Catch Composition and Bycatch Species of Fyke Net from Glass Eel Fishery in Aparri, Cagayan, Philippines

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ABSTRACT

The Cagayan River estuary in Aparri, Cagayan, Philippines, is a traditional site for glass eel collection. Local fishers use fyke nets as the primary fishing gear, with fine mesh nets and motorized fishing boats. Although the target species is the glass eel, the fyke nets also captured untargeted species, or bycatch, which play significant roles in the estuarine ecosystem. This study aimed to assess and identify the species of glass eels and the species composition of bycatch from this type of fishery. A total of 31 bycatch species, belonging to 16 families, were recorded, many of which are economically important, such as Carangidae, Clupeidae, Engraulidae, Gobiidae, Mullidae, Penaeidae, Sciaenidae, and Serranidae. Two species of glass eel were identified based on caudal cutaneous pigmentation, namely, *Anguilla bicolor pacifica* and *Anguilla marmorata*. This type of fishery poses a threat to bycatch species, as most are caught before reaching maturity; however, it has not received adequate attention. The main implication of this study is the need for proper recording and monitoring of these juvenile bycatch species to ensure the sustainability of the resources.

Keywords: *Anguilla* spp., Cagayan River, Estuary, Juvenile

INTRODUCTION

The freshwater eels (Family Anguillidae) are high-valued fish distributed in temperate and tropical waters and various life stages are harvested and marketed globally for farming and consumption, often traded in the East Asian countries (Crook and Nakamura, 2013; Shiraishi and Crook, 2015), with Japan considered the dominant market for eels (Crook and Nakamura, 2013). The international market for cultured eels exceeded 200,000 Metric Tonnes (MT) in 2000 and peaked at 275,014 MT in 2009 (FAO, 2015) with the Philippines ranking fourth globally exporting approximately 120 tonnes of live eel fry from 2004 to 2013 (Crook, 2014). With the rapid increase in global demand for temperate eels, resources of temperate anguillid eels such as Japanese eel (*Anguilla japonica*) and European eel (*Anguilla anguilla*) rapidly declined in recent years (Honda *et al*., 2016) due to some management and conservation measures to control its population shifting the demand to tropical anguillid eels. In Southeast Asia, there is an increase in the gathering of tropical anguillid eels such as Indonesian shortfin eel (*Anguilla bicolor bicolor* and *Anguilla bicolor pacifica*) and the giant mottled eel (*Anguilla marmorata*) which are among the most economically important species in Indonesia and Philippines (Suryati *et al*., 2019) which compensate the declining population of temperate eels (Honda *et al*., 2016) in the global market.

In a study conducted by Cuvin-Aralar *et al*. (2019), Southeast Asian countries filled the

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gaps in the demand of live anguillid fry, particularly Japan (33%), China (17%), Taiwan (10%), and Philippines (4%) in 2004. Consequently, following the demand in the increase of export of live eel fry, a significant increase was also observed particularly in the Philippines to 29% by 2011 and 2012.

In the Philippines, Santos *et al*. (2023) and Aya (2023) identified glass eel major collection sites namely; Davao Region, General Santos City, Sarangani, Cotabato City and Maguindanao in Mindanao Island; and Cagayan River and Lagonoy Gulf in Luzon Island. In the Cagayan Valley region in Luzon Island, Cagayan River is connected to various tributaries where glass eels can be collected such as Aparri, Buguey, Santa Ana, Gonzaga, and Claveria (Ame *et al*., 2013) with the estuary in Aparri as the major collection site and considered as traditional fishing grounds for eels (Cuvin-Aralar *et al*., 2019) and glass eels in this area occur most of the year (Tabeta *et al*., 1976). Cagayan river estuary in Aparri is located at the mouth of the river and is influenced by the Kuroshio and North Equatorial Current (NEC) which aids the transport of glass eels (Tabeta *et al*., 1976; Han *et al*., 2016; Tattao *et al*., 2023). It is inhabited by various freshwater eel species such as *Anguilla bicolor pacifica, A. celebesensis, A. japonica, A. luzonensis*, and *A. marmorata* (Aoyama *et al*., 2015) and known as an important eel habitat (Muthmainnah *et al*., 2016) which concerned researchers to conduct various scientific studies on the identification, seasonal occurrence, biological characteristics and seasonal changes in species composition of tropical eels (Tabeta *et al*., 1976; Yoshinaga *et al*., 2014; Aoyama *et al*., 2015; Hilario *et al*., 2022).

