Estimation of Drift Gillnet Selectivity for *Carangoides ferdau* and *Caranx papuensis* in Kanyakumari Coast of South India

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Abstract

Size selectivity parameters of drift gillnet for *Carangoides ferdau* and *Caranx papuensis* were estimated from catches obtained from the nets of 13.5, 14, 14.5 and 15 cm stretched mesh sizes operated in the Kanyakumari coast of South India from September 2002 to April 2004. In this study, maximum likelihood procedure was followed and a proprietary software GILLNET (Constat, Denmark) was used to fit selection curves *viz*., normal location, normal scale, log-normal, gamma and bi-normal. Of them, bi-normal model was found as best-fit for both the catch data. The fishing power influenced the selectivity of the gear in the case of *C. ferdau* while there was no influence in the other species *C. papuensis*. There was no significant difference between better-fit and best-fit models in both catch data. Modal length increased with mesh size. Shape and size of the selectivity curves were uniform in size. The mesh size 14.5 cm performed better than modeled by capturing larger size group of fishes with narrow selection range. Entangling and gilling appeared as common capture pattern in both the species. Over dispersion was found in the best-fit bi-normal model which also indicated the lack of fit and suggested for multi-nomial fitting of data.

Introduction

Drift gillnets are highly popular in artisanal fisheries of India especially in the south-west coast of India. Drift nets are commonly used for capturing larger carangids like seer fishes. They are abundantly available in Kanyakumari coast of South India. Local fishermen use larger mesh (>40mm) drift gillnets and hooks for capturing these fishes. It is essential to optimize the capture size of the targeted species through estimating the optimum mesh size since gillnet selectivity varies from population to population (Kurkilahti et al. 2002) and mesh size affects the size of fish to be captured. It has been observed in the study area that trawl net catch comprised of smaller carangids with less number of species while drift gill nets catch larger carangids comprising numerous species. Hence experimental studies are required involving currently used gears to determine the suitable mesh size for judicial exploitation of stocks of every fishery and areas since mesh size selected for

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one species may not be useful for others. The estimation of optimum mesh sizes for larger carangids has not yet been attempted in this area. Knowledge of gear selectivity facilitates the management of fishery resources through mesh regulation. The present study was undertaken to determine the selectivity of drift gillnets with respect to large carangids like Blue trevally (*Carangoides ferdau*) and Brassy trevally (*Caranx papuensis*).

Materials and Methods

Gill net selectivity study was conducted with stretched mesh sizes of 13.5, 14.0, 14.5 and 15.0 cm from September 2002 to April 2004 in the Kanyakumari coast of Tamil Nadu, India. The study area is characterized with bottom topography of rocks and corals having depth range of 30 to 60 m and 13 nautical miles away from the shore. The study area was located in the latitude and longitude of 08° 01.145′N 077 ^{o} 49.137′E to 08° 00.821′N 077 ^{o} 45.192′E. It serves as traditional fishing ground for local fishermen. Nets were similar in all respects with the net used by local fishermen having the mesh size of 14 cm. The length of the experimental gillnet was 2700 m and it comprised of randomly arranged 36 gangs (shots) with chosen mesh size. The depth of the gillnet was 80 meshes and each gang contained 1000 meshes in length. Nets were made up of multifilament nylon twine with RTex value of 737 and 786 for the mesh sizes 13.5, 14 cm and 14.5 and 15 cm respectively. The nets were hung to the double-lined head rope having diameter of 6 mm and 288 PVC floats, with 100 mm diameter and 20 mm thickness attached to the head rope. A master float with the size of 280 X 280 X 190 mm (L X B X H) made up of thermocole was attached at both ends of each gang of the net0. The hanging ratio of the nets ranged from 0.5 to 0.56.

Nets were operated by local fishermen from their FRP boat with overall length of 8.4 m in the traditional fishing ground. After every haul, mesh panels were rearranged randomly in order to minimize bias and sampling error. Nets drifted along with the boat for 4-6 h after mid-night and hauled in before dawn. After hauling, the targeted species *C. ferdau* and *C. papuensis* catches were sorted out by species and mesh and stored in separate containers. After bringing the catch to the shore, measurements like fork length (FL), individual weight and total weight of catch were recorded. The measurement of lengths and girths were taken to the nearest cm and mm respectively and weight to the nearest gram.

