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A critical review on the PBF length-composition data for the EPO purse seine fishery with new data collected at Mexican PBF pen rearing operations

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SUMMARY

A PBF stock assessment is to be conducted in November 2012 by the Pacific Bluefin Working Group (PBF-WG) of the International Scientific Committee (ISC) for Tuna and Tuna-like species in the North Pacific Ocean. One of the important pieces of information that is included in the PBF Stock Synthesis assessment model are length-composition data from which selectivities are estimated for different fisheries acting on the PBF stock.

In this paper, we first critically review the available historic PBF length-composition data from the EPO purse seine fishery. Although the observed length range remained more or less stable over the historic period, the same cannot be stated for the average length of the catch. While the average length of the catch fluctuated around about 75 cm (1-year old fish) before the mid-1980s, there is a clear shift towards larger fish beginning around the mid-1980s. Average length of the recent Mexican PBF fishery is centered at about 85 cm (2 year olds). We propose three time blocks of selectivity for the EPO purse seine fishery: 1952-1982 (US PBF target fishery); 1983-2001 (a transition phase which includes the US extinguishing and Mexican PBF opportunistic fisheries, as well as a development phase of the Mexican PBF target fishery); 2002-present (fully developed Mexican PBF target fishery).

Concerns have been raised at previous ISC PBF-WG meetings about the representativeness of available Mexican length-composition data obtained from IATTC at sea observer and port sampling programs. For comparison purposes and validating (or not) the reliability of available IATTC PBF length-composition data for the Mexican fishery, we present PBF length-composition data collected from stereoscopic underwater cameras during pen transfer operations which took place in 2010 and 2011. The PBF average length estimates from the pen data collected in 2010 and 2011 are 92.2 cm (n=1,476) and 92.6 cm fork length (n=2,829), respectively. The new PBF length data collected during pen transfer operation matches very well the IATTC observer data collected during the same trips, as well as the length-composition data used in the stock assessment model.

CONSTANT OR TIME-VARYING PURSE SEINE SELECTIVTY IN EPO?

Among the key assumptions that need to be defined in the stock assessment model is the nature of the selectivity curves acting on the PBF stock. Specifically, decisions need to be made about the shape (functional) form and the temporal variability (constant or time-varying) of the selectivities for the different fisheries. In the PBF assessment, the parameters that define the selectivity curves are estimated internally in the stock assessment model while fitting to length-composition data. In the early PBF stock assessment (Anonymous, 2007), a single (constant) selectivity curve is assumed for the purse seine fishery in the EPO while fitting simultaneously to US and Mexican PBF length-frequency data. However, there have been major changes in the fishery over time (ISC/07/PBF-3/01), and allowing for time-varying selectivity may be necessary to remove the PBF catch out of the correct age-classes in the EPO.

In short, there were two major events which marked the history of the fishery. The first was the gradual abandonment of traditional PBF fishing grounds along the coast of Baja California by US purse-seine vessels targeting PBF, which began in the early 1980s. The second was the emergence of a Mexican PBF target fishery for farming purposes in 1999. A proposal was made to divide the fishery into three episodes for stock assessment purposes (Figure 1; see ISC/07/PBF-3/01 for details): 1) US PBF target fishery (pre-1992); a transition period dominated by an extinguishing US PBF fishery (1993-1998); and a Mexican PBF target fishery for farming (pen rearing) purposes (1999-present). We propose a revision of the temporal definition for the recent Mexican fishery. Specifically, it seems more appropriate to consider the Mexican fishery to be fully developed in 2002 rather than 1999, followed by a development (experimental/learning) phase from 1996 to 2001. In 2001, deep purse seine nets were developed and introduced by one company to catch larger fish. But it is only in 2002 that deep nets became widely adopted by the fishery.

There are some distinct patterns in the EPO purse seine PBF length-frequency data (Figure 2). Although samples show high temporal variability, it seems reasonable to conclude that a dominant observed length range of approximately 50-150 cm fork length (FL) remained more or less stable over the historic period of the assessment. Occasionally, this range expanded or contracted in some years (e.g., very large fish above 150-200 cm caught in the late 1980s, no smaller fish close to 50 cm observed in early 2000s).