Eel culture which is responsible for over 90% of Anguilla production worldwide is mainly dependent on wild-caught (Shiraishi and Crook, 2015) hence, bycatch is inevitable. Bycatch, which includes unintended species caught during fishing operations, is often utilized by local communities but is poorly documented and reported (Alverson, 1994; Soykan *et al*., 2008; Sultana *et al*., 2014). Aparri, a major economic hub in Cagayan, serves as a central point for glass eel consolidation before distribution across the country. Fishers report catching associated species like "tuwel" (*Dendrophysa ruselli*), "mamata" (*Ilisha melastoma*), "pasayan" (*Fenneropenaeus indicus*), "bulung unas" (*Trichiurus lepturus*), and "biala" (*Thryssa setirostris*) alongside their target catch. The observed high abundance of bycatch species from glass eel fishery in the Aparri estuary is similar to some studies conducted on the major glass eel collection sites in Indonesia, particularly in Cikaso and Cimandiri estuaries which accounted for various economically important fish species (Annida *et al*., 2021; Wahju *et al*., 2021).

Understanding the composition of bycatch from the local glass eel fishery is crucial for the sustainability of the resources since it is one of the most serious threats to a healthy ecosystem hence, the main objective of this study is to identify and analyze the catch composition and bycatch of fyke net from glass eel fishery in Aparri, Cagayan, Philippines.

MATERIALS AND METHODS

Study area

The study was conducted at the fish landing site in Toran, a village in the municipality of Aparri, Cagayan, Philippines (Figure 1). It is located at the northernmost point of the northern Luzon region, where the Cagayan River flows into the Babuyan Channel. The municipality of Aparri divided into western and eastern portions by the Cagayan River.

Data collection procedure

Sampling strategy

Data collection was conducted from March to April 2023 which generally marks the dry season in the Cagayan Valley region, characterized by more stable and predictable weather conditions. During this time, the frequency of storms and heavy rainfall is significantly lower, thus minimizing disruptions in fishing activities. This ensures that data collection is contiuous and the sampling process remains consistent throughout the study period. Sampling occurred weekly from the catch of fyke net, the only fishing gear used in catching glass eel in the area. The net used is a fine-meshed net, deployed in shallow waters and operated with 4 bouys to keep the net afloat and 3 anchors (2 for the wings and 1 at the end of the bunt) to keep the net from being washed away by the current. The catching bag measures a total of 20 m (from the first ring to the bunt) while the wings are measured at 10 m each side allowing 10 m mouth opening when set.

The total landed catch was recorded in every sampling schedule from five glass eel fishers, all of whom had at least ten years of experience in the fishery and employed common fishing practices. The total catch was collected from the fishers, and data on individual weight (g) and total length (cm) were obtained using a digital weighing scale (to the nearest 0.1 g) and a measuring board, respectively.

Fyke net operation

The fyke net is the most commonly used fishing gear for catching glass eels in Southeast Asian countries (Muthmainnah *et al*., 2016; Suryati *et al*., 2019; Thuc and Van, 2021), with variations in mode of operation and local materials. Fyke nets are also used in Cagayan, employing two methods: stationary and dragging, similar to trawl fishing (Ame *et al*., 2013). In this study, a fyke net (Figure 2), locally known as a "*tanggar*", was employed. It is a cone-shaped net with a catching bag 20 m long and a mouth opening 10 m wide. The main netting material is made of fine mesh nets.

Species identification

Upon landing, the catch from the glass eel fishers was transported to the Integrated Fish Laboratory of the Bureau of Fisheries and Aquatic Resources, Tguegarao City, Cagayan, Philippines, for species identification. Glass eel were identified using a species identification chart based on caudal pigmentation (Tabeta *et al*., 1976), with the aid of a dissecting microscope at WF10X resolution. Fish and non-fish bycatch species were identified morphologically using various fish identification resources, including books and online databases such as Fishbase and Sealifebase (Froese and Pauly, 2023; Palomares and Pauly, 2023).