Selectivity Model

According to Baranov (1914), selection is a function of the ratio of fish body size and mesh size. Hamley (1975) assumed that catch of a fish of a particular length in gillnet is described as product of retention probability, abundance of that length group, the fishing effort and net efficiency. The gillnet capture increases with Poisson distribution and its selectivity parameters and variances are estimated by maximum likelihood method (Wulff, 1986). Millar (1992, 1995) described a new selectivity model called SELECT (Share Each Length Class Total) including the Hamley's assumptions of catch effort and gear efficiency. In the present study, the software

GILLNET (Generalized Including Log-Linear N Estimation Technique) developed by Constat (1998) which included the Millar's SELECT methodology was used to estimate the selection parameters.

This method assumes that the n_{Lj}, number of fish of length class 'L' encountered in a gear with a mesh size 'j' or expected to contact or caught in the gear is considered as Poisson distributed, or the number of fish of length class 'L' is also Poisson distributed (Feller, 1968). The model for analyzing the data collected from gillnets with different dimensions is

$$n_{Lj} \approx \text{Pois } (P_j \lambda_L r_j (L)) \text{ .... (1)}$$

Where P_j is the relative fishing intensity which comprises of fishing effort, and fishing power, λ_L is the expected number of fish of length 'L' that are in contact with the net 'j' and $r_{j.}$ (L) is the selectivity function of the ratio of fish length to mesh size which is the relative length 'L'. The expected values of catch of relative length 'L' fish in gillnet 'j' is expressed as

$$n_{Lj} = P_j \lambda_L r_j (L) \text{ ………….... (2)}$$

In general, selection curve of gillnets are assumed to be normal shaped. As such, the selection is

expressed as
$$r_j (L) = \exp\left(-\frac{(L - \mu_j)^2}{2\sigma_j^2}\right) \text{ …….. (3)}$$

and the curves observed geometrical similarity [i.e., mean (μ_j) and spread or variance (σ_j^2) is proportional to mesh size (m_j)]. The principle of this method is the proportions of the total catch for each length class 'L' taken by each gear (j_1) to the total catch of all the meshes combined (j = 1,2,3………..j) of the same length class ($\sum n_{Lj}$) (Millar, 1992). It is denoted as

$$y_{lj} = n_{Lj} / \sum n_{Lj} = y_{lj} = n_{Lj} / n_{L+} \text{ ………..(4)}$$

Where n_{L+} is the total number of fish caught with length L_j and y_{lj} has multi-nomial distribution with n_{L+} trials and probabilities, so the expected value (E) of the model is shown as follows;

$$\Phi_{Lj} = E(y_{lj}) = \frac{P_j \lambda_L r_j (L)}{\sum_j P_j \lambda_L r_j (L)}, \, j = 1,2,3,......j \text{ …………. (5)}$$

In this method, λ_L (abundance parameter) is omitted as the probabilities Φ do not rely on it and hence the log-likelihood for the proportion of the catch data is shown as

$$\sum_{L} \sum_{j} n_{Lj} \log_e(\Phi_{Lj}) \dots\dots (6)$$

The above log-likelihood function was maximized to estimate the selectivity parameters using the software **GILLNET**. The selectivity model includes five different functions under two divisions of uni-normal and bi-normal. The uni-normal function includes Normal location (where modal length is proportional to mesh sizes but with fixed spread of the curve), Normal scale, Log-normal, Gamma and Bi-normal. Each model is as follows.

$$r_j(L) = \exp\left(-\frac{(l-k.m_j)^2}{2s^2}\right) \dots\dots (7)$$

$$r_j(L) = \exp\left(-\frac{(l-k_1.m_j)^2}{2k_2^2.m_j^2}\right) \dots\dots (8)$$

$$r_j(L) = \frac{m_j}{l.m_1} \exp\left[m - \frac{s^2}{2} - \frac{\left(\log(l) - m - \log\left(\frac{m_j}{m_1}\right)\right)^2}{2s^2}\right] \dots\dots (9)$$

$$r_j(L) = \left(\frac{l}{(k-1).a.m_j}\right)^{k-1} \exp\left(k-1-\frac{l}{a.m_j}\right) \dots\dots (10)$$

$$r_j(L) = \exp\left(-\frac{(l-a_1.m_j)^2}{2b_1^2.m_j^2}\right) + \varpi \exp\left(-\frac{(l-a_2 m_j)^2}{2b_2^2}\right) \dots\dots (11)$$

All the models follow Baranov's principle of geometric similarity (Baranov, 1948) except normal location curve. All these functions were used to estimate selectivity parameters of gillnet and to get selection curves for the catch data of *C. ferdau* and *C. papuensis*.

