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STOCK STATUS INDICATORS FOR BIGEYE TUNA IN THE EASTERN PACIFIC OCEAN

Haikun Xu, Mark N. Maunder, Cleridy E. Lennert-Cody and Marlon H. Román

SUMMARY

Several uncertainties have been identified in the update assessment of bigeye tuna conducted in 2018, and its usefulness for management has been questioned. While the workplan to improve the bigeye stock assessment is being implemented (SAC-10-11), the staff will monitor a suite of stock status indicators (SSIs) for bigeye, which have been developed based on the methods used to compute stock status indicators for skipjack tuna. All bigeye indicators, except for catch, show strong trends over time indicating increasing fishing mortality and reduced abundance, and are at, or above, their reference levels. Additional analyses suggest that the method currently used to calculate the number of days fished on floating objects is biased towards an increasing trend in days fished, which also will bias the catch-per-day-fished (CPDF). Nonetheless, the increasing number of floating-object sets, particularly those on fish-aggregating devices (FADs), and the decreasing mean weight of the bigeye in the catch still indicate that the bigeye stock in the eastern Pacific Ocean (EPO) may be under increasing fishing pressure, and measures additional to the current seasonal closures, such as limits on the number of floating-object sets, are required. The staff has initiated research into the increase in the number of floating-object sets, per day and per vessel (SAC-10 INF-D), which is probably due to both the vessels' increased efficiency in finding FADs with tuna, due to the increased number of FADs and the increased use of satellite-linked fish-detecting sonar buoys, and the increased number of floating-object sets by vessels with Dolphin Mortality Limit (DMLs) that historically have made a mixture of floating object and dolphin-associated sets. However, further research is needed.

1. INTRODUCTION

Several uncertainties have been identified in the update assessment of bigeye tuna conducted in 2018 (SAC-09-05 and SAC-09 INF-B), and its usefulness for management has been questioned. Therefore, the staff developed several stock status indicators for bigeye, similar to those used for skipjack tuna (SAC-09-07), as a potential alternative basis for management advice and to monitor the stock and the fishery in the future until the uncertainties in the stock assessment have been resolved (see workplan to improve the bigeye stock assessment). We also investigated the relationship between the number of days fished and the number of floating-object sets, using a subset of vessels that fished mainly on floating objects.

2. STOCK STATUS INDICATORS

Six data-based indicators of stock status based on relative quantities, similar to those used for skipjack (Maunder and Deriso 2007), were developed for bigeye tuna in the EPO. Rather than using reference points based on maximum sustainable yield, the current value of each indicator is compared to its distribution of historical values. The indicators are based on data from all purse-seine vessels that fished during 2000-2018, to avoid the period covering the floating-object fishery expansion in the mid-1990s. The distributions of historical values for these indicators are somewhat asymmetric; therefore, to evaluate the current value of each indicator in relation to the distribution of its historical values, we use the 5th and 95th percentiles as reference levels.

All stock status indicators for 2018, except catch, are at, or near, their respective reference levels that indicate high exploitation rates (Figure 1). Initially, the total purse-seine catch of bigeye in all set types declined from its high level in 2000, which was driven by favorable environmental conditions, then increased from 2002 to 2006, and has been generally declining since then, except that catch increased to its average level in 2018. The catch-per-day-fished (CPDF) of bigeye in floating-object sets has generally declined over the 19-year period, and was at the lower reference level in 2018. The capacity of the purse-seine fleet, adjusted for the proportion of the year when the fishery is closed, has fluctuated since 2000, but has increased in recent years, and is now at the upper reference level. Both the number of floating-object sets and the number of days fished in such sets generally increased during the entire period, and in 2018 were above the upper reference level, while the average weight of bigeye in the catch has generally been declining and has been at the lower reference level since 2015.

3. INVESTIGATION OF THE RELATIONSHIP BETWEEN DAYS FISHED AND NUMBER OF SETS

The number of days fished by set type is not easy to determine, since a vessel can make several set types in the same day, and has to be estimated using the multiple regression method (Maunder and Waters 2003), which is also used to develop the indices of relative abundance based on purse-seine catch per unit of effort (CPUE) used in the stock assessments. This method fits a linear regression model to days fished and the number of sets by set type, and uses the estimated coefficients to determine the number of days to assign per set for each set type. There is a high correlation between the number of days fished assigned to the floating-object fishery by this method and the number of floating-object sets (Figure 1). Therefore, we investigated the relationship between the number of days fished and the number of floating-object sets.

