INTER-AMERICAN TROPICAL TUNA COMMISSION

SCIENTIFIC ADVISORY COMMITTEE

15TH MEETING

La Jolla, California (USA)
10-14 Jun 2024

DOCUMENT SAC-15 INF-T

SCIENTIFIC ADVICE ON INTERPRETING THE FISHING INTENSITY METRIC FROM THE NORTH PACIFIC ALBACORE TUNA HARVEST STRATEGIES IN TERMS OF CATCH AND EFFORT MANAGEMENT MEASURES

Background

The Western and Central Pacific Fisheries Commission (WCPFC) Northern Committee (NC) and the Inter-American Tropical Tuna Commission (IATTC) adopted a harvest strategy for north Pacific albacore (NPALB) in 2023 (WCPFC NC Harvest Strategy 2023-01; IATTC Resolution C-23-02). This harvest strategy includes harvest control rules that mandate reductions in fishing intensity if the female spawning stock biomass (SSB) falls below the adopted reference points. The WCPFC NC and IATTC have requested scientific advice from the Albacore Working Group (ALBWG) of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) on interpreting required changes in fishing intensity for NPALB, as described in the harvest strategy.

> *"The NC requested ISC in 2024 to advise how the fishing intensity should be interpreted to actual management measures under this harvest strategy"*

> *"The IATTC scientific staff in 2024 shall collaborate with the ISC to advise how fishing intensity should be interpreted to actual management under this harvest strategy"*

Fishing intensity is an important metric used to measure overall the extent to which a stock is being exploited and is often used in assessments with complex spatial and temporal structure in the population and the fisheries. A single annual estimate of fishing intensity is calculated across all fleets in the NPALB stock assessment and described in the adopted harvest strategy. For NPALB, fishing intensity is currently defined as $F_{\%SPR}$, which is the fishing intensity associated with a specific spawning potential ratio (SPR). It is a measure of fishing mortality expressed as the decline in the proportion of the spawning stock biomass (SSB) produced by each recruit relative to the unfished state. For example, a fishing mortality at age leading to $F_{20\%}$ is expected to result in an SSB of approximately 20% of SSB_0 over the long run. Fishing intensity and SPRs are particularly useful in stocks like NPALB, where: 1) there are multiple fisheries exploiting different age classes of the same stock due to different gear selectivities and/or availability; and 2) important reference points for NPALB are based on dynamic SSB_0 ($SSB_{current,F=0}$). Using fishing intensity and SPRs allows fishing mortality at different age classes to be related to impacts on SSB equivalence and compared using the same units. It also takes into account changes in selectivity that have occurred as NPALB distribution, fishing gear and/or techniques have changed over time.

Fishing mortality on different age-classes have differing impacts on SSB and SPR. It is assumed that female albacore have age-specific differences in natural mortality, maturity, and average weights, which causes fishing on different age classes to have different impacts on the resulting SSB. Fisheries with different age selectivities and/or availabilities will therefore have different levels of catch-per-recruit and $F_{\%SPR}$, even with the same level of maximum F-at-age. A fleet with higher selectivities for juvenile albacore is expected to have a larger impact on female SSB (i.e., a larger decline in SPR) than a fleet with higher selectivity for older fish (See Fig.1 in ALBWG 2024). Under only one fleet with a constant selectivity and availability, an increase in fishing mortality will be associated with a lower SPR, but for a stock with multiple fleets, SPR is also dependent on the relative fishing mortality across fleets and their selectivities and availabilities.

The WCPFC and IATTC members have traditionally used catch and/or effort controls to manage their fisheries. Although the $F_{\%SPR}$ is an effective way to communicate stock status, it is complex to interpret in terms of these operational management controls for each fishery given the variety of age classes intercepted by different gear types in different locations throughout the north Pacific Ocean. Furthermore, the fishing intensity referred to in the current stock assessment and the harvest strategy is reported as the overall $F_{\%SPR}$ and fleet-specific $F_{\%SPR}$ have not been reported on yet.

Summary of Analyses

The ALBWG performed analyses to evaluate the relationships between fishing intensity and catch and/or effort (ALBWG 2024). Given that fishing intensity reported in the 2023 stock assessment and the harvest strategy is the overall annual $F_{\%SPR}$, the ALBWG started by producing estimates of fleet-specific fishing intensities using the base case model from the 2023 stock assessment and the methods described in Lee & Taylor (2023). These estimates were then used to relate changes in the estimated fleet-specific fishing intensities to multiple fleet-specific measures of catch and effort. The 2023 assessment used a relatively complex fleet structure of 35 fleets accounting for various combinations of country, gear, catch unit, area, and season. For this analysis, the ALBWG recommends using a simplified approach with 9 fleet groupings dependent on gear and country to relate to traditional management controls (Table 1).