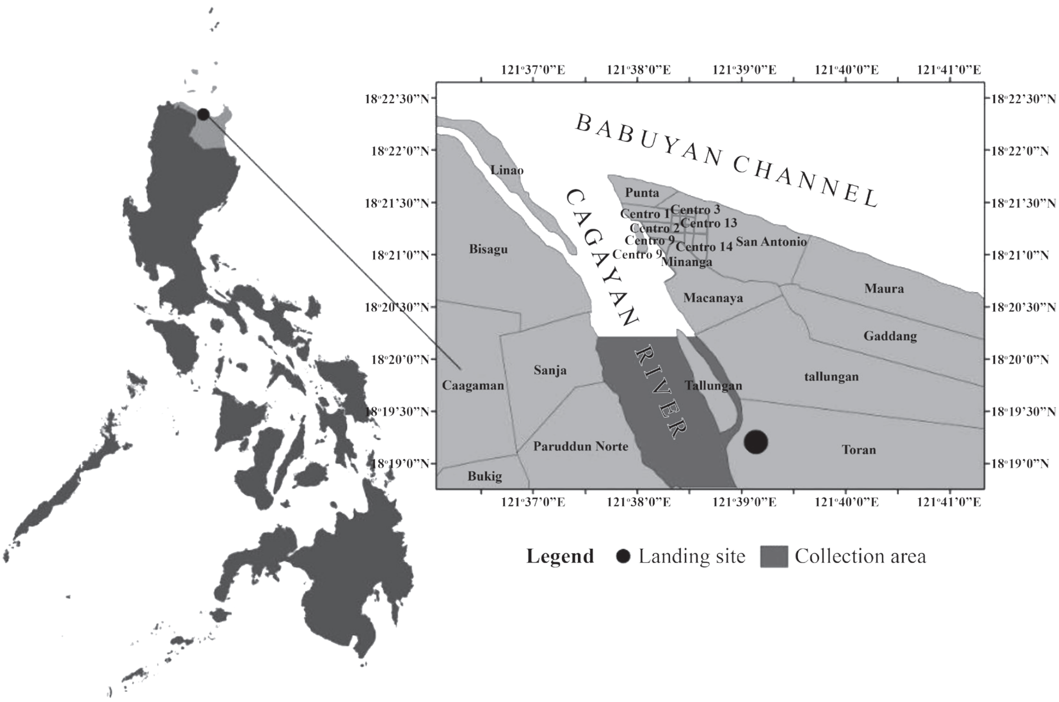

Figure 1. Map showing the study area.

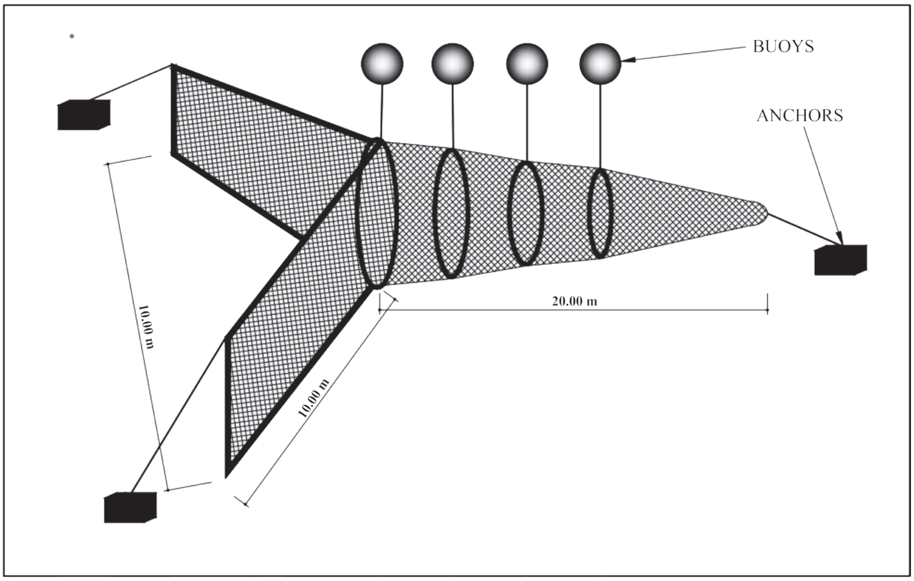

Figure 2. Fyke net used in glass eel collection in Aparri, Cagayan, the Philippines.

Catch composition

Catch composition was analyzed to determine the percentage structure of the catch from each fishing operation. The total catch and total weight (kg) per species, along with their corresponding species identification, were recorded to calculate the percentage composition of each species per sampling day and gear used. Catch composition was calculated using the formula of Annida *et al*. (2021):

$$\text{Catch composition (\%)} = \frac{\text{bi}}{\text{B}} \times 100$$

where b_i is the biomass for an individual fish species, and B is the total biomass of the catch for each fishing operation. Catch composition was calculated separately for the target species (glass eel) and bycatch species in the study area.

Economic importance

The economic importance of the bycatch species from the glass eel fishery was assessed based on local market prices and price valuations from the Philippine Statistics Authority (2023). Bycatch species were classified based on their market value. Species that are typically small, often juvenile, poorly preferred by consumers, and have little to no direct commercial value are categorized as low-market-value species (www.fao.org). In contrast, high-market-value species are those fish which demands better prices and are in higher consumer demand.