Fujimori and Tokai (2001) explained that selectivity parameters are estimated from the observed catch data and not from the Catch per Unit Effort (CPUE) data since it requires observed catch data under the assumption of equal fishing efficiency of the meshes or variation of catch effort at each mesh size. In this method, the data were fitted twice to the above selectivity functions based on the assumption of equal fishing power and the fishing power proportional to mesh size (Millar and Holst, 1997). Further, the residual plots were obtained by plotting mesh size against length class

for every function under both the assumptions. Model deviances (D) (likelihood ratio) for each fit was calculated for corresponding degrees of freedom. Degrees of freedom (DF) was calculated by number of length class multiplied by number of mesh sizes used minus number of length class and number of parameters involved (Millar and Fryer, 1999). The Deviance residual is

$$D = \sum_{ij} res_{ij}^{2} \dots\dots\dots (12)$$

where, res_{ij} is residual of ith length class of jth mesh size. The deviance statistics and residual plots were used to assess the fit of the selectivity models. Evaluations of models were done as given below.

Validity of the Models

After fitting all the functions, goodness of fit was evaluated using model deviance (D) (McCullagh and Nelder, 1989). The deviance was evaluated from the residual difference between the proportion of fish of particular length caught and the relative length obtained from the models. The model, which had less deviance value, was considered as better fit. The deviance was also evaluated in relation to DF by referring to the chi-square distribution $D \sim \chi^{2}(DF)$ to find out the existence of the significant differences between models (Wileman *et al*. 1996). Dispersion parameter was calculated for all the models fitted to catch data of both the species to study the kind of dispersion or spread or variance of the selectivity curve. After assessing the fits with above-mentioned statistical tools, the better-fit model for both the species, were further inspected from residual plots. A good fit of plot was regarded based on appearance of residuals in the plots. If the positive and negative residuals clustered either one side or systematic arrangement will indicate poor fit. The better-fit model which showed lack of fit was further extended to bi-normal model to get an improved fit.

Refitting of Model

The better fit model obtained for the catch data of *C. ferdau* and *C. papuensis* was further approximated to bi-normal model to find out the best fit of the data as suggested by Holst *et al*. (1994). Deviance, degrees of freedom, dispersion parameter and residual plots were also determined and validated as did in the uni-normal models to find out the best fit of the selectivity data for both the species studied.

Results

Overall total catch of *C. ferdau* obtained from four mesh sizes was 906 in number. Of these, 248 specimens were caught from mesh size 13.5 cm, 245 from 14 cm, 202 from 14.5 cm and 211 from 15 cm. In the gillnets of four mesh sizes, 1473 specimens of *C. papuensis* were caught. Of these, 286 specimens were caught from mesh size 13.5 cm, 418 from 14 cm, 375 from 14.5 cm and

394 from 15 cm. Length frequency distributions curves of both the species studied are presented in Fig. 1 and they appeared as uni-modal in shape.
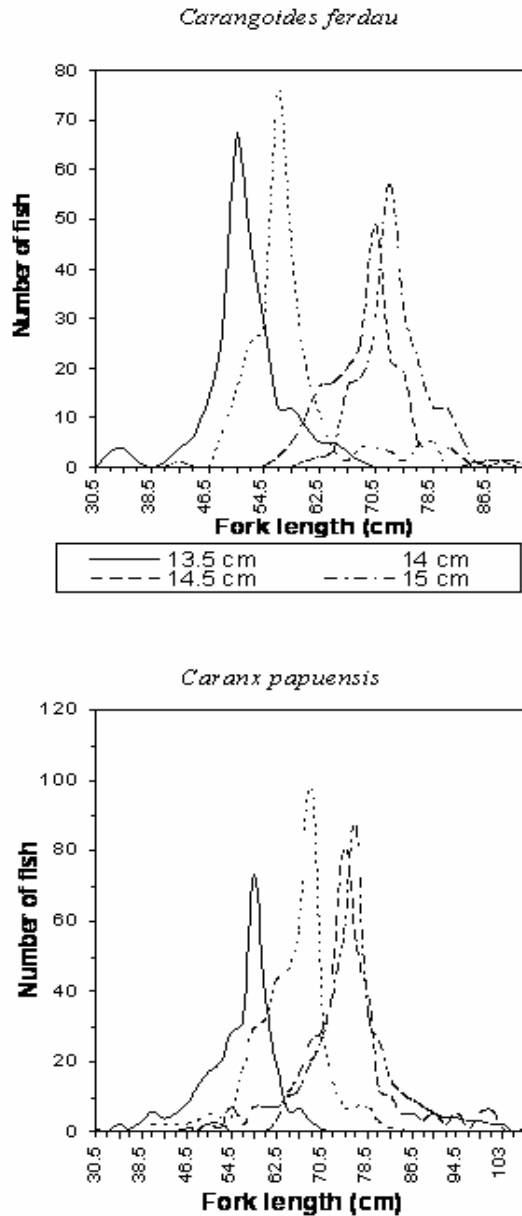
Fig. 1. Length frequency distribution of carangid fishes caught from gillnets with different mesh sizes

