Distribution, abundance and some aspects of biology of kawakawa (*Euthynnus affinis*) from Northern Arabian Sea with an update on neritic tuna fisheries of Pakistan

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ABSTRACT

Neritic tuna contributes substantially to the total fish landings of Pakistan. It is estimated that neritic tuna alone have a share of about 54 % in the total landings of tuna in 2018. Kawakawa contribution is although about 6 % but it is important because it is the main species which is consumed locally in Pakistan. Of the five species of neritic tuna, longtail tuna (*Thunnus tonggol*) contributes 11,985 m. tons during 2018. Landings of frigate tuna (*Auxis thazard thazard*) during 2018 was recorded to be 10,986 m. tons which is followed by kawakawa (*Euthynnus affinis)* as 4,123 m. tons. Other two species i.e. bullet tuna (*Auxis rochei*) and striped bonito (*Sarda orientalis*) contributed insignificantly in the total tuna landings of Pakistan. During 2018, a major part of the fleet mainly operated in the offshore deeper waters; therefore, landings of neritic tunas were comparatively lesser than previous year. The paper also describes some aspects of the population biology of kawakawa from Northern Arabian Sea. Paper also highlights on the importance of neritic tuna in the food security of the country and stressed on the need for further studies on population structure, biology, bycatch and management regime of other neritic tuna species in Pakistan.

INTRODUCTION

Gillnetting for neritic tuna is an important component of the coastal fisheries of Pakistan as a major part of the artisanal fleet is engaged in this fishing. Gillnets consisting of monofilament and multifilament are used for catching neritic tunas. Monofilament net is mainly used for catching frigate (*Auxis thazard thazard*) and bullet tunas (*Auxis rochei*) whereas multifilament nylon nets are used for catching longtail tuna (*Thunnus tonggol*), kawakawa (*Euthynnus affinis)* and striped bonito (*Sarda orientalis*).

Information about neritic tuna fisheries of Pakistan is known through the work of Moazzam (2011, 2012a-c, 2014, 2018), Moazzam and Ayub (2015, 2017), Moazzam *et al.*, (2016) and Nawaz and Moazzam (2014). These studies were based mainly on the fisheries statistical data being published by Marine Fisheries Department, Government of Pakistan and also some information collected through the Crew-Based Observer Programme initiated by WWF-Pakistan in 2012.

Based on the information generated through WWF-Pakistan's Crew-based Observer Programme, data of tuna and tuna like species was reconciled with the landings data available with Marine Fisheries Department, Government of Pakistan. An exercise for reconstruction of landing data for IOTC species since 1987 to 2018 was also carried out. These datasets were provided to IOTC by Marine Fisheries Department,

Government of Pakistan and a part of it was presented in WPNT07 (Moazzam and Ayub, 2017).

MATERIALS AND METHODS

In 2012, WWF-Pakistan initiated a crew based observer programme to collect information about catches of tuna and tuna-like species as well as of the bycatch non-target species in the tuna gillnet fisheries of Pakistan (Moazzam and Nawaz, 2017). This programme has continued, with a growing number of participating fishing crews, each year since 2012. At present 75 observers are engaged in data collection programme. Fishing operations take place throughout the year except during June and July, which is closed season, coinciding with rough sea conditions generated by the southwest monsoon. The tuna vessels generally set 6-8 km long gillnets before sunset and retrieve them the next morning after a soak time of about 12 hours. Vessels operate predominantly in offshore waters, with some effort applied on the continental shelf as well. The information about tuna species (including neritic tuna) is recorded on daily basis on log sheets especially designed for the programme.

Fork length (FL) of three specimens of dominating species from each haul was measured to the nearest 1 cm by all 75 observers and pooled into 10 cm length classes. Growth parameters L∞ and K were estimated by model progression analysis using the program ELEFAN1 (Pauly, 1979) within the FiSAT II program (Darvishi *et al*., 2019). Other population parameters were determined FiSAT II program on the pattern followed by Darvishi *et al*. (2019) for longtail tuna (*Thunnus tonggol*) and Motalagh, et al. (2010) for kawakawa (*Euthynnus affinis*).

RESULTS

Neritic tuna landings during 2018 was observed to be comparatively lower than previous years (Table-I). An overall decrease of 24.11 % in the landings neritic tuna was observed during 2018 as compared to 2017. Major decrease was noticed in case of longtail tuna where a decrease of 37.39 % was noticed during the same period. In case of frigate tuna this decrease was observed to be 16.69 % whereas in case of kawakawa the decrease was only 1.81 %.

Table-I. Landings of Neritic Tuna Landings during 2017 and 2018.