A cross-correlation analysis was initially used to investigate the potential relationships between catch and effort data for each fleet group and the estimated fleet-specific SPR. Depending on the fleet group and the results from the cross-correlation, one or more effort and/or catch variables were used as explanatory variables in a series of generalized linear models (GLMs) to explain the changes in SPR. The GLMs assumed that the intercept was at 0 (i.e., no intercept was estimated) because a catch or effort of 0 is expected to result in no change in SPR. Given the large number of correlations and GLMs performed, as well as the lack of observation error, the statistical significance of the results should be interpreted with caution.

The ALBWG also advises that the relationships between catch or effort, and SPR are expected to change if recruitment and/or fleet selectivity change substantially in the future. The analysis is based on the historical (1994 – 2021) conditions in the 2023 assessment. The results may not be useful if future stock conditions differ substantially from those described in the 2023 assessment. The ALBWG therefore recommends that the fleet-specific catch and effort reduction per unit of SPR estimated in the analysis be thought of as approximate and illustrative, and will likely need to be reevaluated if SSB falls below the threshold or limit reference points, as this may be an indication of exceptional circumstances.

The ALBWG found that all fleet groups exhibited strong relationships between catch and SPRs. For the longline fleet groups, catch was highly negatively correlated with fleet-specific SPR. For illustration, the relationships between fleet-specific SPRs and seasonal fleet-specific catch in weight (Fig. 1) show that catches would have to be reduced by 901 – 1,473 mt, depending on the fleet group, in order to increase fleet-specific SPR by 1%pt (%pt is the arithmetic difference between two percentages) and lower fishing impacts. Those fleet groups with higher catch (mt) per unit of change in SPR have a lower impact on the female SSB per unit of catch in weight. The fishing impact on SSB per unit of catch depends on the ages and sex ratios of fish (i.e., removing male fish do not impact SPR) caught by the fleet group. For example, the USLL, which catches both the largest fish and the highest proportions of male fish, shows the highest catch (mt) per unit of change in SPR among all fleet groups (Fig. 1).

Similar to the longline fleet groups, the surface fleet groups (JPPL and EPOSF) also showed that their fleet-specific catch is highly correlated with the fleet-specific SPR. However, the relationships between catch and SPRs for the surface fleet groups were slightly more variable and uncertain than for the longline fleet groups. This variability occurs because the surface fleet groups catch predominantly juvenile fish (Ages 2 – 4) and are more sensitive to changes in recruitment and availability. Interestingly, our results also show that catches of both fleet groups would have to be reduced by similar amounts in order to increase SPR by 1%pt (Fig. 1). In addition, it was noted that the JPPL fleet group exhibited a stronger relationship between effort and skipjack catch, as compared to albacore catch.

The relationships between effort and SPRs were found to be fleet-specific and more variable than those between catch and SPR. Some of the longline fleet groups (JPLL, and CNLL) had moderate correlations between effort (number of hooks) and SPRs but other longline fleet groups (USLL, TWLL, KRLL, and VUOTHLL) had much weaker relationships. Even among the longline fleet groups with stronger relationships, the correlations between effort (number of hooks) and SPRs were more variable than between catch and SPRs.

Both surface fleet groups (JPPL and EPOSF) also showed moderately strong correlations between the number of vessel days and SPRs. These relationships between effort and SPRs were weaker than for the corresponding relationships between catch and SPRs. In contrast to the similar impact on SSB per unit of catch in weight, the GLMs for effort (number of vessel days) show an order of magnitude difference between the two fleet groups (Fig. 2). This difference is likely due to the order of magnitude difference between the recorded effort for these fleets.

Scientific Advice and Recommendations

It should be noted that both RFMOs currently maintain fishing effort for NPALB at or below the average of 2002 – 2004 levels (e.g., IATTC Resolution C-05-02) and that has maintained the fishing impact on NPALB around or below the target reference point of 45% $F_{\%SPR}$.

