2.6 Identifying appropriate length-based indicators (LbI) and an alternative fishing gear application for giant freshwater prawns to achieve the preferred size of first capture

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Abstract

The recently introduced GFP (*M. rosenbergii*) in Sri Lanka's CBF reservoirs is becoming a high-valued CBF product with export potential by providing a high margin income to fishers. Extensive stocking of GFP is done together with tilapia and carp species and regular stocking of carp and GFP is necessary for the development of CBF in reservoirs as they do not breed naturally in Sri Lankan reservoirs. Therefore, some length-based indicators (LbI) are not appropriate for assessing the current status of Sri Lankan CBF irrigation reservoirs and this study was conducted to determine the optimal sizes of first capture and the sizes of consume acceptability of CBF species rather than using exploitation status. Length-weight sampling was conducted from January 2023 to December 2024 in selected perennial irrigation reservoirs and the results showed that the capture of undersized species (below marketable size: L_{MK}) reached maximum up to 30%, 36%, 30% and 60% for *O. niloticus, L. rohita* and *M. rosenbergii* male and female, respectively. To avoid undersized GFP at the landing sites, an application of trap size selectivity using experimentally selected opera house trap (OHT) was also conducted at Vendrason reservoir, Kantale, Sri Lanka. The experiment included treatments with 8 cm, 11 cm and 13 cm diameter aperture size and deployed in 24 hours, and the results showed that the highest catch per unit effort (CPUE) (0.038 kg hr^{-1}) and mean weight (0.69 kg) were recorded for 13 cm and 11 cm diameter OHT, respectively.

***Keywords**: culture-based fishery, Macrobrachium rosenbergii, length-based indicators, marketable size length, opera house trap, catch per unit effort*

Introduction

Sri Lanka is a good example of R&D efforts on CBF, which generate significant secondary employment and income opportunities for the Sri Lankan fisheries economy. In Sri Lanka's CBF reservoirs, extensive stocking is done mainly for tilapia species, carp species and GFP (*M. rosenbergii*); recently introduced species. For the development of CBF in reservoirs, regular stocking of carps and GFP is necessary as they do not reproduce naturally in Sri Lankan reservoirs. It has also been reported that in many reservoirs in the country, where the genetically improved farmed tilapia (GIFT) strain of *O. niloticus* (Nile tilapia) has been intensively stocked, yields have declined significantly, and the harvested fish are of poor quality. This may call for rebuilding tilapia stocks in reservoirs by stocking pure Nile tilapia and reducing the existing poor quality GIFT strain through heavy exploitation. Extensive stocking of GFP with carp and tilapia in dry zone reservoirs has been done but the prawn yields have been negligible and there is a large gap between the high stocking density of GFP and the yield captured because of relatively low recapture rates (De Silva et al. 2006).

Studies on the population dynamics and stock assessment of target species of fisheries are therefore imperative to sustain their fisheries and benefits to society. It has also been shown that GFP dynamics cannot be assessed in isolation and that the effects of the dynamics of stocked finfish species must be an integral part of a complete understanding (Jones et al. 2021). It is therefore a fact that LbI as suggested by Cope and Punt (2009) and Froese (2004), that is, Indicator 1: 'Let them spawn'; Indicator 2: 'Let them grow' and Indicator 3: 'Let the mega spawners live', are not appropriate to assess the current status of CBF in Sri Lankan irrigation reservoirs. Therefore, the conventional means of optimising fishing strategies through stock assessment approaches are irrelevant. Instead, such stock assessment approaches can be applied to make recommendations on the preferred sizes of first capture, which have consumer acceptability.

Currently under the legal provisions of the Fisheries and Aquatic Resources Act (1996) fishing gear is restricted to gillnets with a mesh size greater than 8.5 cm as part of the management of CBF, and they are targeted at the finfish species including tilapia and carp. Although the potential of CBF for GFP in Sri Lanka's reservoirs is high, the full potential is not being realised as by-catch in finfish fisheries. GFP are caught in the gillnets, although there is a high incidence of damage to the prawns, which reduces their value. It is believed by fishers that GFP could be caught more effectively and with less damage, if a specific gear was used to target the prawns. Traps are used to catch GFP in other Southeast Asian countries such as Thailand, Cambodia and Vietnam are rarely used in Sri Lanka, and the practice is limited to a few fishers in some districts, and use is seasonal (Jutagate and Kwangkhang 2015). This is probably due to fishers' inexperience with GFP and lack of exposure to trap types that could be used. Therefore, there is precedent and technologies that can be applied in Sri Lanka to increase GFP capture.

This paper investigates the optimal sizes of first capture and sizes of consumption acceptability of GFP, carp and Nile tilapia in selected perennial irrigation reservoirs of Sri Lanka using length-based stock assessment procedures, with a view to identifying appropriate LBI and an alternative gear application for GFP to ensure sustainability of CBF in Sri Lanka.

