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"Trash Fish" in a Small Scale Fishery: a Case Study of Nha Trang Based Trawl Fishery in Vietnam

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Abstract

This case study for small scale Vietnam trawl fisheries is the first scientific description of the trawl fishery of Nha Trang city, Vietnam. Except for its codend that is constructed from machine-made web with mesh sizes of from 1.2 cm to 2.0 cm, the wing and all other body parts of the trawl are woven by hand from synthetic fibers. Trash fish, i.e. the proportion of the catch not used for human consumption, accounted for 23% and 22%, respectively, of the total catch of the bottom pair trawling and the otter trawling fleets. However, only 8% and 11%, respectively, of the revenues of the bottom pair trawling and the otter trawling fleets were from trash fish. Catches of the pair trawling fleet were dominated by trash fish, *Trichiurus lepturus* (largehead hairtail), *Loligo* sp. and *Decapterus* sp., while the catches from otter trawling were dominated by trash fish, *T. lepturus* and Penaeidae sp. Most of the individuals from the trash fish category were smaller than 15.0 cm, except for large head hairtail. Some potential measures to reduce the catch of trash fish in the fishery are discussed.

Introduction

The Vietnamese trawl fishery has no official definition of 'trash fish'. However, in this paper, trash fish is defined as the part of the commercial catch which consists of small size individuals of desirable species or of larger size individuals that are not preferred for human consumption. Juveniles of economically favored species occur in the trash fish fraction of the Nha Trang trawl fisheries. Trash fish is used in feeds in aquaculture or as cattle fodder. As no previous studies have been published on the small scale trawl fishery of Nha Trang city and the status of the trash fish category, the present study is designed to fill this gap.

Broadhurst et al. (1997) recommended that bycatch species and the quantity and the size distributions of the species of bycatch are initial information required to improve the selectivity of any fisheries. Thus, data on the trash fish (proportion, size and species) caught in the Nha Trang trawl fishery is important for endeavors to modify trawl gears in order to increase gear selectivity.

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Nha Trang is a city in central Vietnam with a population of 400,000 residents (Directorate of Statistics of Vietnam, 2010). The city's coastline is 19 km and fishing is one of the main forms of incomes of coastal residents. There is no official definition on the water areas of the city. Local fishers use several fishing methods in the coastal areas of the city (less than 24 Nautical miles from the coastline), such as: purse seining, trawling, long-lining, trapping, gill netting and set nets (Khanh Hoa Department of Capture Fisheries and Resource Protection, 2010). Trawl fishery is the most important fishing method employed; about 40% of fishing vessels of the city are trawlers (Khanh Hoa Department of Capture Fisheries and Resource Protection, 2010). There are no official data on the catch and value of the fishery. Trawlers are from two fishing ports, Vinh Truong (VT) port in the south of the city and Vinh Luong (VL) port in the north (Fig. 1). The trawlers have a wide range of engine capacity and are divided into two trawling types: (1) otter trawlers and (2) bottom pair trawlers.

To provide the basis for future efforts to improve gear selectivity, this paper presents the study to (1) describe the trawl fishery of Nha Trang city, Vietnam; (2) investigate the species composition of the trash fish caught in the fishery; (3) assess the average length of dominant species of trash fish; and (4) study the proportions of catch categories in the fishery catch. The study was conducted by gathering information from fishers and assessing the catch of selected trawlers.