Although the observed length rage remained stable over the historic period, the same cannot be stated for the average length of the catch (Figure 2). While the average length of the catch fluctuated around about 75 cm (1-year old fish) before the mid-1980s, there is a clear shift towards larger fish starting around the mid-1980s (shift to extinguishing phase of US fishery). The variability of the length composition data is particularly high after the mid-1980s, which reflects the opportunistic nature of the extinguishing US and Mexican (targeting yellowfin) fisheries at the time. In 1996, the Mexican PBF target fishery initiates and goes through an experimental and learning phase from 1996-2001. From 2002 onwards, the Mexican fishery can be considered fully developed with deep nets widely adopted by the fleet. Average length of the Mexican PBF target fishery is centered at about 85 cm (2 year olds), but can vary towards larger (2003 and 2004) or smaller fish (2008). There are concerns about the representativeness of the available Mexican length-composition data obtained from IATTC at sea observer and port sampling. We address these concerns in the following section of this paper.

The information described above illustrates the time-varying nature of the EPO purse seine fishery. A time-varying selectivity process needs to be incorporated in the PBF stock assessment model in order to remove the catch out of the correct age-classes in the EPO. We propose three main time blocks of selectivity for the purse seine fishery in the EPO:

- 1952-1982: US PBF target fishery (following ISC/07/PBF-3/01)
- 1983-2001: Includes the US extinguishing (1983-1998) and Mexican opportunistic fisheries (1983-1995), and the more recent experimental/ learning phase of the Mexican PBF target fishery (1996-2001). Considering the high variability observed in this period, a full time-varying approach may be desirable within this block (see Aires-da-Silva and Maunder, 2012 for different methods which could be applied).
- 2002-present: Fully developed Mexican PBF target fishery.

VALIDATION OF AT SEA OBSERVER DATA WITH INDEPENDENT SAMPLES FROM PEN TRANSFER OPERATIONS

Ideally, PBF length-frequency data collected at the time of transfer to pens would provide the most reliable information about the length-composition of the PBF catches taken by the Mexican fishery. Unfortunately, obtaining this type of data from live fish has been difficult to obtain due to its high commercial value, or treated as confidential information when collected by the industry. Two alternative sources of data have been used to provide information on the PBF length-composition of the Mexican PBF catches: 1) samples taken at sea by IATTC observers from fish dying during the catch, transport and transfer operations to the pens; 2) samples taken by IATTC port samplers from unloads to canneries which generally take place when pen capacity at sea is exceeded.

Various concerns have been expressed at previous ISC PBF-WG meetings with respect to potential biases with the PBF length-composition data available for the Mexican fishery. One concern is that length-frequency samples taken by IATTC observers at sea are biased low. Since these samples are taken exclusively from dead fish, they may be representative only of the less fit, maybe smaller fish in the school. Another possible source of negative bias is that resulting from vertical segregation of the school by size in the purse seine net. This could result from the larger fish usually found deeper in the net not being available for sampling. More recently (May 2012 meeting), there was disagreement whether the purse seine selectivity in the EPO has shifted towards larger fish in the more recent decades, as we illustrated in the previous section.

For comparison purposes and to validate (or not) the reliability of available IATTC observer/port sampling PBF length-composition data for the Mexican PBF target fishery, we obtained PBF length-composition data collected during pen transfer operations. Stereoscopic cameras have been recently introduced in the bluefin ranch sector and are utilized to obtain counts and estimates of individual fish lengths as well as weight composition data, under at sea transfer conditions. This state-of-the-art technology provides a large volume of high-quality length-frequency data (Phillips et al, 2009).

In this document, we present PBF length-composition data taken by stereoscopic cameras during pen transfer operations which took place in 2010 and 2011. The minimum, average and maximum fork length (FL) estimates obtained for each holding pen sampled are shown on Figures 3a and 3b for 2010 and 2011 (22 and 20 pens, respectively). Each of the sampled pens had a holding capacity between 40 to 60 tons. Most of the fish sampled in 2010 were above 80 cm FL, with the smallest and largest fish observed at 77.5 cm and 122 cm FL, respectively (Figure 3a). Samples taken in 2011 were more variable, with the smallest and largest fish measured at 34 cm and 145 cm FL, respectively (Figure 3b).