The ALBWG cautions that the fleet-specific catch and effort reduction per unit of SPR presented in this document (Figs. 1 & 2) will likely change if stock conditions (i.e. recruitment and/or selectivity or availability patterns) change in the future and it is recommended that the relationships presented in the advice be reevaluated if reference points are breached for the stock (i.e. if the SSB falls below the threshold or limit reference points for NPALB (30%$SSB_{current,F=0}$ and 14%$SSB_{current,F=0}$),) or if exceptional circumstances are identified.

All fleet groups exhibited strong relationships between catch and SPRs. The relationships for the surface fleet groups (JPPL and EPOSF) were slightly more variable and uncertain than for the longline fleet groups, due to these fleets predominantly catching juvenile fish (Ages 2 – 4). However, there was still high correlation between catch and SPRs for these fleets. Based on these results the ALBWG recommends that changes in fishing intensity required by the NPALB harvest strategy can potentially be translated into catch reductions for all fleet groups.

The relationships between effort and SPRs were found to be fleet-specific and tended to be more variable and often less correlated than for catch and SPR. However, the fleet groups using surface gears (i.e., JPPL and EPPOSF) exhibited moderately strong relationships between effort and SPRs. In addition, it should be noted that the WCPFC has adopted a harvest strategy for skipjack tuna in the WCPO (WCPFC CCM 2020-01) and the JPPL fishery, which targets primarily skipjack tuna, is managed using effort controls under that harvest strategy. It should also be noted that the JPPL fleet group exhibited a stronger relationship between effort and skipjack catch, as compared to albacore catch. The ALBWG therefore recommends that changes in fishing intensity required by the NPALB harvest strategy can potentially be translated into changes in effort for the management of surface fleet groups, JPPL and EPOSF.

REFERENCES

ALBWG. 2023. Stock assessment of albacore tuna in the North Pacific Ocean in 2023. Page 124. International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean, Stock Assessment.

ALBWG. 2024. Relationships between fleet-specific spawning potential ratios and measures of catch and effort for North Pacific albacore tuna. ISC/24/ALBWG-01/07.

Lee, H.-H., and I. Taylor. 2023. Calculating spawning potential ratio in fishery groups from a seasonal stock assessment model. ISC/23/PBFWG-2/13. Working paper submitted to the ISC Pacific Bluefin Tuna Working Group Workshop, 27 November -1 December, 2023. Webinar.

Table 1. Fleet groups used in this study with reference to the fleets in the 2023 stock assessment.

Fleet Group	Fleet Group Name	Fleet ID in 2023 assessment	Units of Effort	Fleet Group Description
1	JPLL	F1 to F20	Hooks, Vessels, Days	Japan longline; all areas; all seasons
2	JPPL	F21 to F24	Vessels, Days, Poledays, Avg poles, SKJ catch	Japan pole-and-line; all areas; all seasons
3	USLL	F26 & F27	Hooks, Vessels, Sets	US longline; all areas; all seasons
4	TWLL	F28 & F29	Hooks, Vessels, Days	Taiwan longline; all areas; all seasons
5	KRLL	F30	Hooks	Korea longline; all areas; all seasons
6	CNLL	F31 & F32	Hooks	China longline; all areas; all seasons
7	VUOTHLL	F33	Hooks	Vanuatu & Others longline; all areas & seasons
8	EPOSF	F34	Vessels, Days	EPO Surface fleet (primarily US and Canada); all seasons
9	MISC	F35	NA	Miscellaneous fleets from Japan, Taiwan, & Korea