The size ranges of *C. ferdau* and *C. papuensis* caught from gillnets were 30.8 – 89 cm and 30.5 –106 cm respectively. Estimated selectivity parameters for all uni-normal models including deviance statistics and the corresponding degrees of freedom for every model under the assumption of equal fishing power and fishing power proportional to mesh size are given in Table 1. The selection curves obtained for all uni-normal functions are given in Fig. 2.

Among the uni-normal models, a smaller deviance value was found in log-normal model when compared to other models in both the species. The models which had high deviance value were rejected since it expressed poor fit of data. The estimated model deviance was similar in both the assumption in log-normal and gamma models. However, a small difference was observed in the models of normal scale and normal location in both species catch data. It indicated that fishing power did not influence the deviance value in the former models. No significant difference existed between models except with normal scale ($P<0.05$) in *C. ferdau* and meager difference ($P<0.005$) in *C. papuensis*. Based on deviance value, other better fits followed by log-normal model in *C. ferdau* were normal location under the assumption of equal fishing power, gamma and normal scale under the assumption of fishing power proportional to mesh size. In *C. papuensis***,** other fits followed by log-normal were gamma, normal location under fishing power proportional to mesh size, and normal scale under equal fishing power.
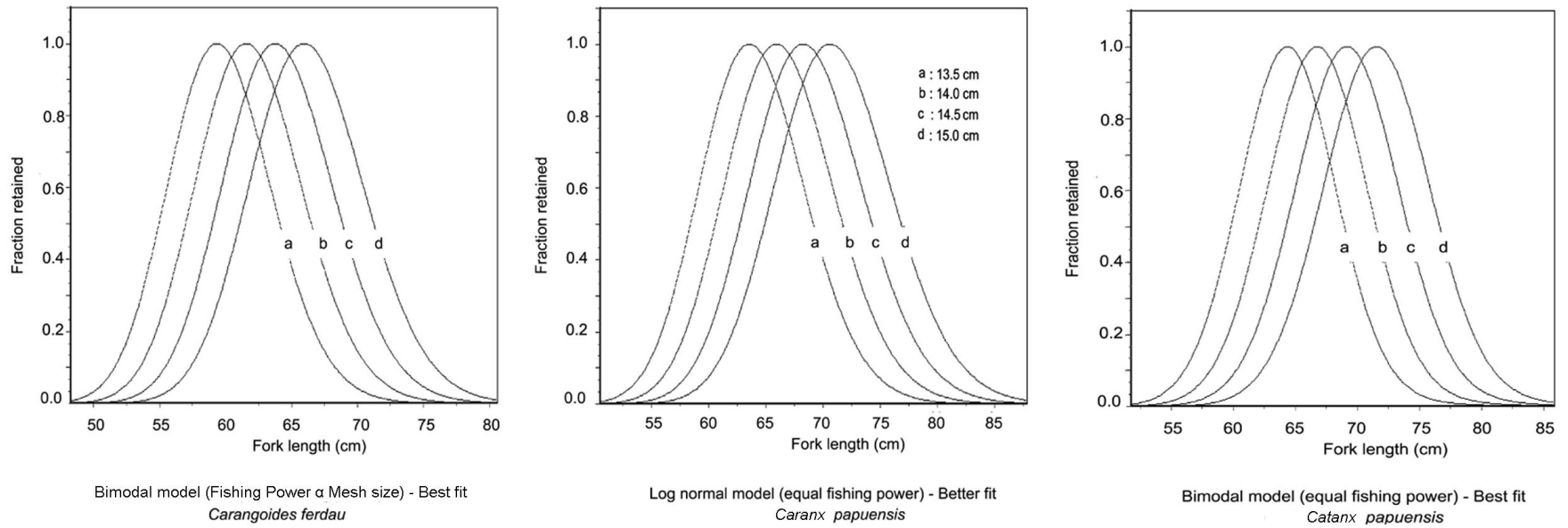
The estimated dispersion parameter (DP) varied greatly among the uni-normal models. The lowest DP existed in the better-fit log-normal model fitted for both the species catch data. The DP was greater than one in the better fit models of both the species *C. ferdau* (4.21) and *C. papuensis* (4.82) since the deviance was higher than the degrees of freedom. It showed over dispersion and lack of fit in better-fit log-normal models. While evaluating the Residual plots obtained from all the models for both the species (Fig. 3) under both the assumptions of equal fishing power and fishing power proportional to mesh size, the mesh size of 14.5 cm performed better followed by 14 cm and 13.5 cm. Deviance residuals were equal for both the equal fishing intensity and fishing power proportional to mesh size in all the uni-models including better-fit lognormal model of both the species.