Sampling effort (numbers of fish measured) is shown on Figures 4a and 4b, for 2010 and 2011, respectively. A total number of 1,476 and 2,829 fish were measured in 2010 and 2011, respectively (total of 4,305 individual length measurements). Taking into account the sample size for each holding pen and its corresponding average length, a weighted average length was computed from the pen samples collected in 2010 and 2011. The weighted average length estimates for 2010 and 2011 are 92.2 cm (n=1,476) and 92.6 cm FL (n=2,829).

Figure 5 shows a comparison between the PBF pen transfer length-composition data described above and comparable IATTC observer data. By "comparable" we mean that we queried for PBF length-frequency data in the IATTC observer databases originating from the same trips from which the pen samples were obtained. At-sea observer samples matching the "pen samples" were available for 2010 only (379 fish).

Two length modes are clearly identifiable in the PBF length-frequency samples collected by IATTC observers in 2010 during the same trips from which the independent pen data were obtained: a dominating length mode centered at about 90 cm (2 year old fish), and a second but much weaker mode at about 110 cm (3 year old PBF). The PBF length-frequency data from the pens provide a good match with the observer data. In particular, the PBF average lengths from the pens generally lie over the 2-year old dominant mode at about 90 cm. Also, the length-range observed at the pens approximates very reasonably with the observed range by IATTC observers.

Mexico provided data from at-sea observer sampling taken in 2010 to ISC11 and the PBF-WG (64 fish measured). Although these trips are not the same from which the pen data was collected and sample sizes are low, the Mexican data was also plotted on

Figure 5 for comparative purposes. As for the IATTC observer dataset, the length modes at about 90 cm (2 years) and 110 cm (3 years) are also visible in the Mexican length-frequency data. In addition, some 4-year old fish (130 cm < LF < 150 cm) are also present in the Mexican data.

The PBF average length estimates obtained from the pen data for 2010 and 2011 are plotted over the PBF length-composition data used in the Stock Synthesis model (Figure 1). The independent estimates from the pen data are fairly consistent with the IATTC samples.

Another independent source of data can be used to further validate the results presented above. On a recent working paper (ISC/12-2/PBFWG/20), PBF catch data from Mexican purse seiners archived in the Japanese Catch Document System (CDS) was presented. Strong caution is necessary when interpreting these data. In particular, individual weight data is not available for purse seiners in this system, but rather average weight of fish is available per set. However, these average weights were compared with the data collected by the IATTC. The dominating average weight estimates in the CDS range between 12 and 17 kg, although smaller (6-8 kg) and larger (20 kg) have been recorded. The estimated PBF mean weight of the EPO catch across the Mexican target fishery period (2002-2011) is at 15.8 kg (range of 6.4-44.8 kg). If extreme point estimates (24.1, 44.8 and 6.4 kg in the 4th quarter of 2003 and the first quarters of 2004 and 2008, respectively) are not considered in the average calculations, a lower average of 13.8 kg is obtained (range of 10.6 and 18.1 kg). In fact, the data from the Japanese CDS (ISC/12-2/PBFWG/20) is very consistent with the data collected by IATTC and used in the PBF stock assessment. Considering the PBF biological information assumed in the current Stock Synthesis model, such dominant average weights (12-16 kg) correspond to 2 year old fish and older.

CONCLUSIONS

Available length-composition data for the purse seine fishery in the EPO is indicative of changes in selectivity over time. There is a clear shift from smaller fish (average length of about 75 cm, 1 year old fish) caught in the early period of the fishery (US PBF target fishery) to larger fish (average length of about 85 cm, 2 year olds) in the more recent period (Mexican PBF target fishery). As a result, a time-varying selectivity approach needs to be considered in the PBF stock assessment in order to remove catch

out of the right age-classes of the PBF stock. For this purpose, we propose three time-blocks of selectivity for the purse seine fishery in the EPO (see above).

There have been concerns that the PBF length-composition data collected by the IATTC and used in the PBF stock assessment model are not representative of the PBF catches taken by the Mexican farming industry. In this paper, we presented the first independent PBF size-composition samples obtained by stereoscopic cameras at PBF pen transfer operations. These samples are very consistent with PBF length-frequency data taken by IATTC observers during the same trips. In addition, the IATTC length-composition data is also consistent with average weight estimates recorded in the Japanese Catch Document System.