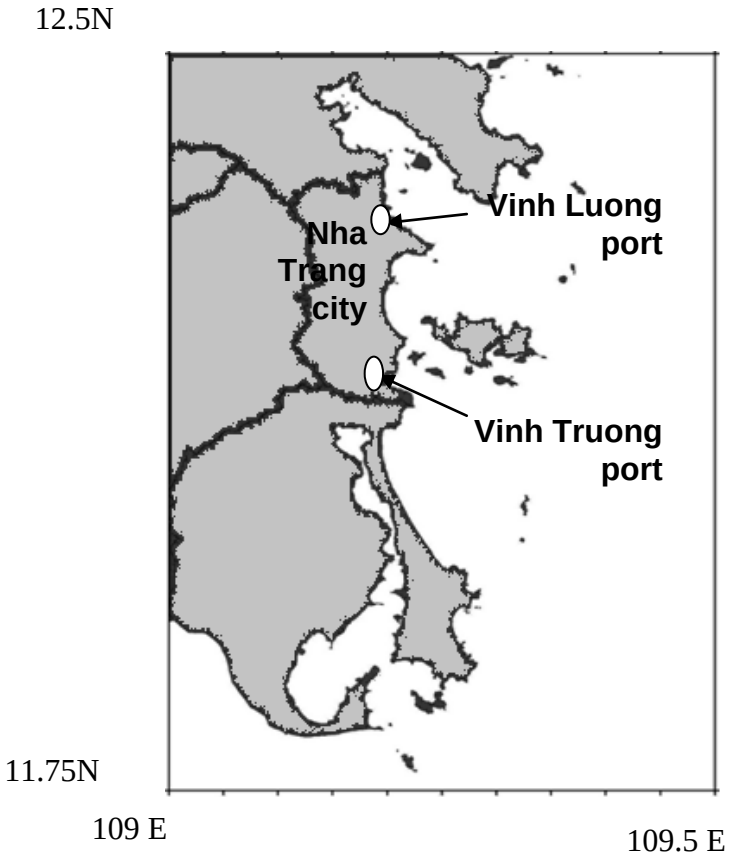

Fig. 1. Map of research site.

Materials and Methods

Nha Trang vessels are made from wood and equipped with inboard engine. Each bottom pair trawler carries from 7 to 10 fishers. The larger boat of the pair, which carries the catch and net, has from five to seven fishers and the smaller boat has two to three fishers. Each otter trawler carries three to four fishers. Typically, the owner of the boat is also the captain. The length of the vessels ranges from 12 to 15 m. The fleet can be categorized into two main groups: (1) the bottom pair trawlers with engine capacity ranging from 45 to 89 HP and (2) the otter trawlers with engine capacity ranging from 22 to 44 HP.

The fishing gear is a local modification of traditional Asian trawl gear. The bridles and sweep line are operated by hydraulic winches, while all other operations on board are manual. Catch is sorted manually into several commercial categories on board the vessel by the fishers (Table 1). Fish, shrimp and crabs are placed in plastic boxes and covered by crushed ice.

Squid is placed in plastic bags and all the bags are kept in plastic boxes covered by ice. All the boxes are kept in the holds of the vessel. In the studied fishery, there has been no discards.

Table 1. Commercial categories in catch of the Nha Trang trawl fishery.

Category	Use/deposition
Total catch	
- Squids	
- Small, medium and large size squid.	Landed, for human consumption.
- Shrimp	
- Medium and large size shrimp	Landed, for human consumption.
- Mixed fish (medium size of several fish species mixed together; selling as a whole without species sorting)	Landed, used for human consumption
- Large size fish (sorting into species and selling by species).	Landed, for human consumption
- Crab	
- Medium and large size crab	Landed, used for human consumption
- Trash fish (damaged, small size, not preferred by humans etc.)	Landed, used in feeds in aquaculture or as cattle fodder.

The Nha Trang city fishery has 403 trawlers, of which 134 vessels are bottom pair trawlers (67 trawl pairs) and the rest are otter trawlers. About 42% of the total trawlers are from VT port, of which 96% are otter trawlers. About 171 trawlers are from VL port, of which 74% are bottom pair trawlers.

The fishing grounds of the fishery are from 109° E to 109.5° E and from 11.75° N to 12.5° N (Fig. 1). Fishing depths range from 25 m up to 150 m, with the dominant fishing depth from 40 to 120 m. Fishing occurs year round except during bad weather or in first week of the lunar New Year when fishers stop fishing for New Year celebrations.

Except for the codends which are constructed from machine made net panels, trawl nets in the fishery are woven by hand by local female workers. The trawls have a two layered codend in which the whole outer layer has a stretched mesh size from 5 cm to 8 cm and the whole inner layer has the entire stretched mesh size of about from 1.2 cm to 2 cm, depending on the fishers' preferences. The mesh size of the trawl net reduces continuously from the wing (5 cm) to the codend (1.2-2 cm) (otter trawling) and from 7 cm to 9 cm at the wing to 2 cm at the codend (bottom pair trawling) (Fig. 2, Table 2). The trawl configurations are similar amongst trawls in each vessel group but they may be different in size between vessel groups (Table 2).

Table 2. Trawl configurations in the fishery **(*** Otter trawling; **: bottom pair trawling).

