</i>	Pampano dolphinfish	Dorado	4802.6	4.138	320	LC	
		<i>Coryphaena hippurus</i>	Common dolphinfish	Dorado	2701.6	2.328	145	LC	
	Istiophoridae	<i>Istiompax indica</i>	Black Marlin	Malasugi	3993.7	3.441	70	DD	
		<i>Istiophorus platypterus</i>	Sailfish	Malasugi	3265.4	2.814	102	LC	
		<i>Istiompax mazara</i>	Pacific blue marlin	Malasugi	156.7	0.135	6	NE	
Xiphiidae	<i>Xiphias gladius</i>	Swordfish	Malasugi	136.4	0.118	7	LC		
Small Pelagics	Caesionidae	<i>Caesio cunning</i>	Redbelly yellowtail fusilier	Dalagang bukid	2.0	0.002	10	NE	
		<i>Pterocaesio chrysozona</i>	Golband fusilier	Dalagang bukid	18.2	0.016	41	LC	
	Carangidae	<i>Atule mate</i>	Yellowtail scad	Galunggong	1057.6	0.911	2560	LC	
		<i>Decapterus kurroides</i>	Redtail scad	Galunggong	764.6	0.659	812	NE	
		<i>Decapterus macarellus</i>	Mackerel scad	Galunggong	16556.8	14.267	217	LC	
		<i>Decapterus macrosoma</i>	Shortfin scad	Galunggong	2057.6	1.773	450	LC	
		<i>Decapterus maruadsi</i>	Japanese scad	Galunggong	164.4	0.142	210	NE	
		<i>Decapterus russelli</i>	Indian scad	Galunggong	2.2	0.002	6	LC	
		<i>Selar boops</i>	Oxeye scad	Mataan	1.3	0.001	8	LC	
		<i>Selar crumenophthalmus</i>	Bigeye scad	Mataan	37.9	0.033	221	LC	
		<i>Selaroides leptolepis</i>	Yellowstripe scad	Mataan	371.4	0.320	487	LC	
	Chirocentridae	<i>Chirocentrus dorab</i>	Dorab wolf-herring	Bilis	2.1	0.002	6	NE	
	Small Pelagics	Clupeidae	<i>Amblygaster leiogaster</i>	Smoothbelly sardinella	Tamban/Bilis	60.7	0.052	51	NE
			<i>Amblygaster sirm</i>	Spotted sardinella	Tamban/Bilis	7.0	0.006	23	NE
<i>Anodontostoma chacunda</i>			Chacunda gizzard shad	Kabasi	57.4	0.049	99	NE	
<i>Dussumieria acuta</i>			Rainbow sardine	Balid-bid	3438.9	2.963	4265	NE	
<i>Sardinella albella</i>			White sardinella	Tamban-hubad	10.3	0.009	46	LC	
<i>Sprattilloides gracilis</i>			Silverstripe round herring	Buwan-buwan	353.1	0.304	559	NE	
Engraulidae		<i>Stolephorus japonicus</i>	Japanese anchovy	Munamun	4.4	0.004	425	NE	
Exocoetidae		<i>Cheilopogon sp.</i>	Flying fish	Isdang lawin	2.0	0.002	15	NE	
		<i>Cheilopogon suttoni</i>	Sutton's flyingfish	Isdang lawin	8.2	0.007	34	NE	
		<i>Cypselurus naresii</i>	Pharao flyingfish	Isdang lawin	818.1	0.705	938	NE	
		<i>Cypselurus oligolepis</i>	Largescale flyingfish	Isdang lawin	8.9	0.008	21	NE	
		<i>Cypselurus poecilopterus</i>	Yellowing flyingfish	Isdang lawin	49.4	0.043	50	NE	
Scombridae		<i>Rastrelliger faughni</i>	Island mackerel	Alumahan	10.3	0.009	41	DD	
		<i>Scomber australasicus</i>	Blue mackerel	Alumahan	2.3	0.002	16	LC	
	<i>Scomber japonicus</i>	Pacific chub mackerel	Alumahan	279.0	0.240	342	LC		
Oceanic Tuna	Scombridae	<i>Katsuwonus pelamis</i>	Skipjack tuna	Dulyasan	9240.1	7.962	473	LC	
		<i>Thunnus albacares</i>	Yellowfin tuna	Tangi/Yellow fin	3195.3	2.753	829	NT	
		<i>Thunnus obesus</i>	Bigeye tuna	Tangi/Dumadara	21625.2	18.634	444	VU	
Pelagics	Albulidae	<i>Albula neoguinaica</i>	Sharpjaw bonefish	Purung	47.8	0.041	125	DD	
	Belontiidae	<i>Tylosurus acus melanotus</i>	Keel-jawed needlefish	Siriw/Layalay	25.0	0.022	60	NE	
	Carangidae	<i>Alectis indicus</i>	Indian threadfish	Talakitok	4.5	0.004	111	NE	
		<i>Alepes djedaba</i>	Shrimp scad	Mangarmang	21.7	0.019	90	LC	
		<i>Atropus atropus</i>	Cleftbelly trevally	Talakitok	132.1	0.114	229	NE	
		<i>Carangoides dinema</i>	Shadow trevally	Talakitok	14.4	0.012	41	LC	
		<i>Carangoides ferdau</i>	Blue trevally	Talakitok	6.6	0.006	16	LC	
<i>Carangoides fulvoguttatus</i>	Yellowspotted trevally	Talakitok	454.7	0.392	568	LC			