To investigate this relationship, we used data from vessels that made more than 50% of their sets on floating objects during 2000-2018. In this data set, the total number of sets and the number of floating-object sets showed a similar increasing trend over time (Figure 2). The number of days fished and the number of vessels also increased over time, but less rapidly than the number of sets. Since the early 2000s, bigeye catch-per-set has decreased, but the CPDF has remained fairly stable. The number of days fished per vessel has declined over time, while the number of floating-object sets per vessel has increased. This is manifested mainly in an increase in the number of days fished with one or more sets (Figure 3) rather than in the number of sets conducted in a single day (Figure 3). There is no definitive evidence as to why the number of floating-object sets has been increasing, but it is possibly due to vessels' increased ability to find FADs with tuna, which has been facilitated by an increase in the number of deployments of FADs equipped with satellite-linked fish-detecting sonar buoys (Figure 3). There is also evidence that the number of sets made by DML vessels that make a mixture of floating-object and dolphin-associated sets has increased (SAC-10 INF-D). The reduction in the catch per set may be due to several factors including, but not limited to, reduced abundance, more FADs that distribute the stock into smaller schools, or a change in fishing strategy (*e.g*. vessels actively choosing to fish on smaller schools), but the reason is not yet clear.

4. CONCLUSION

All the indicators, except catch, show strong trends over time, indicating increasing fishing mortality and reduced abundance, and are at, or above, their reference levels. However, the analysis of the relationship between days fished and the number of sets suggests that the multiple regression method used to calculate the number of days fished on floating objects is biased towards an increasing trend in days fished, which also will bias the CPDF. Nonetheless, the increasing number of sets and the decreasing mean weight of the fish in the catch suggests that the bigeye stock in the EPO is under increasing fishing pressure, and measures additional to the current seasonal closures, such as limits on the number of floating-object sets, are required. It is not clear why the number of floating-object sets, per day and per vessel, is increasing, but it is probably due to both the vessels' increased efficiency in finding FADs with tuna due to the increased number of FADs and the increased use of satellite-linked fish-detecting sonar buoys, and increased number of floating-object sets by vessels that have DMLs and historically have made a mixture of floating object and dolphin associated sets. Further research into this phenomenon should be conducted.

REFERENCES

Maunder, M.N. and Watters, G.M. 2003. A-SCALA: an age-structured statistical catch-at-length analysis for assessing tuna stocks in the eastern Pacific Ocean. Inter-Amer. Trop. Tuna Comm., Bulletin, 22 (5): 435-582.

Maunder, M.N. and Deriso, R.B. 2007. Using indicators of stock status when traditional reference points are not available: evaluation and application to skipjack tuna in the eastern Pacific Ocean. Inter-Amer. Trop. Tuna Comm., Stock Assessment Report, 8: 229-248.

