# Impacts of traditional shore seine operation along the Tuticorin coast, Gulf of Mannar, southeast India

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*Fishing pressure on marine ecosystems has increased drastically all over the world, especially in developing countries and particularly in India. Shore seine, a traditional fishing method, involves bottom trawling which makes huge impact on the ecosystems and consequently on fishing yield. It was observed that important habitats such as seagrasses and coral reefs are affected severely by this shore seine operation. Most of the catch was observed to be juvenile in nature or very small in size. Immediate measures are needed to check this operation by creating awareness among the fishermen coupled with providing alternative livelihood options.*

**Keywords:** By-catch, juveniles, livelihood, mesh size, shore seine.

INCREASING intensity of fishing throughout the world has had impacts on the target species and their supporting marine ecosystems. In an ideal world, fishing would be subject to effective management regimes which would ensure that exploitation of the resources is sustainable in the long term, both from the perspective of the ecosystem and from a socio-economic point of view[1]. In the real world, management of fisheries has been notoriously ineffective, fishery practices have rarely been sustainable, and the present status of fisheries in the world might still be best described as too many people chasing too few fish[1,2]. This scenario fits perfectly well in developing countries in Asia, as fish and fisheries have been an integral part of the socio-cultural and economic fabric of these ancient Asian civilizations.

Tuticorin is a traditional fishing town in the southeast coast of India which has now transformed to a modernized fishing town with all the mechanized crafts. Around 1890, trawler fishing developed in Europe and over the years this technology was transferred to India. The Government of India realized the need for an expanding fishery to provide an inexpensive protein source to improve the health of its poor people. The traditional fishermen started to mechanize their traditional crafts with low-power outboard engines, which has been facilitated by the Government[3]. Though mechanization is almost 100% in Tuticorin, an important traditional fishing system called shore seine is still in operation as this does not demand heavy cost and long travel.

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Shore seines are beach seines operated in the inshore waters which have been commonly used for ages and are locally called 'karai valai'. These gears are operated near or close to the shoreline areas (hence the name karai valai; karai in the local language means shore). Shore seine is practised in many coastal villages along the Indian coast and the operation has state-to-state and region-to-region differences in terms of terminology and mode of operation[4]. There have been few studies which have explained the design, operation, fishery and economy of shore seine operation in India[5–8]. However, the impact of shore seine operation on the environment has not been explained elaborately. In the Tuticorin coast, shore seines are regularly used by the people of Thalamuthunagar, Thirespuram, Vellapatti, Tharuvaikulam, Inigo Nagar and Mullukambi fishing villages. The impact of shore seine on the marine resources is immense, as it involves bottom trawling. Whether mechanized or manual, bottom trawling is detrimental to the marine ecosystem. The bottom trawls are designed to tow along the seafloor which crush, kill and bury the benthic fauna and expose them to predators. It causes physical and biological damages that are irreversible and extensive[9].

Though culture fishery is increasing day by day, the need of capture fishery is inevitable considering the increasing population and increasing demand for protein. Decline in fishery resources is a global phenomenon. Several factors have brought global fisheries to the present plight; they range from uncertainties in stock assessments, overcapitalization, open access and common pool fisheries, shifting baselines, deterioration of coastal habitats, rapid expansion of unsustainable aquaculture enterprises to increasing consumption rates[9]. Shore seine has been quoted as an eco-friendly fishing operation and

is recommended to be encouraged[7]. Though the operation is relatively safer compared to the mechanized trawlers, the destruction due to this system is highly significant as important resources like corals and seagrasses are available mostly near the shore in the Gulf of Mannar. The present study was undertaken to analyse the impact of shore seine operation along Tuticorin coast, and the socio-economic status of the dependant fishermen.

## Materials and methods

The present study was carried out between June 2012 and May 2013 in Tharuvaikulam, Vellapatti, Thalamuthunagar, Thirespuram, Inigo Nagar and Mullukambi fishing villages (Figure 1). Ten respondents from each village who thrive on this operation were selected based on their experience who were 20–70 years of age. Verbatim, accounts of stories, anecdotes or personal biographies told by informants were recorded initially during June 2012. This method provided descriptive, qualitative information while giving the informants the flexibility to present the information in their own way.