		<i>Carangoides hedlandensis</i>	Bumpnose trevally	Talakitok	346.0	0.298	459	LC
		<i>Carangoides sp.</i>	Trevallies	Talakitok	3.2	0.003	5	NE
		<i>Caranx ignobilis</i>	Giant trevally	Talakitok	20.6	0.018	44	LC
		<i>Caranx melampygus</i>	Bluefin trevally	Talakitok	105.6	0.091	154	LC
		<i>Caranx sexfasciatus</i>	Bigeye trevally	Talakitok	330.2	0.284	423	LC
		<i>Caranx tille</i>	Tille trevalley	Talakitok	7.2	0.006	52	LC
		<i>Elagatis bipinnulata</i>	Rainbow runner	Salmon	5736.7	4.943	78	LC
		<i>Gnathanodon speciosus</i>	Golden trevally	Talakitok	81.8	0.070	146	LC
		<i>Megalaspis cordyla</i>	Torpedo scad	Sikkaran	13.5	0.012	16	LC
Pelagics	Carangidae	<i>Pampus argenteus</i>	Silver pomfret	Pampano	3.8	0.003	5	NE
		<i>Parastromateus niger</i>	Black pomfret	Pampano	38.2	0.033	95	NE
		<i>Scomberoides tol</i>	Needlescaled queenfish	Lapis	8.0	0.007	16	LC
		<i>Trachinotus carolinus</i>	Florida pampano	Lapis	143.0	0.123	181	LC
		<i>Trachurus declivis</i>	Greenback horse mackerel	Alumahan	305.7	0.263	452	NE
	Gempylidae	<i>Ruvettus pretiosus</i>	Oilfish	Kintara	236.7	0.204	342	LC
	Hemiramphidae	<i>Hemiramphus far</i>	Black-barred halfbeak	Barasut	6.2	0.005	24	NE
	Megalopidae	<i>Megalops cyprinoides</i>	Indo-pacific tarpon	Bulan-bulan	477.3	0.411	624	DD
	Mennidae	<i>Mene maculata</i>	Mene maculata	Tiyad-tiyad	62.6	0.054	95	NE
	Mugilidae	<i>Moolgarda buchamani</i>	Bluetail mullet	Gassak	5.3	0.005	9	NE
		<i>Moolgarda seheli</i>	Bluespot mullet	Gassak	116.1	0.100	201	NE
	Sphyraenidae	<i>Sphyraena barracuda</i>	Great barracuda	Batag	73.4	0.063	48	LC
		<i>Sphyraena jello</i>	Pinkhandle barracuda	Batag	13.7	0.012	59	NE
		<i>Sphyraena obtusata</i>	Obtuse barracuda	Batag	0.5	0.000	1	NE
		<i>Sphyraena putnamei</i>	Sawtooth barracuda	Batag	38.0	0.033	53	NE
Trichiuridae	<i>Trichiurus lepturus</i>	Largehead hairtail	Espada	11.0	0.010	49	NE	
Neritic Tuna	Scombridae	<i>Auxis rochei rochei</i>	Bullet tuna	Tulingan	3440.8	2.965	899	NE
		<i>Auxis thazard thazard</i>	Frigate tuna	Tulingan	632.5	0.545	824	NE
		<i>Euthynnus affinis</i>	Kawakawa	Tangi	36.3	0.031	70	LC
		<i>Scomberomorus commerson</i>	Narrow-barred spanish mackerel	Tanggigi/ Dumarada	228.8	0.197	292	NT
		<i>Scomberomorus guttatus</i>	Indo-pacific King mackerel	Tanggigi/ Dumarada	143.3	0.123	211	LC
Invertebrates	Loliginidae	<i>Loligo divauctelli</i>	Indian squid	Laki	12.8	0.011	27	NE
		<i>Lololus noctiluca</i>	Luminous bay squid	Pusit	122.2	0.105	19	NE
		<i>Lololus beka</i>	Beka squid	Pusit	818.0	0.705	1	NE
	Octopodidae	<i>Octopus aegina</i>	Marbled octopus	Kurita	5.1	0.004	56	NE
		<i>Octopus cyanea</i>	Big blue octopus	Kurita	24.8	0.021	8	NE
	Panuliridae	<i>Panulirus sp.</i>	Lobster	Binaging	32.0	0.028	8	NE
	Seyllariidae	<i>Parribacus antarcticus</i>	Sculptured mitten lobster	Binaging	3.0	0.003	10	LC
		<i>Scylla serrata</i>	Giant muderab	Rasa	62.1	0.054	8	NE
	Sepiidae	<i>Sepia lycidas</i>	Kisslip cuttlefish	Patawan	1.0	0.001	1	DD
Sharks	Carcharhinidae	<i>Carcharhinus dussumieri</i>	Widemouth blackspot shark	Pating	10.0	0.009	2	NT
		<i>Carcharhinus falciformis</i>	Silky shark	Pating	1.4	0.001	1	NT
		<i>Carcharhinus melanopterus</i>	Blacktip reef shark	Pating	30.0	0.026	2	NT
Rays	Myliobatidae	<i>Aetobatus nari nari</i>	Spotted eagle ray	Pagi	3.1	0.003	4	NE
		<i>Dasyatis kuhlii</i>	Bluespotted maskray	Pagi	10.8	0.009	26	DD
	Dasyatidae	<i>Dasyatis sp.</i>	Rays	Pagi	11.0	0.009	1	NE
		<i>Neotrygon leylandi</i>	Painted maskray	Pagi	26.2	0.023	1	LC
		<i>Taeniura lymna</i>	Bluespotted fantail ray	Pagi	3.9	0.003	4	NT
Total					116,053.3	100	23,980	

