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Project 115 progress update: Exploring evidence and mechanisms for a long-term increasing trend in recruitment of skipjack tuna in the equatorial Pacific and the development and modelling of defensible effort creep scenarios

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EXECUTIVE SUMMARY

This paper provides a summary of the WCPFC Project 115, a joint project between SPC and Japan FRA, including progress to date and plans for the next stages of work. The paper notes the work for this project has been limited in the first half of 2023, and more time is required to allow for industry surveys and due to limitations on project staff time. The project agreement with WCPFC was established in February 2023 with a delivery date of September 2023, but this work will require a no-cost extension of one year until September 2024, with delivery of a final report to SC20.

We invite SC19 to:

- Note that this work is in the early stages,
- Consider the request for a no-cost extension for this project of one year, to be completed by September 2024 and final report presented at SC20,
- Note the initial progress in the development of the Japanese pole and line industry survey.

1.   BACKGROUND

Several skipjack stock assessments have now recognised that the stability in the fishery dependent catch per unit effort (CPUE) indices, assumed to inform on abundance trends (primarily pole-and-line fisheries), are highly influential on model estimations of a stable long-term biomass trend. To account for the stable biomass trend, in the face of increased catches over time, the assessment models predict that increased recruitment must have occurred.

On the other hand, how well the CPUE indices indicate trends in abundance is open to discussion. If CPUE indices suffer from hyperstability due to the approach of targeting schools and/or improved fishing methods and uptake of new technologies over time (referred to as effort, technology, or efficiency creep), their stability may mask an underlying decline in stock biomass. This topic received considerable discussion at the 2022 Pre-assessment workshop, suggesting more detailed analysis is required (Hamer, 2022). Subsequent to that meeting, studies involving the Japanese pole-and-line fishery were conducted and reported to SC18 (Matsubara et al., 2022). This work suggested some level of effort creep was likely, at least 0.2% per quarter (i.e., 0.8% per year), since 1981 when new technologies began being employed by the fleet. However, while this work provides a good basis, as noted in the Matsubara et al. paper, the results are provisional. Further work is required to increase the level of confidence in the quantification and temporal dynamics of effort creep to apply to stock assessments used for management advice.

Finally, the current calculation of the pole-and-line CPUE uses vessel day as the effort metric and may be more prone to effort creep and hyperstability than alternatives. It is recommended that exploration of alternative metrics such as travel distance between fishing events be explored, at least for a recent period, and contrasted with the traditional effort metric of vessel day. This approach appeared promising when applied to purse seine CPUE analysis for the recent skipjack assessment (Teears et al., 2022).

This study is required to: 1. Conduct a detailed exploration of the plausibility and evidence for an increased skipjack recruitment trend, 2. Build on the recent study by Matsubara et al. (2022) to explore the evidence for occurrence and plausible scenarios of effort creep over time, 3. Apply plausible scenarios of effort creep assumptions to the 2022 skipjack assessment models to assess the implications for stock status estimates and trends. The results should provide a basis for consideration of effort creep scenarios to apply within the next skipjack assessment.

Preliminary investigations suggest there may be a link between environmental variability, particularly the size of the Pacific warm pool (see Kim et al., 2020, Lehodey 2003, SC19-EB-WP-01), and levels of skipjack recruitment and catches. This project will support further investigation of this hypothesis, along with a wider consideration of ecosystem drivers, and fishing down of predators that may also influence skipjack recruitment.

Overall, this project will contribute to improving the interpretation and approaches to the skipjack assessment.

The WCPC19 allocated 20,000 USD to support collaboration on this project between scientists at SPC and the Japan FRA.

2.   PROJECT 115 WORK TO DATE

2.1 Overview of work so far

A pre-project planning meeting was held between the project collaborators from SPC and FRA at the FRA, Yokohama offices on January 10th, 2023. This meeting took advantage of the presence of both of the SPC staff in Tokyo at that time on personal travel. At this meeting the discussion was primarily focussed on the effort creep aspects of the work and on developing a general approach and workplan for this research component. Presentations were provided by SPC and FRA staff. The main outcome of the meeting was to develop a plan

of activities and timelines to progress the effort creep analysis. It was clear from those discussion that due to staff workloads and resource limitation at both SPC and FRA, plus the time required to engage with the Japanese pole and line fishing sector, this work would require until at least 2024 (SC20) to complete. The workplan was developed considering this timeline as outlined in section 2.2. The need for additional time for this work was communicated to the WCPFC Secretariat Science Manager. The project agreement with the WCPFC has a timeline for completion being September 2023, however this will require to be extended at no-cost until September 2024.