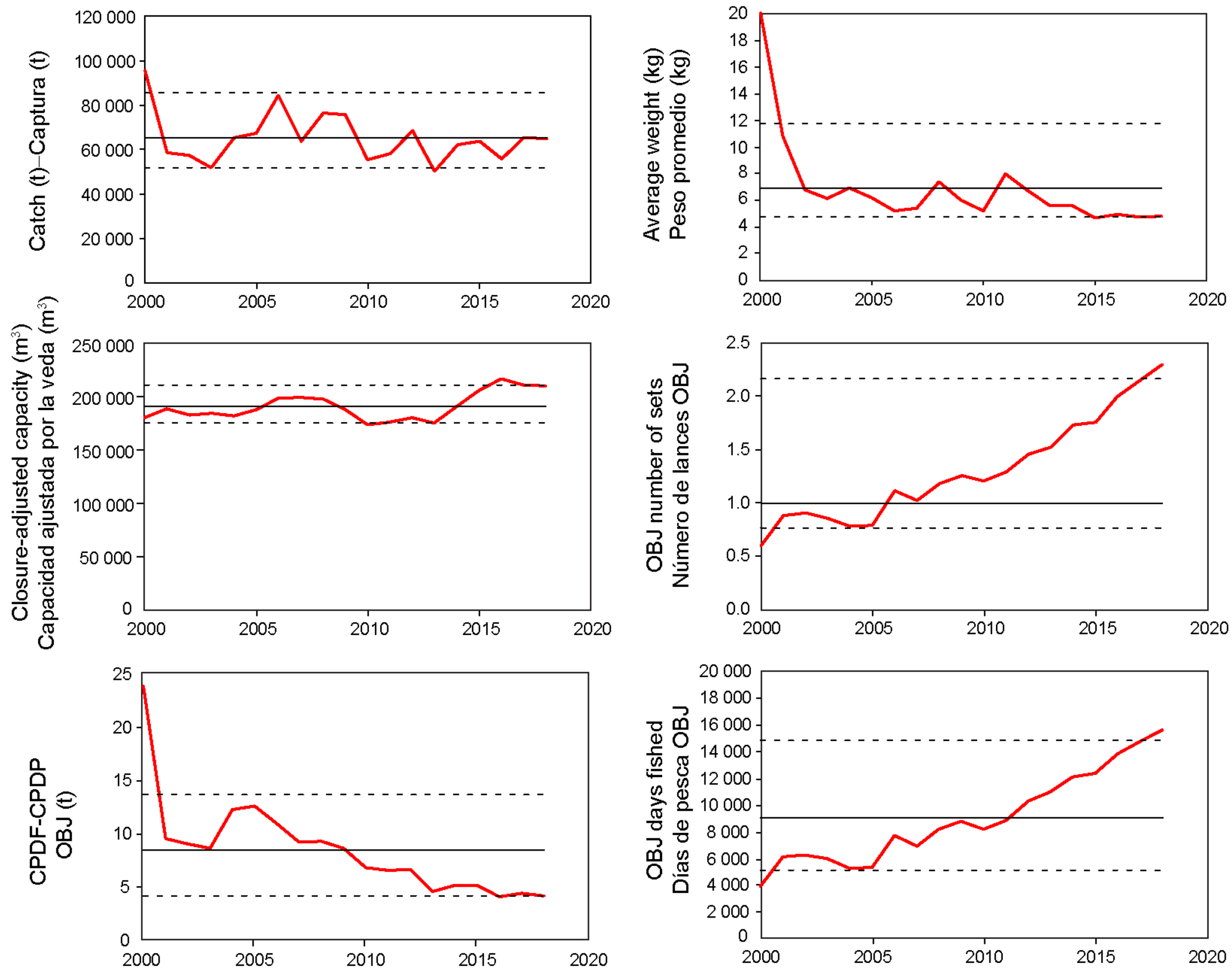

FIGURE 1. Stock status indicators for bigeye tuna in the EPO, based on purse-seine data, 2000-2018. The dashed horizontal lines are the 5th and 95th percentiles, the solid horizontal line is the median. CPDF: catch per day fishing; OBJ: sets on floating objects.

FIGURA 1. Indicadores de condición de población del atún patudo en el OPO, basados en datos de cerco, 2000-2018. Las líneas horizontales de trazos representan los percentiles de 5 y 95%, la línea horizontal sólida la mediana. CPDP: captura por día de pesca; OBJ: lances sobre objetos flotantes.