Engine power (HP)	Codend mesh size inner layer (cm)	Codend mesh size outer layer (cm)	Float- line length (m)	Leadline length (m)
20 - 29 *	1.0- 1.2	2.0- 4.0	16- 18	18-20
30 – 44 *	1.0 – 1.5	3.0 – 5.0	24- 26	26-28
45- <90 **	1.8 -2	5.0 - 7.0	48 – 54	40 - 42

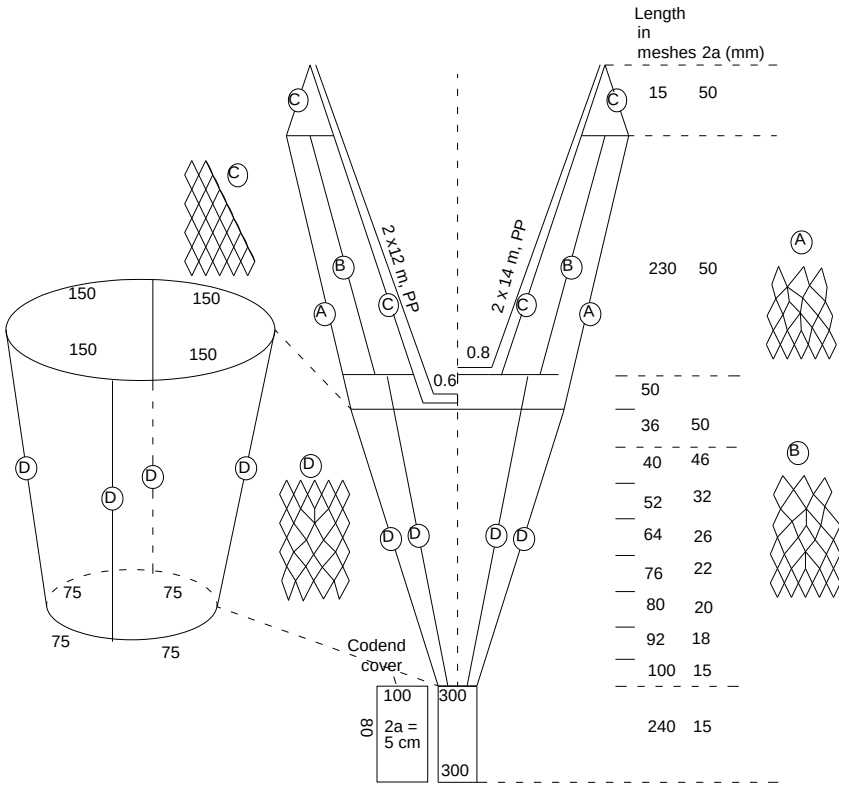

Fig. 2. Net plan of an otter – trawl net deployed by a vessel with a 45 HP engine in the Nha Trang trawl fishery.

Management of the fishery is based on technical measures. There are minimum landing sizes for several important species (Ministry of Agriculture and Rural Development of Vietnam, 2006). Minimum mesh sizes at the codend of shrimp trawl and fish trawl nets are also regulated to 2.0 cm and 2.8 cm, stretched mesh (Ministry of Agriculture and Rural Development of Vietnam, 2006). However, the regulations do not mention the number of layers at the codend of the trawl net. Trawling is prohibited in areas closer than 6 nautical miles from the coastline (Ministry of Agriculture and Rural Development of Vietnam, 2006). In addition, the total weight of 'trash fish' on each fishing trip should be less than 15% of the total catch (Ministry of Agriculture and Rural Development of Vietnam, 2006). However, monitoring and surveillance of the fishery are not conducted properly. In this study, we observed that most of the above regulations are not followed by fishers, with the exception of the zoning rules.

To determine the composition of the commercial landed catch, sales slips were collected from the owners of vessels to gather information on the weight and value of the catch per fishing trip. After each fishing trip, fishers' wives sold the catches at landing points and they were asked to write on the sale slips the information on the weights and price per kg for each catch category. From June 2010 to the end of July 2010, the sale slips were collected from five bottom pair trawlers and from eight otter trawlers.

In July 2010, 20 bags of trash fish weighing from 1.8 to 2.2 kg per bag, were collected from random otter trawlers at the Vinh Truong fishing port and examined to study their species composition and the length frequencies of the main economic species in the trash fish category. Each bag of trash fish was weighed and sorted to the lowest possible taxa. For each taxon, the following data were collected: total weight in kg, numbers of individuals, standard length (SL) to nearest 0.5 cm of each individual of fish and carapace length (CL) were measured to nearest 1 mm for shrimp. Crabs were measured as body's diameter to nearest 1 mm. Mantle length was measured to nearest 0.5 cm for school of squid.