Neritic Tuna Species	Scientific name	2017	2018	% increase/ decrease
Longtail	*Thunnus tonggol*	19,143	11,985	-37.39
Kawakawa	*Euthynnus affinis*	4,199	4,123	-1.81
Frigate tuna	*Auxis thazard thazard*	13,187	10,986	-16.69
Bullet tuna	*Auxis rochei*	2	2	-
Striped Bonito	*Sarda orientalis*	2	3	50
Tunas and Bonitos NEI		5,919	5,120	-13.5
Neritic Tunas		42,452	32,219	-24.11

(data sources: Marine Fisheries Department and WWF-Pakistan)

It may be noticed that the catch of neritic tuna species has substantially decreased during 2018 because of a much longer closed season observed by the tuna gillnet fisheries. In 2018, as fishing was stopped in the late April or beginning of May 2018 and initiated only in last week of August i.e. almost no fishing for four months as against normal 2 month ban of June and July. Additionally the prices of tuna species including some neritic species such as longtail tuna and marlins was dropped substantially in the neighbouring country due to unprecedented depreciation in currency which compelled fishermen to target other species than neritic tunas.

Landings of Kawakawa

Kawakawa is one of the neritic species which is caught mainly on the continental shelf area. As compared to other neritic tuna species (frigate tuna, bullet tuna and striped bonitos), longtail tuna and kawakawa are found in comparatively deeper waters along the shelf of Pakistan. Fig. 1 presents data of landings of kawakawa since 1987 which indicates gradual increase in tuna landing since 1999. Unprecedented increase in landings of kawakawa was noticed in 1988 when its landing was 3,982 m. tons whereas lowest landings of kawakawa was noted in 1998 (1,148 m. tons). Highest landings of kawakawa was noticed in 2016 when it achieved a level of 5,392 m. tons. Such variability is landings is attributed mainly to area of operation of the tuna gillnet vessels which changes depending on the catches of prime tuna species.
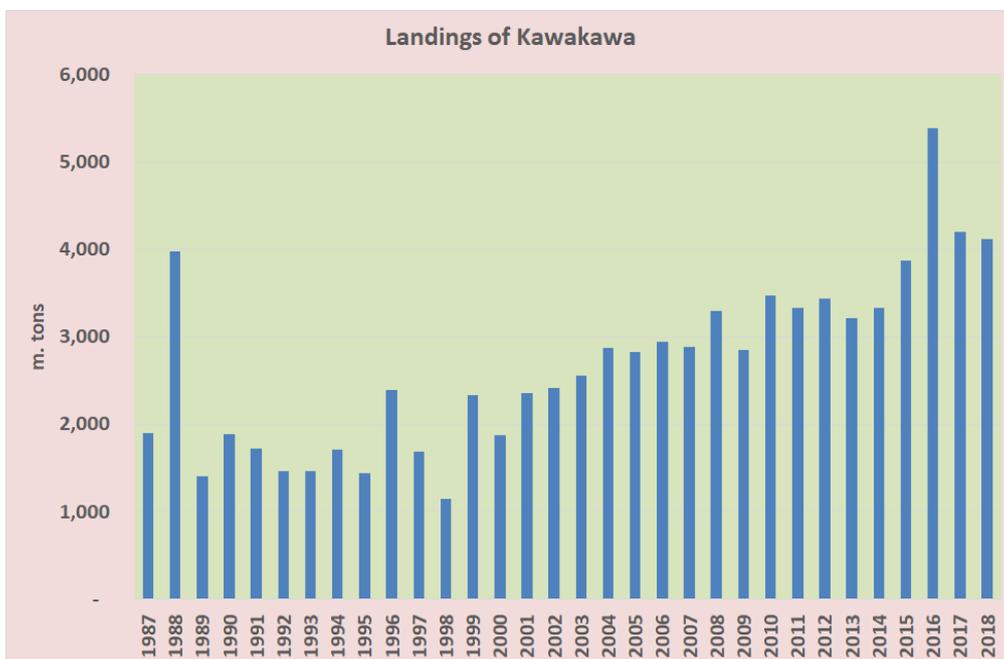

Fig. 1. Landings of kawakawa (*Euthynnus affinis*) in Pakistan (data sources: Marine Fisheries Department and WWF-Pakistan)

Fig. 2 depicts the landings of kawakawa as compared to the landings of all 8 tuna species. It is evident that contribution of kawakawa is insignificant if compared with other tuna species. A major of the tuna fleet prefer to operate in the offshore waters where prime species yellowfin tuna (*Thunnus albacares*) and skipjack tuna

(*Katsuwonus pelamis*) dominate in the catch, therefore, landings of kawakawa is comparatively much lower than other tuna species.