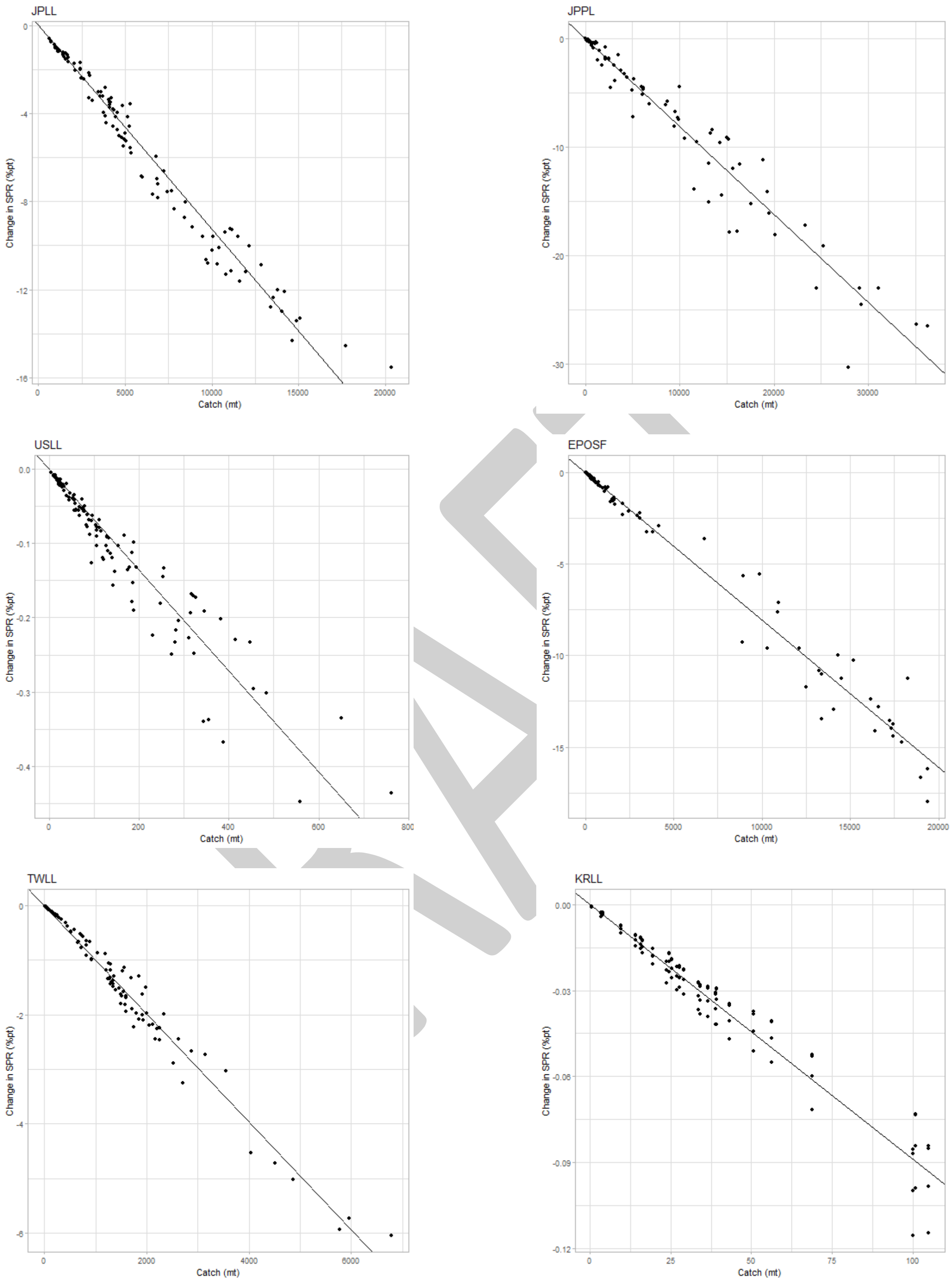

Figure 1. Estimated relationships (line) between seasonal catch in weight (t) and expected change in spawning potential ratio (SPR; %pts, the arithmetic difference between two percentages) for nine fleets using single variable generalized linear models (GLMs) with a fixed intercept at 0. See Table 1 for fleet abbreviations. Note that scales of the x- and y-axes are variable.