RESULTS AND DISCUSSION

Glass eel fishing operation

Glass eel fishing typically occurs during the new moon and first quarter phases of the moon, as fishers believe these dark phases are when glass eels are most abundant. Fishing is carried out by one or two fishers per boat, who set the fyke net either in the afternoon or at night. The anchors and floaters (Figure 3) are deployed along with the main netting material. Anchors are placed on the sea bottom to keep the net open, while buoys suspend the fyke vertically by holding the net's line at the water surface. A motorized boat is commonly used to haul the fyke net during low tide, dragging it to collect the catch. After hauling, the harvest is collected from the catching bag. Glass eels and separated from bycatch species manually by the fishers and local residents. Finally, a scoop net is used to gather the glass eels.

Catch composition

A total of 31 bycatch species were recorded, comprising 96.83% of the overall catch, while glass eels accounted for 3.17% (Figure 4). The species with the largest shares included *Gazza achlamys* (52.67%), *Stolephorus indicus* (17.17%), *Trichiurus lepturus* (13.72%), and *Leiognathus ruconius* (6.92%) (Figure 4). The Leiognathidae family had the highest bycatch abundance, contributing 60.45% of the catch, primarily from *Gazza achlamys*. The Engraulidae family ranked second with an 18.56% share, followed by Trichiuridae (13.72%) and Dorosomatidae (3.21%). Two species of invertebrates from the Penaeidae family: *Penaeus indicus* and *Penaeus japonicas*, were also identified.

Other families with lower bycatch volumes included Cynoglossidae (0.0279%), Gobiidae (0.0041%), Mullidae (0.0062%), Polynemidae (0.0408%), Sciaenidae (0.0991%), Serranidae (0.0094%), Pristigaridae (0.2987%), Clupeidae (0.0944%), and Terapontidae (0.0003%). Though some of these bycatch species have low market value, many are still utilized for family consumption and are economically importance.

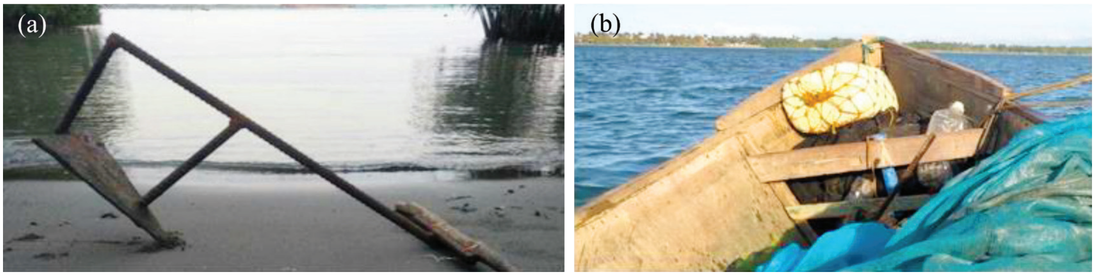

Figure 3. Anchor (a) and floater (b) used in fyke net operation.

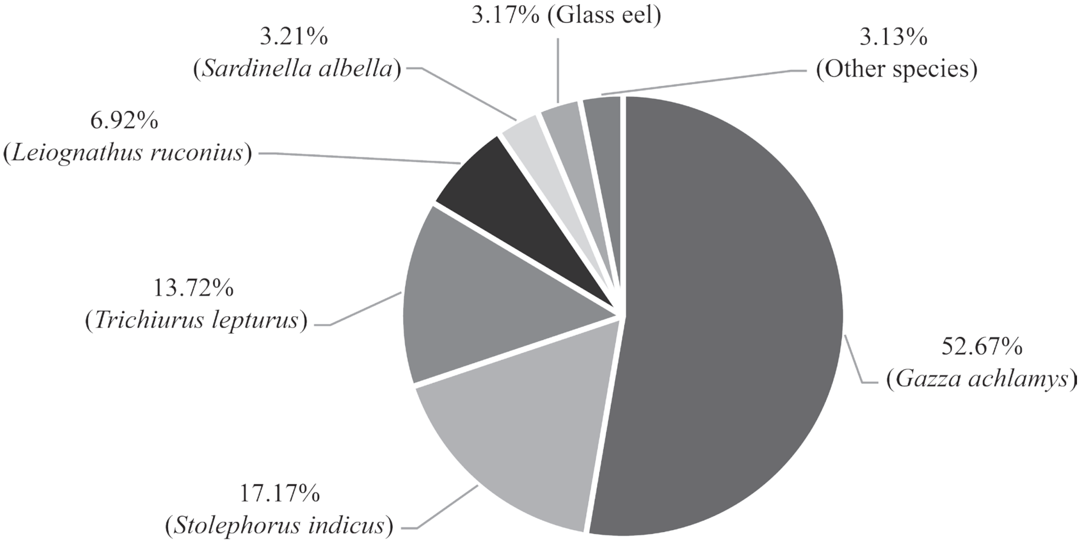

Figure 4. Catch composition from glass eel fisheries in Aparri, Cagayan, Philippines.