Fig. 3 compares the landings of kawakawa with other species of neritic tunas (total landings of longtail tuna, frigate tuna, bullet tuna and striped bonitos). It is evident that kawakawa is an important neritic tuna species but its contribution is comparatively much lower than longtail and frigate tuna.
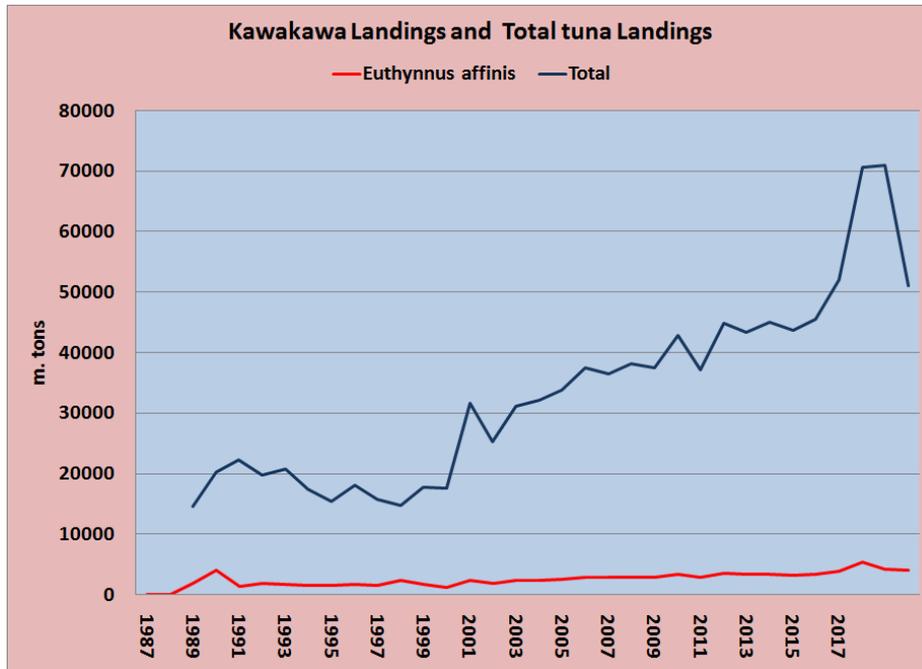

Fig. 2. Contribution of landings of kawakawain total tuna landings of Pakistan (data sources: Marine Fisheries Department and WWF-Pakistan)
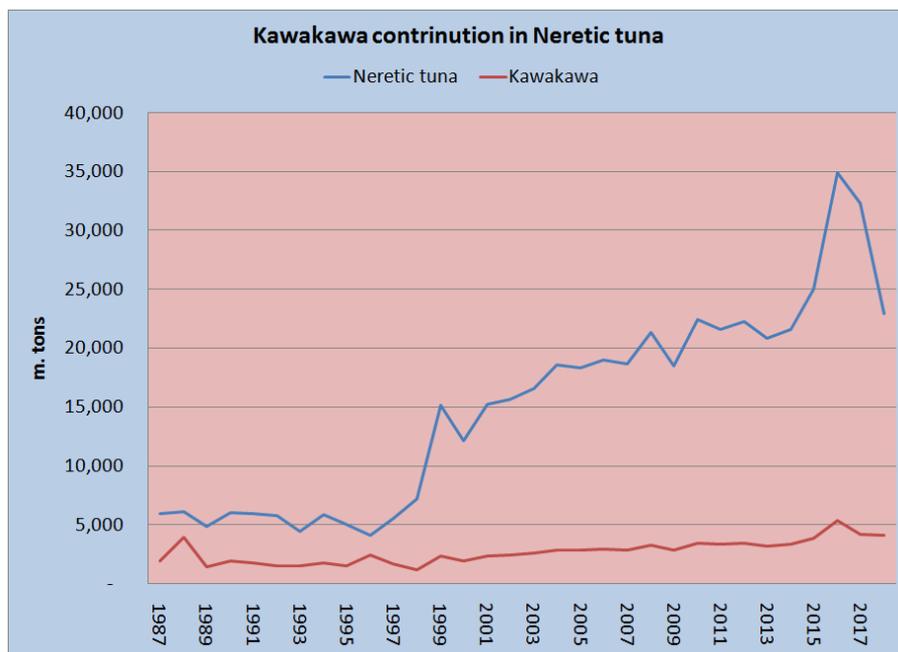

Fig.3. Contribution of landings of kawakawain total neritic tuna landings of Pakistan (data sources: Marine Fisheries Department and WWF-Pakistan)