In the case of *C. ferdau* fishing powers were almost equal in both normal location and gamma model by the presence of equal number of positive residuals in respective mesh sizes. Similarly fishing power of these two models was similar with log-normal model except in the mesh size 14 cm. The fishing power of mesh size 15 cm was equal in all uni-normal models. Residual plots revealed that the mesh size of 14 cm caught wider length group of fish (32.5 to 82.5 cm) and the mesh size 14.5 cm captured narrow range of middle length group fishes (60.5 to 82.5 cm).

Table 1. SELECT model parameters estimates for gillnet selectivity of Carangid species caught

S.No.	Species	Model		Degrees of Freedom	Equal fishing power			Fishing power α mesh size		
					Parameters	SD	Model value	Parameters	SD	Model value
1	*Carangoides ferdau*	Normal location	Fixed spread	85	(k,s) = (4.4412, 4.1250)	0.0235, 0.1013	367.03	(k,s) = (4.60, 4.1319)	0.0235, 0.1015	366.41
		Normal scale	spread α m j	85	(k1,k2) = (4.4801, 0.2903)	0.0236, 0.0070	398.91	(k1,k2) = (4.4991, 0.2896)	0.0235, 0.0070	399.08
		Lognormal	spread α m j	85	(m ,s) = (4.0879, 0.0654)	0.0053, 0.0016	357.63	(m ,s) = (4.0921, 0.0654)	0.0053, 0.0016	357.63
		Gamma	spread α m j	85	(k,a) = (0.0189, 234.6767)	0.0009, 11.3231	367.4	(k,a) = (0.0189, 235.6767)	0.0009, 11.3616	367.4
		Bimodal	spread α m j	82	(a1,b1) = (4.2306, 0.2042)	0.0370, 0.0154	366.69	(a1,b1) = (4.4411, 0.2622)	0.0242, 0.0077	356.02
					(a2,b2) = (4.5649, 0.2944)	0.0469, 0.0116	366.69	(a2,b2) = (5.0160, 0.3488)	0.2835, 0.0743	356.02
					w = 0.5402	0.2485	366.69	w = 0.0096	0.0086	356.02
2	*Caranx papuensis*	Normal location	Fixed spread	109	(k,s) = (4.7438, 4.8670)	0.0211, 0.1077	541.78	(k,s) = (4.7684, 4.8776)	0.0210, 0.1082	540.89
		Normal scale	spread α m j	109	(k1,k2) = (4.7819, 0.3418)	0.0210, 0.0077	561.6	(k1,k2) = (4.8065, 0.3408)	0.0208, 0.0076	561.85
		Lognormal	spread α m j	109	(m ,s) = (4.1572, 0.0719)	0.0045, 0.0016	525.56	(m ,s) = (4.1624, 0.0719)	0.0044, 0.0016	525.56
		Gamma	spread α m j	109	(k,a) = (0.0243, 195.48)	0.0011, 8.7475	527.17	(k,a) = (0.0243, 196.4880)	0.0011, 8.7794	527.17
		Bimodal	spread α m j	106	(a1,b1) = (4.7669, 0.2843)	0.0179, 0.0080	461.41	(a1,b1) = (4.7839, 0.2838)	0.0178, 0.0079	461.6
					(a2,b2) = (5.0173, 0.4871)	0.0749, 0.0271	461.41	(a2,b2) = (5.0664, 0.4846)	0.0759, 0.0264	461.6
					w = 0.0225	0.0111	461.41	w = 0.0237	0.0113	461.6