The species composition of the bycatch from the glass eel fishery is shown in Table 1, which included 2 invertebrate species and 29 fish species. Bycatch was found to belong to 17 families, Anguillidae, Carangidae, Pristigaridae, Dorosomatidae, Clupeidae, Cynoglossidae, Engraulidae, Gobiidae, Lacteriidae, Leiognathidae, Mullidae, Penaeidae, Polynemidae, Sciaenidae, Serranidae, Teraponidae, and Trichiuridae.

Bycatch from the glass eel fishery in Indonesia's Cikaso and Cimandiri estuaries has been reported by Wahju *et al*. (2021) and Annida *et al*. (2021), who recorded 22 species from 15 families. The composition of bycatch using various fishing gears in these studies showed the highest bycatch, consisting of eight to nine species. Gisbert and López (2008) also reported that the bycatch in glass eel fisheries mainly consists of small estuarine species and mugilid fry, similar to the present study. This has a negative impact on the ichthyofauna in the estuaries, including small pelagic species such as anchovies, sardines and ponyfishes, as it alters species composition, dominance, and population dynamics (Gisbert and López, 2008). These species play important roles in the trophic levels, controlling both prey populations and the dynamics of predatory fish (Duarte and Garcia, 2004; Shannon and Cury, 2007).

The increasing number of bycatch species in this fishery poses significant challenges to the sustainability of estuarine resources, as these bycatch species can directly or indirectly affect target populations, depending on the species involved (Wahju *et al*., 2021). However, proper documentation and recording can help reduce bycatch and maintaining a healthy environment (Keledjian *et al*., 2014).

The catadromous life history of eels is well known. According to Wilson *et al*. (2007), Minegishi *et al*. (2012), and Muthmainnah *et al*. (2016), catadromous eels spend their early life stages in the ocean, migrate to shore as larvae, transform into juveniles known as "glass eels" and proceed to rivers as "elvers", where they mature in freshwater. The diversity of bycatch recorded in this fisheries is influenced by the study site's estuarine environment. Estuarine are important nursery grounds for many aquatic species (Miller and Dunn, 1980), providing a physiologically suitable environment with abundant food, shelter, and protection from predators.

Estuarine ecosystems are highly productive and serve as critical breeding and nursery grounds for both estuarine and diadromous species (McHugh, 1967; McLusky and Elliott, 2004). This contributes to the high incidence of juvenile bycatch in the study area, which could have direct effects on the community structure of the ecosystem by depleting populations that represen key trophic levels (Blaber *et al*., 2000).

During the study, juveniles of economically valuable species such as grouper, caranx, goby, terapon, sardinella, hairtail and penaeid shrimps were recorded. Glass eel fishers reported that these juvenile species are often sold at lower prices and sometimes have no buyers. However, if allowed to grow, these species could fetch higher market prices, benefiting the fisherfolk. In the current market in Aparri, Cagayan, large pelagic species and high-value penaeid species have promising market prices ranging from 8.60 to 13.80 USD and 6.89 to 9.48 USD, respectively (1 USD = 58.29 PHP).

Despite being regarded as low-value species, bycatch ponyfishes are still considered economically important due to the strong demand for fish supply in the area. Bycatch species are fully utilized in the Philippines for variety of products, such as salted, fermented, dried, or value-added goods (Sultana, 2014). Local fishers in the study area follow a similar approach, marketing bycatch species, especially those with large catch volumes, for both human consumption and as fresh or dried goods. The residents participate in the sorting process upon landing.

Given the results of this study, recording and monitoring these ecologically and economically important juvenile bycatch species is crucial for the sustainability of resources. In many regions, the diversity of species impacted by bycatch remains largely unknown, as research has primarily focused on industrial fisheries, neglecting small-scale artisanal fisheries that could impact threatened species (Soykan *et al*., 2008).

Table 1. List of species from glass eel fishery in Aparri, Cagayan, Philippines, 2023.