Seasonal Changes in Catches of Kawakawa

Although kawakawa is caught throughout the year in Pakistan by the gillnet fisheries except during June and July which are voluntary close season for tuna fisheries (Fig. 4). However in some years the close season implemented for more than two months i.e. from mid May to Mid August (2017-2019). Higher catches of kawakawa was observed in September to November with peak in October (Fig. 4). During these months tuna gillnet vessels operate in comparatively near the coast whereas they operate in offshore waters during December through April (Moazzam and Nawaz, 2017). In mid April and May, the tuna vessels again operates in coastal waters which is evident from another increase in catches of kawakawa during April and May (Fig. 4).
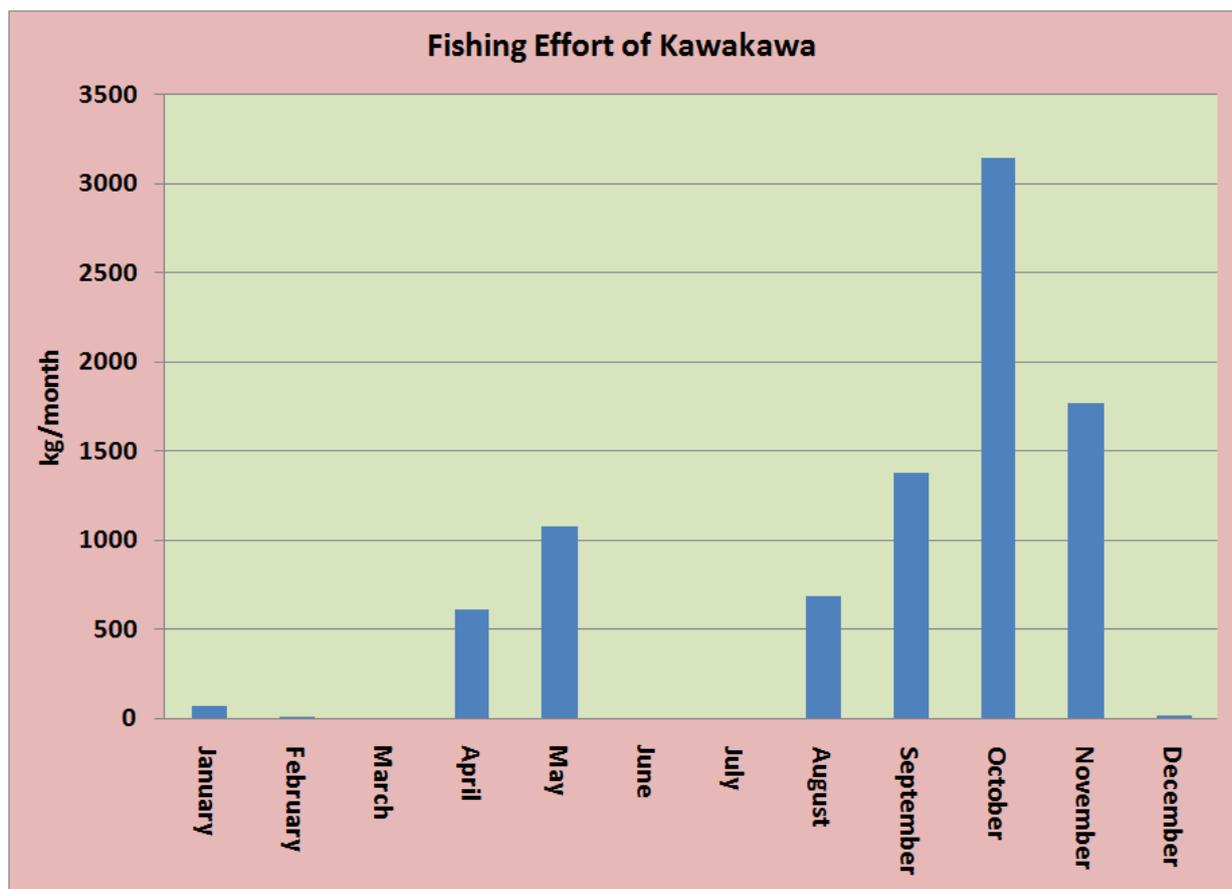

Fig.4. Seasonal changes in the catches of kawakawa by the gillnet fisheries of Pakistan based on pooled data for 2013 to 2018 (data sources: WWF-Pakistan)

