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Scoping Study on Longline Effort Creep in the WCPO: Project 122

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Revision 1:

This version revises the levels of effort creep included in tuna assessments.

1 Overview

Effort creep appears to be occurring in longline fisheries through a range of key factors, including but not limited to: changes in fishing gear, technology, information and communication, use of environmental data and fishing skills. These factors are already well described and documented in existing literature for longline fisheries (Ward and Hindmarsh, 2007). A very recent review of effort creep in purse seine and longline fisheries focused on the Indian Ocean (Hoyle, 2024) is very comprehensive and broadly applicable to longline fisheries in other regions. There are numerous approaches to collecting data on these forms of effort creep for longline fisheries, estimating them in some cases where data are not available, or making assumptions to explore scenarios when there is limited information.

A fundamental assumption for stock assessments using catch per unit effort (CPUE) data as an abundance index, is that CPUE is directly proportional to population size, through a catchability co-efficient, q, which is often assumed to be constant over time. If effort creep is occurring, then this assumption that q is invariant over time is incorrect and there will be some consequences for the stock assessment results. Use of an alternative or additional abundance index rather than only relying on CPUE can help to address such issues, but this is not always possible. Alternative abundance indices, which can be used in stock assessment, can include standardised fishery independent surveys, use of tagging data, as mark recapture data, or using close-kin mark recapture approaches. In some cases, most notably with southern bluefin tuna, approaches such as close-kin mark recapture may offer the potential to calibrate effort creep in future, through the use of the fishery independent abundance series built up over time.

Effort creep can occur in discrete steps in some cases, when new technology is introduced and adopted quickly, such as the introduction of monafilment mainlines. In other cases, change occurs more gradually over a longer time period as changes are adopted within different fisheries over time, or where there is an element of adaptation or learning how to most effectively utilise new technology. There appears to be little doubt that effort creep is occurring in longline fisheries and that these fisheries have become more efficient at catching target species over time, as there are strong economic incentives to innovate and increase fishing efficiency.

In multi-species fisheries, targeting of key species may increase efficiencies for these species and reduce efficiencies for some non-target species, potentially resulting in negative effort creep. This could be happening for species like striped marlin, which is usually caught close to the surface. As the number of hooks between floats has increased in fishing operations due to technological advances and attempts to target species in deeper waters, the catch per hook of species preferring surface waters may reduce as the proportion of hooks in shallow waters reduces. Hence the catchability for species such as striped marlin may reduce over time, if it is measured as a function of the number of hooks set.

When using CPUE as an abundance index, it is preferable to incorporate changes in catchability directly into CPUE standardisation, whenever this is possible. If this is done comprehensively, then in theory the effects of effort creep can be considered to be incorporated into stock assessment. However, there are usually forms of effort creep that are not able to be included in CPUE standardisation, as they either cannot be accurately documented or have not been recorded in logbooks, so an alternative approach is required.

Including vessel identification as a factor in CPUE standardisation is important, as this can often capture a significant component of effort creep, but this is not always possible as information on vessel identification is not always available as a data field for use in CPUE standardisation.

If effort creep cannot be easily explicitly modelled and quantified, an alternative pragmatic approach is to make plausible assumptions about possible rates of effort creep, either using a constant annual fixed rate of effort creep, or by modelling some process allowing for variation in these increments over time, and modifying the standardised CPUE series to incorporate this temporal change in catchability. With this method, it is appropriate to explore scenarios with a range of different values for the annual rate for effort creep, given this value is unknown. If the CPUE series includes vessel identification as a factor, then smaller annual rates seem appropriate.

2 Key points on longline effort creep from WCPFC-SC20-2024/SA-IP-19

Given the comprehensive report already produced (Hoyle, 2024), we provide a summary of the key relevant components from that report. Detailed information is included in WCPFC-SC20-2024/SA-IP-19.

There is considerable uncertainty and debate about how to best incorporate effort creep in stock assessment.

Ward and Hindmarsh (2007) noted that "Pelagic longline fishers have continuously modified their fishing gear and practices to improve fishing power and catchability, which has altered the relationship between catch rates and abundance".

Vessel identifier is an important component to include as a factor in CPUE standardisation, if possible, and can incorporate some components of effort creep.

Calibration of effort creep against a baseline, either independent surveys or mark recapture experiments or close-kin mark recapture, is one means of estimating effort creep. Alternatively, indices can be compared against each other within an integrated assessment platform, or an internal estimate of changes to catchability can be made within Multifan-CL in some cases.

Meta-analysis can be a used to estimate effort creep rates, with estimates falling in the range of 1.3% to 4% per year.

Effort creep can occur through technical improvements in a number of areas, including improvements to the following broad areas:

- navigation
- fish finding
- communication

The introduction of monofilament branchlines was important in the 1980s, as was the change from kuralon to monofilament mainlines in the 1990s. Also changes to bait, set time, set depth and fisher skill.

Effort creep can potentially be negatively affected by changes to effort, such as reductions in vessel numbers, deterioration of vessels with time, behavioural and possible evolutionary responses of fish to fishing and ecosystem changes.

