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A REVIEW OF PAKISTAN'S RECONSTRUCTED CATCH SERIES FOR TUNA AND TUNA-LIKE SPECIES

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PURPOSE

To provide participants at the Working Party on Data Collection and Statistics (WPDCS-15) with:

i.) an overview of revisions to Pakistan's gillnet nominal catch series (1987-2016) submitted by the Government of Pakistan to the IOTC Secretariat in 2017;

ii.) a review of the catch reconstruction methodology;

iii.) an assessment of the extent to which the reconstructed catches can be validated against known characteristics of Pakistan's gillnet fisheries; specifically developments in the fishery since the mid-1990s.

The paper also presents an overview of WWF's crew based data collection program conducted since 2012, as one of the key datasets used in the catch reconstruction. However discussions on the viability of the crew based data collection in the context of the collection of independent and scientific observer data are beyond the scope of the paper.

KEY FINDINGS

- The IOTC Secretariat highlights a number of concerns regarding the input datasets used by the catch reconstruction; specifically, uncertainties in WWF's estimates of active vessels, and the extent to which data collected by crew members (between 2012-2016) are reliable indicators to revise the Pakistan's historical gillnet catches from the mid-1990s.
- Nevertheless, the IOTC Secretariat concludes Pakistan's revised catches to be an improvement of over current estimates in the IOTC database; particularly in recent years, during which catches have been repeated from 2014 levels in the absence of alternative information.
- The IOTC Secretariat further recommends that the revised gillnet catches be incorporated within the IOTC database, but that uncertainties in the underlying data be noted in order to guide future data reviews or discussions related to capacity building activities in Pakistan.

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1. BACKGROUND

In 2017 the Government of Pakistan revised their official estimates of catches of tunas and tuna-like species, as part of a catch reconstruction exercise conducted in collaboration with WWF-Pakistan. Since then, revisions to the historical catches – dating to the late-1980s – have remained pending upload to the IOTC database subject to an appraisal of the catch reconstruction methodology by the IOTC Secretariat.

The data have also remained pending given the scale of the revisions and potential impact on species whose stock status are currently assessed as overfished and subject to overfishing – notably yellowfin tuna (*Thunnus albacares*), and Spanish mackerel (*Scomberomorus commerson*). In the case of both species, the revised catches are as much as two to three higher than Pakistan's previous official catches since 2010, with catches of yellowfin tuna revised upwards from around ≈7,500 t per annum to over 25,000 t).

Following a mission to Pakistan by the IOTC Secretariat in December 2018, a review of the reconstructed catches was conducted. The findings of the review are presented in this paper for the consideration of the WPDCS.

2. FISHERIES DATA COLLECTION IN PAKISTAN

Pakistan's official data on landings are collected by two provincial fisheries departments (Sindh and Balochistan), which are reported to the federal Marine Fisheries Department for compilation and submission to international organizations, including FAO and IOTC.

However official estimates of total catches are generally accepted to be significantly underestimated, with serious gaps in the data even for the main commercial fish species (Hornby et al., 2004; FBS, 2009). Data collection is focused on the 7 major landing centres located in the two provinces, while catches for the 58 smaller landing sites are mostly estimated as no mechanisms for monitoring landings are in place. Catches for landing sites that are available are mostly taken from fish auctioneers, which are often under-reported or lack detailed information on the catches-by-species beyond the main commercial species. Hence a report by the National Account Statistics in 2008/2009 estimated that official catches are likely to be under-reported by at least 30% (FBS, 2009).

The most reliable data available on Pakistan's tuna catches were collected during an IPTP sampling program conducted in Karachi and Balochistan between 1985-1996. Information regarding tuna landings was recorded by interviewing the skippers/tindals of incoming pelagic gillnetters unloading their catches at the harbour. Prior to 1985 very little sampling of landings was conducted in Pakistan.

There are also fundamental gaps in other areas of Pakistan's fisheries data collection. No VMS or logbook system is in place for tuna gillnetters, including vessels operating offshore. Vessel registrations and estimates of active vessels are also considered to be highly unreliable for most years, with the only vessel censuses conducted in 1986 and 2010-2011. While a central registry for fishing vessels exists within the Marine Mercantile Department, there are often long delays updating the electronic records of new vessels and non-operational vessels. A number of registered fishing vessels may also be largely involved in transporting fish to neighbouring countries or between ports rather than actively fishing, while a number of larger scale tuna gillnet vessels may also be double-registered in Pakistan and I.R. Iran (Khan, 2017).