Biological Aspects of Kawakawa

Information about biological aspects of kawakawa were made during December 2016 to December 2018 which indicates that among the 8,317 specimens of kawakawa collected during sampling period, the sizes (fork length) ranges between 29 and 99 cm, however, class intervals between 49 and 69 cm seems to be dominating with peak at size interval of 59 cm (Fig. 5).
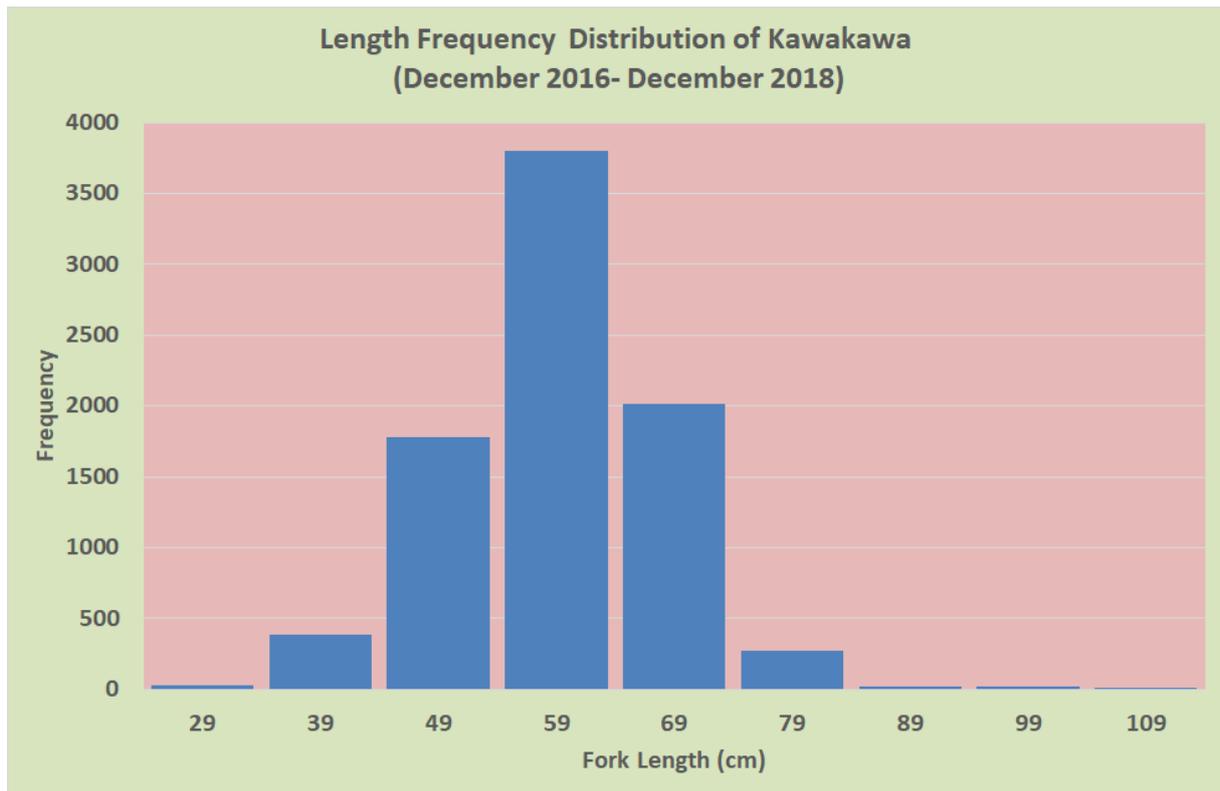
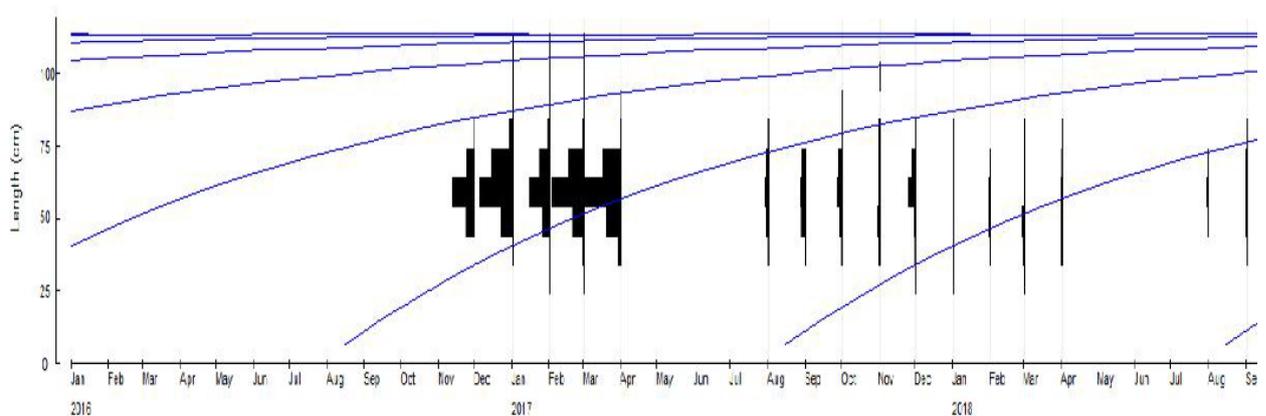Fig. 5. Length frequency distribution of kawakawa (*Euthynnus affinis*) along Pakistan

Fig.6. Monthly length frequency distribution output from FiSAT II with superimposed growth curve of kawakawa from December 2016 to December 2018.