2.2 Effort creep – project approach and what are we really talking about?

It is important to first clarify what we really mean when talking about effort creep in the context of this work and the terminologies used. It should be noted that nominal effort in WCPO skipjack fisheries is not increasing, whether it be number of purse seine sets per year or per day which has been relatively stable since the PNA vessel day scheme (VDS) was implemented (i.e., around 2010) (Hamer, 2023; Hamer et al., 2023), or the number of vessel days in the pole and line fishery that has been decreasing continually since the 1980s. Nominal effort is not 'creeping' up under the current management arrangements and catches of skipjack have stabilised since around 2010 (Hare et al., 2023, 2022). The real concern is that fishing methods/operations have become more 'effective' over time, so that more skipjack can now be harvested under a given level of nominal effort than in the past, thus influencing the relationship between catch rates (CPUE) and the underlying stock abundance (i.e., the catchability). This is more appropriately referred to as 'effectiveness creep', which in effect can cause 'catchability creep'.

Depending on the availability of data on the drivers of effectiveness creep and its extent, it may or may not be possible to appropriately account for (remove) its influence on CPUE time series that are used as abundance indices in stock assessment. If it is not possible to properly account for effectiveness creep in CPUE standardisation, these indices might appear stable or might even increase over time when in fact the stock abundance has declined. Stock assessments that use abundance indices that have not accounted for the 'true' extent of effectiveness creep will likely produce biased (more optimistic) stock status estimates, and potentially provide poor management advice.

This project component is focussed on understanding, describing and quantifying the degree of effectiveness creep, and exploring options to better account for its influence on fishery-dependent CPUE-based abundance indices used in the WCPO skipjack stock assessment. We focus on the long-term Japanese pole and line fishery based indices that inform the stock assessment on the longer term trends. A new free-school based purse seine CPUE index was developed for the equatorial regions in the last assessment that is thought to better account for, or be more robust to, effectiveness creep (Teears et al., 2022) and this may also be considered further, subject to time.

Discussion at the pre-project planning meeting set a general approach and plan to conduct the pole and line fishery effectiveness creep investigations. This was further discussed with a presentation at the SPC 2023 Pre-assessment workshop (PAW) (Hamer, 2023).

The approach is partitioned into two stages:

Stage 1: Background phase: understand, describe, and qualitatively assess the level of effectiveness creep in the Japanese pole and line fishery targeting skipjack in the WCPO.

This stage will involve documenting a narrative of the developments and changes in the operations, including technology uptake, communications and other influences, that may have influenced effectiveness creep in the pole and line fishery (building on the work by Matsubara et al. 2022). This will involve analyses of fishery operational records from logbooks and other information, and importantly surveys of pole and line fishers. The outcomes of this initial stage will be documentation of the likely drivers of effectiveness creep, the industry perspectives on these drivers and the level of effectiveness creep they have experienced. This information be used for deriving qualitative assessment of the extent that effectiveness creep may have driven catchability changes, including the temporal dynamics of these changes, noting that these changes might occur as regime/step changes or more gradual linear trends. This first phase will hopefully provide the qualitative

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evidence or not for occurrence, degree and historical dynamics of effectiveness creep and the factors that have driven it. This will provide a basis for more quantitative analyses in stage 2.

Progress: Work on stage 1 has begun with development of an industry survey and trialling of the survey approach, and questioning on several experienced, long-term Japanese pole and line vessel skippers. The survey is now being refined for wider application. The bulk of the stage 1 work is planned to have been completed by the end of 2023, upon which a review meeting will be held by the project team to discuss the results and plan the analyses to try in stage 2.

Industry survey – pilot phase
The targets of the surveys are the skippers, fishing masters and crews engaging in SKJ fisheries. The survey questions being developed mainly focus on shifts in pole-and-line operations owing to technical developments through time, and how their operation has improved in a quantitative way (draft questions in attachment 1). A preliminary survey was conducted by interviewing three pole and line skippers over age 50 about what they think has been important for their operations, the contents of the questions, and whether the proposed questions are straightforward enough to answer or not. The discussions with these few experienced skippers indicate that they all recognized that catchability has no doubt increased due to the technical developments that are missing in CPUE standardization, though the levels of the improvement greatly differed among them. The skippers gave feedback that will help revise the survey questions. One of the important aspects that was raised was that there is some equipment and events that scientists did not recognize had been critical for improving catches but skippers and fishermen did. For example, equipment such as vessel radar, frequency of receiving weather map forecasts, and general efficiency of information transmission to and from vessels, were indicated as important for finding birds that indicate tuna schools, but importantly to identify the locations of fishery grounds to steam to (with sharing of this information among vessels). These are not well covered in the initial questions that will be updated to reflect this type of feedback. The preliminary survey with these few skippers also provided a lot of useful advice on the questioning approaches and found that a purely document-based questionnaire would lead to less answers and likely misunderstandings and that a face-to-face interview approach will be more productive.

Next steps for industry surveys:
• Late June – early July 2023 (done): Pilot survey interviews with skippers and retired fishermen
• August 2023: review the revised questionnaire with project team and finalize it.
• September 2023: 1st round of the questionnaire/interviews with the fishers/industry stakeholders
• December 2023: Prepare a 2nd round of questionnaire/interviews with the fishers/industry stakeholders (may not be required).
 •Additional ad-hoc interviews to be held when possible, with fishermen who are available at unloading ports.