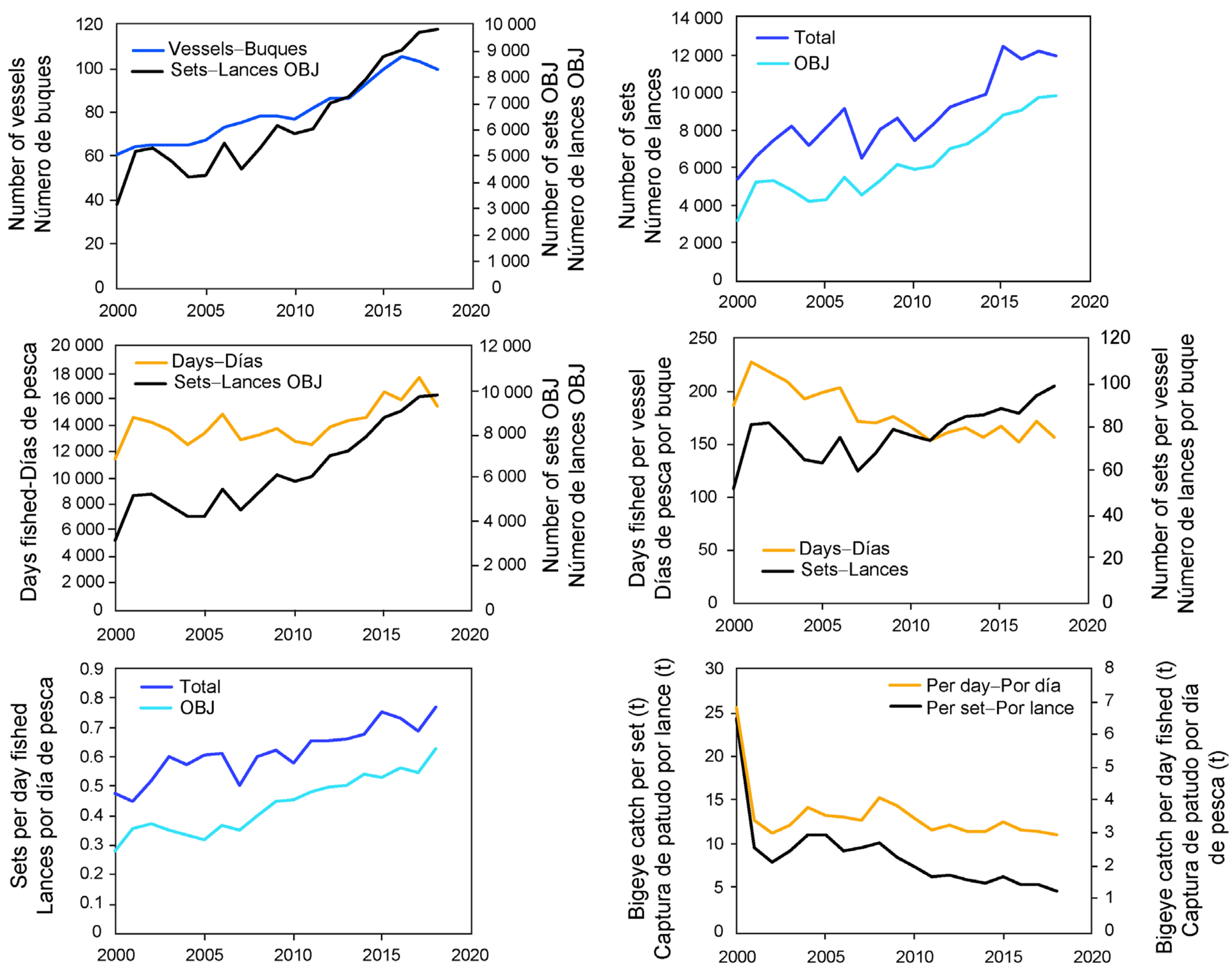

FIGURE 2. Quantities used to investigate the relationship between days fished and the number of floating-object (OBJ) sets, 2000-2018, based on data from purse-seine vessels that made more than 50% of their sets on floating objects.

FIGURA 2. Cantidades usadas para investigar la relación entre días de pesca y el número de lances sobre objetos flotantes (OBJ), 2000-2018, basados en datos de buques cerqueros que realizaron más del 50% de sus lances sobre objetos flotantes.

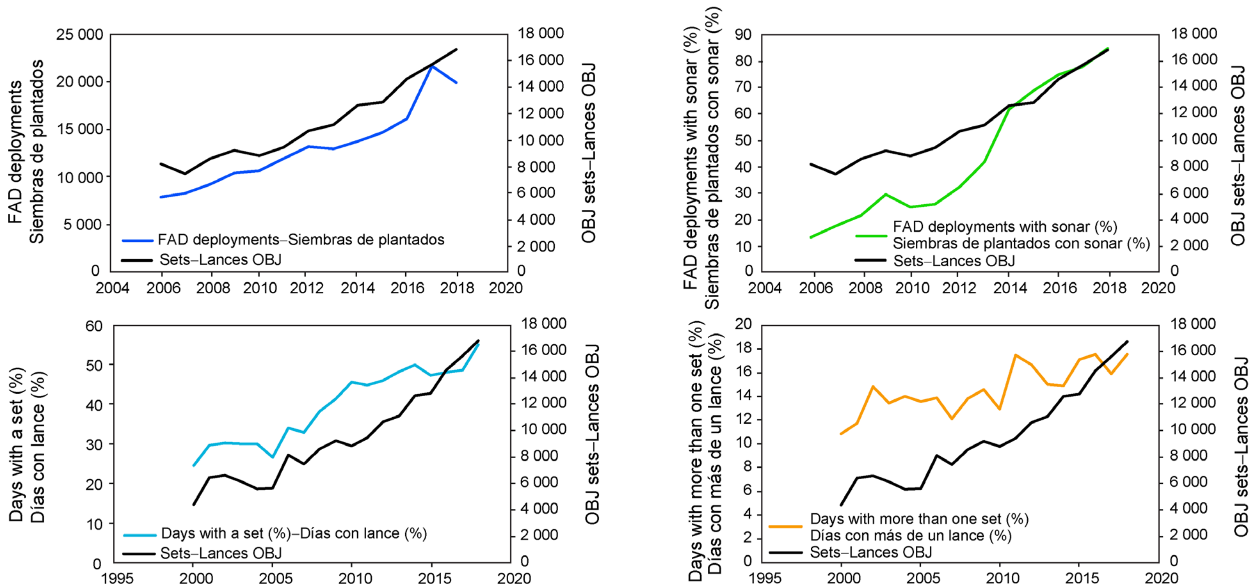

FIGURE 3. Various quantities used to investigate the reason for the increasing number of sets. The proportion of days with a set was calculated as the annual average, for all vessels, of the proportion of days fished with one or more floating-object sets.

FIGURA 3. Varias cantidades usadas para investigar la razón del número creciente de lances. La proporción de días con lance fue calculada como el promedio anual, para todos los buques, de la proporción de días de pesca con un lance sobre objeto flotante o más.