We conclude that the PBF length-composition data collected by IATTC at-sea observers and port samplers is a reliable source of information and provides a reasonable representation of the length-composition of the PBF catches taken by the Mexican PBF target fishery.

REFERENCES

Aires-da-Silva, A., Hinton, M. G., and Dreyfus, M. 2007. Standardized catch rates for Pacific bluefin tuna caught by United States and Mexican-flag purse seine fisheries in the Eastern Pacific Ocean (1960-2006). ISC/07/PBF-3/01.

Aires-da-Silva, A. and M. Maunder. 2012. An exploration of alternative methods to deal with time-varying selectivity in the stock assessment of yellowfin tuna in the eastern Pacific Ocean. Document YFT-01-06. External Review of IATTC Yellowfin Tuna Assessment. La Jolla, California (USA), 15-19 October, 2012.

Phillips, K, V, Boero-Rodriguez, E. Harvey, D. Ellis, J. Seager, G. Begg, J. Hender. 2009. Assessing the operational feasibility of stereo-video and evaluating monitoring options for the Southern Bluefin Tuna fishery ranch sector. Fisheries Research and DevelopmentCorporation and Bureau of Rural Sciences. ISBN 978-1-921192-32-6.

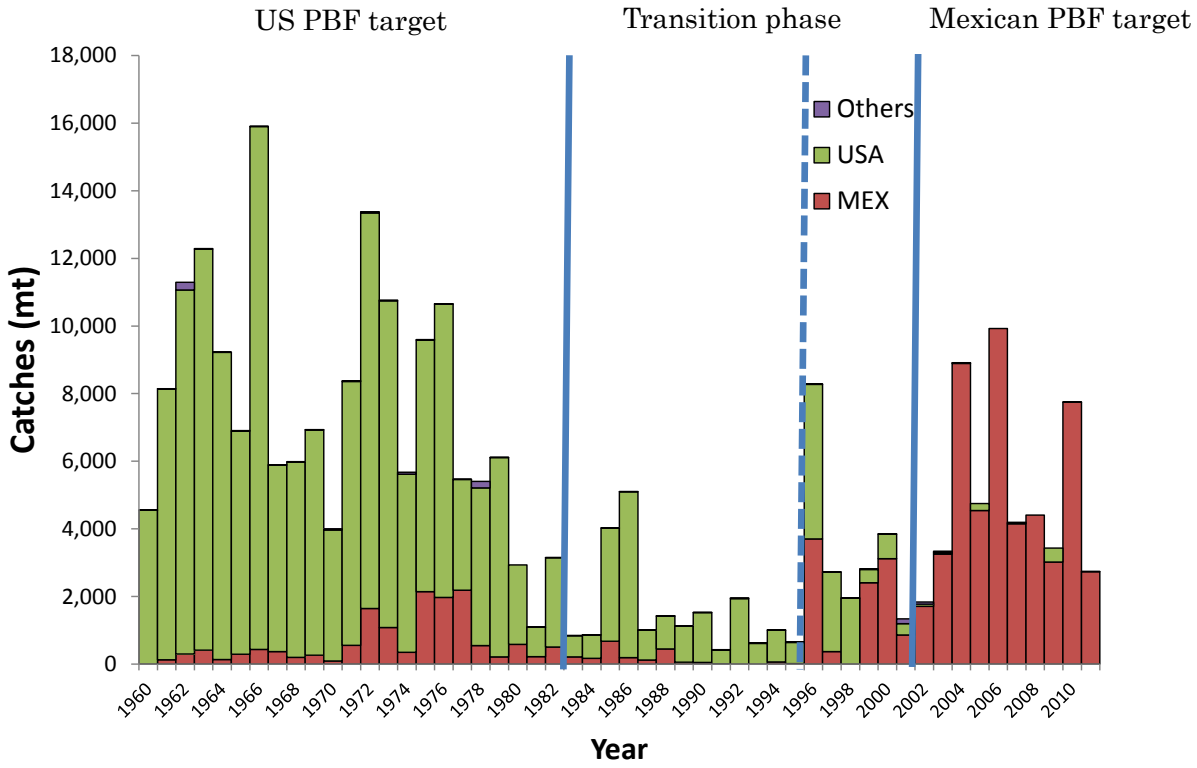