WWF-Pakistan's crew based data collection program

In response to the gaps in Pakistan's fisheries statistics, in 2012 WWF-Pakistan[2] began a crew-based data collection programme onboard tuna gillnet vessels. The aim was to improve the estimates of tuna and tuna-like species, as well as the information on bycatch species, including incidences of entanglement and mortality of cetacean and other endangered, threatened and protected (ETP) species by Pakistan's tuna gillnet fisheries.

Appendix 1 provides a copy of the data collection forms used by crew members. Data is recorded daily on the quantity and estimated weight of all tunas and tuna-like species, bycatch including species of sharks, as well as vessel and trip details including location of the net deployment and retrieval, and gear configuration. After the end of each trip, crew members collecting data are interviewed by WWF-Pakistan in a debriefing session in which the trip details reviewed and the information stored in the WWF office in both hard copy and electronic format (Moazzam and Khan, 2018).

During the course of the WWF program it became apparent that the landings data for tuna species reported by Government of Pakistan differed considerable from the data compiled by WWF-Pakistan. A decision was eventually made to reconcile the two data sources for Pakistan's gillnet fisheries.

Considering the extent of the disparities between the previous official estimates submitted to IOTC for earlier years and estimates of total catches generated though the catch reconciliation process for 2013–2017, it was decided that data for previous years (i.e., 1987-2012) should be also revised –

[2] With the financial assistance of Indo-Pacific Cetacean Research and Conservation Foundation (IPCRCF), Australian Marine Mammal Center, Australian Antarctic Division, Government of Australia, and the ABNJ Project.

taking into consideration various factors including the impacts of piracy, developments in the gillnet fisheries, as well as extrapolation of the data reported through WWF's crew based program.

In 2017 the reconstructed data set was finalized and officially submitted to the IOTC Secretariat by the Government of Pakistan. Since then, the revised catches estimates have remained pending upload to the IOTC database until an appraisal an assessment of the catch reconstruction could be conducted.

3. OVERVIEW OF THE CATCH RECONSTRUCTION METHODOLOGY

The catch reconstruction of Pakistan's gillnet catches utilizes the standard approach to estimate total catches by taking following components:

i.) the number of active gillnet vessels;
ii.) average catches per vessel (for sampled vessels);
iii.) average species composition of catches;

- Multiply the number of active vessels in each year by the average catch of sampled vessels, to estimate the total catches for all gillnet vessels.
- Estimates of total catches are then disaggregated by species according to the catches-by-species reported by sampled vessels, in combination with any other information from landings data.

Further details of each data input are provided below:

i.) Active vessels:

- Estimates of active vessel numbers are based primarily on the results of vessel censuses conducted in 1986 and 2010-2011. For all other years, vessel numbers were estimated by WWF-Pakistan based on empirical knowledge of the fishery. For example, during the years of Somali piracy in the late-2000s, a number of offshore gillnet vessels ceased fishing altogether (compared to other vessels that relocated to fishing grounds within Pakistan's EEZ).
- According to WWF Pakistan, around a total of 700 gillnetters are in operation in Pakistan, of which:
  - around 300 are large tuna gillnet vessels between 15-25m LOA, and account the majority of catches of tunas and tuna-like species (Fig. 1);
  - around 400 comparatively smaller vessels that operate predominately in coastal waters and account for catches of neritic tunas.

Figure 1. Selected pictures of Pakistan tuna gillnets. Source: WWF-Pakistan.

ii.) Average total catches per vessel:

Estimated based on vessels sampled by WWF's crew-based data collection program. Information collected by provincial authorities includes only estimates of total landings, not total landings per vessel, and so cannot be used to derive average catches per vessel.

iii.) Species composition of catches:

Estimated based on catches collated by WWF's crew based data collection, as well as official landings data provided by the Balochistan province and from small scale fisheries. Results of the sampling program conducted by IPTP, including estimates of total catches and catch-by-species, were used for the period 1985-1996.

For the period 1987-1996, estimates of total catches and catches-by-species are largely based on the results of the IPTP sampling program, which were already incorporated in previous official data submitted by the Government of Pakistan. As such, only minor revisions were carried out of the catches during this period.

