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OBSERVATIONS ON BYCATCH RATE FOR VULNERABLE FISH SPECIES ON THE ROMANIAN COAST

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ABSTRACT

Living marine resources obviously contribute to the survival of humanity. Unfortunately, numerous studies highlighted that marine biological diversity faces various threats related to overfishing and illegal fishing, pollution (marine and terrestrial), invasive species, marine litter and climate change. In this context, the incidental catch of vulnerable species (i.e., elasmobranchs, marine mammals, seabirds) is considered one of the main threats to good environmental condition of the marine fauna. The aim of the study conducted in 2020, was to highlight the impact of fishing activities on aquatic resources, especially on vulnerable fish species as picked dogfish *Squalus acanthias*), thornback ray (*Raja clavata*) and common stingray (*Dasyatis pastinaca*), marine mammals and seabirds. The background information was collected by observations from scientific trawl surveys by pelagic and demersal trawl gears, observations from stationary fishing points, observations from commercial beam-trawl fishing operations. The analysis of logbooks of several economic operators and data collected by observers on board vessels, highlighted the low bycatch rate for vulnerable species in most fishing gear.

Key-Words: vulnerable species, by-catch, fishing gear

AIMS AND BACKROUND

It is well known that fishing is the most widespread activity of anthropogenic impact on the marine environment. However, fishing activities have a number of direct effects on marine ecosystems, as it is responsible for increasing the mortality of target species and bycatches (Maureaud *et al.*, 2019); also, the mobile fishing gears which have contact with the seabed exert significant physical impact on the habitat of benthic organisms (Jones, 1992).

About 40% of global fish catches are unintentional, with some fish being thrown back into the sea, dead or seriously injured (Davies *et al*., 2009).
The widely used term *bycatch* refers to the part of catch unintentionally captured during a fishing operation in addition to target species (Carpentieri *et al*., 2021). Understanding bycatch and adopting effective measures to reduce it are essential steps towards minimizing the incidental catch of vulnerable species and, more generally, conserving the marine ecosystems, as well as ensuring a sustainable fishery sector (Carpentieri *et al*., 2021).
The objective of the study was to highlight the impact of fishing activities on aquatic resources, manly on vulnerable species.

EXPERIMENTAL

The methodology used to conduct the present study was elaborated by FAO, 2019.

Analyses were based on the information for 2020 obtained from:

- ✓ fisheries-dependent data, obtained from commercial fishing (observers on board vessels, logbooks, telephone surveys);
- ✓ fisheries - independent data, obtained from scientific surveys and monitoring programs.

This methodology was used because it ensures common minimum standards for collecting data on these species and allows comparisons between fishing activities throughout the region, thus providing a harmonized knowledge, information and evidence base for the best decisions.

An estimate of the total number of individuals of vulnerable species caught by fishing fleets is very important. The key point in obtaining a correct estimate of the total incidental catch of vulnerable species is to have a sampling scheme with adequate coverage and reliable information. The information required to estimate the total number of vulnerable specimens (FAO, 2019) are: sum of number of individuals of each vulnerable species caught in each sampled fishing trip (N), number of sampled fishing trips (D), total number of fishing trips carried out during reference year by analyzed fleet segment (F).

Thus, the bycatch rate (T) for each vulnerable species and fleet segment was calculated according to the formula:

$$T = \frac{N}{D}$$

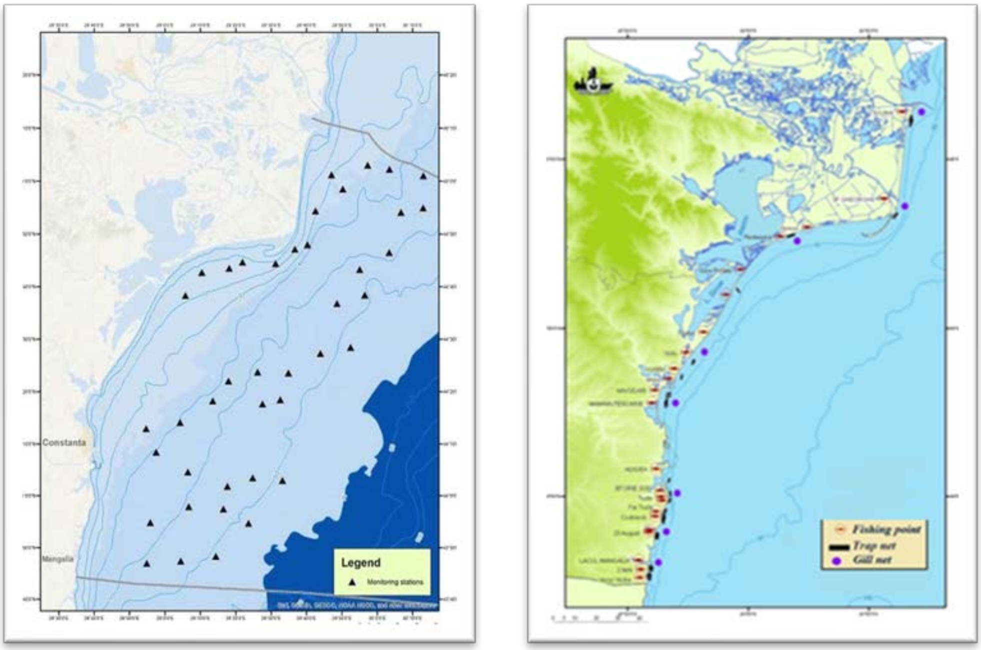
Also, knowing the bycatch rate, we can obtain the estimate number of the individuals caught on the fleet segment analyzed according to the following formula:

$$I = T * F$$

The variables needed to estimate the number of vulnerable species caught were obtained by combining fishing-dependent and fishing-independent data.

Information was collected from most of fishing gears (Fig. 1): 30 observation sheets from scientific fishing operations with pelagic trawling, 40 observation sheets from scientific fishing operations with demersal trawling, 50 data sheets observations from samples taken from the fishing points, 51 observation sheets from beam-trawl fisheries for *Rapana venosa*, analysis of the logbooks of several economic operators, forms completed by observers on board vessels.

The sampling stations cover almost the entire Romanian coastal area.



a) b)

Fig. 1. Maps with scientific fishing stations (a) and commercial fishing stations (b) (A. Spinu, NIMRD)

RESULTS AND DISCUSSION

An important threat to the conservation of the marine environment and its ecosystems are catches of vulnerable species. Thus, analyzing the data obtained for the study, the following vulnerable fish species were identified:

Dasyatis pastinaca – common stingray, FAO code: *JDP*
Raja clavata – thornback ray, FAO code: *RJC*
Squalus acanthias – spiny dogfish, FAO code: *DGS*

Regarding the vulnerable species in the group of mammals and seabirds, we mention that no specimens were observed caught in fishing nets. However, observers on board of commercial vessels have recorded the presence of the following marine mammal species in the fishing area:
Phocoena phocoena relicta – harbour porpoise, FAO code: *PHR*
Delphinus delphis ponticus - common dolphin, FAO code: *DCO*
Tursiops truncatus ponticus – bottlenose dolphin, FAO code: *DBO*

Mammals have approached to the fishing vessels, most likely exhibiting food-seeking behavior (Fig. 2).

Fig 2. Dolphins and birds around the research vessel
(NIMRD original photo)

For the seabirds group, several species were observed in the near the commercial fishing vessels and the following were identified:
Larus ridibundus – black-headed gull
Larus cachinnans – caspian gull
Larus michahellis – yellow legged gull
Phalacrocorax carbo – great cormorant
Sterna albifrons – little tern

The birds showed a behavior of approaching to the research vessel, probably in search of food in the area (Fig. 2).

Regarding the commercial fishing, data from on board observers and from the vessels logbooks were analyzed by calculating the bycatch rate for vulnerable species (Table 1) according to the above-mentioned methodology.