Figure 1. Total catches of PBF by flag for the purse seine fisheries in the EPO, 1960-2011. The vertical solid lines mark the three time-blocks of time-varying selectivity proposed in this paper: 1952-1982 (US PBF target fishery); 1983-2001 (a transition phase which includes the US extinguishing and Mexican PBF opportunistic fisheries, as well as a development phase of the Mexican PBF target fishery in 1996-2001); 2002-present (fully developed Mexican PBF target fishery). The vertical dashed line marks the beginning of the development (experimental/learning) phase of the Mexican PBF fishery (1996-2001).

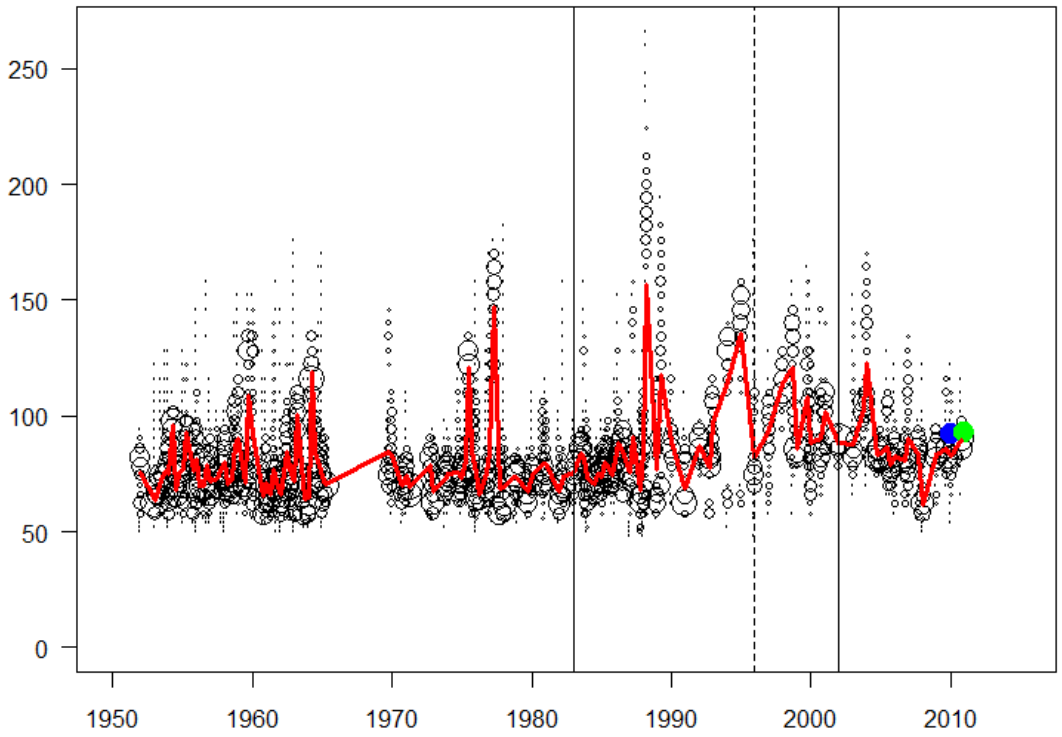

Figure 2. PBF length-composition for the purse seine fishery in the EPO. The red line is the weighted average length. The blue and red dots are the weighted average length estimates from the pen data in 2010 and 2011. The vertical solid lines mark the three time-blocks of time-varying selectivity proposed in this paper: 1952-1982 (US PBF target fishery); 1983-2001 (a transition phase which includes the US extinguishing and Mexican PBF opportunistic fisheries, as well as a development phase of the Mexican PBF target fishery in 1996-2001); 2002-present (fully developed Mexican PBF target fishery). The vertical dashed line marks the beginning of the development (experimental/learning) phase of the Mexican PBF fishery (1996-2001).