4. CATCH RECONSTRUCTION: RESULTS

The results of the reconstructed catch series are presented below, including comparisons with current catches in the IOTC database, and the extent to which the revised catch series reflects developments in Pakistan's gillnet fishery.

4.1 Main species groups

Percentage share of catches by species group: Differences between the reconstructed catches and current IOTC estimates are relatively minimal in terms of the percentage share of catches by main species groups (Fig. 2a). Catches in both datasets are dominated by neritic tunas and seerfish,

accounting for between 60-70% of catches per annum; followed by tropical tunas with ≈20-30% of catches; and billfish with ≈10-15% of catches.

Estimates of total catches by species group: Differences between the data sets are much greater in terms of the estimate of total catches (Fig. 2b). Higher catches are estimated for the reconstructed catches particularly the early-2000s onwards, following the results of the WWF program which concluded official landings to significantly under-report total catches.

Also notable are the sharp increase in the reconstructed catches from the 2012 onwards (increasing from around 65,000 t in 2012 to over 100,000 t in 2016 and 2017).According to WWF sources, unusually high catches of tunas were reported in recent years; in addition, there may also have been an increase in the number of vessels in response to high demand for tuna in neighbouring countries of I.R. Iran and Sri Lanka.

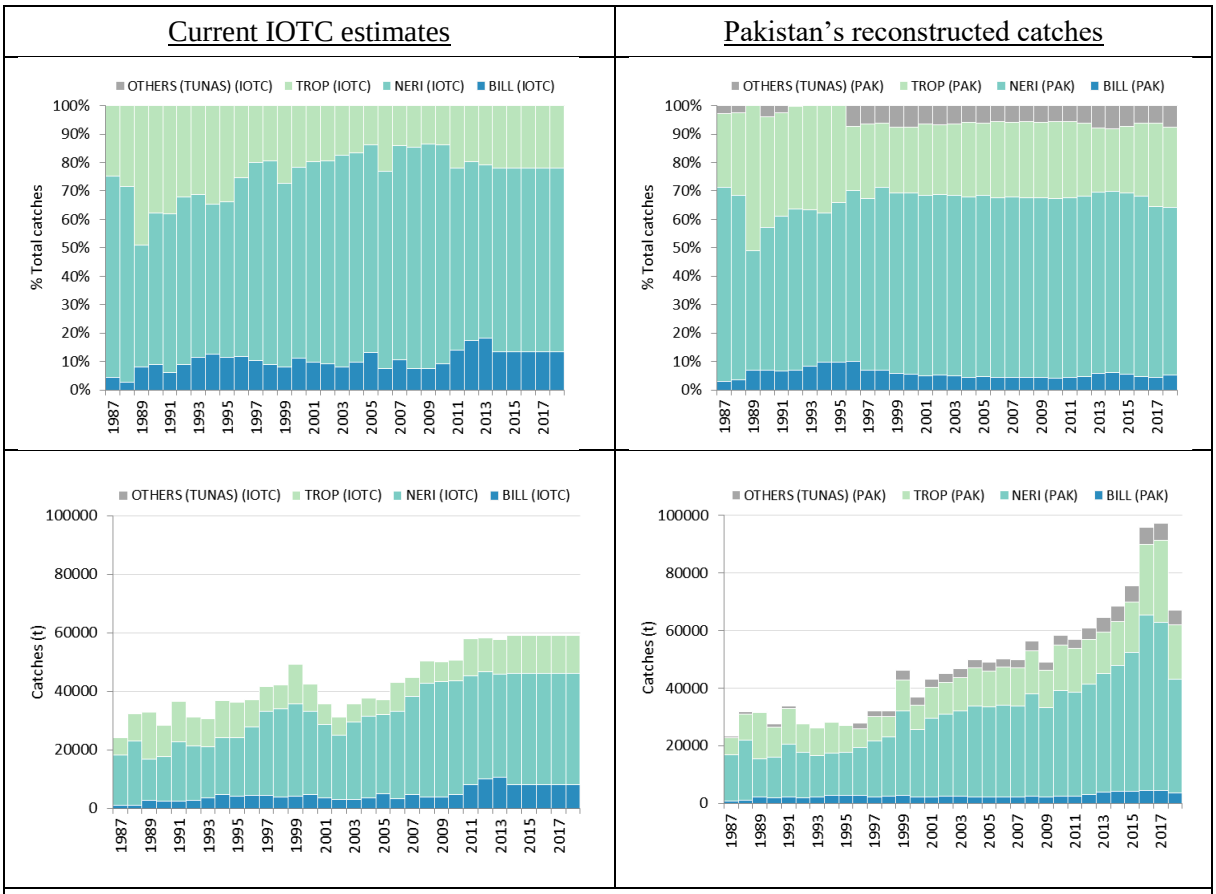

Figure 2. Comparison of current IOTC estimates and Pakistan's reconstructed catches in terms of:

a.) percentage share of catches by species groups (top left; top right)
b.) estimates of total catches (bottom left; bottom right)

4.2 Species level comparison

At species level, differences between the reconstructed catches and current IOTC estimates are more evident (Fig. 3); including a number of major deviations in addition to the sharp increase in catches in recent years discussed in the previous section. In many cases trends in the reconstructed catches can be accounted for by a number of developments in Pakistan's gillnet fishery in the last 20 years, including: the impact of Somali piracy, changing fishing grounds from offshore to predominantly coastal areas, or developments in fishing operations such as the use of sub-surface gillnets.

A discussion of the results for a number of the key species is presented below.