Targeted fish landing data were also collected from all the six villages. Shore seine operation is not carried out on a daily basis and we were informed about the operation by the fishermen themselves after the initial survey. Maximum of 15 days of shore seine operation was witnessed in Thirespuram village in a month. In some villages shore operation happened only once or twice in a month. Total weight of the whole catch of each operation was taken as such and weight measurement was done with the traditional weighing machine used by the fishing traders. The catch does not go to the regular landing centres; specific traders visit the place of the catch to buy them whenever the operation is done. Weight of each fish category was measured using a weighing machine with the help of the fishermen and traders. Underwater photographs of shore seine operation were taken while scuba diving using underwater digital camera; video documentation was also done.

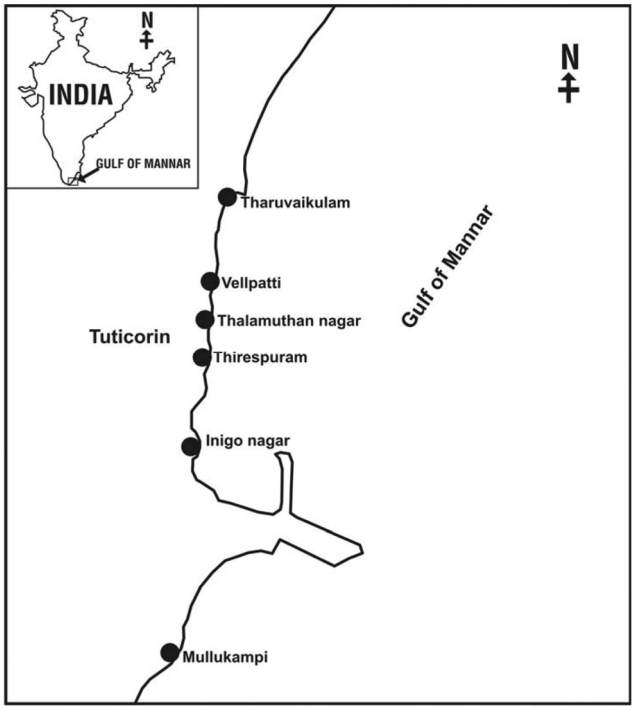


**Figure 1.** Map showing the study area.

## Results

Shore seines in the Tuticorin region are operated near or close to the shore at maximum depth of 3 m. Mesh size of these seines ranges from 10 to 50 mm. A boat (mechanized or not) is used in an area about 1 sq. km near the shore. The seine is laid vertically as the bottom is sunk using weights such as big stones or iron balls, and the surface is made to float using buoys. Two ropes attached to the corners of the seine are placed on the shore for manual dragging. After laying the seine, it is pulled to the shore using the ropes by 7–10 fishermen on each side. While the seine is pulled from the shore, the net sweeps everything from the seafloor. Since the seine is laid vertically from the bottom to the surface, the fish cannot escape and will be eventually dragged ashore. Normally shore seine operation starts early in the morning around 5 am and will be completed by 8 am. Segregation of collected fish is mostly done by the fisher women. Table 1 provides details of shore seine operation in each village.

Generally fishermen from each village use the shores nearby for the shore seine operation. However, sometimes they migrate to other areas for the operation. Fishermen from Thirespuram, Thalamuthunagar and Vellapatti and Tharuvaikulam villages sometimes use nearby Vaan, Koswari and Kariyachalli islands for the operation, though trespassing has been prohibited. Shore seine operation is done inside the Tuticorin fishing harbour by people of Inigo Nagar village. Apart from a few fishermen, others switch to the shore seine operation during the rough weather season or fishing ban season. Such operations, which require 15–20 people, are not carried out every day because most fishermen are also involved in other fishing activities or work as labourers in mechanized trawlers. The fishermen mentioned that there was no significant decline in the amount of catch over the years, but added that they used to catch big fish in shore seine in the earlier days. Income from a single operation ranges from Rs 200 to Rs 25,000 according to the catch and is shared by the people involved. Their target species include sardines, anchovies, needle fishes, snappers, silver bellies, carangids, mullets, cephalopods, crabs and shrimps. By-catches and fingerlings caught in the shore