Effort creep in tuna assessments:

- Since at least 2005, CCSBT have incorporated 0.5% in all years of the assessment, in operating models, projections and management procedures.
- WCPFC has seen sensitivities run for some assessments for ALB, BET and YFT, (0.5% early and sometimes switching to 2% in later years, from either 1985 or 1990 onwards).
- IOTC have conducted sensitivities for some assessments for ALB, YFT and BET (1%).
- IATTC included effort creep in their ensemble for the BET assessment in 2024 (0%, 1% and 2%).
- IOTC agreed to include effort creep in the upcoming YFT assesment in 2024, including effort creep of 0.5% for the joint longline index, exploration of alternative values as sensitivities, and estimation of effort creep for PS in relation to the longline index.

2.1 Key recommendations from WCPFC-SC20-2024/SA-IP-19

Multiple studies recommend that effort creep be accounted for in stock assessments, particularly for target species.

In WCPFC-SC20-2024/SA-IP-19, Hoyle (2024) recommends exploring a range of scenarios with different effort creep factors, following a random walk around an exponential trend, and using a multiplicative effort creep factor, rather than using an additive process, which assumes a linear rate of increase over time.

Attempting to explicitly model all components of effort creep is likely to omit some sources of effort creep. The best method to estimate effort creep is by comparison with a baseline index, when that is possible.

Analyses that already include vessel effects should consider scenarios with smaller rates for effort creep.

Suggested rates of effort creep to explore for longline fisheries range from 1% to 3% per year for an index estimated without vessel effects, reduced to 0.5% to 1.5% for an index estimated with vessel effects.

Incorporating effort creep could result in implausible results, which may require structural changes to models.

“Ignoring effort creep would implicitly assume that a longline vessel from the 1970s, fishing in the present using 1970s technology, would obtain the same catch rates as a modern vessel, despite all the developments of the last 50 years.”

3 Discussion

The implication of including effort creep as a sensitivity on stock assessments are complex, especially for tropical tuna stock assessments that often critically rely on longline fisheries to form the basis for index fisheries with associated abundance indices. Such sensitivities may result in unpredictable changes to assessment outcomes and management advice, and may require significant revision of stock assessment models to ensure outcomes are biologically plausible. Routinely incorporating such sensitivities in key WCPO tuna stock assessments may be a pragmatic first step to investigate possible implications of effort creep and to help inform the requirements for specific further studies or projects.

Effort creep is closely linked to CPUE analysis and perhaps could be included as a component of a broader review of CPUE in tuna RFMOs. The comprehensive review produced by Hoyle (2024) already covers many of the objectives of Project 122. In particular, Hoyle (2024) provides a comprehensive literature review, documenting the existing understanding of effort creep in longline fisheries, the analytical approaches that have been used to quantify effort creep, and how effort creep has been accounted for in stock assessment models fitting to fishery dependent abundance indices. Hoyle (2024) also recommends approaches to investigate and quantify longline effort creep in tuna longline fisheries, and how to account for this in longline CPUE abundance indices. The third objective of Project 122, was to engage with distant water fishing nations (DWFN) and industries on technological developments and perceptions on effort creep, and to ascertain interest in collaboration to quantify longline effort creep, including conducting surveys of their longline fleets to document historical uptake of technologies and gear modifications to inform effort creep scenarios. This project component was difficult to progress in the time before the SC. As recommended below, we suggest this component can be progressed through a no cost extension to this project. Furthermore, we feel that the effort creep implications for fishery dependent CPUE abundance indices should not be considered in isolation from the wider challenges of CPUE analysis and application in stock assessments. A more profitable use of the resources remaining under the current effort creep project

122 (given some redundancies in that proposed work due to the paper from Hoyle (2024)) would be to refocus this work on the broader needs to address challenges with CPUE indices in large tuna fisheries to address one of the TARP priorities, which will clearly include effort creep, among various other issues.

SC20 is invited to note:

- This project has not progressed to completion under the original TOR scope.
- Aspects of the original project scope were somewhat redundant as they were covered in the comprehensive paper submitted to this SC, WCPFC-SC20-2024/SA-IP-19 (Hoyle, 2024).
- As a result we suggest that the remaining resources are utilised in a no cost extension, to pick up incomplete aspects of the current project (engagement with DWFN) and initiate a collaboration on a broader inter-tRFMO project on challenges and solutions to improve the reliability of CPUE indices for tuna assessments (which is a priority research area in the Tuna Assessment Research Plan).
- Such a project will include effort creep and we feel it will be more effective to consider effort creep as a component of a broader project considering challenges associated with CPUE abundance indices for tuna.

4 References

Hoyle, S. (2024). Effort creep in longline and purse seine CPUE and its application in tropical tuna stock assessments. Technical Report WCPFC-SC20-2024/SA-IP-19, Manila, Philippines.

Ward, P. and Hindmarsh, S. (2007). An overview of historical changes in the fishing gear and practices of pelagic longliners, with particular reference to Japan's Pacific fleet. *Reviews in Fish Biology and Fisheries*, 17(4):501–516.