Results

Species composition in the trash fish component of the catch

A total of 44.97 kg of trash fish were examined during this study. Cardinal fishes were the most dominant species in the trash fish with about 36% in weight of trash fish caught. Lizardfish, a commercial species, accounted for about 8% of the total trash fish. Largehead hairtail, the main target species caught by both otter trawling and bottom pair trawling, accounted for 5% of the trash fish category. Approximately 17% of the total trash fish was from low quality fish (spoiled, not whole fish or too small to sort into species) (Table 3).

Table 3. Species composition in trash fish category** and average size of dominant species in trash fish.

Family/ Species (Scientific, English name)	% by weight	Cumulative percentage	Number of specimen	Average Length (±SD)	Size range
Epinephelus spp. ,Grouper	0.29 %	0.29 %	*	*	*
Cephalopoda spp.	0.29 %	0.58 %	*	*	*
Parupeneus cyclostomus, goat fish	0.40 %	0.98 %	*	*	*
Stomatopods, mantis shrimp	0.56 %	1.53 %	*	*	*
Priacanthus macracanthus, red bigeye	1.40 %	2.94 %	*	*	*
Platycephalus indicus, bartail flathead	1.62 %	4.56 %	67	8.0 ± 2.5	5 – 14.5
Argyrops spinifer, king soldier bream	1.67 %	6.23 %	*	*	*
Portunidae spp.	1.69 %	7.92 %	280	1.5 ± 0.4	1 – 2.5
Nemipterus delagoae, delagoa threadfin bream	1.82 %	9.74 %	32	8 ± 1.6	5 - 12
Penaeidae	2.18 %	11.92 %	482	4 ± 1.3	2 - 7
Tylosurusacus melanotus, keel-jawed needle fish	2.27 %	14.19 %	*	*	*
Congresox talabon, yellow pike conger	3.07 %	17.26 %	*	*	*
Engyprosopon grandisquama , largescale flounder	4.25 %	21.50 %	297	7 ± 2.0	3 – 17.5
Trichiurus lepturus, largehead hairtail	4.89 %	26.40 %	79	30 ± 6.0	19 – 41.5
Leiognathus sp., pony fishes	6.27 %	32.67 %	481	5.5 ± 1.5	2 - 9
Johnius dussumieri, sin croaker	6.49 %	39.16 %	270	7.6 ± 1.1	3.5 - 11
Saurida tumbil , lizardfish	8.36 %	47.52 %	249	11 ± 2.0	5 – 19.5
Other (too small, spoiled or not whole fish…)	16.90 %	64.42 %	*	*	*
Apogon spp., cardinal fishes	35.58 %	100.00 %	3280	5.2 ± 1.3	2 - 8.5

*: Not sampled; **: the order of species in the table is from lowest to highest percentage by weight

Length of important species in trash fish category

Average length and length range of 11 dominant species/ families existing in trash fish were examined (Table 3). Standard lengths of most of the fish were smaller than 15 cm, except for the case of largehead hairtail where the SL was larger than 18 cm. The body diameter of *Portunidae* spp. was smaller than 3 cm. Mantle length of squid was smaller than 5 cm while the carapace length of shrimp was smaller than 7 mm.

Catch of the fishery

A total of 122 sale-slips of bottom pair trawling fleet and 160 sale-slips of otter trawling fleet were collected. Trash fish accounted for 23±22 and 22±17 (%±SD) of the catch of bottom pair trawlers and otter trawlers respectively (Table 4 and 5). However, trash fish only contributed 8±15 and 11±11(%±SD) of the total revenues of bottom pair trawlers and otter trawlers respectively (Table 4 and 5). Beside trash fish, the dominant catch categories of the bottom pair trawling fleet were largehead hairtail (27%), squid (10%) and scad fish (9%). The dominant catch categories of the otter trawling fleet were largehead hairtail (19%), several species of shrimp (10%), squid (8%) and trash crab (8%).

Table 4. Catch proportion of the bottom pair trawlers.

Species	% (by weight)	% (by value)	Species	% (by weight)	% (by value)
Crab	1%	1%	Scads	9%	6%
Shrimp	1%	3%	Squid	10%	28%
Stingray	1%	1%	Other	18%	15%
Nemipterus	1%	1%	Trash fish	23%	8%
Lizard fish	2%	1%	Largehead hairtail	27%	34%
Priacanthidae	7%	2%			

Table 5. Catch proportion of the otter trawlers.