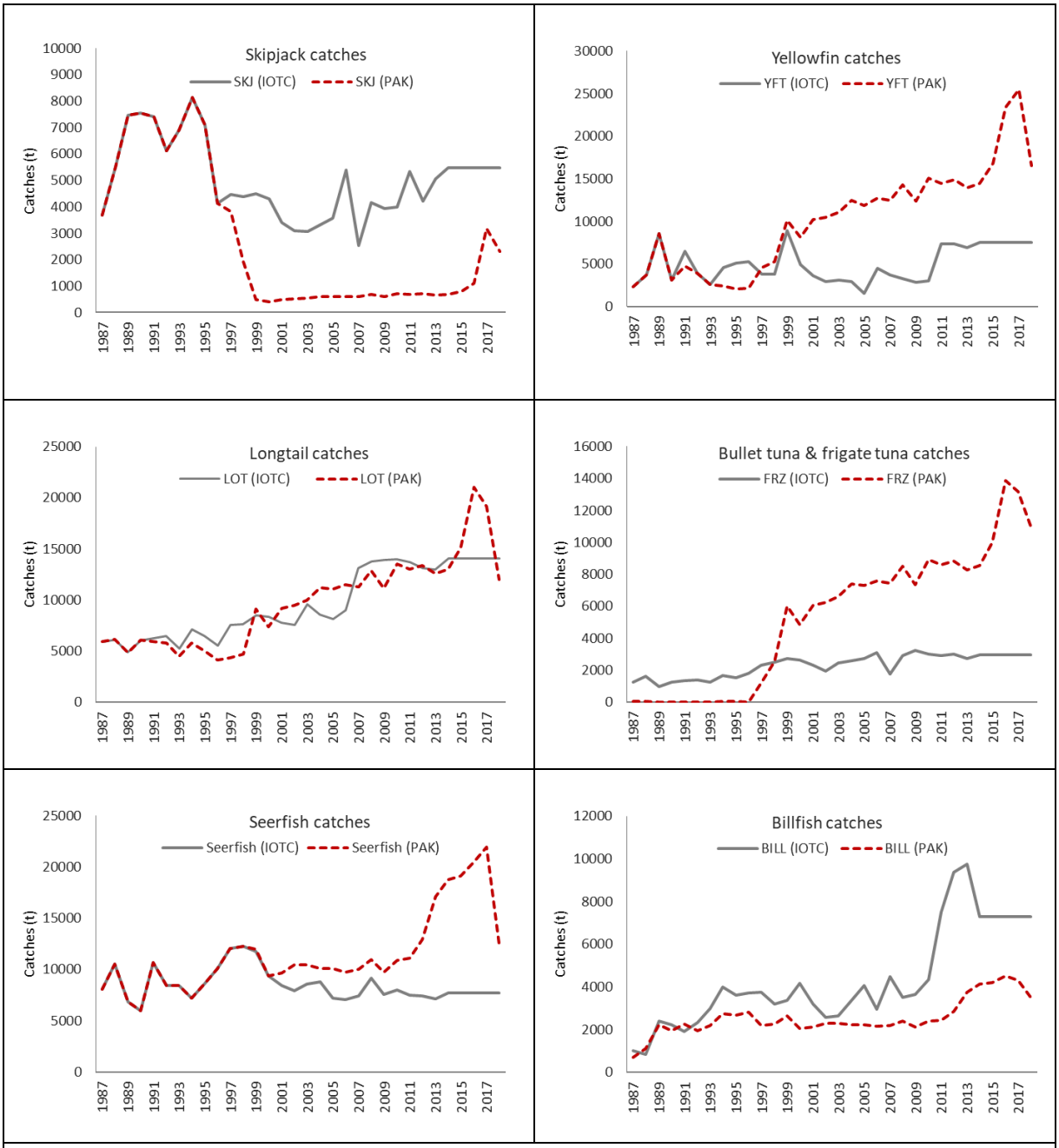

Figure 3. Comparison of current estimates (IOTC) and Pakistan's reconstructed catches (PAK).

Skipjack Tuna:

- Pakistan's gillnet fishery has traditionally operated in Somali waters, in cooperation with leaders of Bosaso in the Gulf of Aden, with up to 200 vessels operating in the waters of Somalia, Yemen (around Socotra) and Oman until the mid-1990s. The importance of Pakistan's offshore fishery can be seen in the relatively high catches of skipjack tuna, which peaked in 1996 at around 8,000 t.
- With the establishment of Puntland in 1998, the conditions for Pakistani vessels to operate in the area became more difficult and a major part of tuna fleet stopped fishing operations in the area and instead confined their fishing grounds closer to the coast of Pakistan.
- Also around the mid/late-1990s, the decline in prices for salted dried products in Sri Lanka and increase in fuel prices contributing to the decline of offshore fishing operations and decline in catches of oceanic species (including skipjack tuna) around this time.
- Taking these factors into account, the reconstructed catches appear more reasonable in accounting for the sharp decline in skipjack tuna in the mid-1990s as a result of the shift in fishing operations to coastal waters and changes in targeting to neritic tunas (such as frigate tuna) and seerfish.
- Since 2016, landings of skipjack tuna have started to increase as gillnet vessels have expanded their offshore operations again, in response increasing prices of skipjack in neighbouring countries, as well as a decrease in the threat of piracy in Somali water –which, again, are reflected more accurately by the reconstructed catches rather than current IOTC estimates.

Frigate Tuna:

- Prior to 1997 there was very little demand for frigate tuna due to relatively low prices in Sri Lanka, or salted dried products. Until the mid-1990s Pakistan's coastal gillnet fleet was engaged mainly in bottom set gillnetting and gillnetting with large mesh for demerso-pelagic species; therefore, catches of frigate tuna until1996 are largely considered to be insignificant.