Bimodal model (Fishing Power α Mesh size) - Best fit
Carangoides ferdau

Log normal model (equal fishing power) - Better fit
Caranx papuensis

Bimodal model (equal fishing power) - Best fit
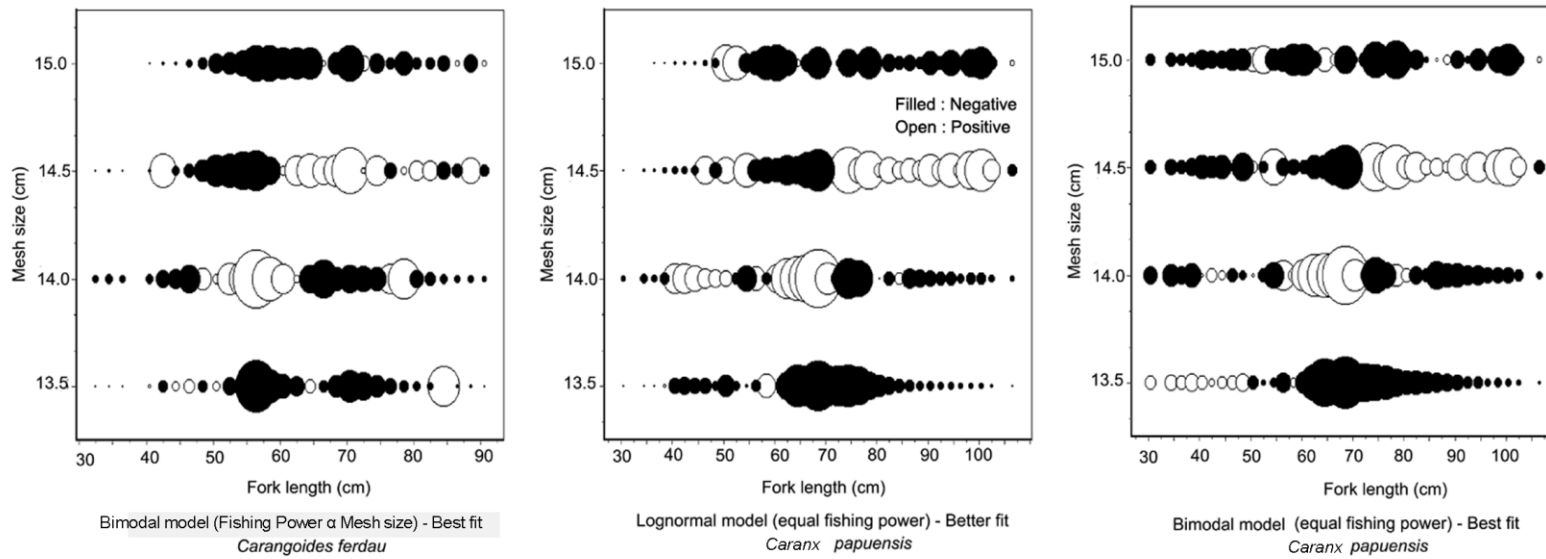*Catanx papuensis*

Fig. 2. Selectivity curves of Better-fit and Best-fit models for different mesh sizes for *Carangoides ferdau* and *Caranx papuensis*

In *C. papuensis*, fishing power of normal location was similar with normal scale in all mesh sizes except with the mesh size of 13.5 cm. The fishing power of the mesh sizes of 13.5 cm and 15 cm was equal in normal location, log-normal and Gamma models. Residual plots of *C. papuensis* were almost similar in all the models. Plots showed capture of middle- sized length group (40.5 - 70.5 cm) from the mesh size of 14 cm while the mesh size 14.5 cm captured the larger size group fish (72.5-102.5 cm). In both the selectivity data deviance residuals were systematically arranged and the values were greater than '2'. It indicated the poor fit of the model in the catch data of both species.