January/February 2024: summary report on survey results and team review meeting, stage 2 analysis planning.

Stage 2:

Pending the outcome of stage 1, that should indicate the primary drivers of effectiveness creep, including technology uptake/advancements, vessel features, gear, communications, and information use etc. a data review phase will occur to identify what data would be available on the identified drivers of effectiveness to underpin more formal analysis of these drivers. The analysis will initially try to provide a quantitative narrative of the temporal history/dynamics of the drivers to validate industry survey results. Once the temporal history of the identified drivers of effectiveness creep are quantified, methods for incorporating the influences of these drivers on CPUE time series will be considered. These may involve both statistical modelling approaches and/or simpler adjustments to CPUE trends over time to create CPUE time series scenarios that take into account plausible evidence-based effectiveness creep scenarios. These adjusted CPUE time series would then be used to fit stock assessment models to explore the sensitivity of the model estimations to the various scenarios.

2.3 Recruitment trends

Successive stock assessments of skipjack in the WCPO estimate a sustained positive trend in recruitment from the 1980s until around 2010, after which it stabilised and then decreased in recent years (e.g. Castillo Jordan

et al., 2022). There is uncertainty whether these predicted longer-term recruitment trends, which the model estimates to account for stable abundance indices (notably pole and line CPUE) and the catch trends, are real or are possibly an artefact of model estimation to fit hyperstable CPUE indices. There are however, lines of evidence that ocean conditions in the tropical WCPO have become more conducive to skipjack recruitment success since the 1980s due to decadal scale climate features and climate change (see SC19-EB-WP-01). This component of the project aims to explore if there is sufficient evidence to support (or not) the trends in recruitment predicted by the assessment model.

This component of the project has not progressed beyond initial scoping discussions on options for analysis and potential indicators of oceanographic conditions conducive to increased/decreased skipjack recruitment. Current work by SPC on climate and ecosystem indicators for tuna populations in the Pacific (included in SC19-EB-WP-01) will provide a basis for developing these indicators. The utility of the SEAPODYM model predictions of skipjack larval habitat are also being considered. There are no survey time series information on skipjack recruitment (i.e., larval, mid-water trawl surveys) to compare to the assessment model estimates. The analysis will necessarily be focussed on identifying conditions that are conducive to stronger/weaker skipjack recruitment and developing time series of these indicators to compare with the assessment model predictions.

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6.   REFERENCES

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7. APPENDICES

Appendix 1: Draft industry survey questions
The questions below were a part of the initial survey of a few experienced skipper, which will be refined before and review again before the broader surveys.

Affiliation of Respondents: (Skipper, fishing master, crew)
Age (10s, 20s, 30s, 40s, 50s, 60s, 70s, 80s, 90s)

Questions regarding effort creep
1. List the factors that are important in search for skipjack.
Ex, bird radar, sonar (low frequency), personnel rotation, introduction of foreign crew, binocular resolution, hull construction (depth of draft), use of QRY information, etc.

Select five of the factors you answered in 1 in order of importance and describe the year in which these factors were introduced to your ship.

2. List the elements and techniques that are important in fishing for skipjack.
(e.g., anglers, how to maneuver the boat, how to spray and throw bait, bait (type, freshness, size), power of foreign crews, anglers' experiences, etc.)

Select five of the factors you answered in 2, in order of importance, and describe the year in which these factors were introduced to your ship.

3. Describe important elements, innovations, and events related to exploration and fishing as you remember in each decade from 1970s to the present.
1970-1980 e.g., introduction of EEZ
1980-1990 e.g.: introduction of refrigeration equipment and sonar

4. What event would make you feel that skipjack has decreased compared to the past? (e.g., is it when you find it more difficult to search a school, or when fishing vessels disappear from the fishery grounds where they used to operate?)

5. By introducing bird radar, do you think it improved the skipjack catch very much?
Very likely, likely, same, unlikely, very unlikely

6. By introducing bird radar, do you think it help you to spot schools of skipjack more quickly?
Very likely, likely, no change, unlikely, very unlikely

7. By introducing bird radar, do you think it gives you a wider area to look for searching skipjack?
Very likely, likely, no change, unlikely, very unlikely

8. Would you continue to use bird radar in the future?
Very likely, likely, unknown, unlikely, very unlikely

9. What would you like to see in bird radar advances?
e.g., range, detection power, UX improvement, price

10. From 1972 to the present, do you think the efficiency of catching and searching for skipjack has improved?
Catching efficiency: up, stayed the same, went down.

Searching efficiency: Increased, unchanged, decreased.

11. Do you think that the efficiency of fishing for and searching for skipjack has improved in the last 10 years due to the development of equipment and other factors?
Catching efficiency: Increased, unchanged, decreased
Searching efficiency: Increased, unchanged, decreased

12. How much would you catch more (or less) tons per day if you could use the equipment you have now in 1972?