As seen in the table above, regarding the commercial fishing, the highest value of the bycatch rate - **2.70**, was recorded for pelagic trawling, the fleet segment 12-18 m, for *Dasyatis pastinaca* species and the lowest bycatch rate - **0.02** was recorded at pontic shad gillnets fishing, the fleet segment 6-12 m (boat) for the same *Dasyatis pastinaca* species; and it was the only vulnerable species identified in this type of fishing.

Table 1. Bycatch rate for vulnerable species, commercial fishing 2020

	fleet segment			
pelagic trawl	***6-12 m (boat)***	***12-18 m***	***18-24 m***	***>24 m***
Total catch target species (sprat)	3624 kg	29042 kg	300 kg	-
Complementary species (total weight)	919 kg	20894 kg	1950 kg	-
No individuals of *JDP* **(N)**	6	325	3	-
No individuals of *RJC* **(N)**	-	40	-	-
No of samples **(D)**	130	120	70	-
No of fishing trips **(F)**	131	130	72	-
Bycatch rate for *JDP* ***(T=N/D)***	***0.04***	***2.70***	***0.04***	-
Bycatch rate for *RJC* ***(T=N/D)***	**-**	***0.33***	-	-
turbot gillnets	***6-12 m (boat)***	***12-18 m***	***18-24 m***	***>24 m***
Total catch of the target species	28031 kg	26783.8 kg	-	-
Complementary species (total weight)	2131 kg	613 kg	-	-
No individuals of *JDP* **(N)**	201	13	-	-
No individuals of *RJC* **(N)**	145	7	-	-
No individuals of *DGS* **(N)**	41	65	-	-
No of samples **(D)**	278	144	-	-
Bycatch rate for *JDP* ***(T=N/D)***	***0.72***	***0.09***	-	-
Bycatch rate for *RJC* ***(T=N/D)***	***0.52***	***0.04***	-	-
Bycatch rate for *DGS* ***(T=N/D)***	***0.14***	***0.45***	-	-
pontic shad gillnets	***6-12 m (boat)***	***12-18 m***	***18-24 m***	***>24 m***
Total catch of the target species	3110 kg	-	-	-
Complementary species (total weight)	5438.9 kg	-	-	-
No individuals of *JDP* **(N)**	5	-	-	-
No individuals of *RJC* **(N)**	-	-	-	-
No individuals of *DGS* **(N)**	-	-	-	-
No of samples **(D)**	194	-	-	-
Bycatch rate for *JDP* ***(T=N/D)***	***0.02***	-	-	-
Bycatch rate for *RJC* ***(T=N/D)***	**-**	-	-	-
Bycatch rate for *DGS* ***(T=N/D)***	**-**	-	-	-
trap nets	***6-12 m (boat)***	***12-18 m***	***18-24 m***	***>24 m***
No individuals of *JDP* **(N)**	5	-	-	-
No individuals of *RJC* **(N)**	6	-	-	-
No individuals of *DGS* **(N)**	8	-	-	-
No of samples **(D)**	50	-	-	-
Bycatch rate for *JDP* ***(T=N/D)***	***0.10***	-	-	-
Bycatch rate for *RJC* ***(T=N/D)***	***0.12***	-	-	-
Bycatch rate for *DGS* ***(T=N/D)***	***0.16***	-	-	-

While gillnets are highly selective in terms of size, they offer limited interspecies selectivity and can catch seabirds, cetaceans, sea turtles and sharks (He, 2006). Among all fishing techniques, gillnetting represents a particular concern because it is known to be associated with relatively high bycatch mortality (Northridge *et al*., 2016).

In the Black Sea, the turbot gillnet fishery is associated with high incidental catch rates of demersal sharks, such as piked dogfish (*Squalus acanthias*), as well as of dolphins (Kara, 2012). In our study, the bycatch rate in turbot gillnet was very low.