After evaluating the better fit log-normal model using various statistical tools in both the species catch data, the log-normal model still exhibited the poor fit which was indicated by the existence of larger size of model deviance, DP and residuals with systematic arrangement in the residuals plots. Thus, the better fit model was further extended to bi-normal model to get the best fit of the data.

Model deviance of the bi-normal model was slightly reduced to 356.02 from the better fit log-normal model (357.63) in *C. ferdau* under the assumption that fishing power was proportional to mesh size. In C. *papuensis*, the model deviance value was greatly reduced from 525.56 to 461.41 under equal fishing power (Table 1). The DP values obtained for the bi-normal model for the catch data of *C. ferdau* and C. *papuensis* were 4.34 and 4.35 respectively. The estimated DP for both the catch data were higher in bi-normal model than better fit log-normal model which indicated the over dispersion of the data. There was no significant difference observed between the bi-normal and log-normal model in the catch data of *C. ferdau* and it was not so in the case of C. *papuensis* (P < 0.005; Chi-Square test). The modal length and spread obtained from the bi-normal model in both catch data increased with mesh size (Table 2). However, the modal length varied between the assumptions of equal fishing power and fishing power proportional to mesh size in all the models. The spread was lesser than better fit log-normal model in both the catch data. Modal length for *C. ferdau* obtained from best fit bi-normal model ranged from 60 to 66.6 cm through the mesh size from 13.5 to 15 cm and the spread ranged from 3.54 to 3.93. In the case of C. *papuensis*, the modal length and spread ranged from 64.4 to 71.5 cm and 3.84 to 4.26 respectively (Table 2).

Residual plot of bi-normal model for the catch data of *C. ferdau* revealed that the mesh sizes of 14.5 and 14.0 cm performed better than modeled (Fig. 3). It was inferred by the presence of more number of positive residuals in the plot. Similarly, in the case of *C. papuensis*, both best and better fit model revealed that the mesh sizes of 14.5 followed by 14 and 13.5 cm performed well. The mesh size 14.5 cm captured larger fishes (72.5-102.5 cm) and 14 cm captured middle length group of fishes (56.5 - 80.5 cm).

Fig. 3. Residuals plots of selectivity curves of Better-fit and Best-fit for different mesh sizes for *Carangoides ferdau* and *Caranx papuensis* (Area of the square is proportional to square of the residual)

Table 2. Modal length and spread of gillnet selectivity curves of various models for Carangids caught.

S.No.	Species	Model	Mesh size (cm)														
			13.5				14				14.5				15			
			Modal length (cm)		Spread		Modal length (cm)		Spread		Modal length (cm)		Spread		Modal length (cm)		Spread	
			a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
1	*Carangoides ferdau*	Normal location	60	60.2	4.12	4.13	62.2	62.4	4.12	4.13	64.4	64.7	4.12	4.13	66.6	66.9	4.12	4.13
		Normal scale	60.5	60.7	3.92	3.91	62.7	63	4.06	4.05	65	65.2	4.21	4.2	67.2	67.5	4.35	4.34
		Lognormal	59.4	59.6	3.91	3.93	61.6	61.8	4.06	4.08	63.8	64	4.2	4.22	66	66.2	4.35	4.37
		Gamma	59.7	60	3.91	3.92	62	62.2	4.05	406	64.2	64.4	4.2	4.21	66.4	66.7	4.34	4.35
		Bimodal	57.1	60	2.76	3.54	59.2	62.2	2.86	3.67	61.3	64.4	2.96	3.8	63.5	66.6	3.06	3.93
2	*Caranx papuensis*	Normal location	64	64.4	4.87	4.88	66.4	66.8	4.87	4.88	68.8	69.1	4.87	4.88	71.2	71.5	4.87	4.88
		Normal scale	64.6	64.9	4.61	4.6	66.9	67.3	4.78	4.77	69.3	69.7	4.96	4.94	71.7	72.1	5.13	5.11
		Lognormal	63.6	63.9	4.61	4.63	66	66.3	4.78	4.8	68.3	68.6	4.95	4.98	70.6	71	5.12	5.15
		Gamma	64	64.2	4.58	4.59	66.3	66.6	4.75	4.76	68.6	69	4.92	4.93	71	71.4	5.09	5.1
		Bimodal	64.4	64.6	3.84	3.83	66.7	67	3.98	3.97	69.1	69.4	4.12	4.11	71.5	71.8	4.26	4.26

a : Equal fishing power   b: Fishing power α Mesh size

The shapes of the selection curves obtained from both uni and bi-normal models were identical and similar in nature in both the species catch data (Fig. 2). The selection curves of every model under both assumptions were similar in shape. The height of the curve was uniform for all mesh sizes and models. Fishing power in relation to the mesh sizes was constant in the case of C. *papuensis*. Nevertheless, in the case *C. ferdau* the fishing power was proportional to the mesh size. There was no significant difference in catch rates between mesh sizes and size classes in the catch data of *C. ferdau*. However, in C. *papuensis*, significant difference (P < 0.01) between size classes was observed and no difference appeared between mesh sizes.