- Catches of frigate tuna began to increase from the late-1990s, during the time that most of the gillnet fleet (including both bottom set and pelagic) moved towards catching Indian mackerel in shallow coast waters. This change in targeting resulted in a major increase in landings of frigate tuna, albeit as a non-target species.
- The use of monofilament nets also became more common place by fishing vessels in this sector, which also contributed to the increase in catches of frigate tuna.
- Again, taking all these factors into account and the reconstructed catches appear to more accurately reflect the increasing catches of frigate tuna from the late-1990s, compared to current IOTC estimates which maintained catches around the same levels as the IPTP sampling in the mid-1990s.

Yellowfin tuna:

- The reconstructed catches for yellowfin tuna are notable for the sharp increase in catches in 2016 and 2017, during which catches increased +60% from 16,800 t in 2015 to >25,000 t in 2017.
- This increase is largely attributed to a period of unusually high catches, in addition to changes in fishing operations, such as the introduction of sub-surface gillnets which are more effective at targeting tunas (rather than billfish and dolphinfish associated more with Pakistan's surface gillnets).
- A second characteristic of the reconstructed catches are how closely yellowfin catches follow the same trend as neritic tunas. This is not coincidental, as Pakistan's catches of yellowfin tuna and longtail tuna are largely driven by the demand in I.R. Iran – where almost all of catches are unloaded, rather than for domestic consumption.
- Fish consumption in Pakistan is around the lowest in the world (at around 2kg per year); the importance of catch trends in Pakistan's tuna fisheries being driven by the demand from neighbouring countries such as I.R. Iran and Sri Lanka should not be underestimated.
- Likewise, the 35% decline in catches between 2016 and 2017 is attributed to falling demand by I.R. Iran, as prices for tuna have collapsed due to depreciation of the Iranian Rial.