**Table 1.** Details of shore seine operation in Tuticorin coast between June 2012 and May 2013

| Village | No. of crafts | No. of fishermen involved | Fishing ground | Fishing season | Total catch (kg) |
|---|---|---|---|---|---|
| Mullukambi | 15 fibre boats and 20 vallams | 300 | Mullukambi shore | May–August | 120,624 |
| Thirespuram | Four vallams | 60 | Thirespuram, Thalamuthunagar, Vaan Island | Throughout the year | 189,674 |
| Thalamuthunagar | 15 fibre boats and four vallams | 100 | Thalamuthunagar, Vaan and Koswari islands | May–August | 78,803 |
| Inigo Nagar | Four fibre boats | 50 | Inigo Nagar, fishing harbour | Throughout the year | 195,120 |
| Vellapatti | Two fibre boats | 20 | Vellapatti, Vaan and Koswari islands | Throughout the year | 188,625 |
| Tharuvaikulam | Six fibre boats | 80 | Tharuvaikulam, Vaan Koswari and Kariyachalli islands | Throughout the year | 181,668 |

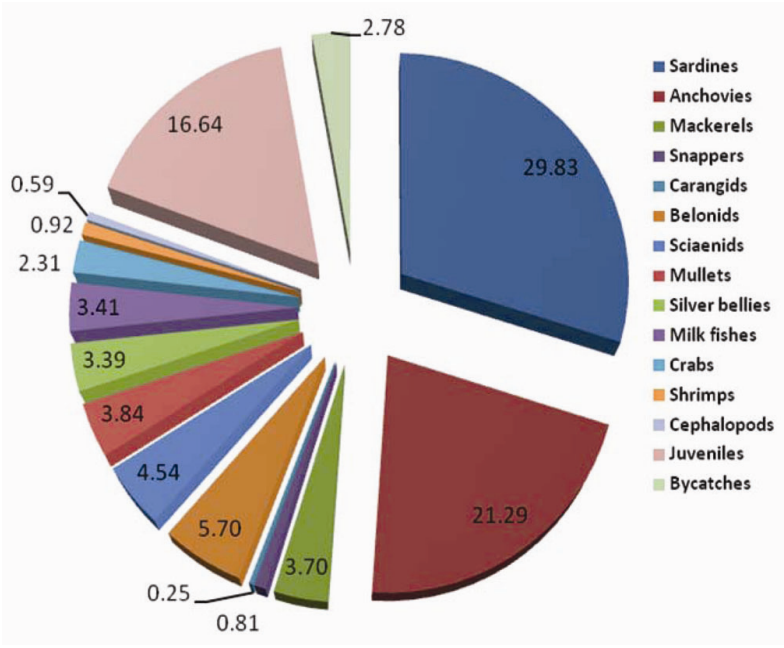


**Figure 2.** Overall proportion of each category in Tuticorin region, southeast India.

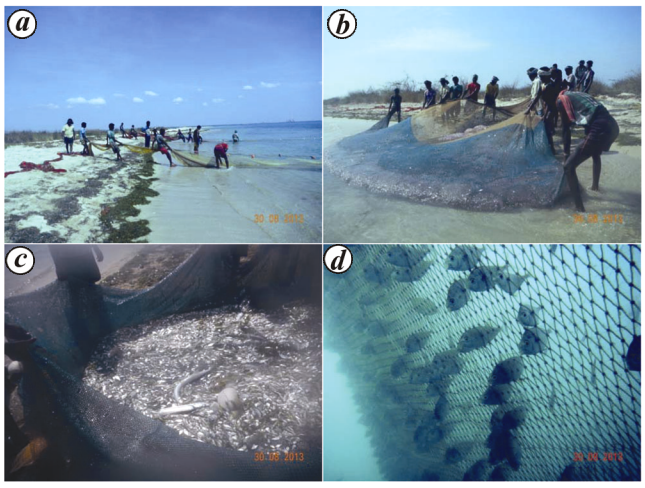


**Figure 3.** Shore seine operation in Tuticorin region. ***a***, ***b***, Fishermen involved in the shore seine operation. ***c***, Total catch of single shore seine operation. ***d***, Underwater image of the operation.

seine are thrown on the shore. By-catches of this operation include sponges, star fishes, sea cucumbers, sea horses, coral rubbles, seagrasses, mollusks, ascidians, sea anemones, etc.

