Harvest of associated wild-fish assemblages in estuarine cage farms: Implications for farm management and livelihood

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Sea-cage farms form attractive habitats for wild-fish populations as they directly provide food-chain support to the fish community through excess feed and organic wastes from the sea cages. They also support wild-fish assemblages indirectly by enhancing plankton productivity and providing substrate for biofouling communities. In cage-farming operations, the farmers realise the major share of the revenue at the end of the farming season during harvest of farmed fishes. Aqua-farmers in Karnataka engaged in farming fishes in cages effectively utilized such ichthyofaunal aggregations around net-cages. This study was conducted at Yedamavinahole, Karnataka where seabass (*Lates calcarifer)* was reared in rectangular cages. Modified shore seines known as '*Iliyabalae*', which are commonly operated near rocky areas for finfishes and shellfishes, in the region are used for harvesting the wild-fish assemblages in the close proximity of fish cages. Details of gear, fishing operations, the composition of wild-fish around the net-cages and average income generation from the *Iliyabalae* operations are presented.

Two variants of the *Iliyabalae* including the regular seine, with single panel of net and a modified seine with three layers of net panels (covered *Iliyabalae)* are operated. The former net consists of a rectangular panel measuring 36-50 m in stretched mesh length and 2.5-6.0 m in width The netting consisted of monofilament (nylon) knotted diamond meshes (52-60 mm when stretched), having uniform twine size. Cork floats of 9.5 cm diameter, having 2 cm thickness are fixed to the head rope (polypropylene rope, 6 mm diameter) at 1.8 m intervals. The sinkers measuring 38-39 mm in length and 8.5-8.8 mm in width, having 30-49 g weight are fixed at 30 cm interval to the sinker line (2 mm polypropylene rope). The sinker line is mounted to the foot rope of 3 mm diameter (polypropylene). A flexible ring measuring 20 cm in diameter, comprised of a 16 mm polypropylene rope, wrapped with cotton ribbon, is attached to the ends of the foot rope for dragging the net.

Iliyabalae (single panelled) with rope ring attached to the foot rope

The *covered Iliyabalae* has three net panels, attached to a headrope of 2.5 mm in diameter.The inner net panel of 50 mm stretched mesh is sandwiched between two net panels consisting of 70 mm mesh on one side and 80 mm mesh on the other. The outer net panels are attached with a 1.5 mm rope on top and all the three panels are mounted together on the head rope. It is relatively smaller in dimensions due to the heaviness of the three panel-webbing and measures about 43 m in length and 4.5 m in width. The cork floats of 78 mm diameter and 21 mm thickness, are mounted to the head rope at 2 m intervals. More number of sinkers per unit of sinker lines at an interval of 15 cm are used in c*overed Iliyabalae*.

Fishing operation with '*Iliyabalae*' is a skilled activity engaging 2-3 expert skin divers. The net is encircled around the floating net-cages taking care to exclude the anchor line. Once the net is positioned in water, the floats are manually pushed

Table 1. Economics of fishing operations

Parameter	Iliyabalae (Net 1)	Covered Iliyabalae (Net 2)
Cost of Net (₹)	3,250 ± 350	4,250 ± 283
Labour cost for net fabrication (₹)	1,125 ± 177	1,900 ± 141
Yield per operation(kg)	20.0 ± 7.1	25.0 ± 7.1
Monthly income (₹)	12,500 ± 7,071	17,500 ± 4,950

below the cages by diving and dragged along with the sinkers so as to cover the entire water area beneath the installed cages. Operations are restricted to dawn or dusk, coinciding with the occurrence of low tides. The use of large meshed (>50 mm) nets inevitably avoids harvest of juveniles. However, when smaller fishes get entangled in the *covered Iliyabalae* they are salvaged live and used as stocking material (captured based aquaculture) for farming in estuarine cages during August-October and February- March. The *Iliyabalae* operations are carried out under each individual cage at fortnightly intervals.

The common fishes represented in the catch from the nets were *Lutjanus argentimaculatus, L. johnii, L. russelli, Gerres filamentosus, Sillago sihama, Liza* sp., *Etroplus suratensis, Caranx sexfasciatus, Scatophagus argus, Epinephelus epistictus, Platycephalus indicus, Siganus vermiculatus, Arius* sp., *Lates calcarifer* and the mud crab *Scylla serrata*. Estimates of wild-fish harvest ranged from 15 to 25 kg by single panel *Iliyabalae* (Net 1) and 20 to 30 kg by *covered Iliyabalae* (Net 2).

Since the farmed stocks were fed mainly with trash fish, the carnivorous wild-fish were

Table 2. Positive impacts of fishing operation and wild-fish attraction to cage farms on the environment and economics

	Factors	Impacts (positive)
Wild-fish assemblages (Family) involved	***Feeding activity by finfish*** • Lutjanidae • Gerreidae • Serranidae • Carangidae • Centropomidae • Platycephalidae • Ariidae • Sillaginidae • Portunidae	Reduces environmental footprint of finfish farming in cages by the removal of excess feed waste
	Scavenging by finfish • Cichlidae • Scatophagidae	Reduces organic input to the substratum/ sediment under the cages by physically increasing faecal pellet settlement time. Facilitates leaching of nutrients from feed/ faecal waste into water column.
	Feeding activity by finfish • Mugilidae	Decrease the anoxic conditions of sediments beneath farms by bioturbation while feeding.
Fishing operation	***Seining operation under the cage***	Dispersal of waste and sediment management, thus circumventing fallowing of cage culture site.Collection of undersized fishes as stocking material for cage farming and recapture of escaped fish possible.
	Economics	Additional income generation apart from cage aquaculture.

predominant in the catch, taking advantage of lost food and possibly preying on the aggregations of smaller fish. The persistent input of artificial feed in cages and the accumulated sedimented waste under fish cages can adversely affect the sediment quality by creating anoxic conditions. The potential positive impact of fishing operation and wild-fish attraction to cage farms on the environment and the economics of *Iliyabalae* is given in Table 2.

Dispersal of waste and sediment management strategies followed in cage-farming include using submerged electrically driven mixers to flush waste from beneath the cage or fallowing of cage culture sites. By adopting seining operation under the cages as described above controlling waste accumulation is possible and the additional income generated by the fish catch is an added advantage.