4.3 Implications on total catches in the Indian Ocean

While the revisions are significant in the context of Pakistan's national fisheries – particularly in the case of tropical tunas – the impact on the total catches in the Indian Ocean should not be over stated. In the case of species with the largest revisions, the impact on total catches in the Indian Ocean can be summarized as follows:

- Skipjack tuna: -1% per annum
- Yellowfin tuna: up to +4% per annum
- Spanish mackerel: between 2% to 10% per annum
- Bullet and frigate tuna: between -4% to +11% per annum

5. VALIDATION OF THE RECONSTRUCTED CATCHES

Validation of the results of the reconstructed catches is generally problematic due to the lack of alternative data sources. Official catches of landings reported by the Government of Pakistan are considered to be incomplete, while the lack of data available from port sampling, logbooks, or scientific observers limits the extent to which the reconstructed catches can be compared.

Estimates of the nominal CPUE is possible, albeit using the relatively crude measure of average catches per vessel per year. However, as already noted, the number of active vessels is considered to

be highly uncertain with no official sources information available on active vessel since the previous vessel census conducted in 2010-11.

Figure 4 shows the nominal CPUE of the reconstructed catches, using the number of active vessels estimated by WWF-Pakistan. The chart indicates that average catches of tuna and tuna-like species per vessel have risen by almost 300% since the late 1990s (from around 50 t per vessel per annum in 1996, to almost 150 t per vessel per year by 2016).

Comparisons can also be made the CPUE of Iranian gillnets which, broadly speaking, are similar in terms of the size of vessels and also fishing operations. While Iran's CPUE is somewhat unexpectedly lower than for Pakistan vessels, the CPUE trend appears to increase at a similar magnitude as Pakistan – at least up until the late-2000s.

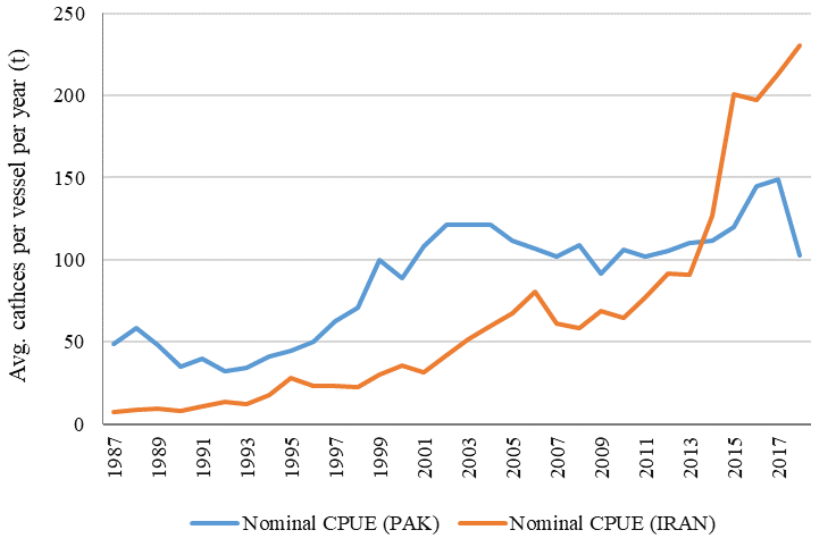

Figure 4. Nominal CPUE for Pakistan and I.R. Iran gillnets (average catches per vessel per year).

The apparent increase in the Pakistan's nominal CPUE can be attributed to a number of developments in the gillnet fishery from the mid-1990s onwards; some of which are likely to have directly resulted in higher catches of tunas and tuna-like species. For example:

- Increases in the average length of gillnets from 3-5km to 7km.