The overall catch through shore seine operation in Tuticorin region was 951,513 kg with sardines and anchovies being the dominant catch with 283,793 and 202,603 kg respectively (Figures 2 and 3). Mullukambi village uses the shore seine system dominantly compared to other villages in Tuticorin. A total of 120,624 kg of fish was caught through shore seine in this village between June 2012 and May 2013. Thirespuram is the biggest fishing village in Tuticorin region; a total of 189,674 kg of fish was caught here through shore seine operation during the study period. In Thalamuthunagar village, a total of 78,803 kg of fish was caught while in Inigo Nagar village, a total of 195,120 kg of fish was caught during the study period. In Vellapatti village, a

**Table 2.** Overall landing of each category between June 2012 and May 2013

| Category | Mullukambi (kg) | Thalamuthunagar (kg) | Thirespuram (kg) | Vellapatti (kg) | Tharuvaikulam (kg) | Inigo Nagar (kg) |
|---|---|---|---|---|---|---|
| Sardines | 43,683 | 28,646 | 51,983 | 66,657 | 51,672 | 41,154 |
| Anchovies | 26,779 | 11,646 | 40,468 | 54,126 | 38,528 | 31,056 |
| Mackerels | 2,274 | 2,222 | 8,026 | 7,323 | 5,125 | 10,246 |
| Snappers | 389 | 878 | 1,501 | 777 | 3,395 | 803 |
| Carangids | 643 | 346 | 615 | 407 | 193 | 188 |
| Belonids | 809 | 2,007 | 4,401 | 4,452 | 20,457 | 22,077 |
| Sciaenids | 1,548 | 2,612 | 9,211 | 7,741 | 8,036 | 14,045 |
| Mullets | 2,695 | 2,986 | 10,990 | 3,002 | 9,437 | 7,438 |
| Silver bellies | 11,042 | 6,842 | 4,134 | 2,107 | 4,248 | 3,846 |
| Milk fishes | 12,012 | 2,826 | 7,449 | 2,238 | 4,810 | 3,110 |
| Crabs | 623 | 2,429 | 2,142 | 4,215 | 3,567 | 9,051 |
| Shrimps | 1,649 | 278 | 1,407 | 1,457 | 1,070 | 2,875 |
| Cephalopods | 448 | 438 | 1,956 | 767 | 465 | 1,565 |
| Juveniles | 11,962 | 12,002 | 38,035 | 30,416 | 26,789 | 39,129 |
| By-catch | 4,070 | 2,645 | 4,358 | 2,941 | 3,878 | 8,537 |