Materials and methods

Length data were obtained by measuring the carapace length, total length, major cheliped length of each GFP, and standard length and total length of finfishes to the nearest 0.1 cm using a tape measure at the local landing centres in 5 reservoirs – Ridiyagama (871 ha), Vendrason (410 ha), Urusita-wewa (262 ha), Karawitagaraya (256 ha) and Kottukchchiya wewa (70 ha) – for stock assessment of *M. rosenbergii*, *L. rohita* and *O. niloticus*. Body weights of all species were also measured to the nearest 0.1 g using a portable scale at the landing site, and sampling was conducted monthly from January 2023 to December 2024. Length-frequency data were analysed using the FAO–ICLARM Stock Assessment Tool (FISAT) to estimate von Bertalanffy growth parameters, mortality rates and exploitation levels. Length at first capture (Lc) was subsequently derived from length-converted catch curves.

Length-weight relationships (LWR) of 3 species categories were determined and average marketable size weight (Wmk) values collected from landing sites and fisher data were converted to marketable size/consumer acceptable length (L_{MK}) using LWRs. The frequencies of fish and GFP smaller than L_c and L_{MK} in the cumulative length frequency samples and time required to grow up to L_c and L_{MK} (in months) were determined.

Initially, a survey was carried out to understand GFP behaviours along with the gear approach at Wayamba University of Sri Lanka using different traps including OHT, a circular crab pot and a cylindrical cane trap (common rattan) and the experiment was conducted in a fibreglass tank aquarium using 10 GFP (male:female = 1:1). After comparing the trap interaction of GFP, the selected OHT was demonstrated to evaluate the gear efficiency of capturing GFP together with an umbrella-shaped trap, which was already imported from Thailand and modified as according to use in Sri Lanka iIrrigational reservoirs. This field activity was conducted in a selected medium-size reservoir, Vendrason wewa, Kantale (410 ha), which already had a high potential of GFP harvest. Each trap was deployed for 24 hours and CPUE was determined to evaluate gear efficiency. Finally, recommendations were made for sustainability of CBF in reservoirs.

Results

LbIs to make recommendations on the preferred sizes of CBF species

Length-based stock assessment results indicated that *O. niloticus* (tilapia) was underexploited in all 5 reservoirs (E<0.5; Table 2.6.1). There is also evidence that the stocking of carelessly selected GIFT strain of *O. niloticus* over about a decade has degraded the quality of the Nile tilapia stocks, which had to be rebuilt by stocking hatchery-reared fingerlings of pure *O. niloticus*. Although LbI-based recommendations are not necessary for *O. niloticus* – stocks that need to be rebuilt – the present analysis showed that the maximum harvest of undersized fish is about 30–60%. The *L. rohita* (rohu) species was found to be underexploited (E<0.5) in all 5 reservoirs except Vendrason wewa and Kottukchchiya wewa (E=0.53 and E=0.55 respectively; Table 2.6.1). In all 5 reservoirs studied, undersized male and female GFP (<L_c and <L_{mk}) were almost above 20% (Table 2.6.1).

Because *L. rohita* and GFP do not reproduce in almost all reservoirs in Sri Lanka, natural recruitment of these species does not occur. Instead, annual stocking is required to maintain CBF. Therefore, conventional

length-based stock assessment approaches to determine optimal fishing strategies (for example, optimal L_c and optimal E) are not sufficient to make recommendations for CBF management. In particular, species that require regular stocking should be harvested to allow younger individuals to utilise food and other resources in the ecosystem for future harvesting.

The LbI proposed by Cope and Punt (2000) and Froese (2004), that is, Indicator 1: 'Let them spawn'; Indicator 2: 'Let them grow' and Indicator 3: 'Let the mega spawners live', are essentially appropriate for naturally recruiting fish stocks because they depend on the size at maturity. The present analysis therefore proposes a new set of LbI. As it is imperative in CBF management, the harvest should consist of fish and GFP that are acceptable to consumers. Therefore, it is proposed that L_c and L_{mk} of naturally non-recruiting finfish and GFP be considered appropriate LbI for CBF management in Sri Lankan reservoirs.

Recommendations on an alternative fishing gear application to reduce the capture of undersize GFP at landing sites

The traditional method of fishing with gillnets is relatively inefficient for catching GFP: it is size selective and allows juveniles to escape, thus preventing over-exploitation of the fishery. Such size selectivity needs to be considered in the development of traps targeting GFP, in accordance with the minimum acceptable market size.

To date, GFP production in CBF has generally resulted in low yields and low escapement rates (Jones et al. 2021). The first CBF experience with GFP in Sri Lanka was unsuccessful, contributing only 0.7% of the fish harvest (Wijenayake et al. 2010; Chandrasoma and Pushpalatha 2018.). More recently, a study by Rajeevan et al. (2018) reported a comparatively higher recapture rate of 2.48% in the reservoir gillnet fishery in Sri Lanka. A recapture rate (proportion of prawns caught relative to

Table 2.6.1: Exploitation rates of *O. niloticus*, *L. rohita*, *M. rosenbergii* male and female in selected CBF reservoirs and L_{mk} range, mean lengths at first capture ranges (L_c), % below L_c and L_{mk} range and corresponding time needed to grow up to L_c and L_{mk} ranges for 5 reservoirs