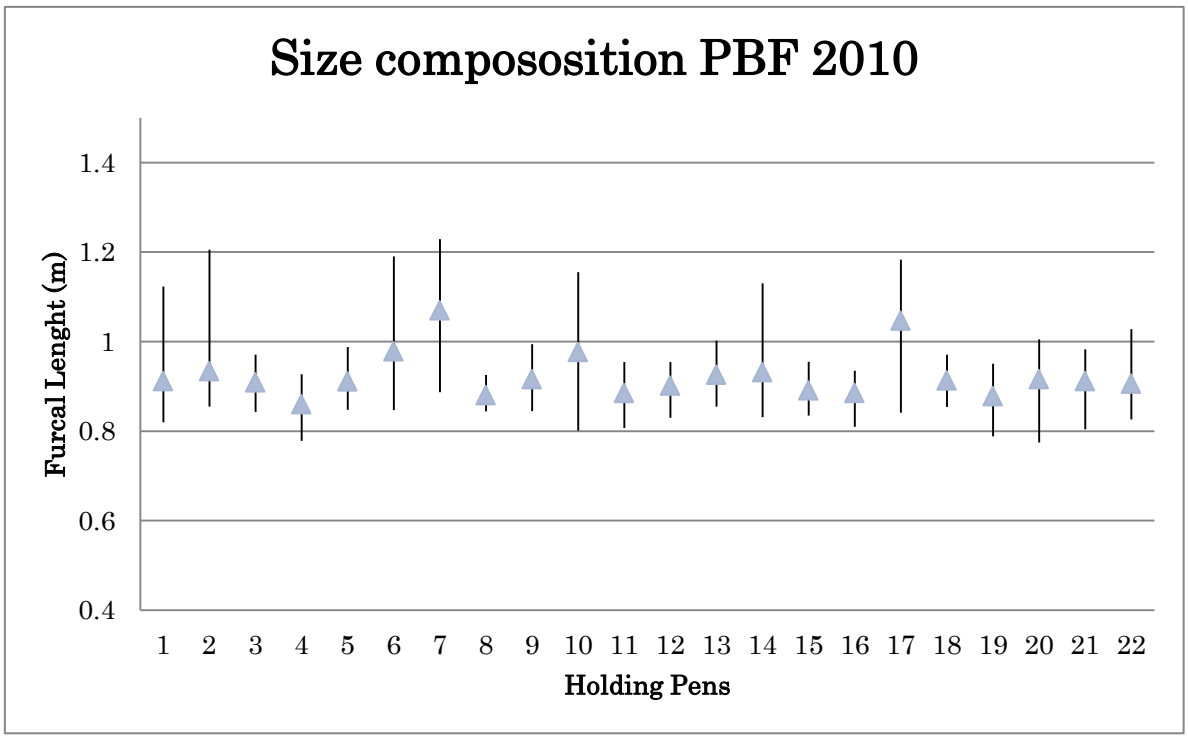

Figure 3a. Minimum, average and maximum length for each holding pen (measured at time of transfer) in 2010.