Group of catches	Family	Scientific name	English name	Local name	Catch (g)	% Composition	Economic importance
Target species							
	Anguillidae	*Anguilla bicolor pacifica* (Schmidt, 1928)	Glass eel	Dalarak	4,993.0	3.1689	
		Anguilla marmorata (Quoy and Gaimard, 1824)	Glass eel	Dalarak			
Bycatch species							
	Carangidae	*Alectis ciliaris* (Bloch, 1787)	African pompano	Talakitok	45.4	0.0288	HMV
		Caranx ignobilis (Forsskål, 1775)	Giant trevally	Talakitok	26.3	0.0167	HMV
		Caranx sexfasciatus (Quoy and Gaimard, 1825)	Bigeye trevally	Talakitok	55.7	0.0354	HMV
		Megalaspis cordyla (Linnaeus, 1758)	Torpedo scad	Sikkaran	10.8	0.0069	HMV
		Scomberoides commersonianus (Lacepède, 1801)	Queenfish	Salayusay	100.9	0.0640	HMV
	Clupeidae	*Ambligaster sirm* (Bloch, 1787)	Spotted sardinella	Bilis	15.4	0.0098	HMV
		Escualosa thoracata (Valenciennes, 1847)	White sardine	Annuraw	133.3	0.0846	HMV
	Cynoglossidae	*Cynoglosus bilineatus* (Lacepède, 1802)	Fourlined Tonguesole	Dadali	20.8	0.0132	LMV
		Cynoglosus lingua (Hamilton, 1822)	Long tonguesole	Dadali	18.1	0.0115	LMV
		Parapaglusia bilineata (Bloch, 1787)	Doublelined tonguesole	Dadali	5.1	0.0032	LMV
	Dorosomatidae	*Sardinella albella* (Valenciennes, 1847)	White sardinella	Bilis	5,051.0	3.2057	HMV
	Engraulidae	*Stolephorus indicus* (van Hasselt, 1823)	Indian anchovy	Munamun	27,060.0	17.1743	HMV
		Thryssa setirostris (Broussonet, 1782)	Longjaw thryssa	Biala	2,182.4	1.3852	LMV
	Gobiidae	*Glossogobius aureus* (Akihito and Meguro, 1975)	Goby	Bunug	6.5	0.0041	HMV
	Lacteriidae	*Lactarius lactarius* (Bloch and Schneider, 1801)	False trevally		82.0	0.0520	HMV
	Leiognathidae	*Gazza achlamys* (Jordan and Starks, 1917)	Smalltoothed ponyfish	Sapsap	82,994.1	52.6741	LMV
		Karalla daura (Cuvier, 1829)	Goldstriped ponyfish	Sapsap	1,179.1	0.7483	LMV
		Equulites elongatus (Gunther, 1874)	Elongate ponyfish	Sapsap	53.7	0.0341	LMV
		Photopectoralis bindus (Valenciennes, 1835)	Orangefin ponyfish	Sapsap	110.1	0.0699	LMV
		Leiognathus ruconius (Hamilton, 1822)	Deep pugnose ponyfish	Sapsap	10,904.9	6.9211	LMV
	Mullidae	*Upeneus mollucensis* (Bleeker, 1855)	Goldband goatfish	Balaki	9.7	0.0062	HMV
	Penaeidae	*Penaeus indicus* (Milne-Edwards, 1837)	Indian white prawn	Pasayan	116.0	0.0736	HMV
		Penaeus japonicus (Bate, 1888)	Kuruma prawn	Pasayan	53.3	0.0384	HMV
	Polynemidae	*Eleutherenoma tetradactylum* (Shaw, 1804)	Fourfinger threadfin	Kugaw	64.3	0.0408	HMV
	Pristigaridae	*Ilisha melastoma* (Bloch and Schneider, 1801)	Indian ilisha	Mamata	470.6	0.2987	LMV
	Sciaenidae	*Dendrophysa ruselli* (Cuvier, 1829)	Goatee croaker	Tuwel	104.0	0.0660	HMV
		Pennaiah aneus (Bloch, 1793)	Donkey croaker	Tuwel	52.2	0.0331	HMV
	Serranidae	*Cephalopholis boenak* (Bloch, 1790)	Chocolate hind	LapuLapu	8.8	0.0056	HMV
		Epinephelus coioides (Hamilton, 1822)	Orangespotted grouper	LapuLapu	6.0	0.0038	HMV
	Terapontidae	*Terapon jarbua* (Forsskal, 1775)	Terapon	Baraungan	0.4	0.0003	HMV
	Trichiuridae	*Trichiurus lepturus* (Linnaeus, 1758)	Largehead hairtail	Bulung-unas	21,620.3	13.7218	HMV

Note: HMV = High Market Value; LMV = Low Market Value

It was observed that the target species (glass eel), accounted for only 3.17% of the total catch. Two species of glass eel (Figure 5), *Anguilla marmorata* and *A. bicolor pacifica*, were identified throughout the study, in line with the species identification of Tabeta *et al*. (1976) and Reveillac *et al*. (2009) and similar to the findings of Hilario *et al*. (2022).