Regarding the trap nets, under a variety of configurations, can be responsible for a range of harmful interactions with vulnerable species, such as collisions, entanglements in the nets of the leader or entrapment in the pound, which may be fatal for the animals (Sacchi, 2021). The samples collected twice a month from trap nets (FPN), fishing points located along the Romanian coast, were analyzed and the bycatch rate of all the vulnerable species was very low, between **0.12-0.16.**

During the pelagic trawling activities in the period of May-October 2020, a higher rate of bycatch was observed for common stingray *(Dasyatis pastinaca),* (Fig. 3) than for thornback ray *(Raja clavata).*

Fig. 3. Common stingray in pelagic trawl catches (NIMRD original photo)

Within the scientific research activities with demersal trawl (OTB) for the target species turbot (*Scophtalmus maaximus*), in 2020, more than 40 observation sheets were made. Complementary to the target species, the following species were identified and analyzed: red mullet (*Mullus barbatus*), horse mackerel (*Trachurus mediterraneus ponticus*), sand smelt (*Atherina boyeri*), whiting (*Merlangius merlangus euxinus*) were frequently identified. Significant quantities of jellyfish were also frequently observed in demersal trawl catches.

The following species: black scorpionfish (*Scorpaena porcus*), goldsinny wrasse (*Ctenolabrus rupestris*), black goby (*Gobius niger*), tub gurnard (*Chelidonichthys lucerna*), Roche's snake blenny (*Ophidion rochei*), common stingray (*Dasyatis pastinaca*), thornback ray (*Raja clavata*), dogfish (*Squalus acanthias*), sand sole (*Pegusa lascaris*), flounder (*Pleuronectes flesus*), sturgeon (*Acipenser gueldenstaedtii*) but also decapod and crustacean species, have been observed very rarely.

The use of the beam trawl gear in fishing was introduced to the Romanian coast in August 2013. Thus, a progressive increase of catches of *Rapana venosa* (target species) was observed, being twice as high as that achieved in manual harvesting with divers in 2012 and almost 15 times higher in 2017 when the catch represented over 98% of the total catch made on the Romanian Black Sea coast. Regarding the bycatch of vulnerable species in scientific fishing, were obtained the following information (Table 2):

Table 2. Bycatch rate for vulnerable species, scientific fishing 2020

	fleet segment			
demersal trawl	***6-12 m (boat)***	***12-18 m***	***18-24 m***	***>24 m***
No individuals of *JDP* **(N)**	-	-	-	12
No individuals of *RJC* **(N)**	-	-	-	9
No individuals of *DGS* **(N)**	-	-	-	7
No of samples **(D)**	-	-	-	40
Bycatch rate for *JDP* ***(T=N/D)***	-	-	-	***0.30***
Bycatch rate for *RJC* ***(T=N/D)***	-	-	-	***0.22***
Bycatch rate for *DGS* ***(T=N/D)***	-	-	-	***0.17***
beam trawl	***6-12 m (boat)***	***12-18 m***	***18-24 m***	***>24 m***
Total catch of the target species	770.189 kg	-	-	-
Complementary species (total weight)	579.297 kg	-	-	-
No individuals of *JDP* **(N)**	4	-	-	-
No individuals of *DGS* **(N)**	5	-	-	-
No of samples **(D)**	51	-	-	-
Bycatch rate for *JDP* ***(T=N/D)***	***0.07***	-	-	-
Bycatch rate for *DGS* ***(T=N/D)***	***0.09***	-	-	-

Analyzing the information from scientific fishing, it can be observed that, the bycatch rate is lower in beam trawl fisheries than in demersal trawl. The highest value of the bycatch rate - **0.30**, was recorded for demersal trawling, the fleet segment >24 m, for *Dasyatis pastinaca* species and the lowest bycatch rate - **0.07** was recorded for the same species in the beam trawl fisheries, the fleet segment 6-12 m.

Analyzed all together, the observations highlighted the low bycatch rate for vulnerable species in most of fishing gears (Table 3).