Similarly, oceanic and neritic tuna belongs to Family Scombridae and pelagic species belongs to ten families namely Family Carangidae, Megalopidae, Belonidae, Sphyracidae, Mugillidae, Gempylidae, Mennidae, Albulidae, Trichiuridae, and Hemiramphidae. The species of invertebrates has five families belonging to Family Loliginidae, Scyllaridae, Octopodidae, Panuliridae, and Sepiadariidae. Sharks belong to Family Carcharhinidae and rays belong to Family Dasyatidae and Myliobatidae.

With regards to the conservation status of each species based on the classification of IUCN Red List of Endangered species, there were 14 species that are nearly threatened (NT), 1 endangered (E), one (1) vulnerable (V), 140 least concern (LC), 10 data deficient (DD), and 72 species not evaluated (NE). Threatened species are Bower's parrotfish (*Chlorurus bowersi*), Duskytail grouper (*Epinephelus bleekeri*), Orange spotted grouper (*Epinephelus coioides*), Brown-marbled grouper (*Epinephelus fuscoguttatus*), Malabar grouper (*Epinephelus malabaricus*), Hawaiian grouper (*Hyporthodus quernus*), Leopard coral grouper (*Plectropomus leopardus*), Yellow tail parrotfish (*Scarus hypselopterus*), Yellowfin tuna (*Thunnus albacares*), Narrow barred spanish mackerel (*Scomberomorus commerson*), Widemouth blackspot shark (*Carcharhinus dussumieri*), Silky shark (*Carcharhinus falciformis*), Blacktip reef shark (*Carcharhinus melanopterus*), and Bluespotted fantail ray (*Taeniura lymma*).

Meanwhile, big-eye tuna (*Thunnus obesus*) and Humphead wrasse (*Cheilinus undulatus*) were already assessed as vulnerable and endangered, respectively. *C. undulatus* was noted to occur only once a year and the landing of this species was noted in Divilacan Bay during the month of September.

Figure 4 shows the percentage abundance of families by weight. Family Scombridae have the highest percentage abundance (34.17%) followed by Family Carangidae (24.81%), Teraponidae (13.67%) and Coryphaenidae (6.47%). Big-eye tuna (*Thunnus obesus*), mackerel scad (*Decapterus*

*macarellus*), largescaled terapon (*Terapon theraps*), and pompano dolphinfish (*Coryphaena equiselis*) dominated the catch of Family Scombridae, Carangidae, Teraponidae, and Coryphaenidae, respectively. Species of oceanic and neritic tunas are abundantly present throughout the year. The year round abundance of free school tunas, round scads and other large pelagic species could be attributed to the presence of floating artificial reefs or fish aggregating device in the area which could attract schools of fish. Most of the catches were derived from small scale fishing using handlines (i.e. multiple handline and simple handline) and gill nets and commercial scale ring netting in conjunction with payao. The top species observed in this study were similar to the findings of Ayson and Encarnacion (2008) in which tuna and other tuna-like species, round scads, and anchovies are the major species caught in the coastal waters of Cagayan adjacent to Isabela waters.