The Von Bertalanffy growth parameters obtained for this species were L∞=114.45 cm, K = 0.96 year^{-1}(Fig.6), which showed this species length attained at the end of 2.3, 3.5 and 4.7th year are found to be 58.0, 62.0 and 64.0 cm respectively (Fig.7). The length-converted catch curve is shown in Fig. 8. The estimated instantaneous rate of mortality (Z) for kawakawa was 3.92 year^{-1}(with 95% confidence interval of slope 1.82 - 6.02). Natural mortality and fishing mortality were estimated 1.165 year^{-1} and 2.76 year^{-1} respectively and exploitation rate was 0.704. The probability of capture curve (Fig.9) showed that the fork length of kawakawa to be attained in 45.63 cm where the probability was 50%.
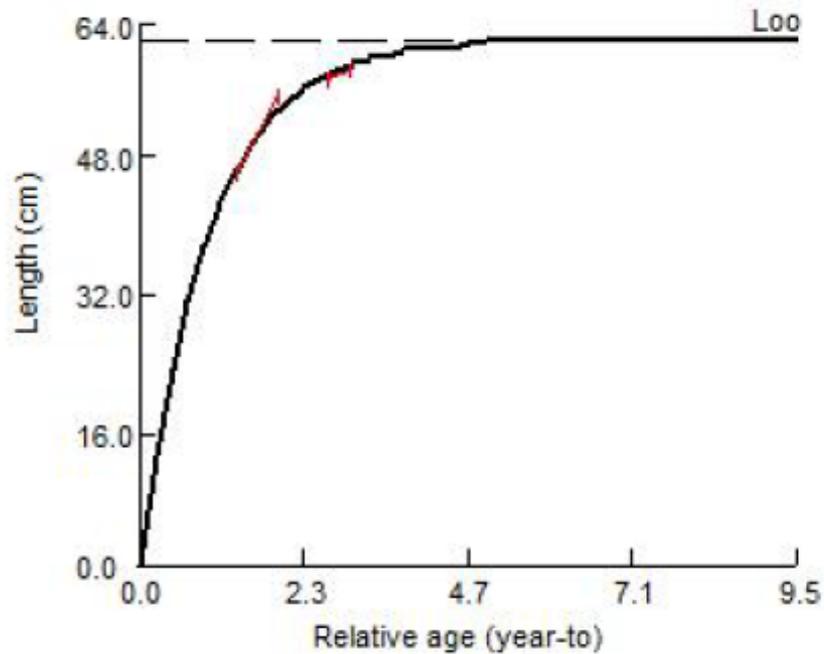
Fig.7. Length at age of kawakawa based on Von Bertalanffy growth parameter from Pakistan coast (December 2016 to December 2018)
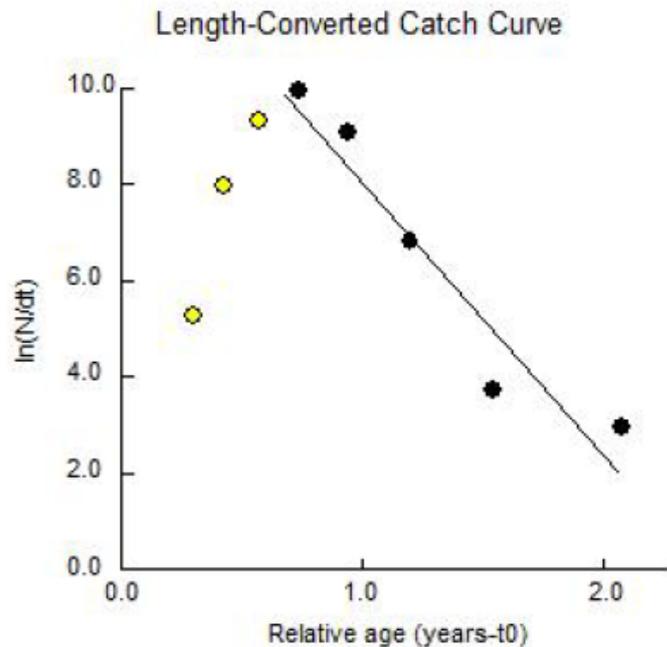

Fig.8. Length-converted catch curve for kawakawa from Pakistan coast (December 2016 to December 2018). Black dost are those used in calculating the parameters of the straight line, the slope of which is an estimate of Z. Yellow dots represent fish not fully selected by the gear used in the fishery and/or not used in mortality estimation
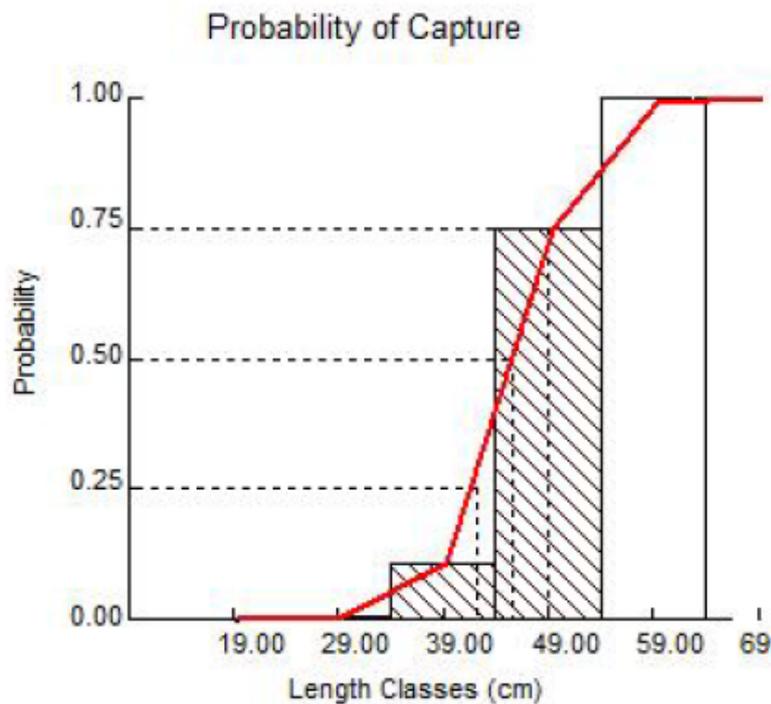
Fig.9. Probability of capture curve of kawakawa from Pakistanbased on data collected from December 2016 to December 2018 (L$_{50\%}$ = 45.63 cm fork length)