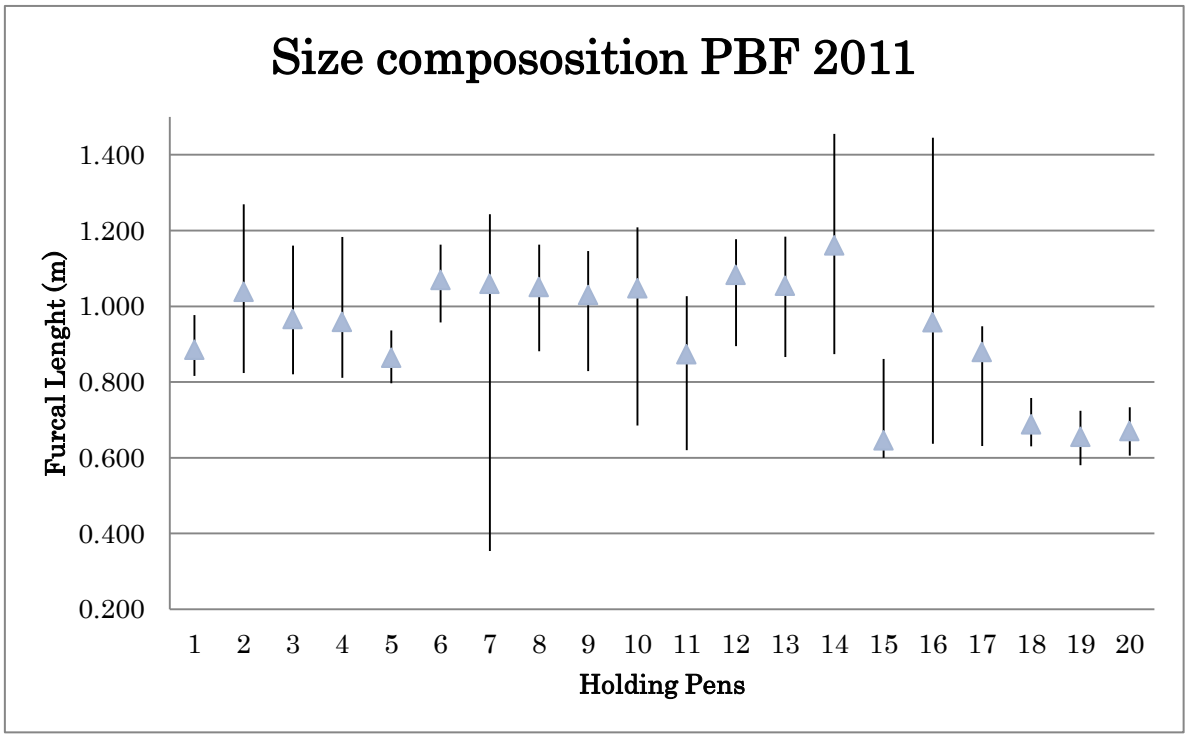

Figure 3.b. Minimum, average and maximum size for each holding pen (measured at time of transfer) in 2011.

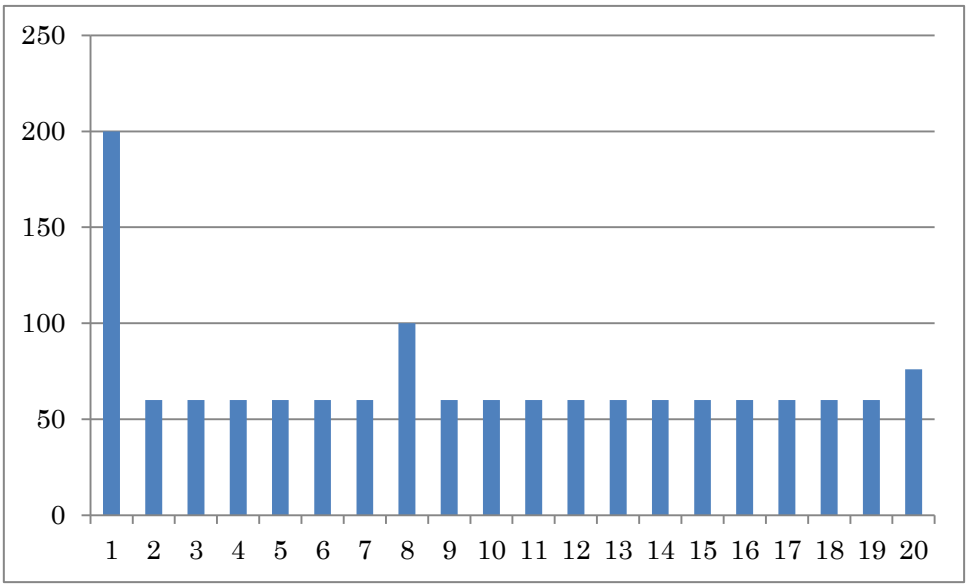

Figure 4.a. Sample size for each holding pen size statistics, 2010.