Discussion

In general, selectivity of fishing gear varies with mesh size and net designs (Hamley, 1975; Sparre *et al*., 1989; Mackiels *et al*., 1994). Estimation of selectivity of gillnet relies on two issues, one is the fish behaviour with the net followed by encountering and retaining with the net and the second one is mode of capture such as gilling, wedging and tangling (Hamley, 1975). Larger mesh has more favourable selectivity properties compared to smaller mesh and yields capture of reduced length range of fish (Hamley and Regier, 1973).

In the present study, bi-normal model was found as best fit for both selectivity data of   *C. ferdau* and C. *papuenesis* under fishing power proportional to mesh size and equal fishing power respectively though asymmetrical log-normal model was shown to be better fit in the beginning with a extreme skewness (Fujimori and Tokai, 2001). Many researchers (Hovgard, 1996a; Fujimori and Tokai, 2001; Park *et al*. 2004) described that the bi-modal curve would be appropriate for the gillnet selectivity. In both selectivity data, Bi-normal model might have occurred due to multiple part capture of fishes (Millar and Fryer, 1999) and entangling (McCombie and Berst, 1969). Multiple selections ultimately led to skewness in the right side of the curve or multimodal selection curves. In *C. ferdau* and C. *papuenesis*, the predominant capture modes were gilling (81.4 %), wedging (17.3%) and entangling (58.4%), gilling (39.1%), respectively. These processes might have occurred either due to the higher swimming speed, girth difference, and shape of body or tangling with the fins.

In the present study, the carangid fishes caught were larger in size since larger meshes were used. They are active and fast swimmers and the swimming speed might have encouraged the fishes to plunge into the meshes deeply for getting wedged or entangled i.e., snagged. Rudstam *et al*. (1984) found that larger fishes had high probability of encountering passive gear than small fish since the former swim faster and travel farther. Use of bigger mesh yielded the right skewed curves in the present study. The experimental gillnet had capacity of entangling larger number of specimens of C. *papuenesis* and capture of small proportion through other capture processes like gilling and wedging. Amarasinghe and De Silva (1994) also have shown that high encountering probabilities of two cichlid species in Sri Lankan reservoirs resulted in skewed gillnet selection curves.

In this study both the catch data appropriately fit the bi-normal model though fishing power affected the selection. The experimental nets contained equal number of mesh in each net and hence the length is proportional to mesh size. In this study one of the major assumptions is that each mesh of experimental fleet of gillnet consisted of different mesh sizes was equally efficient in catching fish of particular modal length as assumed by Madsen *et al*. (1999), Ishida (1962) and Kitahara (1968). The assumption was seen true in the catch data of *C. papuenesis* with the existence of equal fishing efficiency between meshes and it indicated all the meshes had equal fishing effort. In *C. ferdau,* catch efficiency increased with gillnet mesh size, as reported by Borgstrom (1989) and Hovgard (1996b). However, such a trend was not evident for *C. papuensis* probably due to less abundance of larger size fishes in the study area. Modal length and spread of the selectivity curves of both catch data increased with the mesh size conforming to Hamley and Regier (1973). Modal length obtained from the best fit bi-normal model was greater than that of uni-normal model though selection range was narrower in the former. The bi-normal model performed with greater efficiency only in larger length group. The shape of the selection curves was symmetrical though the curves for all mesh sizes did not behave similarly as described by Amarasinghe (1988).

In conclusion, bi-normal model appears to be a suitable fit of selectivity curve for the catch data of both species though the fishing power varied between the catch data. The mesh size 14.5 cm performed well compared to other meshes tested and it captured larger size of fishes with narrow selection range. Modal length increased with the increase of mesh size. In the study, multiple capture patterns were observed and among them, entangling was the predominant mode of capture in both the species.

Acknowledgements

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