The recruitment pattern of kawakawa population along Pakistan coast based on length frequency data collected from December 2016 to December 2018 seems to significantly high during the breeding season as it indicates the strong seasonal recruitment (Fig. 10). Prolong recruitment was noticed during April and October with a peak in August.
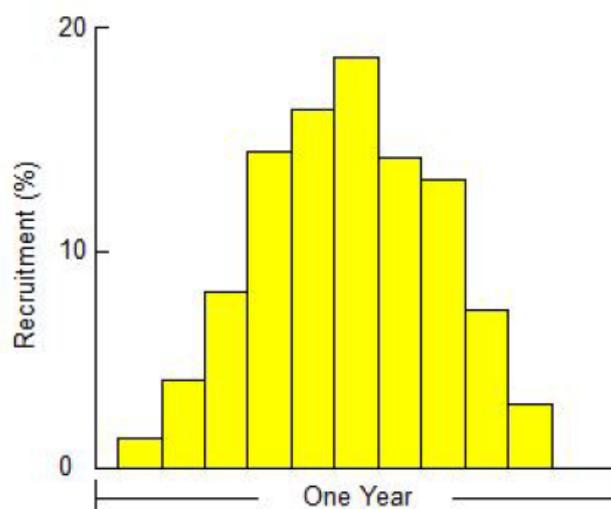

Fig. 10. Recruitment pattern of kawakawa from Pakistan based on length frequency data collected from December 2016 to December 2018.
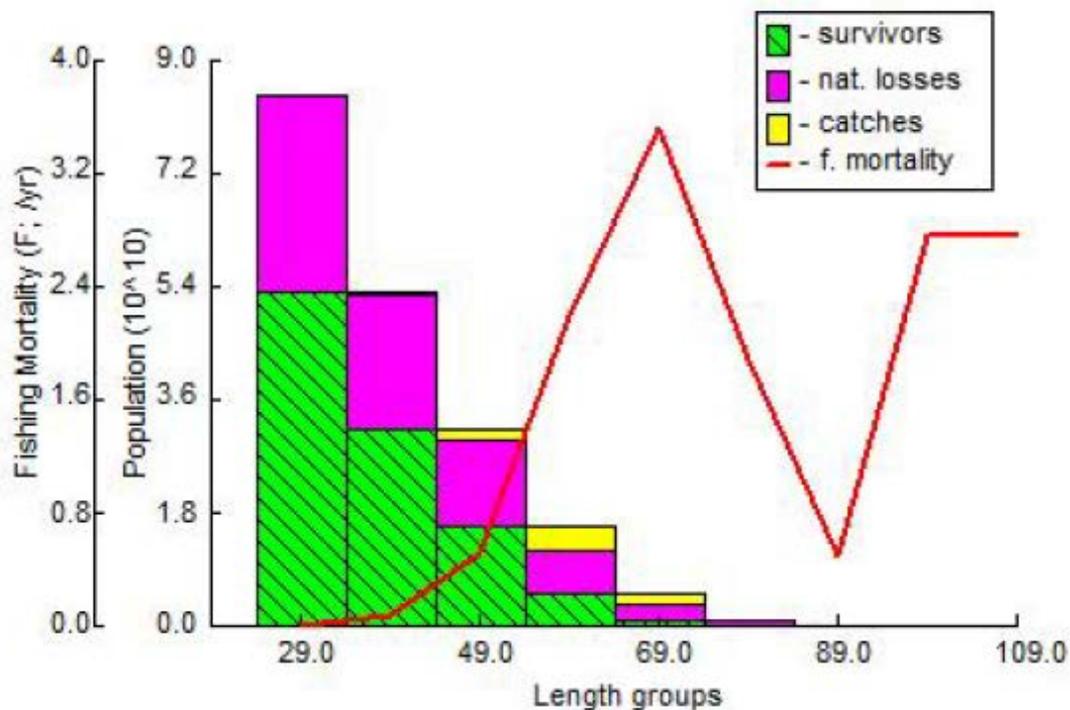
Fig.11. Length-structured VPA of Kawakawa based on data collected during December 2016 to December 2018 (F.Mortality = fishing mortality)

Length-structured virtual population analysis of Kawakawa based on data collected during December 2016 to December 2018 is presented in Fig. 11 which indicates that the maximum number of kawakawa is caught between 59 and 79 cm and the size class that faced maximum fishing mortality (F= 3.6) was 69 cm. From VPA it is evident that the survival rate was highest in in 29 cm size group. This indicates that capture of small specimens and juveniles were comparatively less during the study period, As such the kawakawa population is not under immediate threat due to overfishing. However, to ascertain this, there is a need to study the data from other gears being used in Pakistan.