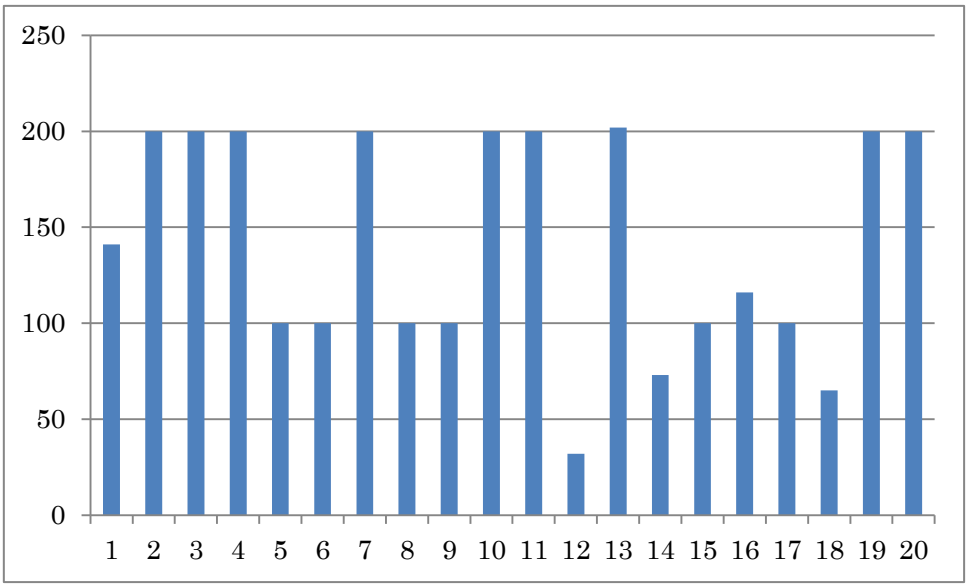

Figure 4.b. Sample size for each holding pen size statistics, 2011

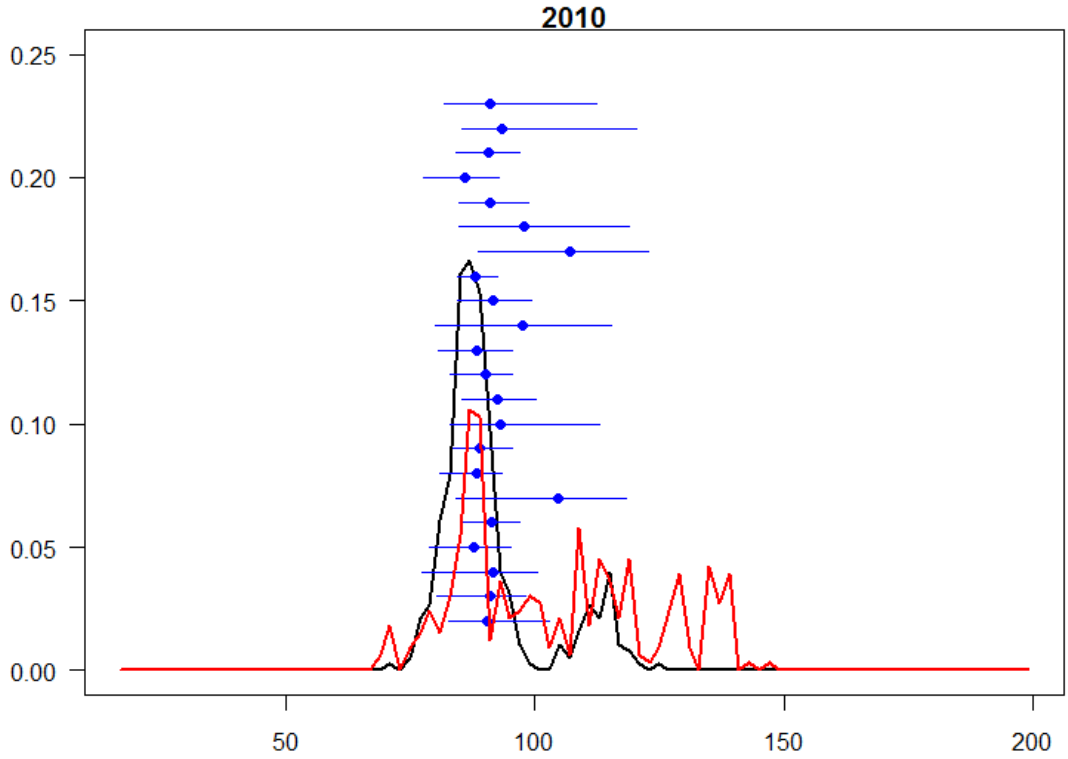

Figure 5. Comparison between IATTC (black line) and Mexican (red line) at sea observer data and the length data collected by stereoscopic cameras during pen transfer operations in 2011. The pen data (horizontal blue lines, 22 pens) show minimum, maximum and average length of the samples.