Anguilla marmorata and *A. bicolor pacifica* were prevalent in the study area, suggesting that these species are the most common in the region. This finding is consistent with Aoyama *et al*. (2015), who observed consistent recruitment of these species throughout the year. Additionally, two species of glass eels were identified in the Philippines by Jamandre *et al*. (2007) using cytochrome b and 16S rRNA gene sequences.

Length composition

Table 2 presents the species collected, including sample size, mean length, mode, length ranges, maximum length (L_{max}), and length at first maturity (L_{m50}) of bycatch species in the glass eel fisheries.

Several bycatch species, such as *C. sexfasciatus, D. ruselli, P. indicus, P. aneus, S. commersonnianus,* and *T. setirostris*, were caught before reaching their length at first maturity, as indicated by the data in table 2. While some mature individuals were caught, their numbers were minimal, including *E. thorocata* (2.63%), *G. achlamys* (0.09%), *L. ruconius* (36.32%), *S. albella* (8.95%), and *T. lepturus* (6.76%). Some species recorded minimal catch, but given their first maturity data, they were still caught in immature stages. Additionally, some species lacked data on L_{m50}, making their maturity status unaccounted for in the table. The high incidence of immature bycatch species found in this study could impact the trophic structure and ecosystem dynamics of the area, affecting species composition, biomass, and endangering numerous fish populations (Alverson, 1994; Pascoe, 1997; Torres-Irineo *et al*., 2014). Moreover, this phenomenon could have long-term effects on the fish population and sustainability of the resources. Economically, this could lead to a loss for fishers, as these species would provide more benefit if caught at larger sizes (Mohamed *et al*., 2014).

The higher catch of small-sized species can be attributed to the fine mesh of the fishing gear used, which is non-selective and increases the likelihood of bycatch. Fine-meshed nets captured fish at early life stages, preventing them from growing to sizes where they could provide maximum biomass (Armada *et al*., 2004).

To reduce the ecological effects of non-selective fisheries, innovation in fishery management is essential (Hazen *et al*., 2018). Modifying fishing gear design to enhance size and species selectivity could reduce bycatch to the lowest possible level without compromising glass eel capture (Gisbert and López, 2008; Tsukamoto *et al*., 2008; Wahju *et al*., 2021). Furthermore, restricting fishing operations during certain periods, particularly during the lean season, could help. During these periods, fishers should be provided with alternative livelihood options. Similar studies in other collection areas should be conducted to develop effective conservation strategies for bycatch management.

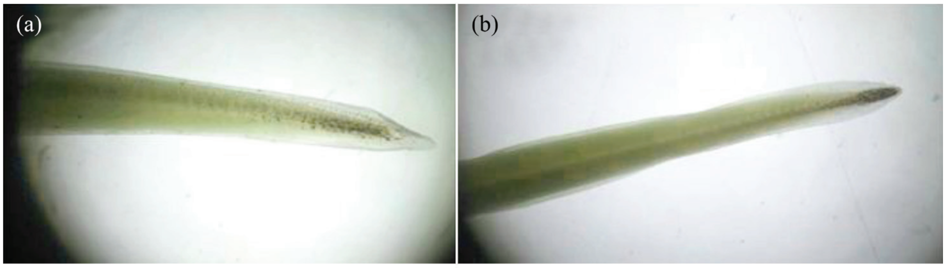

Figure 5. Caudal fin pigmentation pattern of glass eels. a) *Anguilla marmorata*, and (b) *Anguilla bicolor pacifica*.

Table 2. Length composition and maturity of bycatch species from glass eel fishery in Aparri, Cagayan, Philippines, 2023.