CBF spp.		Exploitation										
		Ridiyagama	Urusita wewa	Vendrason	Kottukchchiya	Karawitagaraya	L_c (cm)	L_{mk} (cm)	% fish $<L_c$	% fish $<L_{mk}$	T L_c (months)	T L_{mk} (months)
O. niloticus		0.17	0.36	0.3	0.39	0.46	20–27	22–24	14–60	4–30	5–6.5	3.9–6.7
L. rohita		0.47	0.37	0.53	0.55	0.35	38–42	35–40	0.1–36	1.5–20	16–28	13–20
M.rosen-bergii	Male	0.25	0.25	0.19	0.12	0.25	6.3–8.3	7–8	11–48	13–33	6–13	7.9–9
	Female	0.24	0.17	0.25	0.22	0.26	5.4–6.5	5.5–7	4–31	28–59	6.1–9	9–12.2

the number stocked as PLs) of less than 3% is far below what is required to achieve sustainability, given the relatively high cost of producing prawn PLs in government hatcheries. An acceptable recapture rate would be 5 to 10%, which is likely only achievable with the development of specific fishing gear and techniques to target GFP.

The crab pot and cylindrical cane trap were not effective in capturing GFP in both the laboratory and reservoir experiment. The OHT was more successful in catching GFP than the modified umbrella trap (catching frequency is 0.7 and 0.3, respectively) (Figure 2.6.1). Catch of GFP was achieved in the baited OHT and modified umbrella trap with a weight range of 50–150 g and 90–170 g and carapace length (CL) range from 4.5–6.0 cm and 5.5–6.0 cm for males and females, respectively.

The results for the different aperture size OHT experiment, which was done to evaluate the size selectivity of GFP, shows that the highest weight GFP captured was in the 11 cm diameter trap. However, considering the range of carapace lengths, using a 13 cm diameter OHT could avoid capturing undersized male GFP (smaller male) (Table 2.6.2).

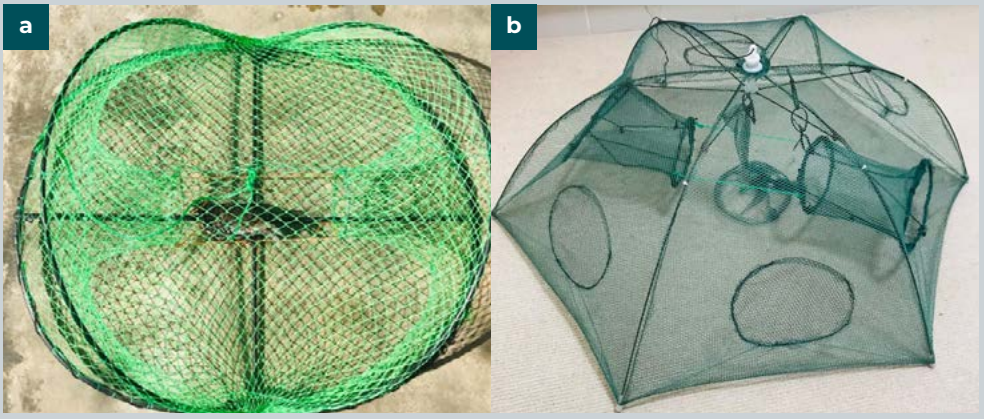

Figure 2.6.1: (a) Opera house trap (so-called because of its shape that mimics the Sydney Opera House) and (b) modified umbrella trap

Table 2.6.2: The evaluate mean weight (kg), mean CPUE (kg hr^{-1}) and carapace length of captured male and female GFP to selected 3 diameter (8 cm, 11 cm, 13 cm) OHTs

		Opera house trap diameter		
		8 cm	11 cm	13 cm
Mean weight (kg)		0.56	0.69	0.63
mean CPUE (kg ha^{-1})		0.029	0.036	0.038
Carapace length range (cm)	Male	4.5–6	4.5–6.5	6–7.5
	Female	5–6	5–6	6–7

Conclusion and recommendations

Exotic carps and *M. rosenbergii* do not spawn naturally in many Sri Lankan CBF reservoirs, and therefore there is no need to consider exploitation if their regular stocking continues. Therefore, marketable size should be the most important factor in CBF. There must be fisheries management practices to catch fish with GFP above L_{mk}. The time required to grow to the desired size (L_c and/or L_{mk}), is also a concern for the management of CBF because there should be sufficient time to harvest both finfish and GFP after stocking. The Lbl indicate that there is a need to implement strategies to reduce the catch of undersized GFP in the landings. At present, GFP are caught as a bycatch in the gillnets used to harvest finfish and the catching efficiency of GFP is rather inefficient, so the introduction of an effective passive gear (such as a prawn trap) is urgently needed.

In terms of catch frequencies, the baited OHTs were more successful in catching GFP than the modified umbrella traps. Increasing the size of the trap aperture also resulted in the avoidance of undersized GFP at landing sites. However, the catch rates were lower than those of the gillnets operated in the vicinity. However, zero damage to GFP by the use of traps achieved considerable success, especially in terms of economic benefits. More comprehensive studies are needed to examine the use of traps in the reservoir environment to achieve optimal catch of prawns within a proper legal approach that ensures the sustainability of the GFP fishery.

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