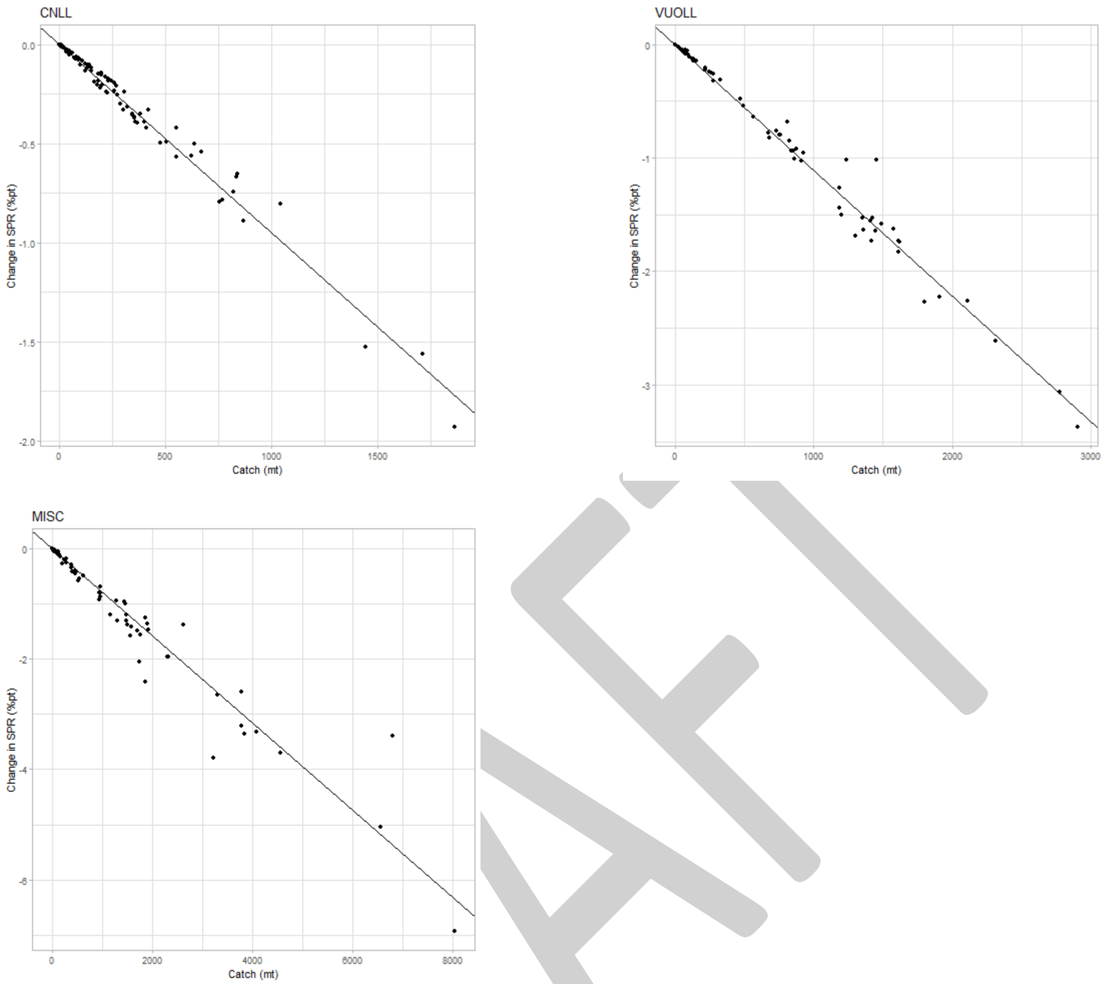

Figure 1. continued.

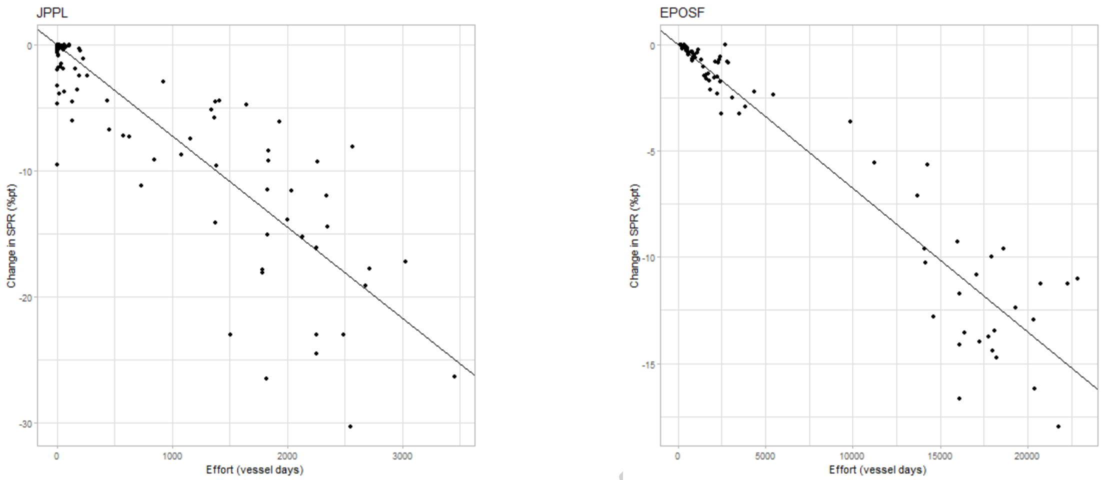

Figure 2. Estimated relationship (line) between seasonal fishing effort (vessel days) and expected change in spawning potential ratio (SPR; %pts, the arithmetic difference between two percentages) for the two surface gears (troll and pole-and-line) fleets using single variable generalized linear models (GLMs) with a fixed intercept at 0. See Table 1 for fleet abbreviations. Note that scales of the x- and y-axes are variable.