Species	**N**	**Mean length (cm)**	**Mode (cm)**	**Length ranges total length (cm)**		**$^*L_{max}$ total length (cm)**	**$^*L_{m50\ (cm)}$**	**Percentage maturity**	
				Min	**Max**			**Immature**	**Mature**
Alectis ciliaris (Bloch, 1787)	3	8.13	-	3.0	11.8	150.0	NDA	N/A	N/A
Amblygaster sirm (Walbaum, 1792)	1	-	-	12.5	-	27.0	15.0	N/A	N/A
Caranx ignobilis (Forsskål, 1775)	6	6.60	7.2	6.1	7.2	170.0	60.0	N/A	N/A
Caranx sexfasciatus (Quoy & Gaimard, 1825)	43	4.28	4.1	3.1	7.2	120.0	42.0	100%	-
Cephalopholis boenak (Bloch, 1790)	2	5.80	-	5.3	6.3	30.0	12.2	N/A	N/A
Cynoglussus bilineatus (Lacepède, 1802)	6	8.06	4.5	4.2	12.8	44.0	NDA	N/A	N/A
Cynoglossus lingua (Hamilton, 1822)	2	9.05	-	8.1	10	45.0	10.8	N/A	N/A
Dendrophysa russellii (Cuvier, 1829)	22	6.42	5.4	3.5	11.6	38.3	14.4 (Nguyen Van *et al*., 2020)	100%	-
Eleutheronema tetradactylum (Shaw, 1804)	3	13.13	-	12.5	13.9	200.0	23.4	N/A	N/A
Epinephelus coioides (Hamilton, 1822)	1	-	-	7.1	-	120.0	41.3	N/A	N/A
Escualosa thoracata (Valenciennes, 1847)	38	7.28	7.1	6.2	9.2	10.0	9.18 (Singh *et al*., 2020)	97.37%	2.63%
Equulites elongatus (Gunther, 1874)	27	4.90	3.9	3.50	8	8.10	NDA		
Gazza achlamys (Jordan & Starks, 1917)	1,058	8.50	4.2	1.6	12.5	17.0	11.0 (Sasidharan *et al*., 2018)	99.91%	0.09%
Glossogobius aureus (Akihito & Meguro, 1975)	1	-	-	9.5	-	50.0	NDA	N/A	N/A
Ilisha melastoma (Bloch & Schneider, 1801)	88	8.11	8	5.5	9.5	22.0	14.9 (Mahmood *et al*., 2011)	100%	-
Karalla daura (Cuvier, 1829)	73	1.46	4.4	2.2	7.7	14.0	NDA		
Lactarius lactarius (Bloch & Schneider, 1801)	1	-	-	19.4	-	40.0	15.0	N/A	N/A
Leiognathus ruconius (Hamilton, 1822)	402	4.72	4.0	1.7	7.5	8.0	5.2	63.68%	36.32%
Megalaspis cordyla (Linnaeus, 1758)	2	7.95	-	7.4	8.5	80.0	22.0	N/A	N/A
Paraplagusia bilineata (Bloch, 1787)	1	-	-	9.7	-	31.6	NDA	N/A	N/A
Peneaus indicus (Milne-Edwards, 1837)	105	1.66	1.8	0.7	3.2	20.5	12.5 (Devi, 1987)	100%	-
Peneaus japonicus (Bate, 1888)	35	3.30	3.9	0.6	8.7	20.0	NDA		
Photopectoralis bindus (Valenciennes, 1835)	6	9.40	11.4	5.8	11.4	14.0	9.3	N/A	N/A
Pennahia aneus (Bloch, 1793)	13	5.54	4.4	4.4	11.1	30.0	16.6	100%	-
Sardinella albella (Valenciennes, 1847)	257	6.35	6	0.6	13.8	15.0	9.0	91.05%	8.95%
Scomberoides commersonnianus (Lacepède, 1801)	42	6.82	6.2	4.5	12.3	120.0	5.2	100%	-
Stolephorus indicus (van Hasselt, 1823)	232	6.22	4.0	4.0	8.3	15.5	9.0	100%	-
Terapon jarbua (Forsskal, 1775)	1	-	-	2.7	-	36.0	13.0	N/A	N/A
Thryssa setirostris (Broussonet, 1782)	140	9.90	12.3	2.9	15.2	18.0	16.0	100%	-
Trichiurus lepturus (Linnaeus, 1758)	207	34.37	31.5	9.4	57.1	234.0	50.6	93.24%	6.76%
Upeneus mollucensis (Bleeker, 1855)	4	6.07	-	5.7	6.5	22.5	NDA	N/A	N/A

Note: N = samples measured; NDA = No data available; N/A = Not Applicable; *Source: Fishbase unless otherwise specified

CONCLUSIONS

This study aimed to determine the catch and bycatch species composition of fyke nets used in glass eel fisheries. The results showed that the catch was dominated by non-targeted species, accounting for 96.83%, while target species made up only shared a 3.17%. A total of 31 bycatch species were recorded, belonging to sixteen families, most of which were caught before reaching maturity. Two species of glass eel were identified: *Anguilla bicolor pacifica* and *Anguilla marmorata*. The intensive exploitation of ecologically and economically important juvenile species in this fishery highlights the need for proper recording and reporting of catches to ensure the sustainability of the resources. Improvements and modifications to fishing strategies could reduce juvenile bycatch and minimize ecosystem damage. Information on the species composition with their corresponding length measurements and the fishing gear used provides baseline information for policy recommendations for the sustainable utilization and management of both glass eels and bycatch species. Further, similar studies is recommended for other collection sites in the province of Cagayan for a more holistic approach to effective conservation and management of the glass eel fishery.

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