As shown in the table above, the average value of bycatch rate for the vulnerable species *Dasyatis pastinaca* was **0.83 ±0.87**, the higest was recorded in pelagic trawl. The average value of bycatch rate for the vulnerable species *Raja clavata* was **0.29 ±1.25,** the higest was recorded in turbot gillnets. The average value of bycatch rate for the vulnerable species *Squalus acanthias* was **0.30 ±1.29,** the higest was recorded in trap net.

Table 3. Bycatch rate for vulnerable species analyzed on fishing gears

fleet segment	6-12 m	12-18 m	18-24 m	<24 m
Dasyatis pastinaca bycatch rate (T)	pelagic trawl (OTM)			
	0.04	*2.71*	*0.04*	-
	demersal trawl (OTB, scientific)			
	-	-	-	*0.30*
	turbot gillnets			
	0.72	*0.09*	-	-
	pontic shad gillnets			
	0.02	-	-	-
	trap net (FPN)			
	1.61	-	-	-
	beam-trawl (TBB)			
	-	-	-	*0.02*
Raja clavata bycatch rate (T)	pelagic trawl (OTM)			
	-	*0.33*	-	-
	demersal trawl (OTB, scientific)			
	-	-	-	*0.22*
	turbot gillnets			
	0.52	*0.04*	-	-
	pontic shad gillnets			
	-	-	-	-
	trap net (FPN)			
	0.36	-	-	-
	beam-trawl (TBB)			
	-	-	-	-

Squalus acanthias bycatch rate (T)	pelagic trawl (OTM)			
	-	-	*0.30*	-
	demersal trawl (OTB, scientific)			
	-	-	-	*0.17*
	turbot gillnets			
	0.14	*0.45*	-	-
	pontic shad gillnets			
	-	-	-	-
	trap net (FPN)			
	0.65	-	-	-
	beam-trawl (TBB)			
	-	-	-	*0.09*

Interactions between fisheries and marine vulnerable species, in particular marine mammals, seabirds, sharks and rays, represent a global conservation issue, and mitigating the impacts of these interactions is an important step to ensure the sustainability of fisheries (Sacchi, 2021).

CONCLUSIONS

Fishing, the most widespread activity of human exploitation of the marine environment, is the activity that has several direct effects on marine ecosystems. Regarding the bycatch rate for all the analyzed vulnerable species it was highlighted that the value was very low.

In commercial fishing, the highest value of the bycatch rate - **2.70**, was recorded for pelagic trawling, the fleet segment 12-18 m, for *Dasyatis pastinaca* species and the lowest bycatch rate - **0.02** was recorded at pontic shad gillnets fishing, the fleet segment 6-12 m (boat) for the same *Dasyatis pastinaca* species. Also, the samples collected twice a month from trap nets (FPN), were analyzed and the bycatch rate of all the vulnerable species was very low, between **0.12-0.16.**

In scientific fishing, the bycatch rate was lower in beam trawl than in demersal trawl. The highest value of the bycatch rate **- 0.30**, was recorded for demersal trawling, the fleet segment >24 m, for *Dasyatis pastinaca* species and the lowest bycatch rate - **0.07** was recorded for the same species in the beam trawl fisheries, the fleet segment 6-12 m.

The captured vulnerable species were taken over and analyzed; there were no living specimens released back into the environment. Also, no other vulnerable species were identified, belonging to other groups (marine mammals, seabirds) caught in fishing gears. However, specimens of marine mammals and seabirds were observed in the area of fishing vessels activity, most likely in search of food.

Since fishing effort determines the level of commercial and incidental catch, the use of mitigation techniques must be accompanied by fisheries management measures, such as limits on fishing units and fishing gear, reductions in the duration of operations (Melvin et al., 1999), seasonal closures of sensitive areas or changes in harvesting techniques or in fishing activities (Sacchi, 2021). The different systems used to reduce bycatch of each group include gear modifications, setting strategies, acoustic, visual deterrents, and management measures.

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