Species	% (by weight)	% (by value)	Species	% (by weight)	% (by value)
Mixed fish	1%	3%	Trash crab	8%	5%
Leather fish	3%	2%	Shrimp	10%	12%
Crab	3%	6%	Other	19%	18%
Lizard fish	4%	3%	Largehead hairtail	19%	16%
Cardinal fishes	4%	2%	Trash fish	22%	11%
Squid	7%	20%			

Discussion

In Vietnam fisheries, the concept of "trash fish" does not mean this catch category has no value. On the contrary, a part of the fishers' income in the Nha Trang trawl fishery was from selling trash fish which has always had markets. Unlike the trawl fishery in Ghana where trash fish is delivered to the coast by transshipments from offshore/ factory trawlers to small boats (Nunoo et al. 2009), trash fish from the Nha Trang trawl fishery is landed directly from the trawl fleets and it is also a part of target catch of fishers. Most of the boats are small and operate close to the coast. The

proportion of trash fish in the catch was larger than 15%, the Vietnamese legal limit on the proportion of trash fish. Fishers are illegally retaining a large proportion of trash fish than allowed by law and they would need to improve the selectivity of their fishing gear to become legal. The preferred codend mesh size in this fishery is considerably smaller than legal mesh size. As a result, the trawl fishery is technically an "illegal fishing activity" and could be considered a threat to sustainability (Pomeroy et al. 2009). The catch of juvenile fish of economic species also risks overexploiting (Eayrs, 2007). Thus, gear changes and other measures to exclude trash fish from the trawls will help fishers to obey the regulations as well as to help the fishery to be more sustainable.

Fishers may lose a part of their income when they exclude trash fish from their trawls. However, this may be subsidized by reducing drag on the trawl net and subsequently increasing the swept area and catch of target species (Broadhurst and Kennelly, 1996, 1997; Eayrs, 2007). In addition, delaying the length at first capture by excluding under sized fish and catching them at suitable sizes would produce higher yield. Reducing trash fish will also help to reduce the sorting time (Matsushita and Ali, 1997).

Around the world, attempts to modify the trawls to improve their selectivity can be divided into two forms: (1) size selectivity where the selectivity is based on the differences of sizes and/ or shapes of target versus non- target species and (2) behavioral selectivity where the selectivity is based on the differences of behaviors between target and non-target species (Broadhurst, 2000; Sistiaga, 2010). Nha Trang trawl fishery is a multi species fishery. Thus, attempts to increase the selectivity of the Nha Trang trawl fishery needs to consider both the above types of solutions.

The codends currently used in the fishery have two layers which may restrict the opening of the codend mesh and reduce the escape of small size individuals (Matsushita and Ali, 1997).The outer layer will protect the inner layer when the codend is in contact with the seabed, which happens regularly. To overcome the issue of two layer codends, the outer layer may be modified to cover only the lower part of it. In addition, since the codend often is very close to the seabed, any modification should be on the upper part of the codend. (Broadhurst and Kennelly, 1997; Broadhurst et al. 1999; Bullough et al. 2007; Grimaldo et al. 2008).

Floats along the codend seams will enable it to stay well off the seabed, i.e. reduce the need for protecting covers. Change of the codend construction will also be a possibility. Square mesh codends and codends with T-90 meshes are known to be more stable during the fishing operation (Sistiaga, 2010).

The idea of trash fish exclusion from trawl gear may be rejected since there is worry on the dependency of poor people on trash fish for human consumption (FAO, 2005). In addition, Peter et al. (2004) found that part of trash fish was used for human consumption or for producing fish sauce in Vietnam. However, the study of Peter et al. (2004) also covered the trash fish from purse seine fishery which caught a lot of anchovy, a favorite fish of Vietnamese and a main material for fish

sauce production. Anchovy is only used as feeds in aquaculture in the peak season when the supply of the fish is higher than the demand for fish sauce production and human consumption. The trash fish in NhaTrang trawl fishery is only used for livestock feeds or feeds in aquaculture.

Conclusion

The paper presents the current status of trash fish caught by a small scale trawl fishery in Vietnam. Trash fish accounts for a part of incomes of fishers and should not be thought as worthless in small scale fisheries. The average proportion of trash fish caught by trawlers in the fishery is higher than the legal proportion of trash fish. The study investigated the species compositions and average length of economic species in the trash fish category. There are species of economic importance, such as: lizard fish, largehead hairtail, mantis shrimp, *Leiognathus* spp. These species are smaller than the legal sizes and if they are released from the trawl gear, the escaped specimens will benefit the fishers in the future.

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