  The increase in the average size of nets is likely one of the main explanations for the increase in catch per unit effort from the late-1990s. The change in gillnet size started around late 1990's when a large number of fishermen shifted to bottom set gillnetting for sharks, which use gillnets of more than 7 km in length. During periods of low catches of sharks, the fishermen shifted to surface gillnetting for tuna. With the collapse of shark fisheries in 2003–2004 almost the entire fleet moved to surface gillnetting and targeting tunas, while continuing to use gillnets up to 7 km in length.

- Increasing market demand for tuna and salted dried fish products after the early-2000s.

  Prior to the late-1990s, a major part of Pakistan's gillnet fleet operated in coastal waters targeting demersal and demerso-pelagic species because of their relatively high prices in local markets. Relatively low prices for tuna and salted dried fish products incentivised fishermen to target other species which fetch higher prices, such as barracuda, queenfish, kingfish, sea breams, snappers, croakers and sharks. As a result, the catch-per-unit effort for tuna and tuna-like species are lower compared to the period following the early-2000s which coincided with a period of unprecedented increases in the prices of yellowfin tuna and skipjack tuna in neighbouring countries.

6. CONCLUSIONS

The Government of Pakistan and WWF-Pakistan – with the support of ABNJ and other stakeholders – should be acknowledged for their initiative to improve the status of fisheries data collection in Pakistan in recent years and efforts to comply with IOTC's mandatory data reporting obligations. Likewise, efforts to revise the Pakistan's historical catches in light of new information collected by WWF in recent years should also be commended.

The implementation of WWF's crew based data collection program since 2012 has succeeded in supplementing important gaps in Pakistan's fisheries data collection, while providing valuable insights into the operation of Pakistan's gillnet vessels. The program should be credited with not only improving the data available for tunas and tuna-like species – subsequently used in the catch reconstruction – but also the data on bycatch associated with Pakistan's gillnet operations (Fig. 5) (Moazzam, 2019). Specifically:

i.) Seasonal changes in catches of bycatch species: Data collected by crew members indicate that the quantity of bycatch by gillnetters exceeds those of tuna species during the months of September, and between November to January.

ii.) Species composition of bycatch: The data also indicates that gillnet bycatch is predominantly composed of sharks and dolphinfish, followed by sailfish and queenfishes.

iii.) Incidences and mortality rates of cetaceans, turtles and other ETP species: Reports from crew members indicate cetaceans contribute ≈1% and turtles ≈2% of total catches, while there is also evidence of strong seasonality in the entanglement of turtles and cetaceans. Also during entanglement, almost all dolphins die, whereas almost all turtles survive.

iv.) Effects of subsurface gillnets on bycatch: The data available suggests an increases in catches of target (tuna) species, and decreases in the incidences of bycatch species such as billfish and dolphinfish.

Figure 5. Selected photos of WWF's crew based data collection program. Source: WWF-Pakistan

Evaluation of the reconstructed catches

In terms of the reconstructed catches, derived in part from the crew data collected by WWF, a number of points are made in support of the revised catch series:

- The revised catches appear to more accurately reflect the general trends in Pakistan's gillnet fishery over the last 20 years; specifically
  - changes in targeting: specifically the decline in catches of skipjack tuna and increases in yellowfin tuna, neritic tunas and seerfish, mostly the result in the shift in fishing grounds from offshore waters to coastal areas from around the mid-1990s;
  - changes in fishing operations: such as the introduction of sub-surface gillnets in recent years, and increases in catches of yellowfin tuna and decrease in catches of billfish and bycatch;
  - fluctuations in the catch trends driven by economic factors: such as the price of diesel or changing market conditions in Sri Lanka and I.R. Iran.
- The data collected by crew members means that Pakistan is now also able to report catches-by-species in greater detail, including species of neritic tunas and since 2018 species of billfish.

Criticisms of the methodology

Nevertheless, a number of potential shortcomings can be highlighted with the reconstructed catches:

1.) The principal concern is the extent to which data collected by WWF for a sample of vessels between 2012 and 2016 can be used as the basis to reconstruct catches dating back to the mid-1990s, particularly given the number of changes to Pakistan's gillnet fisheries highlighted above. While the WWF program began in 2012, the majority of data refer to fishing operations conducted in 2015 and 2016 (as the number of data collectors were increased from 2 in 2012, to 23 in 2015, and 65 in 2016). The proposition is that data collected by crew members – mostly relating to fishing operations over a1-2 year time period – are considered a reliable enough indicator to reconstruct catches back to the mid-1990s, including estimates of the species composition and average catches per vessel.