On the other hand, the least recorded volume belongs to Family Myliobatidae, Chirocentridae, Monocentridae, Sillaganidae, and Sepiidae which only has 0.004 percentage contributions. Species under these families are seldom recorded throughout the study period since some of the species are only by catch (i.e. eagle rays), and other species are highly seasonal.

### Species diversity

There were 23,980 total numbers of fish individuals belonging to 238 species from 54 families of 109 genera (Table 2) sampled from the established landing sites within Isabela waters fishing ground and notably similar to the species observed in the nearby fishing ground, the Babuyan Channel. The average population size of the species in the area is 100.08. Shannon-Weiner diversity index (H) value was found to be high with a diversity value of 3.77. Values of the Shannon's diversity index for real communities typically fall

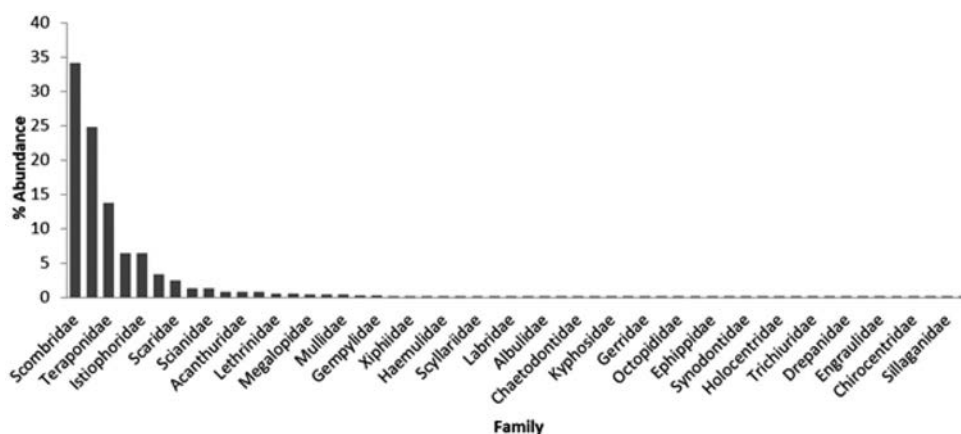


Fig. 4. Percentage abundance by Family in Isabela Waters, Philippines.



between 1.5 and 3.5 for ecological data and rarely exceeds 4.0 (May 1975) where a community with few individuals from many different species has higher diversity than that community of the same number of individuals with most of them belonging to few species. The study revealed that there is existence of variability of diversity of marine fishes in the fishing ground. According to Orth and Colette (1996), the Shannon diversity index has strong values for species with recoveries of same importance and it takes low when some species have strong recoveries.

However, upon comparing the species richness of the area to the nearby fishing grounds in Cagayan Valley Region, the species richness of Isabela waters was slightly lower compared to Batanes Waters with 580 species (Morales et al. 2016) and Babuyan Channel with 256 species recorded (Encarnacion et al., in press). Nevertheless, the obtained diversity value is still high which could be an indication that the habitat is still good and undisturbed. The variations and degree of diversity in different fishing grounds could be due to several anthropogenic factors (i. e. fishing pressure), and ecological factors like topography, habitat type and quality and substrate type.

The Simpson's dominance index value of 0.94 indicates that taxon dominates a community or an area. Simpson's dominance index ranges from 0 (all taxa are equally present) to 1 (taxon dominates the community completely). Pielou's evenness (J) value was 0.7. Ifo et al. (2016) stated that the value of equitability (Evenness index) varied from 0 to 1. The authors furthered that, it is equal to 1 when all the species have same abundance and tend towards 0 when the near total of floral or faunal is calculated to only one species. The data shows that there are similar proportions of different species in the fishing ground as reflected by the evenness value which is nearly or close to 1.0.

## SUMMARY AND CONCLUSION

There are 15 fishing gears operating in Isabela waters and majority of the gears being used are troll line, bottom set gill net, multiple handline and traps. Family Scombridae and Carangidae are the top 2 families occurring in the fishing ground. As to conservation status, *C. undulatus* was already listed by IUCN as endangered species and there are 14 species in the area that are nearly threatened. There were 23,980 individuals of fish collected belonging to 54 families, 109 genera, and 238 species. The computed diversity index was very high (3.77). As observed, few individuals were noted but the species belongs to different Genera and Families. The Simpson dominance index (0.94) indicated that taxon

dominates an area. Evenness index of 0.7 showed that a similar proportion of different species are found in the fishing ground.

Based on the findings of the study, Isabela waters have diverse marine commercial fishes based on the number of families, genus and species documented. It can also be inferred that the year round presence of highly migratory species particularly the oceanic tunas and other large and small pelagic fish species is due to the presence of fish aggregating devices in the area that attract schools of fish where larger species can prey on the smaller one. The information generated in this study can already provide baseline information for management of the marine fishes in the Isabela waters, Philippines.

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