DISCUSSIONS

Neritic tuna including kawakawa are important component of coastal and offshore fisheries of Pakistan. Presently major tropical tuna species including yellowfin and skipjack caught by the gillnetters along Pakistan coast is being transported to neighbouring country for canning purposes. One of the neritic species i.e. longtail tuna (*Thunnus tonggol*) is also among the preferred species for canning therefore, it is also transported along with other tropical tuna species to the neighbouring country. Other neritic species including kawakawa are consumed locally whereas only a small fraction of these neritic tuna is being processed in salted dried form and exported to Sri Lanka. There is a recent change (since 2017) in disposal as small quantities of kawakawa (annually about 400 m. tons) are exported in frozen form to Thailand and other countries for canning purposes.
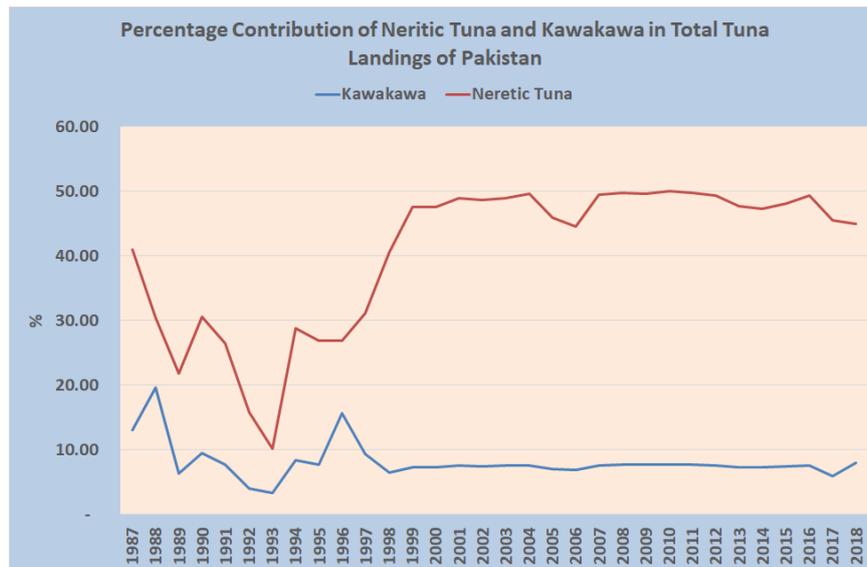
Fig. 12. Percentage composition of kawakawa and neritic tuna in total tuna
production of Pakistan (based on landing data from 1987 to 2018)

Neritic tunas contributes about 44.98 % in total tuna production of Pakistan in 2018
(Fig. 12). Between 1999 and 2018, contribution of neritic tuna in total tuna landings
ranged invariably between 44.95 and 50.05 % indicating their economic importance.
Neritic tunas especially kawakawa and frigate tunas are locally consumed especially
in some of the residential areas of Karachi including slums and squatter settlements.
Neritic tuna species are staple diet and major source of protein in such area. Being
cheaper as compared to other fishes (white meat), neritic tuna are generally
preferred by these communities and is extremely important from food security point
of view. In addition, immigrants from Bangladesh and Myanmar, which have large
settlements in Karachi, prefer neritic tunas over other fishes because of cheaper
rates. Substantially a large proportion of neritic tuna is consumed by the immigrant
population settled in Karachi. The need for sustainable exploitation of neritic tuna in
Pakistan is essentially required to ensure food security of these commuties.

Kawakawa, being largest in size among neritic tunas (excluding longtail tuna which is
transported to neighbouring country) fetches comparatively higher prices whereas
bullet tuna (which is generally of rare occurrence) fetches lowest prices in local
market.

Although WWF-Pakistan in collaboration with Government of Pakistan (Marine
Fisheries Department) has initiated a programme for improvement of data that is
being provided to IOTC based on the WWF-Pakistan's Crew-based Observer
Programme (Moazzam and Ayub, 2017). The landing data of tuna and tuna like
species is not adequately recorded at the landing centres along the coast of
Pakistan. WWF-Pakistan now working with Provincial Fisheries Departments to
establish a credible data collection system at all major landing centres. WWF-
Pakistan will support these department mainly training the concerned staff engaged
in the collection of the data and also help in developing software for storing the data
and its analysis.

Despite importance of neritic tuna, some of the aspects about its fisheries especially bycatch of gillnets being deployed in coastal waters are well understood. Additionally information about discard of tuna fisheries where mainly bullet tuna and smaller frigate tuna is not adequately recorded. Population parameters for neritic tunas are also not adequately known. These information is essentially required to develop a management plan for neritic tuna for Pakistan and other regional countries.

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