2.) The lack of access to alternative data, such as logbooks or port sampling, to validate the reconstructed catches was a common issue throughout the review. While Pakistan and I.R. Iran's nominal CPUEs are broadly comparable, the differences are equally large enough to raise questions on the accuracy of Pakistan's active vessel numbers or average catches per vessel used to generate the reconstructed catches. The estimate of active vessels in particular is a critical component of the catch reconstruction, but also considered highly uncertain with no official data available since last vessel census conducted in 2010-11. Thus, even while the catch trend generally appears reasonable – given the prevailing knowledge of Pakistan's gillnet fisheries – verification of the trend and revised catch estimates is difficult to independently assess.

   Assuming the continuation of Pakistan's crew based data collection programme, a second follow-up review may be warranted, as additional information over a longer time period becomes available; and also the possibility that Pakistan's catches are refined again (albeit by a much smaller magnitude than the revisions presented by this paper).

3.) Another concern is the extent to which the data reported by crew members are representative of the gillnet fleet as a whole, given that vessels are essentially a self-selected sample (based on the willingness of boat owners to voluntary collect information on their fishing operations).Again, the absence of alternative operational level information, such as logbooks or scientific observers, to validate the results of WWF's data means that no assessment of potential bias in the data can be made.

4.) The extent of the IOTC Secretariat's review of the reconstructed catches should also be acknowledged. The Secretariat's access to the raw data collected by crew members was limited to a sub-sample of around 10 vessels – due a back-log entering data from paper-based data forms by WWF-Pakistan, as well as technical issues in extracting bulk data from the database developed for the program. As a consequence, the IOTC Secretariat was unable to conduct a thorough

review of the underlying raw data as part of the review. Instead the focus of efforts was placed on the results of the revised catches and catch estimation methodology.

Despite these concerns, the IOTC Secretariat concludes the reconstructed catches to be an improvement of over current estimates in the IOTC database; particularly in recent years, during which catches have been repeated from 2014 levels in the absence of alternative information.

The IOTC Secretariat further recommends that the catches be incorporated within the IOTC database – pending the approval of the WPDCS – but that uncertainties in the underlying data are noted in order to guide future data reviews or discussions related to capacity building activities in Pakistan.

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Appendix 1. Copy of WWF-Pakistan's crew based data collection form.

A copy of the data collection forms used by crew members onboard gillnet vessels is shown below. Data is recorded on the quantity and estimated weight of all tunas and tuna-like species, bycatch including species of sharks, as well as vessel and trip details including the GPS location of the net deployment and retrieval, and gear configuration including the number of panels.

TUNA FISHERIES INFORMATION

Date_____ Name of Place _____ Time _____

Name of person writing information _____ Name of Boat _____ Registration No. _____

Type of Boat _____ Fish catching Method _____ Duration_____

Area of Fishing _____ No. of Persons on-board _____ Name of Captain _____

No. of Panels _____ Length of one Panel _____ Length of net _____

Breadth of net _____ Ice on board _____ Ration _____Diesel _____

Water _____ No. of Storage Compartments _____ Filled in Compartments _____

Quantity of fish (weight) _____ Placed with Ice _____

Quantity of fish discarded _____ Fish without ice _____

Net Laying position (GPS _____N___ Net Heaving Position (GPS) _____N_

_____E_____E

TYPES OF TUNA

Type of Fish	Total Number	Total Weight	Fish Disposal/with ice
Yellowfin tuna			
Longtail tuna			
Skipjack			
Kawakawa			
Frigate tuna			
Bullet Tuna			

BYCATCH SPECIES

Type of Fish	Total Number	Total Weight	Fish Disposal/with ice
Billfish			
Dolphinfish			
Narrow barred Spanish mackerel			
Shark (Type)			
Dolphin/Whale			
Turtle			
Any other species			

INFORMATION ABOUT MARKET

Auctioned in Fish Harbour _____ Sent to Iran by Boat _____

Sent to Sri Lanka _____ Sold for Karachi Market _____

Fish Sent for Processing _____ Any Other _____

INFORMATION ABOUT TUNA/OTHER SPECIE S LENGTH

Tuna/Other Species	Total length