**Table 3.** Mean catch of each category per month between June 2012 and May 2013

| | Avg ± SE (kg) | | | | | |
|---|---|---|---|---|---|---|
| Category | Mullukambi | Thalamuthunagar | Thirespuram | Vellapatti | Tharuvaikulam | Inigo Nagar |
| Sardines | 3640 ± 1746 | 2387 ± 1224 | 4332 ± 617 | 5555 ± 701 | 4306 ± 466 | 3429 ± 549 |
| Anchovies | 2232 ± 1054 | 971 ± 479 | 3372 ± 984 | 4511 ± 391 | 3211 ± 542 | 2588 ± 519 |
| Mackerels | 189 ± 99 | 185 ± 97 | 669 ± 151 | 610 ± 73 | 427 ± 66 | 854 ± 104 |
| Snappers | 32 ± 16 | 73 ± 47 | 125 ± 43 | 65 ± 27 | 283 ± 109 | 67 ± 33 |
| Carangids | 54 ± 34 | 29 ± 23 | 51 ± 34 | 34 ± 11 | 16 ± 15 | 16 ± 7 |
| Belonids | 67 ± 41 | 167 ± 84 | 367 ± 74 | 371 ± 51 | 1705 ± 100 | 1840 ± 387 |
| Sciaenids | 129 ± 80 | 218 ± 113 | 768 ± 152 | 645 ± 73 | 670 ± 190 | 1170 ± 172 |
| Mullets | 225 ± 130 | 249 ± 124 | 916 ± 227 | 250 ± 81 | 786 ± 212 | 620 ± 99 |
| Silver bellies | 920 ± 715 | 570 ± 287 | 344 ± 135 | 176 ± 89 | 354 ± 76 | 321 ± 62 |
| Milk fishes | 1001 ± 498 | 235 ± 119 | 621 ± 93 | 187 ± 63 | 401 ± 70 | 259 ± 78 |
| Crabs | 52 ± 24 | 202 ± 104 | 178 ± 21 | 351 ± 42 | 297 ± 48 | 754 ± 217 |
| Shrimps | 137 ± 69 | 23 ± 12 | 117 ± 34 | 121 ± 14 | 89 ± 26 | 240 ± 31 |
| Cephalopods | 37 ± 20 | 37 ± 20 | 163 ± 47 | 64 ± 11 | 39 ± 13 | 130 ± 28 |
| Juveniles | 997 ± 575 | 1000 ± 506 | 3170 ± 351 | 2535 ± 207 | 2232 ± 307 | 3261 ± 387 |
| By-catch | 339 ± 161 | 220 ± 110 | 363 ± 86 | 245 ± 39 | 323 ± 47 | 711 ± 93 |

total of 188,625 kg of fish was caught, while in Tharuvaikulam village, a total of 181,668 kg of fish was caught through shore seine. Sardines and anchovies were the dominant categories in all the surveyed villages. Table 2 shows the overall landing of each category during the study period. Table 3 shows the monthly mean catch of each category.

## Discussion

Fishing is the most widespread human exploitative activity in the marine environment[10] and is also a major form of ecological disturbance to marine communities throughout the world[9]. Many marine habitats are sensitive to fishing activities, and such habitats play a vital role in the life cycle of commercially important species. Hence, habitat destruction will be certainly followed by depletion in fishery[11]. The use of destructive fishing gear is a major cause of habitat deterioration, and in recent years, there has been a large and growing research emphasis on the physical effects of different gear types on different habitats[10,12]. It has been reported that bottom trawling is the most damaging fishing activity[9,10], whether mechanized or not. Trawling primarily reduces the surface roughness of the seabed[13] and destructive harvesting by bottom trawls could potentially reduce future harvests through destruction of essential habitats for commercial species or their prey[11]. Shore seines are said to be the least likely gear to maintain sustainable yields in artisanal fisheries[14,15], and are referred to as a destructive gear[16]. Beach seine use can severely degrade the condition of the resource, resulting in lower overall fishery yields[9,11]. It is obvious from this study that there is a huge impact on the

habitats due to shore seine operation and eventually on the fishery resources and ultimately on the livelihood of the dependant people.

The Gulf of Mannar is bestowed with dynamic ecosystems like corals and seagrasses which are the prime reason for its productivity. Seagrasses are responsible for creating a characteristic community in which they form the bulk of the biomass and most of the other organisms of the community depend on their presence in various ways[17]. The Gulf of Mannar is bestowed with wealthy seagrass meadows especially near the shore where shore seine operation is carried out intensively and hence are getting severelly affected. Trawling impacts seagrass beds by suspending the sediments and directly damaging vegetal mass. Apart from seagrasses, seagrass inhabitants such as sea anemones, ascidians, sea cucumbers, sea horses, star fishes, sponges, etc. are brought ashore by the seine where they are simply thrown away. It has been estimated that in Kerala a mammoth 45% of the catch was by-catch during 1997 (ref. 7). It has been observed in the present study that about 26,427 kg of by-catch were wasted in Tuticorin region, i.e. 2.78%. Though the contribution of by-catch seems to be smaller, the discarded organisms include threatened animals such as sponges, sea horses and sea cucumbers whose hunting is banned according to the Wildlife Protection Act 1972. By-catch and their consequent discard have been and continue to be one of the important issues in fisheries management over the years. Discarding the by-catch is considered a threat to protected species, and a waste of fisheries resources, it also degrades the health of marine ecosystems. Moreover, food web of the ecosystem is getting severely affected.

Bennet and Armugam[6] have reported that shore seine had yielded an annual average catch of 609 tonnes between 1987 and 1991 along the Tuticorin coast. It is interesting that the present study has recorded a comparatively higher annual yielding of about 952 tonnes in the Tuticorin coast. The fishermen, however, complain about the big fish they used to catch earlier. The total landing along the Tuticorin coast through shore seine was 951,512.9 kg, with sardines and anchovies being the dominant catch (29.83% and 21.29% respectively). Both sardines and anchovies are less than 10 cm in size. They are utilized by the fishermen, and hence not included in the juvenile category. Apart from these two, the major contributor was juvenile landing with 16.64%. Juveniles of all the other species are included in this category and these little fish are simply thrown on the beach and not utilized. Mangi and Roberts[18] have reported 68.4% of fingerlings in shore seine operations in Kenya. In the Kerala coast, Sathiadhas and Narayanakumar[7] reported that about 40% of the shore seine catch was juveniles. In a recent study in Kerala, it has been reported that about 76.7% of the post-monsoon catch was juveniles[19]. Similarly, in the present study upon including the utilizable sardines and anchovies along with the thrown juveniles, the total juvenile landing reaches 67.76%. The high landing of juvenile fish can be directly attributed to the mesh size used in the seine. Beach seines with small mesh were found to be responsible for the highest quantity of juvenile landing in Kenya[18]. Seines of almost the same mesh size are used in Tuticorin region, causing severe damage. It is interesting that beach seine operation has been banned in Kenya since 2001 (ref. 4).

Most of the juveniles discarded are commercially important species and if left to live, they would certainly give significantly higher yields in the future. According to Venkatachalam[3], there has been a definite and steady decline in marine fishery in Tuticorin region after it reached a peak in 1989. A main reason for this is the use of nets which have a small mesh and thus end up catching juveniles[3]. Fishermen themselves admit that fishery resources have reduced significantly over the years. Reduction in the capture of undersized fish and smaller non-target species can be accomplished using mesh size regulations[20]. Another important concern in Tuticorin region is that shore seine operation is used even in prohibited islands where corals are found. Coral mining (which was happening until 2004) has already degraded the pristine reefs of the Gulf of Mannar[21]. Corals are recovering after 2004 Indian Ocean tsunami[22]. Shore seine operation in the islands indicates that there is no possibility of new recruits in the dragging area. Since dead corals which are the base for new coral recruits are dragged ashore, the area is incapable of coral recruitment.

The fishermen involved in shore seine operation in the Tuticorin region are those who cannot afford to buy big mechanized crafts. The use of destructive gears like beach seines is generally made by poor fisherman[16] and this is being witnessed in Tuticorin as well. Bennet and Armugam[6] reported that the fisherman who operated shore seines from harbour point (Mullukambi) earned about Rs 400–700 per month per family during 1990s. They were working for daily wages under shore seine owners during 1990s[6], but now they own boats and collectively earn between Rs 200 and 25,000 per shore seine operation. Observations from this study clearly indicate the ill-effects of shore seine operation in the Tuticorin region. If this operation is not checked, it is more likely that fishing yield of the region will further deteriorate. Mesh size of the seines has to be seriously looked into. However, considering the economic status of the dependant fishermen, it would be difficult to ban them from continuing shore seine fishing. A similar scenario prevailed with coral miners before the 2004 Indian Ocean tsunami. However, miners voluntarily stopped coral mining with awareness of the protection provided by coral reefs during the tsunami, and provision of alternative livelihoods supported by the Government. Likewise, awareness should be created to the shore seine operators about the impacts of the operation and its consequences. More

importantly, alternative livelihood options should be provided to them in order to completely eradicate this ecologically and economically devastating fishing activity.


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